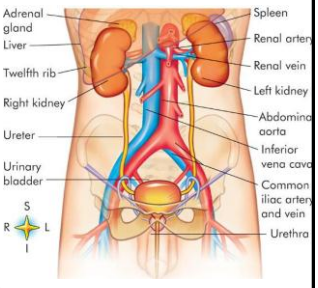
Bio217: Pathophysiology Class Notes
Professor Linda Falkow

Unit VIII: Urinary (Renal) System Disorders and Reproductive System Disorders

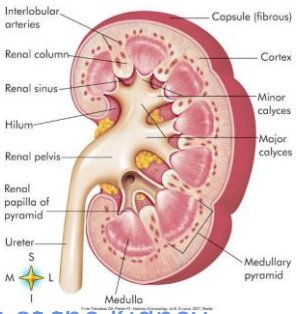
Chapter 28: Structure & Function of Renal & Urologic Systems
Chapter 29: Alterations of Renal & Urinary Tract Function
Chapter 31: Structure and Function of Reproductive Systems
Chapter 32: Alterations of the Reproductive Systems

- Kidneys (2)
  - Retroperitoneal
  - Renal capsule
  - Adipose capsule
  - Renal fascia
  - Hilum
- Ureters (2)
- Urinary Bladder (1)
- Urethra (1)



Structures of Urinary System

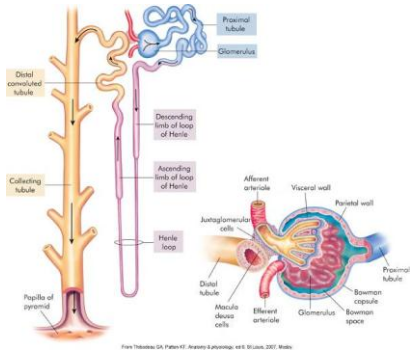
- Cortex
- Medulla
- Pyramids
- Calyces
  - Minor and major
- Renal pelvis



Structures of the Kidney

- 1.2 million nephrons per kidney
- Functional unit of the kidney
  - Cortical nephrons
  - Juxtamedullary nephrons
- Parts of nephron
  - Renal corpuscle (=glomerulus + Bowman capsule)
  - Renal tubules
    - Proximal tubule (pct)
    - Loop of Henle
    - Distal tubule (dct)

Nephron

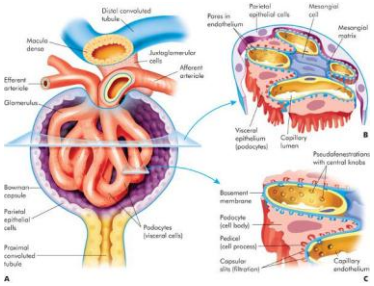


- Glomerular filtration membrane
  - Blood passes through the three layers and forms the filtrate

Nephron

- Juxtaglomerular apparatus
  - Juxtaglomerular cells (→ renin)
  - Macula densa (sense changes in Na+)
  - Renin-angiotensin pathway: reg. BP
    - Decr. blood vol. or decr. Na+ → incr. renin → Angiotensin I → Angiotensin II → aldosterone (incr. reabsorption of Na+ and H_2O)

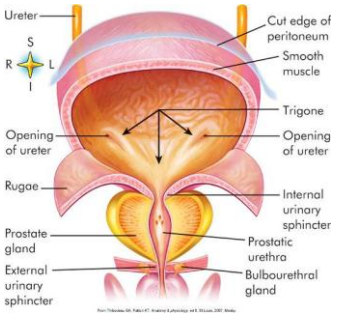
Nephron



Juxtaglomerular Apparatus

- Urinary Bladder
  - Detrusor muscle
  - Trigone
  - Micturition reflex
- Urethra
  - Internal and external sphincters
  - 3 to 4 cm in females
  - 18 to 20 cm in males

