

## Chapter 19: Birds

Phylum: Chordata

Subphylum: Vertebrata

Class Aves (>9900 spp.)

Orders: 28

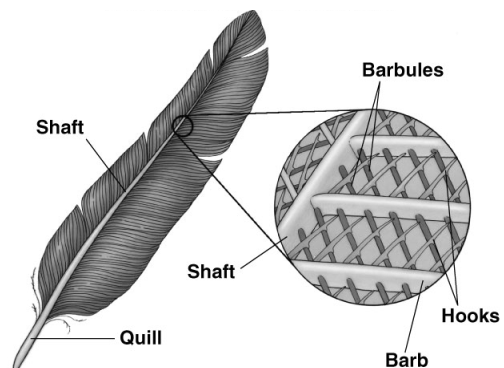
Family: 166



## Birds

### – key characteristics

- feathers
  - modified reptilian scales
- flight skeleton
  - thin, hollow bones



# History of Birds

- **Descended from dinosaurs**

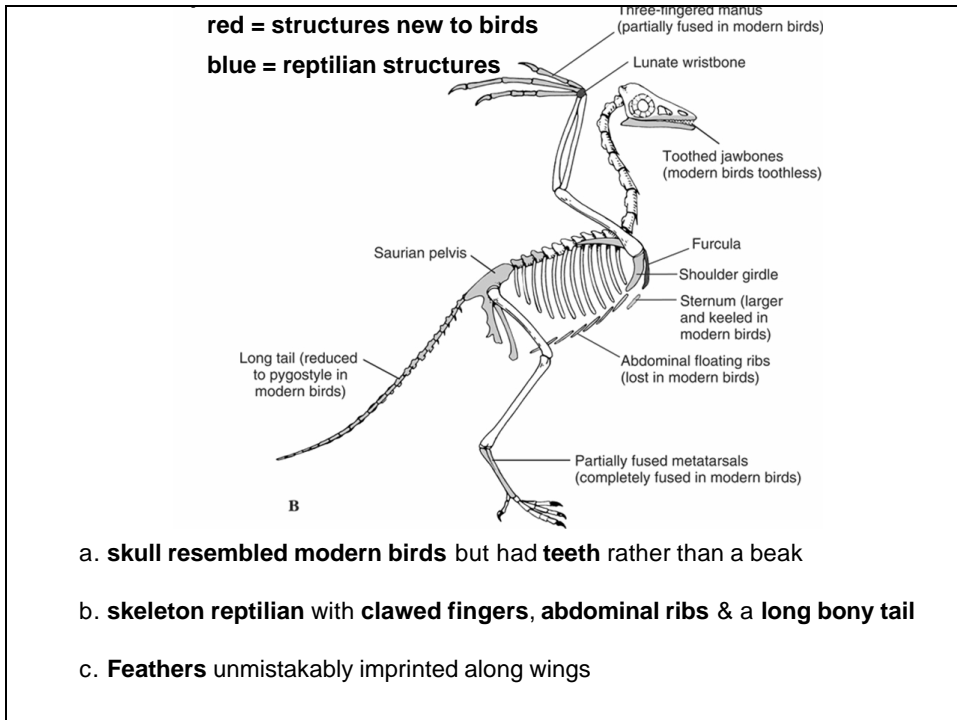
- *Archaeopteryx*
- Aves: separate class key evolutionary novelties
  - 1) feathers
  - 2) light bones
  - 3) super-efficient lungs



