

Announcements

- Friday, meet in Room 331!
- Morning lab 8:00
- Afternoon lab 8:25

I have more gas

What did you talk about in school
this week, Timmy?

My teacher talked about his gas.

Gas Exchange

Diffusion through the cell membrane

External gills

Internal gills

Insect trachea

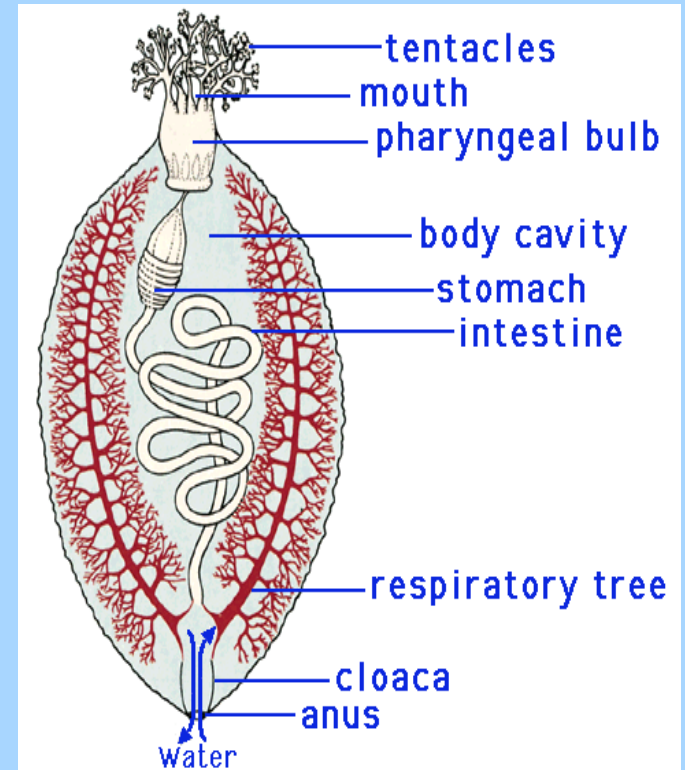
Human lung

Bird lung

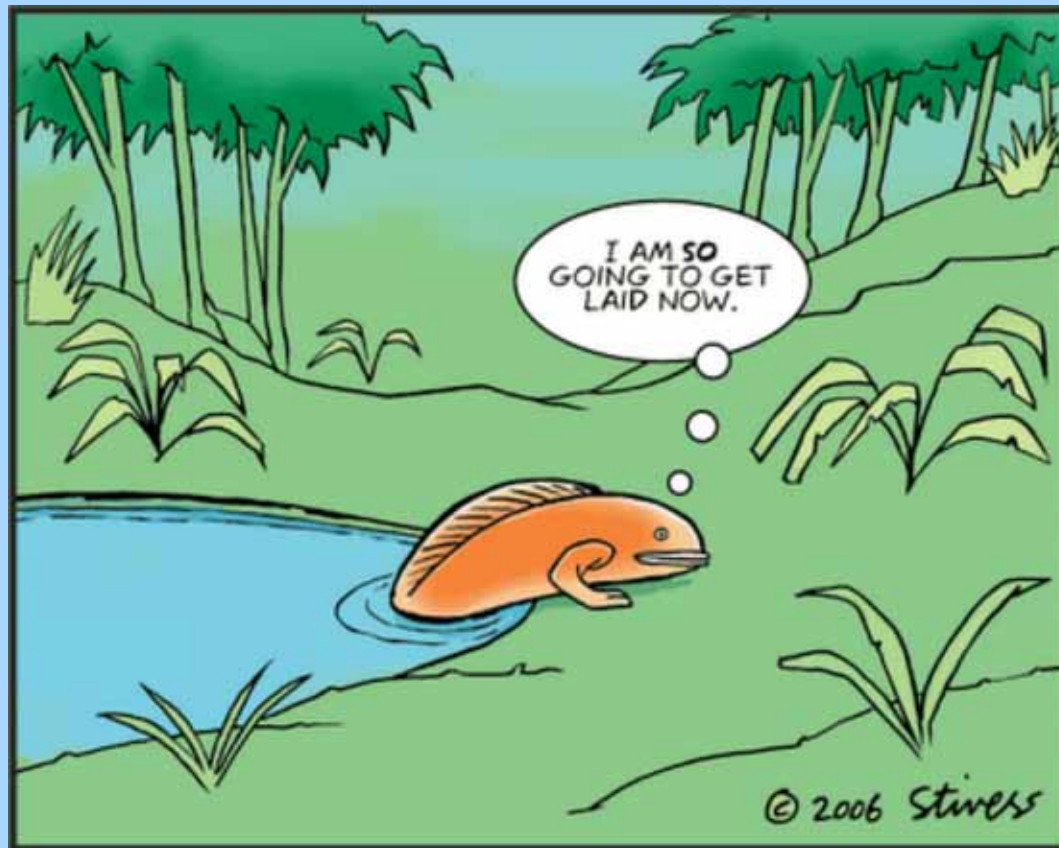
Gas exchange in the water

Gas exchange from air

Sea Cucumber Breathing



What was one evolutionary advantage to moving from the oceans to dry land?

