WICHE Consortium of Healthcare Education Online DOL grant

Dr. Suzanne Buie,DPT,STC
Chair of Health Sciences Department
smbuie@uaa.alaska.edu
Kodiak College
865-456-0789

The list below shows demos of online lab equipment and experiments which have been developed with DOL TAACCCT grant funding. One of the intended outcomes of the CHEO grant is to develop and pilot open source labs among grant partners which could then be available to be shared with any interested faculty to incorporate into their own classes, if appropriate.

The Student Dashboard: https://www.youtube.com/watch?v=ZYfwtp3SxjU

These short videos will give you an introduction to the control panel for the various different kinds of equipment we have available:

Microscope: https://www.youtube.com/watch?v=m7w9ssIgVdw

Absorbance Spectrometer: https://www.youtube.com/watch?v=BYoVCPUI5NA

Emission Spectrometer: https://www.youtube.com/watch?v=X8Mr1nuVm3Y

Air Track: https://www.youtube.com/watch?v=UIg9N3rbULM

Helmholtz Coil: https://www.youtube.com/watch?v=PbEGDhMdZ0Y

CELL DISEASES LAB

Lab Format: This lab is a remote lab activity Microscopy.

Relationship to Theory: In this lab you will learn the underlying principles that allow a microscope to function and you will learn to operate a microscope.

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.

Remote Resources: Primary - Microscope, Secondary – introduction to Microscopy slide set.

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.

Contents

LEARNING OBJECTIVES

After completing this laboratory experiment, you should be able to do the following:

1. Compare the shape of normal red blood cells and sickled red blood cells.
2. Identify the differences between normal skin tissue layers and skin cancer.
3. Identify and describe at the cellular level the difference between acute monocytic leukemia and chronic lymphatic leukemia
4. Compare the diameter of normal blood vessels and the ones suffering from atherosclerosis.
5. Identify the cellular changes that occur in the liver due to cirrhosis.

BACKGROUND INFORMATION

Cells inside organisms undergo a variety of changes as part of adaptations due to growth, stress and aging. During these adaptations, cells are trying to maintain homeostasis to prevent diseases. The human body can be affected by several stimuli such as:

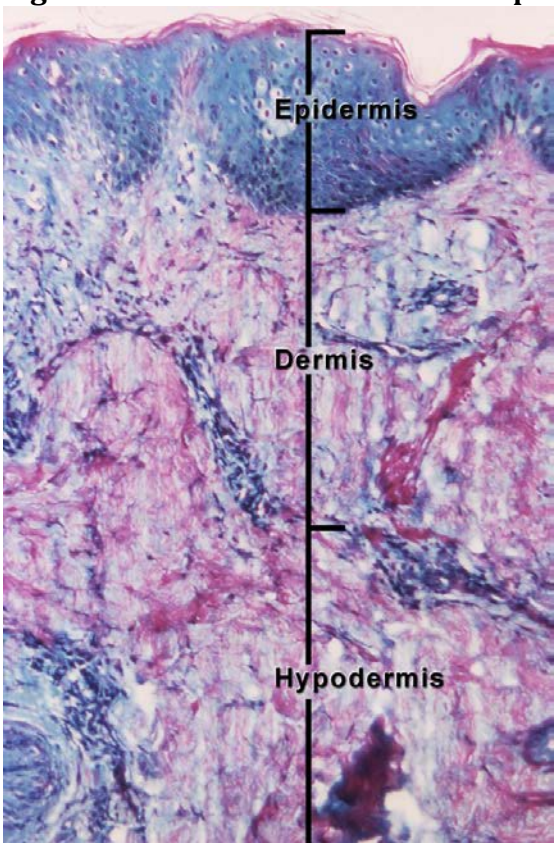
- Physical agents (mechanical trauma, temperature variation).
- Chemical agents (radiotherapy, glucose or lipid accumulation).
- Infectious microorganisms (toxins produced by bacteria or viruses interfering with normal cell metabolism).
- Hypoxia: lack of oxygen supply to cells (it could be detrimental for the brain).
- Genetic factors leading to abnormal cellular metabolism or malformation.
- Nutritional imbalances (more frequent in children).
- Hypersensitivities and allergic reactions

However, some of the changes could cause irreversible effects leading to pathological changes that could be obvious or difficult to detect. Many of the common diseases that affect humans are caused by disruptions of the basic mechanisms of the cell. Medical professionals and scientists rely on histopathology, the microscopic study of tissue to accurately diagnose diseases of the human body. During this laboratory activity, you will be viewing and comparing different types of cells and tissues to identify the differences between diseased and normal issues at the cellular level. We will be looking at cells from several different tissues in the body including the skin, internal organs, and the blood. Each tissues type is described in detail below.

Skin

Our skin is the largest organ. It has several functions;-serving as a protective barrier, regulating our body temperature, producing sweat and other functions. Although most diseases affecting the skin originate in the layers of the skin, (Figure 1) such abnormalities are also important factors in the diagnosis of a variety of internal diseases. There is some truth in the belief that the skin mirrors a person's internal health. Often, the visibility and accessibility of skin make it the first organ of the body to show detectable signs of underlying disease.

Figure 1: Normal human skin tissue specimen



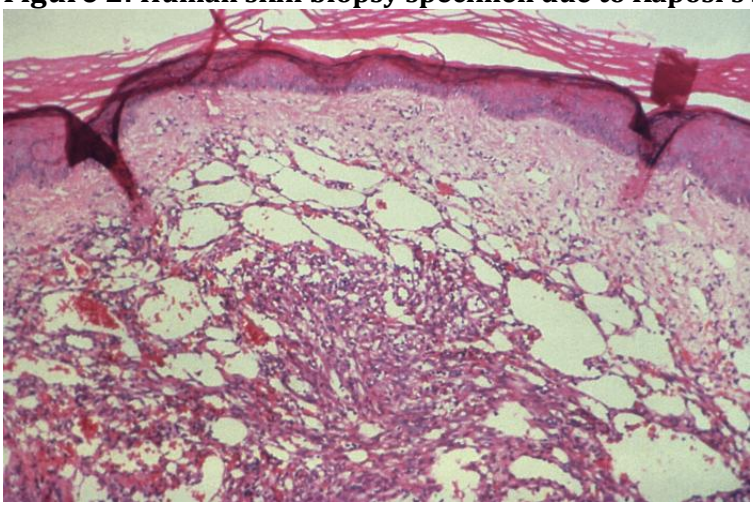
Normal human skin is composed of three layers; epidermis, dermis, and hypodermis. The epidermis is the outermost layer. The epidermis and dermis together make up the cutis. The Hypodermis makes up the subcutis and contains structures like the hair follicles and sweat glands.

