EIGHTH EDITION

handbook of OBSTETRICS & GYNECOLOGY

RALPH C. BENSON

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OBSTETRICS & GYNECOLOGY

Preface

The eighth edition of *Handbook of Obstetrics & Gynecology* has been virtually rewritten, with the addition of much new material. All of this reflects the "information explosion" in this as in other medical specialties. The objective continues to be to provide a readily available source of practical current obstetric and gynecologic information for health care professionals.

This book is not intended to serve as a substitute for a primary textbook but does contain the essentials of diagnosis and treatment of obstetric and gynecologic disorders. Procedures and medications (with dosages and routes of administration, together with alternatives) are presented, but the choice is rarely inclusive or absolute.

This edition includes a new chapter on embryology of the female reproductive tract and new sections on physiologic changes during pregnancy, toxic shock syndrome, and hirsutism. The sections on fetal and neonatal organ function, infections during pregnancy, shoulder dystocia, sexually transmitted diseases, hemolytic disease of the newborn, shock and disseminated intravascular coagulation, urinary stress incontinence, and premenstrual tension have been extensively revised. Much new information has been incorporated into the sections on preeclampsia-eclampsia, high-risk pregnancy, fetal monitoring, and ultrasonography.

The popularity of this handbook overseas is suggested by the availability of translations in Spanish, Portuguese, Italian, and Polish. Serbo-Croatian and Japanese translations are in preparation. In addition, English editions for distribution in Asia are printed in Singapore, Taiwan, Korea, and the Philippines; and a Middle East edition, also in English, is published in Beirut.

I wish to thank my colleagues and readers here and abroad for their valued support and suggestions.

Ralph C. Benson, MD

Portland, Oregon
October, 1983

NOTICE

The author has been careful to recommend drug dosages that are in agreement with current official pharmacologic standards and the medical literature. Because all drugs may evoke idiosyncratic or toxic reactions, because drugs may interact with others in ways that modify therapeutic effectiveness and toxicity, and because some drugs are teratogenic, it is recommended that all clinicians review drug manufacturers' product information (eg, package inserts), especially in the case of new or infrequently prescribed medications. Furthermore, one must be thoroughly conversant with any drugs used in order to advise the patient about signs and symptoms of potential adverse reactions and incompatibilities.

The Author

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Section II: Gynecology

Embryology of the Female Urogenital Tract | 1

FORMATION & EARLY DEVELOPMENT

As early as the first week following implantation of the fertilized ovum, an evagination of the hindgut forms the allantois, the tubular forerunner of the bladder. After the second week, the gut caudal to the origin of the allantois widens to form the cloaca, an incompletely developed urogenital ostium extending from the umbilical stalk to the rudimentary tail—virtually the extent of the inferior ventral aspect of the embryo—into which the gut, the allantois, and the mesonephric ducts open (Fig 1–1). In the fourth week, the cloaca begins to divide into a dorsal portion (the hindgut) and a ventral portion (the urogenital sinus). The tissue separating these 2 structures, the urorectal septum, inserts at the junction of the allantois and the gut. Separation is complete by the eighth week.

Initially, the cloaca does not open to the outside but ends abruptly in a thin partition, the cloacal membrane, which lies in a slight depression (the proctodeum, or anal pit) just anterior to the short tail segment. Normally, the membrane disintegrates by about the eighth week, opening the hindgut and the urogenital sinus to the exterior. The lower hindgut becomes the rectum; its exit is the anus. The external opening of the urogenital sinus is the urogenital ostium.

When the cloacal membrane fails to disintegrate, an imperforate anus results. In females, a rectovaginal fistula, the result of incomplete subdivision of the cloaca, will often be present as well.

DEVELOPMENT OF THE RENAL EXCRETORY APPARATUS

In the first stage of kidney development, the pronephros (primordial kidney) exists from the third to the fourth week of embryonic life. It may transport coelomic fluids. It consists of an incomplete duct with numerous lateral vestigial excretory tubules in the posterolateral mesoderm. The lateral tubules disappear, but the main duct persists and continues to develop longitudinally, becoming the mesonephric (wolffian) duct.

