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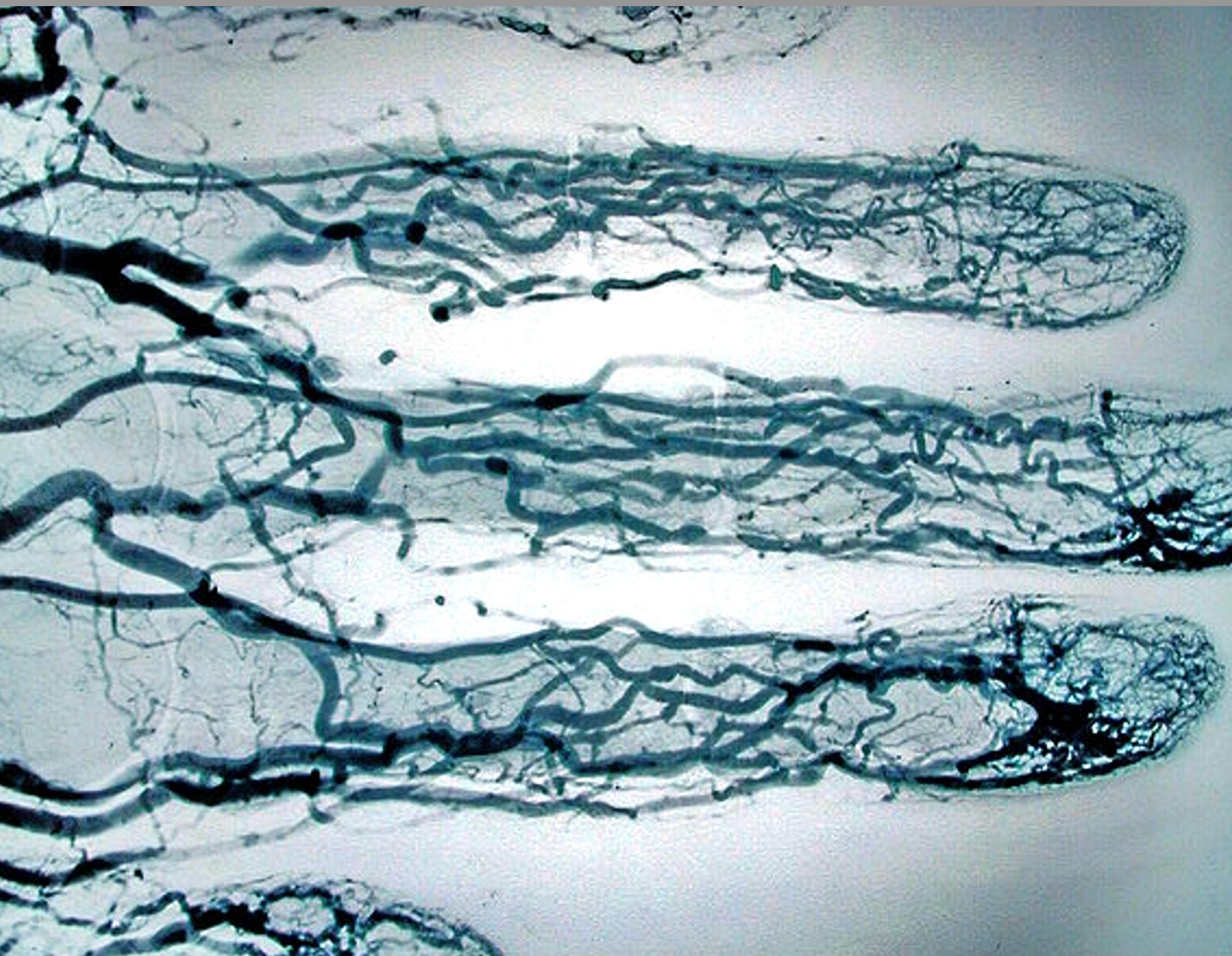
Human Biology - Circulation

Teacher's Guide



Human Biology Circulation Teacher's Guide

The Program in Human Biology,
Stanford University, (HumBio)

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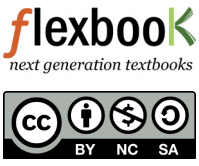

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CHAPTER 1 Introduction to Circulation - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

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1.2 ACKNOWLEDGMENTS
1.3 PREFACE
1.4 LETTER TO THE TEACHER
1.5 UNIT PLANNING

1.1 Overview

Human Biology: An inquiry-based guide for the middle school student.

Developed by the Program in Human Biology at Stanford University and

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Dedication

The faculty, staff, and teachers of Stanford University's Human Biology Middle Grades Life Science Curriculum Project dedicate the publication of the HumBio Curriculum in memory of our colleagues and friends, Mrs. Donna Harrison and Dr. Mary Budd Rowe. Donna was the lead science teacher at Dozier Middle School, the project test site school in Newport News, Virginia. She was an outstanding teacher, a community leader, a devoted wife and mother, and a wonderful human being. Her involvement in the HumBio Project enriched the curriculum materials and brought great joy to our lives. Although her life ended suddenly and tragically, the inspiration she gave to all who knew her will live on in what we do to improve the education of children and youth. Mary Budd Rowe was our most distinguished science education colleague and our dear friend. She guided the early organizational stages of the project as a group of university scientists attempted to address issues of middle level science education. Her unbridled enthusiasm for the education of children always reminded us of the important purpose of our work. Mary continued her unwavering support of the HumBio curriculum until her passing in June of 1996.

1.3 Preface

Stanford University's Middle Grades Life Science Project began in 1986 with the vision of David A. Hamburg, M.D., then President of Carnegie Corporation of New York. A new wave of science education reform was gathering momentum following the release of *A Nation at Risk* by the United States Department of Education and *Educating Americans for the Twenty-First Century* by the National Science Board. Dr. Hamburg brought together the concerns of scientists and science educators over the watered down, vocabulary-laden life science curricula that were typical of middle level science courses at that time with broader public concern over large and increasing numbers of adolescents who engaged in high-risk behaviors leading to school failure, teen pregnancy, and other health problems. Because of his leadership in developing Stanford's undergraduate Program in Human Biology and his interests as a physician and scientist in the major physiological and behavioral transitions in the lives of children, Dr. Hamburg believed that a rigorous middle grades life science curriculum focused on human biology, and where possible on the adolescent, not only would greatly improve the science taught at this level, but through its relevance would capture the interest of this age group.

Initial work on the Human Biology (HumBio) Middle Grades Life Science Curriculum brought together faculty, staff, and students from Stanford's Program in Human Biology and its School of Education with local middle and high school teachers. The curriculum development team was enriched in 1991 by twelve interdisciplinary teams of middle level teachers from diverse test site schools across the country. These teams became our most valued collaborators. The teachers attended annual two week summer institutes at Stanford between 1991 and 1994 and used the draft curriculum units in their classes between 1991 and 1995. The teachers and their students provided extensive formative evaluation data on the field-test materials, which has shaped the final student and teacher versions of the units that comprise the HumBio Curriculum. Using HumBio units as a starting point, many teams also created their own innovative, interdisciplinary materials, which they taught across the middle level curricula in their schools.

The Project's Advisory Board provided insightful advice on the development of the curriculum from the unique perspectives of the professional associations, the institutions, and the fields its members represented. We are grateful to all of those who served for periods of time during the past seven years. We also would like to express our appreciation to the education consultants from universities, the National Middle School Association, and the California State Department of Education who made presentations and worked with the teacher teams during the summer institutes at Stanford. C. Stuart Brewster served with great distinction as our advisor on publication. We are indebted to him for his keen insights and good advice.

The Project faculty, the staff, and the teachers contributed more to the development of the HumBio Curriculum than anyone could have imagined before this work began. Their expertise, determination, and dedication to improving the education of young adolescents were inspirational. Supporting the curriculum development team and the test-site teachers were wonderful groups of Stanford undergraduates from the Program in Human Biology. They helped to ensure a productive and pleasurable working environment, which was an essential part of the success of the summer institutes.

To be sure, none of this work would have been possible without funding from Carnegie Corporation of New York, the National Science Foundation, and most recently The David and Lucile Packard Foundation. On behalf of the entire Project team we would like to thank these foundations and the Program Officers who have worked with us over the years for their support. As always, the final content of this curriculum is the sole responsibility of the Stanford University Middle Grades Life Science Project and does not necessarily reflect the views of Carnegie Corporation of New York, the National Science Foundation, or The David and Lucile Packard Foundation.

H. Craig Heller, *Principal Investigator*

Mary L. Kiely, *Project Director*

January, 1998. Stanford, California

1.4 Letter to the Teacher

Dear Teacher:

Welcome to *Circulation.* This unit was the first one developed for the Human Biology Curriculum. As we experimented with different approaches, formats, and styles, this unit changed many times. It has also been the subject of many demonstrations at meetings of professional educators such as the National Middle School Association and the National Science Teacher Association, and it has been field tested more than any other unit in the curriculum. For us this unit is an old favorite.

