# University of Canada West

# Biology 100 Lab Manual (1st ed.)

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All graphics were created by the **biology team of University of Canada West.**

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BIOLOGY

# ABOUT BIOLOGY LAB

Dear Students,

Welcome to the Biology lab at University of Canada West. The biology lab will be conducted by your professor with the help of the Laboratory technicians.

This lab manual will provide an understanding about the biology concepts. It will also ensure that the students apply the theoretical knowledge into practice, giving you hands-on experience, which will develop your laboratory skills.

Thank you,

Biology Team

# LAB REGULATIONS

## (I) Before attending Lab

**Be ready: Make sure you read the experiments that will be conducted on the day of your lab as questions will be asked to the students. The introductory information is also present in the manual. So, we request students to go through the lab manual before coming for lab class.**

## (II) Laboratory Use

Students must behave respectfully towards all individuals in the lab and follow any instructions given by Lab Instructors and Lab Technicians.

***Failure to comply with these regulations may result in expulsion from the lab***

***Figure 1. Science Lab***

a) The lab must be always kept clean. You are responsible for your equipment and glassware and the cleaning of these, plus cleaning of benches or tables used in the lab.

b) Garbage must be placed in the garbage cans in the labs and not left on benches or in the drawers or sinks.

c) Tampering with equipment and with experiments in progress is prohibited. Equipment is expensive and easily broken. Experiments of other students may be destroyed by tampering.

d) Glass and other hazardous waste material must be disposed of in the appropriate specialized containers.

e) Microscopes must be returned to their proper location.


***Figure 2. Microscope storage area***

## (III) Laboratory Safety

It is your responsibility to ensure that you take adequate precautions to protect your health while in the laboratory. You should adhere to the following guidelines:

- Always work in a well-ventilated area and use a fume hood when volatile chemicals are used.
- Only use equipment free of flaws.
- When to **contact the instructor**


If an accident occurs (no matter how minor) contact the instructor immediately for appropriate first aid.

If a breakage or spill occurs, contact the instructor immediately for advice on safe clean up.

| **DO NOT** | |
|---|---|
|  | Do not smoke, eat or drink in the laboratory |
| | Never chew gum, apply cosmetics (including lip balm), or handle contact lenses in the laboratory. |
| | Treat all chemicals and specimens as potentially hazardous: do not touch, smell, or taste any chemicals. |
| | Avoid touching your eyes, mouth, face, etc., while working in the laboratory, and avoid breathing harmful vapors. |
| | Do not allow flammable liquids and gases near a flame or spark. |
| | To put chemical in pipette use pumps or pipettors (do not use your mouth) |

- When working with hazardous materials, bear the following in mind:

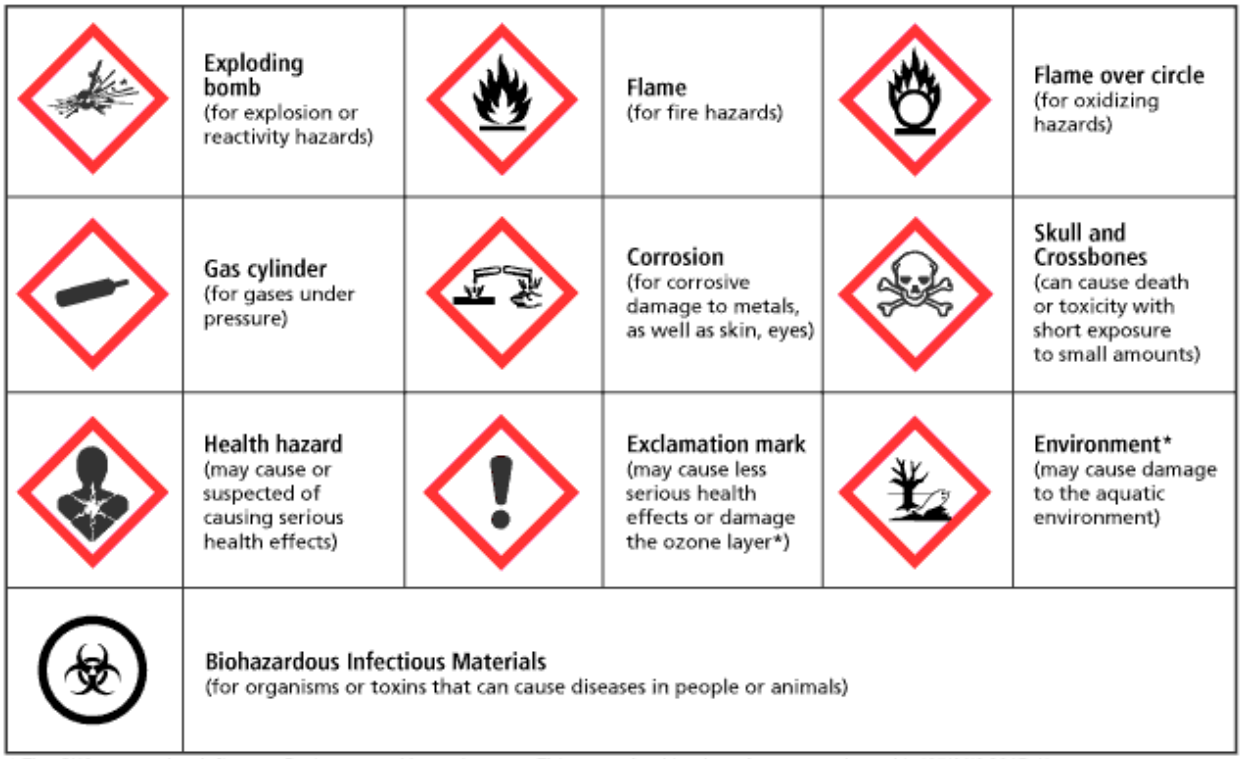



***Figure 3. Hazards symbol*** (Government of Canada, 2024)

- Carefully read the labels of all chemicals that you are working with.
- Wear appropriate clothing. Lab coats are recommended.
- Long hair and jewelry should be tied back to prevent contamination or ignition.
- Safety glasses and gloves are available in the laboratory.
- Closed-toed shoes are required and should be low heeled.
- No wearing shorts (boys and girls) and short dresses in the lab.
- Contact lenses should be removed prior to working in the presence of harmful vapors, which can concentrate behind the lenses.
- Eye contamination requires 15 minutes of washing with the eye bath

turned to a comfortable temperature. Contact lenses should be removed prior to eye washing unless this involves a significant delay.

- If clothing catches fire, it should be doused with water and/or wrapped in a coat or blanket. DO NOT use a CO2 fire extinguisher on a human, as severe freezing damage may result (e.g., blindness).
- Contaminated clothing should be removed, with care to avoid the eye.
- If you touch a hazardous substance, you should immediately keep your hands under running water. Have your partner contact the instructor.
- When removing chemicals to temporary containers, place labels on the new containers first, and never return chemicals to stock bottles.
- Cover spilled liquids immediately with paper towels. Spilled material contaminated with biohazardous microorganisms should be saturated with 1% bleach solution for 30 minutes.

➢ If there is a fire:

- Familiarize yourself with the location of “Exit” doors and the location of safety eyewashes and shower. Be ready to assist your partner should a chemical spill or splash occur.
- If clothing catches fire, it should be doused with water and/or wrapped in a coat or blanket. DO NOT use a CO2 fire extinguisher on a human, as severe freezing damage may result (e.g. blindness).

- Do not take elevators, leave the area quickly, do not block the exits area.

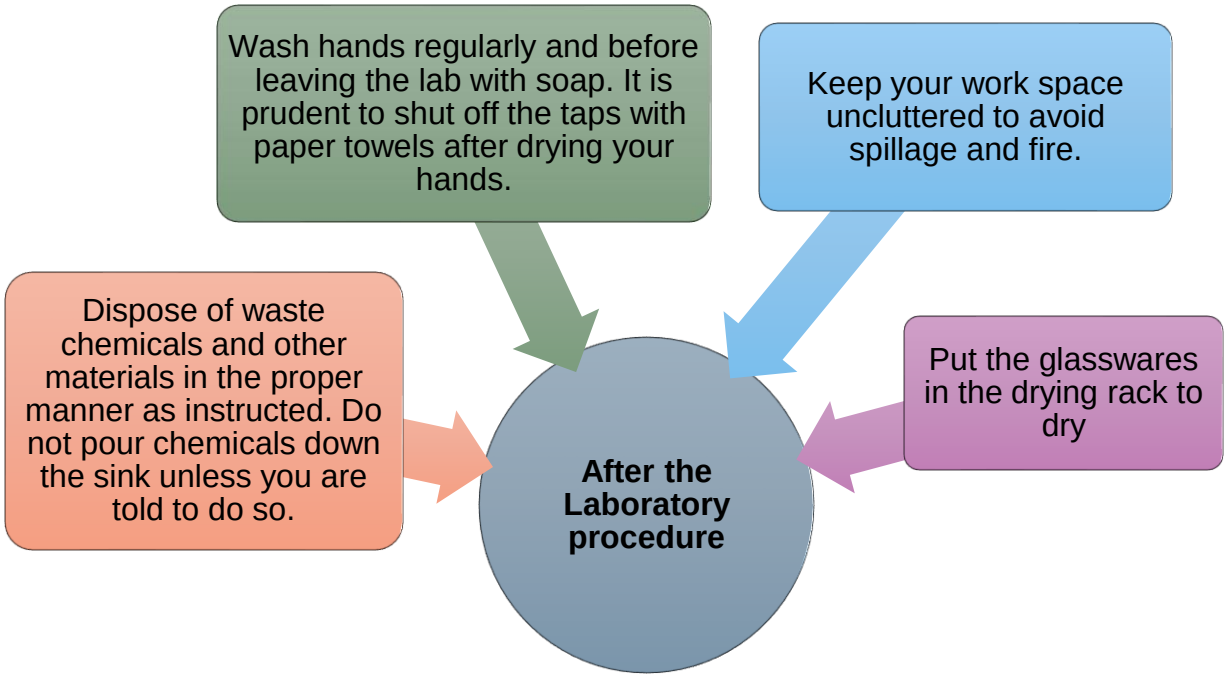




***Figure 4. Cleaning and drying rack area***

## (IV) Lab Attendance Policy

a. **Any lab missed, without a valid reason will receive a mark of zero** for that lab and its related assignments and/or quizzes.

b. If you have a valid reason for missing a lab it is your responsibility to contact your lab instructor that day if you want the absence excused.

c. **Be on time: Do not be late for the lab.**

## (V) Student Rights and Responsibilities

Students have the responsibility to:

**a. Conduct themselves in a manner that does not harm or threaten to harm another person's dignity, physical or mental wellbeing**

**b. Contribute to and sustain an inclusive environment that values civility, honesty, fairness, respect for others**

c. Respect the ideas and perspectives of others even when not in agreement with those ideas and perspectives

**d. Respect others personal information and privacy and treat disciplinary actions as confidential**

e. Obey public laws

f. Report acts of rights violations where there is a reasonable and/or expected threat to the community, or where harm (emotional or physical) has been witnessed.

g. Not disrupt or interfere with UCW activities including classes and programs.

h. Respect the property of UCW and of others

i. Become fully aware of, and comply with, UCW policies and procedures.

**Student Misconduct**

10.2 Conduct which does not respect the rights and dignity of others and that contravenes UCW's mission, mandate, values and policies may be considered student misconduct and therefore subject to the rules governing student misconduct.

10.3 The following is a non-exhaustive list that provides examples of misconduct that may be addressed under Student misconduct policy (University of Canada west, 2011). Conduct not specifically set out below may be subject to proceedings under this Policy. Students shall not engage in the following conduct:

a. Physically, verbally, emotionally, or psychologically aggressive behavior directed towards another member of the community and/or coercion and/or threats towards students, staff, faculty, or other member of the UWC Community.
b. Regardless of the purpose or intent (including jokes), to engage or encourage others to engage in behaviours or activities that harass any person or discriminate against a person based on protected status such as race, ancestry, place of origin, colour, religion, age, sex, sexual orientation, gender identity or expression, marital status, family status, disability.
c. Impede or disrupt teaching, research, administration, disciplinary proceedings, public service functions, or other authorized University functions.

