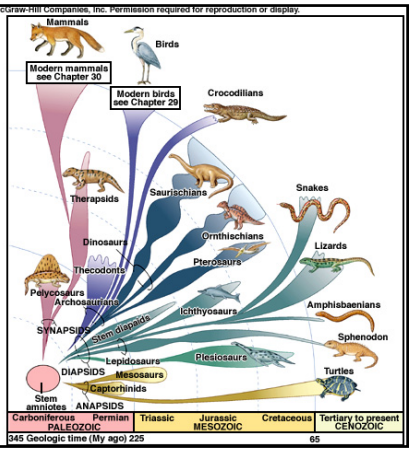
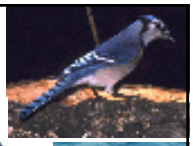
Evolution of the amniotes

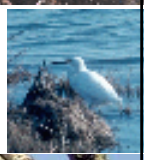


Vertebrates

Tetrapods

Class Aves (Birds)

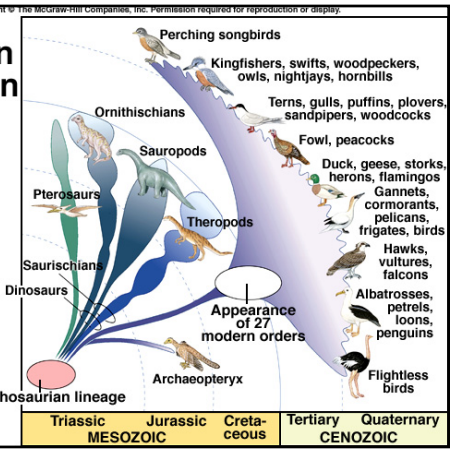




Bird evolution:

- **Poor fossil record**
- **Descend from Archosaurian reptiles**
- **'Archaeopteryx' is earliest known from 147 MY ago**
- **Theropod dinosaurs represent sister group of birds**
- **Still bird-dinosaur controversy**

Evolution of modern birds



Vertebrates

Tetrapods

Class Aves (Birds)

The power of flight:

- Evolution of feathers led to flight
- But, flight restricts morphological diversity
- Some requirements of flight:
  1. Forelimbs modified into wings
  2. Lightweight, yet strong bones
  3. High metabolic rate
  4. Efficient respiration
  5. Efficient circulation

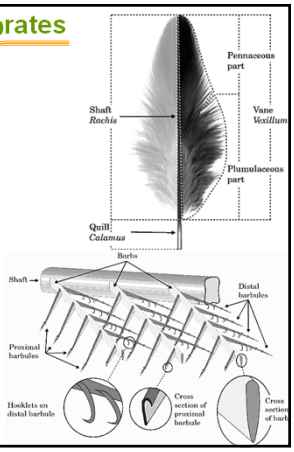
Vertebrates

Tetrapods

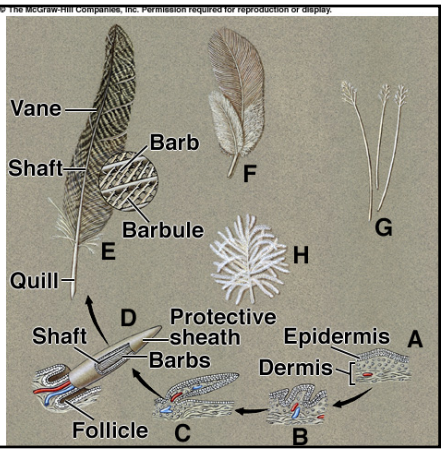
Class Aves (Birds)

Defining traits and their function:

1. Feathers of epidermal origin
   - Hardened keratin, homologous to reptile scales
   - Central quill and shaft
   - Barbs and connecting barbules form vane
   - Contour and down feathers
   - Annual molting



Types and development of feathers



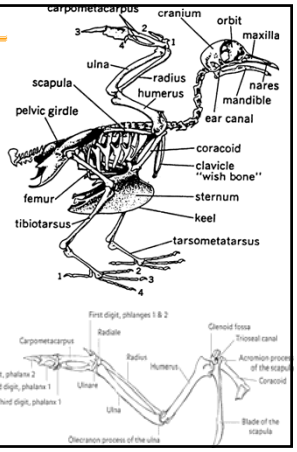
Vertebrates

Tetrapods

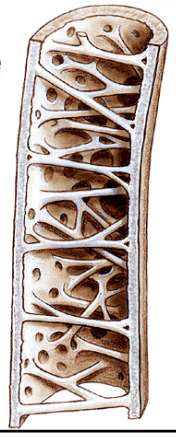
Class Aves (Birds)

