Biology 204
Principles of Biology I

Home Lab Manual

Athabasca University

Contents

The Role of Laboratories

Although humans can learn a great deal by simply reading, nothing beats direct experience for helping us to understand and remember. In the study of biology, "direct experience" means hands-on work with living organisms, materials derived from living organisms, biology equipment, and biology procedures. Besides being interesting and enjoyable, such work helps students gain insight into and experience in formulating biological questions, conducting experiments, collecting and interpreting data, and learning the strengths and weaknesses of various scientific methods. Physically doing things also helps students to understand and remember concepts covered in textbooks.

Sometimes such hands-on work can only be done in the field (where the organisms live), but usually—for reasons of convenience, weather, timing, access to special equipment, and safety—such work is done in a laboratory. A laboratory is nothing more than a space designed and equipped for certain kinds of work. However, because laboratories have these special features, they are expensive to build and maintain, so they are not readily accessible to all students at all times. In *Principles of Biology I*, Athabasca University is increasing accessibility by having students do some hands-on work in their own homes. In this course, Athabasca University supplies certain materials, and students supplement these materials with some readily available items, thereby reducing the amount of time spent in a laboratory.

Home Lab Activities: General Information

Many (but not all) introductory biology labs done at a traditional university can be done at home. Some labs cannot be done at home because

- certain lab equipment, which is essential for introductory biology and for which there is no substitute, is too expensive to buy and ship to students, especially those not living in Canada.
- hazardous chemicals can pose dangers to students, they cannot be mailed, and they are expensive to transport by other methods.
- certain kinds of lab activities are best taught through "live" instruction.
- the study of biology requires live specimens, which can be shown best in a central location.

Before You Begin

1. Safety first: read all the safety instructions that follow. In a conventional lab situation, health and safety is a shared responsibility between lab instructors and students; at home, it is solely the student's responsibility. However, none of the home labs pose risk if you use common sense and follow the recommendations given.

2. Carefully check the contents of the *Home Lab Kit* against the contents list to make sure that nothing is missing. Contact Course Materials (cmat@athabascau.ca) immediately if an item is missing. Review the *Home Lab Manual* to see what supplies you need to provide yourself, and then plan a shopping trip to purchase any additional items you may need. You may have many of these items at home already. If you have problems with any of these items, please contact your tutor.

3. Some of the labs require advance preparation. You will find this information in section 2 (Time Requirement and Preparation) of the respective labs.

How to Write Lab Reports

You are required to submit two lab reports (your choice, from Labs 1-5) which form part of your course assessment. The purpose of a lab report is to demonstrate that you have carried out and understood an experiment. Present your results in graph form whenever possible. Your discussion should demonstrate that you have reflected on the experiment and its purpose and that you can explain both expected and unexpected results. Some labs include questions that need to be answered in your lab reports. Answer these questions in a narrative form, not as direct answers to the questions.

There is no uniform format for preparing a lab report. Different formats may be required for different courses. For this course, lab reports must be written in the format of a scientific paper. Use of SI units is mandatory. Use of imperial measurement units (inches, Fahrenheit, feet, etc.) will be penalized by the loss of marks.

Each lab report will count for 10% of your grade. In addition, you will have to submit digital photographs of your results for Labs 1-6 (3%) and your bioinformatics results for Lab 7 (2%).

Online Lab Report Writing Resources

Please consult the following resources for assistance in writing lab reports. They are listed in order of their perceived quality.

- Writing Lab Reports or Research Papers
  Writing Services, University of Guelph Library. (2004). "Writing Lab Reports or Research Reports." *Learning Commons Fastfacts Series*. Guelph, ON: University of Guelph. Reproduced with permission.
- Writing Lab Reports and Scientific Papers
- Writing Scientific Lab Reports
- Writing Biology Laboratory Reports
- Sample Lab Report

You will note a "Conclusions" section at the end of the sample report. In your lab reports, conclusions can be part of the discussion, but do not present them in a separate section.

Council of Science Editors Style

In your assignments for this course, you are required to use CSE (Council of Science Editors) style.

Home Lab Safety Procedures

Although the home lab activities are designed to be very safe, you should take precautions when working with chemicals (flammable or poisonous), heat sources (potential for burns), and glass or other sharp objects. You should always be careful of potential hazards, and act accordingly.

1. Keep the *Home Lab Kit* and the supplementary materials that you acquire safely away from children and pets **at all times**. Some of the materials used in the Home Labs are poisonous; others could cause injury.

2. Read the assigned home lab activity completely **before** you start to do anything. This will help you expedite the experiment, understand the purpose of the activity, and identify possible hazards.

3. Use a work area, such as a kitchen counter, where there is a flat and stable working surface, access to water, and access to various supplies. Before you begin an exercise, assemble all of the materials you will need to complete it. Gathering materials as you go is both inconvenient and potentially dangerous. It is recommended that you cover your work space with a cheap plastic cloth to protect the working surface from possible spills.

