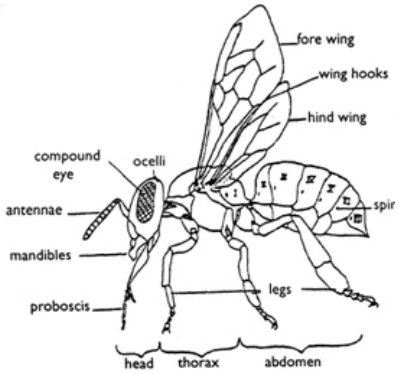
HONEY BEE ANATOMY

Adapted for the ESHPA "Bee Wellness Workshop" from materials provided by the Cornell Cooperative Extension
by Christina Wahl, Ph.D. (Physiology)
Wells College and Cornell College of Veterinary Medicine

When examining a bee with the dissecting scope, consider the following points. Do this in the order given. By following the guide you will not damage any structure before you have a chance to look at it.



Basic principles:

1. Three large body segments:
    a. Head
    b. Thorax
    c. Abdomen

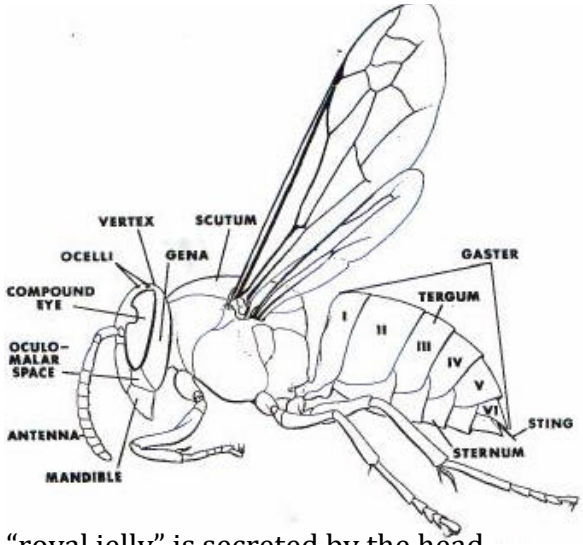
2. No internal skeleton, the "skin" of the bee is its skeleton
    a. Made of chitin, similar to our fingernails and hair (keratin)
    b. Coated with wax that helps prevent dehydration
    c. Covered with fine hairs, these hairs are very important for:
        i. Sensation of the surroundings
        ii. Modifications that allow the "pollen basket" to function
    d. Having an exoskeleton means that growth is not possible unless the whole skin is shed ("molting"). Only larvae and pupae of bees shed their skins during growth. Adult bees do not grow.

What you can't see on the outside:

3. The honeybee circulatory system is open.
    a. All insects have open circulatory systems. This means that their blood bathes the body's tissues directly, since the larger blood vessels are open-ended.

4. Respiration involves an elaborate series of hollow vessels called "tracheae".
    a. Instead of lungs that transfer oxygen to the blood and from there to the cells that need it, as in our system, insects have *tracheae*, a system of closed air tubes connected to *spiracles*, or **holes in the body wall**. If you look closely along the abdominal **tergites**, you will see spiracles (see the diagram above for location of some of the spiracles). Air is sucked into the body by an accordion-like expansion of the abdomen and then pushed through the tracheal tubes right to the cells that need it. Gas exchange is thus direct to the tissues.

Head:



1. Most sensory information is acquired by the head
   - Vision
   - Gustation
   - Olfaction
   - Proprioception (tactile)
   - Auditory

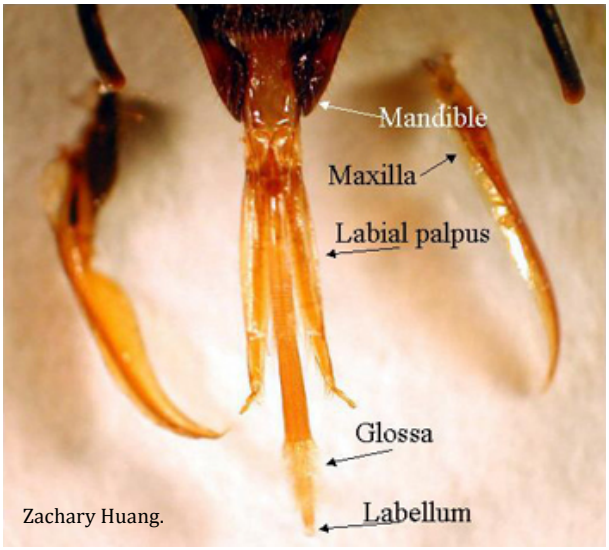
Nectar is sucked from blossoms, food is consumed, and "royal jelly" is secreted by the head.

