68) The refractory period limits the number of action potentials that can travel along an axon in a given unit of time. During the refractory period, the membrane cannot conduct an action potential, so a new depolarization event cannot occur until after the refractory period has passed.

69) a) auditory canal
b) tympanic membrane
c) tympanic cavity
d) eustachian tube
e) cochlea
f) cochlear nerve
g) semicircular canals
h) stapes
i) incus
j) malleus

70) a) parietal lobe
b) occipital lobe
c) temporal lobe
d) frontal lobe

Chapter 15

Blood – Part I

Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Bicycle
Tape
1% milk
Vegetable oil
Red food coloring
Blue Food Coloring
Mixing container and spoon
Metric ruler
Three small clear plastic bottles with caps

National Science Education Standards covered this week:

12CLS5.4 The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.

Definitions

anemia	a dangerous condition occurring when a person has a low level of red blood cells or hemoglobin
blood clot	a "plug" of platelets within a damaged blood vessel
erythropoietin	hormone which is released into the blood and signals the skeletal system to increase the rate of red blood cell production
heme	iron-containing molecule found within hemoglobin
hemoglobin	protein within red blood cells consisting of heme which binds to a single oxygen gas molecule
phagocytic cells	"cells that eat"
platelets	short-lived packets of cytoplasm and dissolved molecules within the blood; assist in the immune response to the vessels of the cardiovascular system
red blood cells (erythrocytes)	major component of blood; responsible for transport of oxygen and carbon dioxide gases throughout the body
white blood cells (leukocytes)	phagocytic cells within the blood ; major component of the immune system

Sample questions to ask your child after completing the weekly reading.

What is the importance of the "donut" shape of the red blood cells?
This shape allows the cells to stack on top of each other easily and to squeeze through very narrow blood vessels. In addition, this shape also allows for the maximum amount of gases to pass through its membrane.

What protein, molecule, and element exist within a red blood cell that allows it to transport oxygen so efficiently?
Within a red blood cell, the protein hemoglobin contains four molecules of heme, each of which harbors the element iron which binds to oxygen very readily.

Place the following items in order of most prevalent to least prevalent within the blood: Platelets, White blood cells, Red blood cells
Red blood cells, platelets, and white blood cells

What are the primary functions of the platelets?
Platelets temporary patch the walls of damaged blood vessels and control the clotting of blood. In addition, platelets help to seal breaks in the walls of our blood vessels.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

1) phagocytic cells
2) blood clot
3) anemia
4) erythropoietin
5) heme
6) red blood cells (erythrocytes)
7) white blood cells (leukocytes)
8) hemoglobin
9) platelets

Multiple Choice and True/False

1) C
2) C
3) C
4) C
5) B
6) F
7) F

Application Questions

Hypoventilation results in decreased blood oxygen levels, which stimulates the release of erythropoietin. This hormone signals the skeletal system to increase the rate of red blood cell production.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

Bicycle
Tape
1% milk
Three small clear plastic bottles with caps
Red food coloring
Blue Food Coloring
Mixing container and spoon
Metric ruler
Vegetable oil

Centrifuging the Components of Blood or…

No whey…!

The four components of simulated blood will be separated with the help of a homemade centrifuge.

Materials:

Bicycle	Blue Food Coloring
Tape	Mixing container and spoon
1% milk	Metric ruler
Vegetable oil	Three small clear plastic bottles with caps
Red food coloring	

Procedure: Pre-lab preparation (for parents):

Prepare the following solutions of simulated blood samples and mark them as Sample A, B, C. The contents are to remain unknown to the child:

Sample A (Normal Blood):

Mix 0.25 cups (~60mL) of 1% milk with 0.3 cups (~78mL) of oil. Add 7-9 drops of red food coloring and one drop of blue food coloring to simulate blood.

Sample B (Anemic blood - Reduced red blood cells):

Mix 0.2 cups (45 mL) of 1% milk with 0.4 cups (105 mL) of oil. Add red and blue food coloring as with Sample A.

Sample C (Erythremic blood - Excessive red blood cells)

Mix 0.4 cups (105 mL) of 1% milk with 0.2 cups (45 mL) of oil. Add red and blue food coloring as with Sample A.

Fill each of the clear plastic bottles 3/4 full and label them Sample A, B, and C. Keep the bottles in the refrigerator until needed.

Procedure (for the students):

Day One:

1) Remove each of the unknown samples from the refrigerator and allow them to come to room temperature. It is to be assumed that each of the three simulated blood samples have been drawn from three different patients.
2) Shake each of the bottles well.
3) Use the ruler to measure the height of fluid in each sample in millimeters. Record this information on the provided data chart.
4) Turn your bicycle upside down so it is resting on the seat and handlebars. Tape one of the bottles to a spoke on the back wheel. Rest the bottom of the bottle against the rim of the tire.
5) Spin the pedals of the bike as fast as you can for about 30 seconds. Wait for the wheel to stop spinning on its own and remove the bottle from the wheel.
6) Carefully remove the bottle from the wheel and place it in the refrigerator.
7) Repeat this procedure with the remaining two bottles.
8) Allow all three samples to rest overnight. This will allow the "blood" to finish settling into layers.

Day Two:

1) Record the height of each layer found within the samples on the data chart.
2) Calculate the percentage of "erythrocytes" in each sample by dividing the <u>bottom</u> layer within the sample with the total height measured in Day One and multiplying by 100.
3) Calculate the percentage of plasma in each sample by dividing the <u>top</u> layer within the sample with the total height measured in Day One and multiplying by 100.
4) Compare your percentages with the following chart to determine the blood health of each patient. Which of the samples contains normal, low, and high RBC counts? What are the possible RBC health results since you do not know the gender for each sample?

