Provincial Level Biology Lab Manual: Instructors Guide

Provincial Level Biology Lab Manual: Instructors Guide

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KAMLOOPS

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Contents

Introduction

Get to Know Your Lab Manual

Who Is It For

This lab manual was written to satisfy the articulation requirements of ABE Provincial Level Biology in British Columbia.

The student version of this lab manual, as well as other course materials, can be accessed in the course pack below:

Provincial Biology (Miller, 2023).

This instructor's guide is meant to help instructors prepare for and set up labs in the most time-efficient way possible.

About This Manual

- **Lab setting** – this lab manual was designed for 2-hour, in-person labs in a biology lab setting. However, many of the labs could be adapted to be kitchen labs, and a few could be adapted to virtual labs.
- **Board notes** – each lab includes notes to put on the board to help students know what to do and provide hints for setup, procedure, and cleanup.
- **Lab activities** – each lab has three activities for students to work through, with materials they need for each at its own station.
- **Bin labs** – setting up specific bins (18 in x 12 in) containing everything (except perishables) needed for each lab cuts down

on prep time and ensures necessary supplies are available.

- **Reference section** – this lab manual includes lab-specific instructions along with a reference section including solution recipes and printable labels.

Visual Prompts

This lab manual makes use of visual prompts for students, which can be found in the table below:

Symbol	You should:
	This symbol is included on the pages that will be handed in for marks. These pages will be either a pre- or post- lab assignment, and your instructor will let you know when it is due.
	A simple question mark next to any of the text in your lab manual means that you are supposed to be thinking about the question being asked, but that you don't need to record an answer. This icon means that there is a question in your lab manual that you need to answer in writing in the space provided.
	This icon means that before proceeding, you need to check in with your instructor.

NOTE FOR KAITLYN – MY SYMBOLS DIDN"T PORT OVER FROM WORD – I AM GOING TO FIX THIS

References

Miller, C. (2023). *Provincial biology*. BCcampus. https://collection.bccampus.ca/course-packs/provincial-biology/.

Acknowledgements

The Open Press

The Open Press combines TRU's open platforms and expertise in learning design and open resource development. TRU Open Press supports the creation and reuse of open educational resources, while encouraging open scholarship and research.

Land Acknowledgement

Thompson Rivers University (TRU) campuses are situated on the traditional lands of the Tk'emlúps te Secwépemc (Kamloops) and the T'exelc (Williams Lake) within Secwepemcúl'ecw, the traditional and unceded territory of the Secwépemc. The rich tapestry of this land also encompasses the territories of the St'át'imc, Nlaka'pamux, Tŝilhqot'in, Nuxalk, and Dakelh. Recognizing the deep histories and ongoing presence of these Indigenous peoples, we express gratitude for the wisdom held by this land. TRU is dedicated to fostering an inclusive and respectful environment, valuing education as a shared journey. The TRU Open Press, inspired by collaborative learning on this land, upholds open access principles, and freely accessible education for all.

Resource Development Team 2024

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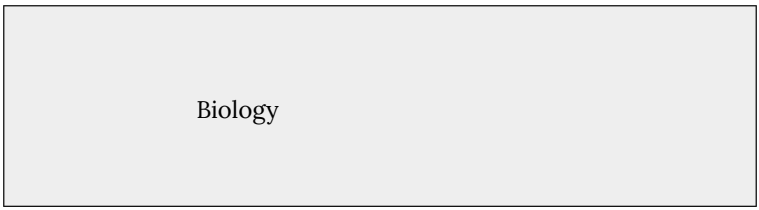
Resources

- Link to Open Course Collection which houses the Provincial Level Biology Lab Manual
- Link to accompanying textbook: Human


Biology

Accessibility

The web version of NAME OF SITE AND HYPERLINK has been designed to meet Web Content Accessibility Guidelines 2.0, level AA. In addition, it follows all guidelines in Appendix A: Checklist for Accessibility of the Accessibility Toolkit – 2nd Edition.

Includes:

- **Easy navigation.** This resource has a linked table of contents and uses headings in each chapter to make navigation easy.
- **Accessible videos.** All videos in this resource have captions.
- **Accessible images.** All images in this resource that convey information have alternative text. Images that are decorative have empty alternative text.
- **Accessible links.** All links use descriptive link text.

Accessibility Checklist

Element	Requirements	Pass
Headings	Content is organized under headings and subheadings that are used sequentially.	Yes
Images	Images that convey information include alternative text descriptions. These descriptions are provided in the alt text field, in the surrounding text, or linked to as a long description.	Yes
Images	Images and text do not rely on colour to convey information.	Yes
Images	Images that are purely decorative or are already described in the surrounding text contain empty alternative text descriptions. (Descriptive text is unnecessary if the image doesn't convey contextual content information.)	Yes
Tables	Tables include row and/or column headers with the correct scope assigned.	Yes
Tables	Tables include a title or caption.	Yes
Tables	Tables do not have merged or split cells.	Yes
Tables	Tables have adequate cell padding.	Yes
Links	The link text describes the destination of the link.	Yes
Links	Links do not open new windows or tabs. If they do, a textual reference is included in the link text.	Yes
Links	Links to files include the file type in the link text.	Yes
Video	All videos include high-quality (i.e., not machine generated) captions of all speech content and relevant non-speech content.	Yes
Video	All videos with contextual visuals (graphs, charts, etc.) are described audibly in the video.	Yes
H5P	All H5P activities have been tested for accessibility by the H5P team and have passed their testing.	Yes
H5P	All H5P activities that include images, videos, and/or audio content meet the accessibility requirements for those media types.	Yes
Font	Font size is 12 point or higher for body text.	Yes
Font	Font size is 9 point for footnotes or endnotes.	Yes
Font	Font size can be zoomed to 200% in the webbook or eBook formats.	Yes

Known Accessibility Issues and Areas for Improvement

- SAMPLE – Tables use merged cells but they have been structured to work properly with screen readers – make sure tables do NOT have merged cells!
- SAMPLE – These videos do not have edited captions:

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Other Formats Available

- SAMPLE – In addition to the web version, this book is available in a number of file formats, including PDF, EPUB (for eReaders), and various editable files. The Digital PDF has passed the Adobe Accessibility Check.

