BSCI202 FINAL STUDY GUIDE
(When you need someone else to explain something that you don't understand, make the font red so that others can fill in as necessary -- we don't all know everything!)

If anyone wants to study in groups, please email me **(mmoore2015@gmail.com)**! Dr. O'Brien highly recommended studying in groups and interacting with the material to me this morning.

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- Blood is the only fluid tissue in the human body, and it is classified as a connective tissue
- Living cells are called **formed elements**
    - **Erythrocytes** are red blood cells; they transport oxygen and CO2; formed from erythroblasts
        - **Biconcave disk** allows the cell to have a large surface area, which is good for diffusion and gas exchange
        - Essentially little bags of hemoglobin with flexible membranes, which allow them to fold up and move through tiny capillaries while maintaining their shape
        - They have no nucleus, and contain very little organelles
        - Because they have no mitochondria and use anaerobic glycolysis for energy, they do not expend any of the O2 they are carrying, which is optimal for O2 transport
        - 5-6 billion RBCs are present per ml of blood
        - They also maintain osmolarity and blood/plasma pH
        - each hemoglobin molecule has 4 heme groups that contain iron (Fe)
    - **Leukocytes** are white blood cells; they defend the body against pathogens
    - **Platelets** are cell fragments; they are formed from megakaryocytes, and are important in blood clotting
- The **non-living matrix** consists of plasma (the fluid component of blood) and solutes
- A blood hematocrit is created when blood is centrifuged
    - Erythrocytes sink to the bottom of the test tube (45% of blood); this is the **hematocrit**
    - The **buffy coat** contains leukocytes and platelets (less than 1% of blood); it is a thin, whitish layer between the erythrocytes and the plasma
    - The **plasma** rises to the top (55% of blood)
- Plasma constituents:
    - **Water** is the solvent for carrying other substances; also absorbs heat
    - **Salts** (electrolytes/ions) like Na+, K+, Ca2+, Cl-, and HCO3- are responsible for maintaining osmotic balance, pH buffering, and regulation of the membrane's permeability
    - Relatively high concentrations of Na+ and Cl-

    - Relatively low concentrations of H+, HCO3-, K+, and Ca2+
- **Plasma proteins** increase osmotic pressure, buffer H+, increase blood viscosity, and provide fuel during starvation; the three major types are listed below:
    - **Albumin** (synthesized in liver) deals with osmotic balance and pH buffering (major component in **kwashiorkor**; major contributors to plasma oncotic osmotic pressure, and they also act as carrier proteins for molecules that don't dissolve in blood easily
    - **Fibrinogen** (synthesized in liver) deal with blood clotting
    - **Globulins** (most synthesized in liver, but some are synthesized by lymphocytes) are responsible for defense (via antibodies), as well as lipid transport; also carriers, clotting factors, precursor proteins (like angiotensinogen), and immunoglobulins
- Substances transported by the blood:
    - **Nutrients** like glucose, fatty acids, amino acids, and vitamins
    - **Waste products** of the metabolism like urea, uric acid, bilirubin, and creatinine
    - **Respiratory gases** (dissolved) like oxygen and CO2
    - **Hormones**
- The average blood volume for men is **5.5L**, and for women it is **5.0L**
- Oxygen-rich blood is scarlet red, while oxygen-poor blood is dull red
- Blood pH is ideally between 7.35 and 7.45 – we use **7.4** as a baseline
- Blood temperature is slightly higher than the body's normal temperature at **38 degrees C** (or 100.4 degrees F), and it is used to transfer heat throughout the body
- **Ringer's Solution** is a solution of distilled water which contains electrolytes and compounds so that they possess the same concentrations as they occur in bodily fluids
    - This solution is iso-osmotic to our blood and tissues because blood and tissue osmolarity must be equal to prevent new movement of fluids
    - Ranges between 280-300 mOsm/L; we use **300 mOsm/L** as a baseline
- **Osmosis** is the cycle in which water (or solvent) diffuses down its concentration gradient
    - Solutes in the body include Na+, K+, and Ca2+ ions
    - Changes in the electrolyte balance causes water to move from one compartment to another; this alters blood volume and blood pressure, and can impair the activity of cells
    - **Water moves from low [solute] to high [solute] = high [solvent] to low [solvent]**
        - solute: the substance being dissolved (ions, proteins)
        - solvent: the substance that holds the solute (water)
    - Pure water has zero solute present
    - Water reabsorption follows solute reabsorption
- **Acidosis** is when blood becomes too acidic (<7.35)
- **Alkalosis** is when blood becomes too basic (>7.45)
    - In each of these, the respiratory system and kidneys work together to help restore blood pH to 7.4
- CO2 can dissolve in water (located in the blood plasma) and form carbonic acid (H2CO3)

    - **$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+$ (this is an acid!) + HCO_3^- (bicarbonate)**
- The **acid-base balance** is essential to maintaining homeostasis
    - Most ions originate as by-products of cellular metabolism
    - There are complications with acid-base disturbance
        - Conformational change in protein structure
        - Changes in excitability of neurons
        - Changes in the balance of other ions
        - Cardiac arrhythmias
        - Vasodilation/vasoconstriction
- **Acids** are proton (H^+) *donors*
    - Strong acids dissociate completely and liberate all of their H^+ in water
    - Weak acids (like H_2CO_3) dissociate only partially
- **Bases** are proton (H^+) *acceptors*
    - Strong bases dissociate easily in water and tie up H^+
    - Weak bases (like HCO_3^- and ammonia) are slower to accept H^+
- BLOOD COMPOSITION REVIEW
    - Plasma consists of:
        - Water
        - Ions
        - Organic molecules
            - Amino acids
            - Proteins (albumins, globulins, and fibrinogen)
            - Glucose
            - Lipids
            - Nitrogenous wastes
        - Trace elements and vitamins
        - Gases (CO_2 and O_2)
    - Cellular elements:
        - Red blood cells
        - White blood cells
            - Lymphocytes
            - Monocytes
            - Neutrophils
            - Eosinophils
            - Basophils
        - Platelets
            - The fetal liver and spleen are the early sites of blood cell formation
            - Bone marrow takes over **hematopoiesis** (blood cell formation) by the seventh month
            - **Fetal hemoglobin** differs from the hemoglobin produced after birth
    - it has a **gamma** subunit in place of a **beta** subunit, and a higher affinity for oxygen
            - **Physiologic jaundice** results when the liver can't rid the body of the breakdown products of hemoglobin fast enough