Honey Bee Biology

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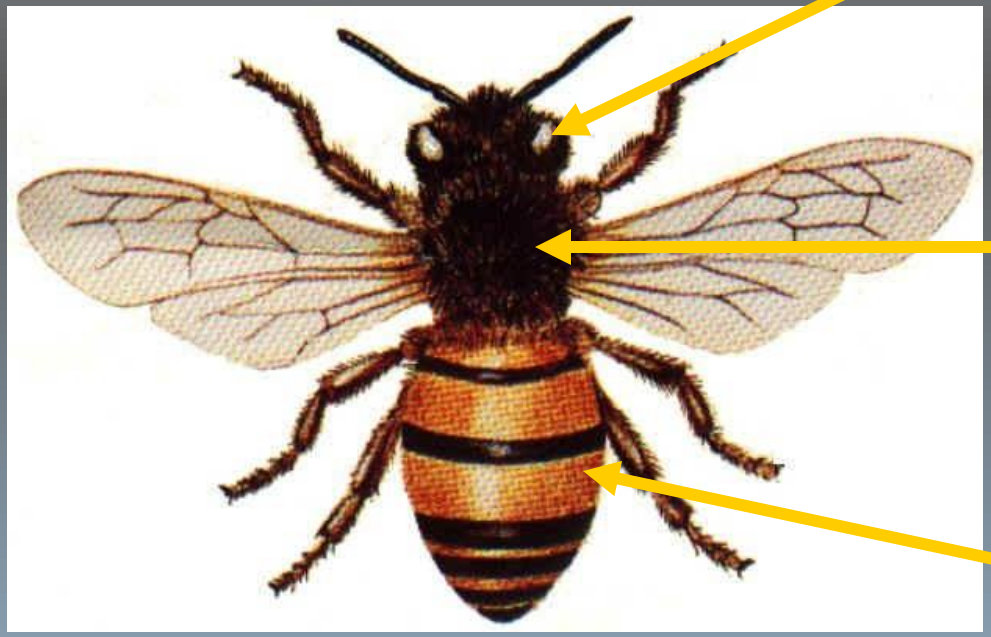
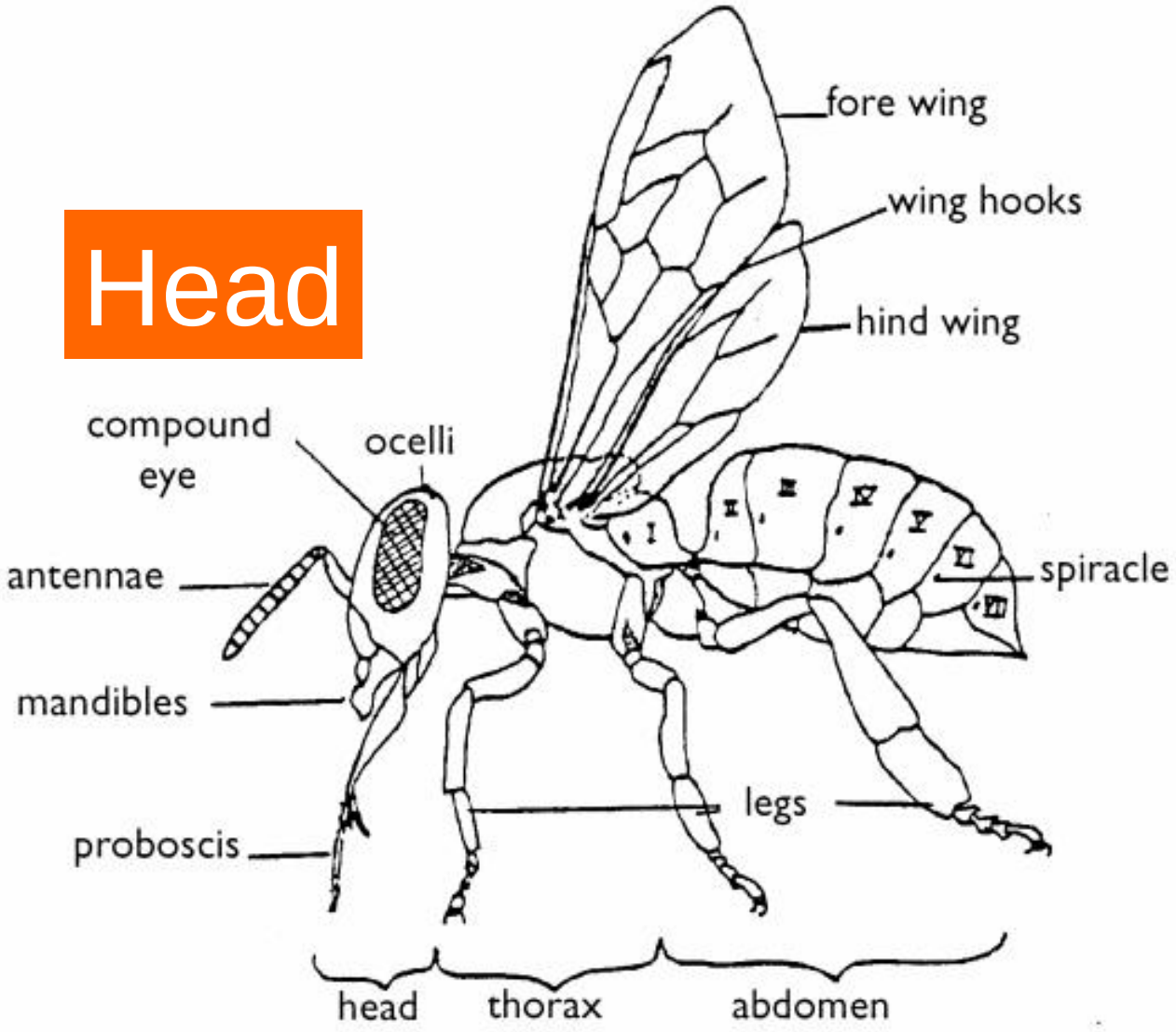
Morphology of the Honey Bee

The honey bee has three body divisions

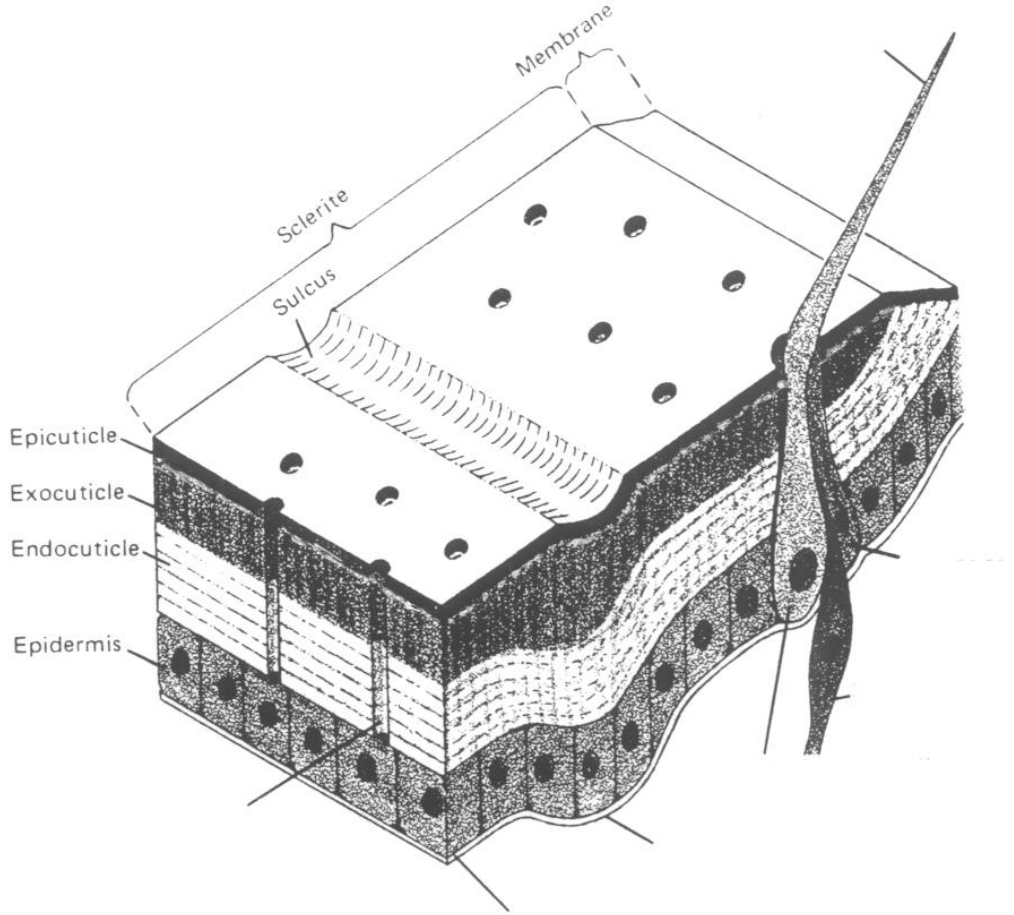


Head

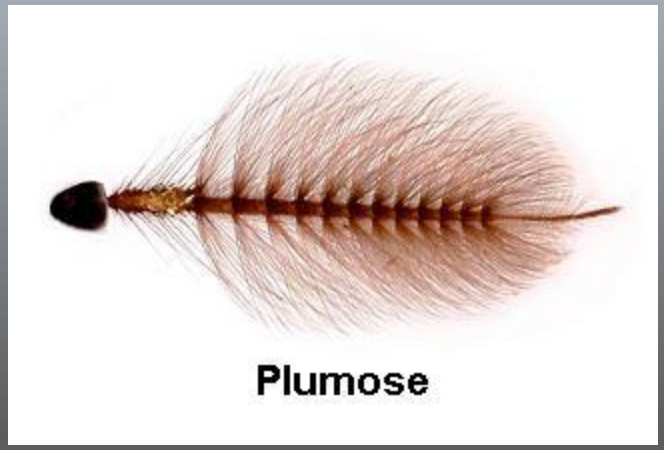


Drawing modified from R. E. Snodgrass

Exoskeleton



Body Hairs



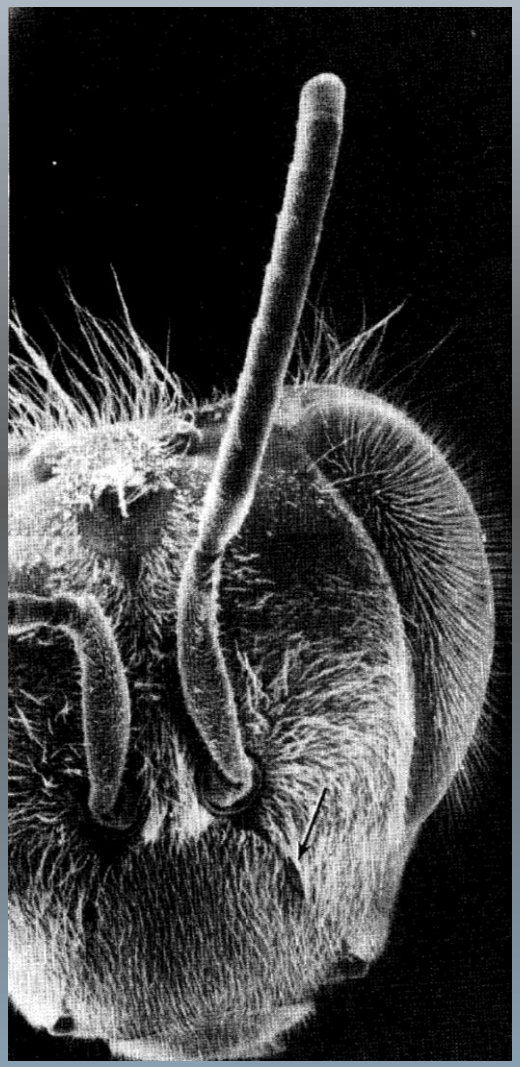
Morphology of the Honey Bee

- The head serves as the major sensory region of the body; eyes, antennae, sensory hairs. It also functions to ingest and digest food

Specialized Structures of the Honey Bee

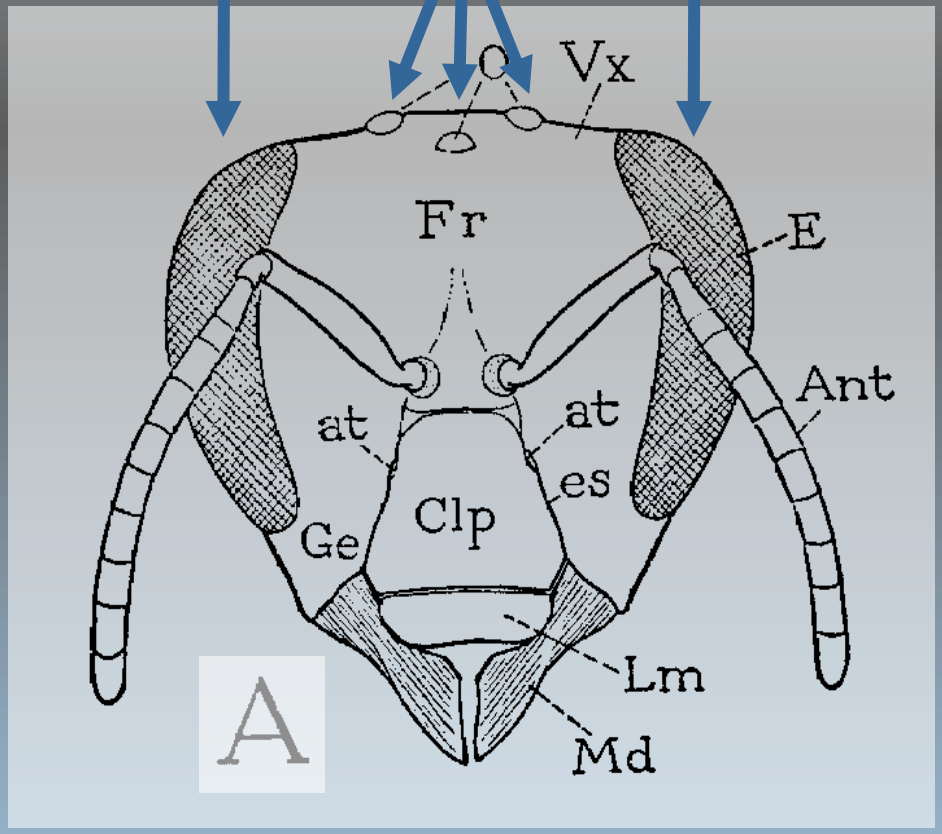
- Visual perception occurs through ocelli and compound eyes
- Olfactory perception occurs via the antennae
- Mouthparts: chewing and lapping. They consist of paired mandibles and the proboscis

Eyes



Compound eyes (2)

Ocelli (3)

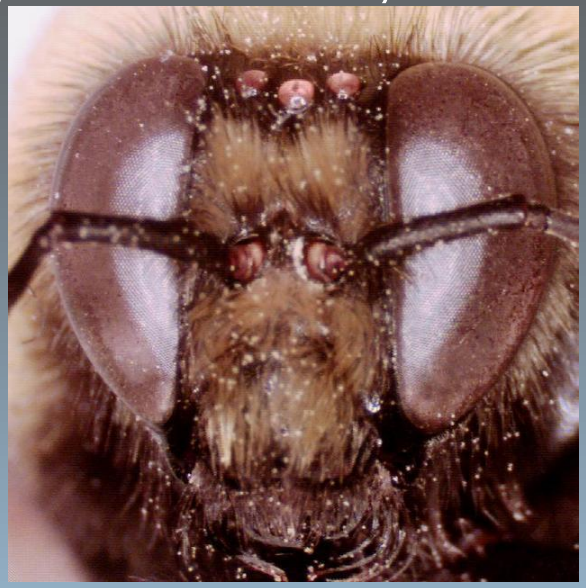


Eyes

•Ocelli – light intensity, diurnal activity patterns, orientation

•Compound eyes – worker: 6,900 hexagonal facets
drones: 8,600 facets

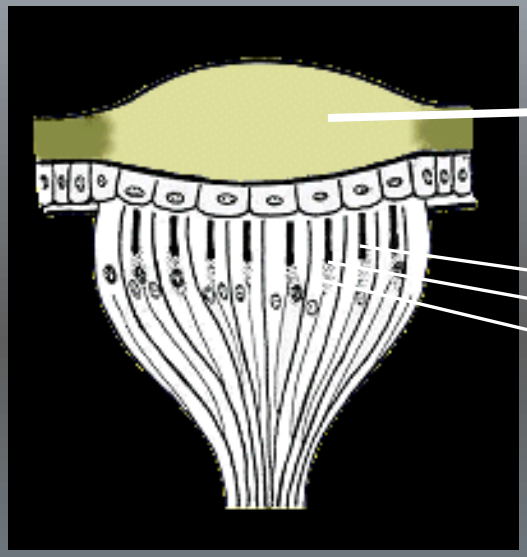
--Each facet has its own lens, pigmented cone, sensory cells
--Mosaic image



