

# *Inquiry into Life*

*Eleventh Edition*

**Sylvia S. Mader**

## Chapter 31 Lecture Outline

Prepared by: Wendy Vermillion  
*Columbus State Community College*

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



# 31.1 Echinoderms

- Characteristics

- All saltwater aquatic organisms
- Endoskeleton of spiny plates
  - Spines protrude through skin
- Many have radial symmetry
  - Larval stage often bilaterally symmetrical
- Very diverse group
  - Sea lilies- class Crinoidea
  - Sea cucumbers-class Holothuroidea
  - Brittle stars-class Ophithuroidea
  - Sea urchins and sand dollars- class Echinoidea
  - Sea stars- class Asteroidea

# Echinoderm diversity

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



- Fig. 31.1

# Echinoderms cont'd.

- **Sea stars**

- Found along shorelines on rocky surfaces
- 5-rayed body with mouth on underside and anus on upper side
  - On oral surface, each arm has an ambulacral groove surrounded by tube feet
- Structures project through skin
  - Spines for protection
  - **Skin gills**-extensions of skin for gas exchange
- Feeding
  - Opens bivalve with its tube feet
  - Digested food taken in and digestion completed in pyloric stomach
- Nervous system-no central brain
  - Central nerve ring gives off branches to each arm
  - Eyespot at tip of each arm

# Echinoderms cont'd.

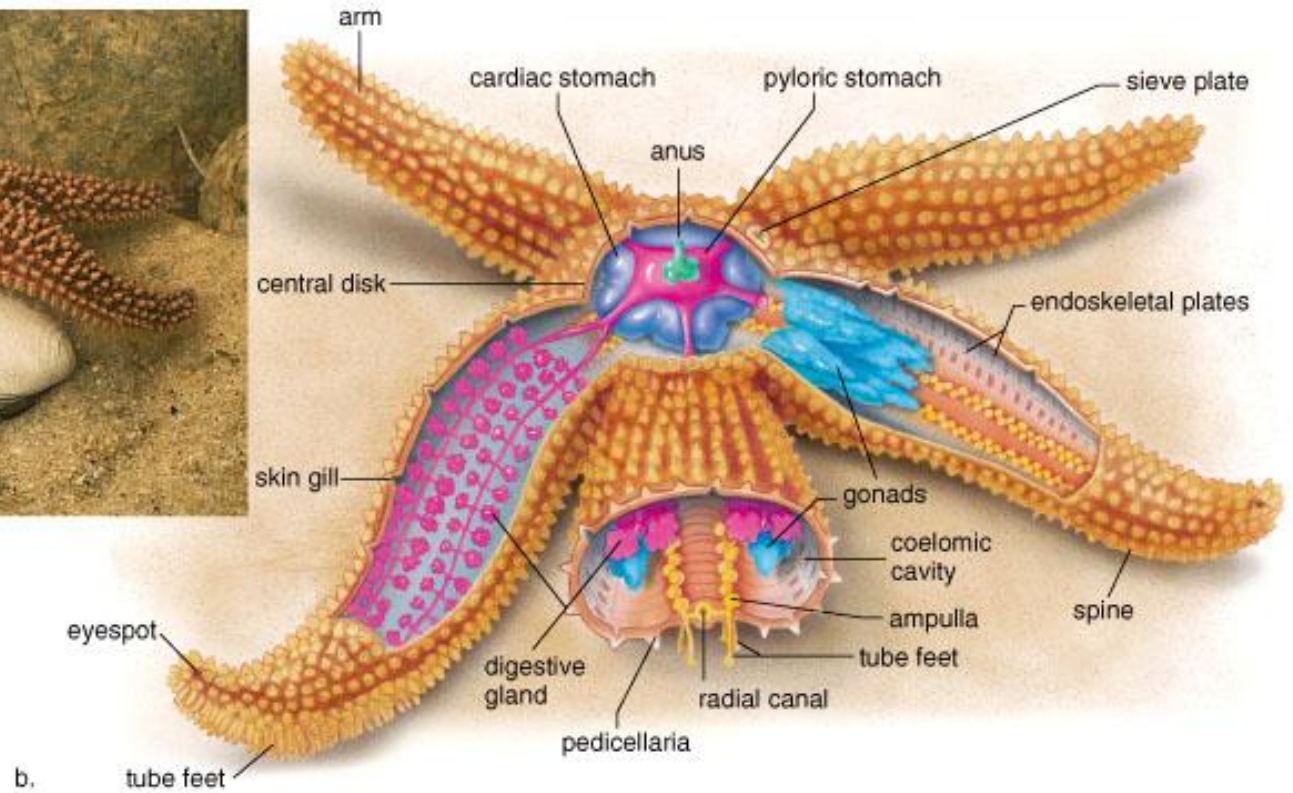
- Sea stars cont'd.
  - Water vascular system-locomotion by tube feet
  - Reproduction is both sexual and asexual

# Sea star anatomy and behavior

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



a.



b.

