

Lecture 7. Respiration and circulation

Class Business

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Reading for this lecture

Required. Gill: Chapter 6, especially pages 141-150

Optional. Procter & Lynch: Pages 189-218

1. Respiration in birds

A) HIGHLY EFFICIENT

- i) Respiration in birds differs significantly from that in mammals. In particular birds have a “one-way” system of airflow, which creates a continuous stream of air moving through the system (like a river). In contrast, in mammals air moves in and out (like the tide) along the same passages, causing air that is already in the system to impede the movement of incoming air.
- ii) In birds, nearly all of the air in the lungs is replaced on each breath. This is not true in mammals. Consequently, birds are able to transfer more oxygen to their blood on each breath than are mammals.
- iii) The tissue of bird lungs is much denser than that in mammals. Therefore, birds are able to accomplish much more with a smaller, compact lung than a mammal could.

B) AIR SACS

- i) A major peculiarity of the avian respiration system is the presence of air sacs. These are found only in birds and help to create the one-way airflow that allows bird respiration to be so efficient.
- ii) Air sacs are discrete, organized structures, that fill parts of a bird’s body cavity and extend into wing and leg bones.
- iii) In addition to their role in respiration, air sacs help to remove excess heat from the body during flight and, when inflated, function as shock absorbers and protect internal organs. Male frigatebirds also use the air sacs in their neck in their breeding displays.

2. Circulation in birds

A) AVIAN HEARTS

- i) Birds have 4-chambered hearts that are rather similar to those of mammals (and unlike the 3-chambered hearts of reptiles). One key difference is that the aortic arch arches to the right in birds and the left in mammals. In both mammals and birds there is a double-circulatory system, with one system of vessels taking blood to and from the lungs, and another transporting blood to and from the rest of the body.
- ii) Compared to mammals, birds have relatively large hearts, high cardiac output, high heart rates (typically 150-350 beat per min when resting, higher when flying), and high blood pressure (up to 300-400 mm mercury).
- iii) These features, combined with a very efficient respiration system, mean that they can get oxygen to their muscles rapidly and maintain the high metabolism needed to fly and live extremely active lives.
- iv) But, these features – especially the resultant high blood pressure – also mean that birds have hearts that are prone to high failure rates and birds die of cardiac failure quite easily.

B) MODIFICATIONS TO THE CIRCULATION SYSTEM

- i) Various types of birds have certain specializations in their circulatory systems.
- ii) The ability to alter blood flow to the legs helps some birds thermoregulate, see Lecture 6, section 3B(v).
- iii) Diving birds are capable of limiting blood flow to non-essential tissues, and thereby reduce oxygen consumption, while diving. This allows them to feed underwater without adverse effects.