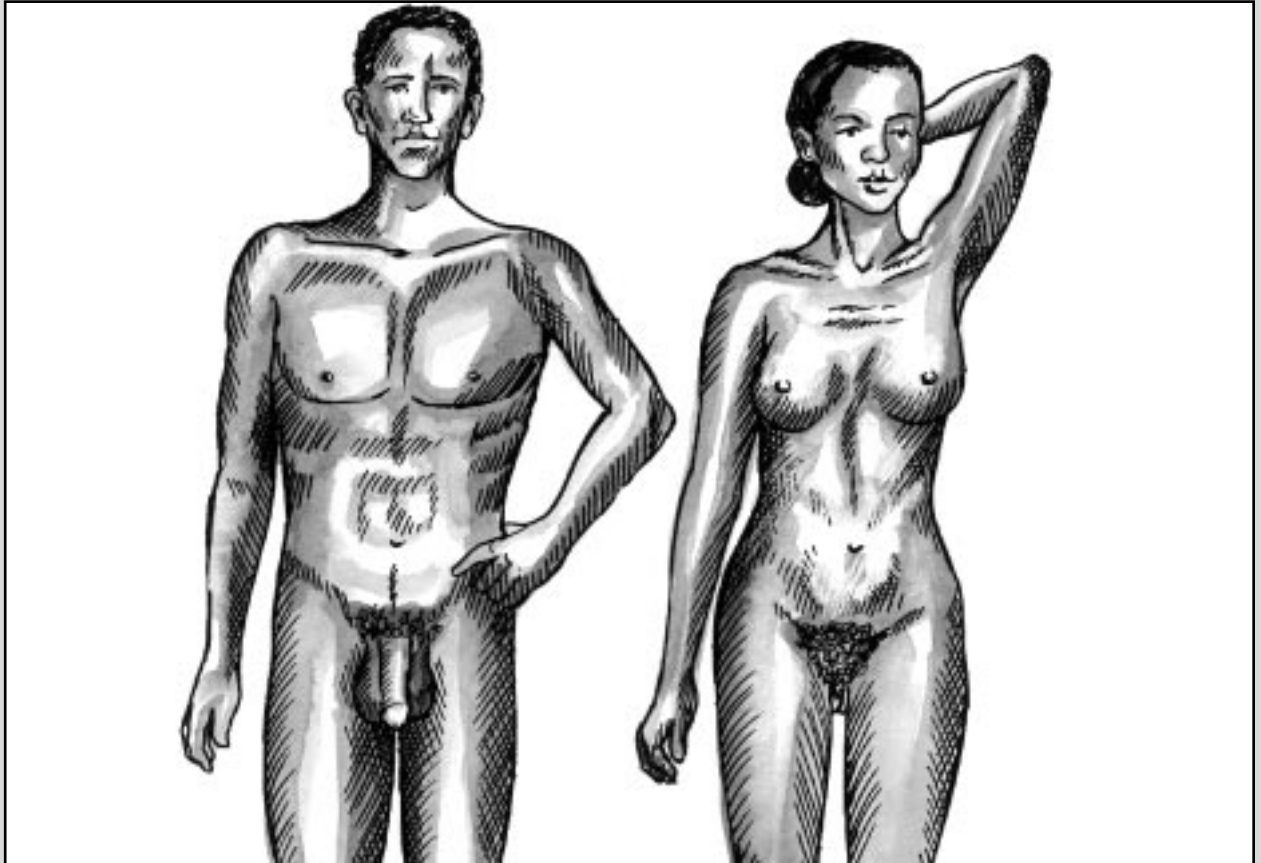


CHAPTER 10

Applied reproductive anatomy and physiology



Contents

- 10.1 Introduction
- 10.2 Female breasts
- 10.3 Female reproductive system
- 10.4 Perineum and anus
- 10.5 Female sexual response
- 10.6 Male reproductive system
- 10.7 The oral cavity

Outcomes

At the end of this chapter you would be able to:

- Understand the anatomy of the female breasts and reproductive system
- Understand the relevant anatomy of the perineum and anus
- Explain the female human sexual response
- Understand the anatomy of the male reproductive system
- Understand the anatomy of the oral cavity.

10.1

Introduction

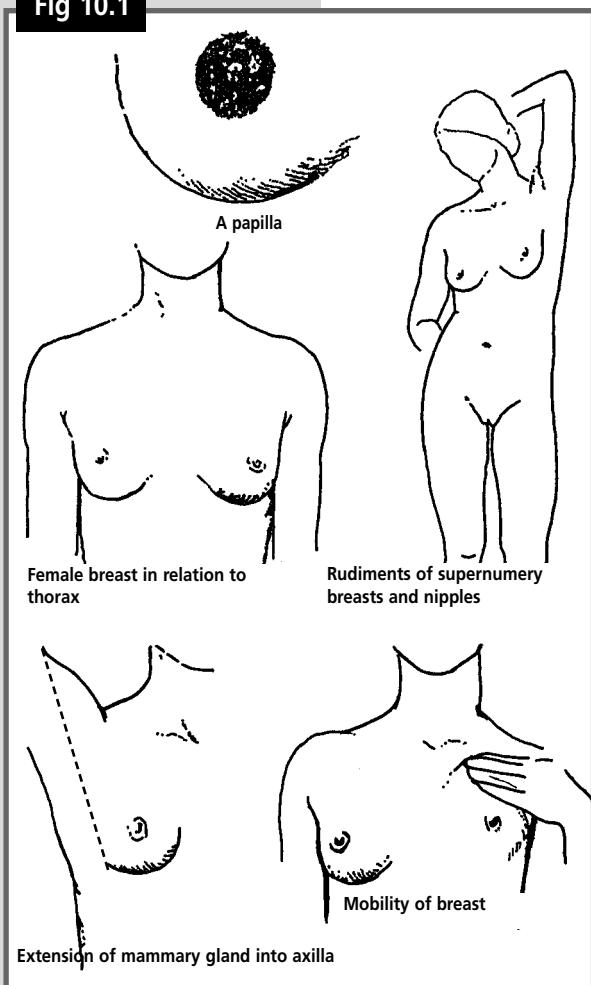
"The most appropriate genital examinations, with respect to patient comfort, and indeed the most legally valuable as far as interpretation is concerned, are done macroscopically by doctors with considerable experience in the examination of normal, diseased and traumatised genitalia and a sound knowledge of the principles of injury interpretation".¹