- Fig. 31.2

# 31.2 Chordates

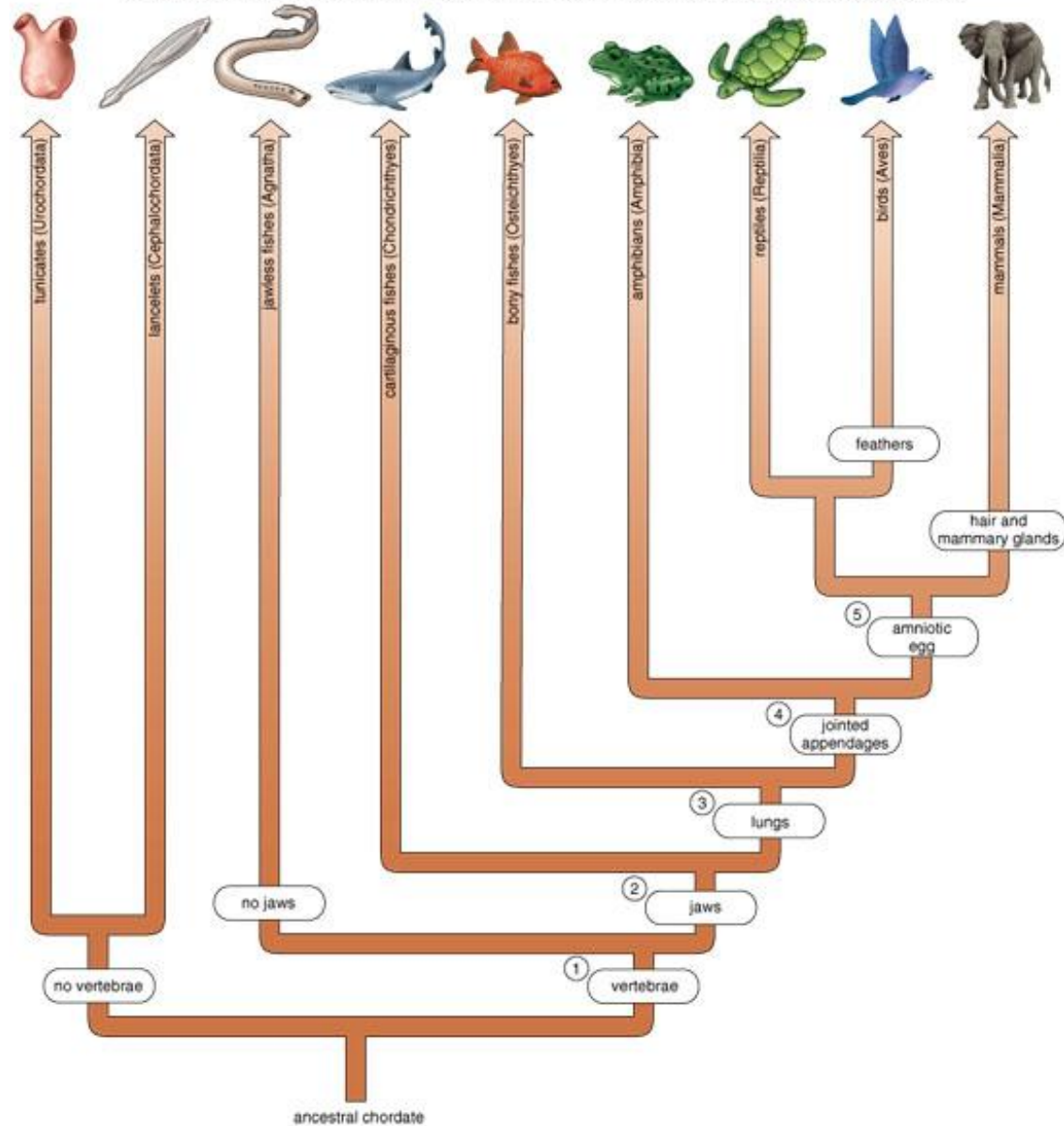
- At some point in life history, each chordate has
  - **Notocord**-dorsal rod for support
    - In vertebrates it is replaced by the spinal column
  - **Dorsal tubular nerve cord**
    - Contains a canal filled with fluid
    - In vertebrates it is protected by the spinal column
  - **Pharyngeal pouches**
    - Only present in embryonic development in most vertebrates
    - Become gills in invertebrate chordates, fishes, and some amphibian larvae
    - In terrestrial vertebrates they are modified for other purposes
      - Humans-auditory tubes, tonsils, thymus and parathyroid glands
  - **Post-anal tail**