4. Keep the following emergency equipment handy in your working area: a fire extinguisher, water, a first aid kit, and a telephone.

5. Keep your working area neat and free from materials that you do not need for the activity at hand.

6. Do not smoke or eat when you are using flammable or poisonous materials. Wash your hands before taking a break for a snack or meal.

7. Avoid working on home labs when young children are present (and curious), but ensure that someone is around who can assist you in case of an accident.

8. Wear appropriate clothing for working with chemicals and open flames (e.g., no large cuffs or frills that could knock your equipment down or catch fire). Tie back long hair so that it will not get into

chemicals or an open flame. Wear an apron or smock to help keep clothing from being stained.

9. **Never** wear contact lenses when working with chemicals, first because if a chemical gets into your eyes, contacts make flushing them with water more difficult and time-consuming, and second because soft lenses will absorb certain chemicals from the air and concentrate them on the eyeballs.

10. Use safety goggles and gloves whenever you handle flammable or corrosive liquids.

11. Work with the (small) quantities indicated. Follow the instructions to prevent fires, burns, and cuts.

12. Label all materials clearly, and make accurate observations and measurements so as to avoid mistakes or do-overs.

13. After use, thoroughly wash and rinse all equipment for reuse. Dispose of leftover materials safely and immediately.

14. Read the following procedure for dealing with poisoning with iodine or methanol. Record the telephone number of the nearest poison centre.

Accidental Poisoning with Iodine or Methanol

If someone ingests iodine or methanol:

1. Call a physician or poison centre immediately. The telephone numbers of poison centres are listed in the emergency number section of most telephone books. Look up the local number and record it here:

   _____.

2. If the person is conscious and not convulsing, induce vomiting.

3. If the person stops breathing, wipe away any chemical residue from the mouth, and start mouth-to-mouth respiration.

4. **For iodine poisoning,** after initial vomiting has occurred, give the victim milk and a starch mixture (composed of 15 g cornstarch or flour in 500 mL of water).

All homes should stock a supply of syrup of ipecac (see your pharmacist) for promoting vomiting of **certain** poisons. Syrup of ipecac should **not be**

given to children under one year of age. Syrup of ipecac takes up to 20 minutes to work. Read the label to determine the correct dosage. Follow the syrup with noncarbonated water only.

Vomiting may also be induced by inserting the back of a spoon or a finger down a person's throat or having a person drink a glass of warm water mixed with two tablespoons of table salt.

Caution: Do not give liquids to or induce vomiting in a person who is unconscious, losing consciousness, or convulsing; and do not induce vomiting for poisoning by administering acidic, alkali, or petroleum products.

Home Lab Kit

If you have not already done so, please become familiar with the contents of the *Home Lab Kit* now. An illustration of the contents is provided below. Please note that some of the items in the kit may puncture or cut skin, or may be small enough to be swallowed by young children or pets. **Keep your home lab materials safely away from children and pets.**

Student Supplied Lab Materials

In addition to what is in the *Home Lab Kit*, you will need many household items. Check to see what you have, and make a list of items you need to buy. Skim through the "Materials" and "Procedures" sections of the home labs before you purchase anything, so that you will know the amounts and kinds of a given item to buy. Remember that some of these items are poisonous or flammable.

Read warning labels carefully, and store the materials in a safe place.

Chemicals: isopropanol (rubbing alcohol), methanol (gas-line antifreeze), iodine solution, table salt, water, sugar, starch.

Equipment: kitchen stove (electric, don't use gas stoves because many experiments use flammable liquids), freezer (outdoors in a typical Canadian winter), a container for ice and a test tube, ice (or a freezer) to cool a test tube , double water bath (e.g., mug in a pot with water on a stove), a watch or clock, a computer with Internet access, a hair dryer (optional), a digital camera (optional), a balance (if available), a blender (possible substitute: a small, sealable, heavy duty plastic bag such as a Ziploc® freezer bag).

Utensils: scissors, knife, paper towels, metric ruler, pencil, thread, teaspoons, yeast, permanent markers, toothpicks.

Other materials: dried yeast, soft leaves of a plant or frozen spinach, potting or garden soil, one large or several small plant pots (possible substitute: sawed-off milk cartons or paper or plastic drinking cups with a few drainage holes made in the bottoms), tray or shallow pan in which to set plant pots, banana (possible substitute: three or four large fresh or frozen strawberries), shampoo.

Lab 1: Chromatography

Read this two-page introduction to paper chromatography online.

1.1 Introduction

Chromatography is an analytic technique for separating chemical compounds primarily by their molecular mass (weight). In essence, known or unknown chemicals are first dissolved in a solvent (e.g., water, mixtures of alcohols, or other organic solvents); then, the solvent with the dissolved chemicals is added to a suitable matrix (e.g., paper or gel), and some force (e.g., gravity, electrical field) is applied to move the chemicals through the stationary matrix. The distance that a molecule moves depends upon factors such as size, cohesiveness to the medium, and electrical charge. The areas where the different molecules end up can be observed under ordinary light or ultraviolet (uv) light, or by staining with appropriate dyes. The distances moved can be used to determine which chemicals are present.

