Deuterostomes

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Learning goals

- Describe deuterostome embryonic development
- Describe the five extant classes of echinoderms.
- List the defining characteristics of chordates.
- Distinguish a chordate from an echinoderm.
- Compare and contrast lancelets and tunicates from vertebrates.
- Compare the different groups of vertebrates.

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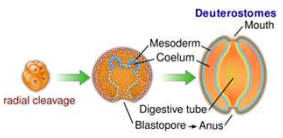
Deuterostome development

- Embryo develops through radial cleavage; new cells form on top of previous cells
- Developmental fate of embryonic cells is indeterminate
- Anus develops first from or near the blastopore
- Mouth develops in another region of embryo
- Folds of arch enter on form coelom



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Phylum Echinodermata (spiny skin)

- Exclusively marine, bottom dweller
- Endoskeleton of calcium carbonate plates covered by living tissue
- **Water-vascular system**
  - Central ring canal with radial canals extending out
- **Bilateral** as larva, **pentaradial** as adult
- All systems organized with branches radiating from center
- Endoskeleton of carbonate plates covered by epidermis

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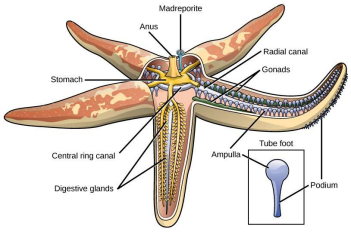
Water-vascular system

- **Water-vascular system**
  - **Radially** organized
  - Canal extends from ring canal into each body branch
  - Water enters through **madreporite**
- **Tube feet**
  - **Ampulla**: Muscular sac at base
  - Used in movement, feeding, gas exchange



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Reproduction

- Regenerate lost parts and asexually by splitting
- Most sexually reproduce
- Gonochoric
- Gametes released into water

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Class Asteroidea

- Sea stars and sea daisies
- Predators
- Ossicles arranged loosely under skin
- Five arms, or multiples of five

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Class Echinoidea

- Sea urchins and sand dollars
- Lack arms
- Double rows of tube feet
- Protective movable spines

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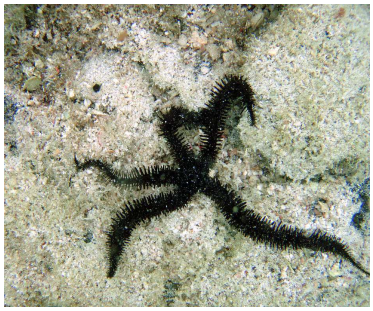
Class Ophiuroidea

- Brittle/serpent stars
- Arms equal diameter
- Easily broken
- No anus



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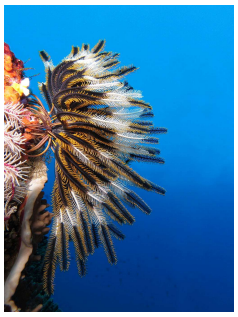
Class Crinoidea

- Sea lilies and feather stars
- Oral surface (mouth/anus) faces up
- Ossicles well developed
- Coarse, jointed appearance



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Class Holothuroidea

- Sea cucumbers
- Soft bodies
- Reduced ossicles
- Few if any spines

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Understanding check

Why are echinoderms considered bilaterians?

What is the purpose of the water vascular system?

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Phylum Chordata

- Endoskeleton
- A flexible rod along back of the embryo
- Key evolutionary advance
- Includes fishes, amphibians, reptiles, birds, and mammals

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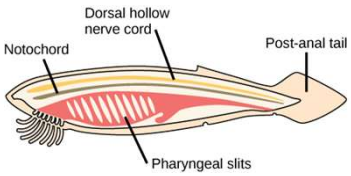
What makes a Chordate?

1. Dorsal nerve cord
2. Notochord (may be replaced by vertebral column)
3. Pharyngeal slits (pharyngeal pouches present in all vertebrate embryos)
4. Postanal tail



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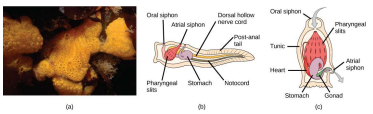
Subphylum Urochordata

- Tunicates
- Larvae are free swimming and have notochord and nerve cord
- Adults
  - Lose tail and notochord
  - Sessile filter-feeders
  - Secrete a **tunic** (cellulose sac) that surrounds the animal



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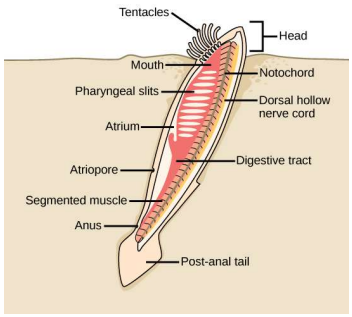
Subphylum Cephalochordata

- E.g., lancelets (*Amphioxus*)
- Fish-like marine
- Notochord persists throughout animal's life
- Spend most of their time partly buried
- No distinguishable head
- Feed on plankton using cilia
- Closest relatives to vertebrates



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Understanding check

What are the four distinguishing characteristics of all chordates?

