IB BIOLOGY | B3.1 | SL AND HL

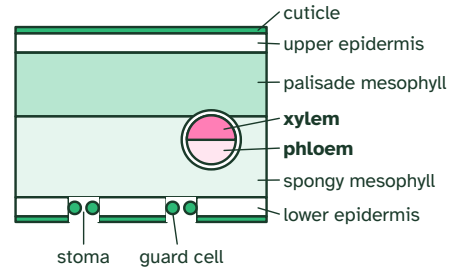
REVISION ON TWO PAGES

How gases get *across*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Gases cross by diffusion, so every exchange surface is thin, moist, permeable and large, and something keeps the gradient across it steep.



Draw it like this. Ruled label lines; no cells.

B3.1.8 START HERE

Draw the *leaf*: a plan diagram

- A **plan diagram** shows where each tissue is: **one outlined region** per tissue, with no cells drawn.
- Top to bottom: cuticle, upper epidermis, **palisade mesophyll**, **spongy mesophyll**, lower epidermis. *Cats Usually Purr Softly Lazily.*
- Veins run through the mesophyll, the **xylem towards the upper surface** and the phloem towards the lower.
- Keep the proportions the micrograph shows.

B3.1.1, B3.1.2

Why size needs a *surface*

- Every cell respires, plant cells too, so it swaps O_2 and CO_2 by **diffusion**, quick only over a cell or two.
- As an organism grows, its **surface area to volume ratio falls** and its centre gets further from the outside, so it needs an **exchange surface**.

TOO	MANY	PINK	LEAVES
Thin A short path to cross.	**Moist** Gases dissolve first.	**Permeable** Lets gases through.	**Large area** More crosses at once.

B3.1.3

Keeping the *gradient* steep

- Diffusion only works while there is a **concentration gradient**.
- **Gills:** water holds about **30 times less oxygen** than air, so a fish pumps a one-way stream of water over them.

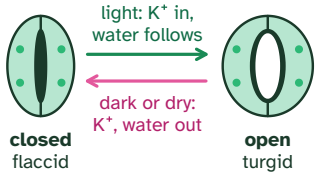
THREE THINGS — *Very Fast Vans*

V **Vessels** dense capillaries at the wall	**F** **Flow** blood that never stops	**V** **Ventilation** fresh air, or water

B3.1.7

A leaf built for *gas exchange*

PART	WHAT IT DOES FOR GAS EXCHANGE
Waxy cuticle	Keeps water in, so gases must go **through the stomata**.
Epidermis	One clear layer of tightly fitted cells; it makes the cuticle.
Guard cells	Open the stoma to let CO_2 in; **close it to save water**.
Spongy mesophyll	Loosely packed; its **moist cell walls** are the exchange surface.
Air spaces	Join every stoma to every mesophyll cell.
Veins	**Xylem** replaces the water lost; **phloem** carries sugars away.



The wall is thicker on the pore side, so turgid guard cells bow apart.

B3.1.9

Transpiration, the cost of open stomata

- The **loss of water vapour** from leaves and stems, a **consequence of gas exchange**: water evaporates inside the leaf and diffuses out of open stomata.

WHAT CHANGES THE RATE — *Lazy Teens Hate Wednesdays*

L **Light** opens stomata	**T** **Temperature** faster	**H** **Humidity** slower	**W** **Wind** faster

B3.1.10 SKILLS

Counting *stomata*

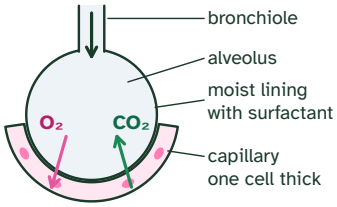
- Stomata **per mm²**, counted on a scaled micrograph or a **leaf cast** of clear nail varnish.
- **Nature of science: repeat the count** in random high-power fields: a more reliable mean; the spread is real variation.

STEP 1	STEP 2	STEP 3
Count Mean of five: 13.	**Area** πr^2 = 0.159 mm².	**Divide** 13 ÷ 0.159 ≈ 82.

