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Chapter 15 : Reproductive System

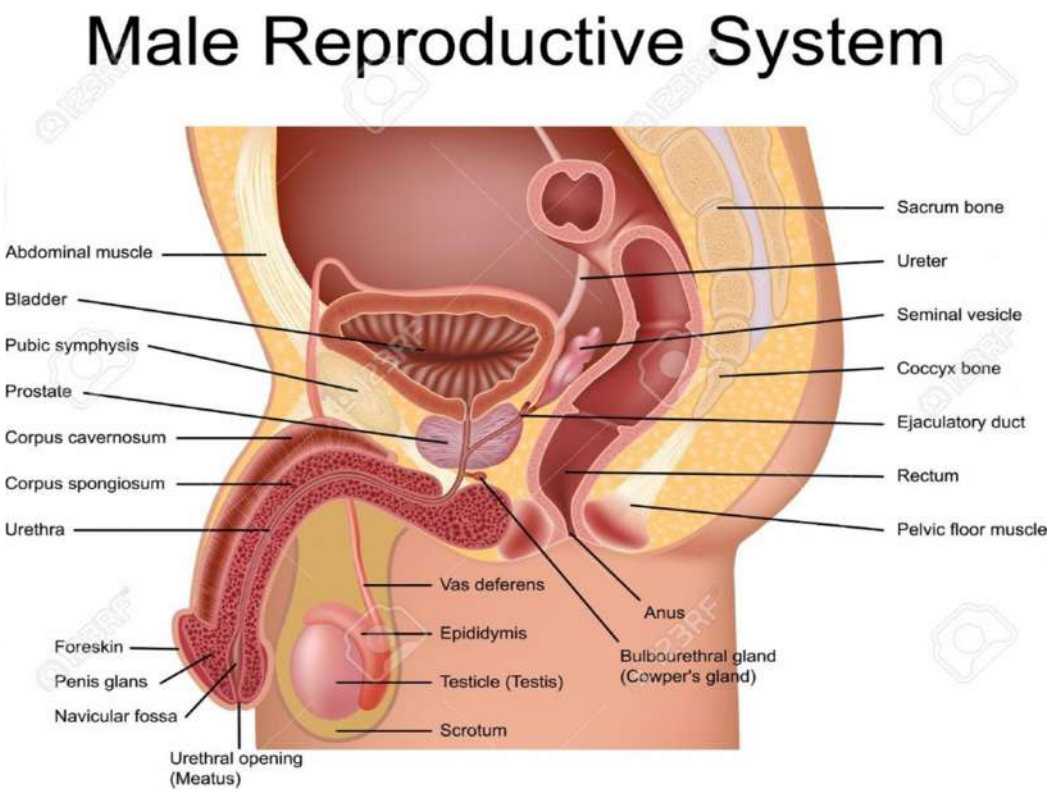
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Chapter 15
Reproductive System

→ Humans are sexually reproducing, unisexual, and viviparous (development of the embryo inside the body of the parent). Both males and females have distinct reproductive organs (gonads), reproductive ducts, and accessory structures.

Anatomy and Physiology of Male Reproductive System



Anatomy and Physiology of Male Reproductive System

- The male reproductive system involves primarily in producing male gametes (ie., sperm) and delivering them to the female reproductive tract.
- The secondary function of male reproductive system is secretion of hormones (e.g., androgens).
- The male reproductive system is located in the pelvis region and consists of
  1) Scrotum and a pair of testes,
  2) Accessory ducts,
  3) Glands, and
  4) External

Scrotum and Testes

- The testes (singular testis) are located outside the abdominal cavity within a pouch called scrotum
- which is a deeply pigmented skin, made up of fibrous and connective tissues, and smooth muscles.

- Scrotum has two compartments, each containing a testis, an epididymis, and the testicular end of the spermatic cord.
- Scrotum helps in maintaining the low temperature of testes (2-2.5°C lower than the normal internal body temperature) required for spermatogenesis.
- Testes, the male reproductive glands are the equivalent of female ovaries.
- They are oval-shaped and are 4.5cm in length, 2.5cm in width, and 3cm in thickness.
- The inner area of each testis is divided into 200-300 testicular lobules and within each lobule 1-4 convoluted loops are present.
- These loops are made up of seminiferous tubules (germinal epithelial (cells) which are lined from within by two types of cells, namely:
  1) Male Germ Cells (Spermatogonia): These cells undergo meiotic divisions to form sperm.
  2) Sertoli Cells: These cells provide nutrition to the germ cells.
- The spaces around the seminiferous tubules are known as interstitial spaces, occupied by small blood vessels and interstitial or Leydig cells.

