

Chapter 1: Phylum Arthropoda

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Similarities between Annelids and Arthropods

- Arthropods are metameric and their segments have appendages
- Nervous system with ventral nerve cords

Phylum Onychophora

Annelid-like

- Segmented; unjointed appendages; similarity in structure of the body wall; segmentally arranged nephridia; pigment

Arthropod-like

- Reduced coelom, open circulatory system, tracheal system; soft cuticle composed of chitin



Peripatus, a small, nocturnal form found among the leaf-litter of tropical forests of South America.

The fossil record indicates that onychophorans have not changed much in 500 million years.



The Onychophoran *Aysheaia* from the Cambrian.

A lobe-limbed, segmented animal. Also note the spines on the legs. The head end has a pair of tapering limbs with spines, and three small projections near the mouth. Traces of the digestive tract can also be seen

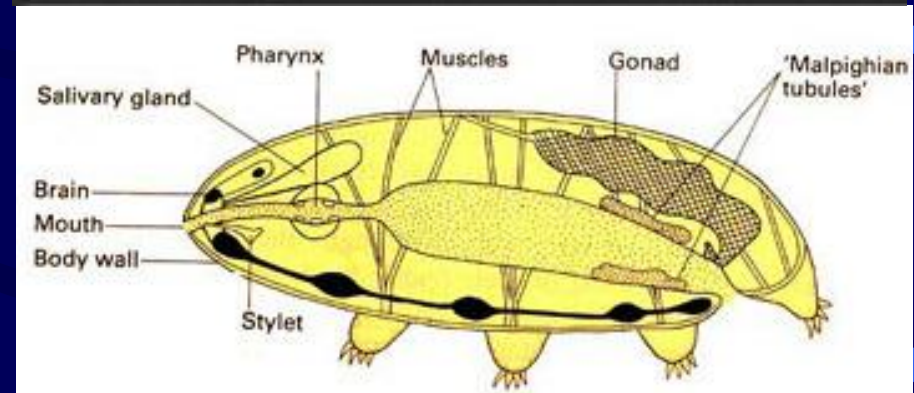
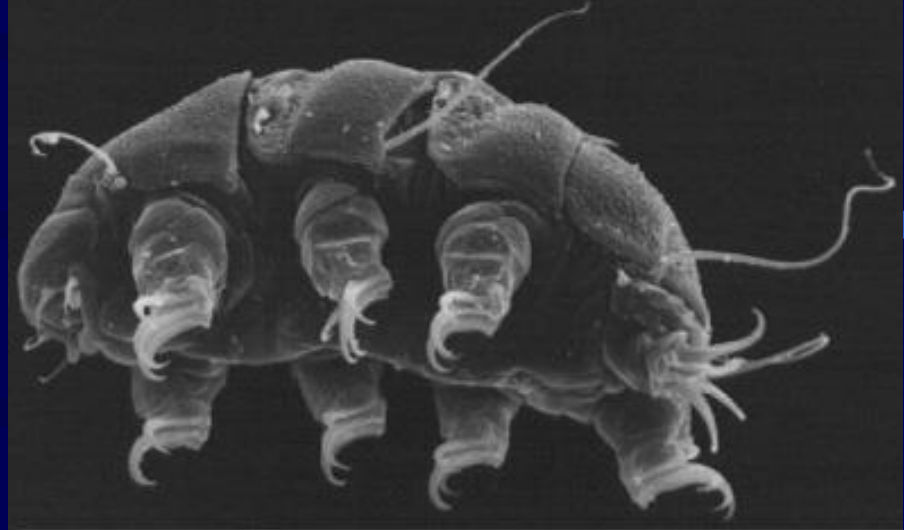
Phylum Tardigrada or “water bears” also have features in common with both annelids and arthropods

Annelid-like

- Unjointed (8) legs; annelid-type nervous system

Arthropod-like

- Presence of a cuticle (nonchitinous) that is periodically molted; similar attachment of muscle fibers to exoskeleton



- One of the most interesting features of tardigrads is their ability to undergo **cryptobiosis**. **Cryptobiosis** is an ametabolic state of life entered by an organism in response to adverse environmental conditions such as desiccation (extreme dry), freezing, and oxygen deficiency. In the **cryptobiotic** state, all metabolic processes stop, preventing reproduction, development, and repair.

Phylum Arthropoda

- Entomology deals with Phylum Arthropoda
- The Arthropoda (from the Greek Arthron, joint and podus, foot) are the largest group of organisms and they occur in all environments on earth.
- The group includes: spiders, ticks, mites, centipedes, millipedes, crustaceans, insects and others.

Reasons for success

1. Versatile exoskeleton
2. Efficient locomotion
3. Air piped directly to cells (terrestrial)
4. Highly developed sensory organs
5. Complex behavior
6. Metamorphosis



