Urogenital System

Objectives - see handout or website
Urogenital System
  shared ducts due to evolutionary legacy and development

Urinary or Excretory System
  blood filtration and excretion of salts and nitrogenous wastes
  osmoregulation
  hormonally mediated influence on blood pressure

Reproductive System
  procreation (and recreation)
  hormonally mediated influence on other organ systems and behavior
Organs of the Excretory or Urinary System

- Kidneys
- Ureters
- Urinary bladder
- Urethra
- External Genitalia
Kidneys

**Perirenal Fascia** – contains kidney and adrenal gland

**Perirenal Fat** – cushions kidney within location

  - retroperitoneal on superior posterior abdominal wall
  - both kidneys
    - “capped” superiorly by suprarenal (= adrenal) gland
    - anterior to quadratus lumborum muscle and lowermost ribs

**Right Kidney**

- Superior margin – 11th intercostal space
- Superior and anterior – suprarenal gland and liver
- Anterior inferiorly – colon
- Medial – duodenum

**Left Kidney**

- Superior margin – 11th rib
- Superior – suprarenal gland and respiratory diaphragm
- Anterior – stomach (superior to hilum), pancreas (at hilum), jejunum (inferior to hilum)
- Anterior/left – spleen
Kidneys

Renal Capsule

Hilum
  medial surface
  entrance of renal artery, exit of renal vein and ureter, from which the kidney is more or less suspended

Cortex – granular appearance
Medulla – striped appearance
  Renal Pyramids
Renal Pelvis
Nephron
microscopic functional unit of the kidney

Cardiovascular component – ultrafiltration
- Afferent Arteriole (most in cortex)
- Glomerulus (most in cortex)
- Efferent Arteriole (most in cortex)
- Peritubular Capillaries or Vasa Rectae (in medulla)

Collecting duct component – countercurrent multiplier

(continued)
Collecting Duct Components of the Nephron

- **Glomerular or Bowman’s Capsule** (cortex) envelops glomerulus
- **Proximal Convoluted Tubule** (most in cortex)
- **Loop of Henle** (in medulla)
- **Distal Convoluted Tubule** (most in cortex)

Collecting system unifying multiple Nephrons

- **Collecting Tubule**
- **Renal Papilla**
- **Minor Calyx** (pl. calyces)
- **Major Calyx** (pl. calyces)
- **Renal Pelvis**
  - most proximal part of ureter
Juxtaglomerular Apparatus
self-regulation of kidney
compares blood pressure in Afferent and Efferent Arterioles
measures osmolarity of Distal Convoluted Tubules

Renin
stimulates conversion of angiotensinogen→Angiotensin I
(angiotensinogen secreted by liver into blood)
Angiotensin I→Angiotensin II (= Vasopressin or Antidiuretic Hormone) in lungs
increases blood pressure by vasoconstriction
increases water and salt resorption by kidney

antidiuretic
Ureters

- conduct urine from kidneys to urinary bladder
- thin walled
- smooth muscle
- retroperitoneal on posterior abdominal wall
- enter urinary bladder posterolaterally
- open within trigone of urinary bladder on posterior wall
Urinary Bladder

storage organ

Diuresis = Micturition = Urination = Voiding

location

posterior to pubic symphysis in pelvic cavity

Females – anterior to vagina, inferior to uterus (posteriorly)

Males – anterior to rectum, superior to prostate gland

Rectovesical pouch - males

Vesicouterine pouch - females
Urinary Bladder

layers
- transitional epithelium
- smooth muscle – detrussor muscle
- adventitia and peritoneum

parts and surfaces:
- Roof
- Inferolateral walls
- Base
- Apex

**Urachus** – extends from apex within median umbilical ligament
- occluded vestige of allantois ending at umbilicus

**Urachal Fistula** (pathology)

**Trigone**
- triangular area of smooth epithelium of inferior base
- located between openings of ureters and urethra
Urethra
expels urine
passes through urogenital diaphragm

