ZOOLOGY – PHYLUM ARTHROPODA


"If we pull this off, we'll eat like kings."

I. Compared and Contrasted to Phylum Annelida (the segmented worms)

A. They are like annelids in that …
   1. They are eucoelomate animals that show metamerism
      a. Well-developed organ systems
   2. Their nervous system is of the annelid plan
   3. They have a complex muscular system capable of rapid contractions
   4. They have a complete digestive system

B. They are less complex than annelids in that …
   1. They have an open circulatory system
      a. They still have a dorsal contractile heart & arteries
      b. The coelom is reduced to a _____ (the main body cavity that contains the blood)

C. They are more complex than annelids in that …
   1. Their somites are more specialized for a variety of purposes, forming functional groups called _____.
   2. They have paired, jointed appendages
   3. The soft cuticle of annelids has become a hard _____ due to the addition of _____ (a nitrogenous polysaccharide) and often calcium carbonate (especially in crustaceans).
      a. This provides the muscles with something resistant to pull on.
      b. They no longer have a hydrostatic skeleton.
   4. They have special mechanisms (gills, tracheae, book lungs, tracheae) for respiration
   5. The sexes are separate (_____)
      a. Often show _____ (sharp changes in form during postembryonic development)
   6. They show a wider occurrence of social organization

II. Characteristics of Phylum Arthropoda

A. Arthropodization
   1. The soft cuticle of the ancestors of arthropods was stiffened by deposition of protein and an inert polysaccharide, chitin.
   2. Joints had to provide flexibility and a sequence of _____ was necessary to allow for growth.
   3. The hydrostatic skeleton function was lost, the coelom regressed and open sinuses replaced them.

B. Phylum Arthropoda

1. This contains over _____ of all known species.
2. The phylum has a rich fossil history dating to the late _____.
3. Exoskeleton
    a. The primitive pattern is a linear series of similar somites with jointed appendages.
    b. Many somites may be fused or combined into specialized groups called **tagmata**.
    c. Appendages are often highly specialized for division of labor.
4. Sizes range from the _____ (four meters in leg span) to the 0.1 mm long _____.
5. Their abundance and wide ecological distribution makes them the most diverse animal group.
6. All modes of feeding occur among arthropods
    a. Most are _____.

C. Classification of Phylum Arthropoda

1. Subphylum Trilobita
2. Subphylum Chelicerata
    a. Class Merostomata
    b. Class Arachnida (The coolest class of animals on earth – at least in Mrs. Estlack's humble opinion!)
    c. Class Pycnogonida
3. Subphylum Crustacea (covered in Aquatic Mandibulates)
4. Subphylum Uniramia (covered in Terrestrial Mandibulates)
    a. Class Diplopoda
    b. Class Chilopoda
    c. Class Pauropoda
    d. Class Symphyla
    e. Class Insecta

III. Why are arthropods so diverse and abundant (in other words successful)?

A. The diversity of species, wide distribution, variety of habitats and feeding habits, and adaptations are due to a constellation of structures and physiological patterns.

B. Versatile Exoskeleton

1. The _____ is highly protective but is jointed, providing mobility.
2. The cuticle contains chitin bound with protein.
3. Thus the procuticle is lightweight, flexible, and provides protection against dehydration.
4. Impregnation with calcium salts makes the procuticle very hard in lobsters and crabs.
5. The cuticle is laminated and further hardened by _____, a chemical process.
6. As the cuticle is thin between segments, it allows movement at the joints.
7. _____, or molting, is the process of shedding its outer covering and growing a new, larger one.
8. Arthropods typically molt _____ times.

a. Each stage between the molts is called an _____.
b. The _____ of the exoskeleton is a limit to ultimate body size.

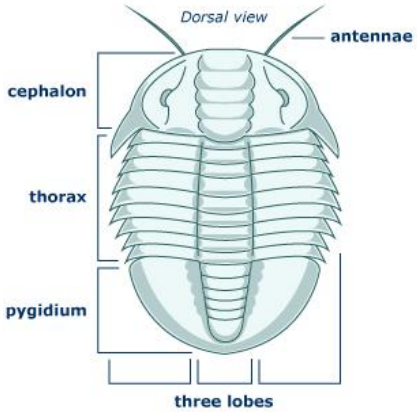
C. Segmentation and Appendages for Efficient Locomotion
1. Usually each somite bears a pair of jointed appendages.
2. Appendages may function in sensing, food handling, walking or swimming.