•Sensory hairs

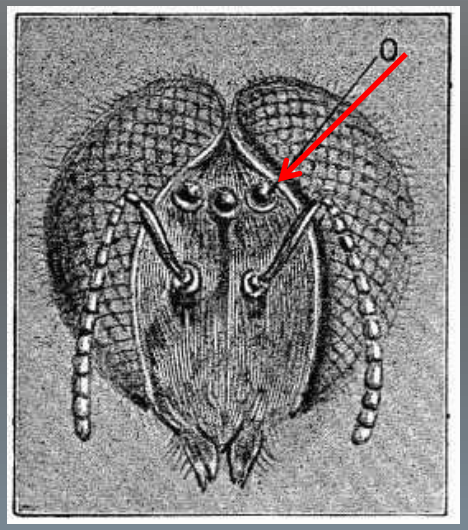
•Color vision- trichromatic vision

Simple eyes- ocelli



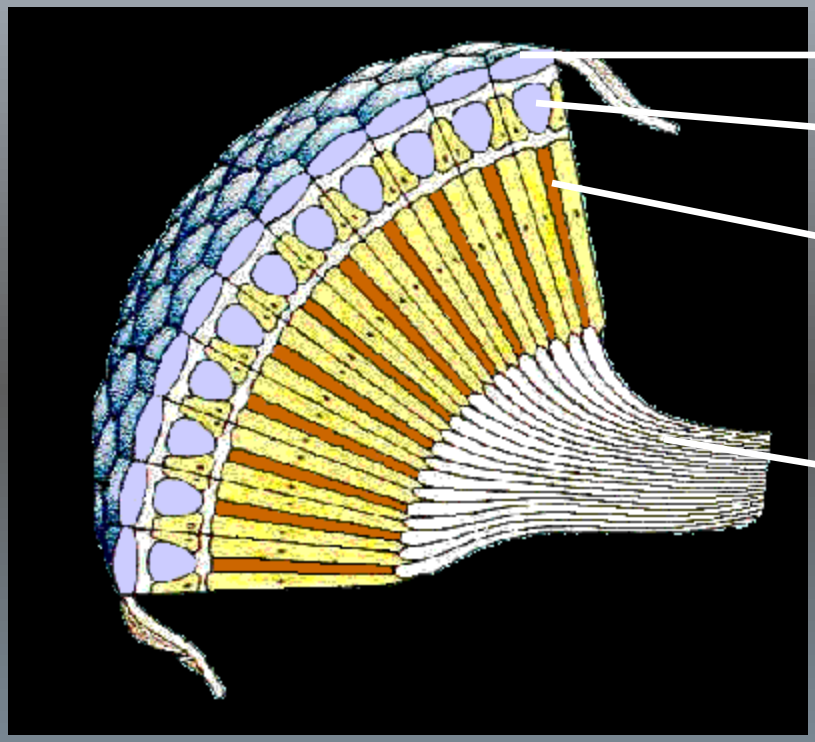
Corneal lens

Sensory rods



Sensitive to many types of wavelengths, polarization, changes in light intensity

Compound eyes- ommatidium



Corneal lens

Crystalline cone

Rhabdom- contains light sensitive pigments (rhodopsin)

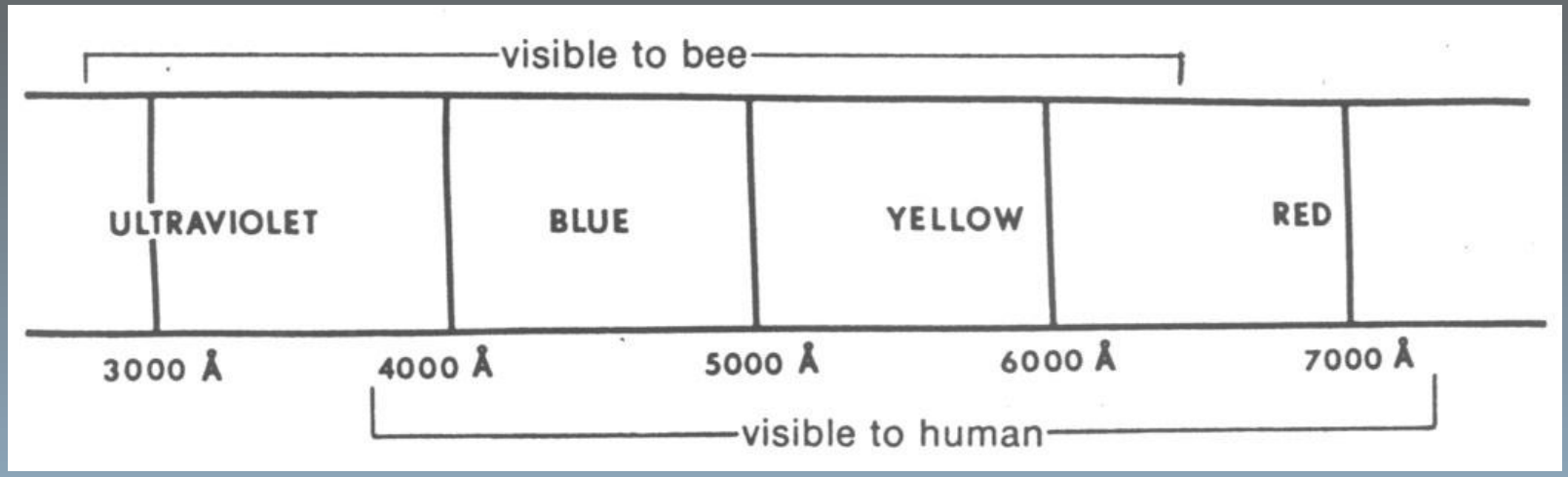
Axons leading to optic lobe

Yellow cells are pigment cells that help to absorb light coming in from adjacent cornea

Color vision

- Trichromatic insects (honeybees) – three types of pigment receptors, like humans – can distinguish more

- Pigment receptors do not coincide with ours (Roy G. Biv)



Compound Eyes

UV patterns visible to bees, not humans:

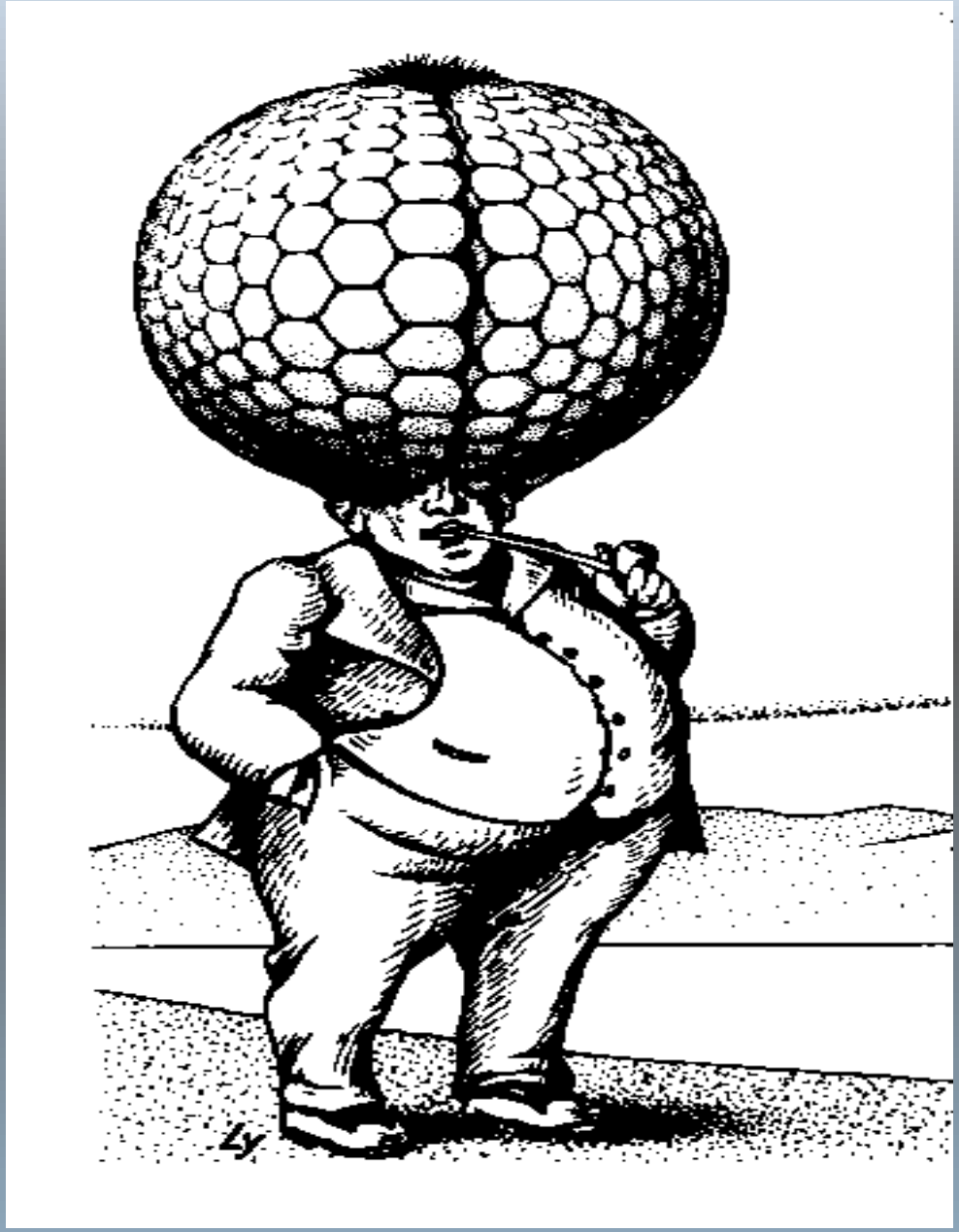
Courtesy Eisner Cornell Univ

Buttercup

swamp mallow

"Nectar guides"

UDEL Collections



- Sensory
  - compound eyes

What does a bee see?

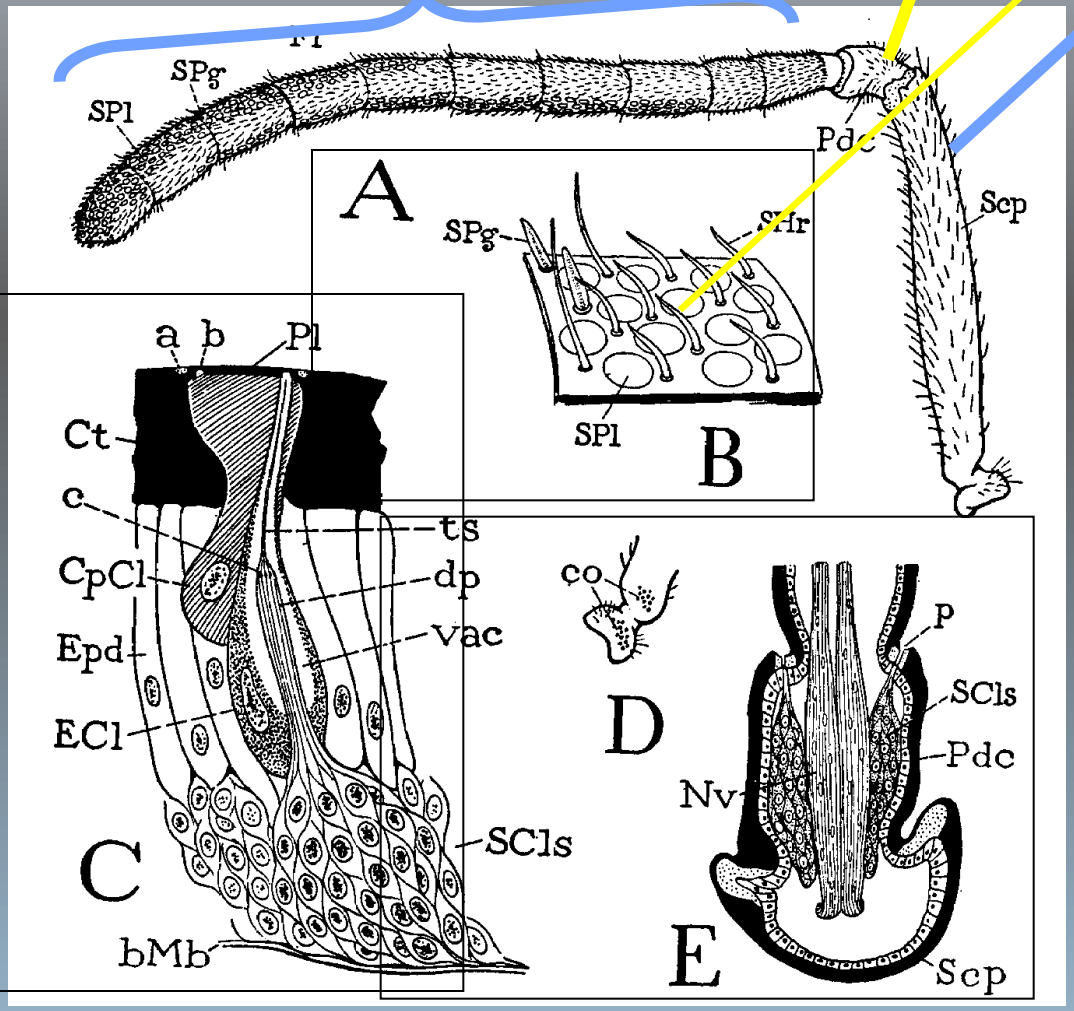
Antennae

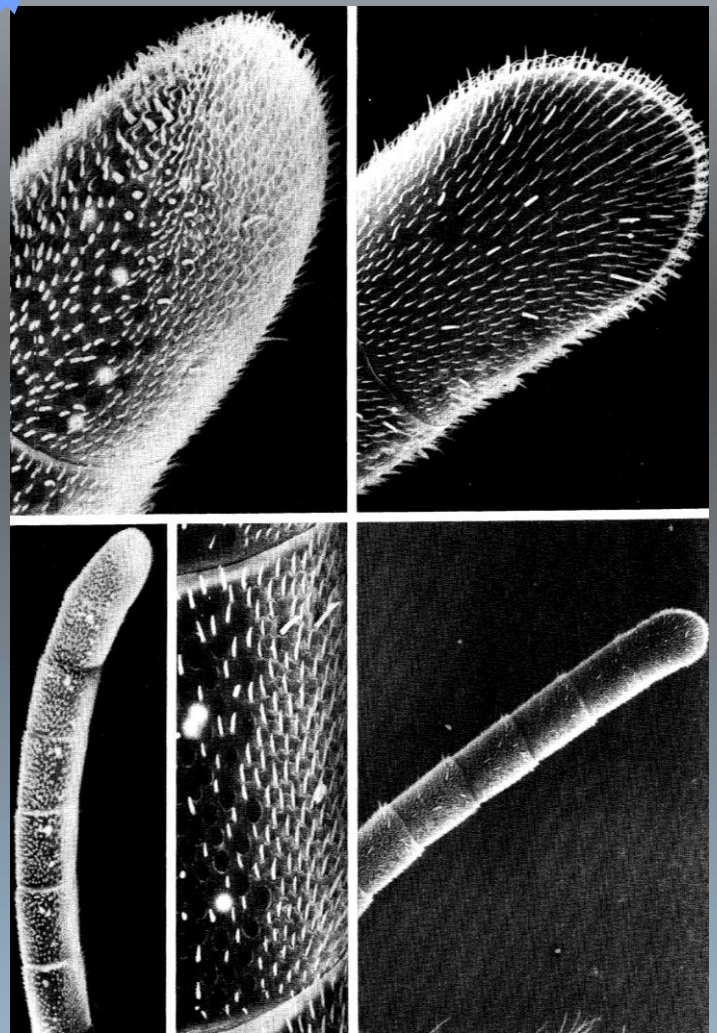
Flagellum

Pedicel

Pore plates

Scape





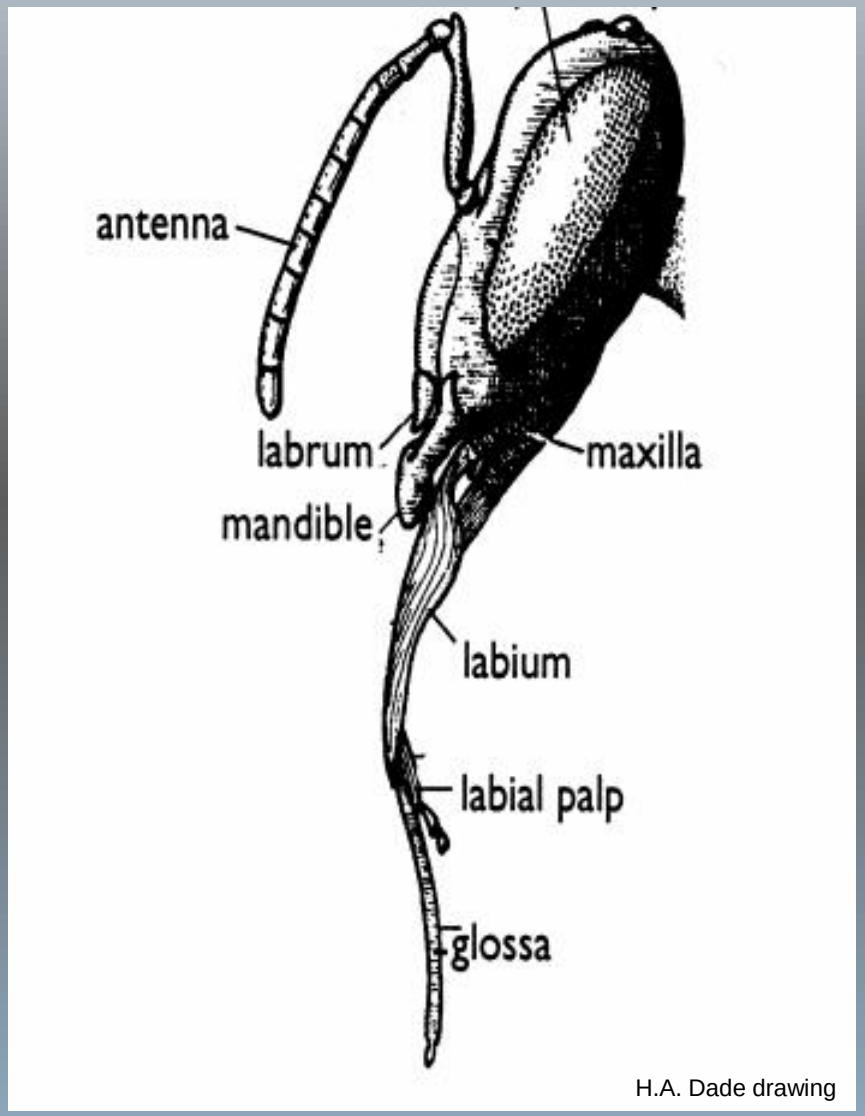
Antennae

- Topochemical olfactory sense
- Carbon dioxide receptors
- Moisture levels
- Taste receptors
- Johnston’s organ- flight speed

Head

- Mouthparts
  - Labrum
  - Mandibles
  - Maxillae (w/ palps)
  - Labium (w/ palps)
  - proboscis (w/ glossa)

