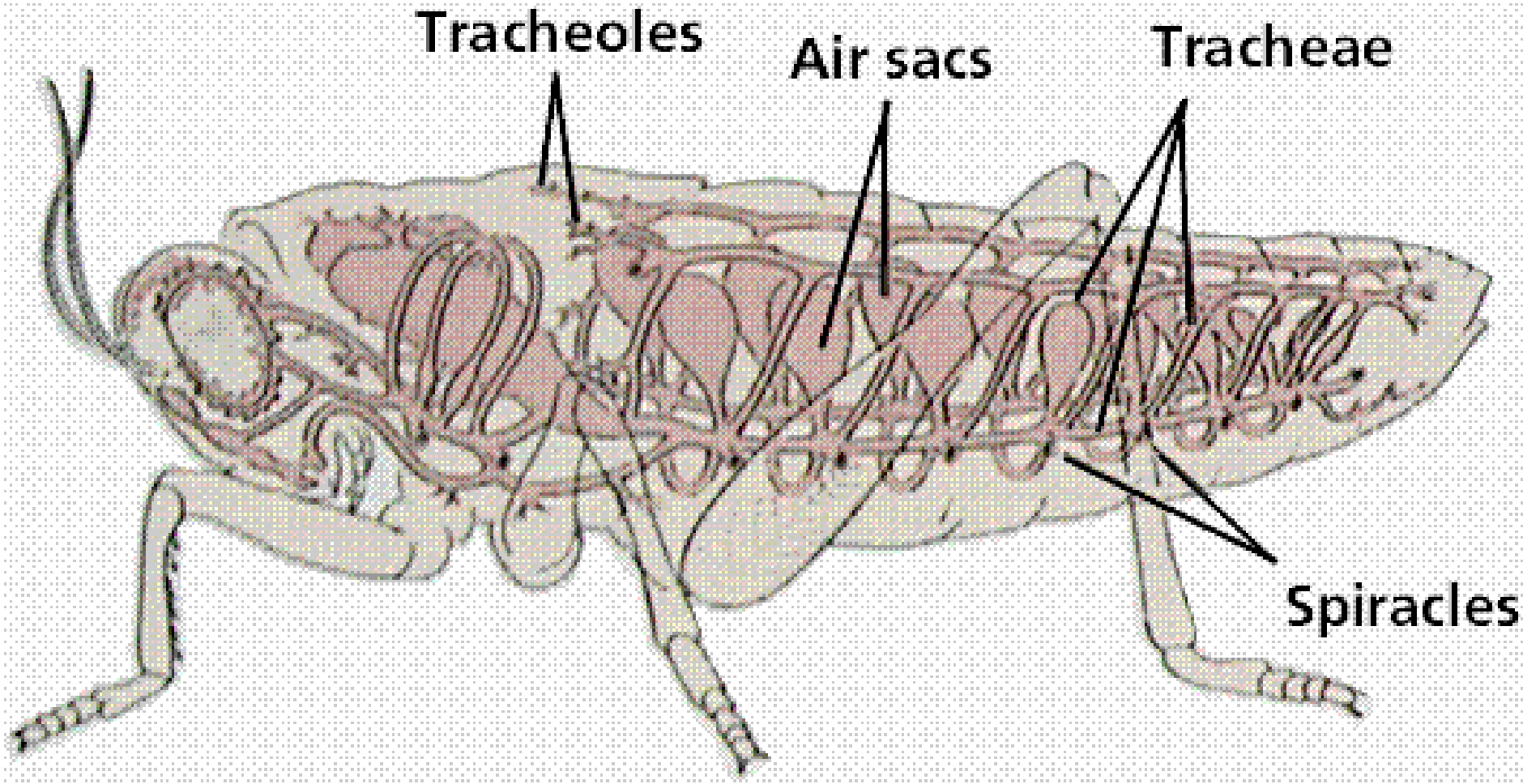
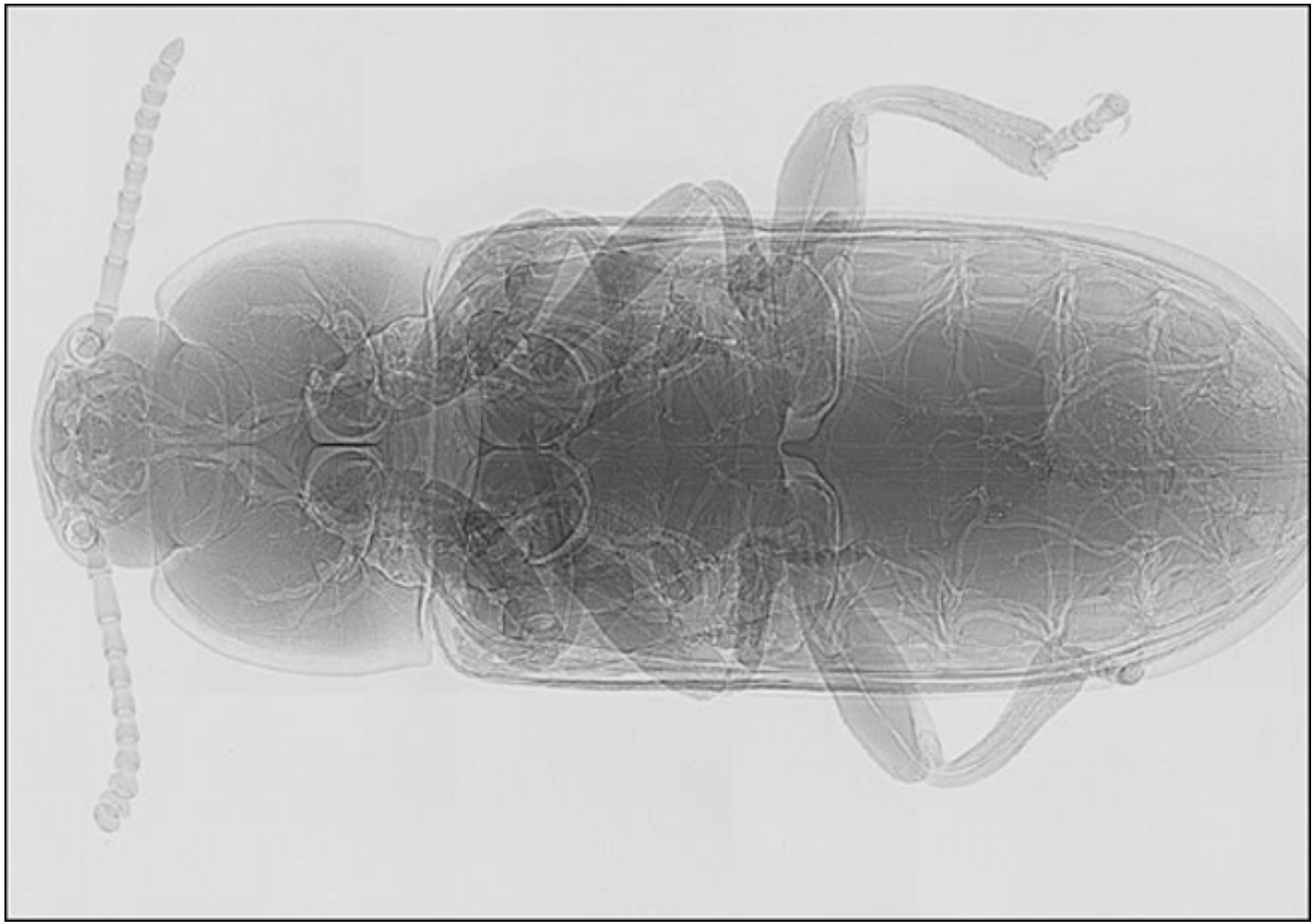
The Insect Gas Exchange System

