Blood Analysis

O B J E C T I V E S

1. To become familiar with the "normal" values obtained with selected blood tests.
2. To understand how common laboratory procedures for examining blood can indicate pathology, or a state of disease.
3. To learn how the following blood tests are performed:

   hematocrit (packed cell volume) determination

   erythrocyte sedimentation rate

   hemoglobin determination

   blood typing

   total blood cholesterol determination
4. To understand what each of these procedures is measuring in a sample of blood.
5. To realize the importance of proper disposal of laboratory equipment that has come in contact with blood.
6. To understand the importance of matching blood types for blood transfusions.

Blood transports soluble substances to and from all cells of the body. Blood cells are also important in defense against pathogens. Laboratory analysis of the blood gives important information about how well these functions are being carried out.

This lab exercise consists of five common laboratory tests performed on blood: hematocrit determination; erythrocyte sedimentation rate; hemoglobin determination; blood typing; and total cholesterol determination.

Hematocrit Determination

Hematocrit refers to the percentage of red blood cells (RBCs) in a sample of whole blood. A hematocrit of 48 means that 48% of the volume of blood is red blood cells. Since the function of red blood cells is the transport of oxygen to the cells of the body, the higher the hematocrit, the more red blood cells are available to carry oxygen.

Hematocrit values are determined by spinning a microcapillary tube filled with a whole blood sample in a special microhematocrit centrifuge. This procedure separates the blood cells from the blood plasma and leaves a "buffy coat" layer of white blood cells between the heavier red blood cell layer and the lighter plasma.

The hematocrit value can be determined after centrifuging by measuring the height of the layer of red cells in millimeters and dividing that number by the height of the initial column of blood to obtain the percentage of red blood cells.

The percentage of white blood cells can also be determined after centrifuging by comparing the height of the buffy coat to the initial height of the blood column.
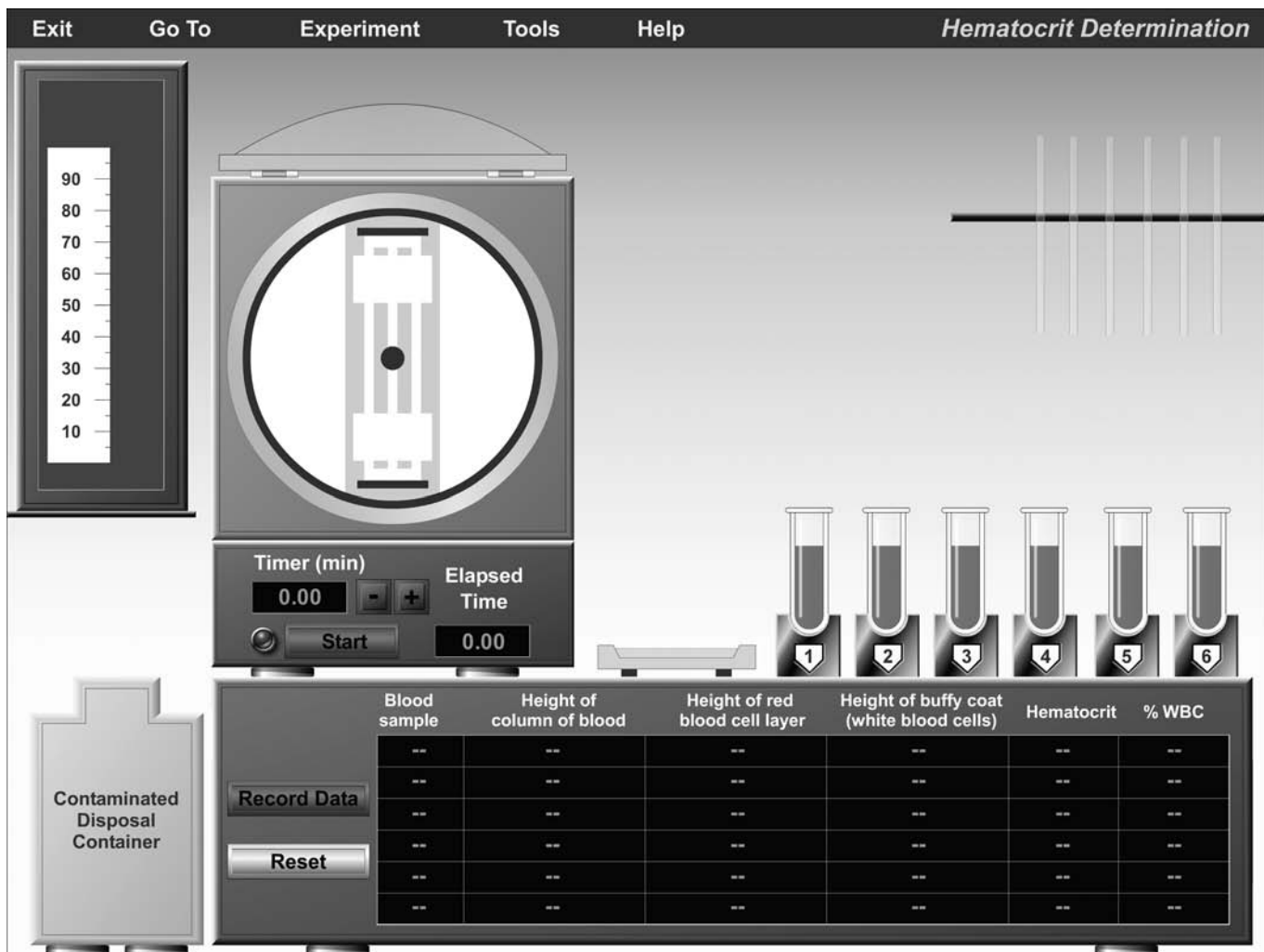
FIGURE 11.1   **Opening screen of the Hematocrit Determination experiment.**

The average hematocrit value for males is 47%, and the average for females is 42%. The normal upper limit is 55%. A lower-than-normal hematocrit indicates **anemia.** A higher-than-normal hematocrit indicates **polycythemia.**

Anemia is a condition in which insufficient oxygen is transported to the body's cells. There are many possible causes for anemia, including inadequate numbers of red blood cells, decreased amount of the oxygen-carrying pigment hemoglobin, abnormal hemoglobin, etc. The heme portion of hemoglobin molecules contains an atom of iron. If adequate iron is not available, the body cannot manufacture hemoglobin. This results in a condition called *iron deficiency anemia. Aplastic anemia* is the result of the failure of the bone marrow to produce adequate blood cells. *Pernicious anemia* is due to a lack of vitamin B_{12}, which is necessary for cell division. Intrinsic factor, produced by the stomach, allows absorption of vitamin B_{12}. Individuals who do not produce adequate intrinsic factor, or individuals who do not have adequate vitamin B_{12} in their diet, will suffer from pernicious anemia. *Sickle cell anemia* is an inherited condition in which the protein portion of hemoglobin molecules is folded incorrectly. As a result, oxygen molecules cannot fit with the misshapen hemoglobin, and anemia results.

