Biology & Anatomy of a Honeybee

Norfolk County Beekeepers Associations Honeybee Anatomy and Biology

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Updated by Tony Lulek 01/27/13

Biology & Anatomy of a Honeybee

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Placing Bees in the Animal Kingdom

Phylum	Arthropod	External Skeleton, Chitinous, Segmented, Invertebrates
Class	Insecta Hexapoda	Six legged 3 major body parts, head, thorax, abdomen
Order	Hymenoptera	2 sets of joined wings connected by hooks, young develop through metamorphosis, ovipositor modified to stinger
SubOrder	Apocrita	Ants, Bees, and Wasps
SuperFamily	Apoidea	Bees
Family	Apidae	Food exchange, pollen baskets, storage of honey & pollen Over 20,000 species
SubFamily Tribe	Apini	Perennial, social colonies, highly eusocial
Genus	Apis	Honeybees 5 Species (and counting)
Species		Apis florea, Apsi dorsata, Apis ceranna, Apis mellifera and Apils laboriosa (napal))

Species ‘Apis’

a. A. dorsada – Asian, Large, Single Comb, Outside Dwelling
b. A. floria – Asian, Small, Single Comb, Outside Dwelling
c. A. cerana – Asian, Small, Parallel Comb, Cavity Dwelling
d. A. laboriosa – Nepal (But little is knows about it)
e. A. mellifera – Africa/Europe/Mid-East, Parallel Comb, Cavity Dwelling
    - Many Races!

A. cerana

Apis cerana is the natural host to the mite Varroa jacobsoni and the parasite Nosema ceranae, both serious pests of the Western Honeybee. Having coevolved with these parasites, A. cerana exhibits more careful grooming than A. mellifera, and thus has an effective defense mechanism against Varroa that keeps the mite from devastating colonies

Races of species Apis mellifera

- A mellifera mellifera – German
- A mellifera ligustica – Italian
- A mellifera carnica – Carniolan - Yugoslavia
- A mellifera caucasca – Caucasian – Caucasus
- A mellifera scutellata – African
- A mellifera caucasica - Russian
- Hybrids
  - Buckfast
  - Starline
  - …..

Genetic Traits of Races

- Color
- Temperament
- Handling Ease
- Production
- Swarming Tendency
- Winter Hardiness
- Propolizing
- Disease Resistance
- Fecundity – Reproductive Rate
- Cleanliness
- Population of Hive
- Pollen Hoarding
- Honey Hoarding
- Conservation of stores
- Plant preference
- Tongue Length
- Whiteness of Cappings

Biology & Anatomy of a Honeybee

Honeybees are social insects

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Lesson Objectives

After successful completion of this lesson you will be able to describe:
(don't worry, there are none of those creepy labs to do)

1. Three members of the colony
   a) Worker
   b) Queen
   c) Drone

2. Development timeline of a Honeybee and their lifetime functions
   a) Egg (Eggs)
   b) Larva (Larvae – "lar-vee" or "lar-vie")
   c) Pupa (Pupae – "pew-pee" or "pew-pie")
   d) Adult (Adults)
   e) Job responsibilities

3. Anatomy: Three major sections of the bee and several parts of each
   a) Head
   b) Thorax
   c) Abdomen

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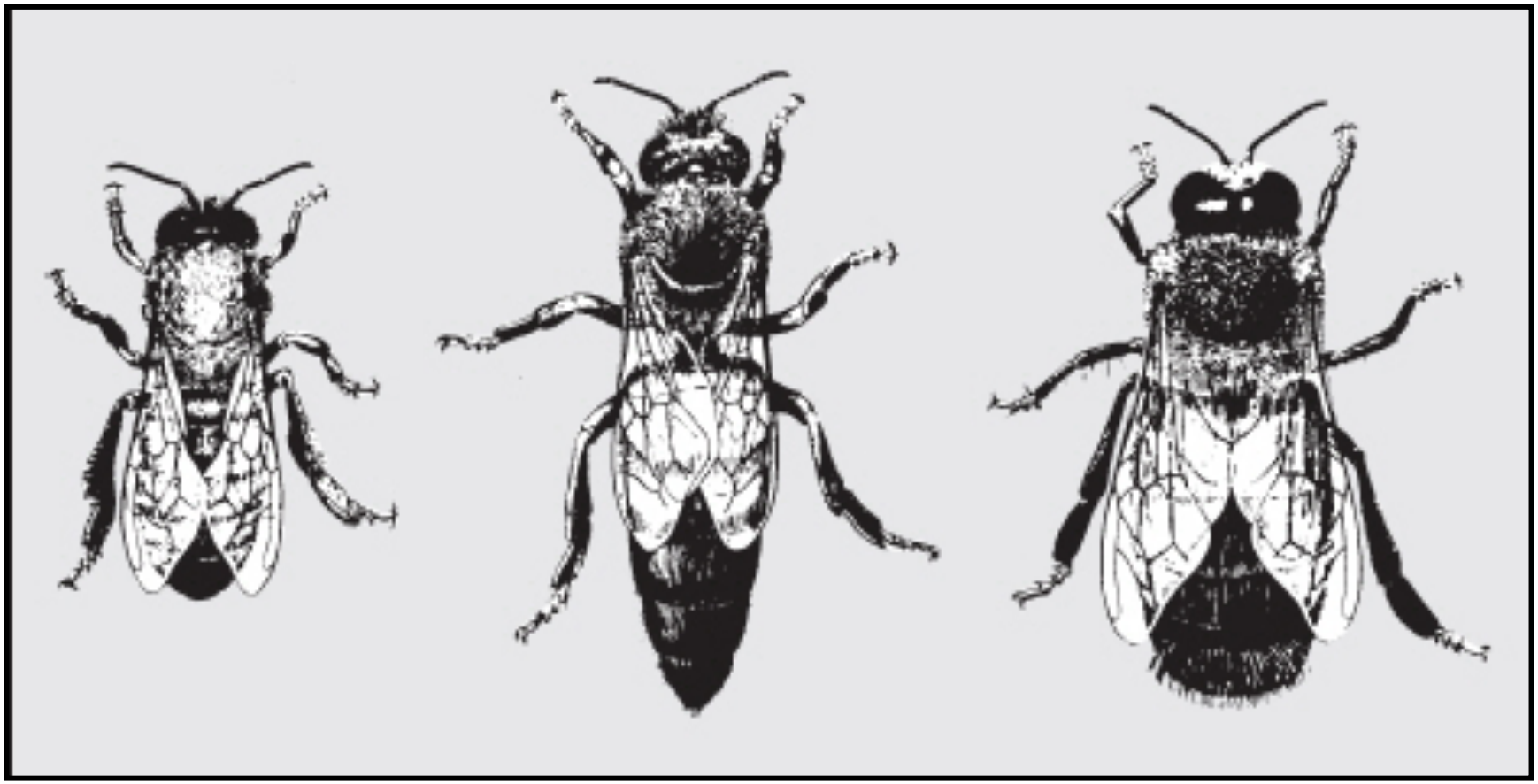
1) Three members of the colony



Worker Queen Drone

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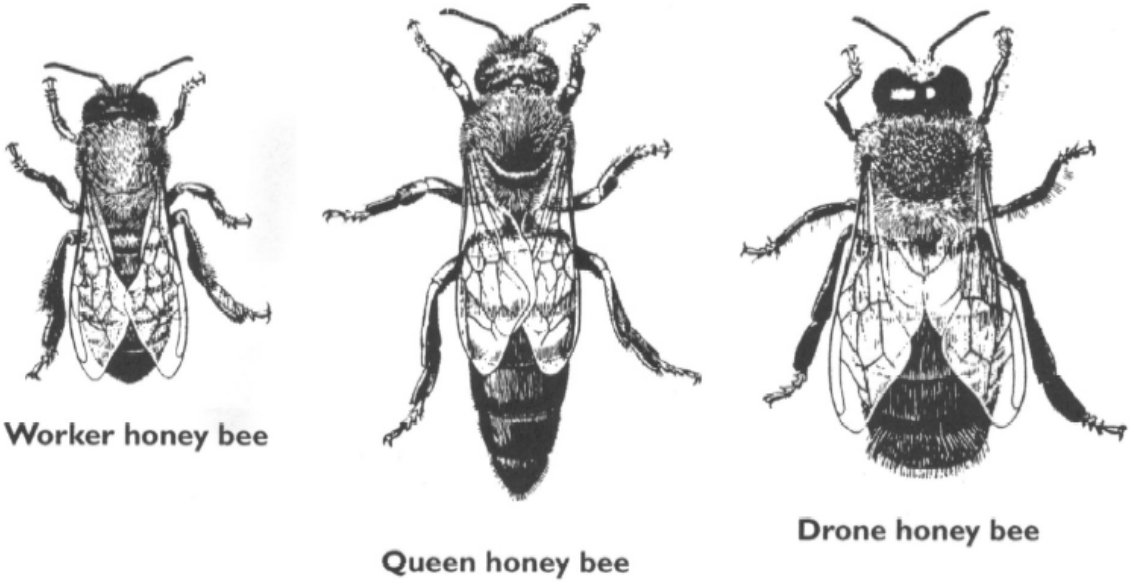
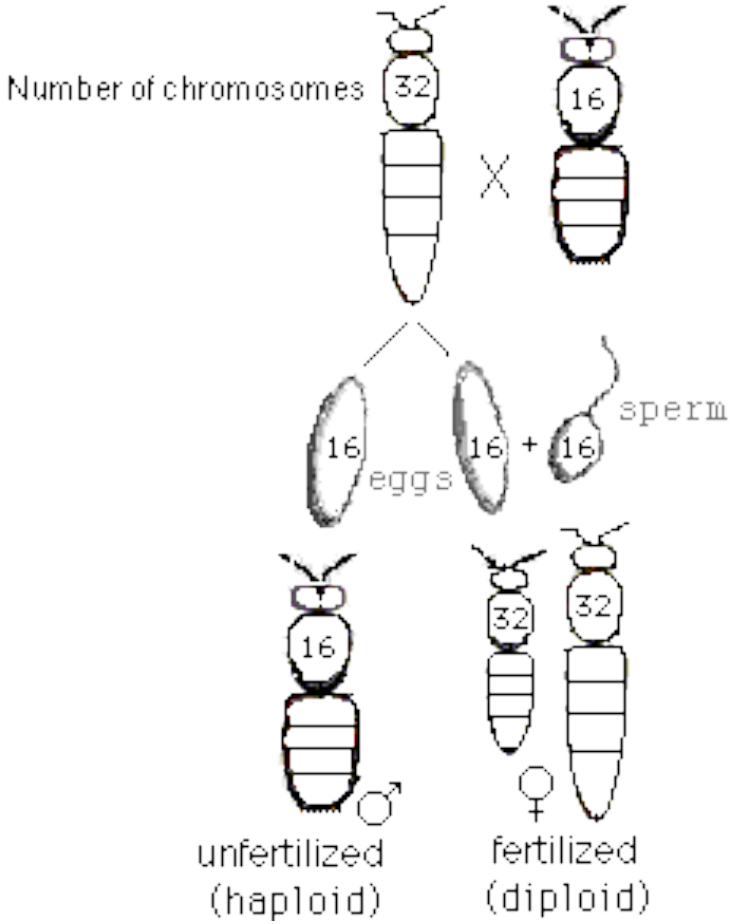


<u>The Worker</u> (female bee) does all the work of the colony. A colony may have between 50,000 and 75,000 bees.

