# Ratna Sagar

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Revised and Updated

# LIVING SCIENCE BIOLOGY

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10

EDUCATION, OUR MISSION

# ICSE
# Living Science
# Biology

## Class 10

## Chapter 13 Reproductive System

## LEARNING OBJECTIVES

**Types of reproduction**

- **Sexual reproduction in humans**

**Reproductive system in human beings**

- **Male reproductive system**
- **Female reproductive system**
- **Menstrual cycle in human females**
- **Fertilization, pregnancy and development of the embryo**

**How twins occur?**

## What is reproduction?

Reproduction is a process by which a living organism is able to produce more of its own kind. Reproduction involves the transmission of genetic material from the parents to the children, thereby ensuring that characteristics not only of the species but also of the parents, are perpetuated. Reproduction ensures continuity of life and survival of a species on earth.

## Types of reproduction

Living organisms reproduce in two ways **– asexual and sexual reproduction.**
**Asexual reproduction** involves the production of an offspring from a single organism without the fusion of gametes. It is a common process of reproduction in lower plants and lower animals.
**Sexual reproduction** is a type of reproduction in which both sexes, the male and the female, are involved. **It is the production of offspring by the fusion of genetic material contained in the sex cells or gametes**. As a result of fertilization, the male and the female gametes unite to form a zygote which develops into an organism. Most animals and higher plants multiply by sexual reproduction.

## Sexual reproduction in humans

The humans reproduce sexually. The reproduction in humans can be studied in two parts –

- ❖ reproductive system in human beings, and
- ❖ fertilization, pregnancy and development of the embryo.

## Reproductive system in human beings

The period during adolescence in which the body attains sexual maturity is called puberty. Puberty tends to be reached early in girls than boys.

In males, sexual maturity is attained at an age of 13–14 years. In females, onset of menstruation takes place around the age of 13 years. This age is known as the age of puberty. During sexual maturity, hormonal changes take place in males and females, and under the influence of these hormones secondary sexual characteristics are developed.

## Primary reproductive parts and accessory reproductive parts

**Primary reproductive parts** include gonads (testes in males and ovaries in females). These are the sites of gamete production – sperms and eggs. **Accessory reproductive parts** include all other structures which help in transfer of sex cells (gametes) and their fusion leading to fertilization and also growth and development of egg till the birth of the baby.

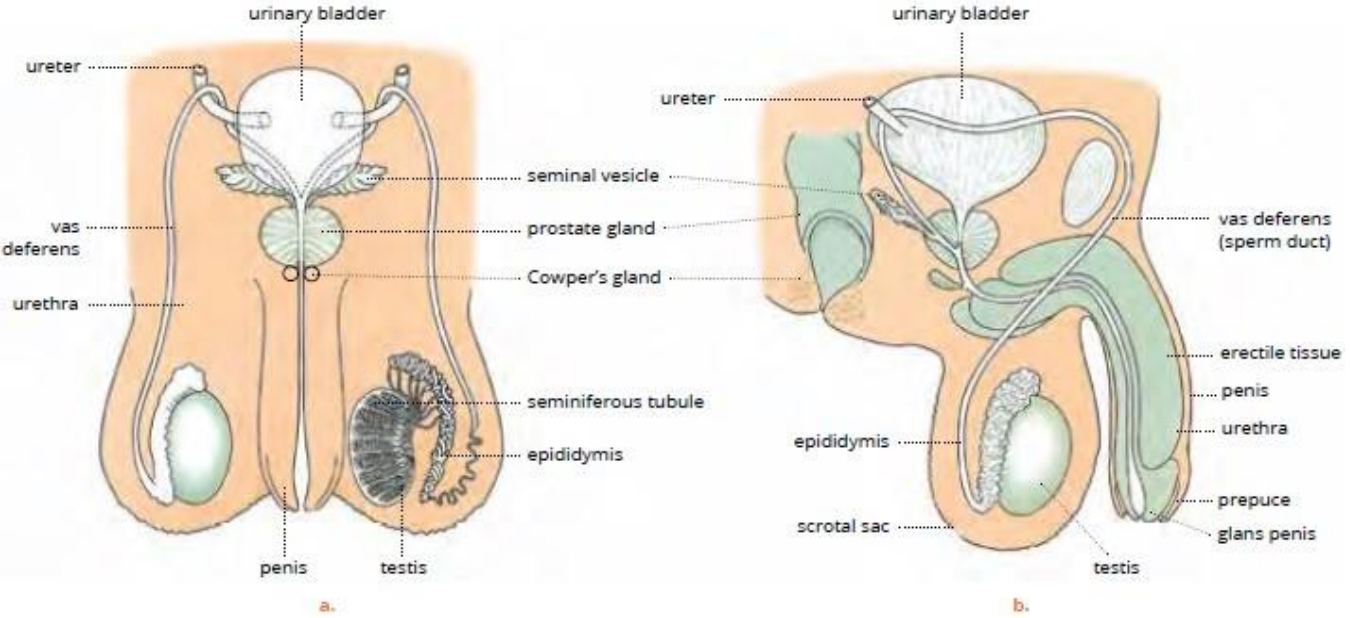
## Male reproductive system

The male reproductive system consists of the following organs – a pair of testes, a pair of epididymis, a pair of sperm duct, urethra, penis and accessory glands.

