INTRODUCTION TO THE MICROSCOPE

The scientific field that studies microscopic samples, specimen that cannot be seen with the unaided eye, using a microscope is called Microscopy. It is not very well documented who exactly invented the microscope, but it is often attributed to two Dutch glass makers, Hans Lippershey (creator of the telescope) and Zacharias Janssen, in the late 1500s. In biology, many structures and organisms are too small to be detected and studied with the unaided eye. The human eye has a limited resolving power (200µm). To be able to overcome this problem an instrument needed to be invented to improve the human’s eye resolution. This instrument was the microscope.

Resolution is the minimum distance between two points, where the two points are still distinguishable as separate points. For example, if two points are less than 200µm apart the human eye will perceive it as one object instead of two. Increased resolving power is possible because of the lens system that increases the magnifying power of the eye when observing a specimen through the microscope. Magnification is the process of increasing the apparent size of an object, but does not increase the size of the physical object. Keep in mind, resolution and magnification are two different concepts. Figure 2.1 demonstrates the difference between the terms on actual micrographs. Looking at 100x magnification the image to the left represents an image that was simply magnified to seem large, however, the image does not show distinct objects until the image has been resolved (the image to the right).

The modern optical or light microscope is based on the same optic principles as the original microscopes. There are three required elements to view an object through the microscope:

1. An appropriate specimen
2. An illumination source
3. A lens system that focuses the illumination source on the specimen.

The Compound Light Microscope

The illuminating system, which concentrates light on the specimen, usually consists of a light source, condenser lens, and iris diaphragm. The light source is a light bulb located at the base of the microscope. The light source illuminates the specimen by passing light through a thin, almost transparent part of the specimen. The condenser lens, located immediately below the specimen, focuses light from the light source onto the specimen. Just below the condenser is the condenser iris
diaphragm, a knurled ring or lever that can be opened and closed to regulate the amount of light reaching the specimen. When the condenser iris diaphragm is open, the image will be bright; when closed, the image will be dim.

The imaging system improves resolution and magnifies the image. It consists of the objective, ocular lenses and a body tube. The objectives are three or four lenses mounted on a revolving nosepiece (turret). Each objective is a series of several lenses that magnify the image, improve resolution, and correct irregularities in the image. The most common configuration for students microscopes includes four objectives: low magnification (4x), medium magnification (10x), high magnification (40x), and oil immersion (100x). Using the oil immersion objective requires special instructions. To avoid damaging your microscopes do not use the oil immersion objective during this exercise.

The ocular is the lens that you look through. Microscopes with one ocular are monocular microscopes, and those with two are binocular microscopes. Oculars usually magnify the image ten times. The body tube is a metal casing through which light passes to the oculars. In microscopes with bent body tubes and inclined oculars, the body tube contains mirrors and a prism that redirects light to the oculars. The stage secures the glass slide on which the specimen is mounted.

The microscope is a precision instrument and should always be handled with care. At all times you must observe the following rules for its transport, cleaning, use and storage:
1. When transporting the microscope, hold it in an upright position with one hand on its arm and the other supporting its base. Avoid jarring the instrument when setting it down. Never attempt to hold the microscope with just one hand.
2. Do not attempt to carry more than one microscope at a time.
3. Always gently place microscopes on the counter.
4. Minimize the use of eye make-up when using the microscopes. Make-up has the tendency to become deposited on the ocular lenses and it will result in an unclear image.
5. Use only special grit-free lens paper to clean the lenses. Clean all lenses before and after use.

Figure 2.1
Magnification vs. Resolution.
6. Always begin the focusing process with the lowest power objective lens in viewing position, changing to the higher power lenses as necessary.

7. Never use the coarse adjustment knob with the high power or oil immersion lenses.

8. Always use a coverslip with temporary (wet mount) preparations.

9. Do not leave slides on the stage when the microscope is put away. Either put back the slides after their use or dispose of the slides properly as directed by the instructor.

