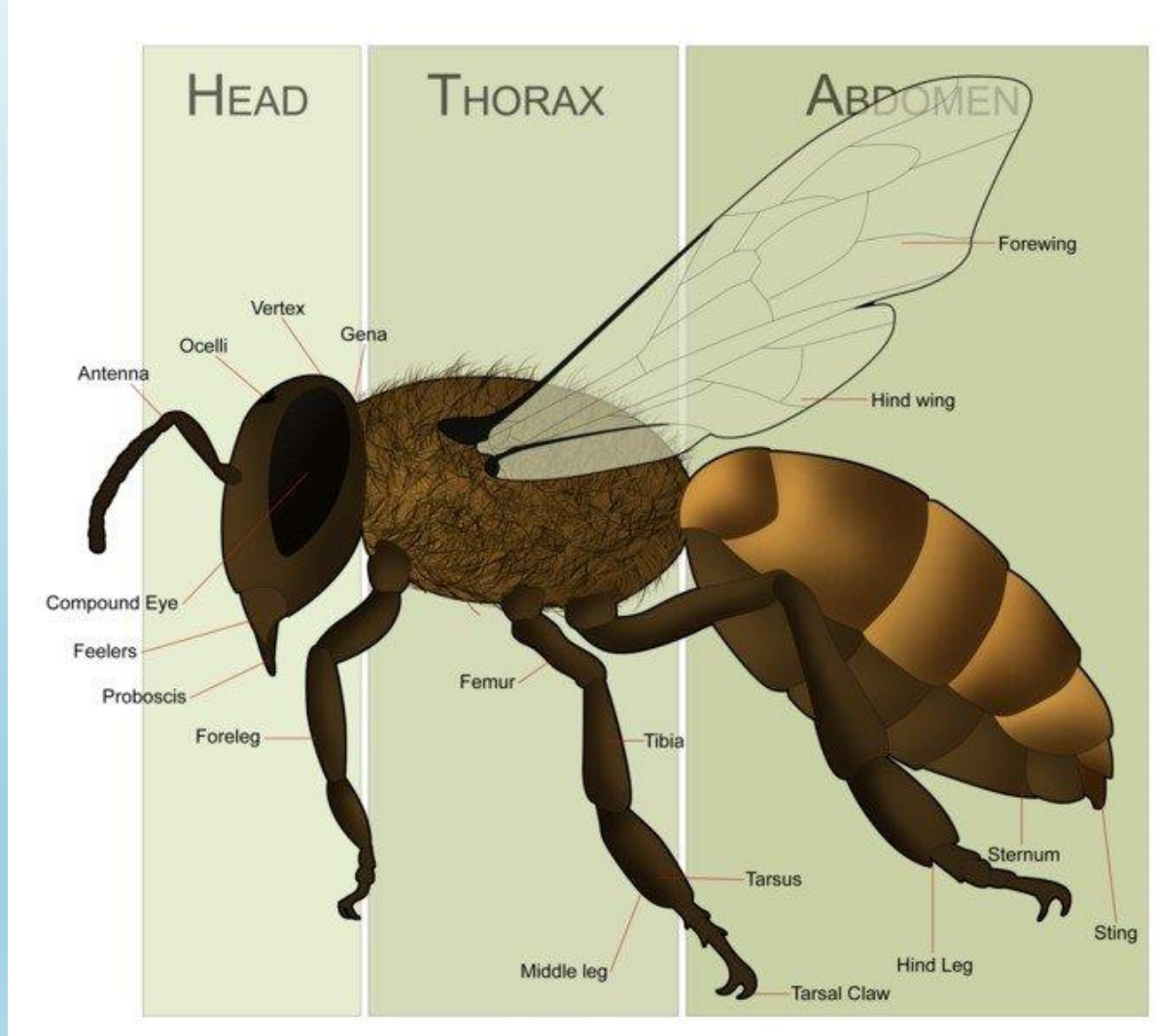
Honey Bee Biology

Honey Bee Anatomy

- Exoskeleton
- Three main body parts
  - Head
  - Thorax
  - Abdomen
- Bilaterally symmetrical body
- Covered in Plumose hairs
  - Sensory functions, protection, and prevents dirt accumulation

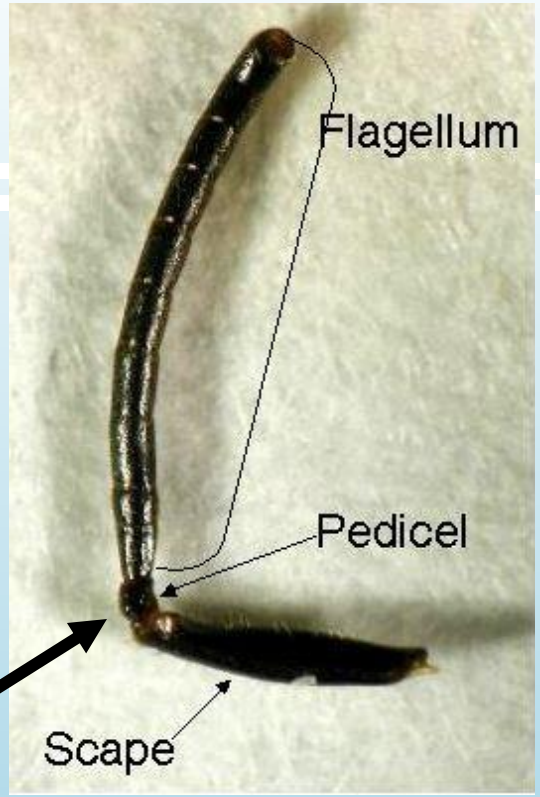


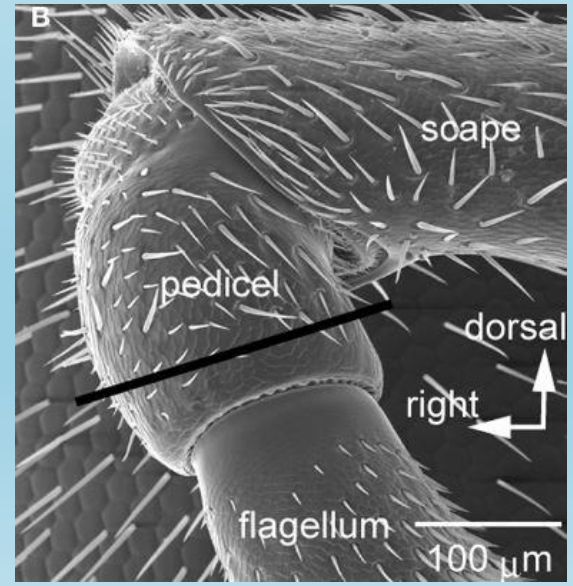
Head

- Main sensory structures
  - Antenna
  - Eyes
  - Mouth
- Various Glands

Antennae – One Pair

- Each consist of three major parts
  - Scape, Pedicel, Flagellum
- Covered in hairs
- Provides
  - Sense of smell
  - Sense of touch
  - Sense of taste
  - Sense temperature/humidity
- Johnston's organ (bee's ear)
  - Sense of flight speed
- Drone antenna are one segment longer and slightly thicker





Brain

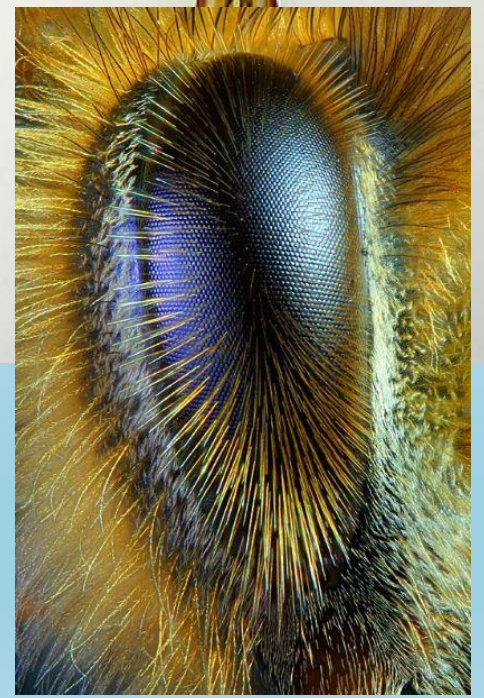
- Sends signals to body parts and structures to coordinate behaviors
- Connected to seven ganglia
  - Concentrations of nerve tissue
  - Spread length the body
  - Act as bee’s spinal cord
  - Nerve cells extend into every muscle and organ