### Testes

❖ Testes are the **male gonads**. A pair of testes are present in a human male.
❖ These are present in a thin pouch made up of skin and connective tissue called scrotal sac or **scrotum**.

Thus, **testes** are **extra-abdominal**. The scrotum is divided into right and left compartments by a muscular septum. One testis lies in each compartment.



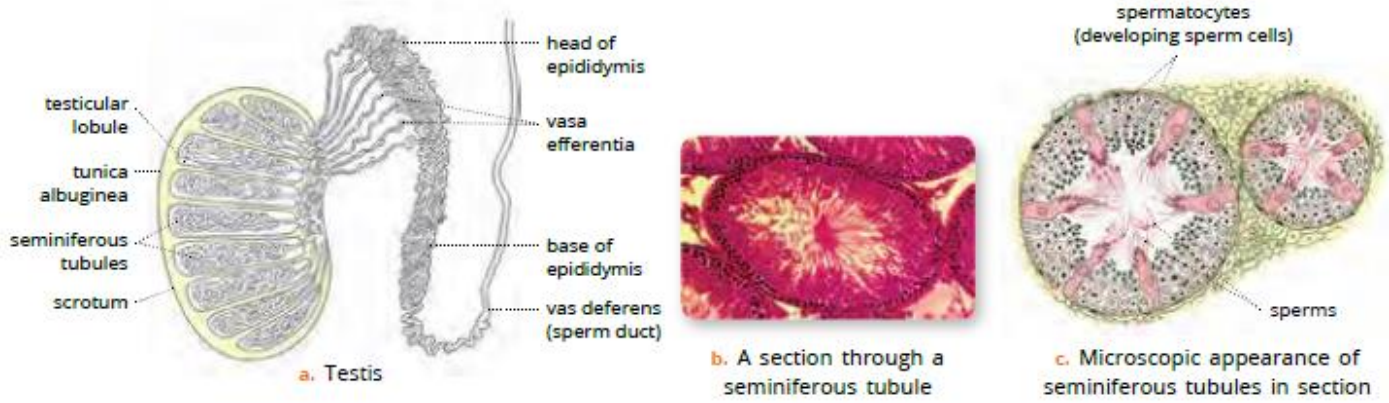

**a.** Position of male reproductive organs in human body
**b.** Male reproductive organs in vertical section

## Structure of testes

❖ Each testis is encased in a capsule of white fibrous connective tissue called **tunica albuginea**. This tissue extends internally as septa dividing the testis into 15–20 lobules.

❖ Each testicular lobule has several highly coiled tubules called **seminiferous tubules** which are the sites of the maturation of spermatozoa. The process of maturation and differentiation of sperm inside the testes is called **spermatogenesis**.

❖ Between the seminiferous tubules is the connective tissue, in which are present clumps of **interstitial cells**, also called **Leydig cells**. These cells secrete the male sex hormone, **testosterone**. This hormone regulates the maintenance of primary and secondary sexual characteristics in males.




Testis and associated structures

## Epididymis

From each testis arise a network of ducts called efferent ducts. These open into a common tube-like structure. This single, 6 m long, highly coiled tube where sperms are stored, get concentrated and become physiologically (mature) active is the epididymis. It remains attached to the testis and lies within the scrotal sac.

## Vas deferens (Sperm ducts)

Each epididymis continues from its lower end as a vas deferens . It enters the abdominal cavity through the **inguinal canal**,

passes over the urinary bladder and joins the duct of seminal vesicle to form the **ejaculatory duct**. The ejaculatory duct opens into the urethra.

## Urethra

The male urethra is about 15–20 cm in length and is differentiated into three parts – an **anterior prostatic part** which passes through the prostate gland, a **middle membranous part**, and a **posterior penile part** which passes through the copulatory organ, the penis. **The male urethra functions as a passage for both semen and urine**. The sperm ducts from each testis open into the urethra near its anterior end.

## Penis

Penis is the **copulatory organ** in males. It is a cylindrical, spongy and a highly vascular organ. It consists of erectile tissue permeated by blood sinuses. The urethra runs through it centrally and serves as a common passage for the exit of urine and semen. It is used to deposit spermatozoa in the female genital tract.

## Accessory glands

There are three accessory glands in males. These include **– seminal vesicles, prostate gland and Cowper's glands**.

