TOPIC 17: CARDIOVASCULAR SYSTEM: BLOOD AND BLOOD PRESSURE

I. Components of blood (Table 15.2)
- A. Plasma (liquid portion of blood)
- B. Erythrocytes (red blood cells)
- C. Leukocytes (white blood cells)
- D. Platelets (involved in blood clotting)

II. Plasma
- A. Composition (Table 15.1)
  - 1. 90% water
  - 2. 8% plasma proteins
  - 3. 1% inorganic ions
    - a) Na^+ and Cl^-
  - 4. 1% nutrients, waste, hormones, etc

III. Erythrocytes (Red Blood Cells)
- A. Structure & Function (Fig 15.1)
  - 1. Flat, thin, disk shaped cells (like a donut with an indentation instead of a hole)
    - a) Gives large surface area for diffusion of O_2
    - b) Thinness allows rapid diffusion of O_2
  - 2. Membrane is flexible
    - a) Allows cell to take odd shapes and squeeze through narrow openings
  - 3. Each erythrocyte contains several hundred million hemoglobin (Hb) molecules. So full of Hb that it
    - a) has no nucleus
    - b) has no organelles
    - c) is essentially a sac of Hb
  - 4. Contain
    - a) glycolytic enzymes for energy production
    - b) carbonic anhydrase which converts CO_2 to bicarbonate for transport back to lungs
  - 5. Production & Destruction
    - a) Each erythrocyte lasts about 4 months (very short life)
    - b) Are replaced at the average rate of 2 to 3 million/second
    - c) Most old erythrocytes removed by spleen; new are produced by bone marrow
- B. Hematocrit (Fig 15.2)
  - 1. 99% of cells in blood are erythrocytes
  - 2. Packed cell volume after centrifugation is composed almost entirely of erythrocytes; packed cell volume called hematocrit
  - 3. Hematocrit levels average 42% for females, 45% for men
  - 4. Cream colored layer on top of erythrocytes called Buffy Layer, is composed of white blood cells and platelets

IV. Leukocytes (white blood cells)
- A. Basics
  - 1. Are mobile units of immune system

a) Defend against pathogens
b) Identify and destroy cancer cells
c) Destroy cellular debris in body
2. Use a seek and destroy approach
3. Do most of their work in tissues, only use blood as transport
B. We'll discuss in detail during Topic 24

V. Platelets
A. Structure
1. Small cell fragments from bone marrow-bound cells
2. Contain actin and myosin
3. Do not leave blood but can be stored in spleen
4. Are functional for about 10 days
B. Function
1. Involved in blood clotting during injury

VI. Hemostasis (the arrest of bleeding from a broken blood vessel)
A. Occurs in 3 major steps
1. Vascular spasms
a) reduce blood flow
b) causes broken pieces of vessel to stick together
2. Platelet aggregation (Fig 15.6)
a) Under normal conditions, vessel releases prostacyclin, which inhibits platelet aggregation
b) When damage occurs to vessel, prostacyclin production stops and platelets attach to collagen exposed by damage
c) Attached platelets release two chemicals that causes nearby platelets to get sticky and aggregate together
d) Platelet actin and myosin contract and strengthen aggregate
e) Additional vasoconstrictors released to reduce local blood flow
f) Release additional chemicals needed for coagulation
3. Coagulation (Fig 15.9-don't worry about details, just know points below)
a) Damage & platelet aggregation initiate cascade of clotting factors
b) Eventually fibrinogen (a blood protein) converted to fibrin, which is a loose protein meshwork, and which also activates Factor XIII .
c) Factor XIII stabilizes fibrin into a stabilized meshwork, which becomes a clot as blood cells get caught in it.

VII. Flow Rate of Blood
A. $F = \Delta P/R$
1. F = Flow Rate = Cardiac Output
2. ΔP = pressure gradient = Blood Pressure
a) difference in pressure between beginning and end of a blood vessel
b) main driving force for blood flow through cardiovascular system
3. R = resistance
a) Measure of hindrance to blood flow caused by friction between blood and walls of blood vessel
b) the smaller the vessel, the greater the resistance, because in a small vessel a larger volume of the fluid comes into contact with more

surface area of the vessel. A small change in radius has huge impact on resistance:

(1) Res $\propto 1/radius^4$

(2) doubling the radius decreases the resistance 16 times & therefore increases the flow rate 16-fold.

VIII. Blood Pressure

A. Rewrite flow rate as $\Delta P = FR$: Blood Pressure = Cardiac Output x Resistance

B. Short term regulation of blood pressure

1. Baroreceptor Reflex

a) Location of two most important (Fig 14.26)

(1) Aortic arch

(2) Carotid sinus

b) Usual reflex arch (Fig 14.28)

(1) receptor

(2) afferent pathway

(3) integrating center (cardiovascular control in medulla)

(4) efferent pathway (autonomic nervous system)

(5) receptor organs

c) Baroreceptors constantly fire Action Potentials (Fig 14.27)

(1) When BP goes up, AP frequency increases

(2) When BP goes down, AP frequency decreases

d) Response to decline in blood pressure (Fig 14.29)

2. Cardiovascular response to exercise (box on page 431)

3. Chemoreceptors in carotid arch and aortic arteries are sensitive to O_2, CO_2 and acid levels; reflexively increase respiration and bp during exercise.

4. Emotions & behaviors (fight or flight, orgasms, blushing).

5. Hypothalamic control over skin arterioles for temperature regulation overrides cardiovascular center control over these arterioles.

C. Long term regulation of blood pressure

1. *Control of plasma volume* by left atrial *volume* receptors and hypothalamic *osmoreceptors* = control of urine output and thrist. Will be discussed later in context of kidney function and overall body water/ion balance.

D. Measuring Arterial Blood Pressure (Fig. 14.8)

1. Large number is systolic pressure

2. Small number is diastolic pressure

3. Mean arterial pressure = (systolic pressure + [2 x diastolic pressure])/3

a) diastole is twice as long as systole when person at rest.

b) In this example: (110 + [2 x 70])/3 = 83.3 mm Hg

c) mean arterial pressure is regulated by blood pressure reflexes.

d) Mean arterial pressure during exercise:

(1) (systolic + diastolic)/2