Chapter 10 - Genital system

The objectives of this chapter are:

1. Describe the testis and its location
2. Describe the excretory ducts and accessory glands
3. Describe the penis
4. Describe the ovary, and its location
5. Describe the uterine tubes, uterus and vagina
6. Describe the external female genital organs.

The male and female genital systems are the organ systems that include all the organs involved in sexual reproduction. According to their position during the embryological development, we distinguish between the internal and external genital organs.

1 - Male genital system

The internal organs of male genital system are:

- paired testes,
- paired epididymides,
- paired ductus deferens,
- paired spermatic cords,
- paired seminal glands,
- paired ejaculatory ducts,
- prostate,
- paired bulbo-urethral gland.

The external organs of male genital system are:

- penis,
- scrotum.

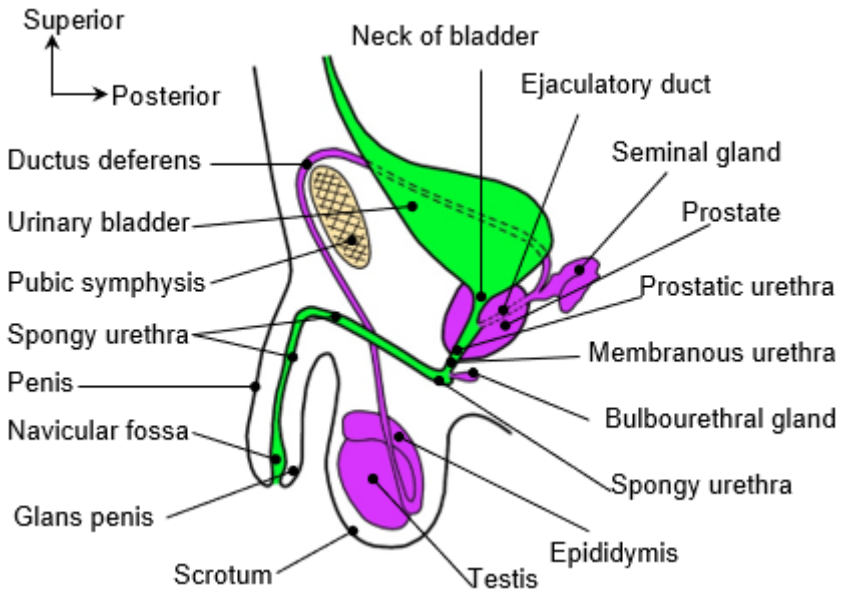

Figure 293: Schematic representation of the male genital organs. Sagittal section.

1.1 - Testis

The testis is a male reproductive gland, homologous to the female ovary. It lies within the scrotum. Its function is the production of sperm cells, the production of testosterone and other male sex hormones (androgens).

The testis has a slightly laterally flattened ovoid shape. It weighs about 20 grams, and it is about 4-5 cm long and 2-3 cm in diameter. On the testis we can observe the lateral and medial surfaces of testis, the anterior and posterior borders of testis, and the superior and inferior pole of the testis.

Each testis is enveloped in a firm fibrous capsule that is white in appearance and therefore called the tunica albuginea. It gives the testis its whitish appearance and firm consistency. Each testis with its tunica albuginea is enveloped in a double-layered serous membrane, called tunica vaginalis. The inner visceral layer is attached to the tunica albuginea of testis. Posteriorly, where the epididymis is attached to the testis, it continues onto the inner surface of the scrotum as the parietal layer. Between the visceral and parietal layer of tunica vaginalis is the cavity of tunica vaginalis testis with a small amount of clear fluid. The tunica vaginalis is the remnant of a pouch of peritoneum and gives the testis considerable mobility.

From the tunica albuginea stem the septa testis which protrude in the parenchyma of testis and divide it into 250-300 lobules of testis. Each lobule is pyramidal in shape and contains 1-3 highly coiled seminiferous tubules. The tubules are lined by a germinal epithelium that is the site of sperm production. In between the tubules there lies the interstitium with Leydig cells that produce and secrete the testosterone.

The convoluted seminiferous tubules run towards the posterior part of testis and straighten into straight tubules which form a network called the rete testis. From this network originate 9-12 efferent ductules which exit the testis at its posterior border and enter the epididymis.

Blood supply

The arterial blood is transported to the left and right testis by the left and right testicular arteries. They are direct branches of the abdominal aorta and arise from the aorta slightly inferiorly to the renal arteries. The testicular artery anastomoses with the artery of ductus deferens which stems from the inferior vesical artery (a branch of internal iliac artery), and with the cremasteric artery which stems from the inferior epigastric artery (also a branch of internal iliac artery).

The venous blood is collected by the pampiniform plexus from which the testicular vein arises. The right testicular vein drains into the inferior vena cava, while the left one drains into the left renal vein.

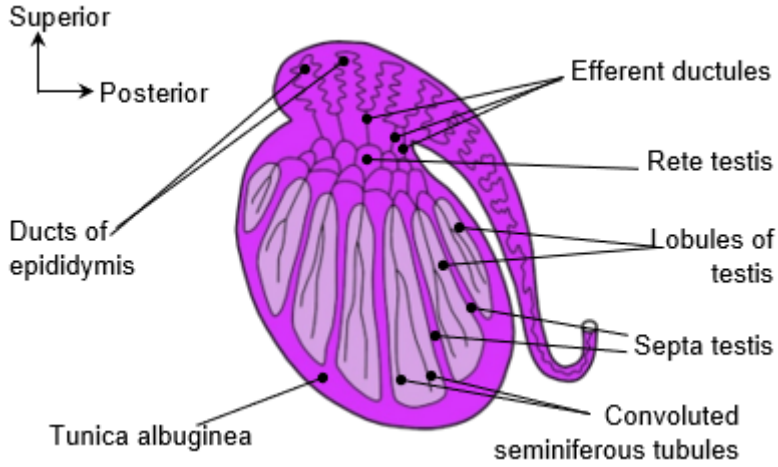

Figure 294: Sagittal section of the testis and epididymis.

