

Invertebrate Zoology (Biol 242)

Chapter 14

Phylum Arthropoda



Scorpion



Cockroach



Spider



Butterfly

Arthropoda : (Greek) = Jointed foot

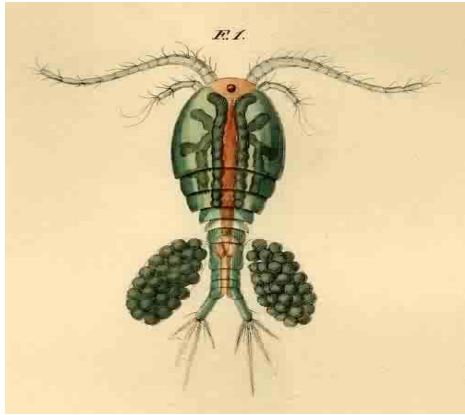
► *Defining Characteristics:*

- *Epidermis produces a segmented, jointed and hardened (sclerotized) chitinous exoskeleton.*
- *Intrinsic musculature between individual joints of appendages.*
- *Complete loss of motile cilia in adult and larval stages.*

- *General Characteristics:*

- The largest phylum within the animal kingdom. It contains **75% of all animal** species (vertebrates and invertebrates).
- Includes many organisms like: **Insects, spiders, scorpions, pseudoscorpions, centipedes, crabs, lobsters, brine shrimps, copepods, barnacles, etc.**





- Body is basically **metameric “segmented”** (**head, thorax & abdomen**).
- A number of segments are modified and fused to form each segment. This is called **tagmatization**.



- Members have an external protective covering (**exoskeleton**) that is secreted by the **epidermis**.
 - ▶ **Exoskeleton is composed of two layers:**
 - **The epicuticle:** outermost layer, **waxy**, water impermeable. This layer is quite thin (**3% of total thickness**).
 - **The procuticle:** the **bulk of the exoskeleton**, made up mainly of polysaccharides (**chitin**) in association with some **proteins**.

- ▶ **Exoskeleton might be hardened by:**
- **Calcification:** deposition of calcium carbonate to some procuticle layers. As in Crustaceans.
- **Tanning (Sclerotization):** achieved through the formation of cross-linkages between protein chains. Takes place in all arthropods.
- Once the **shell** is hardened, its **size remains constant**. When the animal grows, it must **shed (molt) the exoskeleton** and form a new one.
- The process of removing the exoskeleton is called **ecdysis** (an escape).



- All **muscles** of insects are **striated** (no smooth). Striated muscles respond to stimuli much faster than smooth muscles.
- The **circulatory system** is **open**.
- Arthropods are distributed among **2 subphyla** and **6 classes**.
- **Three of these classes** (**arachnida, insecta and crustacean**) contain **95% of all arthropods**.

- *I) Subphylum Chelicerata:*

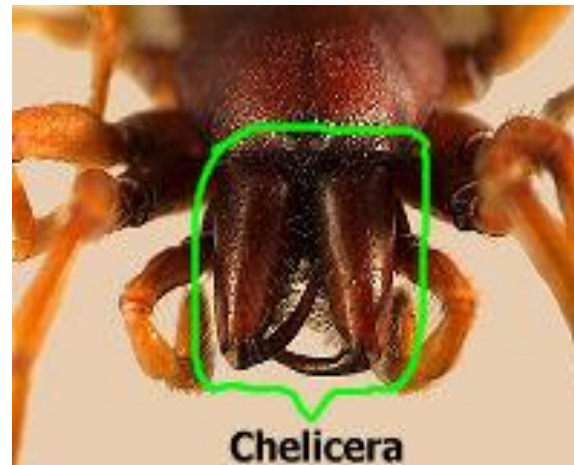
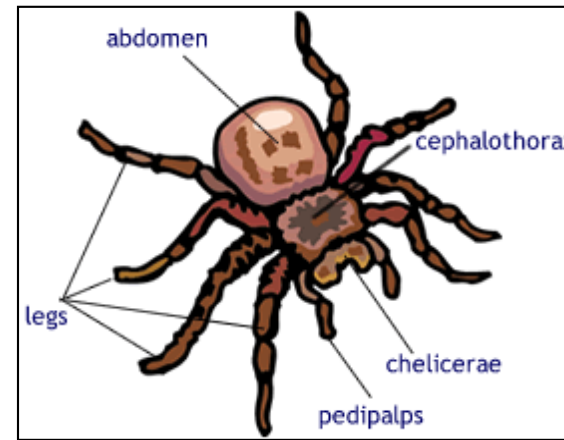
- *Chelicerata: : G. = Claw*

- *Defining characteristics:*

- *Absence of antennae.*

- *Body divided into 2 distinct portions (the prosoma and the opisthosoma), with no distinct head.*

- *First pair of appendages (the chelicerae) on the prosoma is adapted for feeding.*

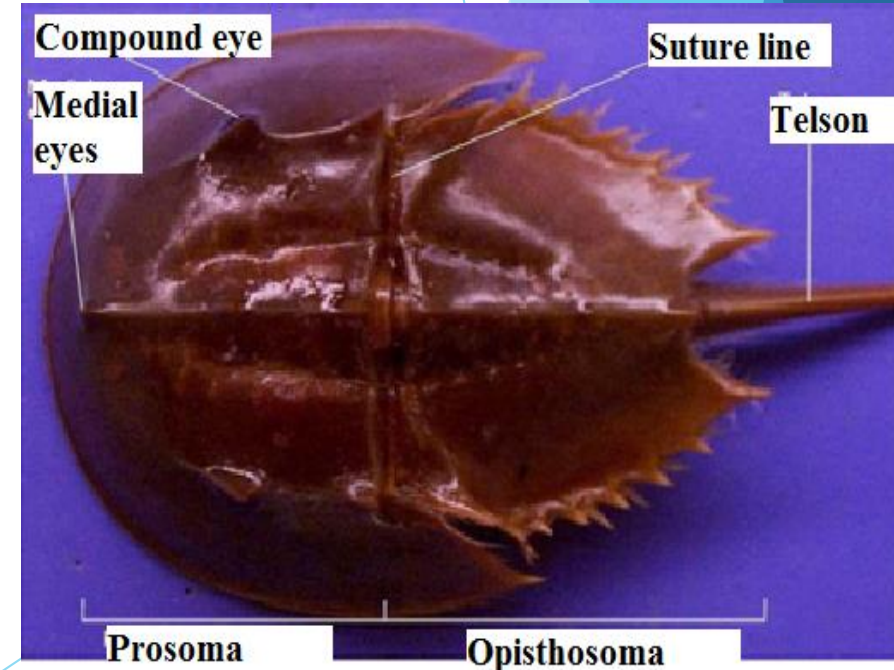


- The only group of arthropods **without antennae**.
- Members of the Chelicerata **lack mandibles** (appendages found adjacent to the mouth in many other arthropod groups and used for chewing and grinding food during ingestion).
- **Divided into 3 classes:**
 - **1) Class Merostomata**
 - **2) Class Arachnida**
 - **3) Class Pycnogonida.**

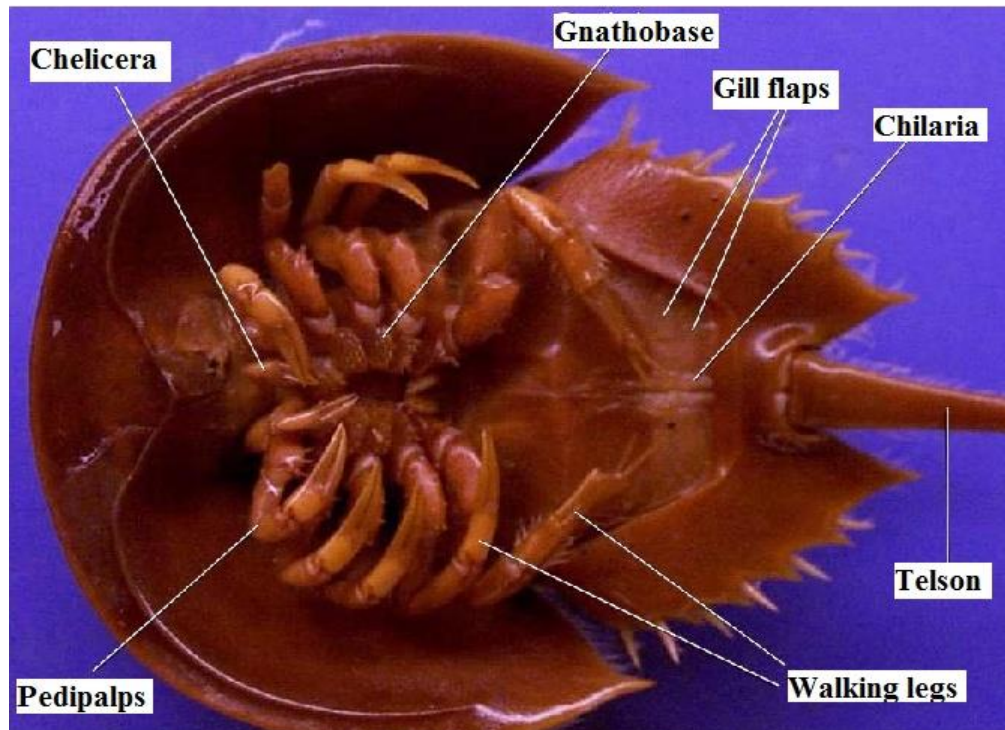
✚ *Class Merostomata:*

- *Defining characteristics:*
 - *Appendages on the opisthosoma are flattened and modified for gas exchange as “book gills”.*
 - *Terminal portion of the body (telson) drawn out into an elongated spike.*
- Composed basically of extinct species. Only **4 living species** are found within this class including the **horseshoe crab** (*Limulus polyphemus*).

