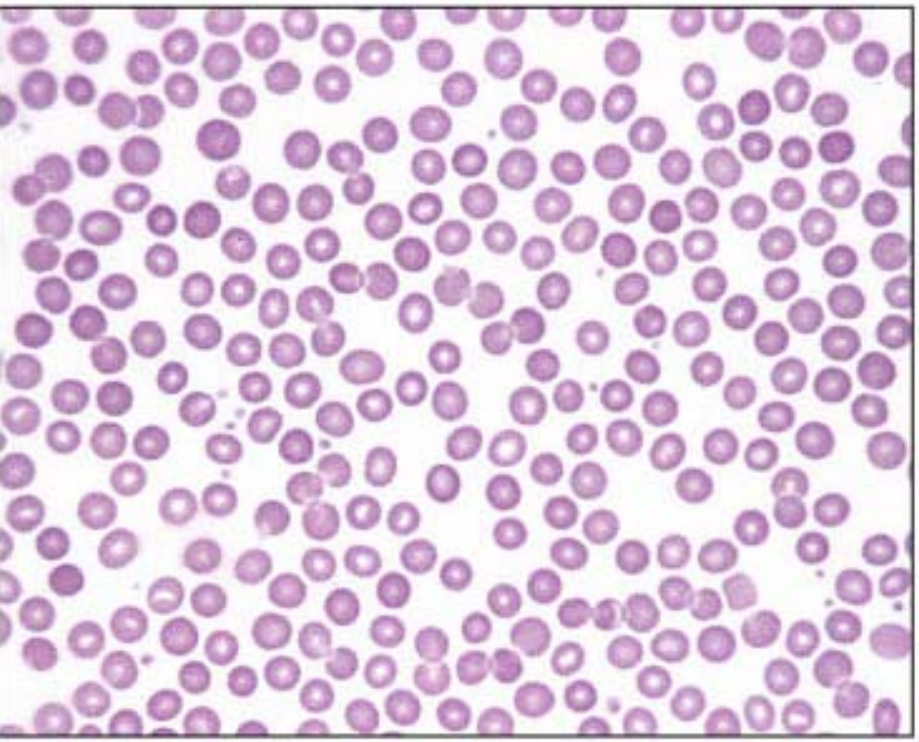


(a) Blood smear

Cardiovascular System I

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)
- 5.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

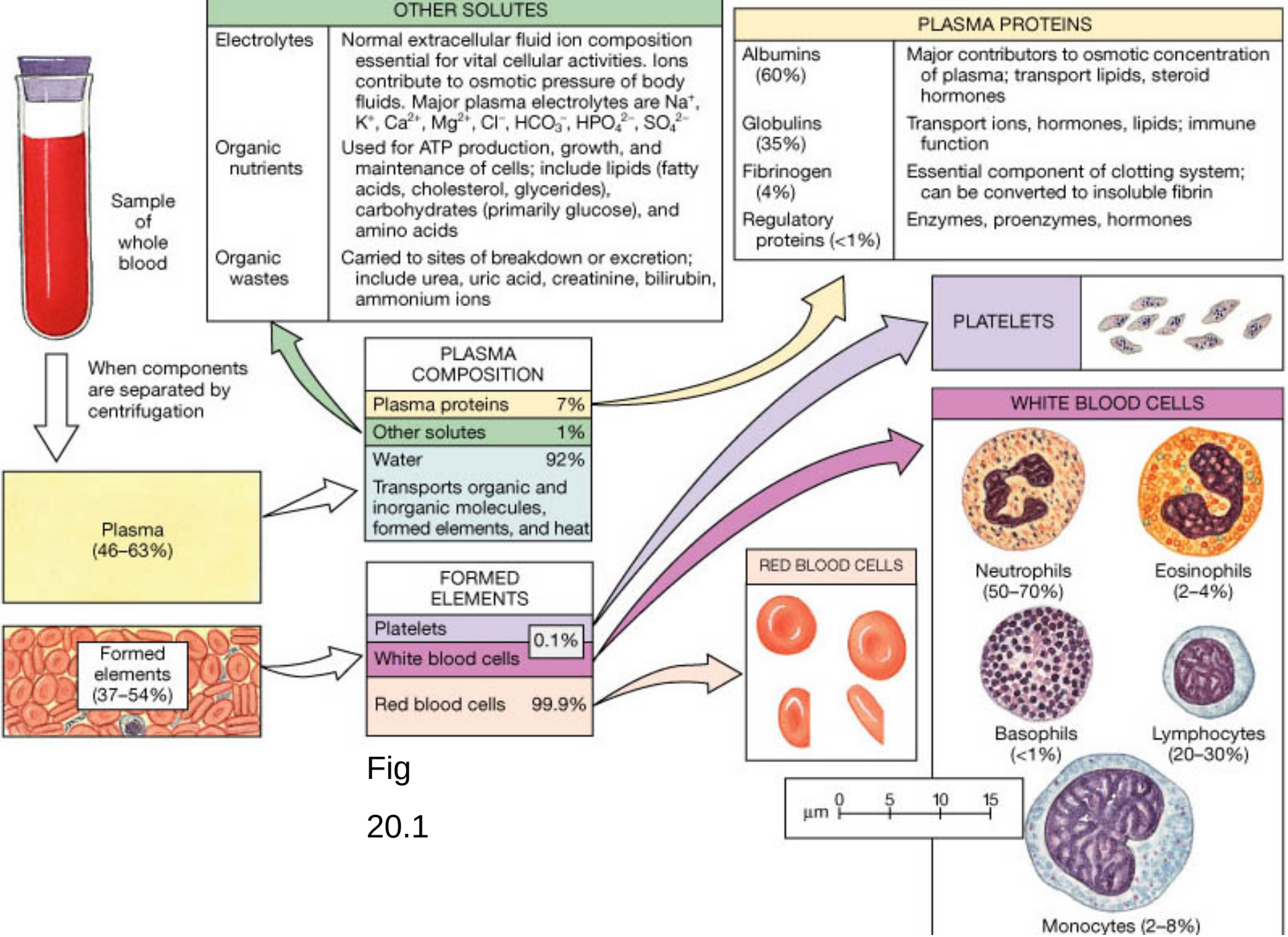

OTHER SOLUTES
Electrolytes
Normal extracellular fluid ion composition essential for vital cellular activities. Ions contribute to osmotic pressure of body fluids. Major plasma electrolytes are Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, HPO_4^{2-}, SO_4^{2-}
Organic nutrients
Used for ATP production, growth, and maintenance of cells; include lipids (fatty acids, cholesterol, glycerides), carbohydrates (primarily glucose), and amino acids
Organic wastes
Carried to sites of breakdown or excretion; include urea, uric acid, creatinine, bilirubin, ammonium ions
PLASMA PROTEINS
Albumins (60%)
Major contributors to osmotic concentration of plasma; transport lipids, steroid hormones
Globulins (35%)
Transport ions, hormones, lipids; immune function
Fibrinogen (4%)
Essential component of clotting system; can be converted to insoluble fibrin
Regulatory proteins (<1%)
Enzymes, proenzymes, hormones
Sample of whole blood
When components are separated by centrifugation
Plasma (46–63%)
Formed elements (37–54%)
PLASMA COMPOSITION
Plasma proteins 7%
Other solutes 1%
Water 92%
Transports organic and inorganic molecules, formed elements, and heat
FORMED ELEMENTS
Platelets 0.1%
White blood cells
Red blood cells 99.9%
PLATELETS
WHITE BLOOD CELLS
Neutrophils (50–70%)
Eosinophils (2–4%)
Basophils (<1%)
Lymphocytes (20–30%)
Monocytes (2–8%)
RED BLOOD CELLS
μm 0 5 10 15

