Circulation: Chapter 25

1. Limits of Diffusion
   A. Small organisms use diffusion
   B. rapid over small distances

2. Most animals have circulatory systems
   A. Blood
   B. Pump (Heart) or propulsive structures
   C. Vasculature

Functional Connections

The Mammalian Heart Fig. 25.1

1. two atria and two ventricles
2. One-way valves
3. Contraction (systole)
4. Relaxation (diastole)
Cardiac Output

1. Cardiac output (CO or Q) (mL/min)
2. Stroke volume (SV) (mL/beat)
3. Heart rate (HR) (beats/min)
4. CO = HR X SV
5. Bradycardia
6. Tachycardia

Right side of the heart

1. Low resistance in the pulmonary circuit
2. Lower ventricular pressure protects blood vessels of the lungs

Figure 9.19

Figure 25.2 The heart as a pump: The dynamics of the left side of the human heart

1. The diagram shows the synchronous changes in
   A. Electrocardiogram (discussed later)
   B. Blood pressure of the left ventricle, left atrium, and aorta
   C. Closing and opening of valves (for one way flow)
   D. Ventricular volume
   E. Ventricular outflow
1. **ATRIAL SYSTOLE**  
   A. End Diastolic volume

2. **ISOVOLUMETRIC CONTRACTION**  
   A. Start of systole  
   B. A-V valves close

3. **VENTRICULAR EJECTION**  
   A. Semilunar valves open

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4. **ISOVOLUMETRIC RELAXATION**  
   A. Semilunar valves close

5. **VENTRICULAR FILLING**

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**Ventricular Filling and Emptying**  
In birds and mammals

1. Ventricles fill passively during diastole.  
   A. atrial contraction is not necessary  
2. The two ventricles contract simultaneously, but the left ventricle contracts more forcefully
Sound patterns
1. Lub: closing of AV valves
2. Dub: closing of semilunar valves (aortic and pulmonary)
3. heart murmur

The Myogenic conducting system
1. Vertebrate hearts are myogenic
   A. Heart cells beat on own when separated from nervous system
   B. cardiomyocytes produce spontaneous rhythmic depolarizations
   C. Cause coordinated contractions
2. Neurogenic hearts in arthropods require nervous stimulation

Figure 25.4 The conducting system and the process of conduction in the mammalian heart
1. SA node is the PACEMAKER
Frank-Starling Law of the Heart

1. What comes in goes out
   A. Increase venous return
   B. causes increase stretch of cardiac muscle fiber
   C. causes increase force of contraction
1. Remember:
+/- 1.92 mmHg pressure for each inch of elevation or depression.

2. How long would your neck have to be before your brain would not receive any blood if systolic pressure = 100 mm Hg? (use whole numbers)
Figure 9.31

Birds and Mammals

Fig. 25.10

1. Four chambered heart
2. Systemic and pulmonary circuits are completely divided
3. Oxygenated and deoxygenated blood completely separate
4. Allows pressure to be different
Fig 25.10 The circulatory plan in mammals and birds

(a) The circulatory plan

(b) A schematic of the circulatory plan emphasizing that the systemic and pulmonary circuits are connected in series

Fig 25.12 Blood flow

Average Blood Pressure
Flow in Vertebrate Circulatory Systems

Figure 9.33

Figure 25.13 Fluid exchange across mammalian systemic capillary walls

Capillary Filtration

[Diagrams and figures related to blood flow and fluid exchange through capillary walls, including pressure differentials and filtration processes.]
The Lymphatic System

1. Usually outflow exceeds inflow
2. The lymphatic system returns it to the circulatory system
3. Lymphatic veins and ducts contain valves to prevent backflow

Moving Blood Back to the Heart

1. Blood in veins is under low pressure
2. Two major pumps assist in moving blood back to the heart
   A. Skeletal muscle
   B. Respiratory pumps
      a. Inhalation:
      b. Exhalation:

Veins Act as a Volume Reservoir

1. Veins have thinner and more compliant walls
2. Small increases in blood pressure lead to large changes in volume
3. In mammals veins hold more than 60% of the blood
Figure 25.14  The circulatory plan in gill-breathing fish
1. closed system
2. Teleost heart has four chambers in series (but only one atrium and one ventricle)
3. Single circuit
   A. Heart → ventral aorta → gill capillaries → dorsal aorta → systemic circuit

Amphibian Circulation
1. Three chambered heart
2. Oxygenated and deoxygenated blood can mix in the single ventricle, but
3. Septa and folds direct oxygenated blood from the lungs to the systemic capillaries
“Reptile” Circulation

1. Turtles, lizards, snakes have a partially divided ventricle → some blood mixing.
2. Crocodilians have a four chambered heart

Mixing of blood in vertebrates with three chambered hearts

1. Reptiles and amphibians cease breathing periodically (e.g., when under water).
2. They shunt blood away from the lungs to the systemic circuit

Crocodilian Blood Shunt
Fig. 25.20

1. Flap valve opens to shunt blood from the pulmonary to systemic circuit
Molluscs
Fig. 25.21
1. hearts and some blood vessels
2. Most have open systems
3. cephalopods have closed systems

Arthropods
Fig. 25.24
1. All have one or more hearts and some blood vessels
2. All have open systems
3. Insects have high metabolic rates
   A. tracheal system for gas transport