

Immunopathology of HIV and AIDS

- **Stage 1:** Infection; virus infects T-cells and impairs function; burst of virus in blood followed by response, recovery, and seroconversion (*2 weeks to 6 months*); flu-like symptoms occur
 - **Seroconversion:** The time period in which one has enough antibodies to render a test positive
- **Stage 2:** Latency period; viral replication in lymph nodes; asymptomatic
- **Stage 3:** Rapid virus production; CD4 T-cell count drops to <400
- **Stage 4:** CD4 T-cell count continues to decrease and T-cells become less functional
- **Stage 5:** CD4 T-cell counts drop lower and more symptoms are present (*viral/fungal infections of skin and mucous membranes*) and immune response is weaker
- **Stage 6:** AIDS; CD4 count <200; opportunistic infections; rapid virus production and CD4 cell turnover

Transmission of HIV

- **Fluids:** Blood, semen, vaginal fluid, breastmilk
- **Sexual:** Usually male-to-male or anally from male-to-female; other STIs increase the risk of transmission
- **Blood:** Needle-sharing, needlesticks, blood transfusion, surgery, injury
- **Mom-to-baby:** In utero, during delivery, breastfeeding
- **NOT by:** HIV is NOT transmitted by respiratory/oral secretion or on surfaces

HIV Prevention

- **Primordial:** Sexual drug education, economic (social determinants of health)
- **Primary:** Safe sex, pre-exposure prophylaxis (PrEP), universal precautions, needle exchange programs
- **Secondary:** Early screening, peri-natal newborn drug therapy, post-exposure prophylaxis (PEP)
- **Tertiary:** Treatment of HIV

~ Genetics ~

Defining Terms

- **Genes:** Sequences of DNA that are biologic and the basic units of inheritance
- **Chromosome:** Genetic material in a cell's nucleus that functions in the transmission of genetic information
 - **Full set:** 23 chromosome pairs; 22 homologous pairs of autosomes and 1 sex-linked pair
- **Genotype:** Genetic constitution
- **Phenotype:** Physical trait presented by the gene
- **Karyotype:** A diagrammatic representation of chromosomes in organized pairs in descending order of size, based on the position of centrosomes

- **Sodium chloride (NaCl):** controls glomerular filtration rate (GFR) by changing the diameter of afferent and efferent arterioles or changing the permeability of the glomerulus
 - High NaCl: afferent arteriole constriction → decreases GFR
 - Low NaCl: efferent arteriole constriction → increases GFR

Renal Hormones

- **Antidiuretic hormone (ADH):** stimulates water retention and lower output of more concentrated urine
 - When absent: there is an increased output of more dilute urine
- **Aldosterone:** regulated by RAAS; increased water reabsorption d/t increased sodium reabsorption
- **Atrial natriuretic peptide (ANP):** secreted by cardiocytes when right atrial BP increases; increased water loss d/t increased filtration and urine output, countering the effects of RAAS
- **Urodilatin:** lowers BP via urination and inhibits water reabsorption
- **Erythropoietin (EPO):** stimulates RBC production in the bone marrow in response to hypoxia
- **Vitamin D:** hydroxylated to active form by liver and kidneys; helps body absorb calcium and phosphate

Tests of Renal Function

- **Urinalysis:** analyzes urine composition
- **BUN/Cr ratio:** analyzes GFR and renal function; a higher ratio means lower GFR and poor kidney function
 - **Creatinine (Cr):** byproduct of muscle metabolism
 - **Blood urea nitrogen (BUN):** the level of nitrogen in the blood in the form of urea

Polycystic Kidney Disease (PKD)

- **Patho:** cysts develop in the nephron and destroy healthy kidney tissue
 - **Cysts:** large, fluid-filled sacs that compress and eventually replace healthy, functional tissue
- **Etiology:** unknown, but there is a genetic link
- **S/S:** HTN, flank pain, abdominal tenderness, hematuria, nocturia
- **Complications:** UTI, pyelonephritis, glomerulonephritis, chronic renal failure

