Table of Contents

LearnSmart Labs: Blood

General Lab Outline

Total Time: 2 hr, 15 min

I. Core Concepts: Blood (15 min)
II. Blood Smear and Differential White Cell Count (40 min)
III. Hematocrit (20 min)
IV. Hemoglobin Content (20 min)
V. Blood Typing Test (20 min)
VI. Final Summary Questions (10 min)
VII. Reports

Assessed Learning Outcomes

1. Core Concepts: Blood
    a. Recall that blood is composed of plasma and the formed elements
    b. Structure and function of the formed elements
        i. Recall the structure and function of red blood cells
        ii. Recall the structure and function of white blood cells
        iii. Recall the structure and function of platelets
        iv. Compare the structure and function of the formed elements
    c. Understand the basis of blood typing
        i. Recall the red blood cells are covered in antigens, and plasma contain antibodies for foreign antigens
        ii. Match blood types and antibodies
        iii. Explain when transfusion reactions occur
    d. Recall how to safely handle human blood
2. **Blood Smear and Differential White Cell Count**
    a. Pre-lab Briefing
        i. Recall the steps to perform a blood smear
        ii. Recall how to perform a differential white blood cell count
    b. Identify different white blood cells
        i. Identify platelets in a blood smear slide
        ii. Identify erythrocytes in a blood smear slide
        iii. Identify neutrophils in a blood smear slide
        iv. Identify lymphocytes in a blood smear slide
        v. Identify monocytes in a blood smear slide
        vi. Identify eosinophils in a blood smear slide
        vii. Identify basophils in a blood smear slide

c. Stimulation of Blood Smear and Differential White Cell Count
    i. Prepare a blood smear
        1. Add a drop of blood
        2. Smear the blood drop
        3. Let blood smear dry in the air
    ii. Stain the blood smear
        1. Add Wright's stain to blood smear
        2. Let Wright's stain react for a suitable time
        3. Add distilled water to the slide with stain
        4. Let the stain and water mixture react for a suitable time
        5. Rinse the stained blood smear
        6. Let the slide air dry
    iii. Perform the correct procedure without guidance
    iv. Dispose of materials contaminated with blood in biohazard container
    v. Perform a different count on prepared microscope slide
    vi. Differential cell count
        1. Count the correct number of neutrophils
        2. Count the correct number of lymphocytes
        3. Count the correct number of monocytes
        4. Count the correct number of eosinophils
        5. Count the correct number of basophils
    vii. Infer the patient's health problem from the results of the differential white cell count
d. Post-lab probing
    i. Explain the outcome if the stain acts for the wrong time
    ii. Identify the normal values of a differential's white blood cell count
    iii. Know the relationship between an abnormal differential white cell count and likely diseases

3. Hematocrit
    a. Pre-lab Briefing
        i. Recall how to prepare a blood sample for a hematocrit test
    b. Stimulation of Hematocrit Test
        i. Fill a capillary tube with blood
        ii. Seal capillary tubes
        iii. Separate blood and plasma in the centrifuge
        iv. Measure the hematocrit for one blood sample
        v. Test all 5 blood samples
        vi. Balance centrifuge
        vii. Recall how to place the capillary tubes in centrifuge
        viii. Infer whether test results indicate doping
        ix. Use safe blood handling practices
        x. Avoid cross-contamination samples

    c. Post-lab Probing
        i. Explain the purpose of a hematocrit test
        ii. Recall the normal hematocrit levels
4. Hemoglobin Content
    a. Pre-lab Briefing
        i. Recall how to prepare a blood sample for a hemoglobin test
    b. Simulation of Hemoglobin Test
        i. Test the three blood samples and positive and negative controls
        ii. Stir until all hemoglobin is out of the red blood cells
        iii. Measure the hemoglobin content
        iv. Use safe blood handling practices
        v. Avoid cross-contaminating samples
        vi. Recall why hemolysis applicators are used
        vii. Infer whether test results indicate doping
    c. Post-lab Probing
        i. Explain the purpose of hemoglobin test
        ii. Recall the normal hemoglobin content
5. Blood Typing Test
    a. Pre-lab Briefing
        i. Recall how to determine the blood type
        ii. Recall which transfusions lead to transfusion reactions
    b. Simulation of Blood Typing Test
        i. Test all blood samples
        ii. Label the test slides
        iii. Recall how the slides should be labeled
        iv. Add blood from only one patient to each slide
        v. Add the test serum to the labeled spot on the slide
        vi. Determine the blood type
        vii. Use safe blood handling practices
        viii. Avoid cross-contaminating blood samples
        ix. Recall why toothpicks are used in this experiment
        x. Use your results to determine who can donate blood to whom
    c. Post-lab Probing
        i. Realize the need for type O packed cell transfusion when donor and recipient do not exactly match
6. Final Summary Questions
    a. Differentiate between the purpose of the various blood tests

