# Topic 5. Cuticle: a Key to Success

Presented by David Merritt, prepared B Cribb & D Merritt

Insect Science Module 1: Taking to Land and Air

## Objectives

- describe the structure and function of the insect integument
- describe the types and functions of variations in cuticle composition and form
- know the structure and function of trachea

Image courtesy of Alex Wild Photography

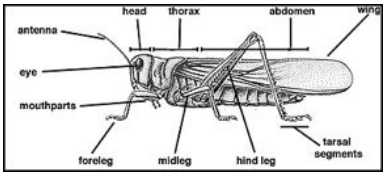
Cuticle is the insect's interface with the environment

**Externally**

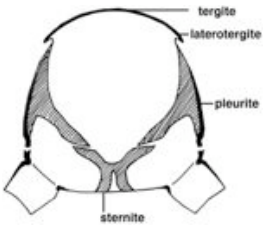
- Transmit sensory information
- Allow for locomotion

**Internally**

- Muscle attachment
- Support the internal organs
- Respiratory system




major segmented plates
- tergite (dorsal plate)
- sternite (ventral plate)
- pleurite (side plate)




Internal cuticular struts that act as cross-braces and points for muscle attachment: they are called apodemes

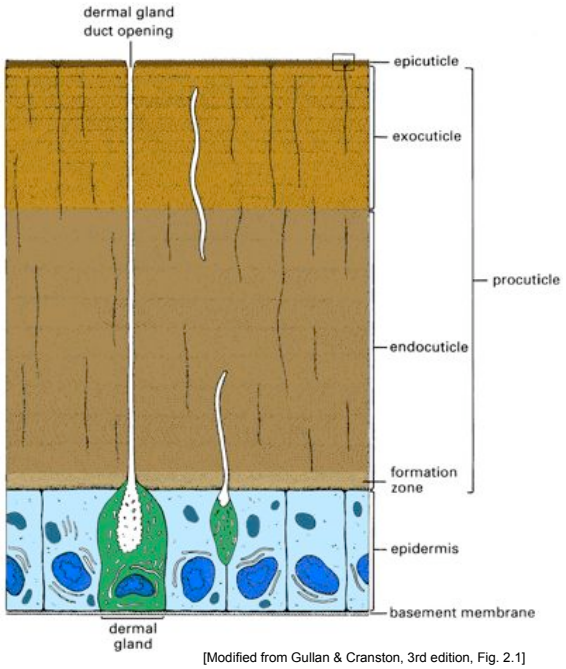
## Cuticle structure

Cuticle + epidermis = integument

Epidermal cells secrete cuticle

Cuticle can be thin and flexible or thick and hardened (sclerotised)

Procuticle contains large amounts of chitin, a polysaccharide




[Modified from Gullan & Cranston, 3rd edition, Fig. 2.1]

## Cuticle structure

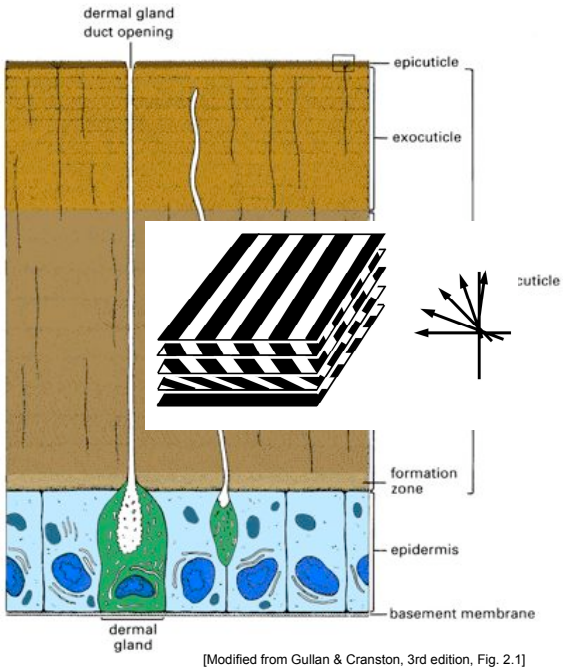
Cuticle laid down in oriented planes

Orientation of chitin fibres changes progressively, producing helicoidal arrangement
Called *lamellate* cuticle

Outer epicuticle has wax layer.