In order to examine the female adult and child who are survivors of sexual crimes, it is essential that the health worker understand the anatomy and physiology of the following: the female breasts, the female reproductive system, the perineum, the anus, the female sexual response, the male reproductive system and the oral cavity.

10.2

Female breasts

Fig 10.1







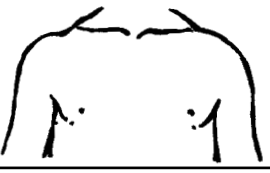



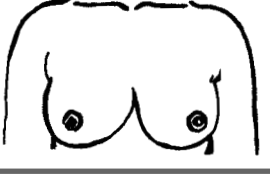

External anatomy of the female breast.

The female breasts are functionally closely related to the genital organs and are briefly discussed in this chapter. The breasts are small until puberty where after they develop to their mature size due to hormonal stimulation (oestrogen and progesterone). The enlargement is as a result of the growth of ductal and alveolar tissues and an increase in fat deposits. During this stage the nipple and areola increase in size and are more sensitive to touch.

After puberty in the premenstrual phase the breasts may increase in size and become more tender. These symptoms usually disappear a few days after the commencement of bleeding. The breasts increase in size during pregnancy as a result of increased levels of progesterone. At the same time the nipple and areola become more pigmented and larger. After childbirth the breasts secrete milk. The breasts return to their original state after breast-feeding stops.

The external anatomy of the breasts is illustrated in Figure 1. The physical development of the breasts can be graded according to the Tanner's Scale. [See pg 227, Table 10.1]

Tanner's Scale: Stage of physical development of the female breasts from adolescence to adulthood²

Stage	Breast development	Pictorial representation – front view	Pictorial representation – side view
1	Slight elevation of nipple only (pre-adolescent)		
2	The breast bud appears as a small mound that is palpable. The areolae enlarge and the nipples remain elevated		
3	Enlargement and elevation of breast and areolae without separation of their contours		
4	The areolae and nipple are projected to form a secondary mound with the nipple and breast contours separated		
5	Mature breast with areolae receding to the same contours as the breast and strongly pigmented		

10.3

Female reproductive system

The female reproductive system is divided into the external and internal genitalia.

External genitalia

The female external genitalia or vulva and perineal structures comprise the following: mons pubis, labia majora, labia minora, clitoris, vaginal orifice, hymen, urethral orifice, vestibule, posterior fourchette, anterior and posterior commissure, fossa navicularis, perineum and anus. [See pg 228, Fig 10.2]

10.3.1

Fig 10.2

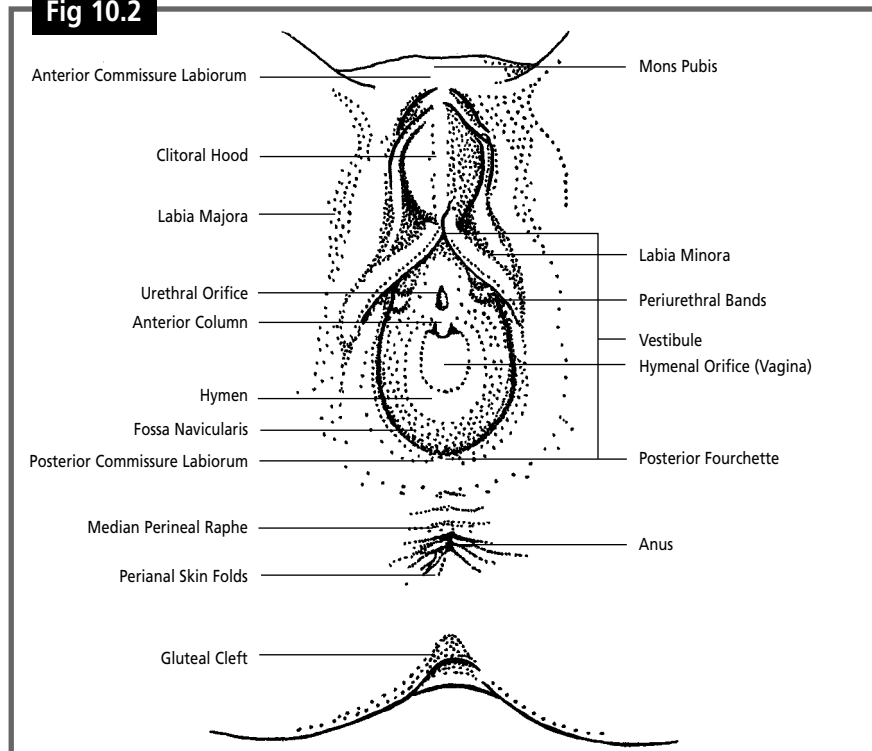


Diagram illustrating the female external genitalia.