Chromatography is used to separate mixtures and identify unknown compounds in molecular biology and in applied fields such as forensic science. In this activity, you will prepare a plant extract and separate its various chemical components.

1.2 Time Requirement and Preparation

This activity takes about 3 hours. You may need to prepare your plant material a day before you start the experiment. See section 1.4.

1.3 Materials

- **From the *Home Lab Kit*:** chromatography paper, three test tubes (large), lid, test tube rack, small pipette, large pipette, forceps, gloves, goggles.
- **Student supplied materials:** soft leaves of a plant or frozen spinach, methanol, isopropanol (rubbing alcohol), scissors, knife, double

water bath (e.g., mug in a pot), paper towels, freezer compartment, ruler, pencil, hair dryer (optional), digital camera (optional).

1.4 Procedure

1. Read the relevant safety information about methanol. Avoid all open flames, and keep kids, pets, and others at a safe distance. Do NOT attempt to extract methanol on a gas stove! Use gloves and goggles while doing the extraction. Never swallow methanol: it can cause blindness.

2. Prepare the plant material: If you use chopped, frozen spinach, no preparation is necessary other than taking it out of the freezer. If you use other plants, cut five or six leaves into small pieces (smaller is better) with a knife. Avoid tough, leathery leaves. Put the leaf material into a freezer until it is solidly frozen (1-2 hours)—in many parts of Canada you can do this step outdoors (in winter). Remove the material from the freezer, thaw it, and put it back into the freezer. Remove it from the freezer again when you are ready for the extraction. The freeze and thaw process cracks the cells open, which will help you with the extraction process.

3. Cut a strip off the chromatography paper. The strip should be as broad as possible, but still slide easily into the large test tube. The strip should be about 1 cm shorter than the large test tube.

4. Prepare your water bath. Place a mug about one-third full into a pot of water. Heat the pot to a temperature just below boiling. Do **not** use a gas stove for this procedure as you must avoid open flames.

5. **Note**: Use goggles and gloves for this step. Using forceps, fill the large test tube with about 1.5 cm (depth) of plant material. After re-reading the safety instructions, use a small plastic pipette to add about the same volume of methanol. Using the large pipette, crush the leaf material in the test tube. Place the test tube into the mug (your water bath). Make sure that the mouth of the test tube **always** points away from your body. If you see the methanol boiling, reduce the heat on the stove. Leave the test tube in the water bath for about 30 minutes, and crush the plant material repeatedly with your large pipette. When you see that the solution is distinctly green, your extraction has been successful. The darker the solution, the better.

6. Turn off the heat.

7. With a pencil, mark a point about 1.5 cm from the end of your chromatography strip. Using your large pipette, place a tiny drop of your chlorophyll extract on the mark (the smaller, the better). Let it dry for 2 minutes (you can accelerate this with a hair dryer). Repeat this step about 10 times, each time adding another tiny drop in the same place; don't add another drop before the previous one has dried completely. At the end of the process, you should have a distinct green dot on your paper strip. This dot contains the whole mixture, seen in one colour. Now you are ready for the chromatography,

which will separate the components into their individual pigment colours.

8. After donning gloves, put a large, empty test tube in the test tube rack. Using your small pipette, fill the test tube to about 1 cm with methanol (your solvent). Ensure that when you drop your chromatography strip into the test tube, that the chlorophyll dot on the paper will be distinctly above the level of the solvent. With your forceps, slide the paper strip into the test tube, and put a lid on the top of the test tube. Keep the test tube and the rack still, avoiding any vibrations while the solvent is running. You can watch as the solvent moves slowly up the paper strip. It should move at least half to two thirds of the length of the strip. This may take 40-60 minutes.

9. Remove the paper strip from the test tube with forceps. Before you dry the paper strip, mark the leading front of the solvent with a pencil. You should see at least two or three different pigments, depending on your plant material.

10. Calculate the R_f values. Notice that the solvent front is usually slightly further up the paper strip than the first pigment. This happens because the pigment tends to absorb to the paper more than the solvent, and this slows its movement. Each chemical has its own characteristic rate of movement, which depends upon the matrix, the solvent, and the type of force applied. This amount of movement can be quantified as a ratio, or an R_f value.

    $$R_f = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent}}$$

    When we have many R_f values for known compounds with standard matrices and solvents, we can identify unknown compounds by comparison.

11. Calculate the R_f values of your pigments. Try to guess their identity.

12. Make a digital photograph of your chromatogram. Do this immediately after drying the strip, because the pigments tend to fade. Submit this photograph to your tutor via the designated assignment drop box at your online course site. If you are unable to photograph your chromatogram, you can send the paper strip to your tutor by post mail.

