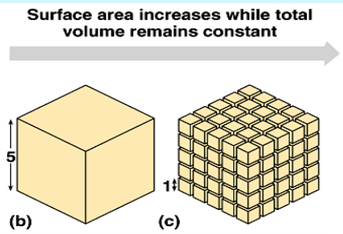
Cell Size & Shape

Cell Size

Increasing the size of a cell increases its surface area, but results in an even greater increase in cell volume and thus its demand for nutrients.

If a cell gets too large, nutrients can't diffuse through to the centre quickly enough. The tiny size of most cells ensures they have a high ***surface area to volume ratio***. This ensure that nutrients can quickly diffuse throughout the cell and that wastes can easily diffuse out.

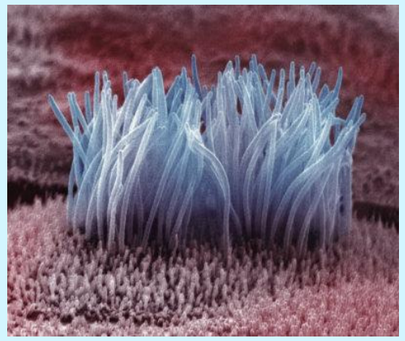
Surface Area : Volume Ratio



Total surface area (height × width × number of sides × number of boxes)	**6**	**150**	**750**
Total volume (height × width × length × number of boxes)	**1**	**125**	**125**
Surface-to-volume ratio (area ÷ volume)	**6**	**1.2**	**6**

Cell Shape:

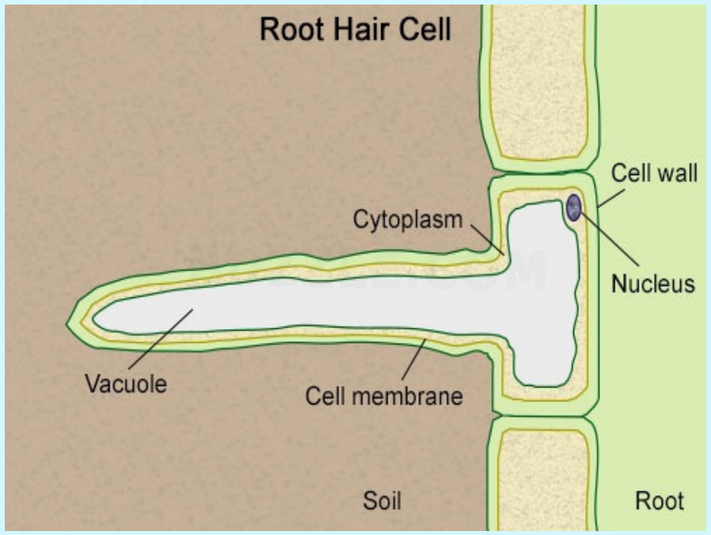
Cells and cell organelles often have special shapes / structures to increase their surface area : volume ratio. For example the folded inner membrane of the mitochondria or the flat pancake-like structures inside chloroplasts provide a greater surface area on which specific reactions can occur. The tiny finger-like projections (villi) that protrude from the cells lining the intestine, increase the surface area without increasing the volume of the cell. Cilia (pictured right) are finger like projections that are sometimes used to increase the cells surface area to volume ratio.



Diffusion Distance:

Cells rely on diffusion to transport certain nutrients and wastes in and out of the cell. The cells lining plant roots often have small extensions called root hairs (because they give the root a furry appearance). These extensions give the cell a much greater surface area for absorbing water (without significantly increasing their volume).

The diffusion of water across the cell membrane (osmosis) is regulated by a large vacuole containing water and a range of solutes. The fact that the root hairs are so thin, reduces the distance that water has to diffuse to get into the vacuole.