- ▶ These are **NOT true crabs**.
- ▶ All are marine and inhabit fine sediment.
- ▶ They are **carnivorous** (feed on small animals in sediment).
- ▶ **Head** and **thorax** are fused to form one unit called the **prosoma (forward-body)** or **cephalothorax**.
- ▶ Cephalothorax is covered by a single unjointed sheet of exoskeleton called the **carapace**.



- Have a pair of **compound eyes** present laterally on the dorsal surface of the prosoma.
- The **first pair of appendages** found ventrally on the prosoma is the **chelicerae** (clawed appendages).



- Chelicerae are followed by **5 pairs of similar appendages**, the **walking legs** (all except the last bear claws).
- **First pair** of walking legs is **called pedipalps** (these are modified for grasping the female during mating).
- **The fifth pair** is modified for **cleaning the gills** and for **removing mud** during burrowing.

- ▶ The **abdomen** (**opisthosoma=behind body**), bears **6 pairs** of appendages.
- ▶ The **first pair** is modified for **reproduction**, and the subsequent **5 pairs** are modified to serve as **gills**.
- ▶ The underside of each gill flap bears approximately 150 leaf-like gas exchange surfaces called **book gills**.



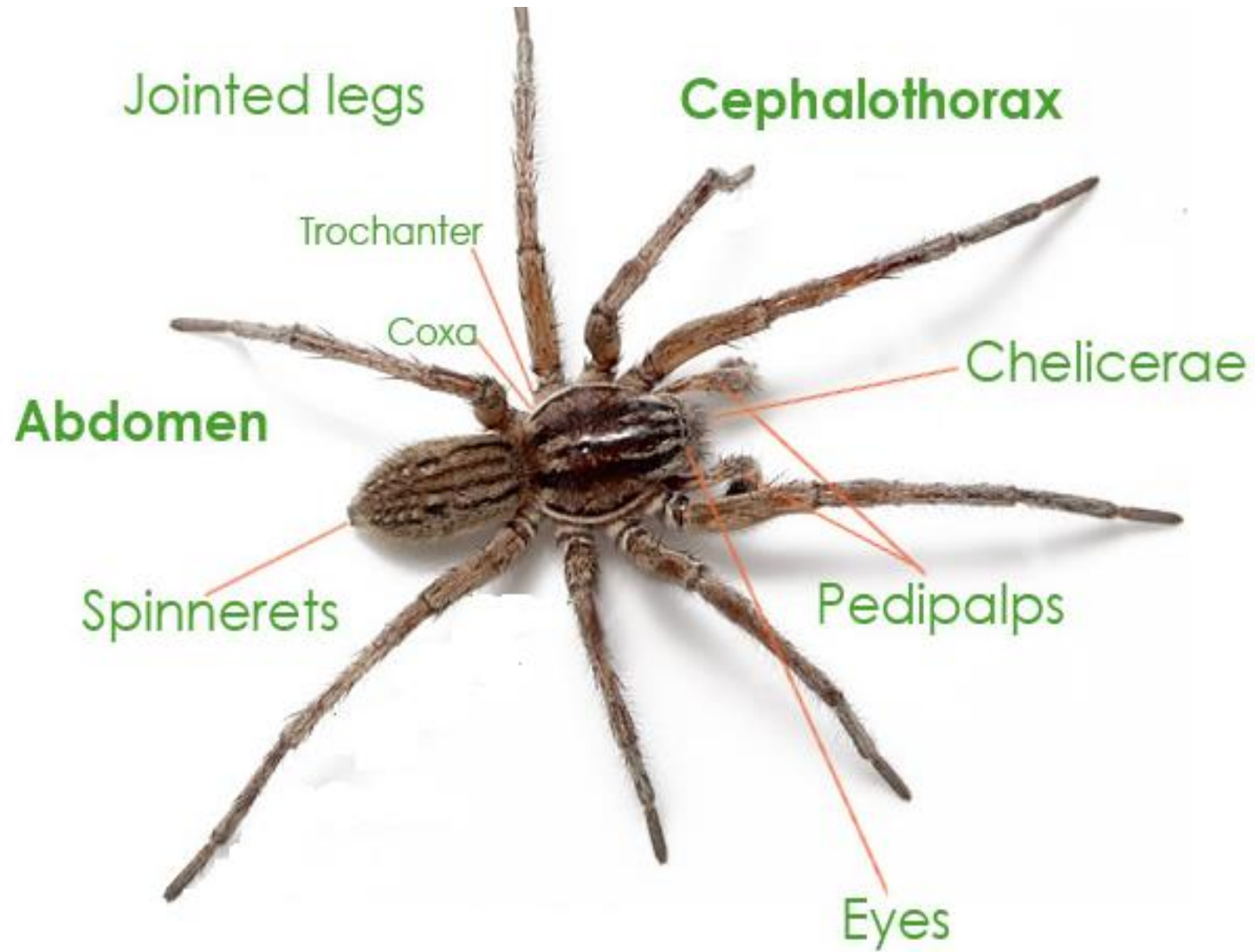
+ Class Arachnida:

- *Arachni: G. = a spider.*
- The majority (more than 70,000 living arachnids) are described as being **terrestrial**.
- This class includes: **spiders, scorpions, mites and ticks.**



Spiders:

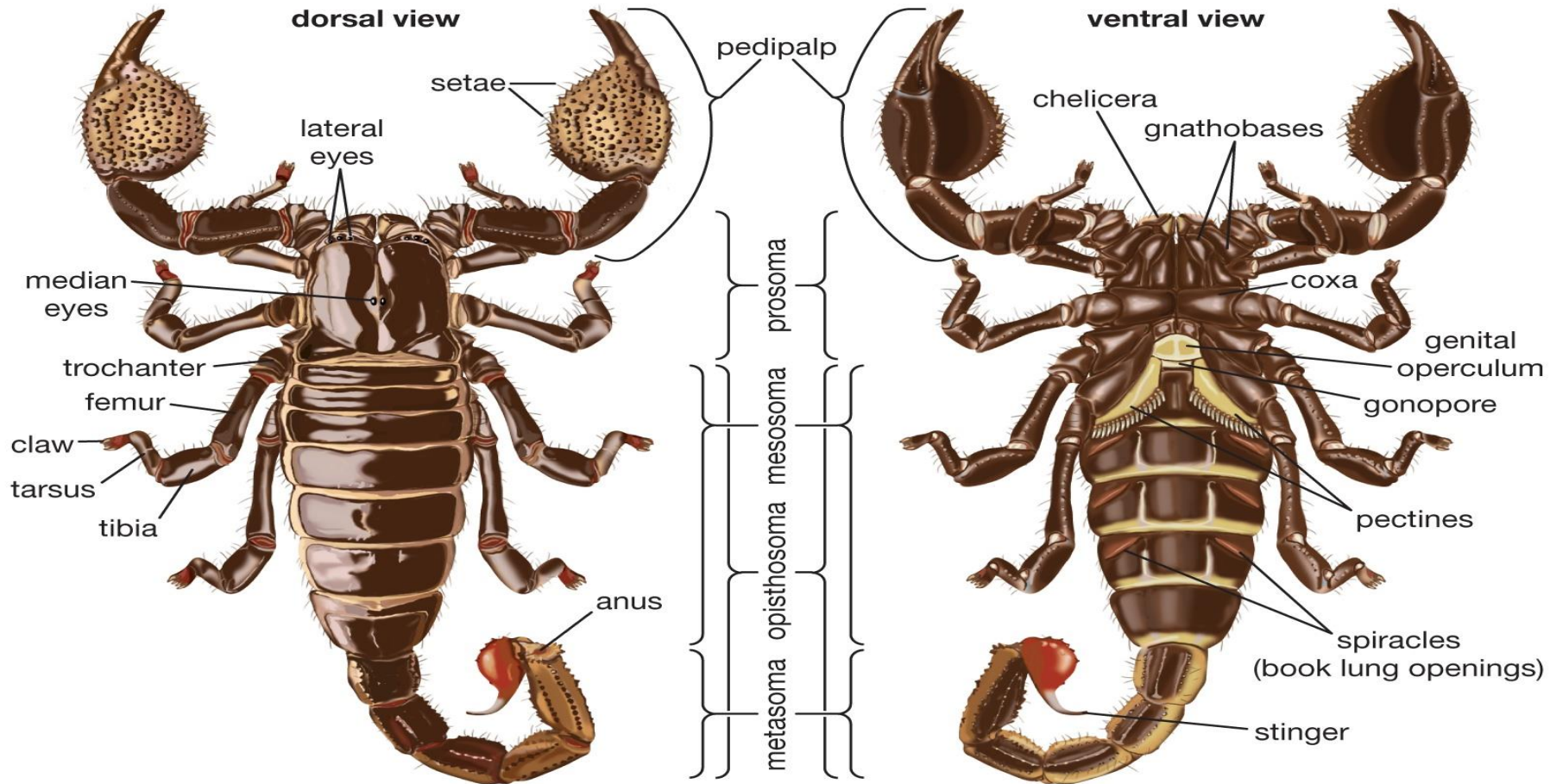
- Spiders constitute about **50%** of all arachnids.
- Spiders are **insect-eaters (carnivorous)**.
- Arachnids (like merostomates) have the head and thorax fused to form the **prosoma** which is covered by the **carapace**.
- From **0-4 pairs of eyes** are found on the prosoma (4 pairs are common).



