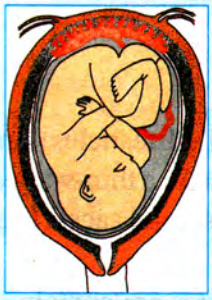
11 The Reproductive System

Syllabus : *The Reproductive System : Organs, fertilisation and a general outline of nutrition and respiration of the embryo. Menstrual cycle : outline of menstrual cycle*

Scope of Syllabus : Functions of organs and accessory glands must be discussed. An idea of secondary sexual characters, structure and functions of the various parts of the sperm and an egg. Fertilization, implantation, placenta, foetal membranes, gestation and parturition, identical and fraternal twins to be explained briefly.



Reproduction is the key point of the **continuance of life** on earth. In a way, all other systems and processes in the body are for supporting the reproduction process. This chapter on the human reproductive system covers a wide range of information useful for even a common man. For our students, one or two long answer type questions and quite a few small ones always find a place in the question paper. For examination purpose, try to understand and memorise, in particular, the structures in the reproductive system, fertilisation and the functions of the placenta.

11 A. THE REPRODUCTIVE ORGANS

11.1 REPRODUCTION IN GENERAL

Reproduction is the formation of new individuals by sexual or asexual means, which can repeat the process in their own turn.

Many simpler organisms like bacteria and yeast reproduce by fission or budding, etc. Many plants reproduce vegetatively non-sexually by various methods. But in humans, reproduction is only sexual.

PATTERNS OF REPRODUCTION

(i) Asexual reproduction

The reproductive units may under asexual type of reproduction consist of any portion of the parent body. The size of the units may range from the whole to a small fragment of the parent body.

Example : A bud grows out of the body of hydra, gets separated and grows into a full hydra.

(ii) Sexual reproduction

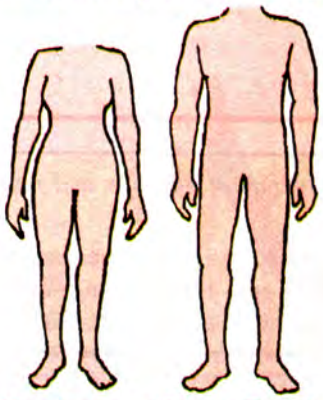
The gametes (sex cells - **egg** and **sperm**) are very small (microscopic in human beings). The gametes must normally unite (fertilisation) to produce a **zygote** which, through a process of development, finally becomes the offspring.

The gametes are usually produced in different sexes (male and female). These sexes often show outwardly differentiating features called **secondary sexual characters**. At least two features are apparent in a cartoonist's partial drawing of a man and a woman standing in a relaxed pose (next page).

Table 11.1 : Differences between asexual and sexual reproduction

Asexual reproduction	Sexual reproduction
1. No mixing of genetic material, therefore, no or less variation in offsprings.	1. Genetic mixing, increased variation.
2. No gametes are formed.	2. Gametes are formed.
3. Normally more offspring.	3. Fewer offspring.
4. Only one parent is involved.	4. Usually, two parents (male and female) are involved.
5. It is a rapid process during favourable conditions.	5. Slower process

Male or Female
(Some secondary sexual characters)



Hips large — Male or Female?
Lower arms projecting out from elbow—Male or female?

Think of sexual distinction in certain animals :
Lion and Lioness ...
Cow and Bull ...
Cock and Hen ...
Peacock and Peahen ...

Secondary sexual characters throughout the animal world serve to identify and attract sex partners. Odours (body smells), calling sounds, skin colouration, body contour, behavioural patterns, etc. are some such sex clues.

In humans, the secondary sexual characteristics include :

- Distribution of hair on body and face (beard and moustaches in males)
- Breasts in females
- Muscularity—stronger built in males
- Skeletal structure
- Psyche and behaviour
- Deeper voice in males

11.2 REPRODUCTION IN HUMANS

The organs of the reproductive system are divided into the primary and accessory parts:

(i) The **primary reproductive parts** include the ***gonads*** (testes in males and ovaries in females) which produce the sex cells (or ***gametes***) — the **sperms** and **eggs.**

(ii) The **accessory reproductive parts** include all those structures which help in the transfer and meeting of the two kinds of sex cells leading to fertilisation and in the growth and development of the egg up to the birth of the baby.

So, according to the above criteria, would you consider secondary sexual characters as given in the box above, as reproductive parts? **No.** These do not participate in reproduction.

11.2.1 Male Reproductive System

The male reproductive system (Fig. 11.1 A-C) consists of the following organs:

(1) **Testes** (one pair) to produce sperms,

(2) **Sperm duct** (**vas deferens**) from each testis to carry the **sperms**,

(3) **Accessory glands** (seminal vesicles, prostate and bulbo-urethral glands) to contribute to the seminal fluid, and

(4) **A penis** for transferring the sperms into the female.

(5) **Urethra** contained inside the penis, conveys the sperms received from sperm ducts.

1. TESTES (*sing. : testis*)

A. Location of testes

- The two **testes** (popularly called testicles) are oval organs which are contained in a thin-walled sac of skin called **scrotum** (or scrotal sacs) (Fig. 11.1 A, B & C).
- In the embryonic stage, the testes are contained within the abdomen. They descend into the scrotum shortly before birth. An abnormal condition results when they do not descend and it leads to sterility, i.e., incapability to produce sperms.
- The high temperature of the body does not permit maturation of sperms. But in the normal condition, being in a separate sac suspended from the body, the testes **escape too much body heat**.

Temperature regulation in the testes

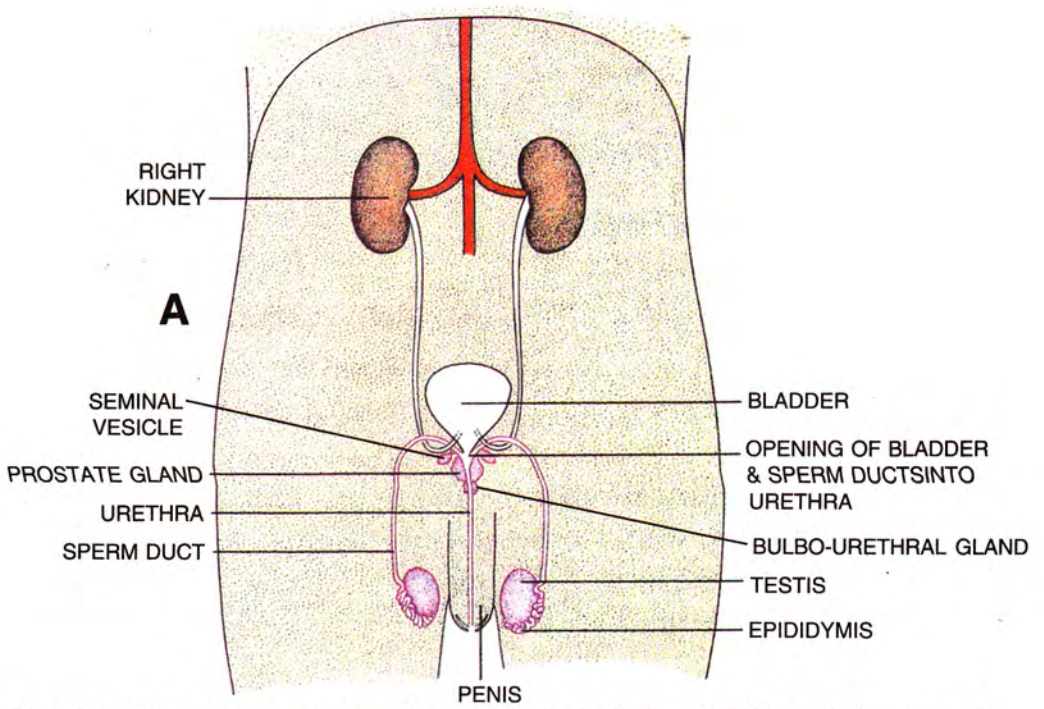
Sperms are produced in the testes at a temperature 2 to 3°C lower than that of the body. This temperature is regulated in a strange manner through the movements of the scrotum wall.
When it is too hot, the skin of the scrotum loosens so that the testes hang down away from the body. When it is cold, the skin contracts in a folded manner and draws the testes closer to the body for warmth.