R williamson photo

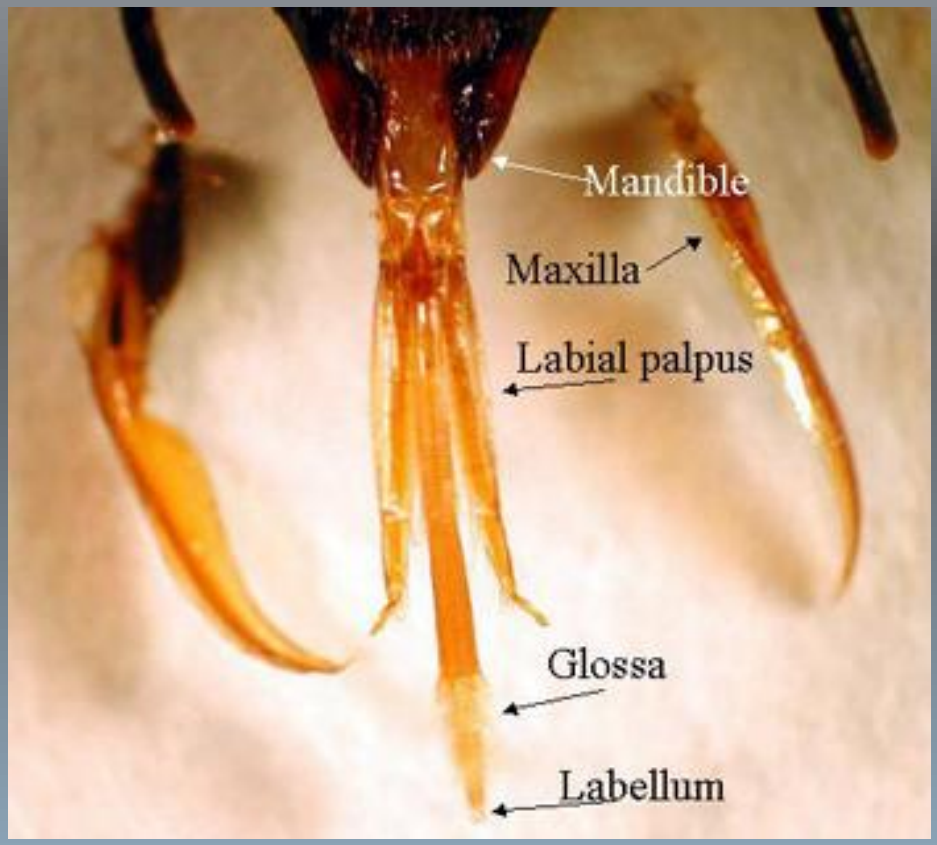


H.A. Dade drawing

Mouthparts

Mandibles

Proboscis

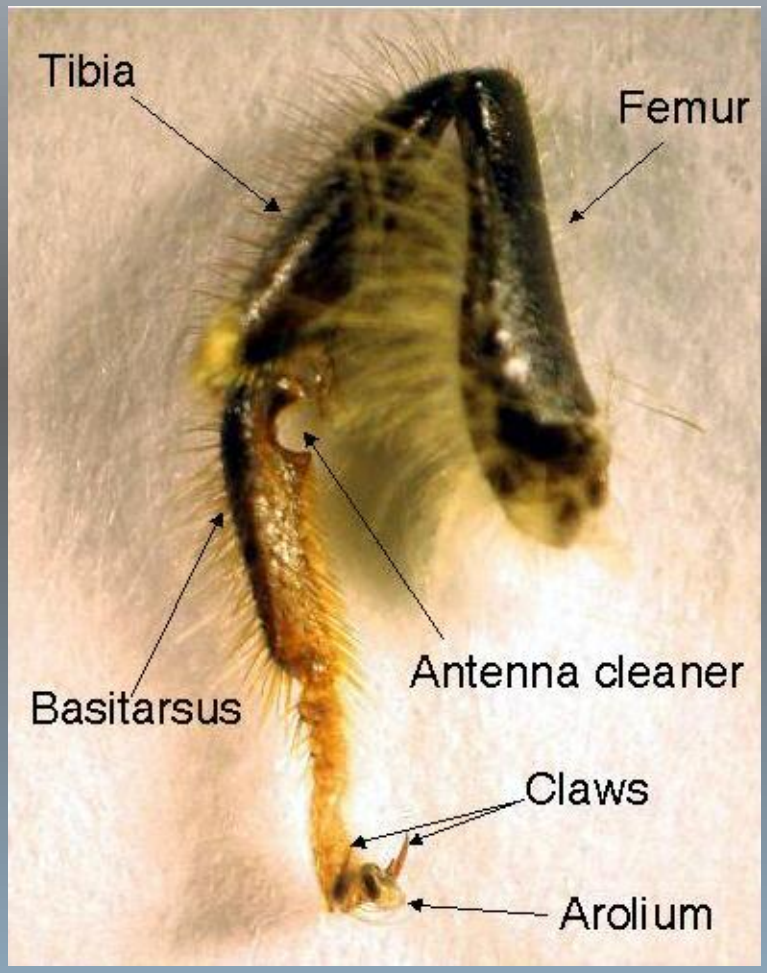


Morphology of the Honey Bee

- The thorax is the locomotory region of the body, housing three pairs of legs and two pairs of wings

Specialized Structures of Honey Bees: Legs

- Worker forelegs are covered in hairs which help clean dust and pollen from head.

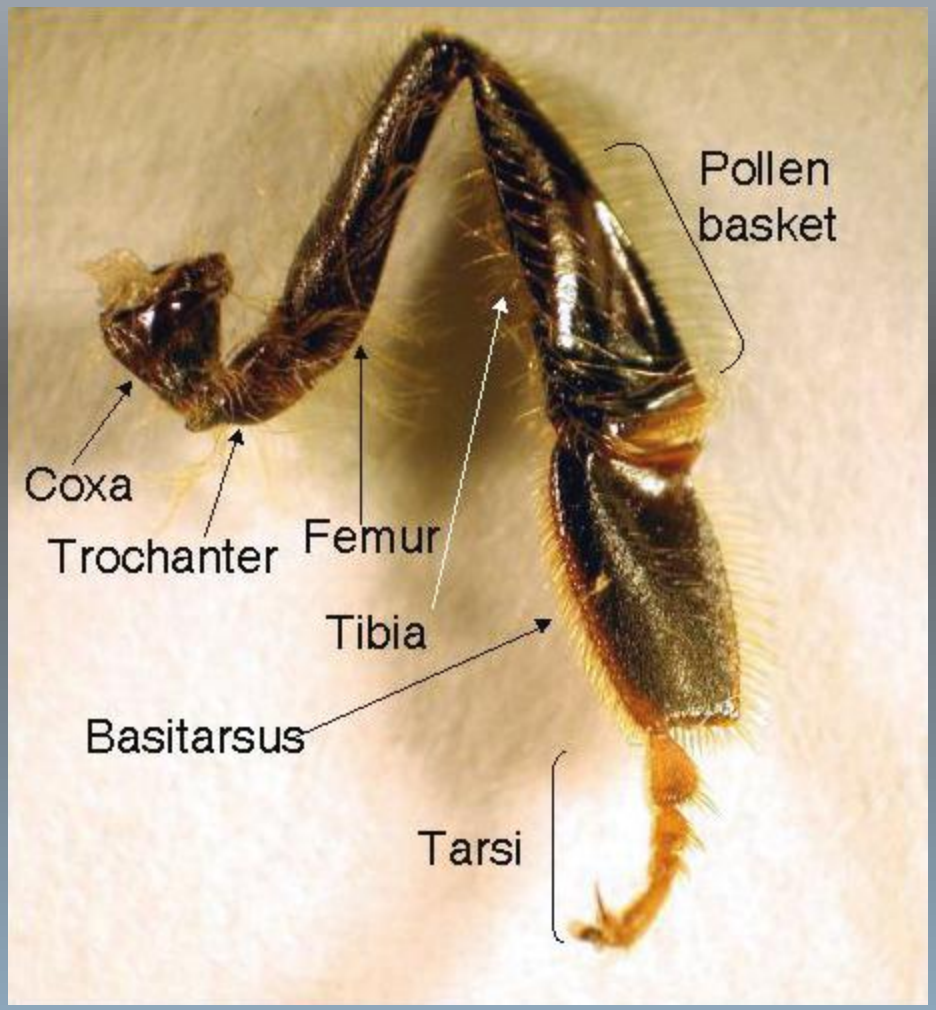


Specialized Structures of Honey Bees: Legs

- Worker middle legs are used to clean thoracic hairs and for transport

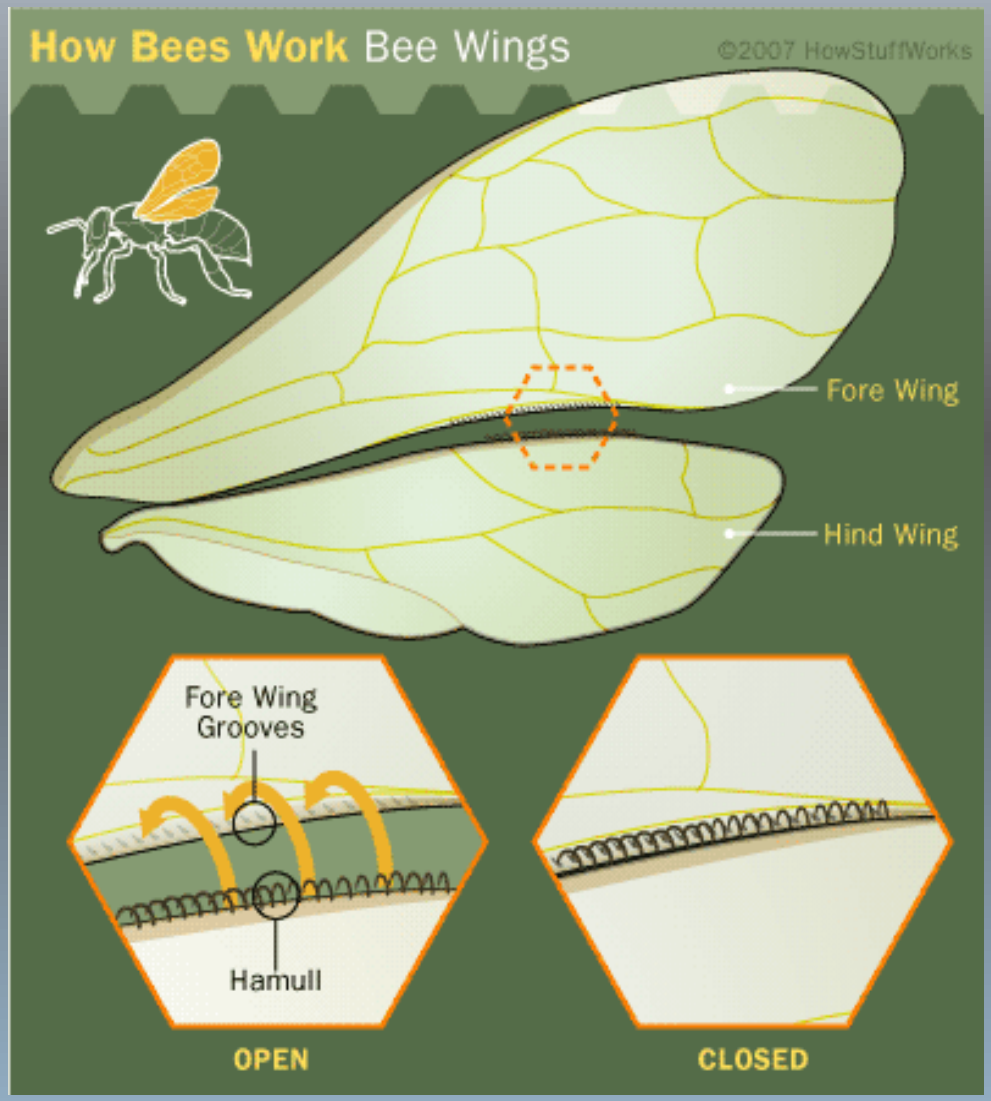
Specialized Structures of Honey Bees: Legs

- Worker hind legs have a corbicula or pollen basket which is used to collect and pack pollen and propolis

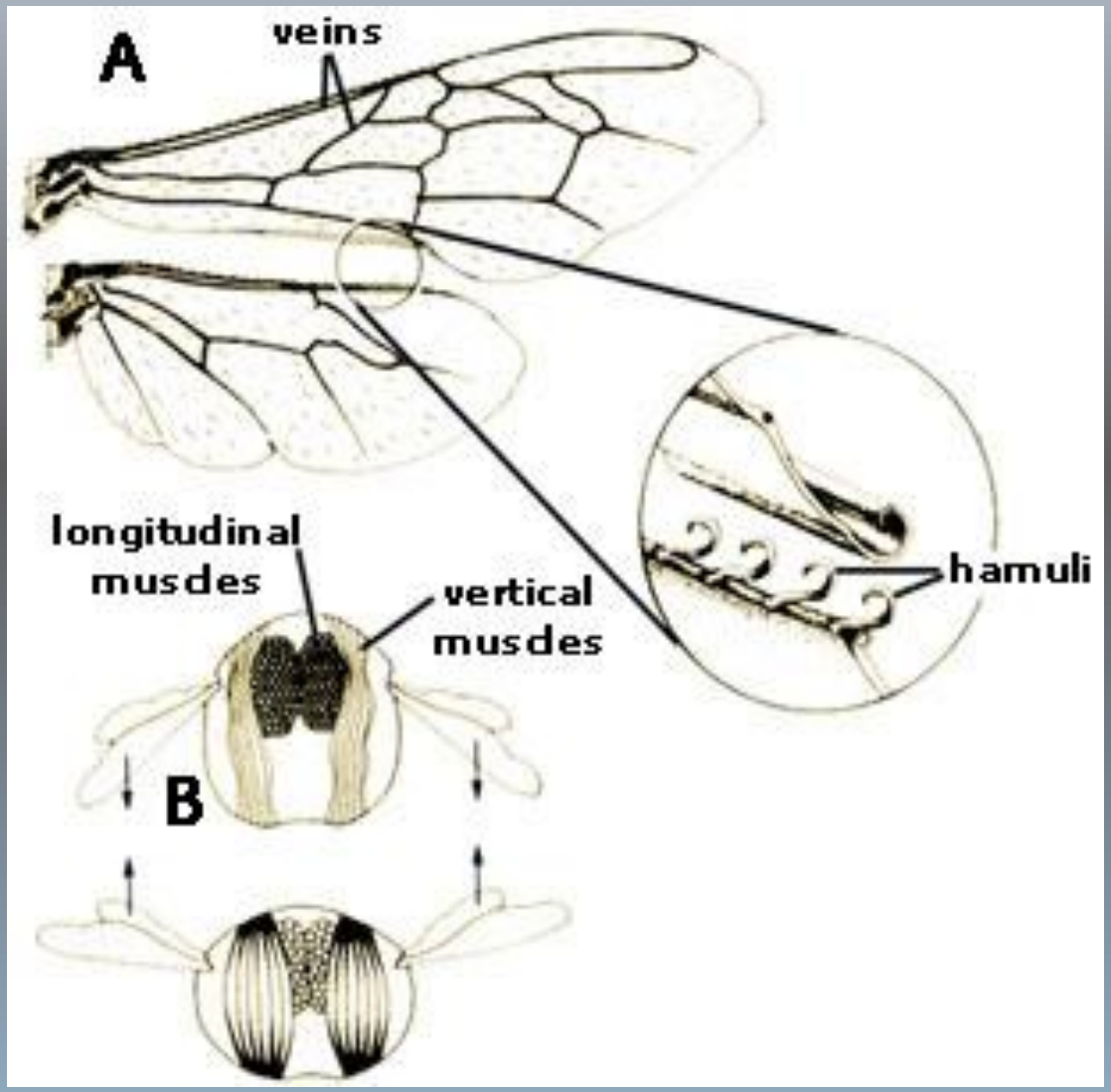


Specialized Structures of Honey Bees

- Wings: They have two pairs of wings that hook together via hamuli.