Respiration:

- By **book lungs** in the most primitive arachnids. These are flattened respiratory surfaces in the abdomen that are connected to the outside by means of an opening called **spiracle**.
- By a **tracheal system** in other species. These open to the outside by spiracles.
- Some have **both book lungs and tracheal systems**.
- **Spinnerets** are located posteriorly (near anus); these **secrete silk proteins** to build the web of spiders.

- ▶ **Scorpions:** the largest among arachnids (could reach 18 cm).
- ▶ All are terrestrial and carnivorous.



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- ▶ All are terrestrial and carnivorous.
- ▶ Usually poisonous species have a **thick metasoma** and **thin Chela**. Non poisonous are opposite.



Poisonous

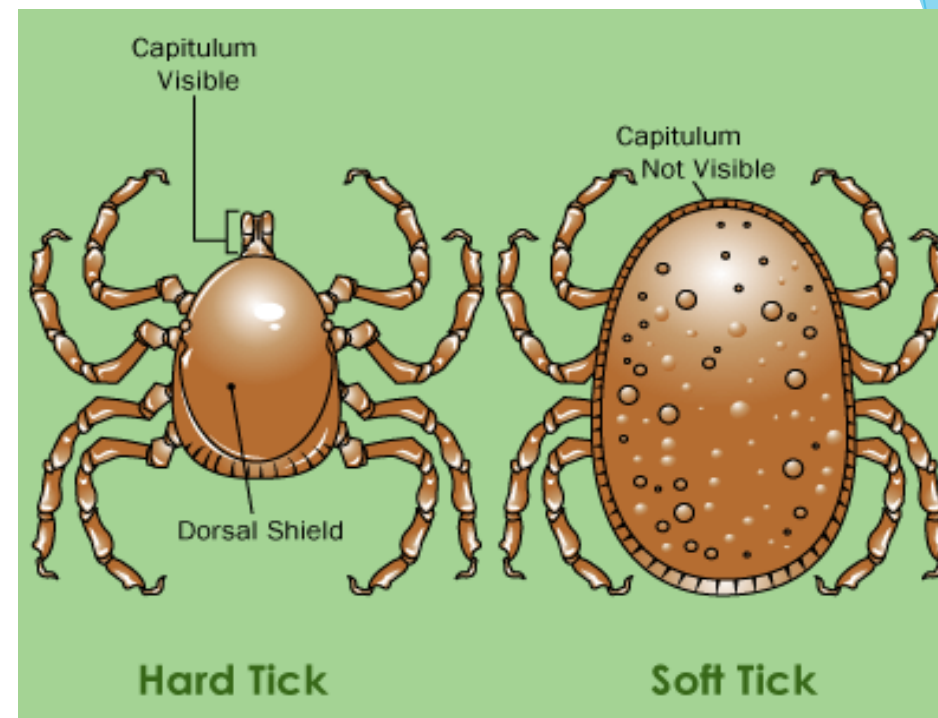
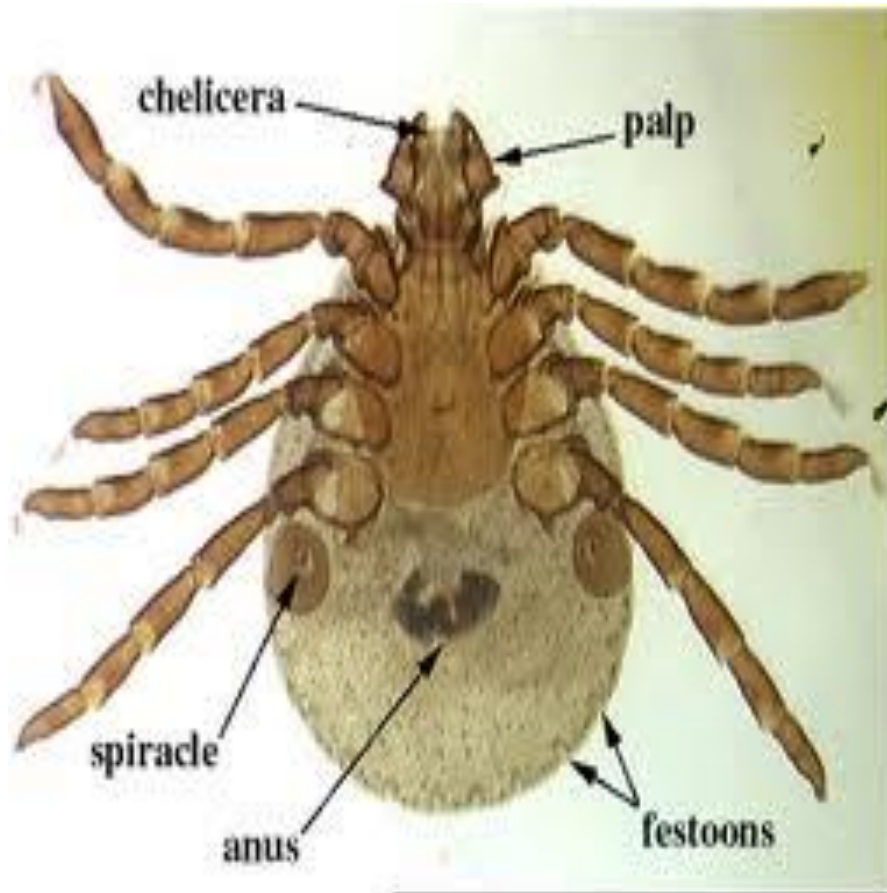


non-poisonous

► Ticks and Mites:

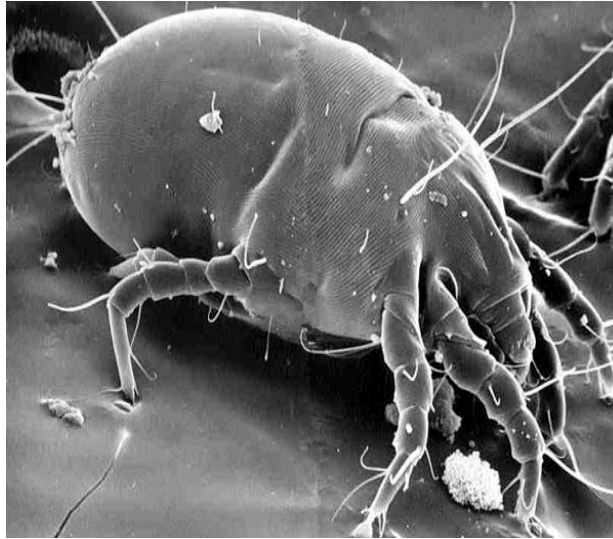
- ▶ are **small in size** (few mites exceed 1mm length, and some species are only 100 μm long).
- ▶ Ticks are larger 5-6 mm long).
- ▶ Feeding habits are diverse and include: **carnivorous, herbivorous, omnivorous, and fungivorous and parasites.**
- ▶ Feed on fluids, which they suck through their muscular pharynx.

Ticks



► Mites

- Found in freshwater, marine and terrestrial habitats.
- Some mites are parasitic, like the **human itch mite** (*Sarcoptes scabiei*) which causes **scabies**.



Class Pycnogonida (pantopoda):

- ▶ *Pycnogonida: G. = Thick knees.*
- ▶ *Pantopoda: G. = All leg.*
- ▶ *Defining characteristics:*
 - *Body is not divided into distinct regions (tagmata)*
 - *Unique proboscis at the anterior end, with an opening at its tip.*
 - *Variable number of walking legs among species.*

- ▶ About 1000 species known as **sea spiders**.
- ▶ All are **marine** and bear conspicuously **long legs**.
- ▶ Size ranges between few mm- 10 cm.
- ▶ Most of the body is the **prosoma** (abdomen is reduced).
- ▶ Most have **4 pairs of walking legs**.
- ▶ Most adults are **carnivores**.



- *II) Subphylum Mandibulata:*

- *Mandibul: L. = a jaw*

- *Defining characteristics:*

- *Appendages on the third head segment are modified as mandibles (for chewing and grinding food).*
- *Retinula of compound eyes contains 8 cells.*

- All members have **mandibles**.

- Appendages could be **uniramous** (single-branched) or **biramous** (double-branched).