10. Unplug the microscope light by grasping the plug, not the cord. Coil the cord around the microscope.

11. Make sure to never over rotate the course or fine adjustment knobs. If they are over rotated the knobs will get stuck and there is no way to fix it.

12. Before putting away the microscope make sure that:
   a. The light switch is in the off position.
   b. The scanning objective (4x), the low magnification objective, is in viewing position.
   c. Lower the position of the stage, using the coarse adjustment knob, as close to the base as possible.
   d. The cord should be wrapped around the microscope.
   e. There are no slides on the stage.
   f. The microscope is put back at its corresponding station number within the cabinet.

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**Figure 2.2**

A compound light microscope.

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**Task 1—USING THE MICROSCOPE**

**Procedure 2.1: Introduction to the Compound Light Microscope**

1. Obtain two compound light microscopes per group from the cabinet. Record which microscopes are obtained. You will be responsible for the microscope. Using the sign-in sheet at the front of the room sign-out the microscopes obtained. These microscopes will be used by your group for the remainder of the semester.

   First Compound Light Microscope #: ____________

   Second Compound Light Microscope #: ____________
2. Using the parts of the microscope noted in Table 2.1, label the microscope parts in Figure 2.2. Make sure when labeling the figure you refer back to the microscope at the table and identify the corresponding part.

3. Using Table 2.1, after identifying where each part is on the microscope go down the list and identify the function of each part of the microscope.

4. Plug in the microscope and turn the illumination source on. Rotate the nosepiece to allow the low power (4X) objective lens to be in the viewing position. It should click into place. Looking through the oculars if it is completely black check the following:
   - The objective clicked properly in place
   - The microscope is turned on and plugged in
   - There is light coming out of the lamp
   - The light intensity knob is turned on
   - The field iris is open
   - The condenser is in its proper place and open
   - Nothing is obstructing the light from coming up to the stage
   Always start at the lowest power objective available on a microscope when attempting to view a specimen using the microscope.

5. Locate the coarse adjustment knob. Turn it while watching the stage.

6. Locate the fine adjustment knob. Turn it while watching the stage.

7. Adjust the ocular lenses so that they fit the width between your eyes.

### Table 2.1

<table>
<thead>
<tr>
<th>Parts of the Microscope</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nosepiece or Turret</td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td></td>
</tr>
<tr>
<td>Interpupillary Distance Indicator</td>
<td></td>
</tr>
<tr>
<td>Stage Clip</td>
<td></td>
</tr>
<tr>
<td>Stage</td>
<td></td>
</tr>
<tr>
<td>Condenser Iris Diaphragm</td>
<td></td>
</tr>
<tr>
<td>Illuminator Condenser</td>
<td></td>
</tr>
<tr>
<td>Mechanical Stage Control Knob</td>
<td></td>
</tr>
<tr>
<td>Substage Condenser Focusing Control Knob</td>
<td></td>
</tr>
<tr>
<td>Substage Lamp</td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td></td>
</tr>
<tr>
<td>Ocular(s)</td>
<td></td>
</tr>
<tr>
<td>Body Tube</td>
<td></td>
</tr>
<tr>
<td>Arm</td>
<td></td>
</tr>
<tr>
<td>Slide Holder</td>
<td></td>
</tr>
<tr>
<td>Coarse Focus Adjustment Knob</td>
<td></td>
</tr>
<tr>
<td>Fine Focus Adjustment Knob</td>
<td></td>
</tr>
<tr>
<td>Field Iris Diaphragm</td>
<td></td>
</tr>
</tbody>
</table>
Questions
1. Why is it best to always start at the low power objective?

2. Which adjustment knob moved the stage more drastically?

3. Which adjustment knob should you use for the low magnification objective? Medium magnification objective? High magnification objective? Explain.