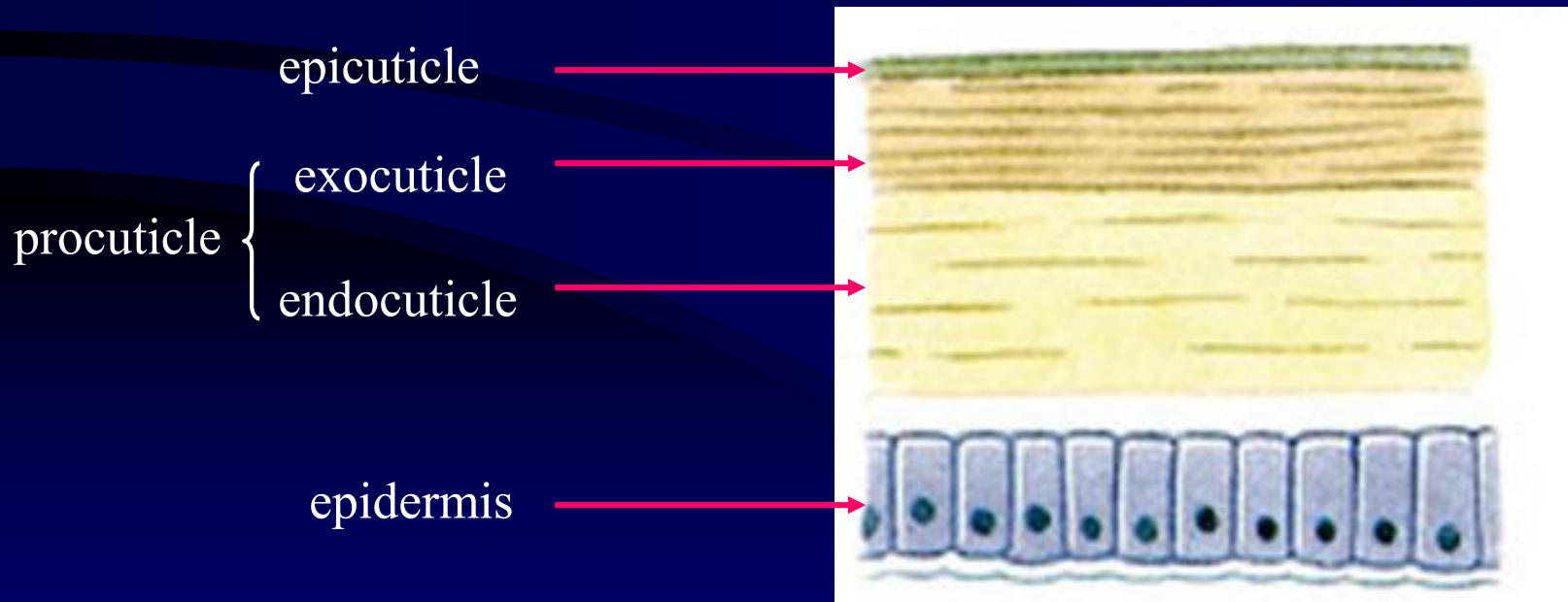
1-The Arthropod Exoskeleton

- Epidermis secretes an external skeleton called the **exoskeleton**
- Advantages of possessing an exoskeleton:
 - provides strong support
 - provides rigid levers that muscles can attach to and pull against
 - offers protection
 - serves as a barrier to prevent internal tissues from drying out; important because many arthropods live on land
 - serves as a barrier to prevent infection



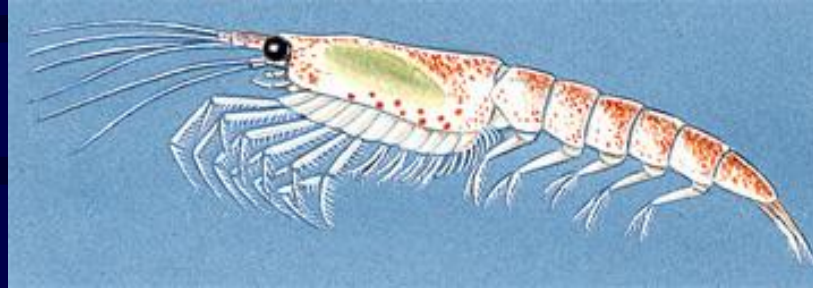
Structure of the Exoskeleton

- Composed of the polysaccharide *chitin* and protein - glycoprotein
- Outer surface called the **epicuticle**; contains waxes
- The thicker portion is called the **procuticle**:
 - **exocuticle**
 - **endocuticle**
- In the exocuticle, the glycoprotein chains are cross linked; process is called **tanning**

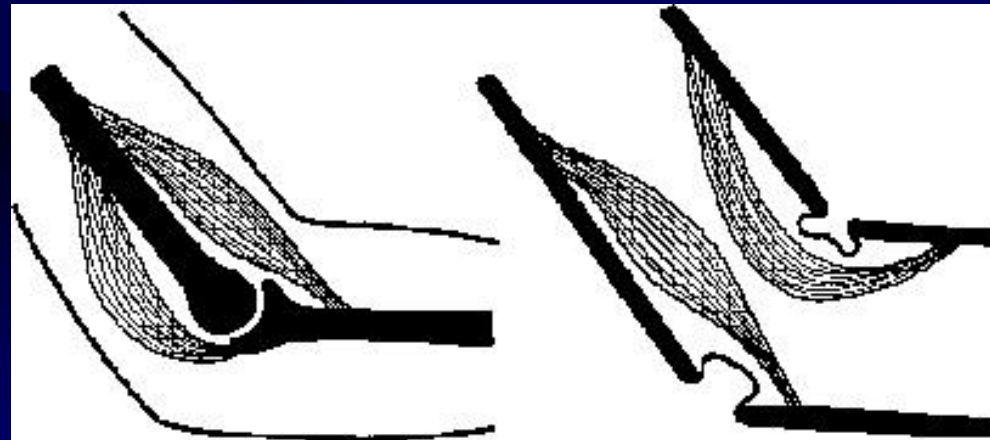


2. Efficient locomotion: Jointed Appendages

- Exoskeleton divided into a number of plates and cylinders



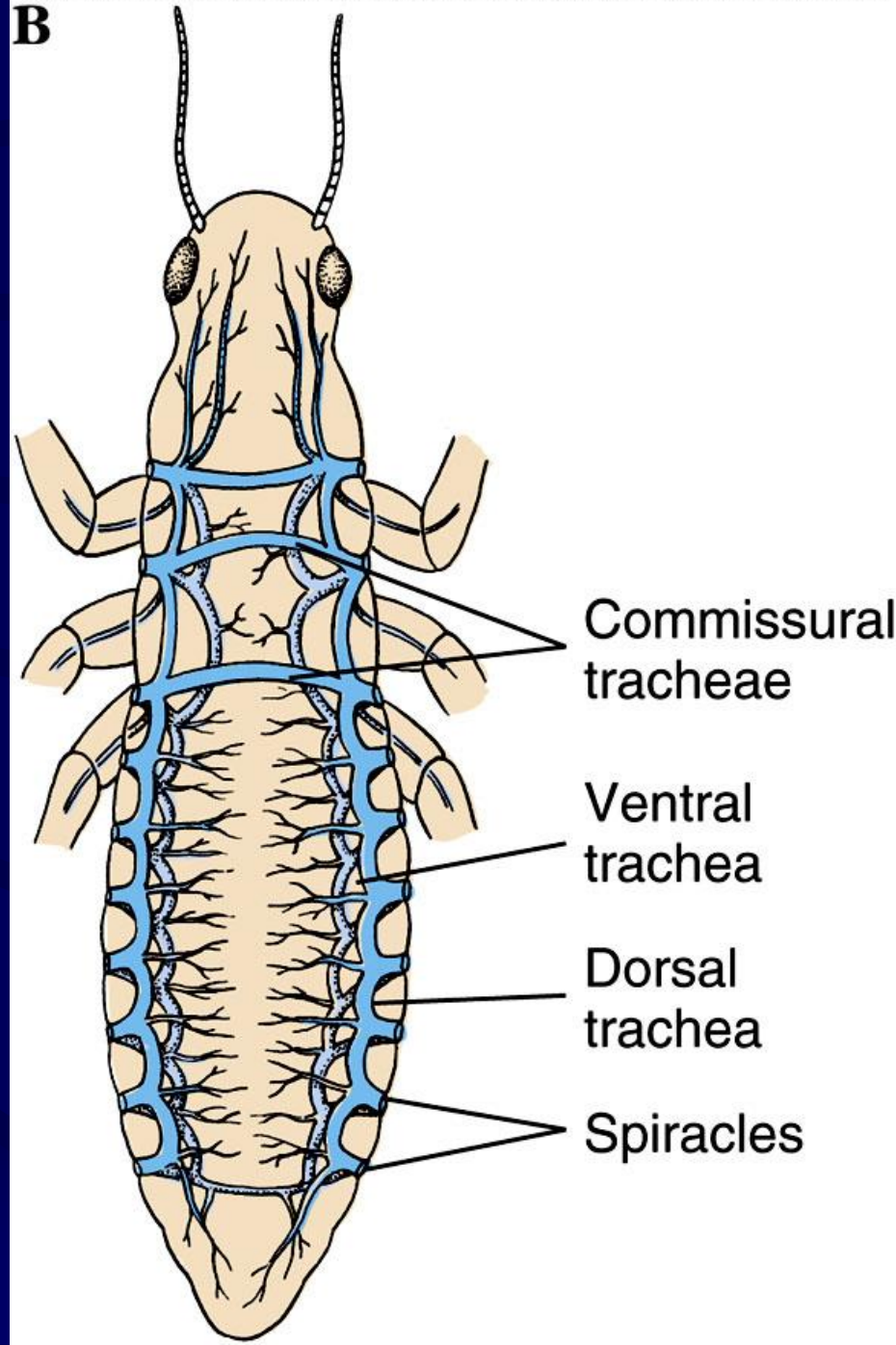
- At the junction point between plates and cylinders, the exoskeleton remains thin and flexible; these are the *joints*
- Jointed appendages allows arthropods to move efficiently and quickly
- Muscles are integral to arthropod movement; they attach to the inner side of the exoskeleton; they often function as a lever system



