

Animal Phylogeny, Acoelomates, and Protostomes

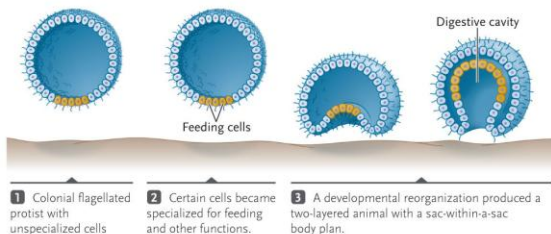
Chapter 29

What is an Animal?

- Multicellular eukaryotes
- Lack cell walls
- **Heterotrophs** – acquire food and nutrients by eating other organisms
- Motile at some time in their lives
 - Some animals **sessile** as adults
- Reproduce asexually or sexually

Animal Origins

- Colonial flagellated ancestor
 - Developed during Precambrian era 700 mya



Tissues

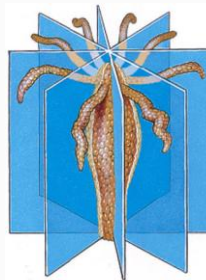
- **PRESENCE OR ABSENCE OF TISSUES**
- **Parazoa** (*para* = alongside; *zoon* = animal)
 - Sponges lack tissues
- **Eumetazoa** (*eu* = true; *meta* = later)
 - All other animals have tissues
 - Organized into either two or three tissue layers.

Primary Cell Layers in Embryos

- In eumetazoans, embryonic tissues form as either two or three primary cell layers
- **Endoderm**
 - Innermost layer
 - Forms lining of gut
- **Ectoderm**
 - Outermost layer
 - Forms external covering and nervous system
- **Mesoderm**
 - Between other layers
 - Forms muscles of body wall and most other structures between gut and external covering

Radial Symmetry (Radiata)

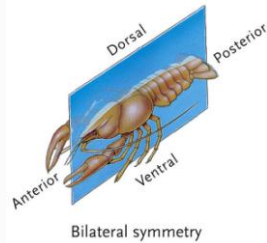
- Body parts arranged around central axis
 - The **Radiata**
 - Cnidaria (hydras, jellyfish, and sea anemones) and Ctenophora (comb jellies)



Radial symmetry

Bilateral Symmetry (Bilateria)

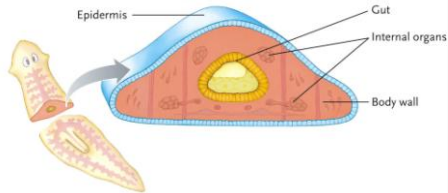
- Mirror image along midline
 - All other eumetazoan phyla
- Leads to development of head where sensory organs and nervous tissue are concentrated (**cephalization**)



Body Plans

- **Acoelomate** (*a* = not; *kóilos* = hollow)
 - No body cavity
 - *Example*: flatworms (Phylum Platyhelminthes)

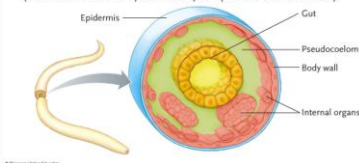
a. In acoelomate animals, no body cavity separates the gut and body wall.



Body Plans

- **Pseudocoelomate** (*pseudo* = false)
 - **Pseudocoelom**: Fluid-filled or organ-filled space between endoderm and mesoderm
 - *Example*: roundworms (phylum Nematoda)

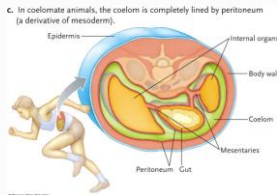
b. In pseudocoelomate animals, the pseudocoelom forms between the gut (a derivative of endoderm) and the body wall (a derivative of mesoderm).