Circulation is an excellent example of what we are trying to achieve in the Human Biology Curriculum. Student interest is stimulated because the science content is relevant to them. They can all relate to their hearts, and many have been touched directly or indirectly by someone suffering from and even dying from a heart attack. Because this material captures their interest, we can achieve a much higher level of science coverage than is normally achieved in a middle grades life science course-and students do not find it difficult! Most importantly, the material is interdisciplinary and provides opportunities for team teaching. Mathematics is involved in calculating blood volumes, blood flow rates, heart rates, and diameter/resistance calculations. Physical sciences are touched upon through considerations of pressure, resistance, flow relationships. Health is obviously a major focus with material on diet, smoking, exercise, heart disease prevention, and CPR. You can teach this unit alone, or you can join with your colleagues in creating a team. At one school teachers formed a team and then combined this unit with the ones on breathing and digestion/nutrition to create an overall theme of physical fitness. This was a huge success with the students.

As with every unit, I must emphasize the importance and the value of the activities. Learning by doing is the most effective form of education. This year I used one of the activities-the Amazing Pump–as a demonstration in my undergraduate physiology class at Stanford. That was the one aspect of the class that got the most frequent and positive comments on the students' course review survey. Just a discussion of pressure, vessel compliance, and flow would not have received even passing mention. The activities for this unit are very diverse and rich. A favorite one with students is the making of a stethoscope and recording measurements of their heart rates. Dissecting a cow heart is also a hit. There are many opportunities in this unit to have a great deal of fun in the course of learning about the heart and circulation.

I hardly need mention that this unit may do more to promote the health of your students than any other activity they might be engaged with. You might think it morbid to point out that one-third of them will eventually die of heart failure. Students at this age have a great sense of invulnerability, but that fact might have an impact. Most students get very involved in the discussions of heart disease prevention stimulated by the unit.

Please let us know about your experience with this *Circulation* unit.

Best Wishes,

H. Craig Heller

Chair, Department of Biological Sciences, Stanford University

1.5 Unit Planning

Content Overview

Circulation: What is it? Why is it important?

In this activity driven unit, students explore these questions to understand their own cardiovascular systems, how they work, and how to keep them functioning effectively. Students make models of the heart and vessels, examine a mammalian heart, and listen to their own heartbeats to gain background for understanding basic structures of the cardiovascular system. They complete investigations of diffusion to connect the movement of molecules, with the passage of oxygen and nutrients out of capillary beds into the cells, and the passage of wastes and carbon dioxide from cells into the capillaries. By investigating how the body's control system regulates pressure and resistance in the vessels, students are introduced to negative feedback systems and their importance in regulating the cardiovascular system. With this background, students approach the concept of homeostasis, the internal body balance maintained by the circulatory system in the face of changing environmental conditions, and investigates how a healthy circulatory system maintains this balance. Students study risk factors for cardiovascular disease, based on their expanded knowledge of the circulatory system, and consider the evidence from the perspective of making good decisions about cardiovascular health and fitness.

Because the key ideas of the unit build in a spiral manner, it is advisable to complete sections 1-7 in sequence.

How is the unit structured?

Section 1 presents an overview of the circulatory system and an in-depth study of blood and its components.

Section 2 explores the heart's structure and how it functions.

Sections 3, 4, and 5 cover the blood vessels-arteries and arterioles, capillaries, and veins and venules.

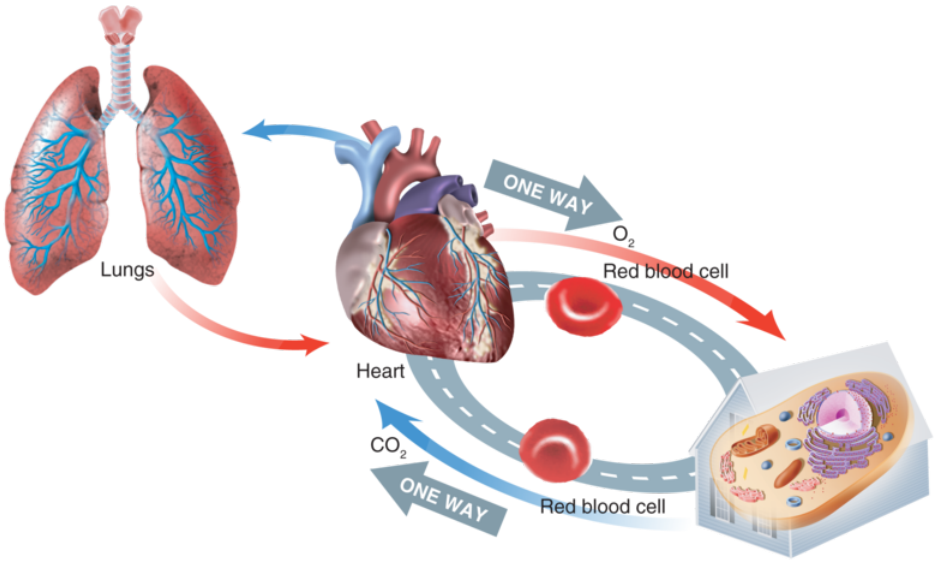
Section 6 goes on to discuss pressure, flow and resistance in those blood vessels.

Section 7 covers cardiovascular health and the risk factors which affect it.

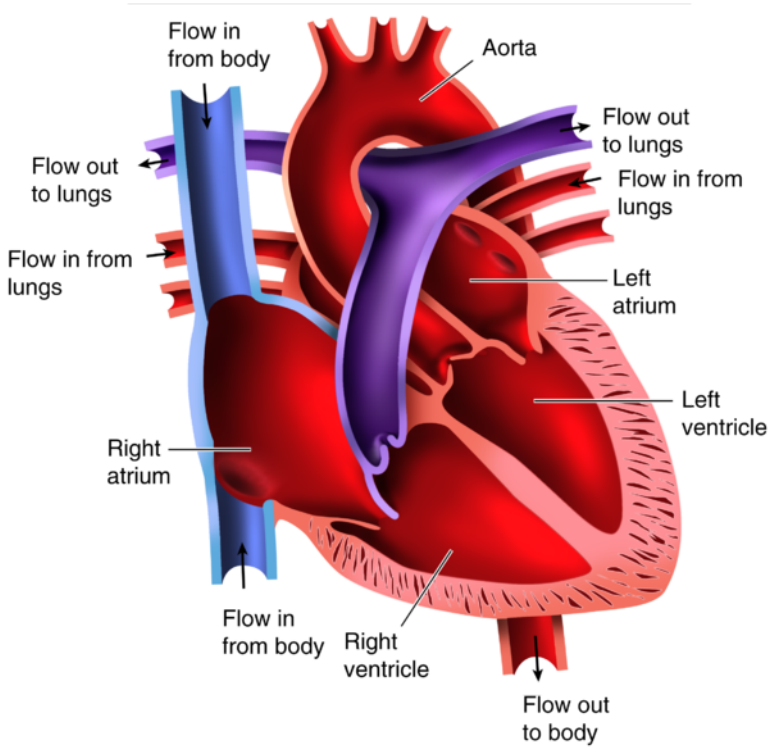
Why teach this unit? Connections to the Real World

According to the American Heart Association approximately $954,000$ people die each year from cardiovascular disease. America spent an estimated $158.5 billion dollars on cardiovascular related health problems in 1997. Approximately, $57,490,000$ people in the US have one or more forms of cardiovascular disease. (Statistics obtained from the American Heart Association).

How is the unit structured?



PE Figure 1.1 Your circulatory system is like the streets of a city with lots of traffic flowing through the streets to and from different destinations.



PE Figure 2.20 The heart's two pumps work together side by side. Can you trace the flow of blood through the heart?

Rarely can you make it through the day without hearing the words "low-fat," "healthy," and "exercise." Why? Because so much is known about cardiovascular health that our lives are filled with advice on how to keep our hearts healthy. An approach to teaching adolescents to make good decisions about their health is for them to explain the structure and function of their cardiovascular system. The more they know about how their bodies work, the better able they will be to make wise decisions that will lead to a healthy lifestyle.

A big part of choosing a healthy lifestyle involves the assessment and assumption of risk factors. This unit introduces the concept of risk. However, the discussion of risk could-and should-extend beyond food, exercise and the cardiovascular system. Many adolescents feel invulnerable-full of energy but lacking the experience of disease and death. At some point, a few will lose a friend or relative to disease or violence, and their understanding will grow. Risk is an inherent part of every youth's life. This unit provides a good opportunity to help them make decisions that could affect their lives for the long term.

This unit also stresses that cardiovascular health and fitness extend beyond personal choices to important public policy issues. The following summary questions provide a context for discussing cardiovascular health in a broader context:

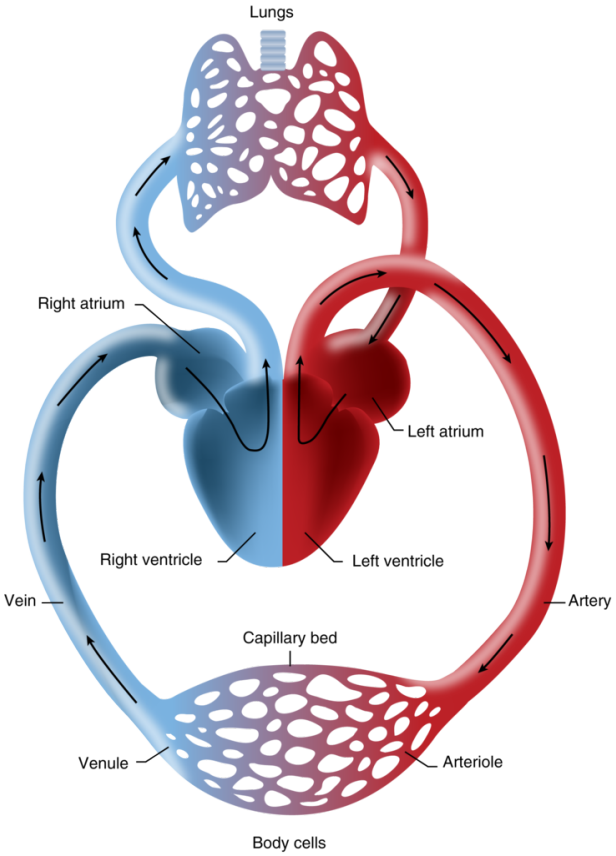
Summary Questions to Consider throughout the Unit

Why don't more people donate blood or, in the event of premature death, healthy vital organs?

