Lecture Outline: Reproductive System
Hole’s HAP [Chapters 22, 23]

I. Introduction

A. Primary sex characteristics
   Male –
   Female –

B. Secondary sex characteristics
   Male: 9 – 14 yrs.
      Reproductive – development of accessory structures plus primary sex organs
      Integumentary – hair follicle development on face, chest, axillary, pubic areas
      Skeletal –
      Muscular –
      Respiratory – enlargement of larynx

Female:
   Reproductive – development of primary sex organs, breast development, and menarche
   Integumentary – hair follicle development in axillary and pubic areas; subcutaneous adipose tissue
   Skeletal –
   Muscular –
II. Male Reproductive Organs

A. Testes

1. Structure
   Tunica vaginalis –
   Tunica albuginea –
   Seminiferous tubules – site of spermatogenesis
   Straight tubules – connects seminiferous tubules to rete testis
   Rete testis – network
   Efferent ducts –
   Interstitial cells (of Leydig)
   - androgen production
   -
   Sustentacular cells
   - provides nutrients to developing sperm
   -

2. Descent of the testes
   Each testis develops near a kidney and then descends through the inguinal canal
   Testes enters the scrotum completing the journey by the _____ gestational month
   Cryptorchidism –

3. Spermatogenesis
   Spematogonia (2n) – stem cells
   -
   -
Primary spermatocytes (2n) – meiosis I →
Secondary spermatocytes (n) – Meiosis II →
Spermatids (n) → spermatozoa

4. Structure of a Sperm Cell
- produced in ___________________
- continuous production, millions produced
- Anatomy: head –
  Acrosomal cap –
  Middle piece – mitochondria
  Tail –

5. Pathway of sperm:
  Seminiferous tubules → __________________ →
  __________________ → efferent ducts → epididymis →
  __________________ → ejaculatory duct → __________________

B. Spermatic Cord
  Contains: ductus deferentia (ductus deferens, vas deferens)
  -
  -

  Inguinal canal: passageway through abdominal muscles for spermatic cord
  - testes pass through here during decent
  - in females nerves and round ligaments to uterus

  Inguinal hernia – intestine protrudes due to weakness in abdominal wall and increased abdominal pressure
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C. Scrotum
- Pouch of skin and subcutaneous tissue

Dartos muscle –

Cremaster muscle –

Normal sperm development =
- medial septum divides scrotum into two chambers
- each chamber is lined with a serous membrane = _________________
- each chamber houses a testis and epididymis

D. Penis
Tubular organ –

Part of urogenital system – conveys urine and semen

Root -

Body (shaft) –

Glans – distal end; surrounds urethral meatus

Prepuce – foreskin

3 Masses
- Corpora cavernosa –

- Corpus spongiosum –

E. Epididymis
- Tightly coiled tubules

- Promotes maturation of sperm cells
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F. Vasa Deferentia (vas deferens, ductus deferens)
   - Muscular tube pushes sperm by peristaltic contractions and by PSCCE
   - About 45 cm each
   - Extends from epididymis to ejaculatory duct

G. Accessory Organs
   Includes seminal vesicles, prostate gland, and bulbourethral glands
   Functions:
     -
     -
     -
     -
     -

1. Seminal Vesicles
   - Attached to vas deferens near base of posterior urinary bladder
   - Secrete alkaline fluid
   - Contents empty into ejaculatory duct
   -

2. Prostate Gland
   - Surrounds proximal portion of urethra
   - Ducts of gland open into urethra
   -
   - Secretion enhances fluid mobility
   - Composed of tubular glands in connective tissue
   - Also contains smooth muscle
   -
3. Bulbourethral Glands
   - Inferior to prostate gland

   - Fluid released in response to sexual stimulation

H. Semen
   2-5 ml per ejaculation

Contains:
   -

   - secretions of seminal vesicles, prostate gland, and bulbourethral glands
     - slightly alkaline
     - prostaglandins
     - nutrients

