1 **Bio 1101 Lecture 14**
Chapter 17: Evolution of Animals

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- Last time, we were discussing the evolution of progressively more recent groups of plants…

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3 **Chapter 17: Evolution of Animals**

How do plants, fungi and animals compare?

Plant	Fungi	Animal
eukaryotic	eukaryotic	eukaryotic
multicellular	multi- & unicellular	multicellular
autotrophs	heterotrophs	heterotrophs
lack nervous/muscle tissue	lack nervous/muscle tissue	have nervous/muscle tissue
cell walls of cellulose	cell walls of chitin	lack cell walls

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4 **Animal Reproduction**

Most animals reproduce sexually

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- Blastula → Gastrula → Embryo

Adult Form Larva

Larvae (plural) are sexually immature forms of some animals; they are anatomically distinct from the adult form
(example: tadpoles of frogs)

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6 **<u>Larvae</u> are sexually immature forms of animals that are morphologically different than the adult and go through <u>metamorphosis</u>**

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- How did the first animals evolve from a protist?
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- First true animals probably evolved from a flagellated protist
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  - Colony → hollow sphere → specialization of cells →infolding to form primitive gut
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- By 550-575 mya, during the Precambrian era, a variety of animals existed
  - Our oldest animal fossils
  - Soft-bodied impressions of sponges, jelly fish, worms, and difficult to classify organisms

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- During the Cambrian Explosion (535-525 mya), a huge variety of animals evolved
  - Predator-prey interactions necessitated adaptations for survival
  - Diversification of shells and spines for protection
  - The Burgess Shale fossils are a famous assemblage of Cambrian fossils in British Columbia, Canada

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- A survey of the animal phyla, beginning with the most primitive (oldest) and working our way up to the most advanced (newest) groups
- Some major characteristics to focus on:
  - Body symmetry
  - Development of body cavities
  - Development of more complex digestive systems
  - Development of more complex tissue layers
  - Development of more complex nervous system

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- Earliest and Simplest Animals: The Sponges (multiple phyla)

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  - Asymmetrical (unlike SpongeBob)
  - Multicellular
  - Lack true tissues (no skin, muscle, nerves, etc.)
    - But individuals cells can react to environment
  - Sessile
  - Filter-feeding

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  - Use specialized flagellated cells, choanocytes, to trap bacteria
  - Amoebocyte cells pick up food from the choanocytes and digest it
  - "spicules" give them structure and are manufactured by amoebocytes

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19 **Sponges**

- According to *National Geographic,* a deep sea sponge (above) may be the oldest animal on planet; some estimated to be 11,000 years old!

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Cnidarians (Phylum Cnidaria)

- Sea anemones, jellyfish, hydras, and corals
- Radially symmetrical
- Mostly marine
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- Have a "gastrovascular cavity"
  - One opening (both mouth and anus)
  -
- 2 different body plans:
  - Medusa
  - Polyp

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- Some are polyps, some are medusas, and some go through both stages
- Polyp is the asexually reproducing stage (budding)
- Medusa is the sexually reproducing stage (produces gametes)

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- Tentacles in a ring around mouth
- Named for their "cnidocytes" – special stinging cells found on their tentacles
  - Defense
  - Capture prey
  - Some inject poison (e.g. jellyfish)
  -

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Flatworms (Phylum Platyhelminthes)

- The simplest, earliest bilaterally symmetrical organisms
- Lack a body cavity, or coelom (acoelomate)
  - A coelom is a fluid-filled space between the gut and the outer body wall
  - Holds and protects internal organs
- No circulatory system
- May be free-living or parasitic
- Either have incomplete digestive tract (only 1 opening), or lack digestive tract

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- Free-living flatworms include the planarian
- The beginning of a collection of nervous tissue at front of organism, and some simple "eye spots"
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Planarian:

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- Flatworms were among the first animals to exhibit cephalization – the concentration of sensory organs at the "head end" of the animal
  - An adaptation for directional movement
    - Most radially symmetrical animals are stationary
  - The head end is first to encounter food, danger, or other stimuli
  - "head" end may contain a brain or simple ganglia, and sensory organs such as eyes