Vertebrate joint

Arthropod joint

B

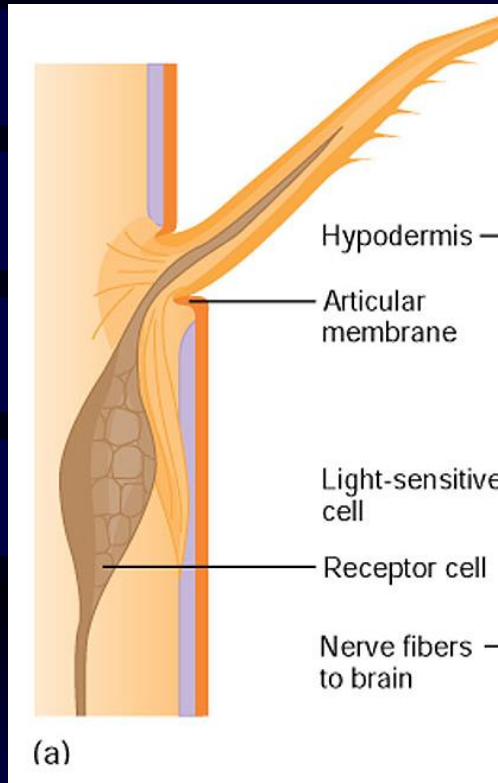


3. Air piped directly to cells

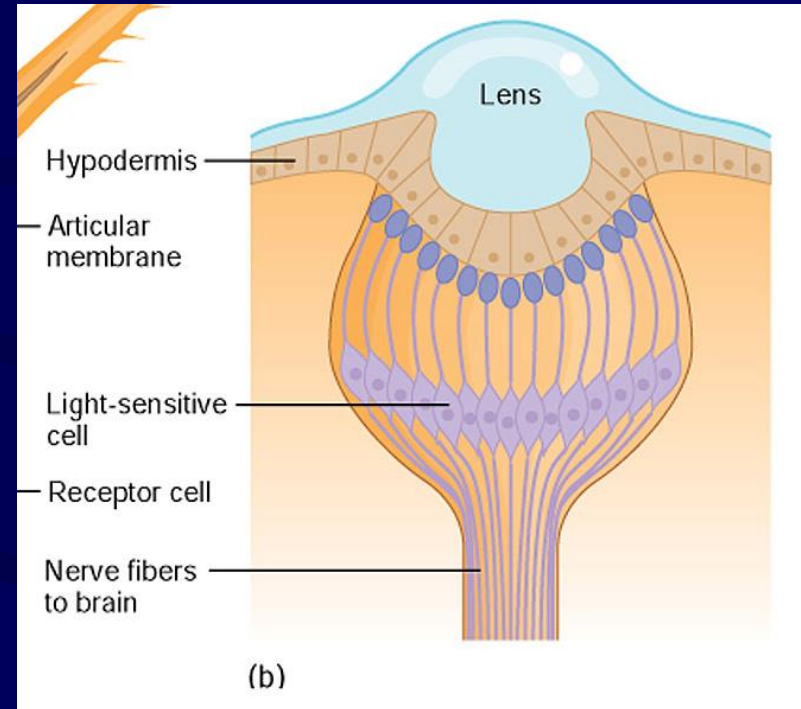
- More efficient than most other invertebrates
- Most have efficient tracheal system of air tubes; some breathe by gills
- Limits size