4. What general rules should be followed when focusing a microscope?

Diaphragm Control

The diaphragm (Figure 2.3) is an adjustable light barrier built into the condenser. It may be either an annular or an iris type. With an annular control, a plate under the stage is rotated, placing open circles of different diameters in the light path to regulate the amount of light that passes to the specimen. With the iris control, a lever projecting from one side of the condenser opens and closes the diaphragm. Use the smallest opening that does not interfere with the field of view. The condenser and diaphragm assembly may be adjusted vertically with a knob projecting to one side. Proper adjustment often yields a greatly improved view of the specimen.

5. Which type of diaphragm does your microscope have?

Figure 2.3
Diaphragm.
Procedure 2.2: Practice and Explore the use of microscopes

1. Obtain the letter “e” slide from the slide box and place it on the stage. As seen in Figure 2.4, make sure the microscope slide is held by the stage clip. Do not look through the oculars until instructed to do so during this procedure.

2. Move the stage back and forth (left and right, forward or backward) so that the “e” on the slide is directly beneath the objective lens. Pay close attention to the orientation and movement of the letter “e” with each change in position.

3. Look through the oculars to position the letter “e” on the slide in view. Use the coarse adjustment knob to move the slide to about 1 cm from the objective lens. Move the coarse adjustment knob until you can see the “e” through the lens.

4. Use the fine adjustment knob to get the letter “e” into sharp focus.

5. Move the letter “e” left and right. And then forward and backwards.

6. Using the nosepiece change the objective lens to the medium 10X power lens and repeat steps 4 and 5.

7. Using the nosepiece change the objective lens to the high 40X power lens and repeat steps 4 and 5. Do not use the course adjustment knob.

Questions

6. What is the difference between the orientation of the letter between the unaided eye and the microscope? What does that tell you about how the microscope processes the image?

7. How does the image move when the slide is moved to the left? Right?

8. How does the image move when the slide is moved up? Down?

Figure 2.4
Slide properly place on the stage.
9. What happens to the brightness of the view when you switch from the 4X to the 10X and again to the 40x objective lens?

10. Why are mirrors important to the function of the microscope?

11. Do mirrors influence the way slides are perceived to move under the microscope? Explain.

---

**Task 2—MAGNIFICATION**

1. Examine the microscope and calculate the total magnification at each objective lens viewing position. Record this information in Table 2.2:

   Equation 2.1: Total Magnification
   
   \[ \text{Objective Magnification} \times \text{Ocular Magnification} = \text{Total Magnification} \]

   **Questions**

   12. How many times is the image of the “e” magnified when it is viewed through the highest power objective lens?

---

**Table 2.2**

<table>
<thead>
<tr>
<th>Objective magnification</th>
<th>Ocular magnification</th>
<th>Total magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13. If you did not know what you had on your slide (an “e”) and you began examining it at the highest power, how could you determine it was an “e”?

14. How is the microscope properly put away?

---

**Task 3—FIELD OF VIEW**

The field of view (FOV) is the area that you can see through the ocular and objective (Figure 2.5). Knowing the size of the field of view is important because you can use it to determine the approximate size of an object you are examining. The field of view can be measured with a small clear plastic ruler.

**Note:** When calculating the FOV Area remember the shape of the field of view.

**Procedure 2.3**

1. Place a clear plastic ruler (mm) on the stage of the microscope.
2. Using the nosepiece place the lowest power objective lens in viewing position.
3. Using the course adjustment, try to get the ruler into focus. Only use the fine adjustment to sharpen the image.

Measure the diameter of the field of view and record this in Table 2.3.

---

**Figure 2.5**

Field of View (FOV) Under Various Magnifications.
4. FOV can easily be determined for the low power objective. At higher powers you will not be able to use the ruler to calculate FOV because the field of view is too small. Instead you can use the following formulas:

   Equation 2.2: Field of View Medium Power Objective
   \[ \text{FOV}_{\text{low}} \times \text{Mag}_{\text{low}} = \text{FOV}_{\text{medium}} \times \text{Mag}_{\text{medium}} \]
   or

   Equation 2.3: Field of View High Power Objective
   \[ \text{FOV}_{\text{medium}} \times \text{Mag}_{\text{medium}} = \text{FOV}_{\text{high}} \times \text{Mag}_{\text{high}} \]

   Use these formulas to calculate the FOV at medium 10X power objective and at high (40X) power objective. Record the results in Table 2.3.

