primary sex organs = gonads
produce gametes
secrete hormones that control reproduction
secondary sex organs = accessory structures

**Development and Differentiation**

A. gonads develop from mesoderm starting at week 5

- gonadal ridges medial to kidneys
- germ cells migrate to gonadal ridges from yolk sac

at week 7, if an XY embryo secretes SRY protein, the gonadal ridges begin developing into testes with seminiferous tubules

the testes secrete androgens, which cause the mesonephric ducts to develop

the testes secrete a hormone that causes the paramesonephric ducts to regress

by week 8, in any fetus (XX or XY), if SRY protein has not been produced, the gondal ridges begin to develop into ovaries with ovarian follicles

the lack of androgens causes the paramesonephric ducts to develop and the mesonephric ducts to regress

B. accessory organs develop from embryonic duct systems

- mesonephric ducts / Wolffian ducts eventually become male accessory organs: epididymis, ductus deferens, ejaculatory duct

- paramesonephric ducts / Mullerian ducts eventually become female accessory organs: oviducts, uterus, superior vagina

C. external genitalia are indeterminate until week 8

<table>
<thead>
<tr>
<th></th>
<th>male</th>
<th>female</th>
</tr>
</thead>
<tbody>
<tr>
<td>genital tubercle</td>
<td>penis (glans, corpora cavernosa, corpus spongiosum)</td>
<td>clitoris (glans, corpora cavernosa), vestibular bulb</td>
</tr>
<tr>
<td>urethral folds</td>
<td>fuse to form penile urethra</td>
<td>labia minora</td>
</tr>
<tr>
<td>labioscrotal swellings</td>
<td>fuse to form scrotum</td>
<td>labia majora</td>
</tr>
<tr>
<td>urogenital sinus</td>
<td>urinary bladder, urethra, prostate, seminal vesicles, bulbourethral glands</td>
<td>urinary bladder, urethra, inferior vagina, vestibular glands</td>
</tr>
</tbody>
</table>

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Male

A. gonads = testes (singular = testis) located in scrotum

1. outer coverings
   a. tunica vaginalis = double layer of serous membrane that partially surrounds each testis; (figure 24.29)
   b. tunica albuginea = fibrous capsule that forms outer wall of testis
      septa divide testis into lobules

2. seminiferous tubules (function = spermatogenesis)
   located in lobules
   highly coiled tubules contain spermatogenic and sustentacular (Sertoli) cells

   a. spermatogenic cells:
      embedded between sustentacular cells
      as they develop, they move from the outside towards the lumen of the tubule (basal compartment to adluminal compartment)

   ① spermatogonia
      stem cells
      located peripherally
      least differentiated
      divide by mitosis
      type A daughter cell becomes stem cell
      type B daughter cell differentiates to become primary spermatocyte

   ② primary spermatocytes (diploid, 2n=46)
      undergo meiosis I (halving of chromosome number, separation of homologous chromosomes)

   ③ secondary spermatocytes (haploid, 1n=23)
      connected by cytoplasmic bridge that allows "Y" spermatocytes to obtain genetic instructions from "X" spermatocytes
      undergo meiosis II (chromatids separate)

   ④ spermatids (haploid)
      connected by cytoplasmic bridge
      differentiate
spermatozoa or sperm (haploid)
   head - acrosome and nucleus
   midpiece - mitochondria
   tail - flagellum

b. sustentacular cells (Sertoli cells) extend from basal lamina to lumen
   transport nutrients to spermatogenic cells
   move spermatogenic cells towards lumen
   phagocytize extra cytoplasm
   secrete testicular fluid
   secrete androgen-binding protein
   secrete inhibin (hormone)
   form tight junctions (blood-testis barrier) that prevent contact between spermatogenic cells and immune system

basal compartment is outside of tight junctions that form blood-testis barrier;
   contains spermatogonia and type B daughter cells

type B daughter cells move through tight junctions to enter adluminal compartment (inside tight junctions that form blood-testis barrier)

all subsequent stages of spermatogenic cells are inside the adluminal compartment

c. myoid cells - located outside tubules; similar to smooth muscle; contract rhythmically

d. interstitial cells (Leydig cells) -
   located outside of seminiferous tubules
   secrete androgens

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3. remaining testicular tubule system:
   a. tubulus rectus - where seminiferous tubules converge
   b. rete testis - network of tubules connecting tubuli recti and efferent ductules
   c. efferent ductules - empty into epididymis; wall contains ciliated e. and smooth m.

B. scrotum - sac of skin and fascia
   located posterior to penis
   suspends testes outside of body cavity (spermatogenesis requires a temperature of 34 degrees C)
   dartos m. = smooth muscle in scrotal fascia; wrinkles scrotal skin (decreases surface area)
   cremaster m. = skeletal muscle between fascia and tunica vaginalis; extends from internal oblique muscles through spermatic cord to surround testes outside of tunica vaginalis; raise testes when they contract

C. epididymis -
   highly coiled tube where sperm mature
   posterior and lateral to testis
   about 6 meters long
   head contains efferent ductules of testis
   duct of epididymis forms rest of head, body and tail
   pseudostratified e. with long microvilli/stereocilia (increase surface area)
   stimulates sperm maturation (gain motility and acrosome activity)
   takes sperm 20 days to travel through epididymis
   sperm stored in epididymis
   phagocytized if not ejaculated