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Subphylum Vertebrata

- Vertebral column encloses and protects the dorsal nerve cord
- Head distinct and well-differentiated possessing sensory organs
- Neural crest, embryonic cells that forms many vertebrate structures
- Internal organs
- **Endoskeleton** made of **cartilage** or **bone**

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Classes Myxini and Petromyzontida (hagfish and lampreys)

- Represents earliest phase of vertebrate evolution
- Lack jaws
- Cartilaginous endoskeleton
- Notochords, pharyngeal gills
- Head
- Rasping mouth attach to fish to feed

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Class Chondrichthyes

- Sharks, skates, rays
- Gill arches modified into **jaws**
- Cartilage skeleton "calcified"
- First vertebrates to develop teeth
- Some have lateral line system: sensory organs under the skin that detects changes
- Eggs are fertilized internally, and some give live birth

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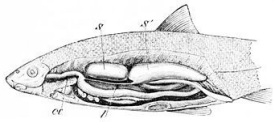
Sub Clade Osteichthyes (bony fishes)

- Most species-rich group of all vertebrates
- **Bony endoskeleton**
- **Swim bladder**: gas-filled sac helps regulate buoyant density
- Hard **operculum** covers gills



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Classes of bony fish

- **Class Actinopterygii: ray-finned fishes**
  - Parallel bony rays support each fin
  - No muscles within the fins
- **Class Sarcopterygii: lobe-finned fishes**
  - Paired fins-long fleshy muscular lobe
  - Supported by core of bones

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Understanding check

What distinguishes Chondrichthyes from Myxini and Petromyzontida?

What distinguishes Osteichthyes from Chondrichthyes?

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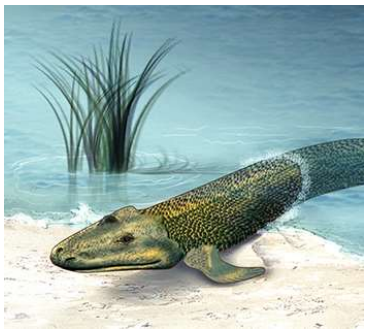
Invasion of land by vertebrates

- Legs to support body's weight
- Lungs to extract oxygen from air
- Redesigned heart and circulatory system to drive larger muscles
- Reproduction still in water to prevent egg drying
- Moist body



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Class Amphibia (frogs, toads, salamanders)



- Lungs
- Legs
- Lay eggs in water
- Soft moist skin: cutaneous respiration supplement lungs
- Pulmonary veins
- Partially divided heart
- **Order Anura**: frogs and toads
- **Order Caudata:** salamanders
- **Order Apoda**: caecilians

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Class Reptilia (turtles, snakes, lizards)

- Internal fertilization: amniotic eggs, which are watertight
- Dry skin with scales prevents water loss
- Thoracic breathing, which increases lung capacity
- Improved circulation
- **Poikilothermic** (ectothermic)

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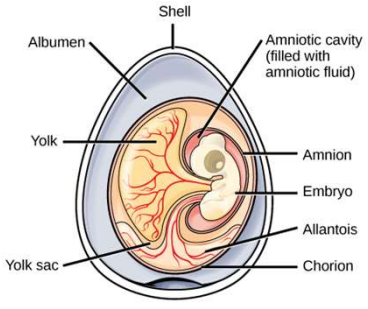
Amniotic egg



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Order Testudines

- Lack teeth; sharp beaks.
- Bodies encased in protective shell
- Web toes or flippers
- Lay eggs on land

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Order Rhynchocephalia

- Single species, the tuatara
- Small lizard like
- Islands off the coast of New Zealand
- "Third eye" on the top of its head, parietal eye
- Feed at night

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Order Squamata

- Two copulatory organs in the male
- Morphology of head/jaws allow greater strength and mobility
- Carnivores
- Rely on agility and speed
- Some lack of limbs, movable eyelids, external ears