<u>The Queen</u> (fully fertile female) specializes in producing eggs. She will lay one egg per minute, day and night, for a total of 1500 in a 24-hour period and 200,000 in a year.

<u>The Drone</u> (male bee) may number up to 500 in a colony in Spring and Summer. Their ONLY purpose is to fly from the hive and mate in the air with queens from other colonies.

Honeybee Chromosomes



Genetics

- Females have 32 Chromosomes, 16 from mother, 16 from father
- Males (Drones) have 16 Chromosome, 16 from mother – haploid - parthenogenesis
  - ***NOTE: The Queen has control over whether an egg is fertilized when she lays it.***

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The Worker Bee

- Female but not fertile
  a. Normally does not lay eggs
  b. If she does, they will be drones
- 13,000 to 75,000 in a colony
- Has several functions throughout her life
- Lives about 4 – 6 weeks in the summer
- Lives about 4 – 5 months in the winter
- Stinger has barbs and stays in your skin – used to defend the hive and herself

Worker Bee

- The life of all honeybees starts as an egg, about the size of a comma "," which is laid by the queen in the bottom of a wax cell in the brood area of a hive.
- A worker egg hatches after 3 days into a larva.
- Nurse bees feed it royal jelly at first, then pollen & honey for 6 days.
- It then becomes an inactive pupa.
- During its 14 days as a pupa, sealed in a capped cell, it grows into a worker (female) bee, emerging on the 20th day.
- Workers do everything but lay eggs and mate.
- They build the comb from wax extruded from glands under their abdomen. They clean, defend, and repair the hive. They feed the larva, the queen, and the drones. They gather nectar, pollen, water, and propolis. They ventilate, cool & heat the hive.

Worker Bee Jobs

Never unemployment or a layoff (Well, except for those drones)

- Workers do the work in the bee society. Employment is based on the age of the bee and the needs of the colony. During their life they pass through many job promotions:
- Nurse Bee
  - ✓ 1 – 12 days
  - ✓ Clean own cell and others
  - ✓ Feeding brood (larvae)
- House Bee
  - ✓ 10 – 20 days old
  - ✓ Comb building
  - ✓ House keeping
  - ✓ Undertaker
  - ✓ Ripening honey
  - ✓ Climate control
  - ✓ Secreting/molding wax into cells
  - ✓ Accept and store pollen and nectar from foragers

- House Security
  - ✓ Guard hive and its entrance (some say only about 5% of bees perform this job)
  - ✓ Orientation flights to learn surroundings
- Field Agent
  - ✓ After about three weeks the girls are ready to spend the rest of their lives as **foragers** gathering pollen, nectar, tree resin (that they turn into propolis) and water for the hive. During this time they work themselves to death – literally
  - ✓ Worker bees in the summer only live about six weeks. In the winter they live a leisurely life for several months

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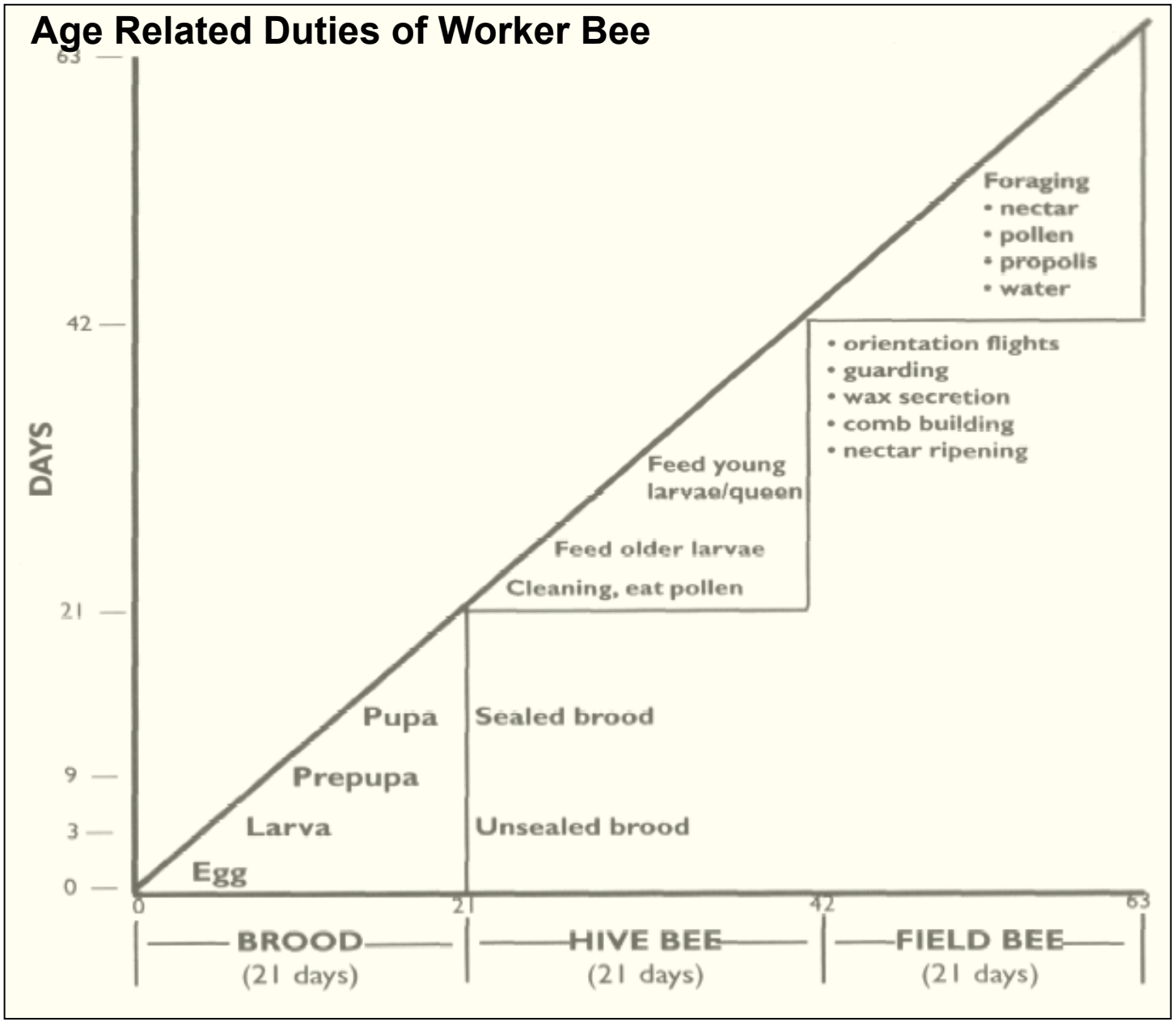
Age Related Duties of Worker Bee



The Queen

- One queen (normally)
- Function: laying eggs
- Can live 2 – 5 years
- Can lay 1500 eggs a day at height of season
- Produces air-borne pheromones ("queen substance") that keep the colony functioning orderly, loyal and protective to that queen
- Stinger does not have barbs – only uses it to kill rival queens

What makes a Queen a Queen?

Feeding a female larva Royal Jelly for the entire larval stage.

The Queen

- **Before an old queen dies, or departs to start another hive, she lays an egg in a large queen cell.**
- **The nurse bees feed the larva a diet of only royal jelly made from a gland on their heads.**
- **In only 16 days a new queen emerges. She seeks out and destroys any rival queens, because there can be only one queen per colony.**

The Queen

- **When 10 days old, a new queen takes a high maiden flight, pursued by drones from nearby hives. She mates with 7 or more of them, storing their sperm for the rest of her life of 2-5 years.**
- **She produces chemical scents which regulate hive activity.**

The Queen

The queen lays about 1200 eggs per day, about 200,000 per season.

This is necessary since worker bees only live 6 weeks in the summertime; and a colony needs to have 40 to 50 thousand bees at its peak.

She is cared for by the worker bees. This queen has been marked with a red dot for easy identification.

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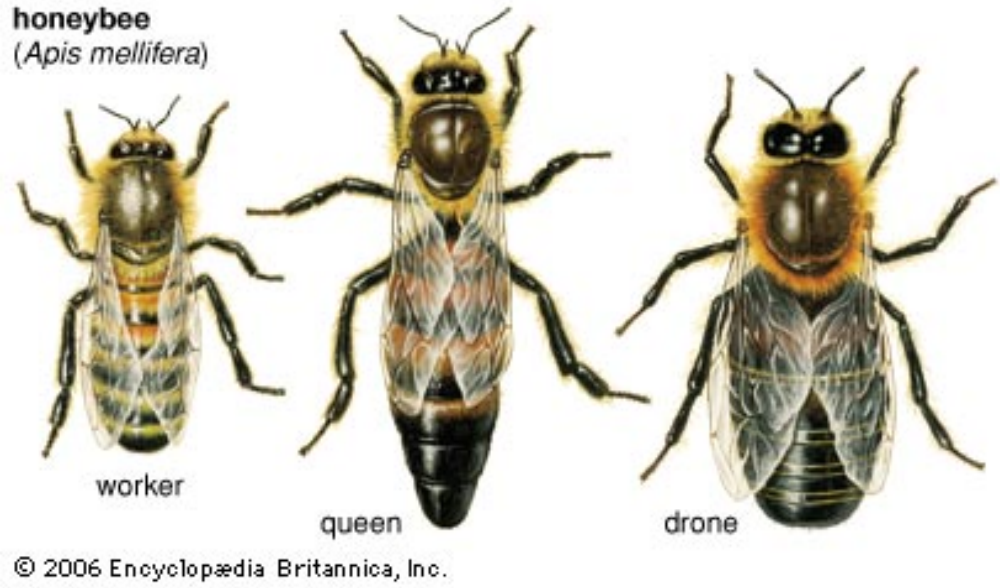
The Drone



- Develops from unfertilized egg - Male
- Larger than workers
- Large eyes & Wings
- Sexually mature at 2 weeks
- One function in life – mate with virgin queens
- Mates once in drone congregation areas at about 300 feet above ground, then dies (maybe not such a good life)
- No stinger (remember, he only has one function)
- Survivors are forced out of hive in the Fall and die
  (definitely not the good life. Maybe if he had another function???)