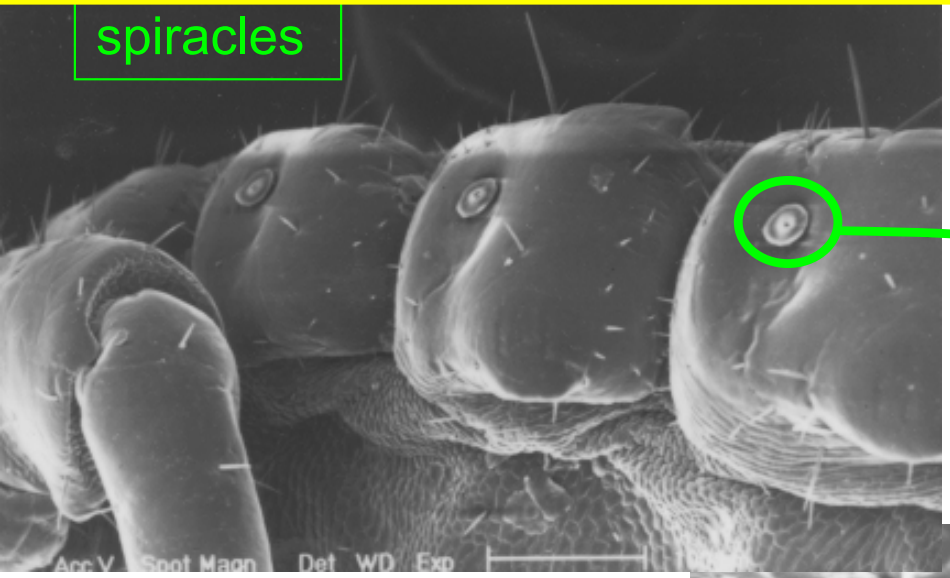


An X-ray of the yellow mealworm beetle - revealing the system of white tubes or tracheae running through its body

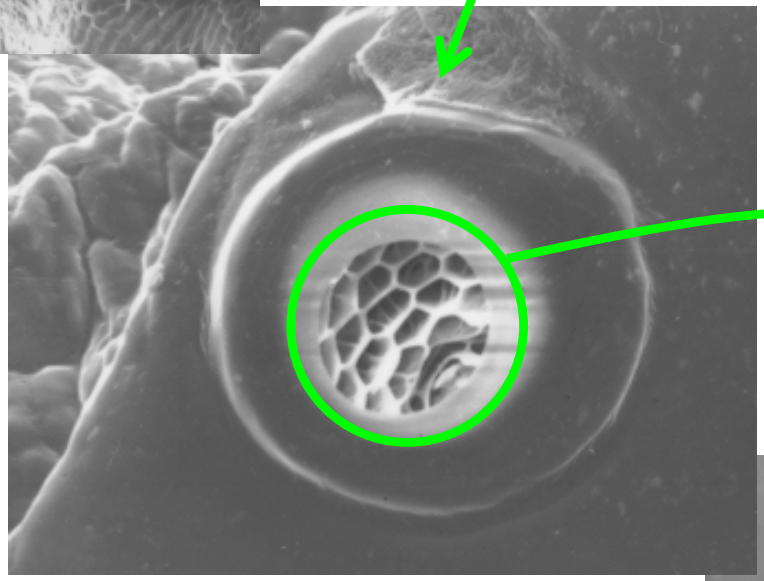


The Insect Gas Exchange System

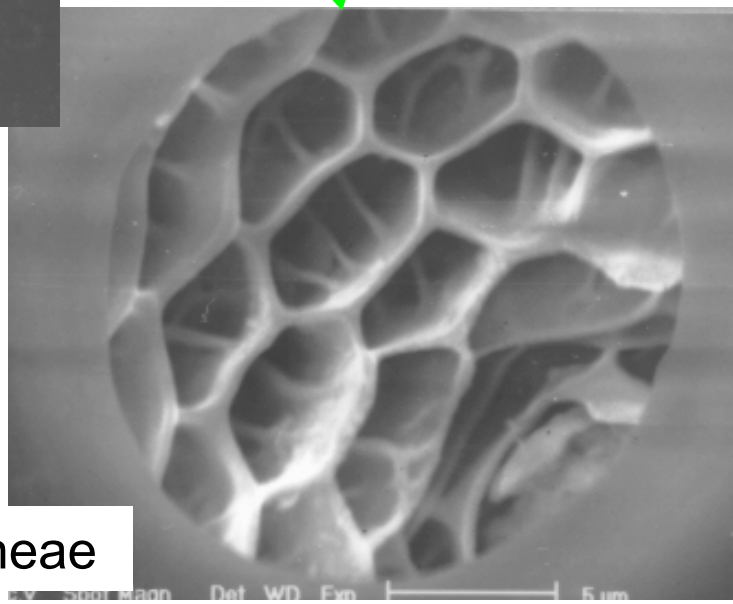
- An insect has spiracles (openings) lined with chitin on the sides of its body.
- The chitin give shape to the openings.
- The spiracles can open and close by small muscles.
- These muscles contract to shut flap like valves and relax to open the valves – allows control of the flow of air as well as slow down the loss of water.