Should all packages of food contain information about possible health effects? For example, should a package of hamburger have a label warning consumers about the effects of eating fatty foods and red meat?

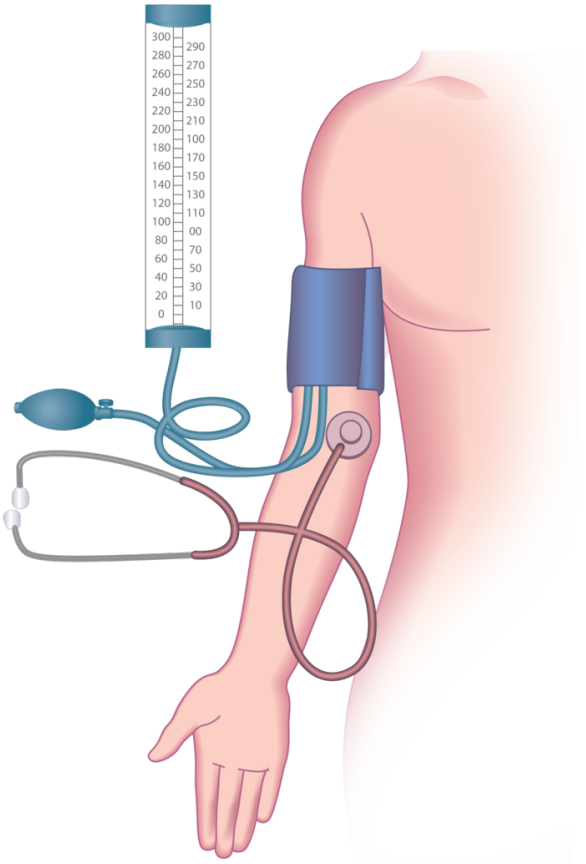
Is risk the same for everyone? How does risk vary from situation to situation?

Section 3: Arteries and Arterioles Section 4: Capillaries Section 5: Veins and Venules



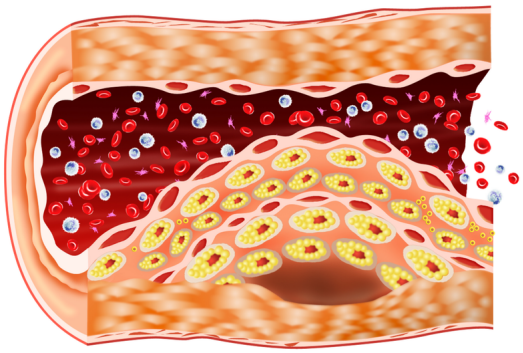
PE Figure 5.1: The veins form a network of vessels that return blood to the heart.

Section 6: Pressure, Flow, and Resistance



PE Figure 6.8: This drawing shows how the cuff and stethoscope should be positioned to read the blood pressure.

Section 7: Cardiovascular Health



PE Figure 7.1: When arteries that feed the heart get narrow, the heart muscle doesn't get enough oxygen.

TABLE 1.1: Unit Activities and Key Ideas

Section	Key Ideas	Activity
1. Circulation Why is blood important to life?	• Complex animals like humans depend on the blood to transport food, water, oxygen, carbon dioxide and wastes to and from the body cells. • Blood is made up of cells and plasma and blood diseases compromise the efficiency of the blood delivery system. • The lymphatic system is a network of vessels and lymph nodes that function to recycle fluids which leak out of blood vessels back to the circulatory system.	**Activity 1-1:** Pathway of Blood through Your Body **Activity 1-2:** Composition of Blood **Mini Activity:** Blood Impressions **Mini Activity:** Artificial Blood
2. The Heart How does the heart pump blood?	• The heart is divided into four chambers: two "pumps" with two chambers each. One pump sends blood to the lungs for oxygen and back to the heart, the other sends the oxygenated blood throughout the body. • The cardiac (heart) cycle is made up of a squeeze cycle and fill cycle: squeeze-fill; squeeze-fill; or systole-diastole, systole-diastole. • The pacemaker is a specialized region of the heart which in combination with the nervous system and the endocrine system help to maintain homeostasis.	**Mini Activity:** Is Pumping Hard Work? **Activity 2-1:** Exploring the Heart **Mini Activity:** Heartbeats **Mini Activity:** Word Origins **Activity 2-2:** Siphon Pump **Mini Activity:** What's Your Cardiac Output Today? **Enrichment 2-1:** What Makes the Heart Beat Faster?

TABLE 1.1: (continued)

Section	Key Ideas	Activity
3. Arteries and Arterioles How does blood get from the heart to all parts of the body?	• Arteries are thick, muscular vessels which carry blood away from the heart. Because arteries are elastic they expand during systole and their contraction during diastole propels the blood through the body. • Arterioles are the smallest arteries, and have rings of muscle around them to serve as valves. By relaxing or contracting they control blood flow into the capillaries, and they control blood pressure in the arteries. • Arteries and arterioles help maintain blood flow by maintaining blood pressure.	**Mini Activity:** Taking Your Pulse **Activity 3-1:** Blocked Arteries
4. Capillaries How do oxygen and nutrients get from blood to cells?	• Capillaries are thin and permeable blood vessels that allow for the exchange of nutrients, gases and waste. • This exchange of nutrients, gases and waste occurs through the process of diffusion. • The capillary network is extensive; no cell is more than 2 cells away from a capillary.	**Activity 4-1:** Making a Capillary Bed Model **Mini Activity:** Transport of Nutrients: Exploring Diffusion **Enrichment 4-1:** Observing Goldfish Capillaries **Enrichment 4-2:** Transport of Materials Exploring Diffusion

TABLE 1.1: (continued)

Section	Key Ideas	Activity
5. Veins and Venules How does blood get back to the heart?	• Veins and venules are the counterparts of arteries and arterioles. They carry blood away from the capillaries Veins back to the heart. • The walls of veins are thinner than those of arteries and can expand and collapse according to how much blood is in them. • The pressure in veins is lower than the pressure in capillaries, so blood flows in one direction; from capillaries to venules to veins. Valves and the action of muscles help carry blood back one way to the heart.	**Mini Activity:** Observing Veins **Mini Activity:** Percentages of Blood **Activity 5-1:** The Direction of Blood Flow
6. Pressure, Flow, and Resistance How is the right amount of blood directed to each part of the body?	• Blood pressure is an important indicator of how hard the heart is working to circulate blood through the body. High blood pressure can indicate a health problem. • Friction builds up resistance in blood vessels contributing to an elevation of blood pressure. • The endocrine and the nervous systems provide feedback that regulates basic functions such as breathing, heart rate and blood pressure.	**Activity 6-1:** Pressure, Resistance, and Flow **Mini Activity:** The You in You **Mini Activity:** Cold Toes **Activity 6-2:** How a Controller Works **Enrichment 6-1:** Your Blood Pressure

TABLE 1.1: (continued)

Section	Key Ideas	Activity
7. Cardiovascular Health How can I keep my heart strong and my arteries clean and clear?	• Cardiovascular disease is the leading cause of death in this country. • Cardiovascular risk factors can be genetic and/or environmental. • Making healthy choices can reduce the risk of getting cardiovascular disease.	**Mini Activity:** Your Target Heart-Rate Zone **Activity 7-1:** Pulse Rate **Mini Activity:** Sources of Stress **Mini Activity:** Risk profile **Enrichment 7-1:** Cardiovascular Disease Risk Scoring

Teacher's Guide Overview

This *Circulation* unit is built around a variety of student activities. Text material can be used to introduce, reinforce, and extend the concepts developed in the activities. The activities are the foundation of this unit, so the unit's success depends on students' involvement in the activities. Embedded activities are interrelated, since the concepts developed in one may be applied in another.

Section Planning

For each section, you'll find extensive advance planning for the student activities and the section topic. Key ideas, section objectives, background information, suggestions for introducing activities, and the materials needed for each activity are listed on the Section Planning page. Review this information ahead of time to ensure that materials for each activity are available when you need them.

Support for Embedded Activities

Embedded activities are those activities contained or "embedded" in the student edition. Procedures for each embedded activity are contained in the student edition. In the Teacher's Guide, you'll find activity planning information, activity assessment, and student reproducible pages for each embedded activity.

Enrichment Activities

Enrichment activities are activities found in the Teacher's Guide. These activities are designed to extend and enrich students' learning experiences. Complete Enrichment activities, including Teacher Activity Notes and the student procedures and reproducible pages, are located at the end of each appropriate section of the Teacher's Guide.