Fig 20.1

Hemopoesis

Blood cell formation

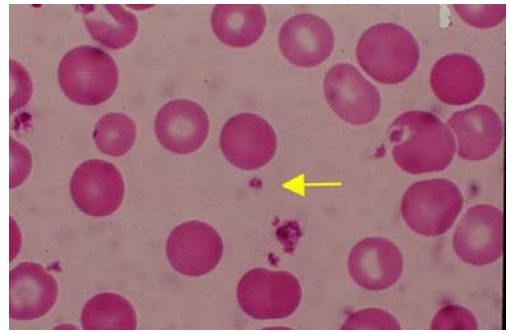
- Before birth- red bone marrow, liver, spleen, thymus. Etc.
- After Birth- (primary sites)- red bone marrow of ribs, sternum, hips. Yellow bone marrow(in extreme emergency)

HEMOCYTOBLAST

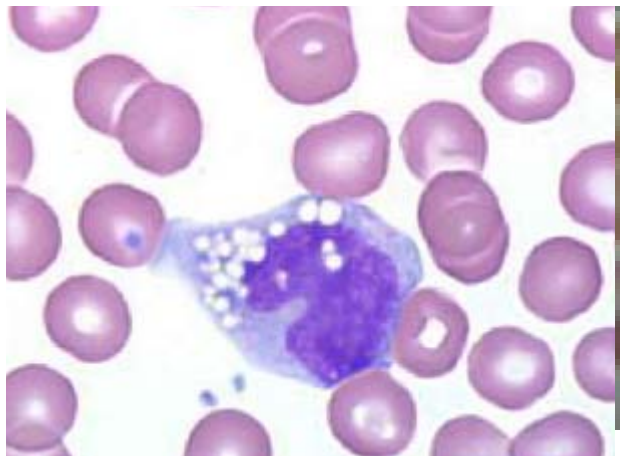
- blood stem cell- for all types of formed elements.

Hempoiesis-blood cell formation

- hemocytoblast



- Erythrocytes Leukocytes Platelets
- Neutrophil Monocyte Lymphocyte



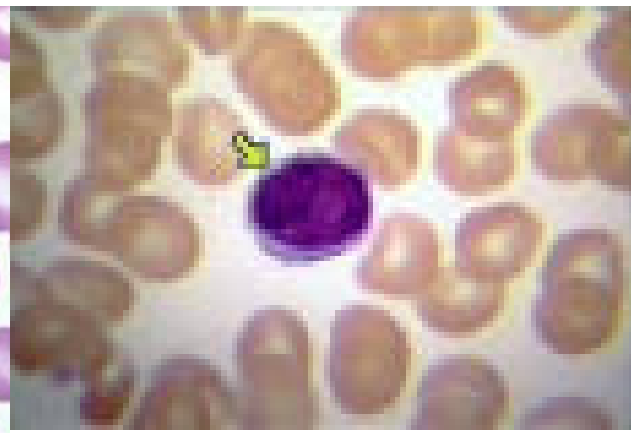
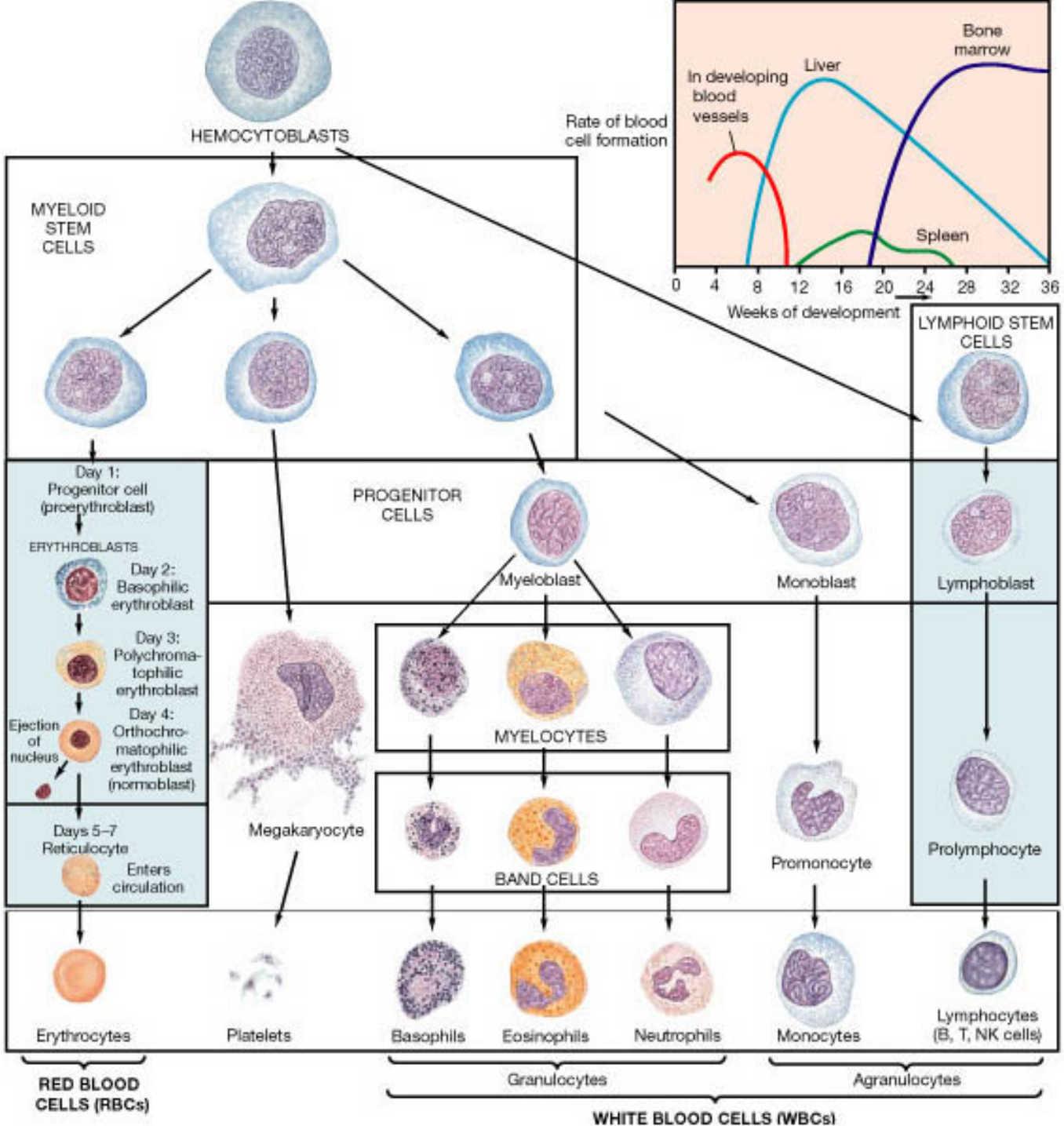