4. Highly developed sense organs

- Sight, touch, smell, hearing, balance, chemical reception



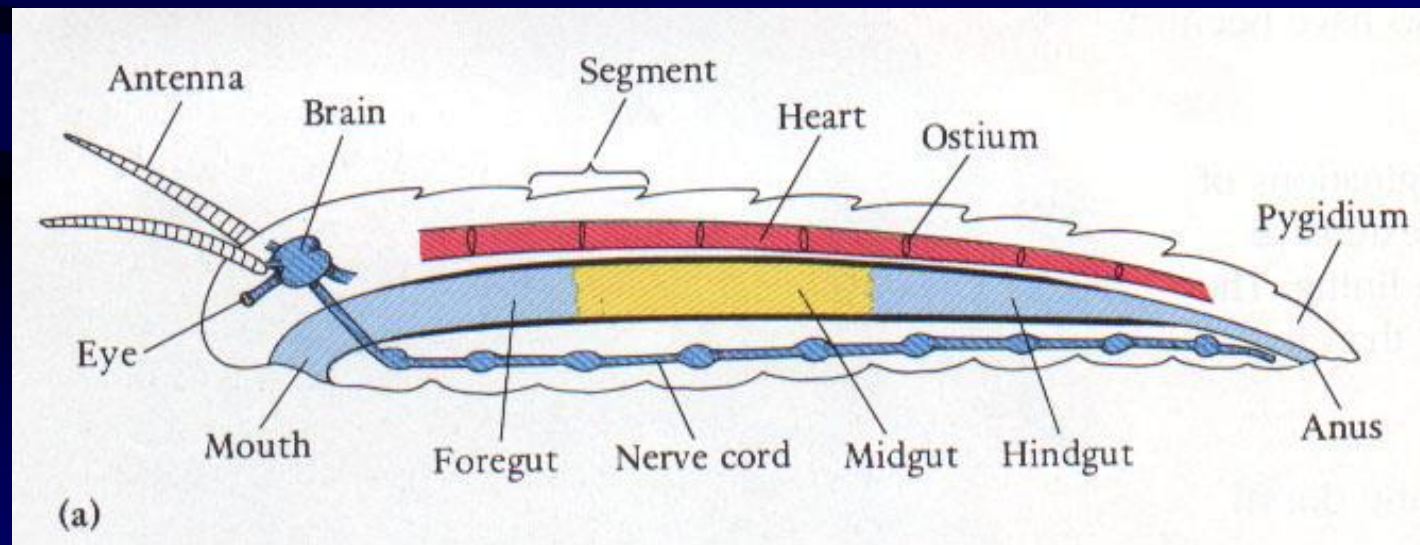
Displacement of seta irritates a nerve impulse in a receptor cell at its base



Eyes convert light energy into nerve impulses

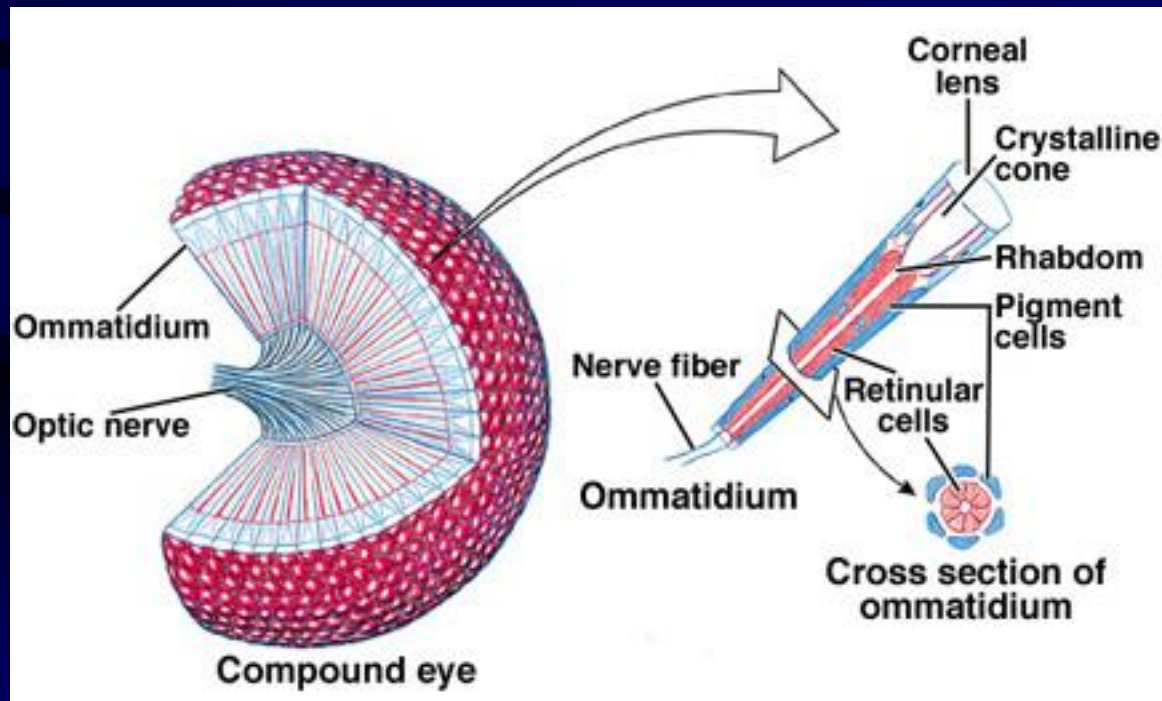
Acute Senses

- Arthropods have a well-developed nervous system that is of the same overall design as the annelids; anterior brain and a double, ventral hollow nerve cord.
- The sensory receptors of arthropods are usually associated with modifications of the chitinous exoskeleton
- The head usually bears various kinds of sense organs (e.g. **antennae**) with extreme sensitivity



Acute Senses cont.

- Many arthropods have **compound eyes** - eyes that are composed of many visual units called **facets (ommatidia)**; capable of color vision and detecting the slightest movements of prey or predators
- Some eyes are simple eyes with only a few photoreceptors; however, they are capable of forming crude images



