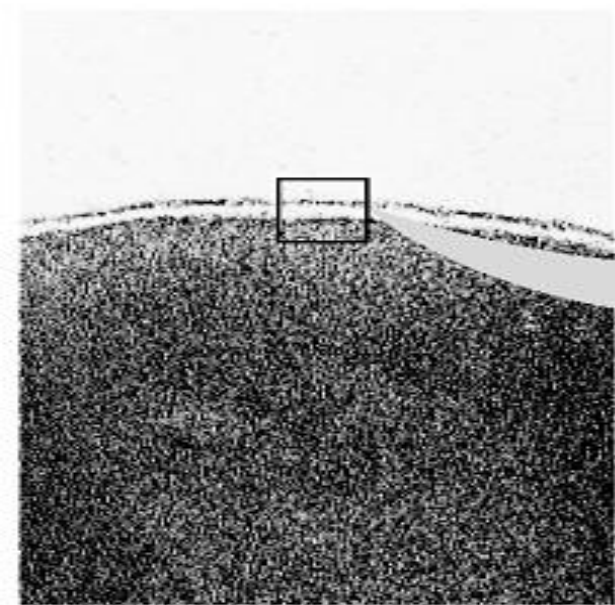
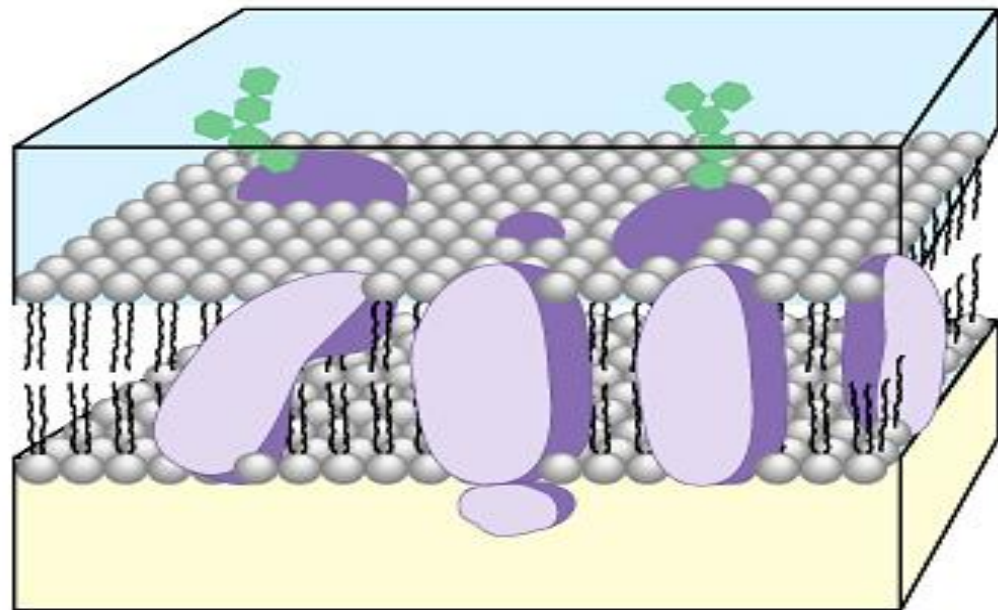

Cell Size is Limited

The cell exchanges substances (taking in nutrient and oxygen, and getting rid of waste) with its outside environment through the cell membrane.