# Chordates cont'd.

- Evolutionary trends among Chordates
  - Invertebrate chordates- tunicates and lancelets
  - Vertebrate chordates- fishes, amphibians, reptiles, birds, mammals
    - Cartilaginous fish-first to develop jaws
    - Some early bony fish had lungs
    - Amphibians-first to have jointed appendages and invade land
    - Reptiles, birds, mammals- terrestrial adaptations for reproduction
      - Reptiles, birds- amniotic egg for development outside the body
      - Mammals- placenta and internal development
  - Figure on following slide depicts evolutionary tree of chordates

# Evolutionary tree of chordates

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



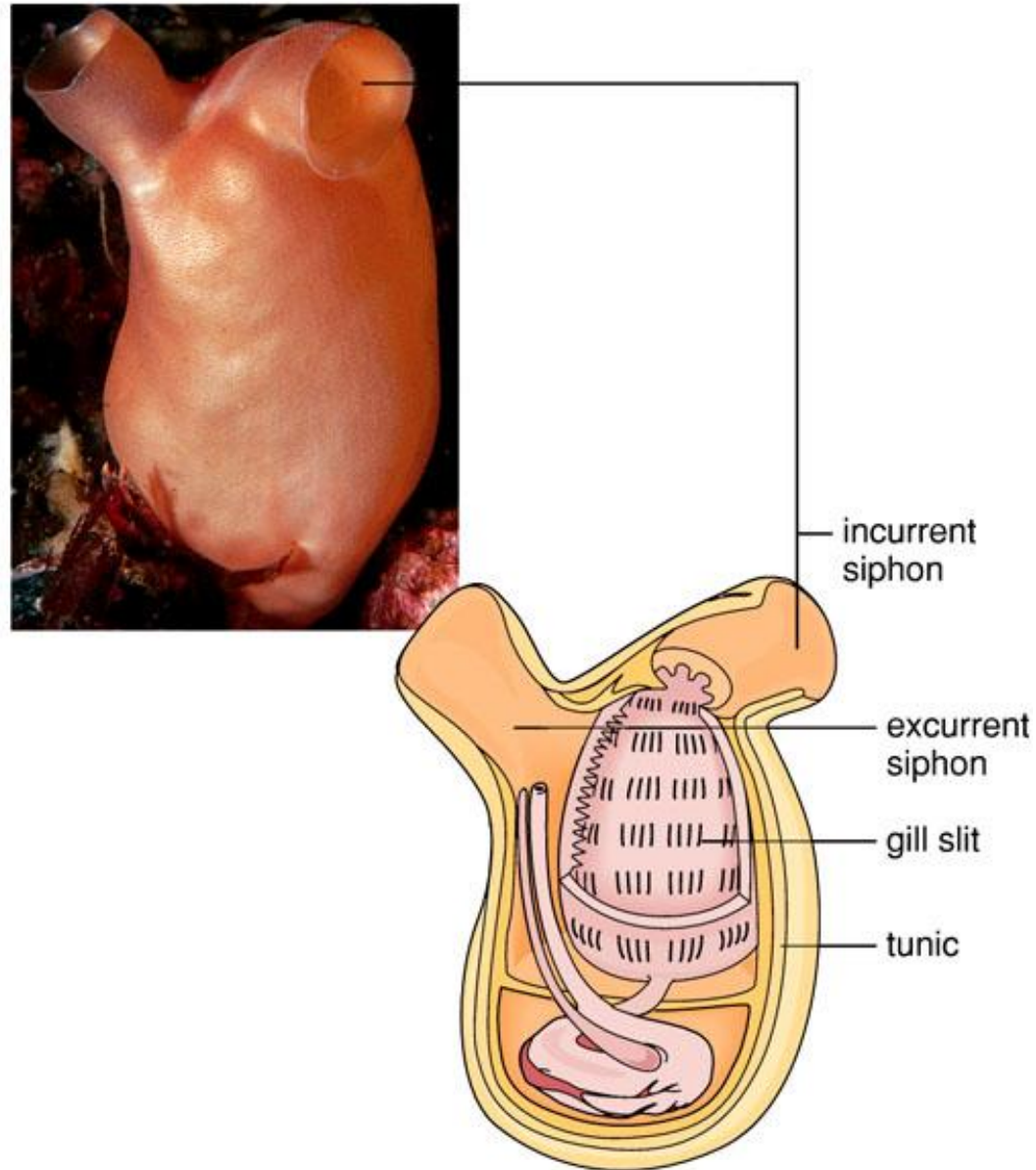
• Fig. 31.4

# Chordates cont'd.

- Invertebrate chordates
  - Tunicates-the sea squirts
    - Subphylum Urochordata
      - Adults are sessile, thick-walled, sac-like organisms
        - » The only chordate characteristics in the adults are pharynx and gill slits
      - Live in ocean and are filter-feeders

