AP Biology
Notes: Cell structure

Observations of cells:

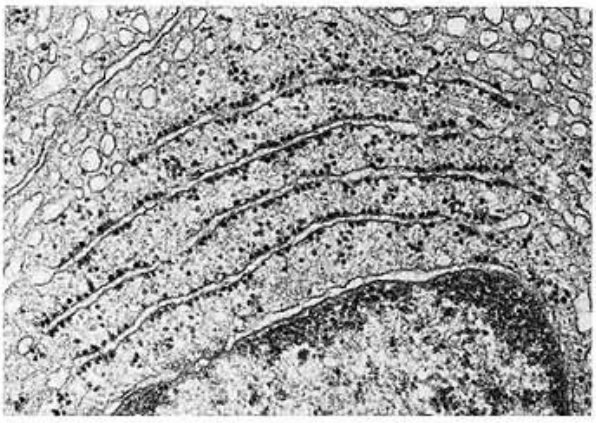
Resolving power- The measure of clarity of an image

Light microscope: Use optics to magnify an image. Resolving power is no finer than 0.2 micrometers.

Electron Microscope: Electron microscope focuses a beam electrons through a specimen Small wavelength allows resolution of 2 nanometers.

Transmission electron microscope: Bean passed through a thin slice of specimen. sample exposed to heavy metals to enhance contrast.

Scanning electron microscope: Electron beams scan surface of cells that have been coated with a heavy metal. resulting image appears three dimensional.



Isolation of organelles:

Cell fractionation: Techniques used to separate organelles from cell.

homogenized using ultrasound or grinding.
Osmotic shock

- Ultracentrifuge used to deposit fractions into pellets using various speeds and time
- Density gradients: using a column of various densities a sample can be centrifuged and collected from
  the appropriate density window of the sample desired

Eukaryotic / Prokaryotic:

Types differ in size and complexity.

Prokaryotic (archaea and bacteria)

- No nucleus. DNA concentrated in region called nucleoid
- Range in size from 1 to 10 micrometers
- replicate by binary fission.

Eukaryotic (fungi, protist, animalia)

- True nucleus
- membrane bound organelles in semi fluid medium called cytosol.
- 10-100 micrometers

Cell Size restriction:

- Faster passage and more efficient communication with environment.
- Large volume would allow only communication around plasma membrane.

Nucleus

Structure:

- Surrounded by a nuclear envelope- double membrane,
  perforated by pores that regulate the movement of large molecules
  between the nucleus and cytoplasm
- nuclear lamina- a layer of protein filaments which line the inner membrane
- chromatin- uncondensed DNA that make up chromosomes
- nucleolus- synthesizes and assembles ribosomal components that pass through the nuclear pores

Function:

- Isolates and regulates DNA function
- helps organize and regulate protein synthesis

Ribosomes

Structure:

- two major sub-units, constructed of RNA and protein
- differ between cell types

Function:

- used in the production of proteins
  *free ribosomes produce proteins to be used in the cytosol
  *bound ribosomes attach to the ER, make proteins to be exported from the cell

Endomembrane System

- consists of the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, and the plasma membrane
- these membranes are all related either through direct contact or by the transfer of membrane segments
  by membrane-bound sacs called vesicles

Smooth ER

Structure:

- large membrane structure, continuous with rough ER and nuclear membrane
- does not contain ribosomes

Function:

- enzymes are involved in phospholipid and sex hormone synthesis
- detoxification of drugs and poisons
- storage and release of ions during muscle contraction

Rough ER

Structure:

- large membrane structure, continuous with smooth ER and nuclear membrane
- ribosomes imbedded in membrane

Function:

- manufactures proteins intended for secretion
- may modify proteins with attachment of carbohydrates

- transported from ER in transport vescicles
- manufacture membranes by inserting proteins

Golgi Apparatus

Structure:

- consists of stacks of flattened membraneous sacs
- vesicles from ER join cis face of Golgi
- Golgi products pinch off trans face of Golgi

Function:

- finish, sort, and ship cell products
- products are modified as they pass from one cisterna (sac) to the next
- vesicles have surface molecules that direct them to plasma membrane or other destinations within the cell

Lysosomes

Structure:

- membrane enclosed sacs of enzymes

Function:

- protect cell from unwanted digestion
- recycle cells macromolecules
- fuse with food vacuoles to digest food particles

Storage Diseases: inherited defect in which lysosomal enzyme is missing

Vacuoles

Structure:

- membrane enclosed sacs
- larger than vesicles

Function:

- food vacuoles- formed as a result of phagocytosis
- contractile vacuoles- pump excess water out of protist
- central vacuole - found in plants and stores organic compounds, poisonous compounds, and dangerous by-products

Peroxisomes

Structure:

- membrane enclosed compartment filled with enzymes

Function:

- break down fatty acids
- detoxify alcohol
- convert hydrogen peroxide

Mitochondria/ Chloroplast

- Major metabolic organelles
- Contain small amounts of DNA that direct protein synthesis

Mitochondria

Structure:

- Smooth outer membrane; folded inner membrane (increase surface area)
- Intermembrane space very important in ATP synthesis
- Cristae- folds of innermembrane
- Matrix- inner space which contains many of the proteins and enzymes used for ATP synthesis

Function:

- Production of ATP for cell energy

Chloroplast

Structure:

- Double membrane bound organelle
- Contain sacs (disk) called thylakoids
- Sacs may be stacked forming granum-multiple stacks form grana
- Thylakoids in viscous fluid called stroma
- belongs to a group of structures known as plastids
  Amyloplast- store starch
  Chromoplast-house other (accessory) pigments

Funtion:

- Contain main pigment for photosynthesis

Cytoskeleton: (Microtubules, Microfilaments, Intermediate filaments)

- network of fibers
- give mechanical support

- maintain or change cell shape
- anchor or direct the movement of organelles and cytoplasm
- control movement of cilia, pseudopods, and even contraction of muscle cells
- mechanically transmit signals from the cell's surface to its interior

Microtubles:

Structure/function:

- hollow rods constructed of columns of a globular protein called tubulin.
- providing the major supporting framework
- serve as tracks along which organelles move
- centrosme-region in which microtubules radiate out from
- centrioles- composed of microtubules assist in cell division
- cilia and flagella- extensions of eukaryotic cells have universal 9-2 arrangement
- basal body- structurally identical to a centriole
- dynein- protein which drives basal body

Microfilaments

- sold rods consisting of a twisted double Chains molecules of the globular protein acitn
- function in support
- form a network inside the plasma membrane
- core of cytoplasmic extensions called microvilli
- myosin-thick filaments made of protein
- actin and myosin also interact in:
    *Cleavage furrows in cell division
    *Ameboid movement in protozoans
    * Cytoplasmic streaming in plant cells

Intermediate filaments

Structure of intermediate filaments:

- filaments that are intermediate in diameter (8-12 nm) between microtubules and microfilaments
- diverse class of cytoskeletal elements that differ in diameter and composition depending upon cell type
- constructed from *keratin* subunits
- more permanent than microfilaments and microtubules

Fucntion of intermediate filaments

- Specialized for bearing tension; may function as the framework for the cytoskeleton
- reinforce cell shape (e.g. nerve axons)
- Probably fix organelle position (e.g. nucleus)
- compose the nuclear lamina, lining the nuclear envelope's interior

Cell surfaces and junctions

Cell walls

- Plant cells can be distinguished from animal cells by the presence of a cell wall
- Thicker than the plasma membrane (0.1-2 μm)
- chemical composition varies from cell to cell and species to species
- Basic design includes strong cellulose fibers embedded in a matrix of other polysaccharides and proteins
- Functions to protect plant cells, maintain their shape, and prevent excess water uptake
- Has membrane -lined channels, plasmodesmata, that connect the cytoplasma of neighboring cells

Plant cells develop as follows:

- Young plant cell secretes a thin, flexible primary cell wall. Between primary cell walls of adjacent cells is a middle lamella made of pectin, a sticky polysaccharide that cements cells together
- Cell stops growing and strengthens its wall.
- some cells:
    1. Secrete hardening substances into primary wall.
    2. Add a secondary cell wall between plasma membrane and primary wall. secondary cell wall is often deposited in layers with a durable matrix that supports and protects the cell.

The extracellular matrix (ECM)

Animal cells lack walls, but they do have an elaborate extracellular matrix = meshwork of macromolecules outside the plasma membrane of animal cells. this ECM is:

- composed mostly of glycoproteins, the most abundant of which is collagen that
- accounts for about half of the total protein in the vertebrate body
- forms strong extracellular fibers embedded in a meshwork of carbohydrate-rich glycoproteisn called proteoglycans

Functions of the extracellular matrix:

Cell attachement:

May be attached directly to the collagen and proteoglycan of their extracellular matrix

Or to the ECM by another class of glycoprotiens-fibronectins
fibronectins bind to transmembrane receptor proteins called integrins that bond on their cytoplasmic side to microfilaments of the cytoskeleton

Provides support and anchorage for cells

Helps control gene activity in the cell's nucleus. The transcription of specific genes is a response to chemical signals triggered by communication of mechanical stimuli across the plasma membrane from the ECM through integrins to the cytoskeleton

Intercellular junctions

Neighboring cells often adhere and interact through special patches of direct physical contact

Plasmodesmata (singular, plasmodesma) = channels that perforate plant cell walls, through which cytoplasmic strands communicate between adjacent cells

- lined by plasma membrane. plasma membranes of adjacent cells are continuous through a plasmodesma
- allows free passage of water and small solutes. This transport is enhanced by cytoplasmic streaming

Intercellular junctions in animals

Tight junctions = intercellular junctions that hold cells together tightly enough to block transport of substance through the intercellular space

- specialized membrane proteins in adjacent cells bond directly to each other allowing no space between membranes
- usually occur as belts all the way around each cell, that block intercellular transport
- frequently found in epitheilial layers that separate two kinds of solutions

Demosomes = Intercellular junction that rivet cells together into strong sheets, but still permit substances to pass feely through intracellular spaces. the desmosome is made of

- intracellular glycoprotien filaments that penetrate and attach the plasma membrane of both cells
- a dense disk inside the plasma membrane that is reinforced by intermediate gap functions = intreacllular junctions specialized for material transport between the cytoplasm of adjacent cells
- formed by two connecting protein rings (connexon), each embedded in the plasma membrane of adjacent cells. the proteins protrude form the membranes enough to leave an intracellular gape of 2-4 nm
- have pores with diameter (1.5 nm) large enough to allow cells to share smaller molecules (e.g. inorganic ions, sugars, amino acids, vitamins) but not macromolecules such as proteins.
- common in animal embryos and cardiac muscle where chemical communication between cells is essential