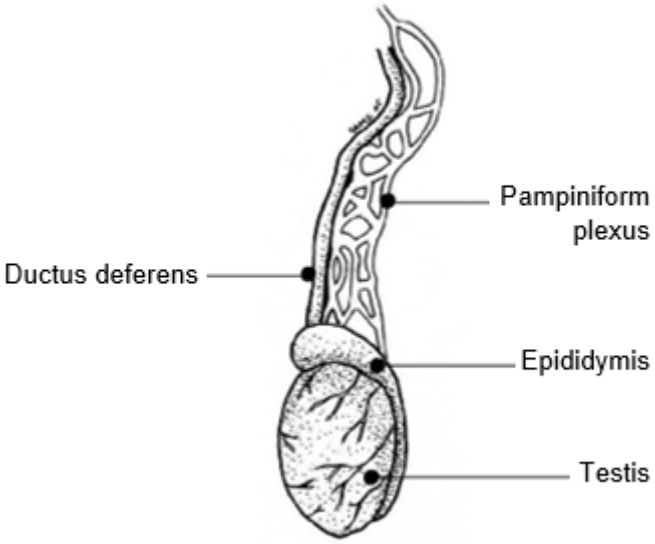

Figure 295: Venous drainage of the testis and epididymis.

1.2 - Epididymis

The epididymis is an elongated organ attached to the posterior border of each testis. In the epididymis, the sperm cells collect and mature.

The epididymis is divided into three parts: the head, the body and the tail. The head of epididymis is the voluminous superior part into which enter the efferent ductules that stem from the testis. The ductules join into a singular duct which is highly convoluted and forms the body and the tail of epididymis. At the inferior pole of the testis, the duct straightens, turns upwards and continues as the ductus deferens.

The blood supply to the epididymis is the same as that of the testis.

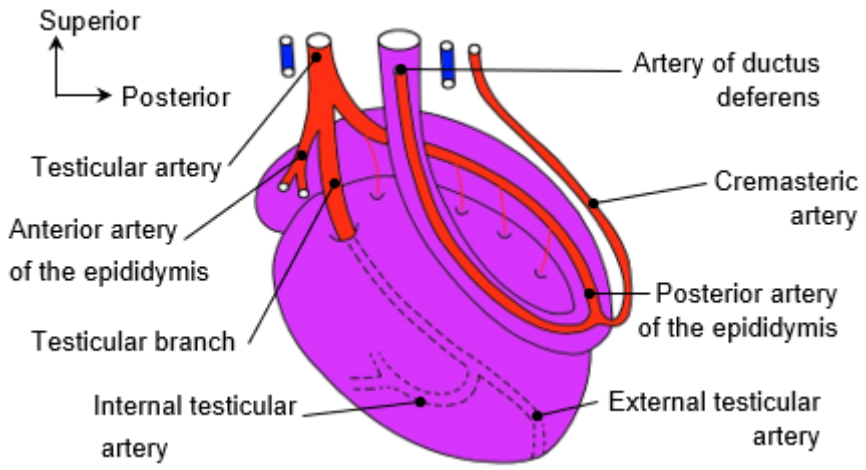

Figure 296: Schematic presentation of the arteries of the testis.

1.3 - Ductus deferens

The ductus deferens, formerly called the vas deferens, is about 50 cm long tube that transports mature sperm cells from the epididymis to the ejaculatory duct.

First part of ductus deferens (scrotal part) lies inside the scrotum, posterior to the testis and epididymis. Its proximal section forms an acute angle with the tail of the epididymis. When it reaches the superior pole of the testis, it enters the spermatic cord inside which it is positioned posteriorly.

Ductus deferens then passes through the inguinal canal and enters the pelvic cavity, and runs medially towards the fundus of urinary bladder.

The terminal part of the ductus deferens is dilated into ampulla of ductus deferens. The ampulla lies posteroinferior to the fundus of the bladder, anterior to the rectum, medially to the seminal gland. At the base of the prostate it joins with the duct of the seminal gland to form the ejaculatory duct.
The wall of the ductus deferens is very thick due to thick muscular layer comprised of three layers of smooth muscle. Its outer diameter is about 2 mm and the diameter of its lumen is about 0.5 mm.

1.4 - Spermatic cord

The spermatic cord is a structure that runs from the abdominal cavity through the inguinal canal to the testis and epididymis in the scrotum. It is formed by several structures enveloped in the coverings.
The coverings of spermatic cord arise from the layers of abdominal wall which bulges during the embryonic development:

- external spermatic fascia: a fibrous outermost layer arising from the aponeurosis of external abdominal oblique muscle;
- cremaster muscle and cremasteric fascia: a muscular middle layer arising from the internal abdominal oblique muscle;
- internal spermatic fascia: a fibrous innermost layer arising from the transversalis fascia.

The contents of spermatic cord are:

- ductus deferens,
- testicular artery,
- pampiniform plexus draining into the testicular vein,
- artery of ductus deferens,
- cremasteric artery,
- lymph vessels,
- sympathetic and parasymphatetic nerves,

- nerve to cremaster (genital branch of the genitofemoral nerve).