OER Adoption Form

Please consider filling out a survey about this textbook to help us better understand how it's used and fits with the needs of our readers.

1. Lab 1: The Microscope

General Information

Lab 1 helps students become familiar with the compound light microscope and its use. Students are guided through a series of exercises showing them:

- What parts make up a microscope.
- How to set a comfortable ocular width.
- How to put a slide on the stage.
- How to navigate around a slide.
- How to move from scanning power to low power to high power.

Students will also learn how to make a wet mount slide and explore the inverse relationship between magnification and field of view/ depth of field.

> **NOTE** — This lab does not teach students how to use the oil immersion lens.

Purchasing Information

Required materials for Lab 1 include:

- A class set of compound microscopes — preferably with 4x, 10x, and 40x objective lenses
- A class set of the following slides and slide materials:
    - Coloured threads slides
        - Available from many places, including Amazon, Ward's Science, and Boreal Science
    - Blank slides
        - 1 class set is recommended in case of breakage
        - Available from lots of places
        - Do not buy plastic ones, as they scratch and bend easily
    - Coverslips
        - Buy lots as they are disposable, and each student needs 2 per lab.
        - Do not buy plastic ones as they scratch and bend easily.
    - A set of random slides with neat samples on them
        - E.g., slides with 4 items per slide that are themed: textiles, insect parts, tiny plants, animals, etc.
        - Some sets are available on the following website: Prepared Slides Bundle: Set I & II (Learning Resources, n.d.).
- Small scissors (like sewing or kids scissors) — 1 pair for every 4 students
- Forceps (or tweezers) — 1 pair for every 4 students
- Small glass bottles with droppers — 1 for water and 1 for IKI
    - Brown glass works best for IKI due to its photosensitivity (see Additional Notes for more information).
- Cutting boards with small paring knives – 1 for every 8 students
- Clear plastic rulers — 1 for every 4 students
- Printed lab labels — laminating them is optional
- Newsprint with small font

- (On lab day) Onion — 1 medium-sized onion is enough for a lab with 20 students, where each makes their own slide.

Lab Setup

Preparations

- Buy an onion.

Lab Activity Setup

Time: Approx. 1 hour

Board Notes

Welcome to Lab 1: Safety and the Microscope

- Please hand in:
  - Signed safety contract from page 7 of your lab manual
  - Pre-Lab 1 Assignment from page 11 of your lab manual
- Find a partner to work with (you each get your own microscope)
- If you get stuck, first ask your partner, then ask the teacher
- Remember to call your teacher over when you reach a symbol
- Cleanup:
  - Slides – get cleaned and returned
  - Coverslips – go into the sharps disposal container

- Microscopes back where you got them
- Wipe down your lab bench and wash your hands before you leave

Setup Photos

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=5#h5p-1

Figure 1.1: *Lab 1 Activity 1 Setup (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 2.1: *Lab 1 Activity 2 Setup (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 3.1: *Lab 1 Activity 3 Setup (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Bin Lab

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=5#h5p-2

Figure 4.1: *Lab 1 Bin (Open) (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 5.1: *Lab 1 Bin (Closed) (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Troubleshooting Microscopes

Why can I not see anything?

Check that:

- The microscope is plugged in and turned on.
- The slide is in the field of view.
- The objective lens is clicked into place.
- The iris diaphragm is set properly.
- The blue filter is working properly.
- Only one eye is used to view (like a pirate).
- The depth of field is not decreased to the point that the item cannot be focused on.

Why do I lose my image when I move up in magnification?

Check that:

- The image is centered in the field of view and very well-focused before increasing magnification.
- The objective lens is in properly and clean.
- The iris diaphragm is set properly.

Why will my course focus not work / why does my microscope keep going out of focus?

Focus tension:

- Cannot move the course focus – the tension is too tight.
- The microscope falls out of focus spontaneously – the tension is too loose.

Additional Notes

IKI is photosensitive and can degrade if exposed to too much light. Degradation causes the colour to change, like in the Figure 1.6 below.

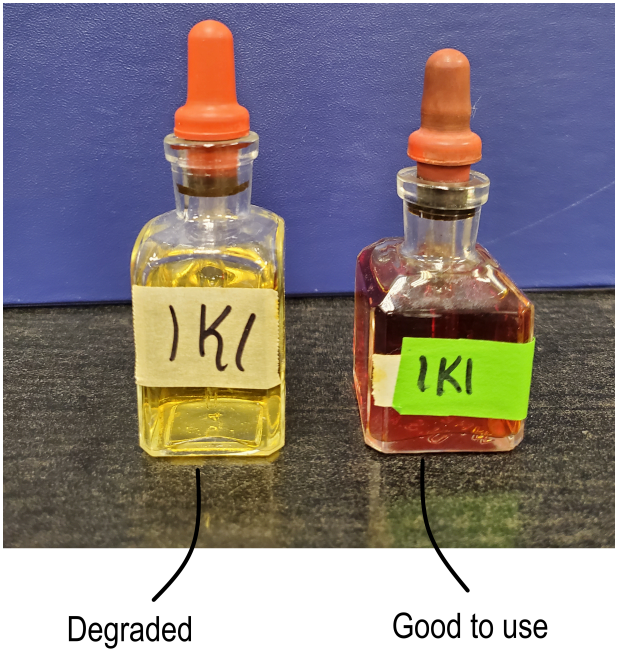

***Figure 1.6**: Degraded vs. Good to Use IKI (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Media Attributions

- **Figures 1.1 to 1.6**, by the author, are under a CC BY-NC-SA 4.0 license.

References

Learning Resources. (n.d.). Prepared slides bundle: Set i & ii.

https://www.learningresources.com/item-prepared-slides-bundle-set-i-ii.