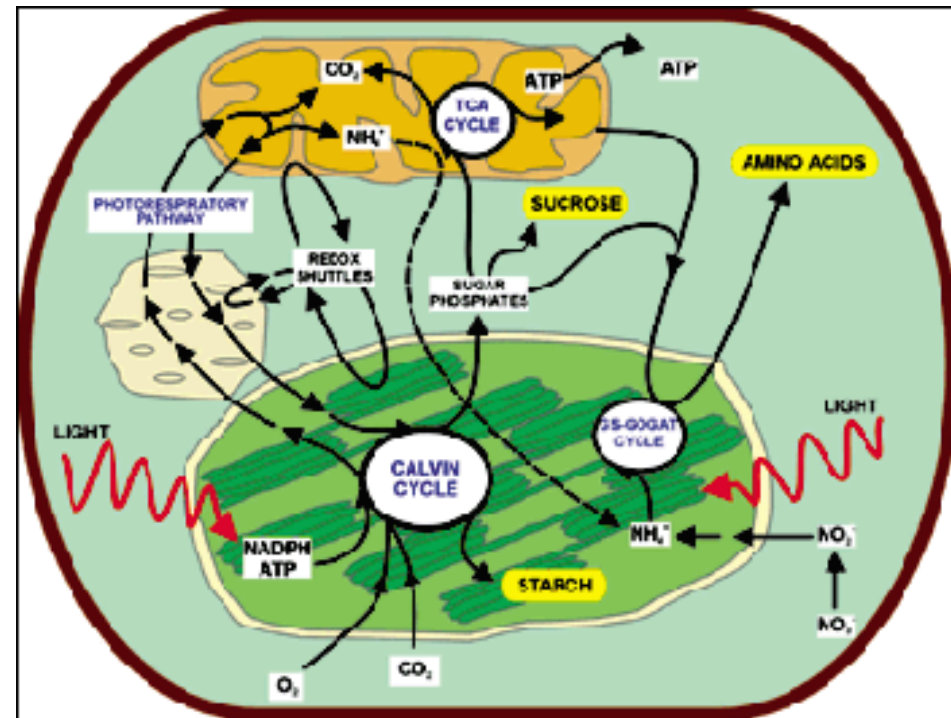


0.1 μm



- This exchange is needed to carry out metabolism

- All the chemical reactions of the cell.



Cells are typically small because of the relationship between surface area to volume

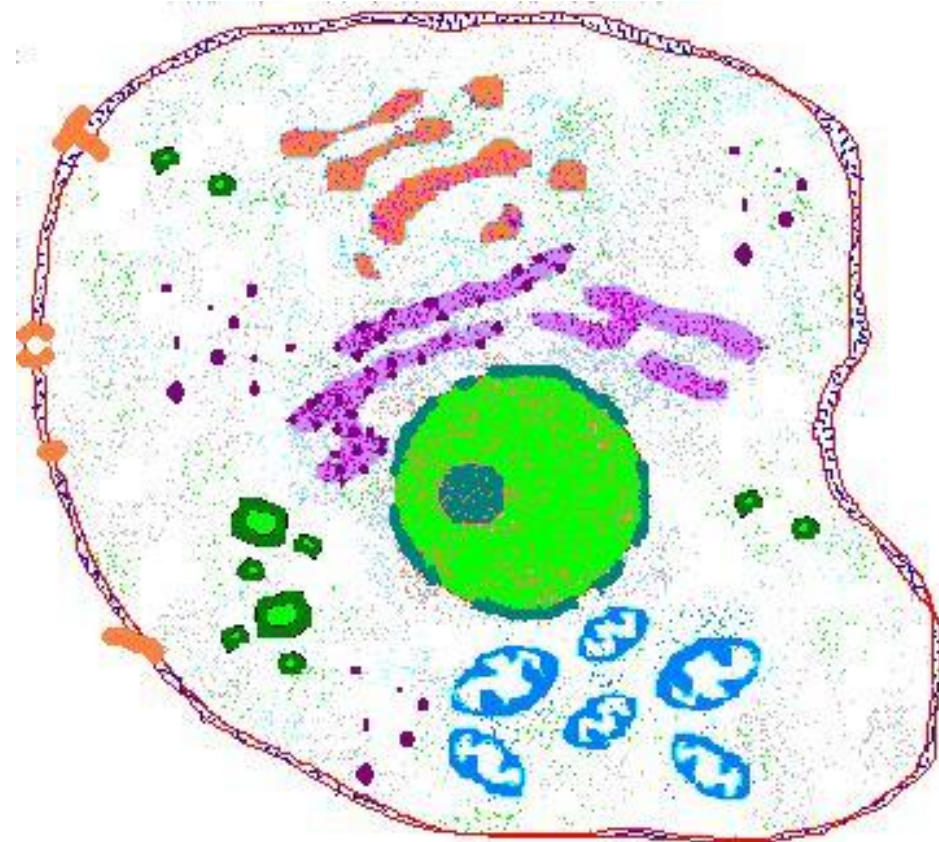
- Surface area to volume ratio:

$$SA/V = 6S^2/S^3$$

where S=length of one side of a cube

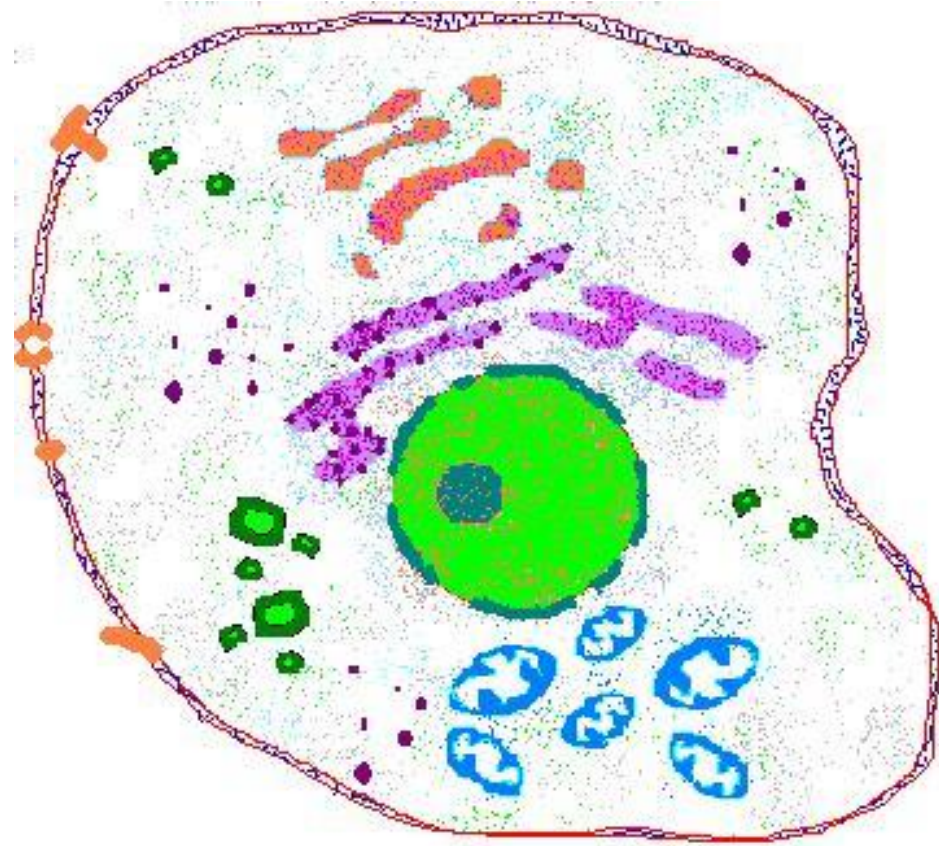
- We use cubes for simplicity of a model. In real life cells are not shaped like cubes, but the concept remains the same.
-

- **Surface area** dictates amount of exchange that can occur across membrane.
- The more surface area, the more exchange of nutrients & gases into the cell and wastes out of the cell.



- **Volume** dictates the amount of materials that are **needed** or produced.


- The more volume, the more nutrients & gases that are needed inside the cell.
- The more volume, the more waste that is produced that must leave the cell.



As a cell becomes too large...

... the surface area to volume ratio becomes too small.

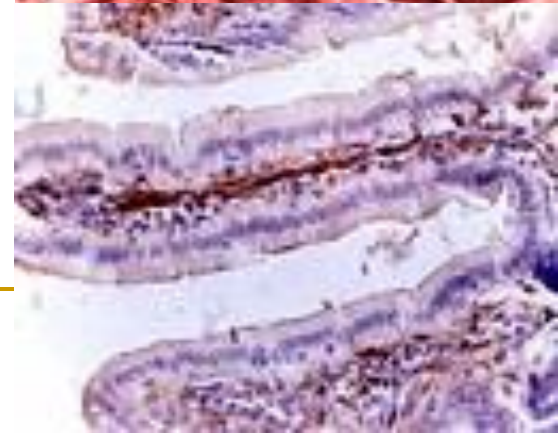
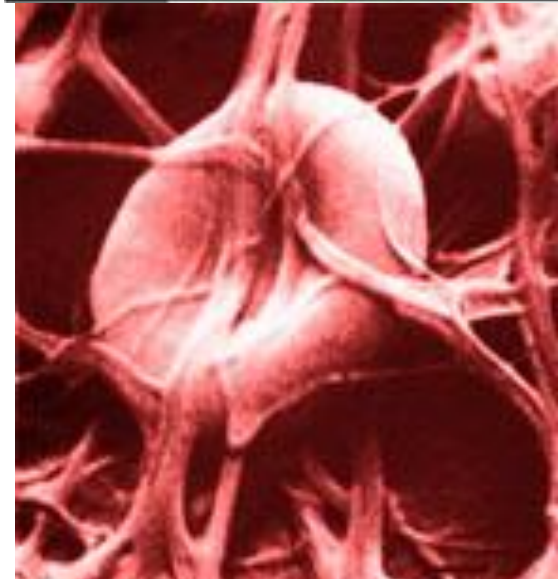
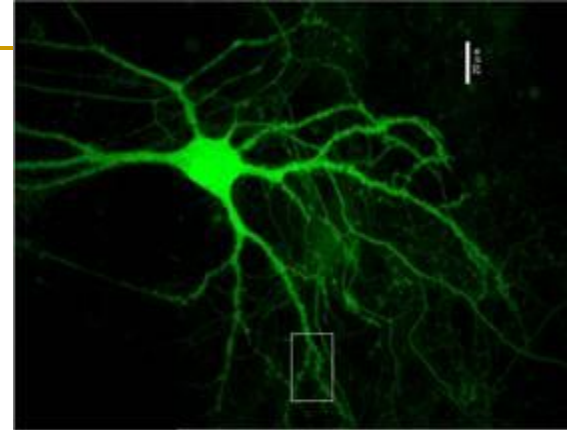
- This means that the rate of transport across the cell membrane of materials (either nutrients in or waste out) is too slow and the cell will not be able to function properly.