Structures of Urinary System



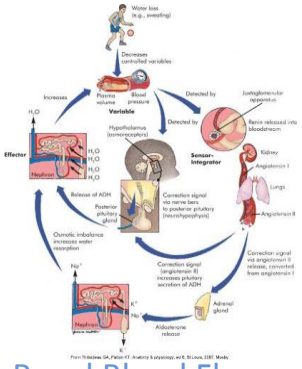
Urinary Bladder and Urethra

- Receive 1000 to 1200 mL of blood/min.
- Glomerular filtration rate (GFR)
- Autoregulation
  - Tubuloglomerular feedback

Renal Blood Flow

- Neural regulation
- Hormones
  - Renin-angiotensin system
  - Aldosterone
  - ADH (conserves water/incr. water reabsorption)

Renal Blood Flow



Renal Blood Flow

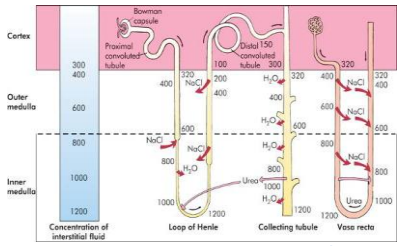
- Filters plasma
- Reabsorbs and secretes
  - Tubular reabsorption and secretion
- Forms a filtrate of protein-free fluid
- Regulates filtrate to maintain fluid volume, electrolytes, and pH

Nephron Function

- Glomerular filtration
  - Net filtration pressure
    - Glomerular capillary oncotic/hydrostatic pressure
    - Bowman capsule oncotic/hydrostatic pressure
  - Filtration rate
    - 180 L/day

Nephron Function

- Countercurrent exchange system
  - Contributes to production of concentrated urine



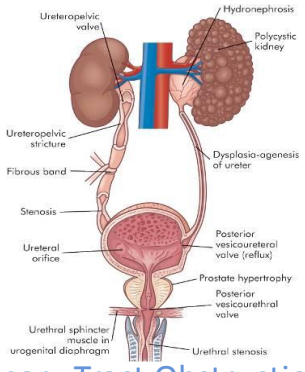
Concentration and Dilution of Urine

- Aldosterone
- Antidiuretic hormone (ADH)
- Atrial natriuretic peptide (ANP)
  - produced by RA, when RA press. increases, inhibits secretion of renin
- Diuretics
  - enhance urine flow (by disrupting Na+ reabsorption and decr. ECF vol.

Concentration and Dilution of Urine

- Urinary tract obstruction
  - interference with flow of urine at any site along urinary tract
  - Obstruction can be caused by anatomic or functional defect
    - Obstructive uropathy – changes in urinary system due to obstructions (anatomic)

Urinary Tract Obstruction



Urinary Tract Obstruction

- **UTI** - inflammation of urinary epithelium caused by bacteria
- Acute cystitis
- Interstitial cystitis
- Acute and chronic pyelonephritis

Urinary Tract Infection (UTI)

- **Acute cystitis**
  - Cystitis is an inflammation of the u.b.
  - *E. coli* most common cause
  - Manifestations
    - Frequency, dysuria, urgency, and lower abdominal and/or suprapubic pain
  - Treatment
    - Antimicrobial therapy, increased fluid intake, avoidance of bladder irritants, and urinary analgesics

Urinary Tract Infection (UTI)

- **Interstitial cystitis**
  - Nonbacterial infectious cystitis
  - Manifestations
    - Most common in women 20 to 30 years old
    - Bladder fullness, frequency, small urine vol., chronic pelvic pain
    - Immunocompromised (undergoing chemo or radiation therapy)
  - Treatment
    - No single treatment effective, symptom relief

Urinary Tract Infection (UTI)

- **Pyelonephritis**
  - Acute pyelonephritis
    - Acute infection of the renal pelvis & interstitium
      - Vesicoureteral reflux (urine reflux up ureter into kidney), *E. coli*, *Proteus*, *Pseudomonas*
  - Chronic pyelonephritis
    - Persistent or recurring episodes of acute pyelonephritis that leads to scarring
    - Risk of chronic pyelonephritis increases in individuals w/ renal infections and some type of obstructive pathologic condition

Urinary Tract Infection (UTI)