B. Structure of testis

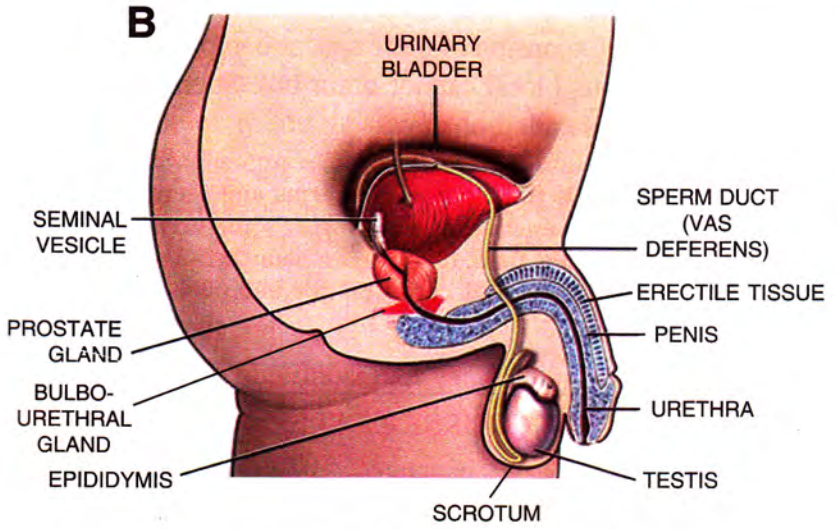
Each testis (Fig. 11.1 C) is encased in a capsule which is internally partitioned into 15-20 lobules (segments). Each lobule contains :

(i) **Seminiferous tubules** (*semini* : sperm, *ferous* : bearing) where the sperms are produced. The process is called **spermatogenesis**.

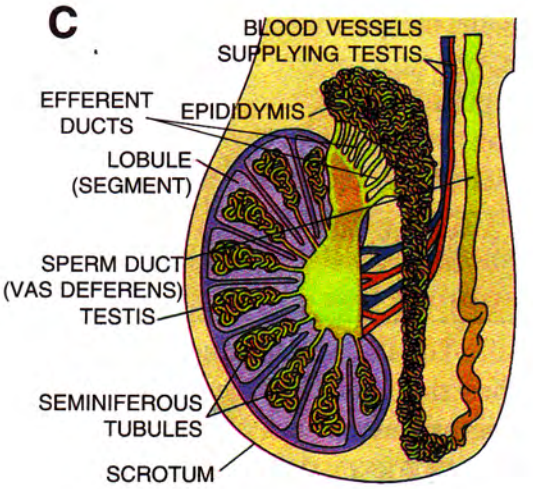
(ii) **Interstitial cells** (*interstitial* : filling in between) which are packing tissues between the coils of the



Arrangement of male reproductive organs in the body (highly simplified and diagrammatic).



Sectional view (diagrammatic) of male reproductive organs, showing passage of sperms from testis to urethral opening



Longitudinal section of testis

Fig. 11.1 : Human male reproductive system.

COMPONENTS OF HUMAN MALE REPRODUCTIVE SYSTEM

Male reproductive system

Testes	Ducts	Accessory glands	Supportive structure
1. Seminiferous tubules produce sperms 2. Interstitial cells produce Testosterone	(i) Epididymis (ii) Sperm duct (Vas deferens) (iii) Ejaculatory duct	(i) Seminal vesicle (ii) Prostate gland (iii) Cowper's gland.	Penis. Transfers sperms into the female organ (vagina)

seminiferous tubules. The **interstitial cells** also called **Leydig cells** produce the male hormone **testosterone**.

The sperm producing cells of the seminiferous tubules keep multiplying and produce sperms. The mature sperms pass into a small network of tubes (Fig. 11.1 C). From the network, arise 12-14 ducts **(efferent ducts)** which join a small tubular knot, the **epididymis** (*epi* : above, *didymos* : testicle) fitting like a cap on the upper pole of the testis. The epididymis is continued by the side of the testis upto its back from where a distinct tube **sperm duct (vas deferens)** arises. The epididymis internally contains a single coiled tube (actually about 6 metres long) which traverses from the upper part of the testis to its back and then it continues into the sperm duct. The epididymis stores the sperms for some days during which they mature and become motile (capable of moving).

2. SPERM DUCTS

The **sperm duct (vas deferens)** from each testis travels upward into the abdomen passing through an **inguinal canal**. The inguinal canal originally is the one which allows the descent of testes along with their ducts, blood vessels, nerves, etc.

Sometimes, due to pressure in the abdomen, the intestine bulges into the scrotum through the inguinal canal and causes the most common type of ***hernia****.*

The two **sperm ducts** loop over the ureters of their side, come together, and join the median duct, or **urethra**, at the back of the urinary bladder.

3. ACCESSORY GLANDS (Fig. 11.1 A & B)

Three male accessory glands are as follows :

(i) Seminal vesicles

- A pair of lobulated glands located between the posterior surface of the urinary bladder and the rectum.
- A duct from each seminal vesicle joins the corresponding sperm duct just before it unites with the urethra.
- Produce a secretion which serves as a **medium for the transportation of the sperms**. The mixture of this fluid and the sperms produces a milky fluid, the **semen**. In the sperm duct, the sperms are sluggish, but by the addition of this secretion, they become active.

(ii) Prostate gland

- A bilobed structure which surrounds the urethra close to its origin from the bladder.
- It pours an **alkaline secretion** into the semen as it passes through the urethra. It neutralises acid in female's vagina.

(iii) Bulbo-urethral glands

- These are two small ovoid glands which open into the urethra just before it enters the penis.
- The secretion serves as a lubricant.

4. PENIS

The **penis** lies in front of the scrotum, cylindrical in shape, serves for the passing out of both semen and urine (Fig. 11.1 C). It is a highly vascular organ, having erectile tissues and vascular spaces. Under the influence of sexual stimulation, blood flows in large amount into the penis and enters into the vascular spaces or sinuses, which makes it rigid and erect. Expansion of these spaces compresses the veins and thus blood cannot drain out. Such condition of penis is called erection.

Semen is the mixture of sperms and secretions from seminal vesicle, prostate, Cowper's and urethral glands. It is a milky fluid. Its average amount is 2–3 ml in a single ejaculation and contains 200,000,000–400,000,000 sperms.

THE COURSE OF SPERMS IN MALE

Seminiferous tubules
(produce sperms)
↓
Network of tubules
↓
Efferent ducts
↓
Upper part (head) of epididymis
↓
Middle part (body) of epididymis
↓
Hind part (tail) of epididymis
↓
Sperm duct (vas deferens)
↓
Urethra (in penis)

PROGRESS CHECK

1. Tick-mark the correct meaning of reproduction
   (a) increase in population
   (b) increase in the number of parents
   (c) production of new individuals
   (d) production of identical individuals
2. What is the significance of the testes being located in scrotal sacs?
   .....
3. State very briefly the chief function of each of the following :
   (i) Seminal vesicles .....
   (ii) Prostate gland .....
   (iii) Cowper's gland.....
   (iv) Sperm duct (vas deferens).....

11.2.2 Female Reproductive System

The female reproductive system (Fig. 11.2 A, B, C, D and E) consist of the following reproductive organs.

1. A pair of **ovaries**,
2. A pair of **oviducts** (or Fallopian tubes) to convey the egg released from the ovary,
3. A sac-like or pear-shaped **uterus** for the growth and development of the embryo developed from the egg,
4. A **vagina**, and
5. **Vulva**, the outermost part.

1. OVARIES

The two **ovaries** are small ovoid bodies. Their peripheral part produces ova or the eggs. Normally, *only one egg matures in each ovary every alternate month*. A maturing egg contained in a cellular sac is called the **follicle**. As the egg grows larger, the follicle also enlarges and gets filled with a fluid and is now called the **Graafian follicle**. When ripe, the follicle bulges over the surface of the ovary. **Oogenesis** is the process in which the ova-producing cells give rise to the mature ovum.