Body Plans

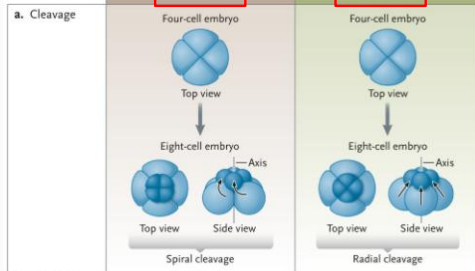
Coelomate

- True **coelom**, body cavity entirely lined by peritoneum derived from mesoderm
- Mesenteries surround inner organs



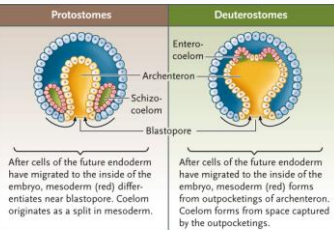
Cleavage in Embryos

- Bilaterally symmetrical animals are divided into two lineages:



Coelom Formation in Embryos

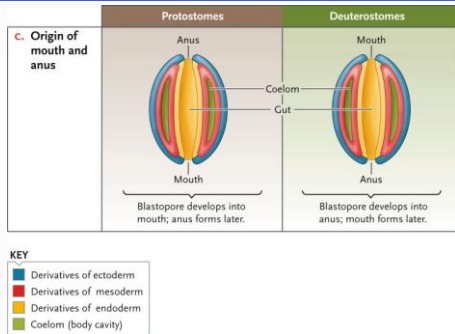
Mesoderm and coelom formation



KEY

- Derivatives of ectoderm
- Derivatives of mesoderm
- Derivatives of endoderm
- Coelom (body cavity)

Origin of Mouth and Anus in Embryos



Segmentation

- In earthworms, each segment may include complete set of important organs and muscles
 - May help survive damage
 - Improves control of locomotion, especially in worm-like organisms
- Evidence of segmentation in vertebrates
 - Vertebral column, ribs, muscles in abdomen
 - Allows greater flexibility of movement

Confirmations by Molecular Phylogeny

- **Parazoa**: Sponges
- **Eumetazoa**: All other lineages
 - **Radiata**: Two tissue layers, radial symmetry
 - **Bilateria**: Three tissue layers, bilateral symmetry

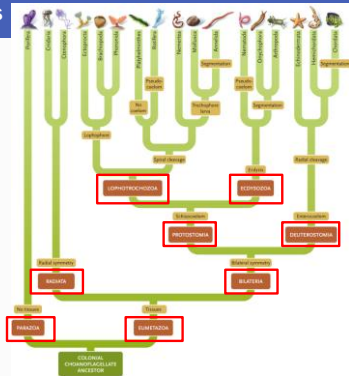
Bilateria (Bilaterally symmetrical animals)

▪ Protostomia

- **Lophotrochozoa** (*lophos* = crest; *trochos* = wheel)
 - Lophophore feeding structure in 3 phyla
 - Trochophore type of larva in annelids and mollusks
- **Ecdysozoa** (*ekdysis* = escape)
 - Cuticle or external skeleton secreted and periodically molted (ecdysis)

▪ Deuterostomia

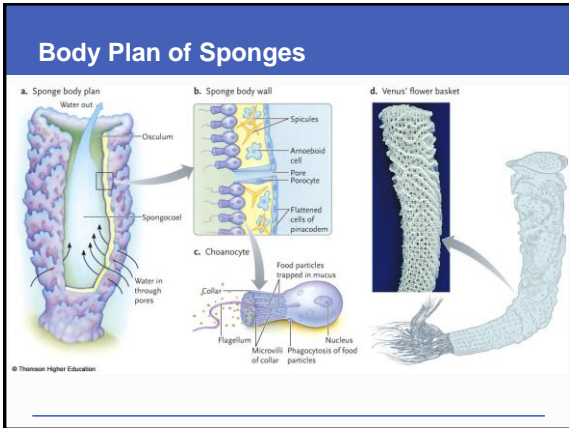
Molecular Phylogeny of Animals



Phylum Porifera: Sponges

- No tissue layers (lack true tissues); asymmetrical; sessile; limited integration of cells
- Abundant since the Cambrian
- Mostly marine; a few freshwater species
- ~ 8000 living species
- Very simple body plans
- System for filtering food particles from the water