Normal size- scarring on upper surface

Shrunken size - scarring

Chronic Pyelonephritis

- **Glomerulonephritis**
  - Inflammation of the glomeruli (typically after a strep infection)
    - Immunologic abnormalities (most common)
    - Drugs or toxins
    - Vascular disorders
    - Systemic diseases
    - Viral causes
  - Most common cause of end-stage renal failure

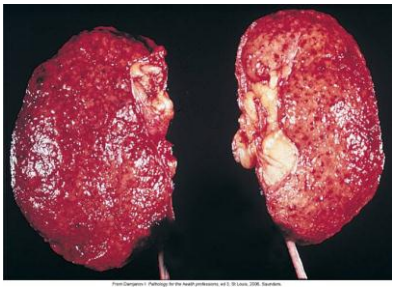
Glomerular Disorders

- Mechanisms of injury
  - Immune response - deposition of antigen-antibody complexes in glomerular capillaries
  - Formation of antibodies against the glomerular basement membrane → break down cells → incr. permeablility

Glomerulonephritis

- Acute poststreptococcal glomerulonephritis
- Rapidly progressing glomerulonephritis (RPGN)
  - Antiglomerular basement membrane disease (Goodpasture syndrome) – rare
- Chronic glomerulonephritis

Glomerulonephritis



Kidneys are small and have granular external surface

Glomerulonephritis

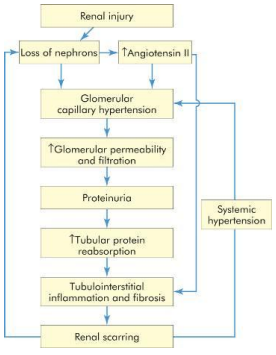
- **Uremia**
  = accumulation of N-wastes and metabolic toxins in plasma
  - Symptoms: confusion, GI complaints, fluid in lungs, infection
  - Describes clinical manifestations of CRF (chronic renal failure)

Chronic renal failure (CRF)

- -progressive, irreversible loss of renal function that affects nearly all organ systems
- Stages
  - Chronic renal insufficiency (GFR 20-35% of normal)
  - Chronic renal failure (GFR 20-25% of normal)
  - End-stage renal failure (GFR <20% of normal)

Chronic Renal Failure

- CRF due to:
  - Glomerulonephritis
  - Chronic infections (pyelonephritis or TB)
  - Congential (polycystic disease)
  - Vascular (HT or nephrosclerosis)
  - Obstructions (renal calculi)
  - Diabetic neuropathy



Chronic Renal Failure

Imbalances in following factors:

- Proteinuria and uremia
- Creatinine and urea clearance
- Fluid and electrolyte balance
  - Sodium and water balance
  - Phosphate and calcium balance
  - Potassium balance
  - Acid-base balance

Chronic Renal Failure

- Alterations seen in following systems:
  - Musculoskeletal
  - Cardiovascular and pulmonary
  - Hematologic
  - Immune
  - Neurologic

Chronic Renal Failure

- Gastrointestinal
  - Alteration in protein, carbohydrate, and lipid metabolism
- Endocrine and reproduction
- Integumentary

Chronic Renal Failure

- 1. Which is an abnormal substance of urine?
  - A. Urea C. NaCl
  - B. glucose D. Creatinine
- 2. The presence of albumin in urine would indicate damage to:
  - A. Glomeruli C. pyramids
  - B. Collecting ducts D. None of the above
- 3. GFR is regulated by
  - A. ANS C. Renin-angiotensin system
  - B. ANF D. All of the above

Concept Check

- 4. An increase in permeability of the dct and cd is due to:
  - A. Decrease in ADH production
  - B. Increase in ADH
  - C. Decrease in blood plasma osmolality
  - D. Increase in water content in blood
- 5. UTIs occur:
  - A. Only in the kidneys
  - B. Anywhere but the kidneys
  - C. Anywhere in the urinary system

Matching:

- ___ 6. acute cystitis a. Infection of renal pelvis & interstitium
- ___ 7. uremia b. Inflam. that is most common cause of end-stage renal failure
- ___ 8. glomerulonephritis c. Renal failure w/ elevated blood urea and creatinine
- ___ 9. pyelonephritis d. U.b. inflam. ranging from hyperemic mucosa to necrosis of u.b. wall

Structure and Function of the Reproductive Systems

Chapter 31

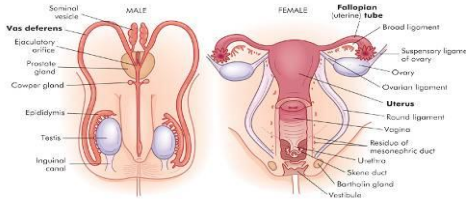
&

Alterations of the Reproductive Systems

Chapter 32

Development of the Reproductive System

- Dependent on sex hormones
  - Males—testosterone
  - Females—estrogen, FSH, and LH

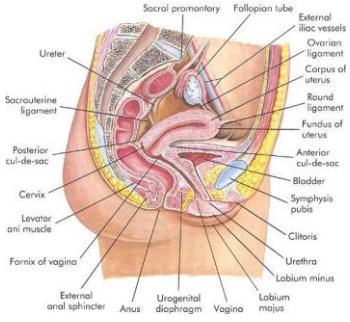


Female Reproductive System

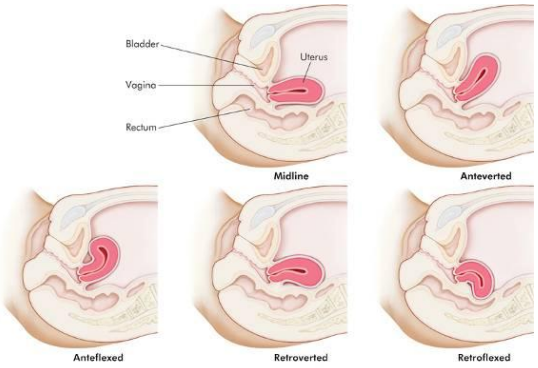
- External genitalia (vulva)
  - Mons pubis
  - Labia majora
  - Labia minora
  - Clitoris
  - Vestibule

Internal Genitalia

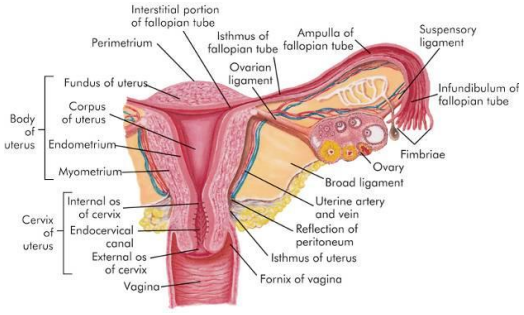
- Vagina
- Uterus
  - Cervix
- Fallopian tubes
- Ovaries



