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| **Part 1 - Get a Lab Appointment and Install Software:** |
| [ ]  | **Set up an Account on the Scheduler (FIRST TIME USING NANSLO):**Find the email from your instructor with the URL (link) to sign up at the scheduler.Set up your scheduling system account; retrieve your email with your username and password; schedule your lab appointment**.  NOTE:** You cannot make an appointment until two weeks prior to the start date of this lab assignment. |
| [ ]  | **Install the Citrix software:** – go to [http://receiver.citrix.com](http://receiver.citrix.com/) and click download > accept > run > install (**FIRST TIME USING NANSLO**).You only have to do this ONCE. **Do NOT** open it after installing. It will work automatically when you go to your lab. (more info at <http://www.wiche.edu/info/nanslo/creative_science/Installing_Citrix_Receiver_Program.pdf>) |
| [ ]  | **Scheduling Additional Lab Appointments:** Get your scheduler account username and password from your email.Go to the URL (link) given to you by your instructor and set up your appointment.(more info at <http://www.wiche.edu/nanslo/creative-science-solutions/students-scheduling-labs>) |
| [ ]  | **Changing Your Scheduled Lab Appointment:** Get your scheduler account username and password from your email. Go to <http://scheduler.nanslo.org> and select the “I am a student” button. Log in to go to the student dashboard and modify your appointment time. (more info at <http://www.wiche.edu/nanslo/creative-science-solutions/students-scheduling-labs>) |
| **Part 2 – Before Lab Day:** |
| [ ]  | **Read** your lab experiment background and procedure below, pages 1-16. |
| [ ]  | **Submit** your completed Pre-Lab 1 Questions (page 9) per your faculty’s instructions. |
| [ ]  | **Submit** your completed Pre-Lab 2 Questions (page 9) per your faculty’s instructions. |
| [ ]  | **Watch** the Microscope Control Panel Video Tutorial <http://www.wiche.edu/nanslo/lab-tutorials#microscope> |
| **Part 3 – Lab Day** |
| [ ]  | **Log in** to your lab session – 2 options:1)Retrieve your email from the scheduler with your appointment info or 2) Log in to the student dashboard and join your session by going to <http://scheduler.nanslo.org> **NOTE:** You cannot log in to your session before the date and start time of your appointment. Use Internet Explorer or Firefox. |
| [ ]  | **Call in** to the teleconference number on the lab control panel to talk to your lab partners and the lab tech. |

# North American Network of Science Labs Online (NANSLO) logo Remote Lab Activity

###  SUBJECT SEMESTER: \_\_\_\_\_\_\_\_\_\_\_\_

## TITLE OF LAB:  Cell Type Comparison

**Lab format:** This lab is a remote lab activity.

**Relationship to theory (if appropriate):**In this lab you will be examining the underlying processes that make up the cell cycle.

**Instructions for Instructors:** This protocol is written under an open source CC BY license. You may use the procedure as is or modify as necessary for your class.  Be sure to let your students know if they should complete optional exercises in this lab procedure as lab technicians will not know if you want your students to complete optional exercise.

**Instructions for Students:**  Read the complete laboratory procedure before coming to lab.  Under the experimental sections, complete all pre-lab materials before logging on to the remote lab, complete data collection sections during your on-line period, and answer questions in analysis sections after your on-line period.  Your instructor will let you know if you are required to complete any optional exercises in this lab.

**Remote Resources:**  Primary - Microscope; Secondary - Elodea Cell Types Slide Set.

### CONTENTS FOR THIS NANSLO LAB ACTIVITY:

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### LEARNING OBJECTIVES:

After completing this lab, you should be able to do the following things:

1. Describe the structural and size differences between prokaryotic and eukaryotic cells.
2. Identify the parts of a cell.
3. Describe the appearance and function of the major components of a cell, including: cell membrane, cytoplasm, and the following membrane-bound organelles: nucleus, rough and smooth endoplasmic reticulum, mitochondria, chloroplast, and vacuole.
4. Explain how plant cells differ from animal cells.
5. Have a visual representation of the organisms that makes up each kingdom.

