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 – **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

<table>
<thead>
<tr>
<th>Divisions:</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-</td>
<td>Prostatic</td>
<td>within <strong>Prostate Gland</strong></td>
</tr>
<tr>
<td>Membranous</td>
<td>Membranous</td>
<td>passes through <strong>Urogenital Diaphragm</strong></td>
</tr>
<tr>
<td></td>
<td>Spongy or Penile</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
<table>
<thead>
<tr>
<th>Undifferentiated</th>
<th>Male</th>
<th>Female</th>
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</thead>
<tbody>
<tr>
<td>Genital Tubercle</td>
<td>Glans Penis of the Corpus Spongiosum</td>
<td>Clitoris</td>
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<tr>
<td>Urogenital Sinus</td>
<td>lumen of the Spongy Urethra</td>
<td>Vestibule</td>
</tr>
<tr>
<td>Urogenital Folds</td>
<td>Spongy 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
Cross-section of seminiferous tubule

Interstitial cells: secrete androgens

Spermatogenic cells: produce sperm

Immature sperm

Sertoli cell
tubule wall
spermatogonium (diploid)
primary spermatocyte

MITOSIS
MEIOSIS I
MEIOSIS II
secondary spermatocyte
early spermatids
late spermatids
immature sperm (haploid)

lumen of the seminiferous tubule

Spermatogonia
Sustentacular cells (Sertoli cells)
Interstitial cells (of Leydig)
1* spermatocytes
2* spermatocytes
Spermatids
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
Subarachnoid space (cave)
Peritoneal cavity
Recto-vesical pouch
Recto-vesical fascia
Rectus Abdominis
Pubo-vesical lig.
Deep dorsal vein of penis
Retropubic space
Retropubic pad of fat
Pubo-rectalis
deep & superf. subcutaneous
Sphincter Ani Externus
Sphincter Ani Internus
Anal (rectal) columns united below by anal valves
Sphincter Urethrae & perineal membrane
Bulbo-spongiosus
"Intrabulbar fossa"
Glans penis
Urethra
Prepuce
Navicular fossa
Testis
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 *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**
Erectile tissues and glands of the Female Reproductive System

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Clitoris
Glans Clitoris – anterior to Vestibule
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Menstrual Cycle

Follicle Stimulating Hormone (FSH)
gonadotropin secreted by Adenohypophysis
stimulates maturation of follicle

Primordial Follicle $\rightarrow$ Secondary Follicle $\rightarrow$ 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

Leutenizing 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 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)
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
tertiary villus

chorion

vitelline arteries

vitelline veins

vascular plexus on yolk sac
Abdominal Hernias
Inguinal
  Direct – most common form in men
  Indirect – congenital birth defect
Femoral – most common form in women