13. This experiment can be extended (repeated) with other types of plant material or with other solvents (e.g., isopropanol).

Lab 2: Osmosis

2.1 Introduction

Osmosis, explained in Chapter 5 of the textbook, is a special form of diffusion that occurs through a semi-permeable membrane. The membrane allows free flow of the solvent (usually water), but blocks the passage of larger solute molecules, such as saccharose. Osmosis through cell membranes is common and may pose a problem for cells without a cell wall, such as animal cells, when they are exposed to hypotonic or hypertonic surroundings.

The semi-permeable dialysis tubing that you will use simulates a cell membrane: only water and smaller molecules can diffuse through the tubing.

2.2 Time Requirement and Preparation

This activity takes about 3-4 hours. No advance preparation is required.

2.3 Materials

- **From the *Home Lab Kit*:** dialysis tubing (note: it looks like a piece of cellophane and is usually stored in a Petri dish. It does not look tubular until it is soaked in water), three 250 mL beakers, syringe.
- **Student supplied materials:** scissors, water, thread, sugar or commercial syrup (use regular, granulated sugar; dextrose—corn sugar—will not work), metric ruler, a balance (if available).

2.4 Procedure

1. Label and prepare three beakers as follows. Fill them about three-quarters full.
   a. beaker #1: water
   b. beaker #2: syrup (commercial syrup or syrup prepared by dissolving 250 g of sugar in 250 mL water)
   c. beaker #3: syrup (commercial syrup or syrup prepared by dissolving 250 g of sugar in 250 mL water)

   Use a balance to weigh the sugar, if possible. Alternatively, 250 g amounts to about 35 teaspoons of sugar (175 mL, or about 2/3 cup).

2. Cut off three segments (each about 10 cm long) of dialysis tubing. Submerse all the segments in a beaker with water until you can see the tubing unfold. Fold **one** end of each segment back on itself (about 1 cm), and tie it tightly with a string (see Fig. 2.1 below). Backfolding is important to prevent the "cells" from leaking.

3. Open the free end of one tube (call it tube #1) by moistening it and rubbing it between your fingers. Using the syringe, fill it with the sugar solution (syrup). Squeeze out all of the air. Fold over the free end and tie it (like the other end) with a thread. Rinse any syrup off the outside of the tube.

4. Fill tube #2 with sugar solution (syrup), and tie its free end as in step 3. Rinse as needed.

5. Fill tube #3 with water, and tie its free end as in step 3.

6. Place tube #1 in beaker #1, tube #2 in beaker #2, and tube #3 in beaker #3, as shown in Figure 2.1 below. The liquids in the beakers should cover the tubes completely. The sealed tubes form model cells.

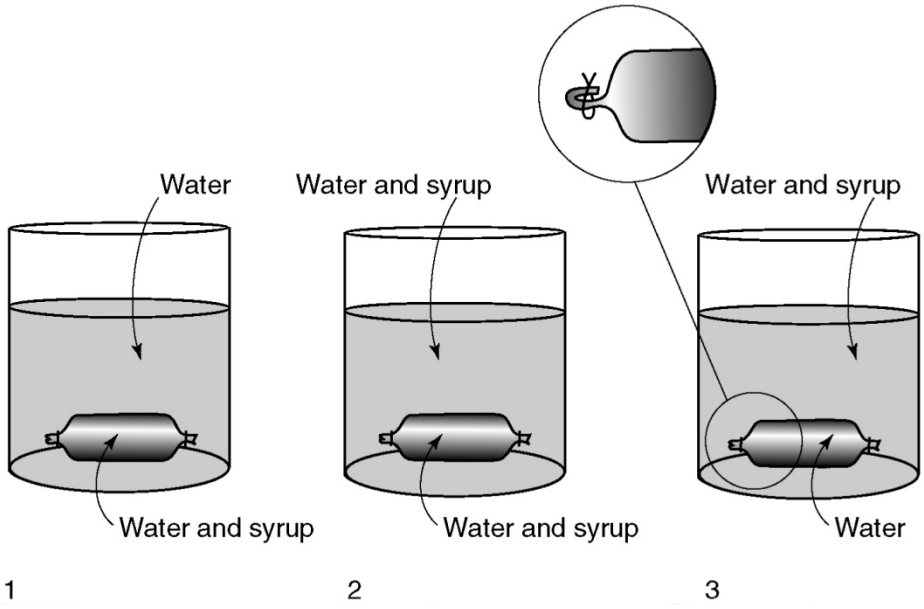


Figure 2.1. Beakers with tied dialysis tubes (model cells).

7. Observe any changes in the model cells after one, two, and three hours, and note your observations in the following table.

Treatment	After one hour	After two hours	After three hours
Model cell #1			
Model cell #2			
Model cell #3			

8. Make a digital photograph of your results, and submit this photograph to your tutor via the designated assignment drop box at your online course site.