**Note:**

10.4 The University will conduct a timely investigation into allegations of misconduct that could, if substantiated, constitute a violation of this Policy. All investigations are conducted in a fair and equitable manner, consistent with the principles of procedural

fairness and natural justice and having regard to the nature and seriousness of the conduct at issue.

10.5 When UCW determines that misconduct has occurred, the outcome of that process will take into account all the circumstances of the misconduct and the circumstances of the student engaging in the misconduct. The University recognized that, where appropriate, an outcome that is educational, developmental or restorative, may be preferable to, or imposed in conjunction with, a punitive outcome.

10.7 Disciplinary Sanctions and other measures applicable under this Policy include:

a. The student may be required to provide a verbal or written apology

b. The student may be required to make restitution in the form of payment of costs, or compensation for loss, damage, or injury, or in the form of appropriate service or material replacement.

c. The student may receive a verbal or written warning or letter of reprimand.

d. The student may be placed on non-academic probation for a specified period of time

e. The student may lose privileges for a specified period of time, including computer privileges, library access, or be prohibited from registering for a particular course or program

f. The student may be prohibited for a specified period of time from having access to all or any part of the campus, with or without conditions

g. The student may be removed from one or more courses for one or more terms

h. The student may be suspended with the loss of all academic privileges for a specified period of time.

i. The student may be subject to suspension, cancellation, or forfeiture of any scholarships, bursaries or prizes

j. The student may forfeit payment for courses, registration, or other fees.

k. The student may be required to enter into a behavioural contract being a set of behavioural expectations, terms, and conditions. Any breach of this contract constitutes student misconduct that may result suspension or expulsion from UCW.

l. The student may be suspended from the University for a specified period of time

m. The student may be required to abide by a behavioural contract (signed) prior to their return to campus.

n. The student may be denied admission or re-admission to the University for a specified or indefinite period of time.

o. The student may be expelled from UCW by the President.

p. The student may receive a notation of academic discipline on the student's record in the Student Information System, which will appear on the student's Transcript of Academic Record.

For more information visit: https://www.ucanwest.ca/wp-content/uploads/2022/08/UCW-9014-Student-Rights-and-Responsibilities-Policy.pdf

# Experiment 1: Microscopes

Effective use of the microscope is a fundamental skill in biology. Microscopy is a technique that is used in hospitals and in forensic labs, for scientists and students, bacteriologists, and biologists so that they may view bacteria, plant and animal cells and tissues, and various microorganisms.

You will be using the microscope throughout this course to view specimens and make drawings of the specimens. This laboratory will show you how to use the microscope and make labeled drawings following conventions used in biology.

## I. OBJECTIVES

- To demonstrate skill in proper utilization of compound microscope.
- Describe the function of each component of a compound microscope.
- Demonstrate how to properly use a compound microscope to view a specimen.
- Define the concepts and explain the significance of magnification, resolution, and working distance

## II. INTRODUCTION

### Study of Light Compound microscope

**Why is it called a light compound microscope?**

- Light because the microscope magnifies the images using light that passes from the light source, filtered through condenser and lens, ultimately presenting a bright illuminated field for observation by the eye.
- Called as Compound because the microscope passes light through the specimen through two different lenses which are ocular and objective lens.

**Use of compound microscope:** It offers the capability to examine small organisms with higher magnification using higher power objectives due to their shorter working distance.

**Parts of microscope:**

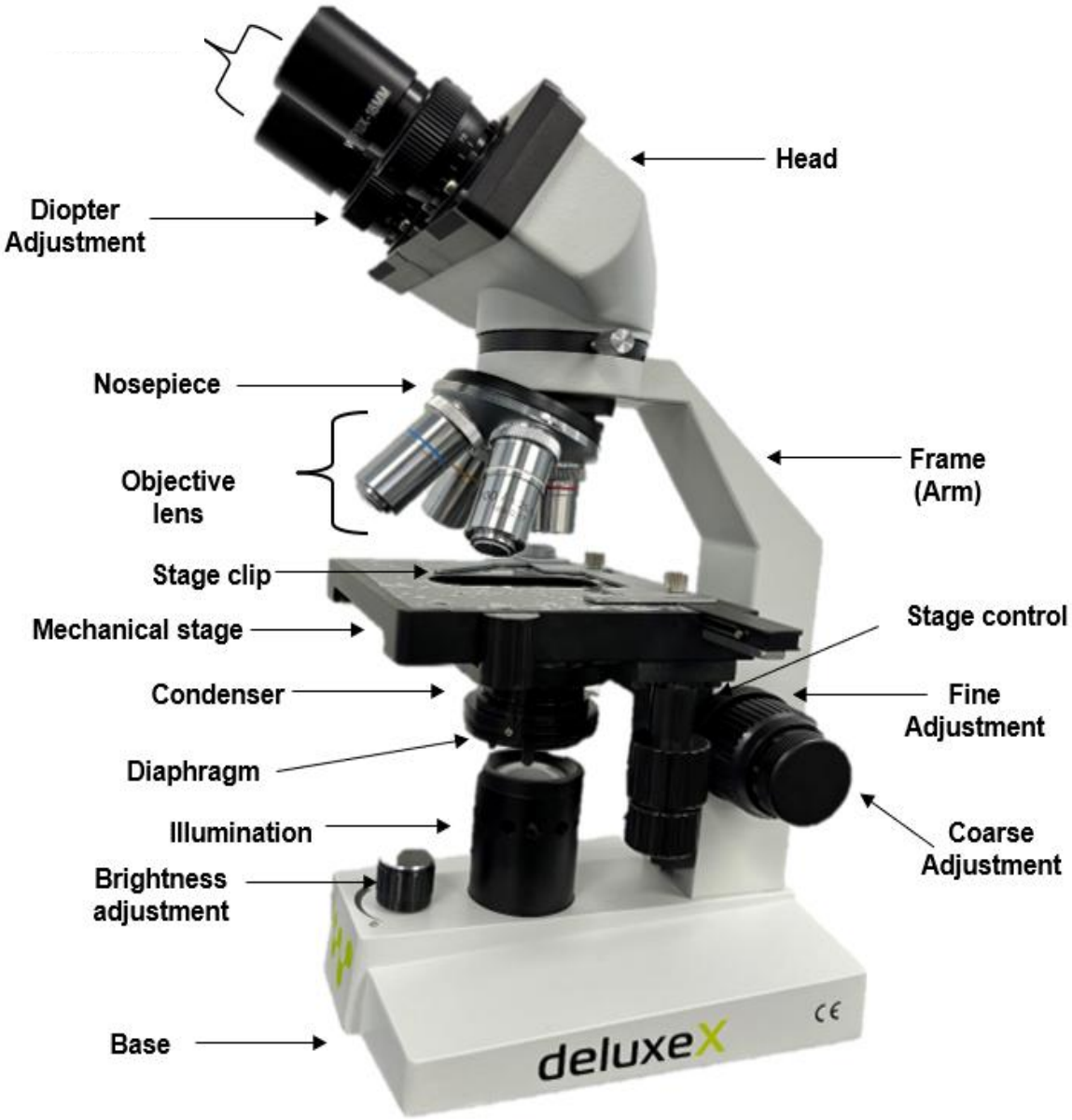



***Figure 5: Compound Microscope***

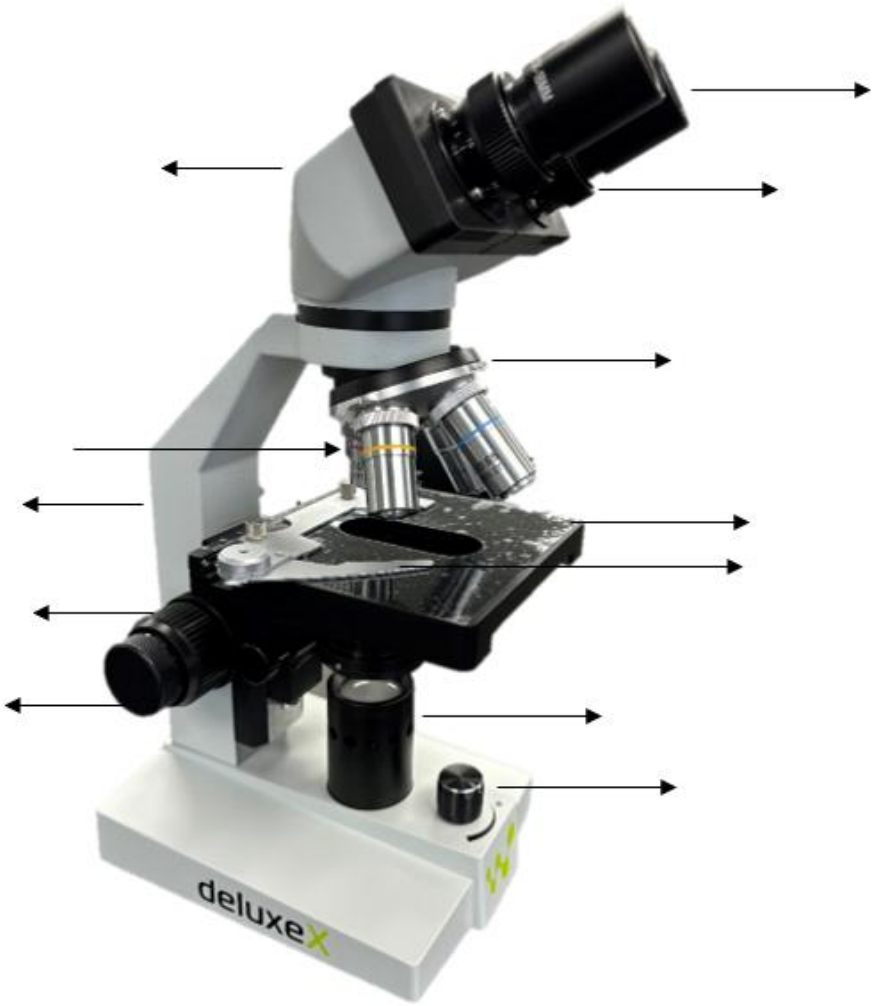
1. **Eyepiece or ocular lens:** Closest to the eyes through which it magnifies and forms an image of the object to be viewed. The different magnifying power is indicated by “X” e.g., 8X, 10X, 40X.
2. **Diopter adjustment:** Adjust the focus on one eyepiece to compensate for any variation in vision between your two eyes.
3. **Head:** Supports the eyepiece (Ocular lens).
4. **Nosepiece:** Rotating disc to hold the objective lens
5. **Arm:** Connect the upper part of microscope to the base of the microscope and functions as a handle.
6. **Objective lens:** The most important part of microscope which is closest to the specimen. The function is to magnify the image of the specimen.

   The power of the objective lens can range from 4X to 100X.
7. **Stage:** The stage is a mechanical system which is moveable to position the specimen under the objective lens.

   It acts as a supporting part to hold the slide.
8. **Stage clips:** Another part of mechanical stage which is a metal clip to hold the slide in place on stage.
9. **Coarse adjustment knob:** To position the slide on the stage so that the object is brought into focus. Not for the higher magnification (100X).
10. **Fine adjustment knob:** To make the image fine (sharp focus).
11. **Condenser:** Concentrates the light (moving up and down to increase or decrease the light) onto the specimen ensuring a clear and sharp image are formed. A glass lens which is found below the stage.