(*) http://phil.cdc.gov/phil/details.asp

Abnormalities of the skin frequently suggest metabolic, malignant, and glandular diseases. Skin cancer is the most common form of cancer in the United States. The two most common types of skin cancer—basal cell and squamous cell carcinomas—are highly curable. However, melanoma, the third most common skin cancer, is more dangerous. About 65%–90% of melanomas are caused by exposure to ultraviolet (UV) light (*)

UV light is not the only cause of skin cancer Kaposi sarcoma (Figure 2), is a malignant tumor of the lymphatic endothelium caused by the Human herpesvirus 8 (HHV8), i.e., Kaposi's sarcoma-associated herpesvirus (KSHV), and arises from a cancer of the lymphatic endotheial lining. It is characterized by bluish-red cutaneous nodules. Kaposi's sarcoma is thought of as an opportunistic infection, affecting patients whose immune systems have been compromised, as in the case of patients with HIV/AIDS. (*)

Figure 2: Human skin biopsy specimen due to Kaposi's sarcoma.



Above is a photomicrograph depicting the histopathologic changes seen in human skin biopsy specimen due to Kaposi's sarcoma. Of importance is the appearance of the dermal layer, which contained a cellular infiltrate, and a proliferation of vascular elements.
(*) http://phil.cdc.gov/phil/details.asp

Like other tissues, skin is afflicted by all types of pathological changes, including hereditary, inflammatory, benign and malignant (neoplastic), endocrine, hormonal, traumatic, and degenerative processes. Emotions affect the health of the skin as well. The reaction of the skin to certain diseases and disorders differs from that of other tissues in many ways. For example, extensive inflammation of the skin may affect metabolism within other organs and systems of the body, causing anemia, circulatory collapse, disorders of body temperature, and disturbance of water and electrolyte balance in the blood. (*)

Internal Organs

The Internal organs of a body are complex structures consisting of a combination of parenchymal tissue and stromal tissue. The cells of the parenchyma are specialized to carry out the function of the organ, while the stromal cells are involved in support (e.g. connective tissue and blood vessels).

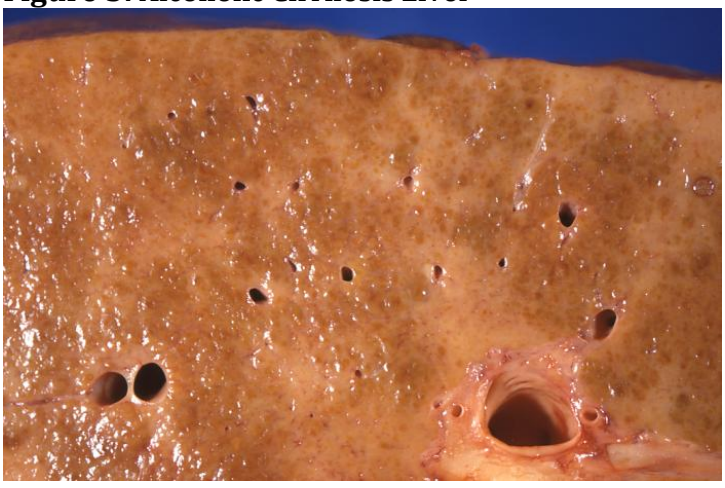
For example, the microscopic anatomy of the liver reveals a uniform structure of clusters of cells called lobules, where the vital functions of the liver are carried out. Each lobule, measuring about one millimeter in diameter, consists of numerous cords of rectangular liver cells, or hepatocytes that radiate from central veins, or terminal hepatic venules, toward a thin layer of connective tissue that separates the lobule from other neighboring lobules.

Hepatocytes occupy about 80 percent of the volume of the liver, and their cytoplasm (the area surrounding the nucleus) contains many mitochondria, which provide the energy needed for

the many synthetic and metabolic functions of the liver cell. The cytoplasm also contains a series of long tubules, called the endoplasmic reticulum, which provides many enzymes essential to liver function. Some of the membranes of the endoplasmic reticulum appear granular, or rough, owing to the presence of ribosomes, which are responsible for forming specific polypeptide (protein) chains after having had the amino group removed (deamination) and having been converted into glucose through a process called gluconeogenesis. The ammonia released from gluconeogenesis is converted to urea in the hepatocyte by way of the urea cycle. The nonribosomal, or smooth, endoplasmic reticulum is where cytochromes (combinations of heme from hemoglobin with various proteins) and certain enzymes undertake the important hepatic functions of drug and hormonal metabolism and also cholesterol synthesis. Hepatocytes also conjugate with carbohydrate components of bilirubin and other fat-soluble metabolic and foreign compounds and thereby are made soluble in water. Bilirubin is the product of hemoglobin metabolism that is formed in the bone marrow and the lymphatic tissue and is carried to the liver after becoming bound to plasma albumin. It is released at the hepatocytic sinusoidal membrane and is transported to the smooth endoplasmic reticulum, where it is conjugated with one or two molecules of glucuronic acid and thereby becomes soluble in water and excretable in bile. The Golgi apparatus, a series of tubular structures between the endoplasmic reticulum and the canaliculus, acts as a transport station for newly made proteins and other hepatocytic products before they are conveyed to other parts of the cell or out of the cell entirely. Lysosomes, another important cytoplasmic constituent, are responsible for the intracellular storage of pigments, such as iron or copper, and for the digestion of certain contents, such as glycogen or foreign particles. The nucleus of the hepatocyte guides replication of the cell and transmits genetic material in the form of messenger ribonucleic acid (mRNA) from deoxyribonucleic acid (DNA) to organelles located in the cytoplasm (*).

The parenchymal cells of certain organs, such as the liver, the heart and the kidneys, are responsible for the metabolism and elimination of excess fat. If the fat droplets are not properly metabolized they end up accumulating in the endoplasm reticulum and the Golgi apparatus of the cells (Figure 3). This accumulations could be irreversible, leading to more serious health problems and may even lead to death.

Figure 3: Alcoholic Cirrhosis Liver



Above is an image of a liver with alcoholic cirrhosis, the yellow color indicates the accumulation of fat inside the hepatocytes interfering with normal activity of these cells

due to excessive alcohol consumption.
http://phil.cdc.gov/phil/details.asp

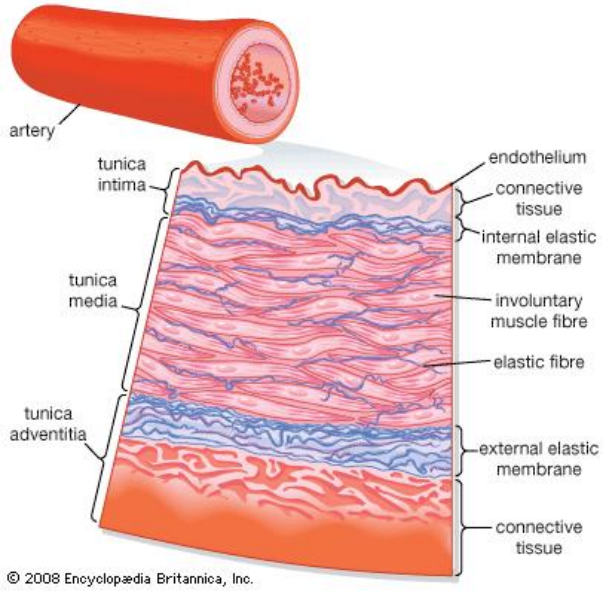
(*) Reference:

http://www.britannica.com/EBchecked/topic/1081754/human-digestive-system/242929/Microscopic-anatomy#ref212928