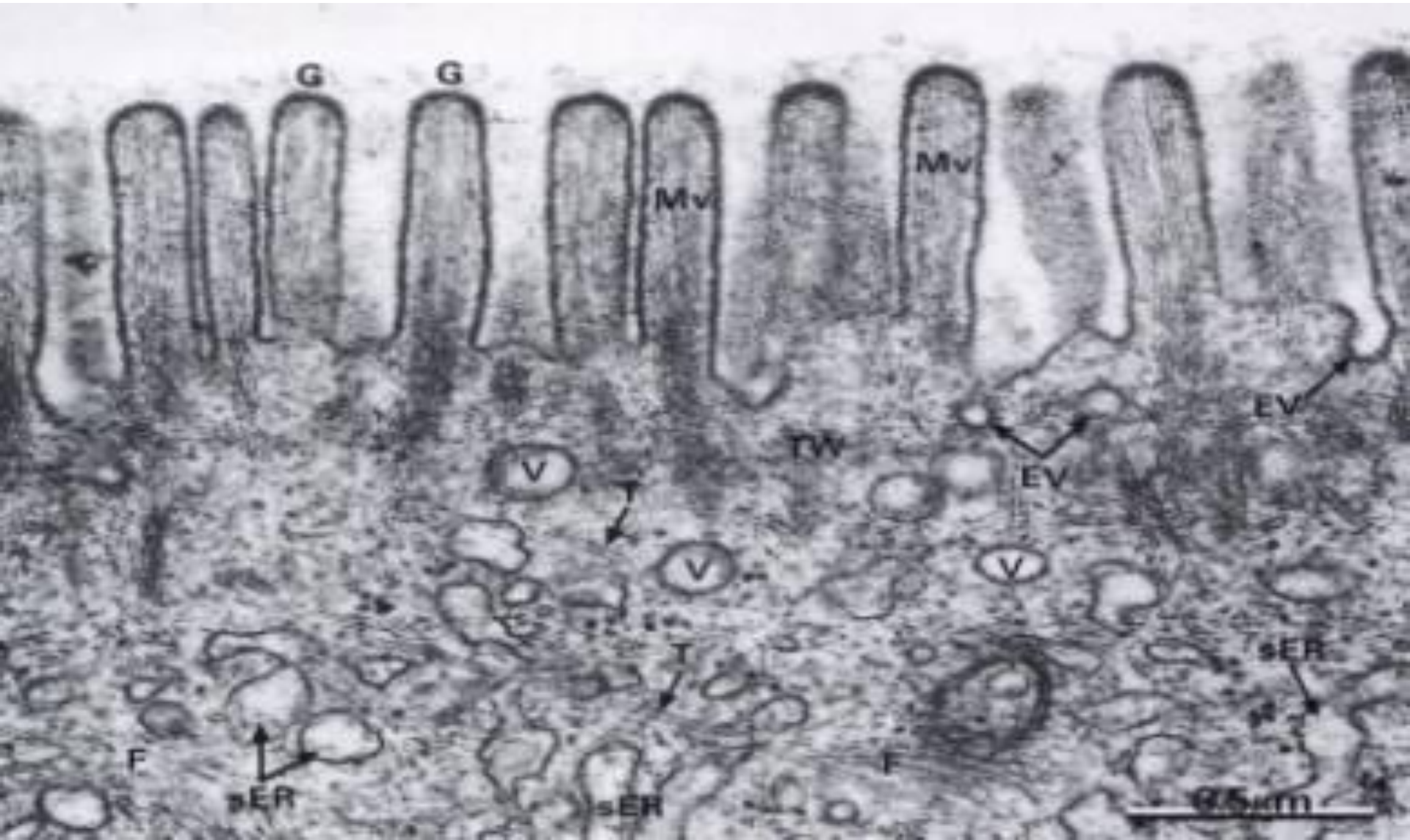
diameter (cm):	0.5	1.0	1.5
surface area (cm ²):	0.79	3.14	7.07
volume (cm ³):	0.06	0.52	1.77
surface-to-volume ratio:	13.17:1	6.04:1	3.99:1