12. **Iris Diaphragm:** It is found below the condenser. Controls the amount of light by opening and closing to reach the specimen.
13. **Illumination:** A light source that direct the light reaching to the specimen through the condenser
14. **Brightness adjustment knob:** A knob which controls the intensity of light coming from the light source.
15. **Base:** A supporting part of microscope**.**

**Exercise 1: Familiarize yourself with all parts of the microscope and label the microscope:**



## III. LET'S START……..

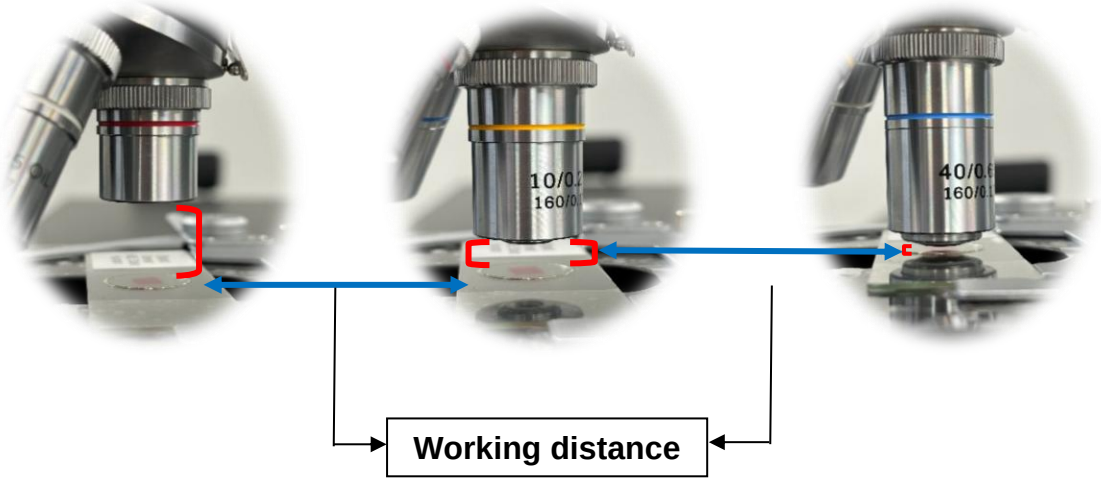
| Steps and Precautions while using microscope |
|---|
| Carrying the microscope:<br>  <br>- Always carry the microscope in an upright position (not tilted) using two hands.<br>- One hand should hold the microscope's arm, and the other hand should support the base. |
| Turn on the light and adjust the light using brightness illumination. |
| Set it down away from the edge of the table.<br>  <br>  |
| Put the slide on the mechanical stage, making sure the slide is secure with the stage clip. |
| Make sure you use the low power objective lens first |
| With the help of stage control knob adjust the position of the specimen in the center of the light path. |

Using the coarse focus knob, elevate the height of the stage until it reaches to its maximum level. Avoid excessive pressure beyond its point to prevent damaging the microscope.

***Working distance***

Distance between the lens and the slide on the stage.

As magnification increases the working distance decreases.




Slowly using the coarse focus knob, the objective is to be raised while looking through the ocular lens till the image is seen. Using the fine focus knob, adjust the focus till the image is clear and sharp. Your microscope is Parfocal – once the object is in focus in lower objective, it should be almost in focus when you switch to higher power.

Improving the image, you can do by adjusting the amount of light using the condenser and diaphragm.

After focusing the specimen on the low objective, adjust it to the center. Once done, rotate the nosepiece to next higher objective. Do the necessary adjustment to get a fine and clear image. Make sure you use fine adjustment knob only to prevent smashing of the slide under the higher magnification.

## IV. MICROSCOPE LAB 2: COUNTING & MEASUREMENT

### Objective

• To demonstrate quantification of cells and tissues using the microscope.

### Introduction

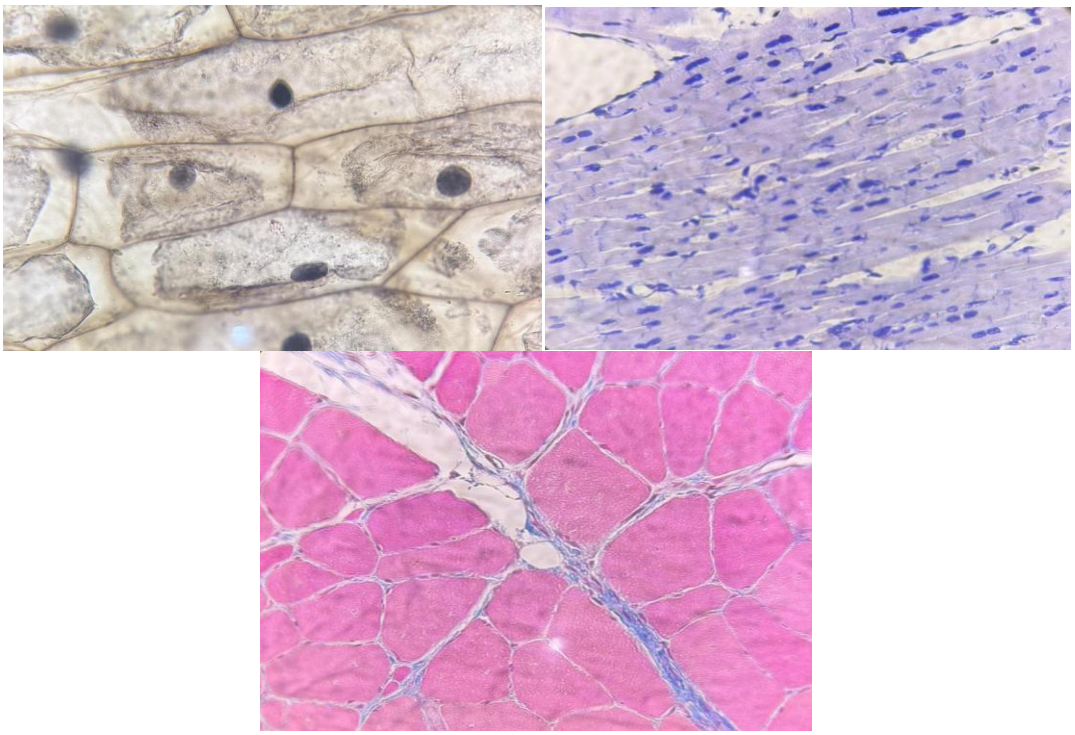
The microscope can help visualize biological structures at the cell and tissue levels. It is also an essential tool for measurements. Biologists can use the microscope to visually count and measure the sizes of cells and microscopic structures. Thus, these skills are often used at the end of an experiment to collect results and can be used across many fields such as microbiology, ecology, medicine, and forensic science. By counting and measuring using a microscope, we can answer questions such as “how quickly are cells growing?” and “what is the measurable difference between healthy and diseased tissues?” In this lab, we will learn these skills via their basic applications in the field of histology, which is the study of biological tissues using the microscope.

A microscope slide is often made for a specimen, which was life that has been specifically prepared for visualizing using the microscope. The slides we use in this lab are of cells and tissues that are not alive but captured at a moment in time. But how can we see inside a tissue, at the microscopic scale? Histology is a discipline in biology and medicine that uses extremely thin sections of tissues such that they can be mounted on a microscope slide. These specimens were cut from a tissue that was frozen in time, so that we may see it under the microscope as if it's still in its living state. The cut is very thin that the thickness is less than a human cell.

To help us identify what we are looking at, histology also uses dyes to stain the specimen with colours. The stained slide often allow us to see beautiful images under

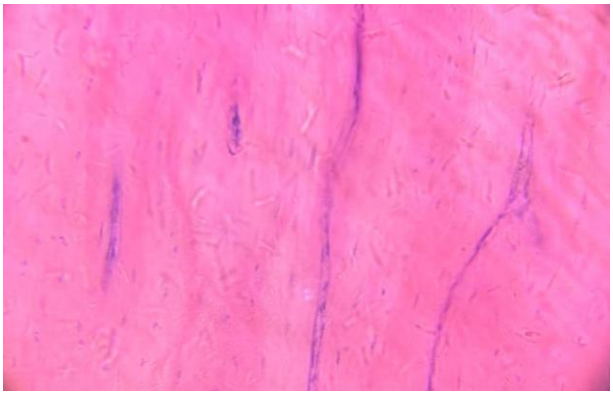
the microscope, such as the examples below. The most commonly used dyes are hematoxylin and eosin. The combination of these two dyes is abbreviated as the H&E stain, where the hematoxylin stains cell nuclei a purplish blue, and eosin stains the connective tissue and cytoplasm pink, with other structures taking on different shades, hues, and combinations of these colors. The H&E stain is the most popular staining method in histology and medical diagnosis laboratories. In this lab we will examine slides made with H&E stain to identify cells inside tissues.

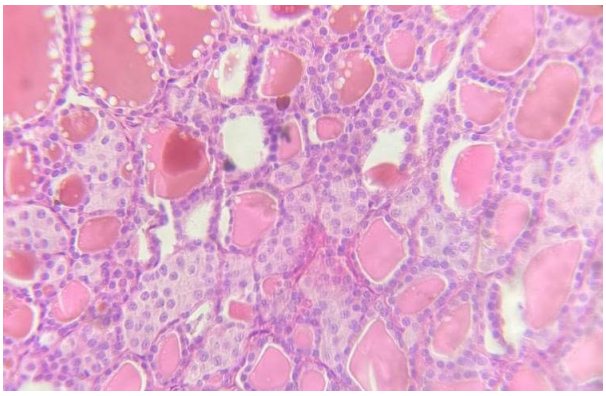
Special stains that use additional dyes can produce different colours and highlight certain structures. In this lab, we will examine slides made with one special stain called the Masson's Trichrome stain. This is a stain that is particularly good at visualizing muscle tissues. It stains cell nuclei dark purplish blue, cytoplasm pink and red, connective tissue blue.



**Identify a Structure**

Using the procedure you learned from the introductory lab, examine a slide labelled with H&E or MT, until you find a recognizable structure. Below are some examples. Zoom in by going to 40X objective lens magnification.





## V. DETERMINING THE TOTAL MAGNIFICATION

Total magnification = Ocular lens magnification X Objective lens magnification

The lens magnification is printed on the sides of the lens.

Example:

If you are using 10X ocular lens and objective lens of 40X

Total magnification will be 10 X 40= 400 which means the image is 400 times larger.

We will not be using the 100X (oil immersion) magnification in this class.

While focusing the specimen, keep filling the following table:

*Table 1: Total Magnification*

| Lens | Ocular lens | Objective lens | Total magnification |
|---|---|---|---|
| Low | | | |
| Medium | | | |

| | | | |
|---|---|---|---|
| High | | | |
| Oil immersion | | | |

## VI. MEASURING THE FIELD OF VIEW

Why do we determine the diameter of the field of view of the microscope?

= To measure the size of a specimen.

When you view through the eye piece, the circular area or the diameter of the circle visible is the **field of view** of the microscope. As you increase the magnification, the field of view gets smaller, therefore there is an inverse relationship seen between the field of view and the magnification.

If the magnification gets greater, the field of view decreases.