Fig 20.8


HEMOCYTOBLASTS
MYELOID STEM CELLS
Rate of blood cell formation
In developing blood vessels
Liver
Bone marrow
Spleen
0 4 8 12 16 20 24 28 32 36
Weeks of development
LYMPHOID STEM CELLS
Day 1: Progenitor cell (proerythroblast)
ERYTHROBLASTS
Day 2: Basophilic erythroblast
Day 3: Polychromatophilic erythroblast
Ejection of nucleus
Day 4: Orthochromatophilic erythroblast (normoblast)
Days 5–7 Reticulocyte
Enters circulation
PROGENITOR CELLS
Myeloblast
Monoblast
Lymphoblast
Megakaryocyte
MYELOCYTES
BAND CELLS
Promonocyte
Prolymphocyte
Erythrocytes
Platelets
Basophils
Eosinophils
Neutrophils
Monocytes
Lymphocytes (B, T, NK cells)
RED BLOOD CELLS (RBCs)
Granulocytes
Agranulocytes
WHITE BLOOD CELLS (WBCs)

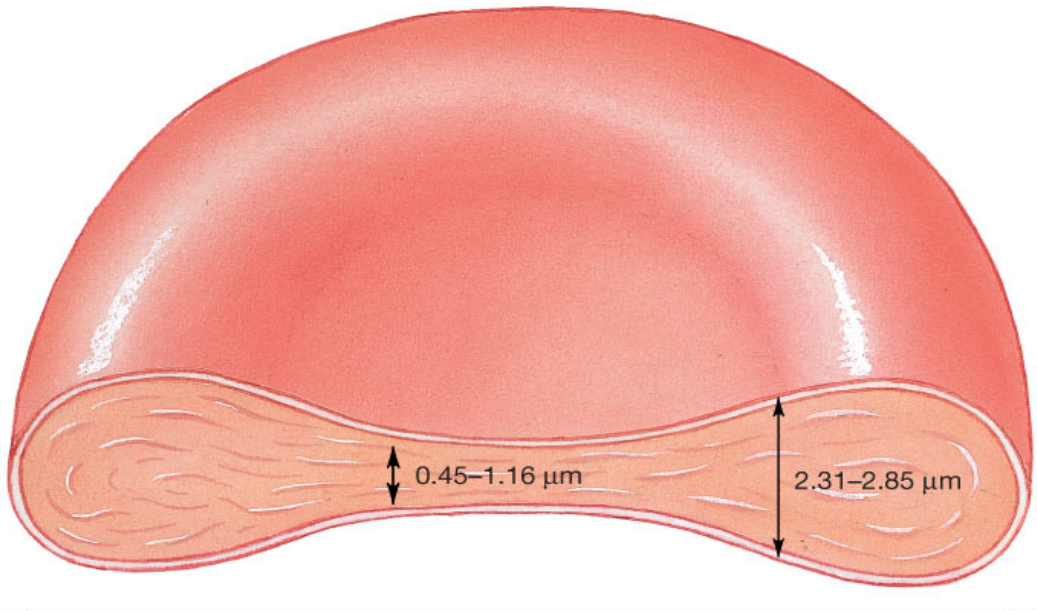
- RBCs (erythrocytes)~ 99% of all blood cells.
- 1000 RBC : 1 WBC
- Hematocrit = ~ % erythrocytes in whole blood