# Anatomy of a tunicate

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

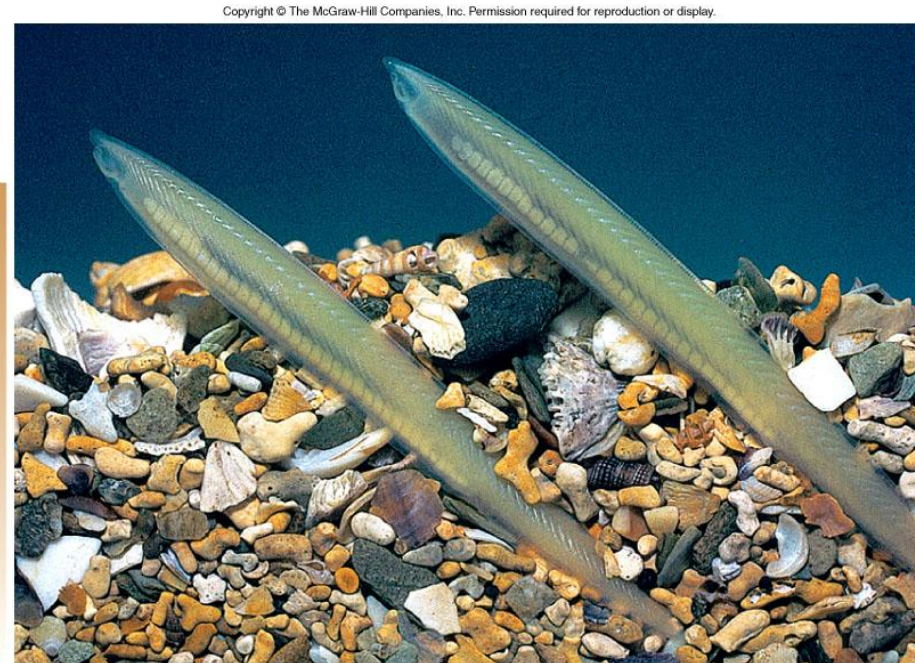
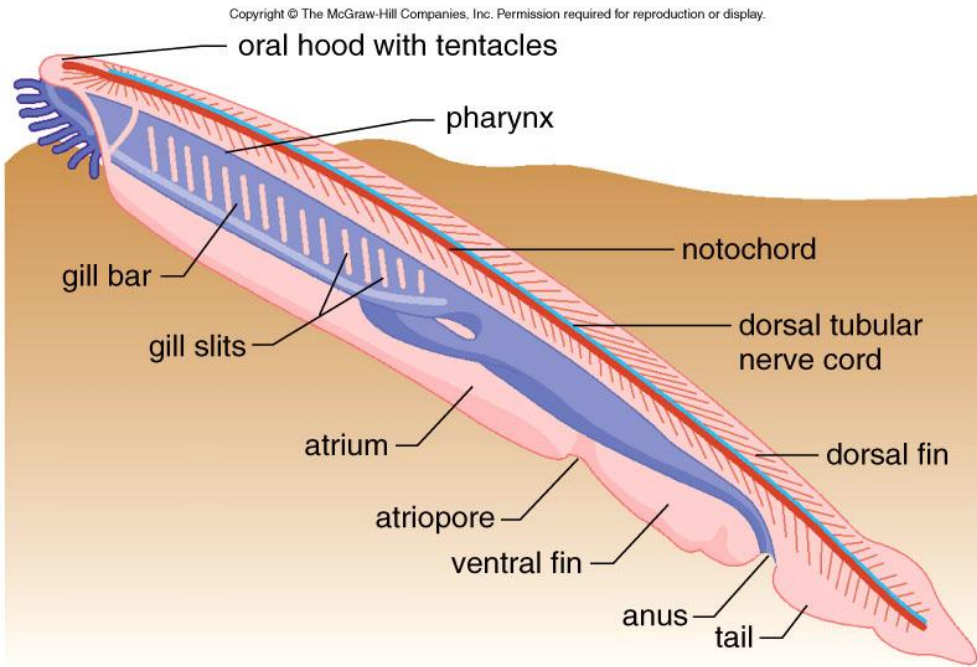


• Fig. 31.5

# Chordates cont'd.

- Invertebrate chordates cont'd.
  - Lancelets
    - Knife-shaped bodies a few centimeters long
    - Live in shallow coastal waters
    - Retain all 4 chordate characteristics as an adult
    - Segmentation is present