Phylum Cnidaria and Phylum Ctenophora

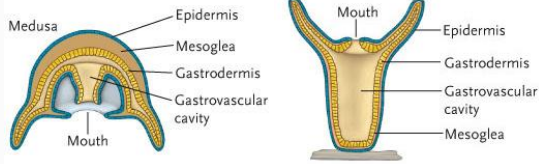
- **Eumetazoans** = true tissues
 - Two well-developed tissue layers
 - Inner **gastrodermis**
 - Outer **epidermis**
 - Gelatinous **mesoglea** between layers
 - **Radial symmetry**
 - **Diploblastic development** = endoderm and ectoderm (no mesoderm – middle layer)
 - No organs or organ systems; no coelom
 - All aquatic

Cnidarians

- 8900 species, mostly marine, some freshwater
- Simplest animals that exhibit a division of labor among specialized tissues
- Capture prey with tentacles and stinging **nematocysts**
- **Gastrovascular cavity**
- Mouth ringed with tentacles
- Life cycle includes **polyps**, **medusae**, or both

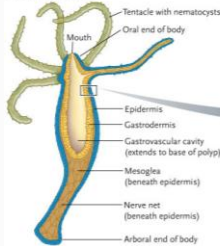
Cnidarian Body Plans

a. Cnidarian body plans

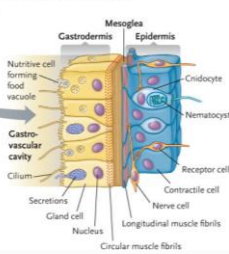


Cnidarian Body Plans

b. Cnidarian polyp



c. Body wall cells and tissues

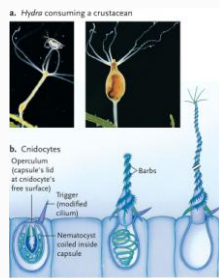


- **Gastrodermis** – gland cells and phagocytic cells
- **Epidermis** – nerve cells, sensory cells, contractile cells and cell specialized for prey capture

Cnidarian Predation

- **Cnidocytes** contain stinging **nematocysts**

- Depending on the species, Cnidarians may prey on crustaceans, fishes, and other animals



- Life cycles of hydrozoans typically alternate between polyp and medusa stages
- See life cycle of Obelia to the right
- Exception: Hydra



- Jellyfish (or jellies) and cube jellies

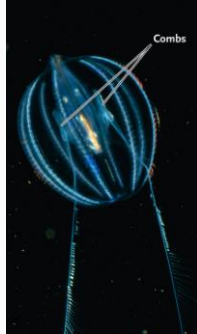


- Corals and sea anemones



Ctenophores

- Comb jellies, 100 species
 - Lack nematocysts, long tentacles capture particulate food, rows of cilia for locomotion



Lophophorate Phyla: Ectoprocta, Brachiopoda, Phoronida

- Use a **lophophore** to feed on particulate matter
 - U-shaped fold with ciliated tentacles surrounding mouth
- Coelomic cavity extends into lophophore
 - Food capture
 - Gas exchange
 - Waste elimination

Ectoprocta, Brachiopoda, and Phoronida

a. Ectoprocta (*Plumatella repens*)



b. Brachiopoda (*Terebraulina septentrionalis*)



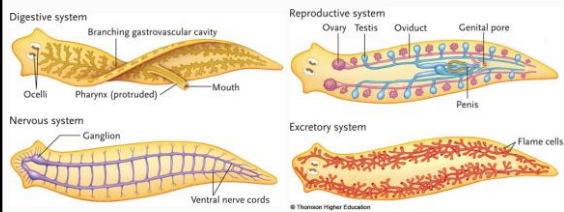
c. Phoronida (*Phoronopsis californica*)



