Cells form 4 basic tissue groups:

1. Epithelial

2. Connective (including hematological tissue)

3. Muscle

4. Nervous

Cells live in a fluid environment of which water is the main component.

1. Water is the medium in which all metabolic reactions occur.

2. Water allows for precise regulation of volume and composition of body fluid.

The human body has two fluid compartments.

1. Intracellular – fluid found inside the cells and accounts for 40% of all total body weight.

2. Extracellular – fluid found outside the cells which includes; intravascular and interstitial compartments. Accounts for 20% of all total body weight.

- Interstitial Fluid – is extracellular fluid between the cells and outside the vascular bed. Includes the fluid in connective tissue, bones, cartilage and CSF. Accounts for 15% of total body weight.

Tom's language; You have fluid in all cells generically called Intracellular fluid. Extracellular fluid is in two places. It is in the blood vessels but outside the cells (blood plasma) called intravascular. Extracellular fluid is also outside the body cells and outside the blood vessels and is called the interstitial spaces. Interstitial space would be the area of swelling when you break an ankle. The fluid (edema) is not in the blood vessels. It is not in the cells. It is outside the blood vessel and outside the cells and is called interstitial.

Water Movement:

Our body is made up of 60% water and the rest is tissue weight.

Water has to move from one compartment to another constantly to maintain homeostasis (balance).

1. Osmosis – movement of water through semipermeable membranes. No energy needed. Water (solvent) moves from low concentration to high concentration.

Note: Osmosis related to water movement. If the osmosis is happening to a gas it is called osmotic pressure and is driven by partial pressure.

Tom's language; you have just made two containers of Kool-Aid. Container A has two cups of Kool-Aid mix and the other container B has one cup of Kool-Aid mix. Both containers have the same amount of water at the start – 2 litters. You need to balance the taste. So water moves from container B to container A. This will dilute the taste of container A but at the same time increase the taste of container B.

2. Diffusion – constant, random motion of all the atoms in a solution. Does not require energy to work. This is the movement of solutes which is the molecules in water.

Tom's language; when you fart the smell (solute) is very concentrated at the anus. As time passes the smell is diffused into the room. This will happen until the smell has become neutral in the room and a balance has been reached. If you keep farting the smell will overcome the room and will constantly smell. That is until a window is open to reach a fresh balance.

3. Active Transport – carrier-mediated process that can move substances from areas of lower concentration to higher. It works against the gradient. This takes energy. Active transport works faster than diffusion.

4. Facilitated Diffusion – carrier-mediated process that moves substances into and out of cells from high to low concentrations. Does not require energy.

Solutions

1. Hypertonic – has a higher concentration of solute than that inside the cells. Causes cells to shrink (crenation). Examples are; sodium bicarb, D50%
2. Hypotonic – solute concentration lower than that of the cell. Moves solution into the cells and causes swelling of the cell. Examples are; 0.45%NS, D5W.
3. Isotonic – equal molecules inside and outside the cells. Examples; 0.9%NS and lactated ringer's.

Anatomy of Capillary Network

Capillary is a thin-walled tube of endothelial cells without elastic tissue resulting in a neutral pressure.

1. Capillary sphincters – are located just before the capillary and just after leaving the capillary. Precapillary, sphincter and postcapillary sphincter.

2. These sphincters control capillary blood flow by opening and closing.

· Arteriovenous shunts skip the capillary tissue. They go from arterial to venous side. Examples; palm, phalanges, nail bed.

· AV shunts are important part of temperature regulation. When arterial blood pressure is normal the AV shunts close. If pressure increased the AV shunts open. This helps regulate our BP and temperature. The term used is shunting blood.

Diffusion across the capillary wall

1. Tissue cell cannot exchange material directly with blood. The interstitial fluid acts as a middle man.

Tom's language; In a divorce with children. The mother gives the kids to the social worker and the social worker gives the kids to the dad- back and forth. This is why plasma is so important.

Plasma pressure proteins move fluid via osmotic pressure. The protein is albumin. Albumin cannot cross the semipermeable membrane but does take up space resulting in pressure.

Changes in the capillary membrane may cause proteins to cross into the interstitial space. This causes tissue edema.

i. Tom's language; when the presphincter opens and too much pressure builds the capillary membrane may allow proteins to exit in the interstitial space. As a result fluid is drawn into the interstitial space resulting is edema.

ii. Plasma protein albumin creates osmotic pressure.

Note: Fluid that collects in the peritoneal cavity is called ascities.