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The Life Cycle of Honeybees

Table 1. Developmental stages of the three castes of bees.

DEVELOPMENTAL STAGE	DURATION OF STAGES		
	QUEEN	WORKER	DRONE
	Days		
Egg	3	3	3
Larval stage	5 ½	6	6 ½
Pupal stage	7 ½	12	14 ½
Total developmental time	16	21	24

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The Birthing Room – Eggs & Larva(e)

The Birthing Room – Larvae & Pupae

The Birthing Room – Pupae

(cell cut-away showing side view)

Worker Cells

Drone Cells

Queen Cells

Worker cells are horizontal while queen cells are vertical. As the queen larva grows, the cell enlarges and becomes peanut-shaped when capped for the pupal stage of development.

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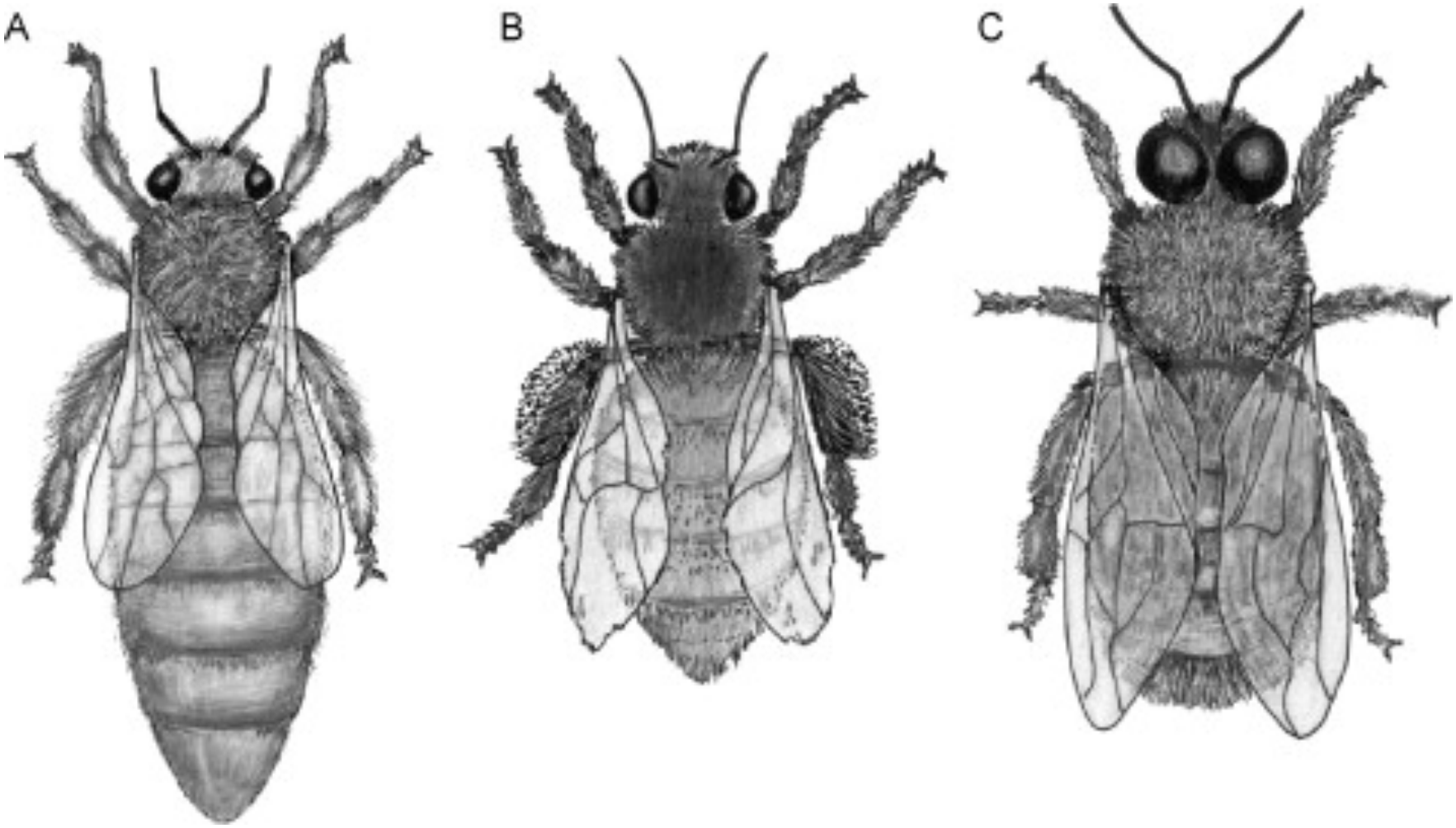
Adults



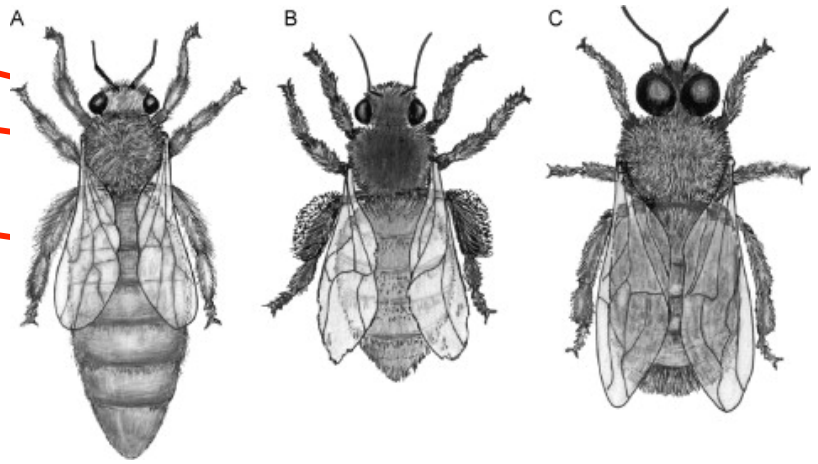
External Anatomy

Bee Anatomy

Insects have a hard outer covering called an exoskeleton, rather than an internal skeleton like vertebrates (humans). The exoskeleton, which is made of a material called chitin, helps to protect the internal organs of the insect and helps prevent desiccation (drying out). In order to grow, the insect must shed the exoskeleton.

The three main sections of the Honeybee's body:

a. Head
b. Thorax
c. Abdomen



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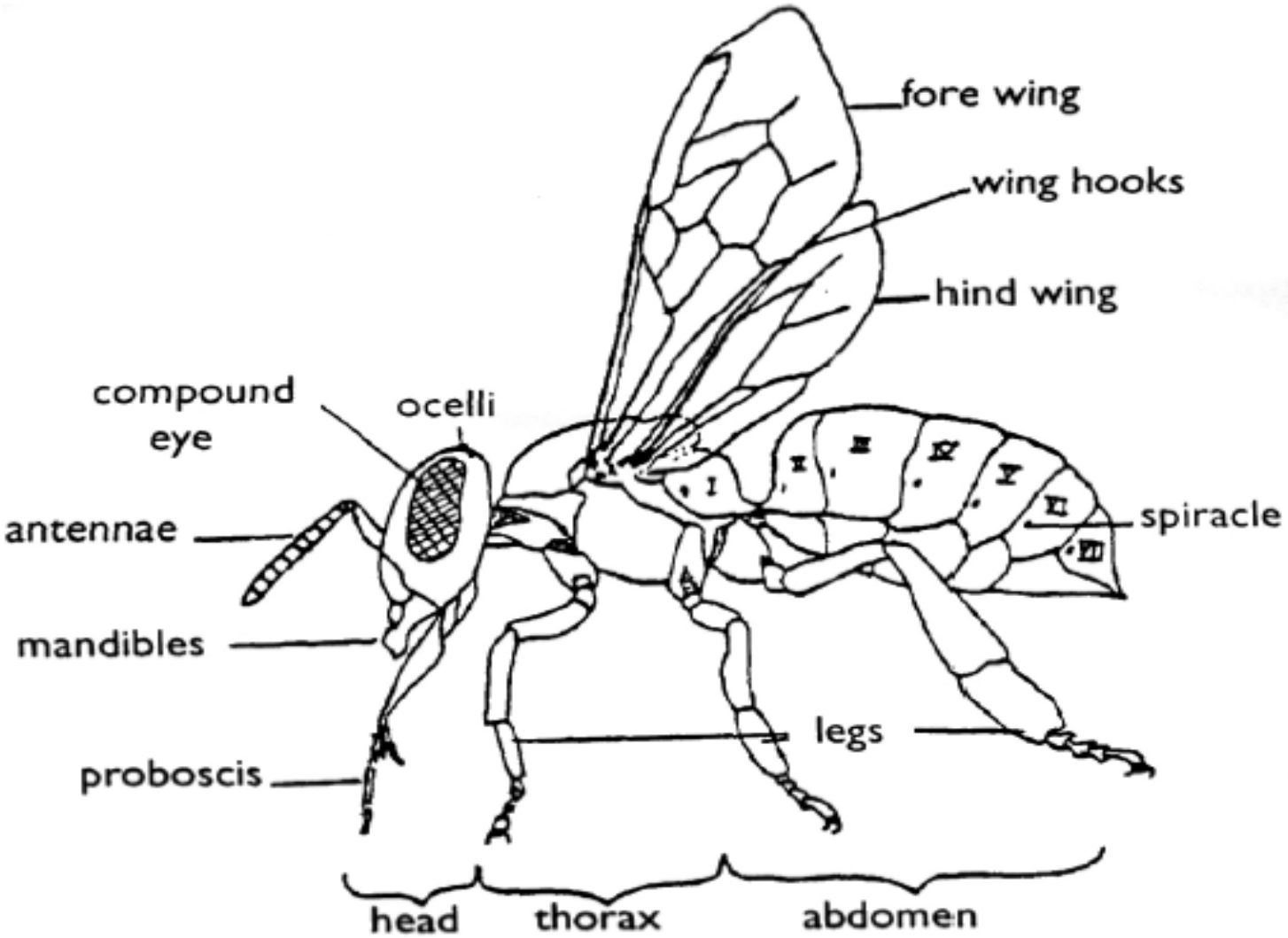