FYI

Lacks mitochondria, ribosomes, nuclei

Rely on Anaerobic metabolism

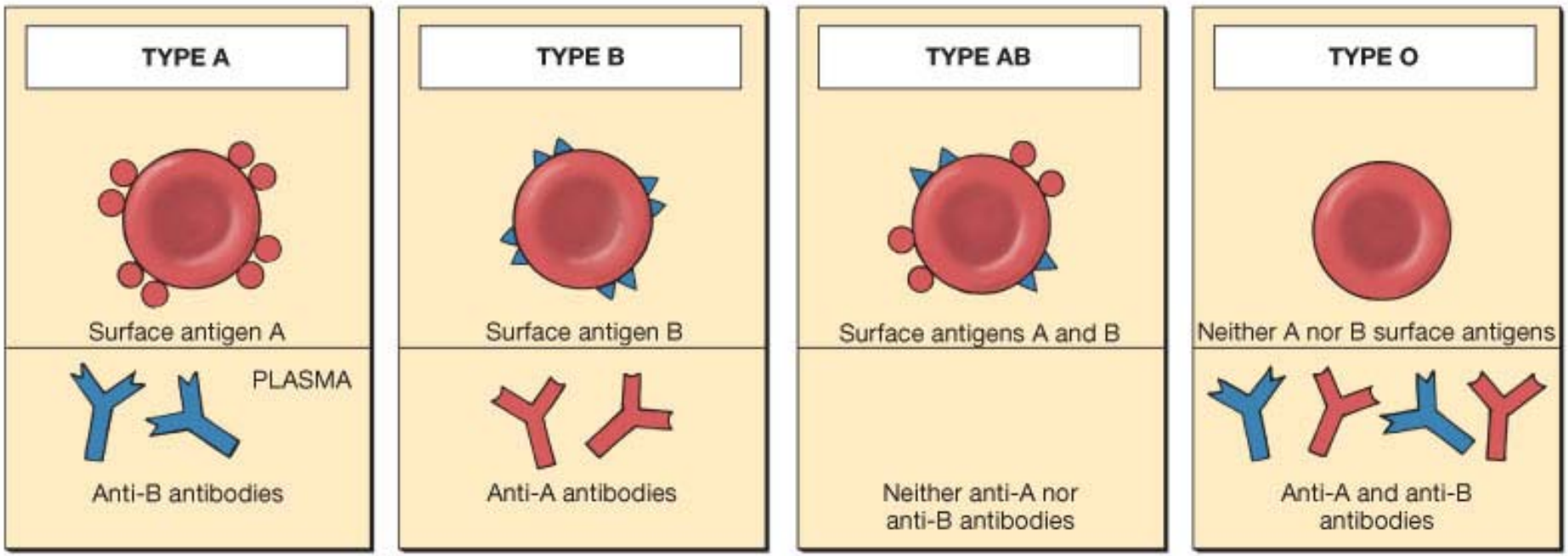
Life span = ~120 days

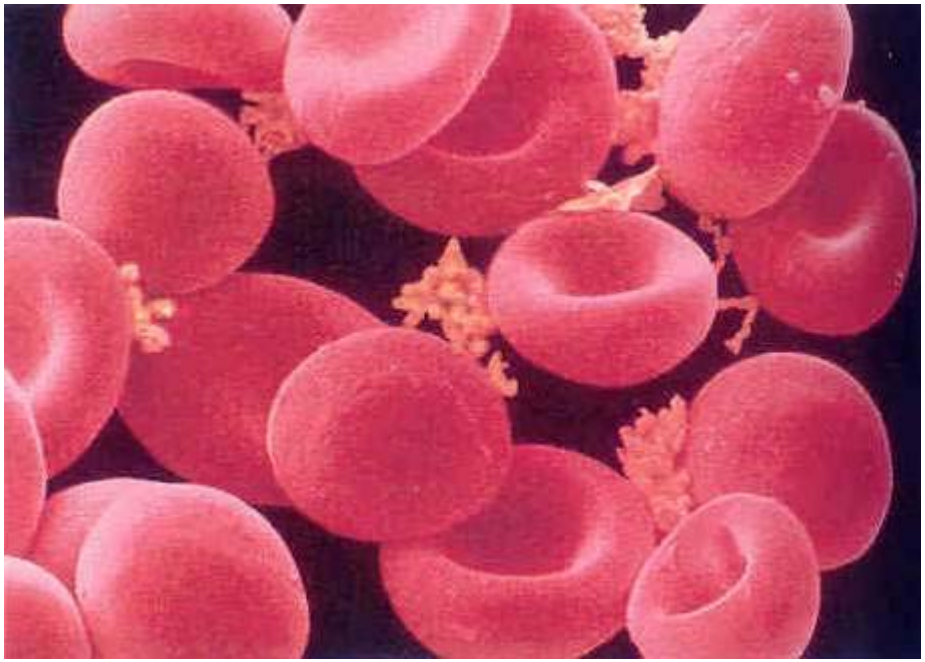


(d) Sectional view of RBC

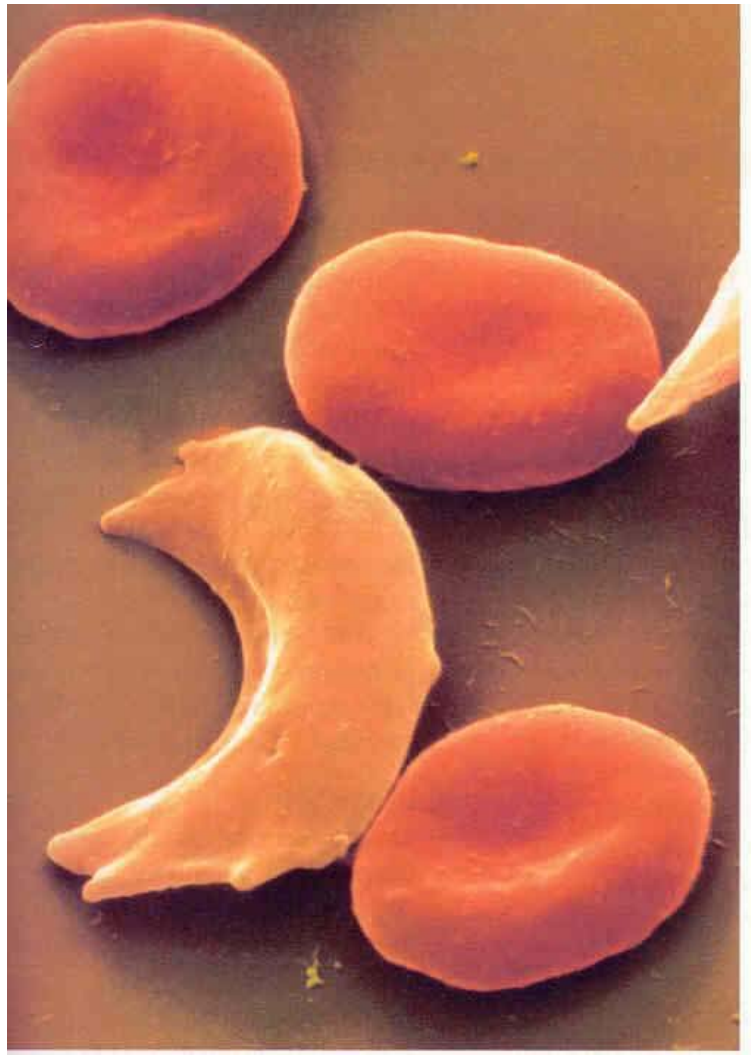
- Hemoglobin Function:
  - Transport Oxygen and Carbon Dioxide. Via hemoglobin
  - binds to oxygen. At high conc. / releases at low.
  - 1 RBC has 280 million hemoglobin
  - 1 hemoglobin carries 4 oxygen molecules
  - iron atom combines REVERSIBLY w/ oxygen.
  - Carbon Dioxide. Carried by protein
  - Cannot move independently (carried by plasma)

Blood Types