D. Air Piped Directly to Cells
1. Terrestrial arthropods use an efficient _____ system that delivers oxygen directly to cells.
2. Aquatic arthropods respire by various forms of efficient _____.

E. Highly Developed Sensory Organs
1. Eyes vary from simple light sensitive _____ to a _____.
2. Other senses accomplish touch, smell, hearing, balancing and chemical reception.

F. Complex Behavior Patterns
1. Arthropods surpass most other invertebrates in complex and organized activities.
2. Most behavior is _____ (or unlearned) but some is learned.

G. Use of Diverse Resources through Metamorphosis
1. Many arthropods have metamorphic changes that result in different larval and adult stages.
2. Larvae and adults eat different foods and occupy different habitat and thus avoid _____.




Fossil

IV. Subphylum Trilobita – an ancient group of arthropods

Trilobites arose before the Cambrian, flourished, and then became extinct 200 million years ago.

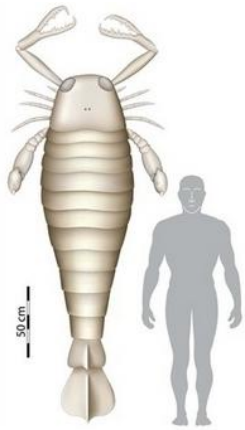
A. They were bottom dwellers (benthic) and probably were scavengers.
B. Ranging from 2 to 67 centimeters long, they could roll up like pill bugs.
C. The body was divided into a head, thorax and pygidium.
D. The head bore antennae, compound eyes, a mouth, and jointed appendages.
E. Each body somite except the last bore a pair of biramous appendages.
F. One of the branches of the biramous appendage was fringed and may have been a gill.

1. Arthropod appendages that are biramous have two branches, an outer branch and an inner branch. These branches may have separate functions.
2. In crustaceans, for instance, the inner branch of a leg is used for walking, while the outer branch may be paddle-shaped or feathery and often functions as a gill.

V. Subphylum Chelicerata

A. Characteristics

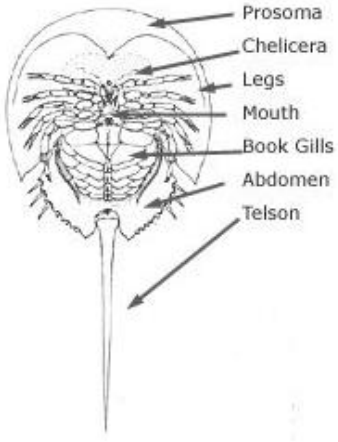
1. Chelicerates have _____ pairs of appendages including _____, _____ and _____.
2. They lack _____ and _____.
3. Most suck liquid food from prey.



B. Class Merostomata: Subclass Eurypterida

1. Eurypterids (giant water scorpions) were the largest of all fossil arthropods at three meters in length.
2. They resemble both marine horseshoe crabs and terrestrial scorpions.
3. It is widely accepted that life first evolved in the ocean.
4. There is good evidence that eurypterids (or an animal very like them) were the first animal to emerge from the ocean to colonize the terrestrial earth.
   a. Other arthropods emerged from the ocean and diversified.
   b. They would be followed by a fish-like animal that evolved into today's amphibians.
      1) From these animals reptiles evolved.
         a) From reptiles, birds and mammals evolved.

C. Class Merostomata: Subclass Xiphosurida, Horseshoe Crabs



1. The modern horseshoe crab is nearly unchanged from ancestors in the Triassic period. ("living fossils")
2. Five species in three genera survive, mostly in shallow marine water.

<u>Structures</u>

a. An unsegmented shield or **carapace** covers the body in front of a **broad abdomen** and a **telson**.
b. The cephalothorax has a pair of chelicerae (the most anterior head appendage that has been modified among chelicerates to serve multiple purposes – envenomation, capturing prey, or eating prey), a pair of pedipalps, and four pairs of walking legs pair of chelicerae.
c. The carapace has two compound and two simple eyes.