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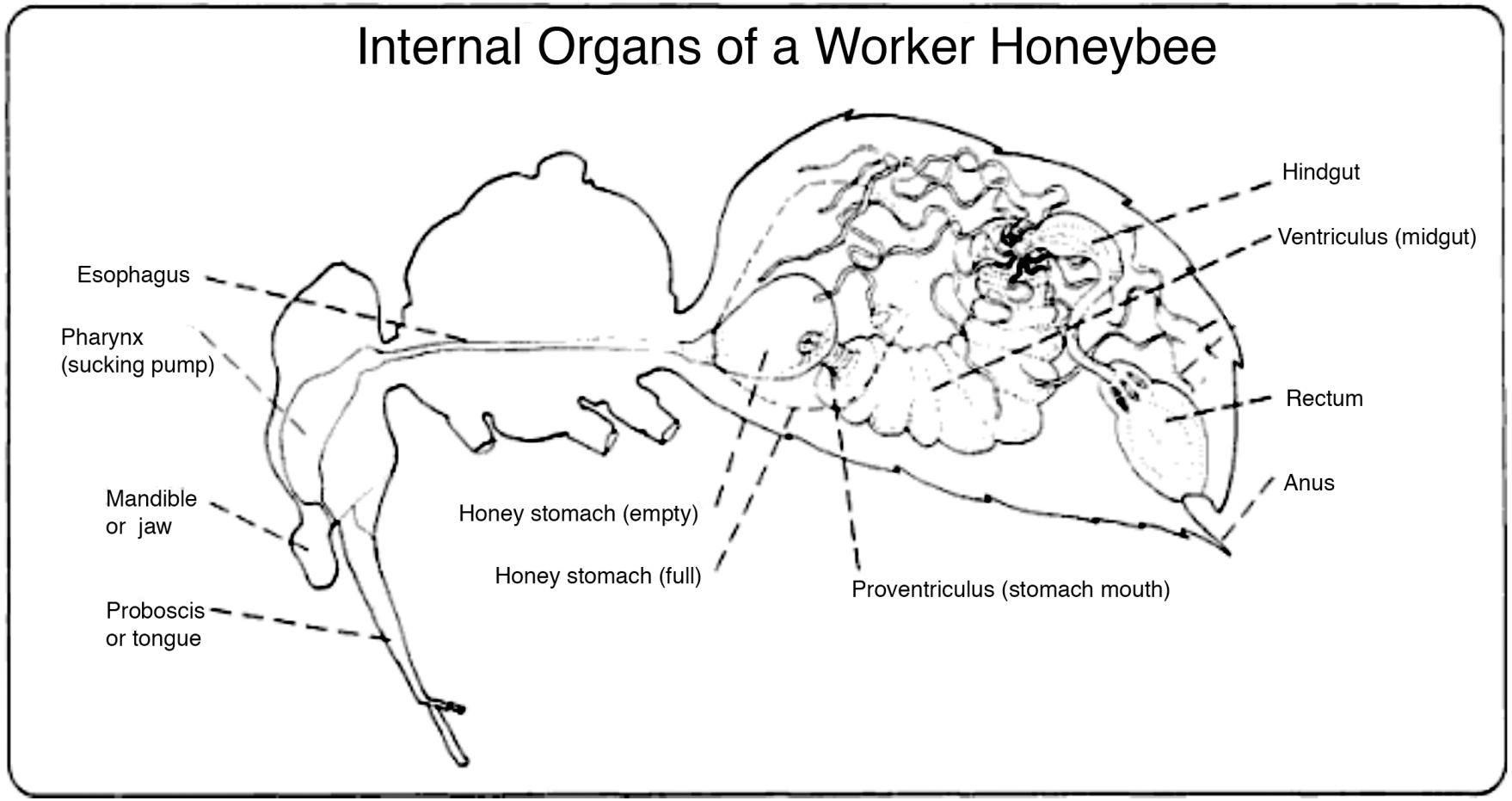

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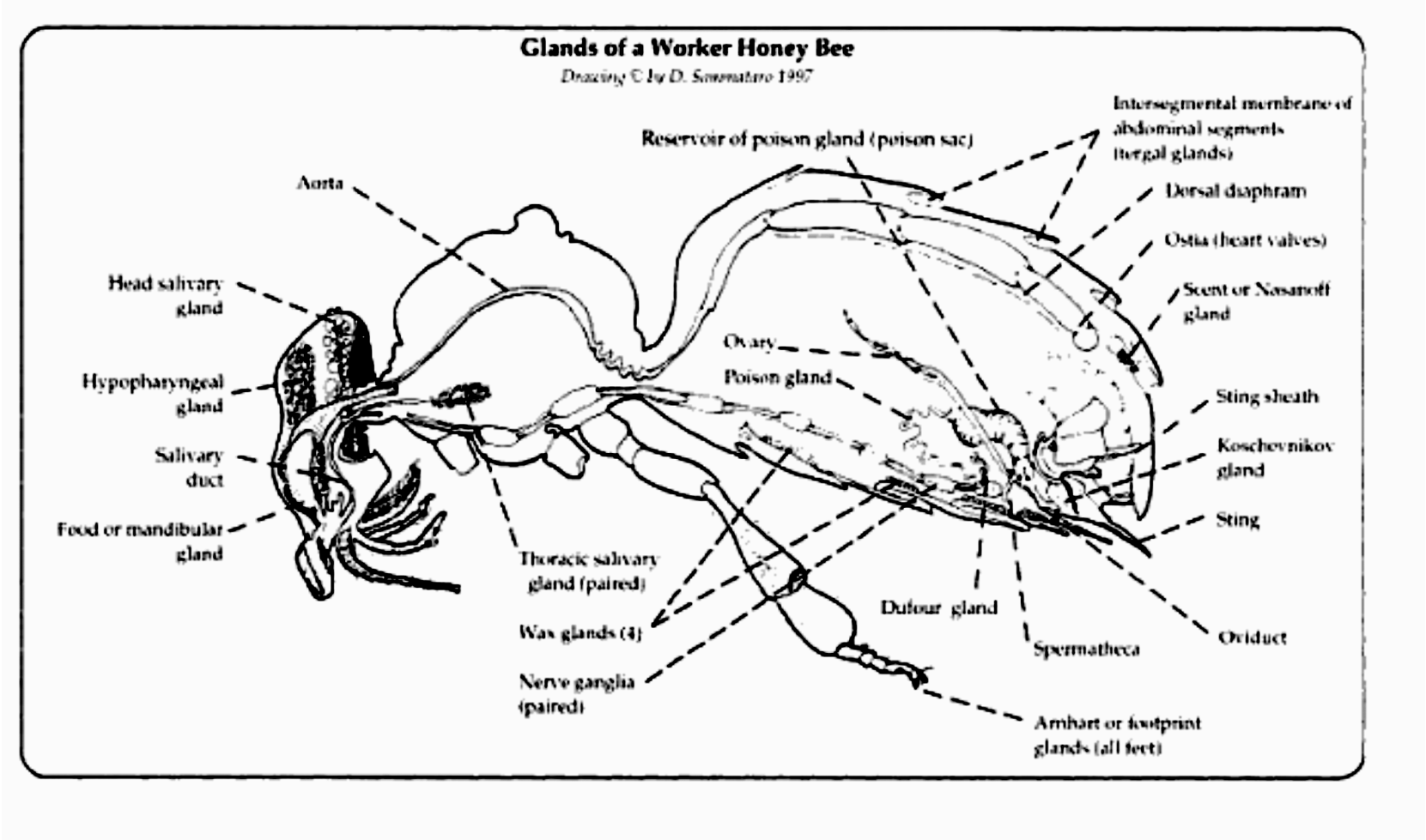