Phylum Platyhelminthes: Flatworms

- Free-living or parasitic species, 13,000 species
- Aquatic and moist terrestrial habitats
- 1 mm to 20 m in length
- **Acoelomate**
- Three layered body plan
 - Endoderm: Digestive cavity with specialized cells
 - Mesoderm: Muscles and reproductive organs
 - Ectoderm: Ciliated epidermis, nervous system, and simple excretory system

Flatworm Anatomy



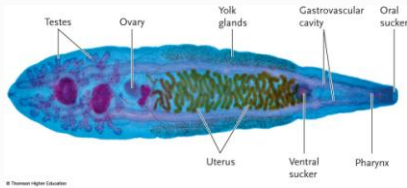
Platyhelminthes Lineages: Turbellaria

- Free-living flatworms
 - Muscular pharynx connects mouth to digestive cavity; hermaphroditic



Platyhelminthes Lineages: Trematoda and Monogeneoidea

- Parasitic flukes with suckers or hooks
 - Tough outer covering
 - Endoparasites (trematodes)
 - Ectoparasites (monogenes)



Platyhelminthes Lineages: Cestoda

- Tapeworms** within intestines of vertebrates
 - Absorb nutrients directly through body wall
 - Lost mouths and digestive systems through evolution
 - Scolex** hooks and suckers attach to intestine
 - Body is series of identical structures (proglottids) with male and female reproductive organs
 - Older proglottids carrying as many as 80,000 eggs break off in the hosts feces
 - Body of a tapeworm can be as long as 20 METERS!!!

Cestoda

a. Tapeworm



b. Scolex



Phylum Rotifera

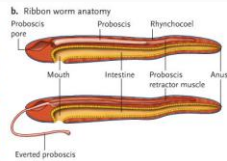
- Tiny freshwater pseudocoelomates, 1800 species
- Microscopic, but with well-developed digestive, reproductive, excretory and nervous systems
- Wheel-like **corona** around head containing cilia
- Toothed grinding organ (mastax)
- **Parthenogenesis**

Rotifer Body Plan



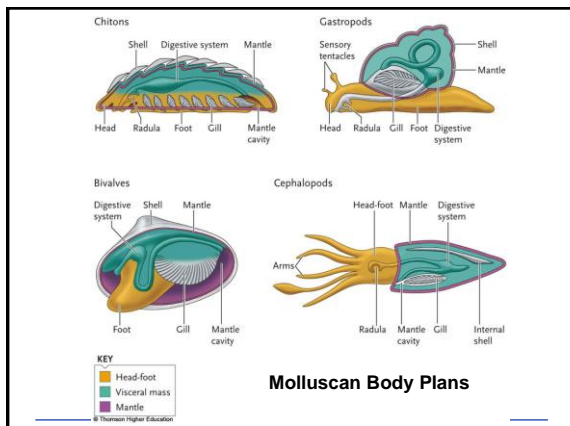
Phylum Nemertea: Ribbon Worms

- Mostly marine, 650 species
- Elongate, colorful ribbon shapes



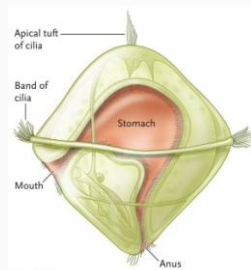
Phylum Mollusca: Mollusks

- 100,000 species, marine, some freshwater
- Eight lineages: Clams, snails, octopuses, etc.
 - Fleshy bodies often enclosed in hard shell
 - **Head-foot**
 - **Visceral mass**
 - **Mantle – one or two folds of the body wall that often enclose the visceral mass**
 - **Shell**
 - **Radula**
 - **Most mollusks have an open circulatory system (but not all!)**



Mollusk Reproduction

- Mostly separate sexes, some hermaphroditic
 - Internal or external fertilization
 - Zygotes of marine species often develop into free-swimming, ciliated **trochophore** larvae
 - Some trochophores develop into second larval stage (**veliger**)



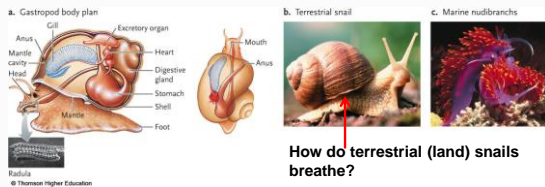
Mollusks: Polyplacophora

- Chitons, 600 species
 - Sedentary, grazing mollusks; oval, bilaterally symmetrical body; dorsal shell with eight plates



Mollusks: Gastropoda

- Snails and Slugs**, 40,000 species, largest group
 - Coiled or cone-shaped shell, aquatic or terrestrial



How do terrestrial (land) snails breathe?