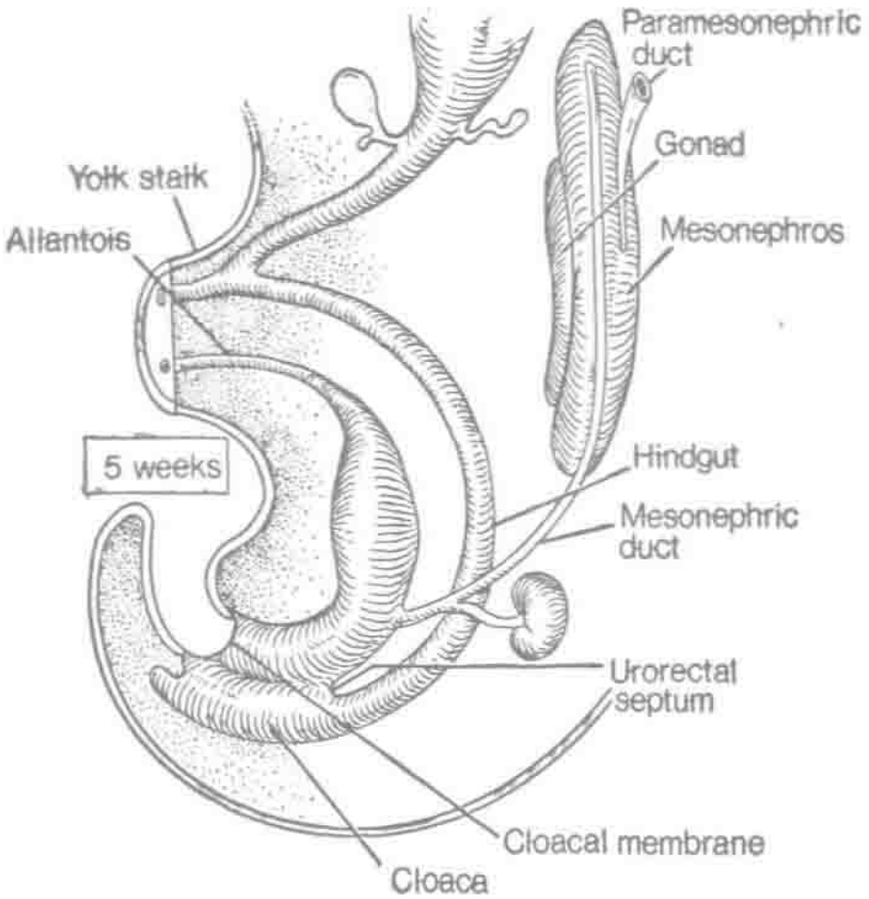

Figure 1–1. Diagrammatic left lateral view of urogenital system in relation to the hindgut at about 5 weeks. The paramesonephric duct does not appear until the sixth week but is shown here to indicate its position and downgrowth. (Reproduced, with permission, from Bacon RL: Chapter 1 in *Current Obstetric & Gynecologic Diagnosis & Treatment,* 4th ed. Benson RC [editor]. Lange, 1982.)

The mesonephros, the second stage in kidney development, extracts waste products from the coelomic fluid and blood. It is located in the lower thoracic, upper lumbar region of the embryo. The mesonephric duct extends caudally to join the cloaca, from which the bladder will later develop. Mesonephric tubules, together with neighboring blood vessels, soon form primitive glomeruli along the duct, the more cephalic of these degenerating as the more caudal ones develop. Degeneration of the mesonephric tubules is almost complete by the ninth week of embryonic life, but a few may persist in females as Gartner's duct or as the epoophoron or paroophoron. In males, the mesonephric duct becomes the epididymis and vas deferens. As the mesonephric tubules grow and degenerate, the metanephric diverticulum (ureteric bud) grows out from the mesonephric duct slightly cephalad to the cloaca to become the ureter and the metanephros, the true kidney.

The metanephros removes catabolic wastes from the blood and largely controls fluid and electrolyte balance. The metanephros and its ureter appear at about the fourth week on each side as a dorsolateral bud from the wolffian duct near the cloaca. These permanent kidneys de-

velop rapidly. The ureter becomes independent of the wolffian ducts, and separate ureteral openings into the cloaca are formed promptly.