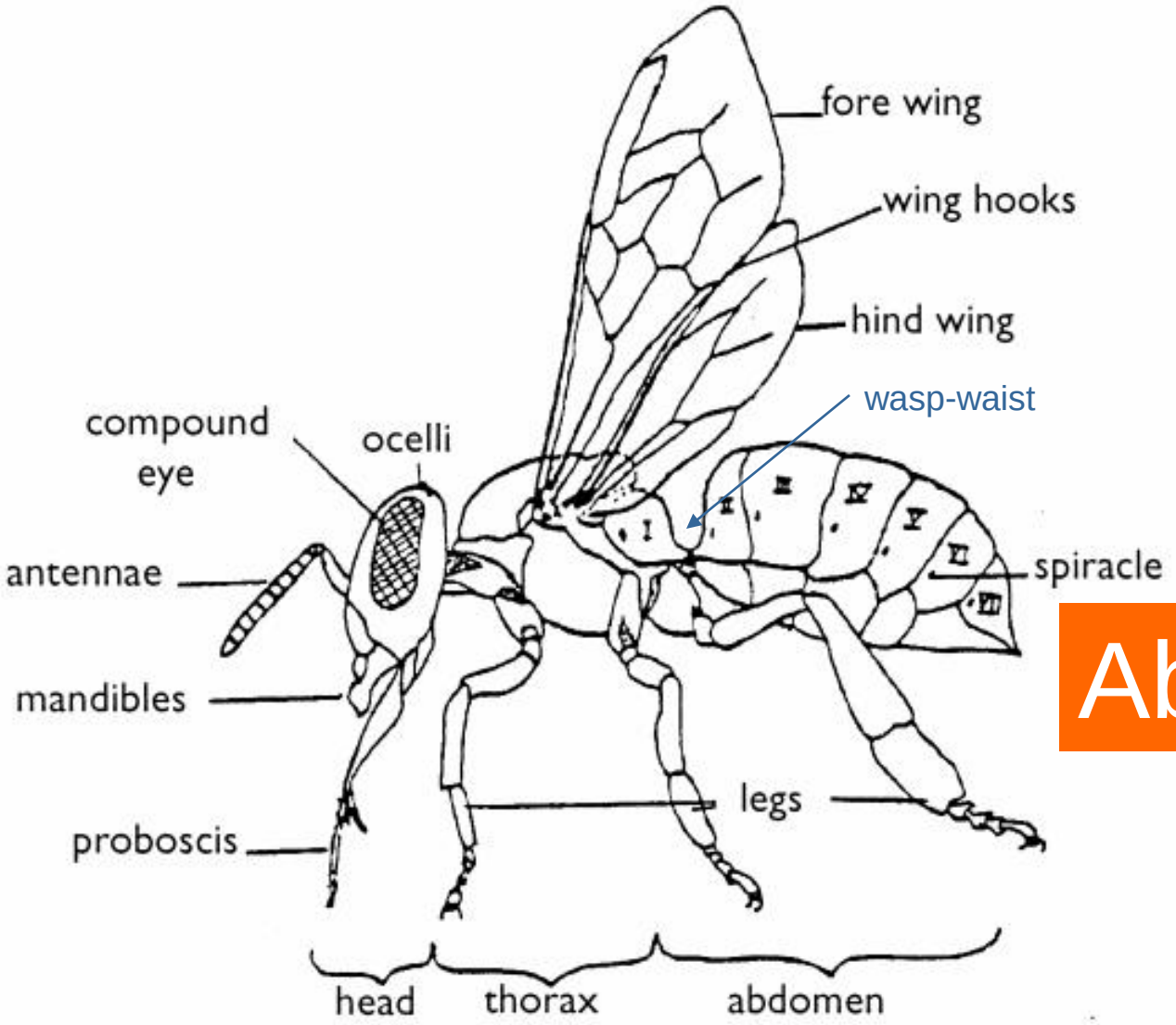
Flight Muscles



Specialized Structures of Honey Bees

- A workers wings beat at a rate of 200 cycles/sec.
- The average flight speed of a worker is 24 km/hr

http://www.abc.net.au/catalyst/stories/3318902.htm



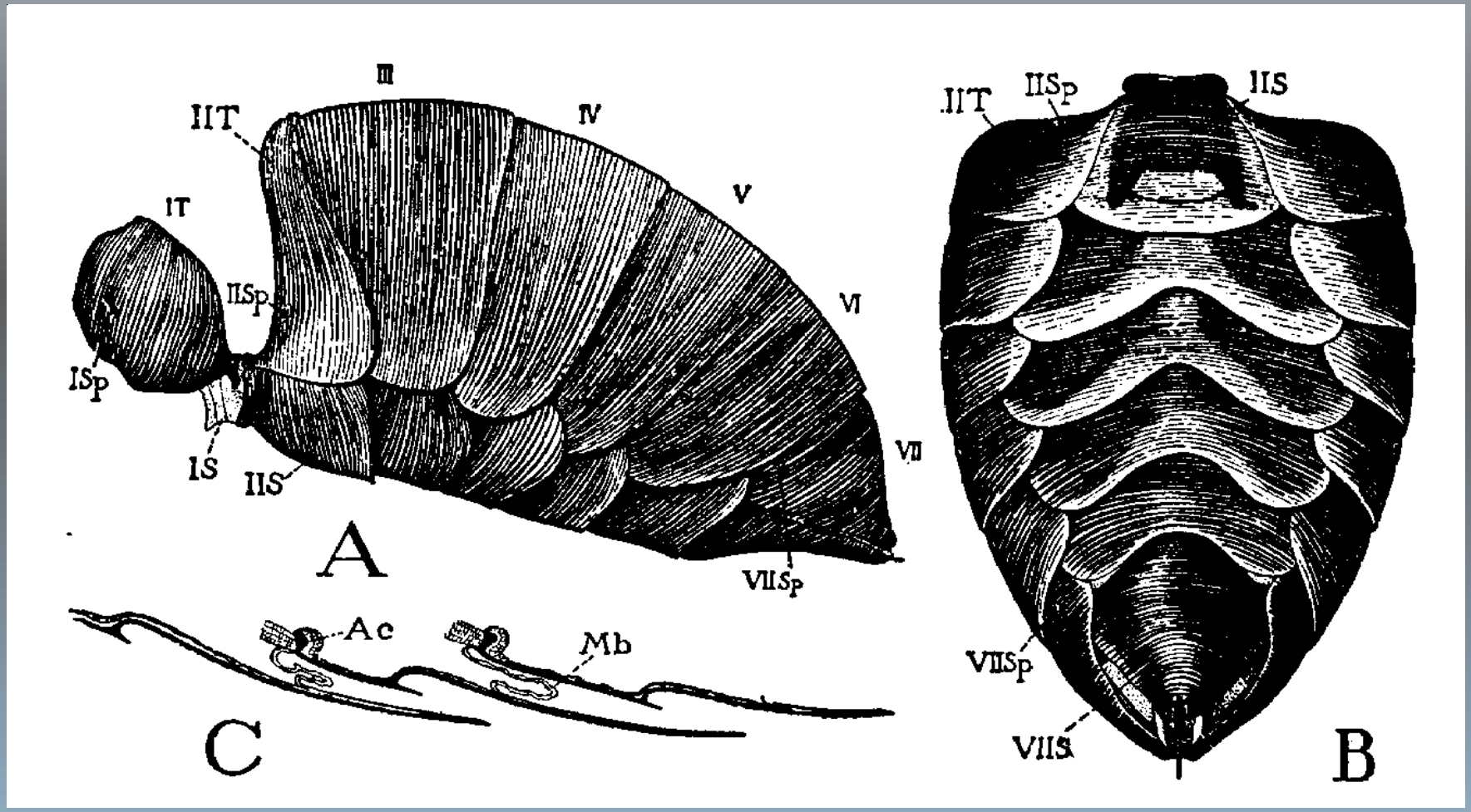
Drawing modified from R. E. Snodgrass

Abdomen

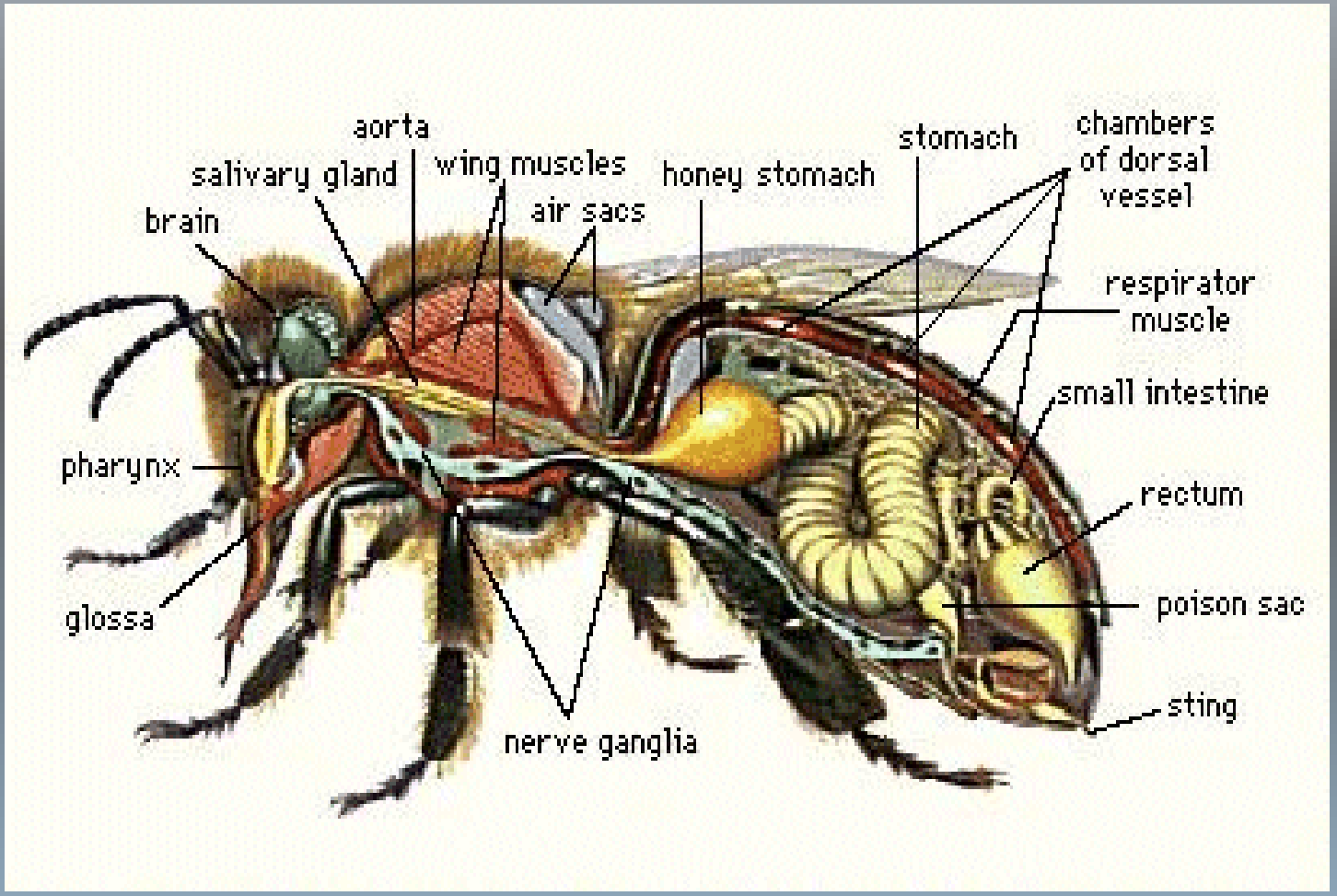
Specialized Structures of the Honey Bee: Abdomen

- Made up of seven visual segments
- Segments are made up of two plates connected by membranes which allow for expansion
- Contains most of the internal organs

The Abdomen: General Structure

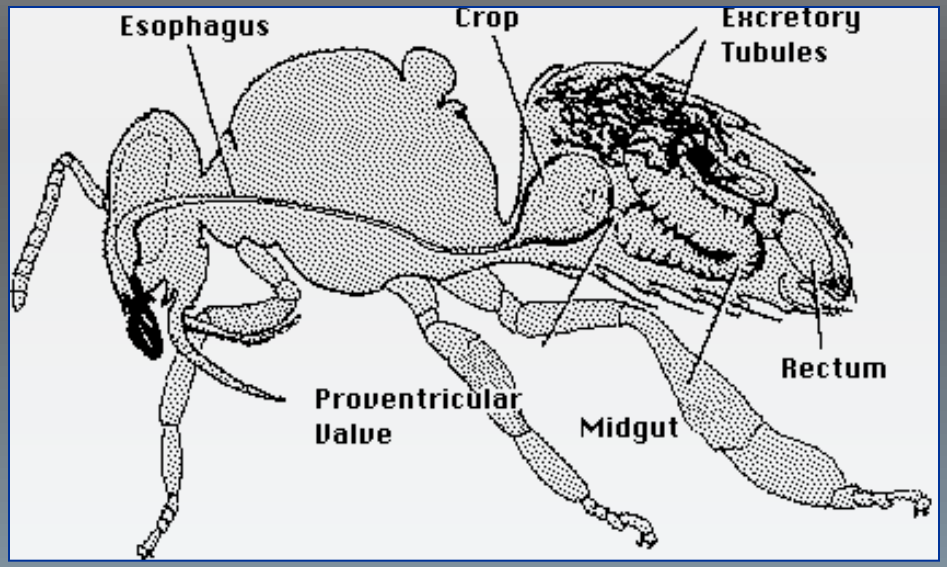


Internal Adult Anatomy



The Digestive System: Honey Stomach or Crop

- This is a specialized expandable structure that holds and stores resources



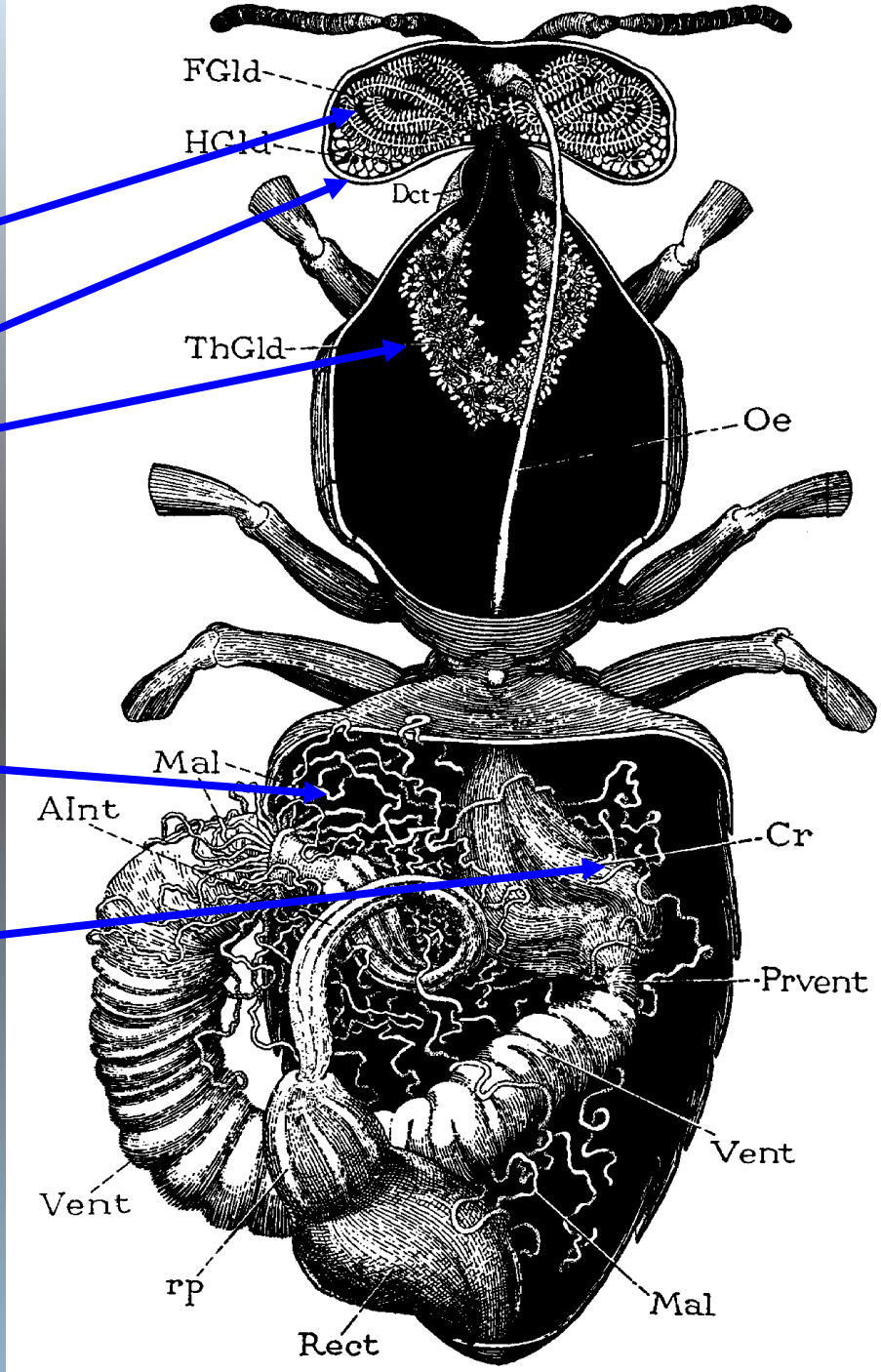
Digestive system

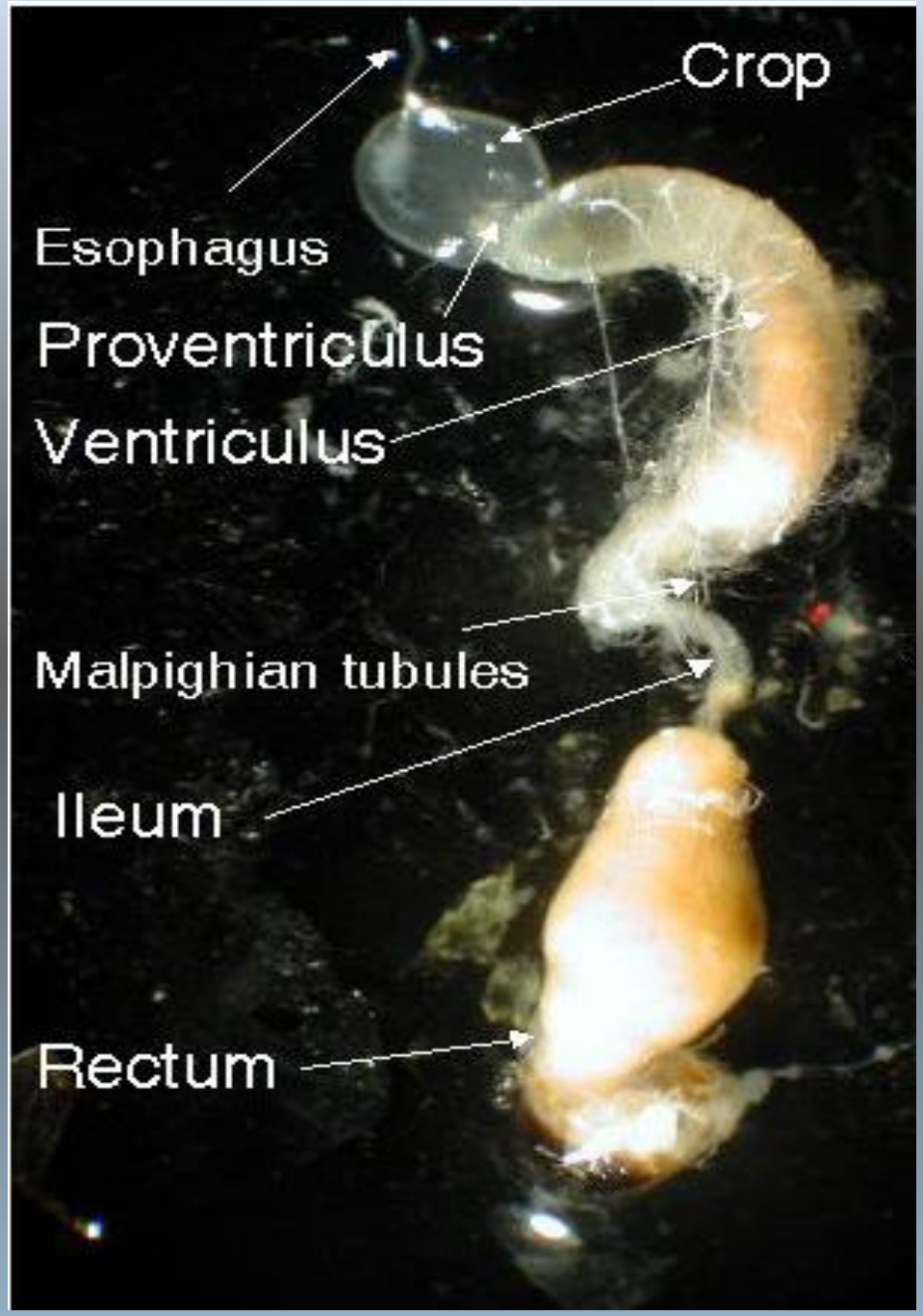
Hypopharyngeal Gland

Salivary Glands

Malpighian Tubes

Crop (Honey Stomach)