4. They walk with their walking legs and swim with abdominal plates.
5. They feed at night on worms and small molluscs.

6. Reproduction

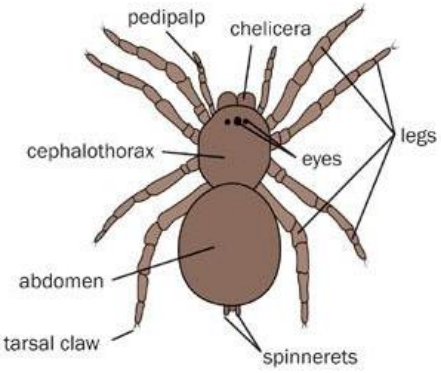
a. During the mating season, they come to shore at a very high tide
to mate.
b. Females burrow into sand to lay eggs; males follow to add sperm
before she covers the eggs.
c. The young larvae hatch and return to the sea at the next very high tide.
d. Larvae are segmented and resemble trilobites.

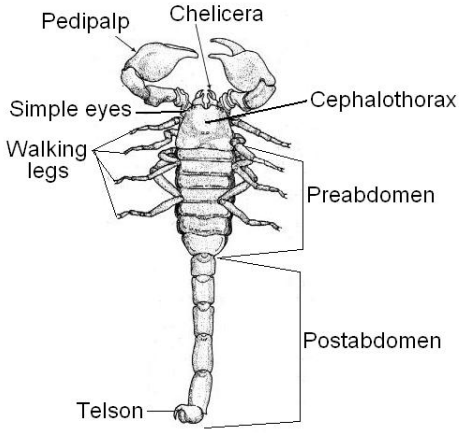
D. Class Pycnogonida: Sea Spiders

1. Sea spiders vary from a few millimeters to larger sizes; all have small, thin bodies.
2. Sea spiders occur in all oceans but are most common in polar waters.

E. Class Arachnida

1. There is a great diversity among scorpions, mites, ticks, daddy longlegs and others.
2. Most are free living and more common in warm, dry regions.
3. Structures
   - **a. Arachnid bodies are divided into a cephalothorax and abdomen.**
   - **b. The cephalothorax bears a pair of chelicerae, a pair of pedipalps and four pairs of walking legs.**
   - c. Antenna and mandibles are lacking.
   - d. Most are predaceous and have claws, fangs, poison glands or stingers.
   - e. Sucking mouthparts ingest the fluids and soft tissues from bodies of their prey.
   - f. Spiders have spinning glands.



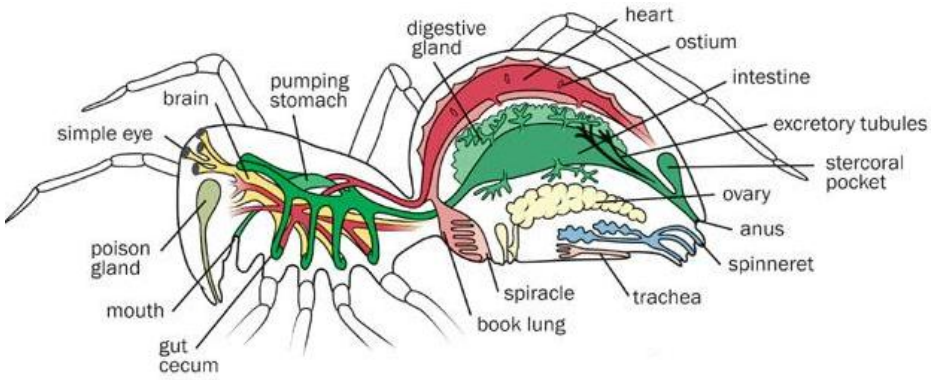


4. Over 70,000 species have been described.
5. Scorpions appeared on land in the Silurian; mites and spiders were found by the end of the Paleozoic.
6. Most are _____ to humans and provide essential control of injurious insects.
7. Some spiders are venomous and can cause pain or death in humans; ticks may carry human diseases and mites can be crop pests.

VI. Phylum Arthropoda - Subphylum Chelicerata – Class Arachnida – Order Araneae
THE SPIDERS

A. About _____ species of spiders are known.
1. The body consists of an unsegmented cephalothorax and abdomen joined by a slender _____.
2. The anterior appendages are a pair of chelicerae with terminal _____.
3. A pair of _____ has basal parts that help them handle _____ and often facilitates mating.
4. Four pairs of walking legs terminate in _____.