- Feed on algae, vascular plants, or animal prey; some scavengers, and few parasites
- Most shelled snail undergo **torsion**

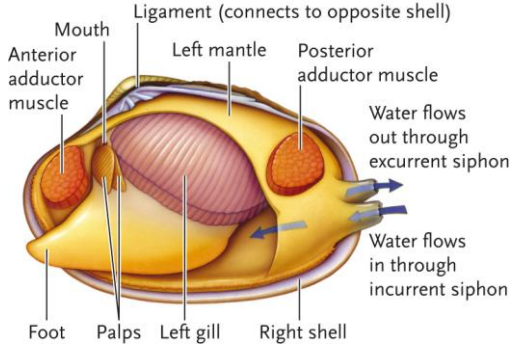
Mollusks: Bivalvia

- Bivalves, 8000 species - clams, oysters, scallops mussels; restricted to aquatic habitats
 - Hinged pair of shells, **adductor muscles**



- Adult mussels and oysters are sessile; some clams are mobile

A. Bivalve body plan



Mollusks: Cephalopoda

- 600 species; Octopuses, squids, nautilus
- Marine predators; most intelligent invertebrates

a. Squid



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b. Octopus



Eye

c. Chambered nautilus

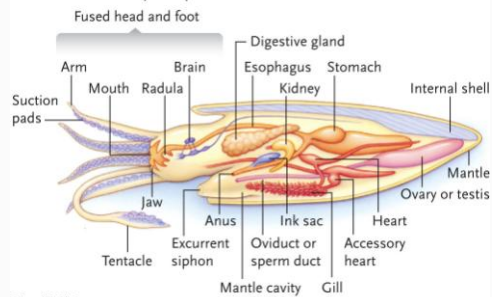


Eye

- Only mollusk group to have a **closed circulatory system**

Squid Anatomy

d. Internal anatomy of squid



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Phylum Annelida: Segmented Worms

- 15,000 species of segmented worms
- Marine, freshwater, and damp terrestrial habitats
- Bristleworms, oligochaete worms, and leeches
- Annelid body is segmented
- Segmentation of body wall muscles, respiratory surfaces, parts of the circulatory, excretory, and nervous systems, and the coelom itself
- **Septa** – transverse partitions that separate body segments
 - **Metanephridia** – excretory organs found in segments posterior to the head

Segmented Worms: Phylum Polychaeta

- Bristle Worms, 10,000 species
 - Polychaete = many bristles
 - Primarily marine; setae project from **parapodia**



Segmented Worms: Phylum Oligochaeta

- Oligochaetes (earthworms), 3500 species
 - Moist habitats; scavengers on decomposing organic matter



Segmented Worms: Phylum Hirudinea

- Leeches (freshwater parasites), 500 species
 - Mostly freshwater parasites
 - Flattened, tapered body with sucker at each end

Leech before feeding



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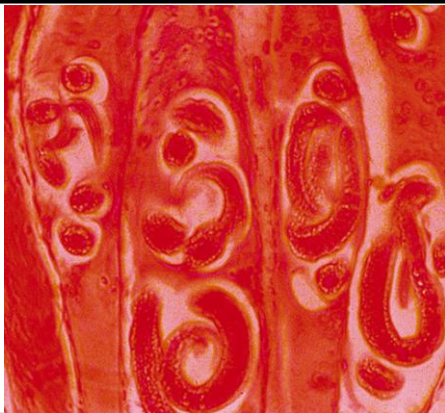
Leech after feeding