   120 million sperm cells per milliliter

III. Erection, Orgasm, and Ejaculation
   Erection – parasympathetic nerve impulses

   -

   Orgasm – culmination of sexual stimulation

   - accompanied by emission and ejaculation

Ejaculation
   Emission –

   - ejaculation is the movement of semen out of the urethra

   - largely dependent on sympathetic nerve impulses
IV. Hormonal Control of Male Reproductive Functions

Hypothalamus controls maturation of sperm cells and development of male secondary sex characteristics

Negative feedback among the hypothalamus, the anterior lobe of the pituitary gland, and the testes controls the concentration of testosterone

1. GnRH
   - from hypothalamus
   - stimulates release of FSH and LH from anterior pituitary gland

2. FSH
   - from anterior pituitary gland
   - necessary to initiate spermatogenesis
   - stimulates sustentacular cells →

3. LH
   - from anterior pituitary gland
   -

4. Testosterone
   - stimulates spermatogenesis, sperm maturation
   - stimulates metabolism (protein synthesis and muscle growth)
   - maintain main sex organs and accessory organs

5. Inhibin
   - from sustentacular cells
   -
   -
Clinical Application
Prostate Enlargement
Benign prostatic hypertrophy – occurs in most men over 50

- Risk factors -

Treatments –
Prostate Cancer – malignant
- can be detected by PSA (prostate specific antigen)

V. Female Reproductive Organs
A. Ovary
1. Structure of the ovaries:
   Germinal epithelium -
   Tunica albuginea -
   Stroma
   Cortex – gives rise to gametes
   Medulla – no follicles, highly vascular
2. Ovary attachments
   Ovarian ligament – extends from uterus to ovary
   Suspensory ligament –
   Broad ligament – attaches ovaries to pelvic floor and pelvic wall
3. Oogenesis – ovum production
   Oogonia (2n) – stem cells in female complete mitosis
   3 – 7 months of fetal development
   Primary oocyte (2n) – about 2 million present at birth
   Secondary oocyte (n) – ovulated mid-cycle each month from alternating ovaries
Ovum (n) – completes meiosis II after fertilization

**Follicle** –

Primordial follicle – primary oocyte and single layer of follicular cells

Primary follicle – primary oocyte and more layers

Secondary follicle –

Tertiary or mature Graafian follicle –

**Polar body** – nonfunctional structure that disintegrates

4. Ovarian Cycle – after puberty monthly activation of different glycoproteins and primordial follicles

**Follicular Phase (pre-ovulatory phase)**

Step 1: Formation of 1° follicles

Step 2: Formation of 2° follicles

Step 3: Formation of 3° follicles

Step 4: Ovulation

**Luteal Phase**

Step 5: Formation of corpus luteum

Step 6: Degeneration of corpus luteum (if not pregnant)
B. Uterine Tubes (fallopian tubes or oviducts)
Conveys eggs toward uterus

1. Regions:
   - Infundibulum – expanded funnel at ovary
   - Fimbriae –
   - Ampulla – middle segment
   - Isthmus – connects to uterus

2. Histology:
   - Ciliated columnar epithelial cells
   - Smooth muscle

C. Uterus
- hollow muscular organ that receives the embryo that has been fertilized in the uterine tube

1. Structure:
   - Fundus –
   - Body – largest center region
   - Cervix

2. Histology:
   - Perimetrium – serosa on fundus and posterior body
   - Myometrium – thick smooth muscle layer
   - Endometrium –
   - Basilar Zone:
     -
     -
   - Functional Zone:
     -
     -
3. Uterine Cycle (menstrual cycle)
   - ~28 day cycle of changes in endometrial structure
   a. Menses [day 0 – 7]
   b. Proliferative phase [day 7 – 14]
   c. Secretory phase [14 – 28]

D. Vagina

   Fibromuscular tube that conveys uterine secretions, receives the penis during intercourse, and proves an open channel for offspring

   Hymen –

   Rugae – folds of stratified squamous epithelial cells (non-keratinized)

   Muscularis layer – smooth muscle

   Acid environment –

E. Female External Genitalia (vulva)

1. Labia majora
   - rounded folds of adipose tissue and skin

2. Labia minora
   - flattened, longitudinal folds between the labia majora

   - well supplied with blood vessels
3. Clitoris
   - small projection at the anterior end of the vulva
   - analogous to the male penis