Red Blood Cell Values					
Normal RBC count (%)		**Low RBC count (%)**		**High RBC count (%)**	
Male	Female	Male	Female	Male	Female
42-54	35-46	<42	<35	>54	>46

Explanation:

A common piece of laboratory equipment for separating blood into its separate components is the centrifuge. The centripetal force induced by the spinning action of this device forces the most dense objects within each sample towards the bottom of the container (away from the axis of the rotating cylinder) and the less dense objects towards the top of the container.

Of the four main components of the blood, the red blood cells (erythrocytes) will be the most dense and most abundant. This is the layer found at the bottom of each sample. The fluid portion of the blood, plasma, is the least dense and is found at the top of the sample after the centrifuge process is completed. The middle layer is a mixture of white blood cells (leucocytes) and platelets.

Within this activity, Sample A contains a simulated normal range of RBC's within the blood; Sample B has a reduced amount of RBC's which simulates the condition known as anemia; and Sample C contains an excessive amount of RBC's and simulates a condition known as **erythremia**.

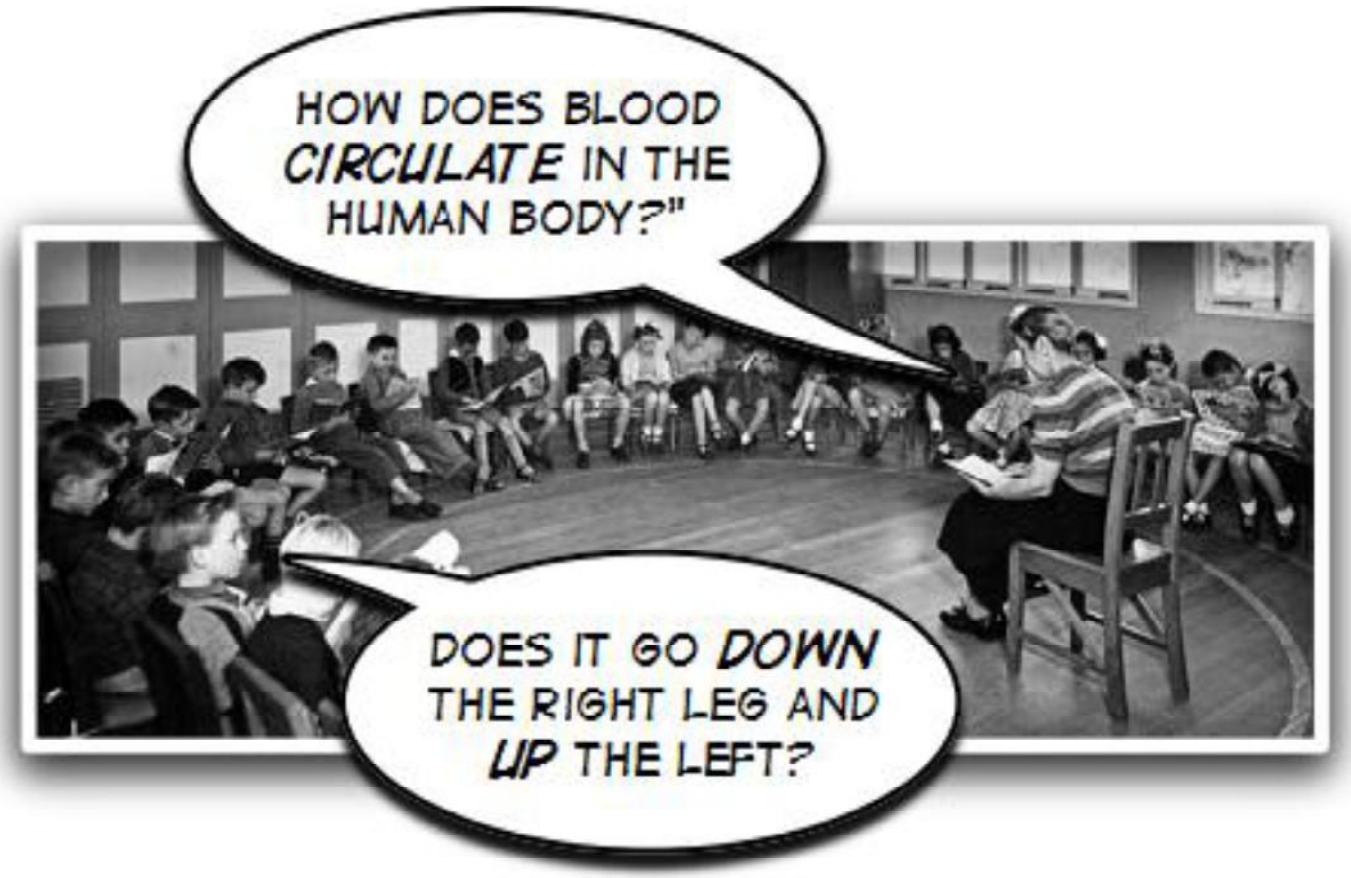
The lowest layer within the milk is actually a collection of dense proteins called **caseins**, while the less dense oil rests on top. Without the excessive oil placed within this mixture, a dense layer of cream would be present on the top of the middle layer. However, the low concentration of fat within 1% requires extra oil to be added. The middle layer contains mostly water and the sugar known as **lactose**. This layer is commonly referred to as **whey**.

Red Blood Cell Count Data Chart

Day	Sample	Height of entire sample (mm)	Height of bottom layer (mm)	Height of top layer (mm)	% Red Blood Cells	% Plasma
1	A					
1	B					
1	C					
2	A					
2	B					
2	C					

Chapter 16

Blood – Part II



Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Twenty 3oz (89mL) paper cups
8 toothpicks
Marker
One cup (250mL) skim milk
Water

Red and green food coloring
1/2 cup (100mL) vinegar
12 eye droppers
Measuring cup

National Science Education Standards covered this week:

12CLS5.6 As matter and energy flows through different levels of organization of living systems — cells, organs, organisms, communities — and between living systems and the physical environment, chemical elements are recombined in different ways.