Eyes – Two Sets

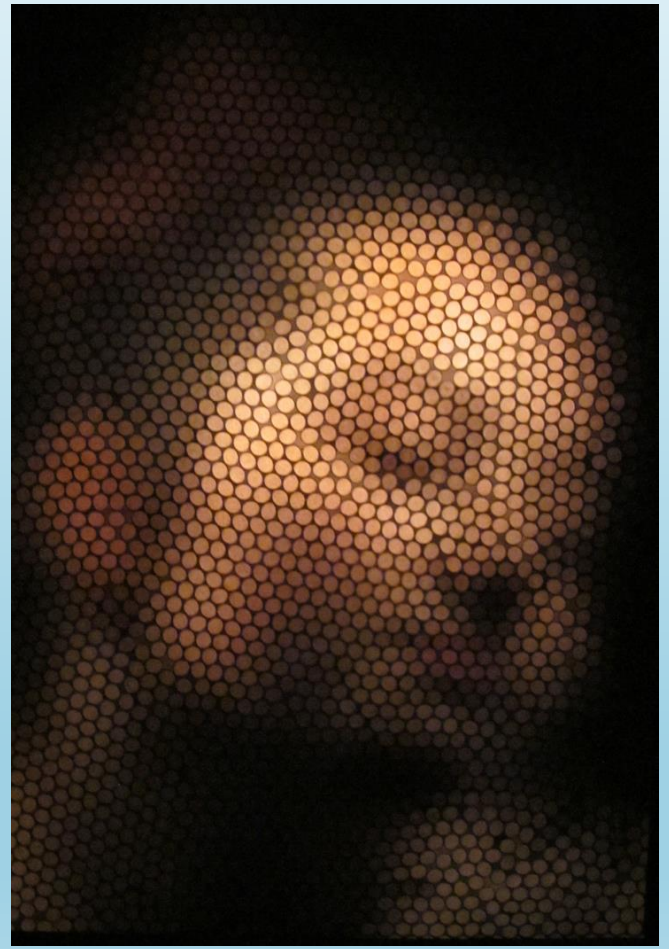
- Three ocelli (ocellus)
- Simple eyes
- Located on top of head
    - In a triangle
- Responds to light
- Cannot ”see”
    - More like sensory organs than eyes

Eyes – Two Sets

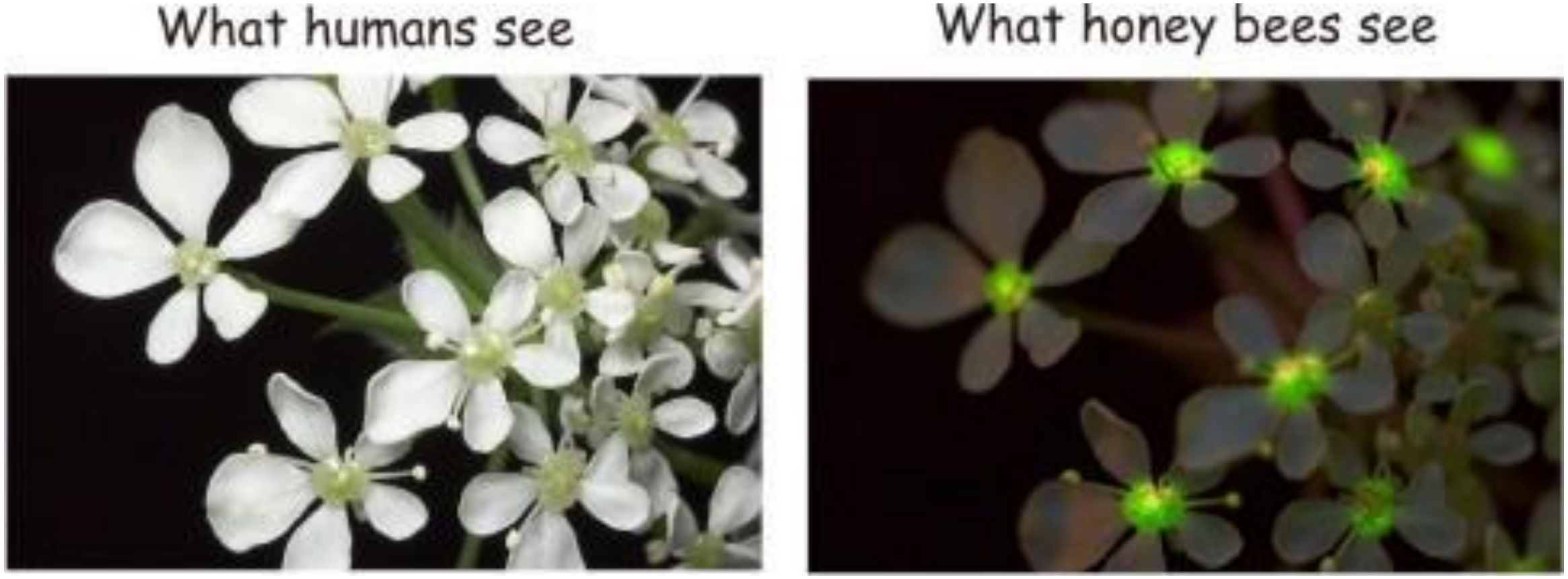
- Two Compound eyes
- Located bilaterally
- Covered in hairs
- Provides fair vision
  - 6,900 facets
- Detects movement/broken patterns
- Can see colors (except some reds)
  - Trichromatic vision
- Can see ultraviolet light



Compound Vision



Ultraviolet Spectrum



Locating Flowers

- Flowers show both colors and patterns
- Visual clues for long range orientation
- Scent for short range orientation
- Many flowers offer nectar guides presenting as “bulls eye”
  - Pattern of different colors or textured lines
  - Some patterns only visible to UV sensitive eyes

Different Eyes in the Hive

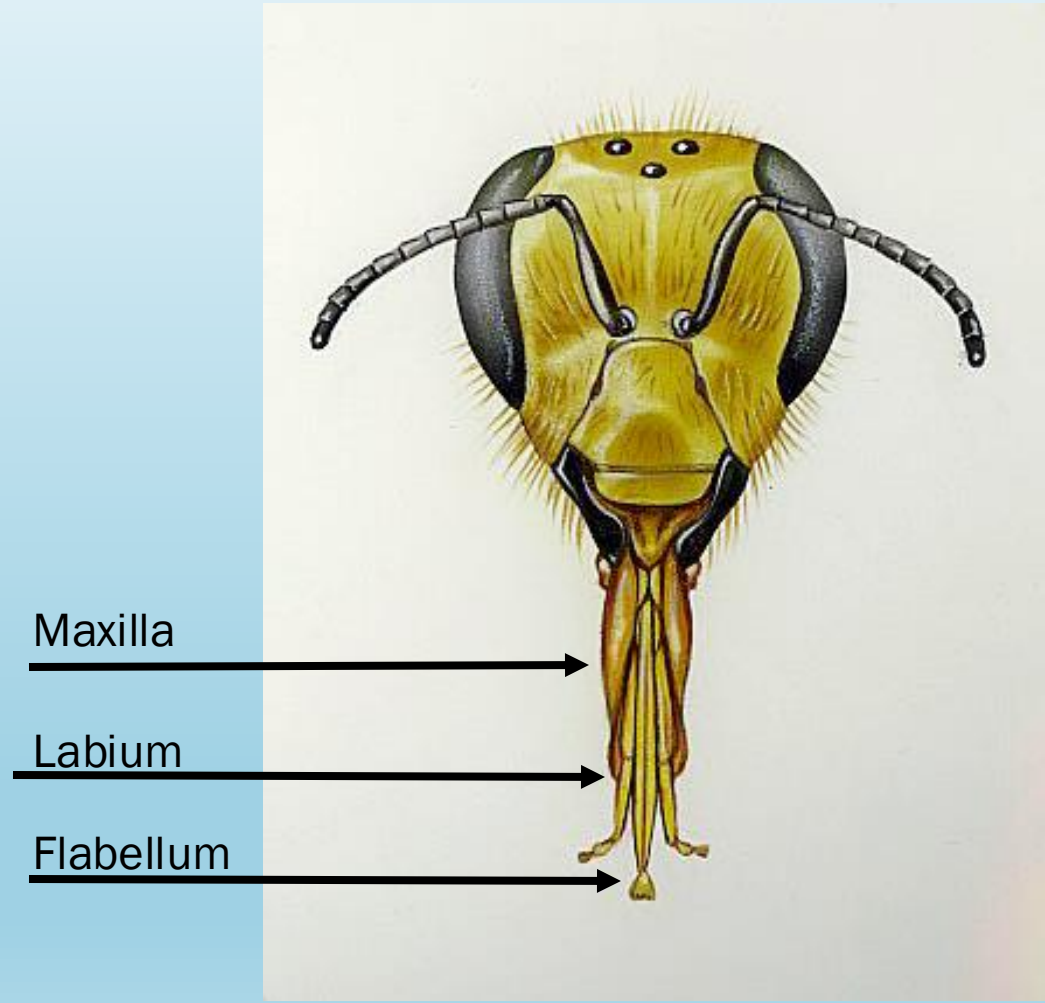
- Queens head is slightly smaller than workers
  - Slightly more round
  - Fewer eye facets
- Drones head is largest
  - Compound eyes twice as large as workers
  - 8,600 facets (vs 6,900)