Functions

1) Testes produce sperm.
2) The Leydig cells of testes secrete testosterone.

Accessory Ducts

The accessory ducts included in the male reproductive system are:

1) Rete Testis
2) Vasa Efferentia or Efferent Ductules
3) Epididymis
4) Spermatic
5) Vas Deferens or Ductus Deferens or Deferent Duct
6) Seminal Vesicles
7) Ejaculatory

Glands

The male accessory glands include

1) Prostate Gland
2) Bulbourethral (or Cowper's) Glands

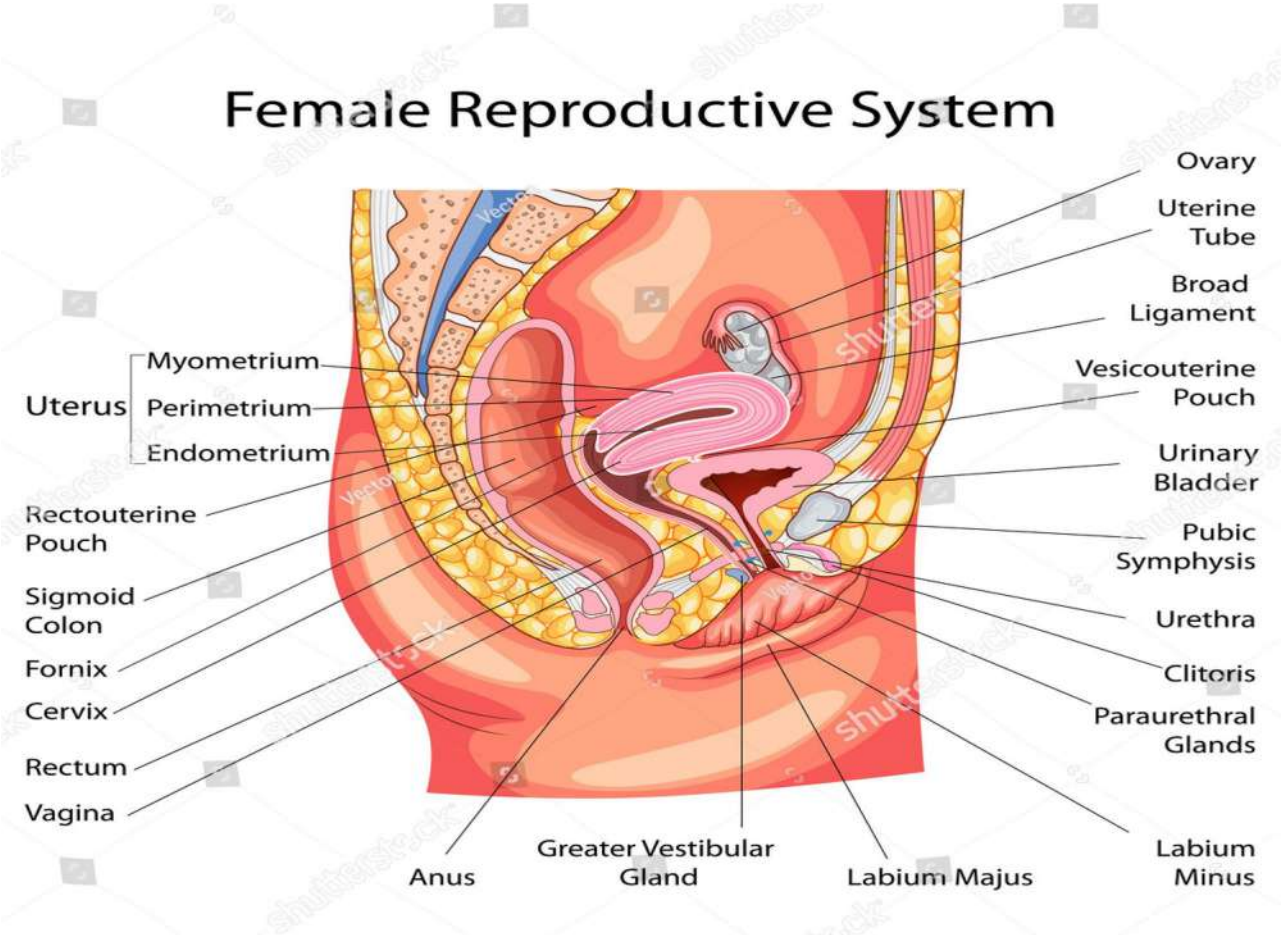
External Genitalia (Penis)