INSTRUCTOR NOTE: Safety requirements for blood handling may vary slightly from those used in this lab. Students may become frustrated if they begin to miss questions. Remind them that when missing a question they should remediate using the provided learning resource, most often a Slide, or the Library for that topic.

Student Instructions for Lab Experiments

Overview for All Experiments:

In the following exercises you will perform tests that allow you to examine the nature of blood and also let you evaluate different samples of blood.

These tests are useful diagnostic tools for physicians because blood composition reflects the status of many body functions and malfunctions.

Before getting started on the actual lab, I would like to go over some core concepts related to blood testing. Then you will proceed with the experiments.

Differential WBC Count:

In this experiment, you will prepare a microscope slide with a blood smear and perform a differential white blood cell count.

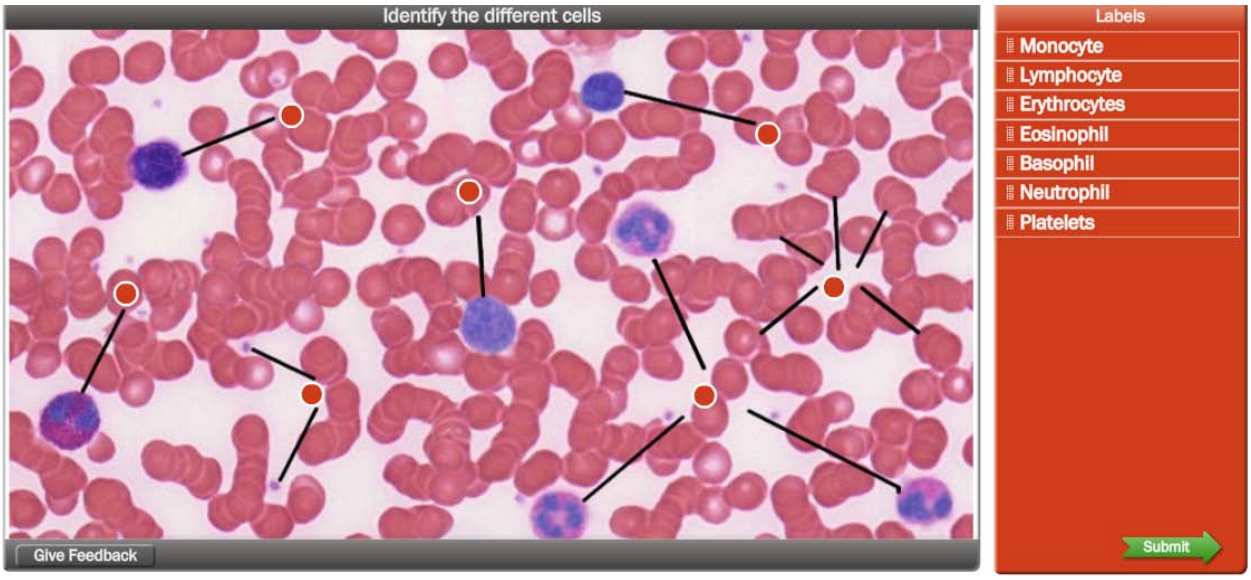
Before you start, I want to make sure that you have the necessary knowledge to execute the experiments.

Let's make sure you know how to prepare a blood smear microscope slide and how to perform a differential white blood cell count.