At about the fifth or sixth week, the ureter divides within the metanephric mass to form calices. Collecting and secretory tubules begin to radiate into the renal mesenchyme from the calices to connect with glomeruli, which appear in the renal cortex at about the same time. The metanephric excretory units develop as those of mesonephric origin atrophy, but the wolffian ducts remain, at least until sexual differentiation has occurred. The metanephros gradually migrates from the medial to the lateral aspect of both the wolffian and the müllerian ducts. As it migrates, it rotates about 90 degrees on its long axis. Meanwhile, the embryo elongates, mainly as a result of growth of the body segments, so that the kidney is ultimately situated in the dorsolumbar region and a long ureter develops.

The terminal wolffian ducts join the cloaca just below the juncture of the allantois and cloaca. Between the second and third months, the lower ends of the wolffian ducts progressively widen, the allantoic stoma opens appreciably, and the upper (urogenital) part of the cloaca becomes separated from the lower (rectal) portion. Thus, the bladder is formed from endodermal and mesodermal elements. Extreme maldevelopment results in exstrophy of the bladder.

The allantoic extension in the umbilical ligament and cord becomes the urachus, which may fail to obliterate late in fetal life. Urine may drain from an umbilical urachal fistula after delivery.

In males, the prostatic urethra develops from the terminal portion of the wolffian ducts, the membranous urethra from a subdivision of the urogenital sinus, and the penile urethra (in part ectodermal) from the closure of a groove beneath the phallus. In females, the origins are similar but there is, of course, no penile urethra and the prostate remains vestigial.

DEVELOPMENT OF THE ADRENAL (SUPRARENAL) GLANDS

The adrenal glands develop from cells that migrate into the region of the developing mesonephros as early as the fifth week. Each adrenal gland has a cortex composed of mesodermal cells that originate from the early urogenital ridge and a medulla composed of ectodermal cells that originate from the crest of neural folds in approximately the same somites as the cortical cells. Later, layering occurs, so that the medullary cells are covered by those of the cortex. Eventually, the adrenal glands occupy positions over the superior pole of the kidney on each side.

The fetal adrenal glands are relatively large. At term, they constitute about 0.2% of the body weight and are 20 times the size of those in

the adult relative to body weight. This attests to their importance in fetal life. The large size is primarily due to the enlarged cortex. The fetal cortex comprises 80% of the cortex; it undergoes rapid degeneration at birth. The remaining 20%, the permanent cortex, does not become fully differentiated until almost 3 years after birth. Regression of the fetal cortex is not complete until adulthood.

Pelvic tumors that produce hormones associated with adrenal medullary cell types, eg, argentaffinomas, may involve the ovaries or retroperitoneal tissues. The tumor cells suggest primitive adrenal cells that may have been "lost" during their migration to the eventual site of the adrenal gland.

ORIGIN OF THE FEMALE GENERATIVE DUCTS

An embryo 6 weeks of age reveals the beginnings of the müllerian ducts, which become the uterine tubes, uterus, cervix, and part of the vagina. On each side, these new channels develop parallel to the wolffian duct, just lateral to the mesonephric structures in the lumbodorsal mesenchyme. The müllerian system develops caudally and ventrally to converge and end near the cloaca (Fig 1–2). The cephalad portions of the müllerian ducts become the uterine tubes, which open to the peritoneal cavity. The upper end of the müllerian duct is often marked by a small persistent cyst (hydatid cyst of Morgagni) attached to one of the tubal fimbria. At the caudad end, the ducts fuse in the midline to form a central canal from which develop the uterus, cervix, and upper two-thirds of the vagina. Concomitantly, an invagination of the inferior part of the urogenital sinus is converted into the lower third of the vagina. Thus, endometrial and endocervical cells are of mesodermal (müllerian) origin, but exocervical and vaginal epithelium are derived from endodermal (urogenital sinus) cells.

The hymen is the vestige of the barrier between the descending müllerian core and the urogenital sinus. The uterus, cervix, and upper vagina are at first solid and then become septate. The cervix is the first part of the müllerian system to lose its longitudinal septum; then the vagina; and finally, at 4–5 months, the uterus. Partial or total failure of disappearance of these septa results in abnormal septa found in later life.

