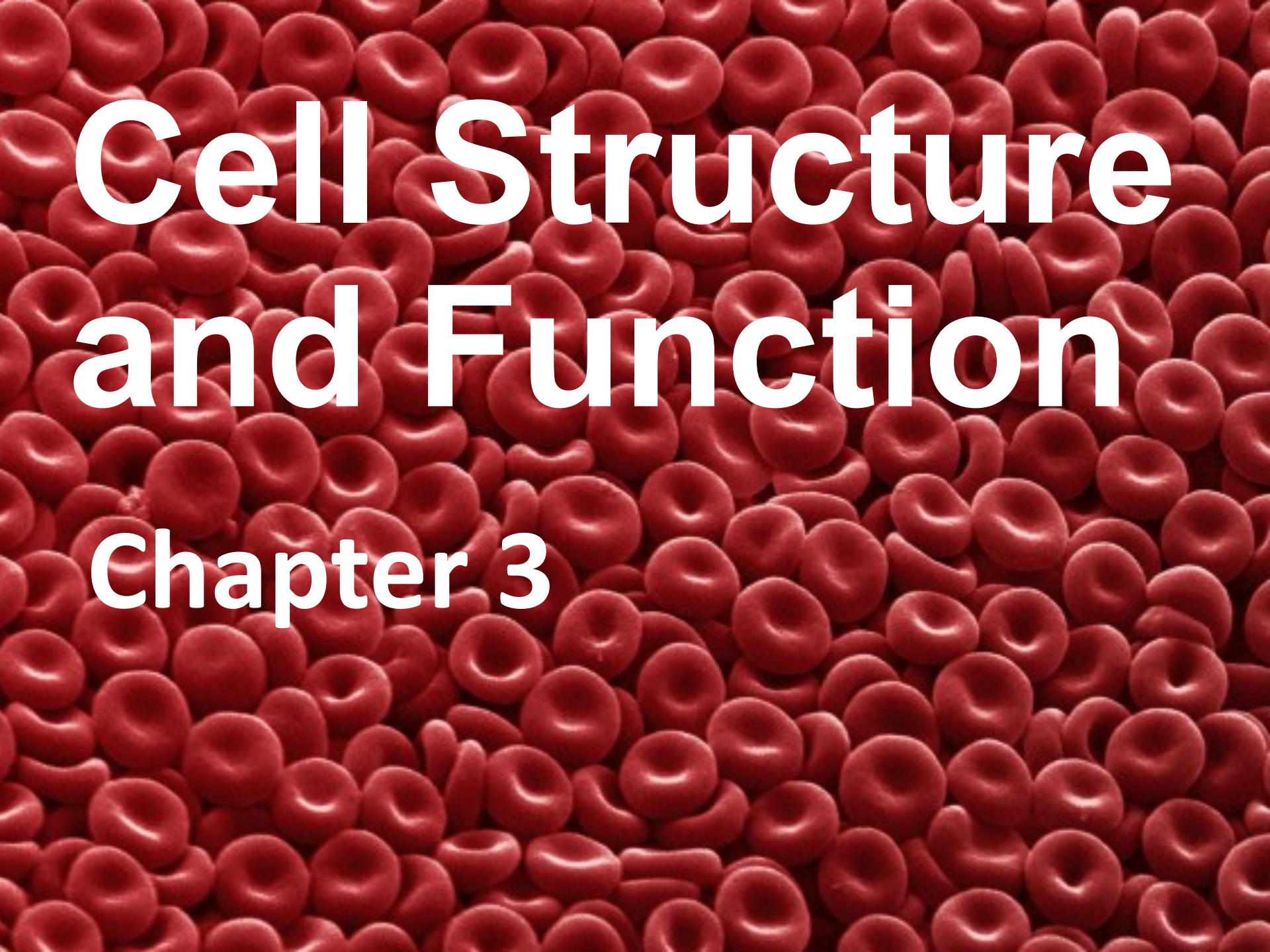

Cell Structure and Function
Chapter 3

Video #1 – The Wacky History of Cell Theory

Video #2 – How We Think Complex Cells Evolved

Video #3 – Cell vs. Virus: A Battle for Health

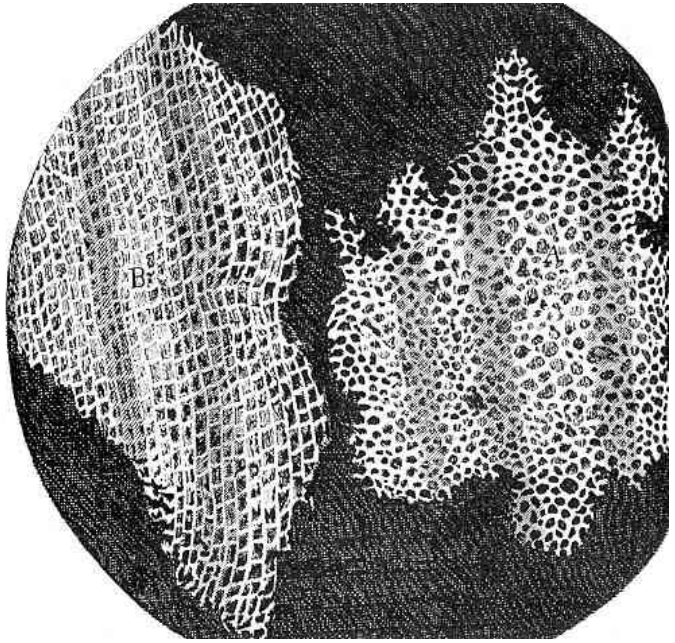
Video #4 – The Operating System of Life

Video #5 – How do Cancer Cells Behave Differently from Healthy Ones?

I. Discovery of the Cell