Important to Know About Blood Samples:

- What is a blood smear and how to make one
- How to stain a blood sample
- How to identify the different white blood cells
- What is a differential white blood cell count

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.



INSTRUCTOR NOTE: Often the Coach will appear at the top right. Sometimes students think she is in the way of completing the exercise. However, if they are patient, she will disappear when she completes talking. Students can reactivate her and make her repeat instructions by clicking on her refresh icon.

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.

Simulator:

Click the Instructions button and follow the steps to make a blood smear.

Move the slide to the microscope to view it.

First, correctly focus the microscope slide. Move to the x40 objective to complete the count.

Hematocrit:

In this experiment, you will measure the hematocrit of blood samples.

Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the hematocrit of a blood sample

Important to Know About Hematocrit Testing:

- What is the hematocrit value
- How is a hematocrit test performed

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.

Simulator:

Click the Instructions button and follow the steps to determine the hematocrit.

Compare the hematocrit to blood doping samples.

INSTRUCTOR NOTE: Students will see a number of possible combinations of doping results and hematocrit levels. If they repeat the experiment, they should expect different results. Each student should have different results.

Hemoglobin Content:

In this experiment, you will measure the hemoglobin content of blood samples.

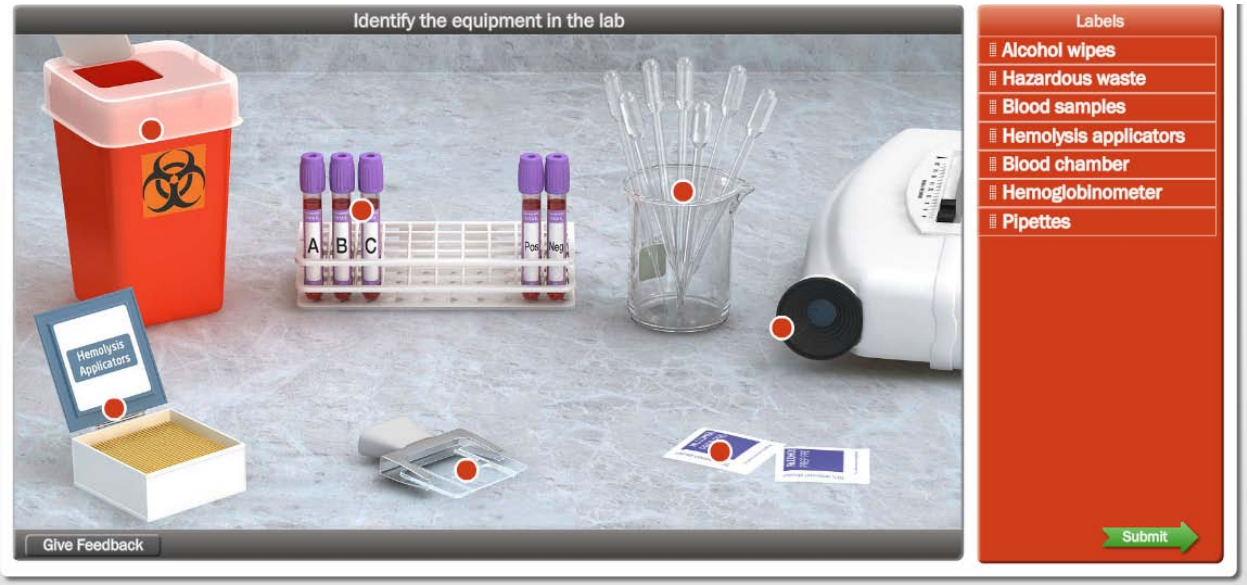
Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the hemoglobin content of blood and how to determine it.

Important to Know About Hemoglobin

- Hemoglobin in red blood cells
- How to measure the hemoglobin content of blood

Student labeling activity before entering lab simulation



Simulator:

Click the Instructions button and follow the steps to determine the hemoglobin content.

Compare the hemoglobin content to blood doping samples.

INSTRUCTOR NOTE: The two halves in the hemoglobinometer will not have a line between them when the correct reading is available. Students will see a number of possible combinations of doping results and hemoglobin concentrations. If they repeat the experiment, they should expect different results. Each student should have different results.