Zoom

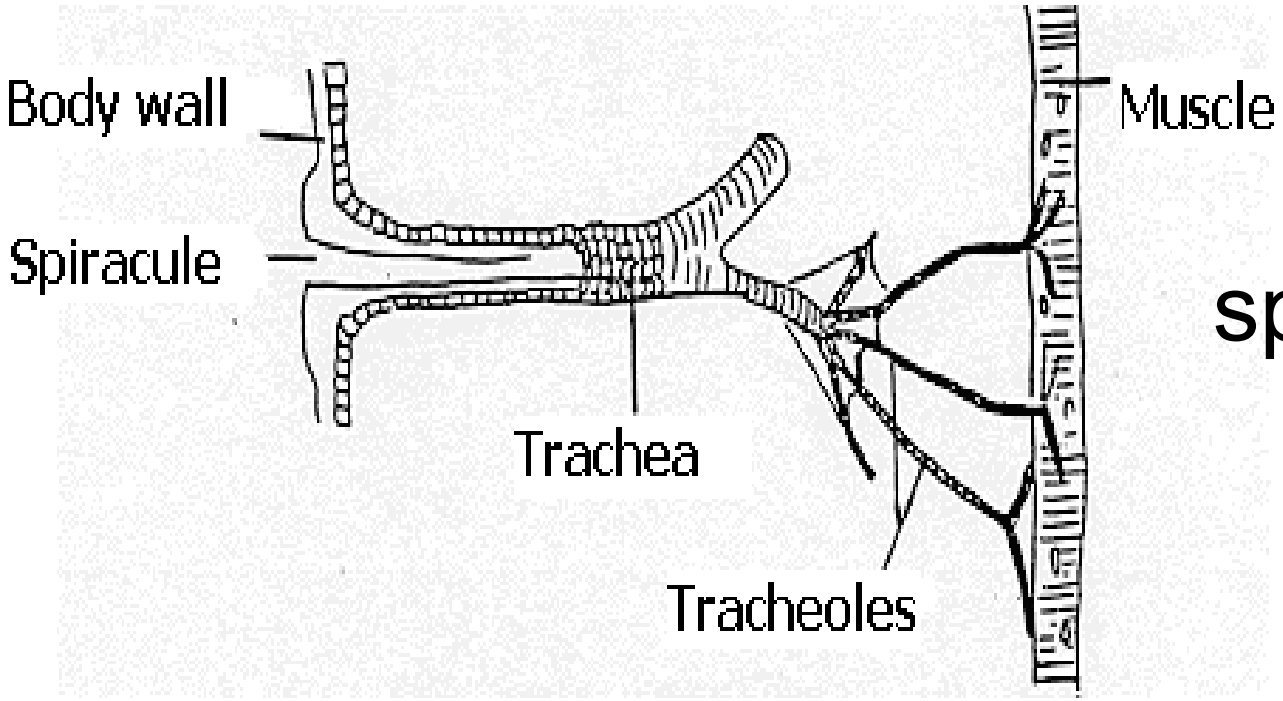


Zoom



The spiracles open into a system of tubes called tracheae

Tracheal System



Outside air

↓

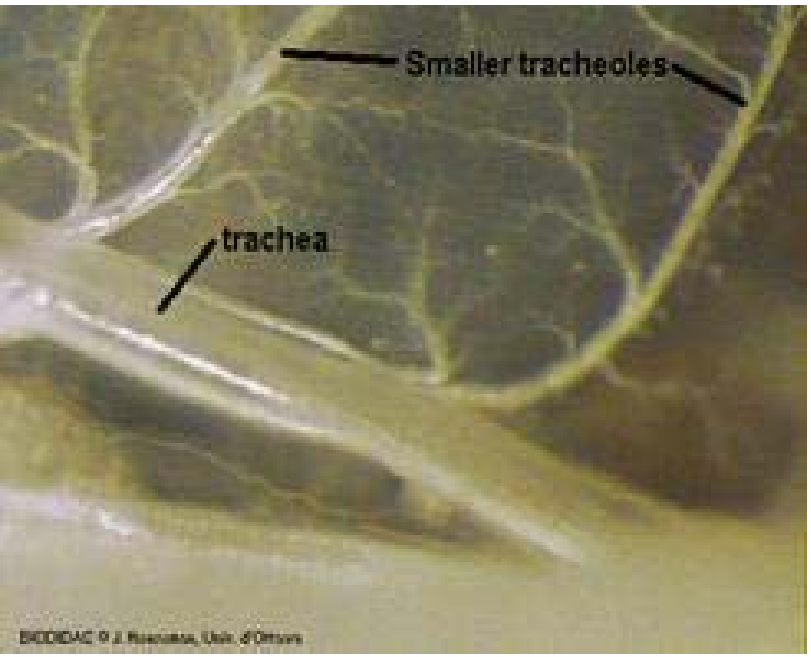
spiracles (openings)