A. Our knowledge of cells is built on work done with microscopes

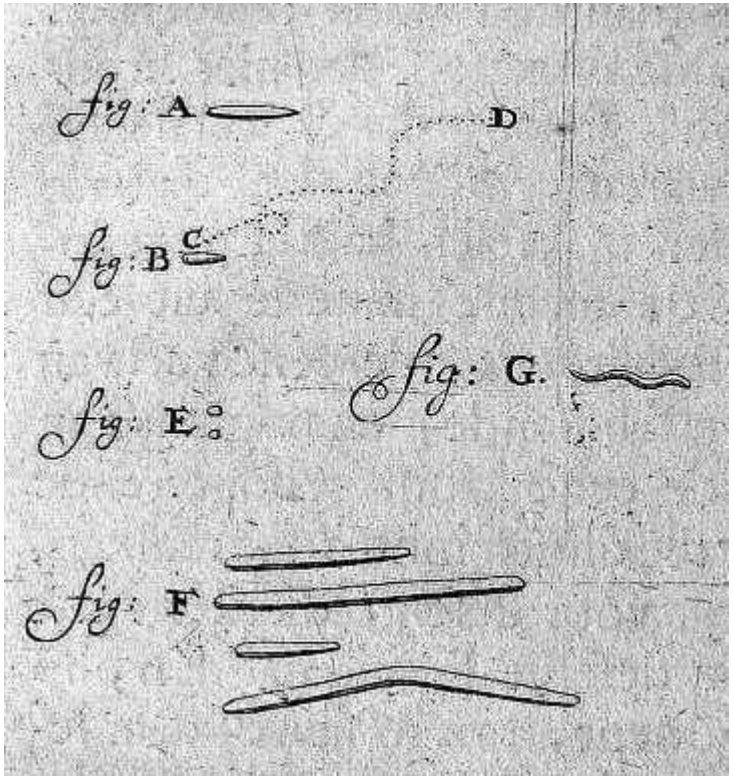
1. English scientist Robert Hooke in 1665 first described cells from his observations of cork slices. Hooke first used the word "cell".



2. Dutch amateur scientist Antonie van Leeuwenhoek discovered microscopic animals in water

3. German scientists Schleiden and Schwann in 1830's were first to say that "*all organisms are made of one or more cells*."