Definitions

albumins	plasma protein; largest by volume; act to regulate the osmotic pressure of the blood
antibodies (immunoglobulins)	a type of globulin which is responsible for attacking foreign invaders within the bloodstream
antigens	specific molecular "locks" on the outer surface of cells that can only be opened by specific molecular "keys"
antisera	blood serum containing specific antibodies against specific antigens
blood type	one of four different types of blood which is characterized by the absence or presence of three different surface antigens (A, B, and Rh)
fibrin	long strands of fibrinogen proteins which assemble around the "plug" of platelets within a blood clot
fibrinogen	plasma protein; works with the platelets in the blood to help with the formation of a blood clot
globulins	second most abundant type of plasma proteins; functions include protection and transport of molecules
hypertonic	solutions containing more solutes as compared to another fluid when separated by a permeable membrane
hypotonic	solutions containing fewer solutes as compared to another fluid when separated by a permeable membrane
isotonic	solutions which are separated by a permeable membrane which contain equal concentrations of solutes
osmotic pressure	the pressure needed to keep water from moving through a porous substance (like the blood vessels)
Rh factor	surface antigen within blood that identifies an individual's blood type as either positive or negative
serum	blood plasma which contains no fibrinogen
solutes	substances that are dissolved in a solution by solvents
solution	a mixture of solute(s) and solvent(s)
solvent	substances which dissolve solutes to form a solution

transport globulins	chemical "taxis" of the blood; bind to important compounds that may otherwise be flushed out of the body
universal donors	individuals who have type O blood
viscosity	resistance of a fluid to flow

Sample questions to ask your child after completing the weekly reading.

Is the average blood temperature higher or lower than our normal body temperature? What is the reasoning for this phenomenon?

Our average blood temperature is slightly higher than our body temperature. The extra heat within the internal blood is spread throughout the body before it reaches the epidermal layers of our skin.

How do albumins increase the osmotic pressure of blood vessels and what is the result of this increase?

The relatively large numbers of albumins within the blood help to keep water from leaking out of the blood vessels by "plugging up" the tiny holes which exist within its walls. This increases the osmotic pressure of the blood as their presence prevents water from moving through the permeable blood vessel walls.

Why would red blood cells swell and possibly burst within a hypotonic solution?

The osmotic pressure within the red blood cell would be much higher as more solutes would exist within the cell as compared to the hypotonic solution. Therefore, water would move into the cell via osmosis, causing the cell to swell and possibly burst.

What is the difference between plasma and serum?

Plasma is whole blood without any red blood cells, white blood cells and platelets; while serum is plasma without any fibrinogen.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

1) solution
2) antibodies (immunoglobulins)
3) serum
4) transport globulins
5) universal donors
6) fibrin
7) blood type
8) albumins
9) fibrinogen
10) viscosity
11) globulins
12) hypotonic
13) hypertonic
14) antigens
15) solutes
16) solvent
17) Rh factor
18) osmotic pressure

Multiple Choice and True/False

1) E
2) E
3) D
4) C
5) D
6) F
7) T

Application Questions

Blood doping rapidly increases the number of red blood cells in the blood, thereby increasing the body's ability to dissolve oxygen into the blood. A boost in the oxygen levels of the body will give an athlete more endurance as it will promote aerobic respiration to continue for a longer period of time. Without this increase in oxygen, anaerobic respiration will cause the muscles to build up lactic acid which will result in muscle fatigue. Unfortunately, the increased number of red blood cells also makes it more difficult for the blood to flow through the blood vessels, increasing the heart's workload.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

Twenty 3oz (89mL) paper cups
8 toothpicks
Marker
One cup (250mL) skim milk
Water
Red and green food coloring
1/2 cup (100mL) vinegar
12 eye droppers
Measuring cup

The Hidden Reactions of Typing Blood or...

A pessimist's blood type is always B-

The typing of simulated blood will be modeled along with the immune responses between antigens and antibodies.

Materials:

Twenty 3oz (89mL) paper cups
8 toothpicks
Marker
One cup (250mL) skim milk
Water
Red and green food coloring
1/2 cup (100mL) vinegar
12 eye droppers
Measuring cup

Preparation (for parents):

1) Mix together one cup (250mL) skim milk with one cup (250mL) of water within the measuring cup.
2) Place approximately 30 drops of red food coloring and three drops of green food coloring to the solution. Mix well and refrigerate this simulated blood solution until needed.
3) Pour ½ cup (120mL) of the simulated blood into each of four separate cups and label them as #1-4.
4) Pour 0.1 cup (25mL) of vinegar in each of four different cups. Label two of them "Anti-A" and two more as "Anti-B".
5) Pour 0.1 cup (25mL) of water in each of four different cups. Label two of them "Anti-A" and two more as "Anti-B".
6) Separate the four simulated blood samples on different areas (stations) of a table.

7) At each of the stations, place the following containers:

Station	Simulated Antiserum	Simulated Blood Type
1	Anti-A = vinegar Anti-B = water	A
2	Anti-A = water Anti-B = vinegar	B
3	Anti-A = vinegar Anti-B = vinegar	AB
4	Anti-A = water Anti-B = water	O

*You should remember from your reading that doctors use blood serum to determine the blood type of an individual. Antiserum is blood serum which contains specific antibodies against specific antigens.

8) Place eye droppers in each of the twelve cups. Do not reveal the contents of the antiserum containers. Only the titles "Anti-A" and "Anti-B" should be provided.