↓

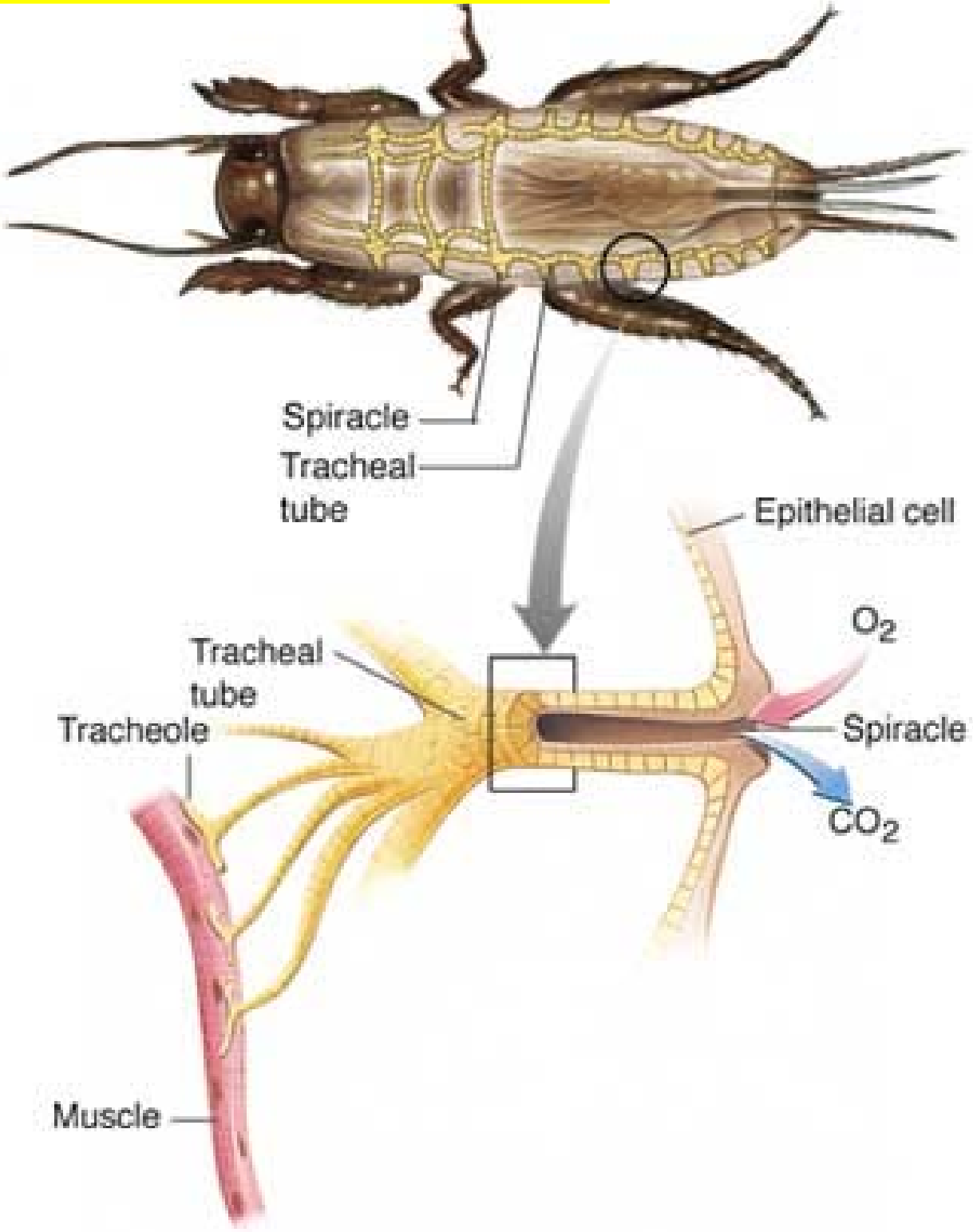
Tracheae

↓

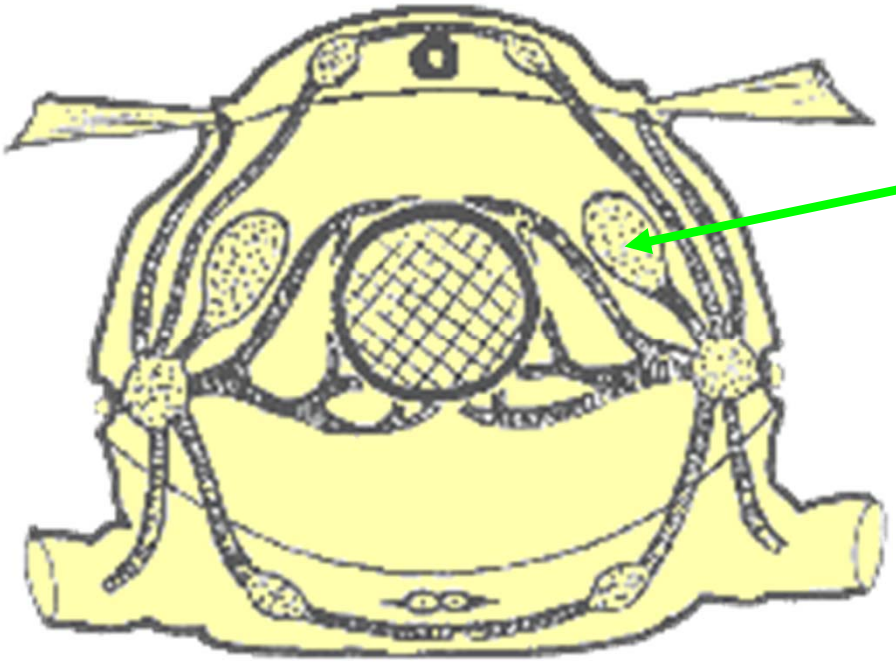
Tracheoles



Trachea walls are reinforced with **Taenidiae** (thickening of the chitin) – allows insects to flex and stretch without developing kinks that might restrict air flow.