Blood and the Circulatory System

The body's circulatory system is composed of several parts the blood vessels, the blood, hart and the lungs. The main function of the circulatory system is to transport food and oxygen to the body's cells and remove waste products and CO_2. The structure of the blood vessels, both large and small, is closely associated with their function (Figure 4). All nutrient materials and waste products exchanged between the organs and the blood must traverse perivascular spaces in the walls of the vessels that are occupied by connective tissue. One of the important functions of the connective-tissue cells is to maintain conditions in the extracellular spaces that favor this exchange. (*)

Figure 4: Artery: transverse section of an artery



Blood vessels are composed of multiple layers of tissue. Each of these layers provides specific functions to the vessel. Connective tissue makes up the outer surface of the vessels and controls transport into and out of the vessel. The elastic membrane and elastic fibre give the vessel its flexibility. While the involuntary muscles help to maintain blood pressure and the endothelium forms the inner surface of the vessel.
http://www.britannica.com/EBchecked/topic/36874/artery#md-media-strip-tab-image-content

Any variation in the diameter of the lumen of the blood vessels will have an impact on the blood flow, nutrients supply, blood pressure and the overall function of the cardiovascular system.

The blood vessels provide the pathway through which the blood circulates. The blood is composed four different types of cells: red blood cells (erythrocytes), white blood cells (leukocytes) and platelets (fragment of giant cells also known as thrombocytes). Each one of these cells is responsible for specific functions inside our organs. Any variation of the number, shape or size of these cells, will have an impact on our health. The function of these cells is:

- Red blood cells function in the transport of oxygen and carbon dioxide to and from the cells.
- White blood cells are involved in the immunity.
- Platelets are involved in hemostasis (stopping the bleeding).

References:

(*) http://www.britannica.com/EBchecked/topic/132995/connective-tissue

EQUIPMENT

- Paper
- Pencil/pen
- Slides
  - Human skin composite
  - Skin cancer
  - Human blood
  - Sickle cell anemia
  - Acute monocytic leukemia
  - Chronic lymphatic leukemia
  - Blood vessels
  - Atherosclerosis
  - Liver
  - Cirrhosis
- Computer with Internet access (for the remote laboratory and for data analysis)

PREPARING TO USE THE REMOTE WEB-BASED SCIENCE LAB (RWSL)

Click on this link to access the Install guide for the RWSL: http://denverlabinfo.nanslo.org

Follow all the directions on this webpage to get your computer ready for connecting to the remote lab.

INTRODUCTION TO THE REMOTE EQUIPMENT AND CONTROL PANEL

Watch this short tutorial video to see how to use the RWSL control panel:
http://denverlabinfo.nanslo.org/video/microscope.html
For a more in-depth description of all the functions of the control panel:
https://www.youtube.com/watch?v=yW_HtlJONoI

There are appendices at the end of this document that you can refer to during your lab if you need to remind yourself how to accomplish some of the tasks using the RWSL control panel.

EXPERIMENTAL PROCEDURE:

Once you have logged on to the microscope you will perform the following Laboratory procedures:

PRE-LAB EXERCISE 1: SKIN COMPOSITE AND SKIN CANCER SLIDES OBSERVATIONS

In this exercise you will use the microscope to distinguish between the three layers of human skin. In this exercise you will identify the skin layers on images you have taken and you will measure and compare the relative size and shape of cancerous skin cells with healthy skin cells.

Pre-lab Questions:

1. Using what you know about cancer do you think the size, and shape of the cancerous skin cells will be bigger, smaller or the same as the ones of the healthy skin?

2. Rewrite your answer to question one in the form of an If … Than … hypotheses.

EXERCISE 1: SKIN COMPOSITE AND SKIN CANCER SLIDES OBSERVATIONS

Data Collection

1. Select the composite skin slide from the slide loader. Using the 10X objective identify the skin sample and bring it in to focus.

2. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of normal skin in the space below.

3. Select the Skin Cancer slide from the slide loader. Using the 10X objective identify the skin sample and bring it in to focus.

4. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of skin cancer in the space below. Label the different skin cancer layers and the 3 different part of a cell (nucleus, cytoplasm and cell membrane) from the dermis. Describe the shape of the cell and its nucleus.

Analysis:

1. Using the image you took in step 2 of this exercise and the insertion tools in word label the different layers of the skin and the 3 different part of a single cell (nucleus, cytoplasm and cell membrane) from either the epidermis or the dermis. Insert your labeled image below.

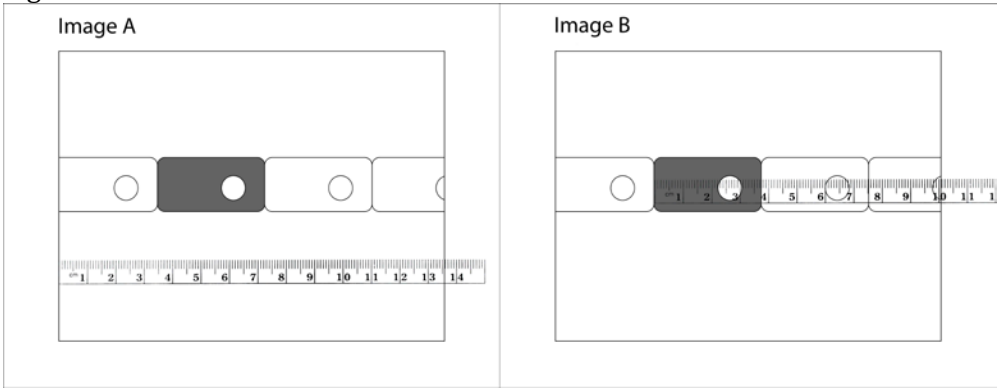
2. Using the image you took in step 4 of this exercise and the insertion tools in word label the different layers of the skin and the 3 different part of a single cell (nucleus, cytoplasm and cell membrane) from either the epidermis or the dermis. Insert your labeled image below.

3. Based on your observation, describe the difference in the shape and number of cell layers between normal skin and skin cancer.

4. Next we are going to measure the size of normal and cancerous cells. 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 205µm.

5. Now if we use the image in figure 5 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 5: Measurements



6. Now if we divide 37mm/136mm = 0.272 which we multiply by the total length of the field of view so 0.272 * 205µm = 55.77 µm rounded for significant figures gives us a cell size of 56µm.

7. Measure the difference in the size of the healthy skin and compare that to the size of the cancerous skin.

8. Are your results in correlation with what you have predicted earlier?

9. Rewrite your hypothesis in light of our new information you collected in this exercise.

PRE-LAB EXERCISE 2: NORMAL RED BLOOD CELLS AND SICKLED CELLS SLIDE OBSERVATIONS

The function of red blood cells is to transport oxygen to cells and carbon dioxide away from them. The shape and size of the red blood cell is important for its function. In this lab exercise you will measure and compare the relative size and shape of normal red blood cells with the sickled celled ones.

