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
a. skull resembled modern birds but had teeth rather than a beak
b. skeleton reptilian with clawed fingers, abdominal ribs & a long bony tail
c. Feathers unmistakably imprinted along wings

Birds & Reptiles Similarities

a. both have skulls that abut the first neck vertebra by a single ball-and-socket joint
b. both have a single middle ear bone → stapes
c. lower jaw in both composed of five or six bones in mammals, one mandibular bone
d. both excrete nitrogenous wastes as uric acid mammals excrete urea
e. 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 & therapods

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
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 O₂ 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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
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

Flight

Perching
Bilateral lungs & air sacs
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 gonadotrophic 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