Mouth – Two Parts

1. Chewing Parts - Mandible
   - Moves laterally
   - Can manipulate solids
     - Wax, pollen, propolis
   - Sharp edges
   - Spoon shaped
   - Lacks muscles strong enough to chew through/bite anything
     - Better suited to smooth and carry

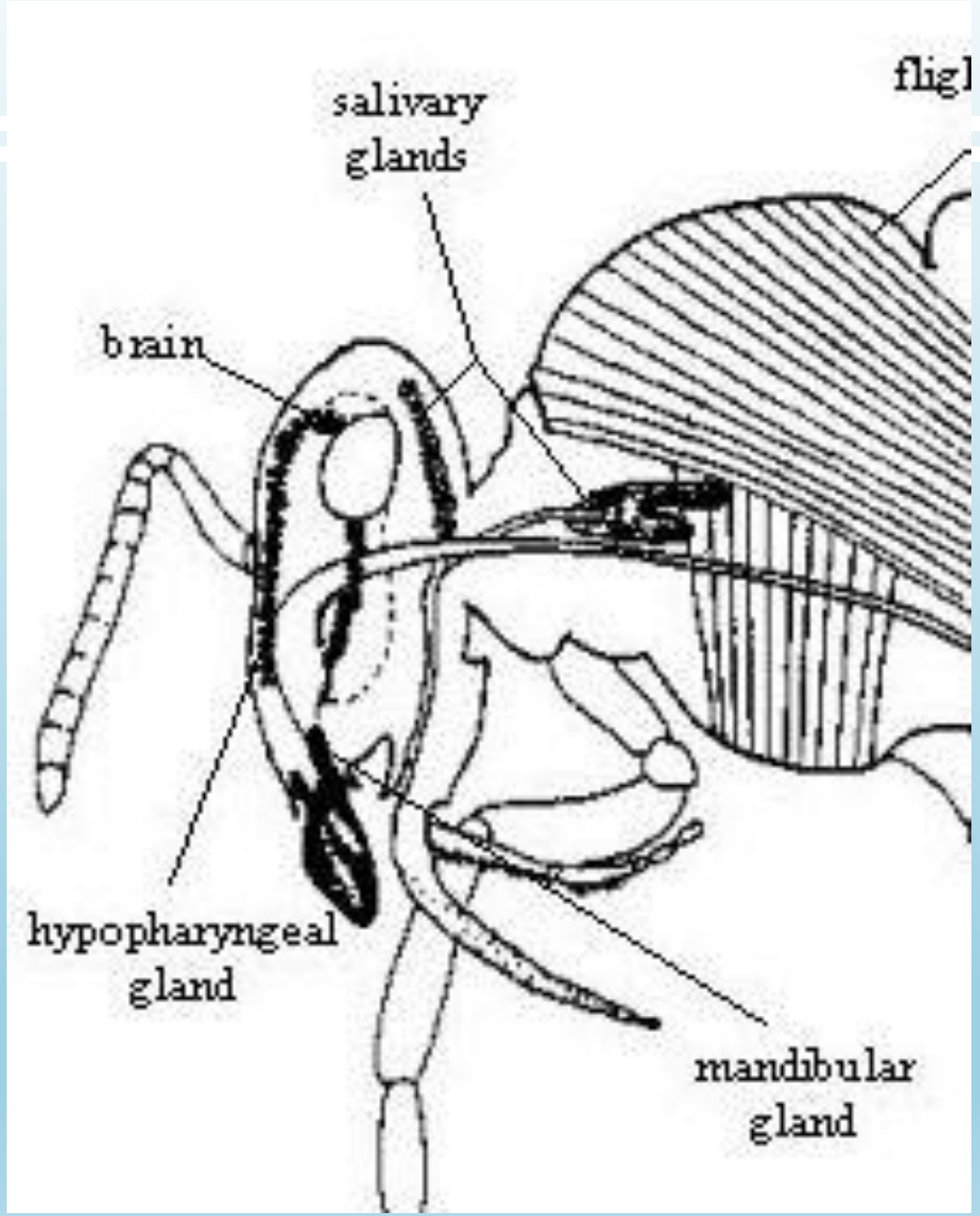
Mouth – Two Parts

2. Lapping Parts
   - Maxilla and labium fold together to form a tube
   - Proboscis sucking tube used for extracting nectar and water
     - Ends with spoon-shaped flabellum
     - The bee's tongue
   - Folds up beneath head when not in use
   - Pharynx – muscles that move labium to suck up nectar



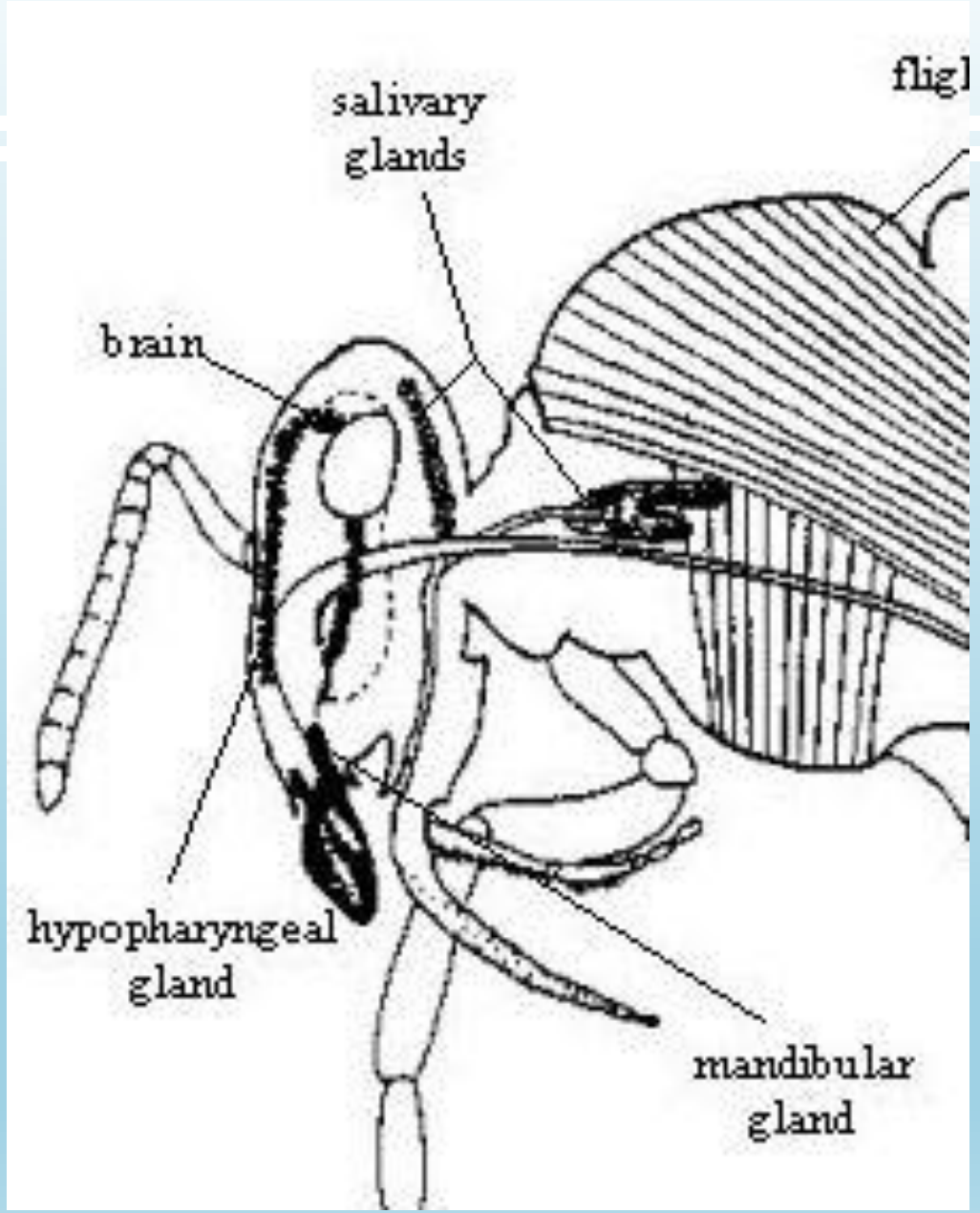
Glands of the Head

- Mandibular gland
  - Queen produces “queen substance” pheromone
    - Attracts drones
    - Stabilizes swarms
    - Inhibits rearing new queens/worker bee ovary development
    - Spread by retinue
  - Young workers produce lipid-rich white substance
    - Mix with hypopharyngeal gland to make royal or worker jelly