B. All spiders are predaceous, mostly on _____, which are dispatched by poison and fangs.
1. The injected venom liquefies and digests the tissues; this is sucked into the spider's stomach.



C. Spiders breathe by _____and/or tracheae.
1. Book lungs are unique to spiders; parallel air pockets extend into a blood-filled chamber.
2. Air enters the chamber through a slit in the body wall.

D. Spiders and insects have _____ for an excretory system.
1. Potassium, other solutes and waste molecules are secreted into the tubules.
2. Rectal glands reabsorb the potassium and water, leaving wastes and uric acid for excretion.
3. This conserves _____ and allows the organisms to live in dry environments.

E. Sensory Systems
1. Most spiders have _____ eyes, each with a lens, optic rods and a retina.
2. They detect movement and may form images.
3. Sensory _____ detect air currents, web vibrations and other stimuli.

F. Web-Spinning Habits
1. Spinning _____ is a critical ability for spiders and some other arachnids.
2. Two or three pairs of _____ contain microscopic tubes

that run to silk glands.
3. A liquid scleroprotein secretion hardens as it is extruded from the spinnerets.
4. Silk threads are very strong and will stretch considerably before breaking.
5. Silk is used for orb webs, lining burrows, forming egg sacs and wrapping prey.

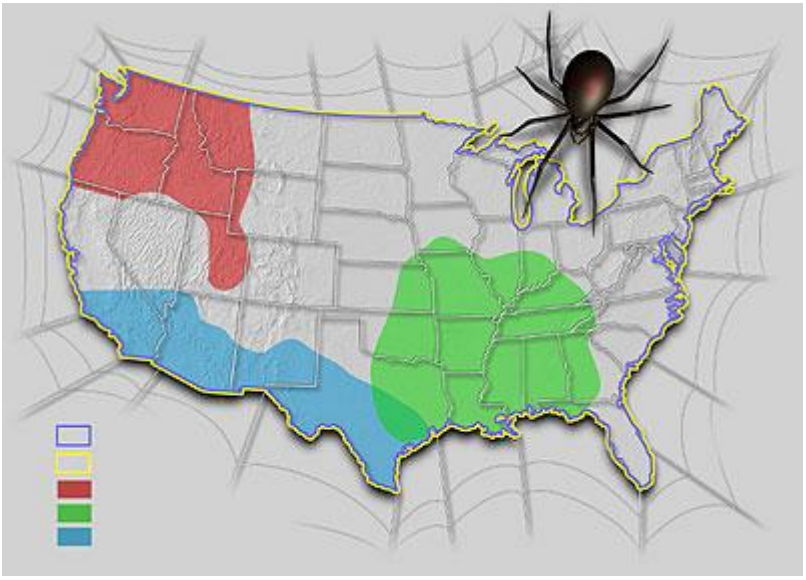
G. Reproduction

1. Before mating, the male stores his sperm in his _____.
2. Mating involves inserting the pedipalps into the female genital openings.
3. A courtship ritual is often required before the female will allow mating.
4. Eggs may develop in a cocoon in the web or may be carried by the female.
5. The young hatch in about two weeks and may molt before leaving the egg cocoon.

Watch this video of jumping spiders courting! http://youtu.be/A6Pu-4qzMkk
OK…this is a funny edit of mating behavior: http://youtu.be/sde06NqYi9A

H. Are spiders really dangerous?

1. Most fear spiders without good reason.
2. Spiders are allies of humans in our battle with _____.
3. American tarantulas rarely bite and the bite is not dangerous.
4. Below is a map (*Discover* 2005) of the distribution of dangerous spider species in the U.S.



Yellow sac spider – throughout USA

Black Widow – throughout USA

Hobo spider

Brown Recluse - *Loxosceles recluse*

Other brown recluse species

I. Species of **black widow spiders**
(_____) are dangerous.
They are distributed worldwide. There are 3 species in the U.S.