5. Complex behavior patterns

- Complex, organized activities
- May be innate (unlearned) or learned



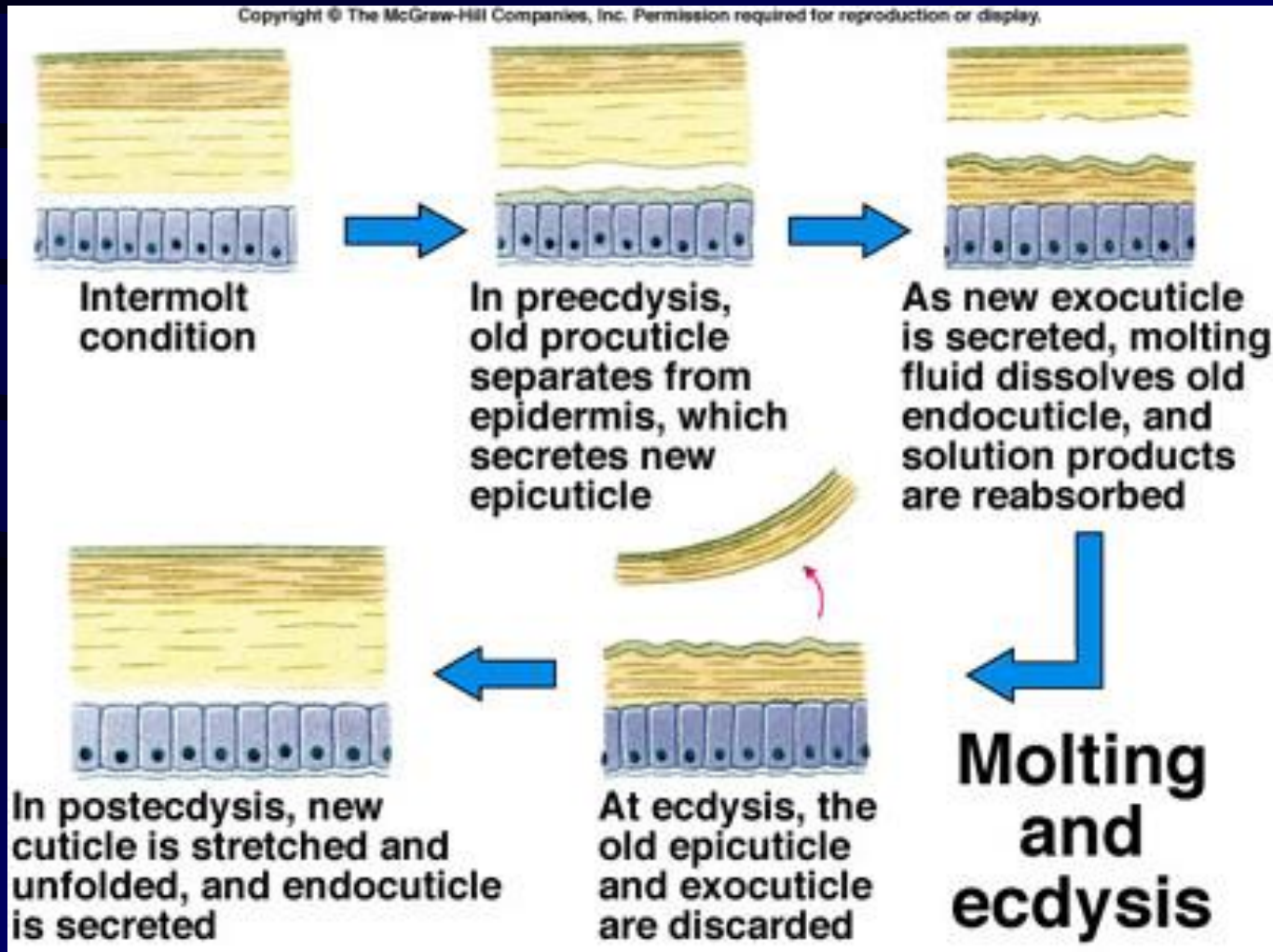
6. Limited intraspecific competition

- Many arthropods undergo metamorphosis
 - meta= between/after; morphē= form; osis= state of
- Different stages (ie. larva, adult) have different nutrition/habitats
 - ∴ no competition



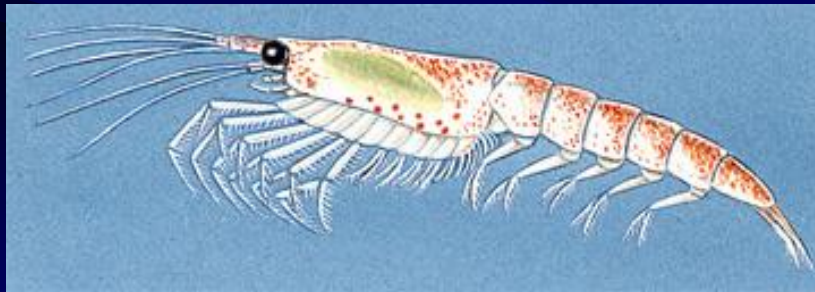
Molting

- In order to grow the arthropod must shed its exoskeleton, and secrete a new and larger one - **molting** or **ecdysis**.



Specialized Arthropod Segments: Reduction in Metamerism

- The evolution of the arthropods witnessed a reduction in metamerism
- The arthropods evolved modified groups of segments (e.g., segments became lost, some fused together)
- The fusion of groups of segments into functional groups is called **tagmatization**
- In so doing, various appendages on segments became specialized for functions other than locomotion, e.g. prey capture, filter feeding, sensing various kinds of stimuli, gas exchange, copulation, etc.



Characteristics of the Arthropoda

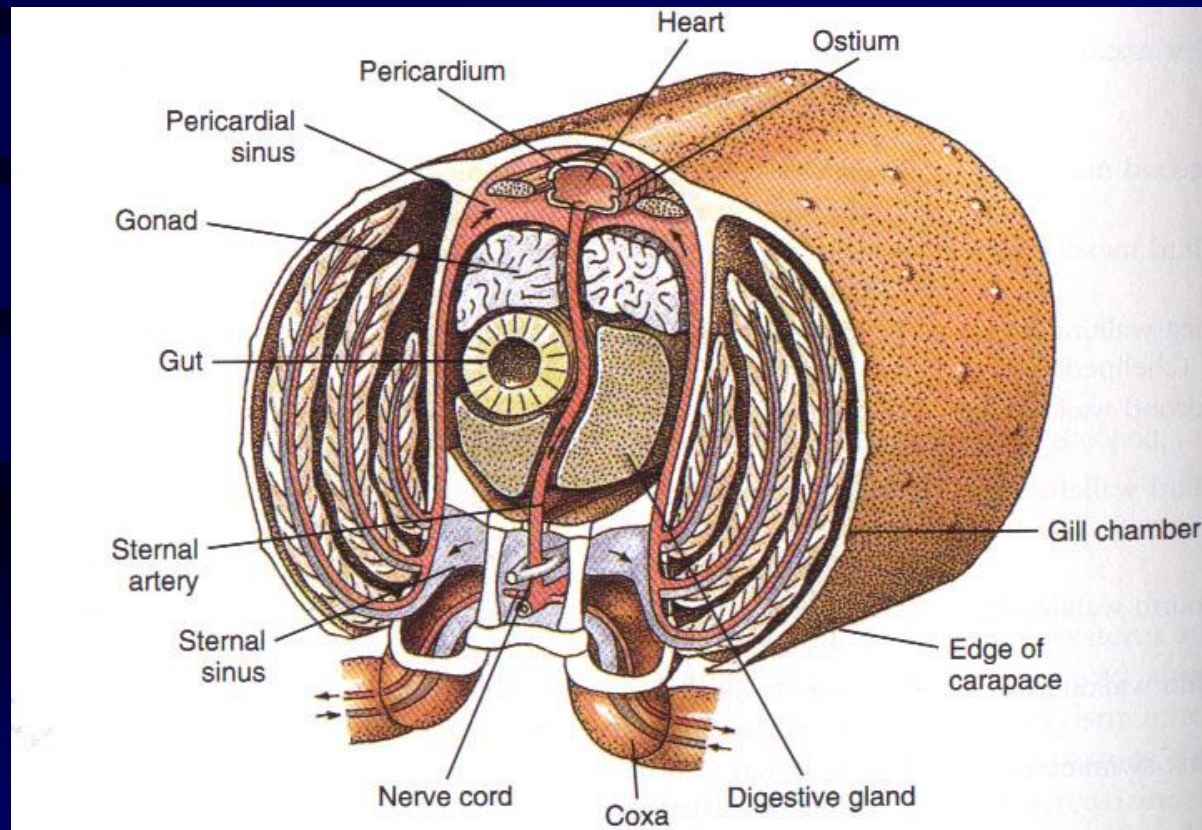
- Respiration occurs in multiple possible ways
 - across the body surface
 - via a system of tracheal tubes (e.g. beetle)
 - Gills (e.g. crabs)
 - book lungs (spiders)