The wolffian ducts continue distally from below the ovary and pass just lateral to the uterus within the folds of the broad ligament; they traverse the peripheral tissues of the cervix and proceed down the anterolateral vaginal wall to the introitus. Normally, most of the unessential wolffian structures disappear, but mesonephric tubules may persist as the vestigial epoophoron and paroophoron within the mesovarium. Parovarian cysts and Gartner's cysts are benign neoplasms

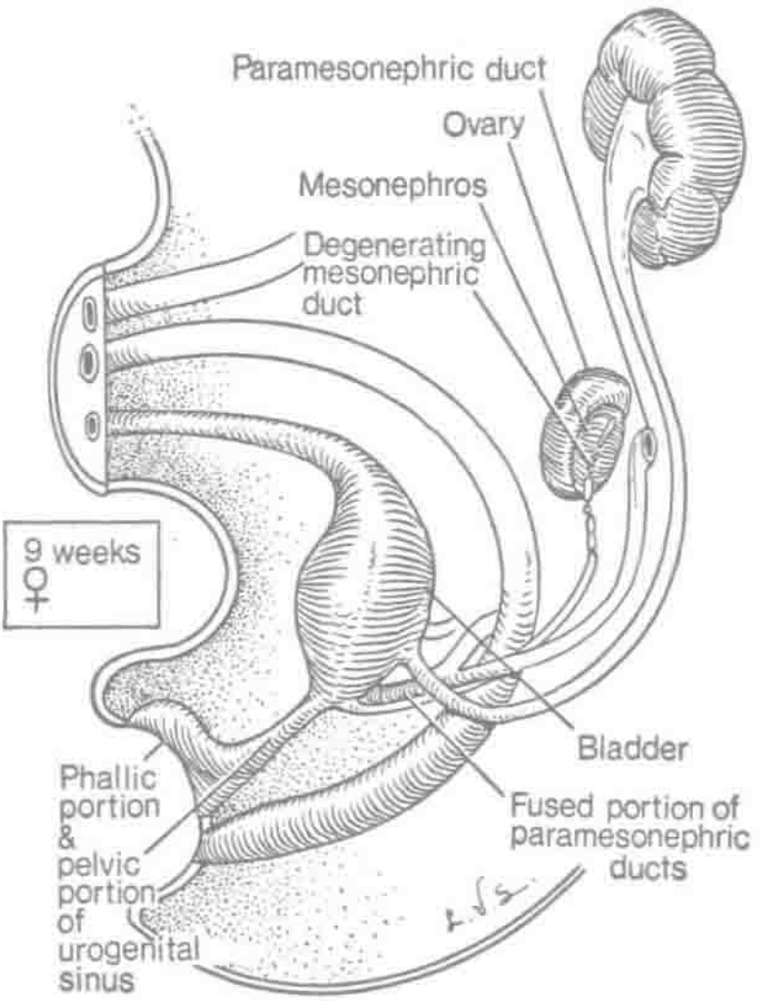

Figure 1–2. Diagram of female reproductive tract at an early stage of sexual differentiation (about 9 weeks). (Reproduced, with permission, from Bacon RL: Chapter 1 in *Current Obstetric & Gynecologic Diagnosis & Treatment,* 4th ed. Benson RC [editor]. Lange, 1982.)

of wolffian duct origin that may require excision. Carcinomas or cysts of wolffian origin are uncommonly discovered in females after birth.

ORIGIN OF THE GONADS

Primitive Stage

At about the fifth or sixth week of embryonic life, the genital ridges form in the right and left dorsolumbar regions within the coelomic cavity. These developments involve the medial aspect of the mesonephric mesenchyme on each side. The cephalad portions of the ridges become the gonads. Finally, the genital ridges separate from the mesonephros. A few mesonephric tubules may remain as vestiges in the epoophoron. Low cells of mesodermal origin line the coelomic cavity and cover the genital ridge. Concomitantly, primordial sex cells migrate from the yolk stalk across the gut mesentery into the cortex of the gonads. Meanwhile, broken columns of partially differentiated cells (Waldeyer's cords), which later become partially canalized (Pflüger's

tubules), appear within the substance of the early gonad, apparently as a downgrowth of superficial cells.