*Archaeopteryx lithographica* fossil found in 1861 linked birds & reptiles



150-148 mya



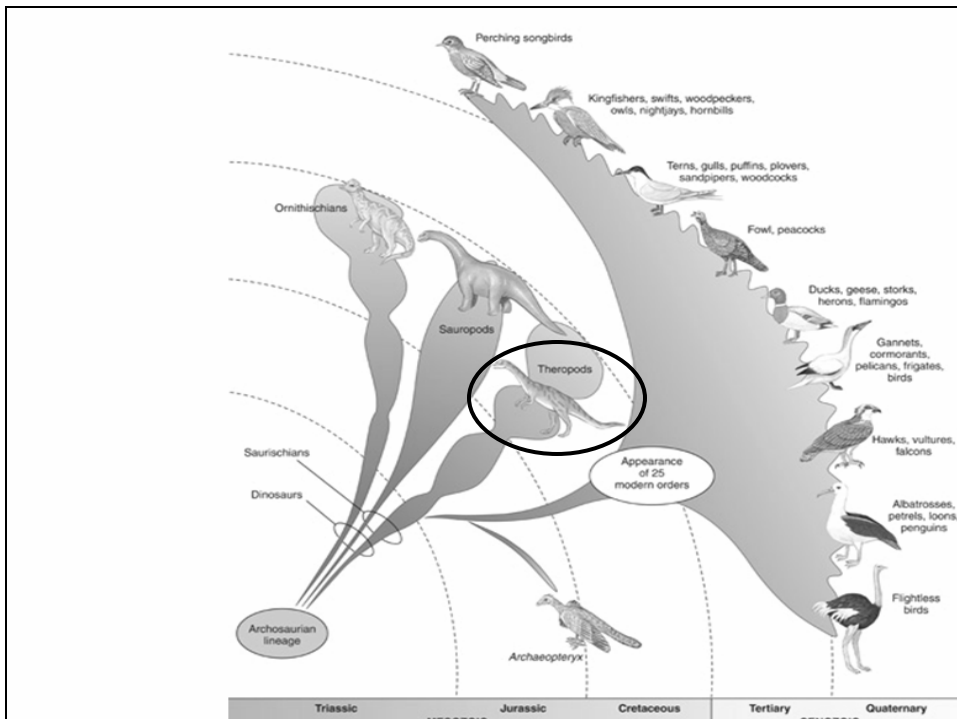
## Birds & Reptiles Similarities

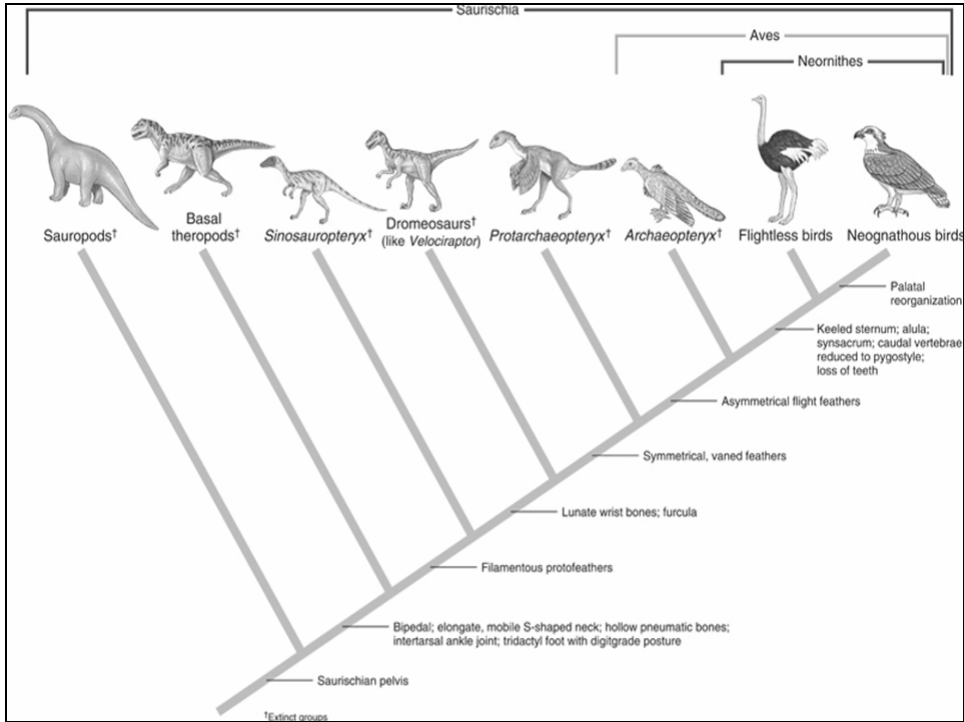
- both have skulls that abut the first neck vertebra by a single ball-and-socket joint
- both have a single middle ear bone → **stapes**
- lower jaw** in both composed of five or six bones  
 in mammals, one mandibular bone
- both excrete nitrogenous wastes as **uric acid**  
 mammals excrete urea
- both lay similar **yolked eggs**;  
 embryo develops on surface by shallow cleavage patterns

