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 uniting 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 – detrusor 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:**

<table>
<thead>
<tr>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td><strong>Prostatic</strong></td>
</tr>
<tr>
<td><strong>Membranous</strong></td>
<td><strong>Membranous</strong></td>
</tr>
<tr>
<td></td>
<td>passes through <strong>Urogenital Diaphragm</strong></td>
</tr>
<tr>
<td>-</td>
<td><strong>Spongy or Penile</strong></td>
</tr>
<tr>
<td></td>
<td>within <strong>Corpus Spongiosum</strong> of penis</td>
</tr>
</tbody>
</table>
External Genitalia

Male

Penis
  Glans
  Prepuce
  Body
Scrotum

Female

Labia Majora (s. Labium Majus)
Labia Minora (s. Labium Minus)
Clitoris
Vestibule of the Vagina
# Fetal Differentiation of the External Genitalia

<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>Clitoris</td>
</tr>
<tr>
<td>Urogenital Sinus</td>
<td>lumen of the <strong>Spongy</strong> Urethra</td>
<td>Vestibule</td>
</tr>
<tr>
<td>Urogenital Folds</td>
<td><strong>Spongy</strong> Urethra</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**
  - **Testes**
  - **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 → Secondary Spermatocytes → Spermatids
Spermiogenesis – morphological maturation of gametes
  - Spermatids → Spermatozoans
Male Sexual ducts

**Epididymis** – head, body, tail

within **Tunica Vaginalis of Scrotum**

**Vas (or Ductus) Deferens**

path:

1) begins within **Tunica Vaginalis of 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 (more on this later)

Navicular Fossa
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
   within Bulb of Penis
   open to Intrabulbar Fossa
   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
     - Bulbospongiosus muscle – responsible for ejaculation
     - Bulbourethral Glands
   - 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
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**
Uterus
unpaired (normally)
located in Pelvic Cavity
superior to Vagina and posterior of Urinary Bladder
anterior 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 **Bulbospinosus 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 u**rethral 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**
Menstrual Cycle

Follicle Stimulating Hormone (FSH)
gonadotropin secreted by Adenohypophysis
stimulates maturation of 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 Proliferative Phase
  hypertrophy of Endometrium, its arteries and spiral glands

(continued)
Menstrual Cycle

Luteinizing Hormone (LH)
gonadotropin secreted by Adenohypophysis
pulse together with FSH stimulates Ovulation

rupture of oocyte with Corona Radiata (Cumulus Oophorus)
from ovary into Peritoneal cavity

Parietal Follicular cells → Corpus Luteum
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 Luteum → Corpus Albicans – scar tissue

Chorionic Gonadotropin
produced by embryo, if present
maintains Corpus Luteum (hence, Progesterone and Secretory Phase)
Embryonic and Fetal Development – Key Terms

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; 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
(a) Hormonal regulation of changes in the ovary and uterus.

(b) Changes in concentration of anterior pituitary and ovarian hormones.
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
Early Embryonic Circulation

dorsal intersegmental arteries
anterior cardinal veins
dorsal aortae
connecting stalk
umbilical arteries
umbilical vein
vitelline arteries
vascular plexus on yolk sac
tertiary villus
heart tubes
chorion
Abdominal Hernias

**Inguinal**
- Direct – most common form in men
- Indirect – congenital birth defect

**Femoral** – most common form in women