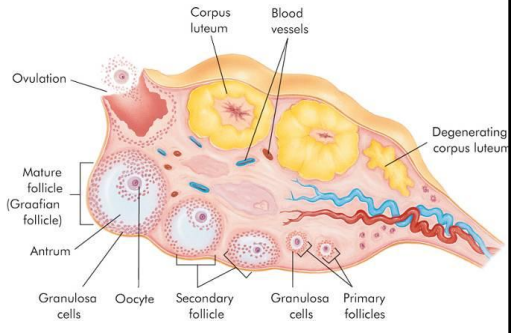
Uterine Position



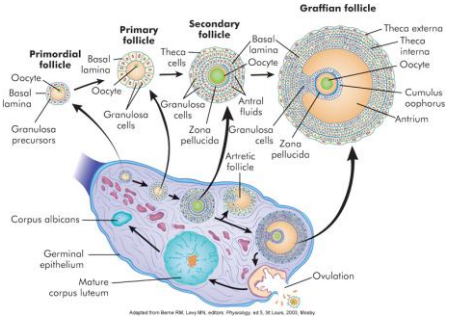
Internal Genitalia



Ovary



Follicle Development



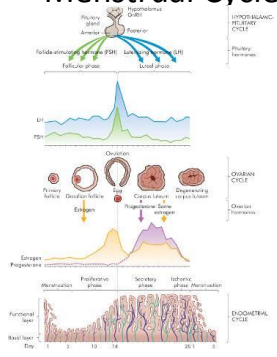
Female Sex Hormones

- Estrogens
  - Estradiol (E2)- 95% produced by ovaries
    - - remainder by adrenal gland & placenta (pregnancy)
  - Estrone
  - Estriol
- Progesterone – from corpus luteum
- Androgens – small amt. from ovaries & adrenal cortex

Menstrual Cycle

- Menarche
- Menopause
- Phases
  - Menstruation (menses)
  - Follicular/proliferative phase
  - Luteal/secretory phase
  - Ischemic/menstrual phase

Menstrual Cycle



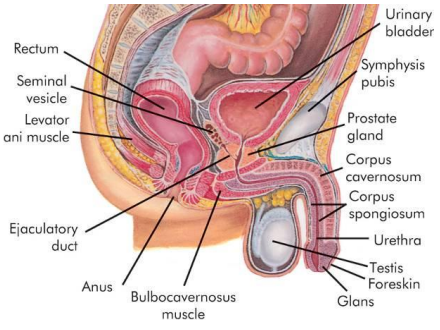
Menstrual Cycle

- Ovarian cycle
- Uterine phases
- Vaginal response
- Body temperature change
  - BBT (basal body temp.) biphasic
  - Follicular phase = ~98°F
  - Luteal phase ~ 0.4 -1.0 °F.elevation

Male Reproductive System

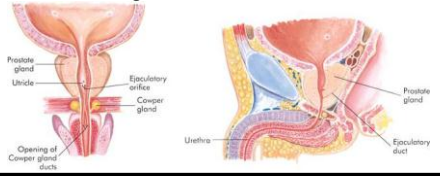
- External genitalia
  - Testes
    - Produce gametes and sex hormones
  - Epididymis
    - Vas deferens
  - Scrotum
  - Penis
    - Glans and prepuce

Male Reproductive System



Male Reproductive System

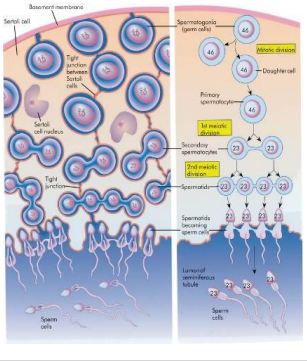
- Internal genitalia
  - Ducts
    - Vas deferens and ejaculatory duct
  - Accessary Glands
    - Seminal vesicles
    - Prostate gland
    - Bulbourethral glands



Spermatogenesis

- Spermatogonia
- Primary spermatocytes
- Secondary spermatocytes
- Spermatids

- Sertoli cells
  (Sustentacular cells)



Male Sex Hormones

- Androgens
  - Primary androgen—testosterone
  - Produced mainly in (interstitial cells of) Leydig cells of testes
  - Testosterone
    - Sexual differentiation
    - Urogenital system dev.
    - Nervous and skeletal tissue dev.
    - Libido

Disorders of the Female Reproductive System

- Hormonal and menstrual alterations
  - **Primary dysmenorrhea** (painful menstruation)
    - Painful menstruation associated with prostaglandin release in ovulatory cycles
  - **Secondary dysmenorrhea**
    - Painful menstruation related to pelvic pathology (endometrioisis, PID, fibroids)
  - **Pathophysiology**
    - Excess PGF from endometrium; → GI upset, headaches, syncope
  - Treatment: Hormones, PG inhibitors, exercise, heat