Procedure (for students):

Within this lab, you will be testing samples of simulated blood with two separate fluids. Any reaction that occurs will be used to determine the blood type at each of the four stations. Make certain keep all of the materials at their individual stations. No sharing of equipment between stations!

1) Place 36 drops of the blood at Station #1 in an empty cup. Label this cup "1 Anti-A". Add ten drops of the Anti-A fluid to the blood and mix it with a toothpick. The fluid "Anti-A" is an **antiserum**, which is blood serum containing specific antibodies against specific antigens, in this case, the antigen would be A.

2) If the Anti-A reacts with the blood it will begin to clump up, and you will need to place a "+" within the attached data chart to indicated a positive reaction. If no reaction takes place, indicate this with a "-" within the data chart.
3) Place 36 drops of the blood at Station #1 in another empty cup. Label this cup "1 Anti-B". Add ten drops of the Anti-B fluid to the blood and mix it with a toothpick. Place a "+" within the attached data chart if the blood clumps together or a "-" indicating that no reaction has taken place.
4) Repeat this procedure at each station and record your results. From the tests you perform, identify which blood type exists within each of the four stations.

	Station 1	Station 2	Station 3	Station 4
Reaction to Anti-A				
Reaction to Anti-B				
Blood Type				

Explanation:

In real blood, clumping occurs when antibodies bind to the antigens on the surface of the red blood cells. If the Anti-B antibody comes in contact with the B antigen, or the Anti-A antibody with the A antigen, the immune response involved with the combining of antibody with antigen can cause a fatal result. This immune response is one method to type blood as A, B, AB, or O. Exposing samples of blood to known antibodies can identify the blood type existing within the sample. Within this activity, the acetic acid within vinegar loosens the proteins within the "blood" (milk) and causes them to clump together much like the clumping reaction caused by the antibody/antigen complex in blood.

The following chart comes from this week's reading.

Blood Type	Surface Antigen on Red Blood Cell	Antibody in Plasma
A	A	Anti-B
B	B	Anti-A
AB	A and B	Neither anti-A or anti-B
O	Neither A or B	Both anti-A and anti-B

Consider this, I have blood type B. I could receive blood from either a type B or type O individual and no clumping would occur. However, if I received blood from a type A individual, my Anti-A antibodies within my plasma would attach to the A surface antigens on its red blood cells. This would likely cause my blood to begin clumping and could cause a fatal result.

Blood type O is known as the universal donor as it contains neither A or B surface antigens on its red blood cells. Therefore, it can be introduced to any patient and will not react with any Anti-A or Anti-B antibodies.

The following chart should identify the answers obtained from each station:

	Station 1	Station 2	Station 3	Station 4
Reaction to Anti-A	+	-	+	-
Reaction to Anti-B	-	+	+	-
Blood Type	A	B	AB	O

1) While working as an intern in a medical lab, you have been assigned to determine the ABO blood type of three individuals. You've mixed antisera with the blood, with the following results.

   Person 1: blood agglutinates (clumps up) with anti-A sera but not anti-B sera.

   Person 2: blood agglutinates with anti-A and anti-B sera.

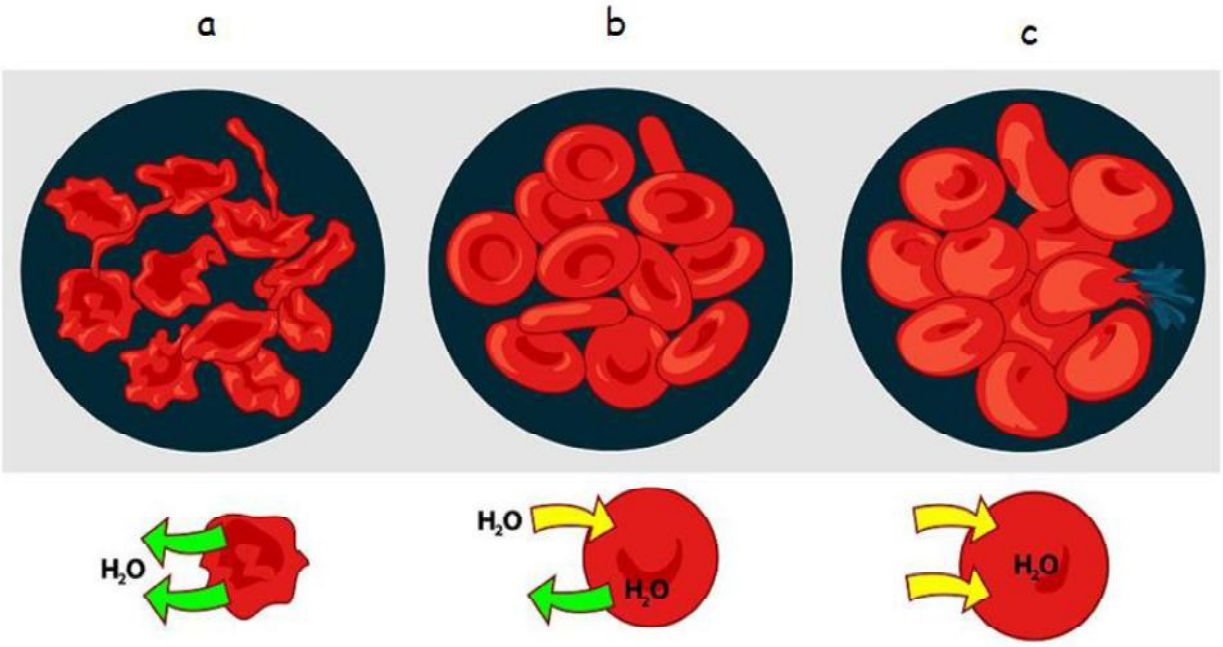
   Person 3: blood does not agglutinate with anti-A nor anti-B sera.