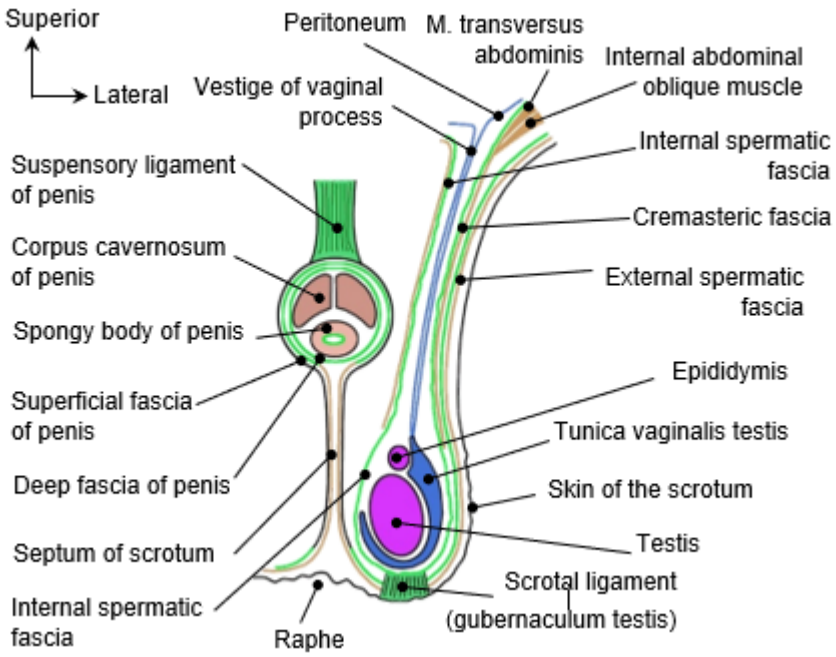

Figure 297: Frontal section of the coverings of spermatic cord.

1.5 - Seminal gland

The seminal gland (also called seminal vesicle) is about 5 cm long lobulated gland that produces fluid which is part of the semen and is essential for nourishing the sperm cells. It is located on the posterior surface of the urinary bladder, laterally to the ampulla of ductus deferens. The excretory duct of seminal gland joins the ampulla of ductus deferens to form the ejaculatory duct.

1.6 - Ejaculatory duct

The ejaculatory duct is about 2 cm long straight tube formed by union of the ampulla of ductus deferens and the excretory duct of seminal gland. It passes through the prostate and opens into the prostatic part of urethra.

1.7 - Prostate

The prostate is an organ formed by glandular part and fibromuscular tissue. The glandular part secretes a slightly alkaline milky fluid that forms part of the semen and helps neutralize the acidity of the vagina. The muscular tissue contracts during ejaculation, pushing the semen through the urethra and closing the connection between the urethra and urinary bladder.

The prostate lies at the neck of the urinary bladder, surrounding the prostatic part of urethra. Its superior part is the widest and is called the base, while the inferior part is narrow and is called the apex. The anterior surface is oriented towards the pubic symphysis, and the posterior surface is oriented towards the rectum. The prostate is about 3 cm high, 4 cm wide at the base, and its weight is 20-30 g. It increases in size with age.

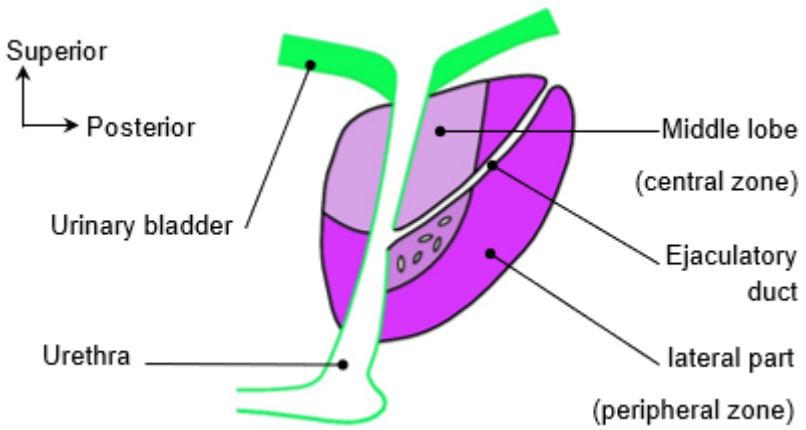

Figure 298: Sagittal section of the prostate.

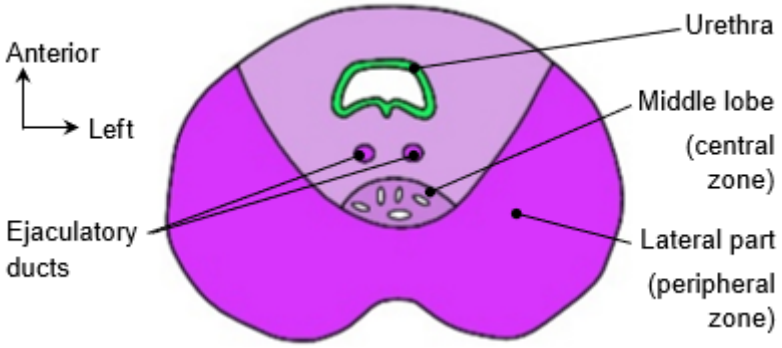

Figure 299: Cross-section of the prostate.

1.8 - Bulbourethral gland

The bulbourethral gland (also called Cowper's gland) is a small gland, about the size of a pea. It produces an alkaline fluid that lubricates the urethra and neutralizes any acidic urine residue.

The bulbourethral gland lies just below the prostate, at the transversal perineal muscles, lateral to the membranous part of urethra, at the level of the bulb of penis. The duct opens into the spongy urethra.