Penis is the male external genitalia. which suspends anterior and lateral to the pubic arch and contains the greater part of urethra. When flaccid it is cylindrical-shaped, but when erect it appears as a triangle having round angles, one side of which forms a dorsum, Penis consists of special tissue that helps in its erection, thus facilitate insemination. The enlarged end of the penis is called the glans penis, which is covered by a loose fold of skin called foreskin.

Functions

1) Penis provides a passage for urine.
2) It also releases sperm in the female reproductive tract to fertilise ovum.

Anatomy and Physiology of Female Reproductive System



The different parts of female reproductive system are enlisted below :

1) External genitalia (vulva),
2) Internal genitalia
   i) Vagina,
   ii) Uterus,
   iii) Uterine tubes, and
   iv) Ovaries.

External Genitalia (Vulva)

The external genitals of females are collectively known as vulva and include the following parts:

- The mons pubis is a pad of fatty tissue present towards the anterior, over the pubic bone. It gets covered with pubic hair after puberty,
- The labia majora are folds of hair-covered skin which extend posteriorly from the monus pubis and surround the vaginal opening

- The labia minora are more pigmented, paired folds of tissue under the labia majora. They protect the female urethra and the entrance of female reproductive tract,
- The clitoris (or glans clitoris) is a small finger like structure, present at the upper junction of the
- two labia minora above the urethral opening. This organ is made up of the same cells as the glans penis.
- Hymen is a thin membrane which partially covers the vaginal opening (located between the urethral opening and anus.
- The borders of vaginal opening have outlets to the Bartholin's glands (or greater vestibular glands).

Internal Genitalia

Following are the internal genitals of the female lying in the pelvic cavity:

1) A vagina,
2) A uterus,
3) Two uterine tubes, and
4) Two ovaries.

Vagina

Vagina is an elastic, muscular tube which joins the uteri cervix with the vulva opening outside the body.
It is located in the pelvic region posterior to the (urinary bladder and anterior to the rectum.
It is around 31 inches long and less than an inch in diameter.
Vagina is capable of becoming several inches longer and many inches wider during sexual intercourse and childbirth.
The inner lining of vagina is made of non-keratinised stratified squamous epithelial tissue, providing protection against friction to the underlying vaginal layers.

Functions

1) Vagina receives the penis during intercourse.
2) It provides for a passage blood during menstruation.
3) It also provides a passage for the baby to pass during partuntion.

Uterus

- Uterus is present within the pelvic region between the bladder and rectum,
- It is a hollow muscular organ having thick walls.
- Fallopian tubes drain into the upper portion of the uterus on both the sides while vagina is connected with its hollow part.
- The released ovum reaches the uterine cavity via fallopian fertilised ovum implants itself the uterus for completion of prenatal growth.
- The length and breadth of upper part and the thickness of uterus is 7.5cm. 5cm, and 2.5cm, respectively. The weight of uterus is 30-40gm

Uterus is made up of the following three Parts

- Fundus: It is the uppermost rounded between the two uterine tubes.
- Body: It is the part extending from the fundus to the cervix
- Cervix: It is the lower narrow part continuous with the body through internal os (mouth) and with through external

The thick uterus wall is made up of three layers

1) Perimetrium or Peritoneum
2) Myometrium
3) Endometrium

Functions

1) Uterus receives the fertilised ovum, retains the foetus during pregnancy, and providing nourishment
2) expels the foetus at the end of pregnancy by contracting its muscular walls.
3) It is also involved in menstruation.

Uterine/ Fallopian Tubes (Oviduct)

- Each fallopian tube is around 10-12cm long and Icm in diameter that extends from the periphery of each ovary to the uterus. The paired fallopian tubes are present on the upper margin of broad ligament on either side. They range from the superior angle of the uterus to the side of pelvis.
- Fallopian tubes are divided into three parts
    1) Isthmus
    2) Ampulla
    3) Infundibulum

Functions

1) Fallopian tubes collect the released ovum and carry it to the uterus with the help of cilia present on the inner surface.
2) They also convey the fertilised egg to the uterus for implantation.
3) They provide the site of fertilisation.
4) They secrete a fluid which nurtures the ovum while it travels into the uterus cavity.