TYPE A
Surface antigen A
PLASMA
Anti-B antibodies
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 → tissue

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

Most abundant → Least abundant:

- "Never Let Monkeys Eat Bananas"
- Neutrophils→ Lymphocytes→monocytes→ 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

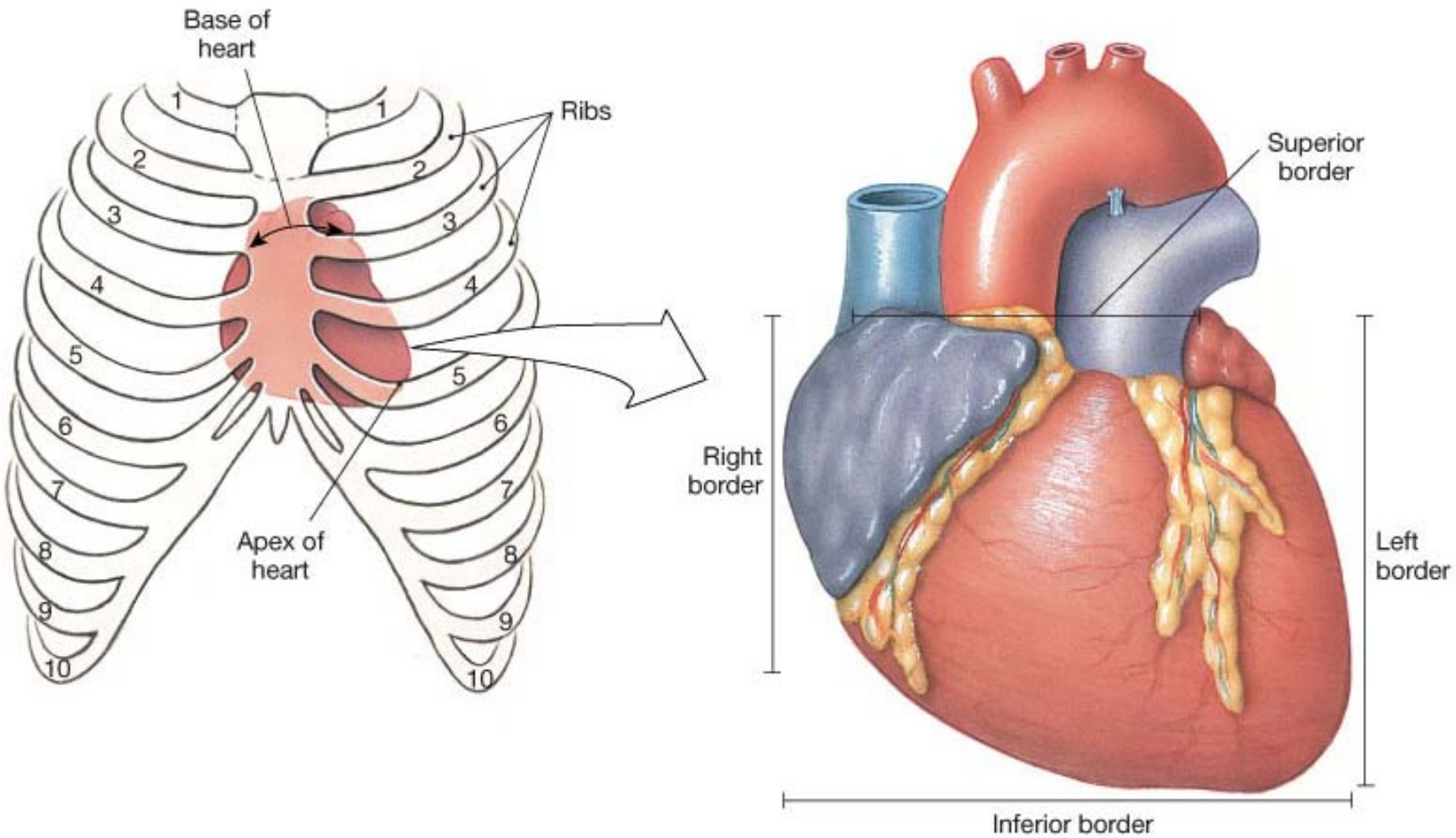
- **Platelets-** (“Thrombocytes”)
- Fragments of large stem cell megakaryoblasts
  - No nucleus; some organelles
  - Initiate blood clotting (known as Hemostasis) with fibrinogen
  - enclosed packets of cytoplasm for blood clotting

