

Insect Anatomy and Physiology



Dr. Jonathan L. Larson
Extension entomologist

What is an insect?

Gross
Destructive
Strange
Beautiful
Fascinating

But, where do they fit into the larger Animal kingdom? How do they work?

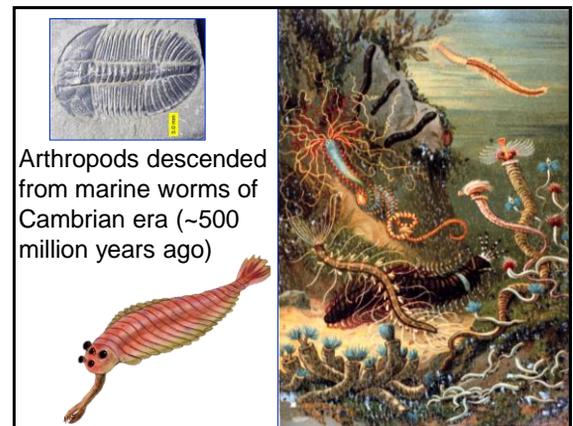
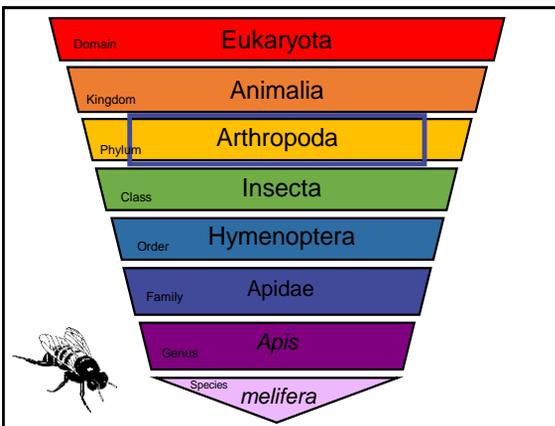
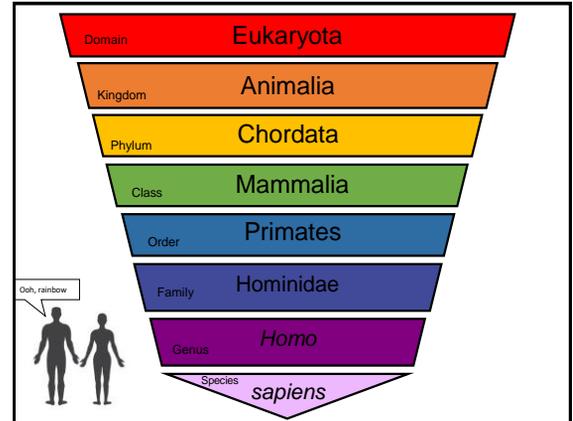


Arthropoda: A phylum of animals more commonly known as arthropods

Insects are one of the representative classes within Arthropoda

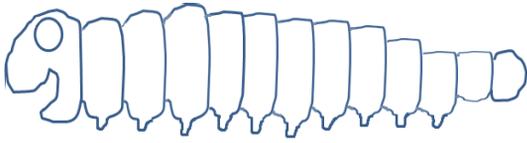


Most of life on Earth is a member of phylum Arthropoda!



Arthropods descended from marine worms of Cambrian era (~500 million years ago)

Once upon a time...



Enid, the ancestor to arthropods

Precursor to insects?