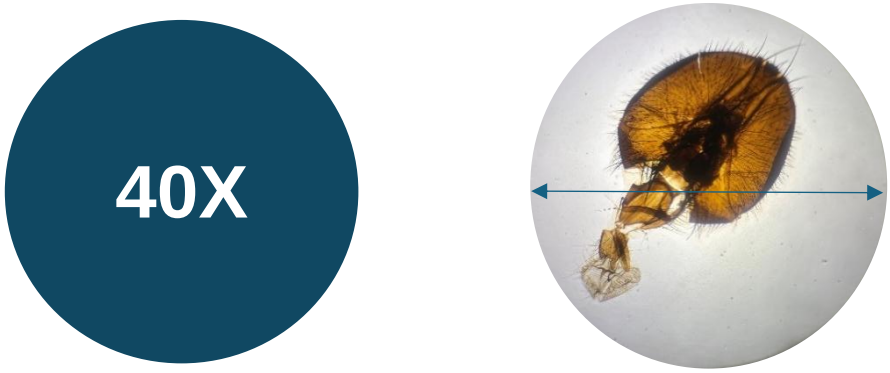



***Figure 6. Field of view***

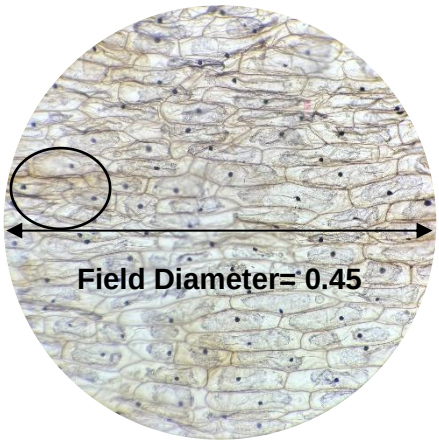
*Table 2: Determining the field of view:*

| Ocular lens | Objective lens | Total magnification | Diameter of field of view |
|---|---|---|---|
| 10X | 4X | 40X | 0.45 mm |
| 10X | 10X | 100X | 0.18 mm |
| 10X | 40X | 400X | 0.045 mm |

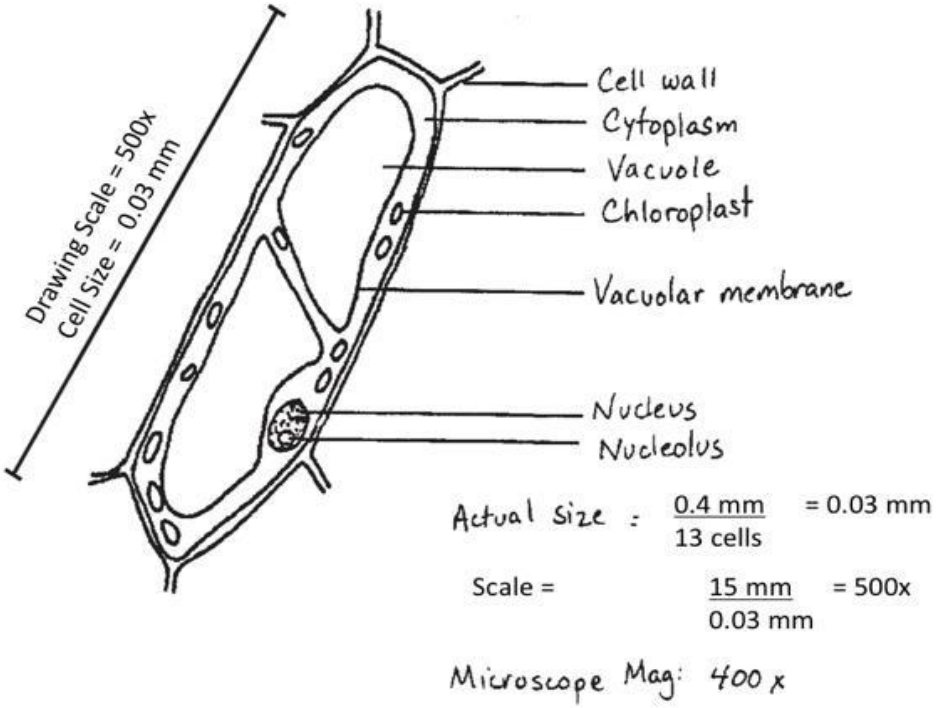
## VII. ESTIMATING THE SIZE OF THE SPECIMEN IS POSSIBLE

Real length of the specimen= (Fraction of the field of view) x (diameter of the field)

Consider an example. Suppose the length of a single cell would fit 3 times across the field diameter at high power. The field diameter was 0.45 mm, then the actual size would be




Size of cell = 1/3 x 0.45= 0.15 mm




Actual size : $\frac{0.4\text{ mm}}{13\text{ cells}}$ = 0.03 mm

Scale = $\frac{15\text{ mm}}{0.03\text{ mm}}$ = 500x

Microscope Mag: 400 x

### Counting and Density

The histological stains provide with us a clear indication of a nucleus on the slide, which is stained very dark. We can easily count how many nuclei are in a field of view.

Now that we know the diameter of the field of view, we can also calculate the area of the field of view.

$$\text{Area} = \frac{\pi d^2}{4}$$

Counting the number of nuclei or cells within a field of view, we can conclude the density of this tissue.

$$\text{Density} = \frac{\text{number of cells or nuclei}}{\text{Area}}$$

For this activity, find two areas of interest, from the same slide or different slides. Draw them. Then, count and calculate the density of the cells or nuclei in this tissue.

## VIII. OBSERVING SPECIMEN ON THE SLIDE

Take three of the slides from the slide box that you will be viewing under the microscope. The important aspect of doing this experiment is to develop the skill of using the microscope, not identifying the parts of the specimen.

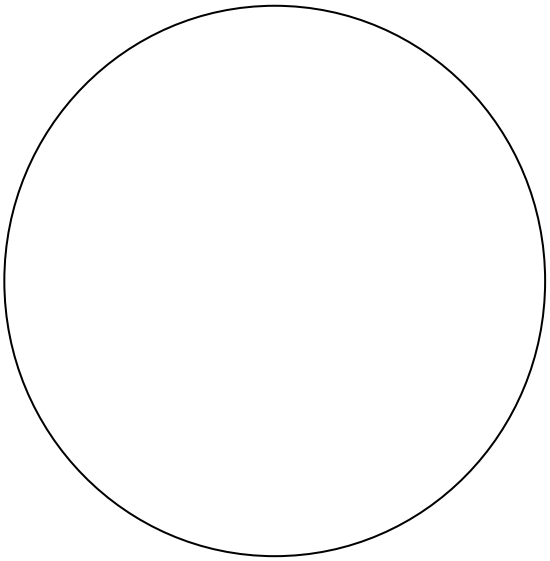
Follow the steps of viewing the specimen under the microscope and once you have focused on the highest magnification, draw the specimen that you can view in the circle provided below. As studied, the circle represents the diameter i.e., the field of view of the microscope. The image should not be perfect, but it should follow the following instructions.

Follow the instructions of drawing:

1. Use sharp pencils to draw the image (NO PEN)
2. The drawing should be smooth and continuous, no double lines allowed.
3. Label the drawing making sure the label lines are straight and parallel to each other.
4. The label lines should be only on one straight, no overlapping of lines.
5. No shading allowed instead you are allowed to stipple (use dots) or dashes (-) or lines to show contrast.

## Exercise 2: Draw what you see.

Drawing:

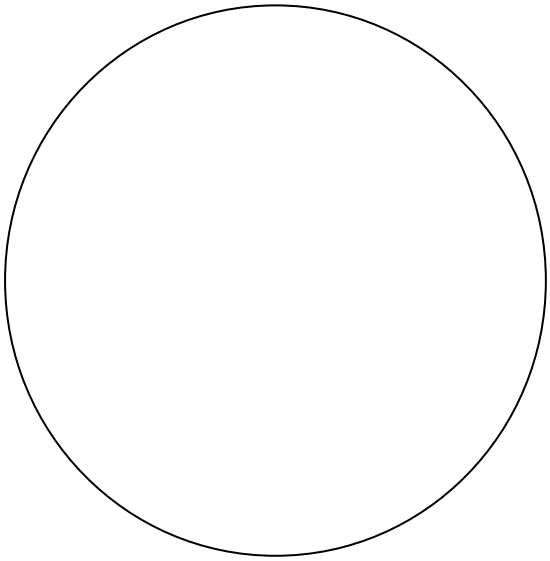


Total magnification = _____

Field diameter = _____

Calculations = _____

Drawing:



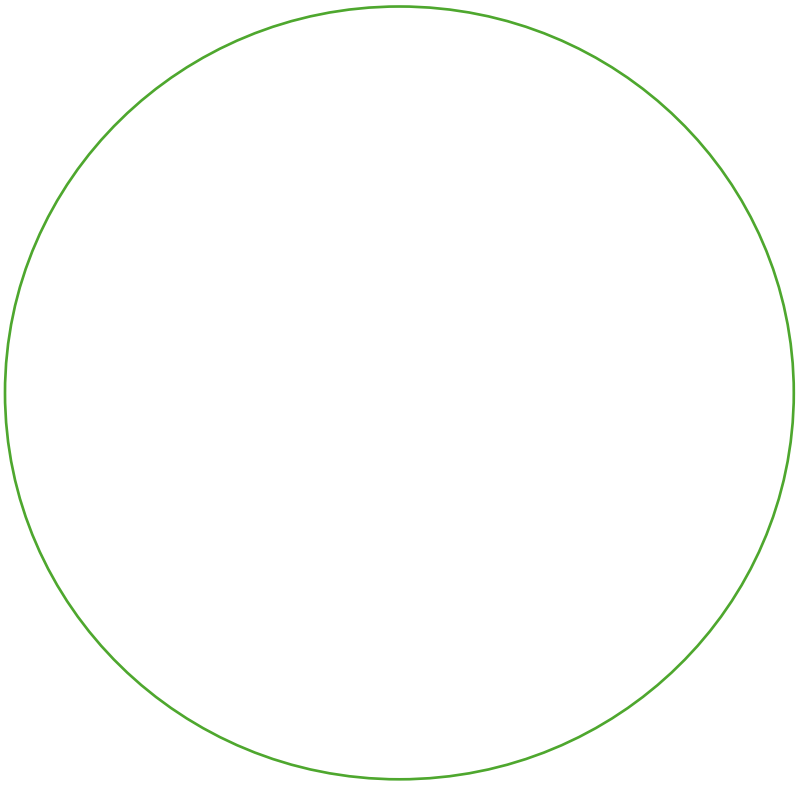
Total magnification = _____

Field diameter = _____

Calculations = _____

**Exercise 3: Draw an area of interest. Count the number of cells or nuclei and calculate the density.**

Tissue type: _____ Student Name: _____



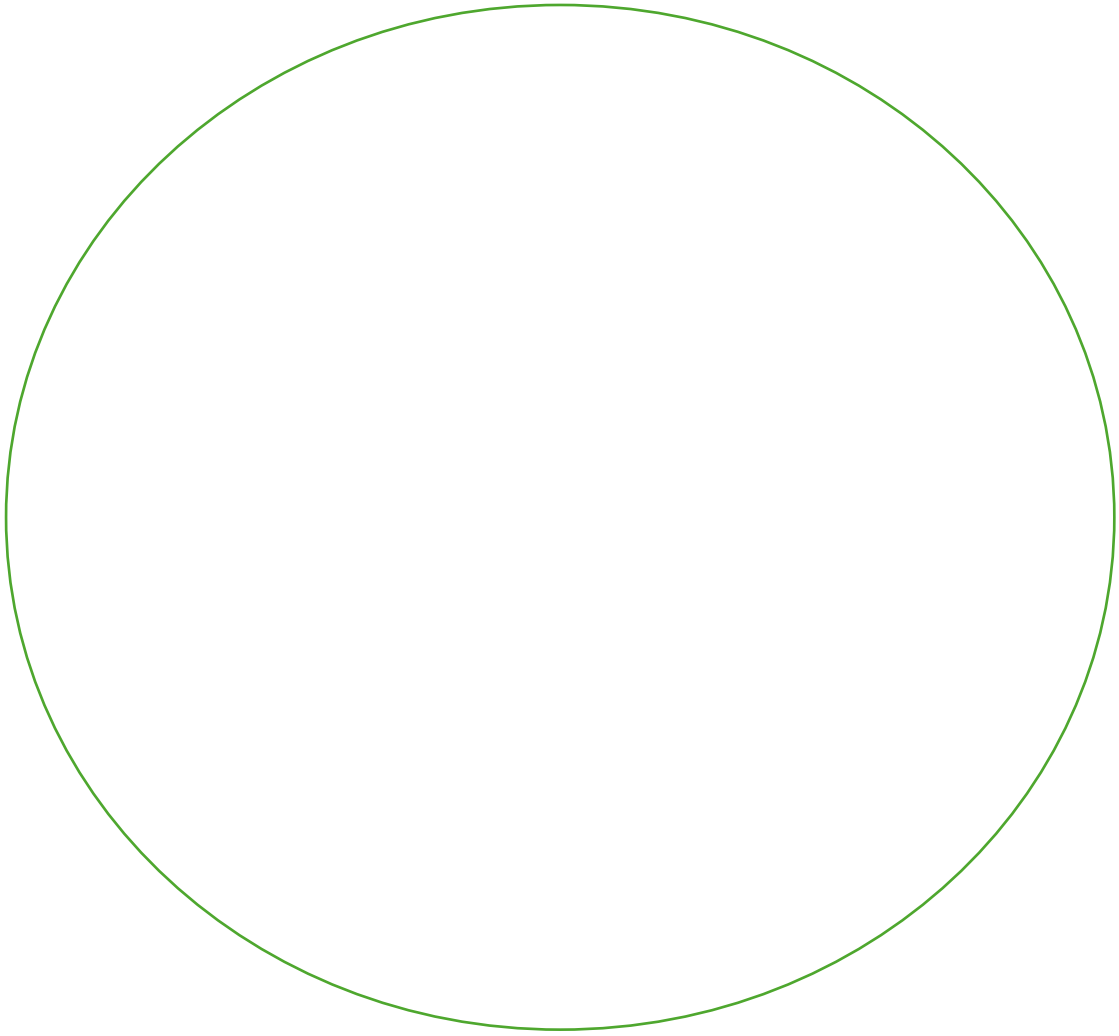
**Show your calculation here:**

Final answer: Density= cells or nuclei per $mm^2$

**Exercise 4:**

Student Name: _____

Tissue type: _____



16 cm

Objective Lens Magnification: _____

Total Magnification: _____

Scale: 1 cm = _____ mm

Actual Length or Width (circle one): _____

## TEST YOUR KNOWLEDGE

1. What are the different types of microscopes?

=

2. If you are looking at a specimen from 10X to 40X and you lose focus, what should be the step to get the focus back?

=

3. Fill the table with its function by appropriate part of the compound microscope.

| Parts of microscope | Function |
|---|---|
| Nosepiece | |
| | Objective lens to first locate a specimen |
| | Focuses light on the specimen |
| Fine focus knob | |
| | Control the amount of light passing through the specimen |

4. What are the 3 differences between compound microscope and electron microscope?

5. How will you correct the following:

   a) The field of view is dark

   b) My viewing field has a spot that remains the same even if I move the slide

   c) I can't see anything under high power.

6. Which objective lens should be kept in focus after using the microscope?

7. How would you describe a microscope that stays in focus when the objective lens is moved?

8. You must have noticed that as you increase the magnification, you need more light or the object get dimmer, why?

## Multiple choice questions

### Question 1

Many of the slides of tissues we looked at under the microscope were prepared using the H&E stain. What does H stand for?

A. Histology

B. Hematoxylin

C. Hepatic portal vein

D. Hemaglobin

### Question 2

What cell structure does H stain for (gives it colour)?

A. It stains the cell blue.

B. It stains the cell red.

C. It stains the connective tissue blue.

D. It stains the nucleus blue.

### Question 3

Many of the slides of tissues we looked at under the microscope were prepared using the H&E stain. What does E stand for?

A. Electric

B. Epidermis

C. Esophagus

D. Eosin

**Question 4**

What cell structure does E stain for (gives it colour)?

A. It stains the connective tissue blue.

B. It stains the nucleus pink.

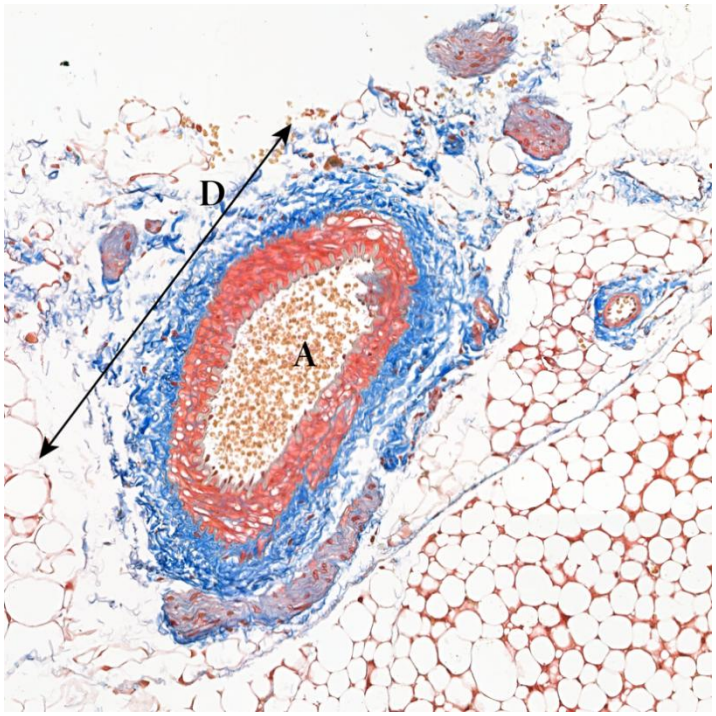
C. It stains the cytoplasm pink.

D. It stains the cell blue.

**Question 5**

Blood vessel under the microscope

The following image is a photo taken on a microscope, using the 40X objective lens. It is a cross-sectional view of a blood vessel (centre left), prepared by a Masson's Trichrome stain. The microscope camera printed the photo with a scale indicating 1cm = 25µm.



What cells are in the middle of the blood vessel (area A)?

A. Red blood cells

B. Enterocytes

C. Muscle fibres

D. Neurons

**Question 6**

What is in the blue area around the blood vessel?

A. Epithelial tissue

B. Skeletal muscle

C. Capillary

D. Connective tissue

**Question 7**

A biologist wants to know how big is this blood vessel, so they measured the length of D, as indicated by the arrows, which is an approximation of the diameter of the blood vessel. Using a ruler on the photo, the biologist measured D as 10cm. What is the actual length of D?

(Hint: use the scale information to find out the actual length.)

A. 0.25mm

B. 1mm

C. 0.1mm

D. 2.5mm

# Experiment 2: DNA and Cell Structure (Plant and Animal)

## I. OBJECTIVES

At the end of the lab, you will learn:

- General idea about DNA and identifying structures such as phosphate, sugar and base.
- Differences and similarities between plant cells and animal cells.
- Comparing the structures and the functions of each organelle in plant and animal cells.
- Describe the mechanisms of diffusion and osmosis.
- Explain how isotonic, hypertonic, and hypotonic solutions affect cells.

## II. DNA

**DNA = Deoxyribonucleic acid**

A double helical structure is a molecule present in our body and located in the nucleic cells of plants, animals, and fungi. The backbone of DNA composed of phosphate, sugar and four bases which are Adenine (A), Cytosine (C), Guanine (G), Thymine (T). The bases are paired as Adenine with thymine and Cytosine with guanine, these pairing cannot be changed.

What makes you is the DNA which has all the information such as the color of eye, height, ethnicity.

**Exercise 1: Label the following:**

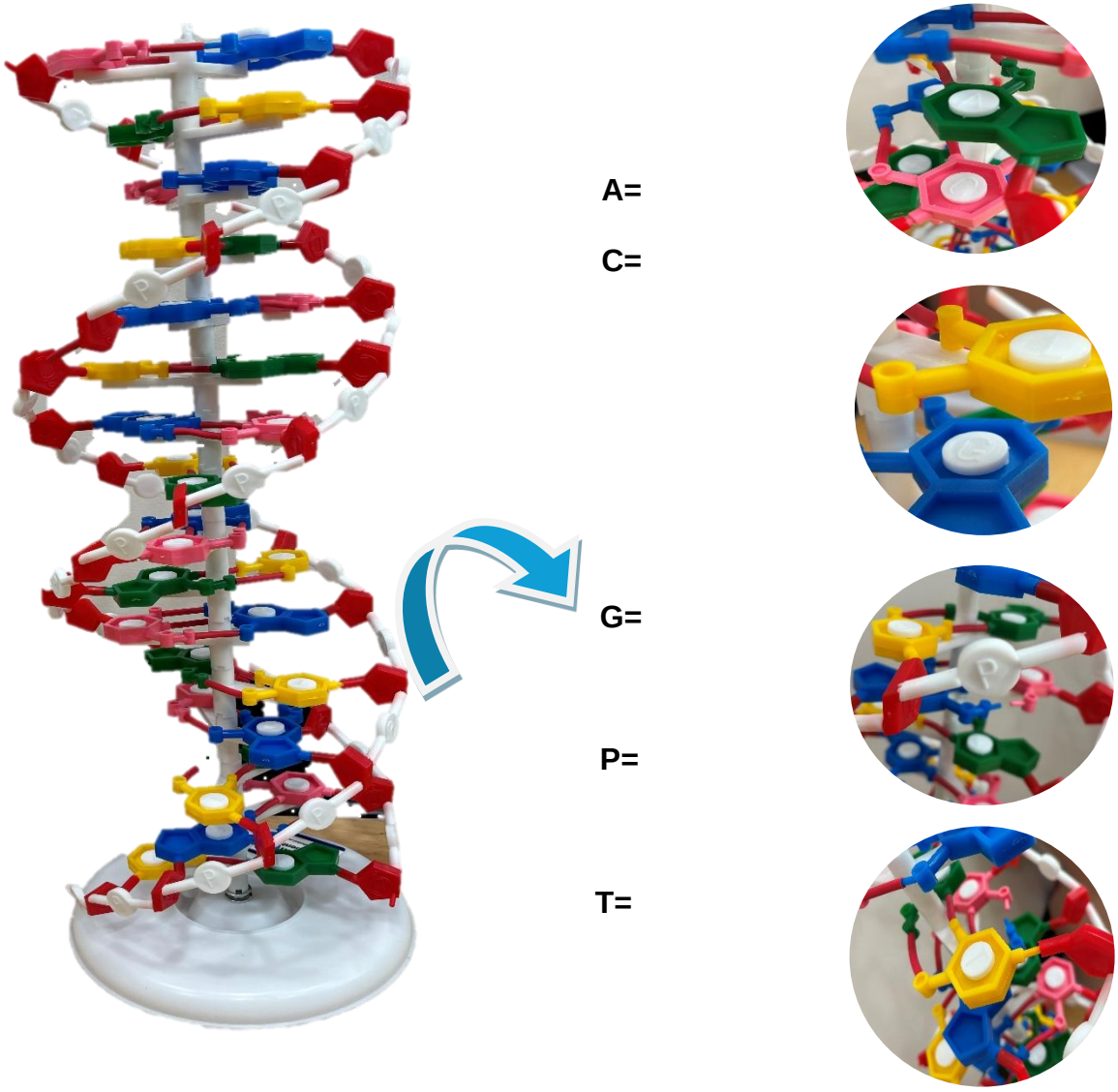



***Figure 7. DNA model***

## III. ABOUT CELLS

**All living beings are made of cells,** and they are the smallest unit of life.

**The cell theory:**

1. Cells are the basic unit of structure and function of organisms.
2. All organisms are composed of cells.

3. Because of its self-producing property, cells come from preexisting cells.

Living organisms exhibit a wide range of dimensions and forms from millimeter to micrometer. Since you have studied the topic “Microscope”, you must be aware by now that to study cells well, we need microscopes because cells are small.

This lab will give you an experience to examine the animal cell model and secondly, when you look at prepared slides, you can see how different kinds of cells join up to make tissues, and how these tissues build up into organs.