   What blood type does each individual have?

2) Solution A is hypertonic as compared to solution B. If solution A is separated from solution B by a semi-permeable membrane, does water move from solution A into solution B or vice versa? Defend your answer.

3) In your dream, you're floating on a raft in the middle of the ocean. The sun's hot, you're very thirsty, and you're surrounded by water. You want to take a long, cool drink of seawater, but something you learned from your reading stops you from drinking and saves your life! Why shouldn't you drink seawater?

4) Correctly identify the following structures within the following image. Use the words from the word bank below:



WORD BANK: isotonic, hypertonic, hypotonic

a)

b)

c)

Unit Quiz Answer Key

1) Person 1 has blood type A, person 2 has blood type AB, and person 3 has blood type O.

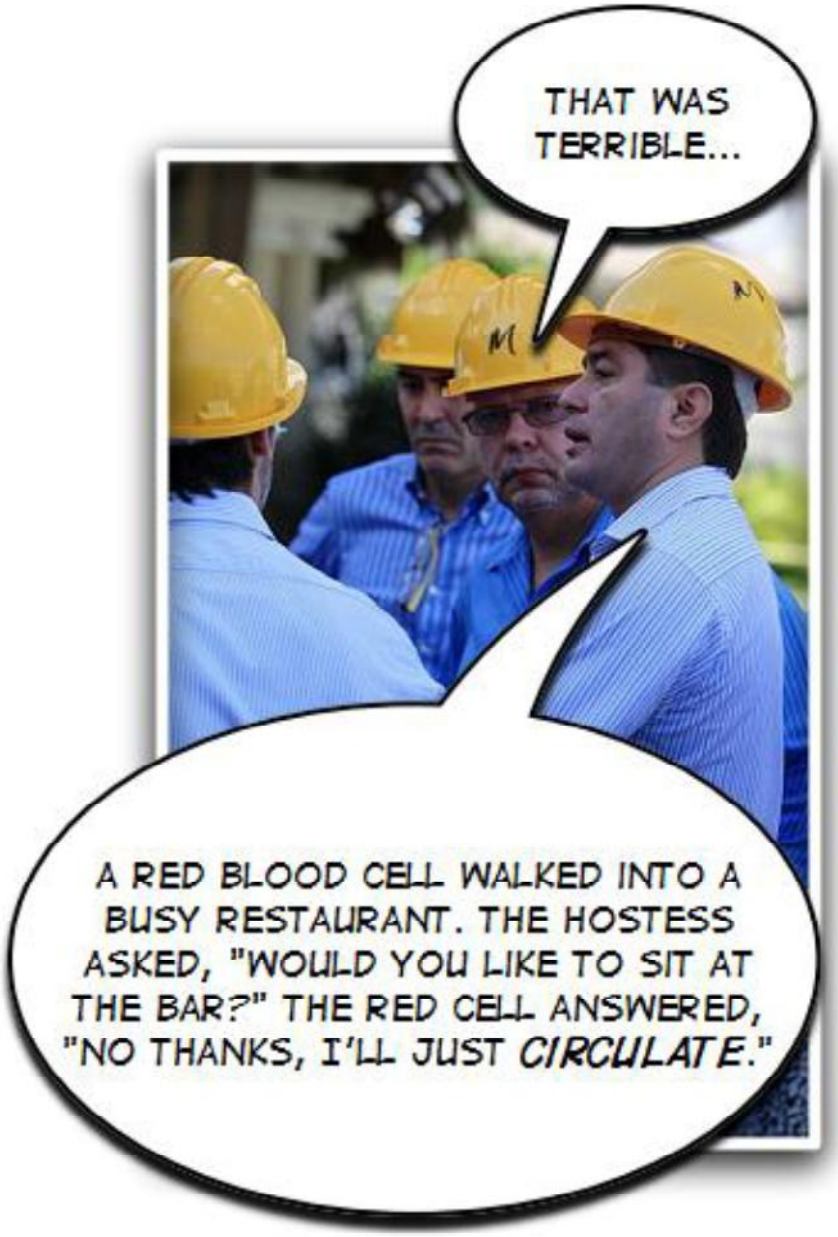
2) Water moves by osmosis from solution B into solution A. Because solution A is hypertonic to solution B, solution A has more solutes than does solution B. Water therefore moves from solution B (with less solutes) to solution A (with more solutes).

3) Seawater is hypertonic to the body. It contains a higher concentration of solutes (such as salt) than within the body's cells. Drinking seawater would cause shrinkage or collapse of red blood cells.

4) Word match from picture:
   a) hypertonic
   b) isotonic
   c) hypotonic

Chapter 17

Cardiovascular System – Part I



Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Scotch tape or Sellotape (UK)
Old water/soda bottle with lid
Scissors
Bowl or tub of water
Drill with 0.4in (1cm) bit (optional)

National Science Education Standards covered this week:

12CLS5.4 The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.

Definitions

aortic semilunar valve	semilunar valve which closes after blood has existed the left ventricle
arrhythmias	irregular patterns in nerve impulses caused by pacemaker cells
arteries	large blood vessels responsible for carrying blood away from the heart and towards the various tissues of the body
atria	two upper chambers within the heart
atrioventricular valves	two valves located between the right atrium and right ventricle and the left atrium and left ventricle
diastole	phase of the cardiac cycle where the heart refills with blood after systole
electrocardiogram	a device used to detect the electrical impulses generated by cardiac muscle
heart	main organ of the cardiovascular system; responsible for pumping all bodily fluids throughout each system
pacemaker cells	located within the right atrium; generate a rhythmical flow of nerve impulses throughout all of the cardiac muscle tissue causing muscular contraction
pulmonary semilunar valve	semilunar valve which closes after blood has exited the right ventricle
semilunar valves	one of two valves which close after blood has exited the right ventricle (pulmonary semilunar valve) and left ventricle (aortic semilunar valve)
systole	phase of the cardiac cycle where blood is forced out of the heart and into the arteries
tricuspid valve	atrioventricular valve located between the right atrium and right ventricle
valves	device which control the passage of fluid in one direction
veins	large blood vessels which deliver blood into the left atrium and right atrium of the heart
ventricles	two lower chambers within the heart

Sample questions to ask your child after completing the weekly reading.