Group Work Activities

Learning science is a process that is both individual and social. Students in science classrooms often need to interact with their peers to develop a knowledge of scientific concepts and ideas, just as researchers, engineers, mathematicians, and physicians who are working in teams do to answer questions and to solve problems. The Group Work activities of the HumBio Curriculum for Middle Grades have been developed to foster a collaborative environment for groups of students. Students plan experiments, collect and review data, ask questions and offer solutions, use data to explain and justify their arguments, discuss ideas and negotiate conflicting interpretations , summarize and present findings, and explore the societal implications of the scientific enterprise. In short, Group Work activities provide an environment in which students are "doing science" as a team.

Projects

The research and action projects in HumBio are varied and provide students with time to explore a particular topic in

depth. With Projects, students have the opportunity to take a position based on knowledge gained through research, debate an issue, and devise a plan of action. In this way, students can apply what they are learning to larger issues in the world around them.

Projects for this unit include

- Research Questions and Action Projects
- Be Heart Smart
- A Cafeteria Case Study
- Tasty Tidbits
- Past vs. Present

Assessment Overview

Within each section of the unit there are suggestions for assessment that can be used individually or in combination to develop a complete assessment package. The list below describes the variety of assessment tools provided.

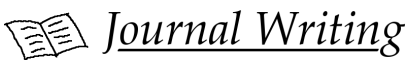
Apply Your Knowledge Questions appear throughout each section. They can be used as homework assignments and as ways to initiate a class discussion. These Questions are designed to assess

- communication skills
- depth of thought and preparation
- problem-solving skills
- ability to apply concepts to related or big ideas
- how well students relate their new knowledge to different problems

What Do You Think?

These Questions appear in each section. They provide students with opportunities to think and write about the concepts they are learning in a larger context. You can use these Questions to assess

- writing skills
- problem-solving abilities
- creativity and depth of thought
- the ability to analyze and summarize



Journal Writing prompts are suggested throughout the unit. These prompts provide opportunities for students to write critically and creatively about concepts and issues. The writing products can be used to assess

- writing skills
- depth of thought
- and the ability to explain and expand concepts

Review Questions

Review Questions are located at the end of each section. These Questions can be used for written responses or as the basis for class discussion. These Questions are designed to assess content knowledge and whether students can explain the concepts explored in the section.

Activity-Based Assessment

Inquiry-based student-centered activities are the foundation of the *Human Biology* Program. The unit is rich with relevant exciting activities that introduce, support, or reinforce concepts students are exploring. Within the Teacher's Guide, you'll find extensive teacher Information, including assessment strategies, for each type of activity:

- Embedded Activities
- Enrichment Activities
- MiniActivities
- GroupWork
- Projects

You can use students' products to assess their progress. These products include models, simultaneous, observations and reports of laboratory investigations, role plays, written responses to questions and written observations, student-designed explorations and procedures, poster presentations and classroom presentations.

PORTFOLIO ASSESSMENT

You may want to have your students develop a portfolio for the unit. A sample assessment portfolio for the unit might contain the following items:

- Written responses to three *What Do You Think*? questions
- An analysis of their two favorite Activities and how those activities helped then understand an important concept
- Two examples of written reports from library research from

  Mini Activity: Cold Toes Mini Activity: Artificial Blood

- An Activity Report from three investigations such as

  Activities 2-1, 2-2, 4-1, 5-1

- An analysis or interpretation of graphs from Activity 3-1
- Example of constructing a model from

  Activity 4-1: Making a Capillary Bed Model

- One example of an artistic creation from

  Mini Activity: Blood Impressions

Getting Started

The *Human Biology Circulation* unit emphasizes learning about the structure and function of the circulatory system and how to apply this knowledge to making good decisions about overall cardiovascular fitness.

As with all *Human Biology* units, the *Circulation* unit is built around inquiry. For each activity, teacher information is included on the section planning page and the activity page.

Plan the Unit to Fit Class Needs. For each activity, helpful hints, strategies and the materials needed are listed in the Teacher's Guide. Checking this information ahead of time will ensure that the materials will be available

when needed. Teacher information for each activity is included in the Plan for each Section under the heading Advance Preparation. The important activity information is also listed in the Activity Planning page under the heading Advance Preparation.

Be aware of any special health problems your students may have which would make it uncomfortable for them to participate in certain activities such as taking measurements of pulse, blood pressure, and heart rates. Examples of such health problems include congenital or accidental cardiovascular conditions. For students unable to participate fully in these activities, you may wish to create an alternative assignment or to have them use data from another group. If the class is prepared appropriately, the affected students may want to share their special circumstances with the class to enhance the appreciation and understanding of all students.

Connect with Other Disciplines. The *Circulation* unit is particularly well suited for interdisciplinary use in combination with the units on Breathing and Digestion and Nutrition.

Although many schools include this unit through health or science classes, the interdisciplinary web provided shows you ways to expand the teaching of this material into other subject areas to reinforce learning for students. For interdisciplinary planning set meetings with your team early. The suggested interdisciplinary breakdown below provides some ideas for connections among subject areas. You are encouraged to tap the talents and interests of your team members as well as of your unique school and community resources in developing other suitable activities for this unit. Your school library/multimedia resource center and the science department at the high school may also be able to provide references that can be very helpful in teaching this unit.

As previously mentioned, continued emphasis upon healthy decision making leading to improved cardiovascular health involves all body systems affected by the circulatory system. Therefore, this unit is ideal for combining with the Human Biology units on Breathing and Digestion and Nutrition. The *Circulation* unit also links well with the Human Biology unit on the Nervous System because of the nervous system's role in controlling and coordinating homeostasis in the body.

Connections to other Human Biology units include Genetics with respect to hereditary predisposition to cardiovascular disease.

Use Current Events. Current events can be an important part of the circulation unit. Students can use current events to make group scrapbooks, bulletin boards, posters, or to give class presentations. Some examples of current event topics include articles explaining guidelines for healthy eating and exercise programs, medical advances in treating blocked arteries and heart disease, and information about new medications helpful in controlling high blood pressure.

Make Career Connections. Encourage student investigation of careers related to cardiovascular health such as in research, industrial production of medications, public education, and in health professions. Examples of health professions include a cardiologist, a surgical nurse specializing in cardiology, and a paramedic.

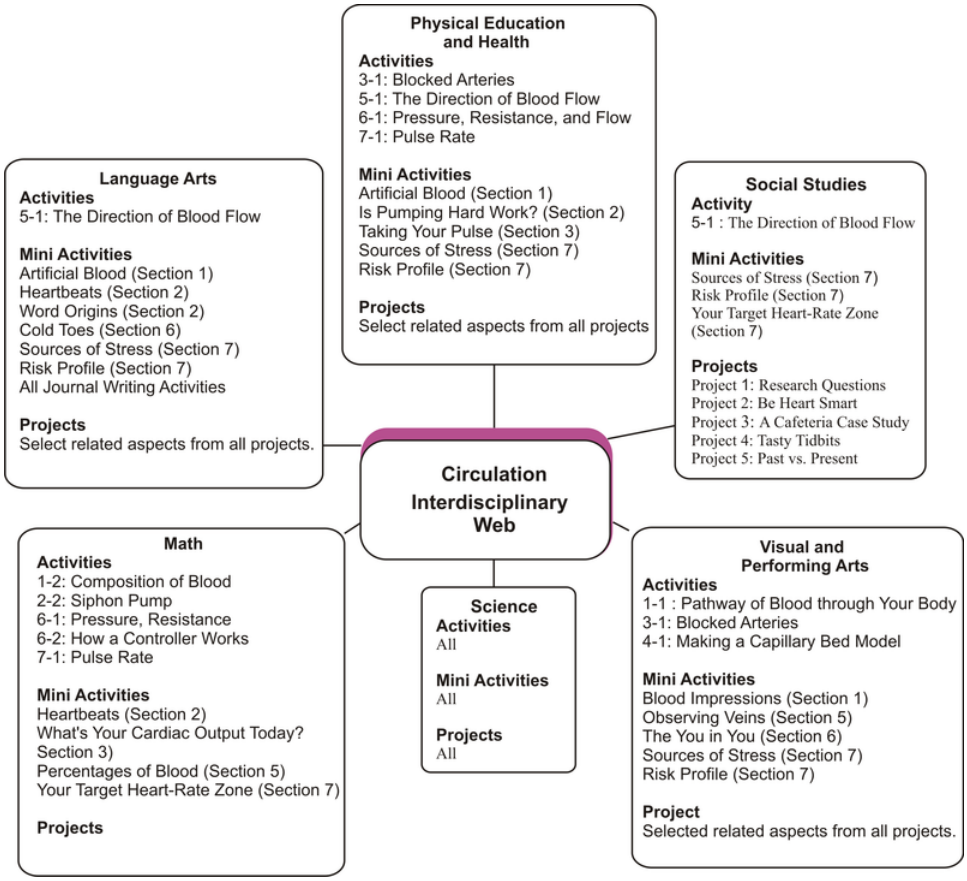
Use a Variety of Resources. For the duration of the unit, we encourage you and your students to use a wide variety of resources. The activities provide rich opportunities for students to explore many concepts, and the more they incorporate information from sources outside the classroom, the richer their experiences will be. Use your own creativity and the student activities in this unit to develop a series of lessons tailored to the needs of your students. Engage students through activities to help them learn about the function, and importance of the circulatory system. Use computer services for student and teacher information, networking (student pen pals, other schools, other teachers, other communities), and connecting with experts in the field.