Indifferent (Neuter) Stage

Before the sixth to seventh week after nidation, the gonads are sexually indistinct. Soon thereafter, the gonads differentiate into male or female structures according to the chromosomal inheritance of the fetus and hormonal influences. Sex hormones of endogenous or exogenous origin stimulate or retard full fetal genital development.

Stage of Ovarian Development

If the conceptus is destined to become a female, the sex cells seem to organize the mesenchymal elements of the gonad by the eighth week. Primordial clusters of ova develop as islands of cells containing one large primitive ovum surrounded by smaller, moderately differentiated cells that will become granulosa cells. Less well differentiated stromal cells become theca cells, and completely nondescript elements remain in the connective tissue series. Waldeyer's cords and the subsequent Pflüger's tubules, essential in testicular development but not required by the ovary, disappear in females. A few vestiges may remain, and these account for unusual cell patterns or even rare ovarian tumors such as Pick's adenoma.

ORIGIN OF THE EXTERNAL GENITALIA

The external genitalia of males and females are similarly derived from the cloacal ectoderm. The genital or cloacal tubercle and the coccygeal tubercle mark the anterior and posterior extensions of the proctodeum. The genital tubercle becomes the mons and clitoris in the female and the penis in the male. The anus forms just forward of the coccygeal tubercle. Labioscrotal folds develop on each side of the urogenital cleft. In females, these ridges become the labia. In males, scrotal pouches develop as fingerlike projections of the peritoneum, and the testes descend into these recesses through the inguinal canals after the 36th week.

In females, fatty tissue soon fills the labia majora. Although peritoneal downgrowths do form as in males, they are imperfect and are rapidly obliterated. In rare individuals, vestiges of the peritoneal extensions persist as cysts of the canal of Nuck. The distal end of the vagina is at first separated from the urogenital sinus by a membrane. If this barrier does not disintegrate properly, an imperforate or abnormally thick hymen results. The urogenital cleft remains patent, providing access to the vaginal introitus and the urethral meatus.

In males, the scrotal folds fuse in the midline, causing partial

closure of the urogenital cleft and displacing forward the small remaining opening, the incompletely formed urethra. The genital tubercle rapidly becomes the penis. The remaining urogenital cleft defect closes completely when the edges of the ventral tract between the corpora cavernosa adhere to complete the terminal urethra. Because of these changes and the small size of the parts, the sex of the fetus cannot be determined clinically with confidence until after the 26th week.

2 | Anatomy & Physiology of the Female Reproductive System

The female reproductive system may be divided into the external and internal genitalia and their supporting structures.

The external genitalia (Fig 2–1), collectively termed the pudendum or vulva, comprise the following structures, all easily visible on external examination: mons veneris (mons pubis), labia majora, labia minora, clitoris, vestibule and external urethral meatus, Skene's glands (paraurethral glands), Bartholin's glands (vulvovaginal glands), hymen, fourchette, perineal body, and fossa navicularis. They present varying contours around the urogenital cleft, which lies anteroposteriorly between the vaginal and urethral openings. The contours of the external genitalia are determined by the bony configuration of the anteroinferior pelvic girdle as well as by the subcutaneous fat, muscle, and fascial arrangement.

The internal genitalia comprise the vagina, cervix, uterus, uterine (fallopian) tubes, and ovaries. They require special instruments for inspection; the intra-abdominal group can be examined visually only by laparotomy, laparoscopy, or culdoscopy (invasive methods) or by contrast ultrasonography or roentgenography (noninvasive methods).

The anatomy of the bony pelvis and the pelvic floor is discussed on pp 26–29.

EXTERNAL GENITALIA

MONS VENERIS
(Mons Pubis)

General Appearance

The mons veneris, a rounded pad of fatty tissue overlying the symphysis pubica, develops from the genital tubercle. It is not an organ but a region or a landmark. Coarse, dark hair normally appears over the mons early in puberty.