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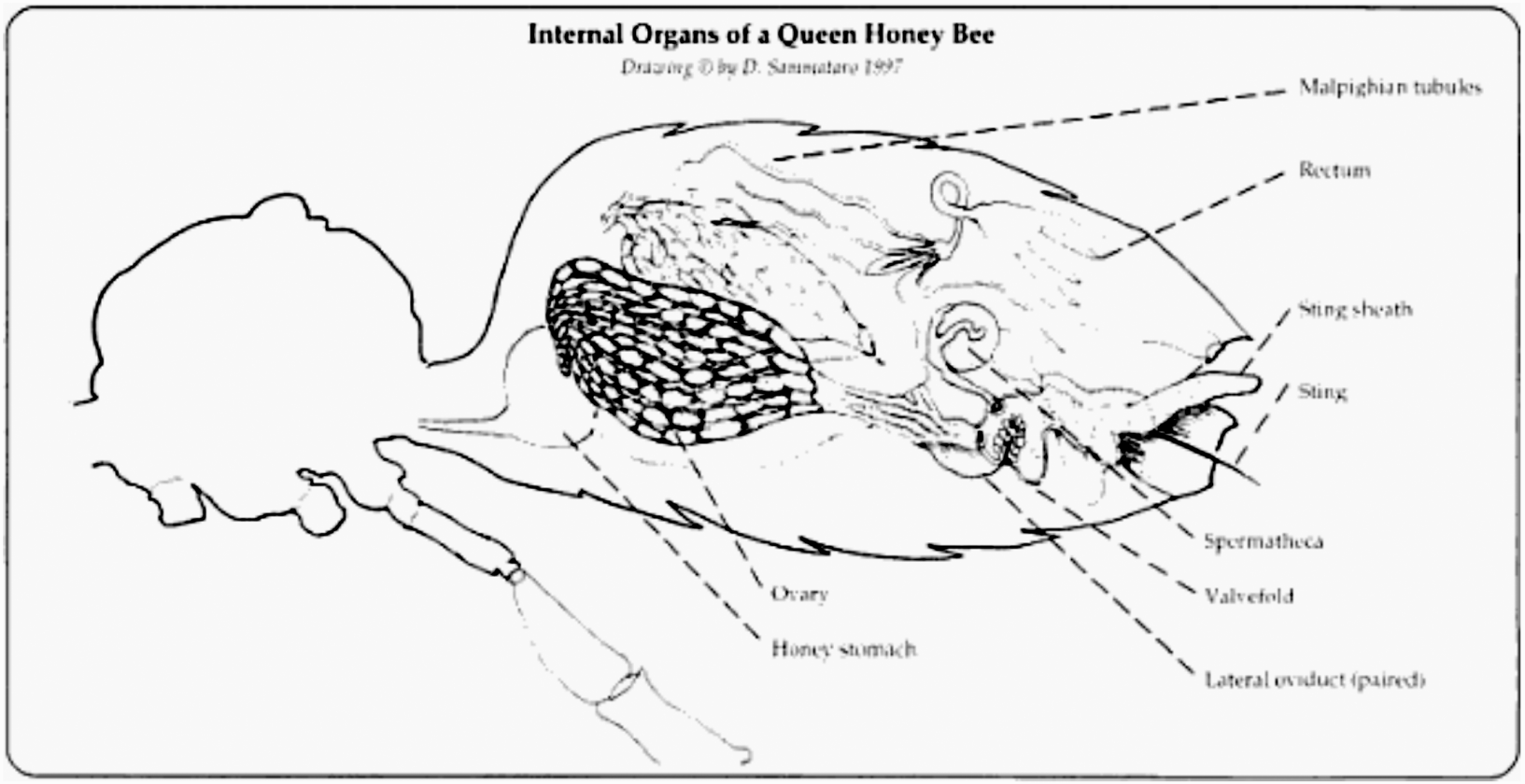

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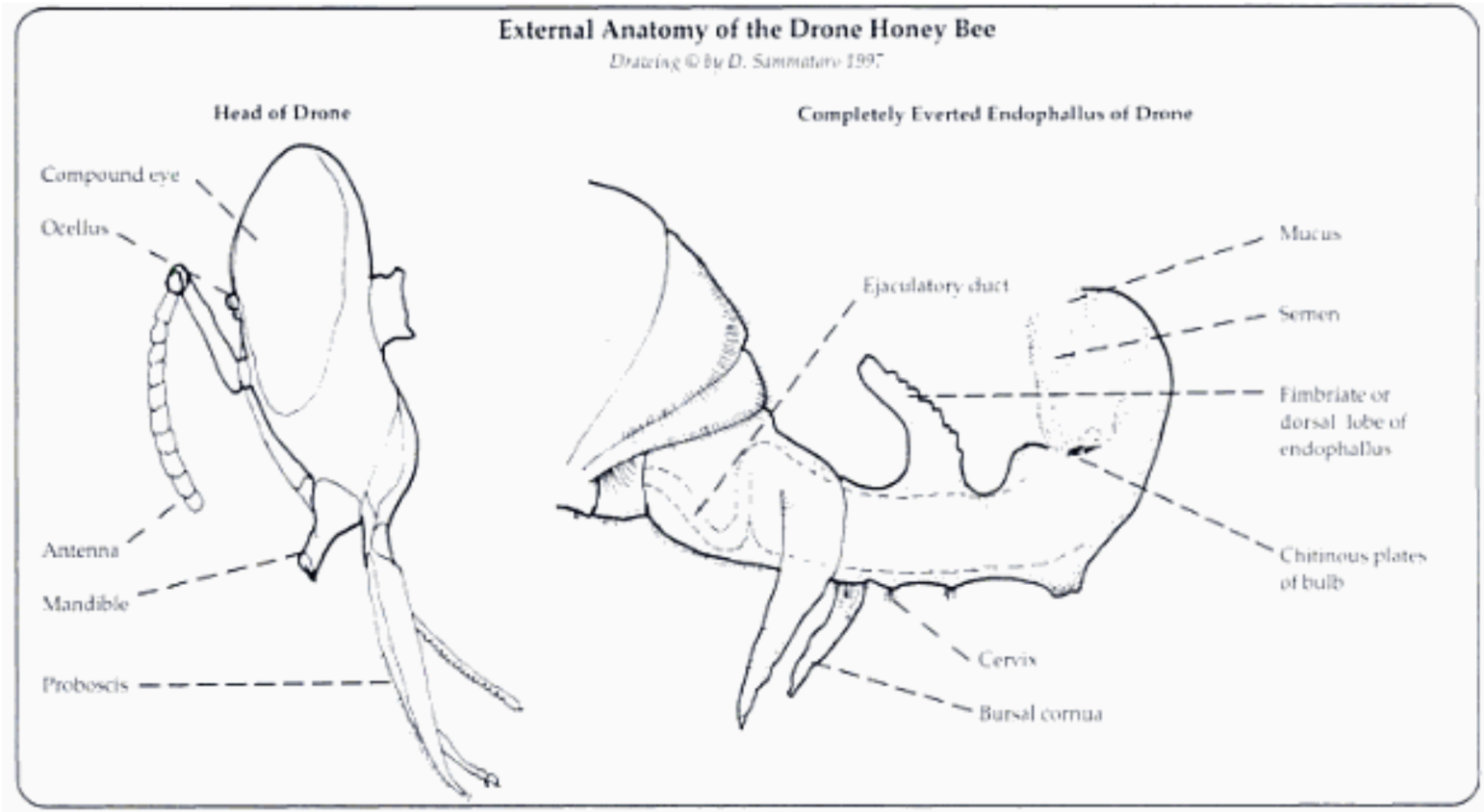

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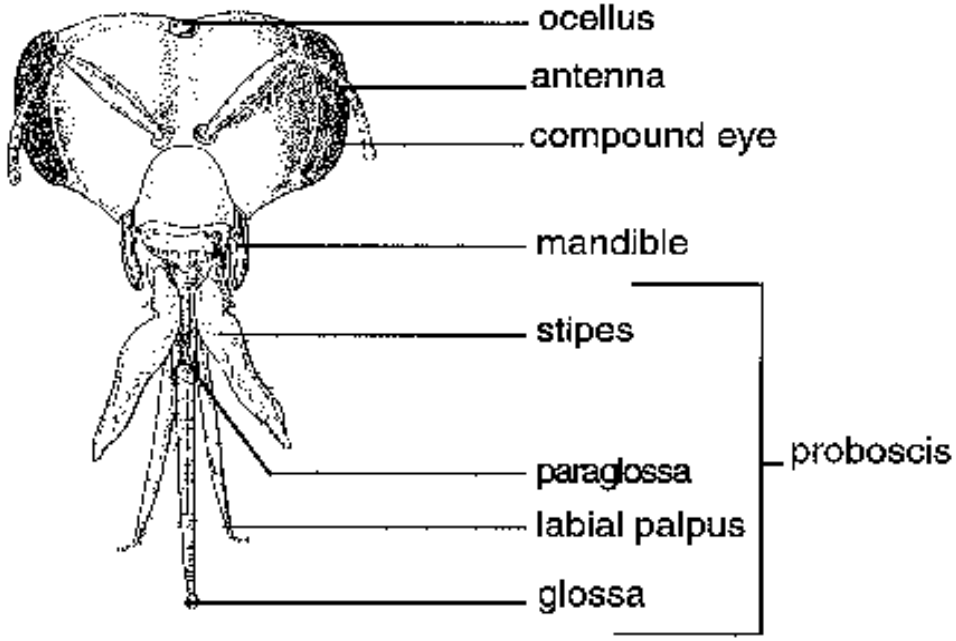
3a) Head

Honey Bee Head and Mouthparts (Hairs not shown)



•There are three eyes, called **ocelli**, located at the top of the head between the bee's two larger compound eyes. The ocelli detect light but can't focus or arrange an image like the larger compound eyes

•Honeybees use their **antennae** to learn about their environment: Tiny sensory hairs on each antenna allow them to smell, taste, feel air movements and to communicate with one another

•The **compound eyes** each have almost 7,000 hexagonal facets. Each facet is like a mini-eye, containing its own lens and sensory cells

•A bee's curved, spoon-shaped jaws, called the **mandible**, are built for many uses: They can be used to ingest food, manipulate wax to build the hive cells, feed the young or queen, and even fight

•The long **proboscis** at the front of the bee's head is used to ingest liquids such as nectar, honey or water. The proboscis is tipped with a spoon-shaped **glossa**