Arthropod Respiratory Advances

- Special respiratory structures allow the arthropods to metabolize more efficiently and thus move rapidly
- High metabolic rates require rapid oxygen delivery, and arthropods can accomplish this with respiratory organs that have a large surface area for collecting oxygen quickly

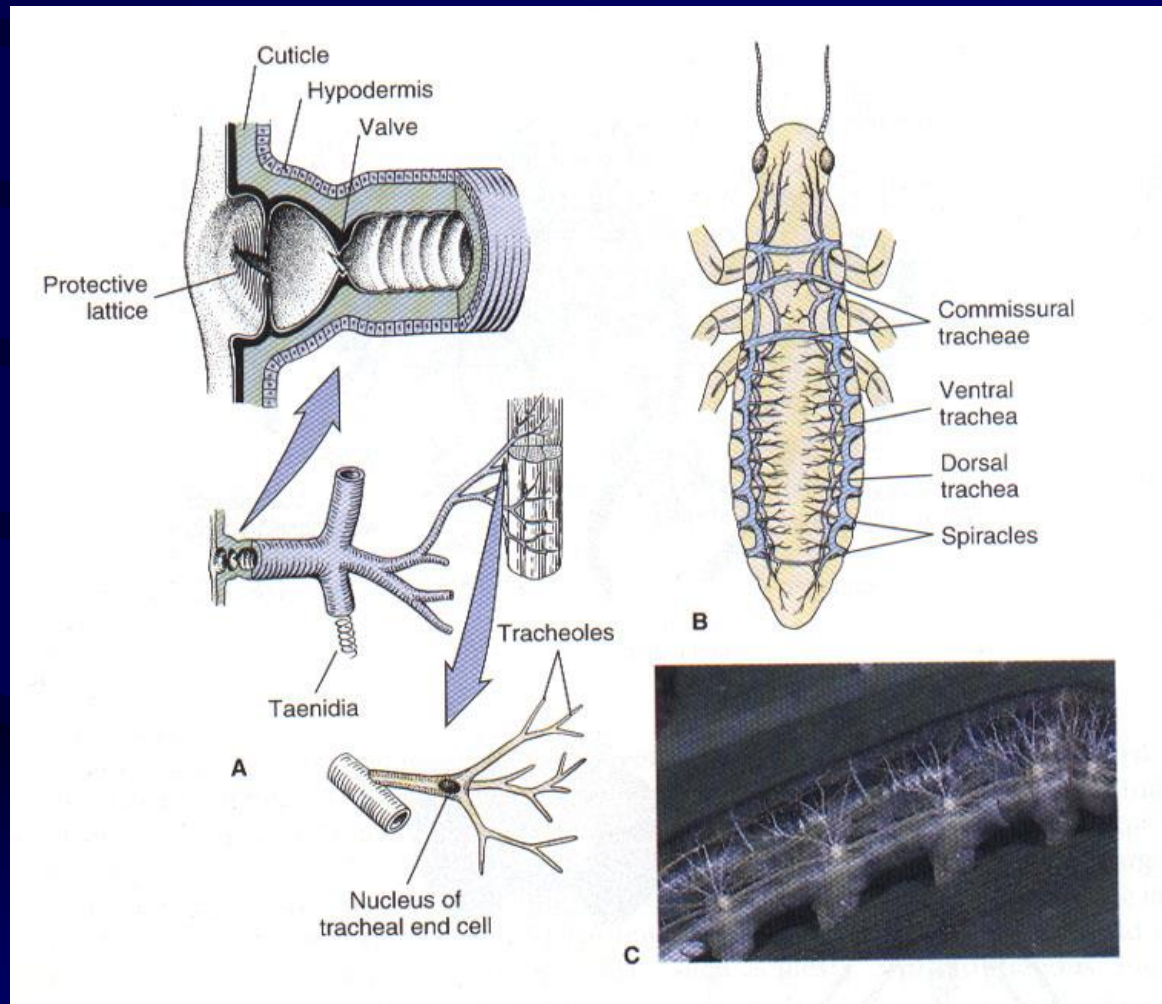
Gills

- Many aquatic arthropods (crabs and lobsters) have **gills**, which are typically modifications of appendages or outgrowths of the body wall - folds of tissue with a large surface area