Mandibles

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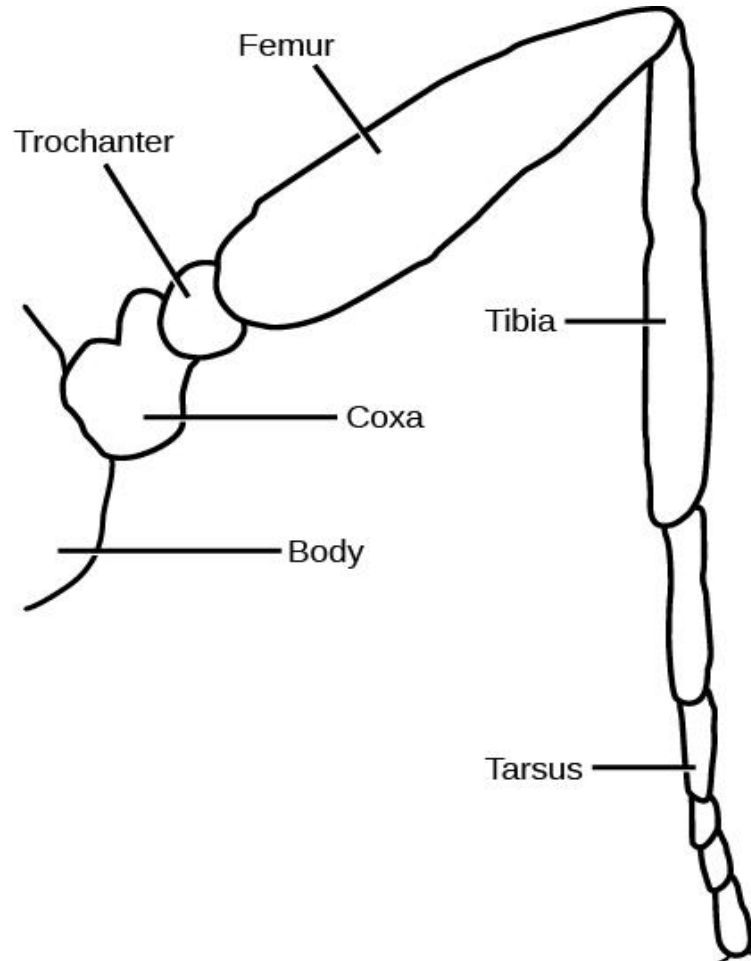
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Uniramous vs biramous appendages



(a) Biramous appendage (crayfish leg)

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(b) Uniramous appendage (insect leg)

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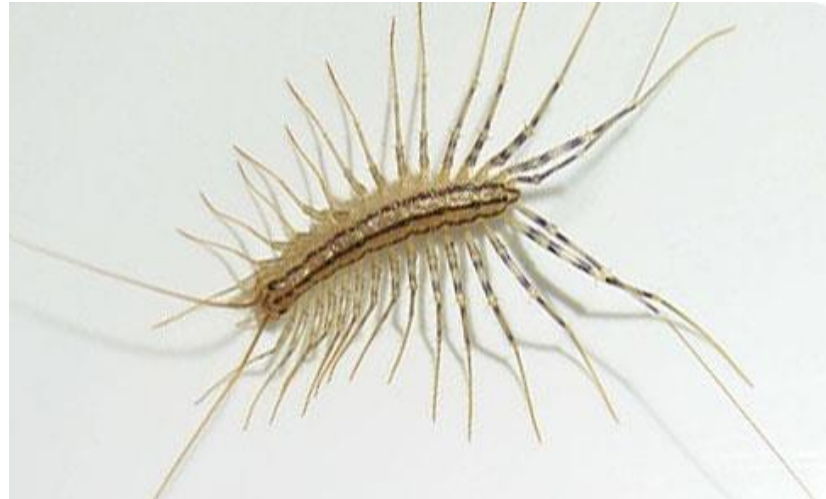
▶ 3 Classes: Myriapoda, Insecta, Crustacea.

✚ *Class Myriapoda:*

- *Myriapoda: G. = many feet*
- *Orders Chilopoda and Diplopoda:*
 - Have many legs (*myriapods*).
 - All their appendages are **uniramous**.

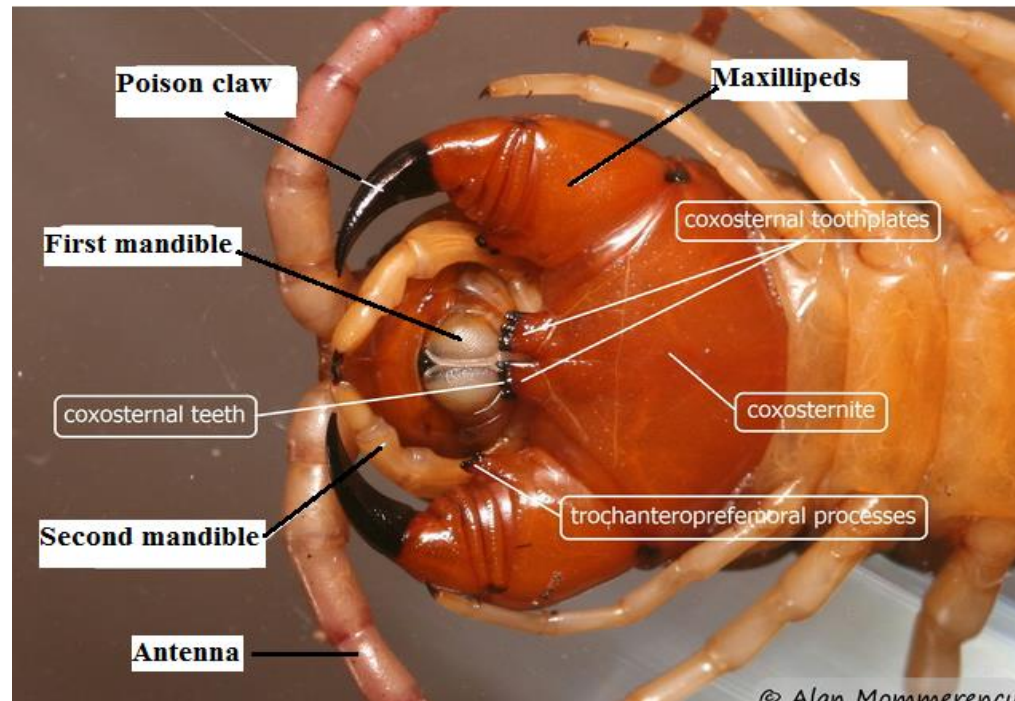


- **Chilopods**: known as **centipedes** (means: 100 feet).
- Fast moving **carnivores**, living in soil, humus, and in people's homes.
- ▶ Mostly **terrestrial** (few marine).
- ▶ Respiration by **trachea** (trachea cannot be closed).
- ▶ Many are **nocturnal** to reduce water loss.



◦ **Head bears:**

- A pair of uniramous **antennae; mandibles; first and second maxillae** and a pair of **maxillipeds** (contain poison glands).
- ▶ **Eyes are usually lacking** (when present ocelli only).
- ▶ Head is followed by **15 or more leg-bearing segments**.
- ▶ Some **produce silk**.

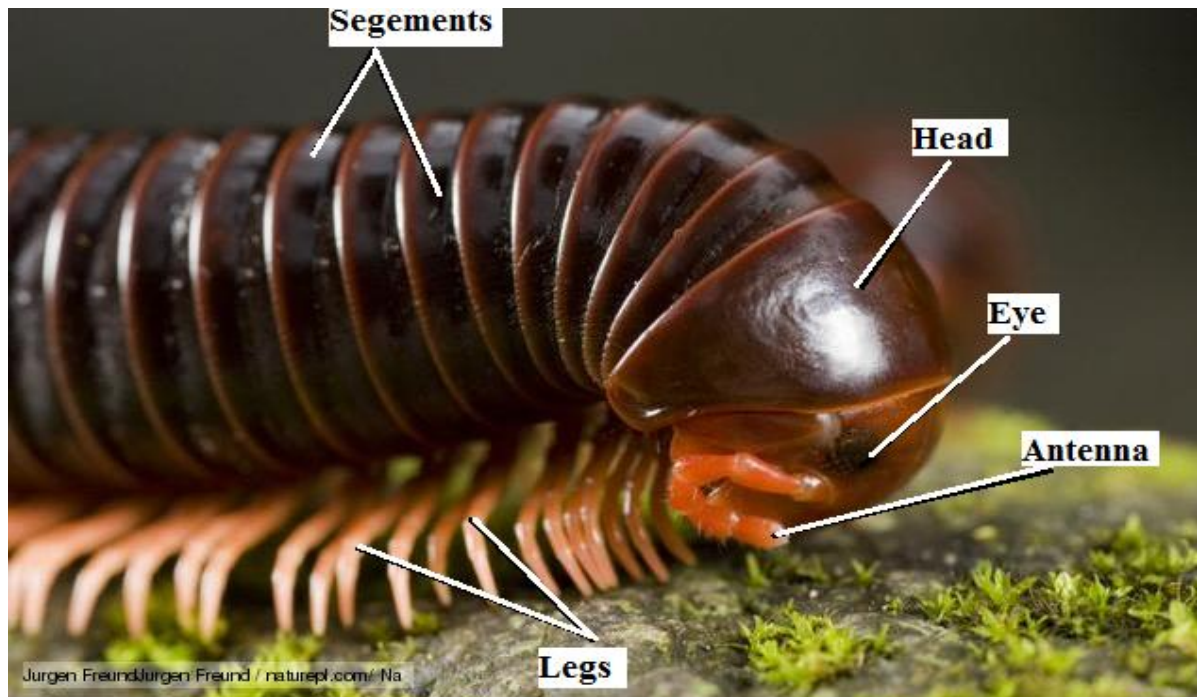


Diplopods: known as **millipedes** (1000 feet).

- About 10,000 species of **slow-moving, deposit-feeders** (some carnivores).
- Pairs of segments have become fused so that each new segment (**diplosegment**) bears 2 pairs of legs (**diplopoda**).
- Each **diplosegment** bears also **2 pairs of spiracles** and **ventral ganglia**.
- **Eyes are lacking**, some have up to **80 ocelli**.