Ovulation is the rupture of the follicle releasing the egg (page 157 Fig. 11.6). The released egg is picked up by **fimbrae** (cilia) of oviducal funnel of the oviduct. The remnant of the follicle persists for sometime to convert into a yellow mass

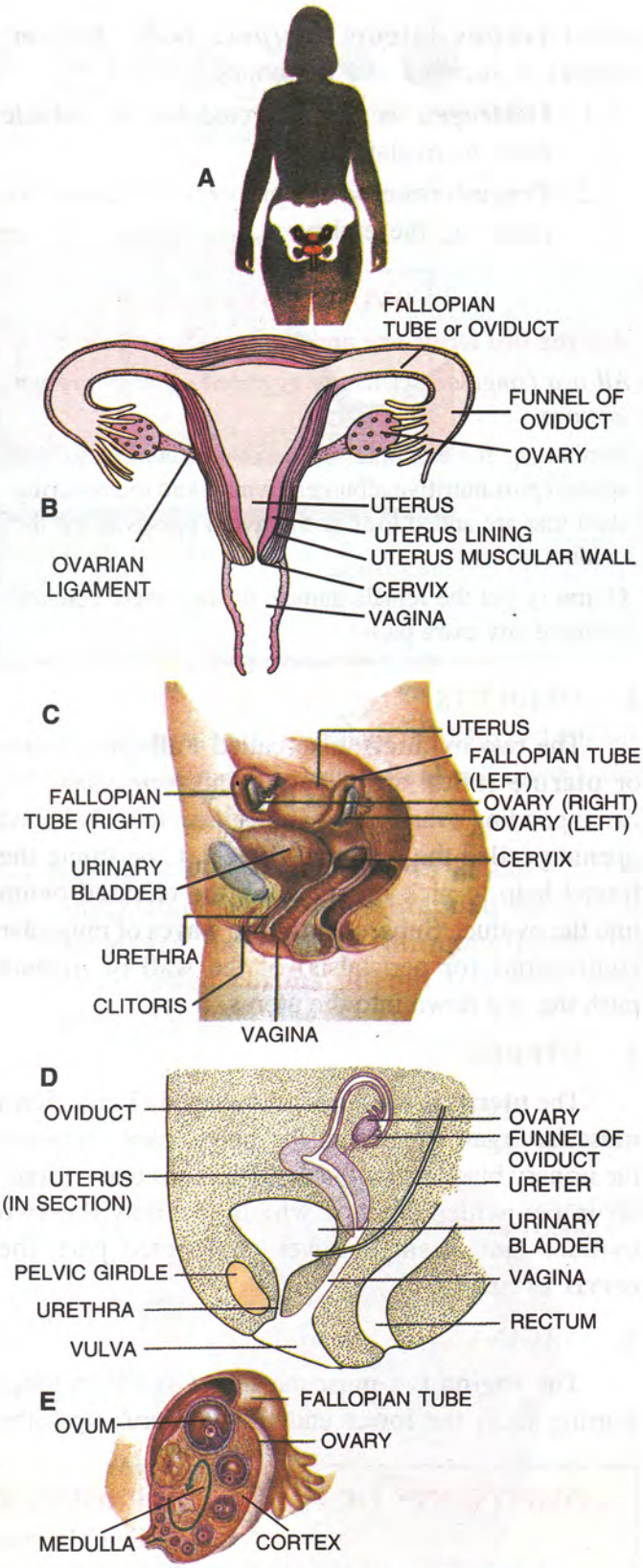


Fig. 11.2 : The human female reproducting organs : A–General position in the body; B–front sectional view (diagrammatic); C– Sectional side view, parts are differently coloured for better distinction. D– Sectional side view (diagrammatic); E–Stages of the growing egg inside the ovary

called **corpus luteum** (***corpus:*** body, ***luteum:*** yellow). It secretes two hormones :

1. **Oestrogen** as was secreted by the follicle prior to ovulation.
2. **Progesterone** which prepares the uterus for receiving the embryo.

OVUM & EGG

Are the two terms one and the same? .... "NO"

All ova (singular ovum) are eggs but all eggs are not just ova.

Hen's *egg*, for example, is the ovum (central yellow sphere) plus nutritive albumen (white) and the covering shell that are added to it as the ovum passes down the oviduct.

Ovum is just the female gamete or the proper egg cell (without any extra parts).

2. OVIDUCTS

The two **oviducts**, also called **Fallopian tubes** or **uterine tubes**, are about 12 cm long. Near the corresponding ovary, each oviduct has a funnel-shaped opening called the **oviducal funnel**. Cilia lining the funnel help to pick up and push the released ovum into the oviduct. Subsequently, the waves of muscular contractions (or peristalsis) of the wall of oviduct push the egg down into the uterus.

3. UTERUS

The **uterus** is a hollow pear-shaped (7cm × 5cm) muscular organ situated in the pelvic cavity between the urinary bladder and the rectum. It has two regions, an upper wider portion which receives the two oviducts and a small lower constricted part, the **cervix** or neck.

4. VAGINA

The **vagina** is a muscular tube (10-15 cm long) starting from the lower end of the uterus upto the outside. The vagina receives the male penis during copulation. The great elasticity of its wall also allows the passage of the baby during childbirth. The opening of the vagina in young females is partially closed by a thin membrane called **hymen** (or the virgin knot). The hymen is frequently ruptured in childhood due to strenuous physical exercise or disease.

5. VULVA

The external female genitalia is called the **vulva**. It contains independent openings of the urethra and vagina. The sides of the vulva have two small fleshy folds, the **labia minora** (lesser lips) which are hidden by larger hairy folds, the **labia majora** (greater lips). These folds are the equivalents of the male scrotum. In the uppermost angle of the vulva in front of the urethral opening is located, a small erectile **clitoris** which is highly sensitive and is the equivalent of male penis.

· Puberty

Puberty is the period during which immature reproductive system of boys and girls mature and becomes capable of reproducing. At age 10 in girls, first sign is the enlargement of breasts. In boys at 11 years, the enlargement of testis is the first sign.

11.3 MENSTRUAL CYCLE

The reproductive period of the human female continues from about the age of 13 years to 45-50 years. This period is marked by a characteristic event repeated almost every month (28 days with minor variation) in the form of a menstrual flow. It may be temporarily stopped only by pregnancy.

MENARCHE and MENOPAUSE

Menarche ***is the onset of menstruation in a young female at about the age of 13 years*** **(arche : beginning).**
Menopause ***is the permanent stoppage of menstruation at about the age of 45 years*** **(pause : stop).**

COMPONENTS OF FEMALE REPRODUCTIVE SYSTEM

Female reproductive system

Ovaries	Oviducts	Uterus	Vagina	External organs
Follicle cells produce ova, oestrogen and progesterone	Transport ova into uterus	Protects and nourishes growing embryo	Receives the sperms	Vulva, . protects urethra and vagina.

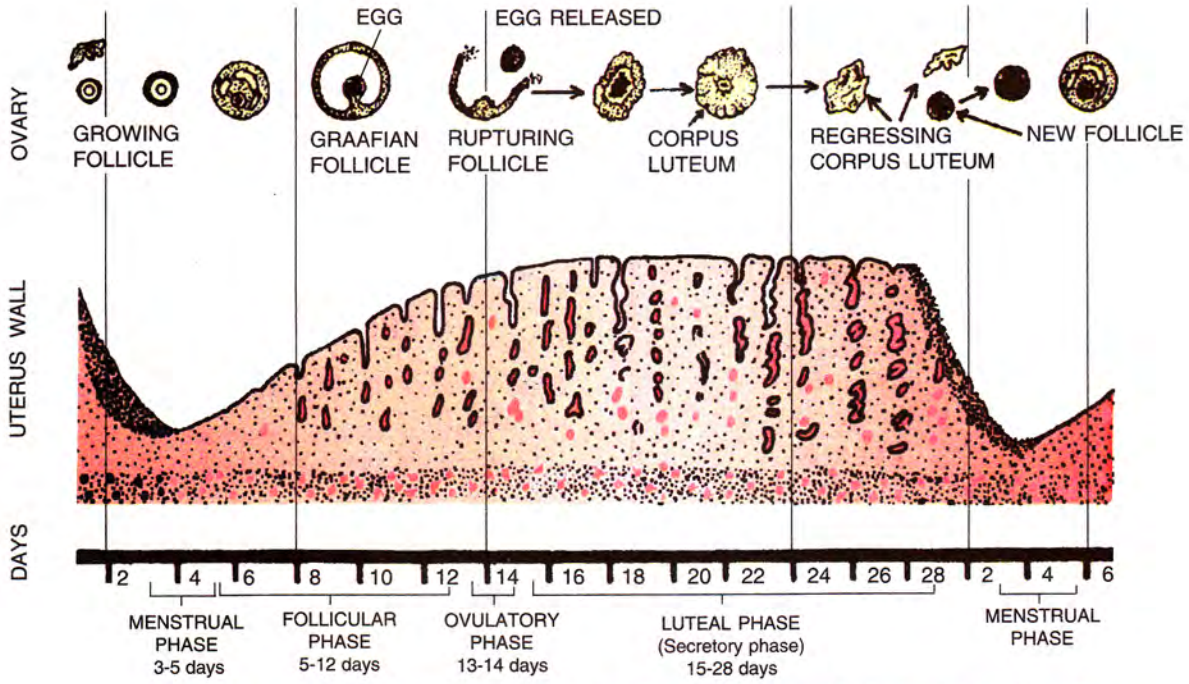


Fig. 11.3 : Uterine changes in relation to follicular changes during menstrual cycle

The period of a menstrual cycle is counted from the day of the onset of the flow to the next onset after 28 days (Fig. 11.3). This period can be divided into four main phases.