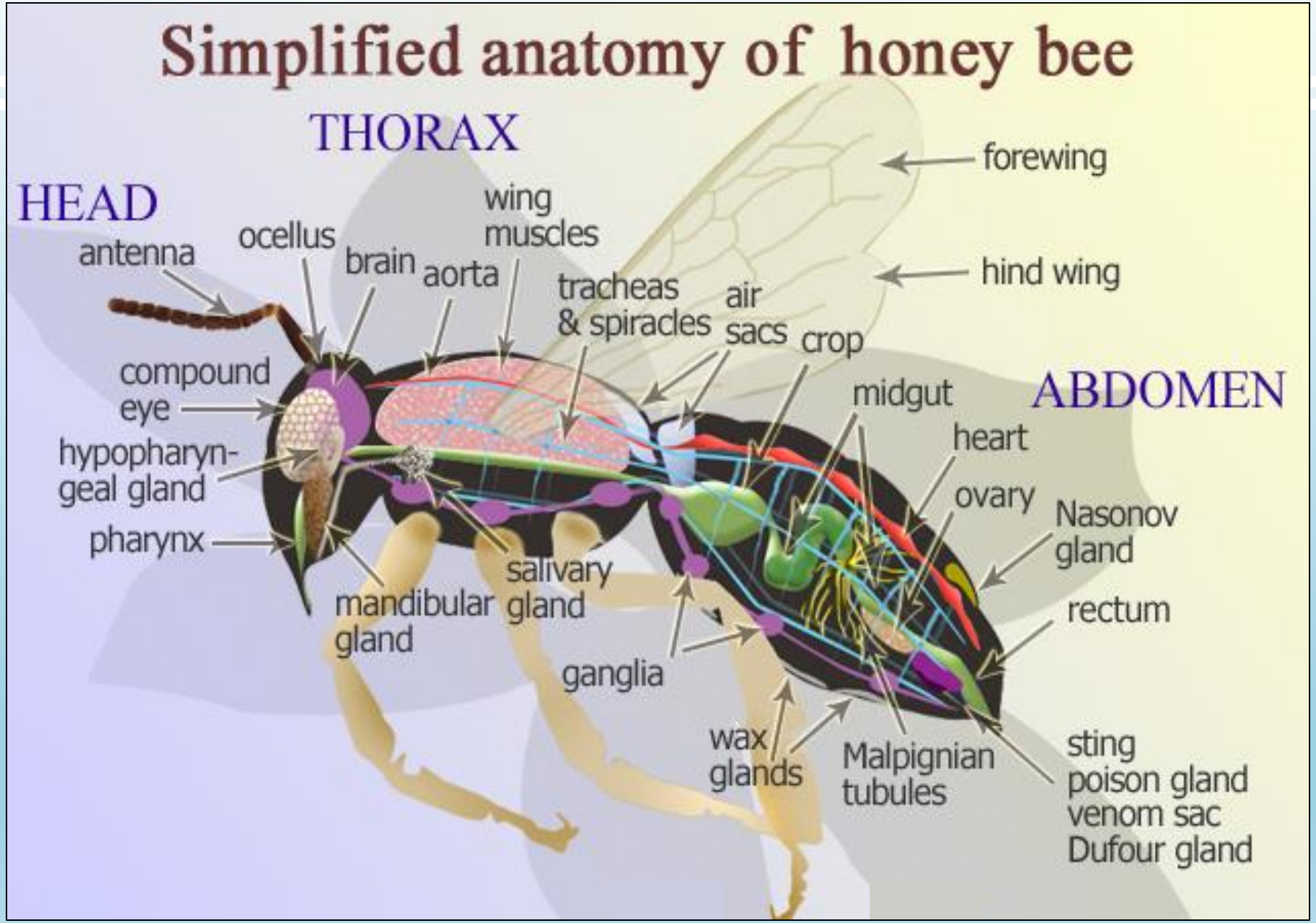
Glands of the Head Cont'd

- Salivary glands
  - Secrete enzyme to break down sugar and honey
  - Helps with pollen/wax moistening
- Hypopharyngeal gland
  - Young bees produce protein rich secretions
  - Foragers produce invertase (breaks down sucrose into fructose/glucose



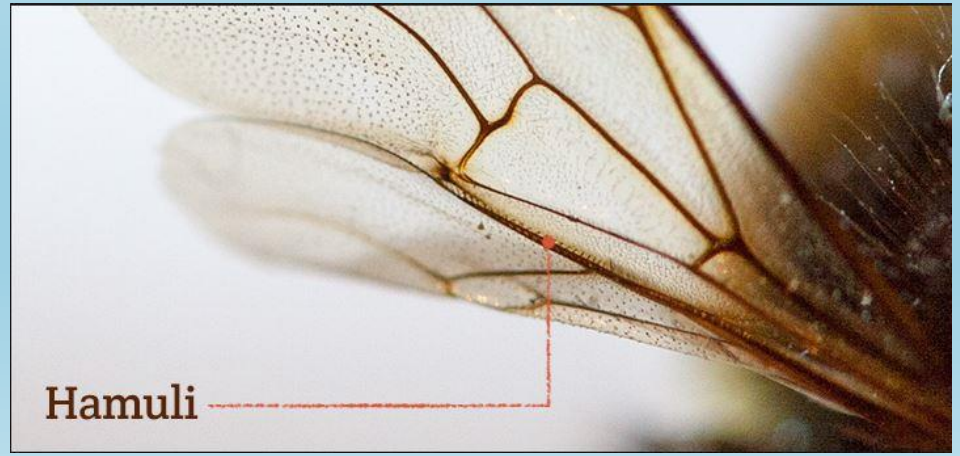
The Thorax

- Locomotion structures
  - Wings
  - Legs
  - Muscles
  - Organs continuing into abdomen


Simplified anatomy of honey bee
THORAX
HEAD
ABDOMEN
forewing
hind wing
antenna
ocellus
brain
aorta
wing muscles
tracheas & spiracles
air sacs
crop
midgut
heart
ovary
Nasonov gland
rectum
compound eye
hypopharyn-geal gland
pharynx
mandibular gland
salivary gland
ganglia
wax glands
Malpignian tubules
sting
poison gland
venom sac
Dufour gland

Wings – Two Pairs

- Fore wing – front, largest
- Hind wing – rear, smallest
- Numerous veins throughout each
  - Circulates hemolymph*
- Connected during flight by hamuli

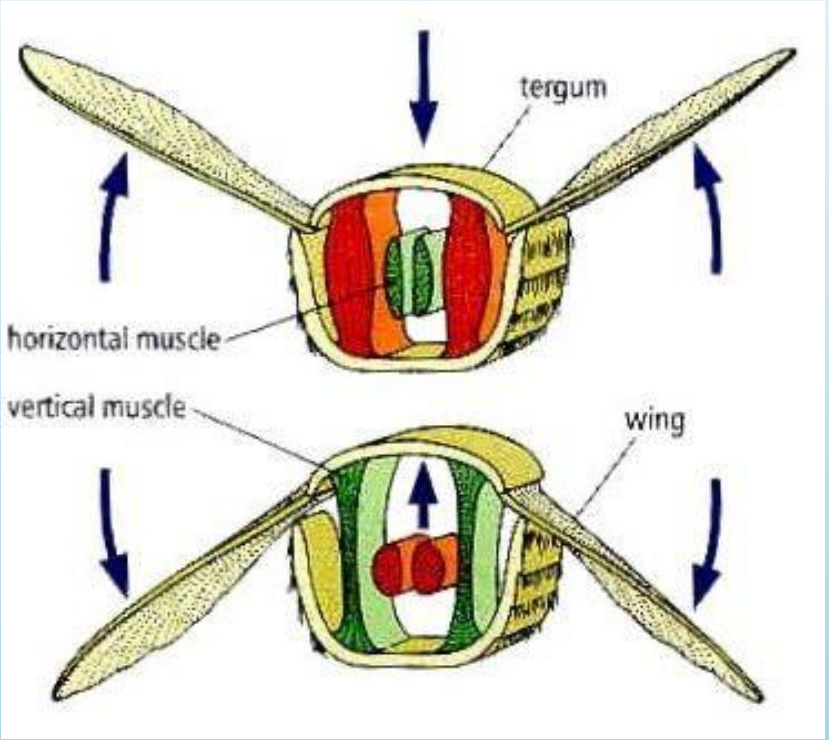


Wing Muscles

- Small direct muscles fold the wings over abdomen
- Flight muscles do not attach directly to the wing
- Attachment points are very narrow
  - Located in the thoracic segments
  - Complimentary pairs