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  - Parasitic flatworms include flukes and tapeworms
    - Complex life cycles
      - Flukes reproduce sexually in humans; eggs shed into water with feces; hatch in water and infect snails; reproduce asexually in snails, and produces a larval form that lives in water; larval form infects fish, and then fish-eating animals

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Tapeworms:

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  - Consist of a scolex ("head" with hooks and suckers for attachment to host) and a long chain of proglottids
    - Each proglottid contains a complete reproductive system
  - May infect a variety of animals, from pigs, cows, fish, and humans
  - Tapeworms are different from other flatworms in that they completely lack a digestive system
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Phylum Mollusca
  - Includes snails, clams, squid, and octopuses
  - Soft-bodied animals
  - True coelom
  - Complete digestive tract
  - Most protected by a hard shell, either internal or external (one exception is slugs)
  - Have a specialized feeding structure called a radula
    - Scrape algae off rocks
    - Cut pieces of vegetative material

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- Body plan:
  - Muscular foot for movement
  - Visceral mass contains organs
  - Thin fold of tissue called the mantle, secretes the shell

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- 3 groups of Molluscs:
  - Class Gastropoda (snails and slugs)
    - Single, spiral shell (or none)
    - May have distinct head w/eyes and tentacles
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  - Class Bivalva (clams, oysters, mussels, scallops)
    - 2-part shell
  -

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  - Class Cephalopoda (squids and octopuses)
    - Usually the shell is reduced, internalized, or absent
    - Intelligent marine predators
    - Beak-like jaws and radula
    - Foot has been extended to form tentacles
-
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39 **Amazing Octopuses!**

- Octopus opens jar:
  - http://www.youtube.com/watch?v=ocWF6d0nelY&feature=related
-
- Octopus intelligence & camouflage
  - https://www.youtube.com/watch?v=r1bxBmJAAJE
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Phylum Annelida

- Segmented worms
- Includes earthworms, leeches, and a variety of marine worms
- Appendages located on each segment, in many species
- True coelom
- Bilaterally symmetrical with complete digestive tract
- Mostly free-living
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Roundworms (Phylum Nematoda)

- Cylindrical with tapered ends
- Bilaterally symmetrical
- Found in nearly every habitat, from soil to water to within the bodies of plants and animals
  - If everything were to disappear on earth except roundworms, you would still be able to see "ghosts" of nearly every living thing due to the roundworms that live inside

them
– Some parasitic, some free-living
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– Have a complete digestive tract, and a pseudocoelom (a primitive body cavity)
  • True body cavities are completely lined by mesoderm (a type of tissue)
  • Pseudocoeloms are only partially lined by mesoderm
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– Roundworms include the species that causes the disease trichinosis
  • From eating infected, undercooked pork
  • Worms burrow into and form cysts in muscle tissue
  •
  •
  Trichinella sp.
  found
  in undercooked
  pork

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• Break…

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Phylum Arthropoda
– Bilaterally symmetrical with complete digestive tract
– Segmented animals
  • Segments specialized for specific functions
– Jointed appendages
– Exoskeleton
  • made of chitin
  • When animal grows, must "molt"
•
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– A large diversity of species (about 2/3 of all species!)
– 5 main groups:
  • Arachnids
  • Crustaceans
  • Millipedes
  • Centipedes
  • Insects
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- Arachnids
  - Spiders, scorpions, mites and ticks
  - Live on land
  - 4 pairs of walking legs, and 1 pair of feeding appendages
    - In spiders, these are fang-like and inject poison
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- Spiders make webs using their spinneret glands, located in the abdomen
- Use the wind to carry the thread of silk for first strand of a web; if it sticks to a good surface, spider will walk across the thread, adding a second thread for support
- Most wait at the edge of their web with a foot on the "signal line" to detect when something is captured

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- Crustaceans
  - Mostly aquatic, such as crabs, lobsters, crayfish, shrimp
  - One terrestrial group are the isopods, or "pill bugs"