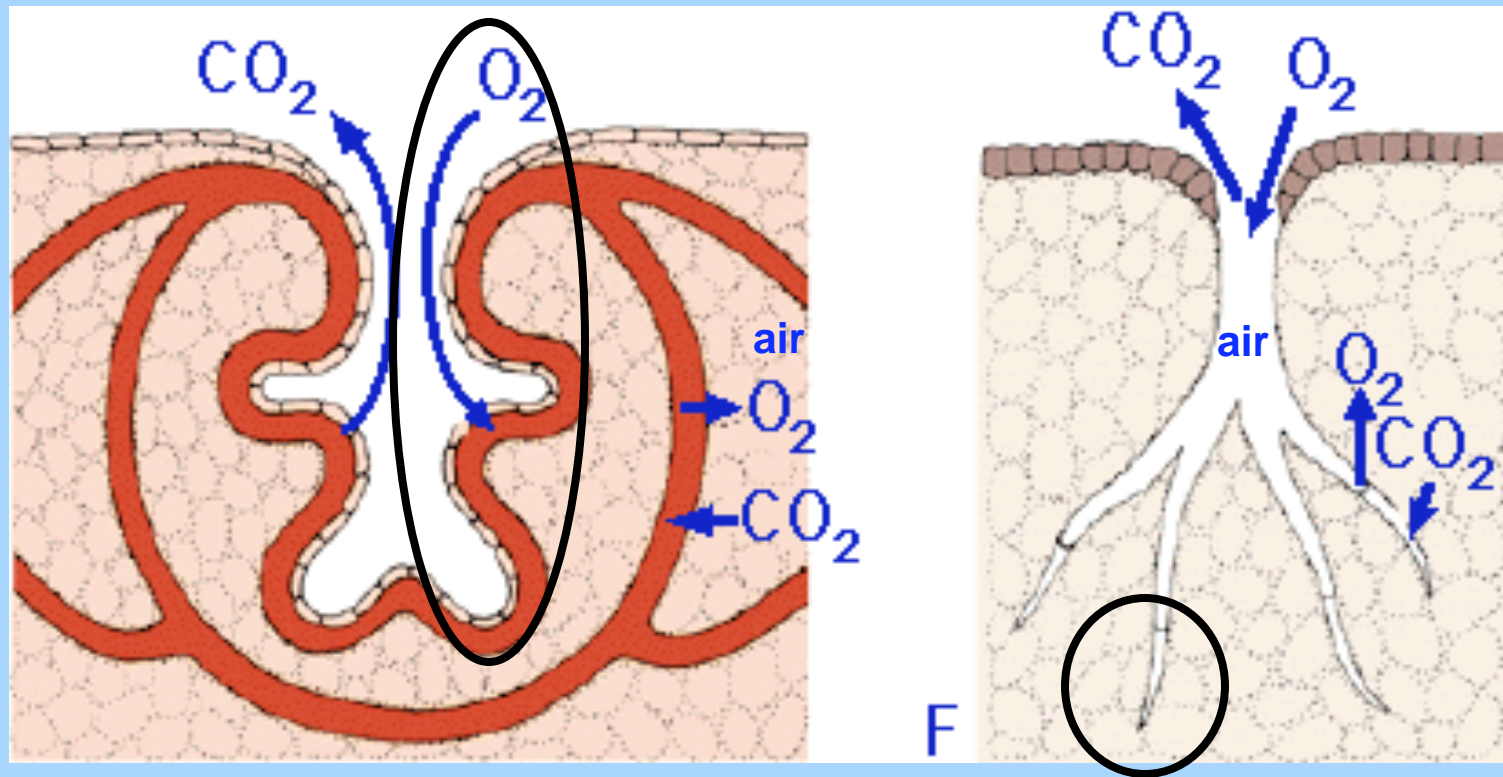


Gas exchange in water vs. air

- Oxygen is more abundant in the air
 - ~200mg/L in air
 - ~10 mg/L in water
- Water 1000x more dense than air
- Oxygen less soluble in water than air

Gas Exchange

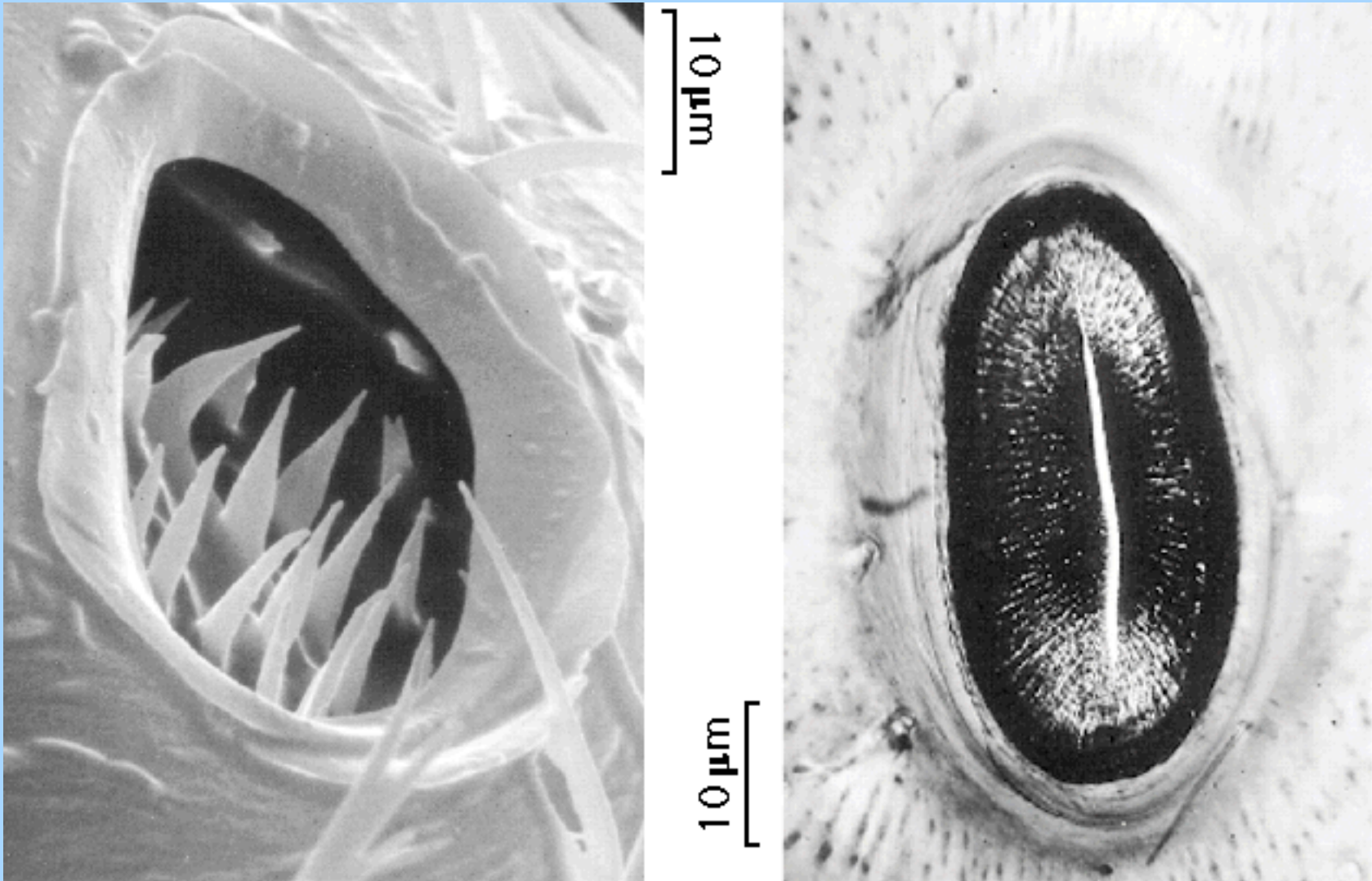
Lungs or Tracheal System



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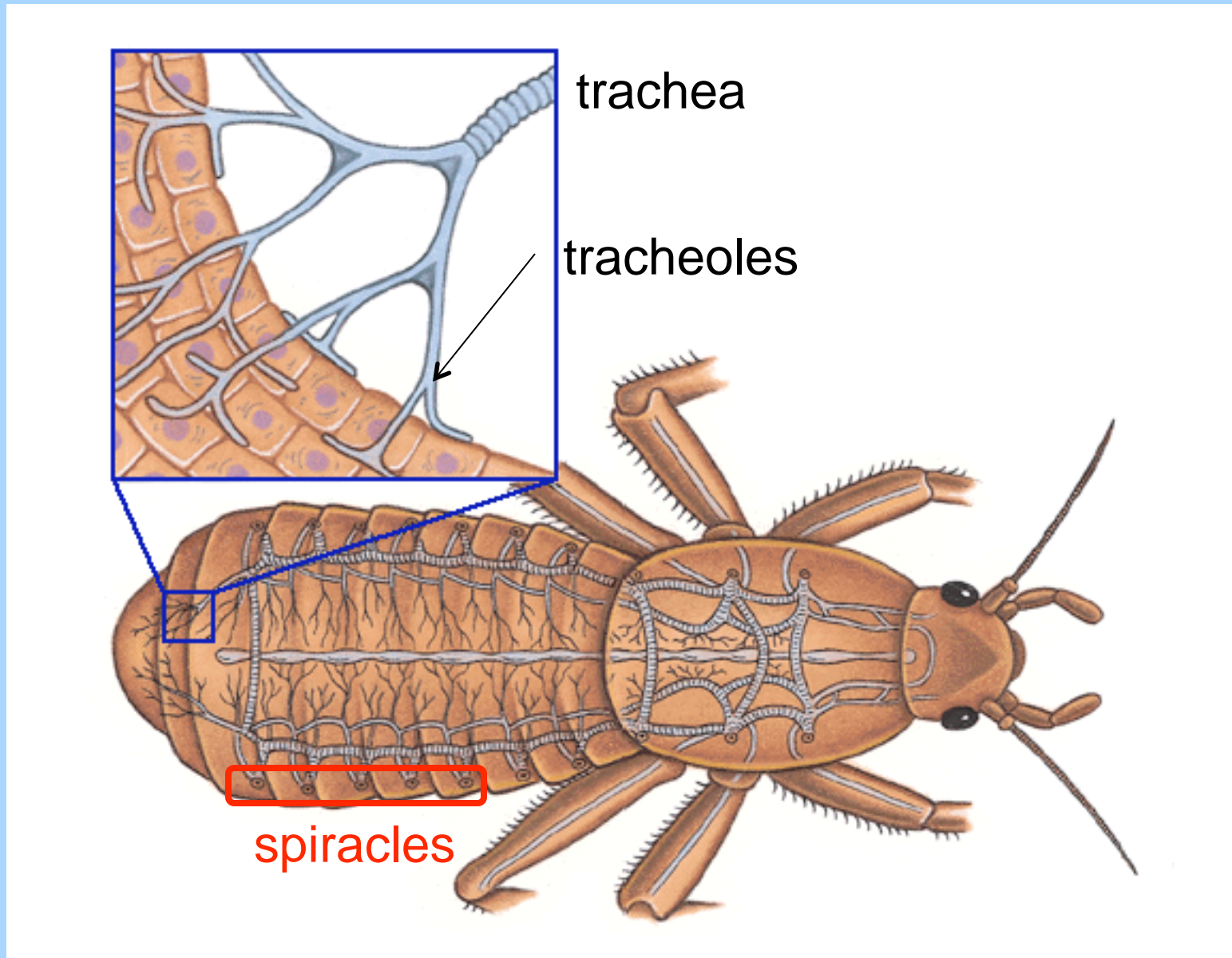
There has to be a liquid interface!