◦ **Head bears:**

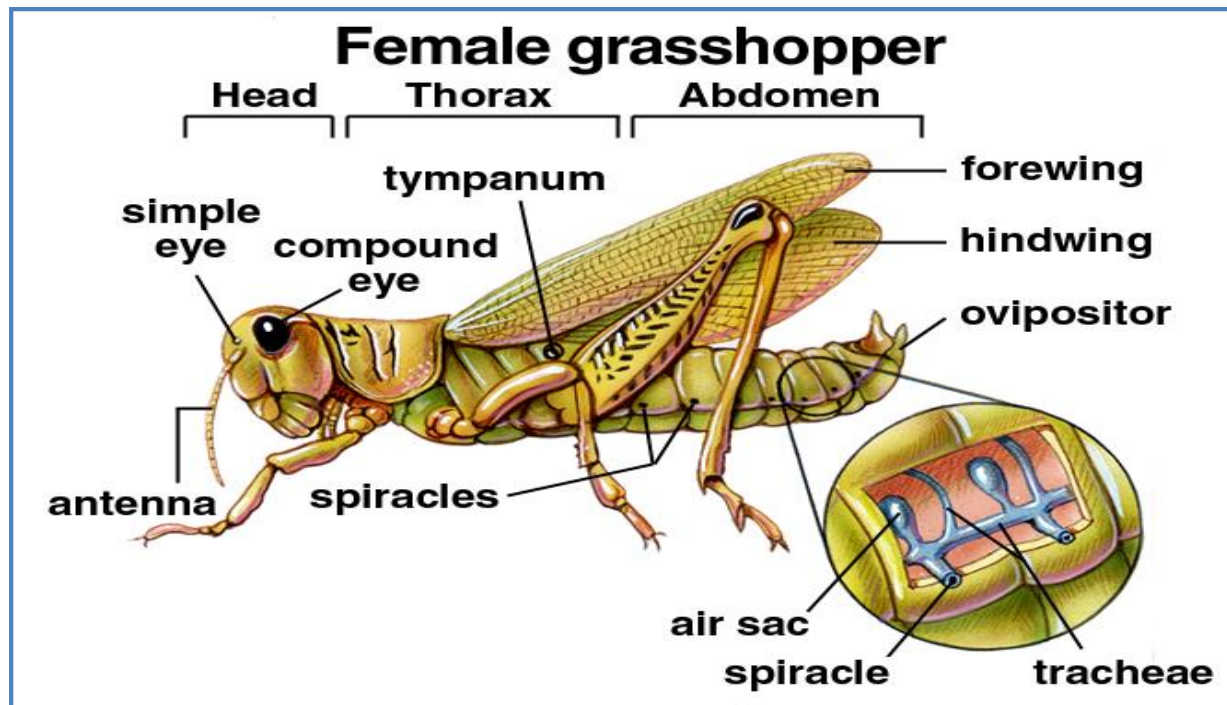
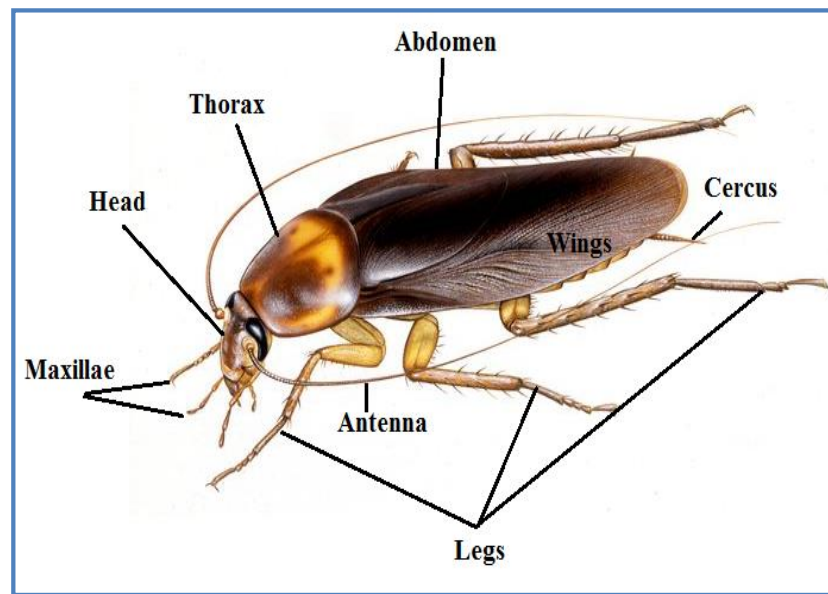
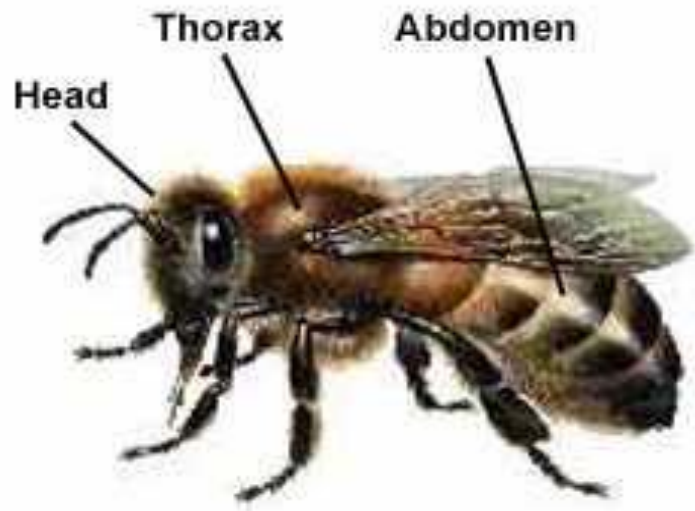
- A pair of uniramous **antennae**.
- A pair of **mandibles**.
- A pair of **maxillae** (second maxillae are lacking).



Class Insecta: (Hexapoda):

- *Insecti: L. = an insect*
- *Hexapoda: G. = six-footed.*
- *Defining characteristics:*
 - *Fusion of 1 pair of head appendages (second maxillae) to form a lower lip (the labium).*
 - *Loss of all abdominal appendages.*

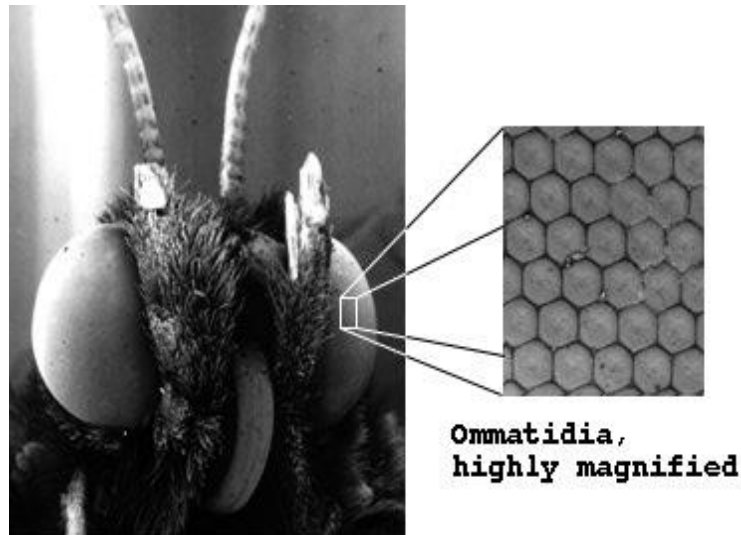
- The largest animal group (over **1 million species**)
- **Live in every habitat** except the deep sea (Evolved the **ability to fly**).
- Most species are **terrestrial**.
- Important group: plant pollination, honey-production, silk production, vectors of diseases, harm agriculture).
- Body is divided into **3 distinct tagmata: head, thorax** and **abdomen**.



- Thorax bears **3 pairs of legs** (**Hexapoda**).
- Legs could be modified for: **walking, jumping, swimming, and digging or grasping** and generally provided with a variety of sensory receptors (**smell, taste and touch**).

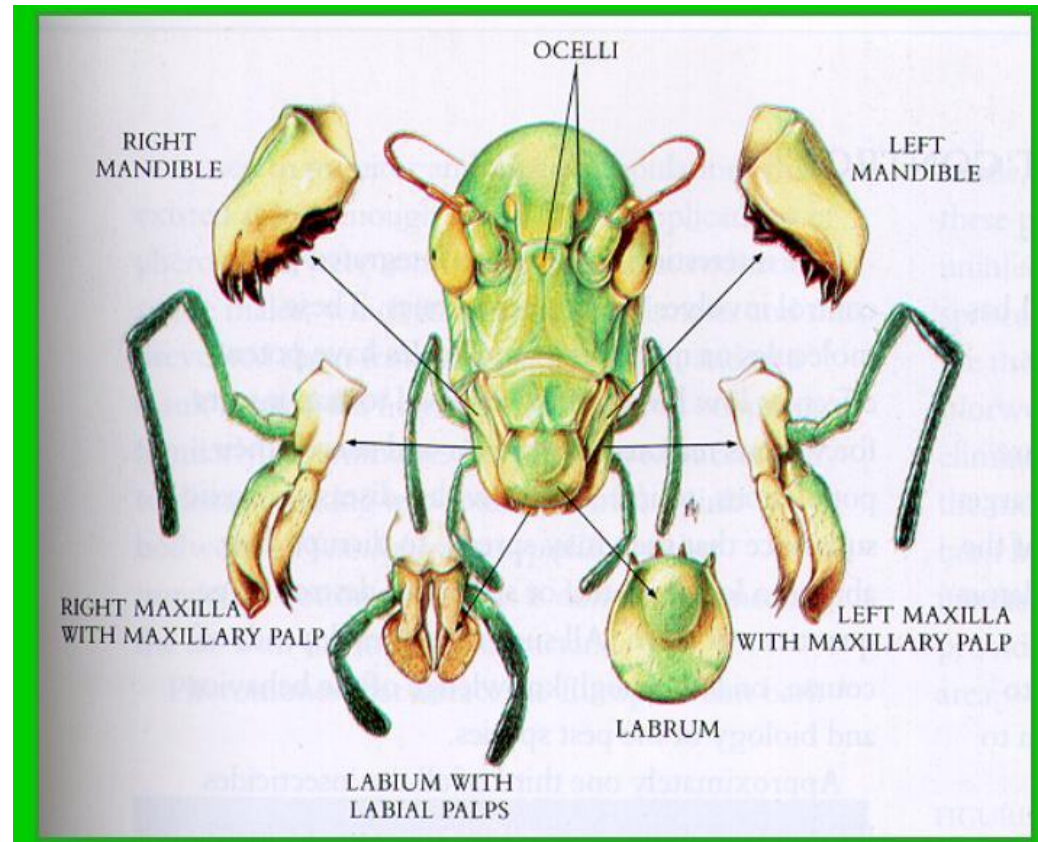


- **2 pairs of wings** (chitinous) are generally carried dorsally **on the thorax**.
- All appendages are **uniramous**.
- Light receptors are in the form of a pair of **compound** eyes (composed of **thousands of ommatidia** “little eyes”). However, **ocelli are present too**.