# Habitat and anatomy of a lancelet, *Branchiostoma*



• Fig. 31.6

# 31.3 Vertebrates

- Overview of the vertebrates
  - Have 4 chordate characteristics at some point in life
  - Distinguishing features
    - Living endoskeleton of cartilage or bone
    - Closed circulatory system with pumping heart
    - Paired appendages
    - Efficient respiration and excretion of wastes
    - High degree of cephalization with well-developed sense organs

# Milestones in vertebrate evolution

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



a. Great white shark, *Carcharodon*



b. Spotted salamander, *Ambystoma*

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



c. Veiled chameleons, *Chamaeleo*

- Fig. 31.7

# Vertebrates cont'd.

- Fishes: first jaws and lungs
  - 3 groups of fishes: jawless, cartilaginous, bony
    - Cartilaginous and bony have true jaws with teeth
      - Jaws allow predatory way of life
      - All fish are **ectothermic**- body temperature matches the environment
    - Adapted to life in water
      - Sperm and eggs released into water, fertilization external

# Vertebrates cont'd.

- **Jawless fish**
  - Superclass Agnatha- hagfish and lampreys
  - Cylindrical body shape with smooth, scaleless skin
  - No jaws, no paired fins
  - Hagfish-scavengers
  - Lampreys- parasitic

# Vertebrates cont'd.

- Cartilaginous fish

- Class Chondrichthyes- sharks, skates, rays

- Endoskeleton of cartilage

- Dermal **placoid scales**-gives body surface a “sandpaper-like” feel

- Gills open, lack **operculum** (gill flap)

- Efficient predators

- Can sense electrical currents in water which indicate presence of prey

- **Lateral line system**-sense pressure created by prey nearby

- Well-developed sense of smell- sharks can detect 1 drop of blood in 25 gallons of water!

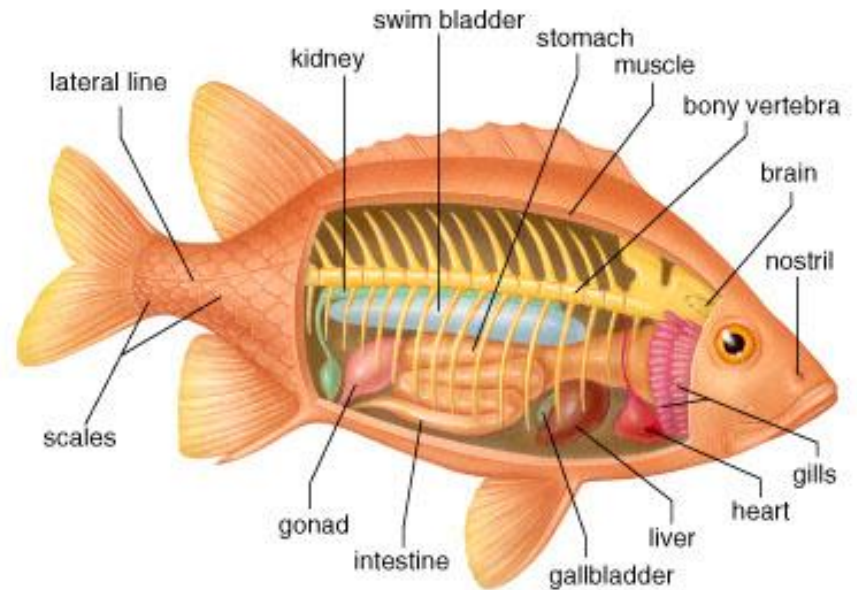
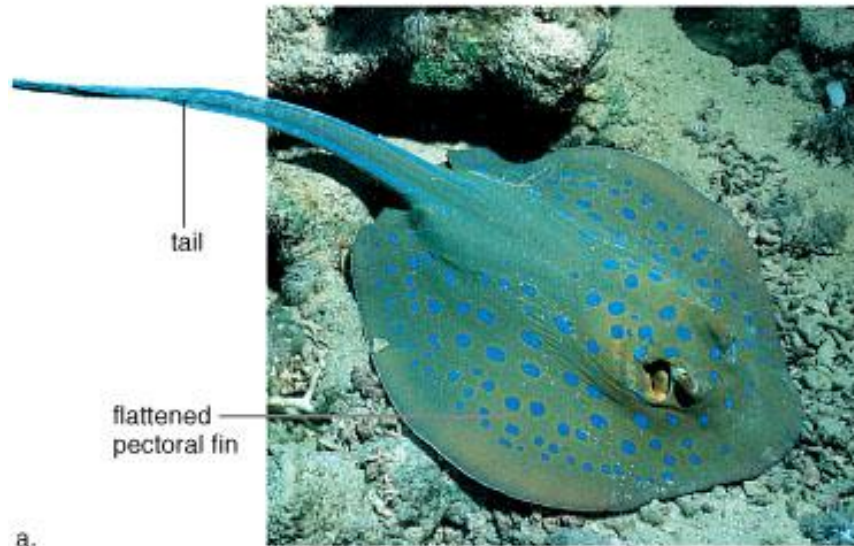
# Vertebrates cont'd.