Polycythemia refers to a significant increase in red blood cells. There are many possible causes of polycythemia, including living at high altitudes, strenuous athletic training, and tumors in the bone marrow.

In the following activity, we will simulate the blood test that is used to determine hematocrit. From the drop-down menu, select **Experiment 11: Blood Analysis** and click **GO.** Before you perform the activities watch the video **Blood Typing** to see how similar the simulation is to actual blood typing. Then click **Hematocrit Determination.** You will see the opening screen for the Hematocrit Determination experiment (Figure 11.1).

To familiarize yourself with the equipment, select **Help** from the menu bar and then select **Balloons On/Off.** This feature allows you to scroll around the screen and view equipment labels. You can turn the feature off by returning to **Help** and then selecting **Balloons On/Off.**

In the upper right portion of the screen is a dispenser containing six thin tubes, which are *heparinized capillary tubes.* Heparin is a substance that keeps blood from clotting. Below the capillary tubes are six test tubes containing samples of blood to be tested. When a capillary tube is dragged to a test tube of blood, it partially fills by fluid capillary action.

To the left of the samples of blood is a container of *capillary tube sealer* (a clay material, shown onscreen as an orange-yellow-colored substance). The capillary tubes must be sealed on one end with this tube sealer so that the blood sample can be centrifuged without spraying out the blood.

When the tubes have been sealed, they are moved to slots in the *microhematocrit centrifuge*. When the **Start** button is clicked, the centrifuge will rotate at 14,500 revolutions per minute.

After the centrifuge stops and opens, the capillary tubes are moved, one at a time, next to the metric ruler on the upper left of the screen. When you click on the **Record Data** button next to the data table at the bottom of the screen, the following information about the sample will be recorded: the height of the column of blood in millimeters, the height of the red blood cell layer, the height of the buffy coat (white blood cells), the hematocrit (percent of red blood cells) and the percent of white blood cells.

In the lower left corner of the screen is a contaminated disposal container. Every piece of glassware that has come in contact with the blood must be disposed of by dragging it to this contaminated disposal container for proper disposal.

ACTIVITY 1

Hematocrit Determination

The following individuals have contributed their blood for this test:

Sample 1: healthy male, living in Boston

Sample 2: healthy female, living in Boston

Sample 3: healthy male, living in Denver

Sample 4: healthy female, living in Denver

Sample 5: male with aplastic anemia

Sample 6: female with iron deficiency anemia

1. Click and drag one heparinized capillary tube over to the test tube containing blood sample 1. Make sure the capillary tube is touching the blood. The capillary tube will fill itself by fluid capillary action.

2. Drag the capillary tube containing sample 1 to the container of capillary tube sealer to "seal" one end of the tube.

3. Drag the capillary tube to the microhematocrit centrifuge.

4. Repeat steps 1–3 for the remaining five samples of blood.

5. Set the timer for the centrifuge for 5 minutes by clicking the (**+**) button, and then click the **Start** button.

6. When the centrifuge stops and opens, click and drag capillary tube 1 to the metric ruler.

7. Click **Record Data** to record the information about sample 1.

8. Click and drag capillary tube 1 to the contaminated disposal container.

9. Repeat steps 6–8 for the remaining five capillary tubes in the centrifuge.

10. Click **Tools,** then **Print Data** to print the data from the table (or fill in Chart 1 at the bottom of the page):

If you wish to restart or repeat the lab, click the **Reset** button next to the data table.

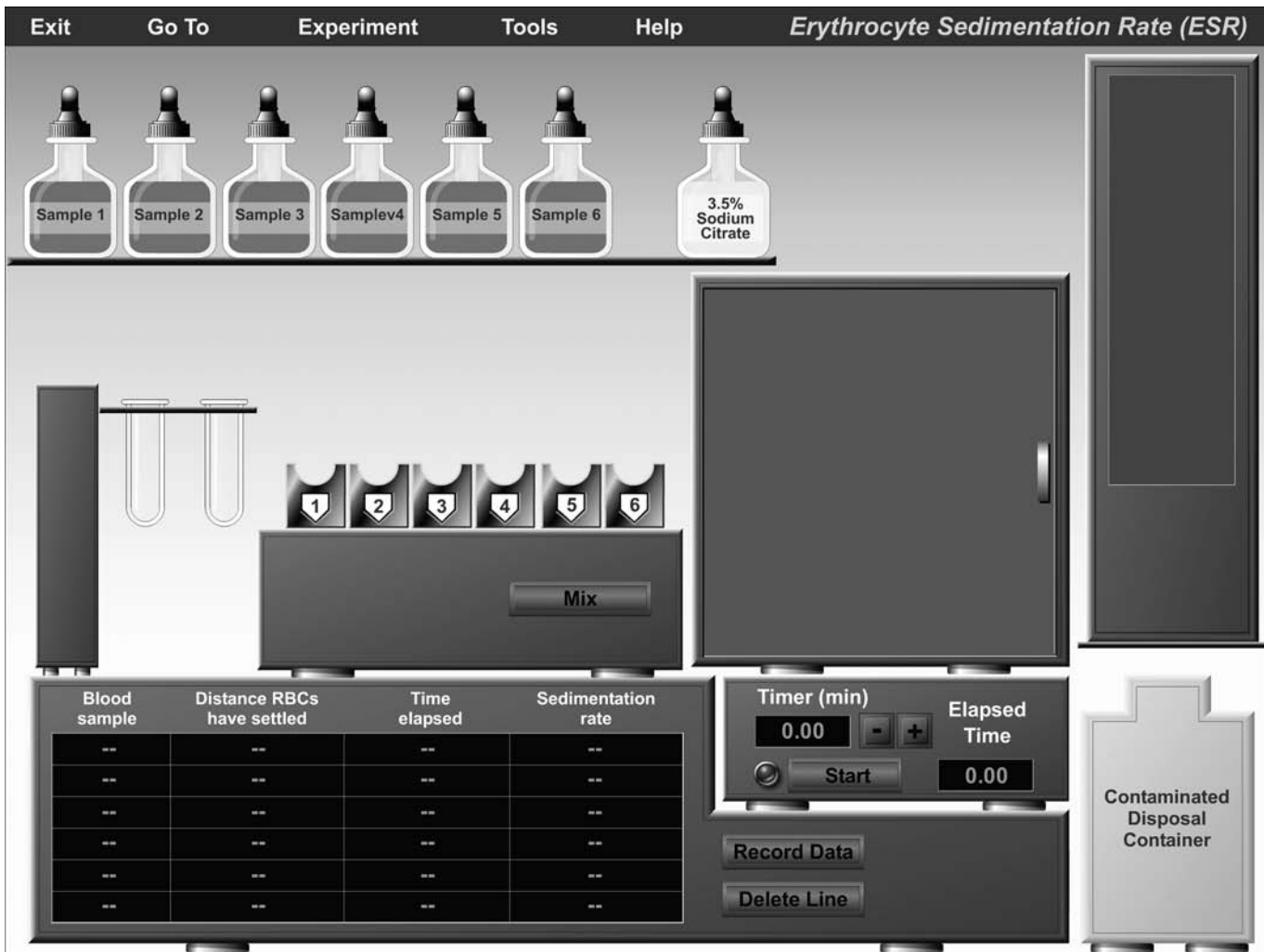| CHART 1					
Blood Sample	Total Height of Column of Blood (mm)	Height of Red Blood Cell Layer (mm)	Height of Buffy Coat (White Blood Cells) (mm)	Hematocrit	% WBC
Healthy male, living in Boston					
Healthy female, living in Boston					
Healthy male, living in Denver					
Healthy female, living in Denver					
Male with aplastic anemia					
Female with iron-deficiency anemia					