Pre-lab Questions:

1. Do your predict the size of normal red blood cells to be smaller, bigger or the same as the sickled celled one?

2. Rewrite your answer to question one in the form of an If … Than … hypotheses.

EXERCISE 2: NORMAL RED BLOOD CELLS AND SICKLED CELLS SLIDE OBSERVATIONS

Data Collection:

1. Select the Human blood slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.

2. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of normal red blood cells below.

3. Select the Sickle Cell Anemia slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.

4. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your picture of sickled cells below.

Analysis:

1. Utilizing the method from exercise 1 determine the length of the normal and sickle red blood cells.

2. Based on your observation, describe the difference in the between shape of normal red blood cells vs sickled cells?

3. Are your results in correlation with what you have predicted earlier?

4. Rewrite your hypothesis to take into account the new information you have learned in this exercise.

5. What is the impact of sickle cell anemia on oxygen transport?

PRE-LAB EXERCISE 3: ACUTE MONOCYTIC AND CHRONIC LYMPHATIC LEUKEMIA SLIDES OBSERVATIONS

Leukemia is a form of cancer that effects the blood. The purpose of this lab procedure is to compare the relative size and shape of the cells in the acute monocytic leukemia with the ones in chronic lymphatic leukemia.

Pre-lab Questions:

1. Do you predict white blood cells to be more or less prevalent in the chronic lymphatic leukemia?

2. Rewrite your answer to question one in the form of an If … Than … hypotheses.

EXERCISE 3: ACUTE MONOCYTIC AND CHRONIC LYMPHATIC LEUKEMIA SLIDES OBSERVATIONS

Data Collection

1. Select the acute monocytic leukemia slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.

2. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of the acute monocytic leukemia below.

3. Select the chronic lymphatic leukemia slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.

4. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of the chronic lymphatic leukemia below.

Analysis:

1. Utilizing the method form exercise 1 determine the size of the cells on both leukemia slides.

2. Based on your observations, describe the cells size and shape in each type of leukemia.

3. Are your results in correlation with what you have predicted earlier?

4. Rewrite your hypothesis to take into to account the new information you learned in this exercise.

PRE-LAB EXERCISE 4: BLOOD VESSEL AND ATHEROSCLEROSIS SLIDES OBSERVATIONS

The purpose of this lab procedure is to compare the diameter of the lumen (inside blood vessel opening) of a regular blood vessel with the one with atherosclerosis.

Pre-lab Questions:

1. Do you expect to see accumulation of fat in the lumen of a regular blood vessel?
2. Do you predict the diameter of the lumen of a regular blood vessel to be small, bigger or the same as the one with atherosclerosis?
3. Write a hypothesis in the IF … THAN … format that predicts what effect you expect to see with respect to fat and lumen size in an Atherosclerosis blood vessel.

EXERCISE 4: BLOOD VESSEL AND ATHEROSCLEROSIS SLIDES OBSERVATIONS

Data Collection:

1. Select the blood vessel slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.
2. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your image of a normal blood vessel below.
3. Select the Atherosclerosis slide from the slide loader. Using the 10X objective identify the blood cells and bring them in to focus.
4. Carefully working your way through all the objectives focusing with each one until you reach the 60X objective and capture an image. Insert your picture of the atherosclerosis vessel below.

Analysis:

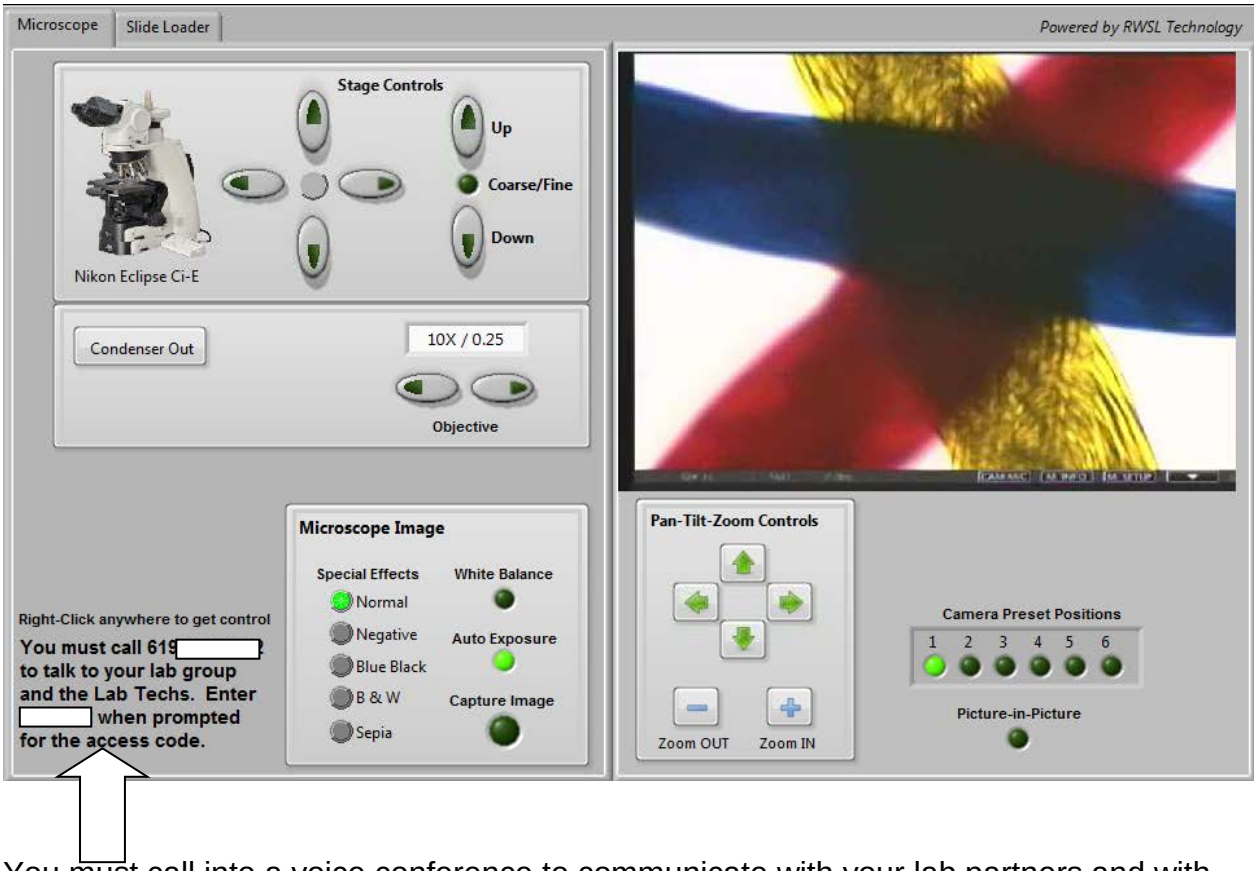
1. Using the same method as you used in exercise 1, measure and compare the thickness of the blood vessel wall in the regular blood vessel and the one with atherosclerosis.
2. How does atherosclerosis impact the blood flow to organs and the blood pressure?
3. Are your results in correlation with what you have predicted earlier?
4. Rewrite your hypothesis to take into account the information you learned in this lab.