Trade off!! – more oxygen in air, but more risk of desiccation



Here are two spiracles, one open with sensors functioning. The other is closed to avoid desiccation/predation, etc.

In an insect respiratory tree, the tracheoles contact every cell.



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Circulatory system and respiratory system separate

Grasshopper breathing

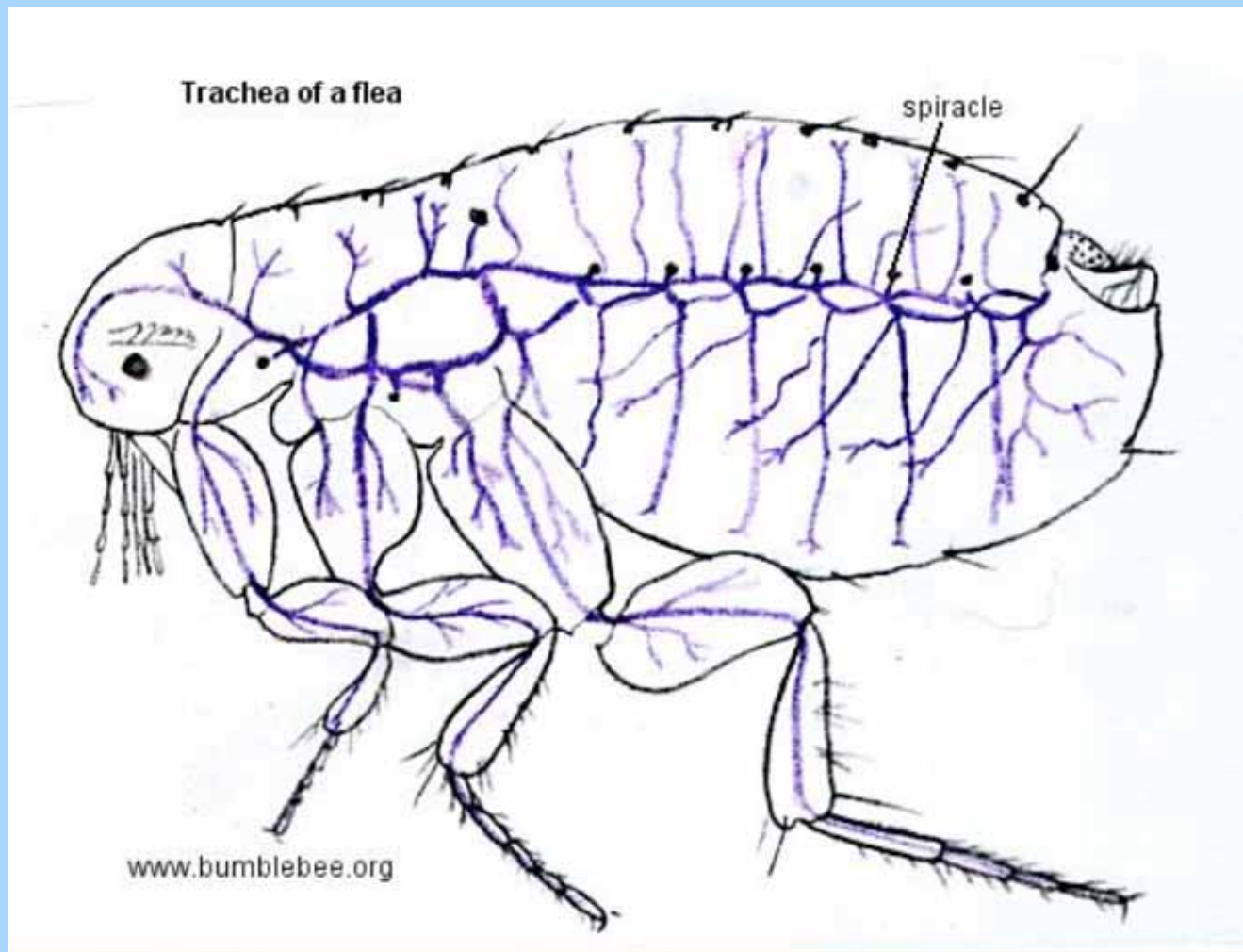


Spiracles



<http://www.flickr.com/photos/buglady/sets/72157627032868823/detail/>

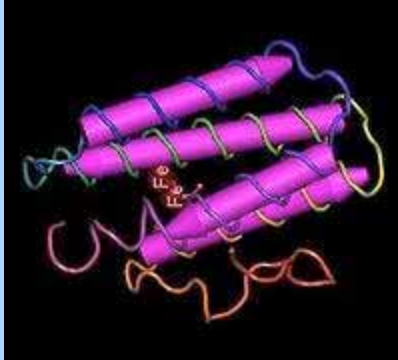
Trachea



Respiratory Pigments

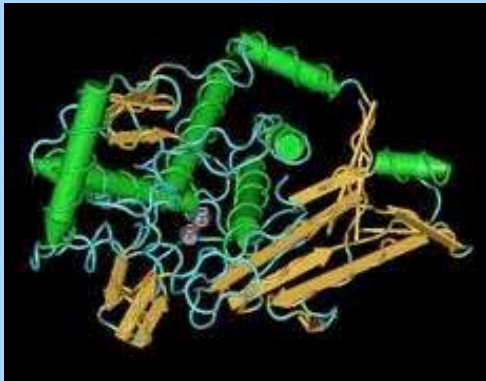
Function: deliver O₂ to the cells

- Hemerythrin – red color, **non-heme Fe protein**, low oxygen binding, few invertebrates and bacteria



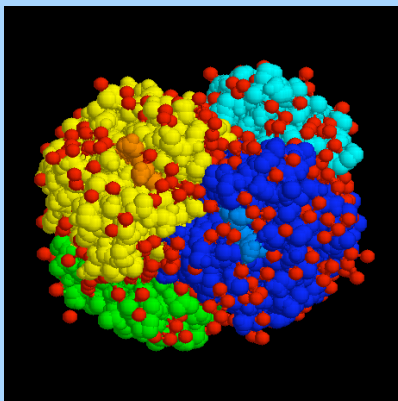
<http://upload.wikimedia.org/wikipedia/commons/7/79/Hemerythrin.jpg>

- Hemocyanin – blue color, **Cu group**, moderate oxygen binding, many invertebrates (molluscs, some crustaceans)



<http://upload.wikimedia.org/wikipedia/commons/f/fb/Hemocyanin2.jpg>

- Hemoglobin – red color, **heme Fe group**, high oxygen binding, 4 polypeptides, vertebrates and some invertebrates