Defining traits and their function:

2. **Light, strong skeleton**
   - Bones contain air cavities with struts for strength
   - Some kinesis in jaws
   - Rigid vertebral column with keel on sternum
   - Forelimb bones fused



Hollow wing bone of a songbird



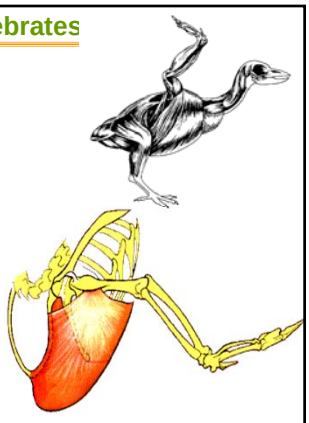
Vertebrates

Tetrapods

Class Aves (Birds)

Defining traits and their function:

3. **Powerful flight muscles**
   - Large pectoralis muscle for wing downstroke
   - Supracoracoideus for upstroke
   - Tendons provide strong grip
   - Complex muscles in neck



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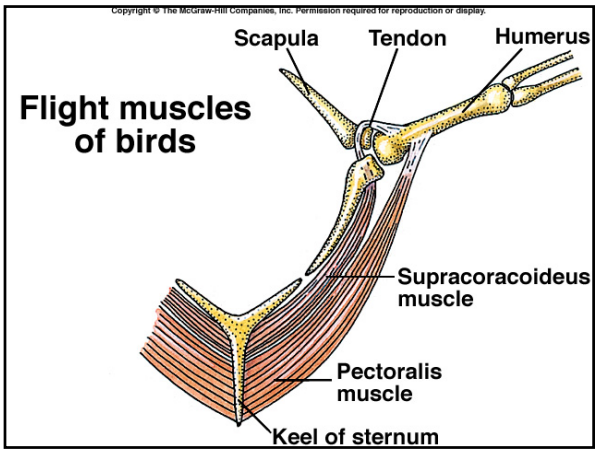
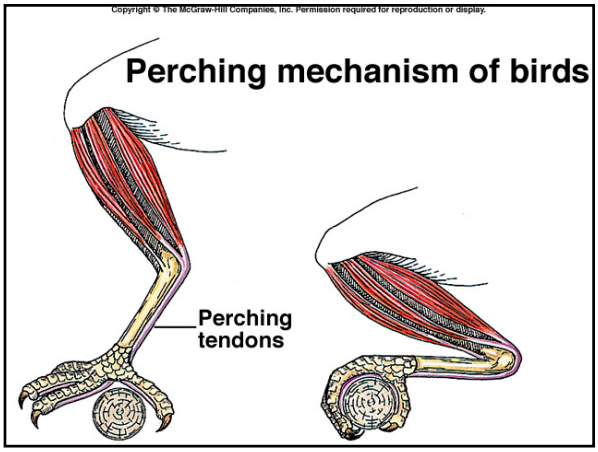




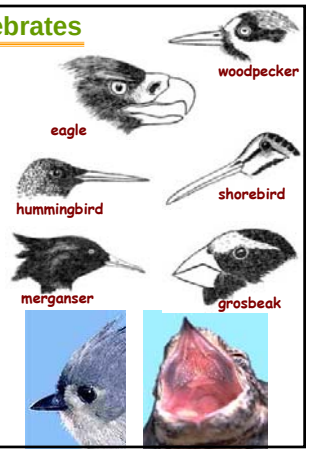
Vertebrates

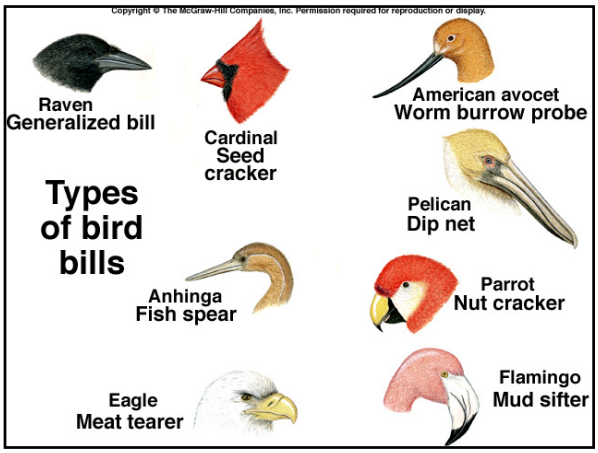
Tetrapods

Class Aves (Birds)