Some cells increase surface area to volume ratio by having:

- Long cellular extensions (e.g. nerve cells)
- Thin, flat cell shapes (e.g. red blood cells)
- Invaginations to increase surface area



Small Intestine Cell of a Bat



Red Blood Cell of a Fish

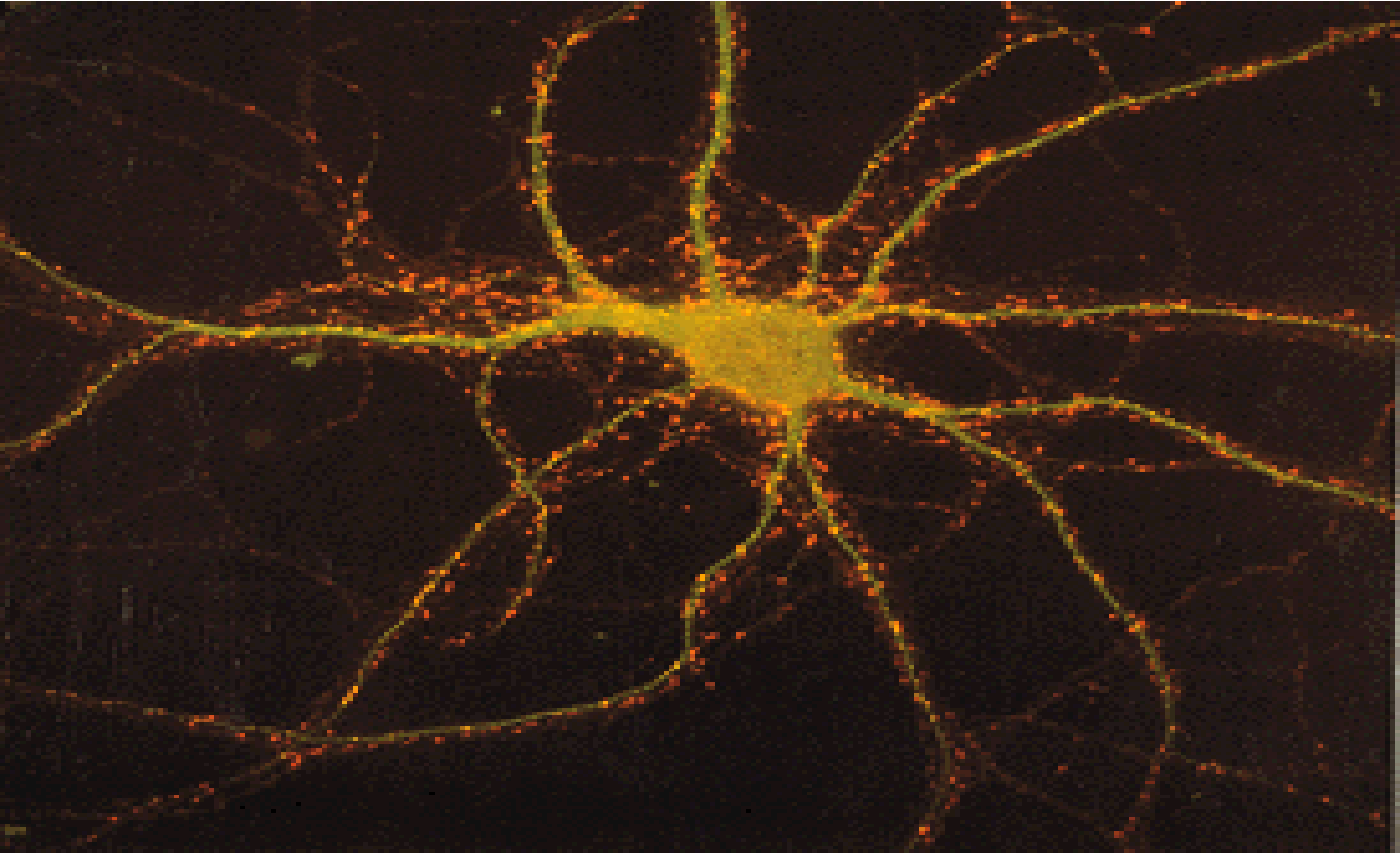
Fish Red Blood Cell

SUSTREC



100um

Human Neuron Cell



When the volume gets too large (small surface area to volume ratio) for efficient functioning of cell, the cell will divide to produce a more desirable surface area to volume ratio.