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Order Crocodylia

- Primarily aquatic reptiles
- Largely nocturnal animals
- Carnivores
- Eyes on top of their heads
- Nostrils on top of their snouts
- Enormous mouths
- Studded with sharp teeth
- Very strong necks
- Build nests and care for their young

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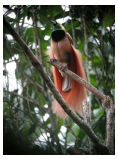
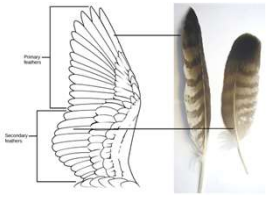
Class Aves

- Birds are the most diverse of all terrestrial vertebrates
- Success lies in unique structure: **feather**
- Birds retain many reptilian traits
  - Amniotic eggs
  - Scales on legs
- Major bird traits
  - **Feathers**
    - Modified scales of keratin
    - Provide lift for flight and conserve heat
  - **Flight skeleton**
    - Bones are thin and hollow
    - Many are fused for rigidity, anchor strong flight muscles
    - Keeled breastbone provides attachment site for flight muscles
- They are **endothermic**





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Understanding check

Why is the amniotic egg such an important evolutionary advancement?

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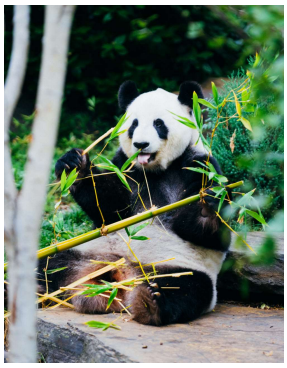
Class Mammalia

- **Hair**
  - Long, keratin-rich filaments that extend from hair follicles
  - Insulation, camouflage, sensory structure, defensive
- **Mammary glands**
  - Females possess mammary glands that secrete milk
- Endothermy depends on higher metabolic rate
  - 4-chambered heart
  - Respiration using **diaphragm**
- Placenta in most mammals
  - Specialized organ that brings fetal and maternal blood into close contact



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Mammalian feeding

- Different types of teeth are highly specialized to match particular eating habits
- Contrast carnivore teeth to herbivore teeth
- Herbivorous mammals rely on mutualistic partnerships with bacteria for cellulose breakdown

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Development of hooves and horns

- Hooves are specialized keratin pads
- Horns are bone surrounded by keratin
- Antlers are made of bone, not keratin

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Monotremes

- Lay shelled eggs
- Like reptiles have single opening (cloaca) for feces, urine, and reproduction
- Lack well-developed nipples
- Only three living species

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Marsupials

- Short-lived placenta
- Embryo moves into marsupial pouch

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Placental Mammals

- True placenta that nourishes embryo throughout its development
- Forms from both fetal and maternal tissues
- Period of development before they are born
- Includes most living mammals

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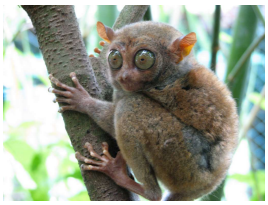
Order Primates: Prosimians

- Lemurs, lorises and tarsiers
- Large eyes with increased visual acuity
- Most are nocturnal



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Primates: Anthropoids

- Include monkeys, apes, and humans
- Almost all diurnal: changes in eye design include color vision
- Expanded brain
- Live in groups with complex social interactions
- Care for young for extended period
- Long period of learning and brain development

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Hominoids and hominids

- **Hominoids**
  - Apes
    - Gibbon, orangutan, gorilla, and chimpanzee
    - Larger brains than monkeys and lack tails
    - Paraphyletic group – some more closely related to hominids
- **Hominids**
  - Humans
  - Soon after the gorilla lineage diverged, the common ancestor of all hominids split off from the chimpanzee line to begin the evolutionary journey leading to humans

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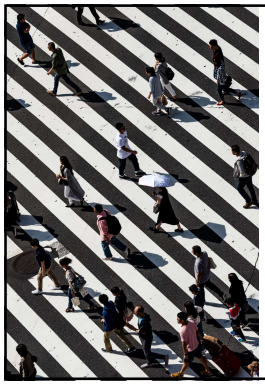

Homo sapiens

- Only surviving hominid
- Progressive increase in brain size
- Effective making and use of tools
- Refined and extended conceptual thought
- Use of symbolic language
- Extensive cultural experience
- We change and mold our world rather than change evolutionarily in response to the environment

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