B3.1.4

The *alveolar* lung

- **A branched network of bronchioles:** trachea, two bronchi, then over twenty divisions, so **no alveolus is far from an airway**.
- **High surface area:** **hundreds of millions of alveoli**, about 70 m^2 in all; air and blood are less than 1 µm apart.
- **Extensive capillary beds:** every alveolus is wrapped in capillaries.
- **Surfactant** (phospholipids and proteins) weakens the pull of the water lining, so **alveoli stay open** as you breathe out.



B3.1.5 AIR FLOWS FROM HIGH PRESSURE TO LOW

Ventilation: *pressure* moves the air

Breathing in muscles contract

The **diaphragm contracts** and flattens; the **external intercostals** lift the ribs up and out. Chest volume rises, so pressure falls: **air flows in**.

Breathing out passive at rest

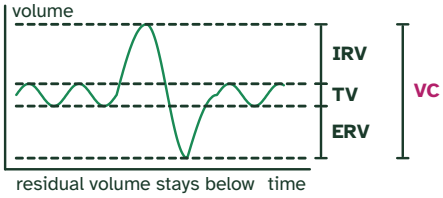
The muscles relax, the diaphragm domes up and the stretched lungs recoil. Volume falls, so pressure rises: air flows out.

- **Forced breathing out:** the **internal intercostals** pull the ribs down and in; the **abdominal muscles** push the diaphragm up.

B3.1.6 SKILLS

Measuring lung *volumes*

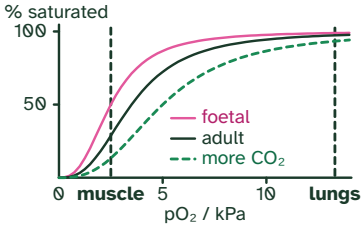
- **Tidal volume (TV):** one ordinary breath, about 0.5 dm^3 at rest.
- **IRV, ERV:** the extra beyond an ordinary breath in, or out.
- **Vital capacity** = **TV + IRV + ERV**; take your best of three.



B3.1.11, B3.1.13 HIGHER LEVEL

Haemoglobin and the *S-shaped* curve

- Four **haem groups** bind O_2 **cooperatively**: each O_2 bound makes the next bind more easily, so the curve is an **S**.
- **Flat top:** about 97% saturated at the lungs. **Steep middle:** a small fall in pO_2 **releases a lot**.
- **Foetal haemoglobin** (gamma chains for beta) lies to the left: **higher affinity**, so it takes O_2 from the mother.



B3.1.12 HIGHER LEVEL

The Bohr *shift*

- **Allosteric binding**: CO_2, and the H^+ it makes in red cells, bind the chains away from the haem and **lower the affinity**.
- So the curve moves right and **more O_2 is released where respiration is fastest**. In the lungs CO_2 leaves and it moves back.

Which way: **Left Loads, Right Releases**.

WATCH OUT

Six mistakes that *cost marks*

- ✕ **Breathing is not gas exchange.** Breathing is ventilation; gas exchange is diffusion across the alveolus wall.
- ✕ **Plants respire too**, in the light and the dark. In bright light, faster photosynthesis hides it.
- ✕ **The diaphragm moves down to breathe in.** It contracts and flattens; it domes up as it relaxes.
- ✕ **Vital capacity is not all the air in the lungs.** About a litre, the residual volume, always stays.
- ✕ **A curve to the right means lower affinity.** More oxygen is given up, not taken.
- ✕ **CO_2 does not take oxygen's place on the haem.** It binds elsewhere on the chains.

COVER THE SHEET

Can you *answer these?*

1. Explain why a large organism needs an exchange surface.
2. Outline how the gradient is kept steep at an alveolus.
3. Describe four adaptations of the lungs for gas exchange.
4. Explain how the muscles draw air into the lungs.
5. Define tidal volume and vital capacity.
6. Outline how a leaf is adapted for gas exchange.
7. Draw a plan diagram of a dicot leaf in section.
8. Explain why transpiration rises in warm, windy air.
9. Outline how to find stomatal density reliably.
10. Explain the S shape of the dissociation curve. HL
11. Explain the benefit of the Bohr shift. HL

IN THE EXAM

Keep the words apart: ventilation moves air; gas exchange is diffusion across the wall. On a curve, **say which way it moves, then what that does to affinity**.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.