Ovaries

Ovaries are oval-shaped paired organs present on either side of the uterus in the pelvis.
These are the primary female sex organs and produce the female gamete (ovum).
Several steroid hormones (ovarian hormones) are also secreted by ovaries.
Each ovary is about 2-4cm long and is positioned on each side of the lower abdomen.
The inner side of the ovaries is covered by a thin epithelium

Functions

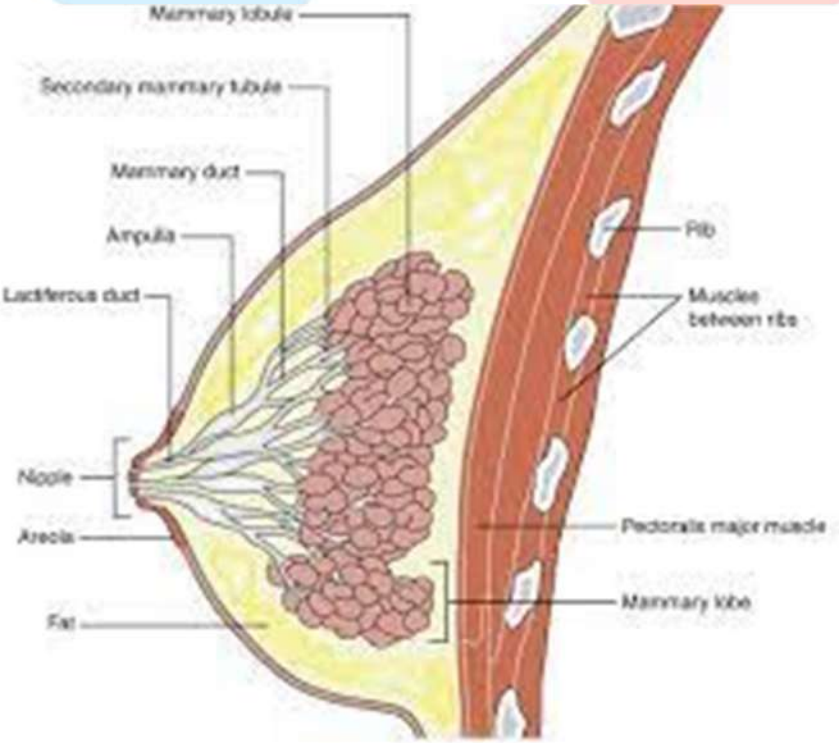
1) Ovaries release the female gametes or ovum.
2) They secrete cestrogens and progestine.
3) They also secrete inhibin which participates in feedback control of pituitary FSH production

Breasts (Mammary Glands)

→ A mammary gland is a characteristic of all mammals but is functional only in females (in males they are undeveloped) The mammary glands are paired structures of glandular, fibrous, and fatty tissues

→ Around 20 lobes of glandular tissue are present in each breast, and each lobe consists of a few lobules surrounding the nipple. The lobules have a cluster of alveoll containing cells which secrete milk stored in alveolar cavities (lumens). Alveoli open into small ducts known as mammary tabules. Several mammary tubules fuse to form a mammary duct; these ducts meet at the centre of the breast to form milk reservoirs (or lactiferous sinus). From cach Lactiferous sinus. narrow duct (or lactiferous ducts) opens on the nipple surface, through which milk is sucked out. The glandular tissue and ducts are supported by the fibrous tissue. The entire surface of breasts is covered with fatty tissue found between the lobes.

→ Nipple is a small conical projection present at the centre of the breast. A dark pigmented area termed areola surrounds the nipple. The areolar surface has a number of schaceous glands (known as Montgomery's tubercles). which are responsible for lubricating the nipple during lactation.



Functions

✓ Breasts are considered sexual but are not a part of the female reproductive system. The mammary glands produce milk to feed the baby

Physiology of Menstruation

- Menstrual cycle or menstruation involves physiological changes occurring periodically in females.
- Menarche is the first menstruation which begins at puberty, Le.. between 8-16 years of age.
- Menopause is the phase when menstruation stops permanently at the end of a woman's reproductive life. In females, the cycle is repeated at an (average interval of about 28/29 days. During the middle of each menstrual cycle, ovulation occurs, thus one ovum is released.