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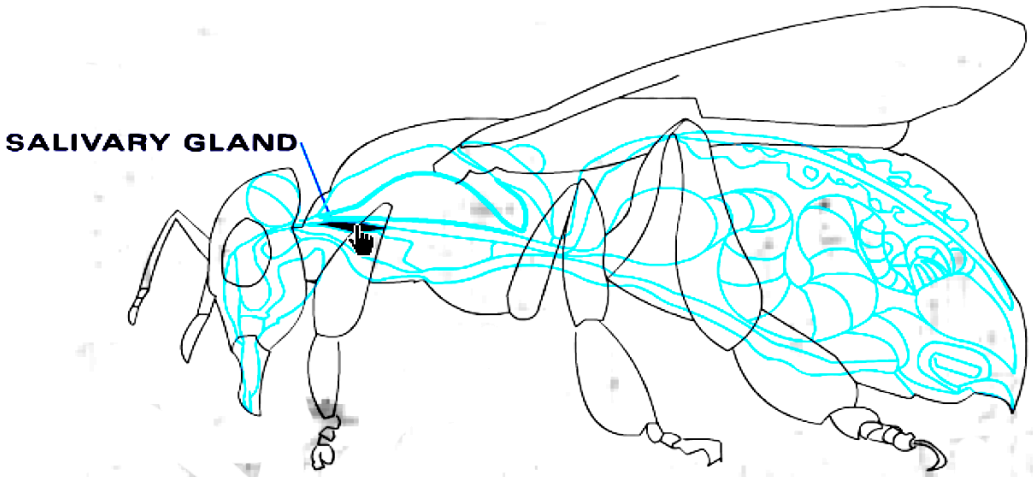
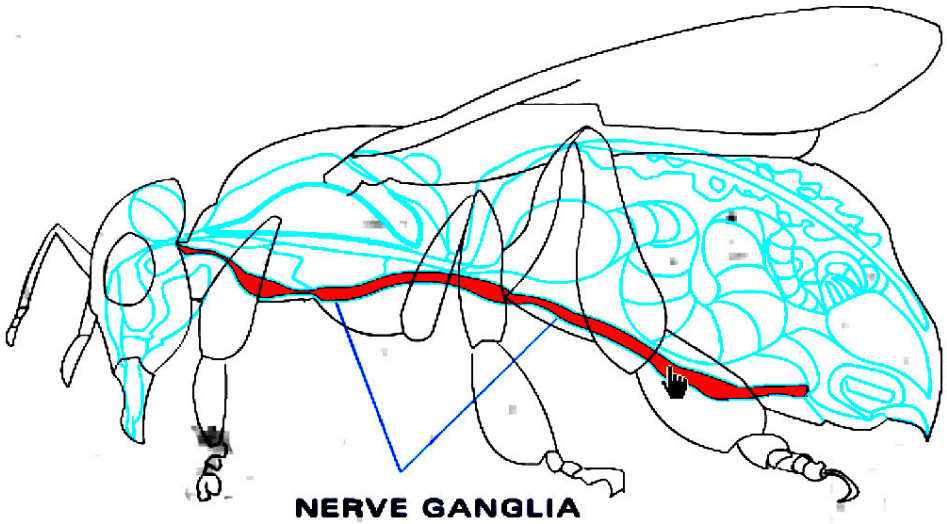
3b) Thorax

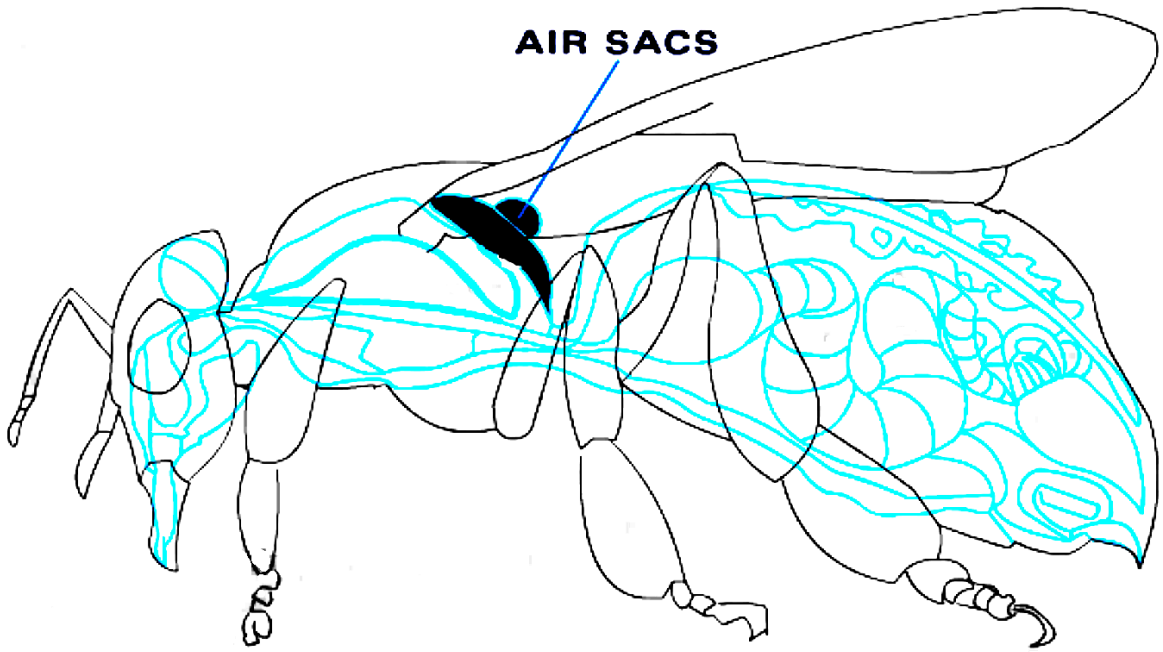
The saliva is mixed with bees wax to make it sticky.





The nervous system comprises a small "brain" and 7 ganglia right down the body. The 7th is near the end of the abdomen. This is why the detached body part of the bee sting continues to pump venom. The ganglia control the wings, hemolymph, legs, etc.…

Thorax (cont.)



The air sacs (think lungs) are connected to the surface by tracheal tubes, emerging near the wings for breathing.

(like having nostrils between your shoulder blades)

There are also breathing pores (spiracles) along the sides of the abdomen. (refer to the page showing the Dorsal Vessel in the Abdomen section)

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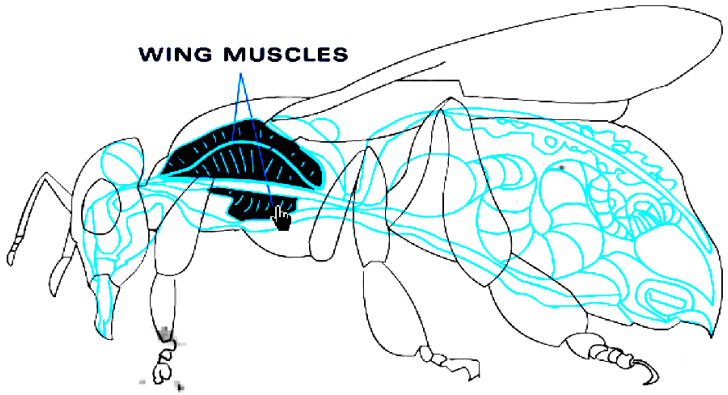
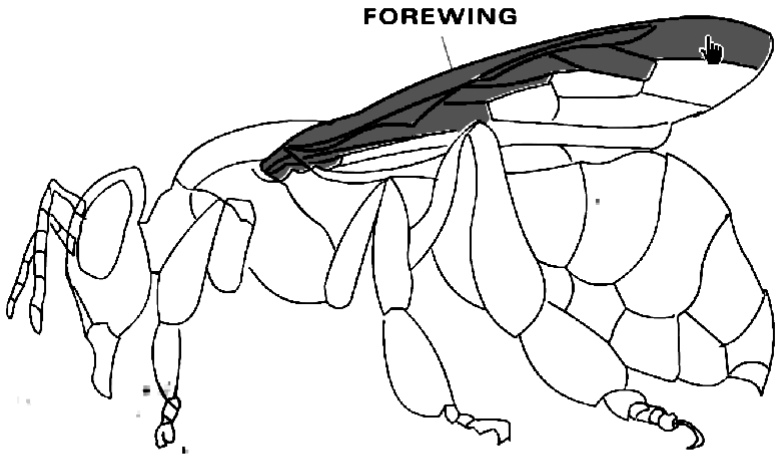
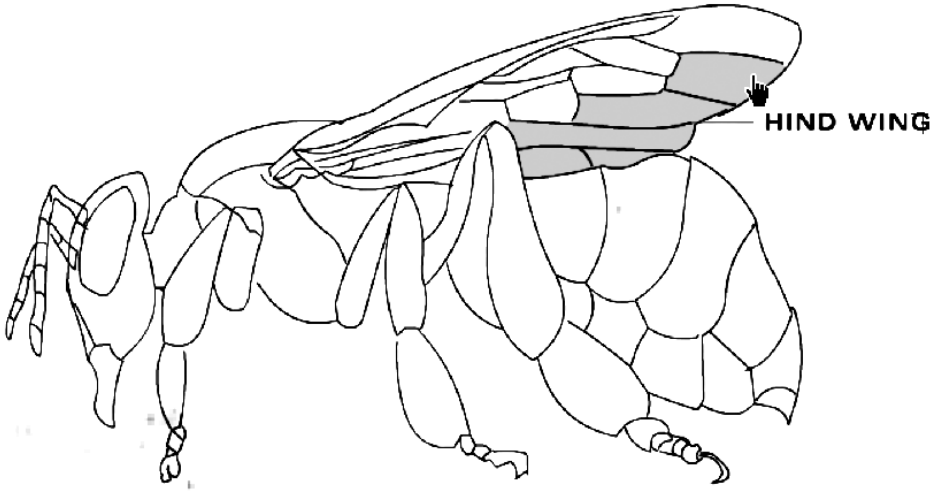
Thorax (cont.)



There is a total of four wings, two on each side. The forewing and hind wing on each side are joined during flight by a system of hooks (think Velcro). It is the rapid flapping of the wings that causes the distinctive "buzz". At 15MPH you can't out-run a Honeybee.