**1. Seminal vesicles:** A pair of seminal vesicles are present at the base of the urinary bladder.

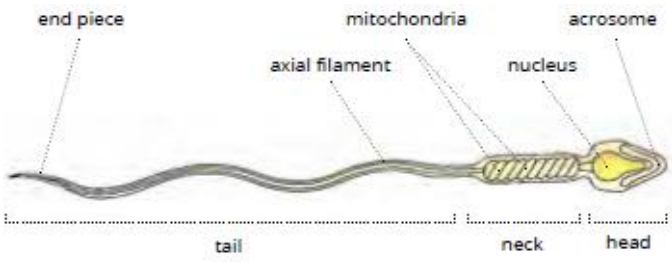
The seminal fluid is an alkaline viscous fluid that contains fructose which provides energy to the sperms. This secretion forms about 60 per cent of the ejaculate. Sperms get active when mixed with seminal fluid.

**2. Prostate gland:** It is a single gland that surrounds the upper part of the urethra. The alkaline nature of this fluid neutralizes the acid in the female tract which would otherwise inactivate and kill the sperms.

**3. Cowper's glands or Bulbourethral glands:** These paired glands lie below the prostate gland and join the urethra at a short distance from that of the prostate gland. They secrete a white, viscous, alkaline secretion resembling mucus which acts as a **lubricant**.

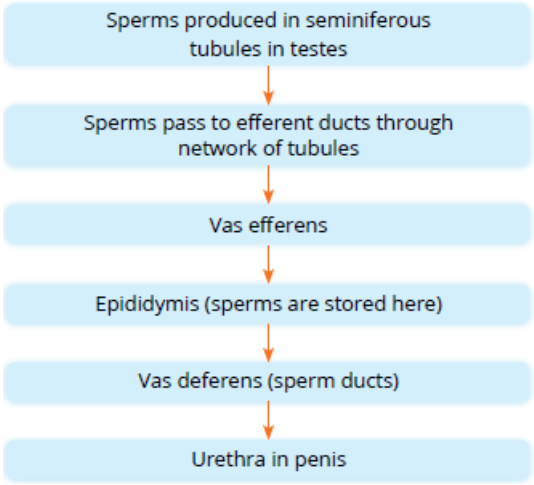
## Spermatozoa and semen

The spermatozoa are minute gametes produced by the testes in males. They are immotile when stored in the epididymis but get activated and motile by the secretions from the accessory reproductive glands in males.




**The secretions of various accessory glands along with sperms form the semen**. Structurally, a human sperm has three main parts – **head**, **neck** and **tail**.

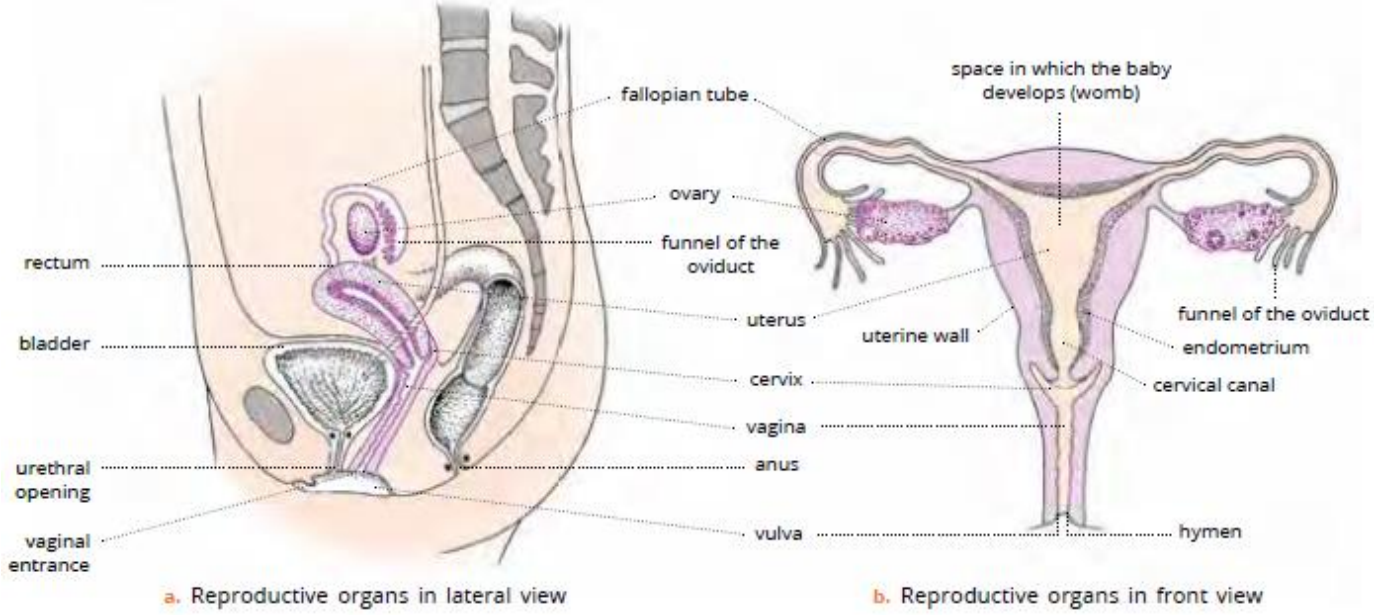
The **nucleus** of the sperm contains genetic material which is transferred to egg and mixes with the female nucleus during fertilization. The middle piece of sperm contains **mitochondria** which provide energy for sperm penetration and sperm motility. The tail helps the sperm in moving forward through the liquid medium while swimming.