## Classified Birds with Theropod Dinosaurs

### Thomas Henry Huxley

- a. group of dinosaurs has a long, mobile, S-shaped neck
- b. **therapods** belong to lineage of **diapsid** reptiles, the archosaurians , which includes **crocodiles**
- c. fossil evidence (Spain, China) confirming relationship of birds & theropods
- d. Dromeosaurs (theropods also) share derived characteristics with birds:
  - 1) **furcula** or **fused clavicles**
  - 2) lunate wrist bones that permit swiveling motions in flight
- e. some dromeosaur-like fossils contained filaments or feathers
  - 1) feathered dinosaurs could not fly
  - 2) filaments & feathers: ? used for thermoregulation & colorful social displays
- f. more derived fossils than *Archaeopteryx* from Spain & Argentina exhibited:
  - 1) **keeled sternums & alulas**
  - 2) **loss of teeth & fusion of bones**



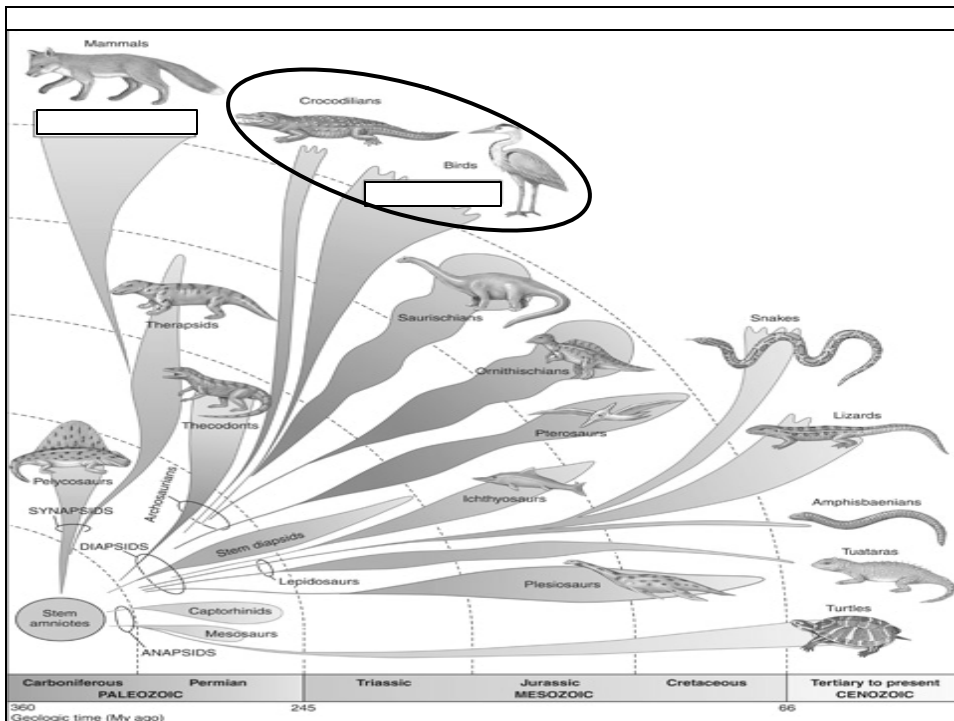
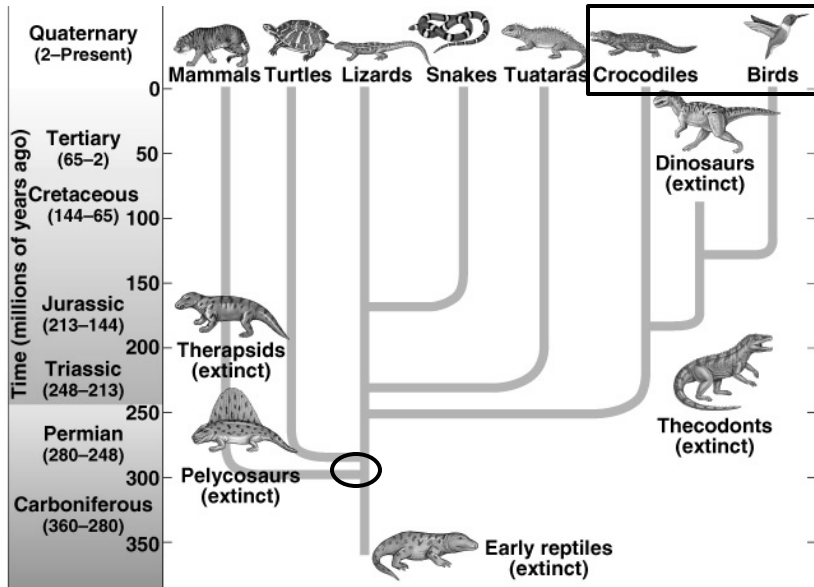