5. Use the formula for the area of the circle to calculate the FOV for each magnification and record the results in Table 2.3.

Questions

15. Discuss the advantages and limitations of viewing specimens under highest magnification.

16. Discuss the advantages and limitations of viewing specimens under low-power objective?

17. Which magnification provides the largest FOV? Which provides the smallest? Explain.
18. Is there a change in the amount of light being emitted between the objective lenses? If so, rank them from brightest to dimmest and explain your reasoning.

19. Why is it more difficult to locate an object starting with the high power objective than with the low power objective?

20. How much more area can you see with the 4x objective than with the 40x objective?

Task 4—Depth of Field

Any microscopic specimen has depth as well as length and width; it is rare indeed to view a tissue slide with just one layer of cells. Organisms no matter how small are three dimensional, which is something that is not easy to see when initially viewing specimen under a microscope. Normally, when viewing a slide under the microscope two or three cell thicknesses can be observed. Therefore, it is important to learn how to determine relative depth with your microscope. When studying a live specimen under the microscope small enough organisms can travel across the depth of field, which can make it tricky when observing the specimen.

Procedure 2.4

1. Place the colored thread slide on the stage and secure it using the stage clip of the microscope.
2. Using the nosepiece place the lowest power objective lens in viewing position.
3. Use the coarse adjustment knob to get the colored threads into focus.
4. Sharpen the image with the fine adjustment knob.
5. Determine the number of threads on the slide
   Number of threads: __________
6. Determine the order in which the threads are placed on the slide.
7. Repeat steps 3 and 4 using the medium 10X power objective lens.
8. Repeat step 4 using the high 40X power objective lens.

Questions
21. How does depth of field affect viewing biological phenomena that are thick?
22. Are all three threads visible under the low power? Can they all be seen at the same time under higher power?

23. Using the microscope identify which color string is on top and which is on the bottom. Write your observations in the space below.

24. Which objective provides the greatest depth of field?

Task 5—WET MOUNT PREPARATION WITH BIOLOGICAL SPECIMENS

Procedure 2.5: Wet Mount Preparation
1. Place a drop of pond water (periphyton) on a clean slide.
2. Position the edge of a coverslip against the drop of pond water at a 45° angle.
3. Gently lower the coverslip onto the slide.
4. Once prepared, view the slide with the microscope. Try to locate any microorganisms present on the wet mount and draw these observations in the space provided.
5. Take note of the tips below as you begin to look for organisms (Figure 2.6).

Figure 2.6
Microscope Tips. (a) These are not specimen, they are air bubbles; (b) these are not specimen, they are clothing fibers; (c) this is not a specimen, this is the edge of the cover slip.
Procedure 2.6: Estimating the size of an object under the microscope

1. Use the diameter of the field of view for the power of magnification you are using.
2. Look through the ocular lens; estimate how many times the object will fit across the field of view. Pick two organisms in the FOV to perform this procedure.
3. Calculate the size of the object using the formula below

\[
\text{Size of object} = \frac{\text{diameter of field of view}}{\text{number of times object fits across field of view}}
\]

<table>
<thead>
<tr>
<th>Organism #1</th>
<th>Organism #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnification: _______ Size: _______</td>
<td>Magnification: _______ Size: _______</td>
</tr>
</tbody>
</table>

Task 6—DISSECTING MICROSCOPE

Procedure 2.7

1. Obtain a dissecting light microscope from the cabinet. Record which microscope was obtained. You will be responsible for the microscope. Using the sign-in sheet at the front of the room sign-out the microscope obtained. This microscope will be used by your group for the remainder of the semester.