(1) Menstrual phase

(3) Follicular phase

(2) Ovulatory phase

(4) Luteal phase

(1) **Menstrual phase.** It lasts for 3-5 days during which blood is discharged. The bleeding is caused due to the shedding of the uterine lining rupturing the blood vessels.

Starting from the onset of the menstruation flow, the ovary begins to form a new egg in a follicle.

(2) **Follicular phase.** As the follicle grows, it produces certain hormones which reactivate the uterine wall to become thickened and to be supplied with a lot of blood. This change is a kind of preparation of the uterus to receive the fertilised egg and to provide for the development of the future embryo.

(3) **Ovulatory phase.** On about the 13th or 14th day, the follicle ruptures (**ovulation**) and the released egg travels down the oviduct.

(4) **Luteal phase.** It lasts from 15-28 days. Uterus lining thickens further. Emptied follicle in the ovary turns into a hormone-producing tissue called **corpus luteum** (*corpus* : body, *luteum* : yellow) (Fig. 11.4).

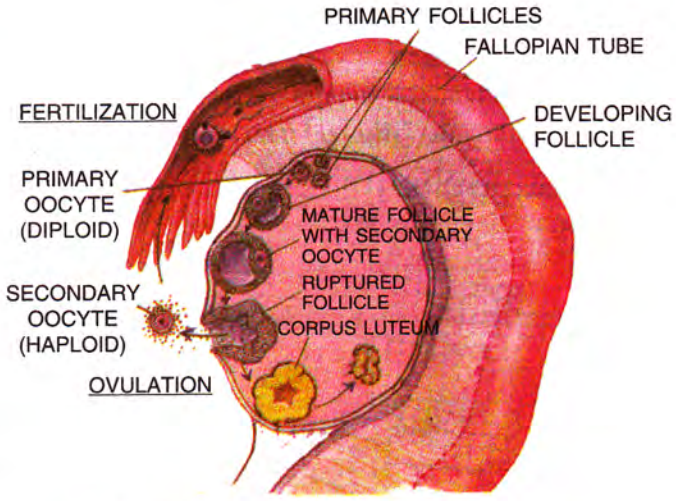


Fig. 11.4 : Maturation of egg, ovulation, and fertilization (diagrammatic)

THE COURSE AND FATE OF EGG INSIDE FEMALE BODY

OVARY
(Releases egg)
↓
FALLOPIAN TUBE

(If fertilised)	(If unfertilised)
↓	↓
Divides and becomes early embryo	Degenerates (may get absorbed)
↓	↓
UTERUS	UTERUS
↓	↓
Implantation (Pregnancy) Forms baby	Degenerates & Passes out in menstrual discharge

If there is no fertilisation, the egg disintegrates and the uterine lining restarts shedding on the 28th day. If on the other hand, the egg is fertilised, it gets **implanted** or fixed in the uterus wall and there is no menstrual discharge. This is because the level of the hormone **progesterone, secreted by the persistent corpus luteum**, is increased and it **prevents maturation of another follicle**.

If there is no implantation, the corpus luteum degenerates and the uterine wall cannot be maintained in its thickened state.

? PROGRESS CHECK

State whether the following statements are **True** (T) or **False** (F) :-

(i) Oviducts and fallopian tubes are one and the same thing. T/F

(ii) One egg is released from each of the two ovaries every month. T/F

(iii) The enlarged mature follicle bursts to release the egg. T/F

(iv) The egg is passed down through the oviduct by muscular contractions. T/F

(v) Clitoris is equivalent to the male penis. T/F

(vi) The vagina is a muscular tube. T/F

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

(Select the most appropriate option in each case)

1. Which one of the following is the correct route that a sperm follows when it leaves the testis of a mammal?
   (a) Vas deferens → epididymis → urethra
   (b) Urethra → epididymis → vas deferens
   (c) Epididymis → urethra → vas deferens
   (d) Epididymis → vas deferens → urethra

2. When pregnancy does not occur, the life of corpus luteum is about -
   (a) 4 days (b) 10 days (c) 14 days (d) 28 days

3. In female, after how much time after fertilisation, does the fertilised egg get implanted in the uterine wall?
   (a) few months (b) one month
   (c) three weeks (d) about seven days

B. VERY SHORT ANSWER TYPE

1. **Name** the following :
   (a) The body part in which the testes are present in a human male.
   (b) The part where the sperms are produced in the testes.
   (c) The fully developed part of the ovary containing a mature egg.
   (d) The accessory gland in human males whose secretion activates the sperms.
   (e) The tubular knot fitting like a cap on the upper side of the testis.

2. **Choose** the odd one in each of the following:
   (a) Oestrogen; progestrone; testosterone; prolactin.
   (b) Ovary; fallopian tube; ureter; uterus.
   (c) Seminiferous tubule; ovum; epididymis; sperm duct; urethra.
   (d) Sperm; implantation; fertilisation; ovum; after birth.

3. **Rewrite** the terms in the correct order so as to be in a logical sequence.
   (a) Sperm duct, penis, testes, sperms, semen.
   (b) Puberty, menopause, menstruals, menarche, reproductive age.
   (c) Graafian follicle, ostium, uterus, fallopian tube.

4. **Write** in sequence, the regions through which a mature sperm travels from the seminiferous tubules up to the urethral opening in the human male.

C. SHORT ANSWER TYPE

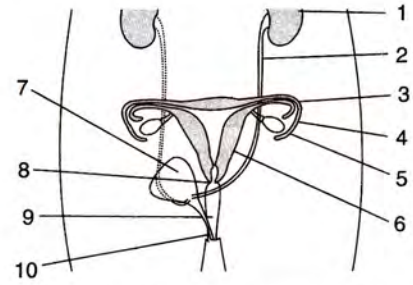
1. **What** is semen?
2. **Describe** the functions of the following :
   (a) Inguinal canal, (b) Prostate gland,
   (c) Testis, (d) Ovary
   (e) Oviduct.
3. **What** are the secondary sexual characteristics in the human male and female respectively ?
4. **What** are the accessory reproductive organs?
5. **Differentiate** between primary and accessory reproductive organs.
6. **What** is hymen?
7. **Define** the following terms :
   (a) Hernia (b) Ovulation (c) Puberty
8. **List** any two changes each in human male and female, which occur during puberty.
9. **Differentiate between the following pairs :**
   (a) Menarche and menopause
   (b) Bulbo-urethral gland and prostate gland.
   (c) Hymen and clitoris
   (d) Uterus and vagina
   (e) Efferent duct and sperm duct.

D. LONG ANSWER TYPE

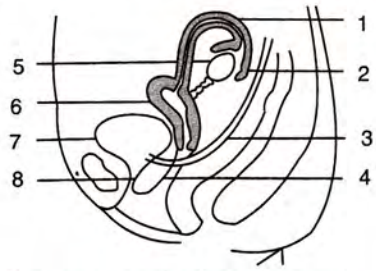
1. **What** is the significance of the testes being located in scrotal sacs outside the abdomen. **Can there be** any abnormal situation regarding their location? If so, what is that and what is the harm caused due to it?
2. Is it correct to say that the testes produce testosterone. **Discuss** ?
3. Suppose a normal woman has never borne a child. **How many** mature eggs would she have produced in her lifetime? Your calculation should be based on two clues —
   (a) Eggs are produced at the rate of 1 egg every 28 days (one menstrual cycle).
   (b) A woman's total reproductive period is 13-45 years.

E. STRUCTURED/APPLICATION/SKILL TYPE

1. Given below is a diagram of two systems together in the human body.
   (a) **Name** the systems.
   (b) **Name** the parts numbered 1-10.
   (c) **Describe** the functions of the parts 3, 4, 5 & 6.