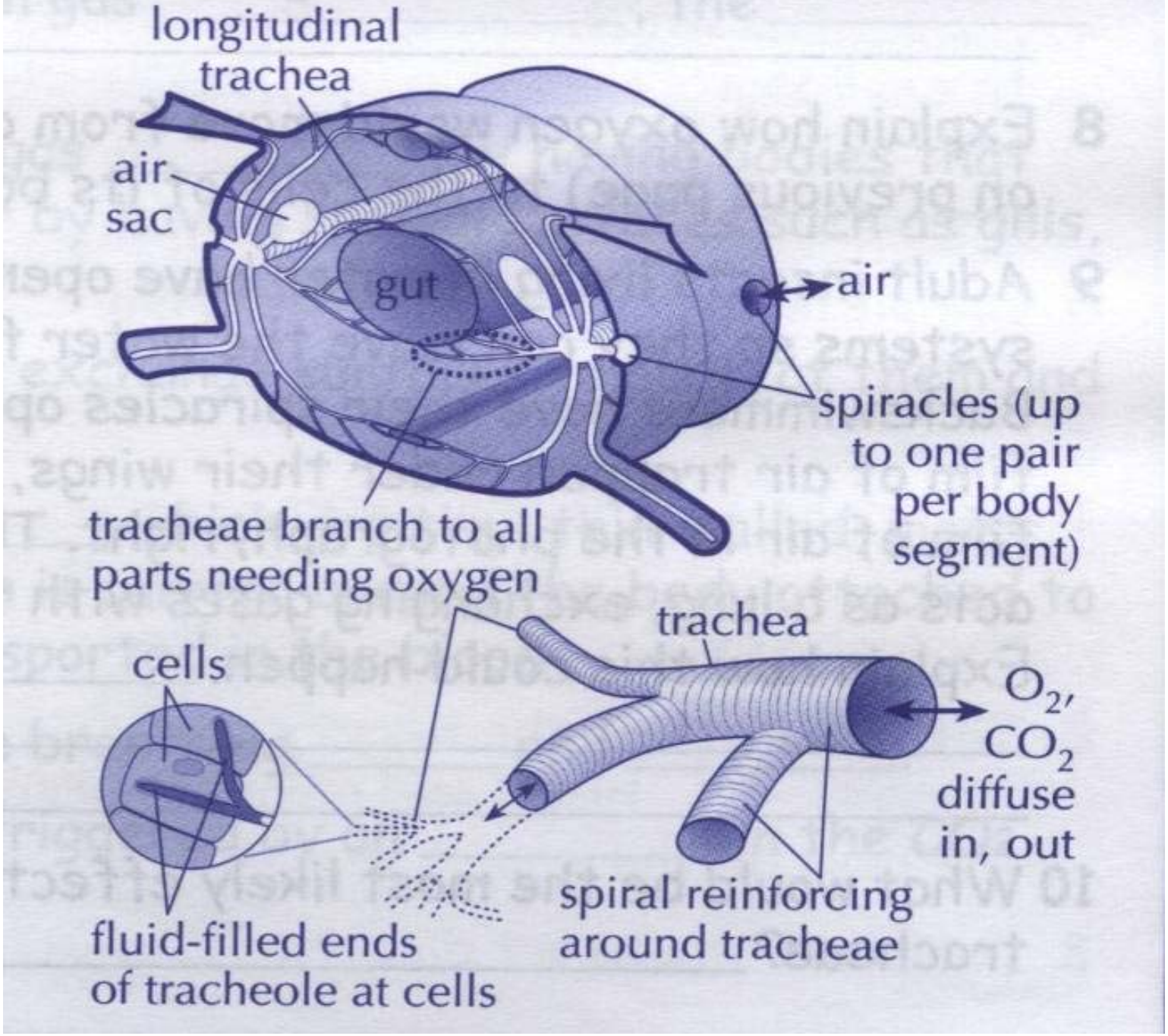


Storage of Air – adaptation for dry habitat



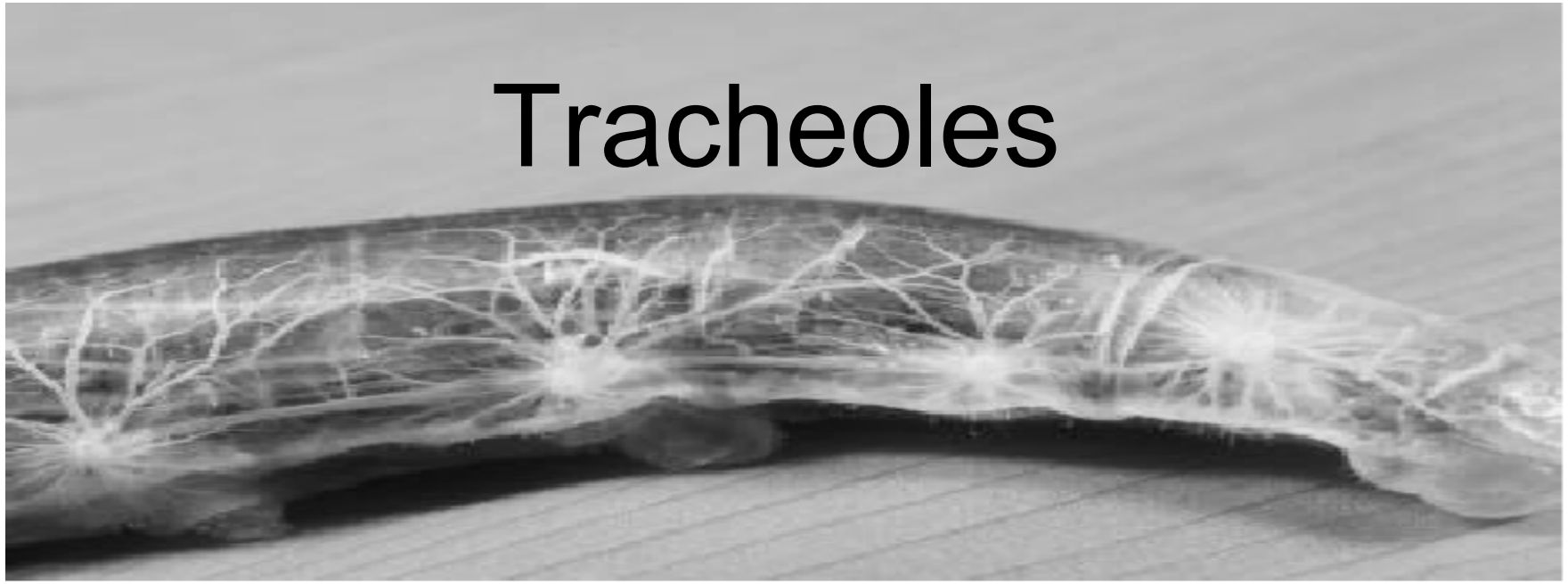
- Collapsible air sacs present in areas without taenidiae
- In dry terrestrial environments, this temporary air supply allows insects to conserve water by closing it spiracles during very dry periods use the stored air in the sacs.