Defining traits and their function:

4. **Feeding and beak morphology**
   - Many carnivores, but some feed only on nectar
   - **Beak morphology** strongly tied to diet
   - Very **high consumption** rates
   - **Crop** for food storage and gizzard for grinding





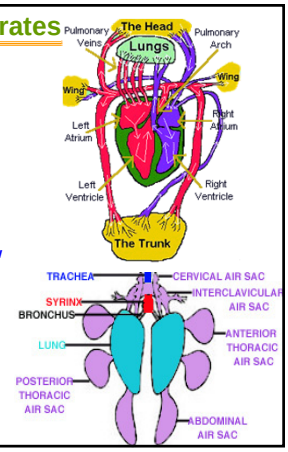
Vertebrates

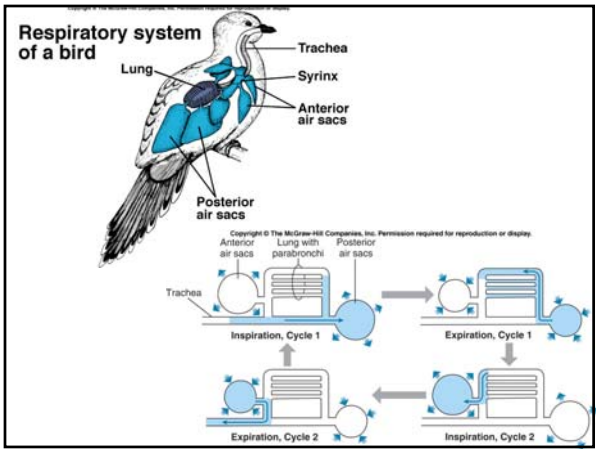
Tetrapods

Class Aves (Birds)

Defining traits and their function:

5. **Efficient circulation and respiration**
   - **4-chambered heart**
   - **Fast heartrate**
   - **Lungs modified for efficient air flow**
   - **Air sacs supply lungs with air constantly**





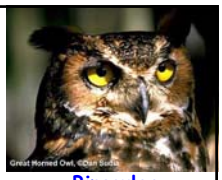
Vertebrates

Tetrapods

Class Aves (Birds)

Defining traits and their function:

6. **Nervous and sensory organs**
   - Well developed divisions of brain
   - Good hearing and excellent vision
   - High number of cones on retina
   - Monocular gives wide field of view
   - Binocular eyes in hunters for better depth perception



Binocular vs. Monocular

Vertebrates

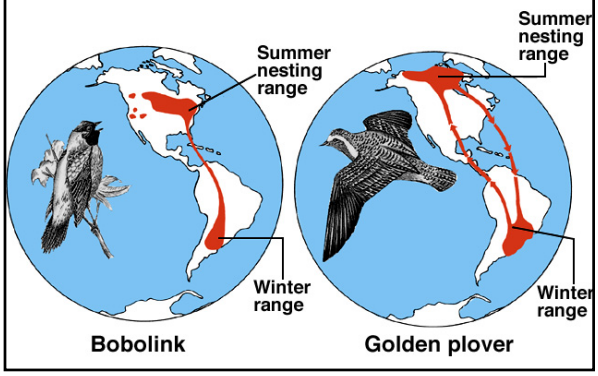
Tetrapods

Class Aves (Birds)

Defining traits and their function:

7. **Reproduction**
   - About half of all birds migrate
   - Photoperiod acts as trigger
   - Internal fertilization
   - Most birds are monogamous
   - Nest building and parental care are typical

Migration patterns of several birds



Vertebrates

Tetrapods

Class Aves (Birds)

Defining traits and their function:

8. **Population dynamics**
   - **Unregulated hunting and habitat loss caused extinction of some**
   - **Today, regulated hunting has contributed to recovery**
   - **Recent sharp declines in songbird populations due to forest fragmentation and tropical deforestation**