SUMMARY QUESTIONS:

1. Explain the difference between etiology and pathogenesis.
2. Provide 2 examples of etiologic factors that may cause diseases in human.
3. Discuss the purpose of cellular adaptation in our body.
4. Provide an example of cellular adaptation and its cause(s).
5. Discuss the difference between reversible and irreversible cell injury and provide an example for each.
6. What is the definition of anemia? List three major causes of anemia.
7. Explain the rationale for each of the following manifestations of anemia: pale skin, increased heart rate, dizziness and fainting.
8. How does blood loss lead to anemia? Does all blood loss lead to anemia?
9. What is jaundice and why does it occur in some forms of anemia and not others?
10. Why do red blood cells need iron?
11. Define leukemia?
12. What is the difference between acute and chronic leukemia? Discuss the predominant cell type and the onset / course of the disease for each type of leukemia.
13. Discuss the role of vitamin K in blood coagulation?
14. What effect does liver disease have on coagulation?
15. Provide an example of a specific type of intracellular accumulation and its impact on the cell's metabolism and the overall health.
16. Discuss the role of diet in the development of atherosclerosis and its impact on the overall function of the cardiovascular system.

APPENDIX A - INTRODUCTION TO THE RWSL MICROSCOPE

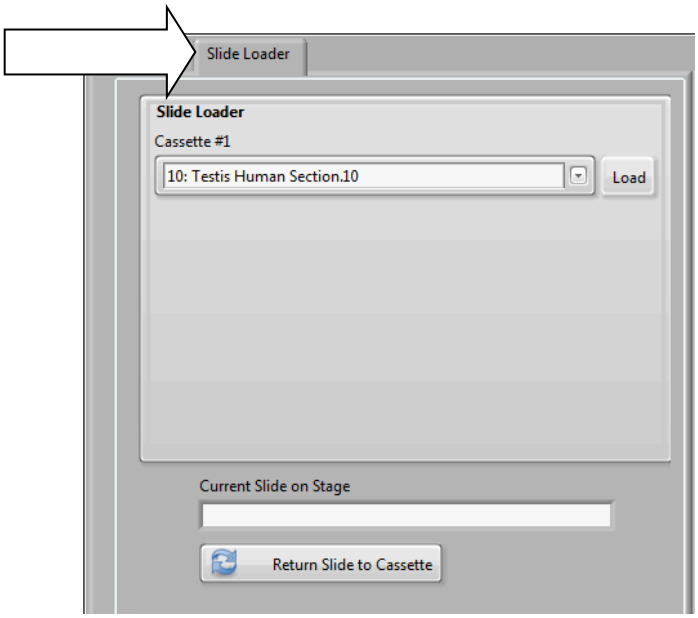
The RWSL microscope is a high-quality digital microscope located in the remote lab facility. You will be controlling it using a control panel that is designed to give you complete control over every function of the microscope, just as if you were sitting in front of it.



You must call into a voice conference to communicate with your lab partners and with the Lab Technicians. This is very important because only one person can be in control of the equipment at any one time, so you will need to coordinate and collaborate with your lab partners.

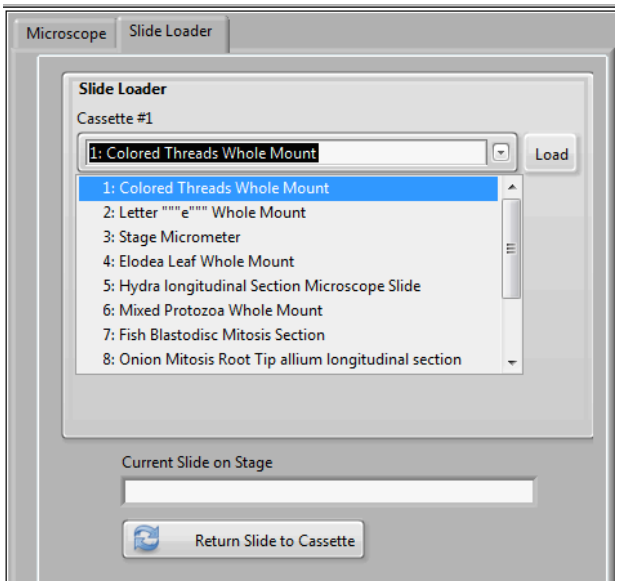
You take control of the equipment by right-clicking anywhere on the screen and selecting Request Control. You release control by right-clicking too.

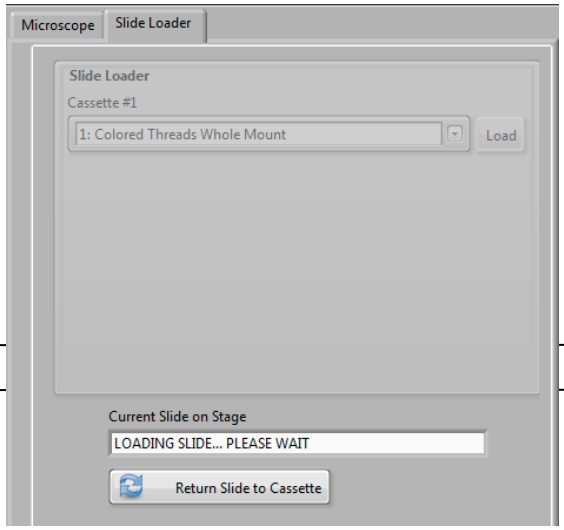
APPENDIX B – LOADING SLIDES



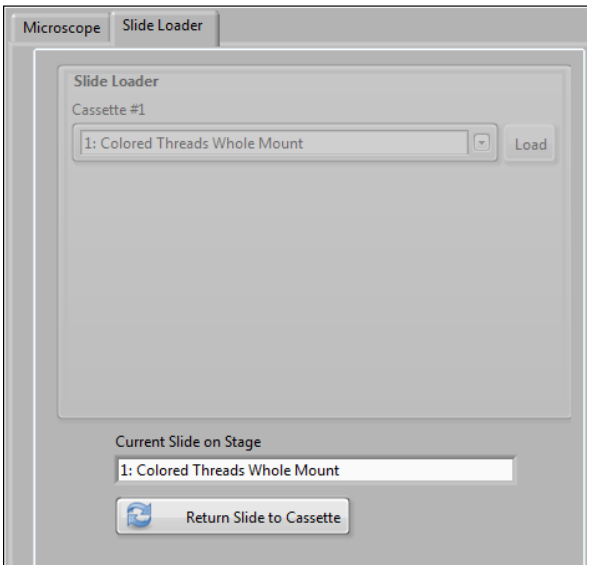
Clicking on the Slide Loader tab at the top of the screen will display the controls for the Slide Loader robot. There can be up to four cassettes available on the Slide Loader, and each cassette can hold up to 50 slides. There will be a drop-down list for each cassette that is available. In the above example, only cassette #1 is available on the Slide Loader. You can click on it to select a specific slide to be loaded, as in the image below:

Once you select the slide you want to load on the microscope, click the Load button to the right of the drop-down list. You will see a message telling you that the slide is loading. You can also watch this happening using the picture-in-picture (PIP) camera (see Appendix F - Camera Controls).





Notice that when a slide is actually on the microscope (or when it is being loaded or unloaded), the cassette controls will be grayed out so you cannot load a second slide until the first is removed.