Blood Typing:

In this experiment, you will determine the blood type of some blood samples.

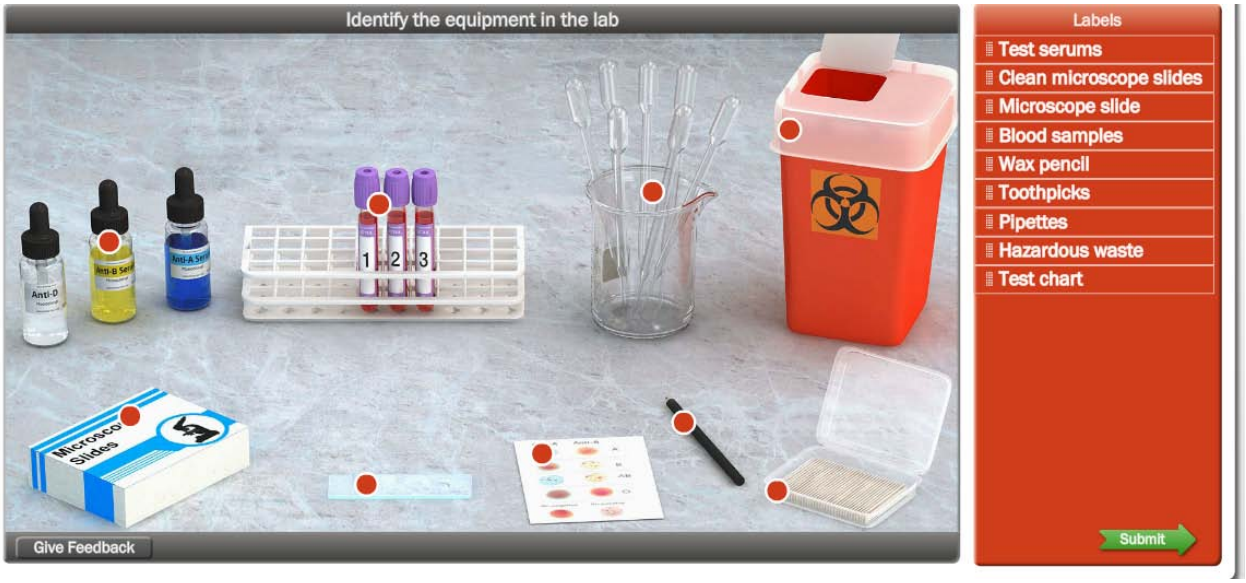
Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the blood typing test.

Important to Know About Blood Typing

- How to determine the blood type
- Transfusion reactions

Student labeling activity before entering lab simulation



Simulator:

Click the Instructions button and follow the steps to determine the blood types.

Remember to label your slides with the sample and test types.

INSTRUCTOR NOTE: Students will see a number of possible combinations of blood types. If they repeat the experiment, they should expect different results. Each student should have different results.

Final Summary Questions

a. Differentiate between the purpose of the various blood tests

INSTRUCTOR NOTE: These final summary questions are designed to assess students that have completed all components of the lab. If you only assign some of the exercises and have not instructed students on the other techniques in class, your students may struggle with some of these questions.

Type of Student Report

Students are provided the following types of reports at the conclusion of these lab experiments.

I. Blood Smear and Differential White Cell Count – ***Debriefing***
II. Hematocrit – ***Debriefing***
III. Hemoglobin Content – ***Debriefing***
IV. Blood Typing Test – ***Debriefing***

LearnSmart Labs: Diffusion

General Lab Outline

Total Time: 2 hrs

I. Core Concepts: Diffusion (10 min)
II. Diffusion in Different Media (1 hr, 20 min)
- **a. Concepts: Diffusion in Different Media (10 min)**
- **b. Diffusion in a Semi-Solid (30 min)**
- **c. Diffusion in a Liquid (20 min)**
- **d. Diffusion in Air (20 min)**

III. Diffusion Across a Membrane (20 min)
- **a. Concepts: Diffusion Across a Membrane (10 min)**
- **b. Diffusion Across a Selectively Permeable Membrane (10 min)**