4. German biologist Virchow in 1858 stated that all cells come from the "*division of pre-existing cells*."



II. Cell Theory

A. All living organisms are made up of one or more cells

B. The cell is the basic unit of life

C. All cells come from the division of pre-existing cells

III. Cells

A. Living things exist at a cellular or multi-cellular level

B. Life occurs only in cells…

1. **Molecules or materials outside of cells are not considered living**
2. **Once they are taken in and become incorporated into the cytoplasm or molecules of the cell they are considered living**
2. **Molecules present carry on biochemical reactions in an organized manner**

C. Cells carry on all the processes associated with life, such as reproducing and interacting with the environment

IV. Cell Size

A. Cells come in many shapes and sizes, although most are microscopic:

1. **Most cells are small, about 0.001 cm in length (1/100 of a mm, or 10 μm).**
2. **Smallest cells are 0.3 μm in size**
3. **Some cells are large**
   a. **e.g. some giant algal cells may be several centimeters long**
   b. **A chicken's egg is a single cell**

B. 40,000 red blood cells would fill the letter "O" on a page of type. You produce about 2.5 million new red blood cells every second!

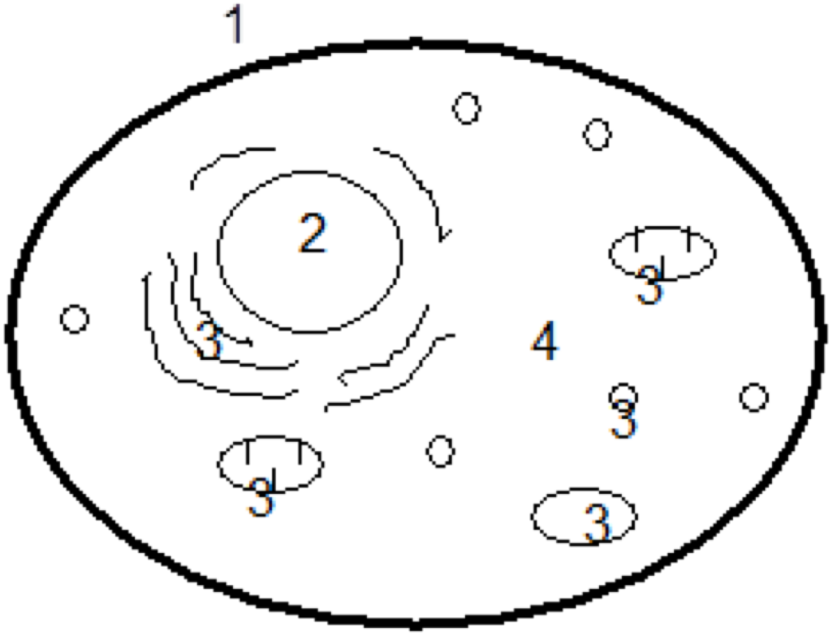
C. Each square cm of your skin contains about 150,000 skin cells.

D. Human beings are composed of about 50 to 100 trillion cells. Micrograph Images

Ted-Ed Electron

V. Eukaryote Cells

- **A. The cell's overall structure can be viewed as:**
  1. **Cell Membrane**
  2. **Nucleus**
  3. **Organelles**
  4. **Cytoplasm**



1. Cell Membrane: the thin layer which separates the cell contents from it's environment. Plant cells also have a cell wall surrounding the cell membrane.