Crop
Esophagus
Proventriculus
Ventriculus
Malpighian tubules
Ileum
Rectum

Nervous System

- 5 main ganglia

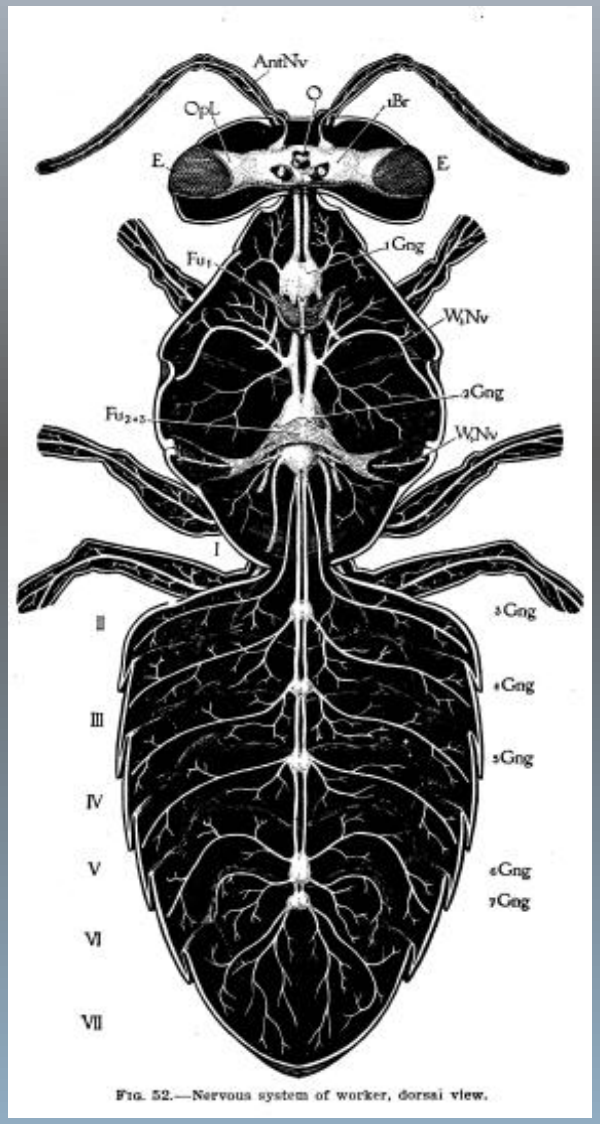


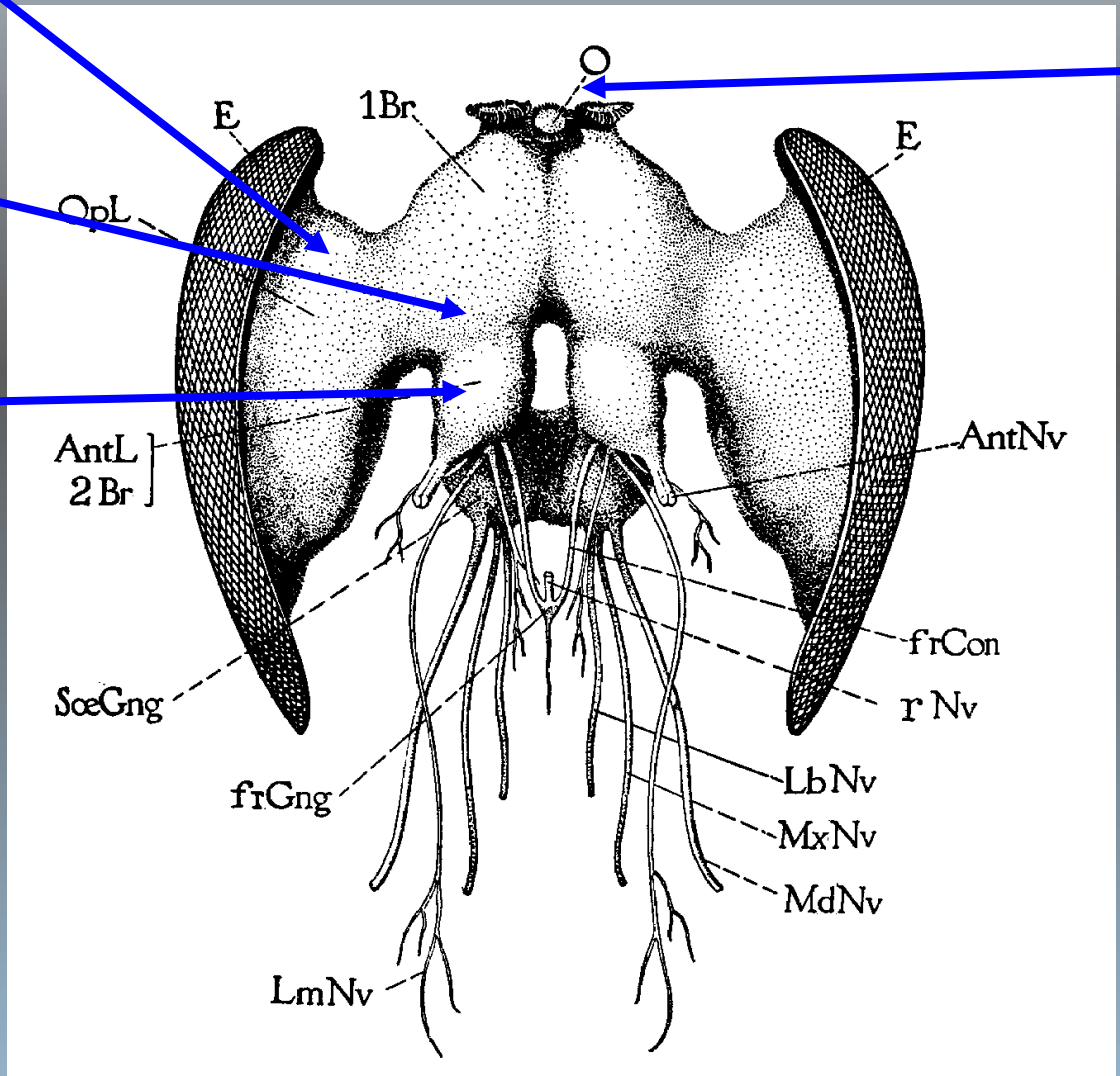
FIG. 52.—Nervous system of worker, dorsal view.