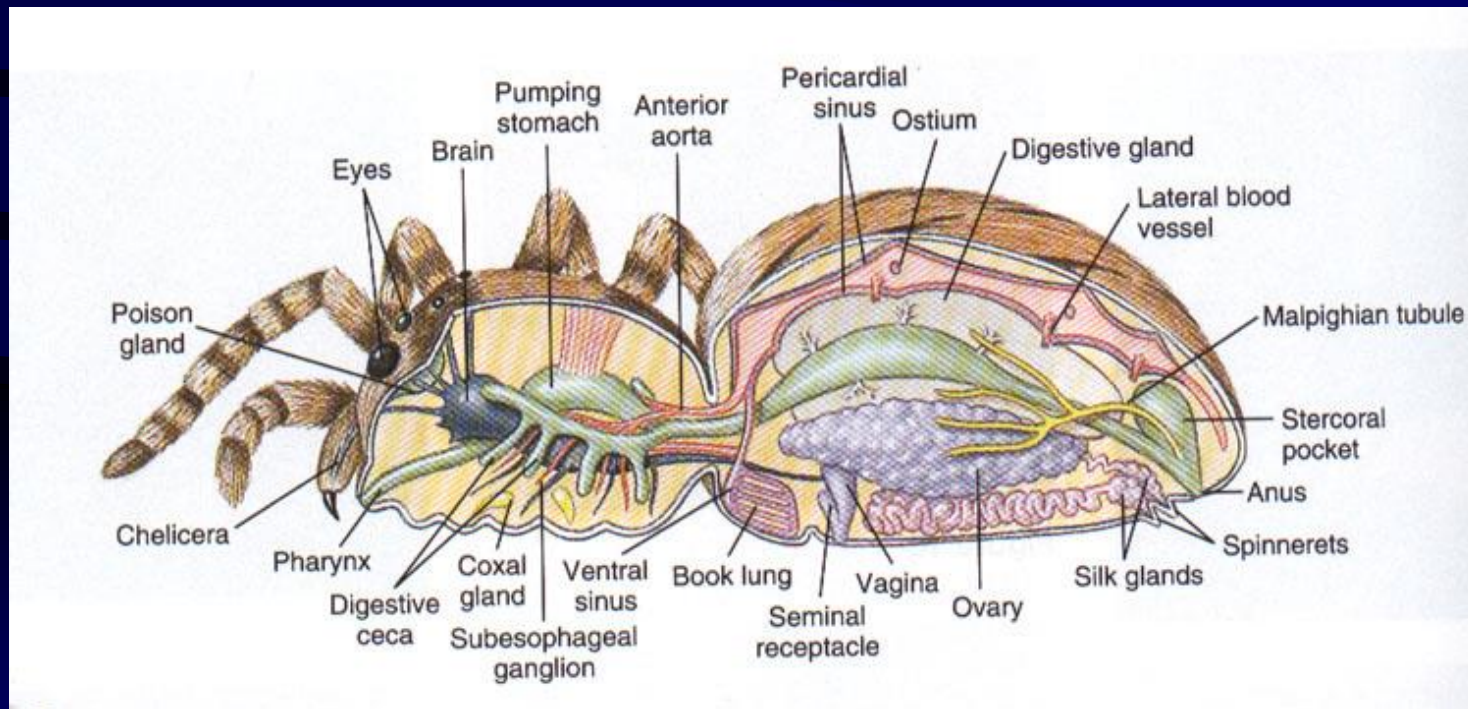
Tracheae

- Gas exchange organs among terrestrial arthropods is usually internal; invaginations of the integument
- Insects have **tracheae**, branching networks of hollow air conducting tubes such that air is sent to every cell in every tissue



Book Lungs

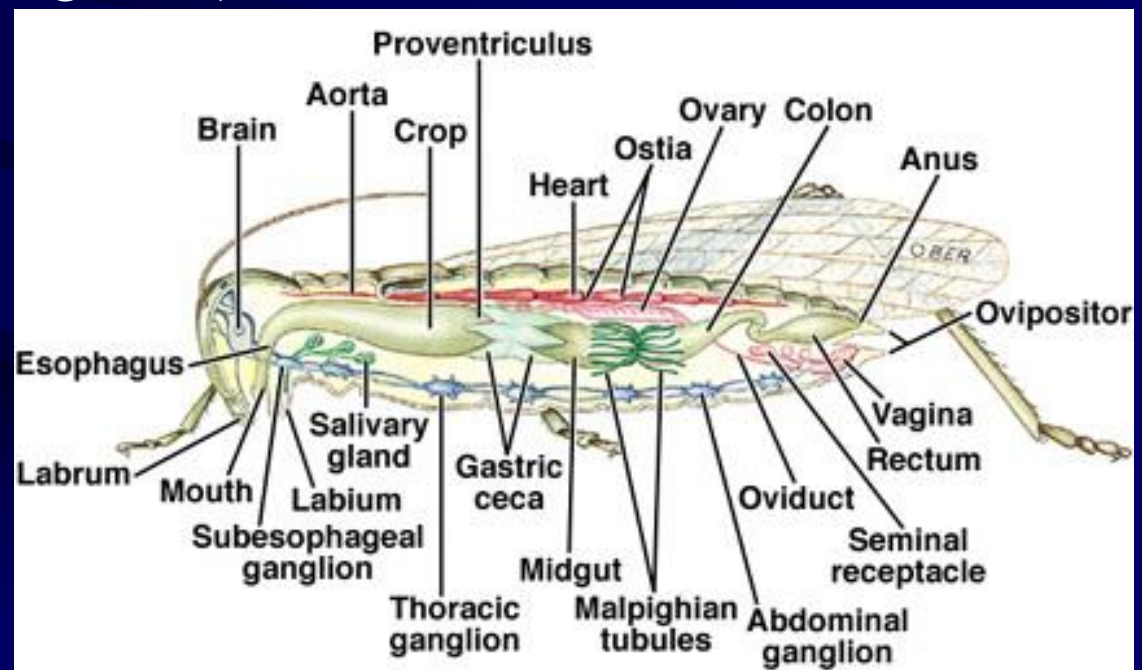
- Spiders have **book lungs**, chambers with leaf-like plates for exchanging gases; air flows over the plates and blood flows through them



Digestive System

Divided into 3 main regions: foregut, midgut, and hindgut

- Foregut and the hindgut are lined with chitin
- Foregut is involved with ingestion, mechanical breakdown, and storage
- Hindgut is involved with water absorption and formation of the feces
- Midgut is not lined with chitin; involved with digestion and absorption
- Outpockets (e.g. digestive glands) increase the surface area for digestion and absorption



Internal Transport and Excretion

- Open circulatory system
- Many crustaceans possess an excretory organ called the **green gland** (antennal gland), which filters fluid from the blood