- Bony fishes

- Class Osteichthyes-most numerous and diverse of all vertebrates
  - Ray-finned fish-paired fins supported by bony rays; have jaws and skeletons of bone
    - Blood pumped by heart with nondivided 2 chambered heart
  - Lobe-finned fish-fleshy appendages could be adapted for locomotion on land
    - Most had lungs

# Jawed fishes

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



# Vertebrates cont'd.

- Amphibians: jointed appendages
  - Class Amphibia- salamanders, frogs, toads, newts
    - Tetrapods, jointed appendages, ectothermic
    - Eyelids keep eyes moist, ears, larynx for vocalization
    - Larger brain than in fish
    - Small lungs present in adults; gas exchange also occurs across moist skin
    - 3-chambered heart-2 atria and a ventricle
      - Rt atrium receives deoxygenated blood from body
      - L atrium receives oxygenated blood from lungs
      - Blood mixes in ventricle
    - Metamorphic life cycle- larval stages in water, adults on land
      - Reproduction generally occurs in water

# Frog metamorphosis

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



a. Tadpoles hatch.



b. Tadpole respire with external gills.



c. Front and hind legs are present.



d. Frog respire with lungs.

# Vertebrates cont'd.

- Reptiles: amniote egg
  - Class Reptilia- turtles, tortoises, snakes, lizards
    - Extinct reptiles include mammal-like reptiles and dinosaurs
      - Evidence suggests birds are “feathered dinosaurs”
      - A common reptilian ancestor most likely gave rise to modern reptiles, birds, and mammals
    - Most are tetrapods; ectothermic but can regulate temperature through behavior (ex: basking)
    - Rib cage to protect organs and expands to inflate lungs
    - Dry skin covered with protective scales
    - Amniote egg covered with leathery shell
    - 3-chambered heart (division between ventricles incomplete) in most; true 4 chambered heart in some
    - Well-developed sense organs: snakes have tongue modified as sense organ

# The tongue as a sense organ

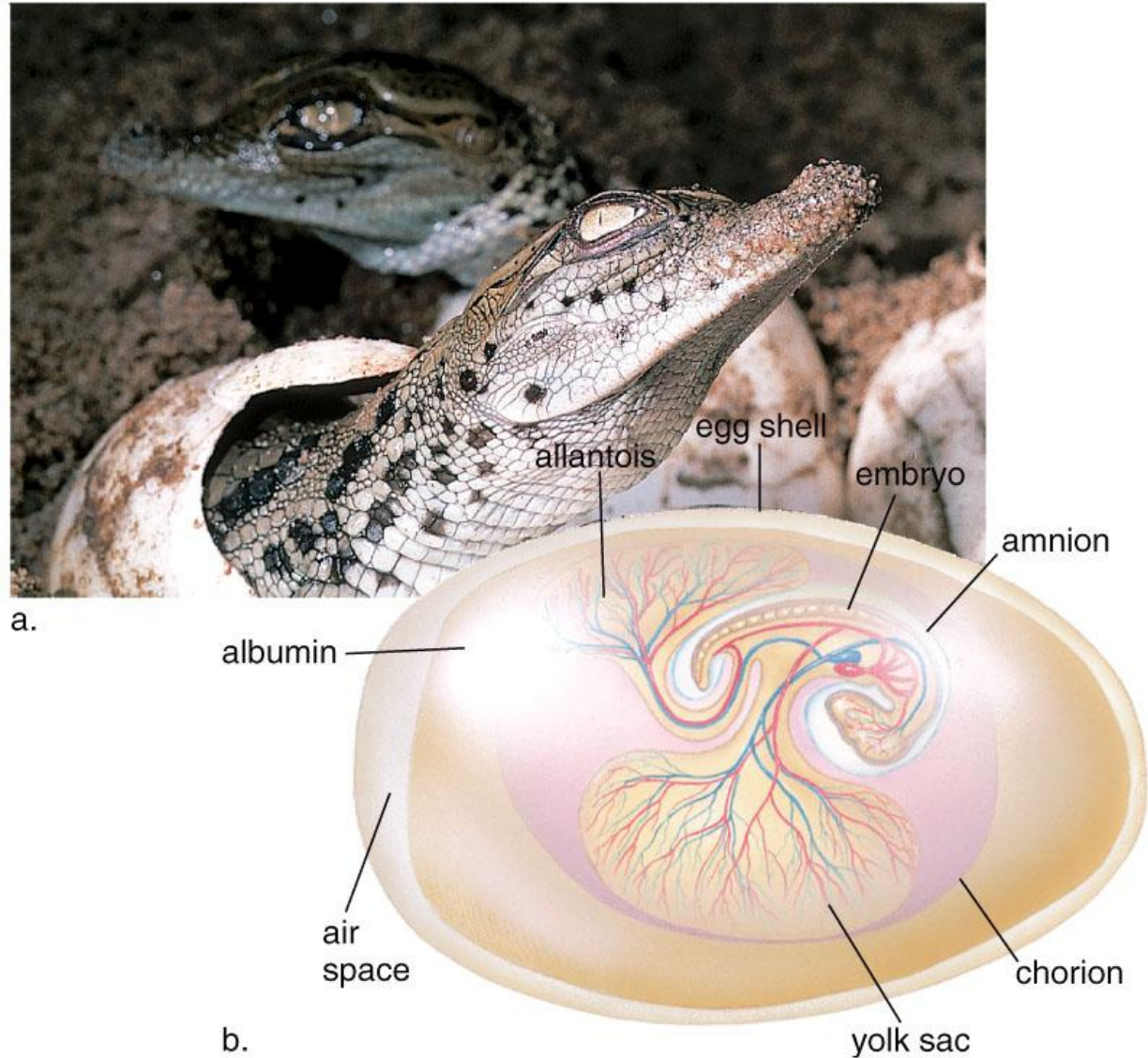
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



