

The Cell

Robert Hooke- in 1665 was the first to describe cells and coined the term "cell"

CELL THEORY:

- 1) All organisms are composed of one or more cells
- 2) Cells are the fundamental unit of life
- 3) Cells arise only by division of existing cells

NOTE: VIRUSES ARE NOT CELLS

*** the invention of ELECTRON MICROSCOPES accelerated our knowledge of cell structure and function:

- 1) Transmission Electron Microscopes(TEM's)
- 2) Scanning Electron Microscopes(SEM's)

TYPES OF ORGANISMS:

- 1) UNICELLULAR- Bacteria, protozoans(protists), some algae
- 2) MULTICELLULAR- Plants, Fungi, Animals, some algae

ADVANTAGES OF MULTI-CELLULARITY:

- 1) Organism can be LARGER
- 2) Cells can be SPECIALIZED- a "division of labor"
- 3) Organisms can be more COMPLEX

CELLS Differ in:

- 1) Size
- 2) Presence/absence of a nucleus
- 3) Location
- 4) Function
- 5) Morphology(shape)

COMMON FEATURES IN ALL CELLS:

- 1) CELL MEMBRANE- "PLASMA MEMBRANE"("lemma")
 - a) surrounds the cell and separates internal contents of cell from the outside environment

b) controls the movement of molecules across the membrane in and out of the cell

2) **CYTOPLASM:**

- liquid inside the cell where chemical reactions occur
- composed mostly of water and other hydrophilic molecules

3) **NUCLEAR MATERIAL:**

- nucleic acids such as DNA and RNA
- they control all cell functioning by "determining" which proteins are made

4) **RIBOSOMES:**

- they are made of proteins and RNA
- function is to serve as the site of **PROTEIN SYNTHESIS** which is the process by which Proteins are put together from Amino Acids

MEMBRANE STRUCTURE
(the Fluid Mosaic Model)

1) the cell membrane is composed of a **LIPID BILAYER**;
the type of Lipid is a **PHOSPHO-LIPID**

2) large **PROTEIN MOLECULES** called **TRANSPORT PROTEINS** are embedded in the bilayer(each one is specific to certain molecules)

3) **CHOLESTEROL** is also present in the bilayer of animal cells; this adds **ELASTICITY** to animal cells

The FLUID MOSAIC MODEL:

*** is the currently accepted model of membrane structure

- 1) Components of the membrane are constantly moving, like a **FLUID**
- 2) the membrane has a pattern of proteins embedded in it, like a **MOSAIC**

***** The PLASMA MEMBRANE is a SELECTIVELY PERMEABLE MEMBRANE**

Selectively Permeable Membranes:

- Some molecules can pass right through and others cannot
 - 1) some molecules go right through the lipid bilayer
 - 2) most molecules must pass through the TRANSPORT PROTEINS though

*** Transport Proteins often have a carb or a lipid attached which serves as a sort of "recognition antenna"

Cells in Multi-Cellular Organisms:

- *** can ADHERE together
- *** in animals, PROTEIN molecules connect one cell to another
- *** in plants, threads of cytoplasm called PLASMODESMATA pass through openings in the cell walls between 2 cells

CELL STRUCTURE AND FUNCTION

Two Basic Types of Cells:

1) Prokaryotic:

- "before nucleus"- the earliest kinds of cells; no organized
- No nuclear membrane surrounding the DNA; it is "free-floating"
- They first appear about 3.5 bya; all of Kingdom Monera(Bacteria) is prokaryotic

2) Eukaryotic:

- "true nucleus"
- The DNA is separated from the rest of the cytoplasm by its own membrane, the NUCLEAR MEMBRANE
- First appear 1.5 bya; include all cells except Bacteria

PROKARYOTIC BACTERIA**1) Very small; 1 to 10 micrometers**

- μm = micrometer = .001mm

2) No organized nucleus**3) No internal membrane compartments(photosynthetic bacteria; however, do have membranes with pigment embedded in them)****4) Some have flagella(tails) for movement****5) The DNA is in a circular loop****EUKARYOTIC CELLS(all organisms except bacteria)**

*** evolved 1.5 bya; for the first 750 million years, they were only unicellular

*** about 750 mya, the first multi-cellular eukaryotes appeared

1) Bigger than prokaryotes(10-50 μm)**2) Contain a NUCLEUS****3) Contain ORGANELLES(internal compartments in the cytoplasm made up of membranes—one or many membranes)****4) Have a CYTO-SKELETON—internal "scaffolding" of protein molecules in the cytoplasm(micro-filaments and micro-tubules)****CELL COMPONENTS AND THEIR FUNCTIONS****1) MITOCHONDRIA: has a double membrane**

- This is the site of ATP synthesis by the breakdown of glucose
- That process is called CELLULAR RESPIRATION

- ***** the MITOCHONDRIA is called the "POWERHOUSE" of the cell and each cell contains MANY of them

2) ENDOPLASMIC RETICULUM: a double membrane forming a complex tube system in the cytoplasm that molecules can move through