Plan for Field Trips. Field trips to local hospitals, industrial sites, or universities need to be arranged in advance. Contact the public affairs offices of these institutions for assistance.

Possible guest speakers include specialists from the careers mentioned above.

If you select a guest speaker with a cardiovascular condition to address that condition, be sure to prepare your students appropriately so they will be sensitive and compassionate listeners. Prepare speakers by sharing with them the knowledge base of students.

Connect with the Home. Because lifestyle changes for improving cardiovascular health may involve changes in family eating and exercise patterns, students should be encouraged to take Apply Your Knowledge questions and Mini Activities home for further exploration. As a class, or as individuals, the new questions raised can become a part of ongoing research for everyone.



Teaching Timelines

You can use these timelines as a place to start in designing your own timelines, or you can use them as they are laid out. If you're planning your own timeline, consider the inclusion of the Embedded activities first. The "Embedded activities" are included in the student edition. The Enrichment activities, Group Work activities, and Projects can then be included, depending on your time restrictions. The timelines are guides that can vary if some activities are done at home or in other classes in addition to science class.

Given your time constraints, it may not be possible to do all the activities on these timelines. If you need to remove activities, be careful not to remove any activities critical to sequential student understanding of the unit. You may want to divide the activities among interdisciplinary members of your teaching team.

Page references in these charts refer to the student edition, except when Enrichments are suggested. The page references for Enrichments refer to this Teacher's Guide.

TABLE 1.2: Option 1: Three Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Introduce Unit Introduce Section 1 **Activity 1-1:** Pathway of Blood Through Your Body	Conclude Activity 1-1 **Activity 2-1:** Composition of Blood Assign **Mini Activities:** Blood Impressions Artificial Blood	Introduce Section 2 **Activity 1-2:** Exploring the Heart	Continue **Activity 2-1:** Exploring the Heart	**Activity 2-2:** Siphon Pump
Week 2	**Mini-Activities:** Heart beats Word Origins What's Your Cardiac Output Today?	**Activity 3-1:** Blocked Arteries Review Sections 1, 2, 3	Introduce Section 4 Teaching Strategies **Enrichment 4-1:** Observing Goldfish Capillaries	**Enrichment 4-2:** Transport of Materials Exploring diffusion	Introduce Section 5. **Activity 5-1:** The Direction of Blood Flow
Week 3	Review Sections 3, 4, 5 Introduce Section 6. **Activity 6-1:** Pressure, Resistance and Flow	**Enrichment 6-1:** Your Blood Pressure	**Activity 6-2:** How a Controller Works	Introduce Section 7 **Activity 7-1:** Pulse Rate Assign **Mini Activities:** Your Target Heart Rate Zone Risk Profile	Unit Review and Assessment

TABLE 1.3: Option 2: Five Week Timeline

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Introduce Unit Introduce Section 1 **Activity 1-1:** Pathway of Blood Through Your Body	Conclude Activity 1-1 **Activity 1-2:** Composition of Blood	Conclude Activity 1-2 Assign **Mini Activities:** Blood Impressions Artificial Blood	Introduce Section 2 Introduce **Activity 2-1:** Exploring the Heart Optional **Mini Activity:** Is Pumping Hard Work?	**Activity 2-1:** Exploring the Heart
Week 2	Optional **Mini Activity:** Heartbeats Assign **Mini Activity:** Word Origins **Activity 2-2:** Siphon Pump	Optional **Mini Activity:** What's Your Cardiac Output Today? **Enrichment 2-1:** What Makes the Heart Beat Faster?	Introduce Section 3 **Mini Activity:** Taking Your Pulse	**Activity 3-1:** Blocked Arteries Review Sections 1, 2, 3	Introduce Section 4

TABLE 1.3: (continued)

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 3	**Enrichment 4-1:** Observing Goldfish Capillaries	**Enrichment 4-2:** Transport of Material Exploring Diffusion	Introduce Section 5. **Activity 5-1:** The Direction of Blood Flow	**Mini Activities:** Observing Veins Percentages of Blood	Introduce Section 6 **Activity 6-1:** Pressure, Resistance, and Flow
Week 4	**Mini Activities:** The You in You Cold Toes	**Activity 6-2:** How a Controller Works	**Enrichment 6-1:** Your Blood Pressure Review Sections 4,5, 6 Including the Key Ideas	Introduce Section 7 **Mini Activities:** Your Target Heart Rate Zone Sources of Stress	**Activity 7-1:** Pulse Rate
Week 5	**Mini Activity:** Risk Profile	**Enrichment 7-1:** Cardiovascular Disease Risk Scoring	Project Presentations, Culminating Activities Unit Reviews Including Unit Assessment	Project Presentations, Culminating Activities Unit Reviews Including Unit Assessment	Project Presentations, Culminating Activities Unit Reviews Including Unit Assessment

Safety for Teachers

- Always perform an experiment or demonstration on your own before allowing students to perform the activity. Look for possible hazards. Alert students to possible dangers. Safety instructions should be given each time an experiment is begun.
- Wear glasses and not contact lenses. Make sure you and your students wear safety goggles in the lab when performing any experiments.
- Do not tolerate horseplay or practical jokes of any kind.
- Do not allow students to perform any unauthorized experiments.
- Never use mouth suction in filling pipettes with chemical reagents.
- Never "force" glass tubing into rubber stoppers.
- Use equipment that is heat resistant.
- Set good safety examples when conducting demonstrations and experiments.
- Turn off all hot plates and open burners when they are not in use and when leaving the lab.
- When students are working with open flames, remind them to tie back long hair and to be aware of loose clothing in order to avoid contact with flames.
- Make sure you and your students know the location of and how to use fire extinguishers, eyewash fountains, safety showers, fire blankets, and first-aid kits.
- Students and student aides should be fully aware of potential hazards and know how to deal with accidents. Establish and educate students on first-aid procedures.
- Teach students the safety precautions regarding the use of electricity in everyday situations. Make sure students understand that the human body is a conductor of electricity. Never handle electrical equipment with wet hands or when standing in damp areas. Never overload electrical circuits. Use 3− prong service outlets.
- Make sure that electrical equipment is properly grounded. A ground-fault circuit breaker is desirable for all laboratory AC circuits. A master switch to cut off electricity to all stations is desirable for all laboratory AC circuits.

- Make sure you and your students are familiar with how to leave the lab safely in an emergency. Be sure you know a safe exit route in the event of a fire or an explosion.

For Student Safety

Safety in the Classroom

- Wear safety goggles in the lab when performing any experiments. Tie back long hair and tuck in loose clothing while performing experiments, especially when working near or with an open flame.
- Never eat or drink anything while working in the science classroom. Only lab manuals, notebooks, and writing instruments should be in the work area.
- Do not taste any chemicals for any reason, including identification.
- Carefully dispose of waste materials as instructed by your teacher. Wash your hands thoroughly.
- Do not use cracked, chipped, or deeply scratched glassware, and never handle broken glass with your bare hands.
- Lubricate glass tubing and thermometers with water or glycerin before inserting them into a rubber stopper. Do not apply force when inserting or removing a stopper from glassware while using a twisting motion.
- Allow hot glass to cool before touching it. Hot glass shows no visible signs of its temperature and can cause painful burns. Do not allow the open end of a heated test tube to be pointed toward another person.
- Do not use reflected sunlight for illuminating microscopes. Reflected sunlight can damage your eyes.
- Tell your teacher if you have any medical problems that may affect your safety in doing lab work. These problems may include allergies, asthma, sensitivity to certain chemicals, epilepsy, or any heart condition.
- Report all accidents and problems to your teacher immediately.

HANDLING DISSECTING INSTRUMENTS and PRESERVED SPECIMENS

- Preserved specimens showing signs of decay should not be used for lab observation or dissection. Alert your teacher to any problem with the specimen.
- Dissecting instruments, such as scissors and scalpels, are sharp. Use a cutting motion directed away from yourself and your lab partner.
- Be sure the specimen is pinned down firmly in a dissecting tray before starting a dissection.
- In most cases very little force is necessary for making incisions. Excess force can damage delicate, preserved tissues.
- Do not touch your eyes while handling preserved specimens. First wash your hands thoroughly with warm water and soap. Also wash your hands thoroughly with warm water and soap when you are finished with the dissection.

CHAPTER 2

Circulation - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

2.1 PLANNING

2.2 USING CIRCULATION – STUDENT EDITION (HUMAN BIOLOGY)

2.3 ACTIVITIES AND ANSWER KEYS

2.1 Planning

Key Ideas

- Complex animals, such as humans, depend on the blood to transport food, water, oxygen, carbon dioxide, and wastes to and from the body cells.
- Blood is made up of cells and plasma. Blood diseases compromise the efficiency of the blood delivery system.
- The lymphatic system is a network of vessels and lymph nodes. Its function is to recycle fluids that leak out of blood vessels back to the circulatory system.

Overview

In this section students make a model of the heart and circulatory system that serves as an introduction to the unit. The model can be used as a reference throughout the unit. The need of body cells for delivery of nutrients, water, and oxygen, and the removal of wastes and carbon dioxide is compared to a house in need of a delivery system, with necessities supplied and wastes removed by pipelines, cables, and trucks. This section also explores the ways in which an efficient blood delivery system can be compromised by diseases.

