Cardiovascular System I

(a) Blood smear
Functions of the cardiovascular system

• Transport system for:
  – Gases-$O_2$ & $CO_2$
  – Hormones
  – Nutrients
  – Wastes

• Temperature regulation

• pH regulation of blood

• Immune function
Components of the cardiovascular system

- Blood-fluid, carries gases, nutrients, hormones, heat, etc
- Heart-pump, push the blood thru the vessels
- Vessels-pipes, carries blood through out the body
Function of blood

• Transportation of: Nutrients, oxygen and hormones; wastes and secretion
• Protection:
  – against microorganisms
  – against dehydration
• Regulation of vital fluid balances:
  – pH balance
  – body temperature.
Composition of blood

• Fluid connective tissue
• Blood is 45% formed elements & 55% plasma
• pH = 7.35-7.45
• Blood temp slightly higher than core body temp (100 degrees F)
• Males- 5-6 liters; Females 4-5 liters
Blood = Plasma + Formed (Cellular) Elements

Plasma

- ~ 55% blood volume
- ~ 92% of plasma is water
  - ~7% dissolved substances (gases, proteins, wastes, nutrients, hormones)
- High dissolved oxygen content
- Dissolved proteins
  - Albumins
  - Globulins
  - Fibrinogen

Cells

- ~ 45% blood volume
- RBCs ~ 99.9% of cells
Plasma Proteins: 90% are made in the liver

Albumin (60%)
- Form lipoproteins for transport of proteins, fats and steroids.
- Maintain osmotic pressure and viscosity of blood

Globulin (35%)
- Transport proteins-bind insoluble ions, hormones.
- Antibodies-attack foreign proteins

Fibrinogen (4%)
- Form fibrin
- Form framework of blood clot
Formed elements ~ 45% blood volume

- Blood cells/cell fragments

- Erythrocytes-transport $O_2$ & $CO_2$
  - RBCs ~ 99% of cells

- Leukocytes-immune function
  - WBCs ~1% of cells

- Platelets-blood clotting
Fig 20.1
Hemopoiesis

Blood cell formation

- Before birth- red bone marrow, liver, spleen, thymus. Etc.
- After Birth- (primary sites)- red bone marrow of ribs, sternum, hips. Yellow bone marrow(in extreme emergency)

HEMOCYTOBLAST

- blood stem cell- for all types of formed elements.
Hemoipoiesis-blood cell formation

- hemocytoblast
- Erythrocytes  Leukocytes  Platelets
- Neutrophil  Monocyte  Lymphocyte
Fig 20.8
• RBCs (erythrocytes) ~ 99% of all blood cells.
• 1000 RBC : 1 WBC
• Hematocrit = ~ % erythrocytes in whole blood

FYI
Lacks mitochondria, ribosomes, nuclei
Rely on Anaerobic metabolism
Life span = ~120 days
• Hemoglobin Function:
  – Transport Oxygen and Carbon Dioxide. Via hemoglobin
  – binds to oxygen. At high conc. / releases at low.
  – 1 RBC has 280 million hemoglobin
  – 1 hemoglobin carries 4 oxygen molecules
  – iron atom combines reversibly with oxygen.
  – Carbon Dioxide. Carried by protein
  – Cannot move independently (carried by plasma)
Blood Types

**TYPE A**
- Surface antigen A
- Anti-B antibodies
- PLASMA

**TYPE B**
- Surface antigen B
- Anti-A antibodies

**TYPE AB**
- Surface antigens A and B
- Neither anti-A nor anti-B antibodies

**TYPE O**
- Neither A nor B surface antigens
- Anti-A and anti-B antibodies
Normal Red Blood Cells

Sickle Cells
- Sickle Cell Anemia
wbc

- Defense against infection and disease
- Live- few hours/ days
- Phagocytosis (cell eating) used by most.
- Less in blood- bone marrow \( \rightarrow \) tissue

- Storage of WBC and release when needed
  - Found (majority) in peripheral tissue and lymphatic system

Most abundant \( \rightarrow \) Least abundant:
- “Never Let Monkeys Eat Bananas”
- Neutrophils \( \rightarrow \) Lymphocytes \( \rightarrow \) monocytes \( \rightarrow \) Eosinophils, Basophils.
Granular Leukocytes (WBCs) the ‘pHils’