### BACKGROUND INFORMATION:

 All living things are composed of one or more cells, which make cells the basic units of life.  Most cells are microscopic but some, such as a human ovum, may be seen by the naked eye.    While cells can vary in size, they generally range from 10 to 100 micrometers. **Figure 1** shows the relative sizes of the different types of cells and the components that they are made up of.

 **Figure 1:** Chart showing relative size of different types of cells.

 The **cell theory** describes some basic concepts that we understand about cells.  Historically, it stems from work done in the mid-1800’s in Germany.  Three scientists, all working independently, came up with the following statements:

1. All animals are composed of cells.
2. All plants are composed of cell.
3. All cells come from pre-existing cells.

According to the cell theory, the cell is the base unit of life.  A single cell possesses all of the requirements for life.  Therefore, to begin the study of biology, one must have a good understanding of a cell.  Cells are broken into two main groups: prokaryotic and eukaryotic.  ***Pro*** as a prefix means “before” and **karyon** refers to nucleus (kernel).  Therefore, a **prokaryotic** cell is one without a nucleus or “pre-nucleus.”

On the other hand, ***eu*** means “true,” so ***eukaryotic*** cells are the cells with a true membrane bound nucleus.

**Prokaryotic** (bacterial types) cells are more primitive. They have been identified in geologic strata dating back 3.5 billion years.  These are also considered to be the simplest life forms because their cells lack membrane bound organelles. See **Figure 2**.  Note that there are no internal membranes within the cell.

 **Figure 2:**  Prokaryotic Cell

**Eukaryotic** cells appear in the fossil record about 2 billion years after prokaryotic cells.   Eukaryotic cells are found in plants, animals, protists, and fungi.  They show a higher level of complexity in that they have internal, membrane bound organelles.  This complexity has led to greater specialization, allowing this group of cells to have success in both single and multi-cellular organisms.

 All eukaryotic cells have internal organelles.  Each organelle has a specific function that relates to the overall function of the cell.  With a greater understanding of the specific function of each organelle, one can start to see structure-function relationships which are inherent in biology.  A good example of this would be a cell that has a role in the production of proteins needed for export.  It would have a greater amount of rough endoplasmic reticulum (ER).  The rough ER functions to produce proteins, and then the protein move into the membrane channels for transport.

* Study the list below to become familiar with all of the different types of organelles and other structures in a cell.  Make note of those that are unique to eukaryotic plant or animal cells.