• Fig. 31.10

# The reptilian egg allows reproduction on land

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



• Fig. 31.11

# Vertebrates cont'd.

- **Birds: feathers**

- Feathers are modified scales; legs of birds have scales
- Amniote egg with a hard shell
- Adaptations for flight
  - **4-chambered heart**- more efficient oxygen delivery
  - **Endothermic**-regulate body temperature above ambient
  - **System of air sacs and one-way air flow through respiratory tract**- increased efficiency of gas exchange
  - **Forelimbs modified for flight**-wings
  - sternum has keel for attachment of large muscles
  - **Well-developed nervous system and sense organs**
    - Navigational senses
  - **Ritualized courtship**, young require parental care
    - Cloaca- common urogenital opening

# Vertebrates cont'd.

- Birds, cont'd.
  - Classification
    - Based on beak and foot types
    - Also on habitat and behavior to a lesser degree
    - Birds of prey- long talons, notched beaks
    - Shorebirds- long, slender bills and long, stilt-like legs
    - Woodpeckers- sharp, chisel-like bills, grasping feet
    - Waterfowl-webbed toes and broad, scooping bills
    - Penguins- wings modified as paddles
    - Songbirds-perching feet

# Bird beaks

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



a. Cardinal, *Cardinalis cardinalis*



b. Bald eagle, *Haliaeetus leucocephalus*



c. Flamingo, *Phoenicopterus ruber*

# Vertebrates cont'd.

- **Mammals: hair and mammary glands**
  - Endothermic, maintain relatively constant internal temperature
    - Hair provides insulation to preserve body heat
    - Efficient circulatory and respiratory systems to supply muscles that generate heat
      - 4-chambered heart
      - Circulatory system has 2 separate circuits for oxygenated and deoxygenated blood
    - Mammary glands allow care for young without having to leave them
    - Internal development in most with birth of live young
  - 3 groups- monotremes, marsupials, placentals based on how they reproduce

# Vertebrates cont'd.

- **Monotremes**

- Have a cloaca like birds- common urogenital opening
- Egg-laying mammals- lay a hard-shelled egg
- Spiny anteater and duck-billed platypus
  - Both found in Australia
- Both males and females have modified sweat glands and secrete milk onto body surface
  - Babies lick up the milk

# Vertebrates cont'd.

- **Marsupials**

- Begin development within female's body, born very immature and development is completed within a pouch
  - Attach to nipples of mammary glands within the pouch
- Virginia opossum is the only marsupial species north of Mexico
- Australian species- no competition from placentals
  - Adaptive radiation gave rise to many marsupial species

# Monotremes and marsupials

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



a. Duckbill platypus, *Ornithorhynchus anatinus*



b. Virginia opossum, *Didelphis virginianus*



c. Koala, *Phascolarctos cinereus*

- Fig. 31.14

# Vertebrates cont'd.

- Mammals cont'd.