Pyelonephritis

- **Patho:** general infection of the renal pelvis and interstitium
- **Acute etiology:** usually d/t poorly-treated bladder infection that travelled up the ureters
- **Chronic etiology:** persistent and recurrent infections leading to scarring and renal failure/malfunction; PKD, renal calculi, stricture/stenosis, hydroureter, hydronephrosis, untreated UTIs/cystitis, obstruction
- **S/S:** vary and may have symptoms of cystitis; hematuria, WBCs in urine
 - Acute: fevers, chills, flank/groin pain, CVA tenderness, dysuria
 - Chronic: often minimal; HTN, frequent urination, dysuria, flank pain

~ Respiratory Disorders ~

The Pulmonary System

- **Components:** lungs, airways, chest wall, circulation
- **Function:** gas exchange
- **Ventilation:** inhalation and exhalation; the physical movement of air into and out of the lungs; a volume
 - **Inhalation:** increases gas volume in lungs
 - **Exhalation:** decreases gas volume in lungs
- **Diffusion:** gas exchange between air spaces in the lungs and the bloodstream
- **Perfusion:** movement of blood from the lungs to other tissue

Anatomy and Physiology

- **Lungs:** series of bifurcating tubes
 - **Bronchiolar branches:** produce mucus and move it out of the airway
- **Lobes:** three in the right lung, two in the left lung
- **Alveoli:** functional unit of the lung; protection, gas exchange; oxygen enters the blood and CO₂ is removed
 - **Type I cells:** promote gas exchange and provide structure
 - **Type II cells:** secrete surfactant, which decreases surface tension and stabilizes alveoli → lung expansion
- **Acinus:** gas exchange airway; bronchioles, alveolar ducts, and alveoli
- **Pores of Kohn:** physically connect the alveoli and promote collateral ventilation
- **Nasopharynx and oropharynx:** nose and mouth; ciliated mucosa warms, humidifies, and filters inspired air
- **Larynx:** connects the upper and lower airways
- **Trachea:** connects the larynx and bronchi; bifurcates into left and right main stem bronchi
- **Bronchi:** main airways that enter the lungs and ventilate both sides
 - **R. bronchus:** straighter alignment to the trachea; used most often for intubation and suctioning

Lung Development

- **24 weeks gestation:** development of gas exchange areas
- **<32 weeks gestation:** lungs still immature
- **8 years:** lung development is complete
- **>8 years:** lung volume expansion increases

Mechanics of Breathing

- **Tidal volume (Vt):** the amount of air inhaled with each breath
- **Vital capacity (Vc):** the max amount of air that can be exhaled after a full inhalation
- **FEV₁:** the max amount of air that can be exhaled in one second after a full inhalation as a percentage of Vc
 - 80%: normal healthy individual

Emphysema

- **Patho:** abnormal, permanent enlargement of acini, destruction of alveolar walls, decreased number of alveoli, and decreased gas exchange
- **Etiology:** smoking, pollutants, genetic alterations
- **S/S:** dyspnea, hyperventilation, polycythemia, cor pulmonale
 - **"Pink Puffer":** not cyanotic (*pink*), prolonged exhalation (*puffer*)
- **Management:** smoking cessation, bronchodilators, nutrition, pursed-lip breathing, relaxation, antibiotics

Chronic Obstructive Pulmonary Disease (COPD)

- **Patho:** a syndrome; pathologic lung changes consistent with emphysema, chronic bronchitis, and asthma
- **S/S:** dyspnea, chronic hyperventilation, barrel chest, expiratory effort, diminished muscle mass on legs
- **Management:** smoking cessation, bronchodilators, corticosteroids, treatment of infections, oxygen use

Airway Obstruction

- **Etiology:** physical object in the airway, post-extubation, mucous plug
- **Stridor:** high-pitched, musical breathing sound
- **Aspiration:** passage of fluid or solid particles into the lung, usually into the right bronchus