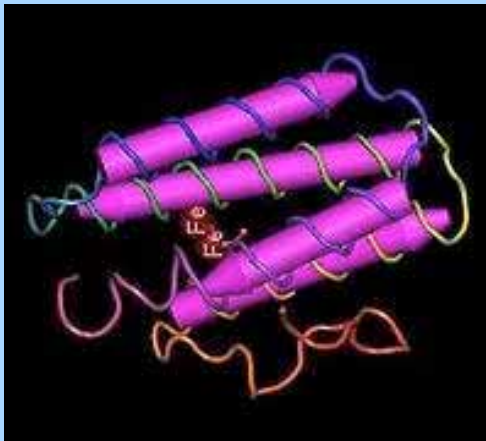


<http://upload.wikimedia.org/wikipedia/commons/d/d2/Hemoglobin.gif>

A phylogenomic profile of hemerythrins, the nonheme diiron binding respiratory proteins

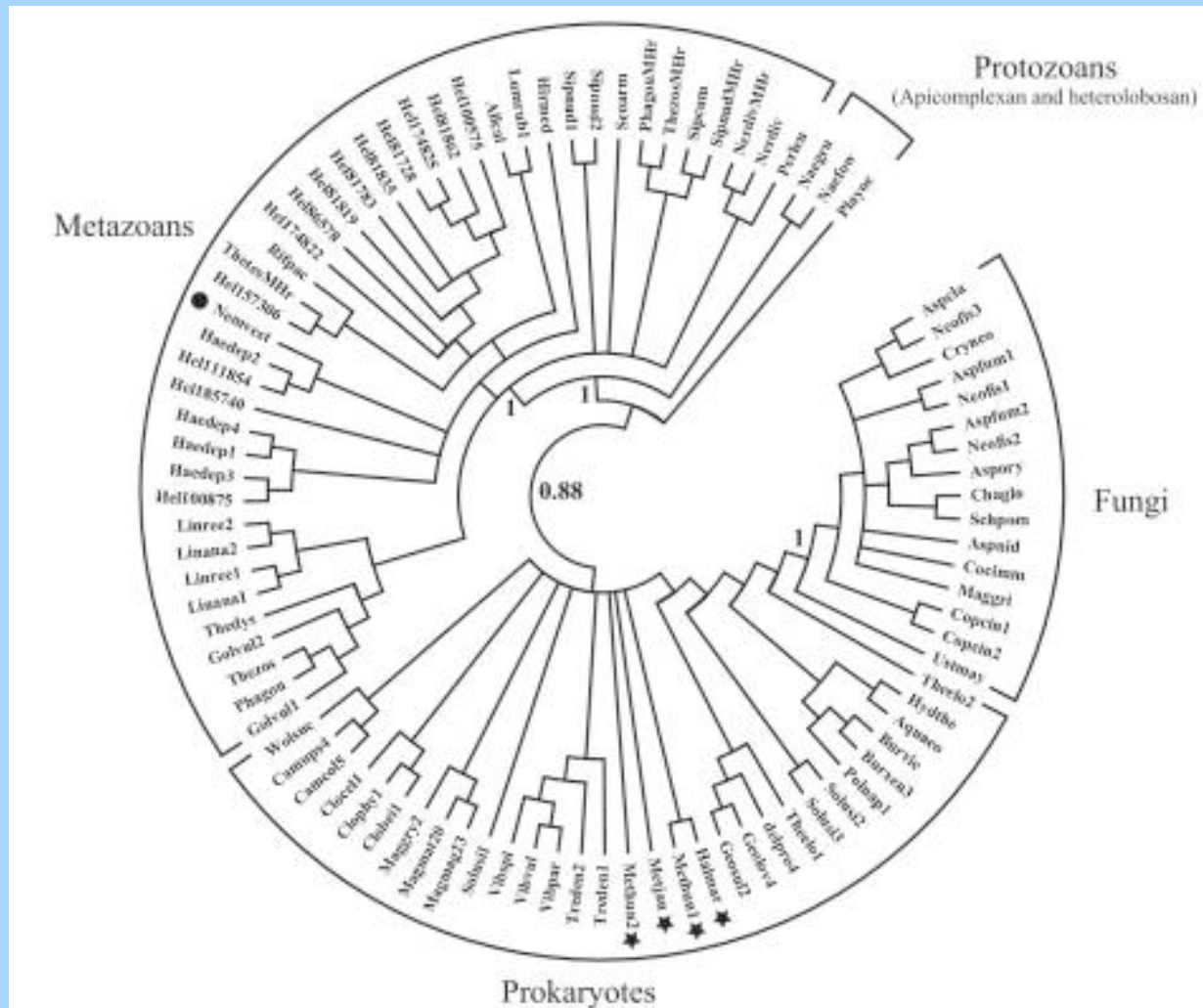
Xavier Bailly,^{✉1} Stefano Vanin,² Christine Chabasse,³ Kenji Mizuguchi,⁴
and Serge N Vinogradov⁵

Who has hemerythrin? Halobacteria!



**3 archaea, 118 bacteria,
several fungi, one
apicomplexan, a
heterolobosan, a cnidarian
and several annelids**

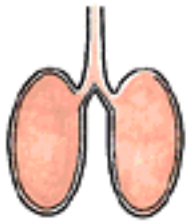
Your next cladogram assignment: circle all the homoplasies!



Very
diverse
group!