## History of Birds

- Birds today
  - adaptations for flight energy demands
    - efficient respiration
    - efficient circulation
    - endothermy

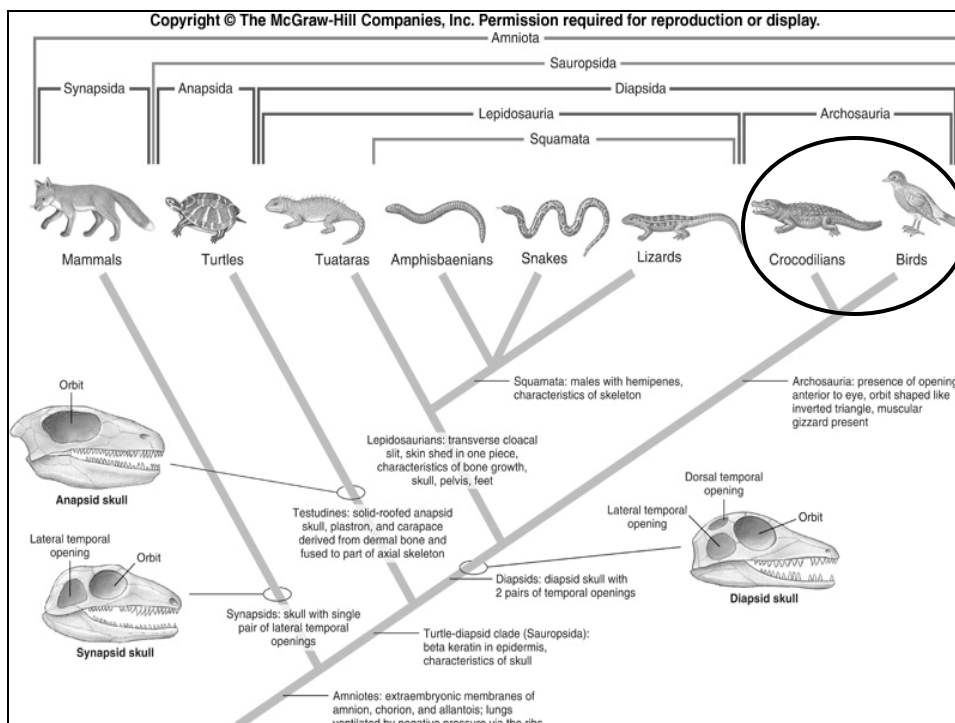


# Evolutionary Relationships



### Uniformity in Bird Structure: (150 million years of evolution)

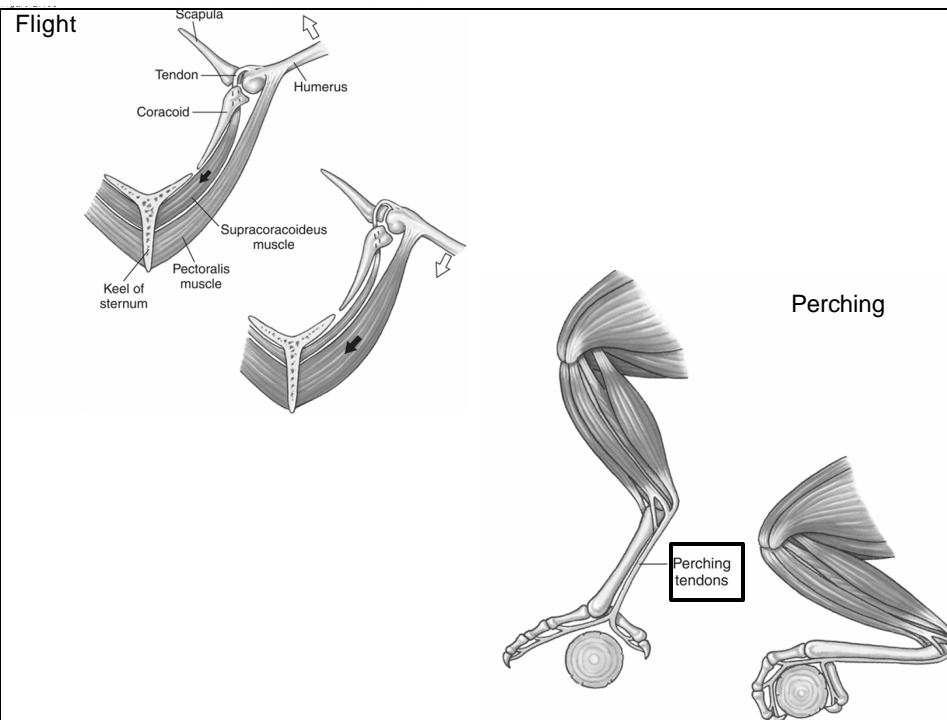
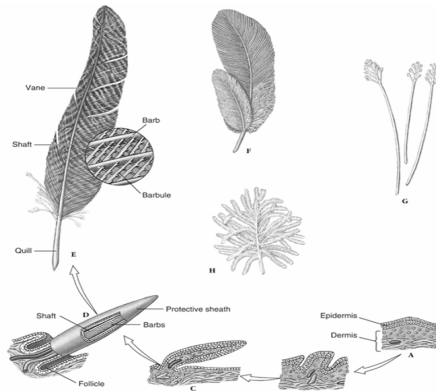
- a. spindled shaped body: head, **disproportionately long neck**, trunk & tail
- b. **feather: unique & essential hallmark feature**
- c. paired **forelimbs** modified as **wings**, although not all capable of flight
- d. paired **hind limbs** adapted for walking, swimming or perching
- e. **fully ossified skeleton with air cavities**
- d. **horny beaks, no teeth**
- e. **non elongated tail**
- f. **four chambered heart, nucleated red blood cells**
- g. lay **eggs**
- h. **endothermic**
- i. **respiration through lungs: syrinx (voice box)** near junction of trachea & bronchi
- j. Metanephric kidney; ureters open into cloaca, no bladder; uric acid
- k. dioecious
- l. left ovary & oviduct develop; right degenerates
- m. paired testes with ureters with vas deferens opening into cloaca; copulatory organ
- n. driving force for uniformity → adaptations necessary for **flight**
  - 1) wings present for support & propulsion
  - 2) respiratory system: meet high O<sub>2</sub> demands & cooling body
  - 3) bones must provide a light but rigid airframe
  - 4) digestion & circulation: meet high-energy demands of flight
  - 5) nervous system: superb sensory systems for high-velocity flight