2. Nucleus: specialized structure within the cell which contains DNA and controls cell functioning and reproduction.

3. Organelles: small bodies with specific structures and functions within the cell.

4. Cytoplasm: the liquid substance between the nucleus and the cell membrane, in which the organelles are located.

VI. Cell Structures and Their Functions :

- Endosymbiont Theory ANIMATION
- Molecular Happenings in cells ANIMATION

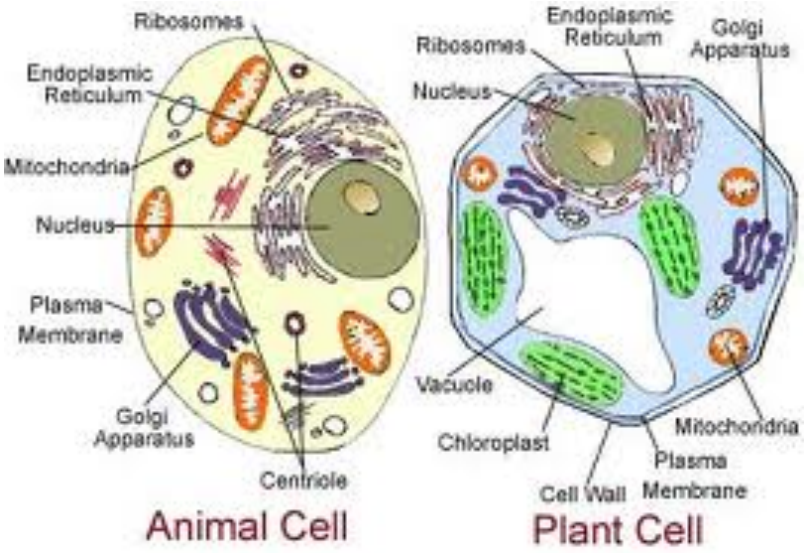
VII. Plant Cell vs. Animal Cell

A. Plant cells have:

1. **A cell wall**
2. **Plastids**
3. **A large central vacuole… animal cells do not!**

B. Animal cells have

1. **Centrioles … plant cells do not!**

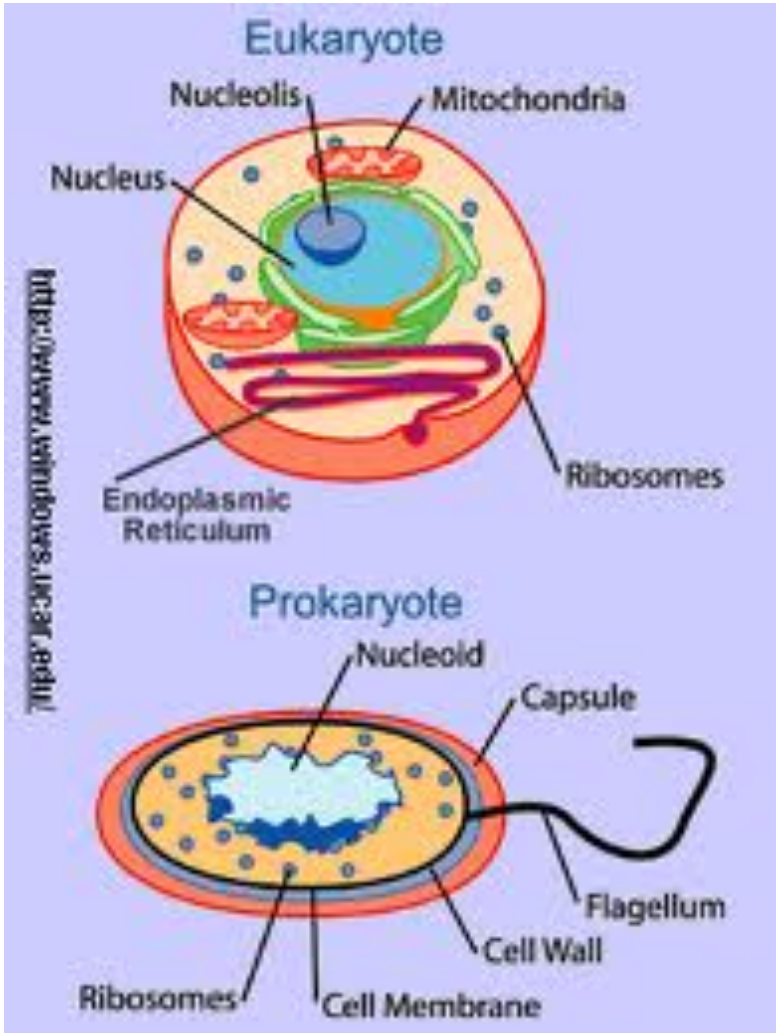


VIII. Prokaryotes vs. Eukaryotes

A. Two classes of cells exist: the PROKARYOTES and the EUKARYOTES

B. The Prokaryotes include the bacteria and the blue-green algae (the Monera kingdom).

1. **These are all single-celled organisms that lack both a true nucleus and other membrane-bounded cellular substructures.**
2. **Prokaryotic DNA is usually circular.**



C. The Eukaryotes include plants, animals, protozoa, and fungi.

1. **These cells contain nuclei and other membrane-bound organelles.**
2. **The genetic material is organized into chromosomes.**

		Eukaryotic	
Structure	Prokaryotic	Animal	Plant
Cell Membrane	YES	YES	YES
Cell Wall	YES	NO	YES
Nucleus	NO	YES	YES
Mitochondria	NO	YES	YES
Chloroplasts	NO	NO	YES
ER	NO	YES	YES
Ribosomes	YES, small	YES, large	YES, large
Vacuoles	NO	YES, small	YES
Lysosomes	NO	YES, usually	NO, usually
Cytoskeleton	NO	YES	YES
Centrioles	NO	YES	NO

Surface Area To Volume Ratio and Cell Size

(Why aren't cells bigger??)