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- Millipedes and Centipedes
  - Many similar segments (resemble annelids)
  - Jointed legs
  - Millipedes eat decaying plant matter; centipedes are carnivores (poisonous)
  - Millipedes = two pairs of legs on most body segments; body round in cross-section
  - Centipedes = one pair of legs on most body segments; body flattened
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- Insects
  - More species of insects than all other species combined
  - 3 pairs of legs
  - 3-part body: head, thorax, and abdomen
  - Other appendages for eating and flying
  - Many insects undergo a metamorphosis
    - e.g. butterflies
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- Phylum Echinodermata
  - Sea urchins, sand dollars and star fish
  - All marine
  - Larvae are bilaterally symmetrical, but when transform into adults, take on radial symmetry

- Most have an endoskeleton
- Water-vascular system, used for gas exchange, waste disposal, and for movement
  - "tube feet"

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- Phylum Chordata
  - Includes the subphylum vertebrata
    - Animals with backbones
  - All Chordates share 4 traits
    - Dorsal hollow nerve cord
    - Notochord
    - Pharyngeal gill slits
    - Post-anal tail

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But we're vertebrates, and we don't have gill slits or tails…

Or do we???

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During embryonic development, we have all of the characteristics of the Phylum Chordata, including post-anal tails and gill slits

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- We'll begin here next time…

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- Phylum Chordata includes the vertebrates, but not all chordates are vertebrates
  - A vertebrate is an animal with a backbone
- Invertebrate chordates include the tunicates and lancelets
  - Tunicates = "sea squirts"
  - Lancelets = small, blade-shaped marine animals

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- Subphylum Vertebrata
  1. Fishes
  - Evolutionarily, the first vertebrates
  - Jawless fishes were the earliest
    - Example: lampreys and hagfishes
      - Note that hagfishes = fishes with a cranium but not a true backbone – however,

they are considered vertebrates due to the cranium;
– Lampreys and hagfishes are jawless fishes

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• And then there came the evolution of….
JAWS!

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• Class Chondrichthyes : the cartilaginous fishes
  – The first fish with jaws
  – No true bone – skeleton of cartilage
  – Includes the sharks and rays
  – Have a lateral line system, which they use to detect movement in the water (helps them locate prey, since their vision is poor)
  – Must move constantly to circulate water over gills and breathe

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• Class Osteichthyes: Bony Fishes
  – More species than in any other Class of vertebrates
  – Tuna, trout, goldfish, etc.
  – Skeleton reinforced by calcium salts = bone
  – Also have lateral line system
  – Keen vision and smell
  – Have an operculum on either side of head to protect gills
    • Can move operculum to circulate water through gills
    • Allows them to breathe when not in motion

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• Class Amphibia
  – Evolved from lobe-finned bony fishes
  – Developed arms and legs
  – Developed lungs for air-breathing
  – Also depend on their moist skin for gas exchange
  – Ectothermic (cold-blooded)
  – Eggs lack shells and usually must be laid in water
    • Undergo metamorphosis, from an aquatic larval form to a terrestrial adult form

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- Amphibians were first vertebrates to colonize land
- Have four legs = "tetrapod"
- All subsequent animals evolving from amphibian ancestor are also tetrapods
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- Class Reptilomorpha – the reptiles and birds
  - First to evolve an amniotic egg
    - Fluid-filled egg with a waterproof shell
    - Allows these animals to reproduce on land (unlike amphibians, which must deposit their eggs in aquatic – or at least wet – environments)
    - Note that mammals are also classified as amniotes, even though most no longer lay eggs
  -
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- Reptiles (Class Reptilia)
  - Snakes, lizards, turtles, alligators, and crocodiles
  - Waterproof scales allow them to conserve water better than amphibians
  - Hard-shelled, water-containing eggs (amniotic eggs) can be laid on land (won't dry out)
  - These characteristics allowed reptiles to exploit terrestrial habitats better than amphibians
  - Cold-blooded
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- Birds (Class Reptilia)
  - Evolved from reptilian ancestor
    - Small, two-legged dinosaurs called theropods
  - Scales evolved into feathers
  - Evolved endothermy – fairly constant body temperature maintained by metabolism
  - Hard-shelled eggs
  - No teeth, so have a gizzard for grinding food (located near stomach)
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- Flight
  - Bones of birds are honeycombed, making them light yet strong, an adaptation for flight
  - Frigate birds are large seagoing species
    - Wingspan of over 6 ½ feet
    - Skeleton only weighs 4 ounces!
  - Other ways birds reduce weight: eliminating some internal organs
    - For example, female birds have only one ovary
    - Lack of teeth also reduces weight