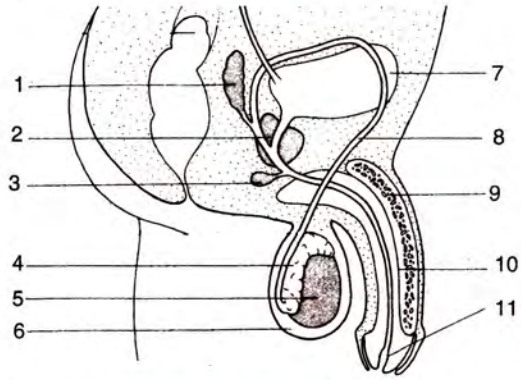


2. The following diagram represents the vertical sectional view of the human female reproductive system.



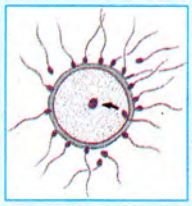
   (a) **Label** the parts indicated by the guidelines 1 to 8.
   (b) **How** does the uterus prepare for the reception of zygote?
   (c) **What happens** to the uterus, if fertilisation fails to take place?

3. Given below is the schematic diagram of the sectional view of the human male reproductive system.



   (a) Name the parts numbered 1-11.
   (b) State the functions of the parts numbered 1, 2, 3, 5, 8 and 11.

11 B. FROM FERTILISATION TO BIRTH



You have learnt about the different parts and their arrangement in the male and female reproductive systems in the Section A of this chapter. Here, you will study how a new individual is conceived and how it grows in the mother's womb and finally born as a baby.

11.4 FERTILISATION (Union of egg nucleus and sperm nucleus)

During copulation (*mating* or *coitus*), the **sperms** are released in the vagina near the cervix of the uterus. A single ejaculation by the human male contains about four hundred million sperms. These sperms actively swim with the help of their tails (Fig. 11.4A) and pass through the cervix into the cavity of the uterus progressing at a rate of approximately 1.5 mm per minute. From the uterus, they climb up, to reach the oviducts. If there happens to be an ovum (egg) in the oviduct, it gets fertilised by just one single sperm (Fig. 11.5).

Fertilisation : ***The fusion of the male gamete* (sperm) *and female gamete* (ovum) *to form zygote is called fertilisation.***

A few days, soon after ovulation (12th or 13th day after the onset of menstruation) are most favourable for conception (becoming pregnant).

Out of the millions of sperms released into the vagina, very few are able to climb up to the upper parts of the oviducts, the rest die on the way and are absorbed.

Functions of the main parts of a sperm (Fig. 11.4 A).

The **acrosome** at the top of the head of the sperm secretes an enzyme (hyaluronidase) which facilitates entry of the sperm into the egg by dissolving the wall of the ovum.

The **nucleus** contains genetic material (22 + X or 22 + Y chromosomes) which, during fertilisation, combines with the nucleus of the egg containing 22 + X chromosomes, and thus restoring the normal number of 23 pairs.

NEITHER THE "SUN" NOR THE "FULL MOON"

It is a microscopic view of human egg (or egg cell) surrounded by sperms

Microscopic view of sperms. Each sperm has a head, a middle piece and a tail

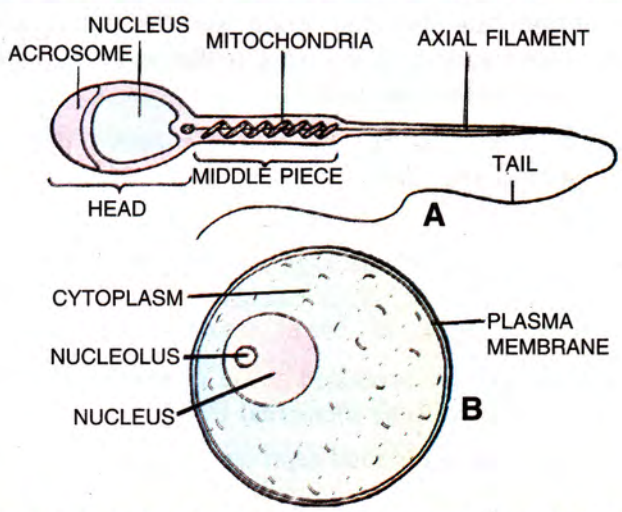


Fig. 11.4 : A–A single sperm (diagrammatic and highly magnified). B–Ovum (magnified and diagrammatic)

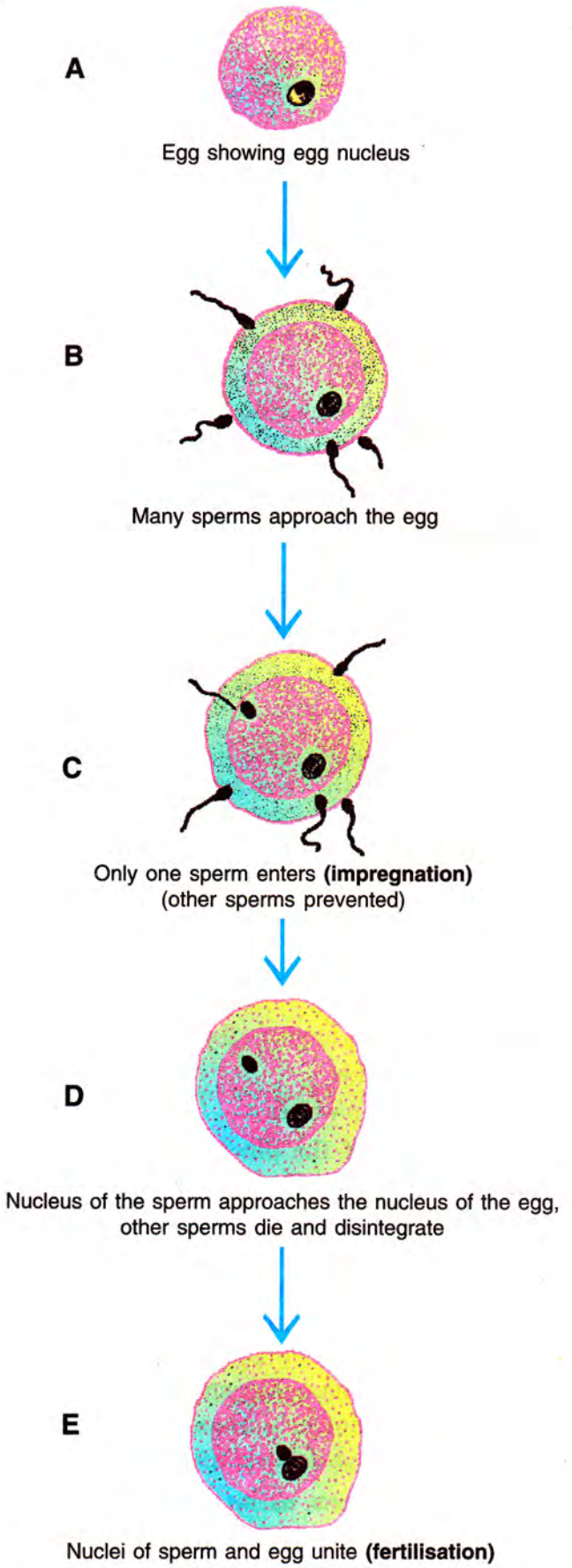


Fig. 11.5 : Stages in the fertilisation of an egg

The **mitochondria** contained in the middle piece, provide energy (ATP) for the activity of the sperm to swim.

The **tail** makes lashing movements for propulsion.

Sperms may remain alive in female genital passage for a few days, but their fertilising power is limited to one or two days only.

During fertilisation, several sperms may surround an egg, but only one sperm enters it. In doing so, the tail is left behind and only the head part (which contains nucleus) penetrates the egg. This sperm nucleus fuses with the nucleus of the egg.

As soon as one sperm enters the egg (ovum), the entry of other sperms is prevented by some chemical barrier.

11.5 IMPLANTATION (CONCEPTION) AND PREGNANCY

The fertilised egg **(zygote)** soon starts dividing **(cleavage)** into 2, 4, 8, 16 cells and so on. By the time it reaches the uterus, it has already formed a small hollow ball of numerous cells **(blastocyst)**. This is a kind of embryo which forms a pit in the wall (endometrium) of the uterus and gets fixed in it in about a week's (5-7 days) time after ovulation. This process is called **implantation** and it produces the state of **pregnancy**. The uterus continues to develop to take care of the developing embryo.

By the end of five weeks of pregnancy, the embryo is quite advanced. The heart and circulatory system have been formed. After two months, limbs have also been formed.