Objectives

Students:

✓ build a model of the heart showing the two pump pathway.

✓ explain the importance of blood circulation.

✓ create a model representing the composition of blood.

✓ describe some effects of blood diseases on homeostasis.

✓ give an example of how the lymphatic system works with the circulatory system to maintain homeostasis.

Vocabulary

anemia, antibodies, blood, blood platelets, bone marrow, circulatory system, edema, fibrinogen, gene, heart, hemoglobin, hemophilia, homeostasis, hormones, leukemia, lymph, lymph nodes, lymphatic system, mononucleosis, organ, nucleus, phagocytes, phagocytosis, plasma, red blood cells, respiratory system, sickle-cell anemia, thoracic duct, vessel, white blood cells

Student Materials

Activity 1-1: Pathway of Blood through Your Body

- Activity Report

Per team

- Paper cups (4) ; Straw; Glue; Paper towels; Colored pencils, pens, or paint (blue and red); Tape; Balloon (white); Colored thread (blue and red); Colored yarn (blue and red, 2 pieces 20 cm each); Lima beans (3 or 4); Scissors; Ruler (metric)

Activity 1-2: Composition of Blood

Per team

- Activity Report
- 2 Beakers, 1,000 ml , or clear plastic containers; 3 Containers, one of which is at least 500 ml in capacity; Red beans, dried (800) ; White beans, dried, about twice the size of the red beans (10) ; Split peas, dried, about half the size of the red beans (75) ; Salt; Yellow food coloring; Raw egg; Water; Small pieces of paper towel; 2 Graduated cylinders, 25 or 50 ml and 500 ml

Teacher Materials

Activity 1-1: Pathway of Blood through Your Body

- Activity Report Answer Key
- Since your students will be working with glue, you may want to provide paper or plastic to protect the table tops.
- Charts and other visuals showing the heart and circulation of blood
- Illustrations of blood vessels

Activity 1-2: Composition of Blood

- Activity Report Answer Key
- Charts and other visuals showing the composition and characteristics of blood
- Resources relating to blood diseases and disorders

See Activities 1-1 and 1-2 in the Student Edition.

Activity 1-1: Pathway of Blood through Your Body

- Ask students to collect large paper cups, straws, red and blue colored pencils, yarn and thread, and lima beans.
- Construct a model for reference.

Activity 1-2: Composition of Blood

- Assemble small bags or other containers filled with correct numbers of beans and peas needed for each group.
- Construct a model for reference.

Interdisciplinary Connections

Art Drawing the pathway of blood through the body can also be done as an art project.

Math Students use data for the composition of blood to construct graphs.

2.2 Using Circulation – Student Edition (Human Biology)

Begin with *Activity 1-1: Pathway of Blood through Your Body*.

Discuss the role of models in science.

Draw students' attention to the key ideas using means such as posters and overhead transparencies.

Complete *Activity 1-2: Composition of Blood* to help students visualize the components of human blood.

Assign *Mini Activities: Artificial Blood* and *Blood Impressions*.

Discuss the importance of blood in maintaining homeostasis and the effects of blood diseases on homeostasis.

Review the *Apply Your Knowledge* and the *Review Questions*.

Throughout and at the end of each section refocus students' attention to the key ideas.

Journal Writing

What makes a delivery system efficient? Imagine you are in charge of a package delivery service. What things might make your job harder? What things might make your job easier? What would be the most important parts of a successful delivery company? Write a paragraph to explain your ideas, and include any lists, diagrams, or drawings you come up with.

2.3 Activities and Answer Keys

Activity 1-1: Pathway of Blood through Your Body

PLAN

Summary Students construct a model of the heart showing the two pump pathway of blood through the body and lungs. To construct the model, they use cups to represent the heart chambers. They use straws, yarn, and thread to represent vessels. They use balloons to represent the lungs. And they use seeds to represent the cells.

Objectives

Students:

✓ identify the number of heart chambers.

✓ describe the separation of blood between the two sides of the heart.

✓ compare and contrast oxygenated and deoxygenated blood.

✓ explain where blood is oxygenated and deoxygenated.

Student Materials

- Activity Report

Per team

- Paper cups (4) ; Straw; Glue; Paper towels; Colored pencils, pens, or paint (blue and red); Tape; Balloon (white); Colored thread (blue and red); Colored yarn (blue and red, 2 pieces 20 cm each); Lima beans (3 or 4); Scissors; Ruler (metric)

Teacher Materials

- Activity Report Answer Key
- Since your students will be working with glue, you may want to provide paper or plastic to protect the table tops.
- Charts and other visuals showing the heart and circulation of blood
- Illustrations of blood vessels

Advance Preparation

Collect large paper cups, straws, red and blue colored pencils, yarn, thread, and dry lima beans.

Have a completed model for demonstration and/or reference after the activity is completed.

Determine where completed models will be stored/displayed.

Provide paper or plastic to protect the table tops.

Gather and organize the student materials listed.

Estimated Time One or two 50 – minute periods

Interdisciplinary Connection

Art This activity could be completed in an art class before starting the unit.

Prerequisite and Background Information

This is an excellent introductory activity. It is recommended that this activity be done at the beginning of the unit. Students do not need any prior knowledge to complete this activity.

IMPLEMENT

This activity can be done as a whole-class demonstration or in smaller groups.

If you choose to implement this activity in small groups, divide the class into pairs or groups of 3 students.

Steps 1-3

Refer students to Figure 1.2 to see an early stage of the model they will build.

Steps 4-6

Refer students to Figure 1.3 to see what the model should look like at this stage. Make sure they know the significance of the colored yarn.

Steps 7-13

The completed model will look like the illustration in Figure 1.4.

Steps 14-16

Monitor students to make sure they are able to explain, in their illustration and their writing, how the blood would flow through their models.

Conclude Activity 1-1 by making sure students follow the cleanup procedures. Make sure the models are stored safely. The constructed models should be available to your students for reference throughout the unit.

Helpful Hints

- Encourage students to use their models to illustrate their working knowledge of the anatomy and physiology of the heart. The students' models will help them learn about the vessels and the pathway of blood.
- Monitor the time to make sure there is sufficient time for cleanup.

ASSESS

Use the construction of the heart model and the written responses to the Activity Report to assess if students can:

✓ locate and describe the function of the four chambers of the heart.

✓ define the terms "oxygenated" and "deoxygenated."

✓ identify the region of the heart that contains oxygenated blood.

✓ identify the region of the heart that contains deoxygenated blood.

✓ explain the location and function of the heart, lungs, blood vessels, and blood capillaries.

Extend Activity 1-1 by asking students to make a *working* model of the heart that demonstrates the two-pump pathway. Use empty liquid detergent bottles or water bottles with nozzle tops. Use scissors to make holes at the bottom of the bottles. Insert tubing as vessels into the holes you made in the bottles.

This is an open-ended activity that can be done now or later in the unit as students gain more knowledge about blood vessels—their structure and I function.

Activity 1-1: Pathway of Blood through Your Body - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Place the model in front of you, with the two blue cups on your left and the two red cups on your right. Set the balloon on top of the cups and position the beans in front of the cups. This is the position of the circulatory system as it would be in a person facing you.
2. Each cup represents a heart chamber. The blood enters the heart through each of the upper chambers and flows into the corresponding lower chambers before leaving the heart. How many chambers make up the human heart?
3. The red heart chambers and vessels contain blood high in oxygen content. The blue heart chambers and vessels contain blood poor in oxygen content. You may remember that the removal of water is called dehydration and decaffeinated coffee is coffee with the caffeine removed. If the blood, which is high in oxygen content is called oxygenated blood then what would you call the blood which has had oxygen removed for use by the cells?
4. Based upon the structure of your model, does blood from the blue (right) side of the heart mix with the blood from the red (left) side of the heart?
5. Look at your model and determine where oxygen is added and removed.

Bonus Question: The threads, yarn, and straws represent the vessels. The straws and yarn represent arteries and veins, and the threads represent the capillaries. Label these vessels correctly on your diagram and be prepared to give reasons for your answers.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Explain why a person living on a mountain at high altitude has a greater number of red blood cells than a person living at sea level.

What Do You Think?

Some athletes use an illegal procedure called "blood doping." Weeks before an important event they have some of their own blood withdrawn and placed in cold storage. Their bodies make new red blood cells to replace the ones that were removed. The athletes have the stored blood transfused back into their bodies just before the event. This increases the number of new red blood cells in their blood and the amount of oxygen they are able to take up with each breath. Why do you think an athlete might do this? Do you think blood doping should be an illegal procedure? Why or why not?

Apply Your KNOWLEDGE

In what other ways does your body keep germs and dirt out? What other protectors does your body have?

Apply Your KNOWLEDGE

What can doctors tell about your health from a blood test?

What Do You Think?

Donations of blood and body organs are needed to save the lives of injured or sick people. Blood can be stored for only a few weeks. So new blood is constantly needed. Organs of healthy people who die prematurely could save the lives of others. At the present time not enough donations of blood and body organs are made available to meet the need. How do you think the medical profession could educate people about the importance of donations of blood and organs?

