**Homeostasis: Internal Fluids & Respiration (Circulation & Gas Exchange) – Chapter 31**

**Updated from 2011 Book (15th edition) Updated 16 January 2011**

**CIRCULATION:**

**intracellular fluid** - fluid **inside** cells; fluid contains potassium (K+), magnesium (Mg++), phosphate (HPO4=), proteins (Fig. 31.1, p. 273)

**extracellular** **fluid** - fluid **outside** cells; contains sodium (Na+), chloride ions (Cl-), bicarbonate (HCO3-); e.g., blood plasma, interstitial fluid (Fig. 31.1, p. 273)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Blood Clotting Process = Coagulation (see Fig. 31.6, p. 276)**

- inner surface of blood vessel is damaged; this causes **platelets and tissue factors** to be released --> then a catalytic sequence of events occurs (Ca++ is necessary for the events to occur) --> then: **Prothrombin --------> thrombin**

**thrombin**

**Fibrinogen -----------> Fibrin Clot**

- in **hemophilia**, blood does not clot properly – caused by a rare mutation on the X chromosome (about 1 in 10,000 men); homozygous females can have hemophilia, but it is much more rare than in males (classic example of a sex-linked inheritance)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Mammalian Blood Components:**

- water (90%)

- plasma proteins (albumin, globulin, fibrinogen)

- glucose, amino acids

- dissolved gases -- O2, CO2, N2

- RBC's = red blood cells = erythrocytes (carry O2)

- WBC's = white blood cells = leukocytes (fight disease, microorganisms, etc.)

- platelets (used in clotting)

- **blood plasma** = extracellular fluid found inside blood vessels; (blood minus the formed elements); formed elements = RBC’s, WBC’s, cell fragments (platelets in mammals) or cells (thrombocytes in other vertebrates) that function in blood coagulation

- **blood serum** = the liquid that separates from blood after coagulation; blood plasma from which fibrinogen has been removed

Plasma is 55% of blood; formed elements are 45% of blood

**from lab -- know general blood flow pattern through the body; know blood flow through the heart (including the valves and the pulmonary circulation)**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Blood Types: refer to Table below (KNOW THIS TABLE AND THE LOGIC BEHIND IT)**

**\*\* Blood types are named for the kind of antigens they carry.**

- **antigen** - substance capable of stimulating an immune response; most often it is a protein

- **antibody** - a protein capable of combining with the antigen that stimulated its production

**Blood Genotype Antigens Antibodies Can Give Can Get**

**Type on RBC's in serum Blood To Blood From**

**O O/O NONE Anti-A and ALL O**

**Anti-B**

**A A/A,A/O A Anti-B A, AB O,A**

**B B/B,B/O B Anti-A B,AB O,B**

**AB A/B AB NONE AB ALL**

- **agglutination** (i.e., clumping together) of RBC's occurs if incompatible blood types are mixed

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Rh Factor** (named after the Rhesus monkey in which it was first found); those people with the Rh factor in their blood are called Rh + (Rh positive); those without the factor are called Rh - (Rh negative); Rh+ blood is not compatible with Rh- blood

**- Problems can arise**:

If an Rh- mother has an Rh+ baby (father is Rh+), she can become immunized by the fetal blood during the birth process. This is not usually a problem for the baby being born at that time. However, in subsequent pregnancies, the mother's antibodies against Rh+ blood can cross the placenta and attack her baby. This can cause a fatal form of anemia of newborn infants called erythroblastosis fetalis.

- this problem can now be prevented by treating the mother immediately after the birth of her first child.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**systole** = contraction of heart

**diastole** = relaxation of heart

**cardiac output** = volume of blood from either ventricle per minute;

it is usually about 5.2 liters/min at rest

**stroke volume** = volume of blood ejected by either ventricle in 1 systole; usually it is about 70 ml

**pulmonary circulation** = blood flow to the lungs

**systemic circulation** = blood flow to the rest of the body (not including the lungs)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Heartbeat (Fig. 31.14, p. 281)-**

- heartbeat originates in the **sinoatrial node (=SA node**) which serves as the **pacemaker** of the heart (SA node is located in right atrial wall)

- then the contraction spreads across the 2 atria to the **atrioventricular (=A-V node)**

- then the electrical impulse goes down the **Bundle of His**

**(= atrioventricular bundle)** into the right and left bundle branches

- then it spreads more slowly up the walls of the ventricles by the **Purkinje fibers**; message then goes into the ventricle walls and contraction of the ventricles occurs (this arrangements allows the contraction to begin at the apex or "tip" of the ventricles and spread upward to squeeze out the blood in the most efficient way; it also ensures that both ventricles contract simultaneously

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**lymph system** - as blood circulates through your body, some of the fluid from the blood gets outside of the blood vessels (due to things like the amount of blood pressure, the osmotic pressure of the fluids inside and outside the blood vessels, etc.) **(see Figs. 31.17, p. 283 and 31.18, p. 284)**

- this fluid is returned to the circulatory system by the lymphatic system; the lymph vessels pick up this fluid from the tissues and the fluid eventually empties back into the venous system

- the **lymph nodes** clean the lymph and help fight disease and infection

- if fluid accumulates in tissues and is not returned to the circulatory system, the condition is called **edema**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**RESPIRATION**:

air pathway (in mammals): mouth --> trachea --> bronchi --> bronchioles --> alveoli (air sacs; gas exchange takes place here)

**diaphragm** - in mammals; we **have negative pressure breathing**

**visceral pleura** - lines the lungs

**parietal pleura** - lines inner walls of chest

**hemoglobin** (= Hb) = respiratory pigment (in mammals and most other vertebrates)

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Compare lungs of vertebrates (Fig. 31.21, p. 286) and gills in fish (Fig. 31.20, p. 285)**

Remember – amphibians use **positive-pressure** **breathing** and most nonavian reptiles, birds, and mammals use **negative-pressure** breathing **(see Fig 31.22, 286)**

**Oxygen Dissociation Curve** - know **Fig. 31.26 ( page 290)**

**Bohr Effect** - CO2 shifts the O2 dissociation curve to the right; i.e., as CO2 enters tissues, it encourages the release of additional O2 from the hemoglobin

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Gas Exchange:**

Know and understand logic of **Fig. 31.25, page 289** (but don't worry about memorizing the actual numbers, just know which numbers are higher and lower with respect to each other)

- **gas exchange (at both alveoli and tissues) takes place due to differences in concentrations and partial pressures of the gases**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

**Control of Breathing**:

- Increased H+ ions stimulates respiratory system in the medulla oblongata of the brain

- Normal, quiet breathing is regulated by neurons centered in the medulla oblongata

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**CO2 Transport in blood—Fig. 31.27, page 291**

1. as bicarbonate ion (HCO3-) (about 67%)

2. combines with Hb & transported as carboaminohemoglobin(23-30%)

3. as dissolved gas in plasma (about 8%)

* bicarbonate ions are transported out of the red blood cells in exchange for chloride ions – this is called the **chloride shift**