The course of sperms in male

## Female reproductive system

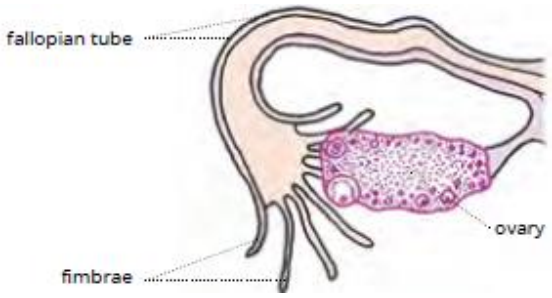
The female reproductive system consists of the following organs – a pair of ovaries, a pair of fallopian tubes, uterus, vagina and external genitalia.




Female reproductive organs in human beings

## Ovaries

A pair of almond-shaped or ovoid-shaped ovaries lie in the lower part of the abdominal cavity, one on each side of the uterus. Each ovary is attached to the uterus by a mesentery, **mesovarium**.



Enlarged view of fallopian tube and ovary

## Oogenesis

Eggs are observed in various stages of development inside the ovary. The **egg mother cells** or **oogonia** are diploid cells which undergo meiosis to produce the haploid **egg** or **ovum**.

## Fallopian tubes (Oviducts)

There are two **oviducts** or **fallopian tubes** or **uterine tubes** in the human female reproductive system. Each oviduct is about 10–15 cm long. The proximal funnel-shaped end of each oviduct lies near the ovary and is called **infundibulum**. Its margin bears finger-like projections called **fimbrae**. Each infundibulum continues as a thin and coiled tube called **oviduct** or **fallopian tube**. Both fallopian tubes open into the uterus.

## Uterus

The uterus is a hollow, pear-shaped, muscular, thickwalled organ located in the pelvic cavity between urinary bladder and rectum.

**Cervix** is mainly a sphincter muscle that closes the lower end of the uterus where it joins the vagina.

## Vagina

It is a muscular tube about 7–10 cm in length. Vagina is the organ where the spermatozoa are deposited during **coitus** (act of copulation) by the penis. It serves as the **birth canal** during childbirth (**parturition**) and also acts as a duct for the passage of uterine secretions and menstrual flow. The opening of vagina in young girls is partially closed by a thin membrane called **hymen**.

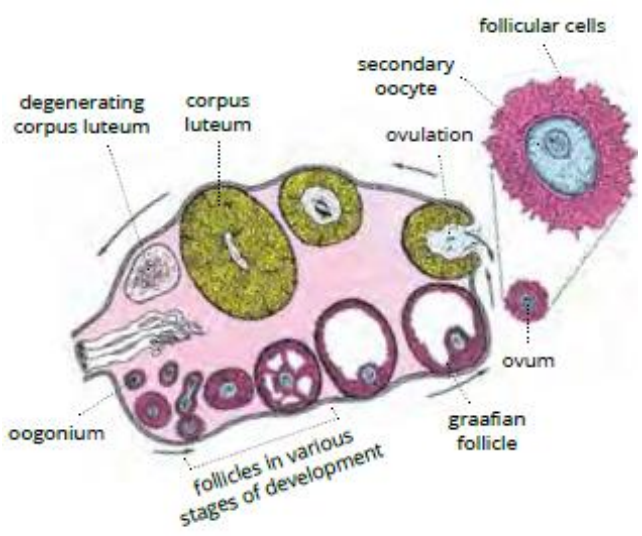
## External genitalia (Vulva)

The external genitalia in human female (also called vulva) mainly consists of **labia majora**, **labia minora** and **clitoris**. The **clitoris** is a small erectile organ which is highly sensitive and is located at the junction of the labia minora. The clitoris corresponds to the penis in males.

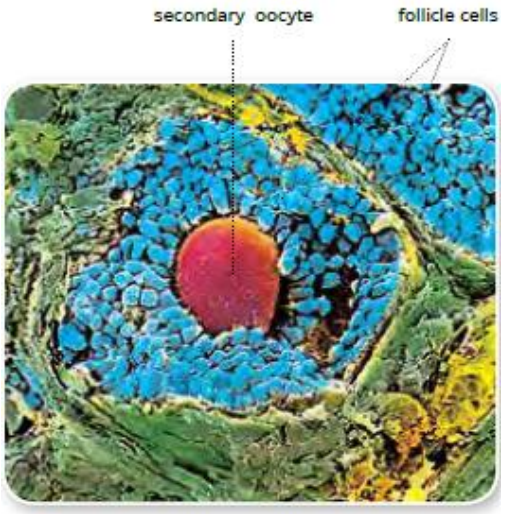
## Menstrual cycle in human females

In a human female, the fertility period extends from the age of puberty, i.e. about 12–13 years up to menopause, i.e. 45–50 years. The stage of **puberty** is marked by the appearance of secondary sexual characteristics. Thus, puberty is a period in which reproductive system matures and becomes capable for reproducing.