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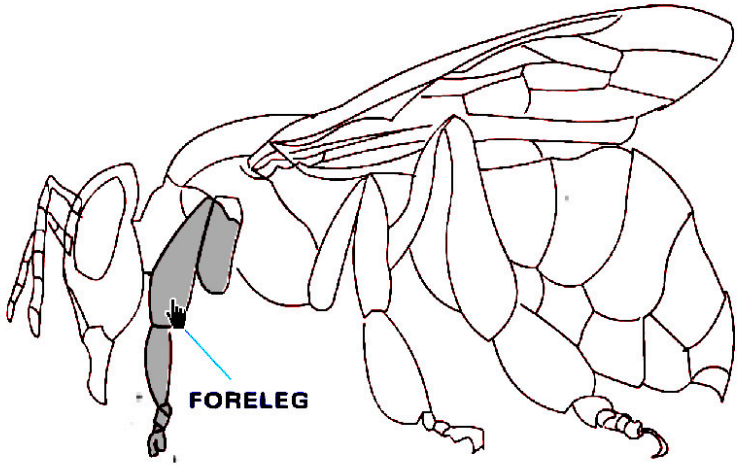
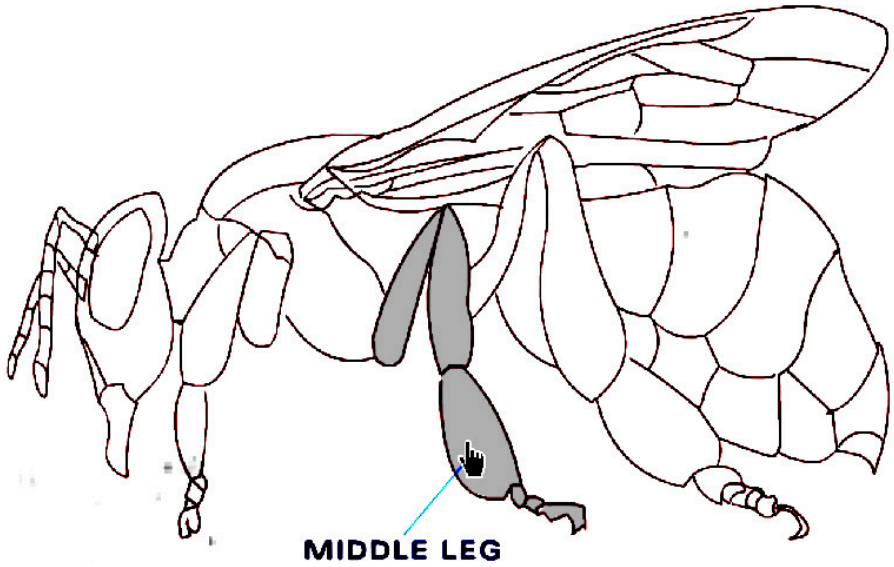
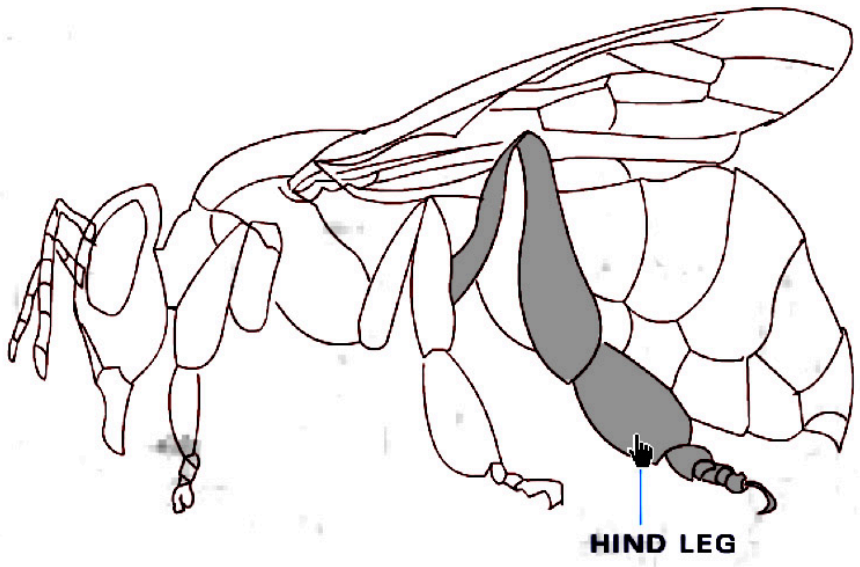
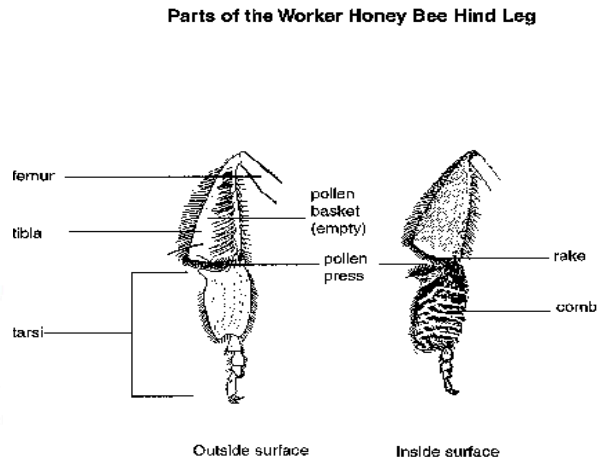
3b) Thorax (cont.)









Like all insects, there are 6 legs. The legs of the bee are primarily used for walking. However, Honeybee legs have specialized areas such as the antennae cleaners on the forelegs, and the pollen baskets on the hind legs.

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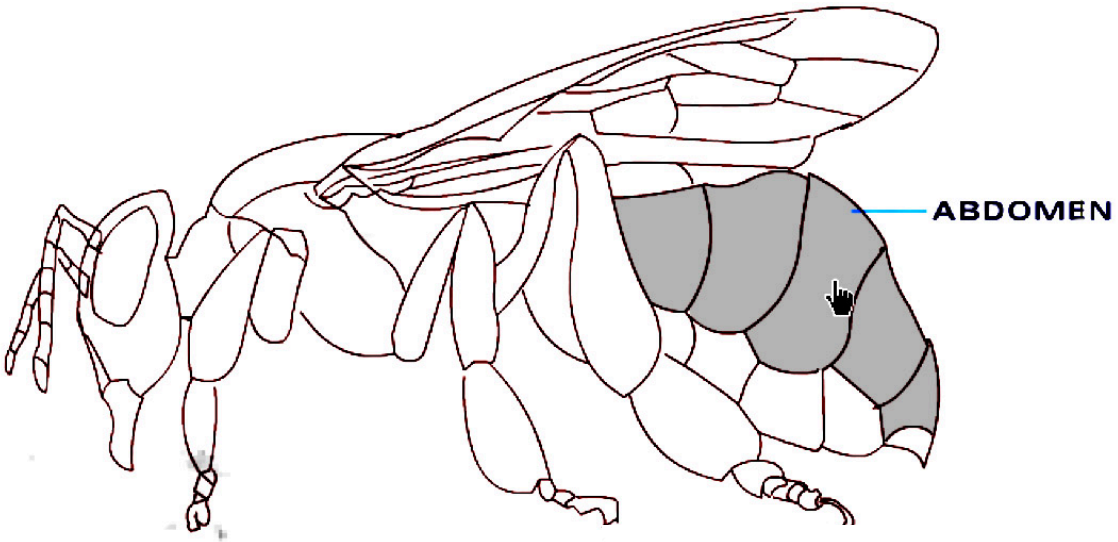
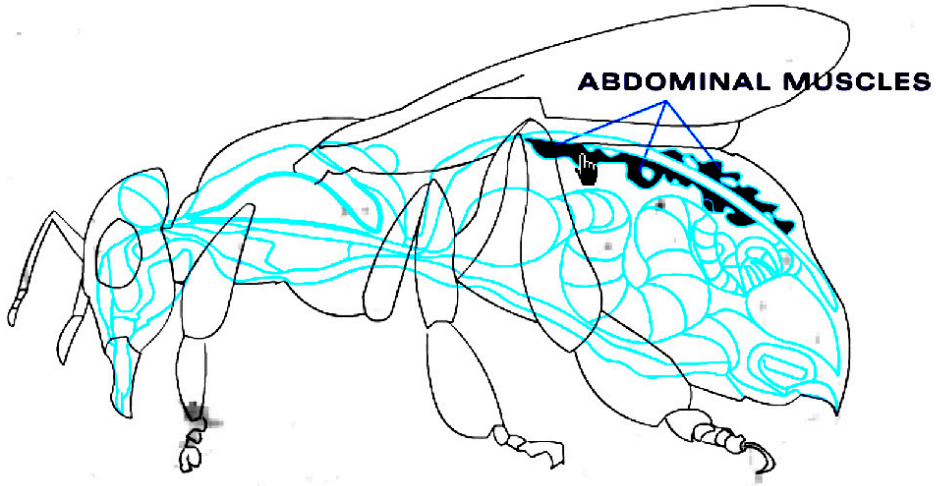
3c) Abdomen



Honeybees have "six-pack" abs.

Actually, as seen from the outside, only six abdominal segments can be observed, but the adult honeybee has nine, while the larva has ten.



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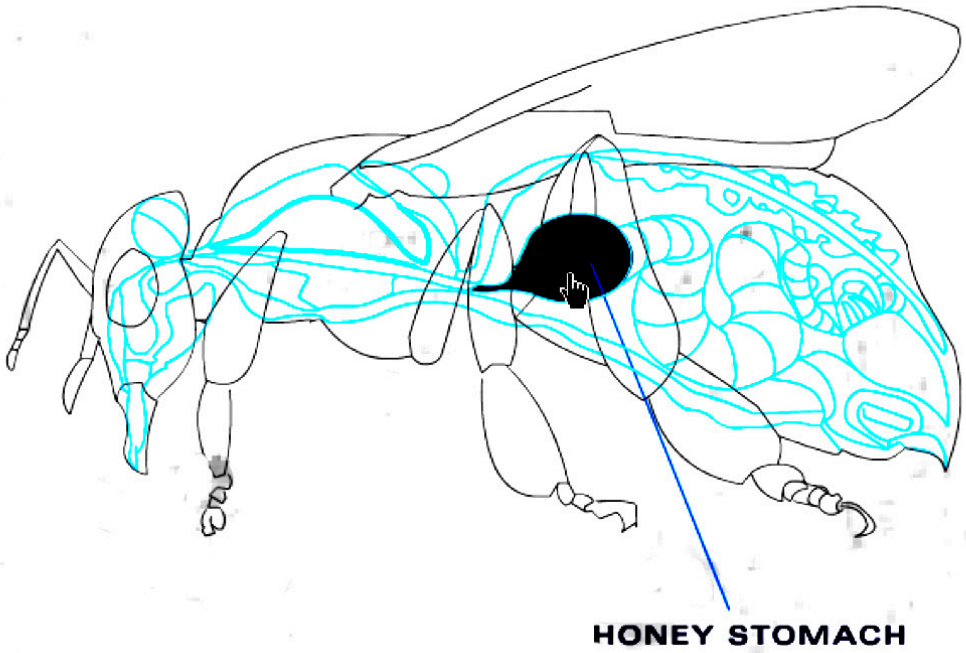
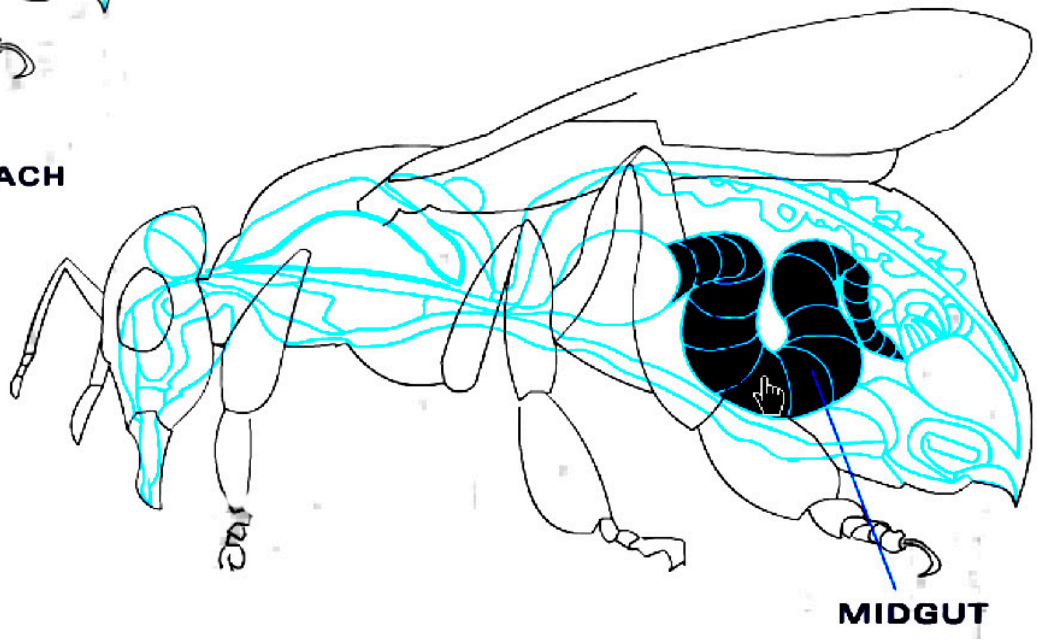
Abdomen (cont.)



