Avian Respiration

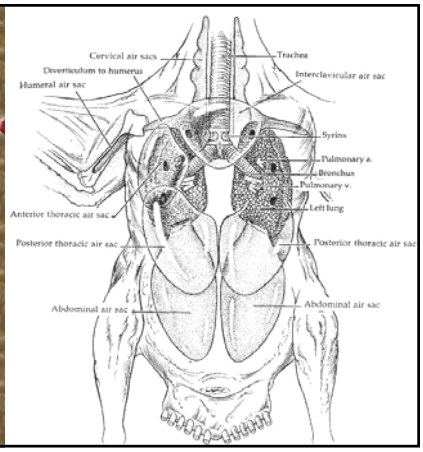
I. Overview

A. Function

- Delivers O_2 from air to tissues and removes CO_2
- Important role in thermoregulation

B. Components

- small lungs
- 9 air sacs (not involved in gas exchange)



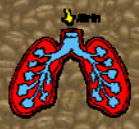
C. Characteristics

Air sacs permit unidirectional flow of air through the lungs.

Air moving through bird lungs is largely fresh air (higher O_2 content)

Mammals have bi-directional air flow (back and forth)

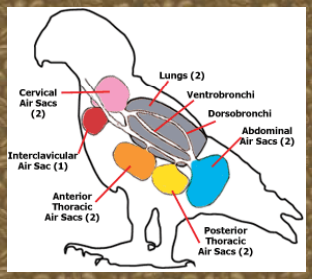
Air moving into mammal lung is a mixture and thus less O_2



II. Anatomy of Respiratory System

A. Air Sacs

- 1 interclavicular
- 2 cervical
- 2 anterior thoracic
- 2 posterior thoracic
- 2 abdominal

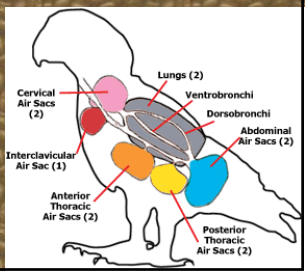


A. Air Sacs

Air sacs can be functionally divided into

anterior

posterior



A. Air Sacs

Air sacs have very thin walls with few blood vessels – no role in gas exchange

act as "bellows" to ventilate lungs

B. Trachea

Breathe through the mouth or nares

During inspiration –

enters pharynx → trachea

B. Trachea

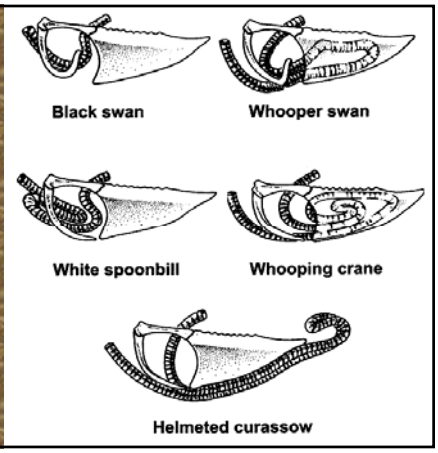
Trachea as long as neck or longer

Cranes trachea coiled within keeled sternum

Provides resonance to calls

Sandhill Crane

Great Curassow



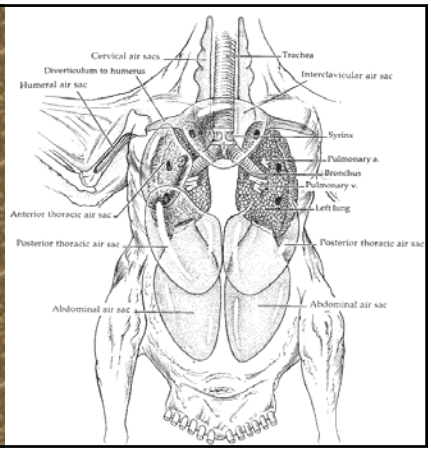
B. Trachea

Typical avian trachea ~ 2.5 x longer, 1.3 x wider than mammals of same size

Larger dead space volume (4.5x)

Compensate with larger tidal volume, lower respiratory frequency

At syrinx trachea bifurcates – two primary bronchi



C. Lungs and Bronchi

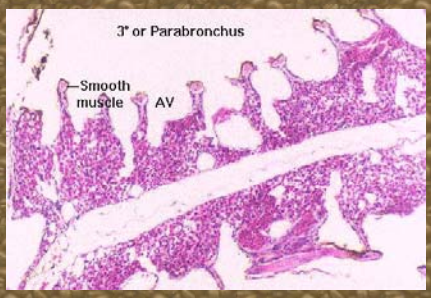
once in lungs - mesobronchi

C. Lungs and Bronchi

mesobronchus conducts air through the middle of the lung
gives rise to recurrent **secondary bronchi**, gives rise to **tertiary bronchi** (also called **parabronchi**).

