How Light Microscopes Work

- Obj. lens gathers light from the specimen and magnifies the image
  - Most scopes have several obj. lenses for different levels of magnification
- Ocular lens magnifies and transmits the image to your eye
  - This mag. is 10X
- To find the total magnification of the scope, multiply the mag. of the obj. lens by the mag. of the ocular lens.
  - For example: 40X (objective lens) x 10X (ocular lens) = 400X magnification

Images Produced by Light Microscopes

- Amoeba
- Streptococcus bacteria
- Anthrax bacteria
- Human cheek cells
- Plant cells
- Yeast cells

The Parts of a Light Microscope

- Light source: Could be a mirror, but most likely it is a bulb built into the base
- Diaphragm: Adjusts the amount of light striking an object
- Objective lens: Gathers light and magnifies image
- Ocular lens (eyepiece): Magnifies objects and focuses light to your eye
- Stage: Holds slide
  - Can be moved using the coarse or fine adjustment knobs to bring the object into focus
- Stage clips: Hold slide in place
- Base and arm: Structural support for the microscope

You need to be able to use scopes to create plan diagrams...

- Instructions are in your lab manual for today
- No sketching
- No shading
- No cells
- Outline tissues only
Microscope Tips:

- ALWAYS start on scanning obj. lens (red lens)
- Use coarse focus on scanning power only
- Fine focus will fine tune what you are examining at all levels of magnification
- If you can't see anything, go back to scanning and coarse focus up and down until you see the tissue or the slide.

Beyond Light Microscopes

- Resolution: image crispness
- Magnification: zoom size
- Light microscopes are limited by their resolution.
  - Cannot produce clear images of objects smaller than 0.2μm
- Electron microscopes use beams of electrons, rather than light, to produce images
  - Electron microscopes can view objects as small as the diameter of an atom

Types of Electron Microscopes

- Transmission electron microscopes (TEMs) pass a beam of electrons through a thin specimen
- Scanning electron microscopes (SEMs) scan a beam of electrons over the surface of a specimen
- Specimens for electron microscopy must be preserved and dehydrated, so living cells cannot be viewed

Images Produced by Electron Microscopes

- Cyanobacteria (TEM)
- Lactobacillus (SEM)
- Campylobacter (SEM)
- Deinococcus (SEM)
- House ant
- Avian influenza virus
- Human eyelash
- Yeast

Cell Theory

- Cell = basic functional unit of life
- All cells come from other cells through division
**Types of cells**

- **Prokaryote bacteria cells**  
  - no organelles

- **Eukaryote animal cells**  
  - organelles

- **Eukaryote plant cells**

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**Prokaryote vs. Eukaryote**

- **Prokaryote**
  - Cell diameter: 0.5-5μm
  - Circular, free-floating DNA
  - DNA naked
  - Ribosomes: 18nm diameter
  - No membrane bound organelles, no ER
  - Cell walls
  - Bacteria

- **Eukaryote**
  - Cell Diameter: 40μm, 1,000-10,000x size of prok’s
  - DNA in double-membrane bound nucleus
  - DNA bound to protein
  - Ribosomes: 22nm diameter
  - Many organelles with specialized features
  - Some with cell walls
  - Plants, animals, fungi, protists

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**Why organelles?**

- Specialized structures
  - specialized functions
    - cilia or flagella for locomotion
- Containers
  - partition cell into compartments
  - create different local environments
    - separate pH, or concentration of materials
    - distinct & incompatible functions
    - lysosome & its digestive enzymes
- Membranes as sites for chemical reactions
  - Surface area!!
  - unique combinations of lipids & proteins
  - embedded enzymes & reaction centers
    - chloroplasts & mitochondria

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**Cells gotta work to live!**

- **What jobs do cells have to do?**
  - **make proteins**
    - proteins control **every** cell function
  - **make energy**
    - for daily life
    - for growth
  - **make more cells**
    - growth
    - repair
    - renewal

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**Nucleus**

- **Function**
  - protects **DNA**

- **Structure**
  - **nuclear envelope**
    - double membrane
    - membrane fused in spots to create **pores**
    - allows large macromolecules to pass through
  - **histone protein**
  - **chromosome**

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**Cytoplasm**
**Nucleolus**
- **Function**
  - ribosome production
  - build ribosome subunits from rRNA & proteins
  - exit through nuclear pores to cytoplasm & combine to form functional ribosomes
- ![Diagram of Nucleolus](image)

**Ribosomes**
- **Function**
  - protein production
- **Structure**
  - rRNA & protein
  - 2 subunits combine
- ![Diagram of Ribosomes](image)

**Types of Ribosomes**
- **Free** ribosomes
  - suspended in cytosol
  - synthesize proteins that function in cytosol
- **Bound** ribosomes
  - attached to endoplasmic reticulum
  - synthesize proteins for export or for membranes
- ![Diagram of Ribosomes](image)

**Endoplasmic Reticulum**
- **Function**
  - processes proteins
  - manufactures membranes
  - synthesis & hydrolysis of many compounds
- **Structure**
  - membrane connected to nuclear envelope & extends throughout cell
- ![Diagram of ER](image)

**Types of ER**
- **Rough** ER
  - synthesis of membrane proteins
- **Smooth** ER
  - synthesis of membrane lipids
- ![Diagram of ER](image)

**Smooth ER function**
- **Membrane production**
- **Many metabolic processes**
  - synthesis
    - synthesize lipids
    - oils, phospholipids, steroids & sex hormones
  - hydrolysis
    - hydrolyze glycogen into glucose
    - detoxify drugs & poisons
Rough ER function
- Produce proteins for export out of cell
  - protein secreting cells
  - packaged into transport vesicles for export

Golgi Apparatus
- Function
  - finishes, sorts, tags & ships cell products
    - like “UPS shipping department”
  - ships products in vesicles
    - membrane sacs
    - “UPS trucks”

Vesicle transport
- protein budding from rough ER
- vesicle forming
- migrating transport vesicle
- fusion of vesicle with Golgi apparatus

Putting it together...

Making proteins
- Nucleus
- Ribosome
- Protein secreted
- ER
- Vesicle
- Protein and protein fragments sent to Golgi apparatus

Centrioles
- Function
  - Guide spindle fibers in nuclear division
  - Only in animal cells
- Structure
  - Hollow cylinder made of protein microtubules
**Lysosomes**
- **Function**
  - little “stomach” of the cell
  - digests macromolecules
  - “clean up crew” of the cell
  - cleans up broken down organelles
- **Structure**
  - vesicles of digestive enzymes
  - synthesized by rER, transferred to Golgi
  - only in animal cells

![A lysosome in action](image)

**Mitochondria**
- **Function**
  - cellular respiration
- **Structure**
  - 2 membranes
    - smooth outer membrane
    - highly folded inner membrane
    - cristae
  - fluid-filled space between 2 membranes
  - internal fluid-filled space
    - mitochondrial matrix
    - DNA, ribosomes & enzymes

- Why 2 membranes?
  - increase surface area for membrane-bound enzymes that synthesize ATP

**Chloroplasts**
- **Chloroplasts are plant organelles**
  - class of plant structures = plastids
  - chloroplasts
    - store chlorophyll & function in photosynthesis
- **Structure**
  - 2 membranes
  - stroma = internal fluid-filled space
  - DNA, ribosomes & enzymes
  - thylakoids = membranous sacs where ATP is made
  - grana = stacks of thylakoids

- Why internal sac membranes?
  - increase surface area for membrane-bound enzymes that synthesize ATP

**Animal Cell**
- **Plant Cell**

**Questions?**