Gas Exchange

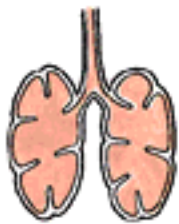
Lung



A
lungfish



C
reptile



B
frog

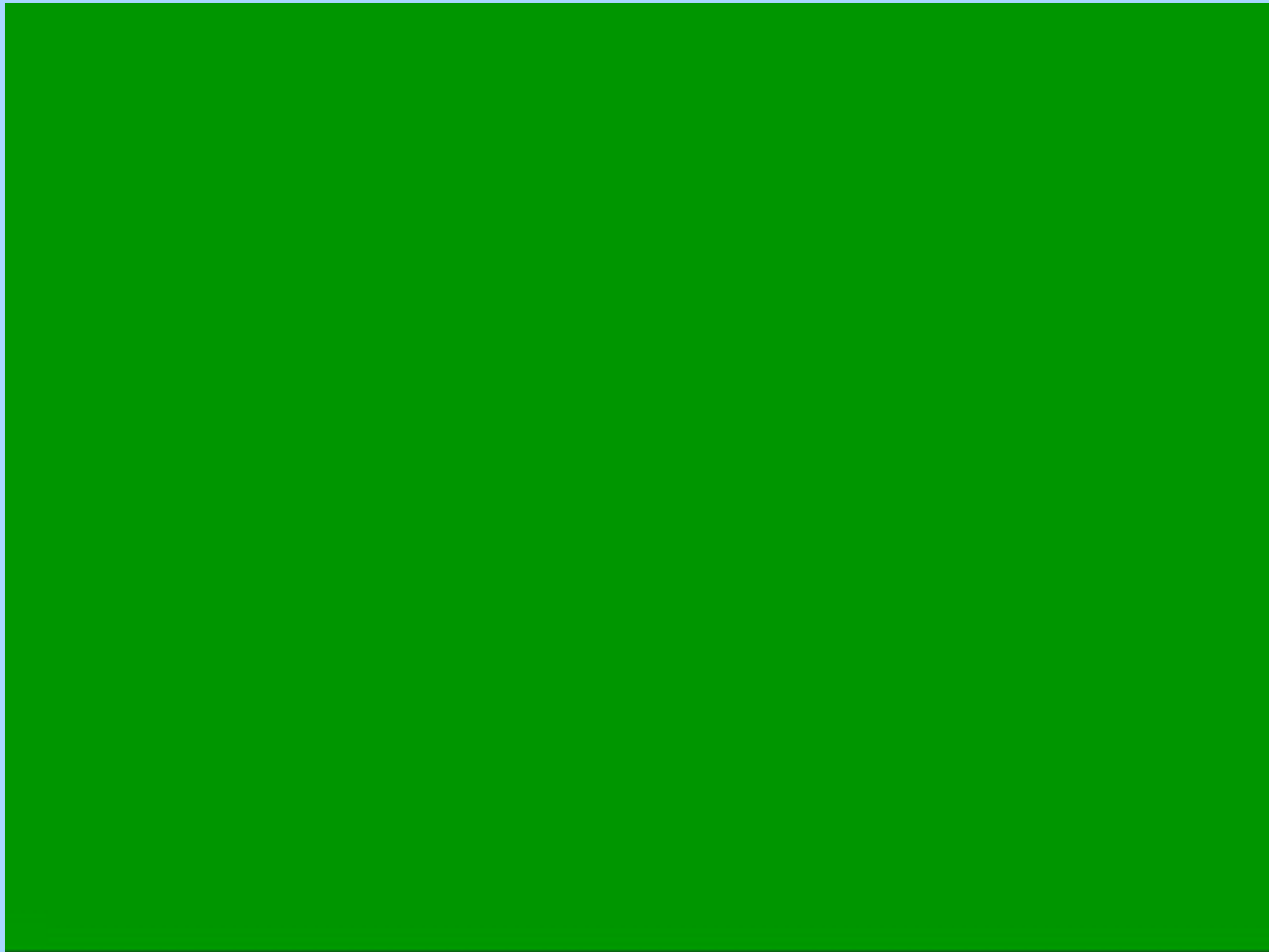


D
mammal



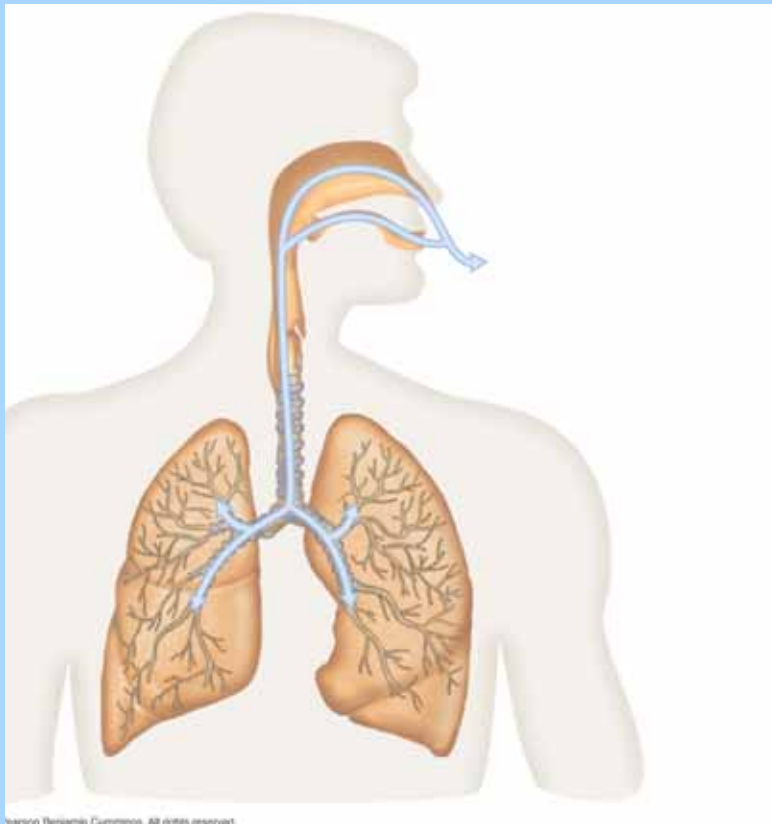
Notice the increase in surface area

How do we maintain that liquid interface?



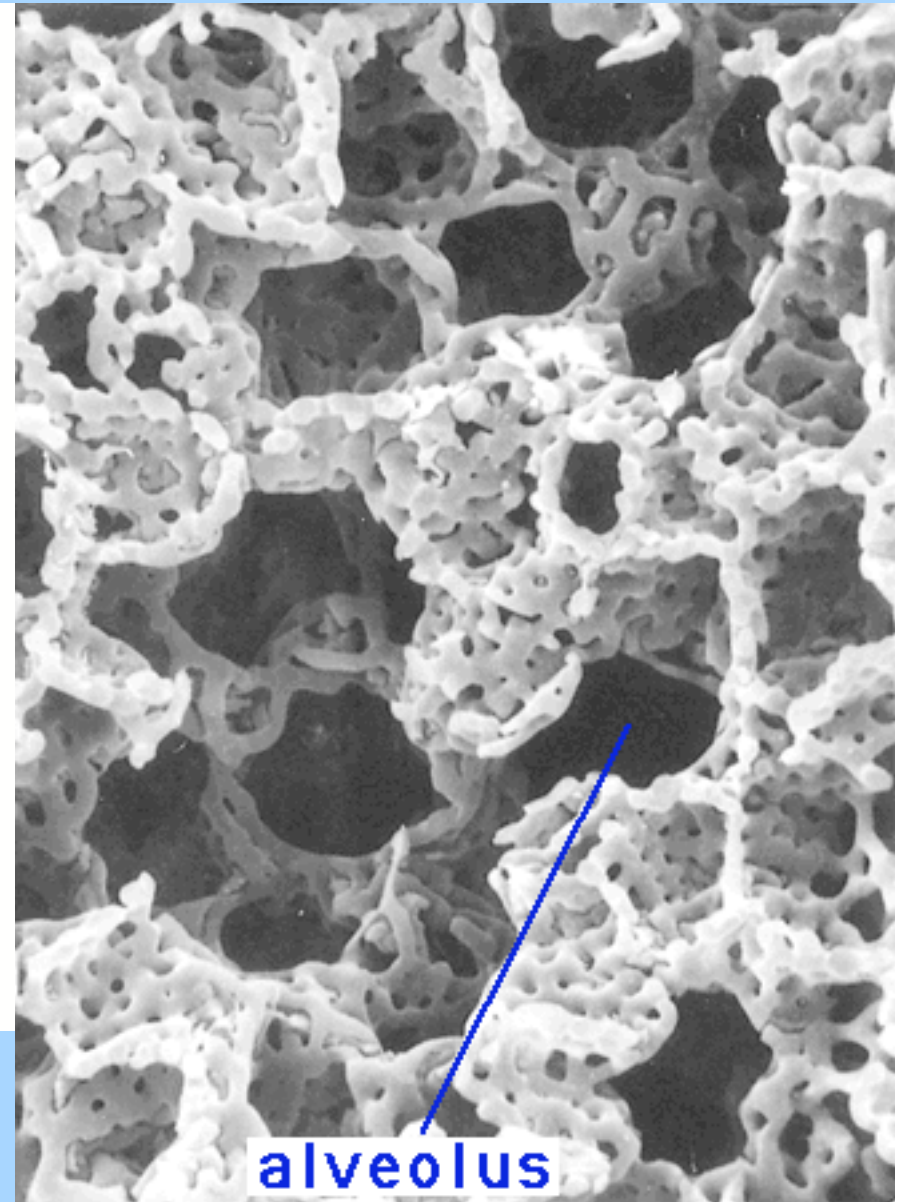
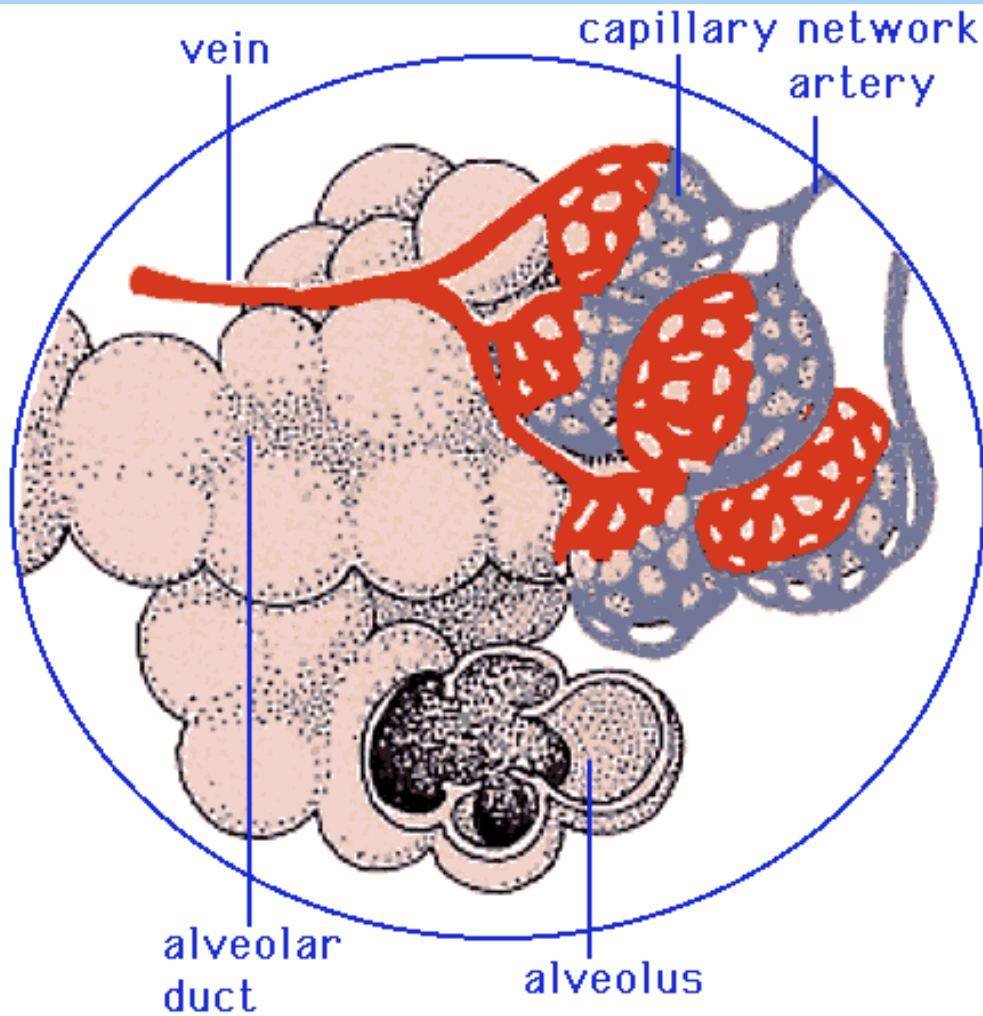
- First 30 seconds