1.9 - Scrotum

The scrotum is a cutaneous sac that contains the testes, the epididymides, and the lower parts of the spermatic cords. It consists of two chambers separated by the septum of scrotum.
The wall of the scrotum consists of two layers:

- Skin of the scrotum, which is thin, wrinkled and pigmented.
- Dartos fascia, which is a superficial fascia with smooth muscle fibres called the dartos muscle. Dartos fascia forms the septum of scrotum.

Inside these two layers, there are the coverings of the spermatic cord surrounding each testis and epididymis, separately in the left and right chamber inside the scrotum: the external spermatic fascia, cremasteric fascia, and internal spermatic fascia.

Figure 300: Photo of the scrotum.

1.10 - Penis

The penis is a copulatory organ that enables the copulation and micturition. It consists of erectile tissue organised in three corpora: the left and right corpus cavernosum and the corpus spongiosum in which the spongy urethra is situated. A firm fibrous tunica albuginea envelops the corpora.
The penis consists of three parts:

- The root of penis is the fixed proximal part of penis, located in the urogenital triangle of perineum. It consists of the left and right crus penis which are attached to the ipsilateral ischiopubic ramus, and the bulb of penis which lies in between the crura penis and is pierced by the urethra.
- The body of penis is the free pendulous part of penis enveloped in skin, located anteriorly to the scrotum. It consists of the left and right corpus cavernosum which are a continuation of the left and right crus penis, and the corpus spongiosum which is a continuation of the bulb of penis. The corpora cavernosa are separated by the septum penis.

- The glans penis is the free distal end of penis. It consists of the corpus spongiosum. On the tip of the glans penis is the external orifice of the urethra. The prepuce of penis is a fold of the skin that covers the glans. It is connected to the glans by the frenulum of penis.

Figure 301: External genital organs in men.

Blood supply

The oxygenated blood is supplied to the left and right corpus cavernosum by the left and right deep artery of penis, and to corpus spongiosum by the artery of the bulb of penis. An additional pair of arteries run along the dorsum of penis, called the dorsal arteries of penis. All the arteries are branches of the internal pudendal artery.

The deoxygenated blood is drained into the internal pudendal veins.

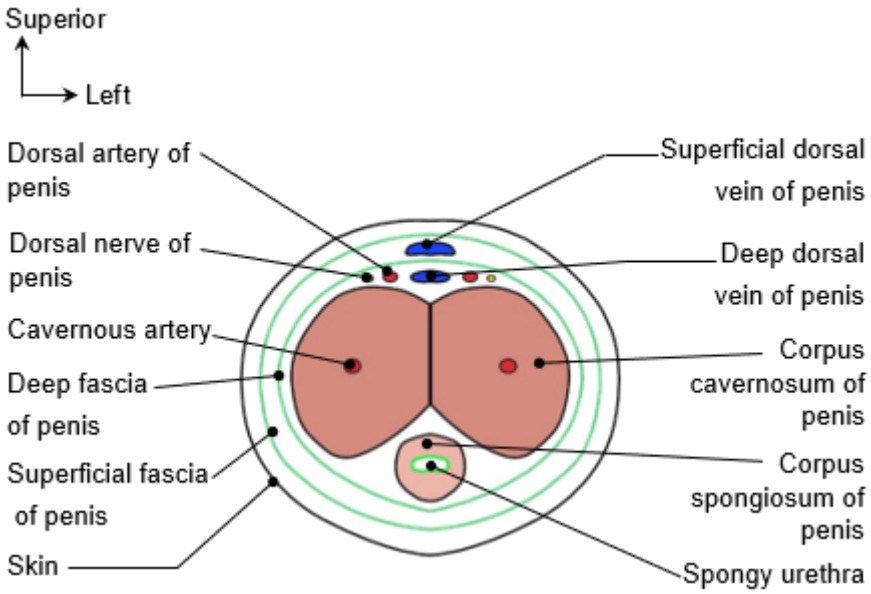

Figure 302: Cross section of the penis.

Figure 303: Dissection of the penis, showing the dorsal veins.

2 - Female genital system

The internal organs of female genital system are:

- paired ovaries,
- paired uterine tubes,
- uterus,
- vagina.

The external organs of female genital system are:

- vulva,
- clitoris.

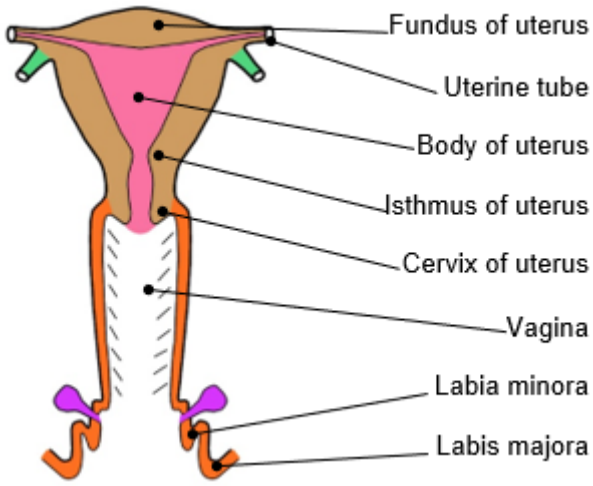

Figure 304: Frontal section through the uterus and vagina.

2.1 - Ovary

The ovary is a female reproductive gland, homologous to the male testis. It lies within the pelvic cavity. Its function is the production of ova (female germ cells) and the production of female sex hormones, oestrogen and progesterone.