Ecdysozoa: Phylum Nematoda

- Roundworms, 80,000 species described
 - Possibly the most abundant animal on Earth
 - Occupy nearly every freshwater, marine and terrestrial habitat
 - Mostly microscopic; feed on decaying organic matter or parasitize plants or animals





Ecdysozoa: Phylum Onychophora

- Velvet Worms, 65 living species
 - Live under stones, logs, and forest litter in the tropics and in moist temperate habitats of the S. hemisphere
 - Flexible cuticle, segmented bodies, unjointed legs
 - Some bear live young, which develop in a uterus



Ecdysozoa: Phylum Arthropoda

- Arthropods, **1 million known species!!!!**
 - **Include more than half the animal species on Earth**
 - Insects, spiders, crustaceans, millipedes, centipedes, and extinct trilobites
 - Segmented bodies with specialized appendages for feeding, locomotion, or reproduction
- **Exoskeleton**
 - Chitin glued together with glycoproteins, waterproofed with lipids and waxes
 - Protection, support against gravity, helps prevent dehydration

Ecdysis in Insects

- Old exoskeleton shed
 - Soft, new exoskeleton allows for increase in size



Arthropoda: Subphylum Trilobita (extinct)

- Trilobites
 - Three-lobed bodies and undifferentiated appendages; abundant in Paleozoic seas



Arthropoda: Subphylum Chelicerata

- Chelicerates
 - Spiders, ticks, mites, scorpions, horseshoe crab

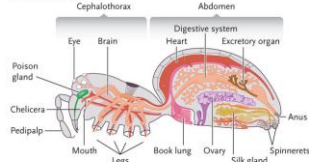


Subphylum Chelicerata: Subgroup Arachnida

a. Wolf spider



b. Spider anatomy



c. Scorpion



d. House dust mite



Arthropoda: Subphylum Crustacea

- Crustaceans, 35,000 species
 - Shrimps, lobsters, crabs and their relatives
 - Mostly marine and freshwater; **carapace** covers cephalothorax

a. Crab



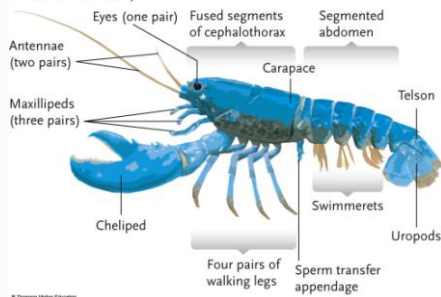
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b. Lobster



Decapod Crustaceans: Lobster Anatomy

c. Lobster anatomy



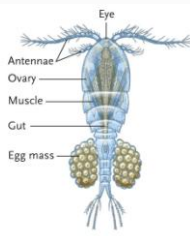
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Planktonic Crustaceans

- Fairy shrimps, amphipods, water fleas, krill, ostracods, **copepods**

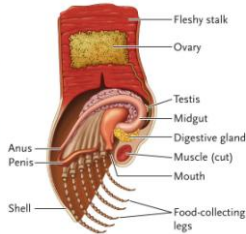


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Sessile Crustaceans

- Barnacles
 - Strong, cup-shaped shell



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Subphylum Myriapoda

- Myriapods (millipedes and centipedes)
 - Head and elongate, segmented trunk



Subphylum Hexapoda

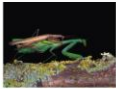
- Insects (30 different orders), 1 million or more species



A. Silverfish (*Thysanura*, *Lepisma saccharinum*) are primitive wingless insects.



B. Dragonflies, like the flame skimmer (*Zygoptera*, *Ephemera cyathula*), have aquatic larvae that are active predators; adults capture other insects in mid-air.



C. Male praying mantids (*Mantodea*, *Mantodea religiosa*) are often eaten by the larger females during or immediately after mating.



D. This rhinoceros beetle (*Coleoptera*, *Lucania cervus*) is one of more than 250,000 beetle species that have been described.