Yea, but it's a dry heat.



- Dry air moistened during passage into lungs

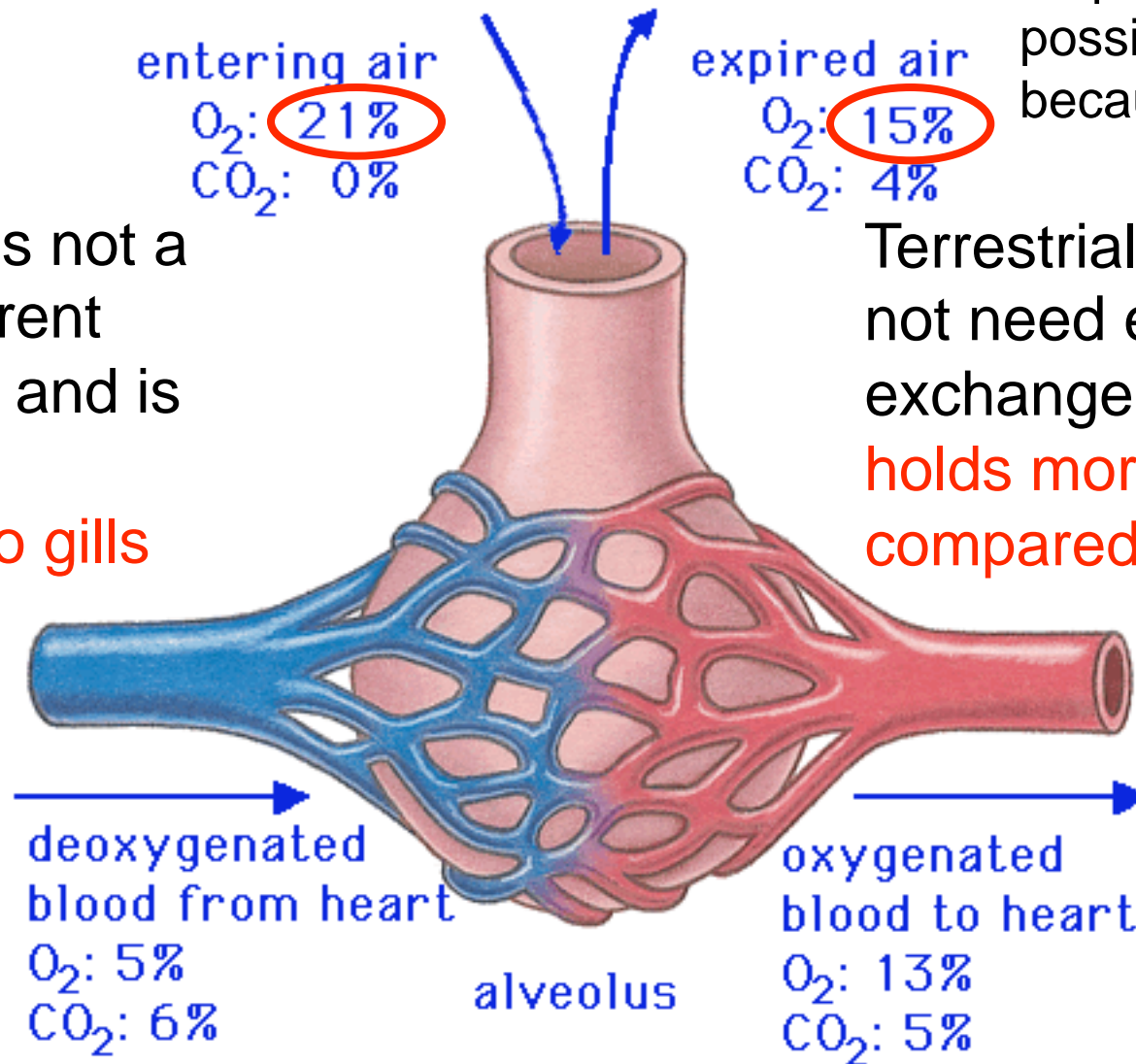
The mammalian lung gas exchange fine structure: **the alveolus**



How the alveolate lung works

“Artificial respiration” is possible because of this!