C. Lungs and Bronchi

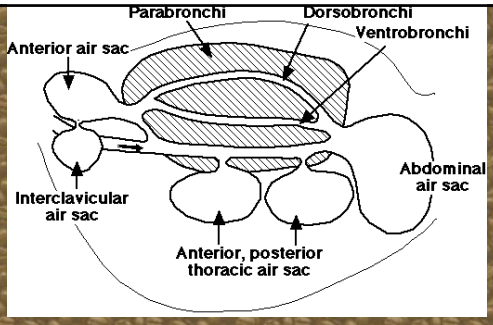
The **parabronchi** - walls are "scalloped" by the bay-like **air vesicles**, place where gas exchange occurs



C. Lungs and Bronchi

- O_2 diffuses from air vesicles into blood & CO_2 from blood into air vesicles
- Air and blood travel at right angles – cross current flow

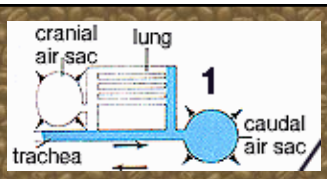
Cross-current flow is very efficient!



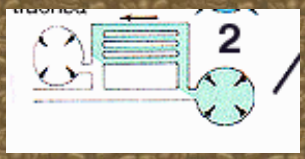
Parabronchi lead to larger
Dorsobronchi lead to mesobronchi

III. Respiratory Cycles

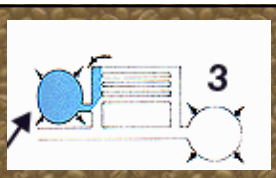
A. Inhalation/Exhalation



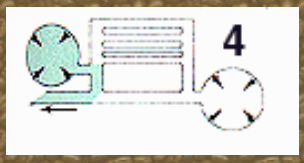
1. Inhalation – air flows through trachea and bronchi into posterior air sacs



2. Exhalation – air moves from posterior air sacs and into lungs



3. Second Inhalation – air moves from lungs into anterior air sacs



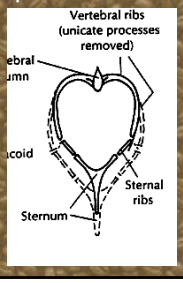
4. Second Exhalation – air moves from anterior air sacs out

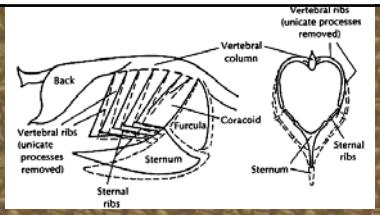
B. Pressure Changes

Air flow is driven by changes in pressure within respiratory system

solid lines - end of expiration

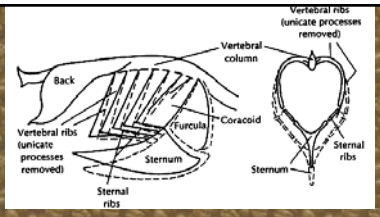
dashed – end of inspiration





During inspiration (dashed):
sternum moves forward & downward, vertebral ribs move cranially to expand the sternal ribs & the thoracoabdominal cavity.

This expands the posterior & anterior air sacs & lowers the pressure, causing air to move into those air sacs.



During expiration (solid):
the sternum moves backward & upward, vertebral ribs move caudally to reduce the volume of the thoracoabdominal cavity.

This reduces the volume of the anterior & posterior air sacs causing air to move out of sacs.

C. Conclusions

Conclusion – takes 2 respiratory cycles to move 1 packet of air completely through system.

Advantage → high O_2 content

IV. Regulation

Ventilation and respiratory rate are regulated to meet demands imposed by changes in metabolic activity

Control center likely pons and medulla oblongata of brain

IV. Regulation

Central chemoreceptors affect ventilation in response to changes in arterial CO_2 concentration and H^+ concentration