F I G U R E   1 1 . 2   **Opening screen of the Erythrocyte Sedimentation Rate experiment.**

What is the hematocrit value of a healthy male living at sea level in Boston?

_____

What is the hematocrit value of a healthy male living at one mile elevation in Denver?

_____

Is there as much oxygen in the air in Denver as there is in Boston?

_____

How do your kidneys respond to a decrease in blood oxygen? (Review this section in your textbook if necessary.)

_____

_____

If your bone marrow is producing an elevated number of red blood cells, what happens to your hematocrit?

_____

What is the hematocrit value of the male with aplastic anemia?

_____

Would the red blood cell count for an individual with aplastic anemia be higher, lower, or the same as the red blood cell count of a healthy individual?

_____

What is the hematocrit value of a healthy female living in Boston?

_____

Explain the difference in hematocrit values obtained from a healthy female living in Boston and a female with iron deficiency anemia.

_____

_____

Erythrocyte Sedimentation Rate

The **erythrocyte sedimentation rate (ESR)** measures the settling of red blood cells in a vertical, stationary tube of blood during one hour.

In a healthy individual, red blood cells do not settle very much in an hour. In some disease conditions, increased production of fibrinogen and immunoglobulins cause the red blood cells to clump together, stack up, and form a column (called a *rouleaux formation*). Grouped like this, red blood cells are heavier and settle faster.

This test is not a very specific or diagnostic test, but it can be used to follow the progression of certain disease conditions such as sickle cell anemia, certain cancers, and inflammatory diseases such as rheumatoid arthritis. When the disease worsens, the ESR increases; and when the disease improves, the ESR decreases. The ESR is elevated in iron deficiency anemia. Sometimes a menstruating female will develop anemia and show an increase in ESR.

The ESR can be used to evaluate a patient with chest pains: the ESR is elevated in established myocardial infarction (heart attack) but normal in angina pectoris. Similarly, it can be useful in screening a female patient with severe abdominal pains because the ESR is not elevated within the first 24 hours of acute appendicitis but is elevated in the early stage of acute pelvic inflammatory disease (PID) or ruptured ectopic pregnancy.

Click **Experiment** on the menu bar, then select **Erythrocyte Sedimentation Rate.** You will see the opening screen for the Erythrocyte Sedimentation Rate lab (Figure 11.2). Use the **Balloons On/Off** feature from the **Help** menu to familiarize yourself with the equipment on the screen.

In the upper left portion of the screen is a shelf with six samples of blood that have been treated with the anticoagulant heparin. Also on the shelf is a dropper bottle of sodium citrate. The sodium citrate is used to chelate with calcium to prevent the blood from clotting.

Below the shelf is a test tube dispenser and a test tube rack. To the right of the test tube rack is a cabinet that contains six sedimentation tubes. This cabinet will open when all six blood samples have been added to the test tubes and diluted with sodium citrate. Below this cabinet is a timer, a window showing elapsed time, and a **Start** button to start the timer.

In the upper right portion of the screen is a magnifying chamber that will help you read the millimeter markings on the sedimentation tubes.

In the lower right portion of the screen is a contaminated disposal container. All glassware that has come in contact with the blood must be placed in this container for proper disposal.

When you click on the **Record Data** button next to the data table at the bottom of the screen, the following information about the sample will be recorded: distance RBCs have settled, time elapsed, and sedimentation rate.

A C T I V I T Y   2

Erythrocyte Sedimentation Rate

The following individuals have contributed their blood for this test:

Sample 1: healthy individual

Sample 2: menstruating female

Sample 3: person with sickle cell anemia

Sample 4: person with iron deficiency anemia

Sample 5: person suffering a myocardial infarction

Sample 6: person suffering from angina pectoris

CHART 2			
Blood Sample	Distance RBCs Have Settled (mm)	Elapsed Time	Sedimentation Rate
Healthy individual			
Menstruating female			
Person with sickle-cell anemia			
Person with iron-deficiency anemia			
Person suffering from a myocardial infarction			
Person suffering from angina pectoris			

1. Individually click and drag six test tubes from the dispenser to the test tube rack.

2. Click on the dropper for blood sample 1, and drag it to the first test tube. One milliliter of blood will be dispensed into the tube.

