Bio217: Pathophysiology Class Notes
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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

Structures of Urinary System

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

Structures of the Kidney

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

Nephron

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

Glomerular filtration membrane

- Blood passes through the three layers and forms the filtrate
• Juxtaglomerular apparatus
  – Juxtaglomerular cells (→ renin)
  – Macula densa (sense changes in Na+)

  – Renin-angiotensin pathway: __________
    • Decr. blood vol. or decr. Na+ → incr. renin →
      Angiotensin I → Angiotensin II → aldosterone
      (incr. reabsorption of Na+ and H$_2$O)

Nephron

• 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

• 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 (_____________________________)

Renal Blood Flow
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Unit 8

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
    • ______ Nephron Function

• Countercurrent exchange system
  — Contributes to production of concentrated urine

Concentration and Dilution of Urine

• Glomerular filtration

• Aldosterone
• Antidiuretic hormone (ADH)
• Atrial natriuretic peptide (ANP)
  — produced by RA, when RA press. increases, inhibits secretion of renin
• Diuretics
  — _______ 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 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

  - **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

  - **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

• **UTI** - inflammation of urinary epithelium caused by bacteria

  - Acute cystitis
  - Interstitial cystitis
  - Acute and chronic pyelonephritis

**Urinary Tract Infection (UTI)**
Glomerular Disorders

- **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

- **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. permeability

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

- **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)

Uremia

**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

Chronic renal failure (CRF)
• CRF due to:
  – Glomerulonephritis
  – Chronic infections (pyelonephritis or TB)
  – Congenital (polycystic disease)
  – Vascular (HT or nephrosclerosis)
  – Obstructions (renal calculi)
  – Diabetic neuropathy

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

• Alterations seen in following systems:
  – Musculoskeletal
  – Cardiovascular and pulmonary
  – Hematologic
  – Immune
  – Neurologic
  – Gastrointestinal
    • Alteration in protein, carbohydrate, and lipid metabolism
  – Endocrine and reproduction
  – Integumentary

• Which is an abnormal substance of urine?
  – A. Urea
  – B. glucose
  – C. NaCl
  – D. Creatinine

• The presence of albumin in urine would indicate damage to:
  – A. Glomeruli
  – B. Collecting ducts
  – C. pyramids
  – D. None of the above

• GFR is regulated by:
  – A. ANS
  – B. ANF
  – C. Renin-angiotensin system
  – D. All of the above
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. Inflamm. 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

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
**Female Sex Hormones**

- **Estrogens**
  - Estradiol (E2) - 95% produced by ovaries  
    - remainder by adrenal gland & placenta (pregnancy)
  - Estrone
  - Estriol
- **Progestrone** – from________
- **Androgens** – small amt. from________

**Menstrual Cycle**

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

- 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 (_____________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 (___________menstruation)
    • Painful menstruation associated with prostaglandin release in ovulatory cycles
  – Secondary dysmenorrhea
    • Painful menstruation related to pelvic pathology (endometriosis, PID, fibroids)
    – Pathophysiology
      • Excess PGF from endometrium; → GI upset, headaches, syncope
    – Treatment: Hormones, PG inhibitors, exercise, heat

Hormonal and Menstrual Alterations

• Primary amenorrhea
  – _________ 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

• Abnormal uterine bleeding
  – Menstrual irregularity
  – Dysfunctional uterine bleeding
Infection and Inflammation

- Pelvic inflammatory disease (PID)
  - Acute inflammatory disease due to ____________
  - May involve any organ of reproductive tract
  - Salpingitis (inflamm. of ___________ tubes)
  - Oophoritis (inflamm. of ___________)
  - 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)

Leiomyomas (benign fibroid tumors)

Note - swollen fallopian tubes, adhesions on ovaries

Benign Growth and Proliferative Conditions

- Endometriosis
  - Presence of functioning ____________ 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)
  - Gardasil (Merck) against HPV 6,11,16,18

- Pap smear – screening test
**Cervical Cancer**

A: progressive degrees of CIN  
(cervical intraepithelial neoplasia)

B: Normal multiparous cervix

C: CIN Stage 1  
(cancer only in cervix)

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**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

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**Disorders of the Testis**

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

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**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 Cryptorchidism (undescended testes)
  - Abnormal dev. of testes
  - Klinefelter (XXY)
  - History of testicular cancer

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**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

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**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 estradiol (in animal studies: both → carcinogenic effect)
  - Action of IGF (insulin growth factor) potent mitogen (increase cell prolif. and decr. apoptosis)
  - 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
- Reproductive factors (early 1st pregnancy lowers risk)
- Hormonal factors (ovarian androgen excess, HRT incr. risk)
- Environmental factors and lifestyle
  - Radiation
  - Diet (high intakes of 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 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