Describe the names and locations of the atrioventricular valves.

The atrioventricular valves (AV) are located between the right atrium and right ventricle (tricuspid valve) and left atrium and left ventricle (bicuspid valve).

Describe the names and locations of the semilunar valves.

The semilunar valves (SV) close after blood has exited the right ventricle (pulmonary semilunar valve) and left ventricle (aortic semilunar valve).

What causes the "lub dub" sound of a heart beat?

The first sound, the "lub" is the sound of the atrioventricular valves closing. This marks the beginning of systole. The second "dub" sound is caused by the closing of the semilunar valves and begins a period of diastole.

Describe the path of the blood throughout all of its steps you have learned so far.

1. *Right atrium*
2. *Tricuspid valve*
3. *Right ventricle*
4. *Pulmonary semilunar valve*
5. *(Blood travels to the lungs)*
6. *Left atrium*
7. *Bicuspid valve*
8. *Left ventricle*
9. *Aortic semilunar valve*
10. *(Blood travels to the tissues/organs in the body)*
11. *Right atrium (…and the process begins again!)*

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

1) electrocardiogram
2) tricuspid valve
3) valves
4) arrhythmias
5) arteries
6) veins
7) pacemaker cells
8) heart
9) semilunar valves
10) aortic semilunar valve
11) pulmonary semilunar valve
12) ventricles
13) atria
14) atrioventricular valves
15) diastole
16) systole

Multiple Choice and True/False

1) C
2) A
3) C
4) A
5) D
6) T
7) F

Application Questions

Don probably has a faulty bicuspid valve. When an AV valve fails to close properly, blood flowing back into the atrium produces a murmur. A murmur at the beginning of systole implicates the AV valve because this is the period when the valve has just closed and the blood in the ventricle is under increasing pressure; if the bicuspid valve fails to close completely, it is possible that the blood will backflow into the left atrium. Additionally, a sound heard at the end of systole or the beginning of diastole would implicate a faulty aortic semilunar valve.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

Scotch tape or Sellotape (UK)
Old water/soda bottle with lid
Scissors
Bowl or tub of water
Drill with 0.4in (1cm) bit (optional)

Welcome to the Lub Dub Club! or…

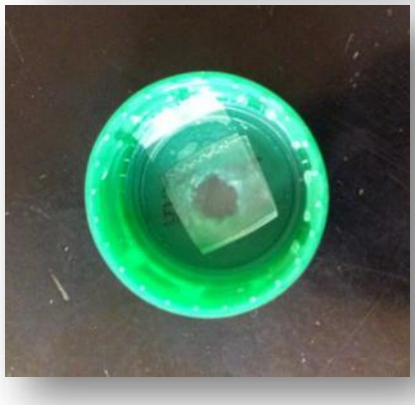
We don't skip a beat! (Sorry. That was terrible…)

Heart valves will be monitored through the construction of a heart chamber model.

Materials:

Scotch tape or Sellotape (UK)
Old water/soda bottle with lid
Scissors
Bowl or tub of water
Drill with 0.4in (1cm) bit (optional)

Procedure:



1) Make a hole within the lid of the bottle. Be careful while using the scissors or drill! After creating the hole, be certain to make the inner surface of the lid as smooth as possible.
2) Cut 1.2in (3cm) of tape and fold 1/3 of the sticky end back on itself. A 0.4in (1cm) area of sticky tape should remain.
3) Stick the tape inside the lid so that the non-sticky flap of tape covers the opening yet can still be opened much like a hinged door.
4) Make a hole in the side of the bottle, approximately 4in (~10cm) from the bottom.
5) Cut and fold another piece of tape such as in Step #2 and adhere it to the outside of

the bottle. The non-sticky flap of tape should cover the hole.

6) Turn the bottle upside down into a large bowl of water. Squeezing the bottle will allow water to pass through the "valve" in the cap. After several squeezes, the bottle should fill up with water and will be expelled through the second "valve" of the bottle.
7) Try not to aim your pump anywhere you want to prevent from becoming wet.

Explanation:

The two valves placed onto the bottles simulate the *atrioventricular and semilunar* valves found within the heart. Squeezing the bottle models "dance" you read about this week:

> *When the ventricles are relaxed and not pumping blood away from the heart, the atrioventricular valves are open and the semilunar valves are closed. To put it simply, a door opens and forces blood into the ventricles without any possibility of escape throughout the body as the exit door is closed.*

> *When the ventricles contract and begin forcing blood throughout the body, the atrioventricular valves close and the semilunar valves open. In this sequence, the door which allowed blood to rush into the ventricles is closed as its exit doors are opened. Once the semilunar valves open, blood is forced out of the heart through the arteries.*

Squeezing the bottle simulates the contraction of the cardiac muscle. The atrioventricular valve in the bottle cap closes while the semilunar valve at the top of the bottle opens, allowing fluid to pass through. When the bottle is released, the atrioventricular valve opens once again, allowing fluid to fill the bottle much like the ventricles of the heart. During this same time, the semilunar valve closes, preventing blood from escaping the heart.

Chapter 18

Cardiovascular System – Part II

Day One:

Today, your child should complete their reading and practice problems for the week.