3. Repeat step 2 for the remaining five samples of blood, using a different test tube for each sample.

4. Click on the dropper for the **3.8% sodium citrate,** and drag it over the test tube containing blood sample 1; 0.5 milliliter of sodium citrate will be dispensed into the tube.

5. The dropper will automatically slide over to each of the remaining samples.

6. Click on the **Mix** button. The samples will automatically mix for a few seconds.

7. After the samples have been mixed, the cabinet with six sedimentation tubes will open.

8. Click on the tube containing blood sample 1. Notice that the pointer is now a small test tube pointed to the left.

9. While still holding the mouse button down, move the mouse pointer to the first sedimentation tube in the cabinet. The contents of the small test tube will pour into the sedimentation tube.

10. Click and drag the now empty test tube to the contaminated disposal container.

11. Repeat steps 8–10 with the other five samples of blood.

12. When the six sedimentation tubes are filled, set the timer for 60 minutes by clicking the (1) button, and then click the **Start** button.

13. After 60 minutes have elapsed, drag sedimentation tube 1 to the magnifying chamber at the top right of the screen. Examine the tube. The tube is marked in millimeters, and the distance between two marks is 5 mm. How many millimeters has the blood settled?

_____

What is in the beige-colored portion of the tube? _____

14. Click the **Record Data** button next to the data table. The distance in millimeters that the red blood cells have settled, the elapsed time, and the sedimentation rate will be entered in the table.

15. Drag the sedimentation tube to the contaminated disposal container.

16. Repeat steps 13–15 with the other five sedimentation tubes.

17. Click **Tools,** then **Print Data** to print the data from the table, or fill in Chart 2 at the bottom of this page:

Did the person with sickle cell anemia show an elevated ESR?

_____

How did the ESR for a person with iron deficiency anemia compare to the ESR for a healthy individual?

_____

Explain the ESR for sample 2, the menstruating female.

_____

Explain the ESRs for samples 5 and 6 (the patients suffering from myocardial infarction and angina pectoris, respectively).

_____

_____

Hemoglobin

Hemoglobin (Hb), a protein found in red blood cells, is necessary for the transport of oxygen from the lungs to the body's cells. Anemia results when insufficient oxygen is carried in the blood.

Hemoglobin molecules consist of four polypeptide chains of amino acids, the "globin" part of the molecule. Each polypeptide chain has a heme unit—a group of atoms, which includes an atom of iron. When the polypeptide chain folds up correctly, it has an appropriate shape to bind with a molecule of oxygen. So, each hemoglobin molecule can carry four molecules of oxygen. Oxygen combined with hemoglobin forms oxyhemoglobin, which has a bright red color.

A quantitative hemoglobin determination is useful for determining the classification and possible causes of anemia and gives useful information on some other disease conditions. For example, a person can have anemia with a normal red blood cell count, if there is inadequate hemoglobin in the red blood cells.

Normal blood contains an average of 12 to 18 grams of hemoglobin per 100 milliliters of blood. A healthy male has 13.5 to 18 g/100 ml; a healthy female has 12 to 16 g/100 ml. Hemoglobin values increase in patients with polycythemia, congestive heart failure, and chronic obstructive pulmonary disease (COPD). They also increase at high altitudes. Hemoglobin values decrease in patients with anemia, hyperthyroidism, cirrhosis of the liver, renal disease, systemic lupus erythematosus, and severe hemorrhage.

The hemoglobin content of a sample of blood can be determined by stirring the blood with a wooden stick to rupture, or lyse, the cells. The intensity of the color of the lysed blood is a result of the amount of hemoglobin present. A hemoglobinometer compares the color of the sample to standard values to determine the hemoglobin content of the sample. The hemoglobinometer transmits green light through the hemolyzed blood sample. The amount of light that passes through the sample is compared to standard color intensities. Green light is used because the human eye is able to easily detect subtle differences in green colors.

From the **Experiment** menu, select **Hemoglobin Determination.** You will see the opening screen for the Hemoglobin Determination lab (Figure 11.3). Use the **Balloons On/Off** feature from the **Help** menu to familiarize yourself with the equipment on the screen.
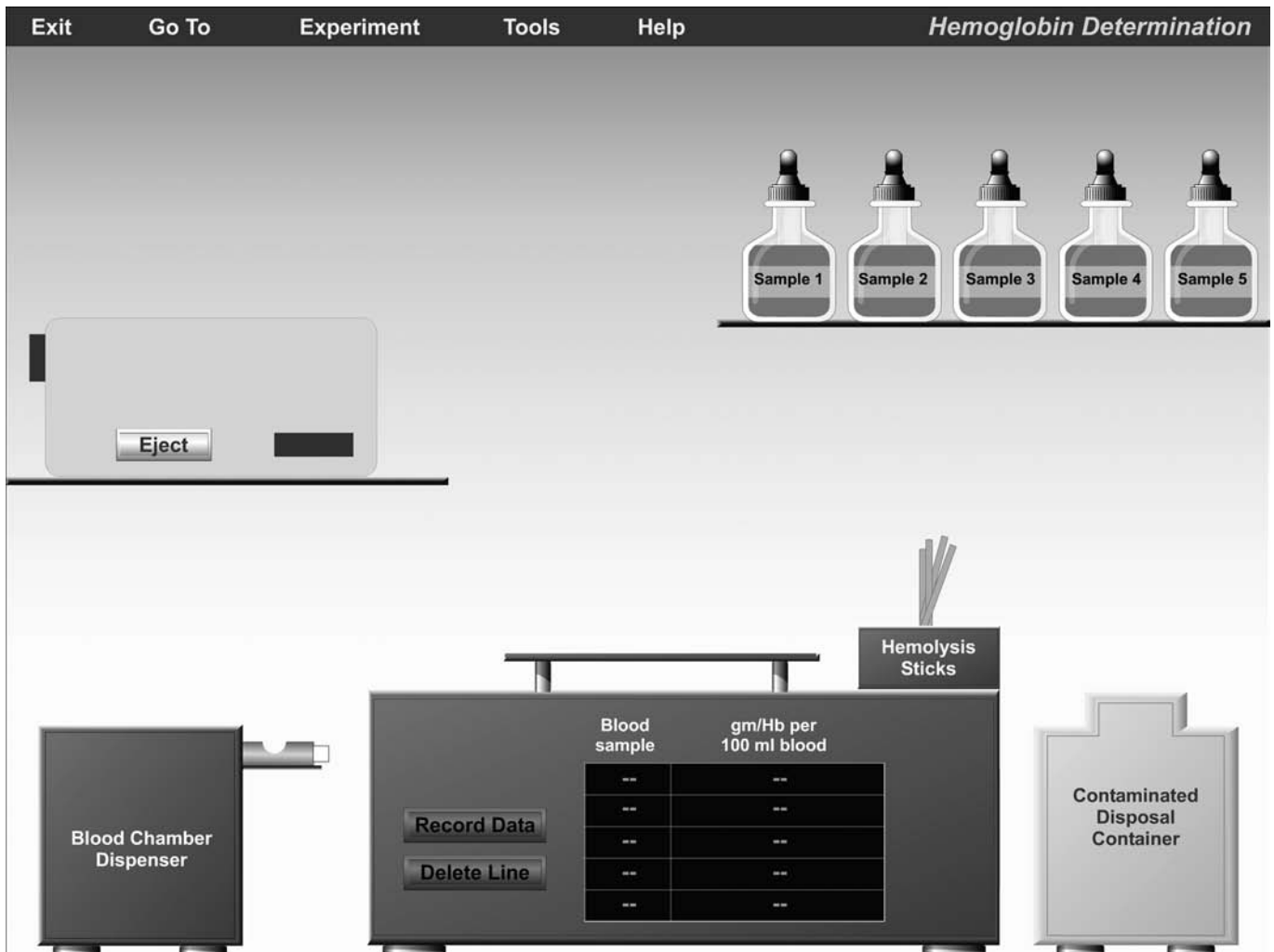
FIGURE 11.3   **Opening screen of the Hemoglobin Determination experiment.**

