Cells as Units of Life

1. Cell Concept
   a. Robert Hooke - cork
      i. Realized that most living things composed of cells.
      ii. Most cells are small - microscopic
          1. Eggs are an exception - very large cells
   b. Cell Theory
      i. All living organisms are composed of cells - Schleiden and Schwann
      ii. Named the stuff inside of cells protoplasm
          1. Originally thought to be a gel-like mixture with special "life properties"
          2. Better microscopes showed that cells have organelles that have specific functions
   c. How to study cells
      i. Light microscope - not much good - you will see in lab
         1. Only see the largest organelles
      ii. Electron microscope - much greater resolving power
         1. Use beam of electrons to illuminate specimen
         2. Use electromagnets as lenses
         3. Transmission EM - shoot electrons through specimen
         4. Scanning EM - bounce electrons off of specimen

2. Organization of Cells
   a. Prokaryotes vs Eukaryotes
      i. Prokaryotes lack membrane-bound nucleus
         1. They still have DNA and an area of cell that functions as a nucleus
         2. No chromosomes
      ii. Prokaryotes are bacteria and bluegreen algae
         1. You will study in microbiology
         2. We will not mention them further
         3. All animals are eukaryotes
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b. Components of Eukaryotic Cells - lots of membrane-bound organelles

   i. Cell membrane - divides cell from outside

   ii. Nucleus - also enclosed in membrane

      1. Nuclei contain chromatin - complex of DNA and histones

         a. Condense to chromosomes in mitosis

      2. Nucleoli - darker staining region of nucleus

   iii. Cellular material called cytoplasm - contains lots of organelles

   iv. Nature of membranes

      1. Fluid - mosaic model

      2. Phospholipid bilayer

      3. May have lots of glycoproteins embedded in lipid bilayer

         a. These conduct materials into and out of cell

   v. Structures

      1. Ribosomes

         a. Sites where proteins are made

         b. Much more complicated than this, but we will come back to them

      2. Endoplasmic reticulum

         a. Channels through cytoplasm - make materials for export from cell

            i. Smooth - just pipes

            ii. Rough - makes materials for export

               1. What material depends on kind of cell

                  a. Digestive enzymes

                  b. Hormones

         b. Golgi Complex

            i. Storage and processing of protein products

   3. Vesicles / Vacuoles
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a. Lysosomes - bags of digestive enzymes
   i. Bacteria engulfed by cell
   ii. Internal "bombs" that terminate cell
      1. During metamorphosis in insects and amphibians
b. Food vacuoles
c. Contractile vacuoles

4. Mitochondria - look like little beans
   a. Cristae inside
   b. Site of intermediary metabolism (source of energy)
      i. Where organic compounds are broken down to produce energy

5. Cytoskeleton
   a. Microfilaments - allow cells to move and contract
      i. Actin and myosin - contraction

3. Surfaces of Cells and their specializations
   a. Cilia and Flagellae
      i. Movable structures on cell surface
      ii. Look like hairs, but they move
      iii. Allows whole cell to move in unicellular animals and sperm
      iv. Allows cells to move materials
         1. Bronchial passages in vertebrates (humans included)
         v. Repeatable structure
            1. 9 pairs of microtubules around a central pair
            2. Basal body - kinetosome
   b. Junctions
      i. Tight junction - connects cells tightly together
      ii. Gap junctions - provide communication between cells.
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4. How do you get stuff into a cell - membrane function
   a. Plasma membrane acts as a selective gate-keeper for cell - how to get past it?
   b. Diffusion and Osmosis
      i. Permeable membrane
         1. Spilled perfume example
         2. Plasma membrane is permeable to some stuff
            a. Oxygen
            b. Carbon Dioxide
      ii. Osmosis
         1. Plasma membrane is selectively permeable to some substance
         2. If you have a semipermeable membrane between two solutions
            a. Water flows from less concentrated to more concentrated solution - osmosis
            b. Happens because water can go thru membrane but solute cannot
            c. Osmotic pressure is the force required to prevent water from crossing the semipermeable membrane
         3. Freshwater fish have a problem - hyperosmotic solution
            a. The fish is more concentrated than the water around it
               i. Kidneys must work overtime to get rid of excess water
            b. Fish in seawater are hypoosmotic relative to seawater - water tends to leave fish - Must drink water and get rid of salt - many marine animals have this problem
            c. A fish in an estuary has a real problem.
               i. May be in freshwater on hour and salt the next because of tides
               ii. Blue crabs in the Chesapeake
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iii. Not many species can adapt to this problem

iii. Mediated Transport

1. Cell has some things that it wants to get in but which don't go through the membrane - nutrients and waste
   a. Mediated Transport
   b. Proteins that span the plasma membrane that move stuff through it
      i. Transporters or Permeases
   c. Takes energy
   d. Facilitated transport
      i. Permease helps molecule through - goes from high concentration to low
      ii. Glucose into cells
   e. Active transport
      i. Energy applied to transport molecules in direction opposite of concentration gradient
      ii. Maintenance of sodium and potassium gradients in nerve cells