General Organization

- Longitudinal trunks: lateral, dorsal, ventral
- Cross wise tracheae: dorsal, ventral, visceral
tracheal epithelial cells

- cuticle shed at molt
- taenidia for strength
tracheoles and tracheole cells

- tracheoles keep cuticle at molt
- intracellular
tracheoles

- in active tissue, tracheoles reach near mitochondria
- atmosphere oxygen diffuses into tissue
- CO2 released from tissue into tracheole
Systems with air sacs

- taenidia reduced or absent
- collapse under pressure
- important in ventilation – forced air movements
- NOT lungs
open (to the air) respiratory systems
Diffusion of oxygen

- faster from spiracle to tracheole
- than from tracheole to mitochondria
resting ventilation, example
hyperventilation - time ‘all closed’ is reduced - continuous
in flight, all spiracles are used

inspiration

expiration
Three general patterns of respiration in insects

Recordings of CO2 release (Ai-Ci) and water loss

3 spiracle phases

- Closed
- Flutter
- Fully open
• end of open phase – gradient favors diffusion out of CO2, H2O

• spiracle closed, CO2 build up, no change in H2O

• spiracle opens – gradient for CO2 flow out high, H2O always the same
Start with Closed Phase

- pO2 falls
- Pressure falls
- Flutter begins
- Pressure equalizes
- Build up of CO2 triggers spiracle to open
- O2 triggers closure
Manipulate oxygen levels

- Red line is oxygen level in atmosphere
- Green lines are CO2 release
- Blue line is the O2 level inside tracheae

2005 Nature 433:516
Diffusion of oxygen

remember that diffusion of oxygen through tissue between the tracheole and mitochondria is slow
• relationship of INSECT HEMOCYANINS to other arthropod hemocyanins
• higher insects have lost them
• (have a new function!)
• labrum
• mandibles
• maxillae
• labium
Your basic gut

FOREGUT

MIDGUT

HINDGUT

[Diagram showing the anatomical parts of the gut including oesophagus, pharynx, salivary gland, preoral cavity, crop, gastric caecum, proventriculus, ventriculus, ileum, rectum, pharynx, and colon.]
• pharynx especially has muscles
• muscles give the ability to PUMP
pharyngeal pump - Lepidoptera
pharyngeal pump - plant fluid feeds
proventriculard spines

midgut

- orthopteroid insects
- push and tear food
- good species specific characters
Your basic gut

FOREGUT

MIDGUT

HINDGUT

Diagram showing the structure of the gut with labeled parts such as oesophagus, crop, proventriculus, ventriculus, gastric caecum, ileum, rectum, pharynx, salivary gland, preoral cavity, Malpighian tubule, peritrophic membrane, and colon.
Midgut - general features

- = ventriculus
- NOT lined with cuticle
- gastric caeca
- secretes enzymes
- absorbs nutrients
- secretes peritrophic envelope