The Bee Brain

Optic Lobe

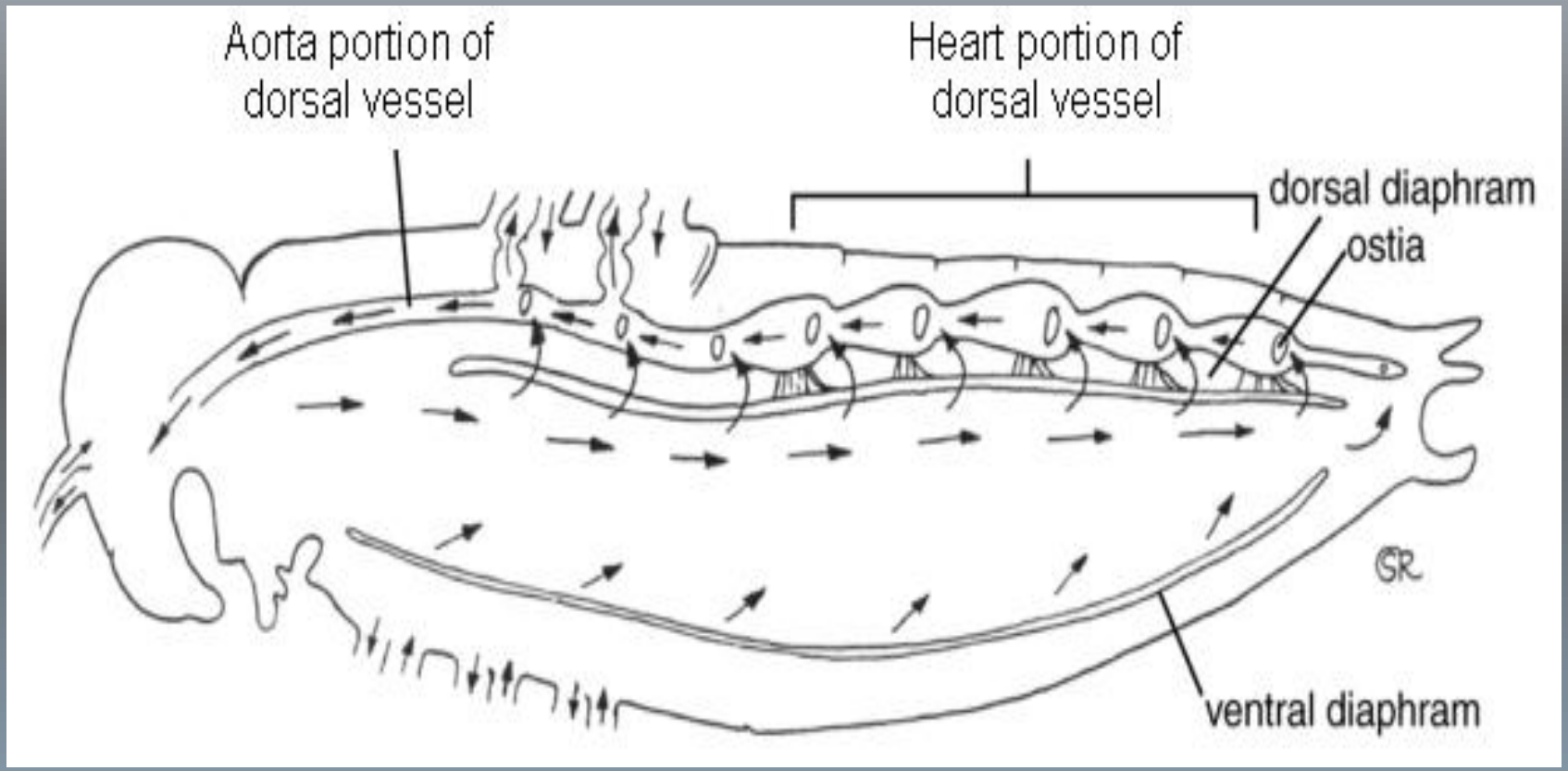
Proto-cerebrum

Antennal Lobe



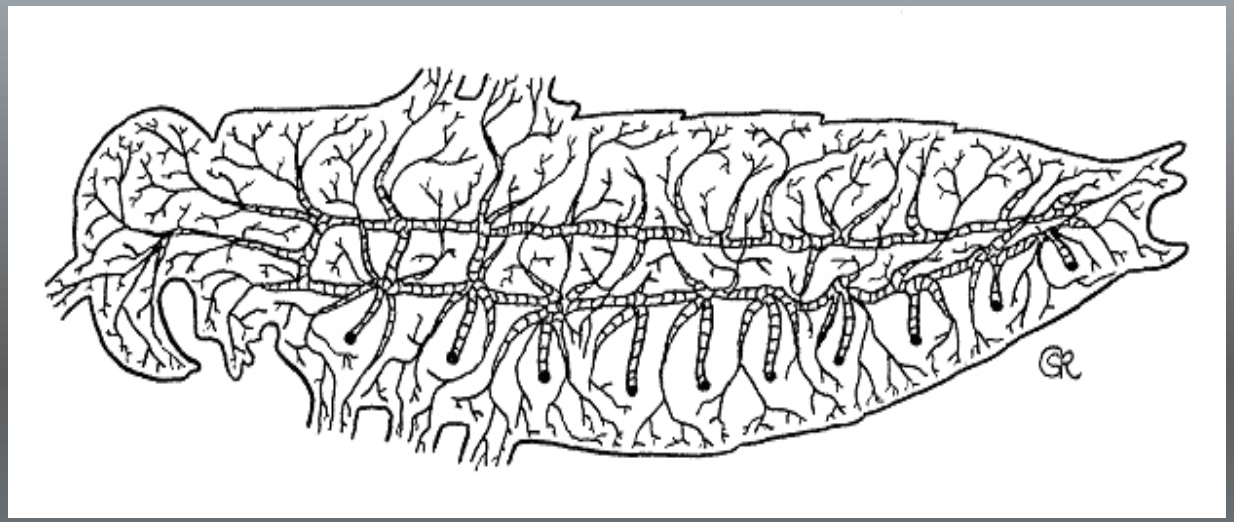
Ocellus

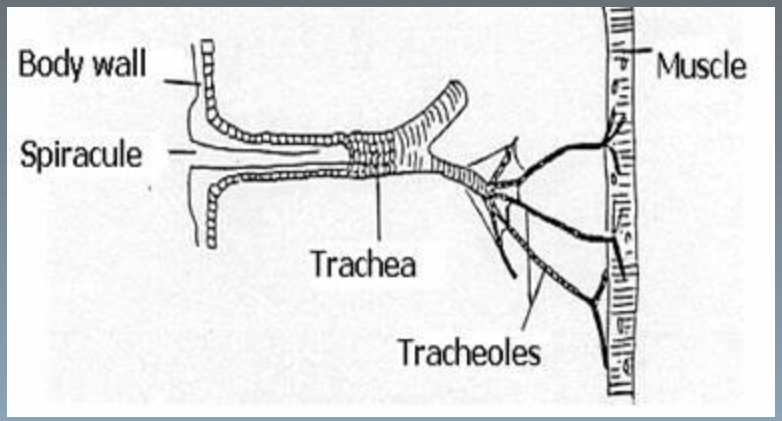
Circulatory System



Open circulatory system

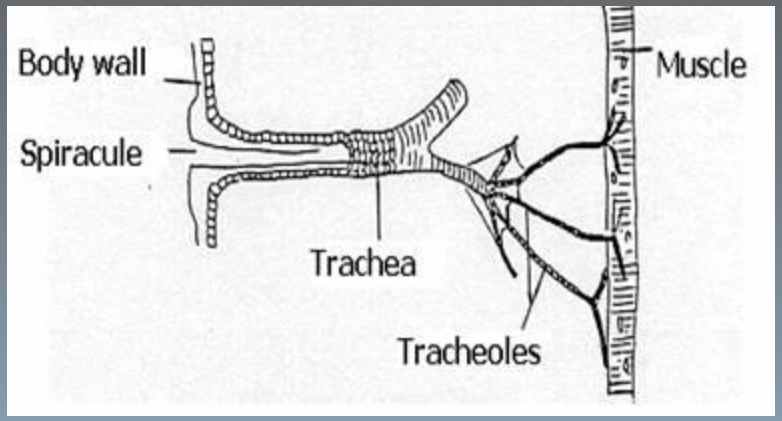
Respiratory System

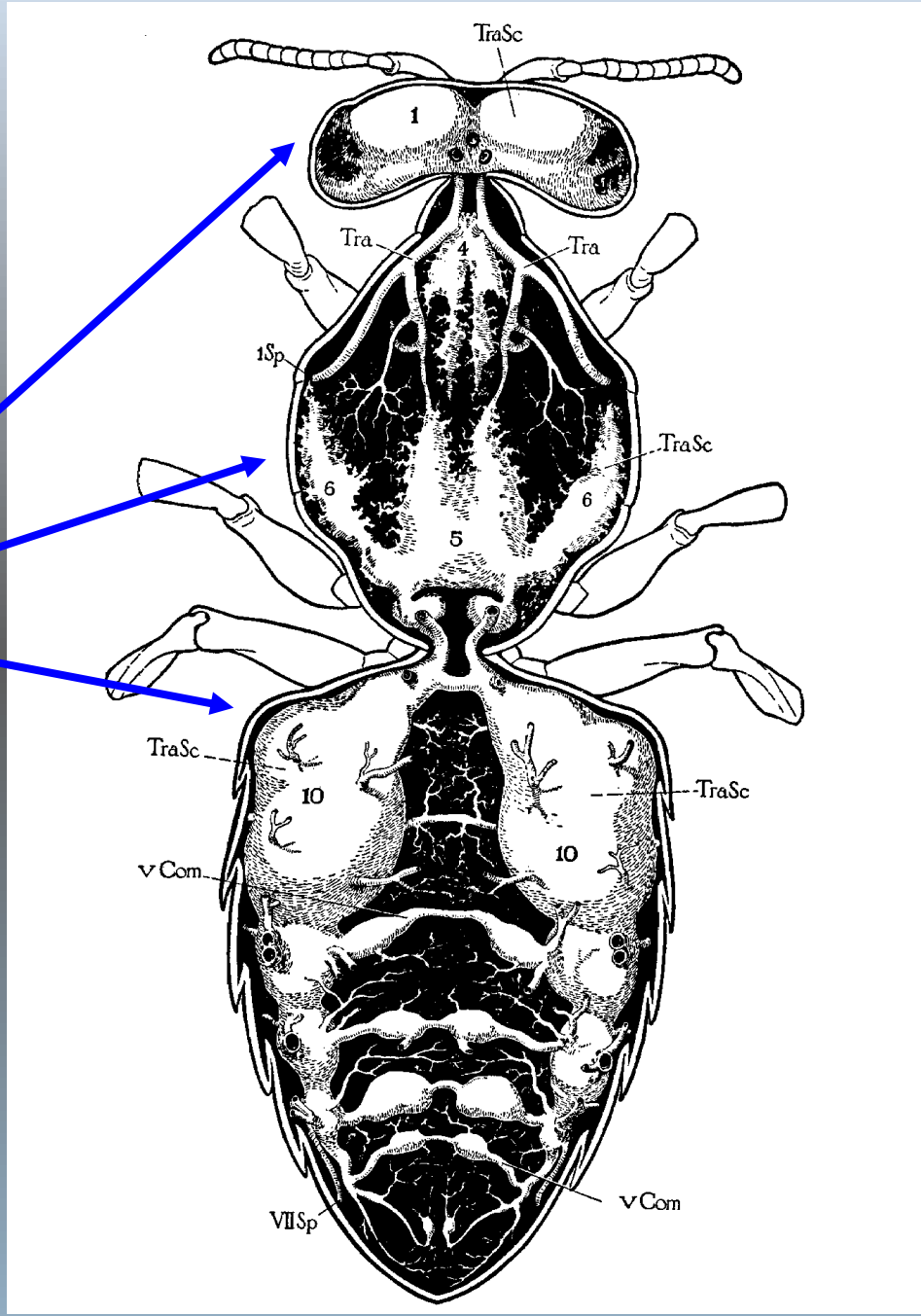




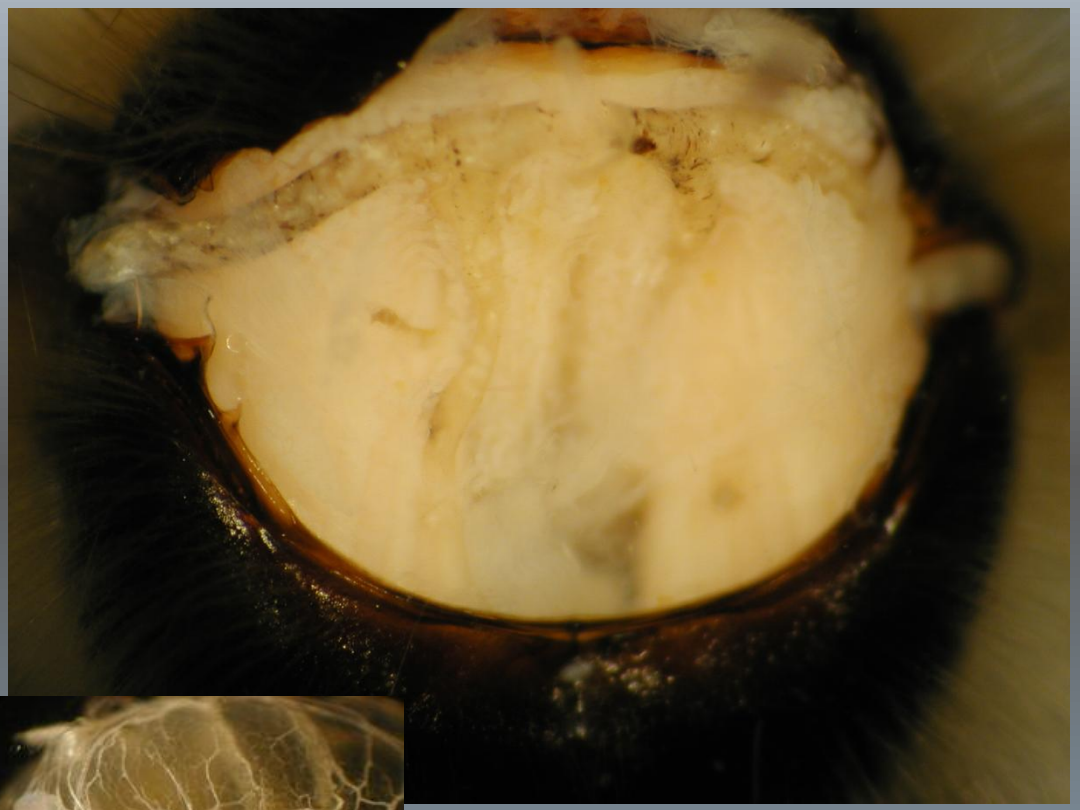
Respiratory System

Tracheal Air Sacs (10)





Trachea

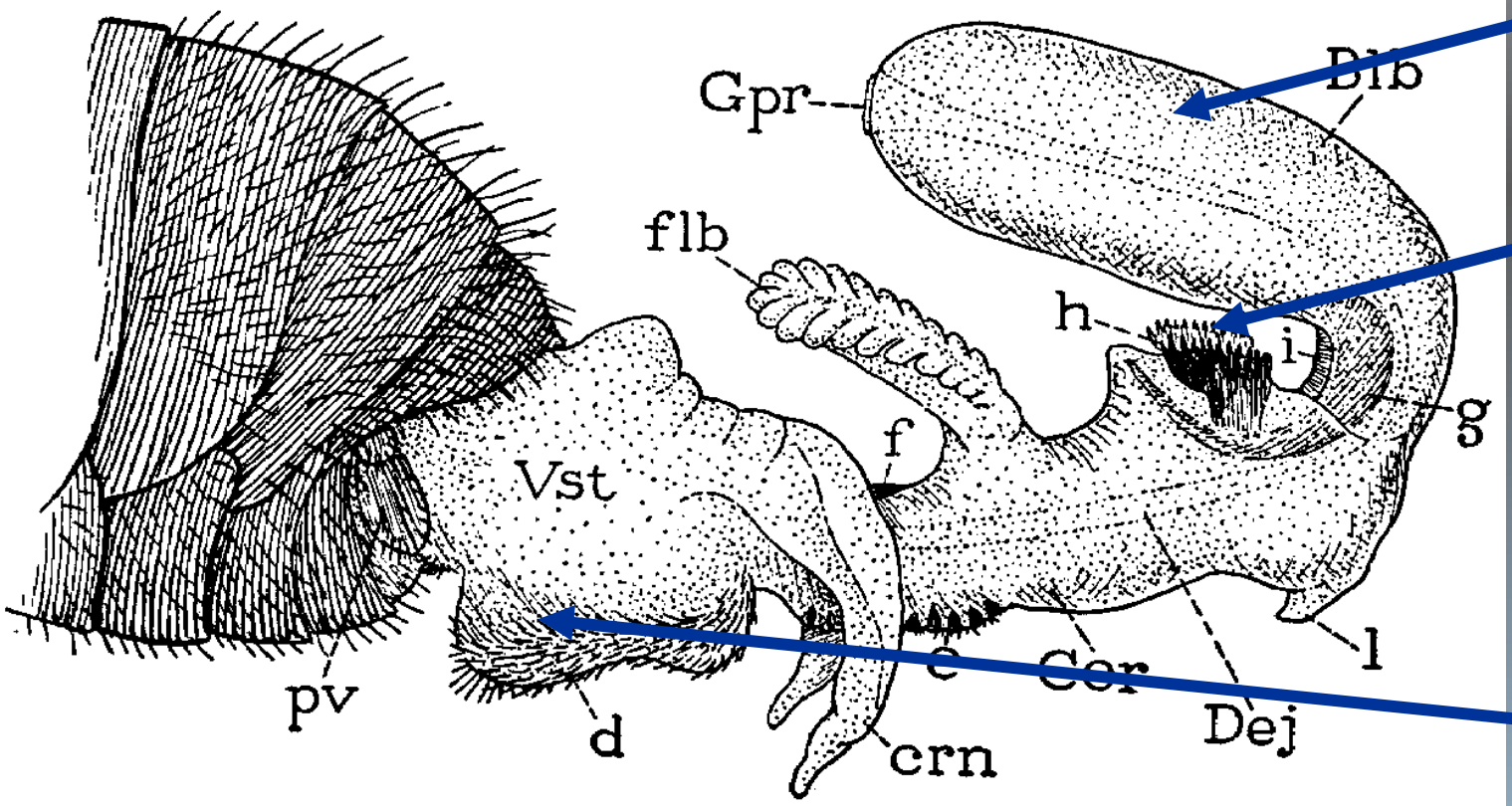


Drones

- Male
- Large body size
- Larger eyes, more antennal receptors
- Fertile
- They do not perform any tasks
  - No stingers, glands, pollen collecting devices
- Once they mate with a queen they die

Drones
Reproductive Organs

Endophallus



Bulb

Hairs

Clasper

The Queen

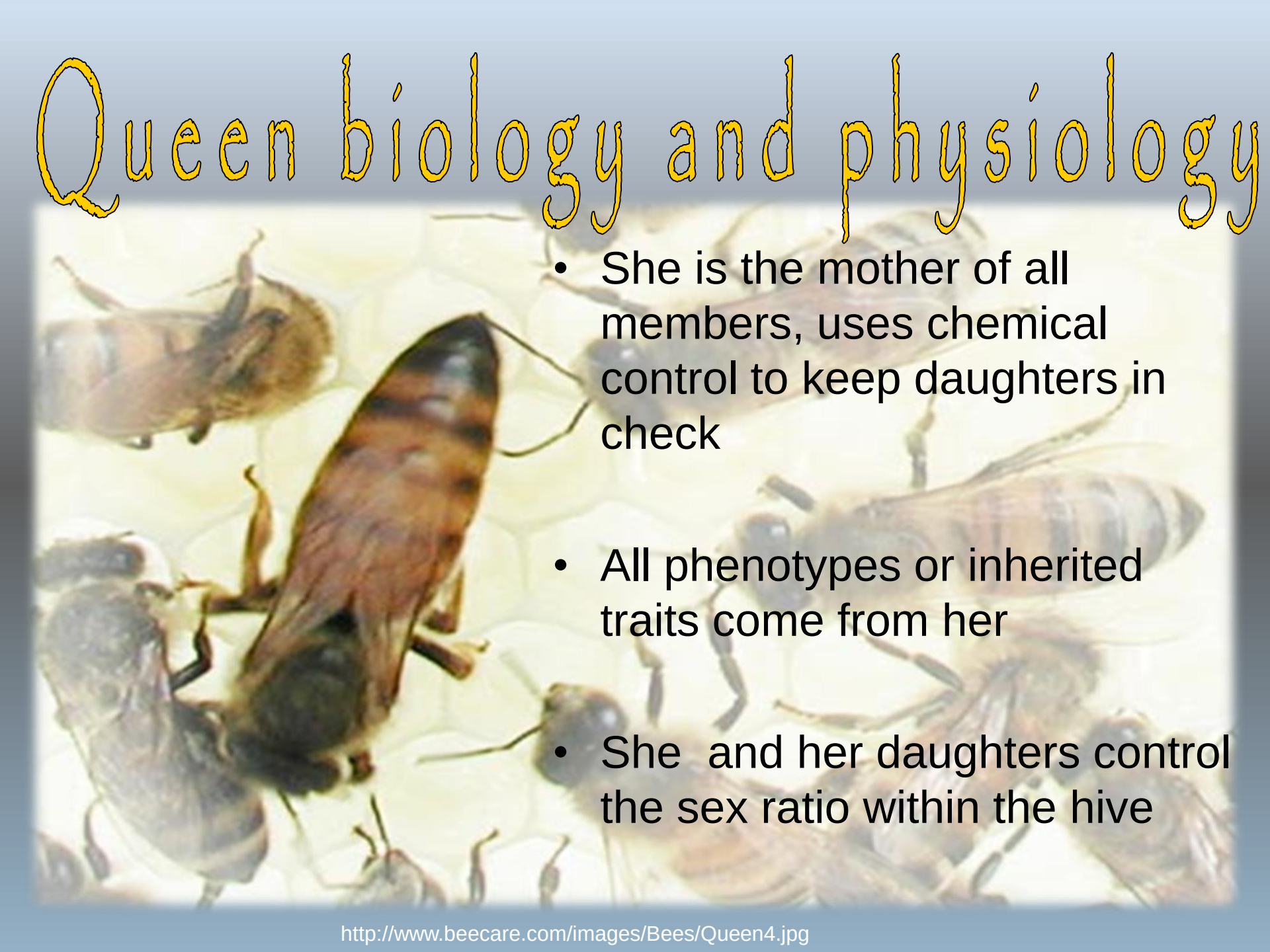
- Largest bee in the hive and each colony contains only one

- Most important function is to lay eggs, large ovaries, spermatheca

- A queen can live for up to 4 years and can lay over 1 million eggs during that time.

http://www.glenn-apiaries.com/Images/spermempty.gif

Queen biology and physiology



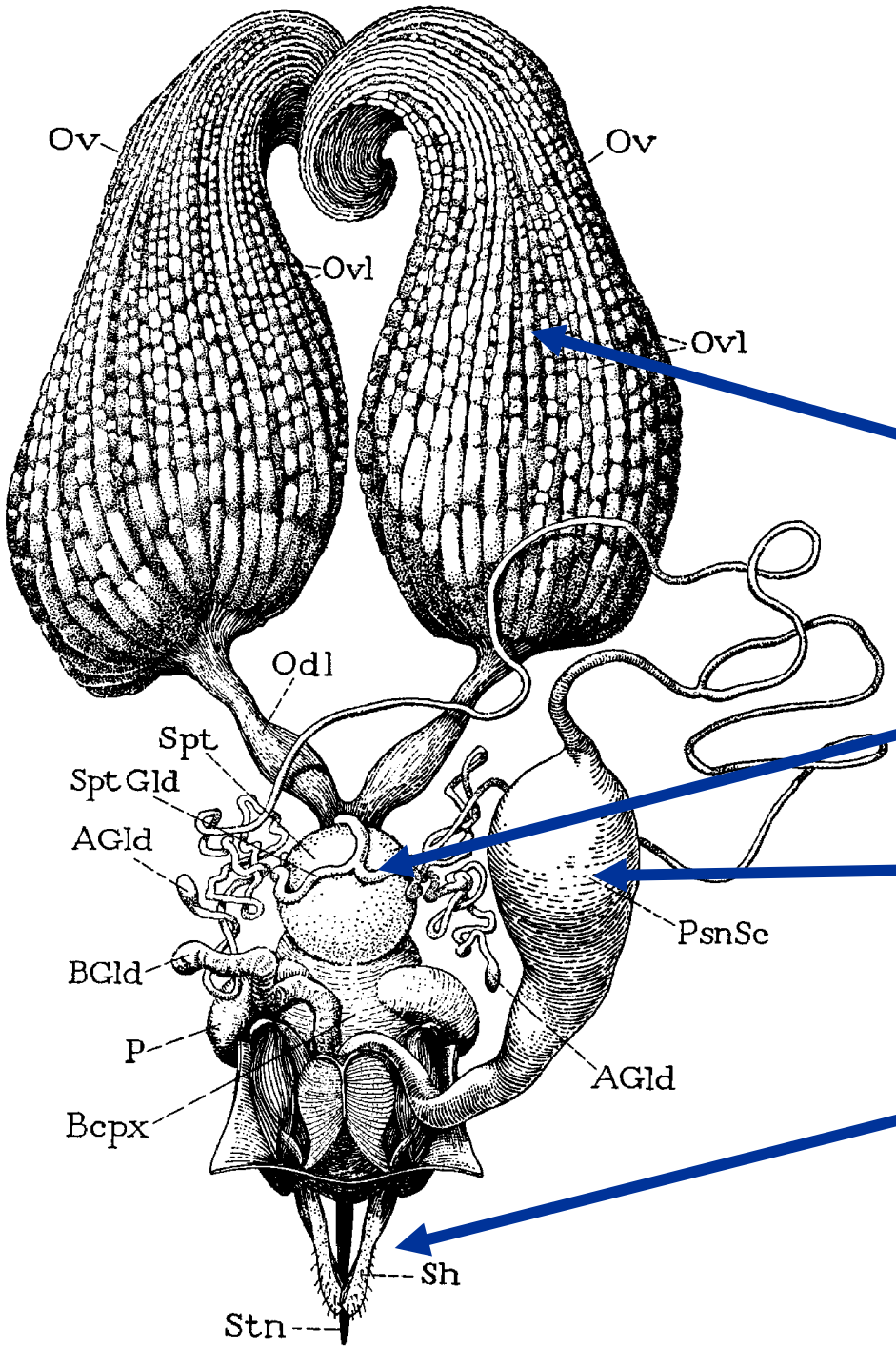
- She is the mother of all members, uses chemical control to keep daughters in check
- All phenotypes or inherited traits come from her
- She and her daughters control the sex ratio within the hive

http://www.beecare.com/images/Bees/Queen4.jpg

The making of a queen

- The quantity and quality of food
- “royal jelly” contains mandibular gland secretions

Queen Reproductive Organs



Ovary (egg production)

Spermatheca (sperm storage)

Poison sac

Sting (sting rival queens)

Haplodiploidy

- Unfertilized eggs become drones

- Fertilized eggs develop into workers or queens

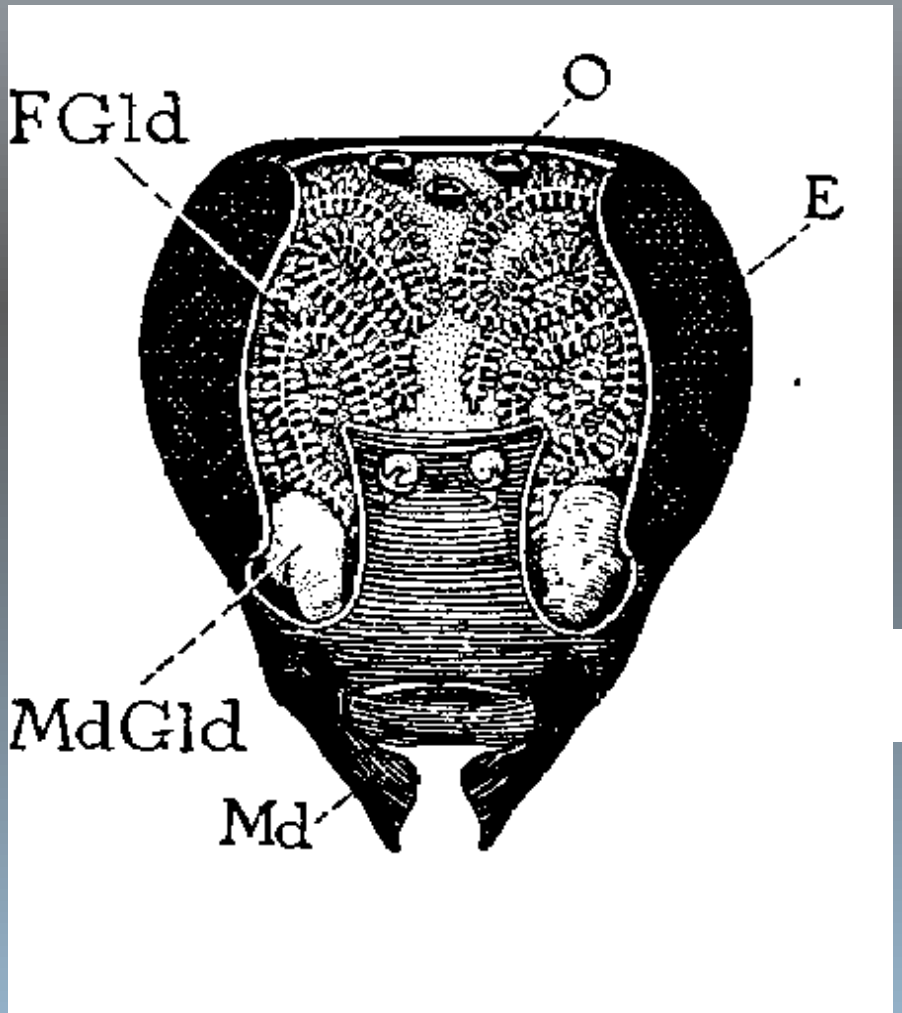
Haplodiploidy: Viable drones come from unfertilized eggs, females from fertilized eggs