2. Lab 2: Osmosis and Diffusion

General Information

Lab 2 has students explore diffusion, osmosis, tonicity, and semi-permeable membranes. This lab includes students making their own "cell" using dialysis tubing.

> **NOTE** — This lab is tied for the most prep required.

Purchasing Information

Required materials for Lab 2 include:

- 250 mL beakers — 5 beakers for every 2 students
- A kettle and access to ice
- A plastic bin for the ice bath
- A 1 L beaker for the cold water
- Liquid food colouring — 1 bottle for every 2 students
    - Do not get the gel kind, as it does not diffuse. You may want to check your food colouring ahead of time to make sure it diffuses nicely
- Small electronic scales — 1 for every 4 students. If you search

for “pocket scale” lots of good options will come up

- Cutting boards with small paring knives – 1 for every 4 students
- Erlenmeyer flasks — For preparing the starch, glucose and saline solutions
    - The size will depend on your class size.
    - E.g., 3L Erlenmeyer flasks for the two saline solutions and 1L Erlenmeyer flasks for the glucose and starch solutions
- 6 1L beakers — For saline, glucose, and starch solutions that students to pour from
- Several small weight boats
    - Plastic shot glasses from the dollar store work too.
- 2 glass bottles and droppers — For the IKI
    - Brown glass works best for IKI due to its photosensitivity (see Additional Notes for more information).
- Dental floss — 1 container for every 4 students
- Test tube tongs
- Clear plastic rulers
- Dialysis tubing — About 8 inches for every 2 students
    - The recommended size is 20.4 mm x 32 mm, but a bit bigger or smaller should still work fine.
    - Can buy in 50 ft lengths
- A glass bowl — For soaking the dialysis tubing
- Glucose test strips
    - Sometimes it is cheaper to buy pet urine testing strips than human medical-grade glucose strips. These strips may look like the Figure 2.1 below.

Figure 2.1: *Glucose test strips for pets (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Lab Setup

Preparations

Time: Approx. 1 hour (to make solutions)
Tasks:

- Buy potatoes — 1 medium potato for every 4 students
- Make glucose, starch, and saline solutions

Activity 2 Solutions

Solution 1: 0.9% saline

- Prepare 1.5 L for 20 students.
- Mix 9 g NaCl for each 1 L water.
- Dissolve well.

Solution 2: 3% saline

- Prepare 1.5 L for 20 students.
- Mix 30 g NaCl for each 1 L water.
- Dissolve well.

> **NOTE** — These solutions need to be precise for students to get good results for this activity.

Activity 3 Solutions

Solution 1: 5% glucose

- Prepare 400 mL for 20 students.
- Mix 5 g glucose for each 100 mL water.
- Dissolve well.

Solution 2: 1% starch

- Prepare 500 mL for 20 students.
- Mix 1 g starch for each 100 mL water.

- Dissolve well.

Pro-Tip — Use cellulose packing peanuts for Solution 2.

- Dissolve a handful in 500 mL of warm water with a stirring rod.
- This way is easier than using lab-grade starch powder, which clumps up very easily.

> **NOTE** — These solutions **do not** need to be precise for students to get good results.

Lab Activity Setup

Time: Approx. 1.5 hours

Board Notes

Welcome to Lab 2: Safety and the Microscope

- Please hand in:
  - Post Lab 1
  - Pre Lab 2
- Please re-use your beakers – limit 4 beakers per pair
- Order of Activities (if you want to get the whole lab done and/or leave on time)
  - Activity 1 — Start and finish
  - Activity 2 — Start and set a 1 hour timer

    - Activity 3 — Start and set a ½ hour timer
    - Activity 3 — Collect results
    - Activity 2 — Collect results
- Cleanup notes:
    - Saline solutions can go down the sink
    - Beaker with IKI given to instructor for disposal
    - Potatoes and "cell" can be composted
    - Beakers washed and placed to dry
    - Lab benches wiped down and hands washed

Setup Photos

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=23#h5p-3

Figure 2.2: *Lab 2 Activity 1 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 2.3: *Lab 2 Activity 2 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 2.4: *Lab 2 Activity 3 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Bin Lab

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=23#h5p-4

Figure 2.5: *Lab 2 Bin (Open) (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 2.6: *Lab 2 Bin (Closed) (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Additional Notes

IKI is photosensitive and can degrade if exposed to too much light. Degradation causes a change in colour, like in Figure 2.7 below.

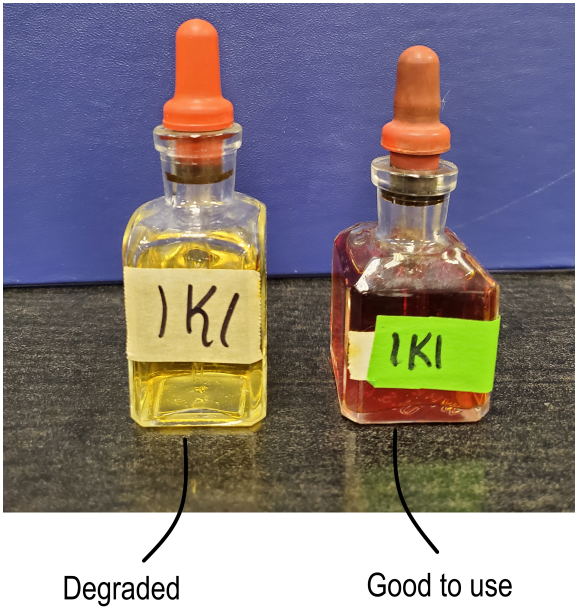

Figure 2.7: *Degraded vs. Good to Use IKI (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Media Attributions

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3. Lab 3: Mitosis and Meiosis

General Information

Lab 3 has students find and observe the various stages of mitosis and meiosis in both plant and animal cells.

It also provides a good opportunity for students to work on their microscope skills from Lab 1.

Purchasing Information

Required materials for Lab 3 include:

- Mitosis in onion root tip
    - The slide might say “allium” (the Latin name for onion).
- Mitosis in whitefish blastula cells
- Meiosis I in lily anther
- Meiosis II in lily anther

Optional materials for Lab 3 include:

- Mitosis and meiosis posters, showing diagrams and photos of the onion, whitefish blastula, and lily anther slides
    - Students can use the lecture slides if posters are not available.

