BODY FLUID COMPARTMENTS:

WATER - 60% of body weight

2 COMPARTMENTS:
A. INTRACELLULAR – 30% - 40%
B. EXTRACELLULAR – 20%
   1. Interstitial – 16%; between cells; not in blood vessels
   2. Plasma – 4-5%; in blood vessels; not in cells
   3. Transcellular – 1-3%; any body compartment covered by epithelial tissue
      - synoval/peritoneal/cerebrospinal

TERMINOLOGIES:

OSMOSIS - Net diffusion of water across a selectively permeable membrane from High to Low concentration
RATE OF OSMOSIS - Rate of water diffusion
OSMOTIC PRESSURE - Precise amount of pressure required to prevent osmosis
   - Higher osmotic pressure on compartment with more particles
OSMOLE - Total number of particles in a solution
      - Number of ions/active particles
      - 1 Osmole = 1 mole of solute particle
OSMOLALITY - Osmoles / Kg of water
OSMOLARITY - Osmoles / L of water
ISOOSMOTIC - Solution has same osmolarity as body fluids; has same # of particles
   - No effect on cell
HYPEROSMOTIC - Solution has higher osmolarity than body fluids; has more particles; less water
   - Cell has more water; Cell will shrivel; since water from cell goes out of cell
HYPOOSMOTIC - Solution has lower osmolarity than body fluids; has less particles; more water
   - Cell has less water; will swell; since water from outside will go into the cell

BLOOD TYPING SUMMARY:

Antigen = Agglutinogen
   - Proteins/receptors on cell membranes that are recognized by own immune system
   - Associated with antigens found on RBC (blood type states same letter of its antigen)
   - Triggers immune response
Antibody = Agglutinins
   - Present in blood; attacks foreign RBC antigen by sticking to it causing hemolysis/rupture

Type O
   - Universal donor, can be given to anybody (specifically O (-))
   - Has NO antigens (antibodies of other blood types will not find antigens to fight with)
   - Has BOTH A & B antibodies
   - Can only receive O
   - Most common (47%) but shortage in blood bank since it’s widely needed; most patients are type O

Type AB
   - Universal recipient, can receive all blood types
   - Has both A & B antigen (has receptors for A & B & AB blood types, plus O w/c doesn’t have antigens)
   - Can only donate to AB (blood type A has antibodies for B, blood type B has antibodies for A, O has antibodies for both A&B)
   - Least common (3% of population)

Terminal Sugars – determinant for antigens
   - A = N-acetylgalactoseamine
   - B = Galactose
   - O = none

YOU ARE WHAT YOU CLUMP!

RH FACTOR = Rho = D
   - RH (+) = presence of Rh; only present upon exposure to Rh; 85% of Americans
   - RH (-) = absence of Rh
THYROID GLAND

A. Anatomy
- Follicular cells/Cuboidal cells – produce Thyroglobulin
- Colloid – storage for organified Thyroglobulin (thyroglobulin w/ iodide) until needed
- Thyroglobulin – produced by ER & Golgi; contains amino acid tyrosine
- Iodine – absorbed and oxidized by peroxidase
- Organification of Thyroglobulin = Tyrosine + oxidized Iodine
- Iodination of Tyrosine = Iodotyrosines; can be combined to form T3;T4

B. Thyroid Hormone
- Synthesized by follicular cells
- Has 2 forms:
  1. T4 – Thyroxine – formed from 2 diiodothyronine; most common form, inactive form; modified into T3 form; time released
  2. T3 – Triiodothyronine – modified form w/ 3 iodines; active form

C. Synthesis of Thyroid Hormone

D. Function of Thyroid Hormone
- INCREASE BODY’S METABOLIC RATE (SUM OF ANABOLIC & CATABOLIC RXN)
  - InCREASE metabolic activity, BMR, energy consumption, oxygen utilization, protein synth, protein catabolism
  - InCREASE blood flow and cardiac output, HR, force of contraction, cardiac excitability, heat elimination
  - InCREASE respiration rate, GI motility
  - InCREASE mental and endocrine activity
  - Promotes growth and brain development in fetal life, and early postnatal life.
  - Stim COH metab, and absorption from GI tract
  - Stim fat metab, lipid mobilization from fat stores
  - Excites CNS (B-adrenergic stimulant), muscle activity
  - Sleep difficulty
  - Na/K+ ATPase activity
  3. Increased activity of iodide pump; increase rate of iodide trapping
  4. Increase Iodination of tyrosine to form TH
  5. Increase size and Increase secretory activity of Thyroid cells
  6. Increase number of Thyroid cuboidal cells