Once the slide is on the microscope, it will be listed in the "Current Slide on Stage" box, and the only thing that the Slide Loader robot can do is return it to the cassette when you click the "Return Slide to Cassette" button.

To move the slide around while it is on the microscope stage, you must return to the Microscope tab to see those controls.

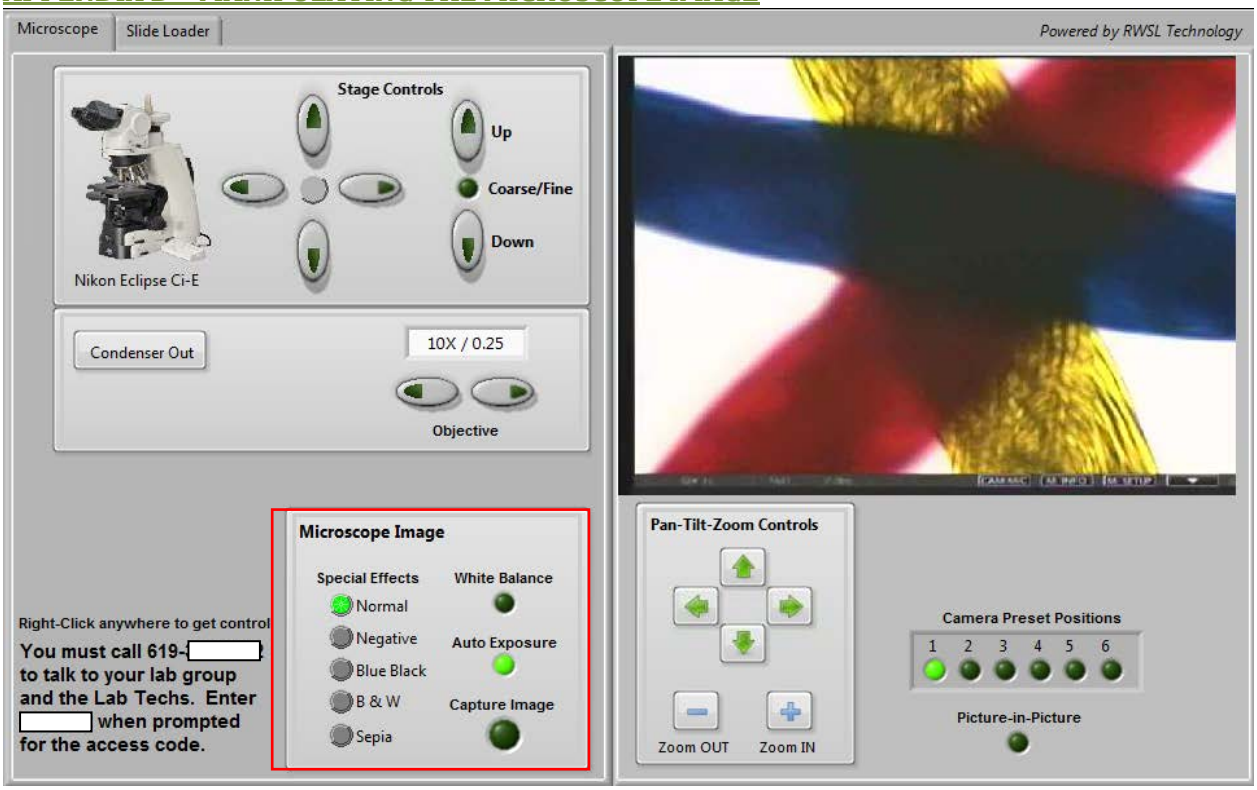
APPENDIX C - MICROSCOPE CONTROL

The microscope stage controls are boxed in red in the above image. The allow you to move the microscope stage (which holds the specimen slide) left, right, forward or backward. You can also focus by moving the stage up and down.

You can change the objective, which gives you increased or decreased magnification, by clicking the buttons under Objective Selection.

The Condenser control controls whether or not the Condenser lens is in the light beam. You want to have the condenser OUT for the 4x objective, but IN for all the others.

APPENDIX D – MANIPULATING THE MICROSCOPE IMAGE



You can manipulate the microscope image by using the controls in the red boxed area above. The White Balance should be used only if the image appears to be brown or gray and you think you might need to adjust it (although it won't hurt anything to click this button).

The Normal, Negative, etc., control buttons in this area are used to display the image slightly differently in order to highlight certain features. Here is some information from the Nikon website (http://www.microscopyu.com/articles/digitalimaging/digitalsight/correctingimages.html) about these settings and when they might be used:

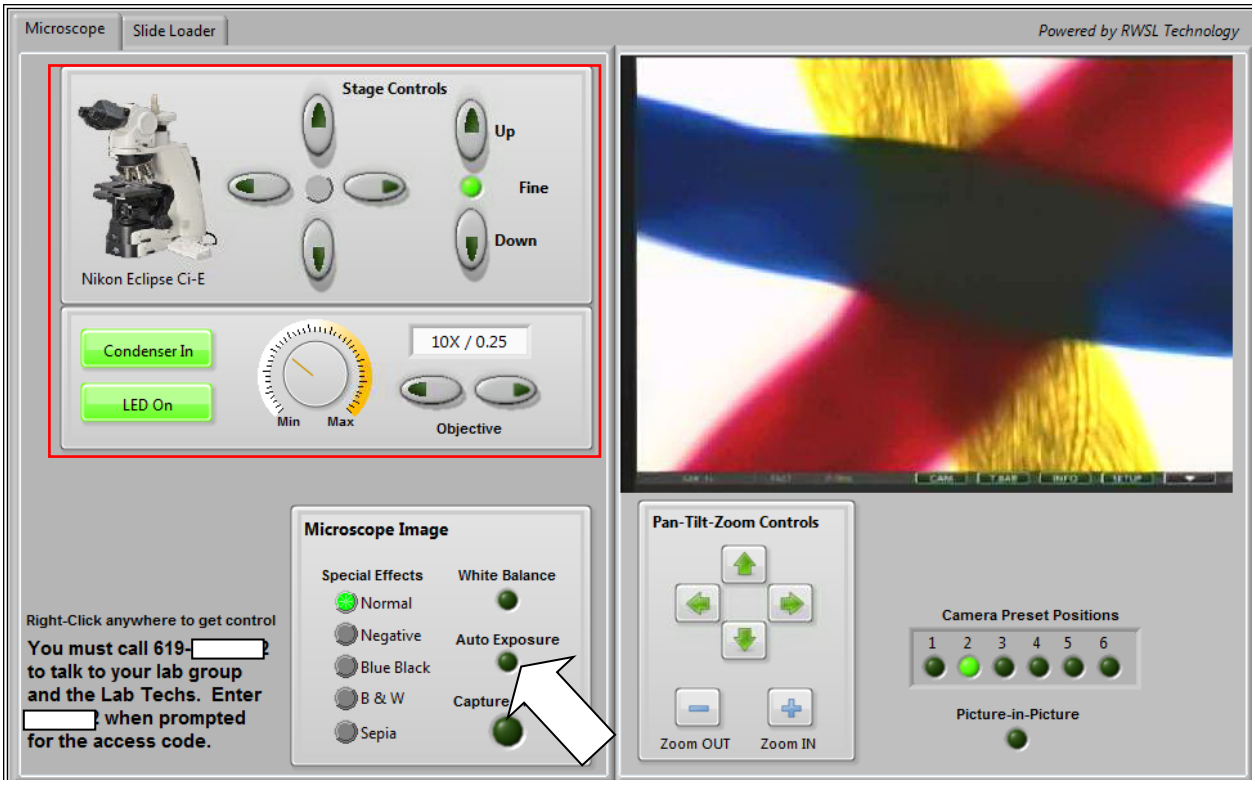
Normal: In this mode, the image is displayed in the natural color scheme that is observed in the microscope eyepieces (Figure 3). For the majority of images captured with the Digital Sight system, the normal color output is the most effective mode for accurate and effective reproduction of all specimen details.