I. Cell

A. Contains many structures and are highly organized

B. May be thousands of each organelle in any given cell

1. **Ex. Mitochondria in muscle cells**

C. Smallest cell: a pleuro-pneumonia like organism with a diameter of about 0.1 μm

D. Largest cell: an ostrich egg

Cell Size Animation

II. Ratio of Cell Surface Area to Cell Volume

Animation

A. As the size of a cell increases, its surface to volume ratio decreases

A cell measures 1 mm^3. Its surface to volume ratio is 6:1

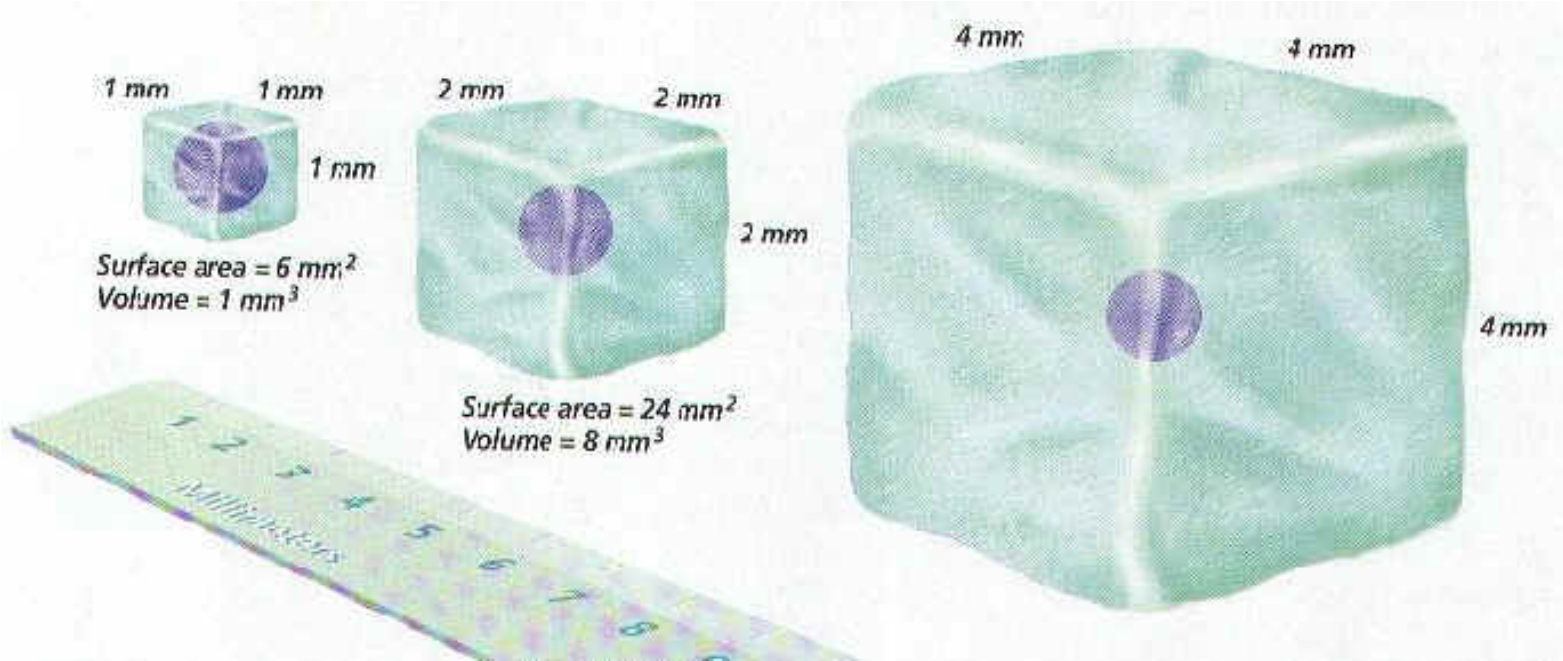
1. **Surface area (for a square): area of one face x 6**
   ex. SA = 1 mm x 1 mm x 6 = 6 mm^2
2. **Volume: length x width x height**
   ex. Volume = 1 x 1 x 1 = 1 mm^3