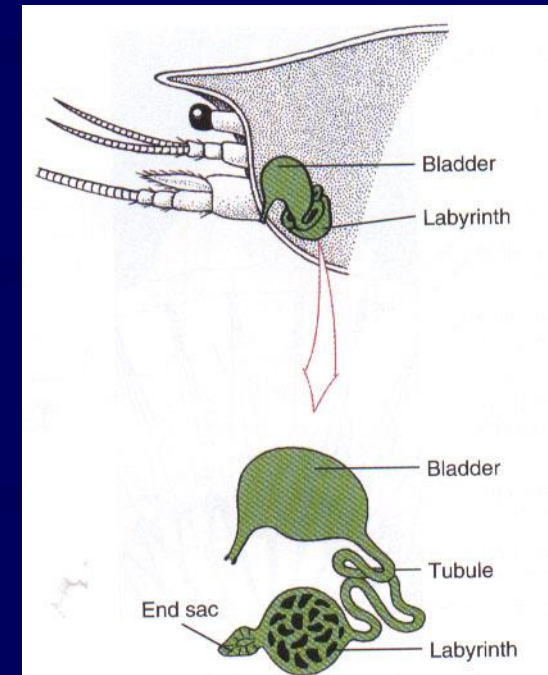
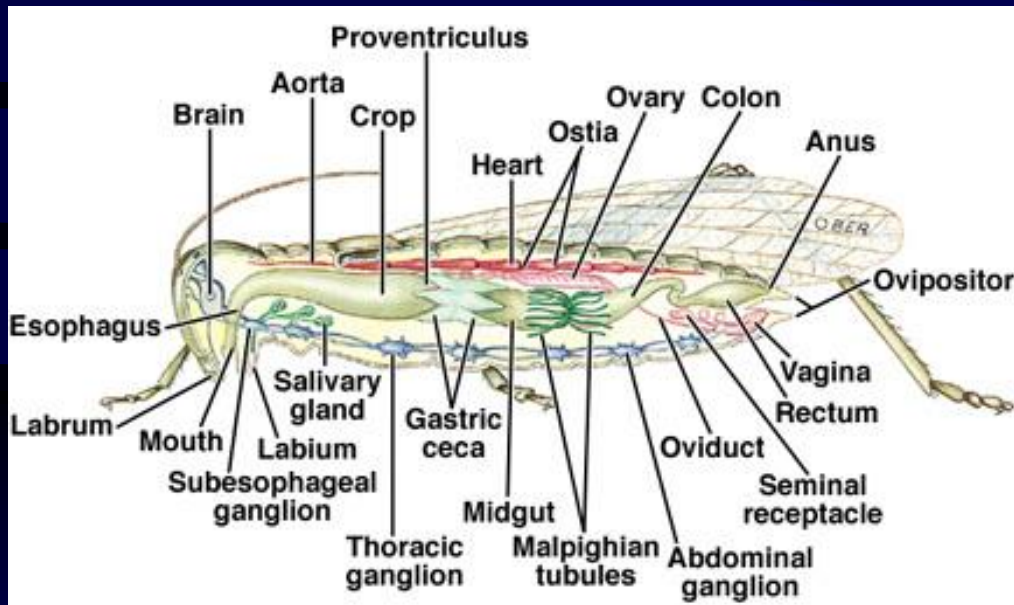


Figure 19-7

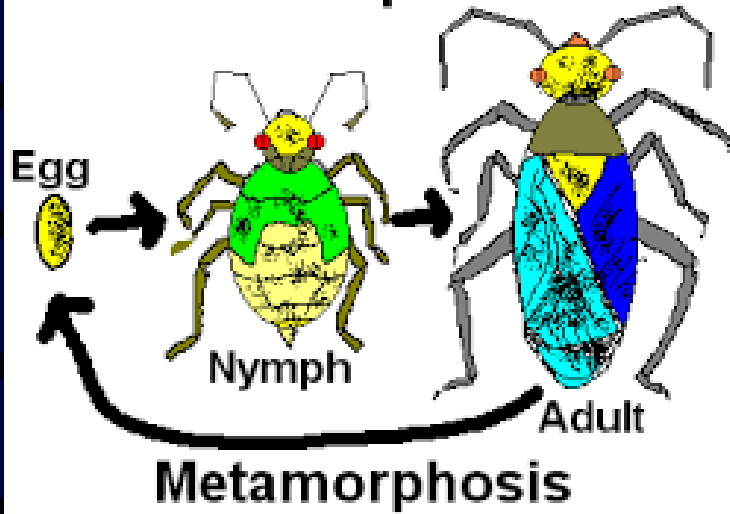
Scheme of antennal gland (green gland) of crayfishes. (In natural position organ is much folded.) Some crustaceans lack a labyrinth, and the excretory tubule (nephridial canal) is a much-coiled tube.

- Most insects and spiders have a excretory system called **malpighian tubules**

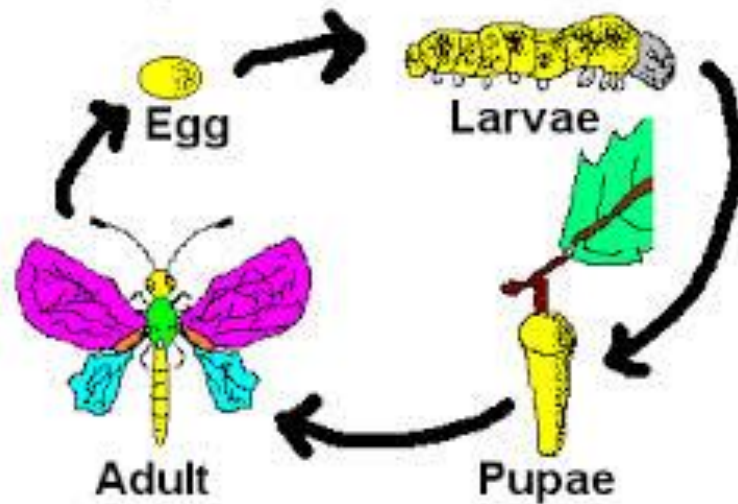
Reproduction

- Sexes are separate; fertilization is external in aquatic forms, internal among the terrestrial forms
- Can be oviparous (Oviparous animals are animals that lay eggs, with little or no other embryonic development within the mother)
- or ovoviviparous (Ovoviviparous animals are similar to viviparous species in which there is internal fertilization and the young are born live, but differ in that there is no placental connection and the unborn young are nourished by egg yolk; the mother's body does provide gas exchange (sharks and rays)..
- Offspring often go through process of metamorphosis.
- (Egg, pupa, Larva, Adult stages)
- Parthenogenesis (reproduction without fertilization) occurs in a some species (e.g. aphids).

Incomplete



Complete Metamorphosis





Aphid giving birth

<http://nathistoc.bio.uci.edu/hemipt/28.jpg>

Characteristics of the Arthropoda

1. They exhibit **bilateral symmetry**.
2. The body consists of three regions: **head, thorax and abdomen**.
3. They have three or more pairs of **jointed legs**.
4. They covered with a **chitinous exoskeleton**.
5. Respiration is by **tracheae or book lungs in terrestrial forms and by gills in the aquatic arthropods**.
6. Circulatory system is **open type**.
7. They are with **complete digestive system, mouth parts**.
Adapted for different methods of feeding.
8. Sexes usually separate.

- Bilaterally symmetrical with a segmented (metameric) body divided into head, thorax and abdomen; cephalothorax and abdomen; or fused head and trunk.



Rove beetle