A. They are called black widows because it was believed they always ate their mate (the male).

1. They do in captivity. This occurs rarely in nature, only when the female is very hungry.

B. The venom is _____.

1. Some people are slightly affected by the venom, while others may have a severe response.
    a. Rarely fatal – only small children and the elderly are typically at risk of death.
2. The first (typical) symptom is acute pain at the site of the bite
3. The local pain may be followed by localized or generalized severe muscle cramps, abdominal pain, weakness, and tremor. In severe cases, nausea, vomiting, faintness, dizziness, chest pain, and respiratory difficulties may follow.
4. Symptoms often diminish after a day or so and cease after several days.

J. The **brown recluse** (_____) spider has _____ venom that destroys tissue around the bite.

1. The venom is extremely poisonous, even more potent than that of a _____.
2. Recluse venom causes less disease than a rattlesnake bite because of the small quantities injected into its victims.
3. This venom is a collection of enzymes that causes destruction of local cell membranes, leading to local breakdown of skin, fat, and blood vessels.
    a. This process leads to eventual tissue death called _____ in areas immediately surrounding the bite site.
    b. Bites often go unnoticed initially because they are usually _____bites.
    c. Many brown recluse bites cause just a little red mark that heals without event.
        1) The vast majority of brown recluse bites heal without severe scarring.

4. Symptoms usually develop 2-8 hours after a bite and can include…
    a. Severe pain & itching at bite site
    b. Nausea, vomiting, and fever
    c. Myalgias (muscle pain)
5. Initially the bite site is mildly red; the redness gives way to pallor with a red ring surrounding the area, or a "bull's-eye" appearance.
6. The center area will then often _____, which over 12-48 hours can sink, turning bluish then _____ as this area of tissue dies.
7. This can leave a deep, infected wound that enlarges, fails to heal, or heals slowly over 6 to 8 weeks, often leaving scarring behind.
8. Treatment for severe bites includes both _____ (to stop the immune response) and _____ (to combat infection of the wound)

K. Black widows and brown recluses are the only *native US* spiders that are dangerous.

1. Some Australian and South American spiders are the most dangerous and aggressive.
2. There are two introduced spiders that are dangerous and are becoming more common in the U.S.
    a. The yellow (golden) sac spiders (*Cheiracanthium mildei)*
    b. 9) The hobo spider, *Tegenaria agrestis*

L. **Yellow (golden) sac spiders (*Cheiracanthium mildei)***

1. **How it was introduced**: accidentally shipped to US in agricultural products, especially grapes.
2. **Where it is found**: well-established in California, the Pacific Northwest, and southeastern Idaho.
    a. Because they were shipped with grapes, they are probably distributed throughout the USA.
3. **Bites**: more aggressive than native venomous spiders. They are very prone to bite defensively
    a. It is likely that many U.S. cases of necrotic arachnidism ascribed to the brown recluse spider outside of its natural range, are actually yellow sac spider bites.

b. Bites generally produce instant, intense stinging pain, not unlike that of the sting of a wasp or hornet.
c. May be followed by localized redness, swelling and itching; these manifestations may or may not evolve into a necrotic lesion, but when that occurs healing is usually complete within eight weeks.
d. Systemic effects are *usually* not severe, but when they occur may include chills, fever, headache, dizziness, nausea, anorexia, and sometimes shock.

M. **The hobo spider, *Tegenaria agrestis***

1. **How it was introduced**: Accidentally shipped from western Europe as egg sacs in commercial shipping vessels to Port of Seattle sometime before the 1930's.
2. **Where it is found**: By 1968 it had become established as far east as Spokane, Washington and Moscow, Idaho, and as far south as Corvallis, Oregon.
    a. The hobo spider is now the leading cause of serious envenomation in the northwestern United States.
3. **Bites**: Typically, defensive bites by the hobo spider are lightning fast, then the animal withdraws

rapidly. Very often the bite itself is painless.

a. Local effects are almost identical to those produced by brown recluse spider.

b. Systemic, or generalized effects are seen in about 45% of persons envenomated by hobo spiders.

c. The most common reported symptom is severe headache, which usually does not respond to over the counter analgesics.

d. Victims may experience a dry mouth, nausea, weakness and lethargy, dizziness, visual disturbances, hallucinations, joint pain and/or other undesirable effects.

e. About 15% of envenomated subjects are poisoned severely enough to require hospitalization.

1. In rare cases *aplastic anemia* (bone marrow failure) can develop several weeks after the bite, which results in a fatal outcome.