Dissecting Light Microscope #: _______
1. Familiarize yourself with all the parts of the microscope labeled in Figure 2.7.
2. Turn on the two light sources. On a dissecting microscope there is a light source from the stage and one from below.
3. Add a small amount of periphyton to a weigh boat or a petri dish and examine it under the dissecting microscope. Try to locate any macroorganisms present on the stage and draw these observations in the space provided.

Periphyton Macroorganisms
Magnification: ________

- Use a ruler to measure the FOV diameter at the lowest and the highest magnification.
  - FOV diameter low power = _____________
  - FOV diameter high power = _____________
- Now calculate the FOV area for both magnifications.
  - FOV area low power = _____________
  - FOV area high power = _____________
- Now calculate the size of an organism viewed under the microscope:

Figure 2.7
Major parts of a dissecting microscope.
Questions
25. Looking through the lens, move the Petri dish containing the “pond water” backwards and forwards, then left and right. Is the direction noted through the lens the same as when observed with the naked eye?

26. How does the image move when the object is moved to the left or right? Up and down?

**Task 7—COMPARISON OF COMPOUND AND DISSECTING MICROSCOPES**

Compare the two types of microscopes we examined today in Table 2.4. For this table use comparative terms (i.e. Smaller vs. Larger).

**Questions**
27. Compare and contrast the structures found in the compound light microscope and the dissecting microscope.

28. What structures are found in the compound light microscope that are not in the dissecting microscope?

29. Discuss the advantages and disadvantages associated with each type of light microscope.

<table>
<thead>
<tr>
<th>Table 2.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristics</strong></td>
</tr>
<tr>
<td>Magnification</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Size of field of view</td>
</tr>
<tr>
<td>Depth of field</td>
</tr>
</tbody>
</table>
Cellular Structures & Functions

In 1665, Robert Hooke was the first to describe a cell as the basic unit of an organism. Upon his observation of thinly sliced pieces of cork (Figure 2.8), Hooke visualized small empty compartments that he termed cellulae (modern derivation = cell), which literally means “small room”. Since Hooke’s initial discovery, there have been several defining historical points that have characterized what a cell is and some of the most of important points are summarized in the cell theory.

The cell theory, proposed by Schleiden, Schwann and Virchow in the 1800s, states that (1) cells are the basic structural and functional unit of life, (2) all living organisms and their products are composed of cells, and (3) all cells come from pre-existing cells. Therefore, in order to understand even the simplest of biological processes, we need to understand cells, their structure and function.

Biologists recognize two cellular organizational plans: Prokaryotic and Eukaryotic cells (Table 2.5). Prokaryotic cells (Figure 2.9) lack a nuclear envelope and thus a nucleus and membranous cytoplasmic organelles. There are two major organismal groups that fall in the category of prokaryotic cells: Bacteria and Archaea. Eukaryotes have many structural features that prokaryotes lack. Only organisms that fall into the Domain Eukarya (protists, plants, fungi, and animals) are considered to have a eukaryotic organizational plan. Although these two types of cells are very different, they share many characteristics. A plasma membrane always surrounds a cell and regulates the movement of materials into and out of the cell. Both types of cells have similar types of enzymes found in the fluid-like filled area within the membrane termed the cytoplasm, depend on DNA as the hereditary material, and have ribosomes that function in protein synthesis.

Task 8—PROKARYOTIC CELLS

All members of the Kingdoms Archaebacteria and Eubacteria have cells of the prokaryotic type. Although Archeans and Bacteria look identical under the light microscope, they differ in their chemical composition and are completely unrelated to one another. Bacteria typically have a peptidoglycan structured cell wall and a cytoplasmic membrane, while Archeans do not have peptidoglycan in their cell wall, but do have a membrane holding the cytoplasmic components of the cell together. Archeans are often found in extreme environments, like hot springs, in which most Bacteria cannot survive. Archeans have stronger chemical bonds in the interactions that hold the membrane together and it is this that allows this cell to survive in extreme conditions.

