SUBPHYLUM VERTEBRATA (Ch. 27-31)

1. CIRCULATORY PATHWAYS

2 chambers (all fishes)
   1 atrium >> 1 ventricle >> gills/tissues

3 chambers (amphibians)
   2 atria >> 1 ventricle >> lungs/tissues

3-1/2 chambers (reptiles except crocodiles)
   2 atria >> 1+ ventricle >> lungs/tissues

4 chambers (birds & mammals)
   right atrium >> right ventricle >> lungs
   >> left atrium >> left ventricle >> tissues

2. RESPIRATORY MEMBRANES

gills - evaginated exchange membrane
   - internal
     - gill pouches (jawless fish)
     - gill slits (cartilaginous fish)
     - opercula (bony fish)
   - external (larval amphibians)

lungs - invaginated exchange membrane
   - positive pressure (adult amphibians)
   - negative pressure (reptiles, birds, mammals)

3. URINARY PRODUCTS

ammonia - soluble & toxic (fishes & aquatic amphibians)

urea - semi-soluble & nontoxic (terrestrial amphibians & mammals)

uric acid - insoluble & nontoxic (reptiles & birds)

4. AQUATIC OSMOREGULATION

marine - sea water is more concentrated than tissues
   - therefore body loses water and gains salt
   • jawless fish - retain salt to match sea
   • cartilaginous fish - retain urea
• bony fish - drink lots, glands secrete salt, very little but concentrated urine

freshwater - freshwater is **less** concentrated than tissues
- therefore body gains water and loses salt
• jawless & bony fishes - drink little, gills absorb salt, lots of dilute urine

5. INTEGUMENTARY PROTECTION

dermis - placoid scales (cartilaginous fish)
  - ganoid / ctenoid / cycloid scales (bony fish)
  - hair (mammals)

epidermis - molted scales (reptiles)
  - feathers (birds)

other - mucous glands (jawless & amphibians)

6. SKELETAL MATERIALS

cartilage only (jawless & cartilaginous fishes)

true bone (all others)

7. MODES OF LOCOMOTION

swimming - most efficient of all

saltatorial - most efficient on land

gliding - most efficient in air

8. MODES OF REPRODUCTION

gonads - monocious (jawless fish)
  - dioecious (all others)

fertilization
  - external (most fishes, amphibians)
  - internal - claspers (sharks)
  - hemipenis (reptiles)
  - cloacal protuberance (birds)
  - penis (mammals)
eggs - oviparous (most classes)
   - ovoviviparous (sharks & snakes)
   - viviparous (most mammals)

9. THERMOREGULATION

endothermic - feathers (birds)
   - hair or blubber (mammals)

ectothermic (all others)

10. COUNTERCURRENT MECHANISMS

to conserve heat
   - muscles in ‘hot-blooded’ fish & bees
   - flippers & flukes in whales
   - ears, legs, tails, & scrota in mammals

to conserve water - nephrons in kidneys
   - nasal passages in camels & giraffes

to extract oxygen - gills & swim bladders in fishes