

Arthropods

- 1) Phylum: Arthropoda
 - a) Arthropods rule the earth!
 - i) They outnumber all other species of animals combined
 - ii) Why are they so diverse?
 - (1) Arthropods have an exoskeleton that is highly protective but doesn't sacrifice motility. However it does limit growth, so when arthropods grow they have to shed their exoskeleton and grow a new one.
 - (2) They have joints and jointed appendages. These provide new methods for locomotion and sensory functions. They also provide a structure for evolution to act on.
 - (3) They have highly efficient trachea system to bring air directly to tissues and cells.
 - (4) Their sensory organs are highly developed
 - (5) Behavioral patterns are highly complex
 - (a) Both **innate** (unlearned) and **learned behaviors** are demonstrated
 - (6) **Metamorphosis** is a progression of changes that allows a species to grow. The stages tend to be very different from the next and each stage is adapted to utilize different niches, which allows a species to exploit diverse resources.
 - b) They span almost every ecological niche and compete for food, space and other resources.
 - c) They also are essential predators, prey, pollinators, and they provide useful items for human use as well (medicine, dyes, silk, honey, wax, etc...)
 - d) Size
 - i) Few exceed 6cm but the largest (Japanese crab) spans 3.7meters and the smallest the parasitic mite less than 0.1mm long
 - e) Feeding
 - i) They have a complete digestive system with digestive glands to aid in breaking down of nutrients
 - ii) Their mouth parts are complex depending on the specific feeding niche, however they come in two types: **chelicerae** and **mandibles**
 - (1) Chelicerae are found on species like spiders. They are basically hypodermic needles used to eviscerate or envenoming prey.
 - (2) Mandibles are jaw like structures used to manipulate food items.
 - f) Circulatory system
 - i) They have open circulatory systems with hearts and hemolymph.
 - g) Respiration
 - i) Terrestrial organisms have breathing holes on the abdomen with individual trachea bringing air to individual tissues and oxygenating the hemolymph.
 - ii) Aquatic organisms almost always use filamentous gills to gather oxygen from water.
 - h) Reproduction
 - i) Arthropods have both male and female forms and reproduce sexually
 - ii) Development takes place in the form of metamorphosis

- (1) **Complete metamorphosis**- these have larvae that are distinctly different from the adult form. They undergo egg to larvae, to pupae, to adult.
 - (2) **Incomplete metamorphosis**- these forms the younger forms closely resemble the adult form except for size.
- i) The phylum is divided into 5 sub-phylum however only 4 still exists today
- 2) Sub-phylum: **trilobita**
- a) These are an ancient group, probably arisen a million years before the Cambrian.
 - b) This group has also been extinct for 250 million years.
 - c) They looked like large pill bugs
 - d) They were bottom dwellers and probably scavengers.
- 3) Sub-phylum: **Chelicerata**
- a) Includes horseshoe crabs, spiders, scorpions, ticks, and others
 - b) This group has 8 walking legs, no mandibles, **chelicerae**, and **pedipalps**.
 - c) They have two segments, a **cephalothorax** and **abdomen**
 - d) **Horseshoe crabs**
 - i) Ancient species who has remained unchanged since the Triassic period.
 - ii) Have a hardened **carapace** a long thin like **telson** or tailpiece and flat “leafy” gills.
 - e) **Sea spider**
 - i) Common in all oceans
 - ii) They walk around drinking juices from soft bodies animals
 - iii) Their abdomen is reduced and only contains the digestive tract, gonads are present in the legs.
 - f) **Spiders**
 - i) 40,000 recognized species
 - ii) They have specialized breathing structures called **book lungs**, which is a series of air pockets in a pool of blood.
 - iii) Spiders have 8 simple eyes
 - (1) Because the vision is usually poor spiders rely on their sense of touch with specialized structures called **setae**.
 - iv) Spiders have the ability to secrete a protein that hardens on contact with the air called silk. Pound for pound this silk is stronger than steel and second in tensile strength only to fused quartz. They can stretch one-fifth of their length before breaking.
 - (1) Some species spin beautiful webs that are very complex. Some include sticky parts to capture prey, support lines to stabilize in the wind, nursery chambers, warning threads, and other structures.
 - (2) Other species make orbs to house themselves and surprise prey.
 - (3) Others make nets to “throw” on potential prey.
 - v) Reproduction
 - (1) Males spin a small web and place sperm on it then fold it up and carry it around with them. He will then undergo courting rituals until a female allows him to deposit the sperm pack into females genital opening.
 - vi) Dangers of spiders