At the time of **menopause**, ovulation and menstruation stop and the reproductive organs decrease in size. During each menstrual cycle, an ovum is matured and released once every 28 days. The period of menstrual cycle is counted from the day of onset of menstrual flow to the next onset after about 28 days. There are four phases of menstrual cycle:



a. Transverse section through an ovary



b. Scanning electron micrograph of egg surrounded by follicle cells

## Menarche and menopause

The onset of menstruation in a female is called menarche. It starts at an age of about 12–13 years. The permanent stoppage of menstruation in a female is called menopause. It occurs at an age of about 45–50 years.

## Menstrual phase

The menstrual cycle starts with the menstrual flow, during which the cellular lining of the uterus, with blood flow, is shed off. This process continues for 3–5 days. During menstrual phase the ovary starts to process a new egg in follicle.

## Follicular phase

From the 5th up to the 13th day of the onset of menstrual cycle, growth and maturation of the **Graafian follicle** takes place. **Graafian follicle is the final stage in the maturation of an ovum inside the ovary**. It consists of an ovum and a mass of nurse cells or follicular cells surrounding it. The Graafian follicle produces a hormone, **oestrogen**. This hormone stimulates the uterus to prepare itself to receive the ovum.

## Ovulatory phase

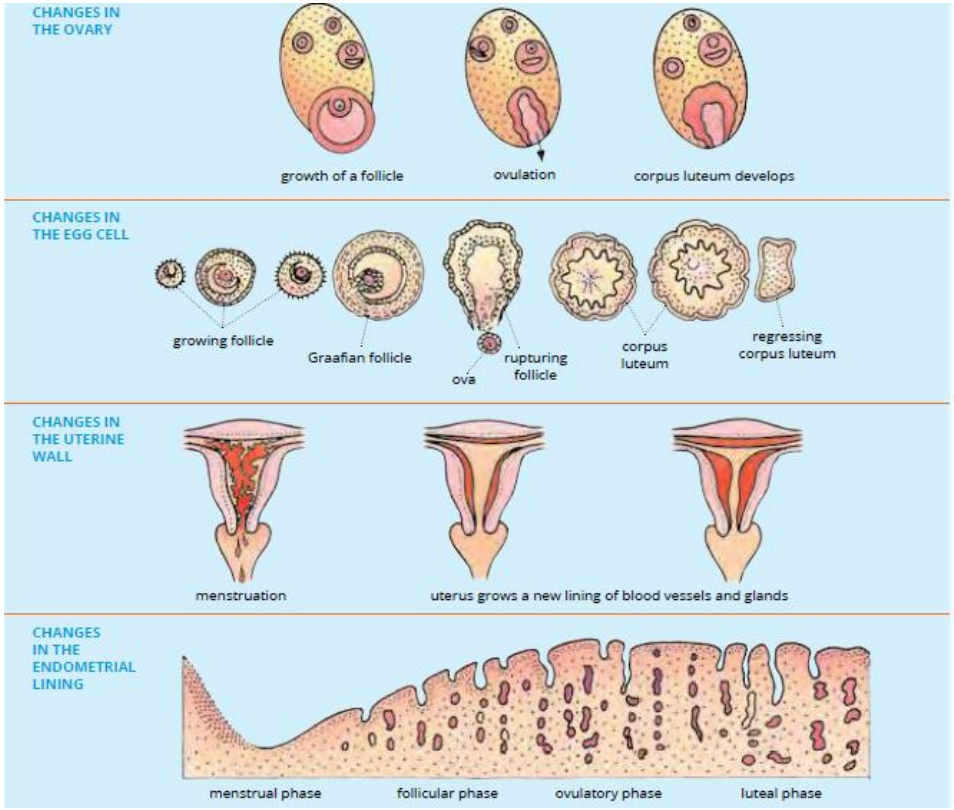
In this phase, ovulation takes place. The Graafian follicle ruptures to release the ovum. The cells of the ruptured follicle form the **corpus luteum** which secretes the hormone, **progesterone**. The release of the ovum from the ovary is called **ovulation**. The ovum reaches the uterus via the fallopian tube on the 13th or 14th day and remains there up to the 16th day (for 48–72 hours).

## Luteal phase

If the ovum does not get fertilized by any sperm during ovulatory period then it degenerates. At the end of the 28th day this ovum is rejected along with the uterine lining. This marks the onset of disintegration of the thickened endometrial lining of the uterus – the next menstrual cycle. The remnant of the Graafian follicle in the ovary turns into **corpus luteum**.

If the ovum gets fertilized while in the fallopian tube, it starts dividing by **repeated mitotic divisions** called **cleavage divisions**. The egg is now an **early embryo**.

It reaches the uterus within 5–7 days of fertilization and implants itself in the thick endometrium. The female is now pregnant and shall give birth to a baby after the development of embryo in 38–40 weeks. This is the **gestation period**.