Lab 3: Enzymes

3.1 Introduction

Enzymes are covered in Chapter 4 of the textbook. The experiments in Lab 3 demonstrate the enzyme action of alpha amylase, an enzyme found in human mouths and pancreases as well as in bacteria and fungi. It works on alpha-glycosidic bonds, breaking down starch (its substrate) into maltose and dextrins (its products). In this lab, we use the iodine test in a semi-quantitative way to determine the degree of the reaction.

3.2 Time Requirement and Preparation

The lab takes about 2 to 2.5 hours. No advance preparation is required.

3.3 Materials

- **From the *Home Lab Kit*:** three small test tubes, one large test tube, test tube lid, two small pipettes, petri dish and lid, test tube rack, amylase, pH paper.
- **Student supplied materials:** small pot, stove, water, starch, toothpicks, corn starch, iodine solution (see safety regulations), marker pens (permanent), watch or clock.

3.4 Procedure

1. Read the safety instructions regarding iodine poisoning. Use gloves when you handle the iodine solution.
2. Prepare a starch suspension (it is a suspension, not a solution, as starch does not dissolve in water). Add 3.5 g (about half a teaspoon) of starch to 250 mL of water in a pot on a stove. Heat the starch suspension, stirring occasionally until the suspension boils. Cool the suspension to room temperature. This step is important. As the starch

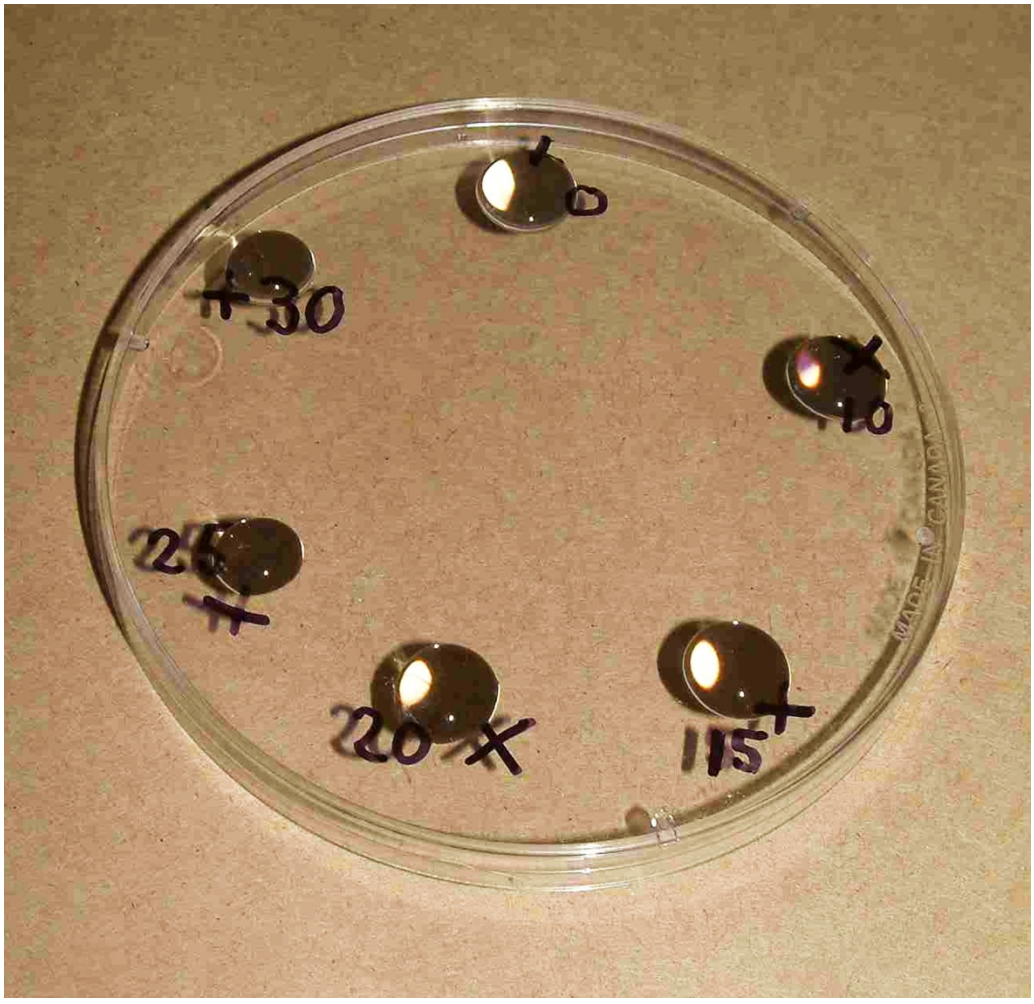
suspension cools, excess starch will settle to the bottom of the pot. To ensure consistency in the amount of starch used in the experiment, do not stir up the starch from the bottom of the pot. Draw from the starch suspension only from the top of the liquid.