E. PATHOPHYSIOLOGY

<table>
<thead>
<tr>
<th>GRAVES DISEASE</th>
<th>HYPERTHYROIDISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-immune disorder</td>
<td>- Auto-immune disorder</td>
</tr>
<tr>
<td>Presence of TSI (Thyroid Stimulating Immunoglobulin)</td>
<td>- Presence of TSI (Thyroid Stimulating Immunoglobulin)</td>
</tr>
<tr>
<td>TSI – acts like TSH, binds to TSH receptors, stimulates release of TH</td>
<td>*TSI – acts like TSH, binds to TSH receptors, stimulates release of TH</td>
</tr>
<tr>
<td>- causes Exophthalmos</td>
<td>- causes Exophthalmos</td>
</tr>
<tr>
<td>- May be caused by local tumor</td>
<td>- May be caused by local tumor</td>
</tr>
<tr>
<td>- presence of TSI causes normal TSH release to decrease</td>
<td>- presence of TSI causes normal TSH release to decrease</td>
</tr>
</tbody>
</table>
**HYPOTHYROIDISM**

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hashimoto’s Thyroiditis</td>
<td>Auto-immune disorder that destroys parts of thyroid &amp; TSH receptors on Thyroid gland; working part becomes over stimulated; results in GOITER/THYROMEGALY</td>
</tr>
<tr>
<td>Iodide Deficiency</td>
<td>Iodine necessary to bind w/ tyrosine in Thyroglobulin; no TH produced - excess TSH</td>
</tr>
<tr>
<td>Cretinism</td>
<td>Mental defects of fetus due to maternal iodide deficiency; IODINE is a factor in myelination of axons in nervous system of fetus</td>
</tr>
<tr>
<td>Myxedema</td>
<td>Develops from total lack of TH; mucus accumulates in interstitial fluid; becomes totally immobile due to its viscous nature</td>
</tr>
<tr>
<td>Defective Thyroid</td>
<td>DEFECTIVE IN: - Iodide Uptake - Peroxidase - Deiodinase</td>
</tr>
</tbody>
</table>

**Comparison of Symptoms:**

| Symptom of Hyperthyroidism | Affected                   | Symptom of Hypothyroidism
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased weight</td>
<td>Mitochondrial enzymes</td>
<td>Increased weight</td>
</tr>
<tr>
<td>Increased BMR</td>
<td></td>
<td>Decreased BMR</td>
</tr>
<tr>
<td>Heat intolerance</td>
<td>Na/K ATPase</td>
<td>Cold intolerance</td>
</tr>
<tr>
<td>Increased heart rate</td>
<td>B1-adrenergic receptor</td>
<td>Decreased heart rate</td>
</tr>
<tr>
<td>Irritable</td>
<td>Sympathetic B-adrenergic receptors</td>
<td>Sluggish (increased somnolence)</td>
</tr>
<tr>
<td>Exophthalamos</td>
<td>TSI (thyroid stimulating immunoglobulin)</td>
<td></td>
</tr>
<tr>
<td>Goiter</td>
<td>TSI or TSH</td>
<td>goiter</td>
</tr>
<tr>
<td>Myelin</td>
<td></td>
<td>Decreased mental development</td>
</tr>
<tr>
<td>Growth Hormone</td>
<td></td>
<td>Decreased growth</td>
</tr>
</tbody>
</table>

**Blockers / Inhibitors**

<table>
<thead>
<tr>
<th>Type</th>
<th>Drug / Toxin</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monoamine Oxidase Inhibitor (MAOI)</td>
<td>Anti-depressant (no particular brands were given)</td>
<td>○ Inhibits MAO from degrading catecholamines in the synapse</td>
</tr>
<tr>
<td>Selective Serotonin Reuptake Inhibitor (SSRI)</td>
<td>Prozac, Ecstasy</td>
<td>○ Inhibits reuptake of serotonin into the presynaptic membrane</td>
</tr>
<tr>
<td>Na⁺ VGC Blocker</td>
<td>Lidocaine - used as anesthesia (dentist shoots this into trigeminal nerve) - Tetrodotoxin (TTX) - from liver of puffer fish and newts - Saxitoxin (STX) – dinoflagellates accumulate in shellfish during red tides</td>
<td>○ Flaccid paralysis ○ Inhibits depolarization</td>
</tr>
<tr>
<td>Vesicle Blocker</td>
<td>Clostridum botulinum - “Botox” - Undercooked turkey - Dented food cans</td>
<td>○ Flaccid paralysis ○ Inhibits neurotransmitter release</td>
</tr>
<tr>
<td>mAChR Blocker</td>
<td>Atropine</td>
<td>○ Flaccid paralysis ○ Inhibits muscarinic receptors (mainly smooth muscles, heart, and glands)</td>
</tr>
<tr>
<td>nAChR Blocker</td>
<td>Curare – made from tree sap; large dose can cause asphyxiation</td>
<td>○ Flaccid paralysis ○ Inhibits nicotinic receptors (mainly skeletal muscles)</td>
</tr>
<tr>
<td>K⁺ VGC Blocker</td>
<td>Tetraethylammonium (TEA)</td>
<td>○ Spastic paralysis ○ Inhibits repolarization</td>
</tr>
<tr>
<td>AChE Blocker (reversible)</td>
<td>Neostigmine – typically given to a person with Myasthenia Gravis - Physostigmine – typically given to a person with Myasthenia</td>
<td>○ Spastic paralysis ○ Temporarily inhibits AChE from</td>
</tr>
<tr>
<td>Drug / Toxin</td>
<td>Effect</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------</td>
<td></td>
</tr>
</tbody>
</table>
| Black widow spider venom | Spastic paralysis  
Stimulates excessive release of ACh |
| Phenylephrine – stimulates alpha receptors (this is in Sudafed PE)  
Isoproterenol – stimulates beta₁ and beta₂ receptors  
Albuterol – stimulates beta₂ receptors  
Ephedrine – increases release of norepinephrine  
Amphetamine – increases release of norepinephrine | Stimulates or mimics the effects of adrenergic receptors; some increase the release of these neurotransmitters |
| Nicotine – stimulates mACh receptors  
Muscarine – stimulates mACh receptors (causes profuse sweating)  
Pilocarpine – stimulates mACh receptors (causes profuse sweating) | Stimulates or mimics the effects of cholinergic receptors |