Respiratory Distress

- **Neonates:** decreased surfactant production d/t immature type II cells
- **Adults:** secondary to lung injury; decreased surfactant production, release of inflammatory mediators
- **S/S:** dyspnea, rapid/shallow breathing, crackles, respiratory alkalosis, decreased compliance, hypoxemia
- **Treatment:** supportive therapy

Pneumoconiosis

- **Patho:** inhaled debris deposits and accumulates in the bronchi, causing chronic inflammation and scarring
- **Examples:** silicosis, black lung (*coal*), asbestosis
- **S/S:** cough, chronic sputum production, decreased lung volume, progressive dyspnea, rapid/shallow breathing, weight loss
- **Treatment:** palliative, prevent further exposure

Chest Wall Restriction

- **Patho:** chest wall is deformed, traumatized, immobilized, weakened, or made heavy by fat
- **Etiology:** obesity, scoliosis, pregnancy, myasthenia gravis, Guillain-Barre, ALS, muscular dystrophy
- **Treatment:** reverse underlying cause, supportive care, mechanical ventilation

~ Neurological Disorders ~

Anatomy and Physiology

- **Central nervous system (CNS):** brain and spinal cord; cognition, consciousness, motion, sensation
 - **Upper motor neurons:** direct, influence, and modify reflex arcs and lower motor neurons
 - **Lower motor neurons:** directly influence muscles
- **Peripheral nervous system (PNS):** peripheral nerves; motion, sensation; efferent neurons
 - **Sensory and motor neurons:** "the messengers"; afferent neurons
- **Dermatomes:** sensory designations
- **Myotomes:** motor/muscle designations
- **Frontal lobe:** executive functions, thinking, planning, organizing, problem-solving, emotions, behavior control, personality
- **Temporal lobe:** memory, language, understanding
- **Occipital lobe:** vision
- **Parietal lobe:** perception, spelling, math, making sense of the world
- **Sensory lobe:** sensation
- **Motor lobe:** movement
- **Neuroplasticity:** the ability of the brain to rewire itself to regain loss of function from injury or disease

Amyotrophic Lateral Sclerosis (ALS)

- **ALS:** Lou Gehrig's Disease; neurologically-degenerative, rapidly progressive, and fatal; weakness and wasting of muscles under voluntary control
- **Muscle atrophy:** d/t motor neuron degeneration and sclerosis of the corticospinal tract in the lateral column
- **Initial S/S:** generalized weakness in muscles that progresses to flaccid or spastic paralysis
 - **Complications:** difficulty with swallowing, secretions, communication, respiration
- **Death:** occurs 2-5 years after onset; usually d/t respiratory failure

Traumatic Brain Injury (TBI) Assessment

- **Altered consciousness:** confused, lethargic, obtunded, stupor, coma
- **Variant breathing pattern:** d/t injury to the brainstem; may be erratic/rapid or prolonged/gasping for air
- **Pupil changes:** altered size and reactivity
- **Eye reflex changes:** eyes remain fixed in place during Doll's Eye Maneuver and Caloric Reflex Test
- **Abnormal posturing:** changes in skeletal muscle motor response
 - **Decorticate:** hemispheric damage; arms crossed over chest ("to core")
 - **Decerebrate:** deeper, severe injury to the midbrain; arms at sides

Types of TBI

- **Coup injury:** initial impact/force against object
- **Contrecoup injury:** ricochet/rebound/secondary impact with the skull
- **Acceleration injury:** person is still and then goes into motion
- **Deceleration injury:** person is moving and then stops
- **Focal:** specific, grossly observable lesion
- **Diffuse:** seen with microscope; shaking effect produces strains and distortions in the brain

Spinal Cord Injury (SCI)

