Morphology of the Honey Bee

The honey bee has three body divisions

Head
Thorax
Abdomen
Head

- fore wing
- wing hooks
- hind wing
- compound eye
- ocelli
- antennae
- mandibles
- proboscis
- head
- thorax
- abdomen
- spiracle

Drawing modified from R. E. Snodgrass
Exoskeleton
Body Hairs

Plumose

[Images of body hairs and a close-up of a bee covered in pollen]
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

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.
• 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:

Buttercup

“Nectar guides”

swamp mallow

Courtesy Eisner Cornell Univ

UDEL Collections
• Sensory
  • compound eyes

What does a bee see?
Antennae

- Antennae: Flagellum, Pedicel, Scape
- Parts: Pore plates, Antennae structures

Diagram showing parts of the antennae:
- Flagellum
- Pedicel
- Scape
- Pore plates

Details:
- Antennae structures labeled: Pl, SPI, SPg, Shr, Pdc, Sep
- Close-up images of antennae structures

Diagram sections:
- A: Antennae overall view
- B: Detailed view of antennae structure
- C: Cross-section of antennae
- D: Detailed view of antennae structure
- E: Detailed view of antennae structure
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)
Mouthparts

Mandibles

Proboscis

- Mandible
- Maxilla
- Labial palpus
- Glossa
- Labellum
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
Abdomen

Drawing modified from R. E. Snodgrass
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)
Nervous System

- 5 main ganglia
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

pv, d, crn, Vst, Cor, Dej, f, h, i, l, g, flb, Gpr, Bib
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
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
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 lose 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=lwfCf1LEgaE
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???