VII. Phylum Arthropoda - Subphylum Chelicerata – Class Arachnida – Order Scorpionida

A. Scorpions are more common in tropical and subtropical zones but do occur in temperate areas.

B. They are _____ and feed largely on insects and spiders.

C. Sand-dwelling scorpions locate prey by detecting surface waves with their leg _____.

D. The cephalothorax has the appendages, a pair of medial eyes and 2-5 lateral eyes.

E. The _____ has seven segments.

F. The _____ has five, long, slender segments that end in a telson.

1. We call the _____ the tail.
2. We call the _____ the stinger.

G. Under the abdomen are comblike _____ that explore the ground and help in sex recognition.

H. The stinger on the last segment has venom that varies from mildly painful to dangerous.

I. Scorpions perform a mating dance where the male guides the female over the _____ (a structure that stores his sperm and that he has attached to the substrate before mating).

1. Watch this! http://youtu.be/UX-jk1H2aDM

J. Scorpions are ovoviviparous or viviparous and produce from six to 90 young.

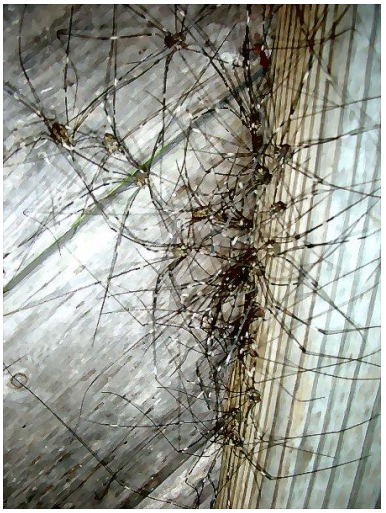
K. Of the many species of scorpions in the United States, only one is considered to be life-threatening. This is the bark scorpion, *Centruroides sculpturatus* (actually a synonym of *C. exilicauda*) found in the Sonoran desert of Arizona.

1. The venom causes a stinging or burning sensation at the injection site, often with very little swelling or inflammation, but always with a positive "tap test" (i.e., extreme pain when the sting site is tapped with a finger).
2. Systemic reactions include progressive hyperactivity (restlessness) progressing to convulsions, "roving eyes," ataxia (staggering gait), thick tongue sensation, slurred speech, drooling, hyperesthesia (excessive sensitivity of skin), muscle fasciculations (twitches), abdominal pain and cramps, and respiratory depression.
3. These symptoms usually subside within 48 hours.
4. Systemic reactions to scorpion stings (even to the sting of the bark scorpion) are rare.

VIII. Phylum Arthropoda - Subphylum Chelicerata – Class Arachnida – Order Opiliones

A. Order Opiliones: **Harvestmen**

1. Harvestmen or daddy longlegs are common, particularly in tropical regions.
2. Unlike spiders, their abdomen and cephalothorax join broadly without a narrow pedicel.
3. They can lose most of their eight long legs without ill effect.
4. They often congregate in large groups.
5. Their chelicerae are pincerlike and they feed more as scavengers than do spiders.
    a) Myth: Their venom is extremely toxic to humans.
    b) Their venom isn't extremely toxic.
    c) Their fangs are too short to puncture human skin.



IX. Phylum Arthropoda - Subphylum Chelicerata – Class Arachnida – Order Acari

A. Order Acari: **Ticks and Mites**

a. Acari are medically and economically the most important arachnids.
b. About 30,000 species have been described, many more are estimated to exist.
c. They are both aquatic and terrestrial, and inhabit deserts, polar areas and hot springs.
d. Most mites are **less than 1 millimeter long**; ticks may range up to 2 cm.
e. Acarines have complete fusion of cephalothorax and abdomen with no sign of external segmentation.
f. **House dust mites** are free-living and often cause allergies.
g. **Spider mites** are one of many important agricultural pest mites that suck out plant nutrients.
h. **Chiggers** are larval *Trombicula* mites; they feed on dermal tissues and cause

skin irritation.
i. The hair follicle mite *Demodex* is harmless but other species cause mange in domestic animals.
j. Tick species of *Ixodes* carry **Lyme disease**.
k. Tick species of *Dermacentor* transmit **Rocky Mountain spotted fever**.
l. The cattle tick transmits **Texas cattle fever**.