Name_____Period____
Mrs. Laux **Cell Organelles Notes** AP Biology

Cell Wall

1. found only in plant cells
2. basically, made of cellulose, a polysaccharide of beta-glucose embedded in matrix of other polysaccharides and proteins
   -fungi-cell walls of chitin (N-group-glucosamine, not –OH)
3. Functions:
   a. protect cell
   b. maintain shape
   c. prevent excess water uptake that would cause cell to burst.

Chloroplasts

1. part of group of plant/algal membrane bound organelles called plastids
   a. amyloplasts (amylo=starch)
      leukoplasts
      -colorless, store starch
      -found in roots and tubers
   b. chromoplasts (chromo=color)
      -plastids contain pigments other than chlorophyll
      -responsible for colors of fruits, flowers, autumn leaves
   c. chloroplasts (chloro=green)
      -chlorophyll containing plastids
      -sites of photosynthesis
      -found in eukaryotic algae, leaves, and other plant organs
2. structure of chloroplast:
   a. 2 membranes
      1. outer membrane
      2. inner membranes form disks called thylakoids
         -stacks of thylakoids called grana
   b. 2 distinct regions:
      1. stroma
         fluid-filled space between outer and inner membrane
      2. thylakoid space-within thylakoid membranes
         -contain photosynthetic pigments

Cytoskeleton

Basics:
1. network of fibers that extends thru cytoplasm that provides a dynamic framework for support and movement
2. mechanical support-maintains cell shape
3. enables cell to change shape
4. enables motility
   -interacts with specialized proteins (motor molecules)
   -ex: organelle movement (vesicles)
      muscle contraction
      locomotor organelles-cilia, flagella

3 Types of fibers

-microtubules-thickest
-microfilaments-thinnest in diameter
-intermediate filaments

Microtubules

1. found in cytoplasm of all eukaryotic cells
2. constructed of globular protein tubulin
3. 2-D sheets of tubulin roll into tubes
4. microtubules extend by addition of alpha and beta tubulin units to end
5. Functions
    a. cellular support
        -make framework for cellular support, radiating from centrosome-the main microtubule organizing center of the cell-MTOC
    b. in animals, make up centrioles and basal bodies
        1. centrioles-cylindrical structures that are found near nucleus and lie at 90 degree angles to one another
            -found within centrosome
            -function only during cellular division
        2. basal bodies-attach to plasma membrane-here cilia and flagella attach to cell
        3. both are structurally identical, and therefore are interchangeable-
            -have 9 sets of 3 microtubules arranged in a ring (9x3)
    c. provide tracks for organelle movement
        -protein motor molecules (ex: kinesin) interacts with microtubule to move organelles (ex: vesicle)
        -protein "walks" vesicle along microtubule
    d. separation of chromosomes during cell division-part of spindle fibers
    e. make up cilia and flagella
        -locomotor organelles found in eukaryotes-provide motility
        -microtubules stem from plasma membrane
        -cilia-short
        -flagella-long
        -both have 9 + 2 arrangement of microtubules
            -9 pairs of microtubules surrounding 2 in center
        -unity between organisms

Functions of cilia and flagella
-propel single celled organisms
    ex: cilia on Paramecium
    flagellum on sperm
-draw fluid across surface of stationary cells
    ex: ciliated lining of trachea
-movement due to presence of dynein (protein motor molecule that changes its conformation in response to ATP
    -dynein causes microtubules in cilia and flagella to "walk" past one another and locomotor organelle to bend

Microfilaments

1. made of globular protein
   monomers of actin and myosin
2. Functions:
   a. muscle contraction-enable muscle fibers to contract
   b. provide cellular support
      ex: intestinal microvilli
   c. localized contractions of cells
      ex: pinching of animal cells during telophase of cell division
      ex: pseudopodia movement
      ex: Cyclosis-flowing of cytoplasm

Intermediate Filaments

1. constructed of protein keratin
2. provide support for cell
   a. framework for cytoskeleton
   b. reinforce cell shape
   c. fix organelle position
   d. forms nuclear lamina-disorganization and reorganization of nucleus during cell divisions
      ex: nucleolus