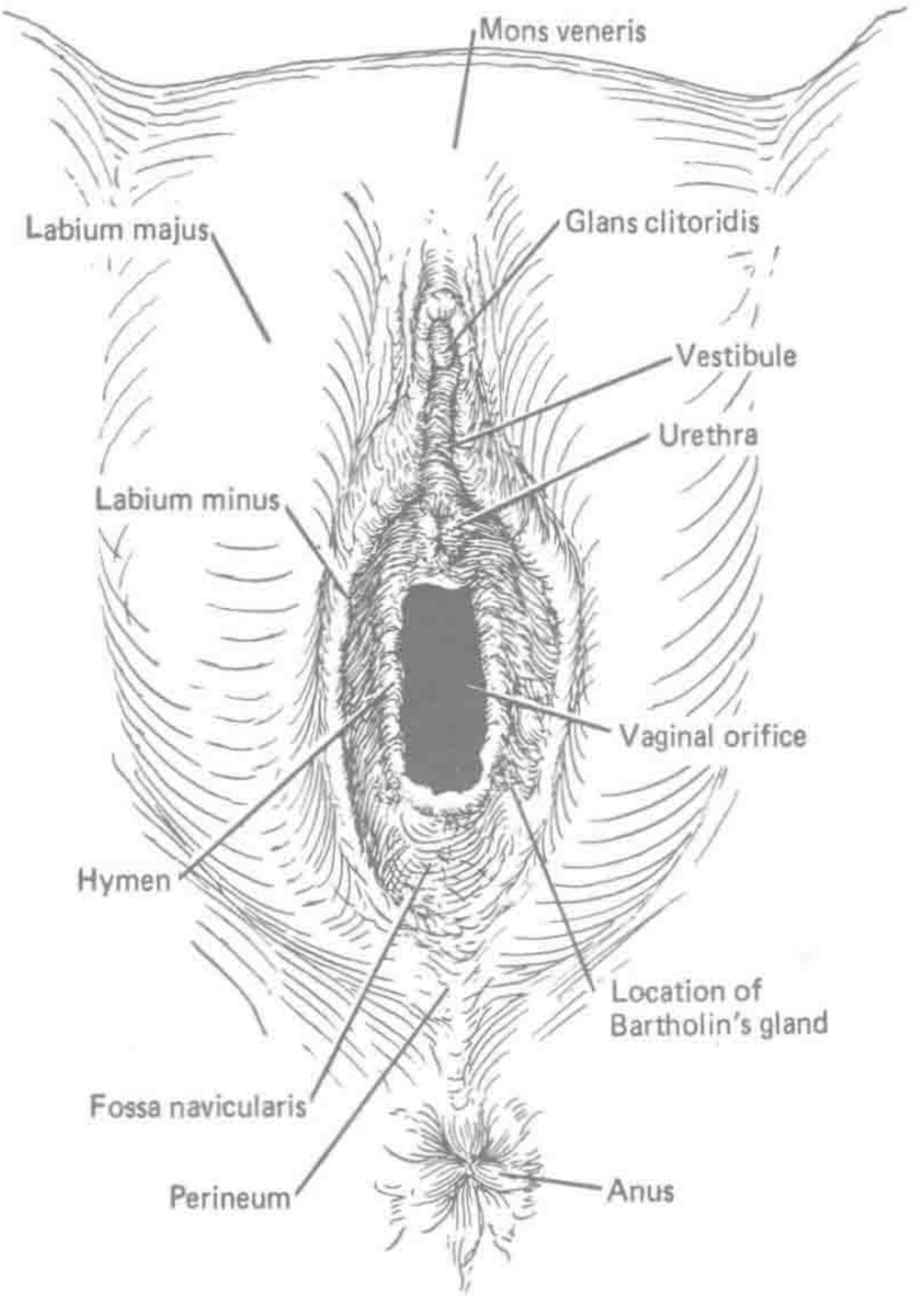

Figure 2–1. External female genitalia.

During reproductive life, the pubic hair is abundant, but after the menopause it becomes sparse. The normal female escutcheon is typically a "triangle with the base up," in contrast with the "triangle with the base down" male pattern.

Histology

The skin of the mons contains sudoriferous and sebaceous glands. The amount of subcutaneous fat is determined by nutritional and possibly by steroid hormonal factors.

Innervation

The sensory nerves of the mons are the ilioinguinal and genitofemoral nerves.