C. If you double the size of the cell to 2 mm across, its surface to volume ratio decrease to 24:8 or 3:1

1. SA = 2 mm x 2 mm x 6 = 24 mm^2
2. Volume = 2 mm x 2 mm x 2 mm = 8 mm^3
3. When the size doubled, the SA:V ratio decreased by half!

Example:

Cell Size	Surface area	Volume	SA:V Ratio
1 X 1	6	1	6:1
2 X 2	24	8	3:1
4 X 4	96	64	1.5:1
8 X 8	384	512	0.75:1



Example:

Sphere	Radius (cm)	Volume (cm^3)	Surface Area (cm^2)	SA:V Ratio
1	1	**4.1**	**12.6**	**3:1**
2	2	**33.5**	**50.3**	**1.5:1**
3	3	**113.1**	**113.1**	**1:1**

Volume of Sphere = $\frac{4}{3}\pi r^3$

Surface Area of Sphere = $4\pi r^2$

III. Limitations of Cell Size

A. When cells get too large, they must divide

B. Cells cannot get too large because of the way that a cell's volume changes with respect to its cell surface area

C. As the cell increases in volume the surface area must also increase in order for the cell to take in or get rid of materials (nutrients in: wastes out)

III. Limitations of Cell Size

D. Diffusion is not a highly rapid or efficient means of distributing materials over long cellular distances, so no portion of even the largest active cells is more than 1 mm from the cell membrane

E. If the surface area is small relative to volume, the cell may build up wastes to such an extent that the cell may die

IV. Solving the Limits of Surface Area To Volume Ratio

A. Cells can divide by mitosis

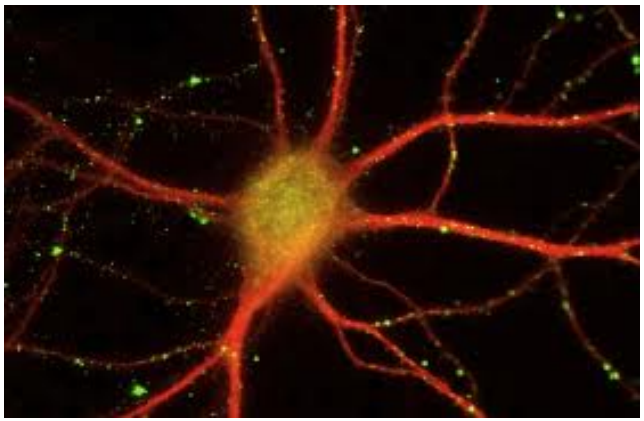
B. Slow down metabolism

1. If a cell metabolizes (carries on its cellular activities) at a slow rate it will produce wastes at a slow rate and need fewer nutrients than a cell that metabolizes at a fast rate

2. A slowly metabolizing cell could then be larger than a quickly metabolizing cell

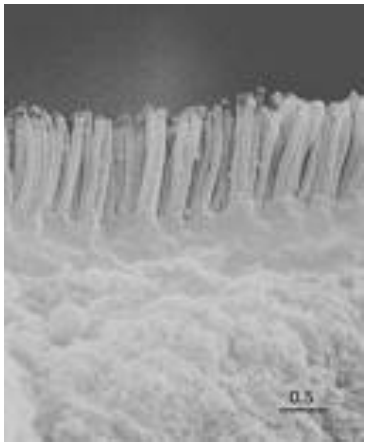
C. Cell shape

1. Shape of the cell can affect the surface area of the cell
2. Spherical cell has the smallest surface area to volume ratio
3. Long or thin or flat cell has a much higher surface area to volume ratio
    a. Get long and thin rather than round and fat: e.g. nerve cells



4. Folds in the cell membrane:

e.g. microvilli of intestinal epithelial cells



5. Which cell has the most surface area if all 4 cells have the same volume?

Ted Ed: Biggest Unicellular Animal?