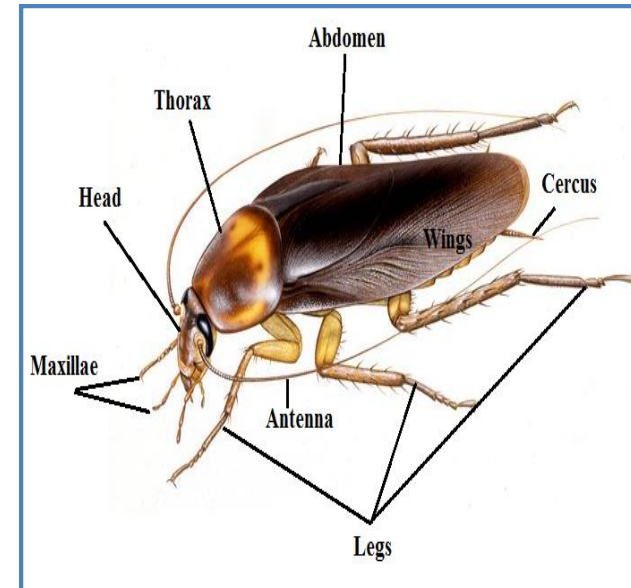
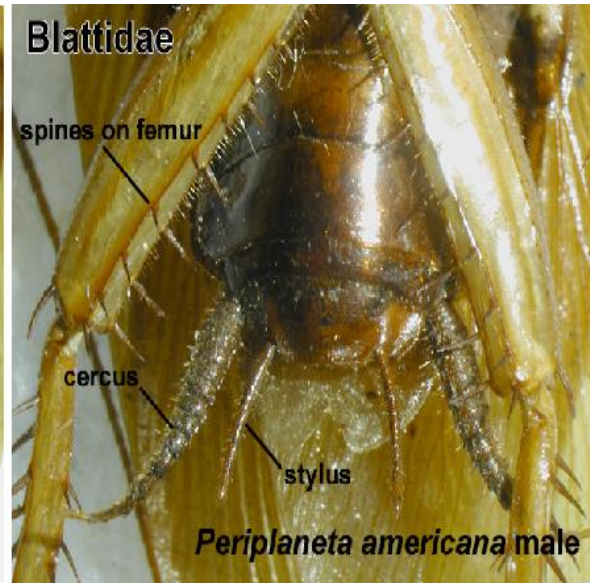
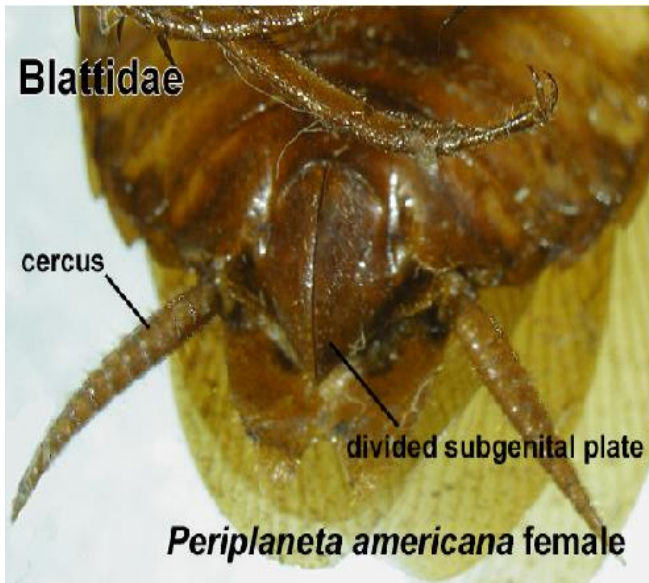


○ **Head bears:**

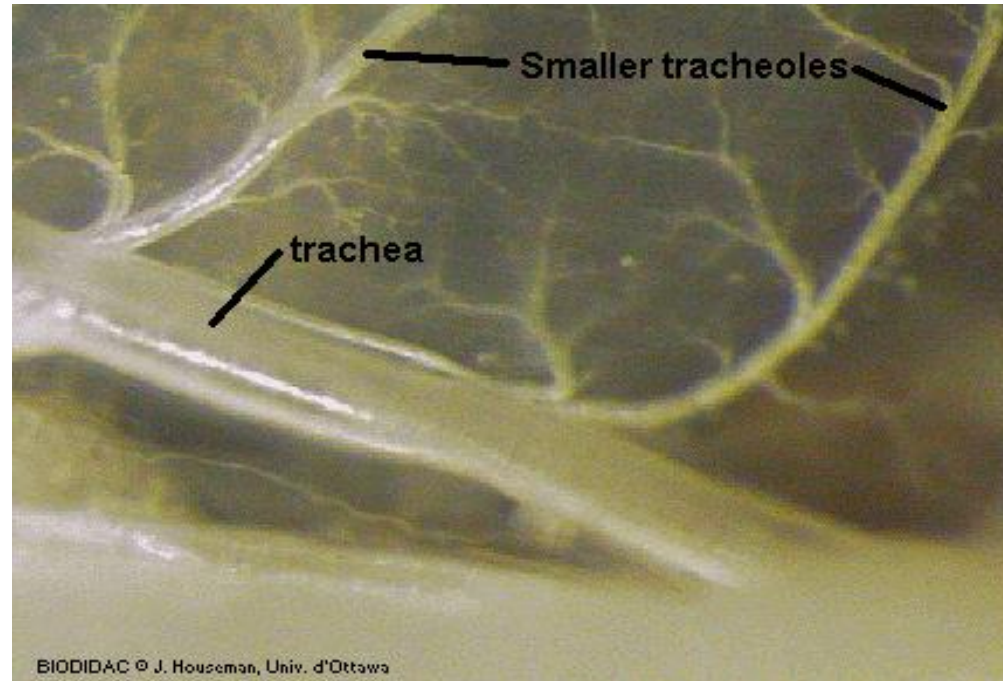
- ▶ A pair of uniramous **antennae**.
- ▶ **3 pairs of mouthparts** (**mandibles**, **first maxillae**, and **second maxillae** that have become fused to form a single appendage called the **labium**).



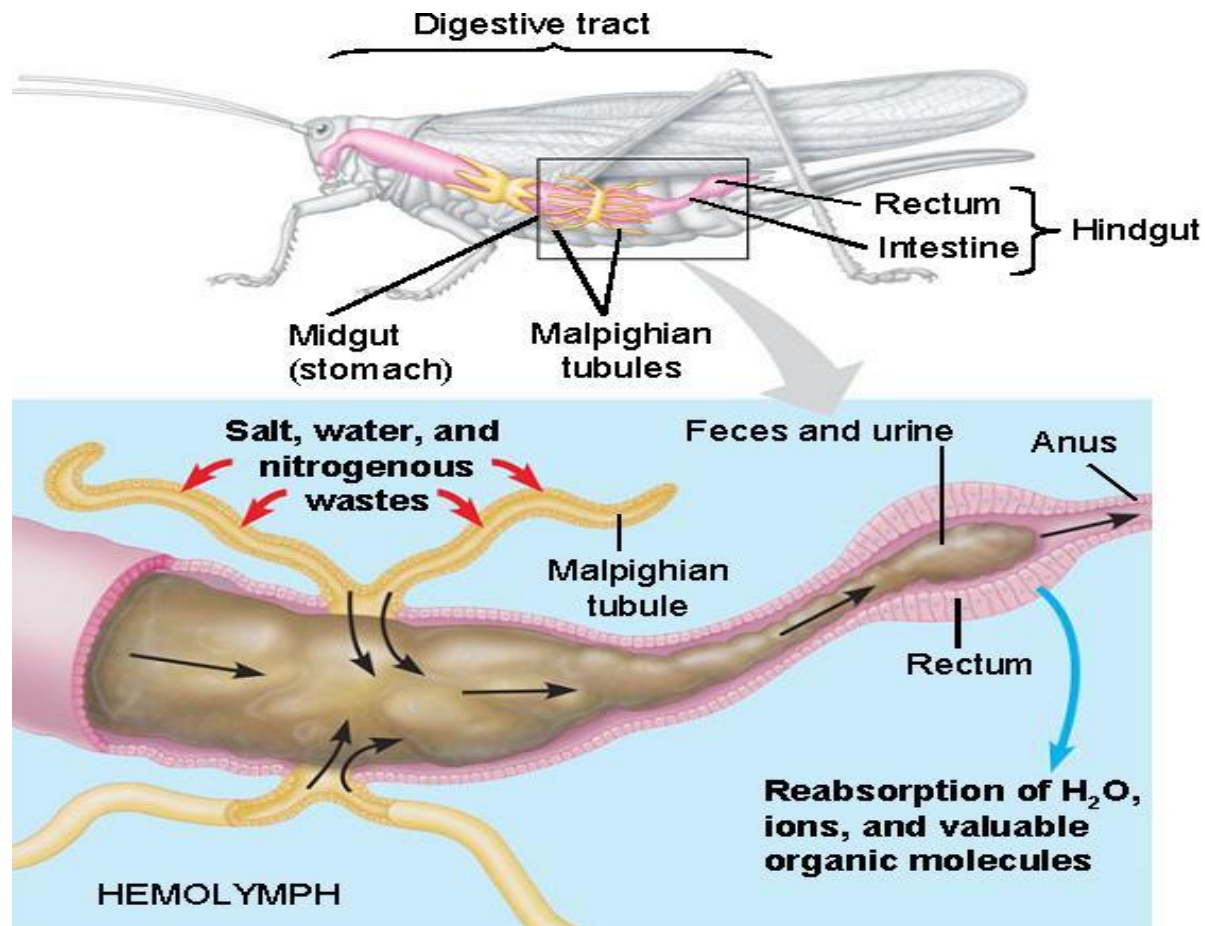
- Mandibles are shielded anteriorly by a downward extension of the head called the **labrum**.
- Abdomen lacks appendages except for a pair of sensory **cerci** found on the last abdominal segment.