The major events of the menstrual cycle are

i. **Menstrual Phase:** This phase is characterised by vaginal bleeding, known as menstruation (or menstrual bleeding, menses, or periods) occurring in non-pregnant women only. It starts on every 28th day and lasts for 3-5 days. If the mature egg does not gets fertilized, the level of progesterone and estrogen decreases in the body, thus releasing the oxytocin hotmone. This hormone stimulates contractions and leads to drainage of blood out of the The innermost layer of uterus, ite.. endometrium, also sheds off and comes out with the blood.

ii. **Follicular Phase:** This phase starts from the 6th day and ends on the 14th day. During this phase, the uterus lining becomes thick due to the increasing amounts of oestrogen. The development of ovarian follicles is stimulated by a complex interaction between the hormones.

iii. After some days, one or sometimes two follicles become dominant and the non-dominant ones die. The dominant follicle undergoes ovulation. The matured follicles secrete estradiol (an oestrogen) in increasing amounts. A new endometrium layer the proliferative (histologically identified endometrium) develops in the uterus under the influence of estradiol.

iv. **Ovulation Phase:** In this phase, a matured egg secretes estradiol in amounts sufficient enough to trigger Luteinizing Hormone (LH) release. Flow of this hormone begins around the 12 day of menstrual cycle and lasts for 48 hours. The release of LH weakens the walls of ovarian follicles, thus they rupture and release the mature ovum. The released ovum is captured by the fallopian tube which is the fertilisation site for divum und sperm The eps if remain unfenilised disintegrates or dissolves in the uterus with time.

v. Luteal Phases In this prise, corpus luteum is formed. After ovulation, the pituitary hormones convert the residual follicle into corpus luteum, which produces progesterone and oestrogens for next 2 works Progesterone converts the proliferative endometrium into a secretory lining for implantation and supporting the early pregnancy. A fertilised egg in the form of an early blastocyst passes through the fallopian tube and implants itself in the uterine cavity after 6-12 days of ovulation.

vi. Fertile period (tline with the highest possibility of pregnancy) ranges from 5 days before ovulation till 12 days after ovulation. In an average 28 days cycle.with a 14 day luteal phase, this begins from the 2^{nd} or the 3^{rd} week of the cycle

Gametogenesis

→ The process of meiotic division involved in the formation of gametes is known as gametogenesis.
→ The primary sex organs (testes in males and ovaries in females) produce gametes, ie, sperms and ovum, respectively.
→ Gametogenesis in females is known as oogenesis (formation of ovum) and in males it is known as spermatogenesis (formation of sperms).

Gonads are the sites of gametogenesis occurring in the following steps:

1) Multiple mitotic divisions of cell and growth of precursor germ cells,
2) Two meiotic divisions (meiosis I and II) for producing haploid daughter cells, and
3) Differentiation of haploid daughter cells for producing functional gametes

Spermatogenesis

→ Production of male gametes or sperm is termed spermatogenesis, which consists of two processes:

- **Meiosis :** Diploid stem cells present at the outer edge. of seminiferous tubules are termed spermatogonia, which undergo repeated mitosis before puberty to produce large number of other spermatogonia; while spermatogonia undergoing repeated mitosis at puberty A and B results in the formation of types A and spermatogonium. To prevent the spermatogonia from getting depleted, type A spermatogonium remains at the tubule periphery; while the type B undergoes meiotic division in which its DNA replicates resulting in a primary spermatocyte. This spermatocyte further undergoes meiosis 1 to produce two haploid secondary spermatocytes. These spermatocytes then undergo meiosis II to produce. four haploid spermatids (round cells with no tail).

- **Spermiogenesis :** The converting process of spermatids mature sperm is termed process only involves into spermiogenesis.

Sperm

→ Spermiogenesis results in the formation of a sperm cell divided into three regions, i.e., the head, mid-piece, and tail.
→ Head contains DNA and acrosome which contains enzymes helping the sperm to permeate the female egg.
→ Mid-piece/body is a block containing mitochondria which provides energy to the sperm to swim.
→ Tail is a type of flagellum which helps the sperm to move in the female reproductive tract by its whip-like movements.
→ A healthy adult male produces around 400 million sperm per day via spermatogenesis occurring in the seminiferous tubules.