Honeybees have reversible movement of foods from mouthparts to/from a honey stomach. The honey stomach is a crop or storage area to hold freshly collected nectar or water for transport to/from the



Digestion of foods occurs in the mid-gut. The hind-gut reclaims water and nutrients and passes small amounts of indigestible wastes to the rectum for storage until excretion.

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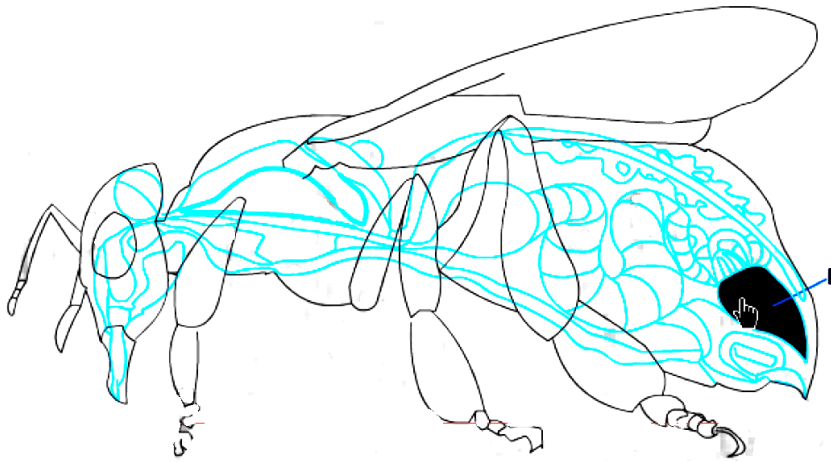
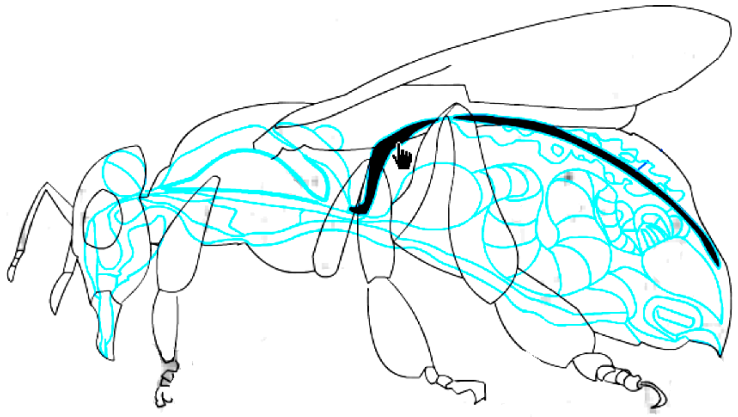
Abdomen (cont.)

In the spring you will find how much waste can be stored when the girls make their cleansing flights over your nice new, clean bee suit or jacket.

(You might want to get the kind with a detachable veil)





The blood (haemolymph) is not carried by arteries and veins but flows loosely around the body, controlled by the dorsal and ventral diaphragms, sometimes called vessels, bellows or heart. Oxygen enters into the bee via spiracles (including two rows of 6 on the abdomen and by trachea connected by 3 spiracles on the upper thorax) then into the bellows in the abdomen which distribute it into the blood.

Abdomen (cont.)

Wax Gland(s): Four pairs of glands, sometimes called mirrors, are specialized parts of the body wall. During the wax forming period in the life of a worker, the glands greatly thicken and take on their glandular structure.

The wax is discharged as a liquid, hardens to small flakes or scales, and sits in wax pockets. The wax scale is then transferred to the mandibles where it is chewed into a compact, pliant mass.
After the worker bee outgrows the wax forming period, the glands degenerate and become a flat layer of cells.

Abdomen (cont.)

Workers have a Nasanoff gland at the end of their abdomen. This Nasanoff gland is used by the guard bees at the hive entrance to disseminate a scent that guides young bees back to the entrance during early flights.

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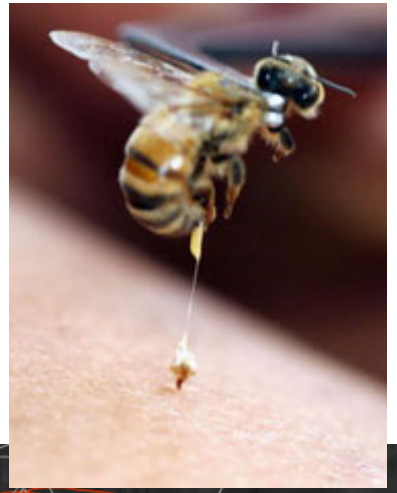
Abdomen (cont.) **And finally – the part you're most interested in...**



On the end of the female bee's abdomen is the *ovipositor* (stinger). The ovipositor of the worker bee is barbed so that it remains imbedded into whatever the honeybee stings. In its struggle to free itself, a portion of the bee (stinger, venom sac, ganglia) is left behind, which damages her enough to kill her. The venom sac continues to contract by reflex action, continuously pumping venom into the wound for several seconds. The queen's ovipositor is slightly barbed and is "reusable": It's used to kill rival queens.

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Review

1. Three members of the colony
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   b) Queen
   c) Drone

2. Development timeline of a Honeybee and their lifetime functions
   a) Egg (Eggs)
   b) Larva (Larvae – “lar-vee” or “lar-vie”)
   c) Pupa (Pupae – “pew-pee” or “pew-pie”)
   d) Adult (Adults)
   e) Job responsibilities

3. Anatomy: Three major sections of the bee and several parts of each
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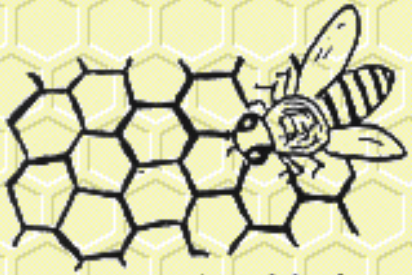
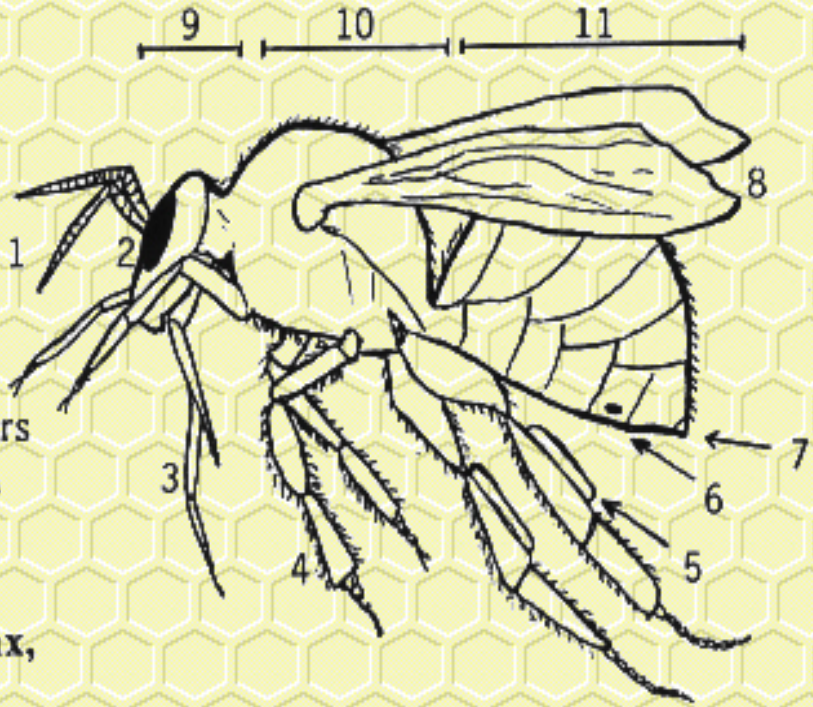
Final Exam Time

Bee on Hive



Match these words with the numbers on the picture. Write the words on the correct line to the side.

Abdomen, Eyes, Feelers, Head, Legs, Pollen Sacs, Stinger, Thorax, Tongue, Wax Glands, Wings



1. Feelers (Antenae)
2. Compound eyes
3. Tongue (Probosis)
4. Fore legs
5. Pollen Sacs
6. Wax Glands
7. Stinger
8. Wings
9. Head
10. Thorax
11. Abdomen

Credits & Reference URLs

http://photo.bees.net/biology/ch5/

http://www.rothamsted.ac.uk/pie/DeBug/Anatomy.html

http://www.pbs.org/wnet/nature/alienempire/multimedia/bee.html

http://maarec.cas.psu.edu/diseasesPests.html

http://www.ent.iastate.edu/zoo/lessonplans/honeybee.html

http://ag.arizona.edu/pubs/insects/ahb/inf2.html

The .pdf files sent to each student