Organelle Distribution & Number

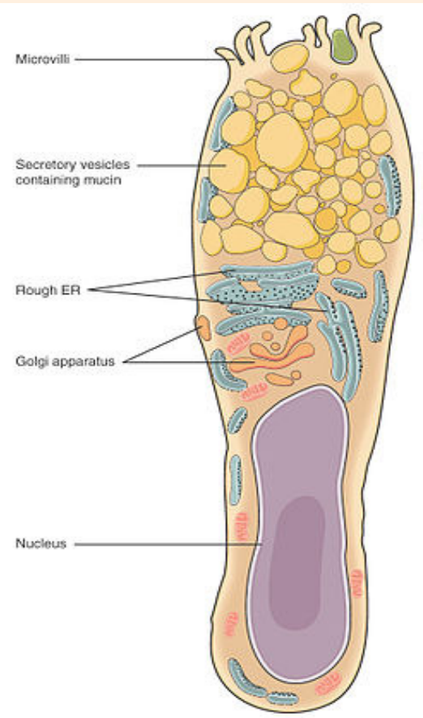
Organelle Distribution:

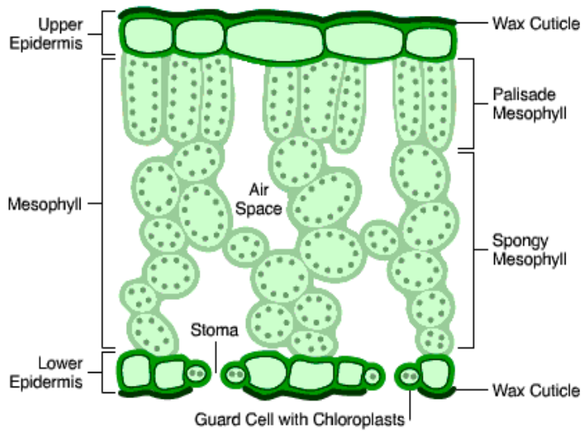
Some organelles are often found near the surface of the cell. This is to reduce the **diffusion distance** so that substances can be rapidly exchanged with the surrounding environment. For instance mitochondria and chloroplasts are often near the cell surface so that CO_2 and O_2 can rapidly diffuse in / out of the cell. Others organelles are found centrally because they don't need to exchange substances with the environment or because they need to be near the nucleus which contains the genetic material (recipes for proteins).

Organelle Number:

Some cells will have greater numbers of certain organelles depending on their function. E.g. A goblet cell (pictured right) secretes mucus and has a…

- **Large rough E.R.** (endoplasmic reticulum) which synthesises the proteins found in mucus. It is found near the nucleus which contains the instructions to make these proteins.
- **Large golgi body** which processes and packages the proteins into vesicles for transport.
- **Large number of vesicles** which transport the mucus to the cell surface where it is secreted (exocytosis).





Example - Leaf Cells

The epidermis lacks chloroplasts (making it transparent) and produces a waxy cuticle that prevents water loss, which would decrease the rate of photosynthesis. The cells containing most chloroplasts are found near the top of the leaf in long cylindrical cells (palisade), with the chloroplasts close to the surface of the cell to maximise the light received for photosynthesis. Beneath the palisade layer is the spongy mesophyll. The cells of the spongy layer are more rounded and not so tightly packed. There are large intercellular air spaces, this maximizes the rate of diffusion of the gases during photosynthesis (CO_2 entering the leaf and O_2 leaving it). Specialised guard cells control the movement of gases and water loss.

Example - Mitochondria

Muscle cells have huge numbers of mitochondria because they require large amounts of energy (ATP). The mitochondria are sandwiched between layers of the contractile fibres so that the ATP generated by respiration only has to diffuse a short distance to where it is needed.

Liver cells are also quite active, producing a large number of enzymes to break down toxins. This too requires a considerable amount of energy and they also have a large number of mitochondria. Osteocytes (bone cells) have fewer / smaller mitochondria as they are less active. Red blood cells contain no mitochondria as oxygen enters / leaves the cell by diffusion (a passive process that does not require energy).