IV. Final Summary Questions (10 min)
V. Reports

Assessed Learning Outcomes

1. Core Concepts: Diffusion
    a. Understand the terms solution, solute & solvent
    b. Understand what a concentration gradient means
    c. Understand molecular motion
    d. Understand diffusion is a result of random movement
    e. Explain what happens during diffusion
2. Diffusion in Different Media
    a. Core Concepts: Diffusion in Media
        i. Compare diffusion through a semisolid, a liquid and a gas
        ii. Understand how diffusion speed depends on molecular speed
    b. Diffusion in a Semi-Solid
        i. Experiment
            1. Formulate a hypothesis
            2. Design an experiment where you test the effect of concentration on diffusion speed
            3. Experiment phase
                a. Put a different number of crystals on each plate
                b. Place all crystals in a relatively short time to make sure all crystals are contributing equally
                c. After starting measurements, do not change the number of crystals
                d. Take a sufficient number of measurements
                e. Measure diameters correctly

4. Analysis phase
    a. Calculate diffusion rates correctly
    b. Make a plot that enables an evaluation of the hypothesis
    c. Correctly evaluate whether hypothesis is support by data
5. Explain the relationship between concentration gradient and diffusion rate (conclusion)

c. Diffusion in a Liquid
    i. Experiment
        1. Set up the experiment correctly
        2. Make correct measurements
        3. Measure under the same conditions used to measure diffusion speed in agar
    ii. Analysis
        1. Calculate the rate of diffusion of potassium permanganate
        2. Compare the rate of diffusion through as semisolid and a liquid

d. Diffusion in Air
    i. Experiment
        1. Set up tube so that HCl and ammonia diffuse from each end
        2. Measure the position of the precipitate that forms
        3. Repeat the experiment with HCl and ammonia exchanged
    ii. Analysis

3. Diffusion Across a Plasma Membrane
    a. Core Concepts: Diffusion Across a Membrane
        i. Describe a semi-permeable membrane
        ii. Explain what will happen when you have starch and glucose on the one side of a semi-permeable membrane and iodine on the other
        iii. Recall what happens when we have starch and iodine in the same solution
    b. Diffusion Across a Selectively Permeable Membrane
        i. Pre-lab Briefing
            1. Understand permeability as it relates to biological membranes
            2. Recall the purpose of iodine in this experiment
        ii. Experimental Learning Objectives
            1. Put starch and iodine on different sides
            2. Document what is in the tubing and beaker before diffusion
            3. Document what is in the tubing and beaker after diffusion
            4. Use a test for glucose after diffusion
            5. Test for starch after diffusion
            6. Test for iodine after diffusion
            7. Wait long enough for diffusion to happen
            8. Recall that to be able to knot tightly, the tubing must have been soaking in water
        iii. Analysis
            1. Based on the experiment draw conclusions about which substances could diffuse across the membrane

4. Final Summary Questions
    a. Understand the relationship between concentration and diffusion
    b. Understand the process of diffusion and identify examples
    c. Understand diffusion as a passive process
    d. Contrast diffusion as a passive transport mechanism with other methods of molecular transport

INSTRUCTOR NOTE: The diffusion lab is very easy and cheap to do in person. But, it is time consuming. You can save time in class by simulating the diffusion experiments using LS Labs.

Student Instructions for Lab Experiments

Overview for All Experiments:

There are two sets of experiments in the diffusion lab.
The "Diffusion in Different Media" experiment will let you investigate how concentration gradients affect the rate of diffusion and how molecules diffuse through different densities of media.
The "Diffusion Across a Membrane" experiment will let you explore how the properties of different molecules affects their abilities to diffuse across a selectively permeable membrane.
But, before you get started on the experiments, you'll want to review some fundamental concepts that will help you work through the experiments more efficiently.

Core Concepts: Diffusion

If you understand a couple of fundamental concepts about diffusion, you'll be able to work more efficiently in the labs.
The first concept to understand is the relationship between the rate of diffusion of a solute and the concentration of that solute. Second, it is important to know how random molecular movement drives diffusion.
I'll ask you some questions about these concepts and if you get them correct, you can move right along. If you struggle, there will be some resources to help you understand.
What is Important to Know About Diffusion

- How diffusion depends on the concentration gradient.
- How random molecular motion drives diffusion.