*Table 3: Cells are divided into **Prokaryotic** and **Eukaryotic** cells.*

| **Prokaryotic cells** | **Eukaryotic cells** |
|---|---|
| Lack of membrane bound nucleus and organelles | Membrane bound nucleus and organelles are present |
| Smaller in size | Larger in size |
| Unicellular | Multicellular and some unicellular |
| Example: Bacteria, Blue green algae | Animal, Plant, Fungi |

In this lab we will learn about the eukaryotic cells which are animal and plant cells.

Remember that all cells maintain a balance called homeostasis so that a body can function normally. Cell membrane is the one that keeps the cell's internal environment stable. It is a semipermeable membrane which regulates the movement of materials inside and outside of the cell.

## IV. CELL STRUCTURE

### a) Animal cell

**Exercise 2: Looking at the animal cell model, identify the organelles and write their functions:**

Cell membrane:

Nucleus:

Nuclear envelope:

Mitochondria:

Golgi apparatus:

Rough Endoplasmic reticulum:

Smooth Endoplasmic reticulum:

Ribosomes:

Cytoplasm:

The organelles missing in the model: The other cell organelles are a hair like structure which are **cilia** and **flagella** which help the cell to move from place to another. Both are similar in structure but their length and functions different.

**b) Plant cell**

The three distinct features from the animal cells are cell walls, chloroplasts, and central vacuoles.

**Exercise 3: Write the functions of the following:**

Cell wall:

Chloroplasts:

Central vacuoles:

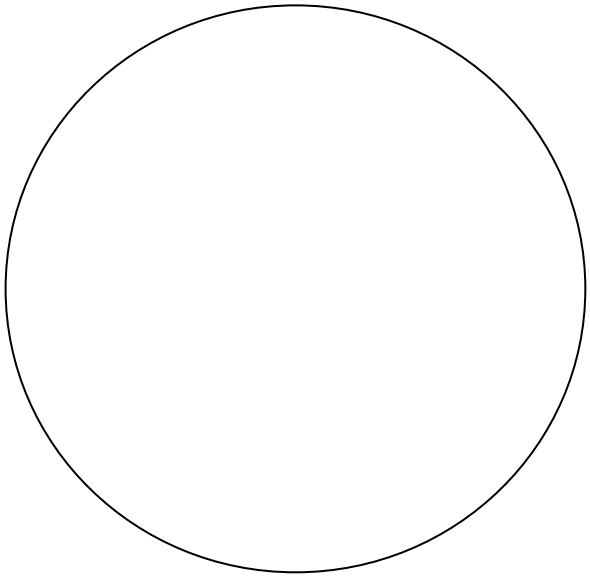
**Exercise 4: Based on what you have studied so far, draw animal and plant cell and label it:**

**Animal cell**

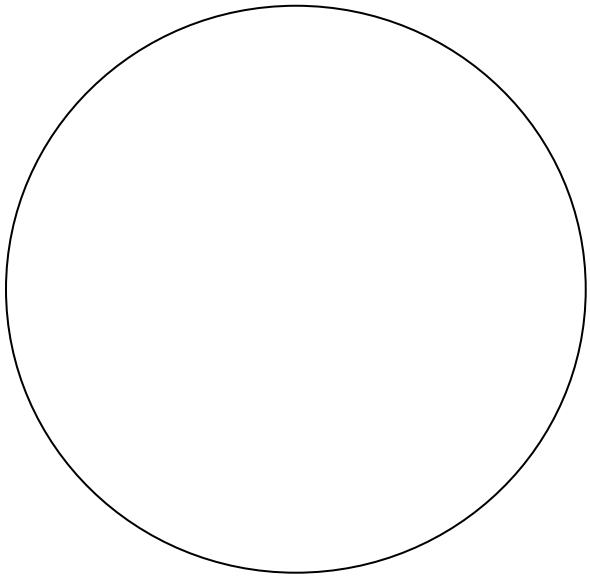
**Plant cell**

**Exercise 3: Draw and label the different muscle cells provided along with their functions, indicating the magnitude of the lens, and determining the total magnification.**

**Cardiac muscle**



**Skeletal muscle**



## V. EXPERIMENT OF LIVING ANIMAL CELL

### Cheek cell

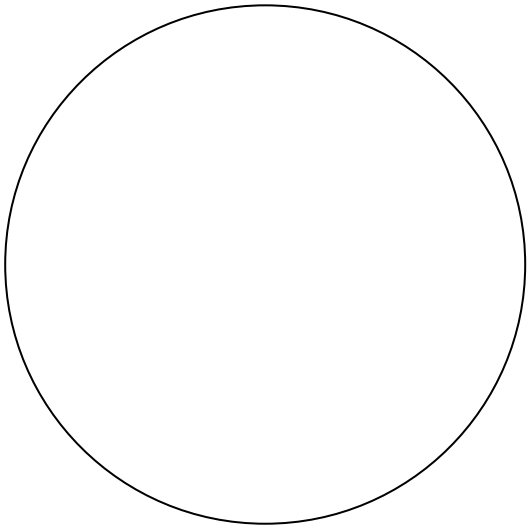
Materials needed:

- Glass slide
- Cover slips
- Methylene blue
- Tissue
- Plastic pipette or dropper
- Toothpick/ cotton swab

Method:

- Using cotton swab or toothpick gently swab the inner side of your cheek.
- Put a drop of Methylene blue on the slide with the help of dropper.
- Smear the cotton swab or toothpick in the methylene blue on your slide for 2-3 seconds to observe more cellular details. Dispose of the used cotton swab or toothpick in the garbage.
- We will use forceps to place our coverslip so while placing the coverslip you must be very careful that there is no air bubble present inside which will hinder your observation under the microscope. So slowly place the coverslip and examine under the compound microscope.

***Draw what you see:***



What is the most prominent feature you observe in the center of cell stained by methylene blue?

=

Why use Methylene blue in this experiment?

=

## VI. EXPERIMENT OF PLANT CELL

**Onion cell**

Materials needed:

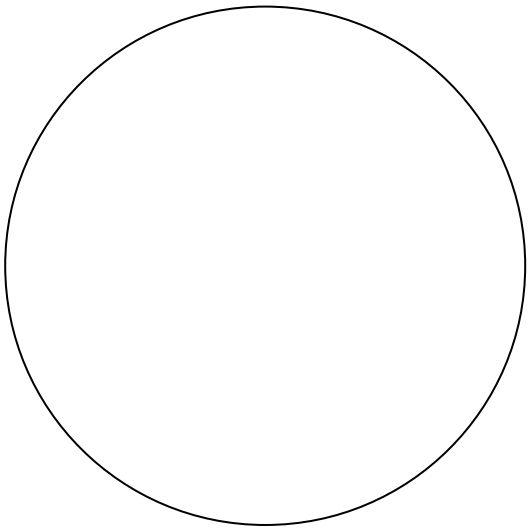
- Glass slide
- Cover slips
- Glycerin
- Methylene blue
- Plastic pipette or dropper

- Forceps

Method:

- Cut onion into halves and then peel thin, transparent layer from the inner surface of the onion bulb using forceps.
- Put a drop of Methylene blue on a watch glass with the help of dropper and place the peel in the methylene blue and wait for couple of minutes to five minutes.
- Take a glass slide and add glycerin to prevent drying out of specimen.
- Take the peel from the methylene blue and place it on the glass slide.
- We will use a forceps to place our coverslip so while placing the coverslip you must be very careful that there is no air bubble present inside which will hinder your observation under the microscope. So slowly place the coverslip and examine under the compound microscope.

***Draw what you see:***



What is the shape of the onion peel under microscope?

=

To prevent drying of the onion peel what did we do?

=

## VII. SCIENTIFIC METHOD EXPERIMENT

**Before you begin**

Before working on this lab assignment, review all relevant lab slides on the scientific method. Review the concepts of dependent and independent variables by studying the examples at:

https://blog.prepscholar.com/independent-and-dependent-variables

For most of the questions in this assignment, there is more than one way to answer a question; there is more than one correct answer! Each student may have a different set of observations and theories. Don't be afraid to express your idea. Be as specific as you can in your answers. Writing general and vague statements is a sign that you did not understand this lab.

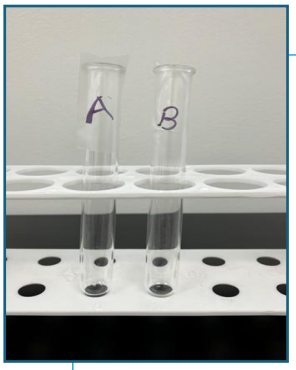
You do not need to put your name on this assignment. You must upload this document to our course while logged-in with your own account.

****Students will work in a group**

Materials needed:

- 2 test tubes
- 2 leaves
- Solution A
- Solution B

Procedure: **DAY-1**




- Label both test tubes with one of your names.
- Label one test tube “A”, the other one “B”.
- Bend one leaf.
- With the ends pointing up, insert the bent leaf into test tube “A” as far as you can, until it is almost at the bottom of the tube.
- Repeat with the other leaf using test tube “B”.

- Once you are ready, ask your instructor or lab technician to add solution A to your tube “A” and solution B to your tube “B”.
- Make sure the leaves are almost entirely submerged in the solution. They should not be floating at the top of the tube.

- Are there any bubbles on your leaf? Are they big or small?
- Count how many bubbles are attached to each leaf in each tube. Do not include bubbles floating in or at the top of the tube. Record the numbers in your results table under “Time 0 min”. If you don’t see any bubbles, record “0”.
- Count and record your numbers by yourself. **Don’t copy your partner.**
- Place your tubes on the tube rack by the window.

  **Start a timer for 15 minutes.**

Observe:

- After waiting 15 minutes, are there more bubbles attached to the leaves than before? Are the bubbles bigger?

****Be careful not to disturb the bubbles!**

- Count the number of bubbles on each leaf in each tube. Do not include bubbles that are floating in or at the top of the tube.
- Record the numbers in your results table under “Time 15 min”.

Recording results:

- Quantitative data – results that were measured in numbers.
- Qualitative data – results that were not measured in numbers but recorded as descriptions. For example:
    - Leaf in tube A was bigger than leaf in tube B.
    - Leaf at time 15 min has bigger air bubbles than at time 0 min.
    - The side facing the wall of the tube has more bubbles.

****Be as specific as possible!**

Analysis:

- Are there more bubbles at 15 minutes than at 0 minutes?
    - Where do you think the bubbles come from?
- Are the number of bubbles in each tube different? Which tube has more bubbles?
- Are your numbers different from your partner’s? Why?

*Table 4: Record your results from the week 3 lab experiment below.*

| | **Time**<br><br>**0 min** | **Time**<br><br>**15 min** |
|---|---|---|
| **Tube A** | | |
| **Tube B** | | |

Results Table: Number of air bubbles on the leaf at time 0 minutes and 15 minutes.

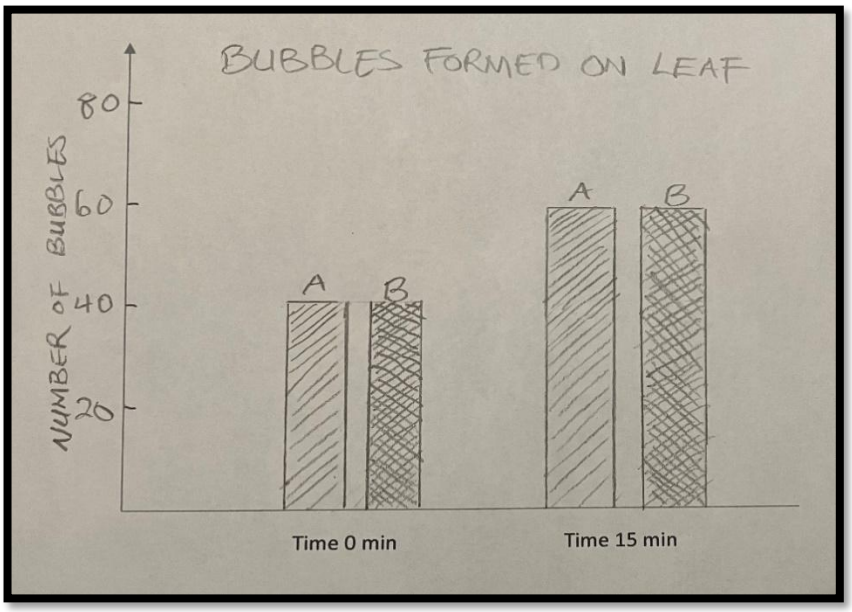
In the space below, write down any descriptive observations, in point form. For example, describe any differences in the size of air bubbles, between each time point and between the two leaves: differences between yours and your partner's numbers.