**Figure 3a:** Generalized animal cell.


**Figure 3b:** Generalized plant cell.
* **Centrioles** – Centrioles are self-replicating organelles made up of microtubules and are found only in animal cells. They have a role in cell division.
* **Cilia and Flagella** – Cilia and flagella are microtubule based structures that function in the locomotion of single-celled organisms.  In multi-cellular organisms, cilia can function to move fluid or materials.
* **Endoplasmic Reticulum** – Extending from the outside of the nucleus into the cytoplasm, the ER is a system of internal membranes within the cytoplasm of the cell.  Some parts of the ER are covered with protein-making ribosomes.  The presence of the ribosomes makes this the Rough ER.  Smooth ER does not have ribosomes that attach to the surface but are involved in the chemical activities of fat metabolism and the detoxification of toxic substances (alcohol & drugs).
* **Golgi Apparatus**  – The Golgi apparatus is the distribution and shipping department for the cell's chemical products.  Think of it as the “Mailboxes Etc.” store of a cell.  It modifies substances made at the endoplasmic reticulum and prepares them for export to the outside of the cell.
* **Intermediate Filaments, Microfilaments, and Microtubules**  – We have mentioned these structures before in reference to cilia, flagella, and centrioles. These are long protein structures that provide a structural framework for the inside of the cell membranes – the cytoskeleton.  They provide the cell with shape, support and the ability to move about the cytoplasm.  They also serve to transport materials from place to place.  Additionally, these fibers help with the process of cell division by contracting together in the middle of the cell to assist in cell division.
* **Lysosomes** – Lysosomes break down macromolecules.  They digest worn-out cell components to make way for newly formed ones.  These organelles also eliminate particles the cell has taken in.  For example:  white blood cells (WBCs) engulf pathogens such as bacteria that are disease causing.  The presence of lysosomes in plant cells is being debated.
* **Mitochondria** – Mitochondria have a unique double-membrane structure, and they have their own DNA. The membrane systems function in a complex series of reactions to extract energy from organic molecules (i.e. food.)  They are the site of cell metabolism.  The inner membrane is bent into numerous folds called cristae.  The cristae separate the mitochondrion into two compartments, an inner matrix and an outer compartment.
* **Nucleus** – The nucleus like the mitochondria has a double membrane structure. It contains the genetic material of the cell (DNA) and separates the nucleoplasm from the cytoplasm.  This membrane has pores, nucleopores, which allow for the passing of molecules.  One nuclear component within this membrane is chromatin which is a mass of loosely organized DNA and proteins.  When tightly coiled into shorter, denser structures, chromatin forms chromosomes.  Another component of the nucleus is the nucleolus which is the site of ribosome manufacturing.  Lastly, the nucleoplasm refers to the liquid matrix on the inside of the nucleus.  The nucleus has two major functions:  (1) it stores the cell's hereditary material, or DNA, and (2) it coordinates the cell's activities. All cells have DNA in a prokaryotic cell but it is not bound by a membrane.  In a eukaryotic cell, the DNA is found in the nucleus.
* **Plasma Membrane**  – All living cells (both prokaryotic and eukaryotic) have plasma membranes that enclose their contents.  The plasma membrane is a phospholipid bilayer.  This means that there are two layers of lipids that create a sort of sandwich.  These membranes regulate the passage of molecules into and out of the cells.
* **Ribosomes** – All living cells contain ribosomes or tiny organelles composed of approximately 60 percent ribonucleic acid (RNA) and 40 percent protein.  They are constructed from two oddly-shaped subunits which serve to manufacture proteins.  Cells that produce large amounts of protein have great numbers of free and attached ribosomes.  Remember, they can be attached to the endoplasmic reticulum creating the rough endoplasmic reticulum.
* **Cytoplasm** – Also known as cytosol, this is the fluid portion of the cell.  It is found in all cell types.  In a eukaryotic cell, it is between the nuclear membrane and the plasma membrane. In a prokaryotic cell, it is found inside the plasma membrane.
* **Cell Wall**  – Plant, fungal cells, and some bacterial cells have a rigid wall surrounding the plasma membrane.  The cell walls are composed of complex carbohydrates and serve a variety of functions from protecting the cell to regulating the life cycle of the plant organism.
* **Chloroplasts** – The chloroplast is a saclike organelle that contains chlorophyll, a green pigment that carries out photosynthesis.  Chloroplasts are found in plants.  Some prokaryotic organisms have chlorophyll, but it is not contained in an organelle.  Photosynthesis produces sugars which are used as an energy source for cells. Like the mitochondrion, chloroplasts have complex double membrane structures, DNA, and are energy organelles.
* **Vacuole** –Vacuole is a membrane bound storage cavity in a cell. In a plant cell, it is a large, single central vacuole that stores compounds, helps in plant growth, and plays an important structural role for the plant.  In other organisms, it can function for storage ingestion, digestion, excretion, and expulsion of excess water.