At birth, the ovary has a shape of flattened lamella, which becomes oval in the second year of life. In adult women, ovary has a slightly laterally flattened ovoid shape. It weighs about 10 grams, it is about 4 cm long and 2-3 cm in diameter. Its volume varies according to the menstrual cycle or pregnancy. After menopause, the ovary atrophies.

An ovary is described as having the lateral and medial surfaces of ovary, the free border of ovary (oriented posteriorly) and mesovarian border of ovary (oriented anteriorly), and the tubal extremity of ovary (oriented superiorly towards the uterine tube) and the uterine extremity of ovary (oriented inferiorly towards the uterus).

Each ovary is enveloped in a firm fibrous capsule that is white in appearance and therefore called the tunica albuginea. It gives the ovary its whitish appearance and firm consistency. Deep to the tunica albuginea is the ovarian cortex in which lie the ovarian follicles with ova. The follicular cells produce and secrete female sex hormones. The innermost part of ovary is called the ovarian medulla and contains vessels and nerves.

Ligaments of ovary

The proper ovarian ligament is a fibrous ligament connecting the uterine extremity of ovary with the uterus. It is the remnant of the gubernaculum.

The suspensory ligament of ovary is a fold of peritoneum which extends from the tubal extremity of ovary to the wall of pelvis. It contains the ovarian artery and vein.

The mesovarium is a peritoneal duplicature. It is part of the broad ligament of uterus, extending from the mesometrium posteriorly to the mesovarian border of ovary.

Blood supply

The arterial blood is transported to the left and right ovary by the left and right ovarian arteries. They are direct branches of the abdominal aorta and arise from the aorta slightly inferiorly to the renal arteries. The ovarian artery anastomoses with the ovarian branch of uterine artery (a branch of internal iliac artery) in the mesovarium.

The venous blood is collected by the ovarian vein. The right ovarian vein drains into the inferior vena cava, while the left one drains into the left renal vein.

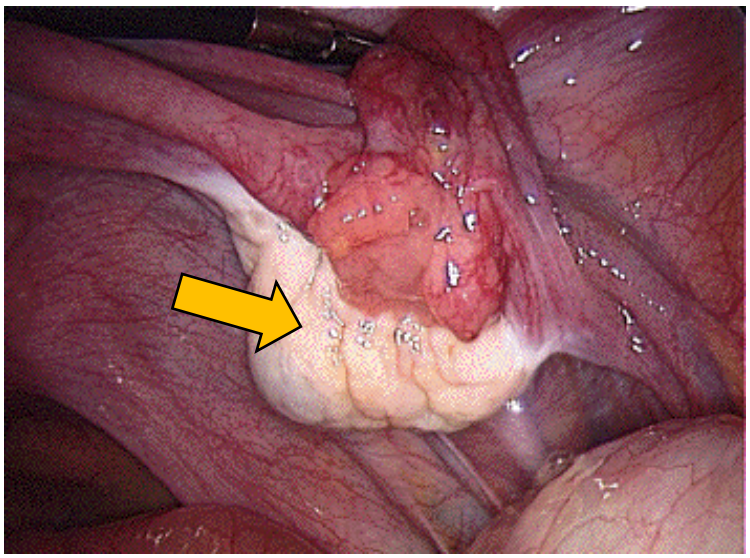

Figure 305: Laparoscopic view of a normal ovary.

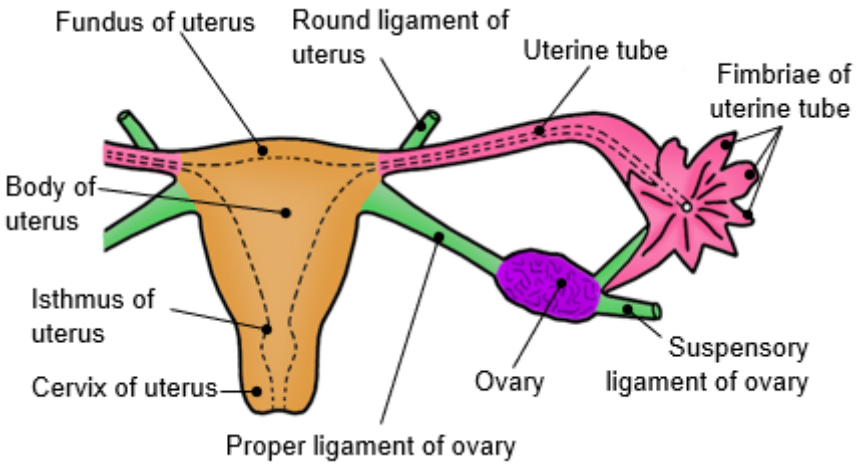

Figure 306: Schematic representation of the attachments of the ovary.

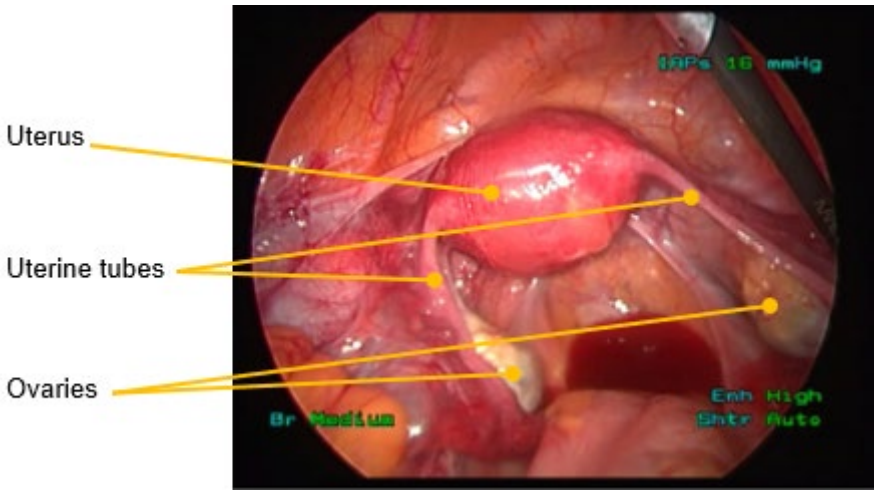

Figure 307: Laparoscopic view of the ovaries, uterus and uterine tubes.