10.3.1.1

Mons pubis

The mons pubis is a fleshy pad over the pubic symphysis that is covered by pubic hair.

10.3.1.2

Labia majora

The labia majora are longitudinal skin folds that form the outer lips of the vagina that run from the mons pubis to the perineum. Together with the mons pubis they form a triangle. Their external surface is pigmented and covered by pubic hair after puberty. Like the mons pubis they contain fat, sebaceous glands, sweat and scent glands. The internal surface is pink and smooth. The labia are thicker in front where they join to form the anterior commissure. Posteriorly, they are almost parallel to each other and do not join but merge with the adjacent skin to form the posterior commissure.

After puberty the labia major and minora increase in size as a result of the effect of oestrogen. After menopause there is thinning of the hair and a decrease in the subcutaneous fat of the mons pubis and labia majora. The labial fold becomes flattened and may disappear. The age-related development of the pubic hair is shown in Table 10.3. [See pgs 231-232]

10.3.1.3

Labia minora

The labia minora are thin skin folds devoid of fat that surround the vestibule [See Figure 10.2] of the vagina. They extend from the clitoris obliquely downwards and bound the vaginal orifice.

Definitions

MONS PUBIS

The mons pubis is a fleshy pad over the pubic symphysis that is covered by pubic hair.

LABIA MAJORA

The labia majora are longitudinal skin folds that form the outer lips of the vagina.

LABIA MINORA

The labia minora are thin skin folds devoid of fat that surround the vestibule of the vagina.

Anteriorly, the labia minora split into two: a part that goes above the clitoris to form the prepuce of the clitoris and a part that goes below the clitoris to form the frenulum of the clitoris. Posteriorly, the labia minora unite in a frenulum or fourchette that is obliterated by child-birth.

Clitoris

The clitoris is an erectile structure that is analogous to the male penis and is situated behind the anterior commissure of the labia majora. Most of the clitoris is enclosed by the labia minora. The glans of the clitoris is situated at the free end of the clitoris and is highly sensitive and plays an important role in sexual responses. In the post-menopausal phase, the clitoris becomes smaller due to a decrease in the oestrogen level.

Urethral orifice

The urethral orifice lies behind the clitoris and immediately in front of the vaginal orifice. It appears as a short vertical slit with slightly raised margins.

Vaginal orifice (introitus)

The vaginal orifice is a vertical slit below the urethral orifice. The size of the vaginal orifice varies inversely with that of the hymen. The orifice is capable of expansion during coitus and delivery. The ducts of the greater vestibular glands open on each side of the vaginal orifice, between it and the labia minora. With a decrease in oestrogen levels, the orifice becomes smaller.

Hymen

The hymen is a thin mucous membrane within the vaginal orifice. It is sometimes described as a collar or semi-collar of tissue surrounding the vaginal orifice. It separates the external genitalia from the vagina. The internal surface of the hymen is folded and the vaginal orifice appears as a cleft between them. It usually has a central opening to allow for menstrual flow. This opening may vary greatly in shape and size. It may take different shapes. [See pg 230, Table 10.2]

10.3.1.4

10.3.1.5

10.3.1.6

10.3.1.7

Definitions

CLITORIS

The clitoris is an erectile structure that is analogous to the male penis and is situated behind the anterior commissure of the labia majora.

URETHRAL ORIFICE

It appears as a short vertical slit with slightly raised margins.

VAGINAL ORIFICE








The vaginal orifice is a vertical slit below the urethral orifice.

HYMEN

The hymen is a thin mucous membrane within the vaginal orifice.

TABLE 10.2

Variations in shape of the hymen

Type	Description	Diagrammatic representation
Annular (circumferential)	The circumference of the vaginal opening is completely surrounded by the hymen	
Crescentic (lunar)	A hymen which is deficient at 12 o'clock and is attached at 11 o'clock and 1 o'clock	
Septate	A hymen that has bands of tissue creating two or more openings	
Cribriform	A hymen with multiple openings (sieve-like)	
Imperforate (occluded)	A hymen without an opening.	
Microperforate	A hymen with a small opening	
Multiparous	A hymen consisting of residual tags (<i>carunculae hymenales</i>)	

The neonatal hymen is under the influence of maternal oestrogen and shows features of the post-puberty hymen. In addition there may be a number of congenital and non-specific findings such as notches, bumps, ridges and bands. A congenital absence of the hymen has not been documented.

The effect of oestrogen on the post-pubertal (or neonatal hymen)

includes: increased elasticity, thickening and redundancy of the hymen (i.e. it covers the vaginal orifice) and lack of pain on palpation. Therefore oestrogenisation of the hymen provides some degree of protection from injury and allows penetration to occur without any tearing.

The pre-pubertal hymen is scanty or thin and is translucent at the luminal margin. It is inelastic and is painful on palpation. In menopause oestrogen is present but in reduced amounts compared to the pre-menopausal phase.

Vestibule

The vestibule is a cleft between the labia minora and contains the opening of the vagina, the urethra and the ducts of the greater vestibular (Bartholin's) glands.

Fossa navicularis

The vestibular or navicular fossa is a shallow depression in the vestibule between the vaginal orifice and the frenulum of the labia. The fossa navicularis may be obliterated by childbirth.