Diffusion in Different Media

Diffusion in a Semi-Solid

In this lab you'll investigate how the rate of diffusion of a solute depends on the concentration of the solute. You'll be able to design an experiment that will let you investigate the relationship between the rate of diffusion of a solute and its concentration

In this particular experiment, you will be measuring diffusion of the chemical potassium permanganate through a semi-solid medium called agar.

Diffusion Through a Semi-Solid

- Determine the average rate in agar.
- Learn how diffusion rates are affected by concentration gradients.

Simulator:

In this experiment, you will test the effect of the concentration gradient on the diffusion rate.

- Add a different number of crystals to each dish.
- Add all the crystals within a short time.
- Measure the spot diameter and record it in the notebook.
- Take measurements at a few times so you can see how the diffusion rate evolves with time.
- Analyze your data.

Tip: Rate [mm/h] = (diameter [mm]/time[min]) x 60 [min]

INSTRUCTOR NOTE: Students should take advantage of the snapshot tool. This allows students to take a picture of the experiment and go back to look at the pictures for measurements. This helps in this simulation because students can place the ruler and take a picture to look at later.

Analyze

1. Calculate the average diffusion rate from time zero for the different times at which you measured. Assume the diameter at time zero to be equal to zero
   Rate [mm/h] = (diameter [mm]/time[min]) x 60 [min]
2. Create a graph to evaluate your hypothesis
3. Save the graph to make it show on your final lab report

Diffusion in a Liquid

In this lab you can investigate how the dye potassium permanganate diffuses through water.
By adding crystals of dye to the plate of water and measuring how far the dye diffuses in a certain amount of time, you can determine diffusion rate.
Diffusion in a Liquid

- Determine the average diffusion rate in water.
- Compare diffusion rates in different media.

Simulator:
The average diffusion ate in agar over the first 15 minute is 50 mm/h using one crystal. In this experiment you will determine the diffusion speed in a liquid and compare it to that of agar.

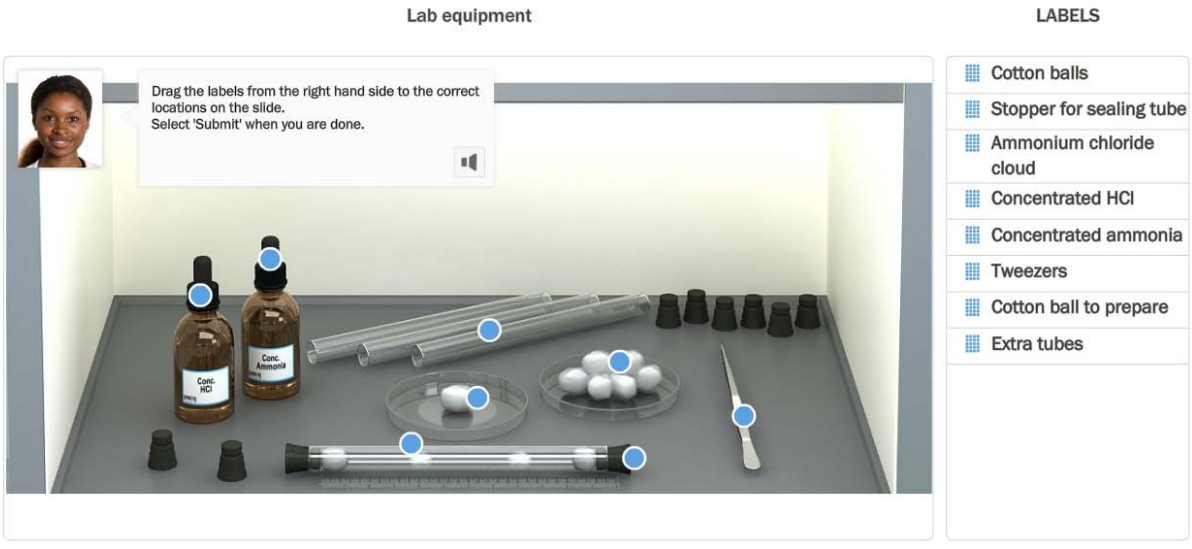
INSTRUCTOR NOTE: Students should take advantage of the snapshot tool. This allows students to take a picture of the experiment and go back to look at the pictures for measurements. This helps in this simulation because students can place the ruler and take a picture to look at later.