Lab Setup

Lab Activity Setup

Time: Approx. 5 minutes (the shortest setup time!)

Board Notes

Welcome to Lab 3: Mitosis and Meiosis

- Please hand in:
  - Post Lab 2
  - Pre Lab 3
- Work with a partner
  - Partner A sets up the onion slide and does diagrams
  - Partner B sets up the whitefish slide and does diagrams
  - Swap microscopes and do diagrams
  - Partner A sets up Lily Anther Meiosis I
  - Partner B sets up Lily Anther Meiosis II
  - Swap
- Double-check that you put your slides away in the right bins & DON'T LEAVE THEM IN THE MICROSCOPES!!

Setup Photos

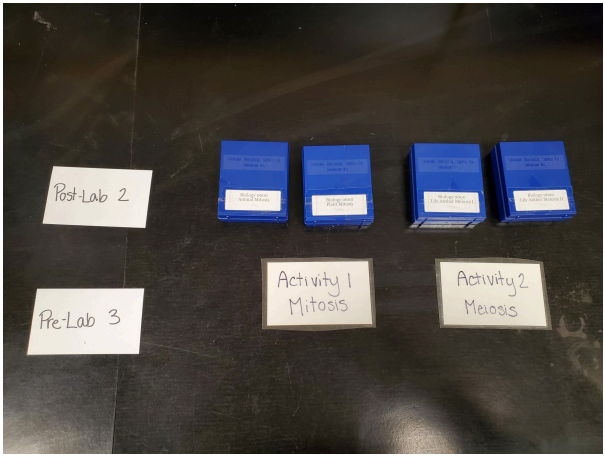

Figure 3.1: *Lab 3 Activity 1 and 2 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

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4. Lab 4: Tissues

General Information

Lab 4 has students observe different and/or defining histological aspects of several tissue types.

This lab is typically run as a "tissue buffet," where the instructor sets up all slides in advance for students. Students rotate from station to station to view each tissue slide.

Although it would be better if students could use this lab to practice their microscope skills, there are a few reasons not to:

- **Lots of instructor support required** — There is often more than one tissue type on a single slide, and students can get confused easily. Compound this with a class with little microscope experience and they need significant instructor support.
- **Time-consuming** — Students may be capable of setting up their own slides, but this is quite time-consuming, and even the classes with the strongest microscope skills may not get through all of the slides in a 2-hour lab.
- **Expensive** — If you set this up as a demo slide, you need only 1 of each tissue slide. If the students set up their own, you need a class set of each slide, which is expensive.

Purchasing Information

Required materials for Lab 4 include:

(If you are setting up demo slides, 1 of each. If the students set up, a class set of each)

- Tissue slides of the following:
    - Stratified squamous — Human skin
    - Simple cuboidal — Kidney tubule
    - Simple columnar — Intestine with goblet cells
    - Pseudostratified ciliated columnar — Trachea lining
    - Loose fibrous connective tissue (areolar tissue)
    - Dense fibrous connective tissue (white fibrous)
    - Compact bone
    - Spongy bone (cancellous bone)
    - Hyaline cartilage — Trachea rings
    - Fluid connective — Blood
    - Skeletal muscle
    - Smooth muscle
    - Cardiac muscle
    - Nervous tissue — Spinal cord smear or neural smear
- Tissue posters — 1 poster for each tissue category
    - Tissue categories — Epithelial, connective, muscular, and nervous
    - Flinn Scientific (n.d.) has some nice ones.

Lab Setup

Lab Activity Setup

Time:

- **Demo slides** – Approx. 1.5 to 2 hours
- **No demo slides** – Approx. 15 minutes

Board Notes

Welcome to Lab 4: Tissues

- Please hand in:
  - Post Lab 3
  - Pre Lab 4
- Work with a partner
  - Look at each tissue type
  - Draw (using coloured pencils) each tissue type
  - Take a photo with your phone if you can (reduces eye strain)
  - Talk about what you're seeing and where the tissue on the slide came from

Don't rush! Have fun!

Tissue Buffet Setup

Microscopes with slides are set up along the outside of the room for students to walk around like it is an all-you-can-eat buffet.

Notes for those who are new to histology:

Epithelial Tissues

If there are multiple tissue types on the slide, remember to look for the free surface. These are typically best viewed at medium light intensity and medium setting on the iris diaphragm.

Stratified Squamous — Best viewed at high power (400x magnification)

Simple Cuboidal — Best viewed at high power

Simple Columnar — Best viewed at high power

Pseudostratified Ciliated Columnar — Best viewed at high power

Connective Tissues

A couple of these slides have multiple tissue types, so make sure you know what the matrix is supposed to look like.

Loose Fibrous — Best viewed at high power.

Try to get some fibroblasts in the field of view.

Dense Fibrous — Best viewed at low (100x magnification) or high power

This one is tricky because students often mix it up with smooth muscle. The main difference is where the nuclei show up. In smooth muscle, the entire tissue is made up of cells, and you will see the nuclei INSIDE the cells. In dense fibrous connective tissue, the cells live in between the fibres, so the nuclei show up OUTSIDE the fibres. Low power shows the long fibres and high power can show the fibroblasts.

Compact Bone — Best viewed at low or high power

Low power is best if you want students to see several osteons but not the osteocytes and/or canaliculi. High power is best if you want students to see these details but not how the osteons are packed together.

Spongy Bone — Best viewed at low or high power

Low power is best for identifying trabeculae. High power is best for identifying osteocytes in lacunae.

Hyaline Cartilage — Best viewed at high power

This slide is typically a cross-section of a piece of trachea and will have many different tissue types on it. Look for the "googly eyes," which will be the pairs of chondrocytes in lacunae within the hyaline cartilage.

Blood — Best viewed under an oil immersion lens (1000x magnification)

Try to find a spot on the slide with all three types of blood cells and, if you can, a couple of different types of leukocytes.