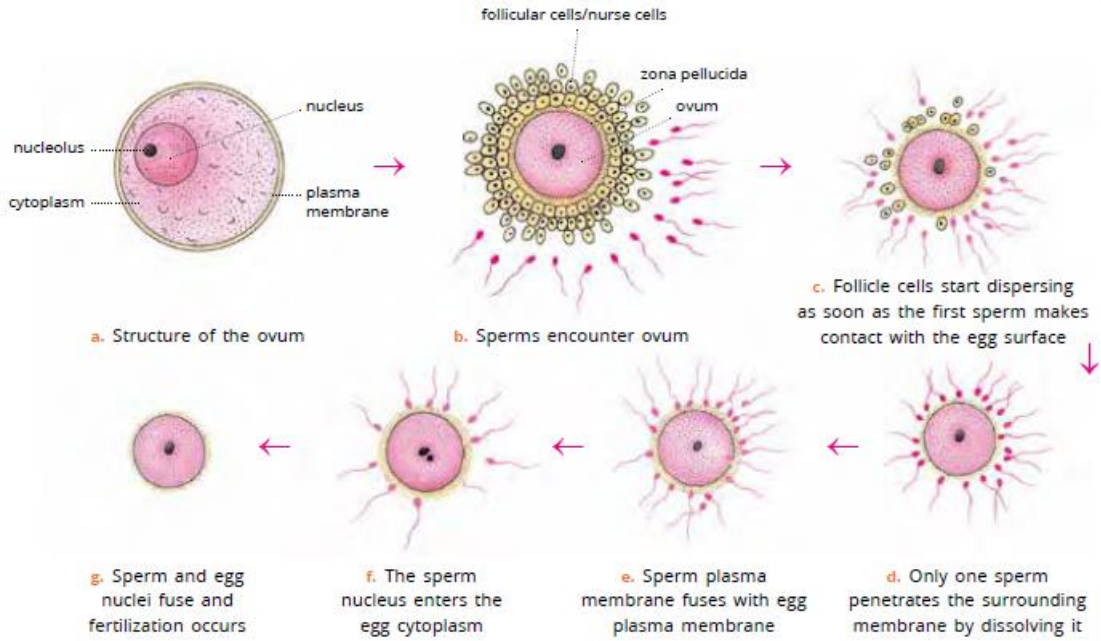

## What happens to the menstrual cycle if the ovum receives sperm?

If the ovum receives sperm, menstruation cease for as long as the woman is pregnant. This is because level of progesterone increases by the corpus luteum and later by the placenta. Progesterone prevents egg maturation in the ovary.

Changes in the female reproductive system that occur during the menstrual cycle

## Fertilization, pregnancy and development of the embryo

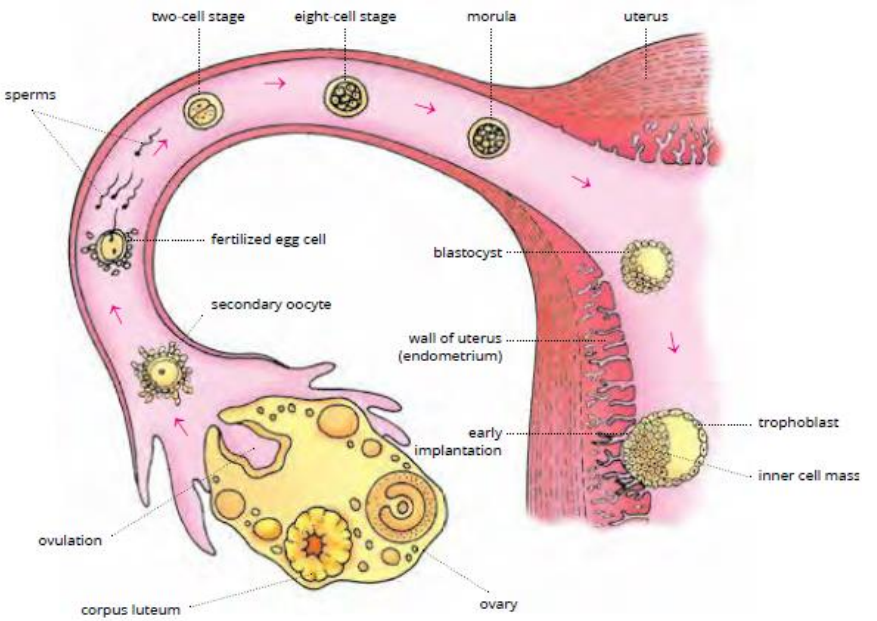
❖ **Fertilization:** The sexual intercourse also known as coitus, the first step towards pregnancy. During intercourse, the semen containing sperms is ejaculated in the vagina. This is known as **copulation**.