- 
- 
- 
- 
- 
- 

**Day-2: How do plants breathe?**

- Show you results precisely and concisely depicting with the help of bar or line graph or pie chart.

  Example: Create your own axis labels, scale, bar drawings, and graph title.




1. What's in the mystery solutions?

   =

2. Analyze your data.

   a. Where did the bubbles come from?

      =

   b. Why was there a difference between the number of bubbles formed in tube A compared to tube B?

      =

3. What about confounding factors?

   =

Look at your qualitative data from last week.

**What happened in our lab?**

In this lab, we did an experiment involving leaves in a test tube. The following questions *require you to review the lecture "the Cell"*, steps of our experiment from the lab slides, and the results that you have recorded.

1) In ONE sentence, describe what you observed after leaving the tubes by the window for 15 minutes. (1 mark)

2) In the space below, explain where you think the bubbles came from. (1 mark)

3) Why was there a difference between the number of bubbles formed in tube A compared to tube B? (3 mark)

**Make a hypothesis.**

Pretend you are a plant researcher who performed the experiment we did in class. Before completing the following questions, think about the outcome of the experiment. Why would you, as a plant researcher, want to do this experiment? Then, think backwards to create a hypothesis for this experiment.

4) As a plant researcher, what research question are you trying to answer using this experiment? Write ONE sentence, in the form of a question. (1 mark)

5) Write your hypothesis, in ONE sentence. (1 mark)

6) Write the null hypothesis, in ONE sentence. (1 mark)

7) What is the dependent variable? (1 mark)

- 

8) What is the independent variable? (1 mark)

- 

9) Does the result you collected in class support your hypothesis? Answer “yes” or “no”, then explain why. (4 marks)

**Design a better experiment.**

The experiment we did in class was very primitive and might not have fully tested your hypothesis. Before answering the following questions, think critically about what we did in this experiment. Was it perfect? Did we follow the best practices in the scientific method? Could we have done it differently?

10) Identify at least FIVE confounding factors in our experiment. Write them down in a list. You may have more than five. (2 marks)

- 

11) Could we have prevented the above confounding factors? Identify ONE way you could eliminate some of the confounding factors you identified. (2 marks)

12) Redesign our experiment: Imagine you are a plant biologist at a university. You have all the money, resources, and space you want to do this experiment. How would you design this experiment so that the confounding factors are eliminated? Be creative. In the space below, writing in a numbered list, describe exactly what you would do in each step of your experiment. Be as specific as you can. Your experiment must be able to prove or disprove your hypothesis in question 5. (10 marks)

## TEST YOUR KNOWLEDGE

1. Which organelles are found only in plant cells?

=

2. Fill in the blanks:

   i. _____ occurs inside the _____ of the plant cells and a major function of plant cells.

   ii. _____ is called the powerhouse of the cell.

   iii. Endoplasmic Reticulum is responsible for regulating _____ levels and _____ metabolism.

3. Why are lysosomes called as a digestion of cell?

=

4. Give three differences between

   a) Animal and plant cells

| | **Animal cells** | **Plant cells** |
|---|---|---|
| | | |
| | | |
| | | |

   b) RER and SER

| **RER** | **SER** |
|---|---|
| | |
| | |

| | |
|---|---|
| | |

5. Write whether it's **True or False** for the following:
   a) The nucleus holds the genetic instructions needed for reproduction to happen.
   b) Only animal cells contain mitochondria.
   c) Both plant and animal cells have parts called organelles that help them breathe and make energy.
   d) Plant cells are the only ones that have a cell membrane.
6. Which cellular component acts like a gatekeeper, controlling the enters and leaves the cell?

=

7. What precautions should we keep in mind right before viewing under microscope during the cheek cell experiment?

=

# Experiment 3: The Digestive system and Nutrition

## I. OBJECTIVES

You will learn by the end of the lab:

### *A. Digestive system*

- Recall the main organs and the functions of digestive system.
- Demonstrate the process of digestion by tracing the path of food through the digestive system.
- Identify and label the anatomical structure of the human digestive system.
- Use a microscope to observe and distinguish between the different types of muscle cells.
- Understand the role of each nutrient in maintaining health.

### *B. Nutrition*

- Know the meaning of nutrients, understand the different types of nutrients and their benefits in our healthy diet.
- Explain the concept of a calorie and determine the caloric value across various portions of food.

# DIGESTIVE SYSTEM

All living beings need food to survive. The role of digestive system is to turn food into useful nutrients by breaking it down with both physical and chemical processes. Each part of the digestive system has its own special tissues that play a specific role.

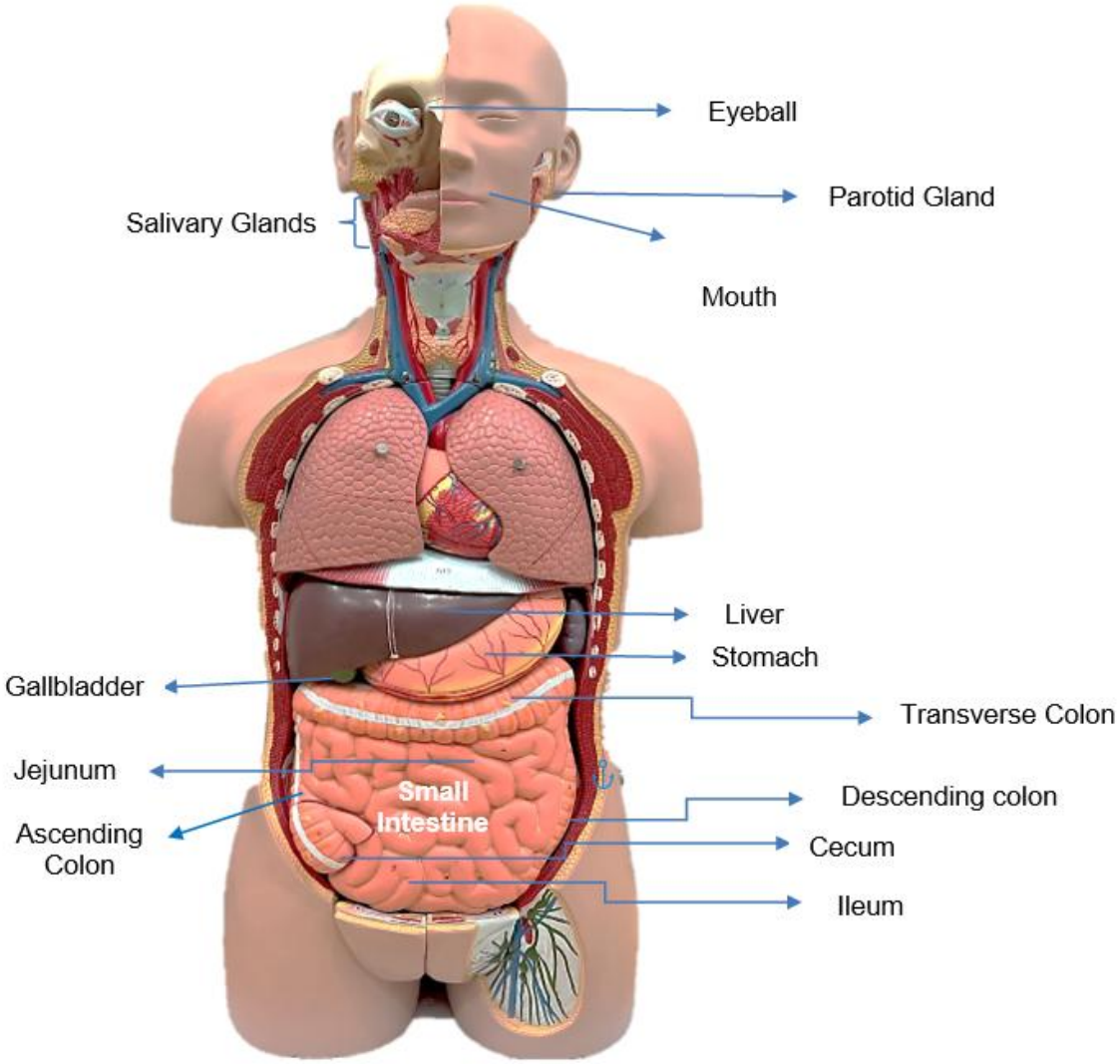



***Figure 8. Organs of the Digestive System***

**The mouth/ Oral cavity**

Food digestion starts from the mouth which is also a point of entry of food. Here physical

digestion starts by breakdown of food with the help of teeth and tongue. Whereas the chemical digestion happens with the help of saliva which softens and moistens the food to be swallowed. The saliva also contains an enzyme called **salivary amylase** which further breaks down the starch into sugars.