Endoplasmic Reticulum

1. major manufacturing center
2. extensive membrane network of tubules and sacs (cisternae) which divides internal lumen (cisternal space) from cytosol; lumen=empty space within the ER
3. continuous with outer membrane of nuclear envelope therefore, membranes of nuclear envelope are continuous with cisternal space
4. **Smooth ER**
   no ribosomes
   functions in metabolic processes:
   a. synthesizes lipids, phospholipids, and steroids
      ex: cells of glands, cells that secrete hormones have large amount of smooth ER
      ex: skin, ovaries, oil glands
   b. participates in carbohydrate metabolism
      ex: smooth ER in liver catalyzes glycogen to glucose
   c. detoxifies drugs and poisons; especially in liver, enzymes catalyze addition of -OH groups to drugs and poisons; Makes them soluble in cytosol; to be extracted from body; smooth ER proliferates in response to alcohol, drugs; may increase tolerance
   d. stores Ca ions necessary for muscle contraction; in muscle cells, ER is called sarcoplasmic reticulum; ER membrane pumps Ca ions from cytosol to cisternal space; in response to nerve

conduction, Ca ions leave from ER back into cytosol-triggers muscle contraction

5. **Rough ER**

cytoplasmic side has ribosomes, manufactures secretory proteins and membrane parts

a. manufacture of secreted proteins

ex: pancreatic cells-insulin-have large amounts of rough ER

-growing polypeptide is threaded thru ER membrane into lumen or cisternal space

-proteins can form/convert to glycoproteins (protein covalently bonded to carbohydrates, ex: oligosaccharide)

-protein departs in a transport vesicle pinched off from ER

b. ER also produces all of the membrane molecules for all organelles in the endomembrane system

membranes of rough ER grow in place as new proteins and phospholipids are assembled

1. membrane proteins are produced by ribosomes on ER
2. polypeptide grows and is inserted directly into ER membrane where it is anchored by hydrophobic regions of proteins
3. enzymes within ER membrane synthesize phospholipids from raw materials in the cytosol
4. ER membrane (new) pinches off and is transported in a vesicle

Extracellular Matrix

-surrounds the cell

1. eukaryotic cells have a cell coat, or glycocalyx, formed by molecules of plasma membrane
   -glycocalyx may act as recognition sites
2. animal cells-have extracellular proteins
   ex: fibronectins and integrins

Golgi Complex

1. packages, processes, and ships products of the ER
2. first discovered in 1898 by Camillo Golgi
3. organelle made of flattened, stacked membranes
   -stacks=dicytosomes
   -spaces=cisternae
4. vesicles transport materials between Golgi and other cell structures
5. has distinct polarity: 2 poles
   a. cis: receiving side of complex
      accepts vesicles from ER
   b. trans: shipping side
      ships vesicles towards plasma membrane

6. during membrane production:
    a. cis side receives vesicle of membrane from ER
    b. vesicle fuses spilling soluble contents into cisternal space
    c. materials move cis to trans
    d. each cisternal space contains unique combinations of enzymes
    e. during this time…could
        1. alter some membrane phospholipids (changing function of membrane constituents)
        or add carbohydrate, protein parts…
        2. can modify oligosaccharide portion of glycoprotein
        3. manufacture certain macromolecules (ex: hyaluronic acids)
        4. create targets for various parts of cell
            vesicles that extend off Golgi may have external molecules that attract to certain organelles (ex: cell membrane)
        5. sorts products for secretion
        6. also manufactures lysosomes
    f. products leave trans face by pinching vesicle off and fusing later with plasma membrane (for excretion)

Lysosomes

-membrane enclosed sacs of hydrolytic enzymes-digest all major classes of macromolecules
-enzymes: lipases, carbohydrases, proteases, nucleases

1. optimal pH, about 5
2. membrane functions:
    a. sequester reactions and hydrolytic enzymes from cytosol
    b. maintains optimal acidic environment for enzyme action by pumping H ions inward from cytosol to lumen
3. Lysosome functions:
    a. intracellular digestion
        -cell membrane ingests material via phagocytosis, forming a vacuole
        -lysosomes fuse with food-filled vacuole; here, hydrolytic enzymes digest food
        -found in large numbers in
            1. protozoans
            2. WBCs- leukocytes
            3. macrophages-phagocytic bacteria, etc.
            4. sperm and egg cells
                -sperm hydrolyzes egg cell membrane
                -egg breaks down yolk
    b. recycle cell's own organic materials
        -engulf other cellular organelles or part of cytosol and digest with hydrolytic enzymes-autophagy

-this results in monomers which are released into cytosol where they can be recycled into new macromolecules
-ex: liver cells recycle 50% of macromolecules every week
-ex: in any active cell, mitochondria are replaced every 10 days.

c. programmed cell death-apoptosis
-important during metamorphosis and development
-ex: deer antlers

4. Human diseases:
-impaired lysosomal function can result in storage diseases-lack a certain enzyme

1. Pompe's disease-missing carbohydrase that converts glycogen to glucose
-results in glycogen accumulation in and damage to liver
2. Tay-Sachs-lipase is missing
-causes lipid accumulation in brain- lysosomes break open-killing cells
-children die very early on
3. rheumatoid arthritis (RA)
-autoimmune disease
-affects 1% of population
-lysosomes in WBCs in synovial membranes of joints leak enzymes into joint cavity, which erodes cartilage and causes inflammation