D. ductus deferens (vas deferens)
   18 inches long
   runs through neck of scrotum in spermatic cord
   enters pelvic cavity through inguinal canal
   arches over ureters and pass behind urinary bladder
   distal end expands to form ampulla
   ampulla joins duct of seminal vesicles to form ejaculatory duct
   ejaculatory duct goes through prostate gland to join urethra
   smooth muscle in muscularis; peristalsis moves sperm into urethra
   vasectomy

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E. spermatic cord - bundle of organs surrounded by connective tissue (fascia) between epididymis and inguinal canal
contains
ductus deferens
blood vessels - testicular artery and vein
    pampiniform plexus = venous network surrounding testicular artery; cools arterial blood
    nerves
cremaster muscle

F. seminal vesicles (2)
located on posterior surface of urinary bladder
produce about 60% of seminal fluid
smooth muscle
secrete into ejaculatory duct

G. prostate gland (1)
located inferior to urinary bladder
surrounds urethra superior to urogenital diaphragm
compound tubuloalveolar gland
fibromuscular stroma
produces about 33% of seminal fluid
multiple ducts open directly into urethra

H. bulbourethral glands (Cowper's glands) (2)
located inferior to prostate, in urogenital diaphragm
mucus released from these glands may remove acidic urine from urethra prior to ejaculation

I. penis
delivers sperm into female reproductive tract
divisions: root, shaft, glans
prepuce (foreskin) = fold of skin surrounding glans
inner edge attached just proximal to glans penis
circumcision
three cylinders of erectile tissue:
corpus spongiosum (1) - posterior, contains urethra, forms glans
corpora cavernosa (2) - anterior
erectile tissue consists of smooth muscle and c.t. partitions filled with vascular spaces

J. bulbospongiosus muscle - (page 281) surrounds base of penis; contracts to cause ejaculation

K. urogenital diaphragm - muscles that form urethral sphincter and form part of pelvic floor

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Female

A. gonads = ovaries

located in pelvic cavity lateral to uterus
held in place by mesenteries
outer layer = germinal epithelium (simple cuboidal e.)
next layer = tunica albuginea (fibrous capsule)
cortex - location of gametes in follicles
medulla - c.t. containing blood vessels, nerves

ovarian follicles:

NOTE: Figures 24.12 and 24.13 can be misleading. Follicles do not move around in the ovary, and a real ovary would not contain all follicle stages at one time. The diagrams are composites and not intended to represent a real ovary.

1. primordial follicle = primary oocyte + 1 layer flat follicular cells
   primary oocytes produced from oogonia (fetal stem cells)

2. primary follicle
   oocyte larger
   zona pellucida surrounds oocyte - glycoprotein
   granulosa (follicular) cells cuboidal, stratified; secrete estrogens
   theca folliculi - layer of c.t. surrounding granulosa cells
   theca externa - resemble smooth muscle cells
   theca interna - secrete androgens

3. secondary follicle
   antrum - fluid-filled cavity
   corona radiata - layer of granulosa cells surrounding oocyte

4. vesicular/Graffian/mature follicle
   very large, ready to ovulate

5. corpus luteum
   cells remaining after ovulation differentiate into hormone-secreting cells
   produce both estrogens and progestin

6. corpus albicans - scar tissue remaining after corpus luteum atrophies

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B. oviducts (fallopian tubes or uterine tubes)

regions:
infundibulum = open funnel-shaped portion that surrounds ovary
fimbriae = motile, fingerlike extensions of infundibulum that "capture" released oocytes
ampulla = expanded region proximal to infundibulum (fertilization occurs here)
isthmus = narrow portion in uterine wall

structure of wall:
mucosa = simple ciliated columnar e.
muscularis = smooth m. - peristalsis

tubal ligation

C. uterus

located in pelvic cavity posterior to urinary bladder and anterior to rectum
normally tilted anteriorly (anteverted)

regions:
body
fundus - superior to oviducts
isthmus - narrow area between body and cervix
cervix - opening into vagina
    internal os opens from body of uterus into cervical canal
cervical canal
    external os opens from cervical canal into vagina
    projects from wall of vagina

layers
mucosa (endometrium) - simple columnar e. + lamina propria (c.t.)
mucous glands
functional layers
    stratum basale (stays)
    stratum functionalis (sloughed)
muscularis - smooth m. = myometrium
perimetrium = visceral peritoneum covers most of the uterus
D. vagina
muscular tube
inferior to uterus
posterior to urethra
anterior to rectum
vaginal orifice = external opening
located in vestibule
posterior to urethral opening
anterior to anus
layers of wall:
mucosa = stratified squamous e. with rugae and mucous glands
hymen = tissue flap around vaginal orifice that fails to recede normally
during development
muscularis - smooth m.
anterior, lateral, posterior fornices (singl. = fornix) form recess around cervix

E. external genitalia/vulva/pudendum
mons pubis = pad of fat superficial to pubic bone
labia = folds of skin
  majora = lateral, covered with hair
  minora = medial
  vestibule = area between labia minora (urethral and vaginal orifices)
clitoris
  corpora cavernosa (2)
  prepuce - anterior junction of labia minora
vestibular glands secrete mucus into vestibule
bulbs of vestibule
  erectile tissue homologous to corpus spongiosum
  lateral to vaginal orifice

F. perineum = area between pubic symphysis, ischial tuberosities, and coccyx (same in male and female)

  obstetrical perineum = area between female vaginal and anal orifices

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