3. Prepare the enzyme (amylase) solution by carefully adding the amylase (white powder) into the large test tube (use a toothpick to get it out from the vial). Add 10 mL of water, apply the test tube lid, and shake. Set aside one of the small pipettes and mark it with a marker pen. Use this pipette exclusively for the enzyme solution.

4. Using a second pipette (not the same as that for the enzyme solution), dilute 1 mL of starch suspension in a small test tube with 1 mL of water. Cover the top of the test tube and shake it. Use a small amount of the suspension to measure the pH of the solution using pH paper.

5. Place a petri dish on a white background (e.g., a sheet of paper). After putting on gloves, use a small pipette to put two drops of diluted starch suspension in the bottom of the petri dish. Add a (separate) small drop of iodine solution right next to the starch suspension drop. Mix the two, using a toothpick. You should see a positive reaction (bluish black), which indicates the presence of starch.

6. Place the lid of your petri dish on a white background. Using a marker, mark six crosses (X) on the outside surface of the petri dish lid in a circular pattern around the periphery. Label the six crosses as 5, 10, 15, 20, 25, and 30. These numbers will refer to minutes.



7. Add a large drop of diluted starch suspension over each of the crosses. You should have a concentric circle of six drops in your petri dish.

8. Using the small pipette designated for the enzyme solution, add a drop of the enzyme solution separately to each of the six starch suspension drops. Set your watch or timer; this will be your time zero.

9. After 5 minutes, add a drop of iodine solution to the first ("5") cross. Note the reaction. Record the colour of the drop immediately, using a scale, such as +++ (extremely dark purple), ++ (dark purple), + (light purple), 0 (no purple). The colour of the iodine solution would be 0.

10. After 10 minutes, add a small drop of iodine to the second drop ("10") and note the result as in the previous step. Continue this process with each X until you reach the last one after 30 minutes.

11. Starting from step 6 above, repeat the experiment. However, this time, add a small drop of vinegar to each of the six starch suspension drops as part of step 7 (before you add the enzyme solution to each drop). After adding the enzymes (step 8), set your time to 0 again, and add your iodine solution in five-minute intervals. Record your observations at each time interval.

12. Make a digital photograph of your results, and submit this photograph to your tutor via the designated assignment drop box at your online course site.

Note: You could do the same experiment with saliva; however, we have replaced the saliva with amylase.

Lab 4: Fermentation

4.1 Introduction

Fermentation is covered in Chapter 6 of your textbook. In this lab, you will indirectly measure the rate of fermentation in yeast cells, based on the production of carbon dioxide (CO_2—a product of fermentation).

Baker's yeast (*Saccharomyces cerevisae*) is a fungus that is commercially important for the production of bread; the CO_2 released by the fermentation of *S. cerevisae* causes bread to rise. Other strains and species of yeast are needed to produce wine, beer, and industrial chemicals. In this lab, you will study the production of CO_2 at different temperatures during the fermentation of sugar by yeast cells under anaerobic conditions.

4.2 Time Requirement and Preparation

This activity takes about 2 hours. No advance preparation is required.

4.3 Materials

- **From the *Home Lab Kit*:** thermometer (to measure water temperature), snap cap vials (without lids), 250 mL beakers, small test tubes, small pipette, measuring cylinder.
- **Student supplied materials:** teaspoons, yeast, water, sugar (dextrose—corn sugar—works best, but table sugar—saccharose—will do), watch or clock, paper towels, permanent marker.

4.4 Procedure

1. In a 250 mL beaker, dissolve 2 teaspoons of dextrose (or 3 tsp. of table sugar) in 250 mL of warm water (about 37°C). In a second beaker, dissolve the same amount of sugar in cold water (about 12°C).

2. Calibrate two of your small test tubes in mL increments with a permanent marker by filling the test tube with 1 mL, 2 mL, and so on (you can use water for this). Use the measuring cylinder for this task. The tubes should have about 4 mL of volume. These marks will allow you to estimate the amount of gas developed (later in the experiment).

3. When the sugar is completely dissolved (the solution is clear), add a tablespoon of dry yeast to each beaker. Stir until the yeast is suspended.

4. Fill one snap cap vial with cold sugar-yeast solution, and the other one with warm sugar-yeast solution almost to the top.

5. Completely fill a small test tube with cold sugar-yeast solution. Using your index finger as a lid, turn the test tube upside down and immerse it into the snap cap vial containing the cold solution. Release your finger only when the test tube is below the liquid level in the vial. Some of the liquid in the vial will likely spill out. Ideally the inverted test tube won't have an air bubble. Don't worry about a small bubble, but repeat this process if there is a significant amount of air in the test tube.

6. Repeat this procedure with a second small test tube, using the warm solution.

7. Set your time at zero (the cold solution will have a slight head start).

8. At intervals of 10 minutes (10, 20, 30, etc.) measure and record the volume of gas development in both the cold and the warm systems, using the calibration marks on your test tubes to help you estimate. Terminate the experiment after two hours or after one of the test tubes is full of gas. Make a digital photograph of this while the experiment is in progress.