Onychophora

- Articulated appendages
- Mouthparts
- May be early ancestor or sister group

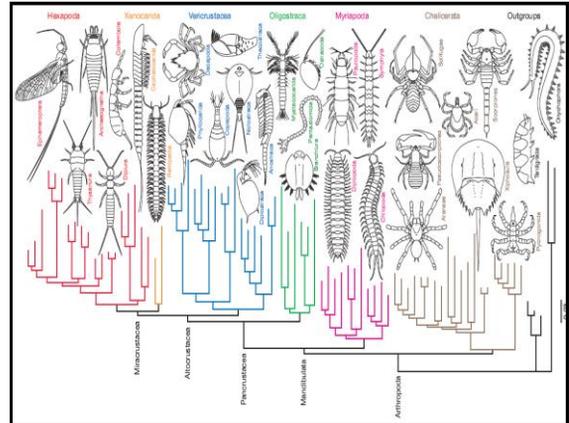


Velvet Worm

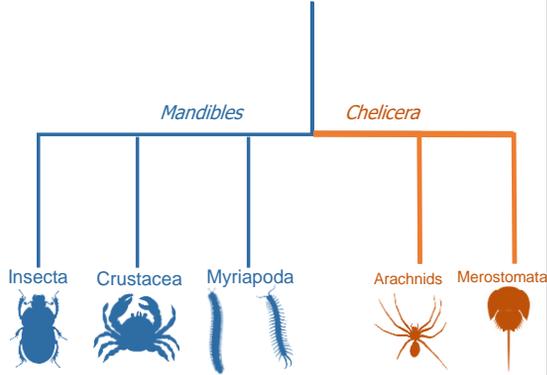
First known land animal



Pneumodesmus newmani



Arthropoda



Uniting traits of arthropods

First is hidden in the name "Arthropoda"

Greek

ἄρθρον; árthron: meaning joint
 πούς; pous (podos): meaning foot



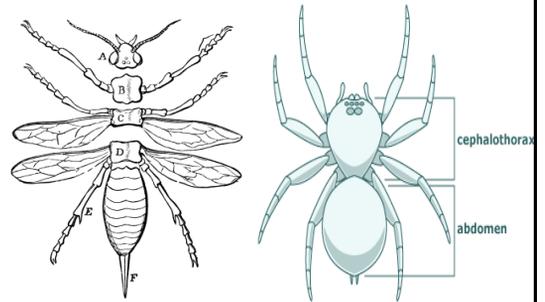
©Warren Photographic

1. All arthropods have jointed appendages

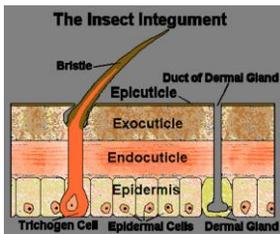
2. All arthropods have bilateral symmetry



3. Arthropods have segmented bodies

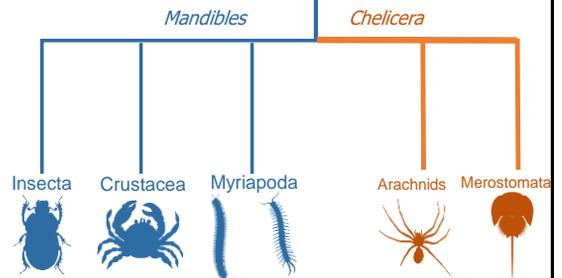


4. Arthropods have an exoskeleton, a waxy cuticle over whole body

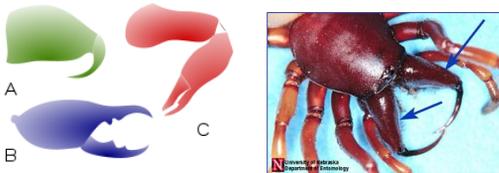


"A suit of armor" provides protection from attack or injury, Muscles attach directly to the body wall, stops fluid loss

Arthropoda



Arthropods with chelicera lack jaws, chelicera can chop food/inject venom



The end result of feeding can be a crunched up ball or a hollow body

Merostomata (*Thigh mouth*): Sea scorpions and horseshoe crabs



All have book gills, 6 pairs of appendages, and a pair of compound eyes

Only extant members of merostomata are the horseshoe crabs



Have been around for 450 million years, are considered living fossils

Arachnida (Spider): All arachnids

Scorpiones



Acari

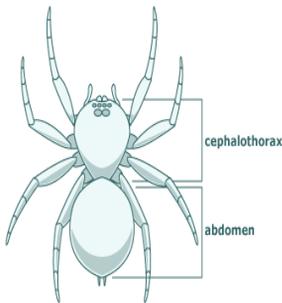


Aranea



Scorpions, ticks, mites, spiders, etc.

Traits: 2 body segments, no antennae, 4 pairs of legs



All other arthropods have mandibles



Myriapoda (Many legs): Centipedes and their cousins the millipedes

Centipedes



Millipedes



Common traits: 1 pair of antennae, 1 pair of legs per body segment, flat bodies, venomous jaws

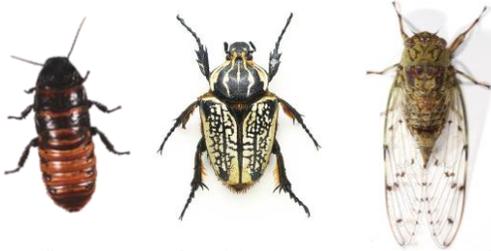
Common traits: 1 pair of antennae, 2 pairs of legs per body segment, round bodies, decomposers

Crustacea (Hard shelled ones): Crayfish, lobsters, shrimp, etc.