In the upper right portion of the screen is a shelf with five samples of blood.

In the middle of the screen is a lab table and a container of hemolysis sticks. The hemolysis sticks will be used to stir the blood samples to lyse the red blood cells, thereby releasing their hemoglobin.

In the bottom left of the screen is a blood chamber dispenser that provides a slide with a depression to receive the blood sample.

Above the blood chamber dispenser is a hemoglobinometer. The hemoglobinometer has a black rectangular slot to receive the blood chamber and an **Eject** button to remove the blood chamber. When the loaded blood chamber is inserted into the slot, the hemoglobinometer view will change to show a split screen that compares the color of the hemolyzed blood sample to a standard color for which given levels of hemoglobin are already known. A window on the hemoglobinometer displays the grams of hemoglobin per 100 milliliters of blood. A small handle on the top right of the hemoglobinometer can be slid down until the colors shown on the device match the colors of the sample of blood to be tested.

When you click on the **Record Data** button next to the data table at the bottom of the screen, the grams of hemoglobin per 100 milliliters of blood will be recorded.

In the lower right portion of the screen is a contaminated disposal container. All glassware and hemolysis sticks that have come in contact with the blood must be placed in this container for proper disposal.

ACTIVITY 3

Hemoglobin(Hb) Determination

The following individuals have contributed their blood for this test:

Sample 1: healthy male

Sample 2: healthy female

Sample 3: female with iron deficiency anemia

Sample 4: male with polycythemia

Sample 5: female Olympic athlete

CHART 3			
Blood Sample	gm Hb/100 ml blood	Hematocrit (PCV)	Ratio of PCV to Hb
Healthy male		48	
Healthy female		44	
Female with iron-deficiency anemia		40	
Male with polycythemia		60	
Female Olympic athlete		60	

1. Click and drag a clean blood chamber slide from the blood chamber dispenser to the lab table.

2. Click on the dropper for blood sample 1, and drag it over to the depression on the blood chamber slide. A drop of blood will be dispensed into the depression.

3. Click a hemolysis stick, and drag it to the drop of blood. The stick will stir the blood sample for 45 seconds, lysing the red blood cells and releasing their hemoglobin.

4. Drag the hemolysis stick to the contaminated disposal container.

5. Drag the blood chamber slide to the dark rectangular slot on the hemoglobinometer.

6. You will see a pop-up window appear, displaying the view inside the hemoglobinometer. The left half of the circular field shows the intensity of green light transmitted by blood sample 1. The right half of the circular field shows the intensity of green light for known levels of hemoglobin present in blood.

7. Click and hold the lever on the top right of the hemoglobinometer, and slowly drag it downward until the right half of the field matches the shade of green on the left side of the field.

8. Click the **Record Data** button next to the data table to record the grams of hemoglobin per 100 milliliters of blood for blood sample 1. Click "X" to close the pop-up window.

9. Click the **Eject** button to remove the blood chamber with blood sample 1 from the hemoglobinometer.

10. Drag the blood sample 1 chamber to the contaminated disposal container.

11. Repeat steps 1–10 for the remaining samples of blood.

Fill in Chart 3, using the grams of hemoglobin per 100 milliliters of blood that you obtained in this exercise. Use the packed cell volume (PCV) data provided below to calculate the ratio of PCV to Hb.

An individual might have a normal or near normal hematocrit value (packed cell volume) and still suffer from anemia if the red blood cells do not contain adequate hemoglobin. A normal ratio of packed cell volume to grams of hemoglobin is approximately 3:1.

What is the hematocrit value for the healthy male?

_____

What is the normal hematocrit value for the healthy female?

_____

What does the ratio of PCV to Hb tell you about the red blood cells of the female with iron deficiency anemia?

_____

Does the male with polycythemia have a normal ratio of PCV

to Hb? _____

Based on these results, do you think his red blood cells contain adequate quantities of hemoglobin molecules? Why?

_____

_____

Does the female Olympic athlete have a normal ratio of PCV

to Hb? _____

Based on these results, do you think her red blood cells contain adequate quantities of hemoglobin molecules? Why?

_____

_____

Blood Typing

All of the cells in the human body, including the red blood cells, are surrounded by a *plasma (cell) membrane*. The plasma membrane contains genetically determined glycoproteins, called antigens, that identify the cells. On red blood cell membranes, these antigens are called agglutinogens.

It is important to determine blood types before performing blood transfusions in order to avoid mixing incompatible blood. Although many different antigens are present on red blood cell membranes, the ABO and Rh antigens cause the most vigorous and potentially fatal transfusion reactions. If a blood transfusion recipient has antibodies (called *agglutinins*) to the antigens present on the transfused cells, the red blood cells will be clumped together, or *agglutinated,* and then lysed. This results in a potentially life-threatening blood transfusion reaction.

