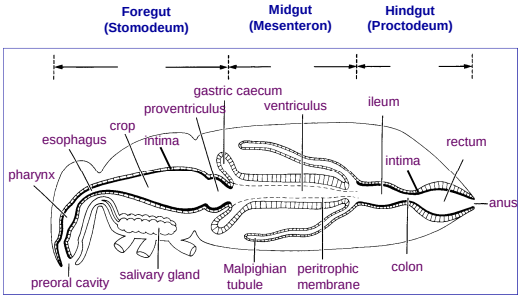
Internal anatomy and physiology



Internal anatomy and physiology

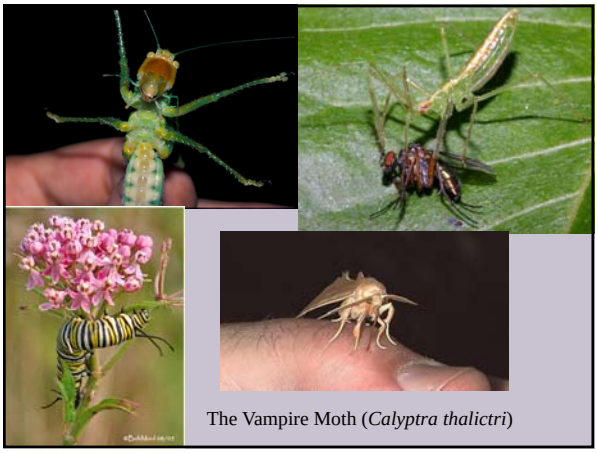
3.6 The gut, digestion, and nutrition

Digestion

Food is ingested in the form of macromolecules (such as proteins, polysaccharides, fats, nucleic acids, etc.) which must be broken down by *catabolic reactions* into smaller molecules (amino acids, simple sugars, etc.) before being used by cells of the body for energy, growth, or reproduction.

3.6 The gut, digestion, and nutrition
Objectives

- **What tissues need to be shed when an insect molts?**
- **Be able to label the diagram and describe the function of each component.**
- **Describe the components of the insect excretory system and explain how the waste products are handled.**



The Vampire Moth (*Calyptra thalictri*)

Digestive Tracts: A Reflection of Feeding Specialization

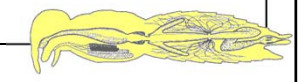
Liquid vs solid:

Solid feeders have a short straight gut

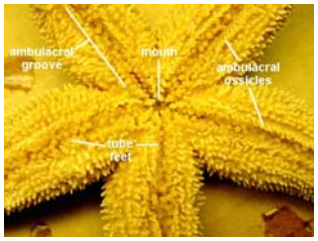
Liquid feeders have long convoluted gut tracts

Developmental Fate of Insect Germ Layers

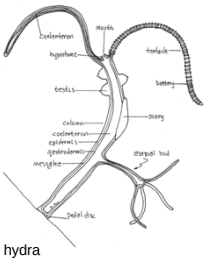
Ectoderm	Epidermis, exocrine glands, brain and nervous system, sense organs, foregut and hindgut, respiratory system, external genitalia.
Mesoderm	Heart, blood, circulatory system, muscles, endocrine glands, fat body, gonads (ovaries and testes).
Endoderm	Midgut



Incomplete digestive system vs. Complete digestive system

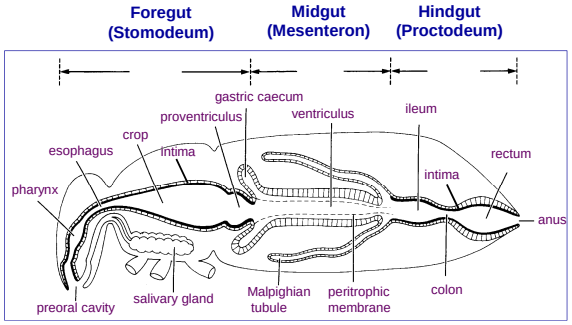


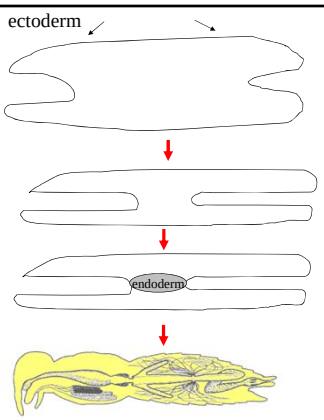
starfish



hydra

Diagram of Generalized Insect Alimentary Tract



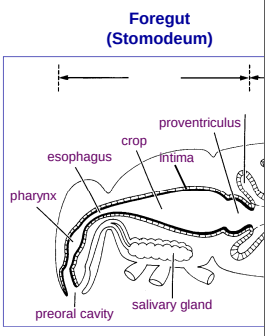


3 regions to Alimentary Canal: FOREGUT, MIDGUT, HINDGUT

- Foregut & hindgut formed by invaginations of epidermis
- Cuticle is NOT sclerotized
  - Soft chitin lining called INTIMA

They actually need to shed this at each molt!

