**Insect Anatomy and Physiology**

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**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

First known land animal

*Pneumodesmus newmani*

Uniting traits of arthropods

First is hidden in the name “Arthropoda”

**Greek**

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

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

“Arthropoda

Insecta

Crustacea

Myriapoda

Arachnids

Merostomata

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

Merostomata (Thigh mouth): Sea scorpions and horseshoe crabs

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

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

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:

- 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)

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.
Serrate and Lamellate
- Saw like
- Fan-like, pages in book

Aristate and Setaceous
- A balloon with a plumose antennae
- Like a thin mustache
- Only on flies
- On fast fliers

Geniculate aka elbowed

Capitate and Clavate
- Capitate
- Clavate
- Capitate and Clavate Insect Antennae After Edward Muenzer (1857)

Insect mouthparts come in many shapes and size, can be diagnostic

Chewing mouth: Most common
- Appears in many groups, both herbivores and predators
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**

**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

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

- **Cerci:** Tactile organs, sort of like butt antennae
- **Ovipositor:** 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.

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

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

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

**Insect Nervous System**
More brains than us! Have several ganglia to control particular organs
The scene seen through my macro tube was quite horrifying, also because in this case, the female started eating her partner before the mating, beginning from his mouth, after immobilizing his claws, in order to leave him without defenses. After that, the male, totally deprived of his head, completed the mating, while the female continued eating him.

**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.