**Classifying Organisms**

* Living things are classified into groups based on their relatedness. Originally this relatedness was determined by physical or biochemical similarities. As technology changes, we are able to get a deeper understanding of the relationships between organisms. For example, in Darwin’s time he was simply looking at the visual and structural similarities and the differences between organisms. Today, we can use DNA analysis to explore the interrelationships between the organisms. This better understanding of the molecular similarities of organisms has led to some changes in how we organize life.  Currently, there are three domains and six kingdoms. This three-domain system, which classifies life on the planet into three different domains - Archaea, Bacteria and Eukaryote, was put forth by American microbiologist and physicist Carl Woese in 1990 by looking at differences in organisms rRNA1.  Therefore, the current taxonomic system has eight main levels which are:



Of the three domains, two are made up of prokaryotic cells- the archea and the bacteria.  At present, there are no agreed kingdom level classifications in the archea and bactierial domains, something which may change as technology and our understanding continues to improve. The archea are a group that like all prokaryotic cells lack a nuclear membrane.  They do have distinct biochemistry and RNA markers from bacteria.  Often these archea are called extremophiles, because they can inhabit areas with extreme environmental conditions such as in the hot sulfur springs and under the polar ice caps.   The characteristics and habitats of these organisms have led scientists to consider the archea some of the oldest species of organisms on Earth2.

The domain bacteria contain the kingdom **Bacteria,** and these are the bacteria you are probably more familiar with as many of them are pathogenic to humans. This group is made up of prokaryotic cells possessing primarily diacyl glycerol diester lipids in their membranes, bacterial rRNA, and no nuclear membrane2.

The domain eukarya contains all of the organisms that are composed of eukaryotic cells. These are the cells characterized by having a true nucleus (one in which the nuclear material is surrounded by a membrane) and membrane-bound organelles.  In this domain, we have the following kingdoms: Protista, Fungi, Plantae and Animalia.

The **Protista** kingdom is a mixed collection of organisms that are placed together because they are not plants, animals, or fungi. It is rather a mixed bag. These organisms can be heterotrophic or autotrophic, motile, or sessile and single or multicellular.

The kingdom **Fungi** are commonly known as fungus and molds. These organisms are primarily multicellular with cell walls composed of chitin. Yeast is the exception.  It is a single celled fungus. Fungi are heterotrophic with extra cellular digestion and primarily sessile but may have a motile life stage.

The kingdom **Plantae** is composed of the plants you are familiar with – everything from moss and ferns to pine trees and corn. These organisms are multicellular, autotrophic, and sessile.

Lastly, the kingdom **Animalia** is composed of all of the animals. These are all heterotrophic, multicellular, and motile. For a minute, just think about the diversity found in this group of organisms – from sponges and insects to elephants and whales.  **Figure 4** gives a simple visual to help you recognize the groups.

 **Figure 4:** Organization scheme for living things.

 **References:**

1. Three Domains of Life, date of publication unknown, PDF - <http://www.usc.edu/org/cosee-west/Nov30_2011/Three%20domains%20of%20life.pdf>
2. Three-domain system, Retrieved from <http://en.wikipedia.org/wiki/Three-domain_system>

###  PRE-LAB EXERCISE 1:  Single Cellular Organisms

The cell is the base unit of life.  From this statement, we understand that all living things are composed of one or more cells.  This lab exercise will explore single celled prokaryotic and eukaryotic cells. We will not make the distinction between the Archea and the Bacteria domains in this lab. Bacteria are often recognized based on shape. The following images in **Figure 5** give you an idea of the 3 shapes- rod shaped (Bacillus), spherical (Coccus) and spiral (Spirillum).

 **Figure 5:** Bacterial shapes

 The protists are in the domain eukarya, kingdom Protista.  While there are some types of protistas that are multicellular, the ones observed today are all single celled.

**Pre-Lab 1 Questions:**

1. Based on your pre-lab reading do you think the cells you will be observing will be prokaryotic or eukaryotic? Explain your reasoning.
2. Rewrite your answer to question one in the form of an If … Then … hypothesis.
3. What structural differences do you expect to see in these two groups of organisms?