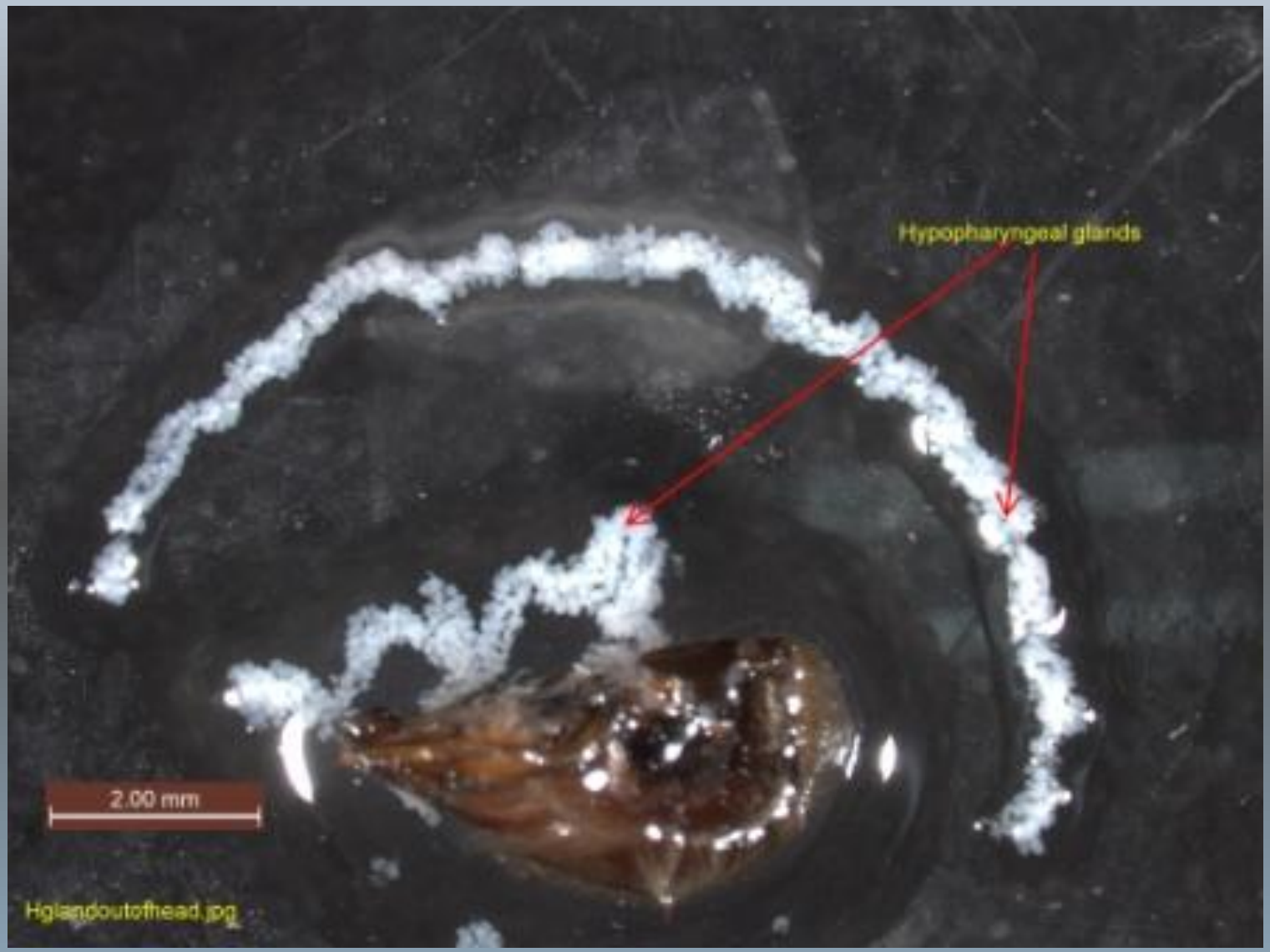
Workers

- They are the smallest bees in the colony and they are female

- They perform many tasks in the hive: make honey, clean the hive, feed larvae and build wax comb
- They also forage for nectar, pollen, propolis and water outside the hive

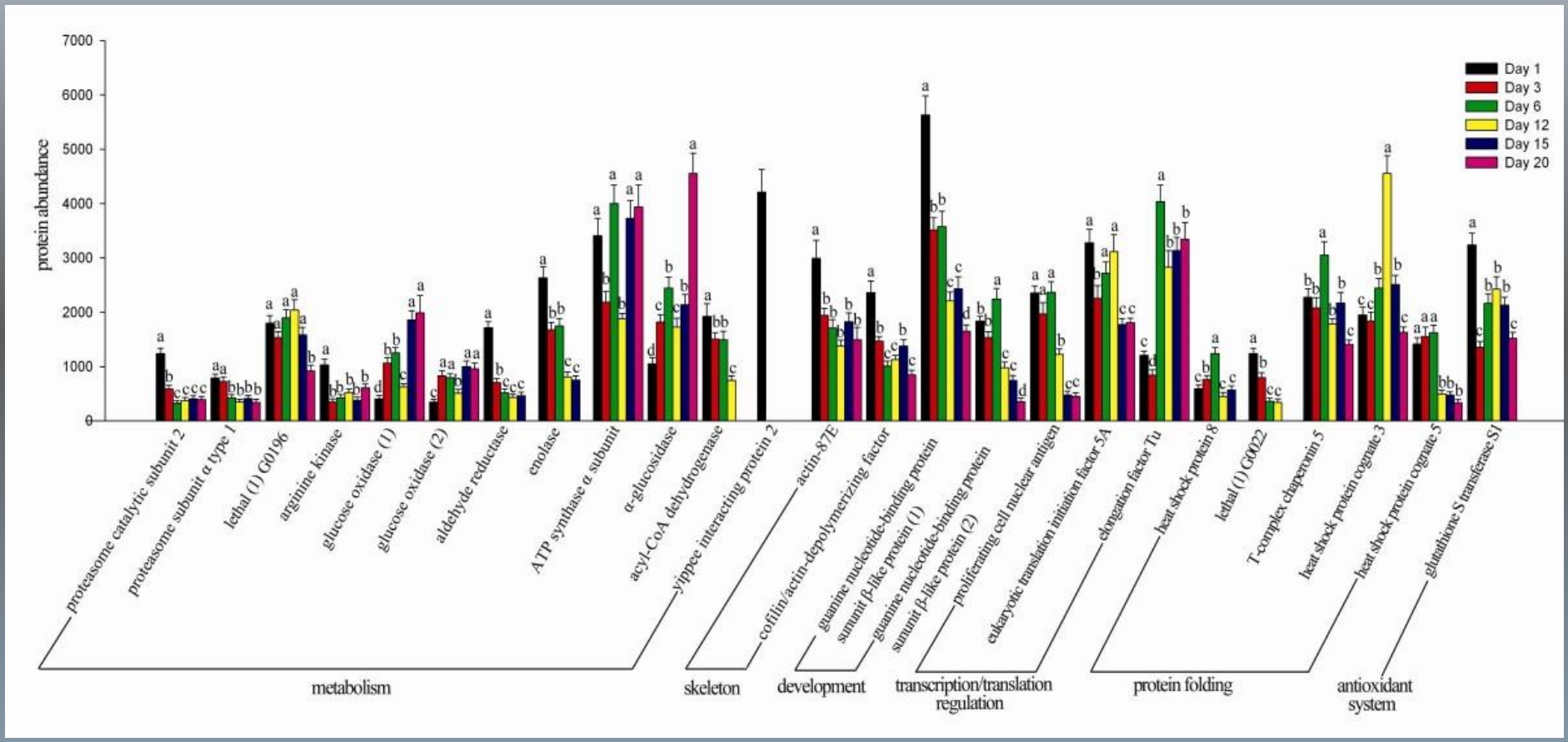
Major Glands of the Head: Hypopharyngeal and Mandibular glands





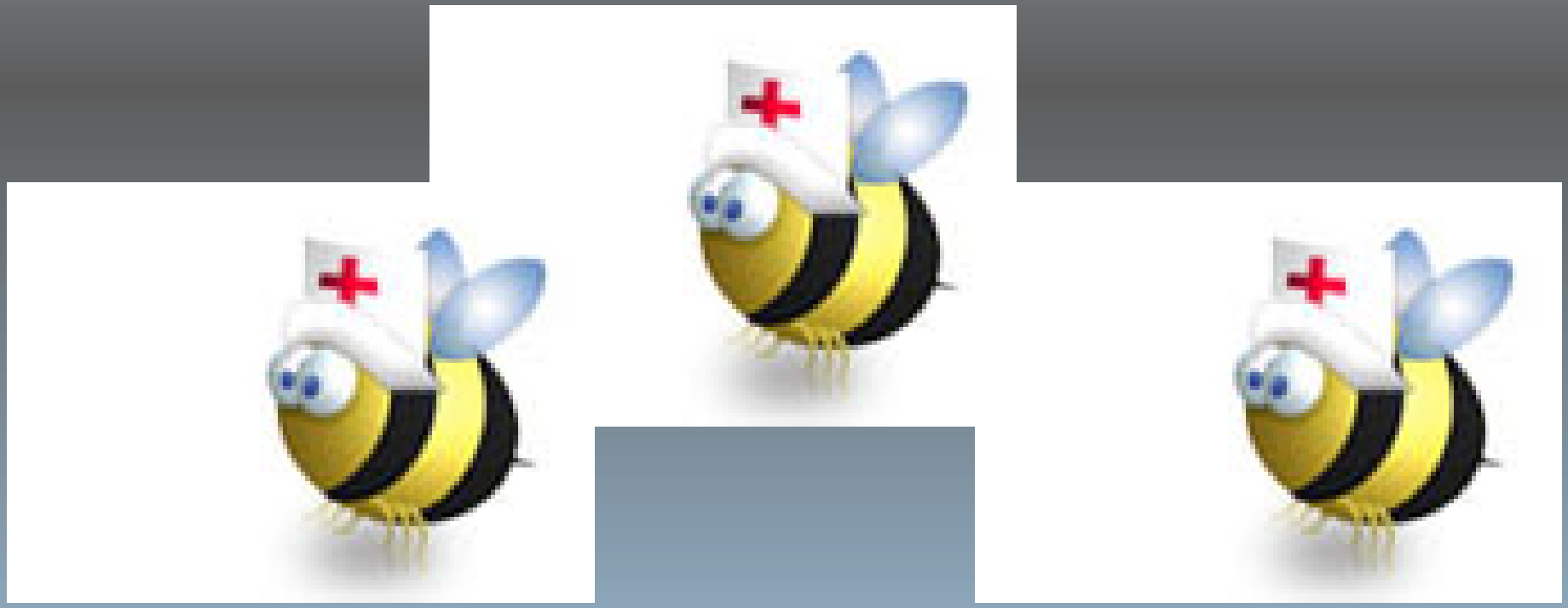
http://honeybeelab.oregonstate.edu/files/images/Hglandoutofheadresized.jpg

Proteins expressed by the hypopharyngeal gland



What to feed the babies?

A glandular secretion from the mandibular and hypopharyngeal glands of worker nurse bees

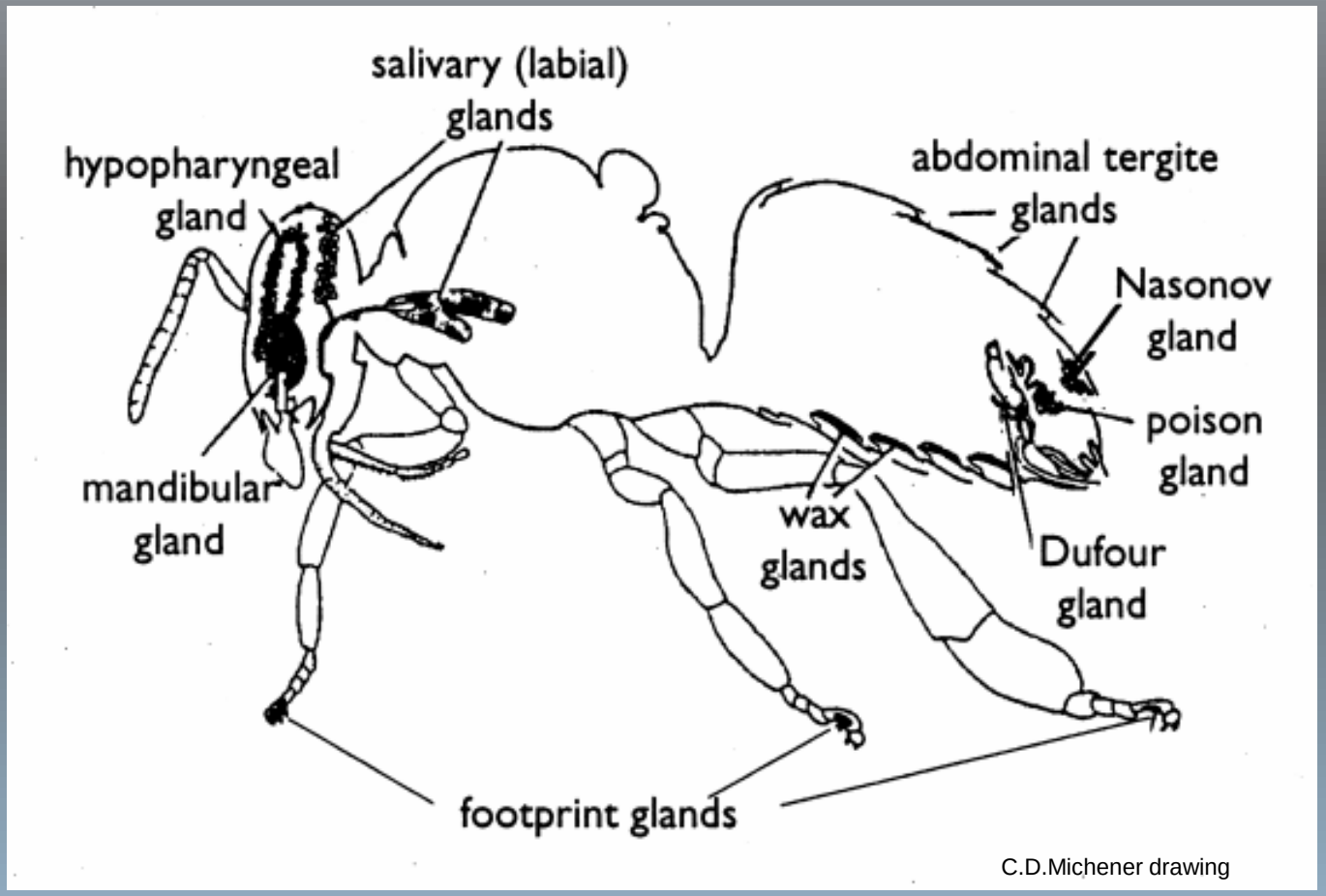


What to feed the babies?