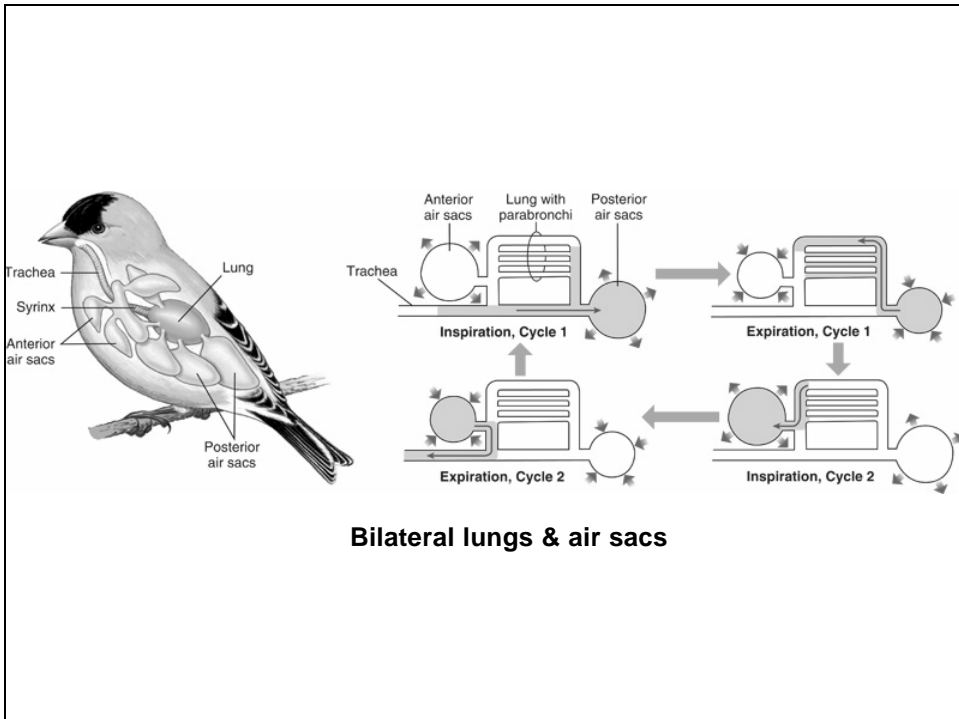
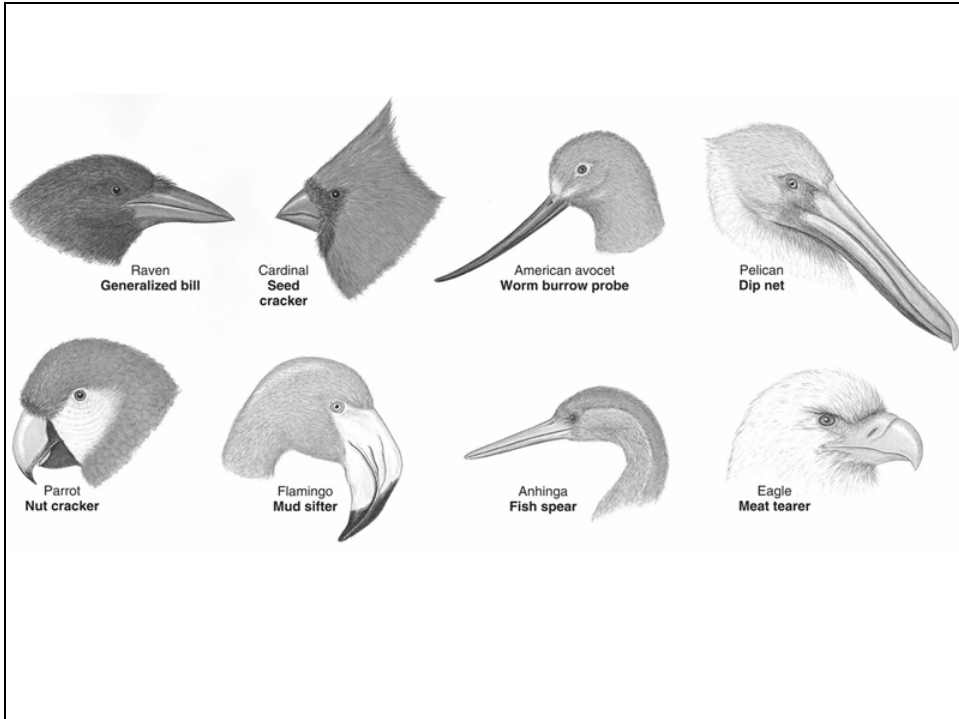