Common traits: 2 body segments, 2 pairs of antennae, 5-7 pairs of legs, swimmerets or gills

Insecta (Cut into sections): All of the insects

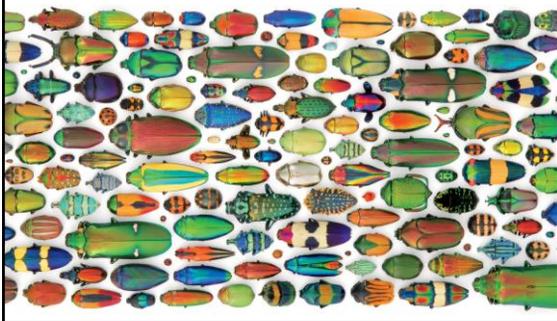


Common traits: 3 body segments, 1 pair of antennae, 3 pairs of legs

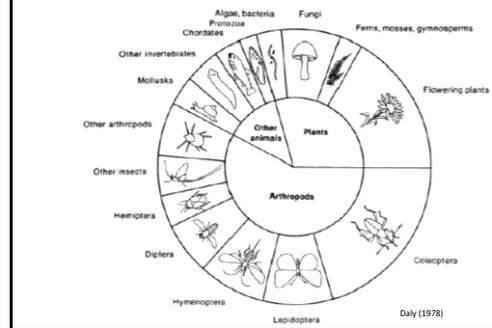
Photos by Alex Wild:
<http://www.alexanderwild.com/>

Despite looking wildly different, these are all insects!!

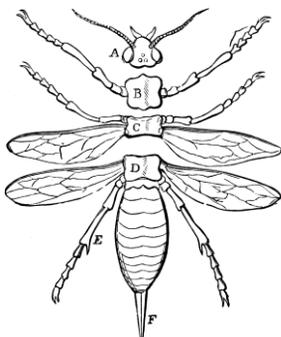
Most biodiverse group on Earth: There are more than 1 million species identified



Possibly upwards of 30 million species in existence



How to build a bug!



Just let me fasten these together, then we can get lunch.

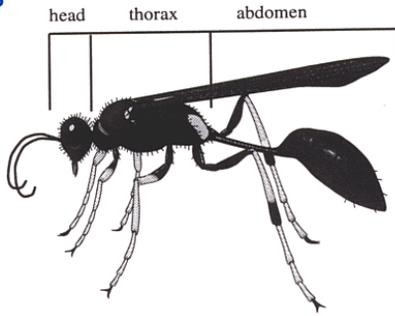


We will remove some of the mystery of insects

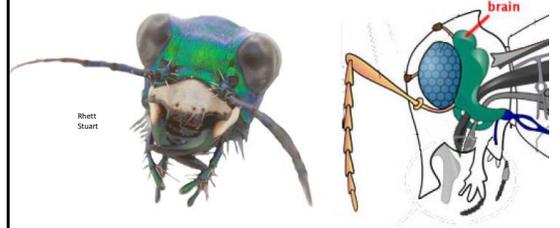


Understanding insect anatomy helps with identification and pest management strategies

Insects have 3 distinct body sections



The Head: Serves as the center for sensory input from sensory organs



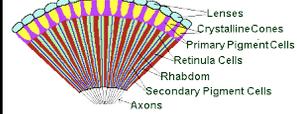
Also houses the insect's largest ganglion

Some have ocelli, or simple eyes. These perceive light and dark



Insects have one pair of compound eyes

Transverse Section Through An Insect Eye



Made up of many facets that create a composite image

Compound eyes detect movement, make insect nearsighted



Insects also perceive color differently than us



All insects come with a pair of antennae, located on head



Antennae are for smelling, touching, and even hearing

Antennae can tell the insect they are touching something delicious to eat



Or, could help them orient towards a food source

Antennae also detect pheromones (a hormone that affects fellow individuals)



Aggregation



Alarm



Epideictic



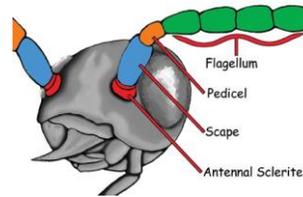
Trail



Sexual

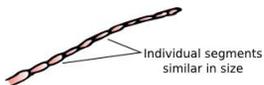
Pheromones differ from sight or sound signals as they travel slowly, do not fade quickly, and are effective over a long range

All antennae are divided into 3 parts



Scape, pedicel, and flagellum; will help with identification!