VESTIBULE

The vestibule is a cleft between the labia minora and contains the opening of the vagina, the urethra and the glands.

FOSSA

NAVICULARIS


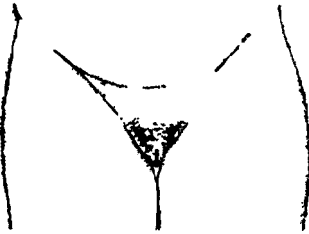

This is a shallow depression in the vestibule between the vaginal orifice and the frenulum of the labia.

10.3.1.8



10.3.1.9

TABLE 10.3

Tanner's Scale: Stage of physical development in the female from adolescence to adulthood³

Stage	Pubic hair	Diagrammatic representation
1	Fine vellus hair similar to that on abdomen (pre-adolescent)	
2	Sparse growth of straight or slightly curled lightly pigmented downy hair along the labia majora	
3	Coarser, darker, curlier hair, sparsely spread over labia majora and mons pubis	

CONTINUED

Stage	Pubic hair	Diagrammatic representation
4	Coarse, curled and darker as in adults but area covered is not as extensive as in adults	
5	Adult distribution of coarse, curled and dark hair in classic triangle shape spreading to inner thigh	

10.3.2

Internal female genitalia

The internal female genitalia lie in the pelvic cavity and comprise the vagina, uterus, and the paired fallopian tubes and ovaries. For the purposes of this chapter, the latter are not described further.

10.3.2.1

Vagina

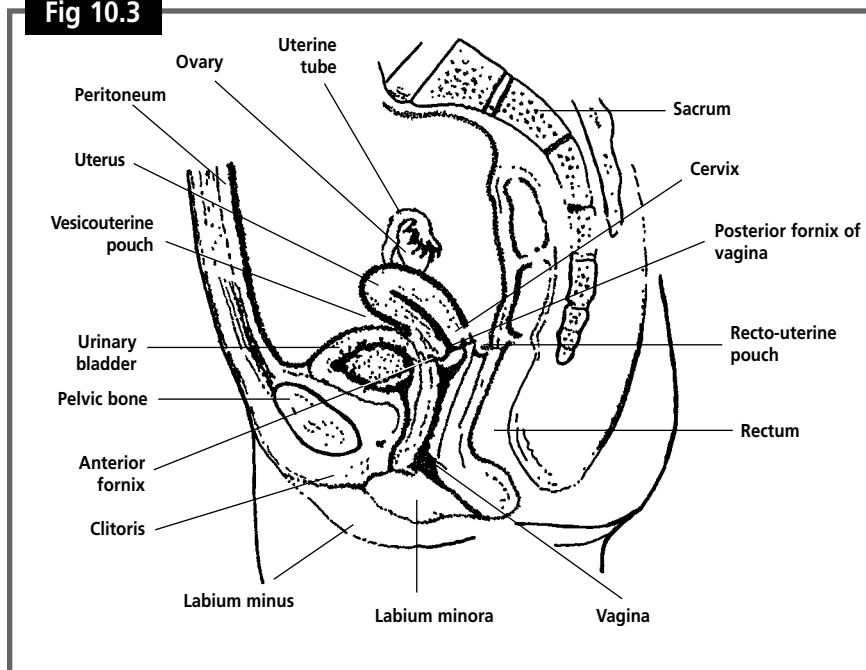
The vagina is a muscular tube lined by stratified epithelium extending from the vestibule to the uterus. It runs upwards and backwards at an angle of 60 degrees from the horizontal between the bladder in front and the anus and rectum behind. [See Fig 10.3]

Definition

VAGINA

The vagina is a muscular tube lined by stratified epithelium extending from the vestibule to the uterus.

Fig 10.3



Section of the female pelvis showing the relationship of the female reproductive organs to the urinary and alimentary tracts.

The vagina forms an angle of about 90 degrees with the uterus. The anterior wall is about 7.5 cm long and the posterior wall about 9 cm long. In a nulliparous adult the vagina is H-shaped in section with transverse ridges or folds called vaginal rugae. The walls of the vagina are highly distensible. Part of the cervix protrudes into the vagina.

The recess between the vaginal part of the cervix and the vaginal walls is termed the fornix. The anterior fornix is the recess between the cervix and the anterior wall of the vagina and it is related to the bladder base and the fossa between the bladder and the uterus. The posterior fornix is the recess between the cervix and the posterior wall of the vagina. The posterior fornix is related to the recto-uterine pouch. It is deeper than the anterior fornix because of the angle that the cervix makes with the vagina. It is the site where semen collects after ejaculation. The lateral fornices are found between the lateral walls of the vagina and the cervix.

Before puberty the rugae are absent. In the elderly, the vagina becomes narrower and less deep. The wall is less elastic and appears pale and smooth due to loss of rugae.

Uterus

The uterus is a hollow organ composed of smooth muscle whose sole function is gestation. It lies between the rectum and the bladder is continuous with the vagina. In a nulliparous adult the uterus is about 7.5 cm long, 5 cm wide and 2.5 cm thick. The uterus is divided into the fundus, body and cervix. [See Fig 10.4]

The fundus is dome-shaped and situated above the opening of the fallopian tubes. The body or corpus is the main part of the uterus and provides the endometrium that is necessary for implantation and growth of the foetus. The body is connected to the cervix at the internal os, where it is narrowest. The cervix protrudes into the vagina as described above and opens into the vagina via the external

Definition

ANTERIOR AND POSTERIOR FORNIX

The anterior fornix is the recess between the cervix and the anterior wall of the vagina and it is related to the bladder base and the fossa between the bladder and the uterus. The posterior fornix is the recess between the cervix and the posterior wall of the vagina.

