CARDIOVASCULAR SYSTEM: BLOOD, THE HEART
Components

- **Cardiovascular system**
  - Heart
  - Blood vessels
  - Blood
  - transport of nutrients, hormones, oxygen, waste, carbon dioxide

- **Lymphatic system (*)**
  - Lymphatics
  - Lymph
  - Lymph nodes
  - Lymph organs
  - Immunity, transports lipids, maintains tissue fluid balance
The Cardiovascular system and Lymphatic system work in tandem.
Hematology

• Study of blood and components

• Composition of Blood
  – Plasma
    • ≈ 55% total volume
  – Formed elements
    • ≈ 45% total volume
    • Erythrocytes
    • Leukocytes
    • Thrombocytes (Platelets)
Plasma

• Predominately water ≈ 92%
• Plasma proteins
• Major solutes
  – Salts
  – Minerals
  – Bicarbonate buffer
• Transported substances
  – Gases
  – Sugars, amino acids, vitamins
  – Hormones
  – Waste products......etc.
Plasma Proteins

• Predominately made in liver
• Major plasma proteins
  – Albumins
  – Lipoproteins
  – Clotting Factors
  – Globulins
    • Including antibodies
      – Gamma globulins
      – Made by lymphocytes
Formed Elements

- Eosinophil
- Lymphocyte
- Neutrophil (PMN)
- Monocyte
- Basophil
Thrombocytes

- Formed by disintegration of megakaryocytes
- Released into plasma
- Last 3-5 days
- Important in blood clotting
Erythroctes (RBC)

- Red blood cells
- Anucleate
- Lack mitochondria
- Millions of hemoglobin molecules
- Life span = 3-4 months
Hemoglobin

- Quaternary protein produced by red blood cells
- Contains 4 iron (Fe) containing peptides that bind oxygen
Erythrocyte Development

- Develop from erythroblasts
- Synthesize hemoglobin until 1/3 full
- Then lose nucleus and mitochondria

Pluripotent (more than one outcome) stem cells can give rise to any fetal or adult cell in the body
Leukocytes

• Granular
  – Neutrophils
  – Eosinophils
  – Basophils

• Agranular
  – Monocytes (macrophage)
  – Lymphocytes
    • T-cells
    • B-cells
    • NK cells
Neutrophils (PMN’s)

- First WBC at an infection site
- 50-60% of circulating leukocytes
- Voracious phagocytes
- Attack microbes
Eosinophils

- Slightly phagocytic
- Effective against helminths
- Allergic and hypersensitivity reactions
- Contribute to chronic inflammation
Basophils

- Mature into mast cells of loose connective tissue
- Produce:
  - Heparin
  - Histamine
- Inflammation, especially related to allergies
Monocytes

- Become macrophage when activated
- Eat microbes cellular debris
- **Antigen Presenting Cells (APC)**
  - link nonspecific body defenses to the immune response
Lymphocytes

- Primary cells of the lymphatic system
- Responsible for specific immunity
  - T cells
  - B cells
  - NK cells
The Heart

- 4 chambers
  - Atria (atrium, singular)
  - Ventricles

- Valves
  - Atrioventricular
  - Semilunar

- Creates pressure to pump blood through 2 circuits
  - Pulmonary
  - Systemic
Circuits of Blood Flow

- **PULMONARY CIRCUIT**
  - Pulmonary arteries
  - Pulmonary veins

- **SYSTEMIC CIRCUIT**
  - Systemic arteries
  - Systemic veins

- Capillaries in lungs
- Capillaries in head, neck, upper limbs
- Right atrium
- Left atrium
- Right ventricle
- Left ventricle
- Capillaries in trunk and lower limbs
Structures of the Heart Wall

- **Pericardium**
  - Visceral pericardium
  - Serous membrane
  - Supporting layer of areolar CT

- **Myocardium**
  - Layers of cardiac muscle tissue
  - CT, blood vessels, nerves

- **Endocardium**
  - Simple squamous epithelium
  - Continuous with mesothelium of blood vessels
Cardiac Muscle Tissue

- Striated
- Branched
- Interdigitated
- Centrally located nucleus
- Intercalated discs
- Fibrous skeleton
  - Collagen, elastin
  - Stabilizes cells
  - Provides support to valves
  - Distributes force of contraction
Superficial Anatomy of the Heart
Superficial Anatomy of the Heart
Superficial Anatomy of the Heart

- Arch of aorta
- Right pulmonary artery
- Superior vena cava
- Right pulmonary veins (superior and inferior)
- Right atrium
- Fat in coronary sulcus
- Fat in posterior interventricular sulcus
- Coronary sinus
- Left pulmonary veins
- Left pulmonary artery
- Left atrium
- Superior vena cava
- Inferior vena cava

(b) Posterior (diaphragmatic) surface
Internal Anatomy of the Heart
Atria

- Thin wall
- Receiving chambers
- Derived from veins
- Auricles
  - folded extensions of the atria
  - increase volume
- Pectinate muscle
  - atrial muscle, “honeycomb” appearance
Ventricles

- Thick wall
- Pumping chambers
- Derived from arteries
- Trabeculae = “crossbars of flesh”

- **R ventricle**
  - thinner wall
  - pumps to lungs
  - moderator bands control the volume of the RV

- **L ventricle**
  - 2-3 X’s thicker than the RV
  - pumps to systemic circuit
Relaxed Ventricles

POSTERIOR
- Fibrous skeleton
- Left AV (bicuspид) valve (open)

RIGHT VENTRICLE
- Right AV (tricuspid) valve (open)
- Aortic valve (closed)
- Pulmonary valve (closed)

ANTERIOR
- Transverse section, superior view, atria and vessels removed

LEFT VENTRICLE
- Aortic valve (closed)

Frontal section through left atrium and ventricle
- Pulmonary veins
- Left AV (bicuspид) valve (open)
- Chordae tendineae (loose)
- Papillary muscles (relaxed)
- LEFT VENTRICLE (dilated)

(a) Relaxed ventricles

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Contracting Ventricles

(b) Contracting ventricles
Coronary Blood Vessels

Diagram showing the Circumflex branch of LCA, Atrial branch of LCA, Great cardiac vein, Marginal branch of LCA, Posterior vein of left ventricle, Posterior left ventricular branch of LCA, Left atrium, Left ventricle, Right atrium, Right ventricle, Coronary sinus, Small cardiac vein, Right coronary artery (RCA), Right marginal branch of RCA, Middle cardiac vein.
Fetal Heart

- Aortic arch
- Ductus arteriosus
- Left pulmonary artery
- Interatrial septum
- Foramen ovale