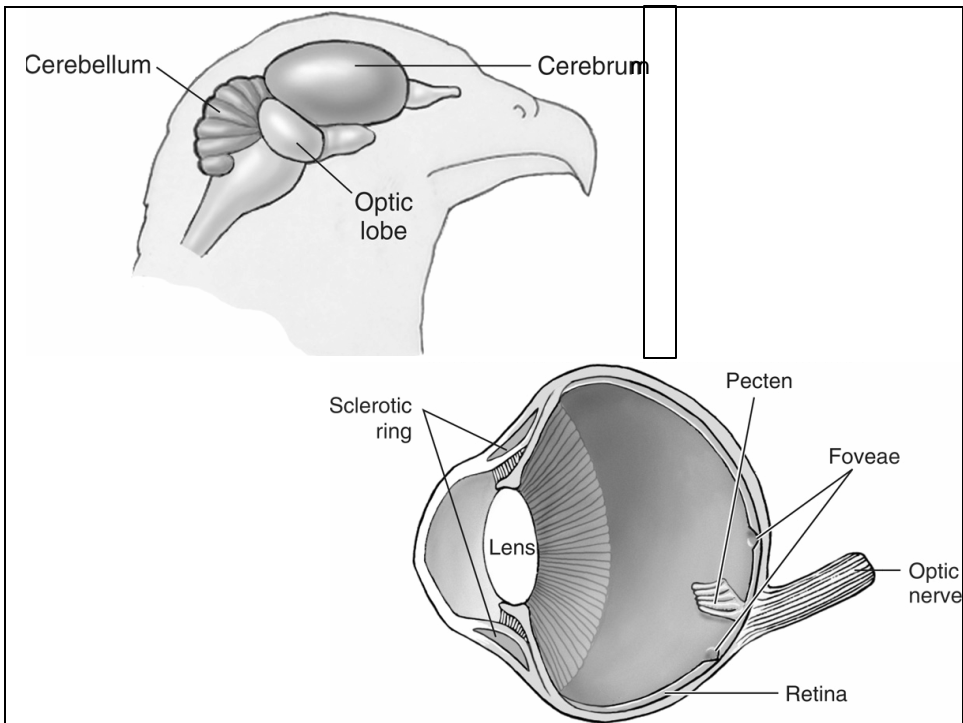
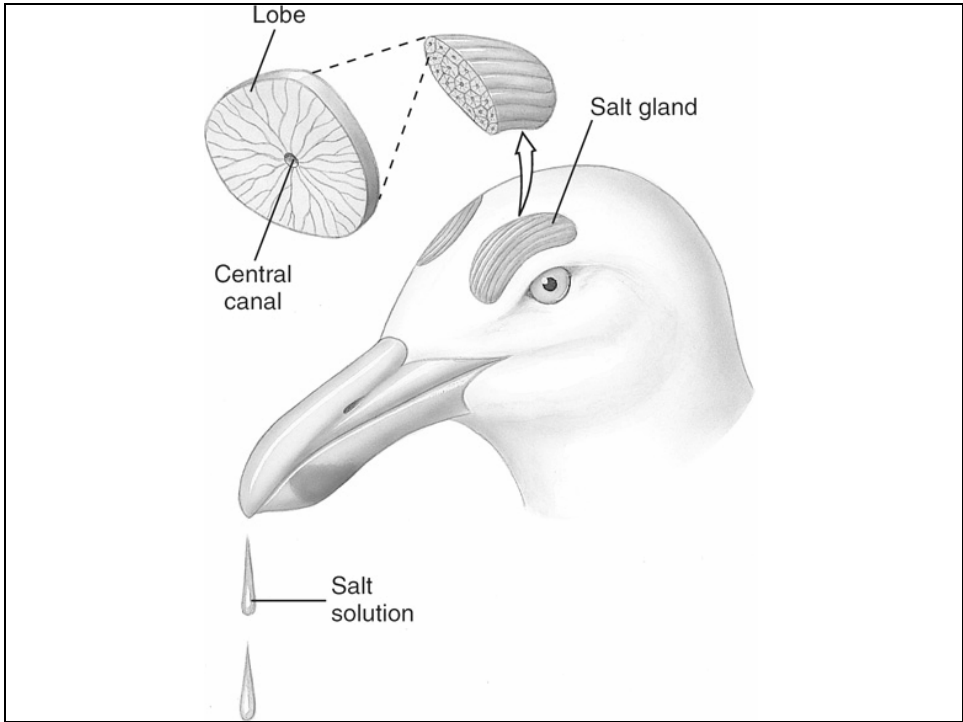
## A. Feathers