10.3.2.2

Definition

UTERUS

The uterus is a hollow organ composed of smooth muscle whose sole function is gestation.

FUNDUS

The fundus is dome-shaped and situated above the opening of the fallopian tubes.

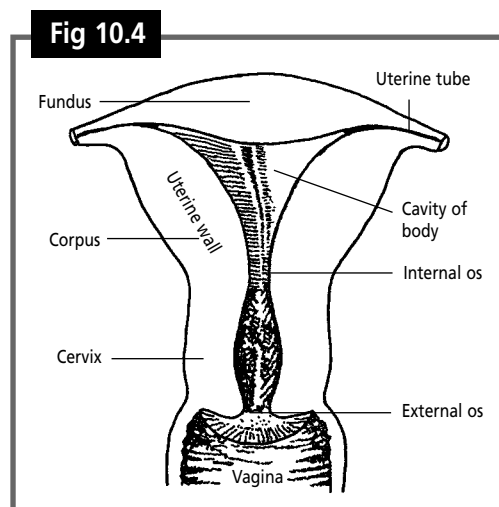


Diagram of the uterus showing the fundus, body and cervix.

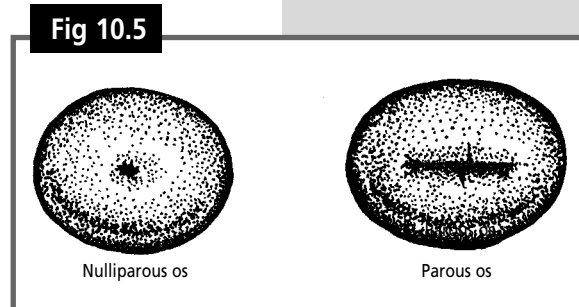


Diagram showing the difference between a nulliparous and a parous external cervical os.

os. The external os is small oval shaped in a nulliparous patient and appears as a transverse slit in a parous patient. [See pg 223, Fig 10.5]

10.3.2.2.1

Changes with age and reproduction

At birth the cervix is larger than the body of the uterus and the difference between the angle of the uterus and that of the vagina is relatively small. The uterus proceeds to grow relatively slowly until puberty, after which it grows rapidly until its adult size and shape is reached.

At puberty which usually occurs between the age of 8 and 14 years the following changes occur: the uterus and ovaries reach maturity; ovulation and the menstrual cycle begins; the breasts become larger [See pg 227, Table 10.1]; the pubic and axillary hair begin to grow [See pgs 231-232, Table 10.3]; the height and width of the pelvis increases; and there is an increase in subcutaneous fat.

The uterus becomes smaller after the menopause and becomes more fibrous and paler in colour. The senile endometrium is thin and fibrotic and the cervix is smaller and may become flush with the walls of the vaginal vault. The external os may become narrow or obliterated.

During menstruation the uterus becomes more vascular and somewhat enlarged. The external os becomes rounded and its lips swollen. During pregnancy the size of the uterus increases greatly. In the 12th week the fundus rises above the level of the pubic symphysis and it increases in size progressively until it reaches the xiphisterum in the 36th week. [See Fig 10.6]

After the 36th week the height of the fundus decreases by about 1cm per week and at 40 weeks the height of the fundus is almost the same as in the 32nd week. The uterus increases in weight during pregnancy and its walls become thinner. After delivery, the uterus reduces in size and weight and reaches its resting state in 6-8 weeks.

At this stage it is usually about 1 cm larger in all its dimensions. The uterine cavity is somewhat larger and the opening of the external os becomes irregular.



UTERUS GROWTH DURING PREGNANCY

During pregnancy the size of the uterus increases greatly. In the 12th week the fundus rises above the level of the pubic symphysis and it increases in size progressively until it reaches the xiphisterum in the 36th week.

Fig 10.6

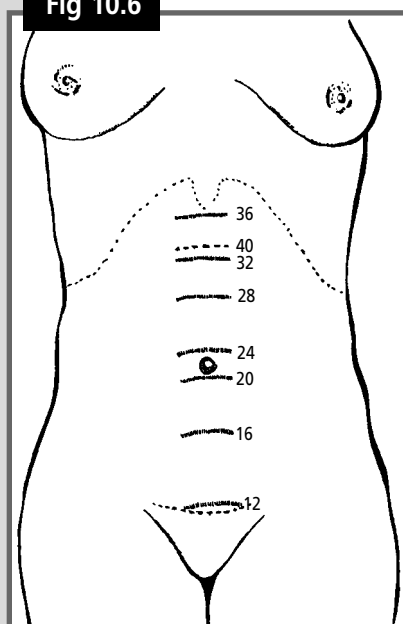


Illustration showing gestational period by the height of the fundus.

10.4

Perineum and anus

Perineum

The perineum is a term that describes the area between the posterior commissure and the anus. [See pg 228, Fig 10.2] With ageing, the skin becomes more pigmented.