A diagram showing the general arrangement of tracheae and spiracles in open tracheal systems



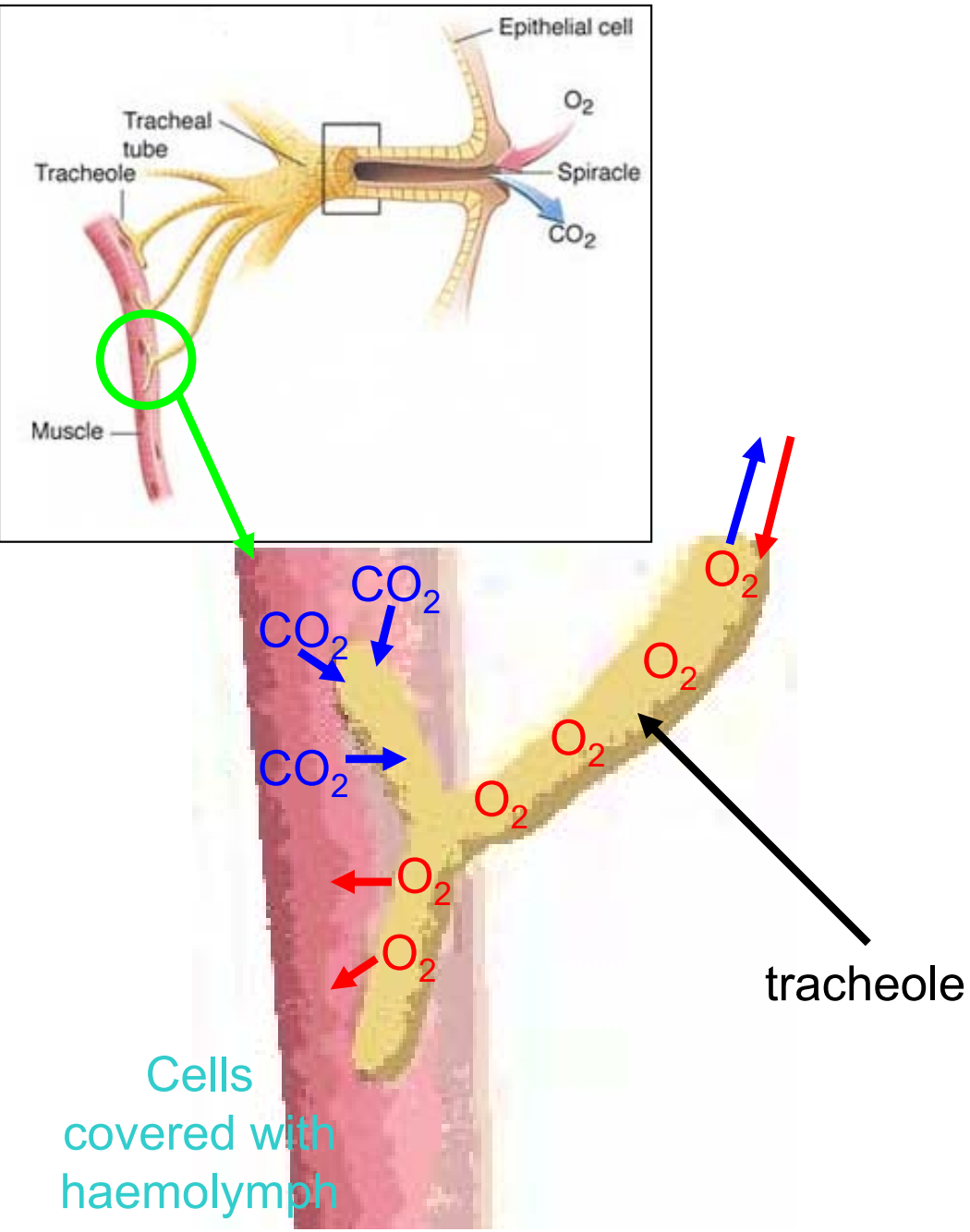
Respiratory tubes in a mayfly larva

Tracheoles



- Trachea lead to smaller tracheoles.
- The ends of each tracheole finishes in a group of body cells.
- The ends are lined with a thin moist surface (membranes) where the exchange of gases can take place.
- The thin membranes are surrounded by watery **haemolymph**.
- The body cells are bathed in the haemolymph.

Passive Diffusion of Gases



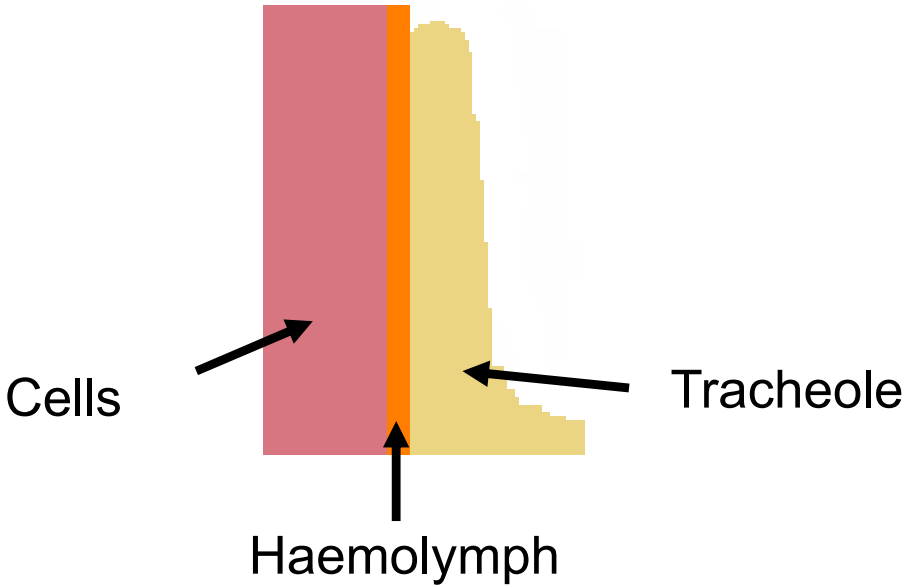
- Oxygen from the air in the tracheoles dissolves into the haemolymph fluid on the thin moist membrane surface and diffuses into the cells.
- O_2 diffuse from tracheoles into haemolymph from a high concentration of O_2 to a lower concentration of O_2.
- CO_2 produced by cell respiration can diffuse from the cells into haemolymph into tracheoles from a high concentration of CO_2 to a lower concentration of CO_2.