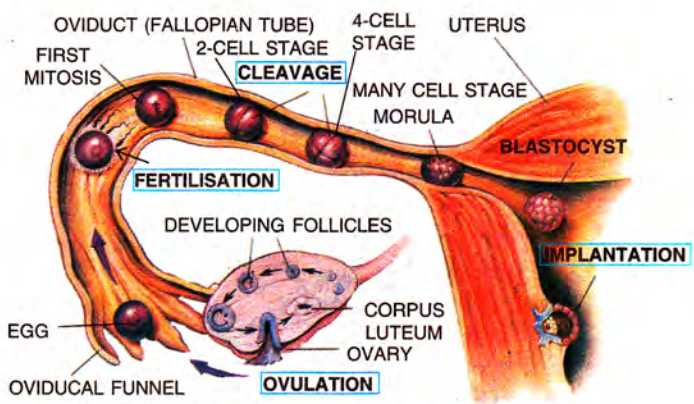


Fig. 11.6 : Maturation of egg, ovulation, fertilisation and implantation (diagrammatic)

Embryo – a growing egg after fertilisation until the main parts of the body and the internal organs have started to take shape.

Foetus – When embryo starts having a look of a baby (from 7 weeks of gestation onwards).

Pregnancy – The state of carrying the unborn young one inside the body.

Gestation – The full term of the development of an embryo in the uterus. In humans, it lasts for about 280 days.

11.6 PLACENTA

The growing **embryo** or the **foetus** (8 weeks old with human-like appearance) is a living organism. It **needs food and oxygen**. It **excretes nitrogenous wastes and carbon dioxide** which need to be continuously removed. These special functions are performed by a structure called **placenta**. Placenta is a disc-like structure attached to the uterine wall (Fig. 11.8). A cord containing blood vessels connects the placenta with the foetus; this is called **umbilical cord**.

The placenta is formed of two sets of minute finger-like processes, the **villi**. One set of villi are given out by the uterine wall and the other set by an extension (allantois) from the embryo. The two sets of villi get interlocked but they never open into each other (Fig. 11.7). Here, the blood of the embryo comes in close contact, but never mingles with the blood of the mother. The foetal (embryo's) blood brought to it by an artery contains carbon dioxide and urea, etc., excreted by the foetus. This blood flows through very fine capillaries of the placenta. Close to these are the capillaries and blood sinuses of the mother.

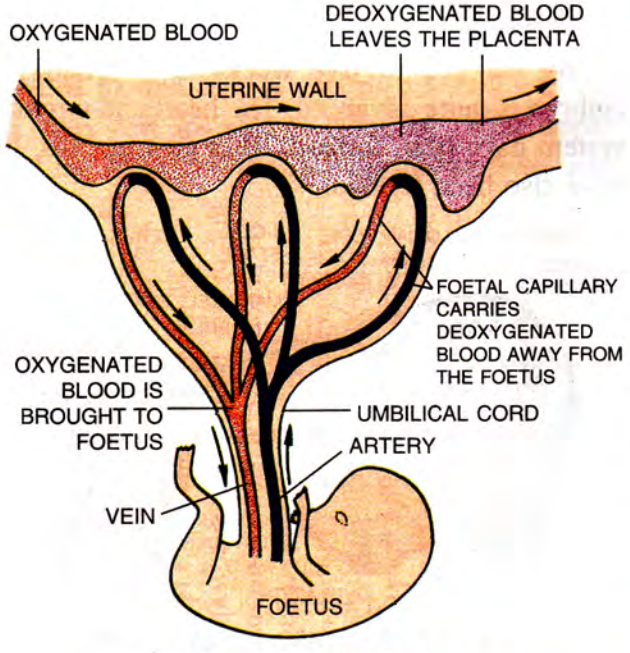


Fig. 11.7 : The Placenta

Functions of Placenta

The placenta allows diffusion of substance from the mother to the foetus and from foetus to the mother as follows.

A. From mother to foetus (for utilisation)

- **Oxygen**
- **Nutrients** such as glucose, amino acids, vitamins, mineral ions (Na, Cl, K, Ca, Fe etc.)

TABLE 11.3 : Materials that can pass through placenta

Mother to foetus ↓ (for utilisation)	Foetus to mother ↑ (for elimination)
1. Oxygen	1. Carbon dioxide
2. Glucose	2. Urea
3. Amino acids	3. Other waste products
4. Lipids, fatty acids & glycerol	
5. Vitamins	
6. Mineral ions such as Na, K, Ca, Cl, etc.	
7. Certain drugs	
8. Alcohol, nicotine	
9. Antibodies	
10. Viruses	

B. From foetus to mother (for elimination)

- **Carbon dioxide**
- **Urea** (& other wastes)

Permeability of the placenta. The placenta is permeable to respiratory gases, nutrients and also antibodies but it *does not allow* the passage of germs from the mother to the foetus. Certain viruses like the HIV of AIDS can pass through the placenta if the mother is already infected. Secondly, if there was a direct continuity of blood between the mother and the foetus without a placenta, the relatively high pressure of the mother's blood would seriously damage the soft and delicate tissues of the foetus.

Placenta also acts as an endocrine gland. It produces the hormones called oestrogens and progesterone. Presence of progesterone in urine provides for certain tests of pregnancy.

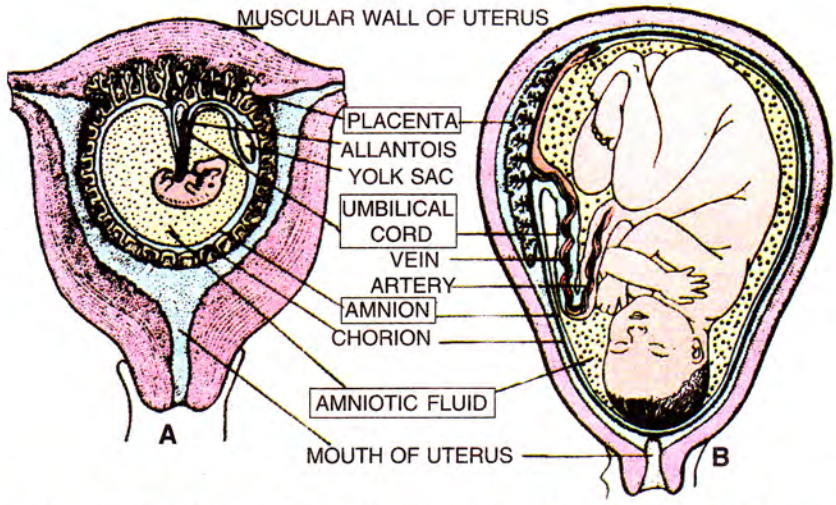


Fig. 11.8 : Growth of embryo (foetus) inside the uterus. A–About 8 week old, B–Almost fully formed

STAGES IN THE DEVELOPMENT OF HUMAN EMBRYO

	Egg (Ovum)	– Unfertilised stage, released from ovary
	↓	
IN OVIDUCT	Zygote	– Fertilised egg, 1-cell state.
	↓	
	Morula	– A **spherical mass** of cells, resulting from repeated division of zygote.
	↓	
	Blastocyst	– Hollow sphere of cells with a surrounding single cellular layer (trophoblast) and an inner cell mass projecting from it centrally. Fixes into the uterine wall.
	↓	
INSIDE UTERUS	Embryo (3 weeks)	– A tiny organism about the size of a large pea, **hardly resembles human being.**
	↓	
	Advanced embryo (5 weeks)	– **Heart and blood vessels** have formed (but **no limbs**).
	↓	
	Foetus (8 weeks)	– **Limbs have appeared.** Some resemblance with ultimate human being.
	↓	
	Infant	– **Born** at the end of nearly 40 weeks.

AMNION

Amnion is a sac which develops around the embryo even before the formation of allantois (Fig. 11.8). A fluid (**amniotic fluid**) fills the space between the amnion and the embryo. Functions of amniotic fluid :

1. Protects the embryo from physical damage by jerks or mechanical shocks. For example, when the mother falls over.
2. Keeps even pressure all around the embryo.
3. Allows the foetus some restricted movement.
4. Prevents sticking of the foetus to the amnion.

11.7 PARTURITION (BIRTH)

The full term of the development of an embryo in the uterus is called **gestation**. In humans, it lasts for about 280 days. At the time of birth, the baby is pushed out by the powerful contractions of the muscles of the uterus, head first (Fig. 11.9). In a few minutes, the blood vessels in the umbilical cord shrink and can be tied and cut. After about 15 minutes, the placenta breaks from the uterus and is expelled out as "after-birth." Uterus contracts and gradually comes back to normal in a few days.