Anus

The anus is the opening of the anal canal. The anal canal is about 3-4 cm long and extends from the perineal skin to the rectum. The junction between the anal canal and the perineal skin is called the anal verge. The boundary between the anal canal and the rectum is the dentate line that consists of downward pointing rectal columns and upward pointing anal papilla. [See Fig 10.7]

The lining of the anus varies along its course. Externally it is lined by skin that is sensitive, pigmented and hair bearing. The interior of the anus is lined by mucosa that is pink and moist but lacks hair and glands, and is pain-insensitive. In its empty state, the lumen of the anus is Y-shaped or a triradiate slit with the long arm of the Y pointing downwards.

The internal and external anal sphincters surround the anal canal.

10.4.1

10.4.2

Definition

PERINEUM

The perineum is the area between the posterior commissure and the anus.

ANUS

The anus is the opening of the anal canal.

Fig 10.7

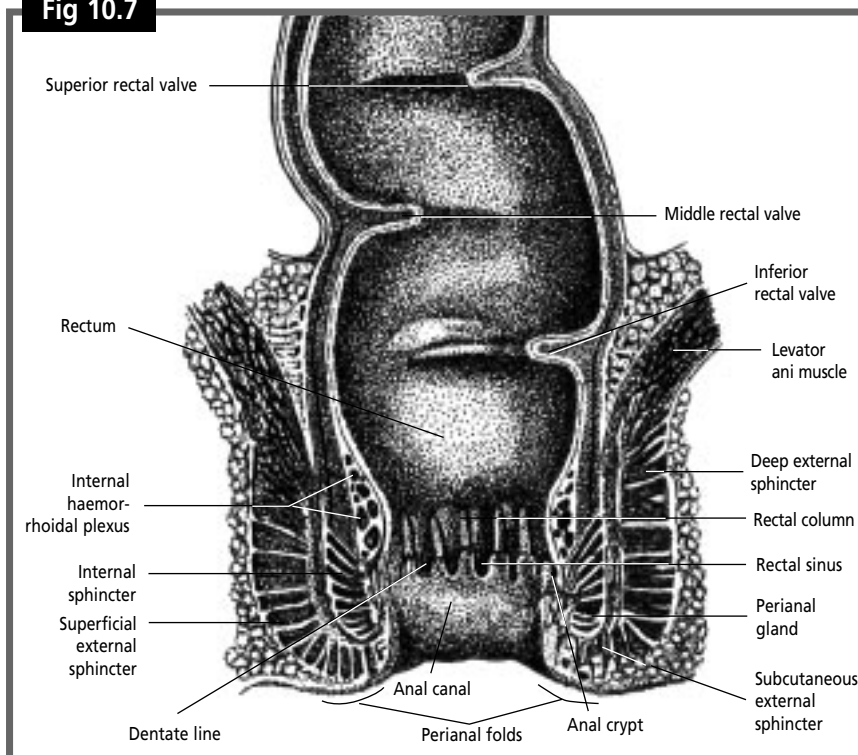


Diagram showing the anatomy of anus and rectum.



RECTUM

The rectum is found above the dentate line and is positioned between the anal canal and the sigmoid colon.

[See Fig. 10.7] The internal anal sphincter is a continuation of the circular muscle layer of the rectum. The external anal sphincter comprises of skeletal muscle that extends along the length of the anal canal and encloses the internal sphincter. During a digital rectal examination, the finger is resisted first by the external sphincter and then by the internal sphincter and other muscles.

The rectum is found above the dentate line and is positioned between the anal canal and the sigmoid colon. [See pg 235, Fig. 10.7] It is about 12 cm long and is lined by red colonic mucosa and tends to be pain insensitive.

10.5

The female human sexual response



ORGASM

During the orgasmic stage regular contractions of the outer one-third of the vagina occur and there are involuntary contractions of the rectal sphincter.

The normal human sexual response prepares individuals for sexual intercourse. It has been described as occurring in four phases: excitement, plateau, orgasmic and resolution. During the excitement phase the female genital tract prepares to receive the penis by increasing lubricating secretions and by muscle relaxation. The inner two-thirds of the vagina starts to expand. In the plateau stage the labia minora engorge in order to open the vaginal orifice and to support the penis and the inner two-thirds of the vagina lengthens further. During the orgasmic stage regular contractions of the outer one-third of the vagina occur and there are involuntary contractions of the rectal sphincter. At the resolution phase there is a loss of tension and a gradual return to the pre-excitement or unstimulated stage.⁴

10.6

Male reproductive system

The male reproductive system consists of the penis, scrotum (which contain the testes and epididymides), the vasa deferens, the seminal vesicles, and the prostate gland. [See pg 237, Fig 10.8] The penis and scrotum are referred to as the external genital organs and are described overleaf.