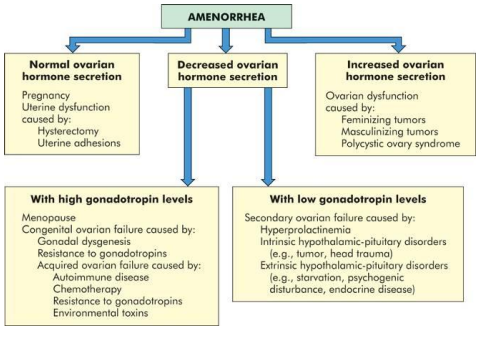
Hormonal and Menstrual Alterations

- **Primary amenorrhea**
  - Absence of menstruation by age 14 (& no secondary sex characteristic dev. by age 16)
  - Pathophysiology:
    - Dysfunctional H-P-O axis; congenital or hypoplasia of uterus; genetic (Turner's syndrome XO)
- **Secondary amenorrhea**
  - Absence of menstruation for three or more cycles or 6 months in women who have previously menstruated

Hormonal and Menstrual Alterations

- Secondary amenorrhea
  - Causes
    - Pregnancy (normal)
    - Dramatic weight loss
      - Malnutrition or excessive exercise
  - Anovulation
  - Hirsutism (increased testosterone)

Amenorrhea



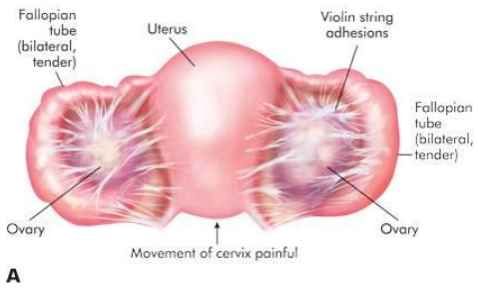
Hormonal and Menstrual Alterations

- Abnormal uterine bleeding
  - Menstrual irregularity
  - Dysfunctional uterine bleeding

Infection and Inflammation

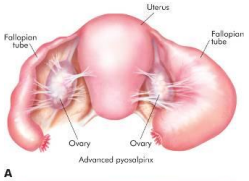
- **Pelvic inflammatory disease (PID)**
  - Acute inflammatory disease due to infection
  - May involve any organ of reproductive tract
    - Salpingitis (infalm. of fallopian tubes)
    - Oophoritis (inflam. of ovaries)
  - STDs migrate from vagina to the upper genital tract
  - Polymicrobial infection (due to gonorrhea or chlamydia
  - Can lead to infertility, ectopic pregnancy, abscess, septic shock (death)

Pelvic Inflammatory Disease (PID)



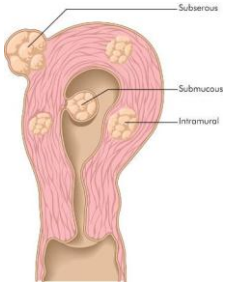
Pelvic Inflammatory Disease (PID) (Salpingitis)

Note- swollen fallopian tubes, adhesions on ovaries



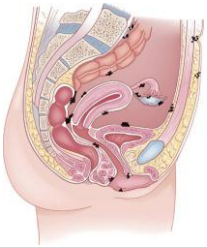
Leiomyomas (benign fibroid tumors)

- dev. from SMC



Benign Growths and Proliferative Conditions

- **Endometriosis**
  - Presence of functioning endometrial tissue or implants outside the uterus (retrograde menses)
  - Responds to hormone fluctuations of the menstrual cycle
  - Occur mostly in abdominal & pelvic cavities



Female Reproductive Cancer

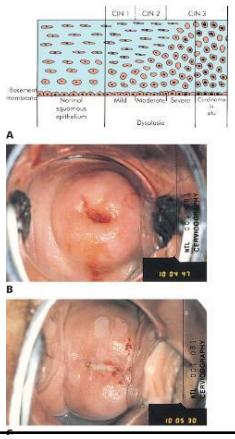
- **Cervical cancer** (2% of cancers in women)
  - Cervical dysplasia (CIN – cervical intraepithelial neoplasia – precancerous)
  - Invasive carcinoma of the cervix
- Risk factors
  - HPV and HIV
  - Multiple sexual partners
  - Poor nutrition and smoking
- Vaccine (2006)
  - Gardisil (Merck) against HPV 6,11,16,18
- Pap smear – screening test