E. Fleas (*Siphonaptera*, *Hoplophaga laevis*) have strong legs with an elastic ligament that allows these parasites to jump on and off their animal hosts.



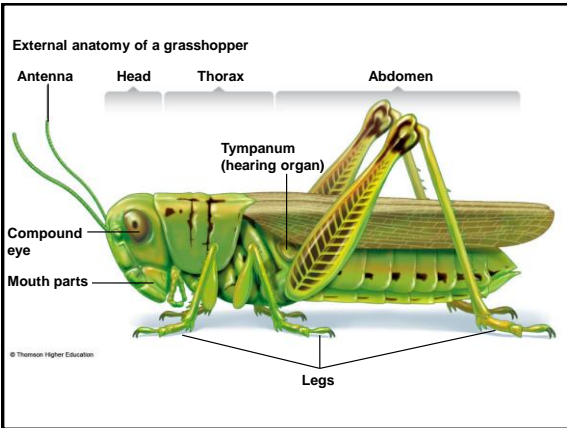
F. Clave flies (*Diptera*, *Tipula* species) look like giant mosquitoes, but their mouthparts are not useful for biting other animals; the adults of most species live only a few days and do not feed at all.

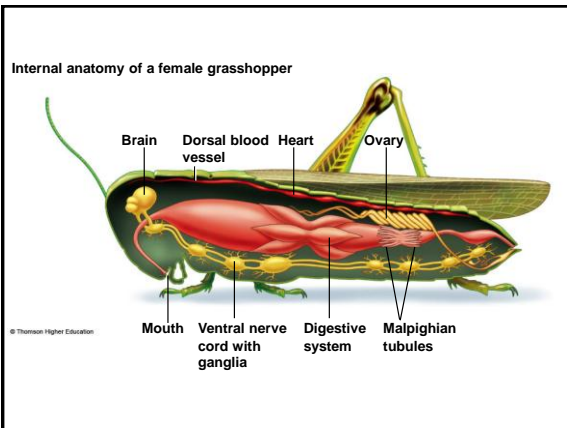


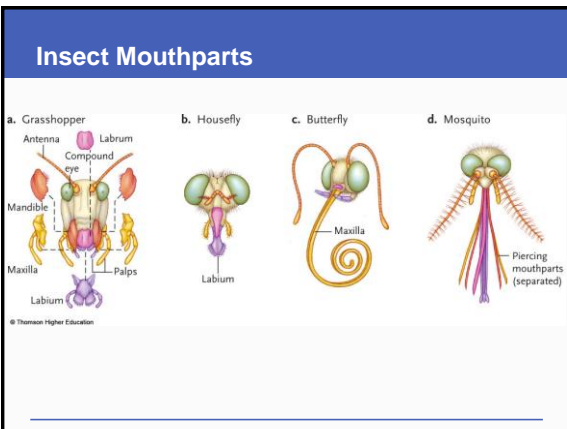
G. The luna moth (*Lepidoptera*, *Actias luna*), like other butterflies and moths, has wings that are covered with colorful microscopic scales.



H. Like many other ant species, fire ants (*Hymenoptera*, *Solenopsis invicta*) live in large cooperative colonies. Fire ants—named for their painful sting—were introduced into southeastern North America, where they are now serious pests.







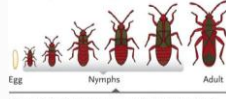
Insect Postembryonic Development

a. No metamorphosis



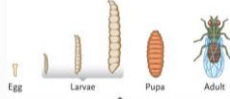
Some wingless insects, like silverfish (order Thysanura), do not undergo a dramatic change in form as they grow.

b. Incomplete metamorphosis



Other insects, such as true bugs (order Hemiptera), have incomplete metamorphosis; they develop from nymphs into adults with relatively minor changes in form.

c. Complete metamorphosis



Fruit flies (order Diptera) and many other insects have complete metamorphosis; they undergo a total reorganization of their internal and external anatomy when they pass through the pupal stage of the life cycle.

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