Fig 10.8

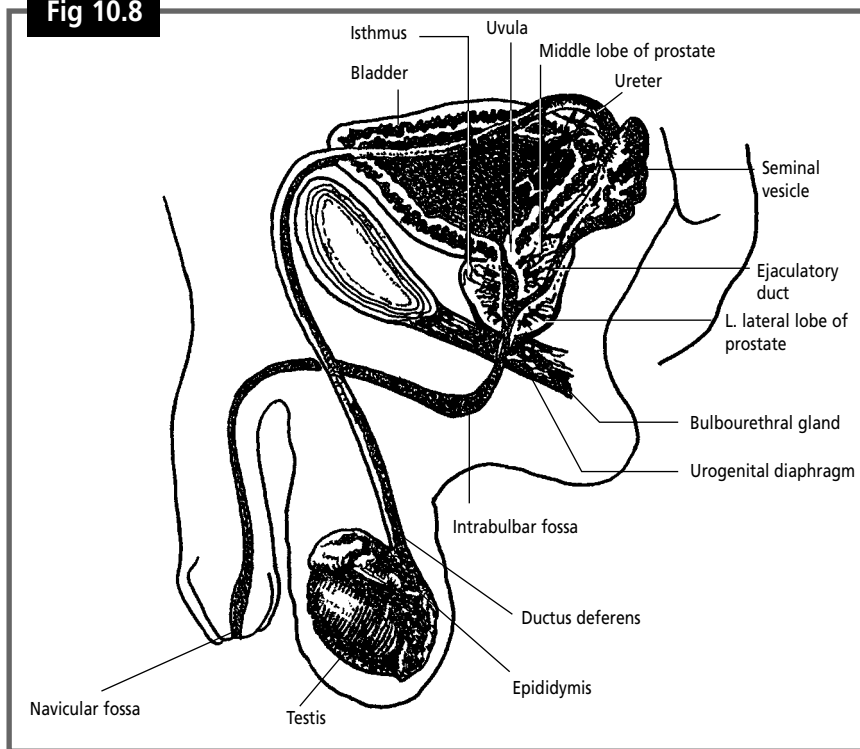


Diagram illustrating the different parts of the male reproductive system.

Definitions

PENIS

The penis is an erectile organ with a rich blood supply and consists of a cylindrical shaped penile shaft with an enlarged area called the glans at the distal or free end.

SCROTUM

The scrotum is a sac made up of pigmented skin which is divided into two parts.

SEMEN

Semen is made up of a cellular component or spermatozoa and a lubricating viscid fluid that contains secretions from the seminal vesicles and prostate gland.

Penis

The penis is an erectile organ with a rich blood supply and consists of a cylindrical shaped penile shaft with an enlarged area called the glans at the distal or free end. [See Fig 10.8] The opening of the urethra or urethral orifice is situated at the glans. The glans is usually covered by a foreskin except in circumcised males where it may be partially or totally removed. The flaccid penis has an average length of 8.5 cm and a circumference of 3.5 cm. During erection the length may increase to an average of 16 to 19 cm and the diameter of the glans may increase to an average of 3.5 cm.⁵

Scrotum

The scrotum is a sac made up of pigmented skin which is divided into two parts, each of which contains a testis, an epididymis and the testicular part of the spermatic cord. [See Fig 10.8] The scrotum is found below the symphysis pubis, in front of the thighs and behind the penis.

Semen

During coitus semen is ejaculated from the urethra. Semen is made up of a cellular component or spermatozoa and a lubricating viscid fluid that contains secretions from the seminal vesicles and prostate gland. Even if spermatozoa is absent from the ejaculate (e.g. in a person who has had a vasectomy) seminal fluid will be present and can be confirmed by testing for prostatic antigens.

10.6.1

10.6.2

10.6.3



EJACULATION

An average ejaculation releases 2-5 ml of semen, which may contain 40 - 100 million spermatozoa per ml.

An average ejaculation releases 2-5 ml of semen, which may contain 40 - 100 million spermatozoa per ml. About 75% of spermatozoa are motile after ejaculation. The motility decreases with time and only 50% are motile after 7 hours. Each spermatozoon or sperm consists of a head, neck, body and tail. [See Fig 10.9]

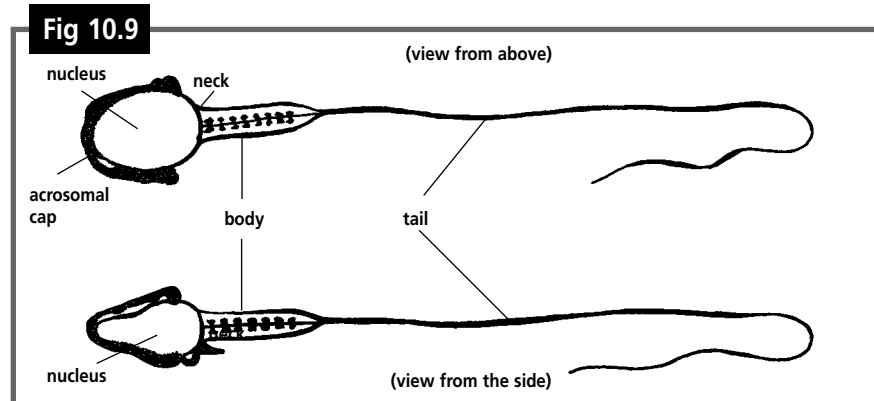


Diagram showing the microscopic anatomy of a spermatozoon.





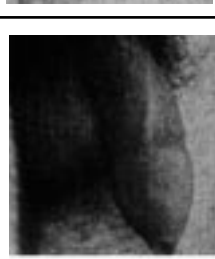
10.6.4

Changes in the male at puberty

Puberty occurs in the male between 9 and 14 years of age. The changes observed are: growth in muscle and bone; increased height and weight; enlargement of the larynx and deepening of the voice; growth of hair on the face, axillae, chest, abdomen and pubis; an increase in size of the penis, scrotum and prostate gland; and the production of spermatozoa. As sexual maturity increases there is darkening of the scrotal skin with the development of rugae. The Tanner's scale for sexual maturation in males uses the appearance of pubic hair, the penis and the scrotum. [See pg 239, Table 10.4] Although there is no clear-cut age of menopause in the male, sexual ability and fertility tend to decline in the elderly.