Muscular Tissues

These are pretty easy since there are only three.

Skeletal Muscle — Best viewed under high power

Smooth Muscle — Best viewed under high power

Cardiac Muscle — Best viewed under high power

Hopefully, you can track down an intercalated disc. Sometimes you cannot, as different slide makers may use different staining, and only some really make the discs show up. You will have to look around to find them; they are at all cell junctions. Play with the iris diaphragm to see if you can get them to show up a bit better.

Nervous Tissue

This lab manual has only one slide, but you can also set up a cross-section of a spinal cord so students can see the distinctive butterfly pattern in the white and gray matter.

Spinal Cord Smear — Best viewed under low or high power

Low power will show a couple of neurons and numerous neuroglia. High power will zoom in on an individual neuron but may not capture the entire length of the axon. Talk to students about how this is an actual smear; unlike some other slides, this slide does not represent what cells would actually look like in a person.

Spinal Cord Cross Section (if you decide to set it up as a bonus) — Depending on the size of the spinal cord cross-section (mouse = tiny, human = huge), you want a scope that can show the entire cross section.

You will use the scanning power (40X magnification) on a compound lens microscope or, for larger slides, a dissecting scope.

Play with the lighting/iris diaphragm to highlight the difference between the regions of gray matter and white matter.

References

Flinn Scientific. (n.d.). *Tissue charts for anatomy studies*. https://www.flinnsci.com/products/biology/anatomy-physiology/tissue-charts-for-anatomy-studies/.

5. Lab 5: Nervous System and Senses

General Information

Lab 5 familiarizes students with the structures and functions of the nervous system by examining models and carrying out activities.

This lab emphasizes:

- Brain anatomy
- Structure and function of the eye
- Mechanoreceptors in the skin

Purchasing Information

Required materials for Lab 5 include:

- A human brain model that shows external features and comes apart to show internal structures
    - The ideal brain model is close to life-size and comes with a key.
    - Available on Amazon and other educational materials sites.
- A Plastimount sheep brain or sheep brain model (life-size)
- A Comparative Brains Specimen Mount Plastimount (for fun)
    - Can be found on the following website: Comparative Brains Specimen Mount Plastomount (Nebraska Scientific, n.d.)

- Slide of a cross-section of a mammalian spinal cord
- Model of the human eye
    - The ideal model is large enough for several students to examine at the same time.
    - Look for a model that comes apart, so students can look at the internal structures easily (it helps if it comes with a key).
- Printouts for Lab 5 (in Lab 5 Printables section in the back matter).
    - In the back matter of this instructor guide
    - Laminating is recommended so they hold up to students handling them.
- Flexible measuring tape (like for sewing) — 1 tape for every 4 students
- Forceps (or blunt scissors/tweezers) — 1 for every 4 students
- Small clear rulers (6 inches) — 1 for every 4 students
- Coins — 1 for every student
    - E.g., pennies, nickels, or anything else metal that is roughly the same size and weight

Lab Setup

Lab Activity Setup

Time: Approx. 1 hour

This lab is typically set up buffet-style, where students move around the room and complete activities. The benefit of this setup is that students can start with any activity and then return to activities they missed; because of this, students do not end up all bunched up at one station.

Board Notes

Welcome to Lab 5: The Nervous System

- Please hand in:
  - Post Lab 4
  - Pre Lab 5
- Work with a partner
- Start at any activity you like (Activity 1, 2 or 3)
- Complete all activities before you go

Setup Photos

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=30#h5p-8

Figure 5.1: *Lab 5 Activity 1 Setup (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 5.2: *Lab 5 Activity 2 Setup Part 1 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 5.3: *Lab 5 Activity 2 Setup Part 2 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 5.4: *Lab 5 Activity 2 Setup Part 3 (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 5.5: *Lab 5 Activity 3 Setup (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

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References

Nebraska Scientific. (n.d.). *Comparative brains specimen mount plastomount*. https://www.nebraskascientific.com/plastomounts-dissection-specimens/3970-comparative-brains-specimen-mount-plastomount.html.

6. Lab 6: The Skeletal System

General Information

Lab 6 familiarizes students with the bones of the human body. Specifically, it introduces them to the axial and appendicular skeleton.

In this lab, students will:

- Have the opportunity to handle real bones.
- Learn how to identify bones by shape, size, and features.

This lab includes a video created during the COVID-19 pandemic that you can view below (please disregard the COVID-era references).

- Learn the Bones of the Human Body (27:32 min) by Basic Biology (2020)

Purchasing Information

Lab 6 can be difficult to purchase items for if you do not have access to your institution's health-related program supplies. If necessary (or on a limited budget), students can watch the video shown above, and you can provide them with smaller models and diagrams to look over.

Note that the following supply list can be expensive without the previously mentioned access to your institution's supplies.

Required materials for Lab 6 include:

- Posters of the skeletal system showing the main bones of the axial and appendicular skeleton
- 2 or 3 complete human skeletons — Preferably real ones, but plastic works too
- Loose bones, including:
    - Skull — Showing plates, fissures, and foramen (nice if the mandible is detachable)
        - (Optional) An "exploded" skull — Shows each piece detached from each other in the same orientation/grouping they would be in a regular skull
    - (Optional) A fetal skull — Highlights differences in fissures and size compared to the female pelvis
        - This skull is optional because it can be difficult to acquire.
        - Although it is not critical to the lab, you will have to amend the manual a bit or provide a photo (in the Lab 6 Printables section of this guide).
    - Pelvis structure models — 1 male and 1 female
    - Sacrum
    - Sternum
    - Loose vertebrae, including:
        - Axis & atlas (C1 and C2)
        - Cervical example
        - Thoracic example
        - Lumbar example
    - Long bones (loose bones and a sample arm and leg), including:
        - Femur
        - Tibia
        - Fibula
        - Humerus
        - Radius
        - Ulna
    - A knee model — Includes bones and ligaments

    - Extra bones for the “name that bone” bonus activity

Lab Setup

Time: Approx. 45 minutes

Board Notes

Welcome to Lab 6: Tissues

- Please hand in:
    - Post Lab 5
    - Pre Lab 6
- Work with a partner, talk about what you are looking at
- Point at the bones with a probe or your finger – please do not point with pencils or pens
- Remember to do the “Name that bone” activity before you leave

Setup Photos

I STILL NEED TO ADD THESE

References

Basic Biology. (2020, October 22). *Learn the bones of the human body* [Video]. YouTube. https://www.youtube.com/watch?v=Sa08rgYE_uU.