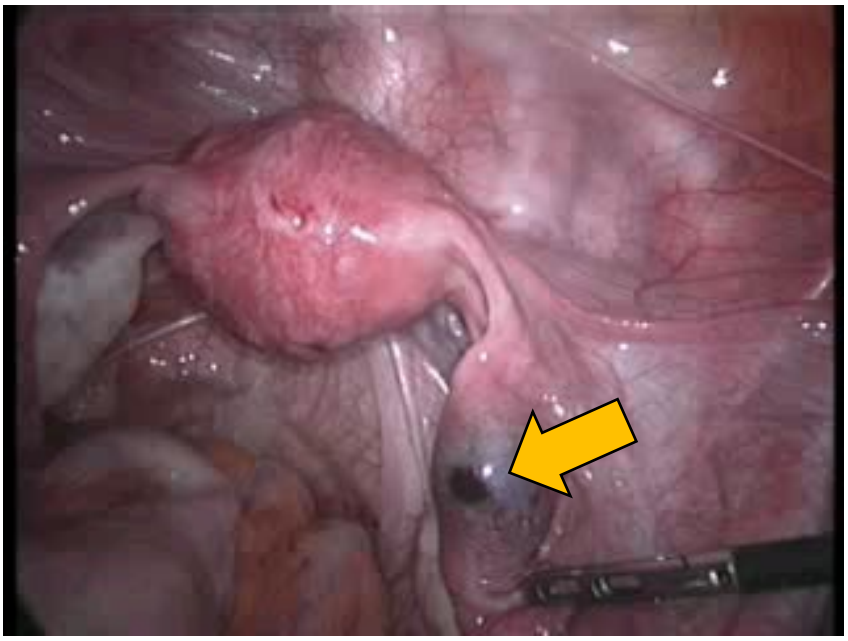

Figure 308: Laparoscopic view of an ectopic pregnancy.

Figure 309: Appearance of a large ovarian cyst.

2.2 - Uterine tube

The uterine tube, also called the Fallopian tube, is a hollow muscular tube that stretches from the uterus towards the ovary. Its function is to convey the mature ovum into the uterine cavity. Conception usually takes place inside the uterine tube.

The uterine tube is about 10 cm long and divided into four parts:

- Intramural part of uterine tube is a part within the myometrium of the uterus. It opens into the uterine cavity with the uterine ostium of uterine tube.
- Isthmus of uterine tube is the narrowest part with a diameter of about 3 mm.
- Ampulla of uterine tube is the longest and widest part with a diameter up to 1 cm. It is the usual place of fertilisation.
- Infundibulum of uterine tube is the funnel-shaped lateral part. It opens into the peritoneal cavity with the abdominal ostium of uterine tube. Finger-like projections called fimbriae emanate from the free edge of the infundibulum and drape over the ovary.

The uterine tube courses between the two layers of the broad ligament at its superior aspect. Part of the broad ligament that envelops the uterine tube is called the mesosalpinx.

2.3 - Uterus

The uterus is a hollow organ with thick muscular walls responsible for the development of the embryo and foetus during pregnancy and for the expulsion of the foetus and placenta during the parturition. It is located in the pelvic cavity, posterior to the urinary bladder and anterior to the rectum. Inferiorly it communicates with the vagina.
The uterus has a shape of an inverted pear. In adult women it is about 8 cm long, 5 cm wide at the upper part, and about 2.5 cm thick. It is flattened antero-posteriorly, therefore we distinguish the anterior and posterior surface of uterus and border of uterus which lies laterally.
The uterus consists of three parts:

- The fundus of uterus is the round uppermost part that lies above the openings of uterine tubes.
- The body of uterus is the wide part of uterus that lies below the openings of uterine tubes. Inside the body lies the uterine cavity having a triangular shape on frontal section; the two superior angles of triangle are formed by openings of uterine tubes while the apex is formed by the internal os of uterus (communication of the uterine cavity with the cervical canal).
- The cervix of uterus is the narrowed inferior part of the organ. It consists of a part that lies superior to vagina (supravaginal part of cervix) and a part projecting into the vagina (vaginal part of cervix). Isthmus of uterus is about 1 cm long narrow superior portion of cervix, connecting the cervix with corpus. Inside the cervix lies the cervical canal. The canal communicates with the lumen of vagina through the external os of uterus.

The uterine wall is composed of 3 layers. The innermost layer is called endometrium and consists of mucosa. It has a basal layer and a functional layer. During the menstrual cycle, the functional layer thickens and is shed. The middle layer, called the myometrium, is thick and composed of smooth muscle. The outermost layer is called perimetrium and is formed by peritoneum.

The peritoneum covers the anterior surface of the body of uterus, the posterior surface of the body and supravaginal part of uterus.