### PRE-LAB EXERCISE 2:  Multicellular Organisms

 All multi-cellular organisms are composed of eukaryotic cells.  In the last exercise, protists were examined, which make up one of the four kingdoms of eukaryotic cells.  Protists are generally single-celled, and the remaining three kingdoms of eukaryotes (plantae, animalia and fungi) are all multi-cellular organisms. In this lab exercise we will investigate the multicellular eukaryotes. As you explore these groups of organisms, pay close attention to differences between plant cells and animal cells.

**Pre-Lab 2 Questions:**

1. Based on your pre-lab reading what structural differences do you think you will see between the Plantae, Fungi and Animalia groups? Explain your reasoning.
2. Rewrite your answer to question one in the form of an If … Then … hypothesis.
3. In the last exercise you explored the Protista kingdom; some protista can be made up of more than one cell and function as colonial organisms. What is the difference between a colonial organism and a multicellular organism?

### EQUIPMENT:

* Paper
* Pencil/pen
* Slides
	+ Mixed protists
	+ Human epithelial cells
	+ Bacterial smear
	+ Yeast
	+ Mushroom/fungus
	+ Elodea, onion, plant epidermal tissue
* Computer (access to remote laboratory

### PREPARING FOR THIS NANSLO LAB ACTIVITY:

#### Read and understand the information below before you proceed with the lab!

**Scheduling an Appointment Using the NANSLO Scheduling System**

Your instructor has reserved a block of time through the NANSLO Scheduling System for you to complete this activity. For more information on how to set up a time to access this NANSLO lab activity, see [www.wiche.edu/nanslo/scheduling-software](http://www.wiche.edu/nanslo/scheduling-software).

**Students Accessing a NANSLO Lab Activity for the First Time**

For those accessing a NANSLO laboratory for the first time, you may need to install software on your computer to access the NANSLO lab activity. Use this link for detailed instructions on steps to complete prior to accessing your assigned NANSLO lab activity – [www.wiche.edu/nanslo/lab-tutorials](http://www.wiche.edu/nanslo/lab-tutorials).

**Video Tutorial for RWSL:** A short video demonstrating how to use the Remote Web-based Science Lab (RWSL) control panel for the air track can be viewed at [http://www.wiche.edu/nanslo/lab-tutorials#microscope](http://www.wiche.edu/nanslo/lab-tutorials%22%20%5Cl%20%22microscope).

**NOTE:**  Disregard the conference number in this video tutorial.

**AS SOON AS YOU CONNECT TO THE RWSL CONTROL PANEL: Click on the yellow button** at the bottom of the screen (you may need to scroll down to see it). Follow the directions on the pop up window to join the voice conference and talk to your group and the Lab Technician.

###  EXPERIMENTAL PROCEDURE:

 Read and understand these instructions BEFORE starting the actual lab procedure and collecting data.  Once you have logged on to the remote lab system, you will perform the following laboratory procedures.  See Preparing for this NANSLO Lab Activity below.

### EXERCISE 1:  Single Cellular Organisms

 **DATA COLLECTION:**

1. Select the Bacteria forms, smear slide (**Slide Cassette 2: #19**) from the microscope interface.  Using the 10X objective, locate the bacterial sample and bring it into focus.
2. Carefully work your way through all the objectives, focusing with each one until you reach the 60X objective and capture an image of the three bacterial shapes.  Insert the images below.
3. Measure the size of one type of bacterial cell.  To determine the size of the cells, we are going to use the ratio method.  In order to do this, you will need one piece of information which is the width of your field of view.  On our microscopes, the field of view is 305µm at 40X magnification and 205µm at 60X magnification.
4. Using the image in **Figure 6** as an example, we can see that the total width of the field of view is 13.6 cm or 136 mm (Image A).  The cell (Gray) is 3.7 cm or 37mm (Image B).