How It Works

- Top to bottom muscles contract while the front to back muscles relax
  - Thorax is compressed from top to bottom
  - Ends of thorax push outward
  - Causes wings to be pulled upwards
- Front to back muscles then contract and top to bottom muscles relax
  - Thorax is compressed from both ends
  - Top and bottom of thorax push outward
  - Causes wings to be pulled down

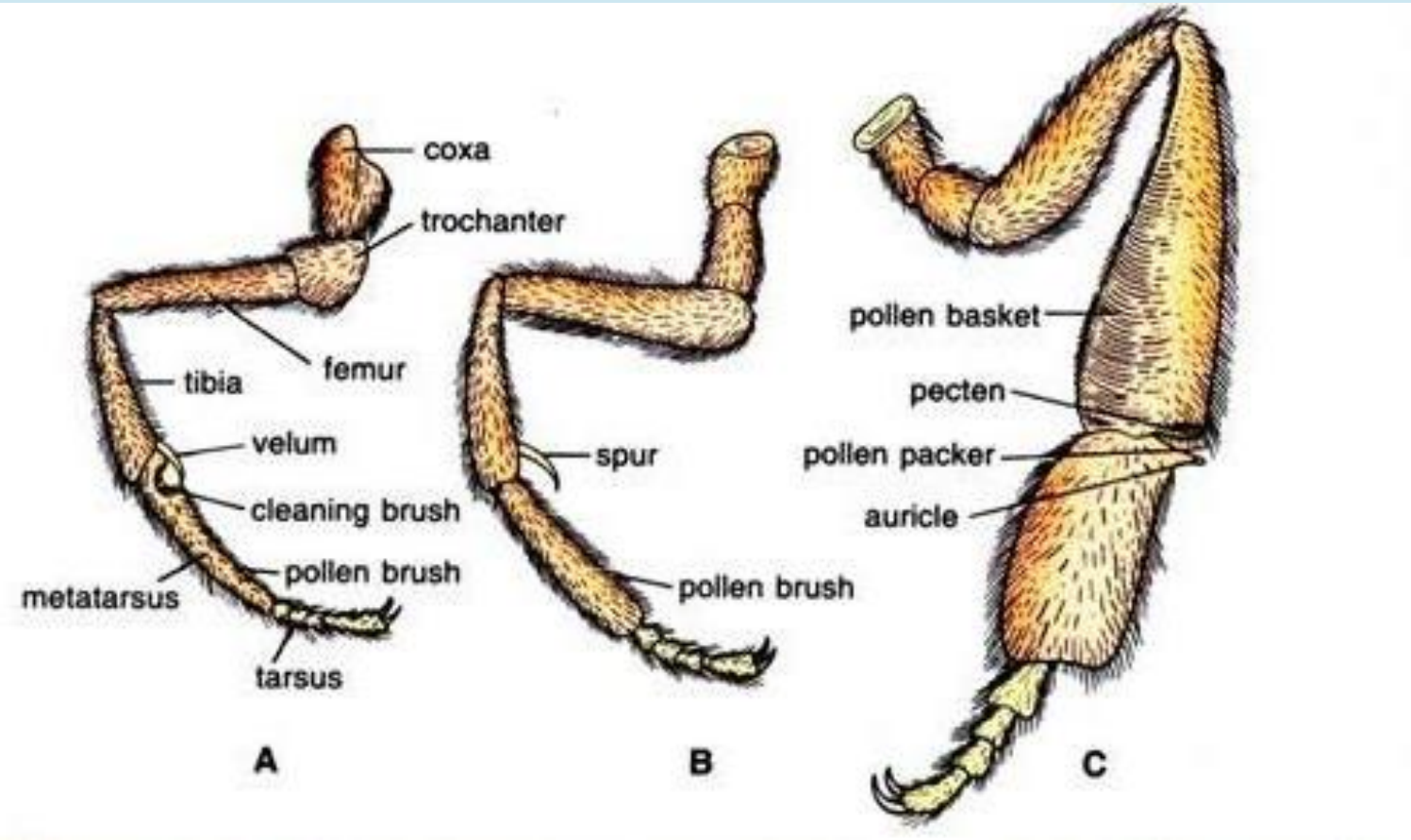


Legs – Three Pairs

- Each pair attached separately to thorax
- Contain sensory organs for touch, taste, and smell
- Covered in hairs to aid in grooming
- Forelegs have antennae cleaners
- Middle legs have wax spurs
  - For spearing wax scales
  - Aids movement towards mandible
- Hind legs have corbicula(e)
  - “pollen baskets”
- Trailing or footprint pheromones

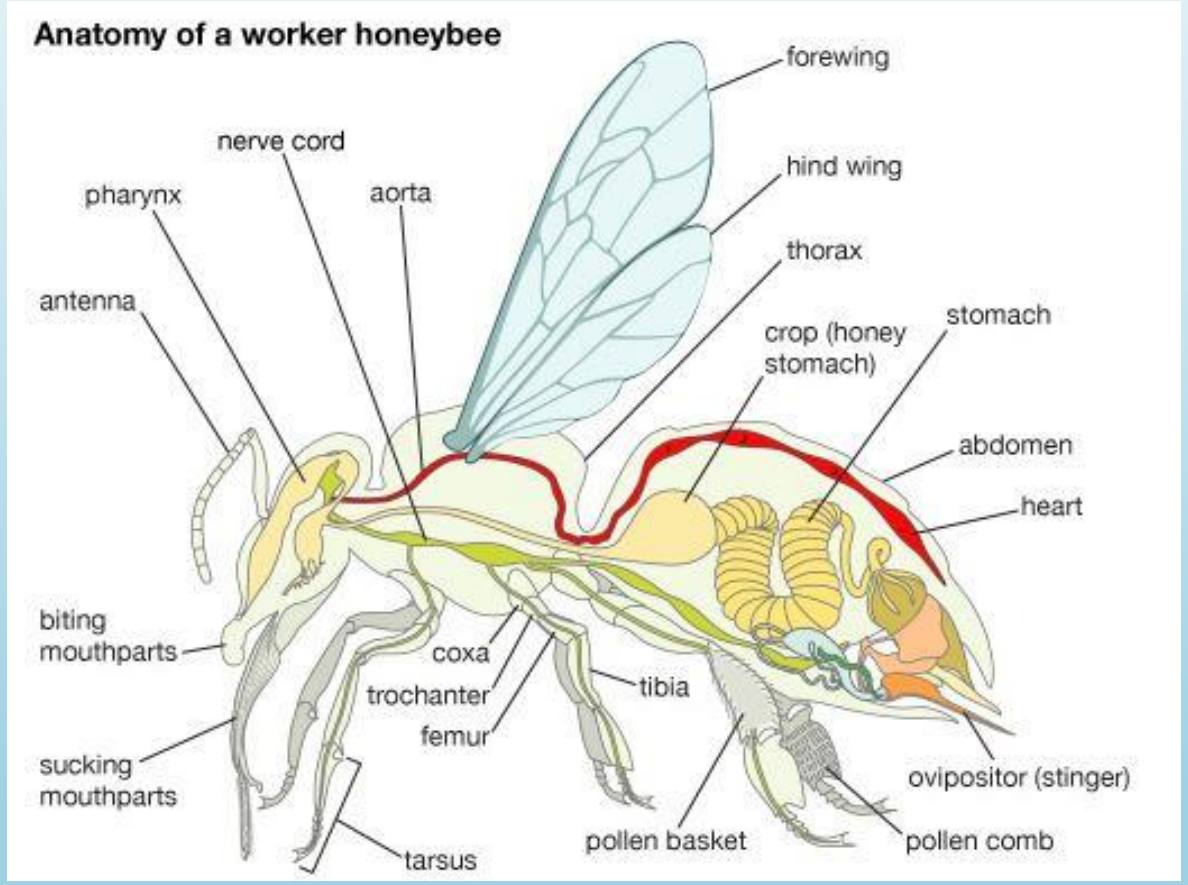
Bee Legs

- When a bee walks, the first and third leg work with the middle leg on the opposite side