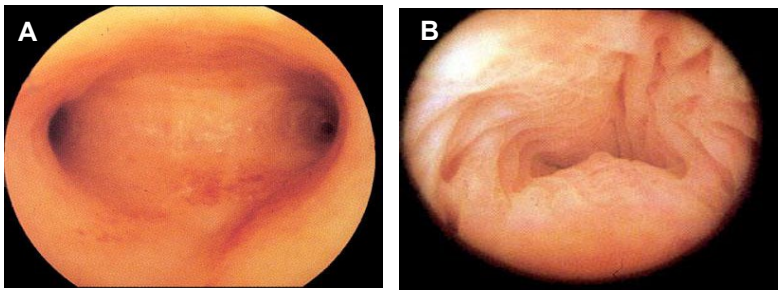

Figure 310: Hysteroscopy view of the uterine cavity with the openings of uterine tubes (A) and the cervical canal (B).

Position of uterus

In most women, the long axis of the body of uterus is bent forward against the long axis of cervix of uterus (the angle between the body and cervix faces anteriorly); this position is called anteflexion of uterus. In addition, the long axis of cervix of uterus is bent forward against the long axis of vagina (the angle between the cervix and vagina faces anteriorly); this position is called anteversion of uterus.

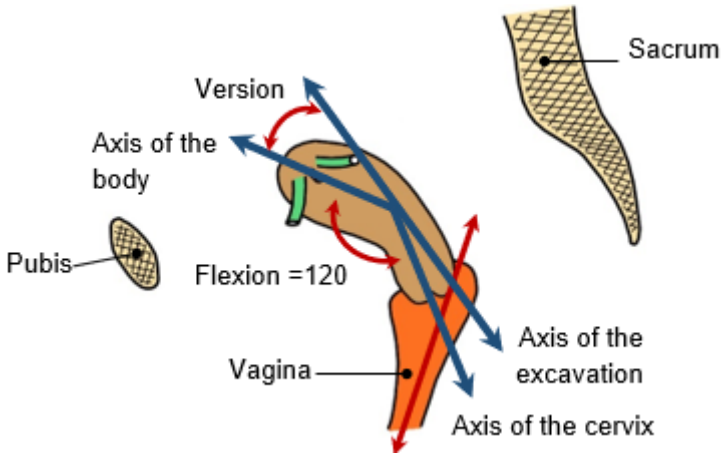

Figure 311: Diagram showing the anteflexion and anteversion of uterus.

Blood supply

The arterial blood supply to the uterus comes mainly from the uterine artery, a branch of the internal iliac artery.

The venous blood is collected by the uterine vein that drains into the internal iliac vein.

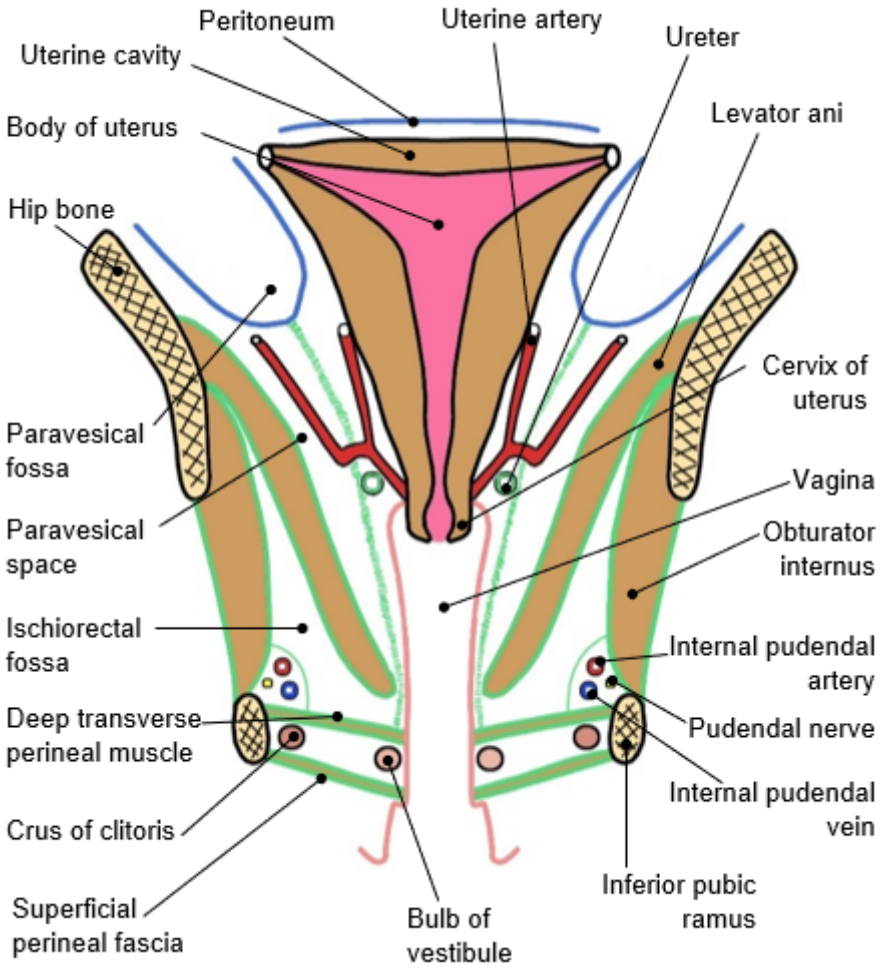

Figure 312: Frontal section of the uterus in pelvic cavity.

2.4 - Vagina

The vagina is about 8 cm long elastic muscular tube extending from the cervix of uterus to the vestibule. It is located partly above the pelvic floor, in the pelvic cavity, and partly below the pelvic floor, in the perineum. It has a function in menstruation, sexual intercourse and childbirth.

The vagina is flattened antero-posteriorly. Its walls are very elastic. The anterior wall of vagina is in contact with the urinary bladder and urethra. The posterior wall of vagina is in contact with rectum. The superior portion of vagina surrounding the cervix of uterus is called vaginal fornix. The cervix is oriented towards the posterior wall of the vagina, therefore the posterior part of vaginal fornix is deeper than the anterior and the lateral parts. The posterior part of vaginal fornix is covered by peritoneum. Above there is the rectovaginal pouch (pouch of Douglas).