Apply Your KNOWLEDGE

What is a bruise? Why does it change color?

Activity 1-2: Composition of Blood

PLAN

Summary Students create a model of the composition of whole blood using a measured quantity of various sizes of beans and peas to represent the blood cells and a measured quantity of liquids to represent the plasma.

Objectives

Students:

✓ demonstrate the relative volumes of the components of blood.

✓ demonstrate the relative size differences among blood cells.

✓ name the three types of blood cells and tell what they do.

✓ explain how homeostasis of the body can be disrupted.

Student Materials

- Activity Report

Per Team

- 2 Beakers, 1000 ml , or clear plastic containers; 3 Containers, one of which is at least 500 ml in capacity; Red beans, dried (800) ; White beans, dried, about twice the size of the red beans (10) ; Split peas, dried, about half the size of the red beans (75) ; Salt; Yellow food coloring; Raw egg; Water; Small pieces of paper towel; 2 Graduated cylinders, 25 or 50 ml and 500 ml

Teacher Materials

- Activity Report Answer Key
- Charts and other visuals showing the composition and characteristics of blood
- Resources relating to blood diseases and disorders

Advance Preparation

Assemble small bags or other containers filled with the correct numbers of beans and peas needed for each group.

Estimated Time One 50 – minute period

Interdisciplinary Connection

Math Consider using this lab with the math teacher (calculation of percents, tables, and graphs).

Prerequisites and Background Information

Students should know how to use a graduated cylinder and how to calculate percentages.

IMPLEMENT

Introduce Activity 1-2 by discussing what a model is and the importance of building and using models.

Procedure A-Modeling the Solid Portion of Blood

Steps 1-3

Provide small bags or other containers filled with the correct numbers of beans and peas needed for each group. Make sure students label the bags correctly.

- Red beans labeled "Red Blood Cells"
- Split peas labeled "Platelets"
- White beans labeled "White Blood Cells"

Pass out Activity 1-2 Activity Reports. Make sure students are filling out their reports as they work through the procedures.

Procedure B-Modeling the Liquid Portion of Blood

Steps 1-3

Make sure students are labeling the containers correctly as they follow Steps 1-3.

- Make sure the water is in a clean 1000 ml container. Sometimes students want to put the water in the solid portion container. Avoid this mistake.
- The raw egg should be placed in a paper cup labeled "Proteins and Fats."
- The pinch of salt should be placed in a paper cup labeled "Minerals, Nutrients, and Wastes." Then make sure students add the yellow food coloring to the salt in this cup.
- Again, make sure students add the materials representing the liquid model to the container of water—not to the container of materials representing the solid portion of blood. They should have two separate containers at this point—model of solid portion of blood and model of liquid portion of block Make sure students are answering the questions on their Activity Reports as they progress.

Procedure C-What can you learn from your model?

Steps 1-2

Guide students as they compare their models to real blood.

- After completing the activity, remind students to return the peas and beans to small bags in preparation for the next class.
- Remind students *NOT* to mix the contents of the two beakers.
- Monitor time to allow for cleanup.

Conclude Activity 1-2 by discussing students' responses to the scenarios in Step 2. Allow students time to complete their Activity Report or assign their completion.

ASSESS

Use the written responses to the Activity Report to assess if students can

✓ identify the three types of blood cells (red blood cells, white blood cells, and platelets).

✓ explain the use of the red blood cells to transport oxygen.

✓ explain the importance of white blood cells to fight infections and diseases.

✓ describe how the platelets function in the clotting of blood.

✓ indicate the relative abundance of red blood cells (94%) , white blood cells (1%) , and platelets (5%) .

✓ demonstrate the relative size of red blood cells, white blood cells, and platelets.

✓ explain how changes in the composition of blood can disrupt the internal balance, or homeostasis of the body.

✓ explain how blood tests can indicate the presence of anemia, sickly cell anemia, mononucleosis, cancer, and deficiencies in the blood clotting process.

Activity 1-2: Composition of Blood - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What are the two components of whole blood?
2. What percent of whole blood is made up of blood cells?
3. Name the three types of blood cells and tell what they do.
4. What percent of blood cells are red blood cells? White blood cells? Platelets?
5. Use your model to demonstrate how a change in the composition of blood upsets homeostasis, leading to particular medical conditions.
6. What percent of whole blood is made up of plasma?
7. What percent of the liquid part of the blood is made up of dissolved substances represented by the yellow water?

Mini-Activity

Blood Impressions Students paint or draw an instructional picture clearly showing the composition of blood.

Artificial Blood Students conduct a research assignment on the composition, synthesis, and use of artificial blood.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

How can your circulatory system help you regulate your body temperature?

An accident victim in the emergency room needs a blood transfusion. Her blood type is A. Which blood type(s) are compatible with hers?

Journal Writing

Your school circulates information. Your body circulates blood. Compare and contrast the methods of delivery between your school and your body.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What are five differences between red blood cells and white blood cells?
2. How do red blood cells carry oxygen? What happens if red blood cells aren't the right shape or there aren't enough of them?
3. What is in plasma? What do the things in plasma do?
4. If the doctor discovers your platelet count is low, what might you have to be careful of? Why?
5. Describe two functions of the lymphatic system.

Activity 1-1 Report: Pathway of Blood through Your Body

1. Place the model in front of you with the two blue cups on your left and the two red cups on your right. Set the balloon on top of the cups and position the beans in front of the cups. This is the position of the circulatory system as it would be in a person facing you. Make a drawing of your model and label: heart, lung, cells, and vessels.

2. Each cup represents a heart chamber. The blood enters the heart through each of the upper chambers and flows into the corresponding lower chambers before leaving the heart. How many chambers make up the human heart?

3. The red heart chambers and vessels contain blood high in oxygen content. The blue heart chambers and vessels contain blood poor in oxygen content. You may remember that the removal of water is called dehydration and decaffeinated coffee is coffee with the caffeine removed. If the blood that is high in oxygen content is called oxygenated blood, then what would you call the blood which has had oxygen removed for use by the cells?

4. Based upon the structure of your model, does blood from the blue (right) side of the heart mix with the blood from the red (left) side of the heart?

5. Look at your model and explain where oxygen is added and removed.

Bonus Question: The threads, yarn, and straws represent the vessels. The straws and yarn represent arteries and veins, and the threads represent the capillaries. Label these vessels correctly on your diagram and be prepared to give reasons for your answers.

Activity 1-2 Report: Composition of Blood

1. What are the two components of whole blood?

2. What percent of whole blood is made up of blood cells?

3. Name the three types of blood cells and tell what they do.

4. What percent of blood cells are red blood cells? White blood cells? Platelets?

5. Use your model to demonstrate how a change in the composition of blood upsets homeostasis leading to particular medical conditions.

6. What percent of whole blood is made up of plasma?

7. What percent of the liquid part of the blood is made up of dissolved substances represented by the yellow water?

CHAPTER 3

The Heart - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

3.1 PLANNING

3.2 USING THE HEART – STUDENT EDITION (HUMAN BIOLOGY)

3.3 ACTIVITIES AND ANSWER KEYS

3.4 ENRICHMENT

3.1 Planning

Key Ideas

- The heart is divided into four chambers—two "pumps" with two chambers each. One pump sends blood to the lungs for oxygen and back to the heart. The other pump sends the oxygenated blood throughout the body.
- The cardiac (heart) cycle is made up of two parts—squeeze and fill. The fill part of the cycle is called diastole. The squeeze part of the cycle is called systole. In systole the heart contracts, forcing blood out. In diastole the heart expands or relaxes, filling the heart with blood. So the heart is always following this cycle-fill, squeeze, fill, squeeze or diastole, systole, diastole, systole.
- The pacemaker is a specialized region of the heart which, in combination with the nervous system and the endocrine system, helps to maintain homeostasis.

Overview

Students explore how the heart pumps blood by building on their initial exploration of the circulatory system in Section 1. They dissect a mammalian heart, which is similar in structure to their own. Then they use a siphon pump to investigate how the heart functions as a double pump. Both of these activities help students learn that the heart is divided into four chambers—actually two "pumps" with two chambers each. One pump takes in blood from the body and sends it to the lungs for oxygen. The other pump takes in blood from the lungs and sends it throughout the body. Students discover that their heart pumps cyclically in a cardiac cycle. In other words, the heart pumps in a cardiac cycle from the time the blood enters the heart until it leaves the heart. The cardiac cycle is made up of a fill part (diastole) and a squeeze part (systole). The cardiac cycle is constant—fill-squeeze-fill-squeeze—or—diastole-systole-diastole-systole.

Objectives

Students:

✓ describe the structure of the 4− chambered heart.

✓ describe the function of the 4− chambered heart.

✓ explain how the heart works as a double pump.

✓ demonstrate the path blood takes through the heart.

✓ describe the cardiac cycle.