The ABO blood groups are determined by the presence or absence of two antigens: type A and type B (see Figure 11.4b). These antigens are genetically determined so a person has two copies (alleles) of the gene for these proteins, one copy from each parent. The presence of these antigens is due to a dominant gene, and their absence is due to a recessive gene.

• A person with type A blood can have two gene alleles for the A antigen, or that person could have one gene allele for type A antigen and the other allele for the absence of either A or B antigen.

• A person with type B blood can have two gene alleles for the B antigen, or that person could have one gene allele for type B antigen and the other allele for the absence of either A or B antigen.

• A person with type AB blood has one gene allele for the A antigen and the other allele for the B antigen.

• A person with type O blood will have inherited two recessive gene alleles and has neither type A nor type B antigen.

Antibodies to the A and B antigens are found pre-formed in the blood plasma. These antibodies will interact with the antigens that are not present, so a person with type A blood will have anti-B antibodies. This is summarized in the following chart:

CHART 4		
Blood Sample	Antigens on RBCs	Antibodies present in Plasma
A	A	anti-B
B	B	anti-A
AB	A and B	none
O	none	anti-A and anti-B

The Rh factor is another genetically determined protein that may be present on red blood cell membranes. Approximately 85% of the population is Rh positive and has this protein. Antibodies to the Rh factor are not found pre-formed in the plasma. These antibodies are produced only after exposure to the Rh factor by persons who are Rh negative.

Separate drops of a blood sample are mixed with antisera containing antibodies to the types A and B antigens and antibodies to the Rh factor. An agglutination reaction (showing clumping) indicates the presence of the agglutinogen.

In this experiment, we will be conducting blood typing tests on six blood samples. From the **Experiment** menu, select **Blood Typing.** You will see the opening screen for the Blood Typing lab (Figure 11.4). Use the Balloons **On/Off** feature from the **Help** menu to familiarize yourself with the equipment on the screen.

In the upper right portion of the screen is a shelf with six samples of blood.

In the upper left portion of the screen is a shelf containing bottles of anti-A serum (blue color), anti-B serum (yellow color), and anti-Rh serum (white color). These bottles contain antibodies to the A antigen, B antigen, and Rh antigen, respectively.

In the center of the screen is a lab table for performing the blood typing. To the left of the lab table is a blood typing slide dispenser.

Above the blood typing slide dispenser is a container of stirring sticks. These sticks are color coded: the blue stick is to be used with the anti-A serum, the yellow stick is to be used with the anti-B serum, and the white stick is to be used with the anti-Rh serum.

To the right of the lab table is a light box for viewing the blood type samples. When you click on the **Light** button, the screen above unrolls to display the blood types.

To the left of the light box is a data table to record your results.

In the bottom right portion of the screen is a contaminated disposal container. All glassware and sticks that have come in contact with blood must be placed in this container for proper disposal.

ACTIVITY 4

Blood Typing

Six individuals with different blood types have donated their blood for this exercise.

1. Click and drag a blood typing slide from the blood typing slide dispenser to the lab table. Note that the three wells on the slide are labeled "A," "B," and "Rh."

2. Click on the dropper for blood sample 1, and drag it over the well labeled A on the blood typing slide. A drop of blood will be dispensed into the well.

3. The dropper will automatically slide over to each of the remaining samples.

4. Click on the dropper for anti-A serum, and drag it over the well labeled A on the blood typing slide. A drop of anti-A serum will be dispensed into the well.

5. Repeat step 4 with the anti-B serum. Be sure to dispense it into the well labeled B.

(a)

A antigen   B antigen

Type A   **Type B**   **Type AB**   **Type O**
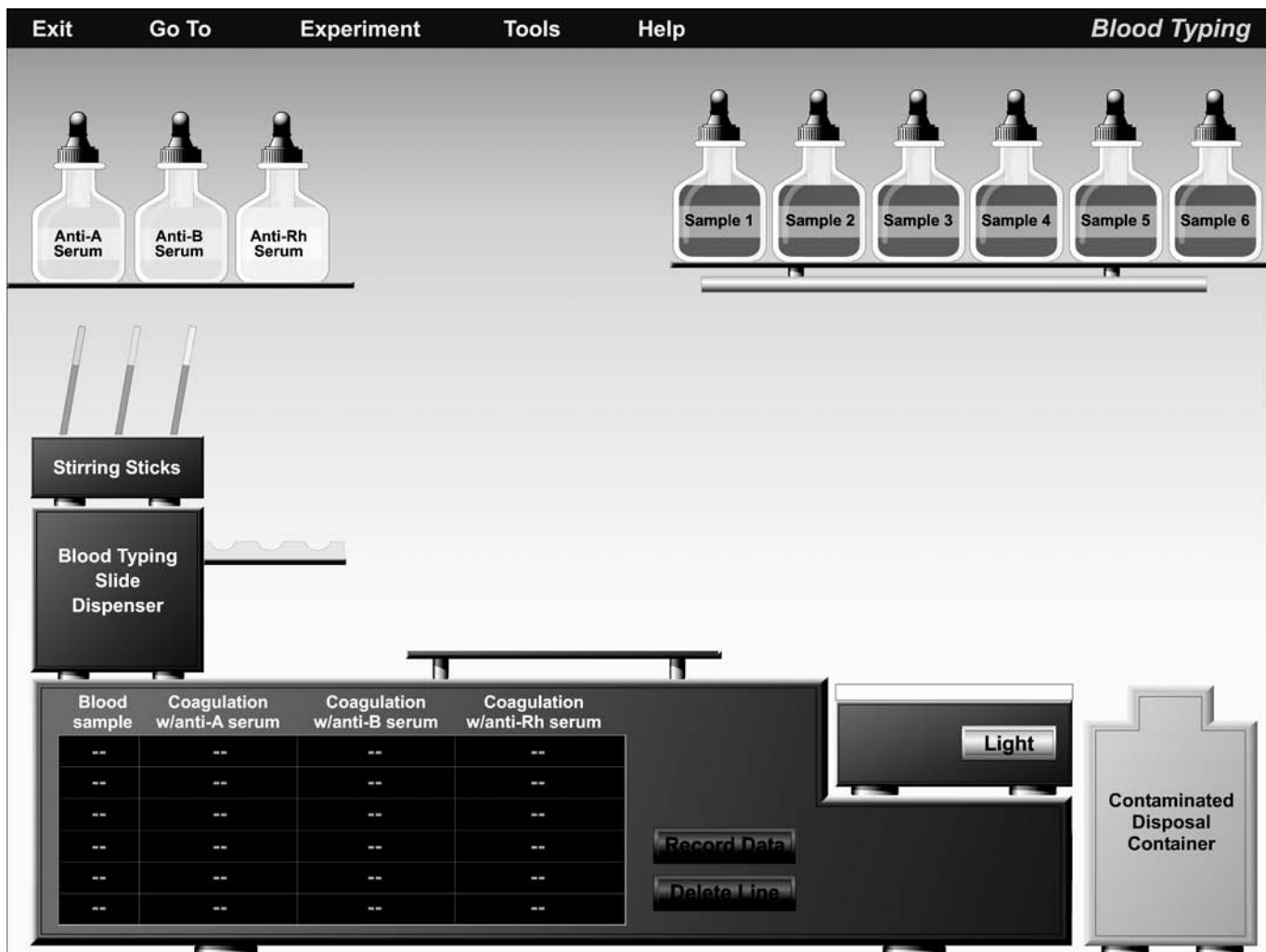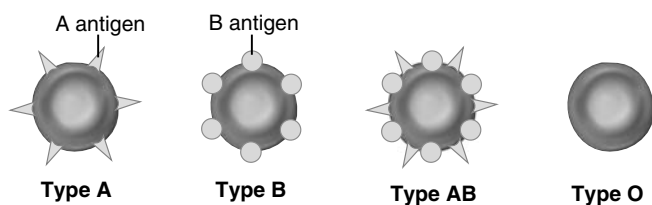
(b) Blood type surface antigens