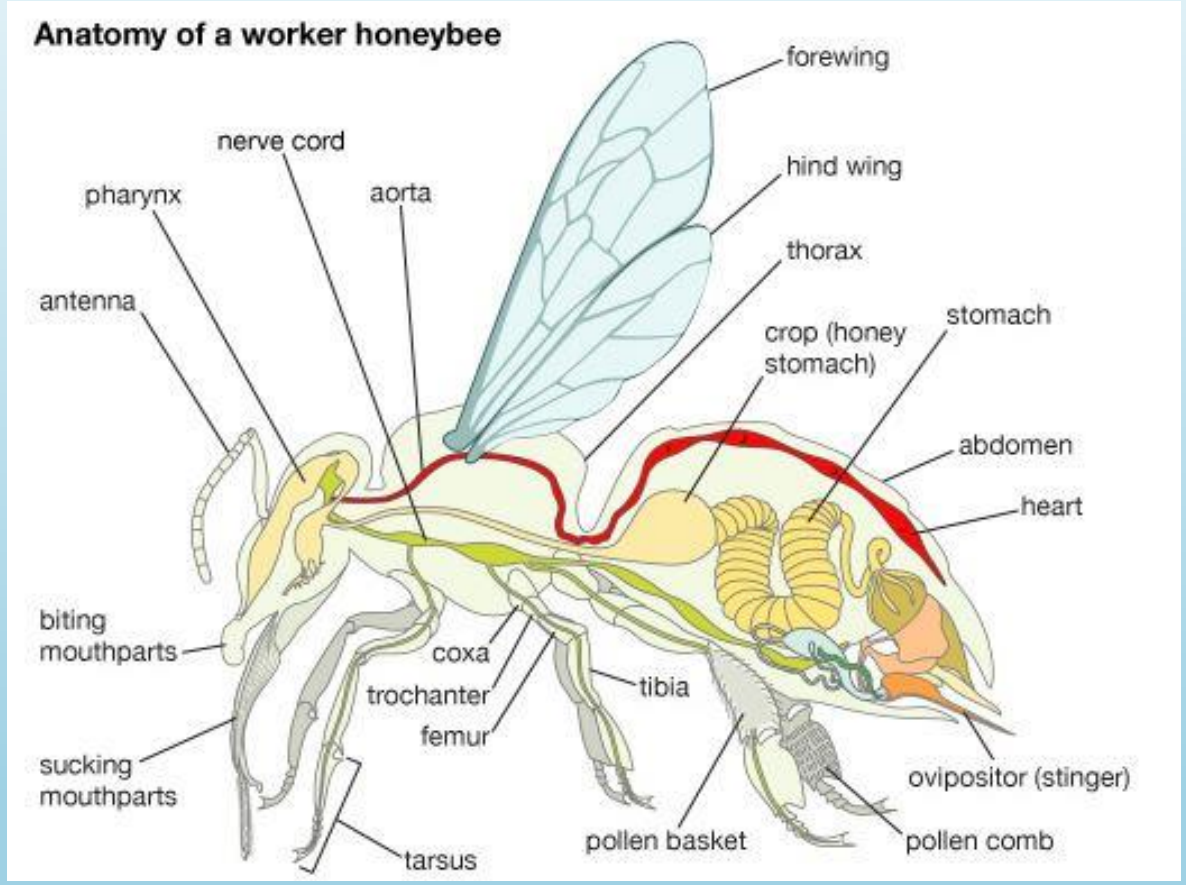
The Abdomen

- Lacks external attachments
- Armored
  - Tergites (on top)
  - Sternites (on bottom)
- Wax Production
- The Sting



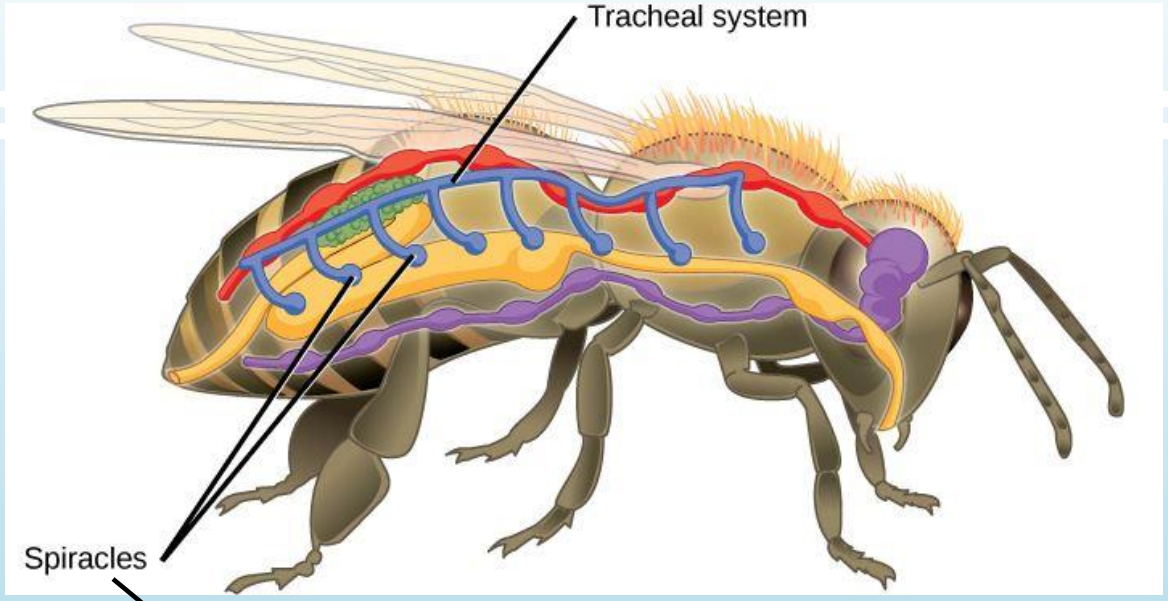
Functions of the Abdomen

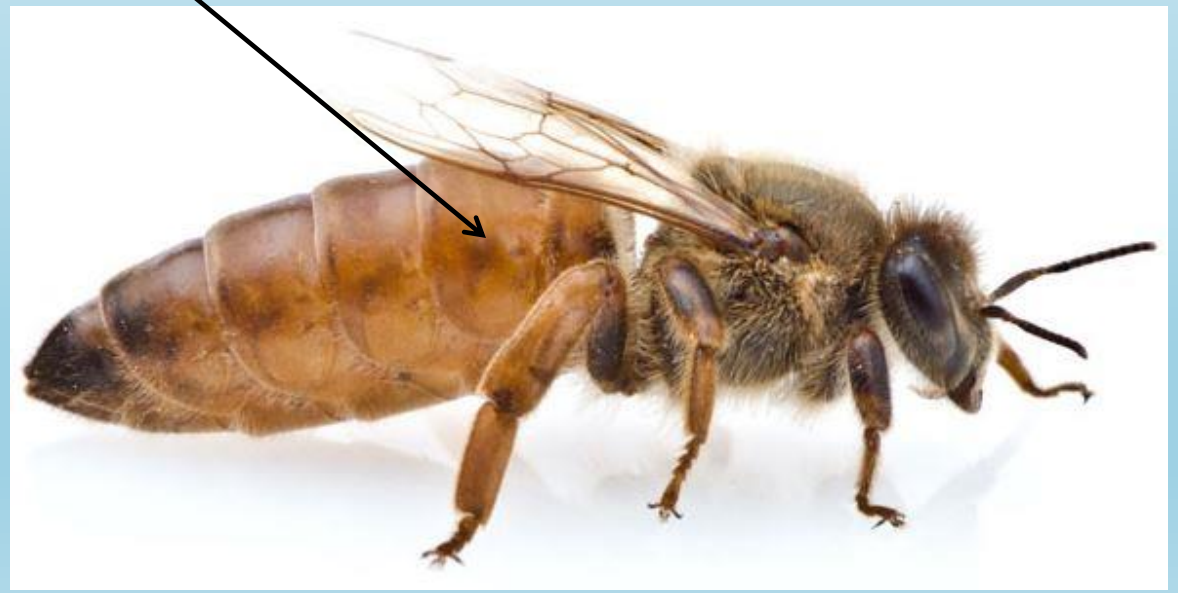
- Constantly moving (pumping)
- This aids in:
  - Respiration
  - Circulation
  - Digestion
  - Excretion