Cuticular hydrocarbons (CHCs) present in this layer: important in mate recognition

Produced by oenocytes




[Modified from Gullan & Cranston, 3rd edition, Fig. 2.1]

## Sclerotization

Also called tanning

Protein in exocuticle is cross-linked

Dark pigment, melanin, is formed as part of the chemical process

Blackened cuticle is said to be melanised

Non-sclerotised cuticle can be thin and flexible, especially the arthrodial membranes (at the joints of appendages and between segments, e.g. honeypot ants)

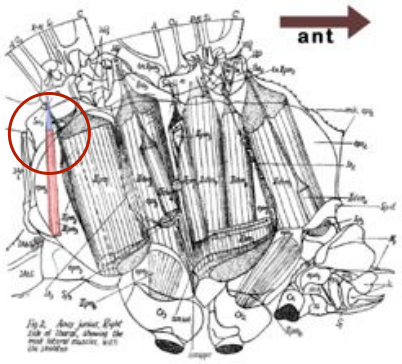
Images Alexander Wild Photography

## Resilin

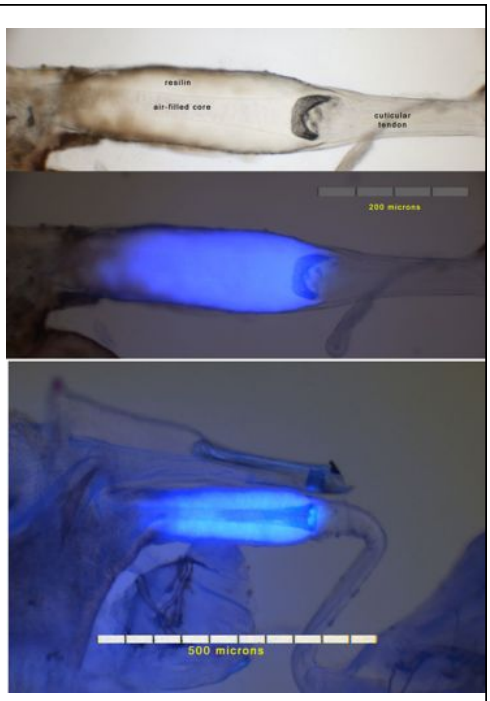
A protein that produces cuticle with rubber-like properties.

Found at wing bases of most flying insects

Dragonfly wing muscle ligament has a solid resilin tube between cuticle and muscle




Clark HW (1940) The adult musculature of the anisopterous dragonfly thorax (Odonata, Anisoptera). J. Morphol. 67: 523-565

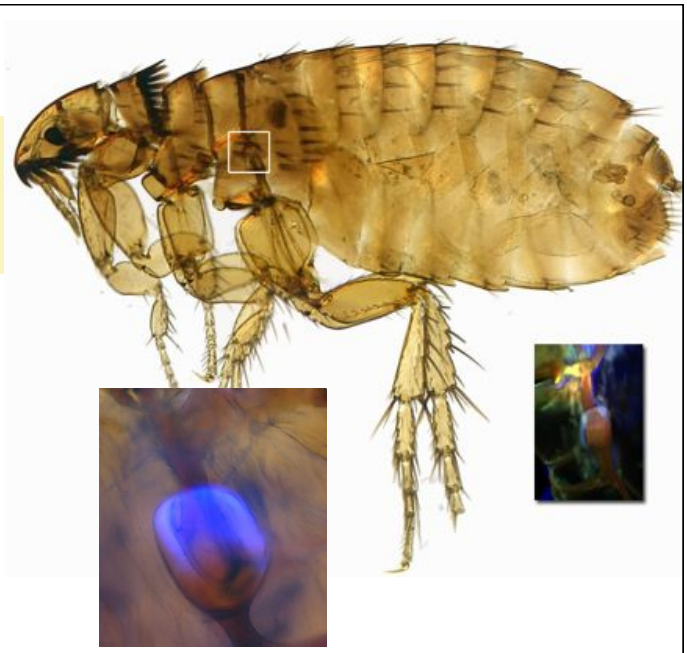



Images: D Merritt

## Resilin

A protein that produces cuticle with rubber-like properties.

Big pads store energy in fleas and other jumping insects



Images: D Merritt

## Resilin

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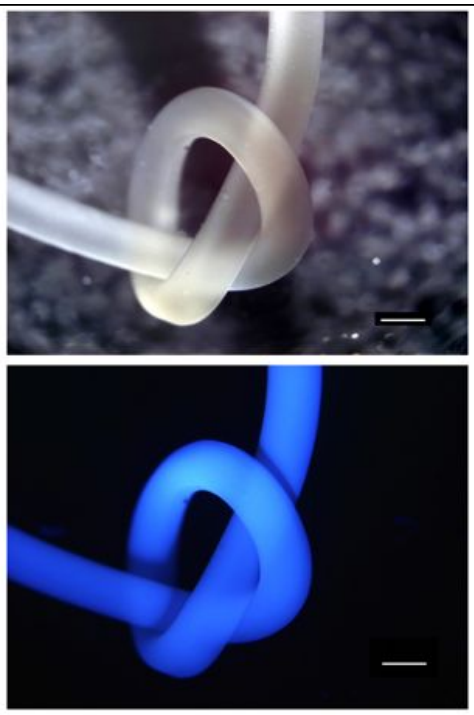
An artificial version (an insect gene placed in bacteria that produced pro-resilin) can be “cast”. Shown to be more resilient than any known rubber.