FIGURE 11.4   Blood Typing. (a) Opening screen of the Blood Typing experiment. **(b)** Antigens determining ABO blood type, found on the surface of red blood cells.

6.   Repeat step 4 with the anti-Rh serum. Be sure to dispense it into the well labeled Rh.

7.   Obtain a blue-tipped stirring stick, and drag it to well A. It will mix the blood and anti-A serum.

8.   Dispose of the stirring stick into the contaminated disposal container.

9.   Select a yellow-tipped stirring stick, and drag it to well B.

10.   Dispose of the stirring stick into the contaminated disposal container.

11.   Select a white-tipped stirring stick, and drag it to well Rh.

12.   Dispose of the stirring stick properly into the contaminated disposal container.

13.   Drag the blood typing slide to the light box, and click the **Light** button. The screen will unroll, displaying the results of the blood typing.

14.   Examine the results labeled A on the screen. If coagulation (agglutination, or "clumpiness") is present, click on **Positive.** If no coagulation is present (the sample will look smooth), click on **Negative.**

15.   Repeat step 14 for the results labeled B and Rh. In each case, choose **Positive** if the sample is coagulated and **Negative** if the sample is not coagulated.

16. Click the **Record Data** button on the data table to record the results of blood sample one.

17. Click and drag the blood typing slide to the contaminated disposal container.

18. Click the **X** at the top right of the scroll to close the scroll.

19. Repeat steps 1–18 for the remaining samples of blood.

Using the data you have collected in this activity, determine the blood type of each sample and fill in Chart 5 at the bottom of the page: (Indicate coagulation as either "positive" or "negative.")

If the anti-A antibody causes the blood to coagulate, which antigen would be present on the blood cells?

_____

If a person has type AB blood, which antigens are present on the red blood cells?

_____

Which antibodies are present in the plasma of a person with type AB blood?

_____

Does a person with type O blood have A or B antigens on the red blood cells?

_____ ▬

Blood Cholesterol

Cholesterol is a lipid substance that is essential for life. It is an important component of all cell membranes and is the basis for making steroid hormones, vitamin D, and bile salts.

Cholesterol is produced in the human liver and is present in some foods of animal origin, such as milk, meat, and eggs. Since cholesterol is a water-insoluble lipid, it needs to be wrapped in protein packages, called lipoproteins, to travel in the watery blood from the liver and digestive organs to the cells of the body.

One type of lipoprotein package, called LDL (low density liproprotein), has been identified as a potential source of damage to the interior of arteries, resulting in the build-up of plaque, or atherosclerosis, in these blood vessels. A total blood cholesterol determination does not measure the level of LDLs, but it does provide valuable information about the total amount of cholesterol in the blood.

Less than 200 milligrams of total cholesterol per deciliter of blood is considered desirable. Between 200 to 239 mg/dL is considered borderline high cholesterol. Over 240 mg/dL is considered high blood cholesterol and is associated with increased risk of cardiovascular disease. Abnormally low blood levels of cholesterol (total cholesterol lower than 100 mg/dL) can also be a problem. Low levels may indicate hyperthyroidism (overactive thyroid gland), liver disease, inadequate absorption of nutrients from the intestine, or malnutrition. Other reports link hypocholesterolemia (low blood cholesterol) to depression, anxiety, and mood disturbances, which are thought to be controlled by the level of available serotonin, a neurotransmitter. There is evidence of a relationship between low levels of blood cholesterol and low levels of serotonin in the brain.

In this test for total blood cholesterol, a sample of blood is mixed with enzymes that produce a colored reaction with cholesterol. The intensity of the color indicates the amount of cholesterol present. The cholesterol tester compares the color of the sample to the colors of known levels of cholesterol (standard values).

From the **Experiment** menu, select **Total Cholesterol Determination.** You will see the opening screen for the Total Cholesterol Determination lab (Figure 11.5). Use the **Balloons On/Off** feature from the **Help** menu to familiarize yourself with the equipment on the screen.