- Hypopharyngeal gland secretions are clear and contain mostly proteins
- Secretions from the mandibular glands are white and contain lipids
- This mixture is called worker jelly

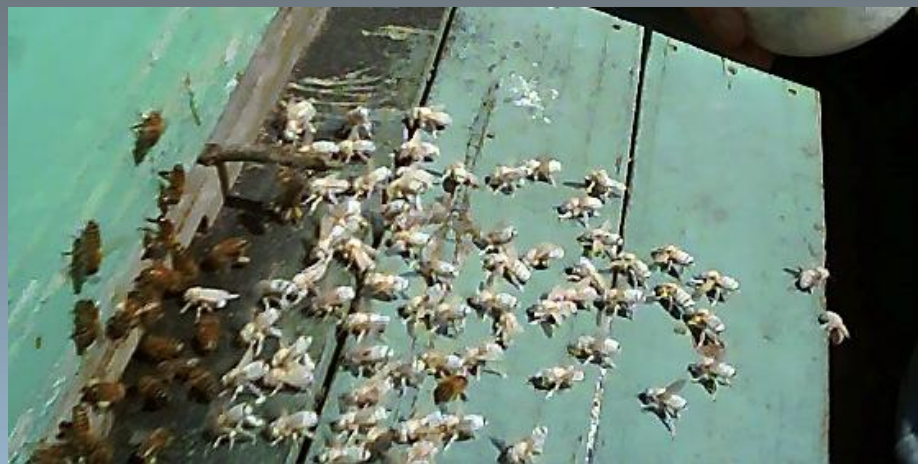
Abdomen

- Exocrine glands incl. wax gland



Major Glands of the Abdomen
Wax glands

Major Glands of the Abdomen
Nasanov gland



Nasanov gland

http://www.youtube.com/watch?v=pyhe_UZPWWs

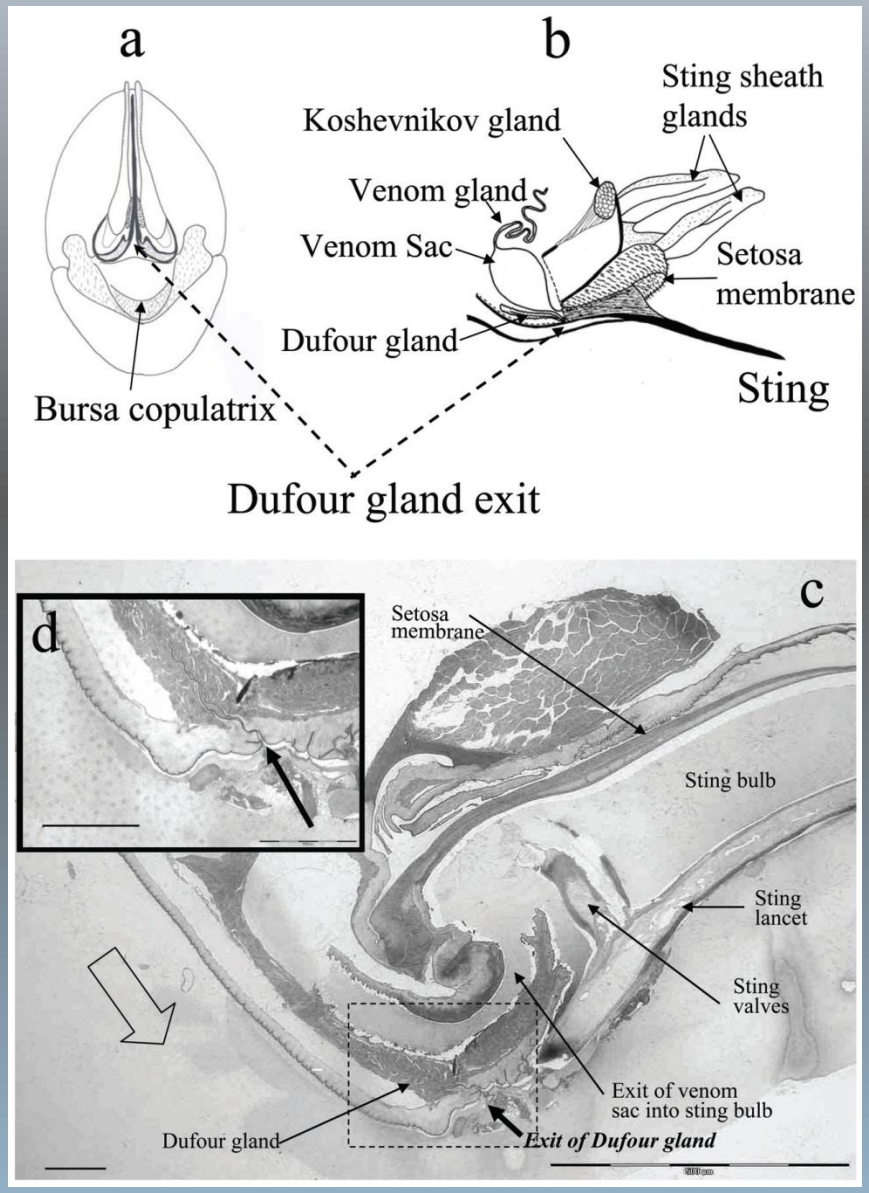
Footprint glands

- Worker: orientation- finding nectar
- Queen: queen cell inhibition

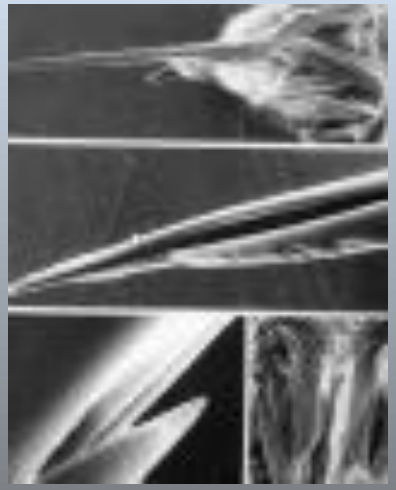
Alarm communication

- Mandibular gland (worker only)
- Sting gland (worker only)

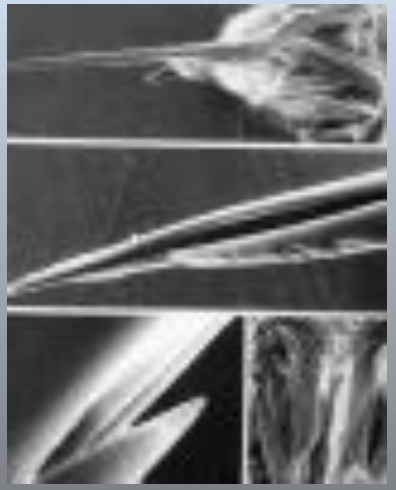
Dufour gland



- Defense and reproduction
- Nest recognition in other bees

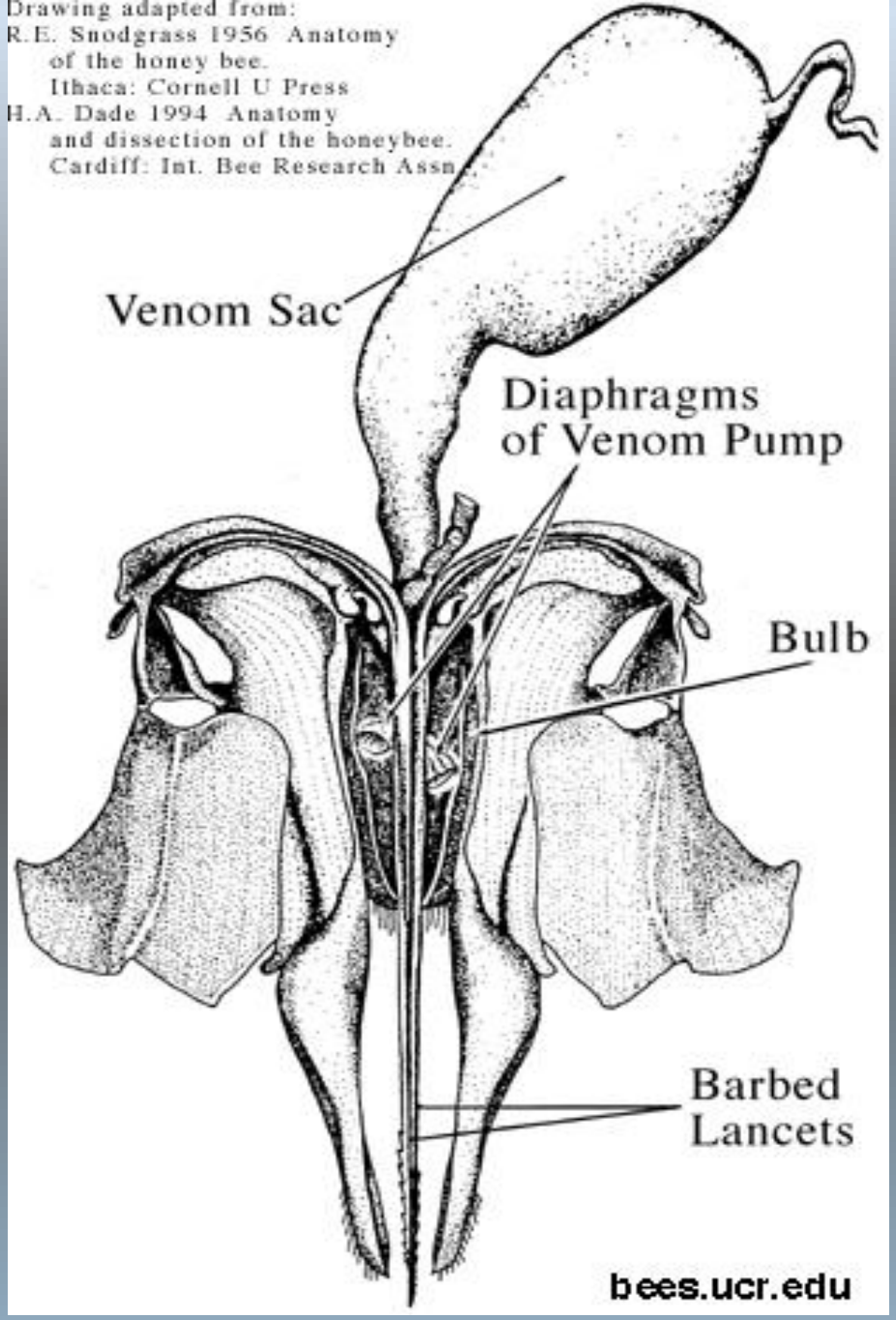


The Stinger!!!!!



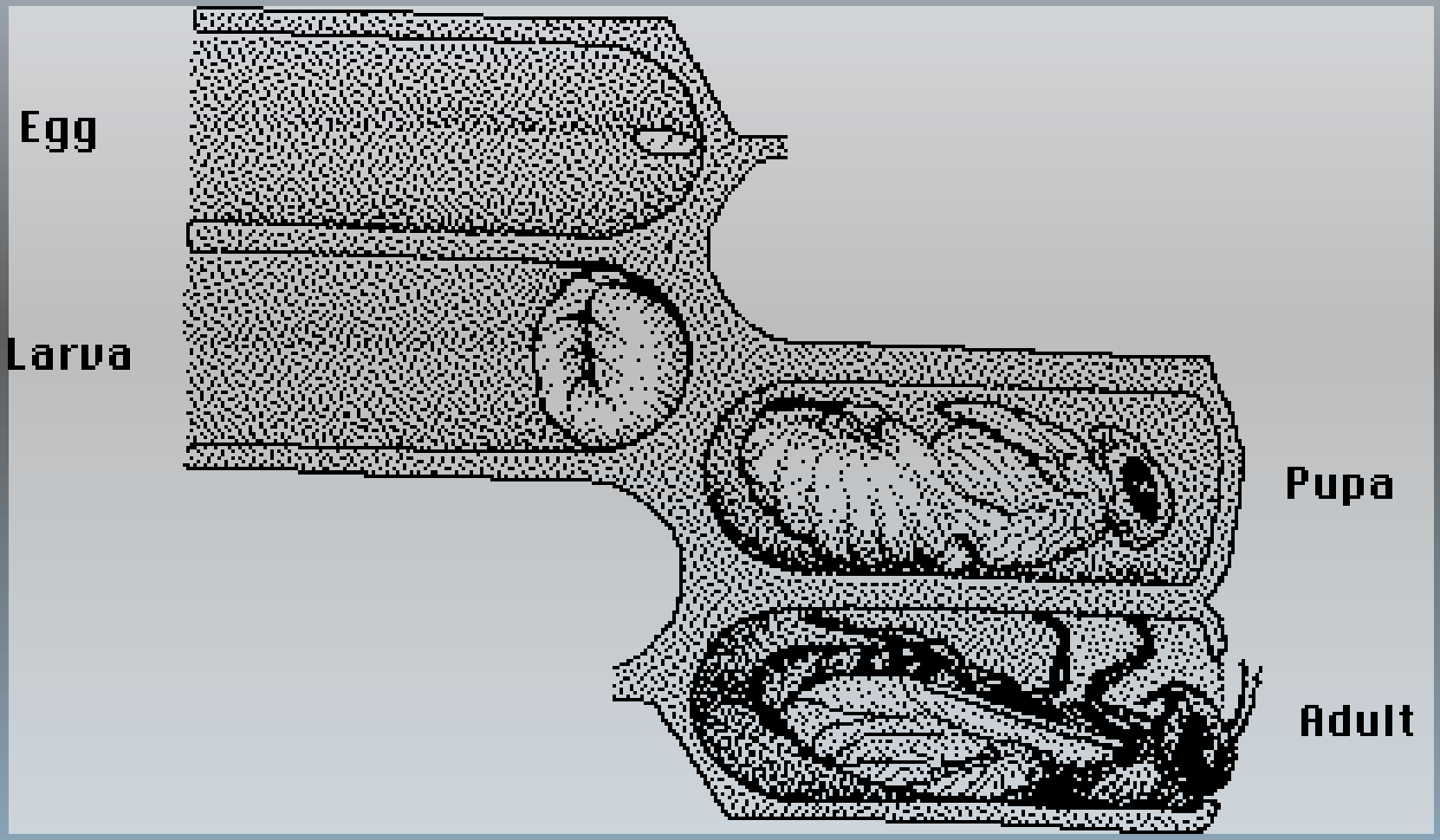
- Has barbs on the sting that saw into surface, which causes the honey bee to loose their sting after use
- Stinger is connected to a venom sac
- Venom is made up of proteins and peptides and can elicit an array of immune responses

http://www.youtube.com/watch?v=IwfCf1LEgaE


Drawing adapted from:
R.E. Snodgrass 1956 Anatomy of the honey bee. Ithaca: Cornell U Press
H.A. Dade 1994 Anatomy and dissection of the honeybee. Cardiff: Int. Bee Research Assn
Venom Sac
Diaphragms of Venom Pump
Bulb
Barbed Lancets
bees.ucr.edu

OOOOUch!!!

Metamorphosis



Three important hormones control the molting process

- Brain releases "Brain hormone" (=PTTH)
  - (Stored & secreted by Corpus cardiacum)
  - In response to e.g. stretch receptors indicating cuticle is too tight (or other cues; see Gotthard reading)
  - Released into hemolymph; acts on prothoracic gland, causing secretion of: Ecdysone (molting hormone)

Three important hormones control the molting process

- Brain releases “Brain hormone” (=PTTH)
- Ecdysone (molting hormone)
- Juvenile Hormone (JH)

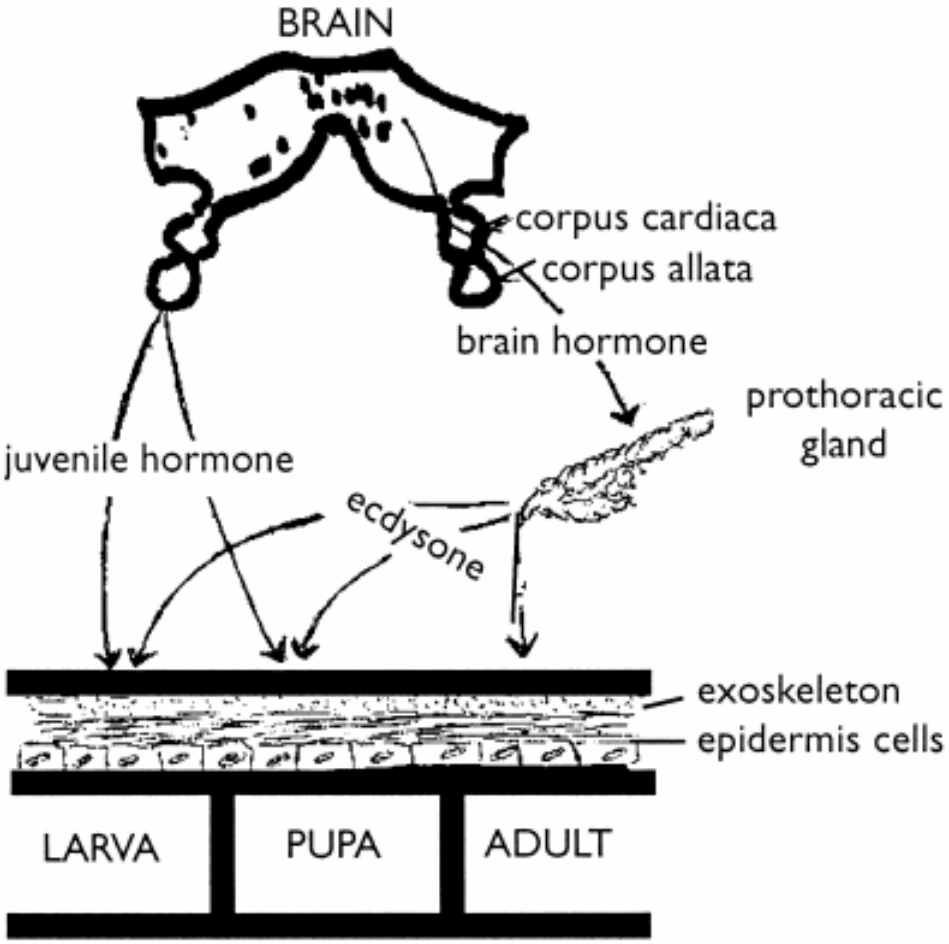
Three important hormones control the molting process

- Ecdysone (molting hormone)
  - Secreted by prothoracic gland (in prothorax)
  - Into hemolymph; acts on epidermis: start the process, apolysis etc.

Third: Juvenile Hormone (JH)

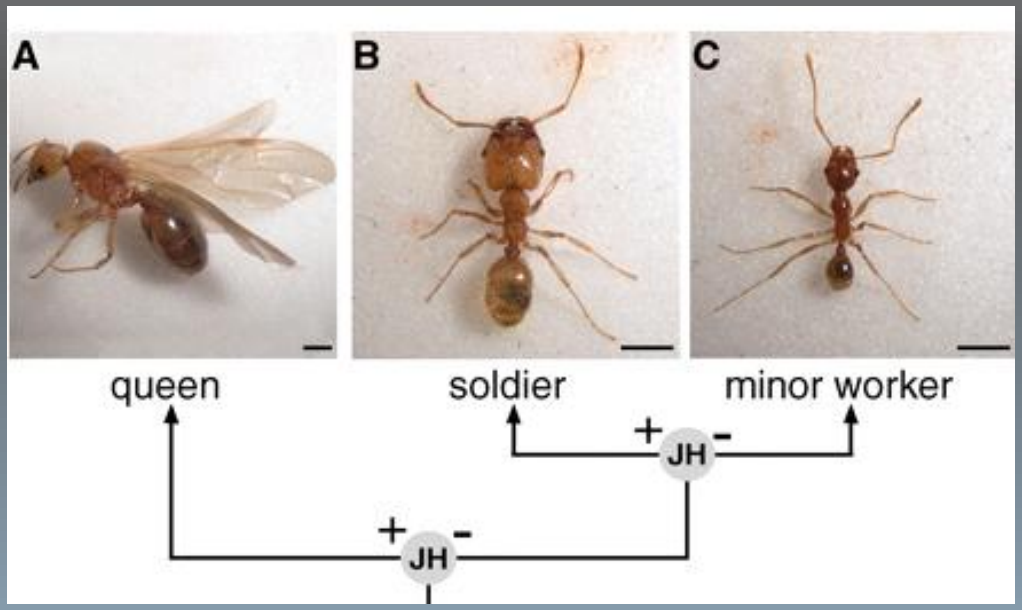
- Secreted by corpora allata
- Into the hemolymph
- Level present in hemolymph determines whether molt is to another juvenile stage or a more advanced stage

Endocrine gland example



JH and age-based polyethism

- Methoprene caused dose-dependent changes in the timing and frequency of occurrence of four important age-dependent tasks: brood and queen care, food storage, nest maintenance, and foraging. These results support the hypothesis that JH is involved in the control of age polyethism.




Questions???