Mitochondria and Chloroplasts

-both organelles that convert energy from surroundings into forms useable for work
-other similarities:
1. enclosed by 2 membranes
2. membranes are not part of endomembrane system
-membrane proteins are not made by ER, but are synthesized by free ribosomes, either within cytosol or within organelles
3. contains ribosomes and some DNA that programs some of their own protein synthesis
4. are semi-autonomous organelles in that they grow and reproduce within the cell

Endosymbiotic theory
-were once independent organisms that were engulfed and happily adapted to their new surroundings
-supported via organelle DNA and ribosomes within 2 organelles and semi-autonomy

Mitochondria

1. make ATP through cellular respiration
2. found in nearly all eukaryotic cells
3. # of mitochondria per cell varies and directly correlates with cell's metabolic activity
4. move, change shape, and divide

5. Structure:
    a. enclosed by 2 membranes that have own unique combination of proteins embedded in phospholipid bilayer
        1. smooth outer membrane is highly permeable to small solutes, but it blocks passage of macromolecules
        2. convoluted inner membrane contains embedded enzymes involved in cellular respiration
        -membrane folds-cristae-increase surface area available for reactions to occur
    b. two membranes divide mitochondria into two compartments
        1. intermembrane space
            -region between inner and outer membranes
            -reflects solute composition of cytosol, because outer membrane is permeable to small solute molecules
        2. mitochondrial matrix
            -compartment enclosed by inner mitochondrial membrane
            -contains enzymes that catalyze many steps of cellular respiration
6. Human Diseases
    -several human diseases are caused by malfunctions of mitochondrial DNA
    a. young adult blindness
    b. progressive muscle disorders
    c. Alzheimer's disease (some cases)
    d. Type 2 diabetes

Nucleolus

1. found in nucleus
2. assemble the 2 subunits that make up ribosomes (in eukaryotes)

Ribosomes

1. complexes of RNA and protein
2. site of protein synthesis
3. not membrane-bound (not part of endomembrane system)- prokaryotes also have ribosomes
4. free or bound to ER (interchangeable)
    a. proteins made from free ribosomes will function in the cytosol.
    b. bound make proteins destined for membrane inclusion or export
        cells specializing in protein secretion often may have many bound ribosomes
            ex: pancreatic cells (insulin)

Nucleus

1. in eukaryotes, near center of the cell.
2. contains most of genes that control the entire cell (DNA)

3. enclosed by nuclear envelope
    a. controls materials that pass between nucleoplasm and cytoplasm
    b. pores allow transport of materials
    c. double membrane
        composed of bilayer of phospholipids
4. genetic material in nucleus
    organized into chromatin
        complex of DNA and histone proteins
            make up chromosomes in eukaryotic cells
    chromosomes are only present during cell division
        each species has a specific chromosome number
        ex: humans have 46
            sperm and egg each have 23

Peroxisomes

-contain enzymes that transfer H from various substrates to oxygen, producing hydrogen peroxide

1. bound by a single membrane
2. found in nearly all eukaryotic cells, but proliferate more in cells that synthesize, store, or degrade lipids.
3. often have dense, crystalline cores, collection of enzymes
4. once produces hydrogen peroxide (poisonous), enzyme catalase converts hydrogen peroxide to water and oxygen
5. Functions
    a. breakdown of fatty acids into smaller molecules (Acetyl CoA)
        -products carried to mitochondria as fuel for cellular respiration
    b. detoxification of alcohols and other compounds
        -in liver, peroxisomes enzymatically transfer H from poison to oxygen
    c. plants have specialized peroxisomes called glyoxysomes
        -found in fat storing tissues of germinating seeds
        -contain enzymes that convert lipid to carbohydrate
        -makes energy in seed oils available for germinating seedling

Vacuoles

-large membrane-enclosed, fluid-filled sacs
-variety of forms, variety of functions

1. Food vacuoles-vacuole formed by phagocytosis, which is the site of intracellular digestion
    -membrane of all vacuoles called tonoplast
2. Contractile vacuoles
    -found in freshwater protozoans (ex: *Paramecium*)
    -pumps excess water from cell
    -maintains water concentration
3. Other vacuoles
    -store wastes, toxins

4. Central vacuole

-large vacuole found in most plant cells

-develops by accumulation of smaller vacuoles derived from ER and Golgi bodies.

-many functions:

a. stores organic compounds

_ex: protein storage in seeds

b. stores inorganic ions

c. sequesters dangerous by-products from cytoplasm (ex: toxins)

d. holds pigments (some)

ex: flower colors

e. carries out functions of lysosomes (in some)

f. may protect plant from predators by containing poisonous/unpalatable compounds

g. plays a role in plant growth by absorbing water and elongating cell