The Respiratory System

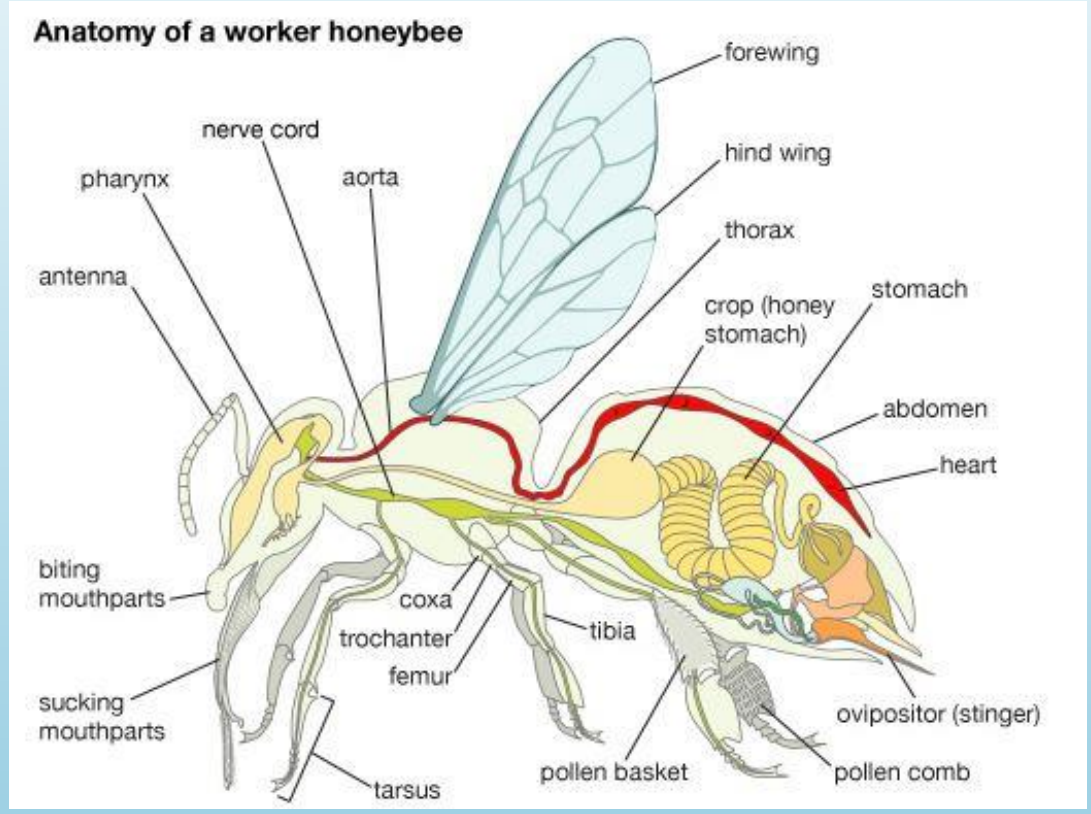
- Spiracles (breathing holes)
  - Two Thoracic
  - Eight Abdominal
  - Brings in oxygen
  - Takes out carbon dioxide
- Tracheal tubes
  - Leads to all parts of the body
- Several internal air sacs throughout body





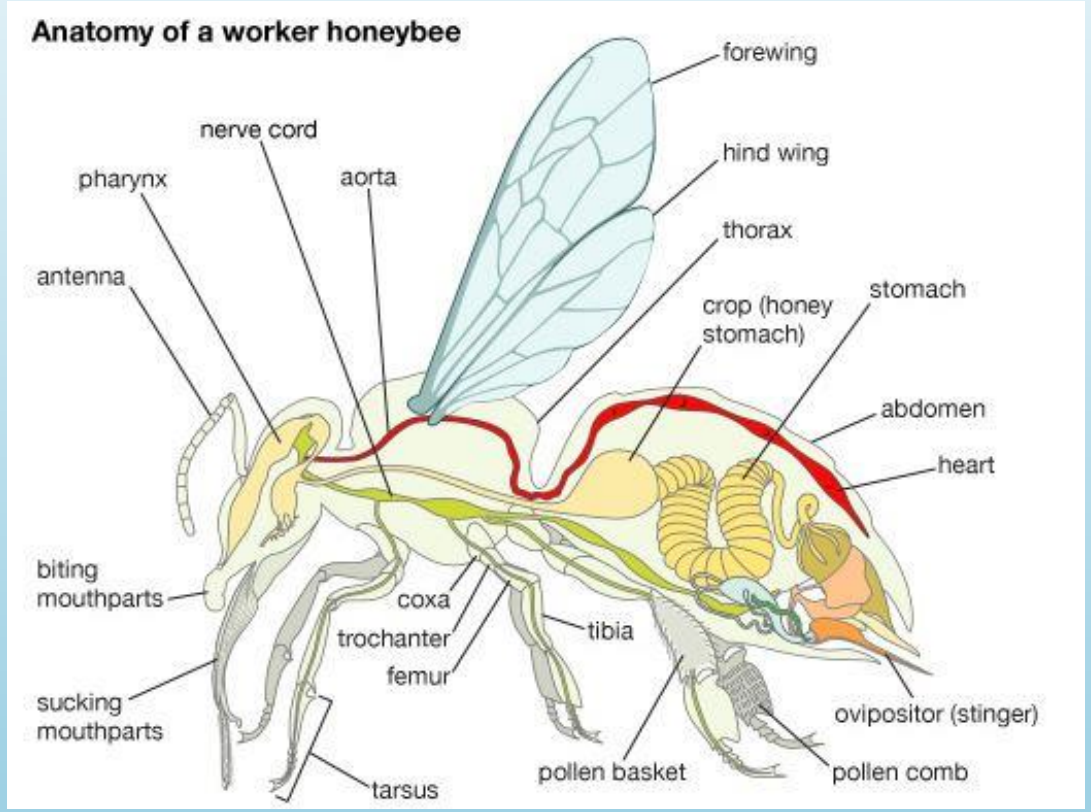
The Circulatory System

- Dorsal aorta (located in thorax)
- Dorsal heart (located in abdomen)
  - Has four chambers
  - Holes for absorption (ostia)
- Pumps hemolymph
  - Bathes organs
  - Transports nutrients/hormones to body tissues
  - Transports waste to excretory system
  - Does not contain oxygen carrying cells



The Digestive and Excretory System

- Composed of three main sections
  - Foregut
  - Midgut
  - Hindgut
- Foregut involved in food transportation
- Midgut involved in digestion
- Hindgut involved in excretion



Digestive and Excretory Development

- Foregut, midgut, and hindgut develop separately
- Foregut and Hindgut develop as invaginations from either end
- Foregut and Hindgut both lined with cuticle
  - Same lining as bee exterior

Imagine, for example, holding a balloon between the pointer fingers of both of your hands, with the fingers being on opposite sides of the balloon. Imagine, now, pushing your fingers toward one another, pressing both sides of the balloon in toward the center.

Foregut

- Lined with cuticle
- Composed of three main sections
  - Mouth
  - Esophagus
  - Crop (honey stomach)
- Crop acts as temporary storage
  - Honey, Nectar, honeydew, and water
  - Controlled by valve posterior to esophagus
- Separated from midgut by proventriculus valve
  - Can grind and pulverize food particles (pollen)