- **Effects:** damage to vertebral column (*fracture/dislocation*), damage to motor neurons, herniated discs, searing of spinal cord (*never move patient without stabilizing the spine first*)
- **Complications:** loss of voluntary control, flaccid paralysis, hypotonia, muscle atrophy, hyporeflexia
- **Extent of transection:** results of the injury
 - **C2:** quadriplegic, vent dependent
 - **C4:** able to move head, mouth, shoulders, and diaphragm
 - **C6:** weak hands, able to drive with hand control
 - **T1:** paraplegic, normal upper body

Brain Bleeds

- **Etiology:** injury, aneurysm, burst artery in late stage HTN, burst arterial aneurysm
- **Effects:** shift and distort brain, herniation, compressed blood vessels, ischemia
- **S+S:** severe headache, altered LOC, low GCS score, compromised brain stem function
- **Epidural bleed:** between the skull and dura; mostly arterial
- **Subdural bleed:** between the dura and arachnoid; mostly venous
- **Subarachnoid/intracerebral bleed:** between the pia mater and brain; venous or arterial
- **Hemorrhagic stroke:** bleeding within the brain

Stroke/Cerebrovascular Accident (CVA)

- **S+S:** depend on the affected area; unilateral numbness and weakness, confusion, trouble speaking or understanding, visual disturbances, dizziness, trouble walking, severe headache
- **Hemorrhagic stroke:** 20% of occurrences; brain bleeds; high mortality and morbidity rate
- **Ischemic stroke:** 80% of occurrences; usually d/t blood clots or thromboembolism
 - **Treatment:** early is crucial (*within 3 hours of onset*); fibrinolytic used for re-perfusion
- **Risk factors:** HTN, A. fib, African American, smoking, high cholesterol, sedentary lifestyle, prior stroke or TIA
- **Prevention:** platelet inhibitors, anticoagulants

- **Smoking and alcohol:** alter and decrease the effects of estrogen
- **Treatment:** increased calcium intake, resistance exercise, meds, stress management, smoking cessation, decreased alcohol intake

Bone Tumors

- **Etiology:** often originate from somewhere else or are metastatic
 - **Primary tumors:** four types depending on cell type origin
 - **Osteogenic:** from bone cells
 - **Chondrogenic:** from cartilage
 - **Collagenic:** from fibrous tissue
 - **Melogenic:** from bone marrow
 - **Osteosarcoma:** malignant bone-forming tumor; usually seen in the knee of adolescents
-

~ Endocrine Disorders ~

Anatomy and Physiology

- **Glands:** synthesize and release hormones
- **Hormones:** regulate cell and organs, work for MS for communication and control, only target specific cells
 - **Elimination:** via excretion by kidneys
 - **Deactivation:** via liver or cellular mechanisms
- **Homeostasis:** maintained via positive and negative feedback loops
- **Adrenal medulla:** main source of catecholamines (**Epi and NE**)
- **Adrenal cortex:** synthesizes corticosteroid hormones from cholesterol
 - **Sex hormones:** formation of secondary sex characteristics at puberty
 - **Mineralocorticoids:** **aldosterone**; fluid and electrolyte balance
 - **Glucocorticoids:** fight-or-flight response, catabolism, lipolysis, glucose production, stress response, anti-inflammatory actions, immune response, osteoblasts, insomnia, bone resorption
- **Thyroid gland:** metabolism, CNS development, growth hormone release, calcitonin release
 - **Controlled by:** the hypothalamic-pituitary axis, TRH, TSH
 - **Iodine:** required for thyroid hormone production

Insulin Physiology

- **Functions:** lowers amount of glucose in circulation, glucose transport, lipid and cholesterol synthesis, protein synthesis
- **Counter-regulatory hormones:** increase glucose levels; oppose the effects of insulin
 - **Glucagon:** stimulates glycogen breakdown in the liver → glucose production
 - **Glucocorticoids:** stimulate glucose production
- **Increase insulin needs:** fever, stress, infection, pregnancy, surgery, hyperthyroidism
- **Decrease insulin needs:** liver disease, hypothyroidism, vomiting, renal disease