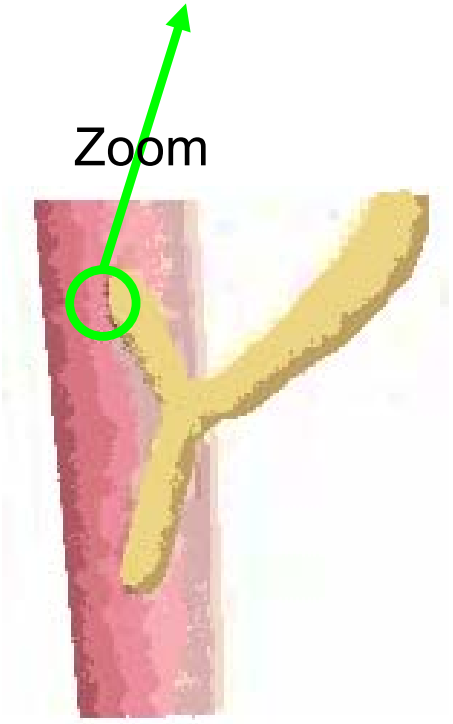
Increased Surface Area for Gas Exchange

Extensive network of trachea and tracheoles ↑'s surface area exposed for diffusion of:

- O_2 into haemolymph and further to the body cells.
- CO_2 out of cells into haemolymph into tracheoles.

Thin Surface for Gas Exchange





Thin surface to endings of tracheoles ↓'s the barrier to diffusion of:

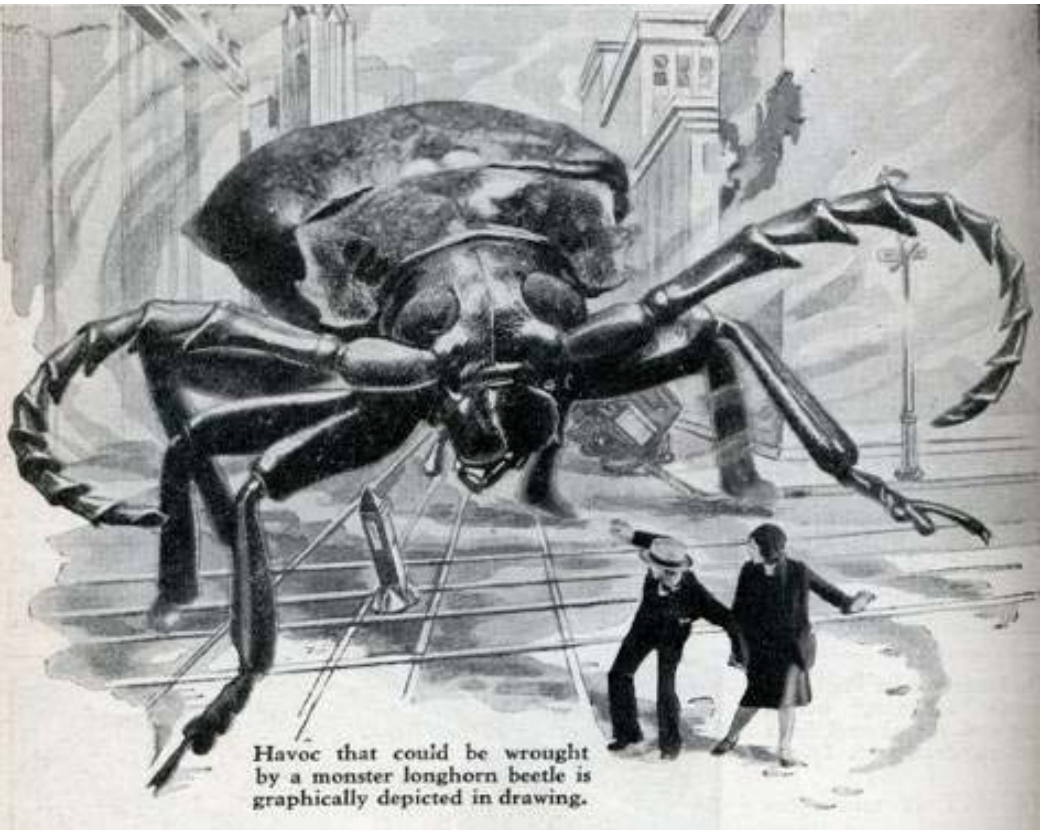
- O_2 into haemolymph and further to the body cells.
- CO_2 out of cells into the haemolymph into the tracheoles.

Moist Surface for Gas Exchange

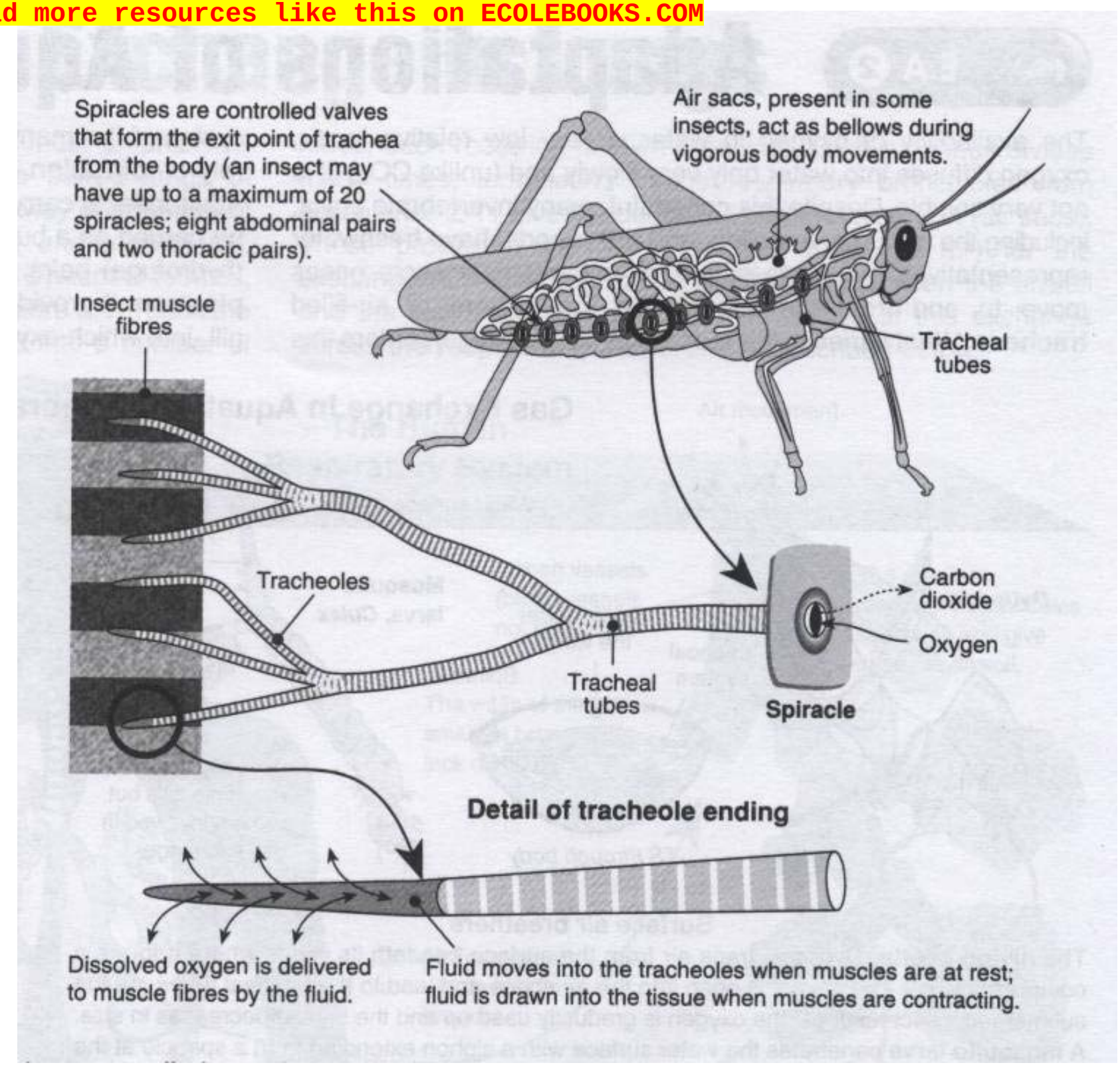
Moist surface at end of the tracheoles is important for:

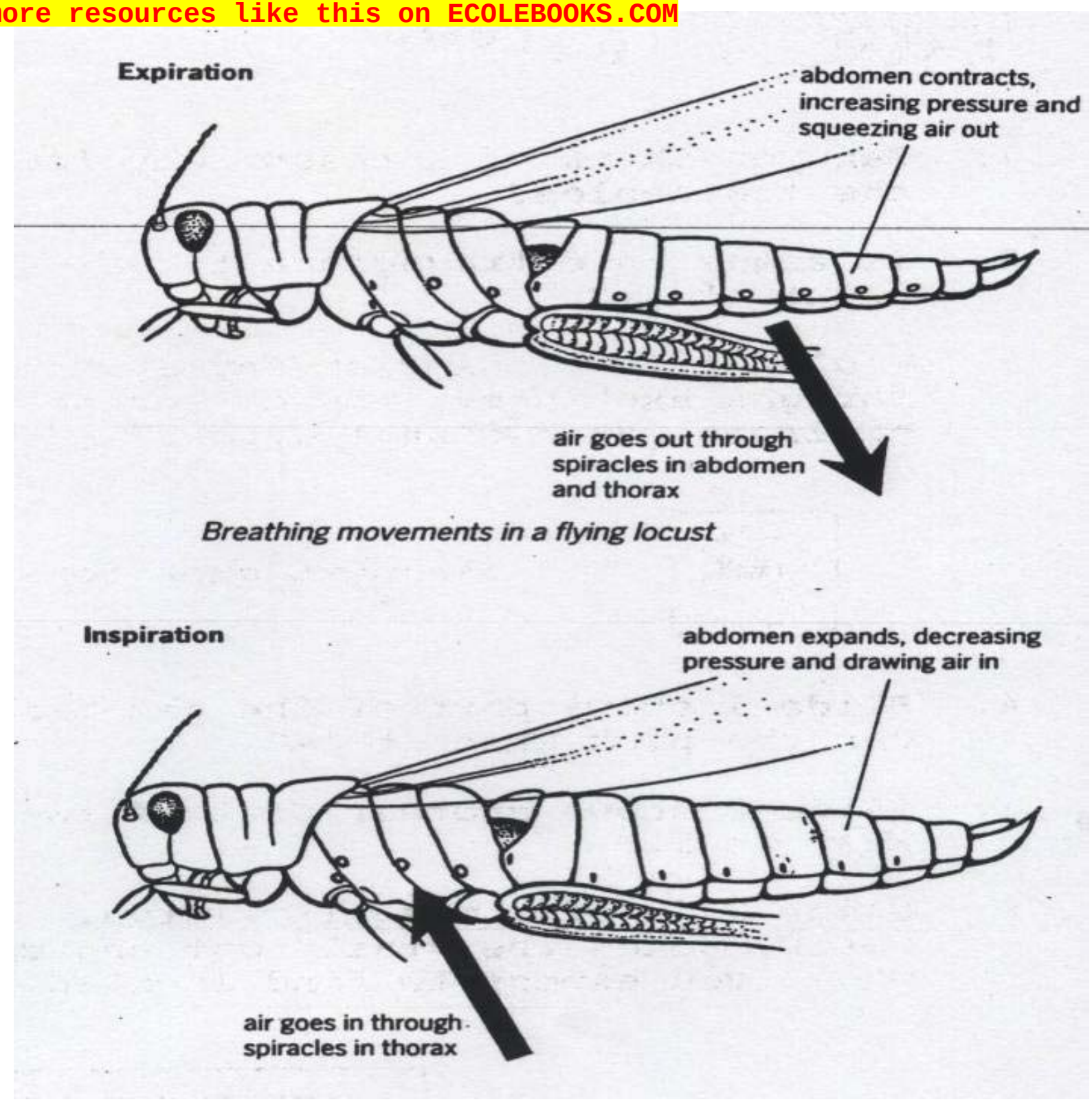
- O_2 to dissolve into the watery substance for diffusion into the haemolymph.
- CO_2 to dissolve into the water substance for diffusion out of the haemolymph into the tracheoles

What Prevents Insects from being the Size we see in the Horror Movies?



- Insects rely upon passive diffusion and physical activity for the movement of gases within the tracheal system.
- Diffusion of O_2 and CO_2 through the air in the tracheal tubes is fast enough only for distances less than 1cm for the body surface. This limits the size/radius of the insect's body.
- Larger organisms use a blood circulatory system (blood vessels) to over come this limitation.





Breathing movements in a flying locust