Highly magnified view of a human ovum and stages showing its fertilization

A single ejaculation may contain 2–4 hundred million sperms, only one will actually fertilize the egg. If the ovum receives a sperm during the ovulatory period, the two fuse to form a **zygote**. This act of fusion of male gamete (sperm) and female gamete (ovum) to form zygote is called **fertilization**.
13–15 days of the menstrual cycle are most favourable for conception. Of the millions of sperms ejaculated in the vagina, the first one to reach the ovum fertilizes it. Only one sperm can fertilize the ovum. **Fertilization occurs in the fallopian tube.**

❖ **Implantation:** The zygote immediately begins to divide by rapid mitotic divisions called **cleavage**. The daughter cells produced by cleavage divisions get smaller and smaller progressively. **Successive cleavages produce** a solid mass of cells called the **morula.** With further development this ball of cells becomes hollow and is called blastocyst.

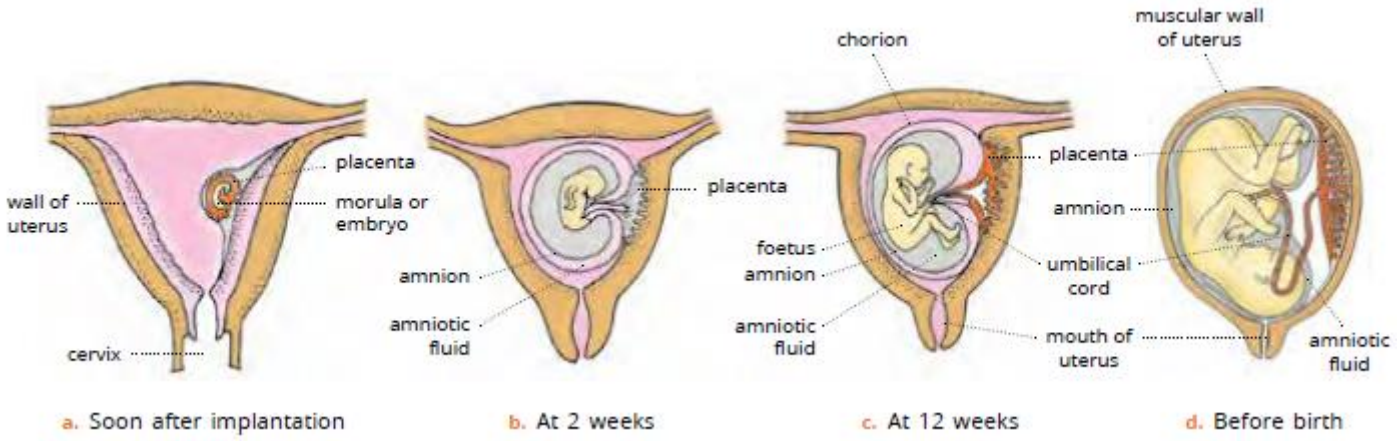



Development of an egg, ovulation, fertilization and its implantation

The fixing of blastocyst in the endometrium of the uterus is called **implantation** and the female is said to be pregnant or in the stage of **pregnancy**. Implantation takes place about a week after fertilization.

## Placenta

The developing **embryo** is attached to the uterine wall by an organ called **placenta**. Placenta is an association between maternal and foetal tissue meant for physiological exchange. **Umbilical cord** is a tough structure that serves as the blood vascular connection between the foetus and placenta. It develops from embryonic cells.




Development of embryo within the uterus

## Foetal membranes

During development, the embryo gets surrounded by four special membranes which protect and nourish it. These are as follows:

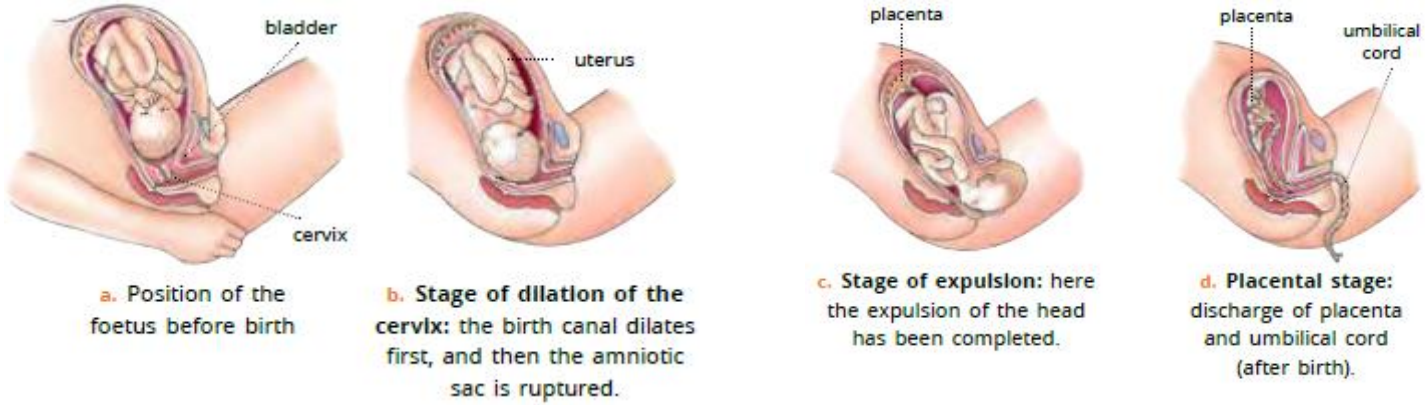
- **Yolk sac:** contains nutrients
- **Allantois:** acts as a waste bag

The first two are non-functional in humans as this work is done by placenta.