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

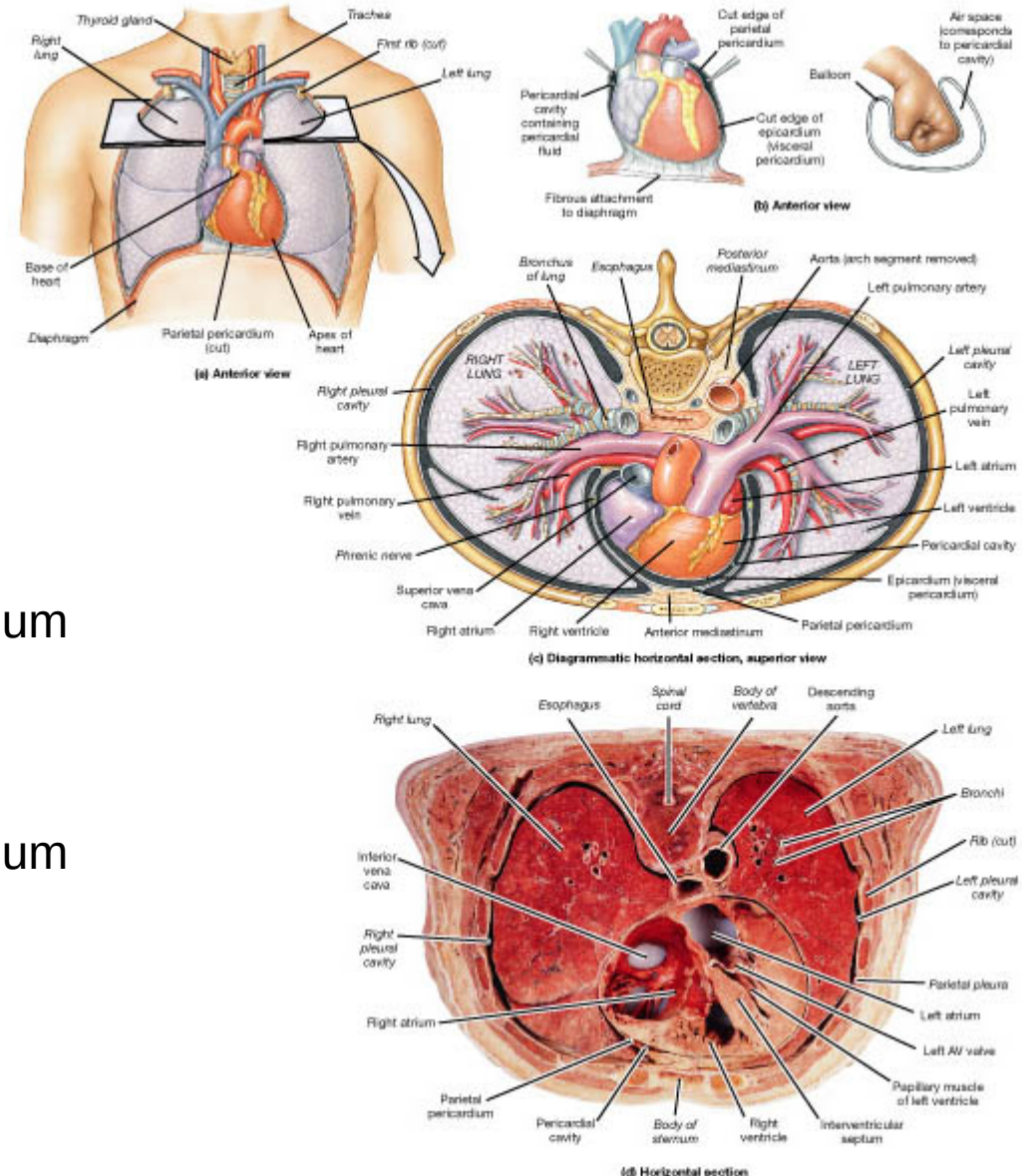
Position and Orientation of the Heart



- 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

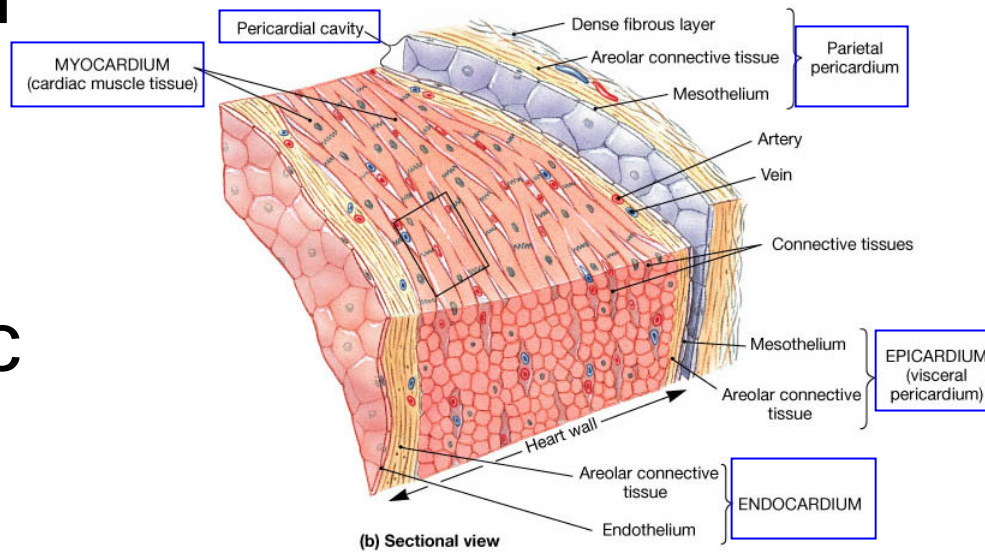


Fig 21.3

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

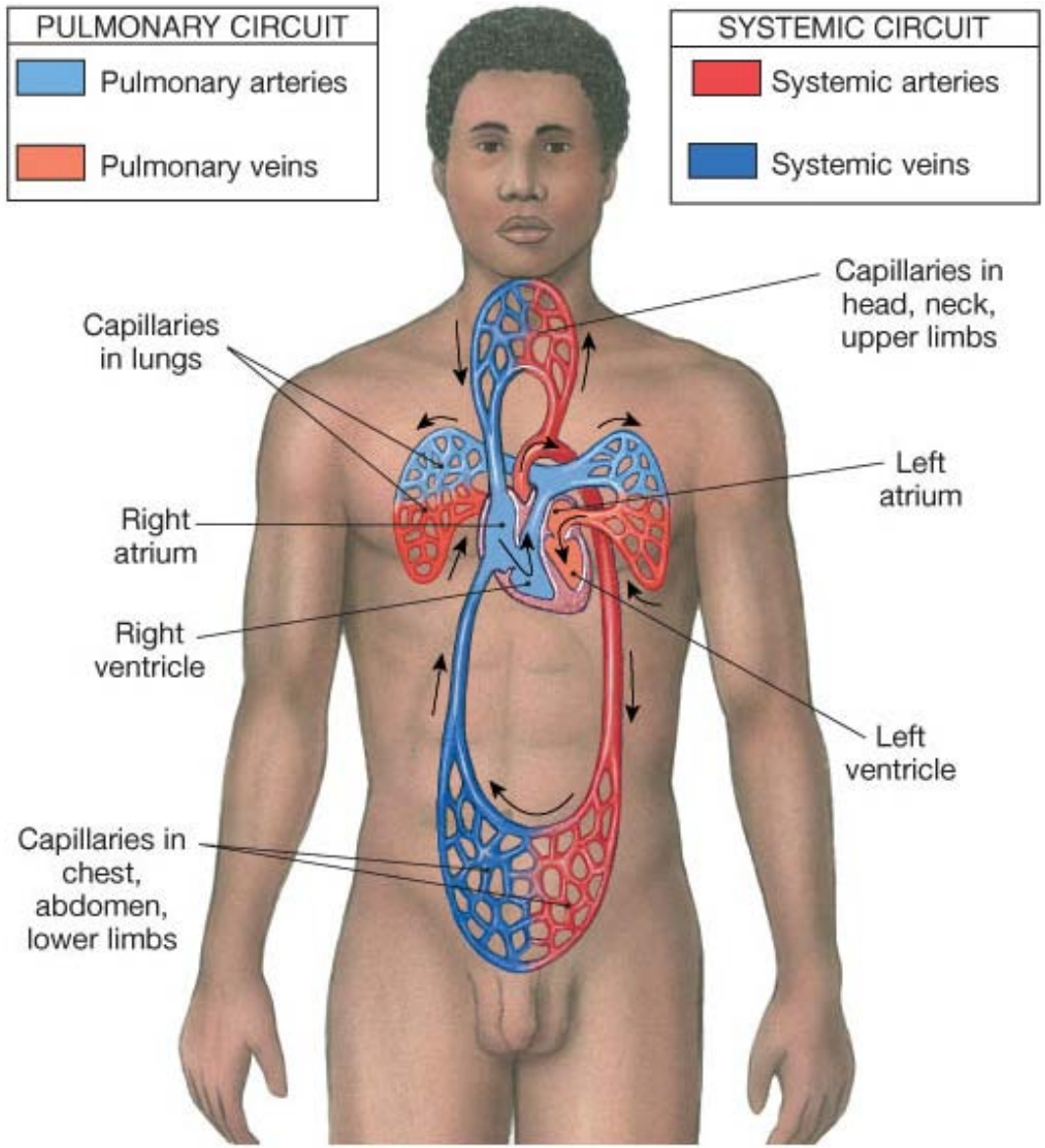
        * Interconnected by intercalated discs
            - Desmosomes
            - Gap junctions