Diffusion in Air

In this lab, you will be able to design an experiment to investigate the diffusion of two gases through air. The gases will be produced by the evaporation of two volatile liquids. When the gases mix, they form a visible substance in the air in a sealed tube.
Diffusion in Air

- Compare the diffusion rate of two gases in air.
- Learn about the factors that affect the diffusion rate through air.

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.



Simulator:
In this experiment, you will compare the diffusion speed through air of different chemicals.

INSTRUCTOR NOTE: Students should measure the middle of the gas cloud precipitate. This position will vary slightly each time the lab is performed.

Diffusion Across a Membrane

In this module there is only one lab. You will be able to design an experiment that investigates what kinds of substances can diffuse across a selectively permeable membrane.

Core Concepts: Diffusion Across a Selectively Permeable Membrane

Before we got to the lab, it's important to have an understanding of two important concepts.
First, I'll need to make sure that you understand what a selectively permeable membrane is and second, how diffusion across a membrane occurs.
What is Important to Know About Diffusion Across a Membrane

- What a selectively permeable membrane is
- How diffusion across a selectively permeable membrane occurs

Diffusion Across a Selectively Permeable Membrane

Before starting the experiment, I want to make sure that you have the background knowledge needed to execute and interpret the experiment.
Let's review the factors that determine whether substances can diffuse across a membrane.
Important to Know About Diffusion Across a Selectively Permeable Membrane

- The factors that determine whether substances diffuse across a membrane.

This lab is a little more complex than the others. Here, you'll need to set up an experiment to determine the properties of a selectively permeable membrane.
Some substances will move across the membrane, and some won't. You'll need to determine what can and what can't move across the membrane.
There are two substances you can use to investigate this: starch and glucose. These substances have different properties so you'll need to think about how those properties affect their ability to move across the membrane.
Diffusion Across a Selectively Permeable Membrane

- Design an experiment to test whether different substances can diffuse across a selectively permeable membrane.
- Test whether starch, glucose and iodine can diffuse across a membrane.

Simulator:
In this experiment, you will test which substances diffuse across a membrane.

INSTRUCTOR NOTE: Students should measure the middle of the gas cloud precipitate. This position will vary slightly each time the lab is performed.

Final Summary Questions

1. Understand the relationship between concentration and diffusion
2. Understand the process of diffusion and identify examples
3. Understand diffusion as a passive process
4. Contrast diffusion as a passive transport mechanism with other methods of molecular transport

INSTRUCTOR NOTE: These final summary questions are designed to assess students that have completed all components of the lab. If you only assign some of the exercises and have not instructed students on the other techniques in class, your students may struggle with some of these questions.

Type of Student Report

Students are provided the following types of reports at the conclusion of these lab experiments.

I. Diffusion in a Semi-Solid – ***Lab Report***
II. Diffusion in a Liquid – ***Debriefing***
III. Diffusion in Air – ***Debriefing***
IV. Diffusion Across a Selectively Permeable Membrane – ***Debriefing***

LearnSmart Labs: Digestive System

General Lab Outline

Total Time: 1 hr, 35 min

I. Core Concepts (10 min)
II. Digestive System Anatomy and Physiology (60 min)
- **a. Digestive System Anatomy (40 min)**
  - **i. Digestive Tract Anatomy (10 min)**
  - **ii. The Mouth (10 min)**
  - **iii. The Stomach (10 min)**
  - **iv. Small Intestine (10 min)**
- **b. A Journey Through the Digestive System (20 min)**