The new-born "announces" its arrival by letting out sharp cry. This cry is the nature's clearing process of the baby's respiratory passage.

The **gestation period** and the **number of young ones** normally produced at a time in some mammals are as follows :

	Gestation Period	Young ones produced
Rabbit	32 days	(6-8)
Cat and dog	65 days	(4-6)
Swine	114 days	(4-8)
Human and human-like apes	280 days	(1)
Cow	290 days	(1)
Horse	340 days	(1)
Elephant	600 days	(1)

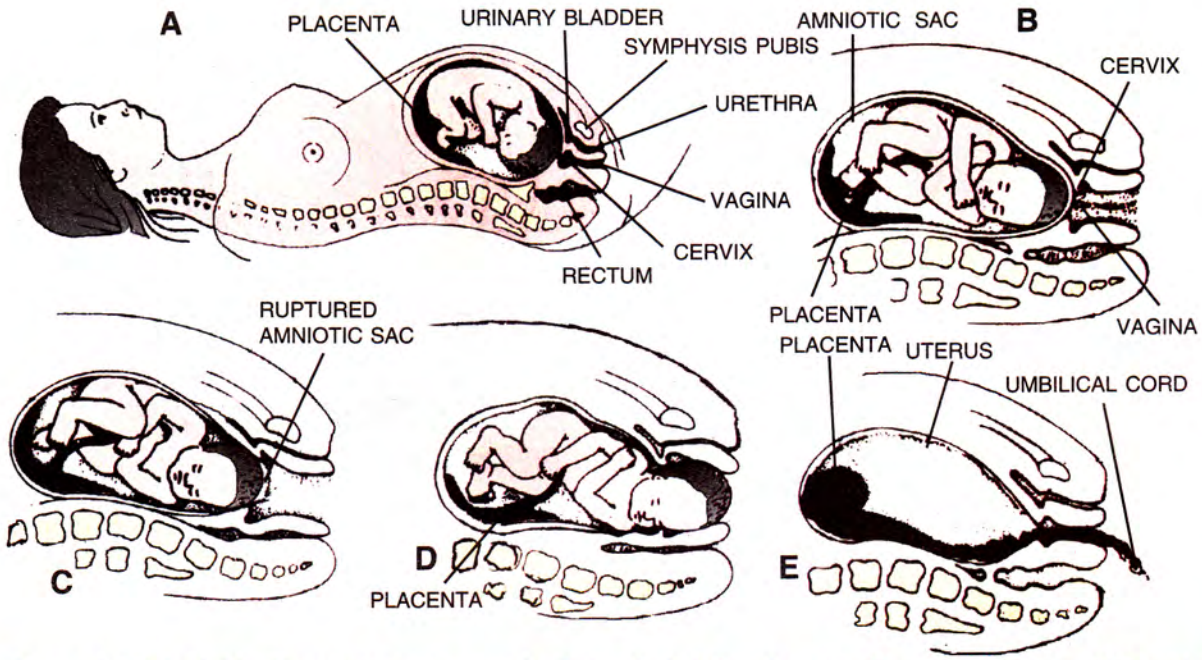


Fig. 11.9 : Stages in Birth (A-D) – Uterus contracts, cervix dilates, baby's head passes through cervix, amniotic sac ruptures at this time and released fluid passes out through vagina. A baby is born and the afterbirth (placenta) is discharged (E)

PROGRESS CHECK

1. Name the three main regions of the human sperm, and briefly mention the function of each.

   (i) Part ..... Function .....

   (ii) Part ..... Function .....

   (iii) Part ..... Function .....

2. Fill in the blanks :

   (i) Implantation is the process of fixing of the ..... in a pit in the wall of .....

   (ii) Heart and circulatory system are formed in the embryo by the end of ..... months of pregnancy.

   (iii) A cord containing ..... vessels connects the ..... with the foetus.

3. List the substances which the foetus receives from the mother through placenta.

   .....

4. How are carbon dioxide and urea, excreted by the foetus, removed?

   .....

5. Does the foetus inside the mother's uterus breathe ? Yes/No

6. Write one sentence each using the following terms pertaining to reproduction in humans.

   (i) Gestation .....

   (ii) 280 days .....

   (iii) Head first .....

   (iv) Placenta .....

   (v) After-birth .....

   (vi) Tied and cut .....

7. Mention if the following statements are **True (T)** or **False (F)** :

   (i) Placenta produces certain hormones. ..... T/F

   (ii) Amniotic fluid serves to provide oxygen to the foetus ..... T/F

   (iii) Heart and blood vessels have been formed by the end of five weeks of pregnancy. ..... T/F

   (iv) Mother's blood flows into the foetus through placenta ..... T/F

TWINS – FRATERNAL & IDENTICAL

1. **FRATERNAL TWINS (Produced from two eggs)**
   Sometimes, two eggs are released from ovaries at a time and both may get fertilised to produce two individuals. Such twins produced from two eggs are called *fraternal twins*. Fraternal twins may be either **both boys**, or **both girls**, or **one boy and one girl**. Fraternal twins in all respects are like the normal sisters and brothers, but here they are of the same age having been born within a few minutes of each other. About 75 per cent of all cases of twins belong to this type. Fraternal twins are biologically known as : **Diovular** (meaning produced from two ova), or **Dizygotic** (meaning produced from two zygotes, that is, two fertilised eggs).
2. **IDENTICAL TWINS (Produced from one egg)**
   Sometimes, a single fertilised egg may get split and separated into two parts during its early stages of cell division. Each of these two split parts then behaves like an independent egg and produces one complete individual each. Identical twins being produced from a single egg are either **both boys** or **both girls**; and for the same reason, they are very similar (identical) to each other. Yet, all is not similar in identical twins, for example **fingerprints**, **birth marks** and even **handwritings** are not similar.

MORE THAN TWO – THE TRIPLETS, QUADRUPLETS, ETC.

Sometimes, three, four or even more babies are born from a single pregnancy. Such births may arise due to a variety of conditions, for example :-

Triplets (three born at a time) may be produced **either** from one single zygote, splitting into two, and one of the split parts again splitting into two, or the triplets may be produced from two eggs in which one zygote produces a pair of identical twins and the other develops normally into one baby.

Quadruplets (four born at a time) may be produced as two pairs of identical twins from two eggs or in other combinations of identical and fraternal twins.

The chances of survival of all the children in multiple birth decrease with the increase in their number. Rare cases of six or seven babies produced are known but only a fewer number survives.

FIRST TEST-TUBE BABY OF THE WORLD

Born on July 25, 1978. Her mother's fallopian tubes were blocked. The same one when grown up as a complete woman is this, here driving the car. →

And now, she herself is the mother of a normal baby son. ↓

TEST-TUBE BABIES

Sometimes, the mothers are incapable of conceiving for some reason. In them, the mature ovum is taken from their ovary and it is made to fertilise in a petri dish (*in vitro* fertilisation, "vitro" means "glass", referring to fertilisation in glass containers) and allowed to develop upto a certain stage. Thereafter, it is placed back in the uterus for further natural growth and the children thus born are called "***test-tube***" babies. (The word "test-tube" is symbolic with laboratory). Thousands of such babies have already been produced in India.

TWO UNLUCKY CONJOINED TWINS

Just a few years ago, two Iranian twin sisters 29 years old Ledan and Laleh were fed up of the difficult life they were leading with their joined skulls. They decided to undergo surgery — if successful, they would lead a happy life, if not, they would be freed forever. Sad, the luck did not favour.

SURROGATE MOTHER is any such woman who offers to carry any one else's fertilised egg/embryo in her own womb till completion of pregnancy and delivers the baby.

SIAMESE TWINS — A developmental abnormality

These are conjoined twins produced from a single egg, who have failed to separate completely. The place and the extent of the joint between the two varies considerably (two such examples are shown here). In some rare cases the two conjoined twins have been successfully separated surgically. One such case, was reported in August 1996, in which two seven-month old twin girls, joined at the abdominal region, were successfully separated at Christian Medical College, Ludhiana; some more surgery will be required at puberty after which they would be expected to become complete women (anatomically).

Sita and Gita successfully separated at Delhi's Batra Hospital in April, 2010.

Why is the name Siamese Twins?

The first case becoming world famous was that of two twin boys born to a Chinese mother in Siam (now Thailand) in 1811 who were joined at the thoracic region and lived upto the age of 63 years. They were married to twin sisters (non-conjoined).