Water Balance

1. Balanced by ADH. Water is stimulated to be reabsorbed into the plasma from the distal renal tubules and collecting ducts of the kidneys.

2. Volume-sensitive receptors and baroreceptors (found in the heart and great vessels) also can stimulate ADH release.

3. Alcohol (ethanol or ingestible alcohol i.e. in beer, wine, hard liquor) and Caffeine (coffee, some teas and power so-called energy drinks) directly inhibit ADH.

· Tom's language; Water follows sodium. Sodium is the major extracellular cation of the body. If more plasma/fluid is going into the kidneys then sodium is also going. Water follows the sodium and as a result we produce more urine. Caffeine and Booze inhibit ADH and that is why we pee a lot after we drink them.

Electrolytes

1. Predominant Cations (positive);

   a. Intracellular – Potassium (K+), Calcium (Ca++), Magnesium Mg++)

   b. Extracellular – Sodium (Na+)

2. Predoninant Anions (negtive);

   a. Intracellular – Phoshate (PO4/3-)

   b. Extracellular – Chloride (Cl-), Bicarbonate (HCO3-)

Electrolyte Imbalances

1. Potassium – Major positively charged ion in ICF. The body must maintain a narrow range for normal nerve, cardiac, and skeletal function.

   a. Extra potassium is eliminated in the kidneys.

   b. Hypokalemia – most common cause is diuretic use.

   c. Hyperkalemia – poor kidney function, burns, severe infection.

   d. Care for excessive hyperkalemia is calcium, insulin and glucose.

2. Calcium – Cation with two positive charges. Helps with neuromuscular transmission, growth, health of bones, muscle contractions.

a. Hypocalcemia – results from endocrine problems with parathyroid, renal failure, inability to active vitamin D.

b. Care: vitamin D, calcium

c. Hypercalcemia – cause by tumors, thyroid dysfunction, diuretic therapy.

d. Care; treat the causing disease, lasix, steroids.

Acid Base:

- 7.35 to 7.45 is normal range for pH.

- H+ is Hydrogen ion and think as it an acid. The more H+ the more acidic.

- We neutralize/eliminate H+ by:

1. Buffer Systems – made of of carbonic acid and bicarbonate.

2. Lungs and breathing out CO_2

3. Kidneys eliminating H+ with urine.

How it works. $CO_2 + H_2O$ (transfers back and forth) H_2CO_2 (transfers back and forth) $H^+ + HCO_3^-$

CO_2 is carbon dioxide

H_2O is water

H_2CO_2 is carbonic acid

H^+ is hydrogen ion

HCO_3^- is bicarbonate

Respiratory acidosis is when an increase of CO_2 and H_2O combine into carbonic acid.

Metabolic acidosis is when an increase of H^+ and HCO_3^- combine into carbonic acid.

Summary:

What does the following formula mean/result in? Since the CO_2 is exchanged in the lungs it is respiratory in nature. Since the CO_2 is decreased it is respiratory alkalosis.

$\downarrow CO_2 + H_2O \rightarrow \downarrow H_2CO_3^- \rightarrow \downarrow H^+ + HCO_3^-$

What does the following formula mean/result in? Since a sole H^+ is exchanged in the body tissue cells it is metabolic in nature. Since the H^+ is decreased it is metabolic alkalosis.

$\downarrow H^+ + HCO_3^- \rightarrow \downarrow H_2CO_3^- \rightarrow H_2O + \downarrow CO_2$

What does the following formula mean/result in? Since the CO_2 is exchanged in the lungs it is respiratory in nature. Since the CO_2 is increased it is respiratory acidosis.

$\uparrow CO_2 + H_2O \rightarrow \uparrow H_2CO_3^- \rightarrow \uparrow H^+ + HCO_3^-$

What does the following formula mean/result in? Since a sole H+ is exchanged in the body tissue cells it is metabolic in nature. Since the H+ is increased it is metabolic acidosis.

$\uparrow H^+ + HCO_3^- \rightarrow \uparrow H_2CO_3^- \rightarrow H_2O + \uparrow CO_2$

Blood Gasses

Normal blood gas values;

1. PaO2 is 80 to 100
2. PaCO2 is 35 to 45
3. pH is 7.35 to 7.45

What is the following ABG telling us:

PaO2	PaCO2	pH	Result
90-normal	30-too little	7.45	Respiratory Alkalosis
60	60-too much	7.35	Respiratory Acidosis
85 - normal	42 - normal	7.47	Metabolic Alkalosis
85 - normal	42 - normal	7.34	Metabolic Acidosis