7. Lab 7: Heart Dissection

General Information

Lab 7 is the only dissection in the lab manual. Although students really look forward to it, there is some trepidation. Because of this, Lab 7 has some safety considerations.

Talk to students about being prepared and healthy, including:

- Reading over the lab.
- Watching the dissection video (link below).
- Getting a good night's rest.
- Eating breakfast before coming to the lab.

Also, talk to your students about what to do if they feel ill (e.g., nauseous, dizzy, or lightheaded), such as sitting down immediately and/or telling a friend. These incidents are uncommon, but it is always better to be proactive than reactive.

Caution students that they should treat the hearts in the same way they treat any raw meat in their kitchens. Ensure that they are washing their hands thoroughly and sanitizing their workspace.

The following video shows a full heart dissection, which follows the instructions in the lab manual. You can share the link with your students before the lab.

- Heart Dissection (26:32 min) by Learn Basic Biology (2020)

Purchasing Information

Thompson Rivers University is lucky to have a Retail Meat Processing program, and I buy fresh or frozen pig hearts directly from them. This option is less expensive than buying preserved hearts from a lab supply company and has the added benefit of the hearts not smelling bad from the preservatives.

If you do not have a source at your institution, you can buy pig hearts from a local butcher. Furthermore, if you have friends who hunt, deer hearts also work well too, although they are bigger than pig hearts.

The hearts keep fairly well in the freezer (if properly bagged) and last about a year before becoming too freezer-burnt.

Required materials for Lab 7 include:

- A class set of dissection trays (glass or plastic foodware dishes also work fine)
- A class set of dissection scissors (scalpels do not work as well for this type of dissection)
- A class set of probes
- Latex or vinyl gloves — For students who wish to use them
    - Buy medium to extra large sizes (smalls seem to only fit children)
- Fresh or preserved pig hearts (see discussion above) — 1 heart for every 2 students
    - Keep a couple of spare hearts in case any are damaged.

Lab Setup

Preparations

Tasks:

- Preorder and prep the pig hearts.

Lab Activity Setup

Time: Approx. 30 minutes

- You can spend some time rinsing the hearts out for the students so they do not find huge blood clots.

Board Notes

Welcome to Lab 7: Heart Dissection

- Please hand in:
    - Post Lab 6
    - Pre Lab 7
- Work with a partner
- Be safe:
    - Be careful with scissors
    - Sit down if you feel lightheaded
    - Ask for help if you need it
- Dispose of hearts in the waste bag provided
- Clean your dishes well with warm, soapy water

- Wipe your lab bench down with disinfectant

Setup Photos

No photos are needed! Each student pair gets a dissection tray, a probe, a pair of scissors and their heart.

References

Learn Basic Biology. (2020, October 30). *Heart dissection* [Video]. YouTube. https://www.youtube.com/watch?v=tCNQlpETaOc.

8. Lab 8: Blood Typing

General Information

Lab 8 uses the Ward's Blood Typing Kit, which simulates blood typing in a lab using synthetic blood and antibodies.

In this lab, students will:

- Practice a blood typing technique.
- Learn to make inferences about antigens, antibodies and blood type compatibility.

Purchasing Information

Required materials for Lab 8 include:

- Ward's Simulated ABO Blood Typing Kit — 1 complete kit for every 2 students
  - Find it on the Ward's Science website: Simulated ABO and Rh Blood Typing Lab Activity (Ward's Science, n.d.a).
  - This kit comes with:
    - Blood typing trays
    - Mixing sticks
    - 4 squeeze bottles of synthetic blood (Mr. Smith, Mr. Jones, Ms. Brown and Mr. Green)
    - Squeeze bottles of antibodies — Anti-A, Anti-B, and Anti-Rh
  - If you run low on supplies, you can also buy a refill kit: Simulated ABO Blood Typing Kit (Ward's Science, n.d.b).

- Ward's Simulated Blood Typing "Whodunnit Kit" — 1 complete kit for every 2 students
    - Find it on the Ward's Science website: Simulated Blood Typing "Whodunit" Kit (Ward's Science, n.d.c).
    - This kit comes with:
        - Blood typing trays
        - Mixing sticks
        - 6 squeeze bottles of synthetic blood (Victim, Crime Scene, Suspects 1-4)
        - Squeeze bottles of antibodies — Anti-A, Anti-B, and Anti-Rh
    - If you run low on supplies, you can also buy a refill kit.

Lab Setup

Lab Activity Setup

Time: Approx. 15 minutes

Organize the materials into Ziploc bags. Make sure to have enough pre-made bags so each pair of students has one.

Blood typing activity bag:

- 1 vial of each of the 4 synthetic bloods
- 1 vial of each of the 3 types of antibodies
- 2 mixing trays
- 2 mixing sticks

Whodunnit activity bag:

- 1 vial of each of the four suspects' blood and the murder scene blood

- 1 vial of each of the 3 types of antibodies
- 2 mixing trays
- 2 mixing sticks

Board Notes

Welcome to Lab 8: Blood Typing

- Please hand in:
  - Post Lab 7
  - Pre Lab 8
- Work with a partner
- Make sure to mix the antibody and blood for at least 20 seconds (sing "Happy Birthday" in your head)
- Clean out trays right after you record results (if the trays sit too long, it wrecks them)
- Do not let your skin come into contact with the "blood" or "antibodies" if at all possible
- Return your activity baggie with all the supplies it came with
- Wipe down your lab bench when you are all done

Setup Photos

These are not setup photos. They are a step-by-step walkthrough of how blood typing works.