Cervical Cancer

A: progressive degrees of CIN
(cervical intraepithelial neoplasia)

B: Normal mulitparous cervix

C: CIN Stage 1
(cancer only in cervix)



Female Reproductive Cancer

- **Ovarian cancer** (> 5% of all female cancer deaths)
- Cause – unknown; incr. risk with age, family history (breast or ovarian cancer)
- Pathophysiology:
  - Arise from epithelial cells (on outside of ovary, or stroma)
  - Associated with BRCA genes (breast cancer)
- Symptoms: abdominal pain & swelling (ascites)
- Metastasis: pelvis, colon, stomach, pleura

Disorders of the Testis

- **Orchitis**
  - Acute inflammation of the testis
  - Complication of a systemic disease or related to epididymitis
  - Mumps most common cause

Disorders of the Testis

- **Cancer of the testis**
  - Among the most curable of cancers (>95% cure)
  - Common in men between ages 15 and 35
  - Causes painless testicular enlargement
- Risk factors
  - History of Crytorchidism (undescended testes)
  - Abnormal dev. of testes
  - Klinefelter (XXY)
  - History of testiscular cancer

Disorders of the Prostate Gland

- **Benign prostatic hyperplasia** (BPH)
  - Enlargement of the prostate gland
  - Symptoms associated with urethral compression
  - Relationship to aging
  - Evaluation
    - Digital rectal exams
    - Prostate-specific antigen (PSA) monitoring

Disorders of the Prostate Gland

- Cancer of the prostate
  - Accounts for 29% of all cancers in males
  - Prostatic cancer is asymptomatic until adv. stages
  - Symptoms are similar to BPH
- **Pathophysiology**
  - 95% of neoplasms are adenocarcinomas
  - Related to steroid hormone use
  - T → DHT and estradial (in animal studies: both → carcinogenic effect)
  - Action of IGF (insulin growth factor) potent mitogen (increase cell prolif. and decr. apotosis)
    :. Cancer cell lives and multiplies

Disorders of the Prostate Gland

- Cancer of the prostate
  - Dietary factors (high sat. fat, incr. calcium levels → decr. Vit. D which protects against prostate cancer, low fiber and complex CHO, incr. protein
  - Hormones (anabolic steroids)
  - Vasectomy (possibly due to elevated androgens, antisperm antibodies)
  - Chronic inflammation
  - Familial factors (5-10%)

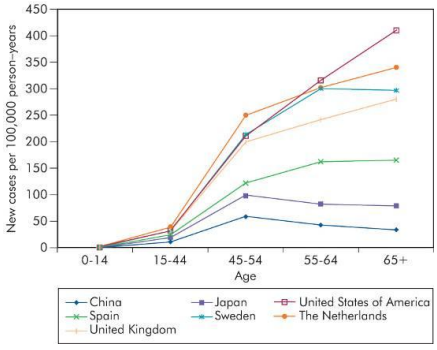
Benign Breast Lesions

- Nonproliferative breast lesions
  - Fibrocystic changes (FCC)
- Proliferative breast lesions without atypia
  - Epithelial hyperplasia
  - Florid hyperplasia
  - Sclerosing adenosis
  - Complex sclerosing lesion
  - Papillomas

Breast Cancer

- Most common cancer in American women
- Leading cause of death from ages 40 to 44
- Second most common killer after lung cancer
- Black women more likely to die from it

Breast Cancer



Breast Cancer

- Reproductive factors (early 1st pregnancy lowers risk)
- Hormonal factors (ovarian androgen excess, HRT incr. risk)
- Environmental factors and lifestyle
  - Radiation
  - Diet (high intake fruits,veg., whole grains, low fat)
  - Chemicals (xenoestrogens – mimic estrogens, found in pesticides, plastics, detergents, drugs) (PCBs, DDT)
- Physical activity
- Familial factors and tumor-related genes

