Transport of gases by blood.

Reading - Chapter 13 in “Animal Physiology”, pages 525-538.

Architecture of the circulatory system.

Reading - Chapter 12 (pages 473-476, 481-495, and 499-511)

Thermoregulation

Reading - Chapter 17

Davenport diagram for a terrestrial vertebrate

Davenport diagram for a terrestrial vertebrate

H₂O + CO₂ ↔ H₂CO₃ ↔ HCO₃⁻ + H⁺

FIGURE 15-28 The pH-bicarbonate relationship (Davenport diagram) for human blood. The normal acid-base balance (position N; 1.2 mmol L⁻¹ CO₂; pH 7.4; 5.44 kPa pCO₂) can be disturbed by respiratory acidosis (RAC) or alkalosis (RAL), or metabolic acidosis (MAC) or alkalosis (MAL).

RAC - Respiratory acidosis
RAL - Respiratory alkalosis
MAC - Metabolic acidosis
MAL - Metabolic alkalosis
pH values of foods:
www.cfsan.fda.gov/~comm/lacf-phs.html

**Metabolic alkalosis** results from altered *metabolism*. Results in decreased *hydrogen* ion concentration leading to increased *bicarbonate* and *carbon dioxide* concentrations. Metabolic alkalosis most commonly occurs when a person *vomits* profusely, as doing so depletes the body of H+ ions, which leads to a profusion of bicarbonate in the body.

**Metabolic acidosis** is a state in which the blood pH is low (under 7.35) due to increased production of H+ by the body or the inability of the body to form bicarbonate (HCO3-) in the *kidney*. Its causes are diverse, and its consequences can be serious, including *coma* and *death*.

//en.wikipedia.org/wiki/Metabolic_acidosis

High rate of ventilation leads to low PCO2 in blood of aquatic animals.
Aquatic animals regulate respiration by monitoring $O_2$ levels.

Terrestrial animals regulate ventilation by monitoring $CO_2$ levels.

Architecture of the circulatory system

1. convective
   Lung
   - $P_{pa}$
   - $P_{pv}$

2. diffusive
   Heart
   - $P_{ave}$
   - $P_{ven}$

3. convective
   Tissue
   - $P_{ave}$
   - $P_{ven}$

4. diffusive

From chapter 12 of Eckert read pages 473-476, 481-495, and 499-511.
Most invertebrates have open circulation.

Mammalian and avian system:
Two circuits - systemic and pulmonary
Lymphatic system

Note - most of the blood resides in the veins in a resting vertebrate.
Why is there a difference in pressure in the left and right ventricles during systole?

Basal vertebrate heart (fish) is/was composed primarily of spongy myocardium.
Controversy - Did lungs evolve so fish could live in hypoxic water? or Did lungs evolve to provide $O_2$ to the heart, allowing increased activity metabolism?

Basal tetrapod heart (frog heart)

Reptile heart
Systemic pressure is limited by the need to keep pulmonary pressure low.

i.e., systemic

i.e., pulmonary

i.e., ventricular

Complete separation of ventricle results in a two pump system.
Avian and mammalian double pump allows high systemic pressure.

A four chambered heart results in the right side receiving only venous blood.

How is the right side supplied with oxygen?
Coronary circulation is most highly developed in birds and mammals.

Water flow out of and into capillaries

Lymphatic system

Why did birds and mammals lose lymphatic hearts?
This limits capillary pressure.

Skeletal muscle pump
Ventilatory pump
Standing Dog

A

Ventilatory pump

B

Skeletal muscle pump
A looped atrioventricular arrangement enhances blood flow.

Figure 12.9

Architecture of the heart

The fold in our heart?

Figure 15-6

A sagittal section through the heart of a dogfish and the structures that surround it in the pharynx floor.
Circulatory constraint on sustained activity.

A great unanswered question of our time.