Filiform antennae: Segments are same size, threadlike in appearance



Most common type of antennae

Pectinate and Plumose

Suggestive of a comb



Feather-like



Lots of surface areas to pick up more info

Chewing mouths lead to many different types of damage/symptoms



Piercing-sucking: 2nd most common, can be used on plants or on animals



Needle like mouthparts used to siphon fluids for food

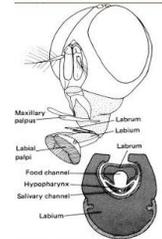
Piercing-sucking creates distinctive damage as well



Plant damage

Skin damage

Sponging mouthparts: Must liquify your food first



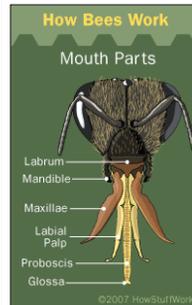
Found mainly on flies

Siphoning mouthparts: Straw like proboscis for liquid food



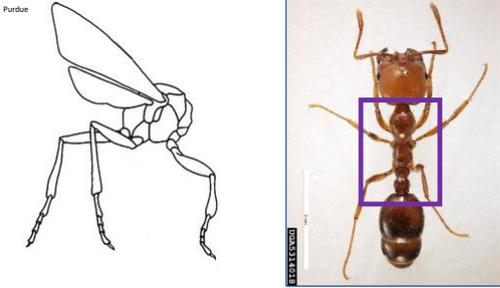
Found mainly on butterflies and moths

Chewing-lapping: Used to consume both pollen and nectar



Wasps, bees, and few others

Thorax: Main purpose is for locomotion, the insect's legs and wings are located here

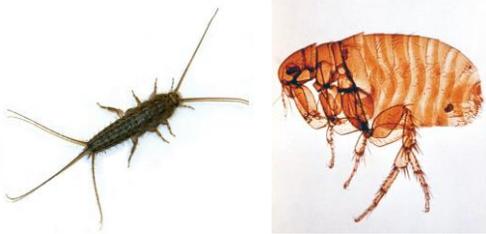


Insects are the only invertebrates to have evolved wings



Wings are usually membranous with veins, wing folding is more advanced

Not all insects have wings though

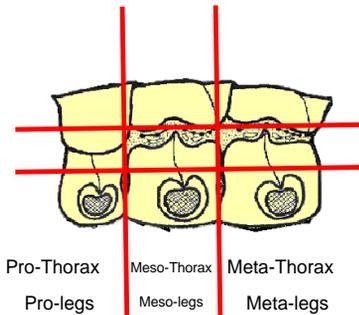


Some have no wings at all, others only have wing pads and they don't develop

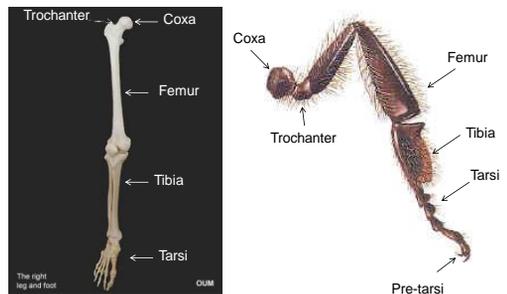
All insects have 3 pairs of jointed legs

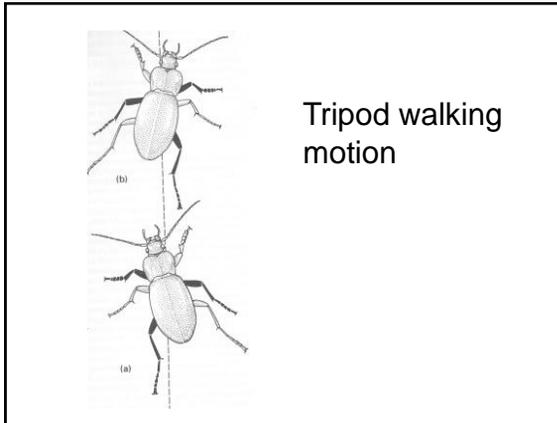


Thorax is a cylinder with 9 pieces

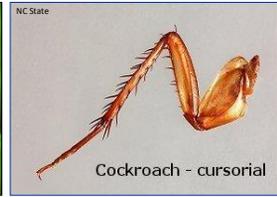


We aren't so different...