Below are the supplies for this week's lab:

Stopwatch or clock with a second hand

Camera (optional)

National Science Education Standards covered this week:

12CLS5.6 As matter and energy flows through different levels of organization of living systems — cells, organs, organisms, communities — and between living systems and the physical environment, chemical elements are recombined in different ways.

Definitions

aorta	large artery which carries all of the blood out of the left ventricle
arterioles	branches of arteries whose diameters are smaller than that of the aorta
blood pressure	a measured force of the blood pushing against the inner walls of the arteries near the heart
blood-brain barrier	layer of endothelial cells within the capillaries surrounding the brain and CNS which fit very tightly together, allowing only the smallest of materials to diffuse through the vessel walls (i.e. oxygen, carbon dioxide, etc.)
capillaries	the tiniest blood vessels in the human body
diastolic pressure	the minimum blood pressure achieved during each heartbeat
endothelial cells	innermost lining of cells within both arteries and veins; surrounded by layers of smooth muscle and connective tissue
inferior vena cava	a large vein that carries blood from the lower half of the body into the right atrium of the heart
pulmonary artery	large artery which carries blood from the right ventricle after it passes through the pulmonary semilunar valve
pulmonary veins	four veins which carry blood back into the left atrium of the heart, through the biscupid valve, and into the left ventricle
pulse	the rhythmical throbbing of arteries that can be felt through the skin
superior vena cava	delivers blood to the heart from the upper half of the body
systolic pressure	the maximum blood pressure achieved during each heartbeat
venules	vessels attached to both the capillaries and veins; the diameter and the wall thickness of these vessels increase in size from the capillaries and towards the veins

Sample questions to ask your child after completing the weekly reading.

Blood enters the heart through _____ and leaves the heart via _____.
Blood enters the heart through veins and leaves the heart via arteries.

What are the similarities and differences between arteries and veins?
Both have three tissue layers which make up an inner lining of cells (endothelial cells or endothelium), a middle layer made of smooth muscle, and an outer layer made of connective tissue. However, since the arteries are responsible for pumping blood out the heart, its walls are much thicker because of the increased pressure it must maintain.

How are larger particles prevented from entering the cells of the central nervous system?
The blood-brain barrier prevents large molecules such as fats and other foreign particles from passing through the vessel walls into the CNS. This is due to the tightly-fitted layers of endothelial cells within the capillaries surrounding these areas.

Describe how two different veins return deoxygenated blood into the right atrium of the heart.
The inferior vena cava is a large vein that carries blood from the lower half of the body into the heart. Its colleague is the superior vena cava which delivers blood to the heart from the upper half of the body. Both of these large veins deliver its oxygen-poor blood into the right atrium of the heart. Its flow is controlled by the opening and closing of the tricuspid valve before it reaches the right ventricle of the heart.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the lab activity and start collecting all of the necessary materials!

Answer Key for Practice Problems

Vocabulary Review

1) inferior vena cava
2) blood pressure
3) arterioles
4) superior vena cava
5) pulmonary veins
6) endothelial cells
7) aorta
8) pulmonary artery
9) blood-brain barrier
10) systolic
11) diastolic
12) pulse
13) capillaries
14) venules

Multiple Choice

1) E
2) B
3) A
4) E
5) B
6) C

Application Questions

Answer *a* is correct. The elevated heart rate is a negative-feedback mechanism that attempts to return blood pressure back to a normal value. In this case, the negative-feedback mechanism was inadequate to restore homeostasis, and medical intervention (a transfusion) was necessary.

Day Three: Lab Activity

Your child should have already read through this lab and has been reviewing all of this week's vocabulary words.

Collect your supplies for the lab:

Stopwatch or clock with a second hand
Camera (optional)

The Mysterious Shrinking Veins or…

Are they supposed to disappear like that?

The path of venous blood will be explored in these two activities.

Materials:

Stopwatch or clock with a second hand
Camera (optional)

Procedure:

Activity One:

1) Place two fingers side-by-side onto a vein on your opposite wrist. You will need a vein that is at least 2in (5cm) in length.
2) Slide the finger closest to your body along the vein and remove your finger. Keep the other finger pressed against the vein during this process.
3) Notice how the vein shrinks in size and becomes less visible.
4) Now release the other finger from the vein and witness your vein reappear.

