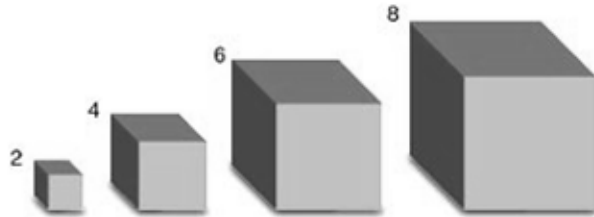# Surface area to volume ratio.

Surface area refers to the outside area of an object, e.g. it is the area around the outside of a cell. Unit = cm^2.

Volume refers to the amount of space inside of the object, e.g. it is the space inside the cell. Unit = cm^3.

| Cube size	Surface area	Volume	SA:V ratio
2 cm cube	2 x 2 x 6 = 24cm^2	2 x 2 x 2 = 8cm^3	24 to 8 = 3:1
4 cm cube	4 x 4 x 6 = 96cm^2	4 x 4 x 4 = 64cm^3	96 to 64 = 1.5:1
6 cm cube	6 x 6 x 6 = 216cm^2	6 x 6 x 6 = 216cm^3	216 to 216 = 1:1
8 cm cube	8 x 8 x 6 = 384cm^2	8 x 8 x 8 = 512cm^3	384 to 512 = 0.75:1

As the cube size increases or the cell gets bigger , then the surface area to volume ratio - SA:V ratio decreases.

When an object/cell is very small, it has a large surface area to volume ratio, while a large object/ cell has a small surface area to volume ratio.

When a cell grows, its volume increases at a greater rate than its surface area, therefore it's SA: V ratio decreases.

Cells may increase their SA:V ratio by having:
- Long thin shape / elongated shape. e.g. nerve cells
- Folding the surface of the object/ cell membrane. e.g. villi of the lining in the small intestines
- Plant cells are much larger than animal cells and they have a large vacuole which pushes the organelles to the edge of the cell where they get regular access to resources.
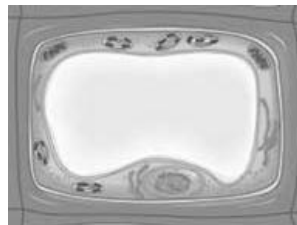

Why is SA:V ratio important:

Cells need to be small because they rely on diffusion for getting substances into and out of their cells. When a cell grows, there is comparatively less membrane for the substances to diffuse through resulting in the centre of the cell not receiving the substances that it needs. Diffusion is less efficient, cell processes slow down and the cell stops growing. The cell then needs to divide into two smaller cells, which each have a larger SA: V ratio and can diffuse materials more efficiently again.

Small cells are more efficient at diffusion as they have a HIGH SA:V ratio.

In class you may have done an experiment where you placed special agar into a solution of NaOH. All three cubes soaked in the solution for the same amount of time but the bigger cubes did not change colour on the inside as the NaOH hadn't diffused in yet. This shows that large cell takes long/is less efficient at diffusing materials into the centre of the cell.
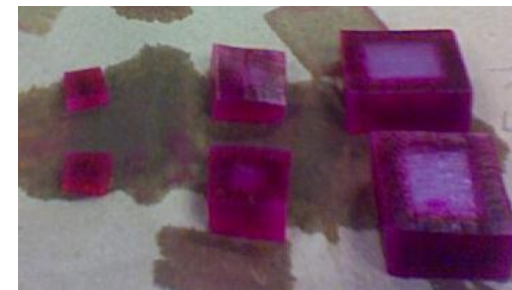
Cubes cut in half to measure how far the NaOH has diffused.

SA:V ratio in unicellular organisms. Their small size means that they have a large SA:V ratio and it is adequate for the many materials to move into and out of the cell by diffusion and active transport. But it does limit the organism's size. Once they get too big, they must divide.

SA:V ratio in multicellular organisms. By being multicellular, plants and animals have overcome the problems of small cell sizes. Each cell has a large SA:V ratio but they have evolved features such as gas exchange organs (lungs) and circulatory system (blood) to speed up and aid the movement of materials into and out of the organism.

(left margin: efficiency ● multicellular ● ● unicellular organism ● diffusion ● SA:V ratio ● volume ● surface area)