Divisions:
Female  Male

- Prostatic  within Prostate Gland

Membranous  Membranous  passes through Urogenital Diaphragm

- Spongy or Penile  within Corpus Spongiosum of penis
External Genitalia

Male

Penis
  Glans
  Prepuce
  Body
  Scrotum

Female

Labia Majora (s. Labium Majus)
Labia Minora (s. Labium Minus)
Clitoris
Vestibule of the Vagina
<table>
<thead>
<tr>
<th>Undifferentiated</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genital Tubercle</td>
<td>Glans Penis of the Corpus Spongiosum</td>
<td>Glans Clitoris</td>
</tr>
<tr>
<td>Urogenital Sinus</td>
<td>Lumen of the Spongy Urethra</td>
<td>Vestibule of Vagina</td>
</tr>
<tr>
<td>Urogenital Folds</td>
<td>Body of Penis</td>
<td>Labia Minora</td>
</tr>
<tr>
<td>Labioscrotal Folds</td>
<td>Scrotum</td>
<td>Labia Majora</td>
</tr>
</tbody>
</table>
Male Reproductive System

Testes
sexual ducts
glands
erectile tissues

Penis

Scrotum
contents:
receives Spermatic Cord
Tunica Vaginalis
Testis
Epididymis
Gubernaculum
**Testes**

internal architecture:

- **Capsule** or **Tunica Albuginea**
- **Septa**
- **Seminiferous tubules**
  - **Interstitial cells**
    - **Sertoli cells** – supportive
    - **Leydig cells** – secrete testosterone
  - **Spermatogonia** – reproduce by **mitosis** throughout life

**Rete Testis**

**Efferent Ductules** or **Vasa Efferentia**

**Spermatogenesis** – two **meiotic** cell divisions producing **gametes**

- Primary Spermatocytes $\rightarrow$ Secondary Spermatocytes $\rightarrow$ Spermatids

**Spermiogenesis** – morphological maturation of gametes

- Spermatids $\rightarrow$ Spermatozoans
Spermatogenesis

testis
epididymis
Sertoli cell
seminiferous tubules
lumen
Spermatogonium
mitotic division
primary spermatocyte
meiotic division I
secondary spermatocyte
meiotic division II
spermatids
mature sperm
acrosome
spermatid cytoplasm
Cross-section of seminiferous tubule

Interstitial cells: secrete androgens

Spermatogenic cells: produce sperm

Immature sperm

Sustentacular cells (Sertoli cells)

Spermatogonia

1° spermatocytes

2° spermatocytes

Interstitial cells (of Leydig)

Spermatids

Lumen of the seminiferous tubule

a

seminiferous tubule
Male Sexual ducts

Epididymis – head, body, tail
within Tunica Vaginalis of Scrotum
Vas (or Ductus) Deferens

path:
1) begins within Scrotum
2) Spermatic Cord
   parts and contents:
   Dartos muscle
   Cremaster muscle
   Pampiniform Plexus of Testicular Vein
   Testicular Artery and Vas Deferens
3) Inguinal Canal
4) crosses roof and base of urinary bladder medial to ureters and Seminal Vesicles

(continued)
Male Sexual ducts

Ejaculatory Ducts
  union of Vas Deferens and Seminal Vesicles

Prostatic Urethra
  Prostatic Utricle
  openings of Ejaculatory Ducts

Spongy or Penile Urethra
  Intrabulbar Fossa (integral to ejaculation; more on this later)
  Navicular Fossa (analogous to a vestibule of the urethra)
Semen vs sperm

Male Sexual Glands

1) Seminal Vesicles
   paired on base of Urinary Bladder lateral to Vas Deferens
   join Vas Deferens to form Ejaculatory Ducts

2) Prostate
   unpaired
   surrounds Prostatic Urethra
   inferior to Urinary Bladder
   anterior to Rectum
   superior to Urogenital Diaphragm

(continued)
Male Sexual Glands (continued)

3) Bulbourethral or Cowper’s Glands
   paired
ducts open into Intrabulbar Fossa of Bulb of Penis
   homologous to Greater Vestibular glands of female

4) Intrinsic Glands of the Spongy Urethra
   pre-ejaculatory secretions
Male Erectile tissues