9. Use the table below to record your observations of the level of CO_2. Graph the volume of gas generated (vertical axis) versus time (horizontal axis).

Time (minutes)	Tube #1 warm	Tube #2 cold
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		
110		
120		

Total CO_2 in mL/hr:

Tube #1 _____

Tube #2 _____

10. Submit the digital photograph of your experiment to your tutor via the designated assignment drop box at your online course site.

Lab 5 Genetics: Albino Corn

5.1 Introduction

Mendelian genetics is covered in Chapter 11 of the textbook. In this lab, you will compile the results of your own observations of corn phenotypes. Your seed material is a random sample of seeds obtained from a heterozygous cross. The recessive allele codes for albino plants (plants without chlorophyll), which you will observe after germination.

5.2 Time Requirement and Preparation

This activity takes place in three stages. First, you must soak the seeds for at least 12 hours the night before you plant them (5 minutes). Next, you must plant the seeds (10 minutes). You should be able to read the results after two weeks, or when the seedlings are large enough (5 minutes).

5.3 Materials

- **From the *Home Lab Kit*:** corn kernels (i.e., seeds).

  Caution: The corn kernels may be treated with a fungicide; you should consider them poisonous.

- **Student supplied materials:** cup, potting or garden soil, one large or several small plant pots (possible substitute: paper or plastic drinking cups with a few drainage holes made in the bottoms), tray or shallow pan in which to set the plant pots, water.

5.4 Procedure

1. Soak the corn kernels overnight in a cup of luke-warm water to speed germination.

2. Fill the plant pots with soil. Plant the kernels about 1 cm deep, at intervals of about 2 cm. Pack the soil down with your hand.

3. Soak the soil with water until water drains from the holes of the containers.

4. Place the pots in a warm, well-lighted area.

5. Keep the soil moist, but not soaking wet. The tray or pan will catch the excess water.

6. After two weeks, the plants should be a few centimetres high. Note that the seedling develops a root first before a shoot grows upward.

7. Count the number of green and white plants. Record your count. Take a digital photograph of your plants at this stage.

   The corn kernels that you have planted were obtained from the crosses described below, where *PP* or *Pp* = green leaves (normal chlorophyll), and *pp* = albino plants (white, lacks chlorophyll).

   P_1: *Pp* × *Pp* (heterozygous green × heterozygous green)

   F_1: (your kernels)

8. If you choose this lab as one for which you will write a lab report, ensure that you include the answers to the questions below in your lab report:

   a. Using a Punnett square, determine the expected F_1 phenotypic ratio.

   b. What are the F_1 phenotypes?

   c. What are the F_1 genotypes?

   d. What F_1 phenotypic ratio did you find?

   e. Did your results meet your expectations?

   f. What are your conclusions?

9. Submit the photograph you took of your plants to your tutor via the designated assignment drop box at your online course site.

Lab 6: DNA Extraction

6.1. Introduction

In this interesting lab, you will extract DNA from bananas without fancy molecular lab equipment. This lab is not eligible for the lab report assignment.

6.2 Time Requirement and Preparation

This activity takes less than an hour. No advance preparation is required.

6.3 Materials

- **From the *Home Lab Kit*:** large test tubes, 250 mL beakers, small pipette, test tube rack, measuring cylinder, funnel, filter paper.
- **Student supplied materials:** isopropyl alcohol/isopropanol (rubbing alcohol), container that can hold ice and the test tube, ice to cool the test tube (or a freezer), one small or one-half of a large banana (possible substitute: three or four large fresh or frozen strawberries), knife, 150 mL of water, blender (possible substitute: a small, sealable, heavy-duty plastic bag such as a Ziploc® freezer bag), teaspoon, one or two pinches of table salt (iodized or non-iodized), one teaspoon of shampoo.

  Caution: Isopropanol is poisonous and flammable.

6.4 Procedure

1. After putting on gloves, fill the test tube half full of isopropanol. Chill the test tube and its contents in a container of ice or a freezer for at least 20 minutes.

2. Place 25 mL of water in one of the beakers; add one or two pinches of salt and one teaspoon of shampoo. Dissolve the shampoo and salt by slowly mixing the contents with the teaspoon. Avoid causing the shampoo to foam.

3. Cut up the banana and put the pieces into a blender with about a half-cup of water. Blend for 20-30 seconds until smooth. If you use a freezer bag instead of the blender, you will have to knead the bag with your hands for several minutes until the banana is thoroughly mashed and mixed with the water.

4. Add 5 or 6 teaspoons of the banana and water mixture to the water, salt, and shampoo mixture. Stir with the teaspoon for about 5 minutes.

   Note: Shampoo is a detergent. The detergent breaks down the cell membranes of the fruit by dissolving the lipids and proteins in it. The gentle mixing gets the cell contents, including long strands of DNA, into solution. The salt helps to get the DNA strands to clump together.

5. Fold the round filter paper twice so that it fits into the funnel, and put the funnel with the filter into a large test tube in the test tube rack.