**Figure 6:** Measurements
5. Dividing 37mm/136mm = 0.272 which we multiply by the total length of the field of view so (40X; 0.272 \* 305µm = 82.96µm or 60X; 0.272 \* 205µm = 55.76µm) rounded for significant figures gives us a cell size of (40x; 83µm or 60X; 56µm).
6. Using your image of a bacterial cell and a ruler, determine the size of the bacterial cell.
7. Record your bacterial cell size in a data table. You will need a data table with columns for bacteria cell size, Protista cells size, plant cell size, and animal cell size.
8. Select the Mixed Protozoa Whole Mount slide (**Slide Cassette 1: #6**) from the microscope interface. Using the 10X objective, locate the bacterial sample and bring it into focus.
9. Carefully work your way through all the objectives, focusing with each one, until you reach the 60X objective and capture an image of several different types of protists.
10. Repeat steps 3 – 7 for one protista cell.
11. Record your Protista cell size in the data table.

 **ANALYSIS:**

1. Based on your observations, which cells were prokaryotic? eukaryotic? Use your observations to support your claim.
2. Research the two prokaryotic kingdoms.  What characteristics caused these organisms to be separated into two kingdoms?  Do you agree with the separation?  Explain your answer.
3. Research the endosymbiotic theory at the following websites.  Keep in mind that sometimes websites stop working.  If this is the case, do a web search  with the key word “Endosymbiosis”:

<http://www.biology.iupui.edu/biocourses/N100/2k2endosymb.html>
<http://evolution.berkeley.edu/evolibrary/article/_0/endosymbiosis_01>
<http://evolution.berkeley.edu/evosite/history/endosym.shtml>

Write a two to three paragraph summary discussing this theory and if there is evidence to support it.  Can you propose an alternate theory?
4. Based on the claim made above do you accept or reject your initial hypothesis? Use evidence gathered to explain why you would accept or reject your initial hypothesis
5. **(Optional)** Rewrite your hypothesis based on the evidence form analysis question 2.

### EXERCISE 2A:  Multicellular Organisms Plantae

**DATA COLLECTION:**

1. Select the Elodea leaf whole mount slide (**Slide Cassette 1: #4**) from the microscope interface. Using the 10X objective, locate the Elodea sample and bring it into focus.
2. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective and capture an image of the Elodea cells.  Insert your Elodea images below.
3. Measure the size of one Elodea cell.  To determine the size of the cells, we are going to use the ratio method.  In order to do, this you will need one piece of information which is the width of your field of view.  On our microscopes, the field of view is 305µm at 40X magnification and 205µm at 60X magnification.
4. Refer to Exercise 1, questions #4 – #6, to collect data on the size of the Elodea cells.
5. Record your Elodea cell size in a data table.
6. Using your word processor and the image you captured in step 2, label the chloroplast, cell wall, plasma membrane, and nucleus, if visible. Paste the labeled image below.
7. Select the onion root tip slide (**Slide Cassette 1: #8**) from the microscope interface. Using the 10X objective, locate the onion sample and bring it into focus.
8. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective and capture an image of the onion cells.  Insert your onion images below.
9. Using your word processor and the image you captured in step 2, label the cell wall, plasma membrane and nucleus. Paste the labeled image below.
10. Select the plant allium (onion) epidermis (**Slide Cassette 2: #9**) from the microscope interface. Using the 10X objective, locate the plant epidermal sample and bring it into focus.
11. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective and capture an image of the plant epidermal cells.  Insert your plant epidermal images below.
12. Using your word processor and the image you captured in step 2, label the stomata. Paste the labeled image below.

**ANALYSIS:**

1. Why were there no chloroplasts in the onion root tip cells?
2. What is a plastid, and what other types of structures can a plastid become?
3. What were the similarities and the differences seen in the Elodea and the onion cells?
4. What important function do stomata have for plants?