An interactive H5P element has been excluded from this version of the text. You can view it online here:

https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=36#h5p-9

Figure 8.1: *Lab 8 Step 1: Tray (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 8.2: *Lab 8 Step 2: Add blood (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 8.3: *Lab 8 Step 3: Add antibodies (Credit: Christine Miller) CC BY-NC-SA 4.0 license*
Figure 8.4: *Lab 8 Step 4: Mix and read results (Credit: Christine Miller) CC BY-NC-SA 4.0 license*

Media Attributions

- **Figures 8.1 to 8.4**, by the author, are under a CC BY-NC-SA 4.0 license.

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Ward's Science. (n.d.c). *Simulated blood typing "whodunit" kit*.

https://www.wardsci.com/store/product/10424325/simulated-blood-typing-whodunit-kit.

Labels — All Labs

Lab 2 Recipes

Lab 2 Recipes

Activity 2 Solutions

> **Note** — These solutions need to be exact for the activity to work well.

Solution 1: 0.9% saline

- Prepare 1.5 L for 20 students.
- Mix 9 g NaCl for each 1 L water.
- Dissolve well.

Solution 2: 3% saline

- Prepare 1.5 L for 20 students.
- Mix 30 g NaCl for each 1 L water.
- Dissolve well.

Activity 3 Solutions

> **Note** — These solution do not need to be exact for the activity to work well.

Solution 1: 5% glucose

- Prepare 400 mL for 20 students.
- Mix 5 g glucose for each 100 mL water.
- Dissolve well.

Solution 2: 1% starch

- Prepare 500 mL for 20 students.
- Mix 1 g starch for each 100 mL water.
- Dissolve well.

Pro-Tip – use cellulose packing peanuts for Solution 2.

- Dissolve a handful in 500 mL of warm water with a stirring rod.
- This way is easier than using lab-grade starch powder, which clumps up very easily.

Lab 5 Printables

Lab 5 Nervous System Printables

You can visit the following Google Doc link to print each diagram onto an 8.5 in by 11 in sheet of paper. The images are under a CC BY-NC-SA 4.0 license.

- Images for Lab 5 for the Provincial Biology Lab Manual (Miller, 2024)

You can also access the individual sources for these images below.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=79#h5p-6

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Lab 6 Printables

Lab 6 Skeletal System Printables

Providing labelled diagrams out can be helpful for students during this lab. I currently use a mix of resources. I print and laminate some open source colour diagrams (can be found in the link below).

Additionally, I have several copies of "Martini's Atlas of the Human Body." The book has great visuals with a nice level of detail in labelling the provincial level anatomy. You can buy used copies online for about $10 to $15 and new copies for about $80.

I usually have 5 of these set out, open to specific pages, including:

- Different types of vertebrae
- Regions of the spine
- The arm
- The leg
- A labelled diagram of an entire skeleton

If you can afford the 5 copies, you do not need to print out all the diagrams provided below.

You can visit the following Google Doc link to print each diagram onto an 8.5 in by 11 in sheet of paper. The images are under a CC BY-NC-SA 4.0 license.

- Images for Lab 6 for the Provincial Biology Lab Manual (Miller, 2024)

You can also access the individual sources for these images below.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://provincialbiologylabinstructorsguide.pressbooks.tru.ca/?p=82#h5p-7

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Answer Keys

Lab 1 Pre-Lab Assignment

1. Wear a lab coat and close-toed shoes.
   Tie back long hair.
   Any items from the safety agreement on page 5, including reading the lab ahead of time, knowing where safety equipment is, and keeping your work area clear of clutter.
2. Wash glassware. Wipe countertops. Wash hands.
3. Because light passes through 2 lenses, you can see tiny things.
4. Objective lens — Magnifies the image
   Condenser — Focuses light on the specimen
   Stage — What you place your slide on
   Base and Arm — What you hold when carrying the microscope

Lab 1 Post-Lab Assignment

1. With one hand supporting the base and one hand holding the arm.
2. A fixed mount slide is a pre-prepared slide that is permanent. A wet-mount slide is made as needed and then dismantled or thrown away once used.
3. Use the fine focus knob when on low power or high power. Use the course focus knob on scanning power and sometimes on low power.
4. Answers will vary.
5. An increase in magnification causes a decrease in the field of view.

Lab 2 Pre-Lab Assignment

1. Diffusion is the movement of particles from an area of high concentration to a low one. Osmosis is the same type of movement, but specifically the movement of water across a semi-permeable membrane.
2. Semi-permeable means that some substances can cross and some cannot. We are using dialysis tubing as our semi-permeable membrane.
3. Hypotonic, Hypertonic.
4. To determine if substances have crossed the semi-permeable membrane.
5. To keep the cell contents separate from its surroundings and regulate the entrance and exit of molecules.

Lab 2 Post-Lab Assignment

1. The hot water had higher kinetic energy, causing the molecules to move faster.
2. Answers will vary.
   Mainly looking for some thought about comparing cells, tonicity, or consistency.
3. To determine if water entered or left the cell. To determine if a solution was hypo-, iso- or hyper-tonic.
4. To see if glucose had left the "cell." Because we already knew glucose was in the cell as we put it there.
5. Answers will vary.
   Possibly more pronounced results as cells had more time to reach an isotonic state through osmosis.

Lab 3 Pre-Lab Assignment

1. S — The cell is replicating its DNA.
   M — The cells are actively going through cell division.
   G2 — The cell is making final preparations for cell division.
   G1 — The cell is carry out regular cell processes.
2. Prophase → Metaphase → Anaphase → Telophase
3. Mitosis results in 2 identical diploid cells, while meiosis results in 4 unique haploid cells.
4. Synapsis and crossing over and independent alignment/ assortment
5. Meiosis 1 → Metaphase 1

Lab 3 Post-Lab Assignment

1. Answers will vary.
   The animal cells are round, and the plant cells are rectangular. The chromosomes in the plant cells look thicker vs. the thinner ones in animal cells. In animal cells, mitosis looks like a clear central line, while it looks a bit messier in plants. Students will often comment on the colour of the dye.
2. Answers will vary.
   Students will either pick metaphase or anaphase. Either answer works as long as they relate the length of time to seeing the fewest of this stage through their microscope.
3. The drawing should show chromosomes aligned at the equator. The drawing should include a rectangular cell wall for the plant cell and a round cell membrane for the animal cell. Encourage students to draw what they saw, not what their diagrams look like.
4. Answers will vary.