Notice this is not a counter-current mechanism and is inefficient compared to gills



Terrestrial animals do not need efficient exchange because air holds more oxygen compared to water

Negative pressure ventilation

Diaphragm

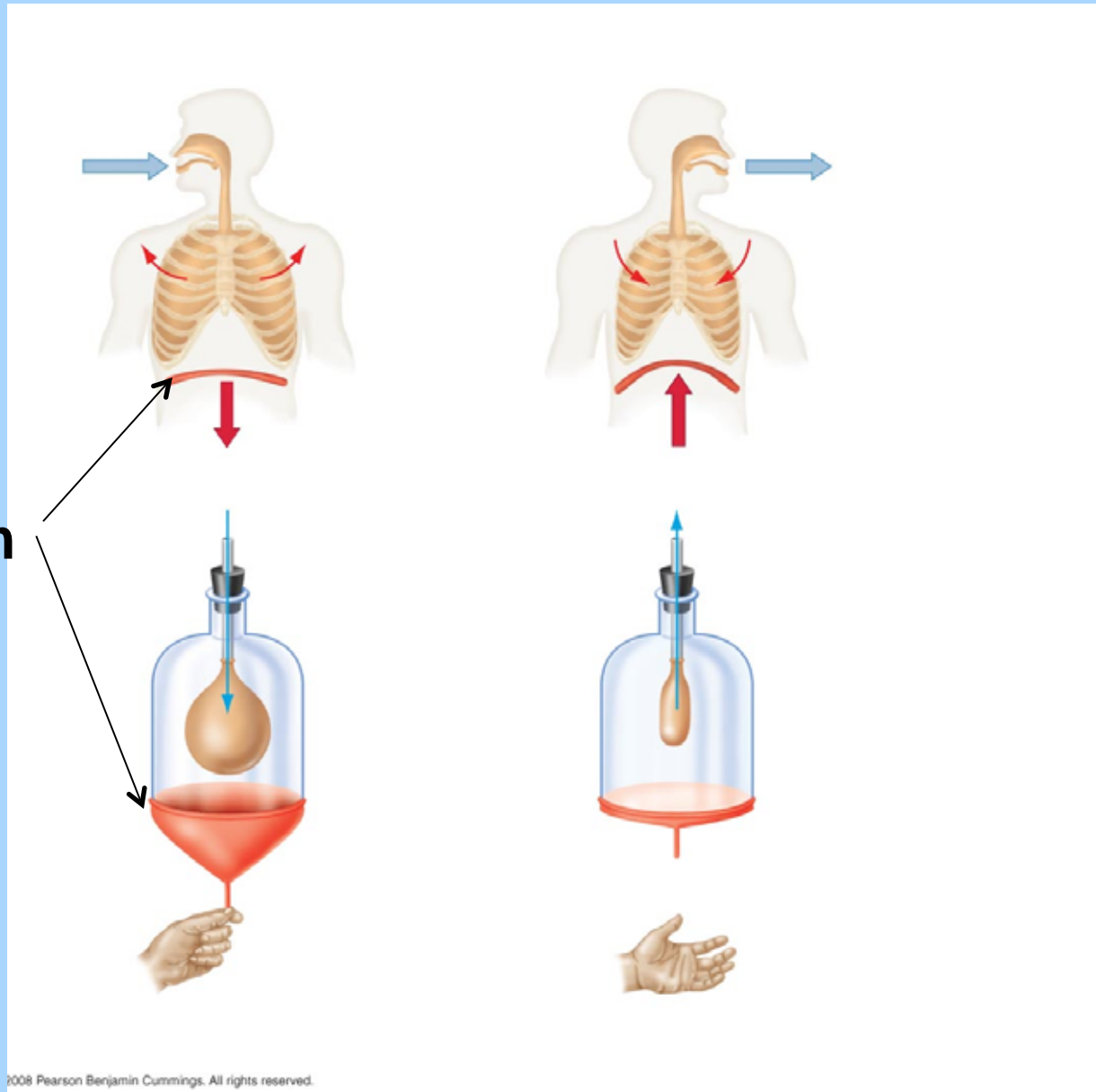
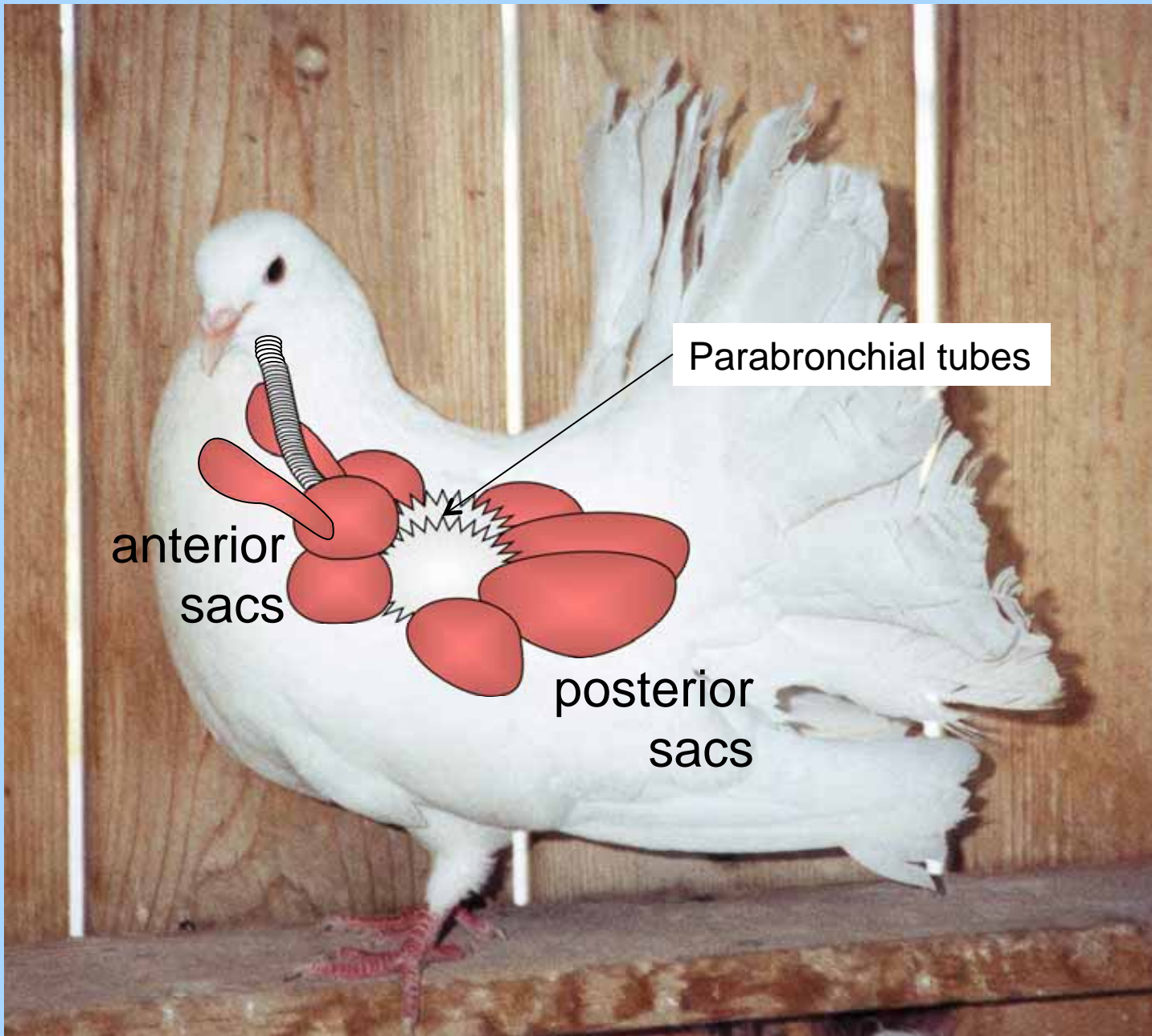