Negative: The **Negative** effect displays a brightness- and color-inverted form of the image, where red, green, and blue values are converted into their complementary colors (Figure 4). The technique is useful with specimens for which color inversion can be of benefit in exposing subtle details, or in quantitative analysis of specimens.

Blue Black: This mode represents the black portions of the **Negative** image in blue, and is often useful to reveal details in specimens having a high degree of contrast. As a special effect, the **Blue Black** mode can be beneficial as a presentation tool.

Black & White: This mode displays a grayscale form of the image (Figure 6). It can be effectively used for monochromatic images such as those acquired with differential interference contrast or phase contrast techniques. In many cases, digital images destined for publication in scientific journals must first be converted into black & white renditions of those captured in full color. The **B & W** filter can often aid the microscopist in preparing images for publication or oral presentation.

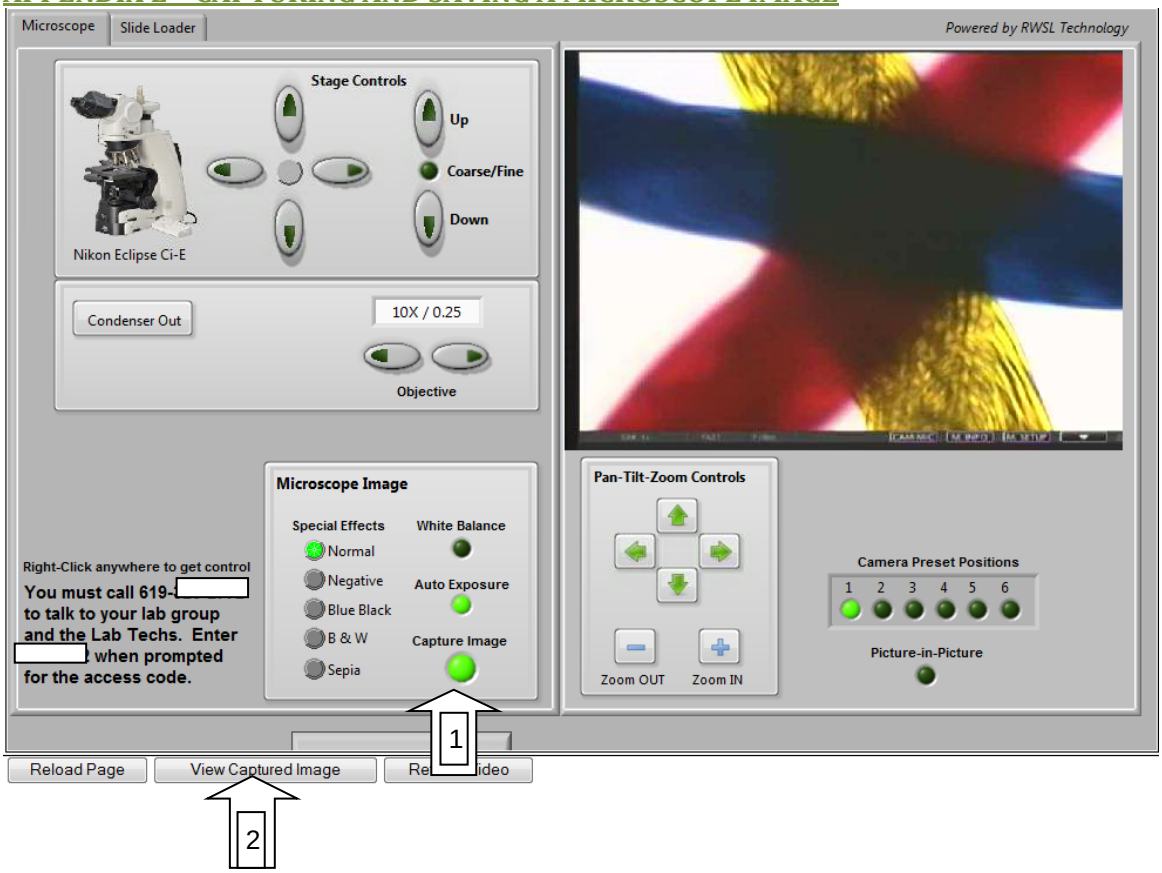
Sepia: This effect is essentially a monochrome image version displayed in sepia (brownish) tones instead of grayscale (Figure 7). The **Sepia** mode is more likely to be utilized in general photographic applications than in microscopy, although the effect may enhance the visibility of specimen detail in certain instances.



Auto Exposure is normally turned on, but you can turn it off if you want to play around with the brightness of the light source and not have the microscope camera automatically adjust, though it's usually best to leave it turned on.