Ambulatory Legs: Cursorial, walking, running, or simple legs



Most common of all legs

Saltatorial Legs: Jumping legs



Built very similar to walking legs, difference lies in femur

Clasping: Leg with femur and tibia formed into pincer like structure



Common in lice, used to grasp on to different surfaces.

Different places, different claws



Bird louse on feather

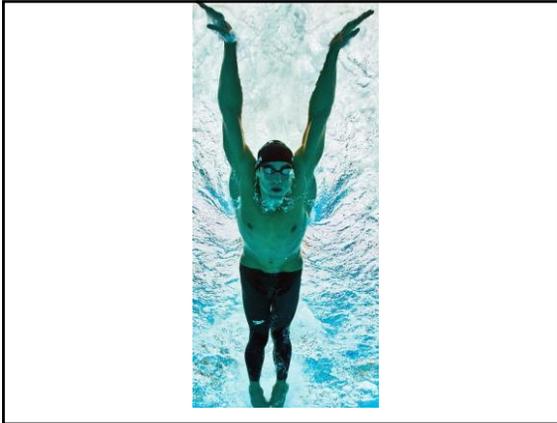


Head lice on human

Natatorial Legs: Swimming legs



Leg flattened into a paddle like organ, typically hairy as well



Fossorial Legs: Digging legs

Tibia or tarsi modified into scraper like organ

Raptorial Legs: Grasping legs

Legs are armed with opposing spines or spurs on the femur & tibia

Abdomen: "The business end"
Externally: Tympanum, spiracles

Internally:
A little bit of: cardiac, nervous, respiration, digestion
Mostly: sexual reproduction

Cronodon

External anatomy: At the posterior end of the abdomen may be cerci or an ovipositor

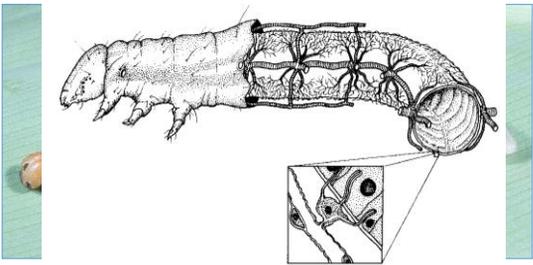
Cerci **Ovipositor**

Tactile organs, sort of like butt antennae Sword like egg laying device, can be defensive

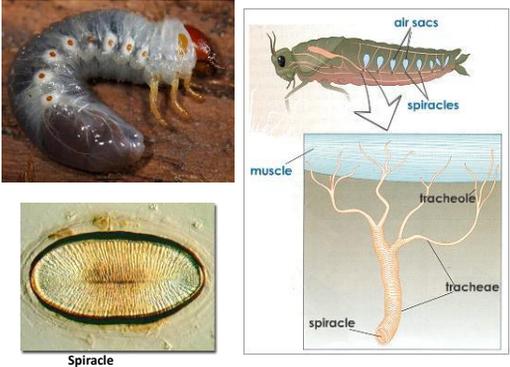
Tympanum: The main type of hearing organ, located externally on abdomen

A membrane stretched across an air sac, it is vibrated by sound similar to our ear drum

Insect Respiratory System: A complex of networked tubes known as a tracheal system

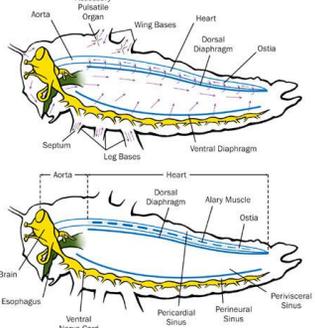


Spiracles are the valve like opening where air enters the body

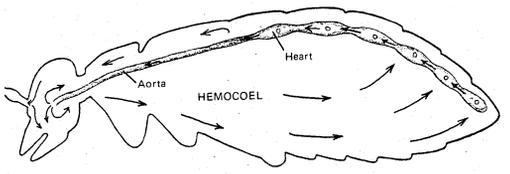


Spiracle

Internal anatomy: Compared to us, the nervous system and circulatory system are reversed