- Placental mammals

- Extraembryonic membranes of reptilian egg are modified as placental membranes
    - Adapted for active life on land
      - Well-developed brain and sense organs
      - Limbs that allow rapid movement
      - Lungs expanded by rib cage and a diaphragm
      - 4-chambered heart
      - Internal body temperature is constant-allows optimum nerve and enzyme functions
      - Hair- insulates body

# Vertebrates cont'd.

- Placental mammals cont'd.
  - Differentiated teeth-incisors, canines, premolars, molars
    - Shape and size of teeth may determine type of food eaten
  - Classification of placental mammals is on methods of obtaining food and mode of locomotion; for example:
    - Order Chiroptera- bats; wings supported by digits for flight
    - Order Perissodactyla-horses; long, hoofed legs for speed
    - Order Cetacea-whales; paddle-like forelimbs

# Placental mammals

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



a. White-tailed deer, *Odocoileus virginianus*



b. African lioness, *Panthera leo*



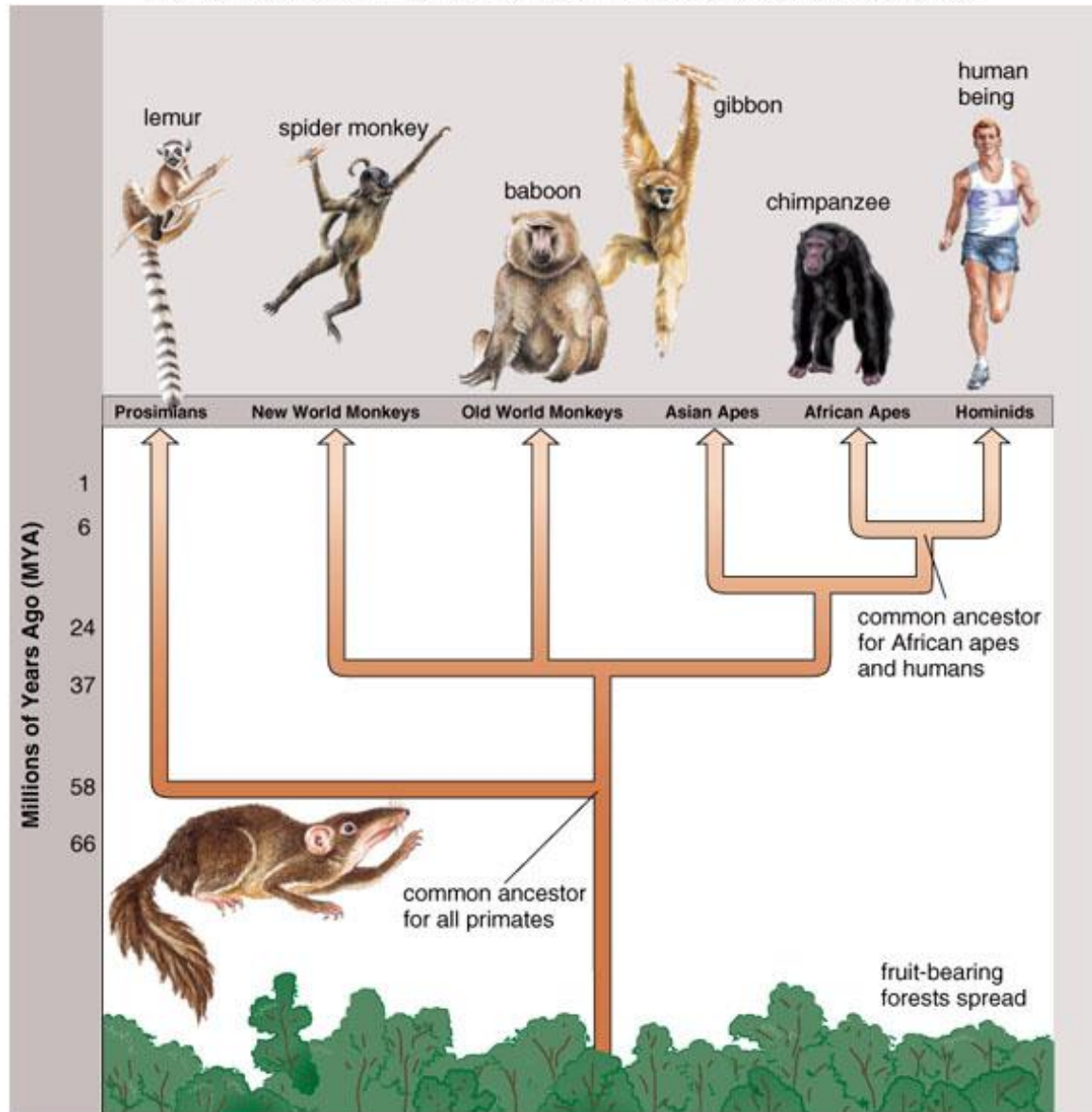
c. Golden tamarin monkey, *Leontopithecus rosalia*



d. Killer whale, *Orcinus orca*

# Evolution of primates

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



• Fig. 31.16