6. Pour as much of the banana-water-shampoo-salt mixture as you can into the filter, and let it stand for several minutes until you get a few millilitres of clear filtrate in the bottom of the test tube.

   Note: Only the materials dissolved in the water pass through the filter. Because cell walls do not dissolve, most of the cell membrane materials clump together with the detergent and do not pass through the filter.

7. Take the test tube of cold isopropanol out of the ice bath or freezer. With the small pipette, add a few millilitres of the clear banana filtrate to the alcohol. Do **not** shake the filtrate-alcohol mixture. Simply let it stand for a few minutes. Most of the chemicals used in this lab are soluble in alcohol, but DNA is not.

8. Within a minute you will see a cloudy, white, uniform substance close to the bottom of the test tube. This is **not** the DNA. The DNA will precipitate in the alcohol and will appear only after several minutes as stringy white gel above the cloudy fraction. Take a digital photograph of your experiment at this stage.

9. Submit the photograph you took in step 8 to your tutor via the designated assignment drop box at your online course site.

Lab 7: Bioinformatics

7.1 Introduction

Bioinformatics is a way of using databases via the World Wide Web to gather information about sequences of DNA and proteins. After sequencing a particular strand of DNA you can find out more about the organism sequenced by comparing it with sequences stored in the databases—*bioinformatics*. Bioinformatics can be used, for example, to identify unknown organisms if your obtained sequence matches closely with a sequence in the database. The same would apply if you had an amino acid sequence of proteins. Bioinformatics can also answer questions about the proteins coded by a particular piece of DNA (or vice versa), the functions of a protein, and the evolutionary relationships between organisms based on the comparison of DNA (or RNA) sequences.

In this simple, introductory lab you will work with two of the DNA sequences that you will find in the Resources section of your course website, under the heading, "DNA Sequences for Lab 7." Identify the two DNA sequences assigned based on your first name. Assume that you just sequenced those two pieces of DNA and want to know more about them. You will perform a "BLAST" search (**B**asic **L**ocal **A**lignment **S**earch **T**ool) on the Internet.

This lab is not eligible for a lab report assignment, but you must send the required information in section 7.4. step 10 to your tutor (worth 2% of your final grade).

7.2 Time Requirement and Preparation

This activity takes less than an hour. No advance preparation is required, but you are strongly encouraged to log into the BLAST Website to browse through the introductory information (click on Help).

7.3 Materials

- **Student supplied materials:** A computer with Internet access; DNA sequences found in the Resources section of your course website.

7.4 Procedure

1. Access the BLAST Website. Please note that the website and its features may change occasionally; contact your tutor if some of the items described no longer work.

2. Click on "Nucleotide blast," as we are dealing with a DNA sequence.

3. Look for "DNA I" in the resources section of your course website. It will be under the heading “DNA Sequences for Lab 7.” Highlight this sequence and copy it. **Note:** DNA I is a sample sequence that you will work with for practice before entering the DNA sequences assigned to you, according to your first name.

4. Put your cursor in the first field under the "Enter Query Sequence" heading and paste the sequence of DNA I into the field.

5. Scrolling down, go to "Choose Search Set" and select "Nucleotide collection" under Other Databases (since we don't know if the sequence is from a human or another species).

6. Leave other options as default and click on "BLAST," in the lower left-hand corner. The search may take a while, depending on the length of the sequence.

7. Scroll down to "Descriptions." You will find the first match as "Human Growth Hormone." An important column is the E value, which is a measure of reliability. The smaller the E value, the better the reliability. An E value larger than 10^{-4} is considered statistically insignificant. In our case, the E value is 0, indicating a highly reliable match.

8. Scroll down to "Alignments." You will find "Identities = 2657/2657 (100%)," which tells you that all 2657 bases in your sequence matched with the particular sequence in the database. You will see the whole sequence that you submitted (your "query") aligned base for base with the sequence in the database (the "subject"). If the identities were less than 100% you would find an occasional difference in corresponding bases.

9. Note the accession number GenBank (gb): M13438.1 and click on this number after scrolling up again to "Descriptions.” You will find

some literature and "features" here. You are now looking for the chromosome on which the gene is located. The features often contain a link to the chromosome, but not in this example. Go back to the previous page and click on the "G" (gene) link in the last column of "Descriptions." You will find that the gene is located on human chromosome 17, and that there is some supporting literature.

10. Repeat steps (1-9—as needed), using the **two** DNA sequences (you will complete the process twice) that correspond to your first name in the "DNA Sequences for Lab 7" page of your course website. Record the following information for **each sequence** and submit it to your tutor:
    - name of the sequence (DNA X)
    - gene accession number
    - gene name
    - number of base pairs
    - location on which chromosome
    - E value
    - Indicate whether the information is reliable.
    - Supply one literature resource on the gene.

By now you should have an idea about the vast amount of information located on this site. Feel free to explore more.