2.5 - Vulva and clitoris

The vulva includes the mons pubis, labia majora, labia minora, vestibule of vagina, greater vestibular glands (Bartholin's glands), and lesser vestibular glands. The clitoris is homologous to the penis in the male.

1) **Mons pubis** consists of a mass of subcutaneous adipose tissue anterior to the pubic symphysis covered with the skin with pubic hairs.
2) **Labia majora** are a pair of folds consisting of adipose tissue covered with skin with pubic hairs. They lie inferiorly to the mons pubis. The left and right labium majus are joined by the anterior and posterior commissure of labia.
3) **Labia minora** are two smaller, thinner, hairless skin folds that lie medially to the labia majora. Their anterior ends split into two layers. The upper layers join superior to the clitoris and form the prepuce of clitoris, while the lower layers join inferior to the

clitoris and form the frenulum of clitoris. The joined posterior ends of both labia form the frenulum of labia minora.

4) **Vestibule of vagina** is an area between the left and right labium minus. It contains the vaginal orifice and the external orifice of female urethra as well as the openings of the vestibular glands. Bulbs of vestibule are located on each side of the vestibule, each of them covered by the bulbospongiosus muscle. They consist of an erectile tissue and are homologous to the bulb of penis in the male.

5) **Greater vestibular glands (Bartholin's glands)** are paired pea-sized glands with short ducts on each side of the vagina. They are homologous to the bulbourethral (Cowper's) glands in the male. Their secretion keeps the vulva moist and provides lubrication during sexual intercourse.

6) **Clitoris** is located inferior to the mons pubis, at the anterior end of the vulva. it is composed of paired crura, a body and glans. The crura of clitoris are attached to the ischiopubic rami. Anteriorly, they converge as corpora cavernosa and form the body of clitoris. Distally, the body is topped by the glans of clitoris, which is formed by the joined anterior end of the bulbs of vestibule.

2.6 - The breasts

The breasts are part of the organic system called integument. They are located on the anterior thoracic wall, in front of the pectoralis major muscle and its fascia. They are present in both sexes. In females, their function is production of milk to feed infants.

The female adult breast is an apocrine gland, called the mammary gland. It consists of a system of lactiferous ducts embedded in connective and adipose tissue.

The body of each breast is divided into 15 to 20 lobes separated by the connective tissue. Each lobe contains numerous lobules comprised of the tubuloalveolar glands. The secretory ducts (lactiferous ducts)

converge towards the nipple. Before opening onto the nipple, each lactiferous duct dilates into the lactiferous sinus.

The nipple is small and surrounded by a coloured area of skin, called the areola.

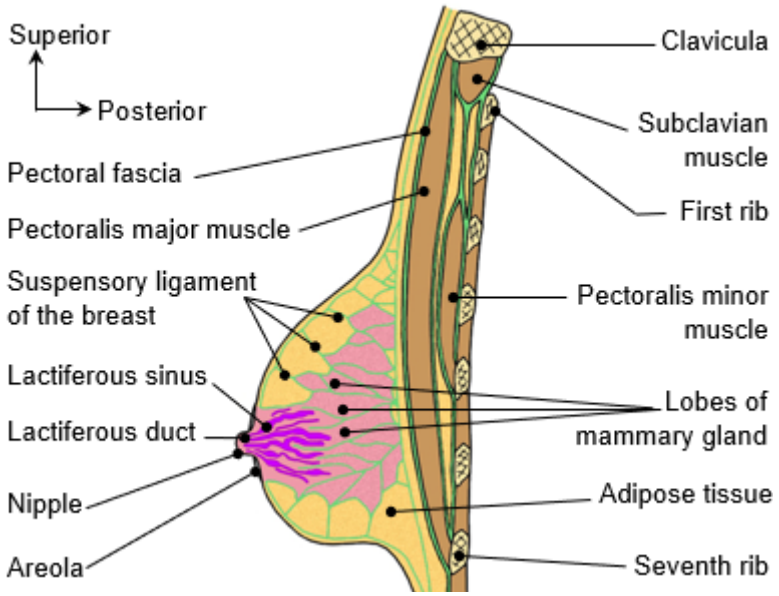

Figure 313: Sagittal section of the breast.

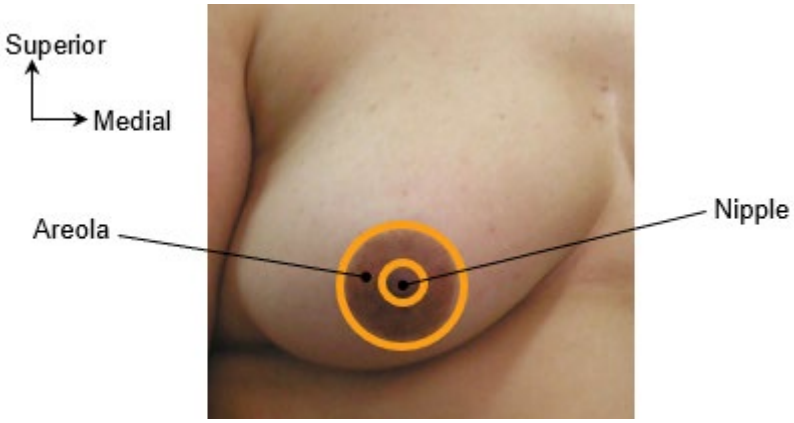

Figure 314: Photography of the right breast from the front.