- Wings with feathers act as airfoil
  - Feathers likely first evolved as insulation
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- Class Mammalia
  - The mammals
  - Also evolved from reptiles
  - First mammals were small, mouse-sized, and nocturnal
  - Diversified after downfall of dinosaurs
  - Hair derived from scales
  - Evolved endothermy separately from birds
  - Earliest mammals were egg-layers
  - Today, only 3 species of egg-laying mammals (monotremes)
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- Most mammals are born (have lost the "egg" over time)
- Marsupial mammals have a brief gestation period; tiny baby is born, attaches to mother's nipple and is protected in a pouch
  - Example: kangaroo and koala
  - Nearly all marsupials live in Australia, New Zealand, and South America
  - North American marsupial = opossums
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- Placental Mammals
  - Have longer gestation period and more elaborate placenta
  - Don't have a "pouch"
  - Examples: dogs, cats, cows, rodents, bats, whales, and primates (including humans)
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- Evolution of Humankind
  - We share a common ancestor with the chimpanzees about 7 million years ago
    - Note that this does not mean we "evolved from chimps"
    - Rather, chimpanzees are more like our phylogenetic "cousins"
    - We are related to chimpanzees through common descent
  - Bipedalism (walking upright on two legs) was an important adaptation of our ancestors
    - The fossil named "Lucy" (of the species *Australopithecus afarensis*) was an important insight into the importance of bipedalism in our early evolution
    - Lucy had small brain, but walked upright
    - This fossil hominin dates back 3.24 million years
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- Enlargement of the human brain is first evident in fossil hominins dating back 2.4 million years ago
- After first standing up, then evolving larger brains, human ancestors began making tools
- *Homo habilis* remains have been found with their handmade tools
- Why did we evolve larger brains? A number of different hypotheses:
  - For building tools
  - For hunting or gathering food
  - For attracting mates

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- First human species to extend beyond Africa was *Homo erectus*
- *Homo erectus* fossils dating 1.8 million years old have been found in former Soviet republic of Georgia
- This species had larger brain than *Homo habilis* and was also taller
- Lived in huts or caves, built fires, made clothes from animal skin, and made stone tools
- Eventually spread through Europe and Asia
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- A descendant of *Homo erectus* was *Homo neadnerthalensis* (the "Neanderthals")
- Also had large brains and made diversity of stone and wood tools
- Lived in Europe as far back as 350,000 years ago, but went extinct 28,000 years ago
- Are modern humans related to Neanderthals?
  - DNA evidence suggests our last common ancestor with Neanderthals lived about 500,000 years ago
  - However, early *Homo sapiens* co-existed with Neanderthals and may have inter-bred with them
  - Video: http://www.youtube.com/watch?feature=endscreen&v=HpQiBPdFtog&NR=1
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- Oldest *Homo sapiens* fossils were discovered in Ethiopia and date from 160,000 to 195,000 years old
- These humans lacked the heavy browridge of the Neanderthals and had a more slender skeleton
- A uniquely human trait is that, although primate brains in general continue to grow after birth, human brains continue to grow for a longer period than any other primate
- We have an extended period of parental care, which allows our offspring to learn from earlier generations
  - The basis of culture – the social transmission of knowledge, customs, beliefs, and art over generations
  - Although not restricted to humans, it is particularly well developed in our species

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- Break, then movie…