Figure 2.8
(a) Cell walls in cork tissue, as drawn by Hooke in 1665. (b) Hooke’s Micrographia. Hooke’s spore drawing in 1665.
Cyanobacteria

The common name “blue-green algae” for cyanobacteria characterizes the primary feature of about half the organisms found in this classification. The defining characteristic and the common name are derived from the pigments phycocyanin (blue) and chlorophyll (green) present that give them their color. These pigments are not contained within membrane-bound chloroplasts, like in eukaryotic plant cells. However, despite not having chloroplasts cyanobacteria still photosynthesize and

Table 2.5
Prokaryotes vs. Eukaryotes

<table>
<thead>
<tr>
<th>Structure</th>
<th>Prokaryote</th>
<th>Eukaryote (Animal)</th>
<th>Eukaryote (Plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Wall</td>
<td>Present</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Cell Membrane</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Flagella</td>
<td>Sometimes</td>
<td>Sometimes</td>
<td>Absent (mostly)</td>
</tr>
<tr>
<td>ER</td>
<td>Absent</td>
<td>Usually Present</td>
<td>Usually Present</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Microtubules</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Centrioles</td>
<td>Absent</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Golgi Apparatus</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Nucleus</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Chloroplasts</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Chromosomes</td>
<td>Single circle of DNA</td>
<td>Multiple</td>
<td>Multiple</td>
</tr>
<tr>
<td>Vacuoles</td>
<td>Absent</td>
<td>Small</td>
<td>Present and large</td>
</tr>
</tbody>
</table>
actually produce the majority of the earth’s oxygen supply. All cyanobacteria are prokaryotes and most are surrounded by a gelatinous matrix, called a mucilaginous sheath. They live in soils, on moist surfaces, and in water (can be found easily in South Florida pond waters). Cyanobacteria are the largest of the prokaryotes and are easily seen using the compound light microscope.

Procedure 2.8

1. Examine a prepared slide of Oscillatoria and one of Gloeocapsa. Sketch each organism in the space provided below. Note the magnification at which you viewed your specimens.
2. On clean slides, prepare a wet mount of Oscillatoria and another of Gloeocapsa. Compare your observations to those previously visualized using prepared slides.

Observations of Cyanobacteria Wet Mounts

<table>
<thead>
<tr>
<th>Oscillatoria</th>
<th>Gloeocapsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnification: _______</td>
<td>Magnification:</td>
</tr>
</tbody>
</table>

Questions

30. Were you able to locate nuclei in either species? Did you expect to? Explain.


33. Where are the pigments located in the cyanobacteria that you examined? Are they present throughout the entire organism or only in certain locations?

34. How does the cell morphology differ between the two species of cyanobacteria?

35. How many cells are held together within one sheath of Gloeocapsa?

**Task 9—EUkARYOTIC CELLS**

Eukaryotes evolved approximately 1.5 billion years ago. In general, eukaryotic cells tend to be much larger and have a more complex structural design than prokaryotes since they possess a membrane-bound nucleus as well as a number of other membrane-bound organelles (Table 2.5).

The similarities observed between the prokaryotes and eukaryotes led to the development of the Endosymbiotic Theory. This theory proposes that eukaryotic cells arose from a prokaryotic ancestor (Figure 2.10). By engulfing and establishing a

![Figure 2.10](image)

**Figure 2.10**
The endosymbiotic theory.

2–18
symbiotic relationship with cells that could undergo photosynthesis (photosynthetic bacteria) and create energy (ATP) through cellular respiration (aerobic bacteria), this new cell type has an advantage over its more ancestral form. The new relationship allowed the host ancestor cell to provide protection to the engulfed energy-producing cell and provide nutrients to the engulfed cells, while the engulfed cells allowed for metabolic processes like cellular respiration to occur within the host, a crucial evolutionary adaptation. The creation of this symbiotic relationship was the first step in moving towards a compartmentalized cell with each compartment (organelle) maintains an important and unique function.