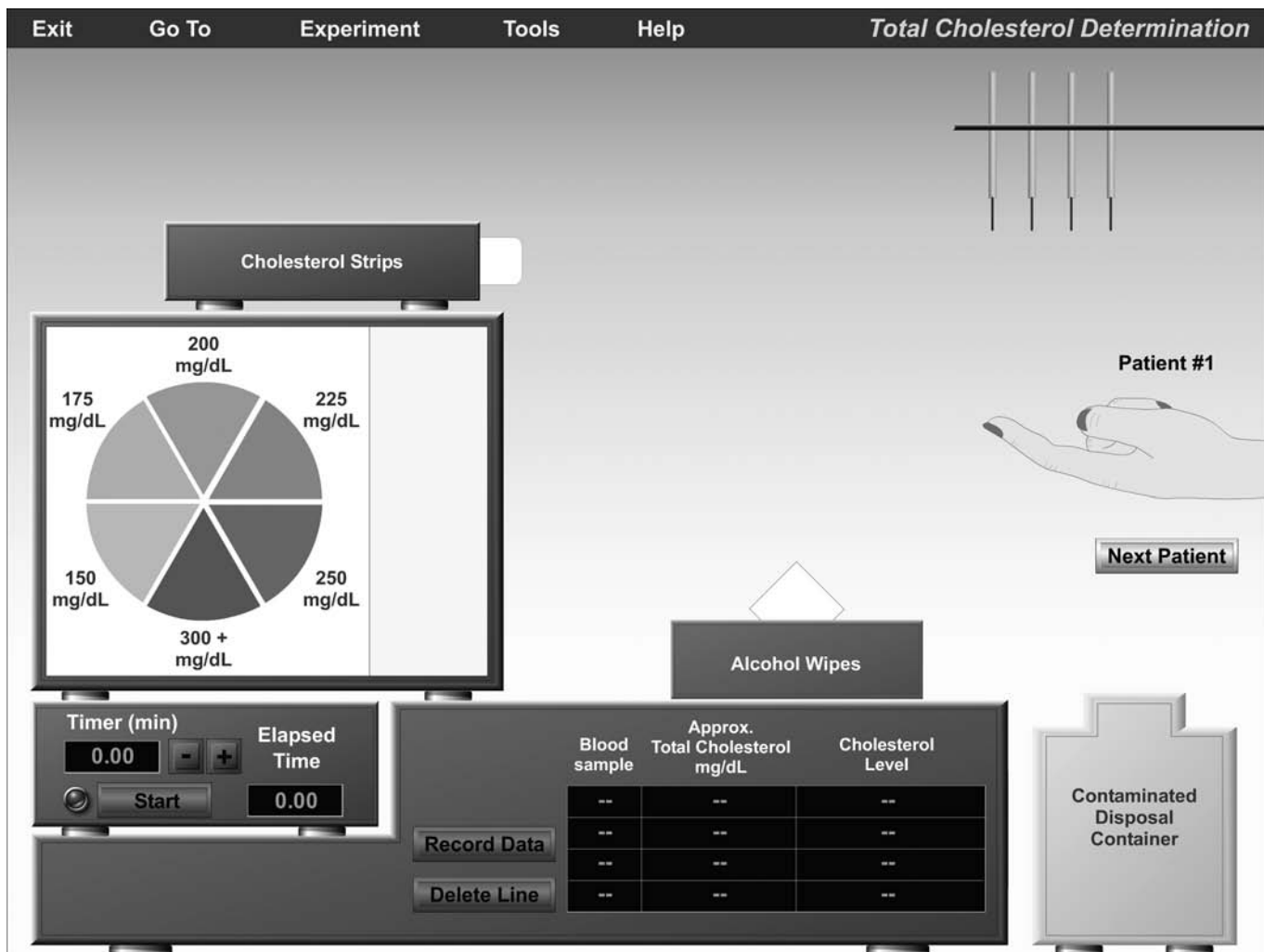| CHART 5				
Blood Sample	Agglutination with Anti-A Serum	Agglutination with Anti-B Serum	Agglutination with Anti-Rh Serum	Blood Type
1				
2				
3				
4				
5				
6				

FIGURE 11.5   **Opening screen of the Total Cholesterol Determination experiment.**

In the upper right portion of the screen is a dispenser of lancets, sharp needlelike instruments that are used to prick the finger to obtain a drop of blood.

Beneath the lancet dispenser is a patient's finger. The patient can be changed by clicking the **Next Patient** button beneath the finger.

On top of the data table is a container of alcohol wipes for cleansing the finger tip before it is punctured with the lancet.

The left portion of the screen shows a cabinet containing a *color wheel* that is divided into sections showing different intensities of green. Each shade of green corresponds to a range of total cholesterol levels. Below the cabinet is a timer that can be set for 1 to 3 minutes.

In the upper left portion of the screen is a cholesterol strip dispenser. These cholesterol strips contain chemicals that convert, by a series of reactions, the cholesterol in the blood sample into a green-colored solution. These reactions take 3 minutes. By matching the color of the cholesterol strip to a color on the color wheel, we can determine the cholesterol level of a given blood sample. Higher levels of cholesterol will result in a deeper green color.

The bottom of the screen has a data table for recording the total cholesterol level of the blood samples.

In the lower right portion of the screen is a contaminated disposal container. Any piece of equipment that has come into contact with the blood must be disposed of properly by dragging it to this contaminated disposal container.

A C T I V I T Y   5

Total Cholesterol Determination

1. Click and drag an alcohol wipe over the end of patient 1's finger.

2. Click and drag a lancet to the tip of the finger. The lancet will prick the finger to obtain a drop of blood.

3. Drag the lancet to the contaminated disposal container.

4. Drag a cholesterol strip to the finger. The blood should transfer to the strip.

5. Drag the cholesterol strip to the rectangular area to the right of the color wheel.

CHART 6	Total Cholesterol Determination	
Blood Sample	**Approximate Total Cholesterol**	**Cholesterol Level**
1		
2		
3		
4		

6.   Set the timer for 3 minutes, and click **Start.** Notice that the strip begins to change color.

7.   After 3 minutes, decide which color on the color wheel most closely matches the color on the cholesterol test strip. Click on that color. It is sometimes difficult to match the color on the cholesterol strip with the appropriate color on the color wheel. If the color you have chosen is not the exact match, you will see a pop-up window asking you to try again.

8.   Click on **Record Data** to record this information in the data table.

9.   Drag the cholesterol test strip from patient 1 to the contaminated disposal container. Record your results in Chart 6.

10. Click **Next Patient** to expose the finger of patient 2.

11. Repeat steps 1–10 for the next patient.

12. There are a total of four patients. Repeat steps 1–10 until you have collected data for all four patients.

What health problems might be in store for patient 2, based on these results?

_____

What advice about diet and exercise would you give patient 4?

_____ ▬