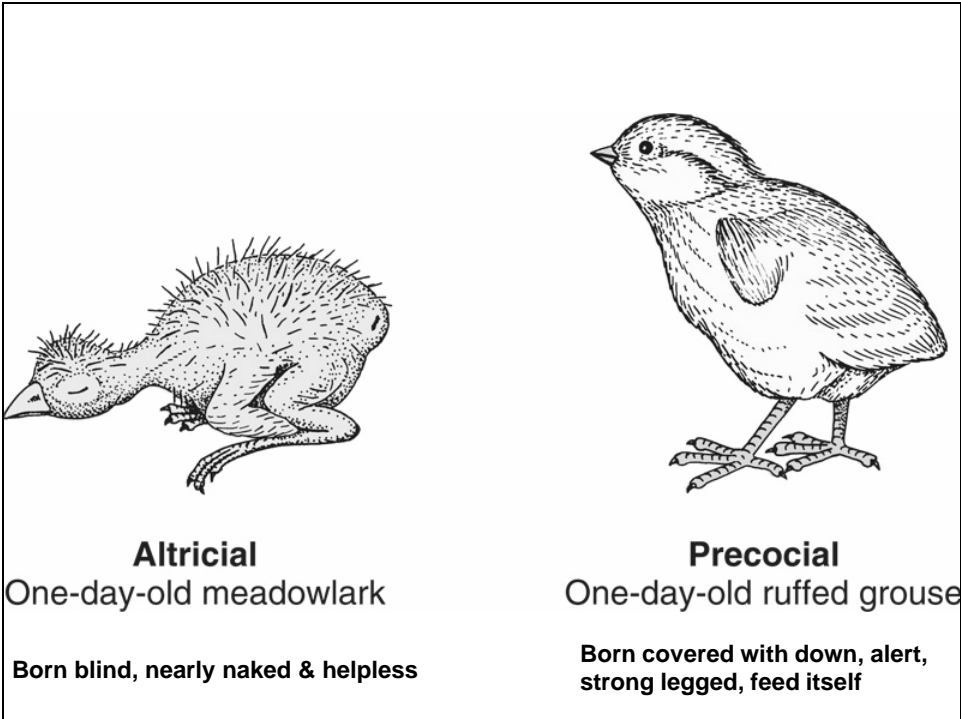
### 1. Structure

- a. special bird adaptation that contributes to more power or less weight
- b. **hollow quill** emerges from **skin follicle** & continues as a **shaft** or **rachis**
- c. rachis bears numerous **barbs**
- d. up to several hundred barbs arranged to form a flat, **webbed surface**, the vane
- e. each barb resembles miniature feather; numerous parallel filaments or barbules spread laterally
- f. with up to 600 **barbules** in each side of a barb, ~ > 1 million in whole feather
- g. barbules from two neighboring barbs overlap; they “zip” together with tiny hooks
- h. when separated, “zipped” back together by **preening**





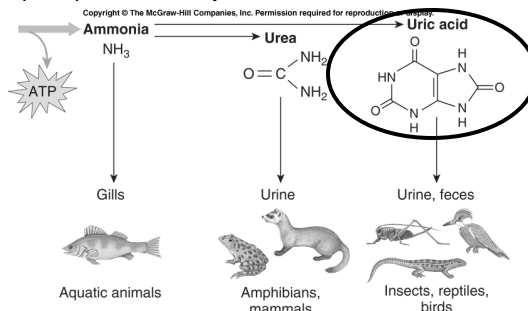




### Water Conservation

1. all amniotes have **metanephric kidneys** drained by ureter
2. nephrons of reptilian metanephros **lack loop of Henle** allows conc. of solutes
3. mammalian kidney **with loop of Henle** allow water absorption
4. marine/marsh birds: **salt glands** near nose or eyes to secrete salty fluid hyperosmotic to body fluids
5. nitrogenous waste excretion: **uric acid** rather than urea or ammonia
6. uric acid: **low solubility & precipitates readily**; this allows water to be conserved

### Nitrogen Endproducts



## Bird Migration

1. ~50% migrate
2. move between **southern wintering & northern summer breeding** regions
3. exploit seasonal changes in abundance of insects & avoid bird predators
4. appearing once/yr prevents buildup of specialized predators
5. expands living space & reduces aggressive territorial behavior
6. favors homeostasis by avoiding climatic extremes & food shortages
7. follow established north-south routes
8. some use different routes in fall & spring
9. many aquatic spp make rapid journeys (but warblers take 50-60 days)
10. smaller spp migrate at night & feed by day; others daytime migrants
11. Arctic tern circles from North America to coastlines of Europe & Africa to winter quarters, a total of 18,000 kilometers (11,200 miles)
12. photoperiod: long days of late winter/early spring → development of gonads & fat
13. long day length stimulates anterior lobe of the pituitary
14. release of pituitary gonadotropic hormone → physiological & behavioral changes
  - a. gonadal growth
  - b. fat deposition
  - c. migration
  - d. courtship
  - e. mating behavior
  - f. care of young

## Direction Finding in Migration

1. experiments suggest navigation chiefly by sight
2. recognize topographical landmarks & follow familiar migratory routes
3. involves pooling navigational resources & experiences of older birds
4. highly accurate innate sense of time & an innate sense of direction
5. navigation by earth's magnetic field; related to magnetite ( $\text{Fe}_3\text{O}_4$ ) found in neck musculature of pigeons
6. **Sun-azimuth Orientation**
  - a. navigation by sun at day & stars at night
  - b. use sun as a compass; an internal clock tracks position
  - c. North Star used as an axis at night
7. migration involves a combination of environmental & innate cues
8. natural selection culls individuals making errors; only best navigators leave offspring