### EXERCISE 2B:  Multicellular Organisms Animalia

**DATA COLLECTION:**

1. Select the human epithelial slide (**Slide Cassette TBD**) from the microscope interface. Using the 10X objective, locate the sample and bring it into focus. There will be three different types of epithelium: squamous, columnar, and cuboidals.
2. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective and capture an image of the human epithelial cells.  Insert your human epithelial images below.  You should have an image of each type of cell on the slide.
3. Measure the size of one human epithelial cell.  You may pick any one of the human epithelial cell types. To determine the size of the cells, we are going to use the ratio method.  In order to do this, you will need one piece of information which is the width of your field of view.  On our microscopes, the field of view is 305µm at 40X magnification and 205µm at 60X magnification.
4. Refer to Exercise 1, questions #4 – #6, to collect data on the size of the human epithelial cells.
5. Record your human epithelial cell size in a data table.
6. Using your word processor and the image you captured in step 2, label the nucleus, cytoplasm, and plasma membrane. Paste the labeled image below.

**ANALYSIS:**

1. Are all of the epithelial cells you viewed the same shape?  Think about structure function relationships.  Does the structure of the observed cells fit their functions?  Explain your reasoning.
2. How does the size of the epithelial cell compare to the plant cells?

###  EXERCISE 2C:  Multicellular Organisms Fungi

**DATA COLLECTION:**

1. Select the Ascomycetes:  Yeast three types slide (**Slide Cassette 2: #42**) from the microscope interface. Using the 10X objective, locate the yeast sample and bring it into focus. Yeast is a single celled organism in the fungi kingdom.
2. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective.  Select an area on the slide so that the yeast cells completely fill the field of view.
3. Position the slide so that the left edge of a cell is at the left edge of your field of view.  Capture an image of the yeast.  Insert your yeast images below.
4. Select the Wood rot fungus, Section slide (**Slide Cassette 2: #46**) from the microscope interface. Using the 10X objective, locate the fungus sample and bring it into focus
5. Carefully work your way through all the objectives focusing with each one until you reach the 60x objective.  Select an area on the slide so that the fungus cells completely fill the field of view
6. Position the slide so that the left edge of a cell is at the left edge of your field of view.  Capture an image of the fungal cells.  Insert your fungus  images below.

**ANALYSIS:**

1. Fungi reproduce by spores.  How are spores structurally different from seeds?  Is a spore asexual or sexual?
2. Are fungi autotrophic or heterotrophic?  Explain your reasoning.
3. Many fungi are parasitic or disease causing.  Research a fungus of your choice, and write a paragraph summing up your findings.

### SUMMARY QUESTIONS

1. Based on your observations what structural differences did you see between the Plantae, Fungi and Animalia groups?  Use your observations to support your claim.
2. After completing the lab what surprised you the most about the organisms you observed?
3. Fill out the following chart. Some have been completed to get you started.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Kingdom  |   | Archea  |   | Fungi  |   |   |
| Motility  |   | motile  |   |   |   | sessile  |
| Food Production  |   |   | Both autotrophic and heterotrophic  |   | heterotrophic  |   |
| Type of Cell  |   | Prokaryotic  |   |   |   | Eukaryotic  |
| Domain  | Bacteria  |   | Eukarya  |   | Eukarya  |   |

1. Of the cell types you studied, which ones do you think would be most successful in harsh conditions?  Defend your answer.
2. What characteristics do plants and fungi share? Plants and fungi were initially classified as one group.  What characteristics would have led early taxonomists to do this?  Do you agree with the separation of these organisms into two separate kingdoms?  Explain your reasoning.
3. Research the importance of members of the Protista and Fungi Kingdom to man.  Write a two to three paragraph mini-essay on one of these organisms and their importance to the ecosystem.

For more information about NANSLO, visit [www.wiche.edu/nanslo](https://cheo.pbworks.com/NANSLO).

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