Questions
36. Based on the endosymbiotic theory, some of the eukaryotic organelles have prokaryotic origins. Which organelles do you think these are and why?

37. What evidence would you need to gather to support the endosymbiotic theory? Explain how each piece of evidence would support the theory. (Hint: consider the structure of the modern eukaryotic cell)

Task 9A—EXPLORING PLANT CELLS

Plant and animal cells share most of the same organelles (Table 2.5). These include: (1) membrane-bound nucleus (contains genetic material, i.e. DNA, and is the control center of the cell), (2) cytoplasm, (3) endoplasmic reticulum (network of tubules used for protein translation and transport), (4) Golgi apparatus (processes proteins and lipids), (5) ribosomes (aid in translation of the genetic code) and (6) mitochondria (used for aerobic respiration). However, structures like chloroplasts (used for photosynthesis), the cell wall (surrounds the plasma membrane), and the central vacuole (contains water, ions, nutrients and waste products) are unique to plant cells (Figure 2.11).

Figure 2.11
Plant cell structure.
**Procedure 2.9: Examine Plant Cells**

1. Collect one leaf from a sprig of *Elodea* and place the leaf, with the top surface facing up onto a clean slide.
2. Add one drop of pond water (same water sample that the *Elodea* came from).
3. Properly add a coverslip, as instructed during the preparation of a wet mount.
4. Examine this slide with the compound light microscope. Remember to always start on low power and then move to a higher magnification. Draw the specimen in the space provided.

**Elodea**

Magnification: _______

---

5. From an onion bulb collect one thin piece of epidermis by peeling the thinnest layer possible from each scale using forceps (Figure 2.12). The onion preparation should be about 1-cell thick.
6. Add 1 drop of 0.1% neutral red to the piece of onion.
7. Place a coverslip over the onion.
8. Set to stain for 5–10 minutes before visualizing.
9. Examine this slide with the microscope, starting at the lowest power.
10. Draw what you see in the space provided:

   Staining often reveals the structure of cells and cell organelles more clearly. A dye preferentially stains some parts of the cell while leaving others clear. Janus B Green stain, for instance, preferentially stains mitochondria.

**Onion-Neutral Red Stain**

Magnification: _______
Questions
38. What shape are the Elodea cells? What shape are the onion cells? Are they round or do they have distinct sides?

39. Try to determine how many cells thick your leaf and onion is by focusing up and down through the layers of cells.

40. What cell structures are visible? What are the functions of these structures? Make sure to label these structures in your scientific drawing above.

41. Are there any visible chloroplast? Explain your reasoning.
42. Why are the onion cells not green?

43. Why do you think plants have cell walls? Why are cell walls absent in animal cells?

44. Locate the chloroplasts within the cells. Try to estimate of the number present in one cell. Where in the cell do you generally find the chloroplasts?

45. Locate the central vacuole. Since it contains water, what should you see within it? Should there be any shapes or colors? This information should help you to locate it.

46. Locate the nucleus in the Elodea leaf. It may be pressed against the edge of the cell by the vacuole and may appear gray compared to the surrounding chloroplasts which are green. To enhance visibility, add a drop of iodine to the slide.

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**Task 9B—ANIMAL CELLS**

**Procedure 2.10: Examine Animal Cell**

1. Using a toothpick, gently scrape the inside of your cheek.
2. Add one drop of water to a clean slide.
3. Stir the scrapings from the toothpick into the drop of water and then add a drop of methylene blue followed by a coverslip.
4. Sketch a few of the cells in the space provided. Label any visible organelles on your drawing.
5. Sketch a few of the cells in the space provided. Label any visible cellular structures on your scientific drawing.
Figure 2.13
Animal cell.

Human Epithelial Cell- Methylene Blue Stain
Magnification: _________

Questions
47. What structure are visible in the cheek cells? Make sure to label the structures in the sketch above.

48. Compare and contrast the structural components of the cheek and onion cells.