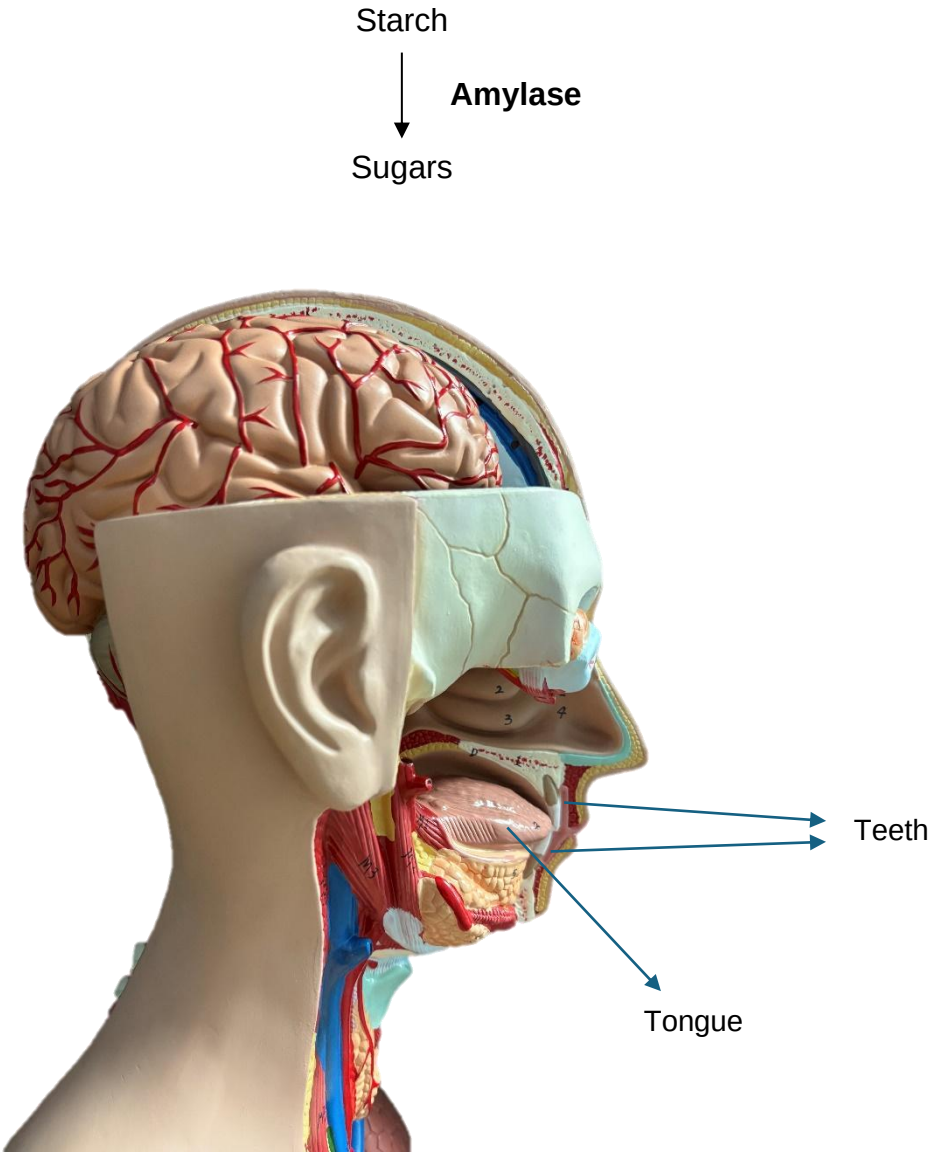


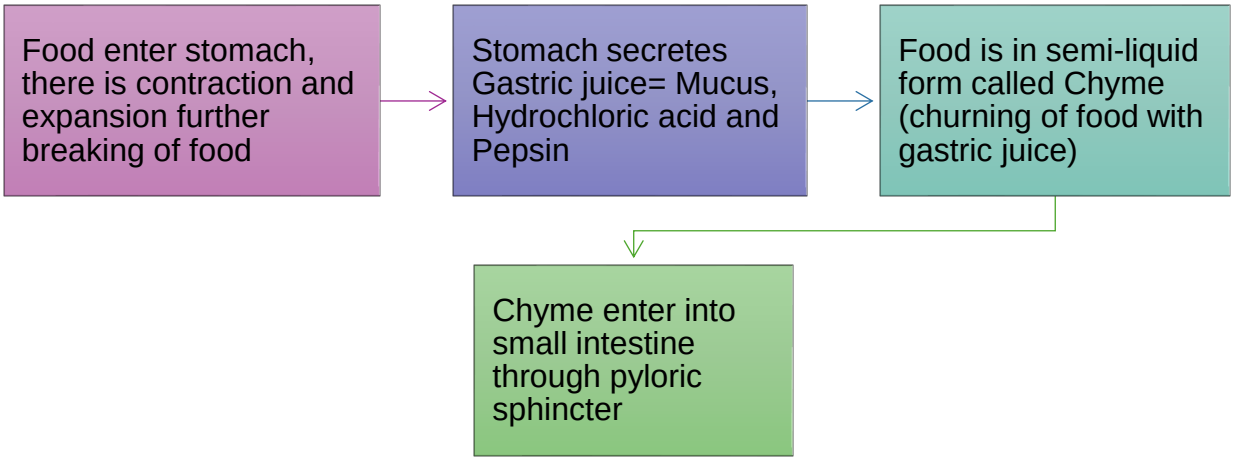

***Figure 9. Lateral view of head model with organs of digestive system***

**Pharynx**

The tongue pushes the chewed food into the pharynx. The food passes first from the esophagus and then through the **peristalsis** or the wave-like contractions pushing the food towards the stomach.

The _____ canal is a tubular canal that connects from mouth to the anus.

**Stomach**




What's the role of: -

- Pepsin: _____
- Mucus: _____
- Hydrochloric acid: _____

**Small Intestine**

Majority of the food digestion and absorption occurs in small intestine.

Looking at the model, what are the different parts of small intestine seen?

_____

**Pancreas and Liver**

They are called accessory glands as they are not a direct part of the digestive system.

Pancreas and Liver secrete into the small intestine especially duodenum.

Pancreas secretes:

- Enzymes: Amylase, trypsin, nuclease, lipase
- Bicarbonate: neutralizes the acid chyme.

Liver produces **Bile** → stored in gallbladder → enter small intestine by bile duct.

↓

Contains bile salts, bicarbonate ions, and phospholipids. ⟶ Breakdown of fat into small droplets of fats that can be absorbed.

The lining of the small intestine has folds like little finger-like projections called **villi**, that make a big surface area for absorbing nutrients and water into the bloodstream.

**Large Intestine**

The purpose of large intestine/ **colon** is to final absorption of undigested material (minerals and water) passing from small intestine → undigested materials are called **feces** → **rectum** stores feces before elimination → passed through **anus.**

**Exercise 1: Draw a labelled diagram of the human alimentary canal.**

## TEST YOUR KNOWLEDGE

**1.** List the structures in order of the movement of food to elimination.

**2.** Fill in the table with the following functions:

| Structures | Functions |
|---|---|
| Small Intestine | |
| Villi | |
| Colon | |
| Rugae | |
| Common Bile Duct | |

**3.** Digestion process continues in large intestine = True/ False?

**4.** Choose the appropriate answer:

**a)** What facilitate the movement of food through the digestive system?

a. digestive enzymes

b. gastric acid

c. mucous membranes

d. smooth muscles

**b)** What comprises of the digestive system:

a. mouth, esophagus, and stomach

b. esophagus, stomach, and intestines

c. colon, rectum, and anus

d. pancreas, liver, and gallbladder

**c)** Into what does the digestive system breaks down food:

a. Saliva

b. Nutrients

c. Amylase

d. Sphincters

**d)** Where do nutrients from food travel during the absorption process?

a. the mouth into the stomach

b. eliminated from the body as waste

c. stored in the liver

d. the intestines into the bloodstream

**e)** How long does a digestive system takes on the food you eat:

a. 24 hours

b. 15 hours

c. 10 hours

d. 20 hours

**5.** To prevent choking when we swallow the tissue called _____ closes over the windpipe.

**6.** Which two glands _____ and _____ empty into which part of small intestine _____?

**7.** _____ a series of muscle contractions, pushes the food down from the esophagus to the stomach.

**8.** The liver is in the _____ quadrant.

**9.** Connect the following to their respective ways in helping digestion:

| | |
|---|---|
| Pancreas | making bile and processing nutrients |
| Liver | making enzymes |
| Gallbladder | storing bile |

# NUTRITION

Food is the necessity for humans and animals. Food packages provide information on the recommended serving size alongside the energy content, measured in "calories" which you must have noticed on the food packages you get from the store.

## I. CALORIES

Energy is expressed in terms of calories.

Calories signify the energy your body can obtain from the key nutrients in your food.

All person caloric values differ according to their age, height, weight.

Eating more calories than one expends leads to weight gain, while consuming fewer calories than expended results in weight loss. Therefore, if you eat as much as you use up, your weight stays the same.

*Calculate calories:*

$$\text{No. of servings in the bag} = \frac{\text{size of total bag (grams)}}{\text{serving size (grams)}}$$

Total calories = # of servings in the bag x number of calories per serving

**Exercise 1: Look at the label of the food you have and calculate the calories intake you will be having.**

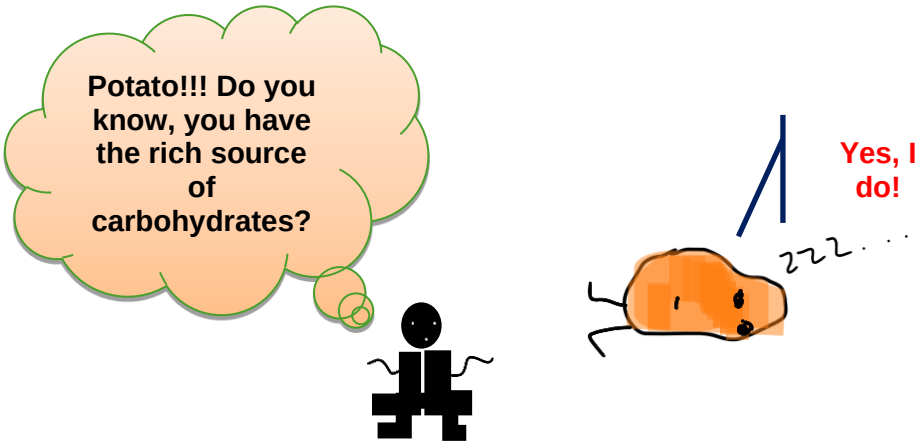
## II. MACRONUTRIENTS

The food which our body need it in large quantity.

**What are the 4 types of Macronutrients:**

- _____
- _____
- _____
- _____

a) Carbohydrate




Food: Vegetables, fruits, whole grains, fibers, vitamins, and minerals are great sources of carbohydrates.

Carbohydrates are the energy source in the body and glucose is the preferred energy source which circulates in the blood, main source of energy for the muscle, our nervous system and only source for the brain.

**What are carbohydrates composed of?**

= _____ (carbon, hydrogen, and

oxygen)

b) Fibres

Fiber is composed of carbohydrates that are indigestible, such as cellulose. There are two types of fibres:

- Soluble fibres: absorb water. Example: Oats, barley, nuts, beans, some fruits and vegetables. In case you have diarrhea and constipation, soluble fibres are effective source.
- Insoluble fibres: doesn't absorb water. Example: Celery, wheat bran, and whole grains.

c) Protein

Protein plays a crucial role in maintaining a healthy diet composing of 4 elements: C, H, O, N. Proteins consist of amino acids linked together by peptide bonds, forming relatively large molecules.

Cells use 20 different amino acids to make proteins.

*Non-essential amino acids*

11 amino acids body can synthesize

*Essential amino acids*

9 amino acids body cannot make.

**List the name of the food high in protein?**

= _____

**Which protein should be eaten in limited quantity?**

= _____

The requirement of amino acids is important to replace the old ones by producing new body proteins.

d) Lipids

Lipids also contain has C, H, O much like carbohydrates and proteins, the only difference lies on the higher amount of carbon and hydrogen.

*Cholesterol*

A type of lipid which is a waxy substance found in the body but the excess of cholesterol is bad for your health.

Cholesterol can be 2 types:

- LDL (low-density lipoprotein) (bad) cholesterol: the plaque formation can block the artery.
- HDL (high-density lipoprotein) (good) cholesterol: help in removing the bad cholesterol from the artery.

## III. ESSENTIAL NUTRIENTS

Essential nutrients are nutrients that our bodies need but **can't produce** on their own, so we must get them from our diet.

Essential nutrients:

- Vitamins
- Minerals

- 9 essential amino acids
- Fatty acids: omega-3 and omega-6

*Vitamins & Minerals:*

**Vitamins** are organic substances that our bodies need to work well, but we only need them in small doses.

**Most of the vitamins we obtain from food, why can't our body make vitamins?**

=

*Table 5: 2 types of vitamins*

| Water soluble | Fat soluble |
|---|---|
| Vitamin: B and C | Vitamin: A, D, E, K |
| Vitamins that are easily washed out of body | Upon absorption, stored as fat. Excessive amount can be toxic |

**What are the major dietary sources for:**

| | |
|---|---|
| **Vitamin C** | |
| **Vitamin $B_{12}$** | |
| **Vitamin A** | |
| **Vitamin E** | |
| **Vitamin D** | |
| **Vitamin K** | |

**Minerals** are the chemical inorganic elements. The human requirement for major dietary minerals are >200 mg/day.

Calcium, phosphorus, sulfur, potassium, chlorine, sodium and magnesium are the major minerals of human.

## TEST YOUR KNOWLEDGE

1. Why can't our bodies make essential nutrients?

=

2. Micronutrients provide majority of the energy. T/F
3. Describe the chemical difference between carbohydrates, proteins, and fats.

4. What is the key difference between vitamins and minerals? Name some examples of each.

5. What is an essential nutrient? Provide an example of an essential nutrient required in your diet.

6. Choose your favorite food/snack label, cannot be the same as your classmate. You can use cereal chocolate, cookies, or anything you like. Submit your food

label with your assignment.

a) How many servings are in the entire container/package? SHOW YOUR WORK!

b) How many calories are in the entire container/package? SHOW YOUR WORK!

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