Week #2
External Morphology
of Insects

The Integument
Consequences of having your skeleton on the outside
1. Muscles attach on the inside
2. The exoskeleton is also a suit of armor
3. Sensing the outside world is a challenge
4. Growth is impaired
5. There is a limit on insect size

Parts of insects

- Integument (body wall)
  - Skeleton
  - Cuticle
  - Formation
  - Physical properties
- Head
  - Major functions
  - Eyes
  - Mouthparts: types and positions
  - Antennae
  - Modifications
- Thorax
  - Segments
  - Legs
  - Wings
  - Modifications
- Abdomen
  - Cerci
  - Ovipositor
  - Modifications

The Integument
Outer covering; includes cuticle and epidermis

Cuticle
The external skeletal structure, composed of chitin and protein

Exoskeleton
The external, hardened, cuticular skeleton to which muscles are attached internally
The Integument

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Chitin, a major cuticle component, is insoluble in water, alcohol, ether, dilute acids, and dilute or concentrate alkali.

Chitin, polysaccharide similar to cellulose; gives the cuticle its strength
Chitin is the main component of the cell walls of fungi, the exoskeletons of arthropods, including crustaceans, and the mouthparts of mollusks and cephalopods, including squid and octopuses.

Cross-section of the insect integument

Epicuticle (0.1-3.0 μm)
Structure:
Inner epicuticle, outer epicuticle, superficial layer. Also, cement layer (shellac-like layer), wax layer, superficial layer (glycoprotein).
Function: protection, water retention, serves as communication surface, sunblock.

TEM of Larval Sclerite
Chitin, a major cuticle component, is insoluble in water, alcohol, ether, dilute acids, and dilute or concentrate alkali.
Epidermis - a major biosynthetic tissue, responsible for production of chitin fibrils, lipids, peptides and proteins found in cuticle (and hemolymph).

Basement membrane - exocellular matrix that partitions insect tissues (connective tissue layer).

Softer Side of the Exoskeleton

Resilin: An elastic substance consisting of cross-linked protein chains, found in the cuticles of many insects (intersegmental membranes, wing connective areas, leg joints (flea). Elastic cuticle regions contain high concentrations of resilin are not sclerotized.

Cicada song: http://en.wikipedia.org/wiki/Cicada
Physical properties of cuticle:

- COLOR
- Permeability
- Barrier to pathogens
- External processes
- Skeleton

Physical properties of cuticle: COLOR

PHOTO: Bruce Coleman

PHOTO: Fowke Entomology

PHOTO: Department of Entomology, UC Berkeley
Insects are arthropods
phylum: Arthropoda
They share many features with the annelids (phylum Annelida) and onychophorans (phylum Onychophora)

**Cuticle Color**

**PIGMENTS**
- Brown-black color: due to deposition of melanin
- Yellows to reds: carotenoids, papiliochromes, flavonoids and pterines
- Red, blues, and greens: tetapyrroles
Physical properties of cuticle: Permeability
Physical properties of cuticle: block pathogens

Thailand rainforest fungus with its carpenter ant victims
- NW side of plant
- 25 cm up from surface
- Ideal temp and humidity
Physical properties of cuticle: **External processes**.

- Sensilla or setae (hairs)

Mediterranean fruit fly (*Ceratitis capitata*) pulvillar pad with tenent setae. Pulvilli are the hairy adhesive organs at the end of fly legs. Tenent setae are the hairs (with adhesive ends) that make up the pulvilli. The pulvilli allow the fly to attach to smooth surfaces.

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A hind leg of *Leptoscelis tricolor* (Hemiptera: Coreidae)

Physical properties of cuticle: **Skeleton**

Spines of beetles (Coleoptera)

Insect parts: most information will be covered in lab and course notes

Some highlights...
Mouthpart positions (head types)

- **Hypognathous**: projecting lower jaw
- **Prognathous**: protrusive jaws
- **Opisthognathous**: receding jaws

Many insects e.g. Hemipterans (aphids, cicadas)

- **Prognathous**: protrusive jaws
  - e.g. Many beetles

- **Opisthognathous**: receding jaws
  - e.g. Hemiptera (aphids, cicadas)

**Myrmeomorphy – ant mimicking**

Family: Alydidae (Hemiptera)

**Antennae**

Contain complex of chemoreceptors, mechanoreceptors, thermoreceptors, and hygroreceptors used for:

- **Touch**
- **Humidity**
- **Smell**
- **Hearing**

**Antennal Forms**

A. *setaceous* (dragonfly)  
B. *filiform* (ground beetle)  
C. *moniliform* (bark beetle)  
D. *clavate* (darkling beetle)  
E. *clavate* (ladybird beetle)  
F. *capitate* (sap beetle)  
G. *serrate* (Click beetle)  
H. *pectinate* (fire-colored beetle)  
I. *plumose* (mosquito)  
J. *aristate* (syrphid fly)  
K. *stylate* (shrike fly)  
L. *flabellate* (cedar beetle)  
M. *lamellate* (scarab beetle)  
N. *geniculate* (chalcid wasp)

ar: arista; fl: flagellum; ped: pedicel; scp: scape; sty: style
Pronotum – design in shielding

Modifications of the thorax

Entylia carinata (Hemiptera: Membracidae)

Ceresa basalis (Hemiptera: Membracidae)
**Types of Insect Legs**
- Cursorial (to run)
- Raptorial (to prey)
- Saltatorial (leap)
- Natatorial (Swimming)
- Fossorial (to dig)
- Prehensile

**Membranous Wings**

**Elytra**

**Hemelytra**

*Heteropteran Hemiptera*

*Photo: Lyle Buss*
Examples of Ovipositors

Examples of Cerci

Modifications in the abdomen

Formosan Termite Queen Isoptera (now Blattaria)