- Proteins and lipids move through these tube systems
- ER is the site of NEW MEMBRANE SYNTHESIS- i.e Phospho-lipids

a) ROUGH ER- ribosomes are attached and proteins are synthesized here

b) SMOOTH ER- no ribosomes attached and LIPIDS are synthesized here

3) GOLGI APPARATUS or COMPLEX:

- Flattened sacks of membranes with associated vesicles
- Lipids and proteins get MODIFIED here with carbohydrates

4) LYSOSOMES:

- Special types of vesicles that are filled with DIGESTIVE ENZYMES
- Known as the cellular "RECYCLING CENTERS"

5) FLAGELLA or CILIA(in some cells)

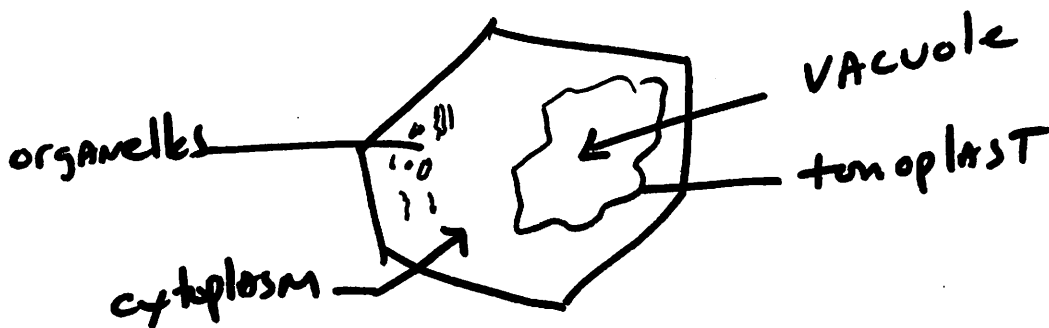
- Made from protein filaments; "tails" or "hair-like projections" or the outside of some cells for MOVEMENT

6) MICROTUBULES and MICROFILAMENTS:

- Part of the cyto-skeleton; play a key role in cellular division(MITOSIS)

Differences Between Plant and Animal Cells

- 1) **CELL WALLS:** Made of a polysaccharide called **CELLULOSE**
 - Rigid and non-soluble
 - A substance called **PECTIN** helps to "glue" the cell walls together in multi-cellular organisms
- 2) **VACUOLES:** sacs filled with fluid(water) surrounded by a membrane called a **TONOPLAST**



- Vacuoles are STORAGE AREAS for water and much more prominent in plant cells than in animal cells
- 3) **PLASTIDS:** double-membrane structures found in plants
 - a) **CHLOROPLASTS:** green because they contain the pigment chlorophyll; enables the plant to manufacture glucose from the energy of the sun via **PHOTOSYNTHESIS**
 - b) **CHROMOPLASTS:** contain other pigments to color flowers, fruits, leaves, etc.
 - c) **AMYLOPLASTS or LEUKOPLASTS:** store **STARCH** as a plant's reserve food supply

CONCENTRATION GRADIENTS

*** molecules tend to be more dense in one area and less dense in another (in terms of spatial arrangement),

So.....

GENERAL RULE

MOLECULES MOVE "DOWN"
CONCENTRATION GRADIENTS FROM HIGH
CONCENTRATION TO LOW CONCENTRATION

Different Ways Molecules Get Across Plasma Membranes:

- 1) Diffusion: RANDOM movement of molecules from an area of HIGH concentration to LOW concentration; small molecules like O₂ or CO₂ usually move right through the lipid bilayer
 - 2) Osmosis: the process by which WATER MOLECULES pass down a concentration gradient across the plasma membrane
- There are three osmotic conditions for solutions which surround cells:

1. **ISOTONIC SOLUTION**: internal and external solutions are in **BALANCE**; there is no *net* exchange of water occurring (there will always be some random flow into and out of the cell)
2. **HYPOTONIC SOLUTION**: higher concentration of water molecules OUTSIDE the cell (in other words, **LOWER** concentration of dissolved substances (solute) outside the cell, than inside the cell); Cell will **GAIN** water from outside: animal cells will eventually **BURST**, plant cells do not because of the **CELL WALL**
3. **HYPERTONIC SOLUTION**: **LOWER** concentration of water (or High solute concentration) outside the cells than inside; the cell will **LOSE** water to the outside

Transport of Molecules by Membrane Proteins:
(mostly charged ions and polar molecules)

- 1) **PASSIVE TRANSPORT** (also called **FACILITATED DIFFUSION**)
 - Molecules moving down concentration gradients without the need for energy input but they are moving through the transport proteins
- 2) **ACTIVE TRANSPORT**:
 - Molecules moving **UP(!)** concentration gradients
 - *** **ENERGY INPUT IS REQUIRED FOR THEM TO MOVE FROM LOW TO HIGH**

Other Forms of Transport:

- 1) **ENDOCYTOSIS**: cells "take in" materials from their surroundings (**phagocytosis**- taking in solid particles; and **pinocytosis**- taking in liquid droplets)
- 2) **EXOCYTOSIS**: substances being ejected from the cell in "vesicles"

NOTE: Endocytosis is frequently seen in cells like white blood cells or in single celled organisms like amoebas