1) Corpus Spongiosum
   unpaired parts:
   - **Bulb of Penis**, including:
     - **Intrabulbar Fossa** – widening of urethra associated with:
       - **Bulbourethral Glands**
       - **Bulbospongiosus muscle** – responsible for ejaculation
     - **Spongy Urethra**
     - **Glans Penis**

2) **Corpora Cavernosa** (sing. **Corpus Cavernosum**)
   paired forms **Body of Penis**
   **Crura** – buttressed by **Inferior Rami of Pubes**
Female Reproductive System

- Ovaries
- sexual ducts
  - Oviducts or Fallopian Tubes
- Uterus
- Vagina
- mesenteries
- external genitalia
- erectile tissues
- glands

Diagram illustrating the female reproductive system with labeled parts such as uterine tube, ovary, uterus, vesicouterine pouch, vagina, clitoris, labium minus, labium majus, rectouterine pouch, fornix, cervix, and greater vestibular gland.
Ovaries

paired
intraperitoneal
suspended from posterolateral abdominal wall
walnut-size

internal architecture:

**Stroma**

**Follicles**

- Follicular or Granulosa cells
- **Oocytes**
  - 1000-2000 at birth
  - non-replicating

**Oogenesis**

Oogonia reproduce mitotically before birth

**Primary Oocytes**: Oogenesis arrested in Prophase of first meiotic division until puberty or even much later in life

**Secondary Oocytes**: develop within maturing follicle prior to ovulation; second meiotic division arrested in Metaphase completion of meiosis II stimulated by fertilization
Female Sexual ducts

1) **Oviducts** or **Fallopian Tubes**
   - paired
   - intraperitoneal
   - divisions, listed from proximal to distal:
     a) **Ostium** – opening to peritoneal cavity, facing medially toward ovary
     b) **Fimbria** – finger like margins of **Ostium**
     c) **Infundibulum** – normal site of **fertilization**
       ~ 10 days for embryo to move to and implant in **Uterus**
       **Ectopic Pregnancy**
     d) **Ampulla** – widening
     e) **Isthmus** – narrowing proximal to **Uterus**

2) **Uterus**
3) **Vagina**
**DAY 0**
- Fertilized Egg (zygote)
- Ovulation
- Oocyte

**DAY 1**
- First Cleavage

**DAY 2**
- 2-cell stage

**DAY 3-4**
- 4-cell stage
- 8-cell uncompacted morula

**DAY 4**
- 8-cell compacted morula

**DAY 5**
- Early blastocyst

**DAY 6-7**
- Late-stage blastocyst (hatching)

**DAY 8-9**
- Implantation of the blastocyst
Uterus
unpaired (normally)
located in **Pelvic Cavity**
superior to **Vagina** and posterior of **Urinary Bladder**
anteior to **Rectum**
intraperitoneal
Layers of Uterus listed from luminal to superficial:

1) **Endometrium** - mucosa epithelium
   connective tissue, supporting:
   arteries
   **Spiral Glands**

2) **Myometrium** - smooth muscle
   stimulated by **oxytocin** (secreted by
   **Neurohypophysis** or **Posterior Pituitary**)

3) **Peritoneum**
Parts of Uterus

Fundus
Body
Cervix
Ostium
External Os
Internal Os
Cervical Plug
Vagina
unpaired
located in Pelvic Cavity
posterior to Urinary Bladder
anterior to Rectum
inferior to Uterus
superior to Urogenital Diaphragm
opening to Vestibule posterior to Urethra
Layers of Vagina from luminal to superficial:

1) **Mucosa**
   - stratified squamous epithelium, lightly keratinized or cornified intrinsic glands?

