Chapter 26: Diving by Marine Mammals

1. Fig 26.2 Durations of dives by wild Weddell seals (most <20-25 minutes; some > 1hr)
2. Fig 26.3 Depths of dives by wild Weddell seals (most <200 m; up to 600 m)
3. Figure 26.5: Diving by an individual elephant seal (up to 120 min)

Blood O₂ stores in diving mammals

1. Diving mammals have high blood O₂ concentrations,
   A. Carrying capacity
   B. Blood volume:
2. Total Blood O₂ stores:
   A. Carrying capacity X Volume.
   B. Humans: 15 mL of O₂ per kg, Weddell seals: 85 mL O₂ per kg

Diving Physiology: Challenges of Diving

1. Skeletal muscles, Brain, Heart need the most energy
2. Brain, Heart need the most O₂
3. Hypoxia

Blood O₂ stores in diving mammals:

1. Muscle O₂:
   A. much higher muscle myoglobin content
   B. higher affinity of myoglobin for O₂
2. Lung O₂:
   A. air in the lungs of diving mammals is a disadvantage.
   B. Buoyancy
   C. Diving mammals lungs are compressible

Diving Physiology: Challenges of Diving

1. Brain and heart tissue require aerobic metabolism
2. Skeletal muscles can use anaerobic metabolism
Diving response, 1.
   A. Collapse of the lung: Figure 26.6 The thorax is highly compressible in marine mammals
Diving Response, 2 Bradycardia

1. Figure 26.10 Diving heart rate varies with dive duration in a graded manner in freely diving seals

Diving Response, 3 Peripheral vasoconstriction

1. Shunting: Figure 26.8 Circulatory patterns are radically changed during forced or prolonged submergence
2. Figure 26.9 The forcibly submerged seal (artificially vasoconstricted) as a "heart-lung-brain machine"

Oxygen Supply During Diving

1. Decreased metabolic rate
   A. Increased anaerobic metabolism
   B. Oxygen debt (from stored lactic acid) must be repaid after diving
2. Figure 26.11 Metabolic subdivision of the body during forced submergence
   A. (26.11a). Oxygen is depleted faster in muscles than the blood

Aerobic capacity and lactic acid build up (Fig. 26.14) limit dive duration

Weddell Seals only swim intermittently at depth (Fig. 26.15)
1. Diving Response, 4
2. Increase in hematocrit (in a few cases): RBCs stored in their spleen.
3. Oxygen supply during diving
4. cutaneous and rectal respiration
   A. not important in birds and mammals
   B. some reptiles (sea snakes)
   C. green turtles can stay dormant underwater

Decompression sickness (the bends)
1. Bubbles of nitrogen in tissue and blood
2. Nitrogen tension > 2 atmospheres
3. No problems with CO₂ or O₂
4. At depth, human diver breathes at high pressure
5. this drives nitrogen into tissue, blood, fat
6. when pressure drops, it bubbles out;
7. use of helium instead of nitrogen
8. Human divers adjust rate of depressurization.

How marine mammals avoid the bends
1. sperm whales can dive to over 1100 m
2. elephant seals can dive to over 1500 m
3. do not super-saturate blood with Nitrogen

Other Problems for Human divers
1. Problem 2: Oxygen Toxicity
2. Problem 3: Narcotic Effects Of Inert Gases
3. Problem 4: Effects Of High Pressure