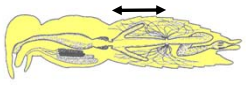
- http://www.youtube.com/watch?v=LYwkC0XqrA8&feature=player_detailpage
- European Sawfly: http://www.youtube.com/watch?v=1eOwLVTDSSc&feature=player_detailpage



- Chitin layer, called intima
- What it does: ingestion, storage (crop), grinding (proventriculus)
- Entry of two glands: silk and saliva
- Saliva -anticoagulants, lubricants, enzymes, microbes
- Stomadeal valve

MIDGUT

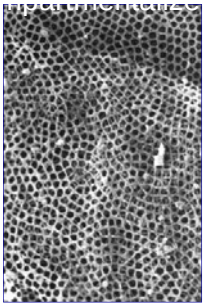
- Visible as long, skinny tube in cockroach
- Primary site for:
  - production and secretion of digestive enzymes
  - digestion and absorption of nutrients



Perga affinis (Hymenoptera: Pergidae)

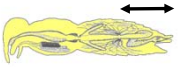
MIDGUT

- Midgut is NOT epidermal in origin
  - NOT lined with cuticle
  - PERITROPHIC MEMBRANE or ENVELOPE
    - Saran-wrap, papery layer
    - Chitin fibrils, protein carbohydrates



An intestinal mucus layer reinforced by chitin

Hindgut

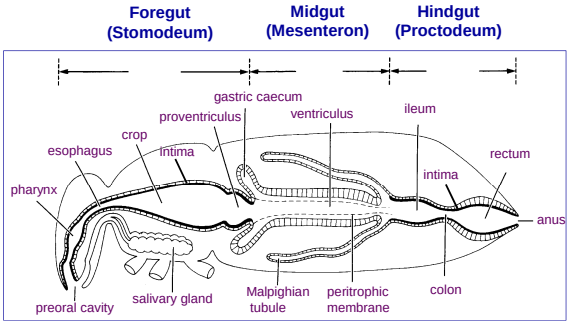


- Purpose: absorb water, salts and other useful minerals
- Starts with PYLOROUS
  - Pyloric sphincter
  - MALPHIGIAN TUBULES (yellow, stringy)
    - Increase surface area
- Continues with ILUEM, COLON, and RECTUM *(hard to distinguish)*

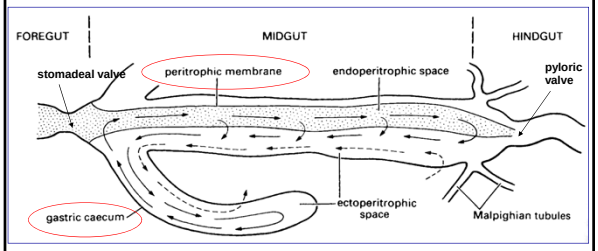
Midgut continued Peritrophic Membrane

- Peritrophic membrane creates a space
  - Inner and outer space
- Creates 2 phases of digestion
  - 1st digestive enzymes digest big particles to become small enough to pass through the membrane
  - 2nd flow back to gastric caecae and finish digestion
  - Un-digestible particles pass through to hindgut

Diagram of Generalized Insect Alimentary Tract



Generalized Flow of Ingested Food and Digestive Fluids



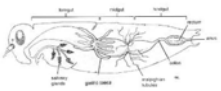
Midgut is a heterogenous environment-variable domains localized at different site in the lumen

Hindgut

Ileum, rectum in concert with Malpighian tubules conduct following functions:

- Malpighian tubules (few to >100/insect) deliver nitrogenous wastes et al., to ileum from hemocoel.
- Cells in hindgut reabsorb needed salts (inorganic ions) providing for osmoregulation.
- Rectal pads in rectum reabsorb amino acids, water, ions

Excretory system



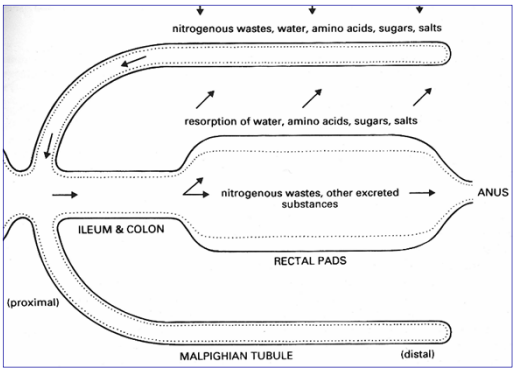
Tortoise beetles

2 primary organs *(for simplicity)*

1. Malphigian tubules
2. Rectum

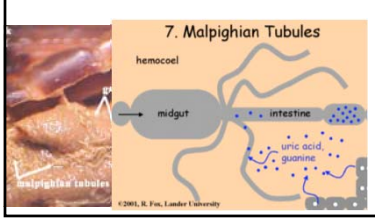
Excretory System

- Function: remove waste from body
  - Food waste or nitrogenous waste from metabolic activity
- Hindgut
- Both aquatic and terrestrial conserve ions like sodium, potassium, chloride, etc.
  - Aquatic – dilute frass directly into water
  - Terrestrial – need to conserve water
- Production of urine and frass result of excretion AND osmoregulation
  - Excretory system handles both of these functions



2 primary organs *(for simplicity)*

1. Malphigian tubules
   - yellow, stringy, free flowing and bathed
   - Junction between midgut and hindgut
   - Vary (spp., diet) from 2 to over 200



Tenebrio molitor larva, pupa and adult