2) **Muscularis**
   - smooth muscle
   - voluntary **Bulbospongiosus muscle** inferiorly

3) **Adventitia**
Mesenteries of the Female Reproductive system

Suspensory ligament – of Ovaries

Broad ligament – of Uterus

Mesovarium – between Epöophoron and Ovary

Mesosalpinx – between Epöophoron and Oviduct

Female homologs of the Gubernaculum (continued)
Female homologs of the Gubernaculum

**Ovarian Ligament**
- homolog of proximal Gubernaculum
- location
  - from *Ovary* to *Uterus*
  - within *Broad Ligament*

**Round ligament or Ligamentum Teres**
- homolog of distal Gubernaculum, i.e., distal to *Uterus*
- Location:
  - within *Broad Ligament* in peritoneal cavity
  - passes through *Inguinal Canal*
  - terminates in *Labium Majus*
Erectile tissues and glands of the Female Reproductive System

Lesser Vestibular (= Skene’s or Paraurethral) Glands
located in anterior **Vestibule** lateral to **urethral orifice**

Greater Vestibular or Bartholin’s glands
located in posterior **Vestibule** posterolateral to vagina

**Clitoris**
- **Glans Clitoris** – anterior to **Vestibule**
- **Crura** – paired, buttressed by **Inferior Ramus** of **Pubes** lateral to **Vestibule**
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Menstrual Cycle

Follicle Stimulating Hormone (FSH) is a gonadotropin secreted by the Adenohypophysis that stimulates maturation of the follicle.

Primordial Follicle → Secondary Follicle → Mature (= Graafian) Follicle

Secondary Follicle includes:
- Antrum
- Cumulus Oophorus vs Parietal Follicular cells
- Estrogen — Follicular Fluid of Antrum produced by Follicular cells stimulates the Proliferative Phase, promoting hypertrophy of the Endometrium, its arteries and spiral glands.

(continued)
Menstrual Cycle

Leutenizing Hormone (LH)
- **gonadotropin** secreted by Adenohyphysis
- pulse together with FSH stimulates **Ovulation**
- **rupture of oocyte** with **Corona Radiata** (Cumulus Oophorus) from ovary into **Peritoneal cavity**
- **Parietal Follicular cells** → **Corpus Leuteum**
- secrete **Progesterone**
  - stimulates **Secretory Phase**
    - maintenance of hypertrophied endometrium for implantation
  - cessation of progesterone production results in:
    - **Ischemic Phase** – atrophy of endometrium, followed by:
    - **Menstrual Phase** – sloughing of endometrium
    - **Corpus Leuteum** → **Corpus Albicans** – scar tissue

Chorionic Gonadotropin
- produced by embryo, if present
- maintains **Corpus Leuteum** (hence, Progesterone and Secretory Phase)
(a) Hormonal regulation of changes in the ovary and uterus

(b) Changes in concentration of anterior pituitary and ovarian hormones
Extraembryonic Membranes – membranes that are derived from the zygote and surround and support the developing embryo but are not part of the embryo

1) Amnion – membrane that encloses developing embryo in amniotic cavity and fluid
2) Chorion – membrane that encloses extraembryonic coelom ("chorionic cavity"); interacts with endometrium of uterus to form embryonic contribution of placenta
3) Chorioamniotic membrane – fusion of the two above in later development

Connecting Stalk – tissue uniting developing embryo with extraembryonic membranes and maternal tissue; as embryo enlarges as fetus the connecting stalk will be recognized as the umbilical cord

Yolk Sac – a cavity, continuous with primitive gut; contained within connecting stalk

Allantois – a cavity, outgrowth of primitive gut; grows into connecting stalk carrying with it umbilical arteries and vein; unites with chorion to form embryonic contribution of placenta
Fetal Development – More Key Terms

**Decidua Basalis** – portion of endometrium that lines the uterine wall and that interacts with chorion basalis to form maternal contribution of placenta

**Decidua Parietalis** – portion of endometrium that lines the uterine wall and does not contribute to the placenta

**Decidua Capsularis** – portion of endometrium that overlies the chorion but does not contribute to the placenta

**Chorion Frondosum** – portion of the chorion that interacts with the decidua basalis to form the embryonic contribution of the placenta

**Chorion Laeve** – portion of the chorion that does not contribute to the placenta
Abdominal Hernias
Inguinal
  Direct – most common form in men
  Indirect – congenital birth defect
Femoral – most common form in women