TABLE 10.4

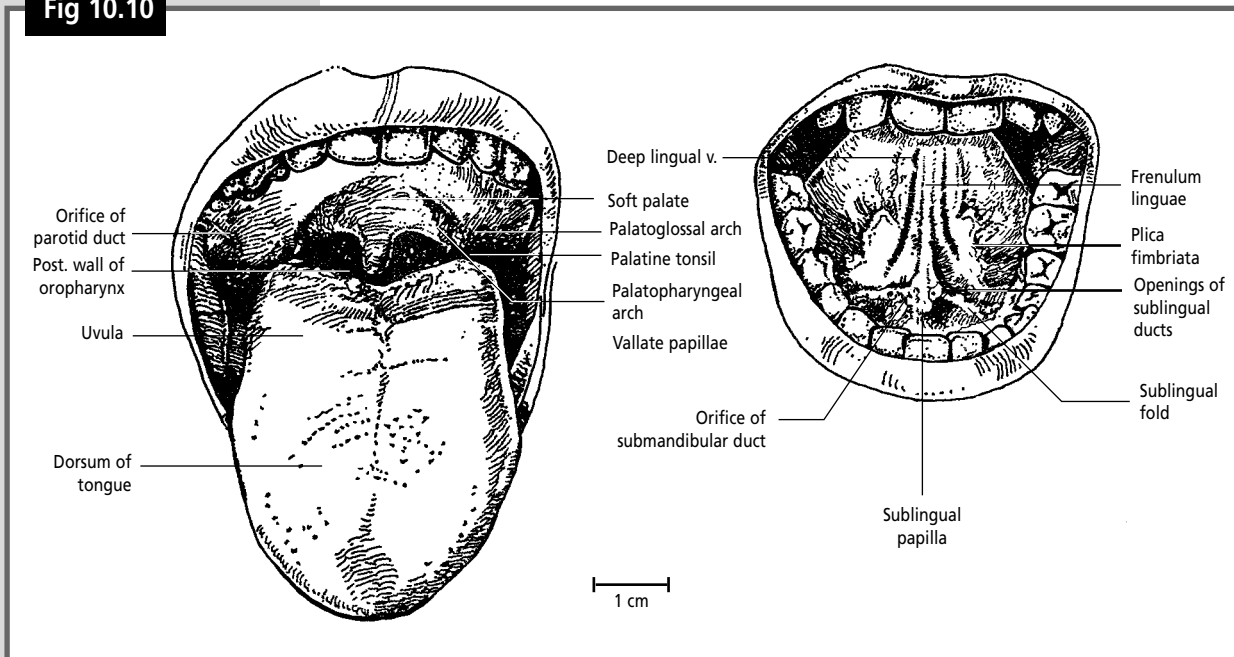
Tanner's scale of male sexual development^{6,7}

Stage	Pubic hair	Penis	Scrotum	Diagrammatic representation
1	No true pubic hair, fine vellus hair as on the abdomen	From birth to puberty - penis gradually increases in overall size with little change in general appearance	From birth to puberty - scrotum gradually increases in overall size with little change in general appearance	
2	Sparse growth of slightly pigmented straight or slightly curled hair mainly on either side of base of penis	Slight or no enlargement of penis	Testes and scrotum larger, skin of scrotum slight changes in texture and colours (redness)	
3	Darker, coarser curlier hair spreading sparsely over the symphysis pubis	Further enlargement of penis in length and width	Further enlargement and descent of scrotum	
4	Pigmented, coarse and curly hair but not as extensive coverage as in the adult and no spreading to medial thighs	Further enlargement in dimensions and development of glans	Further enlargement; scrotal skin more pigmented	
5	Adult size and shape (inverse triangle) spreading to medial thighs	Adult in size and shape	Ample scrotum	

10.7 The oral cavity

The mouth or oral cavity is a space that is surrounded by the lips in the front, the pharynx at the back, the cheeks on the sides, the palate on the top and the tongue and the floor of the mouth on the bottom. [See pg 240, Fig 10.10] The lips are two mobile folds which contain

Fig 10.10



The oral cavity showing tongue, palate and saliva glands.



THE TONGUE

The tongue's surface is normally moist and pink and has a rough appearance due to the papillae. Sometimes the tongue may have a white coating on it ('furring').

muscle and fibrous tissue that bound the opening of the mouth. The lips are covered on the outside by skin and internally by mucous membrane. The sharp junction between the two is known as the vermilion border. The inner parts of the lips are attached in the midline to the gums by the frenulum of the upper and lower lips.

The hard palate forms the front part of the roof of the mouth. The soft palate lies behind the hard palate on the roof the mouth and blends with the walls of the pharynx at the sides. The cheeks and the inner part of the lips are lined by mucous membranes that attaches to the gums. The uvula is a fold of muscle covered by mucous membrane that hangs down from the midline of the soft palate. Attached to the midline of the top of the soft palate are two pairs of arches on each side of the mouth. The front arches are referred to as the palatoglossal arches and the back pair as the palatopharyngeal arches. Between the arches on each side lies the palatine tonsil. The tongue is a muscular mobile structure over the floor of the mouth, which is covered by a mucous membrane that has numerous projections or papillae on the top or dorsal surface. The surface is normally moist and pink and has a rough appearance due to the papillae. Sometimes the tongue may have a white coating on it ('furring'). The undersurface of the tongue is smooth and attached by a fold of mucous membrane, the frenulum, to the floor of the mouth.