- (1) Spiders do produce venom which as the vast majority is completely harmless to humans. Spiders only bite for food, so biting you is not very advantageous.
- (2) Only two species in the United States pose any threat to humans, the back widow and the brown recluse.
 - (a) Back widows have a neurotoxic venom that kills about 4 or 5 people per 1000 bites. That's only .005%
 - (b) The brown recluse has a hemolytic toxin which attacks tissues. Though this looks bad it is very rarely fatal.
- g) Scorpions
 - i) Have extended abdomen into a long tail with a venom sac and stinger at the end.
 - ii) They feed on insects and spiders, they use their front claws for grasping.
 - iii) Only one species in the United States is potentially dangerous and found in Arizona, New Mexico, and Mexico.
- h) Ticks
 - i) These are parasitic of vertebrates and invertebrates
 - ii) However they carry a greater number of pathogens than any other species except mosquito.
 - (1) They carry, Lyme disease, Rocky Mountain Spotted Fever, Tularemia, and many many others.
- 4) Subphylum Myriapoda
 - a) Has one pair of antennae and mandibles
 - b) Respiration occurs through tracheal systems and skin surface
 - c) Centipedes
 - i) All are active predators of worms and insects
 - ii) Each segment contains one pair of legs
 - iii) The head has a modified appendages to form venom fangs
 - d) Millipedes
 - i) Typically herbivorous living on decaying plant and animals
 - ii) They have 2 appendages per segment
- 5) Subphylum Crustacea
 - a) Lobsters, crabs, shrimp, water fleas, copepods, and barnacles
 - b) Body plan
 - i) Most have a head thorax and abdomen though some have fused together in a few species.
 - ii) They are segmented and each segment has an appendage
 - iii) Some of these appendages are extremely modified to fit a species needs.
 - iv) They have hardened exoskeleton covering their bodies called a **carapace**.
 - (1) In order to grow they have to molt their carapace and grow a new one periodically.
 - c) Feeding
 - i) This varies greatly from one species to another.
 - ii) However all use their front walking legs for food capture and **maxillae** to shred food and deliver it to the mouth.

- iii) Claws seen in many crustaceans are adaptations mostly used for defense or mating rituals but some do hunt with them
 - (1) The pistol shrimp
 - d) Respiration and circulation
 - i) Circulatory system is open but they do have a heart and vascular gills
 - ii) Gills come in many shapes some are outside the carapace while some are located behind the carapace and require the organism to pump water to them.
 - e) Reproduction
 - i) Almost all crustaceans have different sexes and reproduce sexually
 - ii) In most cases fertilization takes place externally and eggs are released into the water, however some species do carry their eggs around with them to protection and aeration.
 - iii) Blue crab example
- 6) Subphylum hexapoda
 - a) Have head thorax and abdomen
 - b) Have 6 legs
 - c) Includes the most divers of the arthropods (insects) and a few other smaller groups.
 - d) Insects
 - i) Represents half the known life on earth
 - ii) Body structure
 - (1) Segmented bodies supported by an exoskeleton made of **chitin**
 - (2) Three segments
 - (a) Head is the location of the sensory organs (eyes, mouth)
 - (b) Thorax has 3 pairs of legs, possibly wings
 - (c) Abdomen which is segmented but no other major external structures except in specialized forms
 - iii) Nervous system
 - (1) Though most organisms we have talked about recently have had well developed nervous systems with “brains”, nerve cords, and many sensory structures (touch receptors, light receptors, etc...), however insects are the earliest taxonomic group to have developed **nociceptors** (pain receptors).
 - iv) Digestion
 - (1) Though the digestive tract is similar to most other arthropods, insects also have a well-developed hind gut for a terrestrial lifestyle. The hind gut absorbs 90% of water from its diet.
 - v) Respiration/ circulation
 - (1) Insects have an open circulatory system
 - (2) They do not however have any lungs or gills
 - (3) they take in air through tubes in the abdomen and diffuse it through the body with help from a heart like structure
 - vi) reproduction
 - (1) because of the diversity in habitats and niches of insects there is no one method or reproduction

(2) Some fertilize internally while others fertilize eggs that have been deposited.

vii) Life cycle

(1) Insect exhibit both complete and incomplete metamorphosis

(a) Incomplete

(i) Dragonflies

(ii) Stone flies

(b) Complete

(i) Butterflies

(ii) Flies

(iii) Bees/ wasps/ ants

viii) Special adaptations

(1) Socialization

(a) Colony forming ants wasps, and bees have evolved the highest level of social interaction that would normally only be given to humans.

(b) They collectively care for their young (including the young of others in their colony)

(c) There are overlapping generation in an adult colony

(d) They have a division of labor

(e) They have reproductive and non-reproductive groups

(f) Some entomologists (those who study insects) call these colonies “super organisms” because they function as one unit.

(g) Honey bees are one of the only groups of non-human organisms to develop a symbolic communication method called dance language.

(2) Flight

(a) Insects are the only non-vertebrate to develop flight

(b) Despite popular belief bumblebees can fly well within the laws of physics

(3) Defense

(a) Insects are relatively soft and would make a great meal to a passerby

(b) Camouflage is a very effective way to stay out if predators ways and some (like the walking stick) have mastered that art.

(c) Poisons also work well at preventing being eaten, the monarch butterfly feeds only from the milkweed plant which is toxic to most animals. These toxins make the butterfly taste horrible so predators have learned to avoid this butterfly

(i) The viceroy butterfly has a pattern that mimics the monarch but actually is completely harmless.

(d) chemical defenses

(i) some ground beetles can produce nasty chemicals internally then when threatened spray them on a predator.

(4) Human use

(a) carmine, cochineal extract or natural red 4 are all red food dyes derived from a beetle looking (though not actually a beetle in the traditional sense) insect

(b) pollination cannot be overstated, without it the world we know would be dead

(i) Many organisms pollinate like bees, wasps, flies and many others.

- (c) Silkworms make silk
- (d) Maggots for wound treatment against gangrene
- (e) Defense against pests and unwanted bugs