- **Neutrophils**
  - 70% circulating leukocytes
  - Highly mobile phagocytes
  - Involved in fighting bacterial infections
- **Eosinophils** (acidophils)
  - Much less common
  - Attracted to foreign compounds reacted with antibodies
  - Used in fighting parasitic & allergic reactions
- **Basophils**
  - Relatively rare
  - Migrate to damaged tissue
  - Release histamines.
Agranular Leukocytes

- **Lymphocytes**
  - Primary cell of the lymphatic system
    - **T-cells** attack foreign cells directly
    - **B-cells** produce antibodies

- **Monocytes**
  - Migrate into peripheral tissues and differentiate into **Macrophages**
  - Highly mobile phagocytic cells
• **Platelets**- (“Thrombocytes”)
• Fragments of large stem cell megakaryoblasts
  – No nucleus; some organelles
  – Initiate blood clotting (known as Hemostasis) with fibrinogen
  – enclosed packets of cytoplasm for blood clotting
The heart

- 4 muscular chambers
- 2 superior chambers - atria
- 2 inferior chambers - ventricles

- The heart pumps blood thru two circuits
- Pulmonary circuit - lungs
- Systemic circuit - everywhere except the lungs
Position and Orientation of the Heart
• **Size**
  – 5 in x 3 in (fist)
• **Location**
  – Mediastinum (within Pericardial cavity)
  – Right chambers slightly anterior
  – Apex points left
  – Lays on diaphragm
• Base-deep to sternum at 3rd intercostal space
• Apex- Deep to 5th left intercostal space

• 3 layers of Heart:
• Endocardium
• Myocardium
• Epicardium- AKA visceral pericardium
Pericardial cavity

Visceral pericardium

Parietal pericardium

Fig 21.2
The heart wall

- Parietal pericardium
- Epicardium/visceral pericardium
- Myocardium-cardiac muscle tissue
- Endocardium—epithelia tissue
The Fibrous Skeleton

Is an internal connective tissue of the heart

1. Provides attachment for heart’s valves
2. Support muscle cells, blood vessels, nerves
3. Evenly distribute the force of contraction
4. Physically isolates muscle cells of the atria from those of the ventricles
• Bands of Fibrous Connective Tissue
  • -Found within Myocardium
  • -Shapes Chambers
  • -prevents overfilling of chambers
  • -Electrically separates atria from ventricles
Myocardium

• FYI

• Cardiac muscle:
  • similar to skeletal muscle
  • much more dependant on oxygen
  • contracts w/o signaling from the nervous system
  • contains cells junctions called intercalated discs and gap junctions
Intercalated discs & gap junctions

• Intercalated discs hold adjacent cardiac muscle cells together
  – Cells work together during contraction
  – Mechanically links cells together

• Gap junction allow ions to pass from cell to cell
  – Electrical stimulation in one cell can pass directly into other cells
  – Electrically/chemically links cells together

• Cardiac muscle cells work as a well organized unit
The Heart is Dual Pump

• Most of the heart is Myocardium
  - Contractile Myocardiocytes
    * Interconnected by intercalated discs
      - Desmosomes
      - Gap junctions
Pulmonary circuit
- from heart
to lungs
back to heart

Systemic circuit
- from heart
to body
back to heart
Atria vs. ventricles

- Blood enters the heart via atria
- Atria have thinner walls than ventricles
- Atria pump blood to the ventricles
- Ventricles pump blood thru the pulmonary and the systemic circuit
The Right Atrium

• Contains the SA and AV nodes
• Receives blood from systemic circuit
• Superior vena cava
  – Inferior vena cava

• Coronary veins
  – Return blood to *coronary sinus* then on to right atrium

• *Foramen ovale* open during embryonic development
  – *Fossa ovalis* after birth
The Lt. Ventricle has a much thicker myocardium.
• **Pulmonary Circuit**- oxygenation of blood
  - From the Pulmonary semilunar valve ➔ Through the lungs ➔ to the entrance of the left atrium
• **Systemic Circuit**- oxygenation of tissue
  - From the aortic semilunar valve ➔ through the body ➔ to the entrance of the right atrium
Interactive physiology CD
Histology CD
neutrophil

monocyte

platelets

lymphocyte
Intercalated discs
A - layer of elastic fibres (tunica adventitia)
B - layer of smooth muscles and elastic fibres (tunica media)
C - endothelium and elastin (tunica intima)
D - blood