Figure 44.12 pg 986

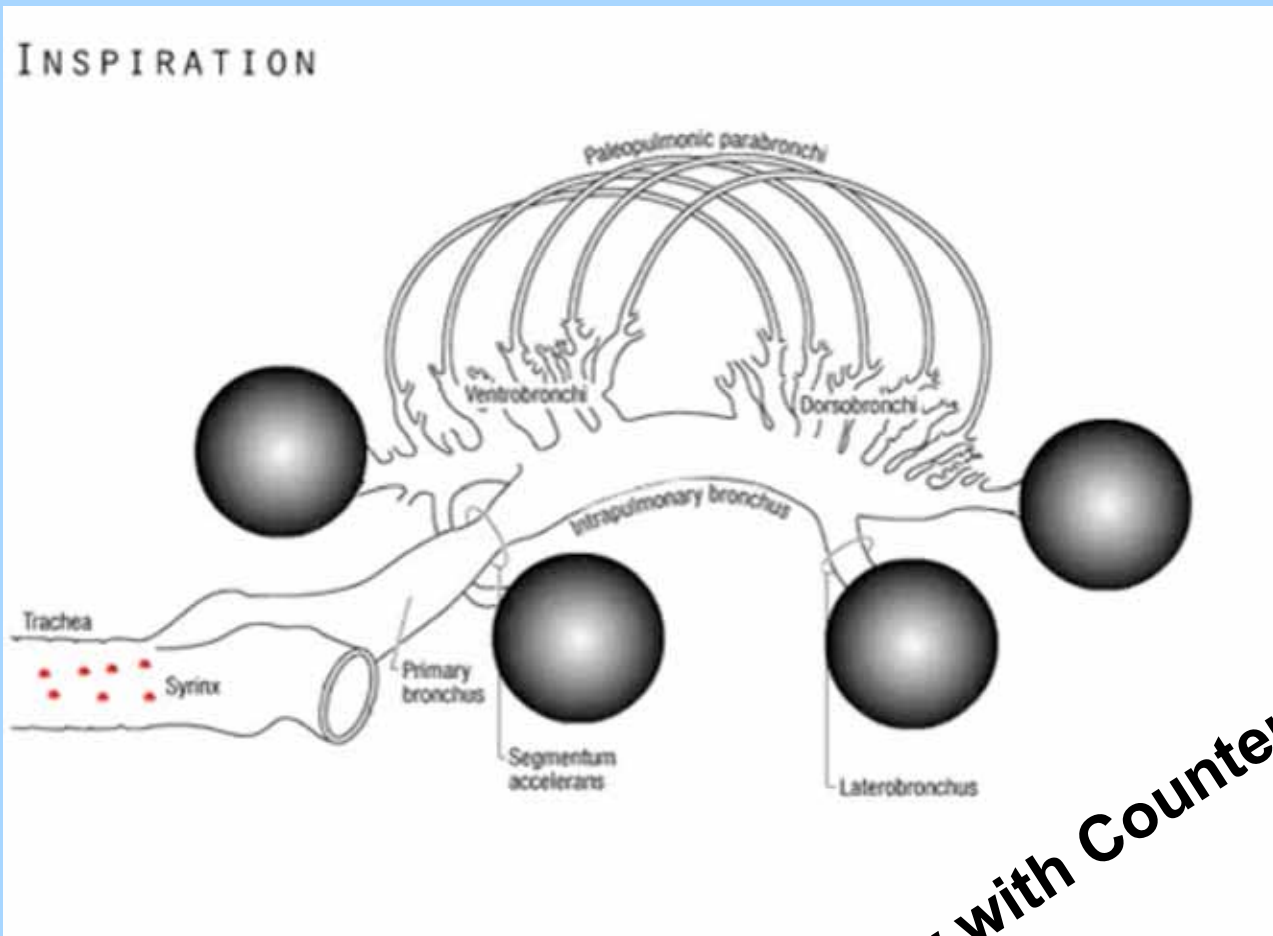
The lung



Bird breathin'

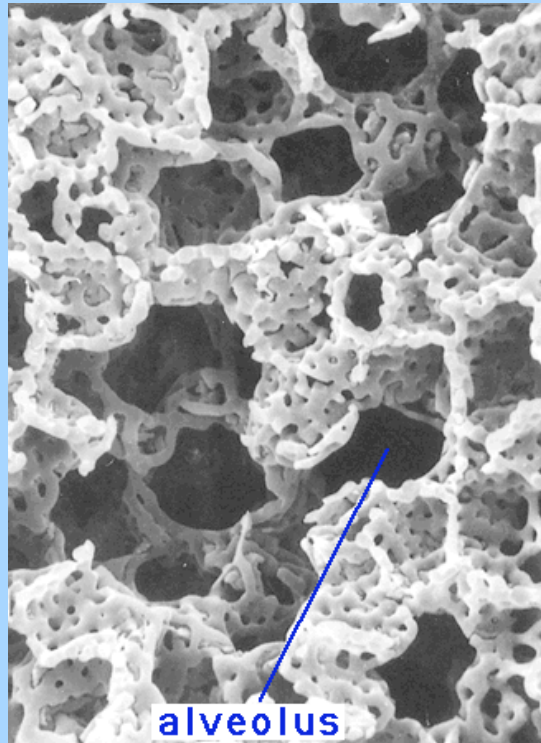


To breathe like a bird



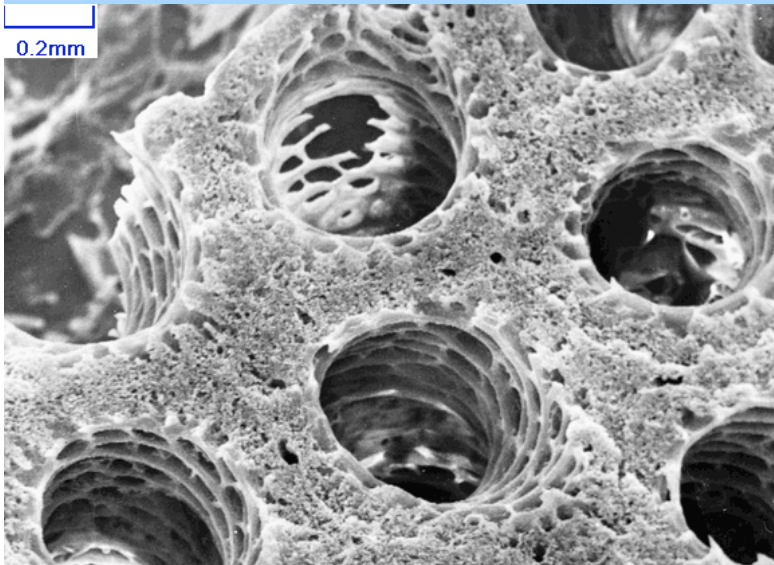
Now with Countercurrent Exchange!

Human alveoli

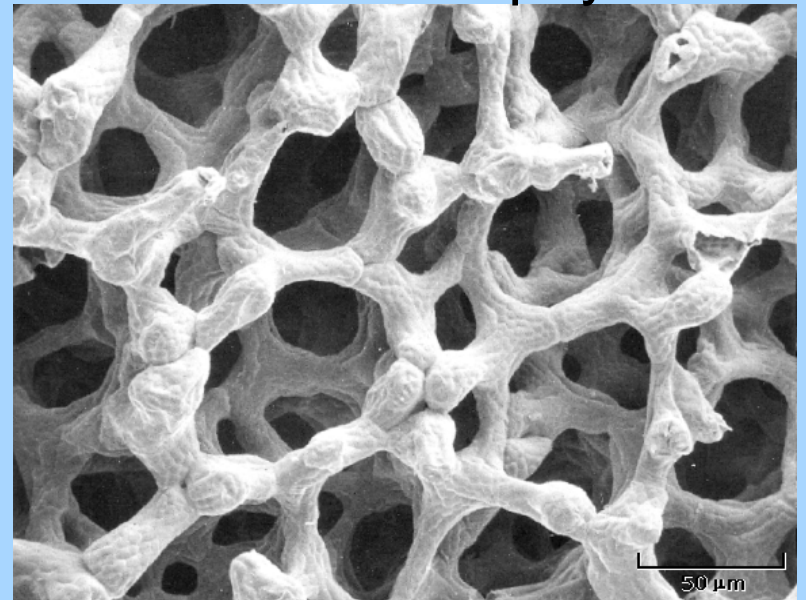


Convergence!

Bird parabronchi



Plant spongy mesophyll



Air Breathers:

Trachea, human lungs, bird lungs

- Oxygen is more abundant in air
- All systems need a liquid interface to exchange oxygen
- Respiratory pigments needed to 'pull' oxygen into solution
- Bird lungs the most efficient of the 3
- Similar Nanostructure of 3 air systems

Air Breathers:

Trachea, human lungs, bird lungs

- Spiracles → Trachea → Tracheoles
- Hemerythrin → Hemocyanin → Hemoglobin