- **Chorion:** outermost membrane, takes part in placenta formation from embryonic side.
- **Amnion:** a membranous sac filled with amniotic fluid, completely envelops the developing foetus.

## Gestation and parturition

Parturition is the process of childbirth. The sequence of events that occur during childbirth is called labour. The period of complete development of the foetus from the beginning of the last menstrual period till birth of the baby is called **gestation period**. It is of about 280 days.




a. Position of the foetus before birth

b. **Stage of dilation of the cervix:** the birth canal dilates first, and then the amniotic sac is ruptured.

c. **Stage of expulsion:** here the expulsion of the head has been completed.

d. **Placental stage:** discharge of placenta and umbilical cord (after birth).

Parturition is the process of childbirth

## How twins occur?

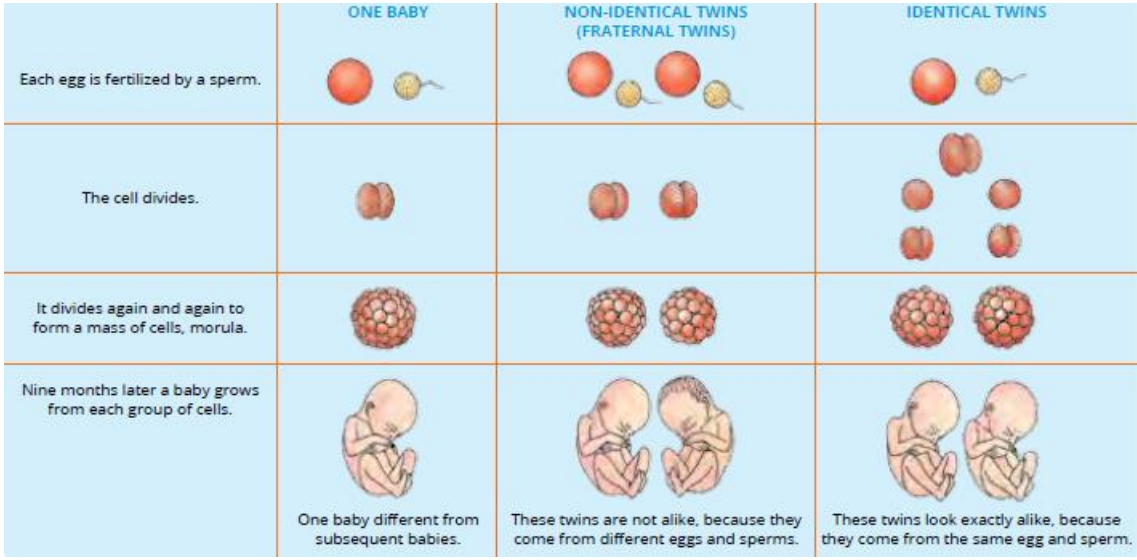
Usually, only one ovum is released by an ovary in every reproductive cycle. If this ovum gets fertilized, one baby is born. But sometimes more than one egg may be released and fertilized. Or an ovum may divide into two or more separate cells after fertilization. This is how twins, triplets, quadruplets, etc. are produced.

## Identical twins

Identical twins are the result of a fertilized egg/zygote separating into two cells after the first cleavage division. Both of which continue to divide, so two identical embryos come from the same egg and sperm. Such twins look alike and are of same sex. Since identical twins develop from the same zygote, these are called **monozygotic twins**.

## Non-identical or fraternal twins

Non-identical twins occur when two eggs are produced at the same time and each is fertilized by a different spermatozoa. These twins do not resemble each other physically.




Types of twins

They can be of the same sex or different sexes. Since fraternal twins develop from two different zygotes, they are called **dizygotic twins**.

## SUMMARY...

- ❖ Reproduction is a process by which a living organism is able to produce more of its own kind.
- ❖ In sexual reproduction, both male and female gametes are produced and the process of fertilization takes place. The humans reproduce sexually.
- ❖ The age of 13–14 years in males and 12–13 years in females is called puberty. At this age, sex organs get matured and several secondary sexual characteristics appear in them.
- ❖ The male reproductive system consists of – a pair of testes, a pair of epididymis, a pair of vasa deferentia, urethra, penis and accessory glands.
- ❖ The female reproductive system consists of – a pair of ovaries, a pair of fallopian tubes, uterus, vagina and external genitalia.
- ❖ The fusion of male gamete (sperm) and female gamete (egg) to form a zygote is called fertilization.
- ❖ The fixing of a fertilized egg in the form of mass of cells (blastocyst) in the uterine wall is called implantation.
- ❖ Placenta is an association between maternal and foetal tissues meant for physiological exchange.
- ❖ Amnion contains amniotic fluid which surrounds the foetus in placenta and acts as a shock absorber.
- ❖ Twins are of two types – fraternal and identical twins.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