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

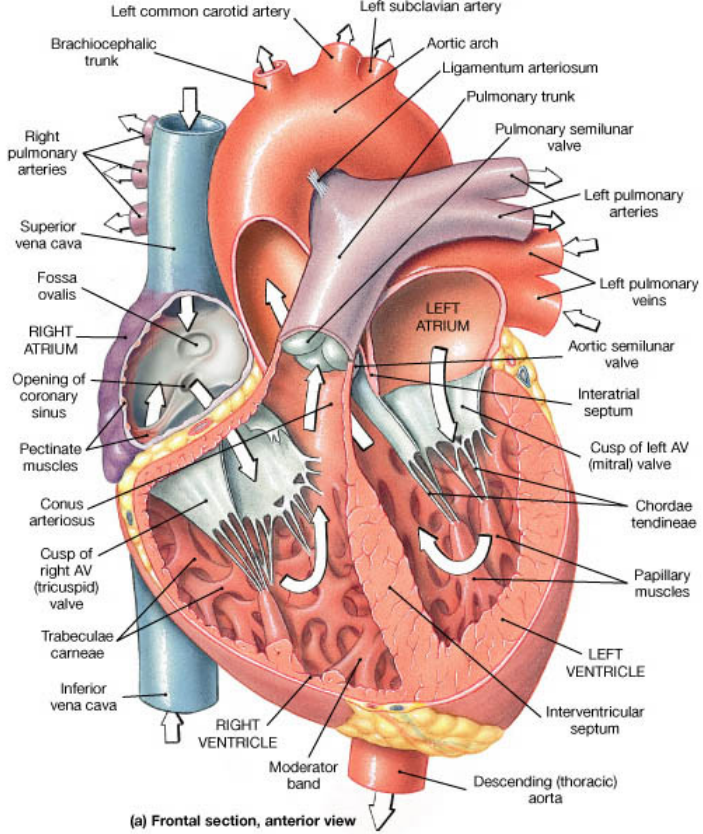
The Right Atrium

- 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

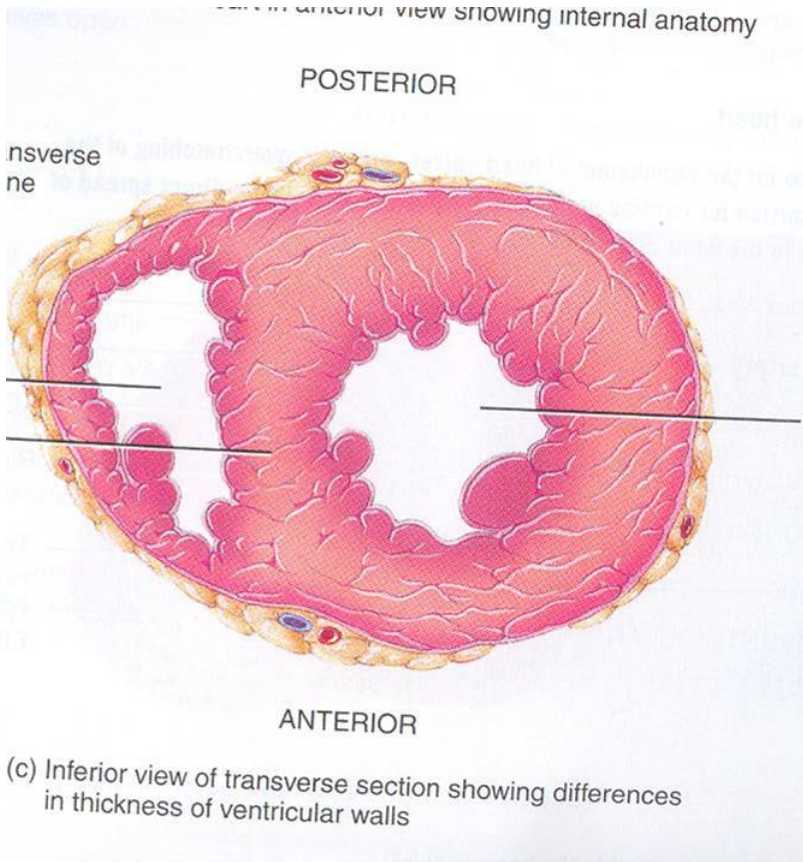
- *Foramen ovale* open during embryonic development
  - *Fossa ovalis* after birth