- ▶ Gas exchange is generally by a **tracheal system**.
- Most **spiracles** (openings of the trachea) are on the abdomen.
However 1-2 could be found on the thorax.
- Spiracles may be closed to reduce water loss.
- Trachea branch to form a network of smaller tubules called **tracheoles**.



- Excretion is by **Malpighian tubules** (about 250 pairs/insect).

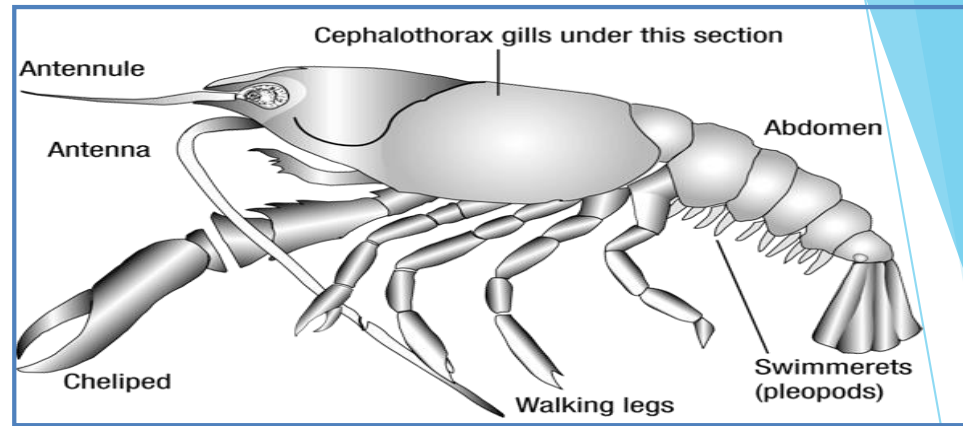


✚ Class Crustacea:

■ Crustacea: L. = *a crust*.

■ Defining Characteristics:

- Head bears *5 pairs of appendages* (including *2 pairs of antenna*).
- Development includes a *triangular larval form* (the *nauplius*) bearing *3 pairs of appendages* and a *single median eye*.



- ▶ This class contains approximately **45,000 species**.
- ▶ It is divided into **5 major subclasses**:

- ▶ *Subclass Malacostraca.*

- ▶ *Subclass Branchiopoda.*

- ▶ *Subclass Ostracoda.*

- ▶ *Subclass Copepoda.*

- ▶ *Subclass Cirripedia.*



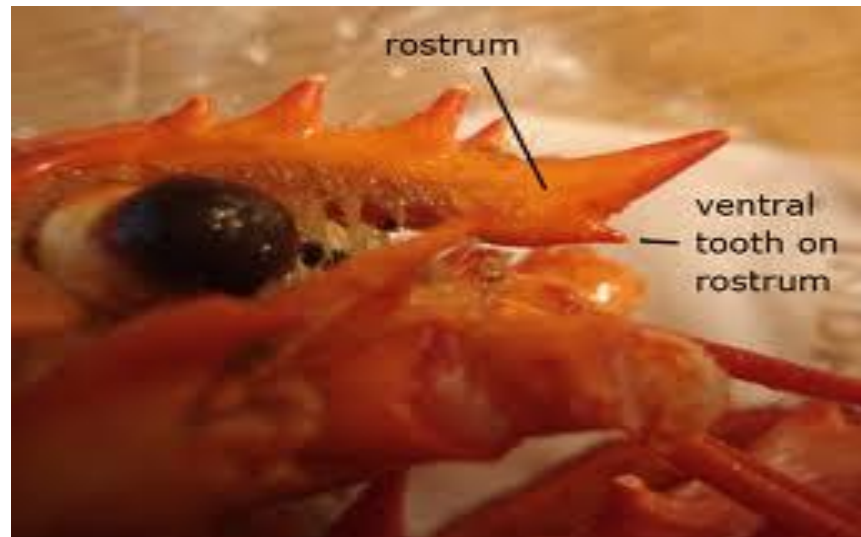
➤ *Subclass Malacostraca:*

- *Malacostraca: G. =soft shell*
- *Defining Characteristics:*
 - *Thorax with 8 segments, abdomen with 6-7 segments with telson.*
 - *Appendages on the 6th abdominal segment are flattened to form uropods.*
- The **largest subclass** (contains 75% of all crustaceans).

- Includes many familiar groups of organisms like:
crabs, shrimps, crayfish, hermit crabs, lobsters.

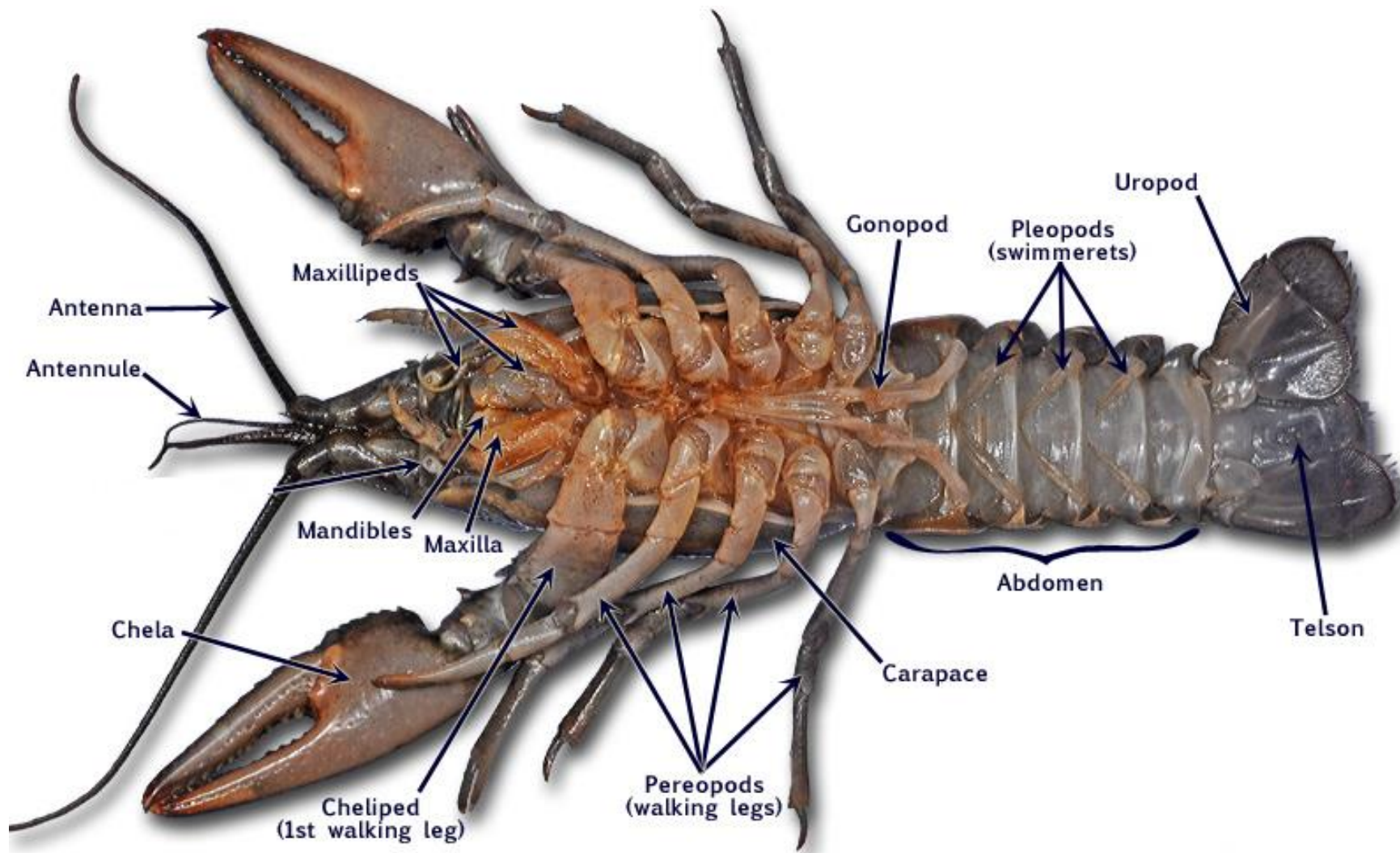


- Body is basically divided into **head, thorax and abdomen**.
- Head and thorax are fused (**cephalothorax**) and covered by a **carapace**.
- In some species the carapace carries an anterior projection called the **rostrum**.