Images: D Merritt


Additives
Some insects have additives such as metals
Leafcutter ants have zinc in mandibles
Pupae of Diptera have calcium in pupal case
Image Alexander Wild Photography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Some insects have additives such as metals
Leafcutter ants have zinc in mandibles
Pupae of Diptera have calcium in pupal case
10µm
Image B. Cribb

## Colours

- Interference colours
- Light waves interacting as they are reflected within tiny ridges of the cuticle
- Light scattering
- Beetles (weevils from nth Qld) can produce colours through opal-like mechanism of packed spheres, called “photonic crystals”
- Many insect colours are due to pigments in the epidermal cells or in cuticle that reflect one colour and absorb others

Image: Alexander Wild Photography

Right from: Parker & Martini. Structural colour in animals: simple to complex optics. Opt Laser Technol (2006) 38 (4-6): 315-322

## Camouflage

- Crypsis often involves both shape and colour, plus behaviour
- Mantids
- Stick insects
- Moths
- Caterpillars

http://www.freakingnews.com/Insects-Camouflage-Pictures--1272.asp

FreakingNews.com

## Internalised Cuticle

- Hindgut, foregut and part of internal reproductive system are cuticle-lined
- The respiratory system is cuticle-lined
- A system of branched tubes, called trachea.
- Finest processes called tracheoles
- Spiracles open to outside (a)

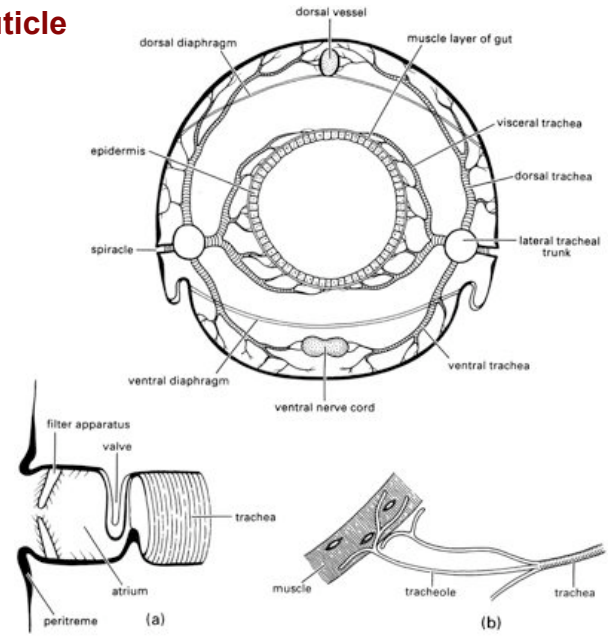
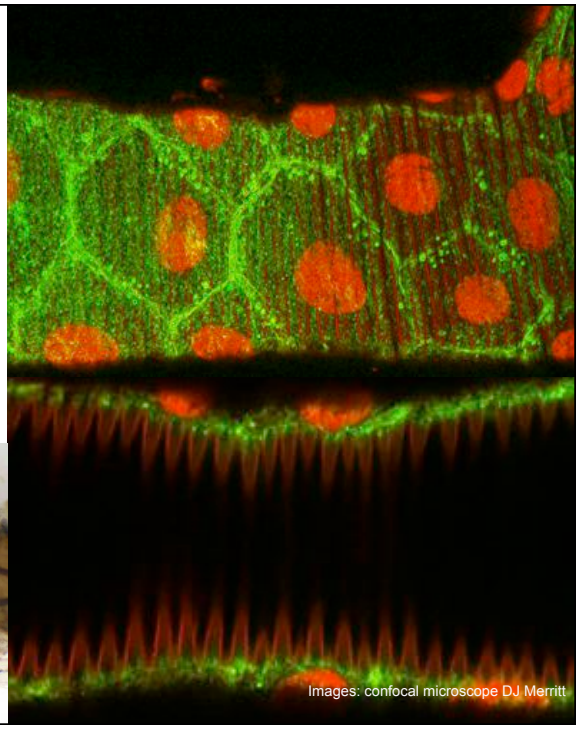