- The world's first live octuplets were born in 1967 but all babies died within 14 hours
- The world's first surviving octuplets were born on December 20, 1998 but the tiniest infant died of heart and lung failure a week after being born. The 5 daughters and 2 sons celebrated their 10th birthday on December 20, 2008. ⟶⟶⟶⟶⟶⟶⟶
- Second surviving octuplets were born in Dec. 2008, to a mother in U.S.A.

— Times of India, 28 Jan, 2009.

REVIEW QUESTIONS

A. MULTIPLE CHOICE TYPE

(Select the most appropriate option in each)

1. In humans, the fertilisation takes place in :
   (a) uterus (b) oviducal funnel
   (c) fallopian tube (d) vagina
2. The middle piece of sperm provides :
   (a) energy (b) food
   (c) gene (d) chromosomes
3. The normal gestation period in humans is :
   (a) 270 days (b) 290 days
   (c) 280 days (d) 295 days

B. VERY SHORT ANSWER TYPE

1. **Name** the following :
   (a) The fluid surrounding the developing embryo.
   (b) The body part in which the embryo develops.
   (c) The membrane which protects the foetus and encloses a fluid.
   (d) The canal through which the testes descend into the scrotum just before birth in human male child.
2. **Choose** the odd one in each of the following:
   (a) Sperm; implantation; fertilisation; ovum; afterbirth.
   (b) Relaxin; cervix dilates; amniotic sac ruptures; child birth; follicle.
3. **Rewrite** the terms in the correct order so as to be in a logical sequence.
   (a) Implantation, ovulation, child birth, gestation, fertilisation.
   (b) Coitus, ovum, sperm, sperm duct, urethra, vagina.
4. **Give appropriate terms** for each of the following :
   (a) The onset of reproductive phase in a female.
   (b) Rupture of follicle and release of ovum from the ovary.

(c) Monthly discharge of blood and disintegrated tissues in human female.

(d) Process of fusion of ovum and sperm.

(e) Fixing of developing zygote (blastocyst) on the uterine wall.

5. **Match** the items in column I with those in column II and write down the matching pairs (some may not match)

Column I	Column II
(a) Acrosome	(i) An embryo which looks like human baby
(b) Gestation	(ii) Luteinizing hormone
(c) Menopause	(iii) Ovum producing cells
(d) Foetus	(iv) Semen
(e) Oogenesis	(v) Spermatozoa
(f) Ovulation	(vi) Complete stoppage of menstrual cycle
	(vii) Time taken by a fertilised egg till the delivery of baby.

C. SHORT ANSWER TYPE

1. (a) **State** whether the following statements are **TRUE (T)** or **FALSE (F)** :

(i) Fertilisation occurs in vagina. (T/F)

(ii) Uterus is also known as birth canal. (T/F)

(iii) Nutrition and oxygen diffuse from the mother's blood into the foetus's blood through amnion. (T/F)

(iv) Gestation period in humans is about 380 days. (T/F)

(b) **Rewrite** any two of the wrong statements by correcting only one word either at the beginning or at the end of the sentence.

2. **Complete** the following table by writing the name of the structure or the function of the given structure :

Structure	Function
1. Corpus luteum	1. .....
2.	2. Produces male gametes in mass.
3. Placental disc	3. .....
4.	4. Increases the force in uterine contraction
5. Umbilical cord.	5. .....
6. Fallopian tube	6. .....

3. **Given** below are the names of certain stages/substances related to reproduction and found in human body. Answer the questions related to them,

(a) **Foetus.**
- Where is it contained?
- How does it differ from embryo?

(b) **Hyaluronidase.**
- Is it an enzyme or simply a protein?
- What is its function?

(c) **Morula.**
- What is this stage?
- Name the stage which comes next to it?

(d) **Amniotic fluid.**
- Where is it found?
- What are its functions?

(e) **Gestation.**
- What is its meaning?
- How long does it normally last ?

(f) **Placenta.**
- What are the two sources that form placenta?
- Name any two main substances which pass from foetus to mother through placenta.
- Name any two hormones it produces.

(g) **Implantation.**
- The development stage that undergoes this process.
- The approximate time after fertilisation, when it occurs.

D. LONG ANSWER TYPE

1. **Differentiate** between :

(a) semen and sperm

(b) implantation and pregnancy

(c) follicle and corpus luteum

(d) amnion and allantois

(e) impotency and sterility

(f) prostate gland and Cowper's gland (the nature of secretion)

(g) identical twins and fraternal twins

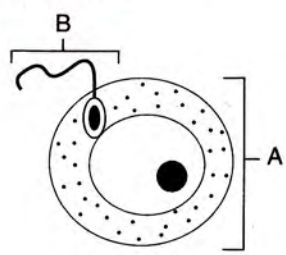
2. **Name** and describe very briefly, the stages in the development of human embryo.

3. **Describe** the functions of

(a) amnion (b) placenta

F. STRUCTURED/APPLICATION/SKILL TYPE

1. The diagram below represents two reproductive cells A and B. Study the same and then answer the questions that follow :



(a) Identify the reproductive cells A and B.

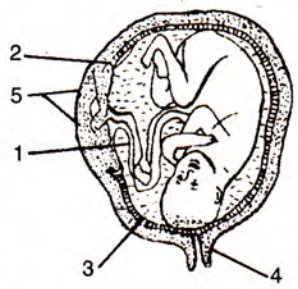
(b) Name the specific part of the reproductive system where the above cells are produced.

(c) Where in the female reproductive system do these cells unite?

(d) Name the main hormones secreted by the (l) ovary (2) testes.

(e) Name an accessory gland found in the male reproductive system and state the function of its secretion.

2. The diagram given alongside is that of a developing human foetus in the womb. Study the same and answer the questions that follow :



(a) **Name** the parts '1' to '5' indicated by guidelines.

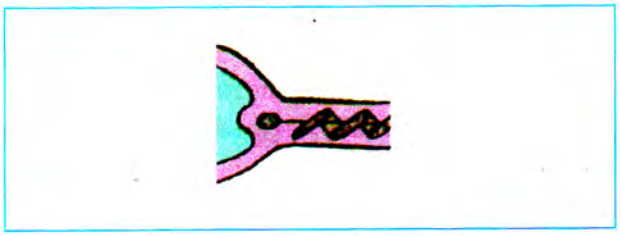
(b) **What term** is given to the period of development of the foetus in the womb?

(c) **How many days** does the foetus take to be fully developed?

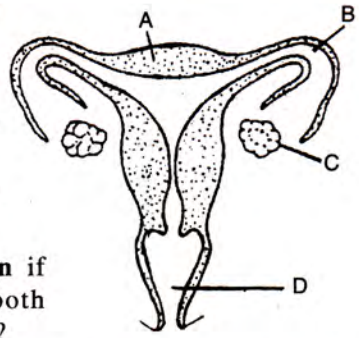
(d) **Mention** two functions of the parts labelled '2' other than its endocrine function.

(e) **Name** any one hormone produced by the part labelled '2'.

3. **Given** below is a portion of the diagram to show the diagrammatic highly magnified view of a single human sperm. Complete the diagram to show its normal structure.



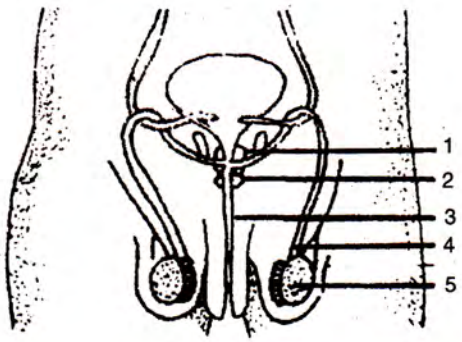
4. The figure given alongside represents the female reproductive system of a mammal.



(a) **Name** the parts labelled A - D.

(b) **What will happen** if the part B on both sides gets blocked?

5. **Given** below is the outline of the male reproductive system. Name the parts labelled 1 to 5.



WHAT IS IT ?

Just a **fancy** or a **superstition** !

DAY → **12-12-12** at **12:12 NOON** ← TIME

A few caesarian births on this day and at this time at the request of the parents!

SIMILARLY

(Horoscopes as you want)

Some people have been getting caesarians done on the same day and time as that of the birth of certain worshipped "Gods" or on particular Zodiacs.

Positive feed-back mechanisms are very few. One example is that of uterine contractions during child birth. Normal state of uterus is uncontracted, one contraction instead of commanding to come to normal gives a message to continue to contract further (positive feed-back till delivery is completed).