2. Structures of the head

   a. Antenna(e)
      a. Composed of a "scape" attaching it to the head, a "pedicel" or small joint, and a "flagellum" where most of the sensory parts are located
      b. Thousands of sensory organs
         i. Mechanoreceptors (sense of hearing)
         ii. Odor receptors
         iii. Gustatory receptors

   b. Eye(s)
      a. Two large compound eyes
         i. Ommatidia are tiny functional "eyes" composed of lens and retina, just like our eyes, but there are thousands of these per compound eye.
         ii. Bee eyes are hairy! There are hairs distributed among the ommatidia
         iii. Drones have the largest compound eyes
      b. Three simple eyes
         i. The simple eyes provide circadian information about daylength and light intensity.

   c. Mouth
      a. Honeybee mouthparts can both chew and suck (some insects can do either one or the other but not both). They can suck with the proboscis and chew with their mandibles.
      Bees bite pests (like mites) with their mandibles. They transfer liquids to each other (trophallaxis) with their proboscis.



What you can't see on the outside:

d. Inside the head is the brain of the bee.
e. The head contains glands, including:
    a. The "corpora allata" near the esophagus, which makes juvenile hormone
    b. The "corpora cardiaca" on the walls of the aorta near the brain makes "prothoracicotropic hormone", or PTTH. PTTH can stimulate the production of ecdysteroids, by a gland located in the thorax, the prothoracic gland. These, in turn, stimulate molting.
    c. The mandibular gland, this simple sac-like gland is attached to the mandibles and in the queen, it is the source of the powerful queen pheromone. In young workers, it produces some components of the royal jelly. In old workers, it makes alarm pheromone.
    d. The hypopharyngeal gland. In young workers, this makes protein-rich secretions that contribute to royal jelly. In old workers, it makes invertase, an enzyme that breaks down polysaccharides into simple sugars.
    e. The salivary glands make saliva, and bees use it to alter the physical properties of wax.

Thorax:

1. The thorax is the center for locomotion. It has three segments, each with a pair of spiracles for letting in air, a pair of legs, and the last two segments each have a pair of wings.
2. Legs
    a. Some parts of the leg are named just like human leg bones.
        i. Femur: Segment closest to the thorax
        ii. Tibia: Attached to the femur
        iii. Basitarsus: Attached to the tibia
        iv. Claws and arolium (tarsi): foot parts.

    b. On the front leg there is a special structure used to clean antennae.
    c. On the rear leg there is a structure called the corbicula, or pollen basket. It is a concave surface with hairs on the edges and a central long bristle that goes through the pollen pellet or propolis so the load stays put while the bee is flying.
3. Wings
    a. The front wings are larger than the hind wings.
    b. The two wings are connected by wing hooks on the hind wing that hitch into a fold on the rear edge of the front wing.
    c. Two sets of very powerful muscles power the wings. You can peel off the thorax and see these. The wing muscles work against the natural elasticity of the thoracic exoskeleton. When the longitudinal muscles contract, they pull in the side walls of the thorax, making it "taller" and pulling the wings down (power stroke). When the vertical muscle

contracts, it pulls in the upper and lower walls of the thorax, raising the wings (this latter effect is aided by the recoil properties of the exoskeleton). Honey bee flight muscles contract several times for each nerve impulse, making them very fast.

Abdomen:

1. Workers, drones, and queens are easily distinguished by the size and shapes of their abdomens. The abdomen is the center for digestion and reproduction. It also houses the principle defense mechanism of the honeybee: its sting.
2. Between sternites on the lower side of the abdomen are the openings of wax glands. Workers around 6-12 days old can make wax scales in their four pairs of wax glands. The wax is almost transparent until the workers chew it up and add saliva. Then it becomes more whitish.
3. Respiratory spiracles are seen along each side of the abdomen, one pair per tergite.
4. Digestive tract
    a. Esophagus: starts in the mouth, passes through the head and thorzx, and connects to the:
    b. Crop: where nectar and honey are stored, then comes the:
    c. Proventriculus: a sceritized tooth-like valve that prevents the contents of the crop to enter the
    d. Ventriculus: this is the midgut and largest part of the intestine. It is the functional stomach. Attached to the junction of the ventriculus with the hindgut are
    e. Malpighian tubules. These are the insect equivalent of the kidneys.
    f. The ileum and the rectum form the hindgut, and are very expandable. This feature allows workers to refrain from defecation for many months during the winter when they are unable to get out and fly.