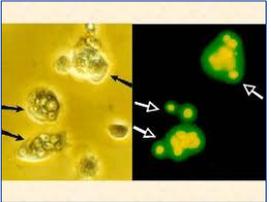


Insects have an open circulatory system, this means their "blood" is free floating, contacting organs



The hearts in the abdomen help pump the fluid forward into the aorta

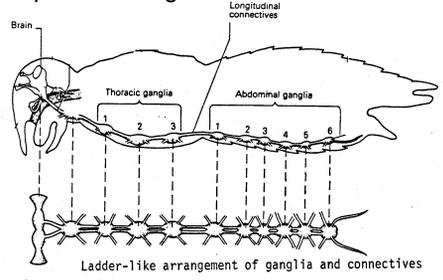
Hemolymph: Insect blood
Carry nutrients to tissues, carry away wastes, function in phagocytosis



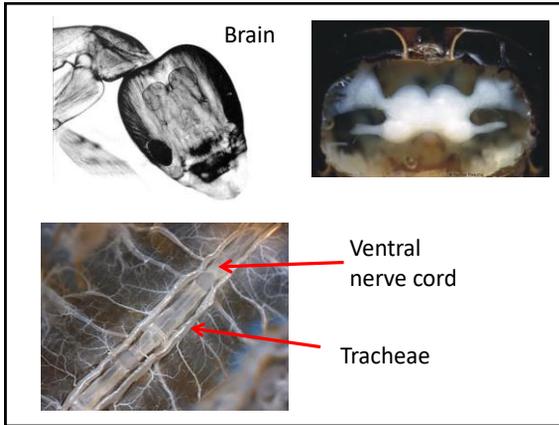
Insect blood cells that have engulfed bacterial or fungal invaders

Unlike human blood, insect blood cells lack hemoglobin and do NOT carry oxygen

Insect Nervous System
More brains than us! Have several ganglia to control particular organs



Ladder-like arrangement of ganglia and connectives

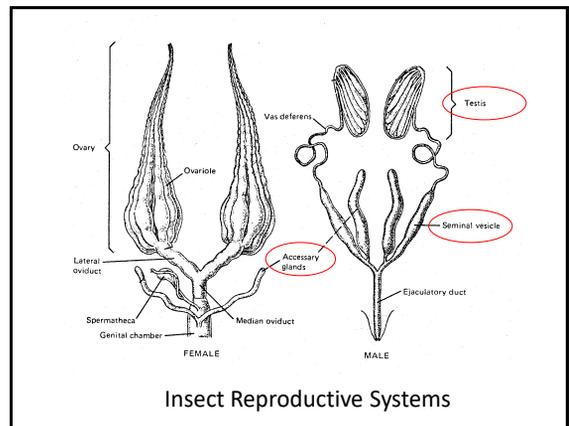
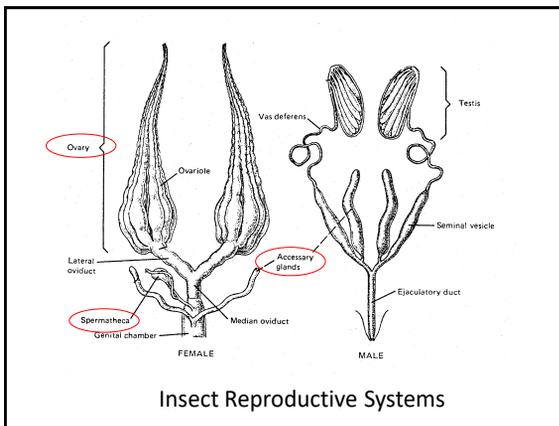


Insect digestion: Insects have a "complete digestive system", meaning there is a mouth and anus rather than a combined organ

The abdomen contains the midgut, where most digestion occurs and the organs responsible for waste production and disposal

Insect Reproductive Systems

Most insects use internal fertilization

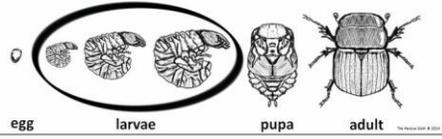


After mating most females will lay their eggs

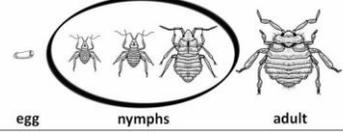


Depending on the insect and its location, the eggs may hatch quickly or overwinter

Complete Metamorphosis



Incomplete Metamorphosis



2 types of development in insects, **Complete and Incomplete Metamorphosis**