Oogenesis

- Oogenesis is initiated during the embryonic development stage of the female child, and Primordial Gamete Cell (PGC) undergoes mitotic division to form oogonia (i.e., diploid stem cells of ovaries).
- During the embryonic development stage, millions of oogonia are formed within each foetal ovary; no more oogonia are formed after birth.
- The oogonia start dividing and enter into prophase-I of the meiotic division, forming primary oocytes (chromosome number 2N).
- From birth to puberty, a large number of these follicles get degenerated and thus at the time of puberty only 60,000-80,000 primary follicles are left in each ovary.
- The primary follicles get surrounded by more layers of granulosa cells and a new then, and are called secondary follicles.
- The secondary follicle transforms into a tertiary follicle, characterised by a fluid-filled cavity called antrum.
- The theca layer becomes double layered, namely an inner theca interna and an outer theca externa.
- At this stage, the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division.
- It is an unequal division resulting in the formation of a large haploid secondary oocyte and a small first polar body.
- The secondary oocyte possesses bulk of the nutrient rich cytoplasm of the primary oocyte.
- The first polar body undergoes either meiosis II to yield two smaller polar bodies or simple disintegration, while the secondary oocyte waits to complete meiosis 11 until is fertilised by a sperm.
- If sperm does not impregnate the secondary oocyte, it completes meiosis II and yields an ovum and a second polar body. The process of oogenesis results in 4 haploid cells, out of which only one (i.e. the ovum) is a functional gamete.

REPRODUCTION

The process of reproduction in humans relies on sexual intercourse between a male and a female, although there are exceptions to this. Practices and behaviors surrounding human reproduction vary widely across cultures, but in every case, it involves sperm, an ovum (egg), a uterus and a baby. The steps involved in reproduction process are:

1) Fertilisation
2) Cleavage of the zygote
3) Blastocyst formation
4) Implantation
5) Pregnancy
6) Parturition

Fertilisation.

- Fusion of sperm (male gamete released into the vaginal during intercourse) with the egg is termed fertilisation Fertilisation occurs in the ampulla of the fallopian tube. Semen is released into the vagina during copulation (or (coitus) Around 300 million sperms are present in the semen, out of which only a few hundreds of them travel to the ampulla by their tail movements and uterus peristaltic action. Sperms take 5 minutes to reach the fallopian tube, survive for 1-3 days, and fertilise the released ovum within. 12-24 hours of ovulation.

Cleavage of the Zygote

- Once the fertilisation process is over, the zygote undergoes cleavage (rapid mitotic cell divisions)The first division begins 24 hours
- after fertilisation and takes around 6 hours to complete. The further divisions occur in comparatively less time. The second cleavage completes by the 2 day after fertilisation resulting in four cells and by the 3rd day after fertilisation, 16 cells are formed. The smaller cells produced by cleavage are called blastomeres. Continuous cleavages of the zygote result in a morula (a solid sphere of cells surrounded by the zona pellucida and is almost the same size as the original zygote)

Blastocyst Formation

- The number of cells in morula increases by the 4 day after fertilisation as it keeps moving forward in the fallopian tube to reach the uterus. By the 5 day after fertilisation the morula enters the uterus. Now the glands of the uterine endometrium release uterine milk. which enters the morula by passing through the zona pellucida.
- At the 32-cell stage, this fluid enters the morula, accumulates between the blastomeres, and arranges them around a blastocyst (a large fluid-filled cavity

Implantation

- The blastocyst remains free in the uterus for 2 days and then implants itself on the endometrium which is in its secretory phase. By the 6h day after fertilisation. the blastocyst undergoes Implantation either in the posterior portion of the fundus (uterus body) or towards the endometrium with the immer cell mass

Pregnancy

- A phase or duration between conception and childbirth, in which one or more offspring in an embryonal or foetal stage of development are carried inside the bodies of females, is termed pregnancy. In about 38 weeks from fertilisation, Le, about 40 weeks from the 1 day of last menstruation, childbirth normally occurs. So, pregnancy lasts for 9 months. Embryo is the under-developed human in the initial weeks of pregnancy, and foetus is the developing human in two months of pregnancy till childbirth.

Parturition/Childbirth

→ The final stage of pregnancy is termed parturition or childbirth, which occurs within 15 days of the due date calculated by the doctor (ie, 280 days from the last menstrual period) The term labour is used to denote the series of events that expel the infant from the uterus.