Fig 21.6



The lt. Ventricle has a much thicker myocardium

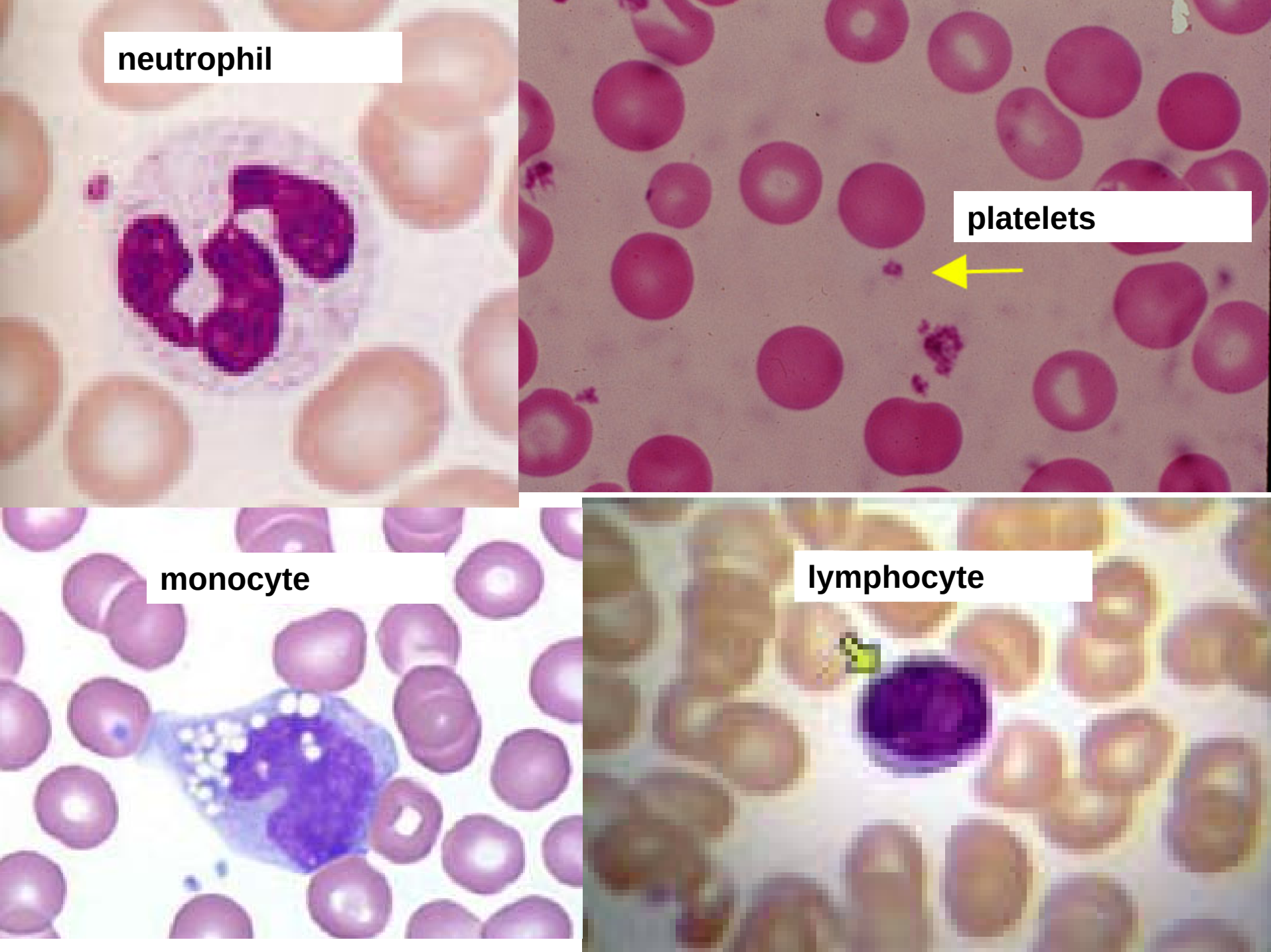
Rt. Vs. Lt. ventricle

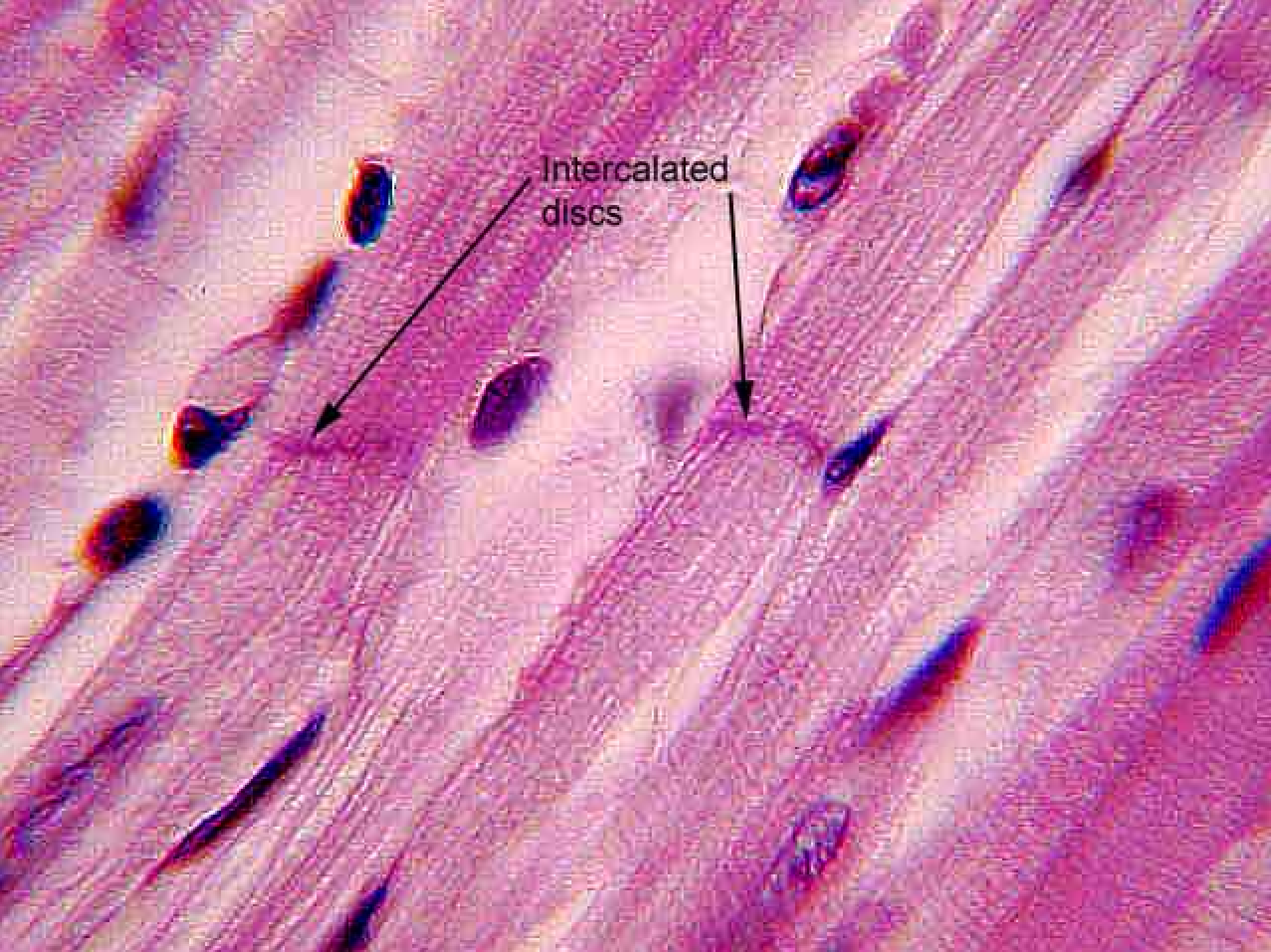


(c) Inferior view of transverse section showing differences in thickness of ventricular walls

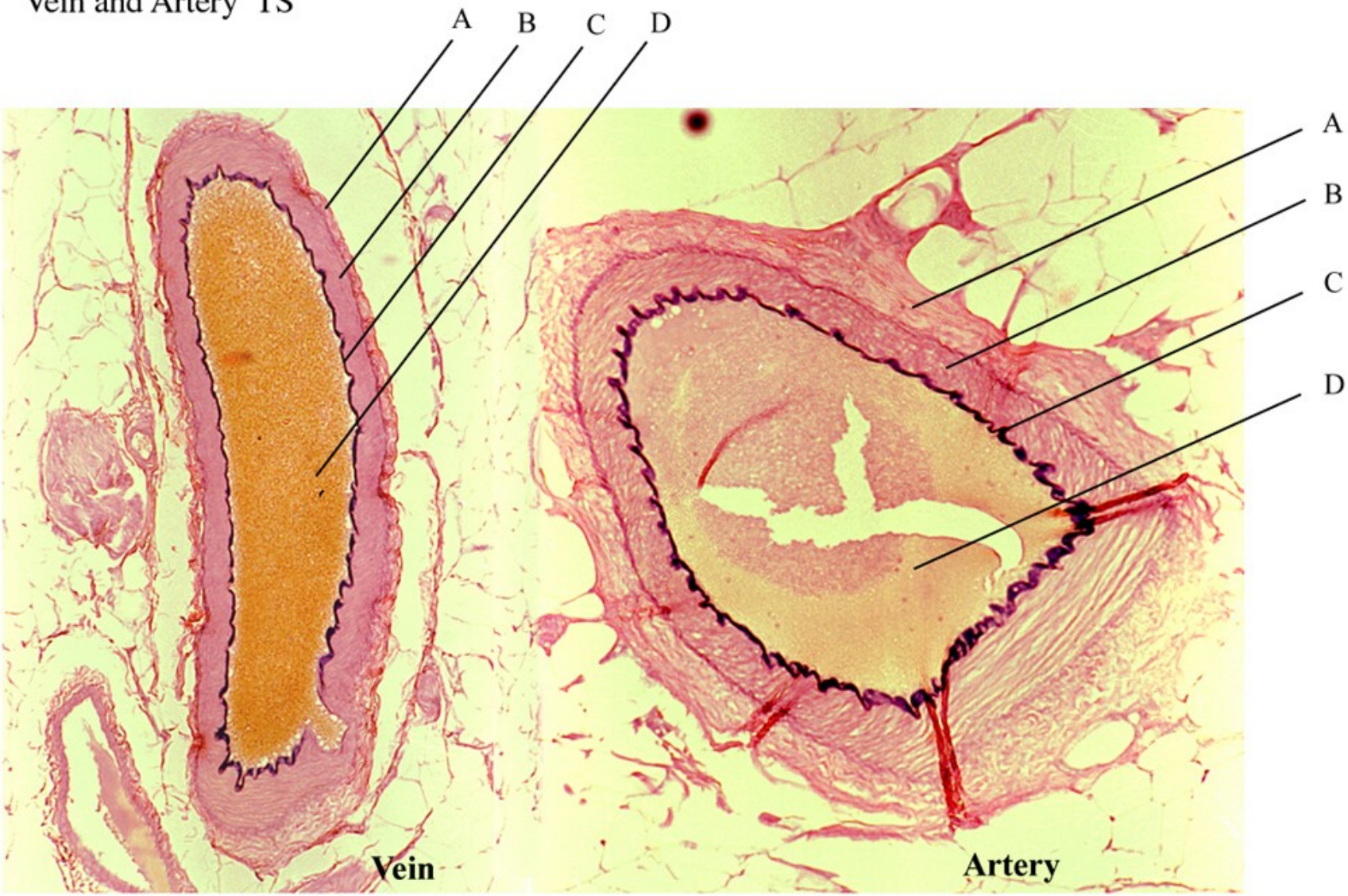
- Pulmonary Circuit- oxygenation of blood
- From the Pulmonary semilunar valve→Through the lungs→to the entrance of the left atrium
- Systemic Circuit- oxygenation of tissue
- From the aortic semilunar valve→through the body→to the entrance of the right atrium

Interactive physiology CD
Histology CD


neutrophil
platelets
monocyte
lymphocyte


Intercalated
discs

Vein and Artery TS



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