III. Enzymes and Digestion (25 min)
IV. Final Summary Questions (10 min)
V. Reports

Assessed Learning Outcomes

1. **Core Concepts**
   a. Recognize the common names for the alimentary canal
   b. Differentiate between alimentary canal and accessory organs
   c. Recognize the 3 major steps of digestive function (ingestion-digestion-absorption)
   d. Know the general structure of the alimentary canal
2. **Digestive System Anatomy and Physiology**
   a. Digestive Tract Anatomy
      i. Digestive Tract General Anatomy
         1. Introduction to the Esophagus
            a. Recognize the general structure of the GI-tract in the esophagus
         2. Digestive Tract Label Game
            a. Identify the major tissue layers in a drawing of the esophagus
         3. Microscopic Game: Esophagus Cross Section
            a. Correctly identify selected layers of the digestive tract in the micrograph
      ii. The Mouth
         1. Introduction to the mouth
         2. Label games
            a. Open mouth
            b. Tooth

iii. Stomach
    1. Introduction to the Stomach
        a. Know the gross anatomy and functions of the stomach
    2. Stomach Label Game
        a. Identify major areas of the stomach
        b. Identify the major components of the stomach wall
iv. Small Intestine
    1. Introduction to Small Intestine
        a. Recognize general and special microstructures of the small intestine
        b. Small intestine surface
    2. Label the Small Intestine
        a. Identify major structures in this small intestine micrograph

b. A Journey Through the Digestive System
    i. Pre-lab Briefing
        1. Know the components of the digestive system and their location in the body
    ii. Experimental Learning Objectives
        1. Examine structure of the head
            a. Examine the salivary gland
                i. Know functions of saliva
            b. Examine the mouth
                i. Know the digestive system structure of the mouth and their functions
        2. Fix digestive organs in the correct order
            a. Fit the esophagus into the torso
            b. Fit the stomach into the torso
            c. Fit the liver into the torso
            d. Fit the pancreas into the torso
            e. Fit the intestines into the torso
        3. Anatomy of the digestive organs
            a. Know the location of the esophagus
            b. Know the stomach gross anatomy
            c. Know the location of the liver
            d. Identify the location of the pancreas
            e. Know the anatomy of the small intestine
            f. Know the location of the large intestine

4. Physiology of the digestive organs
    a. Know the origin and function of major enzymes and chemicals released by the stomach
    b. Know the major digestive function of the liver
    c. Identify the digestive contribution of the pancreas
    d. Differentiate between absorption in the small intestine and large intestine
    e. Identify the major function of the large intestine

iii. Post-lab Questions
1. Describe the relative locations of the major digestive organs
2. Select the structure connected to the duodenum

3. Enzymes and Digestion

a. Pre-lab Briefing
i. Know the action of salivary amylase
ii. Identify the major factors that influence enzyme activity
iii. Correctly predict the effect of a very acidic pH for salivary amylase function

b. Experimental Learning Objectives
i. Set water temperature to boiling temperature – 100 degrees Celsius – before adding test tubes with Benedicts
ii. Turn on water bath at 37 degrees Celsius before adding test tube
1. The purpose of testing in 37 C water bath
iii. Have test tubes in boiling water for exactly 5 minutes
iv. Use clamp to remove test tubes from hot water
v. Make acidic test solution: Starch, pH 2 buffer and amylase
1. Add all 3 ingredients to this test tube
vi. Make neutral test solution: Starch, pH 7 buffer and amylase
1. Add all 3 ingredients to this test tube
vii. Understand purpose of and make neutral control solution: Starch, pH 7 buffer and water
1. Add all 3 ingredients to this test tube
2. The purpose of making a neutral pH control solution
viii. Understand purpose of and make sugar control solution: Maltose, pH 7 buffer and water
1. Add all 3 ingredients to this test tube
2. The purpose of making a maltose control solution
ix. Add Benedicts Reagent to all 4 test tubes
x. Carry out experiment without contaminating the tube with stirring rod
xi. Write test results in Notebook (color in test tubes)
xii. Avoid cross contamination with pipettes

c. Post-lab Questions
i. Recognize the significance of the different colors in the test results
ii. Interpret the experimental results correctly

4. Final Summary Questions

a. Final Summary Questions