Lab 4 Pre-Lab Assignment

1. Epithelial — Forms linings and coverings
   Connective — Cells in a non-cellular matrix
   Muscular — Is contractile
   Nervous — Conducts electrical impulses
2. Atom → Molecule → Cell → Tissue → Organ
3. Tissue is a group of specialized cells working together to perform a specific function. This branch of science is histology.
4. Yes.

Lab 4 Post-Lab Assignment

1. Epithelial cells have a free surface and a basement membrane. Half marks for "forms linings and coverings."
2. The loose fibrous connective tissue has open spaces between the cells and between protein fibres. The dense fibrous connective tissues are made of densely packed parallel strands of fibres, with no extra spaces between them.
3. Osteocyte — Supportive connective/bone
   Intercalated disc — Cardiac muscle
   Chondrocyte — Supportive connective/cartilage
   Leukocyte — Fluid connective
   Neuroglia — Nervous
   Collagen & elastin — Fibrous connective
   Goblet cell — Epithelial
   Peristalsis — Smooth muscle
4. Answers will vary but must include visual characteristics. May talk about the shape and layering of cells, type of matrix (fibres, bone, cartilage, fluid), striations, and relative size of cells.

Lab 5 Pre-Lab Assignment

1. Chemoreceptor — Presence of chemicals
   Photoreceptor — Presence of light
   Thermoreceptor — Change in temperature
   Mechanoreceptor — Movement/pressure
2. Central nervous system (CNS). Peripheral nervous system (PNS).
3. Sensory input, interpretation/integration, and motor output.
4. Fight or flight. Rest and digest.
5. Neurons and neuroglia (glial cells).

Lab 5 Post-Lab Assignment

1. Brain and spinal cord
2. Answers will vary.
   Can include size (sheep smaller), shape (sheep elongated), and position of the brain stem (sheep exits the brain at an angle more to the dorsal side).
3. Answers will vary.
   Should discuss age, gender, and eye health.
4. Answers will vary.
   Should talk about the density of receptors in different areas of the dermis.

Lab 6 Pre-Lab Assignment

1. Osteocytes. Bone marrow.
2. Axial — Ribs, spine, and skull

Appendicular — Leg, arm, and shoulder

3. Sinus — A cavity or open space
   Condyle — A rounded bump where a bone meets another bone
   Foramen — A hole or opening
   Diaphysis — The middle portion of a long bone
4. Proximal. Medial. Inferior.

Lab 6 Post-Lab Assignment

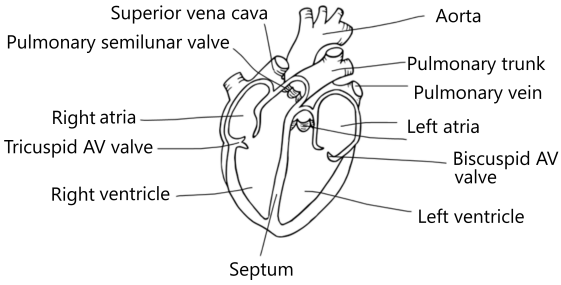
1. Answers will vary.
   Should mention that the ball on the femur is extended, and on the humerus, it sits directly atop the bone.
   Should talk about range of motion and/or weight-bearing function.
2. Answers will vary.
   The tibia is much thicker and has a flattened space on the proximal end for the femur to articulate.
   The fibula is much more slender.
3. Femur — Large ball on the proximal end
   Cervical vertebrae — Large central foramen and two smaller transverse foramen
   Patella — Small oval-shaped bone found at the knee
   Sacrum — Curved triangular-shaped bone with several pairs of foramen
4. Ossicles of the inner ear. Femur.

Lab 7 Pre-Lab Assignment

1. The AV valves sit between the atria and ventricles and have chordae tendineae supporting them. The semilunar valve sits

at the exit of the ventricles and has no chordae tendineae.

2. Epicardium — Connective tissue
   Myocardium — Cardiac muscle tissue
   Endocardium — Epithelial tissue

3. 

Lab 7 Post-Lab Assignment

1. The tricuspid valve had three cusps and three points of attachment for the chordae tendineae, which are much smaller. The bicuspid valve had two cusps and two points of attachment, and the chordae tendineae were much larger.
2. The myocardium of the left ventricle was much thicker than that of the right ventricle.
3. These went directly back to the heart tissue. The purpose of these coronary arteries is to provide high-oxygen blood to the myocardium.
4. The aorta was much stretchier to accommodate for fluctuations in blood pressure due to the pumping of the left ventricle.
5. The left ventricle because it has to be strong enough to pump blood to the entire body.

Lab 8 Pre-Lab Assignment

1. Erythrocyte — A red blood cell
   Antigen — A glycoprotein projecting from the surface of a red blood cell
   Antibody — A protein created by the immune system that targets and destroys a specific antigen
   Agglutination — Clumping of blood cells caused by exposure to an antibody
2. The blood type is A+. Antibodies are Anti-B
3. To avoid agglutination, which can kill the patient. Agglutination and death.
4. Blood typing. We expose an individual's blood to each antibody type and watch for agglutination. If agglutination occurs to a specific antibody, we know that that type of antigen is present.
5. Blood type B+. Can receive B+, B–, O+, O–.

Lab 8 Post-Lab Assignment

1.

Patient	Response to Anti-A	Response to Anti-B	Response to Anti-Rh	Blood Type
Mr. Smith				
Mr. Jones				
Ms. Brown				
Mr. Green				

2.

3.

4.

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