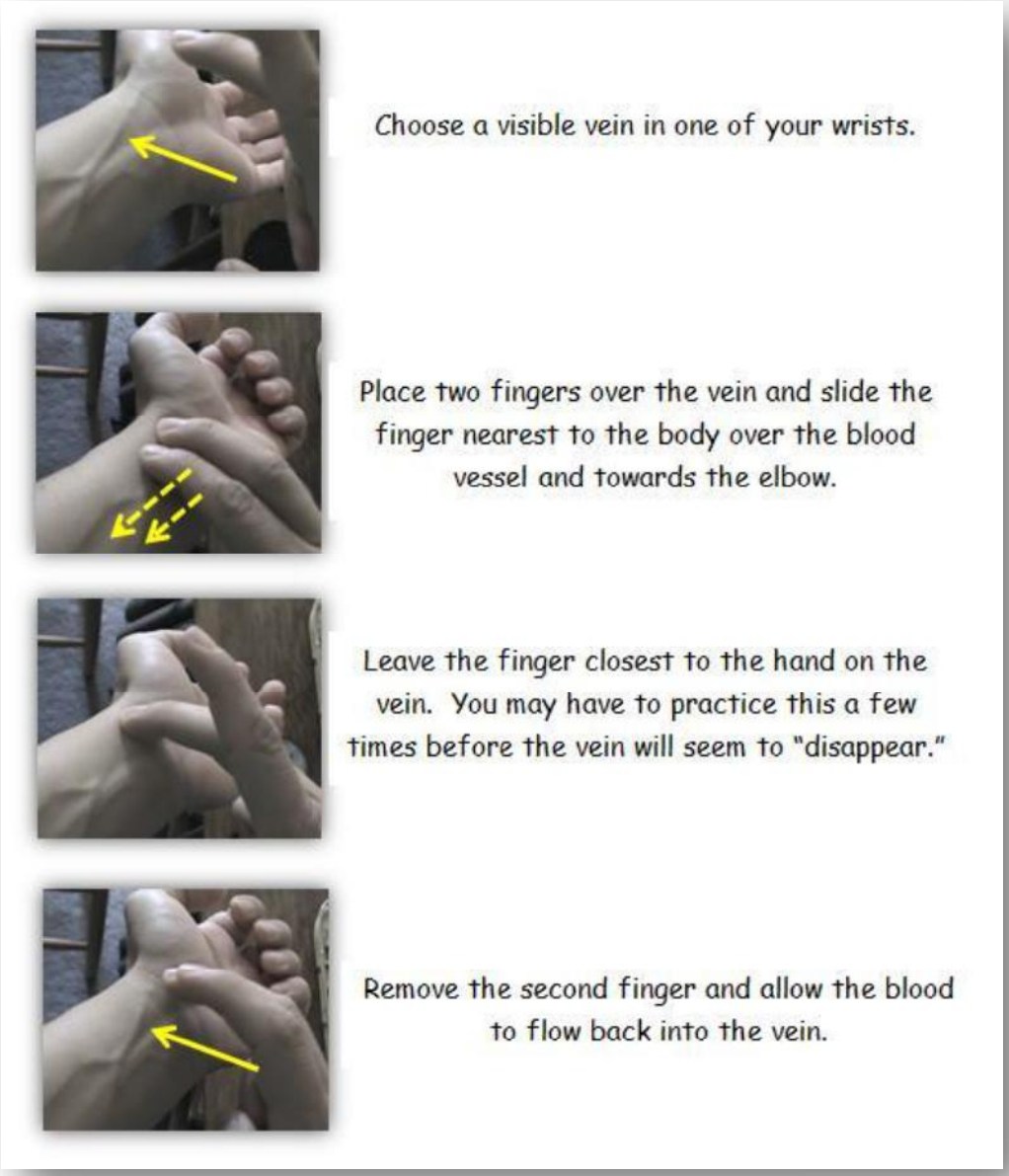
Activity Two:

1) Remove your shoes and socks and stand perfectly still for one minute.
2) Observe the size of the veins in your feet. This would be a good time to take a picture of the veins. The veins should appear to swell after standing for one minute.
3) Immediately take 8-10 quick steps in place and observe the same veins for one minute. Taking pictures every few seconds or a digital movie of these veins may help as well.
4) After taking a few steps, the veins should appear to have disappeared (collapsed); however, they should begin to swell again within the observation time.

Explanation:

Activity One:

The path of venous blood flows from the hands towards the heart, as you learned during your reading this week. The blood pressure within venules is so low that it cannot overcome the force of gravity. Therefore, muscular contraction is necessary to force the blood back towards the heart. In addition, venules contain a series of small valves which, much like the valves of the heart, help to drive all blood in a forward direction. The finger that remained pressed against your vein blocked the flow of blood downstream towards your heart. So, when your other finger slid along the vein itself it forced its blood through the tiny valves and out of that section of the vein. When you removed your stationary finger, you should have noticed that the vein becomes visible once again. This is due in large part to the muscular contractions within your hands which drive the blood back towards the heart and the minimal blood pressure which also helps to move venous blood as well.



Activity Two:

While you remain still, the veins in your feet fill with blood as the minimal amount of muscular contractions cannot help to drive your blood towards the heart. This is why your veins should appear larger than normal after standing still for one minute. The quick steps drive the blood from the veins by compressing the vessels much like squeezing toothpaste from a tube. At this point, the veins appear collapsed. However, as you remain still for another minute, blood begins to accumulate once again into your veins as they "reappear".

Unit Quiz (Weeks 17-18)

Choose the correct answer in the following questions:

1) **Which one of the following blood vessels carries oxygen-rich blood:**
   a) inferior vena cava
   b) pulmonary vein
   c) pulmonary artery
   d) coronary sinus
   e) superior vena cava

2) **The superior vena cava empties:**
   a) oxygen-rich blood into the left atrium
   b) oxygen-poor blood into the right ventricle
   c) oxygen-poor blood into the left atrium
   d) oxygen-poor blood into the right atrium
   e) oxygen-rich blood into the left ventricle

3) **True or False:** Veins draining the head and arms empty into the inferior vena cava.

4) **True or False:** Arteries always carry blood away from the heart.

5) **True or False:** Diastolic blood pressure is the pressure in the arteries when blood is being forced out of the heart.

6) **True or False:** The pulmonary arteries carry deoxygenated blood to the lungs.

7) Explain why the walls of the ventricles are thicker than the walls of the atria.

8) Jack spent 10 minutes sharpening his favorite knife before carving the roast. Unfortunately, he sliced his finger along with the roast. His wife slapped a towel over the spurting cut and drove him to the emergency room. What type of blood vessel did Peter likely cut, and how do you know?

Unit Quiz Answer Key

1) b
2) d
3) F
4) T
5) F
6) T

7) The walls of the ventricles are thicker than the walls of the atria because the ventricles must produce a greater pressure to pump blood into the arteries. To be more precise, the wall of the left ventricle is thicker than the wall of the right ventricle because the left ventricle produces a much greater pressure to force blood through the aorta than the right ventricle produces to move blood through the pulmonary arteries.

8) Jack likely cut an artery. Blood flows from arteries in rapid spurts due to the high pressure generated by contraction of the ventricles.