- Head bears:

- **One pair** of stalked, large compound **eyes**.
- **Two pairs** of **antennae** (first “small antennules” and second “longer antennae”).
- **One pair** of mouth parts called **mandibles**: food crushing.
- **One pair** of **maxillae**: generate water current and manipulate food.
- **One pair** of **maxillipeds**: food manipulation.



- Thorax bears: 5 pairs of walking legs called **pereopods**.
- Abdomen bears: 6 appendages. The **first 5** appendages are called **pleopods**. They function in **swimming, generating respiratory currents and for brooding eggs** and **developing young** in females.
- **Last pair** lies on either side of the **telson** forming the **uropods**.
- Appendages are usually **biramous** (have 2 branches).

➤ Subclass Branchiopoda:

- *Branchiopoda: G. = Gill foot.*
- *Each thoracic appendage is modified to form a large, flattened paddle (for gas exchange and locomotion).*

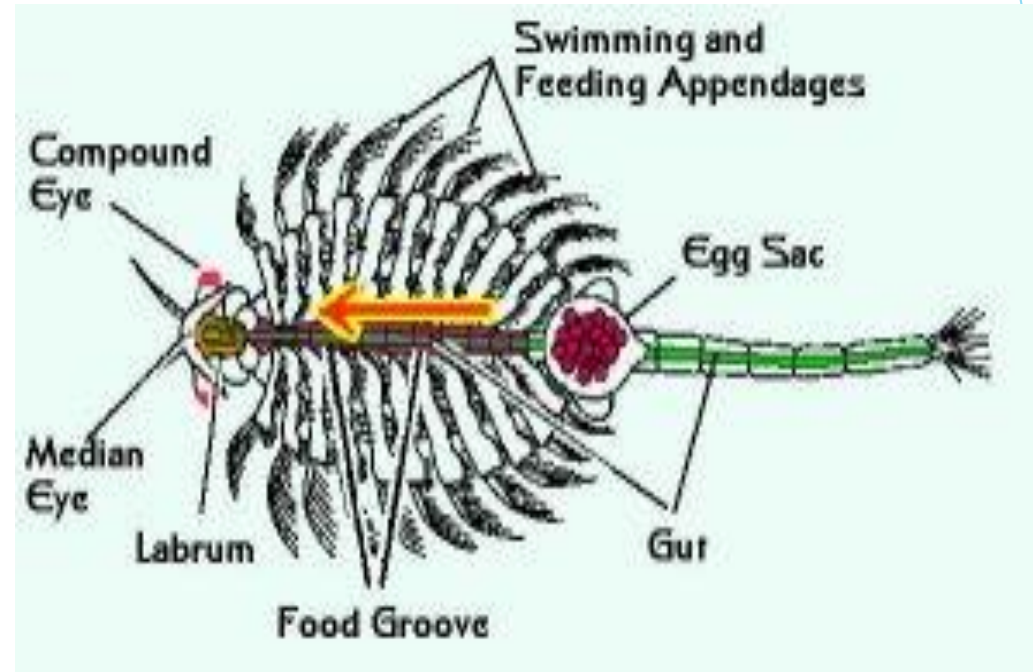
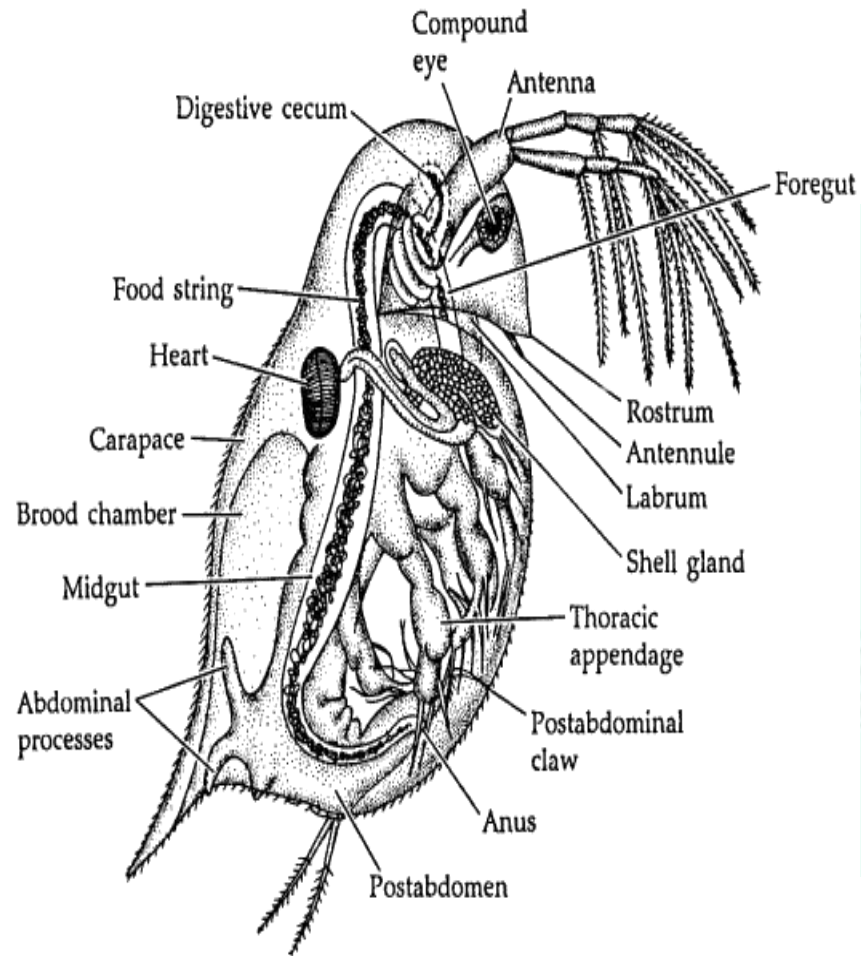


Daphnia



Artemia

- ▶ A diverse group of **small, primarily freshwater** crustaceans “800 species” (few marine).
- ▶ Mostly **filter-feeders** (few carnivorous).
- ▶ Body is enclosed in a **bivalved carapace** (some lack carapace).
- ▶ An important group as **zooplankton**.
- ▶ All species are **microscopic**.
- ▶ Head bears a **single, non-stalked median eye**.
- ▶ Examples: **Brine shrimp** (*Artemia salina*), **water flea** (*Daphnia*).



▶ *Subclass Ostracoda:*

▶ *Ostracoda: G. = a shell.*

▶ *Defining Characteristics:*

▶ *Head and body are enclosed in a bivalved carapace.*

▶ *Trunk of the body bears no more than 2 pairs of limbs.*



Cypris

- ▶ Small (< few mm) live mainly in both **marine and freshwaters**.
- ▶ About 6650 species that are **mostly free living**
- ▶ Most species are **bottom-dwellers** (benthic).
- ▶ Feeding habits: **herbivores, carnivores, suspension-feeders and scavengers**.



▶ *Subclass Copepoda:*

▶ *Copepoda: G. = oarfoot.*

▶ *Defining Characteristics:*

▶ *Thorax with 6 segments, abdomen with 5 segments.*

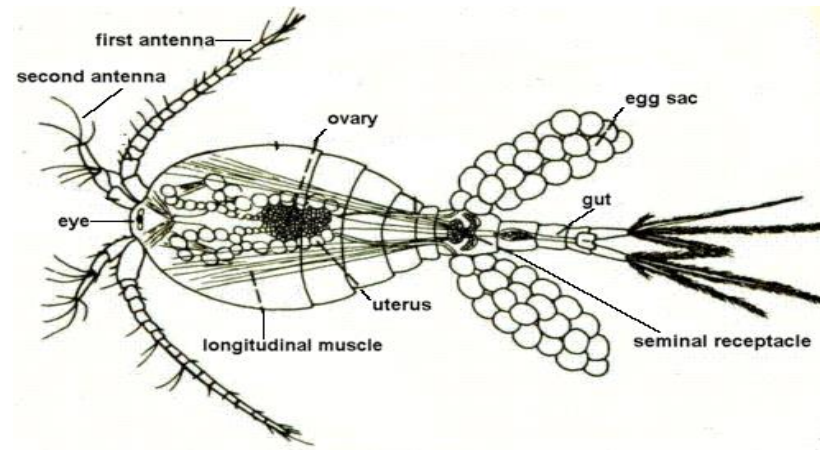
▶ *Loss of all abdominal appendages*

▶ *Most species bear a single “naupliar” eye.*



Cyclop

- ▶ About 8500 species, most of them are **marine and filter-feeders** (feed on phytoplankton).
- ▶ **Small**, less than 1 mm long
- ▶ **2/3 of copepods** are **planktonic** others are **meiobenthos** (live in or on the sediment).
- ▶ Dominate the **marine zooplankton**.
- ▶ Among the most abundant animals on earth.



► Subclass Cirripedia:

► Cirripedia: *L.* = hairy foot.

► Defining Characteristics:

► All species are highly **modified for attachment** to hard substrates, including the outer surfaces of other animals.

► Thoracic limbs modified as filtering cirri.

► No abdomen.



- ▶ 1000 species of **exclusively marine organisms** that are **commonly known as barnacles**.
- ▶ All are **exclusively sedentary**.
- ▶ **Some are stalked (*Lepas*) others are none stalked (*Balanus*)**
- ▶ Most species live within a **thick calcium carbonate protective shell**.