4. Vestibule
   - space between the labia minor that encloses the vaginal and urethral openings
   - Vestibular glands secrete mucus during sexual stimulation

VI. Hormonal Control of Female Reproductive Functions
   Estrogens inhibit LH and FSH during most of the reproductive cycle

1. Hormonal Regulation
   GnRH –

   FSH – stimulates development of primordial follicles
   ___________________________ → ___________________________

   LH – causes rupture of Graafian follicle → ovulation & corpus luteum development
   ___________________________

   Inhibin – from developing follicles
   ___________________________

   Estrogens (estradiol, estrone, estriol)
   -
   - maintains secondary sex characteristics
   - maintains reproductive structures and glands
   -
- development of breasts and ductile system of the mammary glands

- increases vascularization of skin

Progesterone – causes increased glands and vessels in endometrium

hCG (human chorionic gonadotropin)
- appears in pregnancy in maternal blood or urine
- hormone produced by developing placenta
- maintains corpus luteum

Menopause – usually occurs in late 40s or early 50s

- ovaries no longer produce as much estrogens and progesterone
- some females secondary sex characteristics may disappear
- hormone therapy may prevent effects on bone tissue

**VII. Mammary Glands**

Specialized integumentary structures

Milk production =

1. **Structure:**
   Lobes – 15 – 20 per breast
   
   Alveoli – milk secreting glands \( \rightarrow \) ___________________ \( \rightarrow \)
   
   ___________________ \( \rightarrow \) nipple
2. Development of mammary glands
   Estrogens, Prolactin, GH, thyroid hormones affect development at puberty

   Human placental lactogen (hPL) – placental hormone that helps prepare mammary glands

   Prolactin (PRL) –

   Oxytocin –

Pregnancy, Growth, and Development

Pregnancy – the presence of developing offspring in the uterus

Growth –

Development – the continuous process by which an individual changes from one life phase to another

Fertilization
   - occurs around day 14 in ampulla of the uterine tube
   - many sperm required, only one penetrates the egg

   Zygote –

Implantation
   - begins about the 6th day of development
   - trophoblast ( ) will help form the placenta

   Fertilized ovum
   - 12-24 hours after ovulation

   Cleavage
   - 30 hours to third day
Morula
- third to fourth day

Blastocyst
- fifth day through second week
- trophoblast and inner cell mass forms

Gastrula
- end of second week
- primary germ layers forms

Hormonal changes during pregnancy

Secretion of ___________ maintains corpus luteum

Corpus luteum secretes estrogens and progesterone

Placenta secretes large amounts of estrogens and progesterone

Estrogens and progesterone stimulate and maintain uterine lining, inhibit FSH and LH, inhibit uterine contractions, and enlarge reproductive organs

___________ from corpus luteum inhibits uterine contractions and relaxes pelvic ligaments

_______________ stimulates breast development

___________ promotes sodium retention

_______ maintains calcium concentrations in blood

Placenta
- develops by 3\textsuperscript{rd} month

Fetal membranes:
Amnion –

Chorion –
Maternal structures:

Decidua basilis – part of the endometrium where embryo adheres

Chorionic villi – Chorion grows into decidua
  - contains fetal blood vessels

Fetal Blood and Circulation
  - oxygen and nutrients diffuse into the fetal blood from the maternal blood

Fetal Cardiovascular Adaptations

Fetal blood has greater oxygen-carrying capacity

Umbilical vein carries oxygenated blood from placenta to fetus

_______________ conducts half the blood from umbilical vein to inferior vena cava; liver is bypassed

_______________ conveys blood from right atrium to left atrium; lungs are bypassed

_______________ conducts most of the blood from pulmonary trunk to aorta; lungs are bypassed

Umbilical arteries carry blood from internal iliac arteries to placenta

Birth Process
  as birth approaches, progesterone levels decrease
  prostaglandins synthesized which may initiate labor
  stretching uterine tissue stimulates release of oxytocin
  oxytocin stimulates uterine contractions
  fetal head stretches uterus
  positive feedback results in stronger and stronger contractions and greater release of oxytocin
Clinical Applications