Image: Gullan & Cranston

## Respiratory System

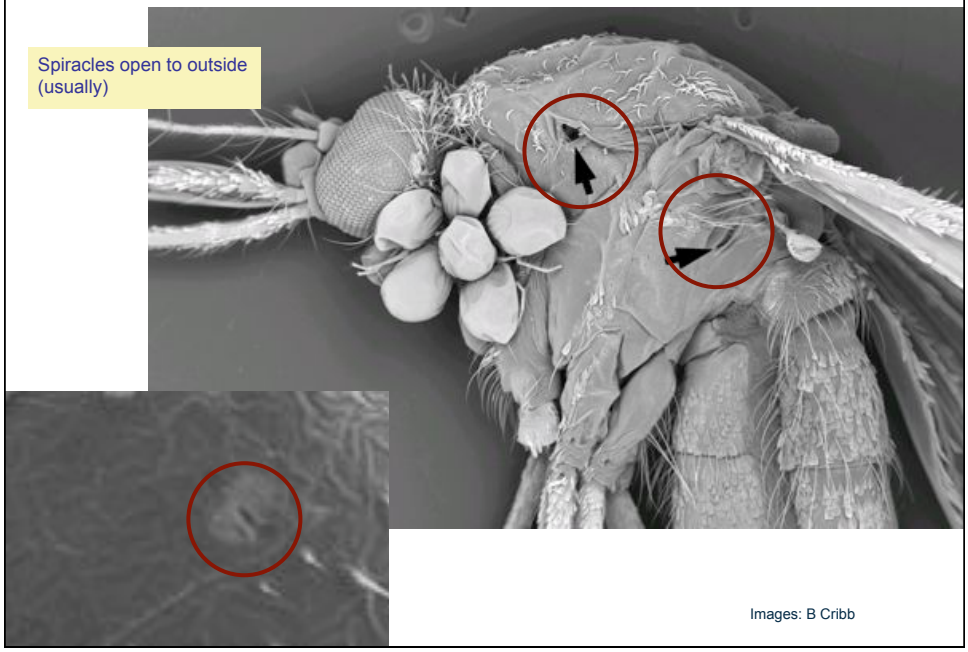
- A system of branched tubes, called ***trachea***.
- Flattened epidermal cells surround the trachea
- Tracheal lining is cuticle with spiral ridges, called *taenidia*
- The larger trachea are drawn out of the body at each moult



Images: confocal microscope DJ Merritt

## Internalised Cuticle

Spiracles open to outside (usually)



Images: B Cribb

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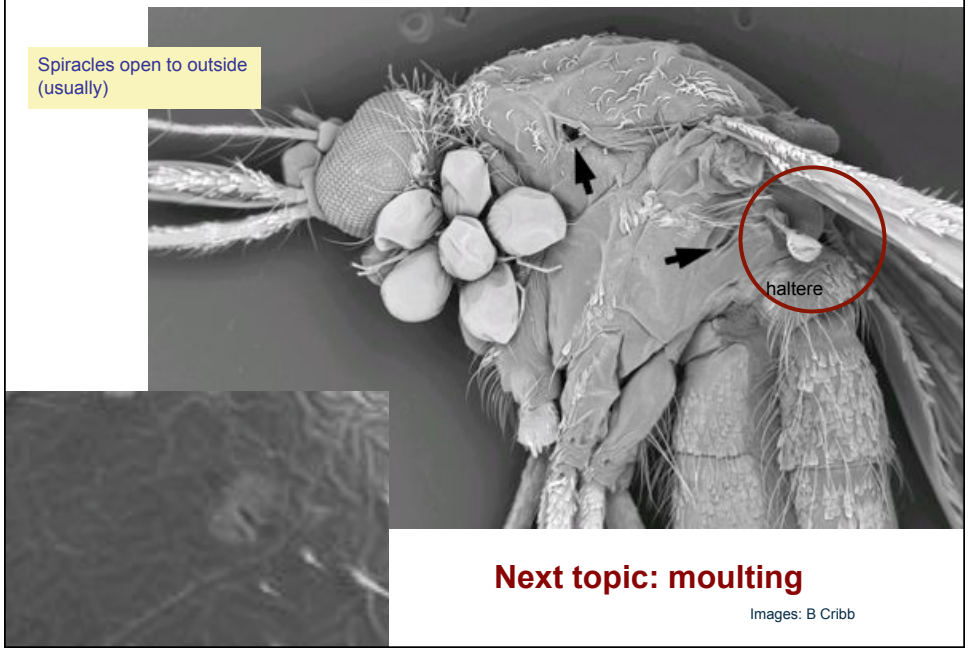


**Next topic: moulting**

Images: B Cribb