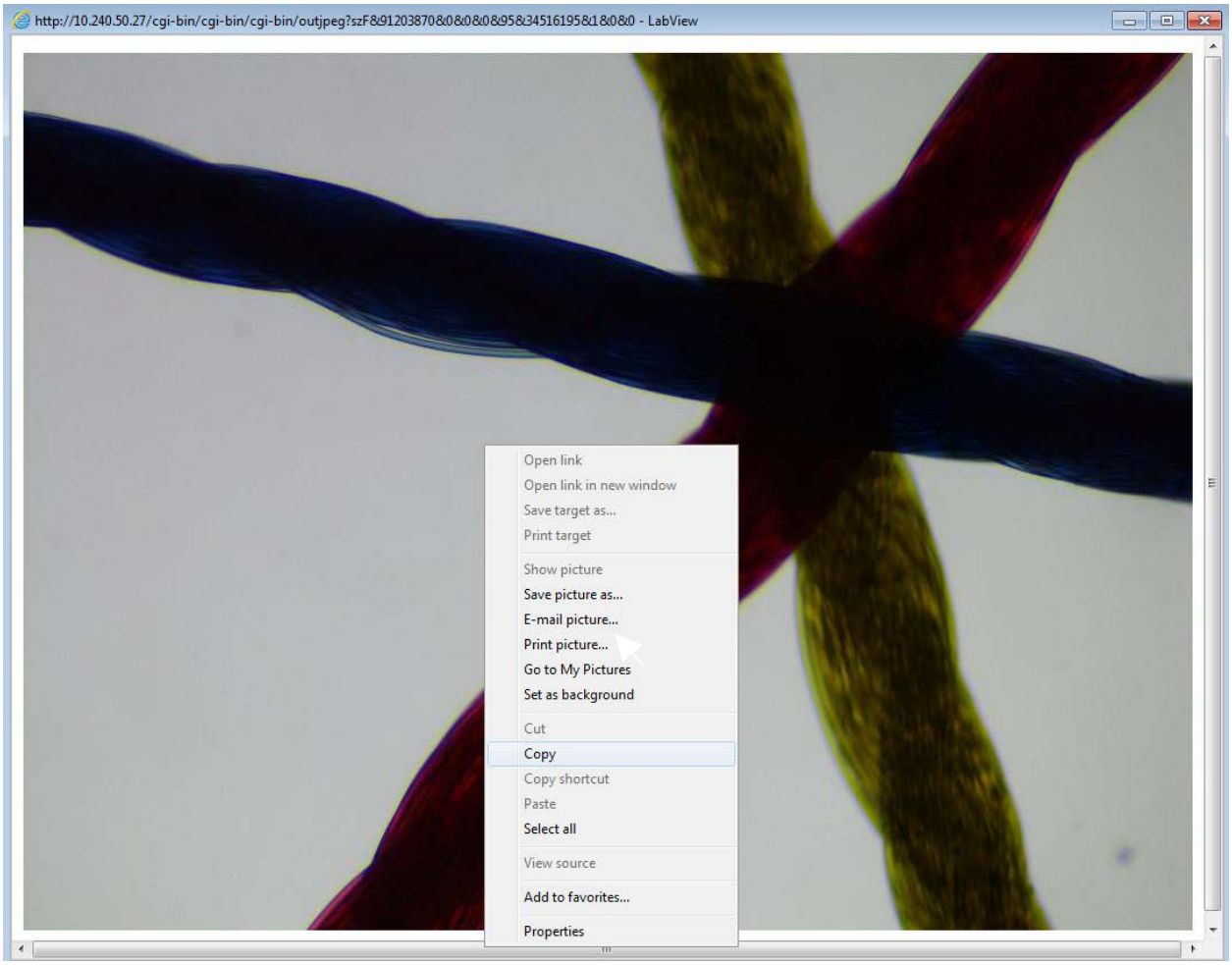
If you turn off the Auto Exposure, then some new controls appear that let you turn the LED off or on, and also adjust the intensity of the light source. The intensity of the light source can be increased or decreased manually with the dial that now appears next to the Objective control.

APPENDIX E – CAPTURING AND SAVING A MICROSCOPE IMAGE



You can capture a high-resolution image of what is currently in the field of view of the objective by clicking the Capture Image button, which will turn bright green while it is capturing the image. When the Capture Image light turns off, the image has been successfully captured. After the image is captured, click View Captured Image to see the high-resolution image (below).

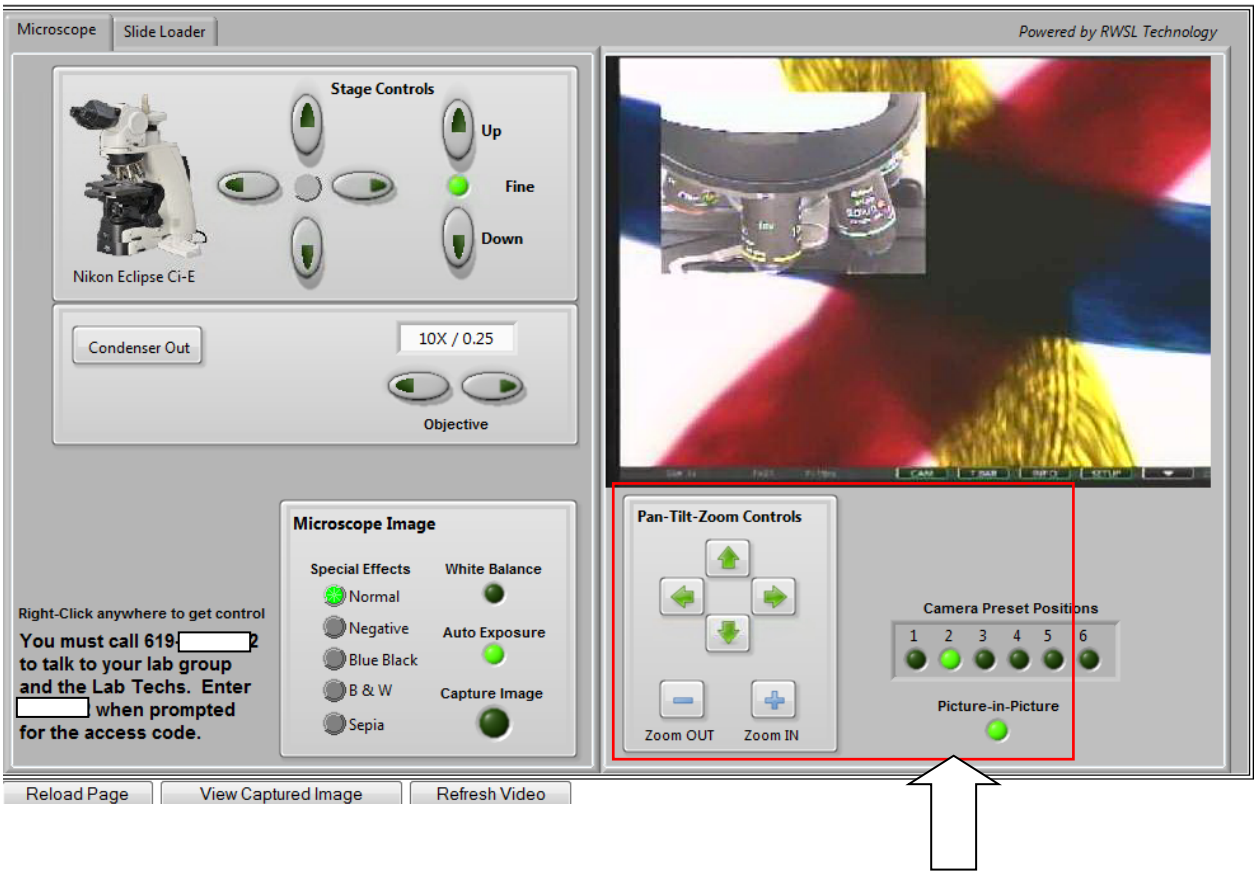
After opening this image, right click on it and select "Copy". Then paste it into a document so you can use it later in your lab report. This is illustrated below.



After right-clicking and selecting Copy, just open a document and right-click and select Paste. You can either paste it directly into your lab report document or into another one for safe-keeping until you use it later.

You can use drawing tools in your editor to annotate this image so you can show your instructor that you knew what you were supposed to be looking for!

APPENDIX F - CAMERA CONTROLS



Clicking the Picture-in-Picture button will open a window that shows the view from a camera placed directly in front of the microscope. The arrow buttons allow you to swivel the camera around so you can see whatever you want to look at in the lab. The Camera Preset Position buttons are programmed to show you particular portions of the apparatus. If you hover the mouse over them, a box will pop up that lists what each position will show you (see below).