Midgut

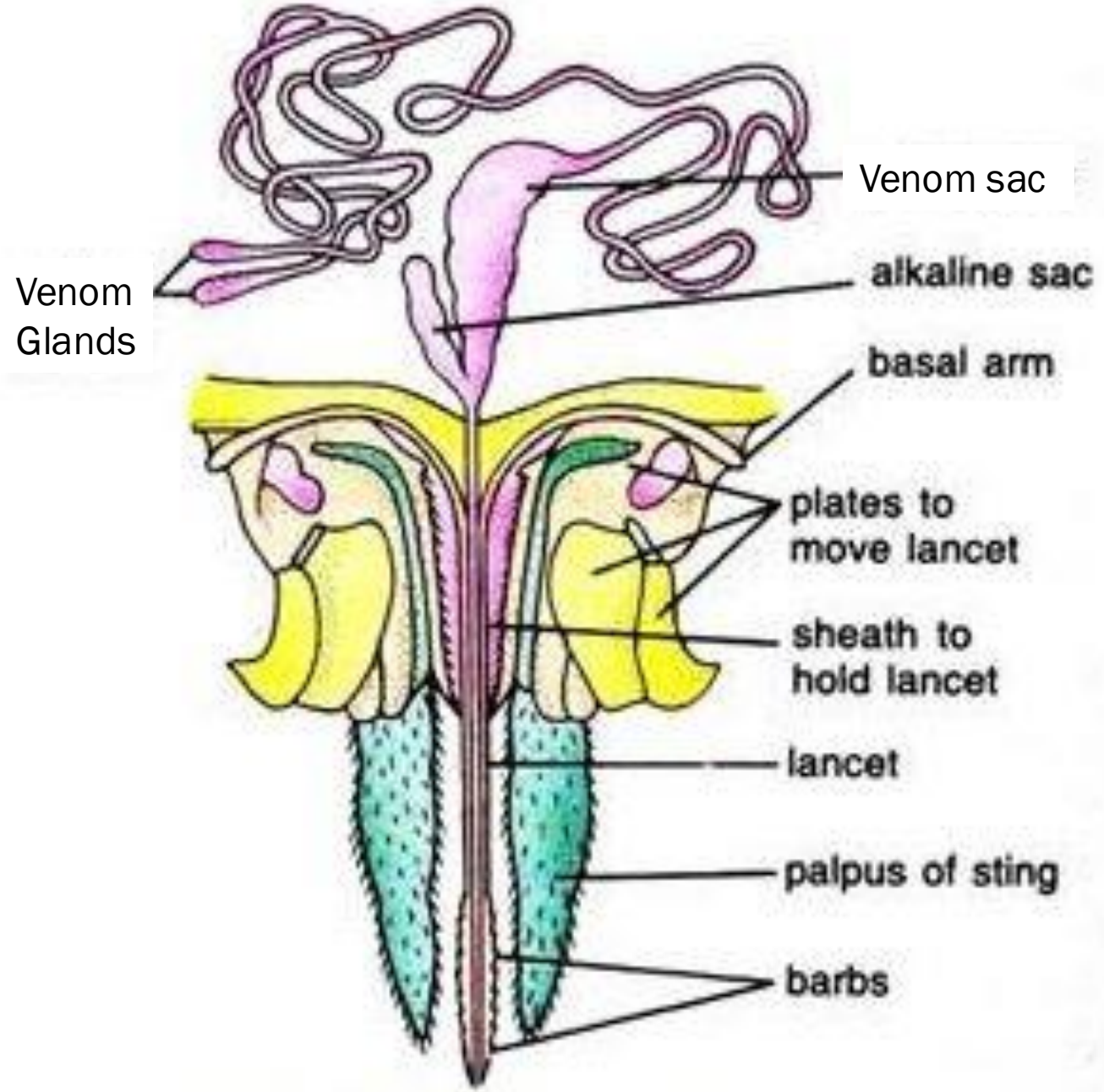
- Ventriculus aka the stomach
- Primary site of enzymatic digestion
- Primary site of nutrient absorption
  - Nutrients pulled into hemolymph for transport
- Contain Malpighian tubules
  - Occur at end of midgut
  - Initial section of digestive tract
  - Float freely in body cavity
  - Extract waste products from hemolymph
  - Produce uric acid granules to help with osmoregulation (water management)

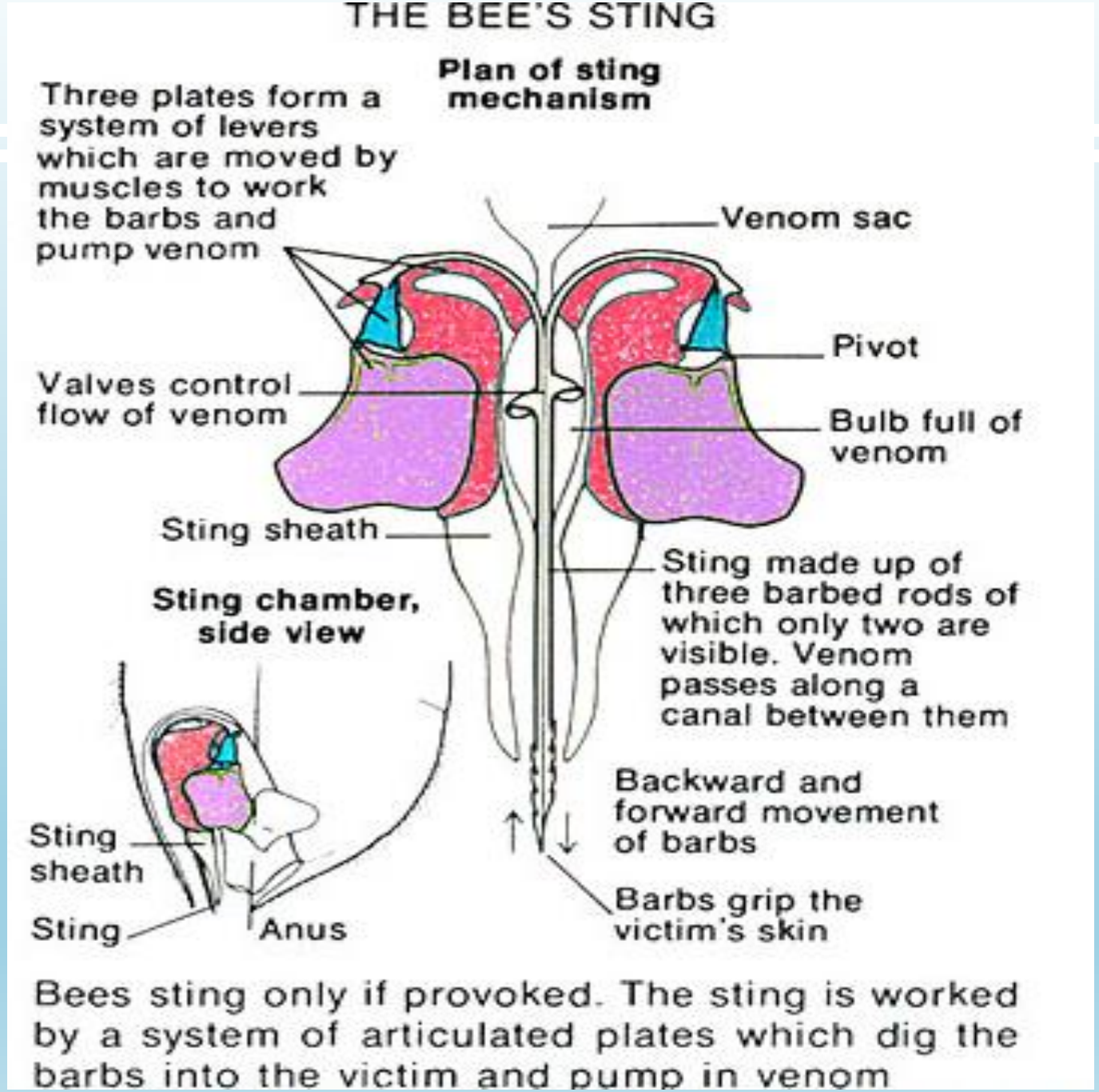
Hindgut

- Lined with cuticle
- Composed of two main sections
  - Ileum
  - Rectum
- Ileum is a short tube connecting midgut to rectum
  - Sometimes called the small intestine
- Rectum is primary site of water absorption
  - Water
  - Salt
  - Other beneficial substances
- Rectal pads
  - Small areas that reabsorb >90% water used by Malpighian tubules to collect waste
  - Defecate moderately liquid to dry feces (uric acid solids/shells of pollen grains)

The Sting

- Barbed unlike other bees
  - Must be scraped off
- Koschevnikov gland produces alarm/attractant pheromone
- Venom produces release of histamines




THE BEE'S STING
Plan of sting mechanism
Three plates form a system of levers which are moved by muscles to work the barbs and pump venom
Venom sac
Pivot
Valves control flow of venom
Bulb full of venom
Sting sheath
Sting made up of three barbed rods of which only two are visible. Venom passes along a canal between them
Sting chamber, side view
Backward and forward movement of barbs
Sting sheath
Sting
Anus
Barbs grip the victim's skin
Bees sting only if provoked. The sting is worked by a system of articulated plates which dig the barbs into the victim and pump in venom

Wax Glands

- Located on ventral abdomen
  - On inner sides of sternites
- Wax produced as scales
  - Soft and malleable
  - Moved to mandibles for use
- Not all bees produce wax
  - Depends mainly on age
- Swarms produce large amounts of wax

Nasanov Gland

- Located on dorsal abdomen
- Pheromones serve as location signal
- Activated at water sites, colony entrances, swarm clusters, etc.
- Similar to lemongrass

Questions?