**Stimulants**

<table>
<thead>
<tr>
<th>Type</th>
<th>Drug / Toxin</th>
<th>Effect</th>
</tr>
</thead>
</table>
| ACh Stimulant (slide 3-30) | Black widow spider venom | Spastic paralysis  
Stimulates excessive release of ACh |
| Sympathomimetics (slide 5-13) | Phenylephrine – stimulates alpha receptors (this is in Sudafed PE)  
Isoproterenol – stimulates beta₁ and beta₂ receptors  
Albuterol – stimulates beta₂ receptors  
Ephedrine – increases release of norepinephrine  
Amphetamine – increases release of norepinephrine | Stimulates or mimics the effects of adrenergic receptors; some increase the release of these neurotransmitters |
| Parasympathomimetics (slide 5-15) | Nicotine – stimulates mACh receptors  
Muscarine – stimulates mACh receptors (causes profuse sweating)  
Pilocarpine – stimulates mACh receptors (causes profuse sweating) | Stimulates or mimics the effects of cholinergic receptors |

**Bilirubin in Bile**

- Bilirubin- major end product of hemoglobin degradation (hemoglobin → globin & heme → heme opened up release free iron & 4 pyrrole nuclei → 4 pyrrole nuclei → biliverdin (reduced to free bilirubin → plasma); free bilirubin + albumin → enters hepatic cells & released; → conjugated to urobilinogen (highly soluble) (1) reabsorbed back to blood in gi tract or (2) enters kidney → oxidized to urobilin → urine (3) stays in feces → oxidized to stercobilin

**Jaundice** – yellowish tint to body tissues, yellowness of skin & deep tissues
- caused by excess bilirubin in the ecf
- (1) Hemolytic (free bill) - increase destruction of red blood cells w/ rapid release of bilirubin into blood  
(2) Obstructive (conjugated) - obstruction of bile ducts or damage to liver cells; can’t be processed out

**HEMATOCRIT**
- packed cell volume  
- measures the percentage volume of whole blood that consists of the formed elements  
- cell count in relation to plasma

**Males** = 42-52%  
**Females** = 37-47%

**Equation**

\[
\text{Hematocrit} = \frac{\text{packed cell volume}}{\text{total whole blood volume}}
\]

\[
= \frac{\text{RBC}}{\text{total whole blood volume}}
\]

**True Hematocrit**

\[
\text{HCT\% reading from Reader} \times 0.96
\]

**Why?**  
Plasma packing or plasma trapped between RBCs

**MEAN CORPUSCULAR VOLUME (MCV)**
- average volume, in cubic microns, of a single erythrocyte (RBC)  
- used to determine Anisocytosis (size abnormality) increase-macrocytic; decrease-microcytic
- normal range 80-100 cu microns or femptoliters

\[ \text{MCV} = \frac{\text{Hematocrit (\%) x 10}}{\text{RBC count in millions (first 2 numbers only)}} \]

**MEAN CORPUSCULAR HEMOGLOBIN (MCH)**
- average weight of hemoglobin in a single erythrocyte (RBC)
- normal range 27-36 picograms (pico-trillionth)
- increase – average hgb weighs more in 1 rbc; decrease- average hgb weighs less than normal

\[ \text{MCH} = \frac{\text{Hemoglobin in gm\% x 10}}{\text{RBC count in millions (first 2 numbers only)}} \]

**MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION (MCHC)**
- average % of Hemoglobin in one RBC
- normal range is 32-36%
- increase- too much hemoglobin count; decrease- too little hemoglobin count

\[ \text{MCHC} = \frac{\text{Hemoglobin in gram\% x 100}}{\text{True Hematocrit (\%)}} \]