Breast Cancer

- Manifestations
  - Painless lump, dimpling of skin, edema
- **Pathophysiology:**
  - 70% arise from ductal (glandular) epithelium
  - Genetic alterations of DNA, chromosomes, suppression of apoptosis
  - 1/3 are hormone dependent (Progesterone or estrogen receptor positive)
- Treatment
  - Based on stage of cancer
  - Surgery, radiation, chemotherapy, hormone therapy, biologic therapy and bone marrow transplantation

Disorders of the Male Breast

- Gynecomastia
  - Overdevelopment of the breast tissue in a male
  - Results from hormone alterations
    - Idiopathic and system disorders, drugs, or neoplasms
- Male breast cancer
  - Most commonly seen after age 60
  - Tumors resemble carcinomas of breast in women
  - Crusting and nipple discharge are common clinical manifestations

Chlamydial Infections

- Chlamydia (bacterial)
  - Infections caused by *Chlamydia trachomatis*
  - Most common STI in the United States
  - Obligate, gram-negative, intracellular bacterium

Sexually Transmitted Urogenital Infections

- Syphilis
  - *Treponema pallidum*
    - Corkscrew-shaped, anaerobic bacterium that cannot be cultured in vitro
    - Infects any body tissue
    - Syphilis becomes a systemic disease shortly after infection.
      - Maternal-fetal transmission

Sexually Transmitted Viral Infections

- Human papillomavirus (HPV)
  - 120 different types of HPV
    - 30 serotypes are unique to stratified squamous epithelium
    - Divided into high-risk and low-risk serotypes
  - HPV is a nonenveloped, circular double-stranded DNA virus

Sexually Transmitted Viral Infections

- Genital herpes
  - Two serotypes
    - Herpes simplex virus type 1
    - Herpes simplex virus type 2
      - 80% of initial and 98% of recurrent infections are type 2
  - Transmitted through contact with a person who is shedding the virus in a secretion or from a peripheral lesion or mucosal surface

Sexually Transmitted Parasitic Infections

- Trichomoniasis
  - Caused by *T. vaginalis*
    - Anaerobic, unicellular, flagellated, parasitic protozoan
  - Adheres to and damages squamous epithelial cells
    - Urethra, vagina, and Skene and Bartholin glands
  - Accounts for 25% of infectious vaginitis cases

Sexually Transmitted Parasitic Infections

- Pediculosis pubis
  - Caused by the crab louse *Phthirus pubis*
  - Transmitted primarily by intimate sexual contact or contact with infected bed linens or clothing
  - A crab louse has a 25- to 30-day life cycle
    - Stages: egg or nit, three nymphal stages, and an adult stage

Sexually Transmitted Parasitic Infections

- Scabies
  - Caused by the adult female itch mite, *Sarcoptes scabiei*
  - Transmission of scabies requires prolonged close skin-to-skin contact
    - Typically occurs between family members or sexual partners

Concept CHECK

- 1. Progesterone
  - A. Stim. lactation
  - B. Incr. uterine tube motility
  - C. Thins the endometrium
  - D. Maintains the thickened endometrium
- 2. The ovaries produce
  - A. Ova, estrogens, oxytocin
  - B. Ova only
  - C. Ova and estrogens
  - D. Testosterone & semen

- 3. Cells that produce testosterone:
  - A. Interstitial cells
  - B. Testicular endocrine cells
  - C. Sustentacular cells
  - D. Spermatogonia
- 4. The function of testosterone:
  - A. Dev. Of male gonads
  - B. Bone and muscle growth
  - C. Influence sexual behavior
  - D. Growth of testes
  - E. All of the above
- 5. Acute PID
  - A. Mainly affects males
  - B. Is usually caused by viruses
  - C. Never causes peritonitis
  - D. May cause infertility or tubular pregnancy

- 6. Endometriosis
  - A. Has ectopic endometrium responding to changing hormone levels of the menstrual cycle
  - B. Occurs mainly in the pleural cavity
  - C. Causes infertility in most women
  - D. Does not occur after treatment
- 7. The infectious cause of orchitis is
  - A. Streptococci
  - B. Gonococci
  - C. Chlamydial organisms
  - D. Mumps virus