Vocabulary

aorta, aortic valve, arteries, atrium, bicuspid valve, cardiac output, coronary arteries, diastole, heart rate, inferior vena cava, pacemaker, pericardium, pulmonary artery, pulmonary valve, pulmonary vein, siphon pump, stroke volume, superior vena cava, systole, tricuspid valve, veins, ventricle

Student Materials

Activity 2-1: Exploring the Heart

- Activity Reports 1, 2, and 3
- Animal heart (sheep, cow, or pig); Tweezers; Scalpel; Scissors; Probes; Apron or smock; Plastic disposable gloves; Dissection pan; Paper towels; Plastic bag

Activity 2-2: Siphon Pump

- Activity Report
- Siphon pump (available at Marine Stores—Tempco fuel pump); Siphon pump, split lengthwise; 2 large containers (i.e., buckets, dishpans, etc.), filled $\frac{3}{4}$ with water; Inlet and outlet hoses—supplied with pump; Siphon hose with bulb

Teacher Materials

Activity 2-1: Exploring the Heart

- Activity Reports Answer Keys
- Newspaper to protect working surface.
- Container for used heart specimens
- Soap and paper towels
- Charts and other visuals showing the heart and circulation of blood

Activity 2-2: Siphon Pump

- Activity Report Answer Key
- A pump split lengthwise so that the valves are visible; Towels or sponges to clean up water spills; Models students produced in Activity 1-1

Advance Preparation

See Activities 2-1 and 2-2 in the Student Edition

Activity 2-1: Exploring the Heart

Purchase disposable gloves or obtain gloves donated by a local hospital, clinic, or doctor/dentist office.

Order mammalian hearts such as cow, pig, or sheep. Contact a local butcher to make sure you can obtain hearts. Or you can order prepared dissection materials from the following.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-334-5551.

Activity 2-2: Siphon Pump

Order the siphon pumps. Purchase siphon pumps from a marine store or from Tempco Products. Cut convenient lengths of plastic tubing to be used for siphons. The pumps are the ones used to pump fuel on boats. Using a saw or sharp knife, split one pump lengthwise so students can observe the valves inside. Collect 2 buckets or dishpans for each lab station.

Display constructed models from Activities 1-1 and 1-2 and a siphon pump (Activity 2-2).

Interdisciplinary Connections

Music Compare the rhythm of a heartbeat to a piece of music. Explain similarities and differences.

Language Arts Describe in writing the sequence of events that must happen to pump blood through the heart.

Art Draw a diagram or paint a picture of a mammalian heart. Label the parts of the heart.

Drama Pantomime the circulation of blood through the heart by walking through a large heart diagram marked on the floor with masking tape.

Enrichment Activity

Enrichment 2-1: What Makes the Heart Beat Faster?

Students observe the effects of the hormone epinephrine (adrenaline) on the beating heart of a brine shrimp by counting the number of times the brine shrimp legs pulse per minute.

Obtain the adult brine shrimp from an aquarium store. (The pulsating blood is not noticeable in newly hatched shrimp.) They can be stored in a container in the refrigerator for a few days without food or a water change. *Daphnia,* or water fleas, can be used in place of brine shrimp. They need to be ordered from a science supply house. Since they need to be kept alive with special food, the specified delivery date must be close to the date of the activity. It is difficult to keep these critters alive for long periods of time. Also order epinephrine.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-334-5551.

3.2 Using The Heart – Student Edition (Human Biology)

Draw students' attention to the key ideas of this section using means such as posters and overhead transparencies.

Discuss with students the role of dissection in learning about the human body. For example, students will use a mammalian heart to increase their knowledge of the structure of their own heart.

Begin this section with *Activity 2-1: Exploring the Heart.* You may want to assign the Activity Report before beginning the activity.

Assign *Mini Activity: Heartbeats* and *Mini Activity: Word Origins.*

Remind students of the important role of models in science.

Activity 2-2: Siphon Pump gives students another opportunity to use a model and provides them with a concrete example of the pumping action of the heart.

Assign *Mini Activity: What's Your Cardiac Output Today?*

Discuss the importance of a healthy heart in maintaining homeostasis.

Select from Journal Writing prompts, *Enrichment Activity 2-1: What Makes the Heart Beat Faster?, Mini Activity: Is Pumping Hard Work?,* and the Breathing Projects beginning on TE page 164.

Review the *Apply Your Knowledge* and the *Review Questions* responses.

Throughout and at the end of the section refocus students' attention to the key ideas.

Read the *Prerequisites and Background Information* for *Activity 2-2: The Siphon Pump.*

3.3 Activities and Answer Keys

Activity 2-1: Exploring the Heart

PLAN

Summary Students dissect a mammalian heart. The sheep heart is an excellent specimen, since it is about the same size and shape as the human heart.

Objectives

Students:

✓ identify the anatomy of the heart.

✓ describe the functions of the heart chambers and valves.

✓ explain the pathway of blood through the heart.

Student Materials

- Activity Reports 1, 2, and 3
- Animal heart (sheep, cow, or pig); Tweezers; Scalpel; Scissors; Probes; Apron or smock; Plastic disposable gloves; Dissection pan; Paper towels; Plastic bag

Teacher Materials

- Activity Reports Answer Keys
- Newspaper to protect working surface
- Container for used heart specimens
- Soap and paper towels
- Charts and other visuals showing the heart and circulation of blood

Advance Preparation

Purchase disposable gloves or obtain gloves donated by a local hospital, clinic, or doctor/dentist office.

Order mammalian hearts, such as cow, pig, or sheep. Contact a local butcher to make sure you can obtain hearts. Or you can order prepared dissection materials from the following.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-334-5551.

Contact the American Heart Association for pamphlets, heart drawings, and other related materials.

Make arrangements with your custodian for disposal of used specimens. If possible, freeze the specimens before disposing of them.

Estimated Time Two or three 45 – minute periods

Interdisciplinary Connection

Art Students could build a life-size model of the heart using clay or another material.

Prerequisites and Background Information

Students should be familiar with the pathway of blood through the body and heart. An introduction to the anatomy of the heart will also be helpful.

Helpful Hints

- Confirm that students can correctly identify the left and right sides of the heart specimen, the top and bottom, and the front and back.
- Be sure to allow adequate time for cleanup.
- The guideline in Step 6 of the Procedure will help in positioning the heart in its anatomically correct position.

IMPLEMENT

Introduce Activity 2-1 by demonstrating procedure Steps 1-6.

Steps 7-8

It can be difficult to find the structures within the heart. It often helps if the teacher finds the first structure and shows students. Then guide students as they find the other heart structures. When most students finish Steps 7-8 stop them and review as a group what they have discovered.

Steps 9-11

Follow the same process as described above for demonstration, modeling, guidance, and review. As students proceed, remind them to use Figures 2.2, 2.3, and 2.4 as models. But also assure them that the structures they are exploring in the real specimen can look different from those in a drawing. This is the reason it is helpful for the teacher to model and demonstrate some parts of the dissection.

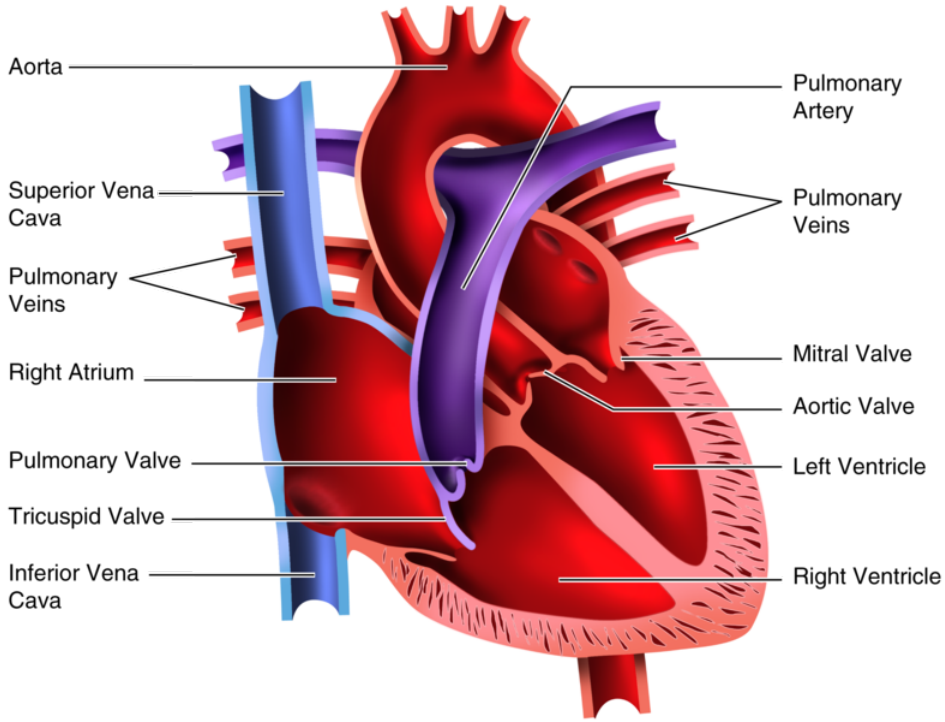
Steps 12-14

Make sure students are pushing the straws through the openings and not through the walls separating the chambers of the heart.

Steps 15-18

As you review, remind students to answer the corresponding questions in their Activity Reports. Remind them that it's much easier and more accurate to answer the questions as they proceed through the exploration rather than to try to remember later.

The actual modeling and dissection will take approximately two 45 – minute periods. Stress the need for students to wash their hands thoroughly as the last step of cleanup each day. If the lab requires a second day make sure the specimens are stored in a refrigerator overnight.



Conclude Activity 2-1 by discussing what students observed and what they learned about the structure of a mammalian heart. Make sure students have completed their Activity Reports. And make sure the lab is cleaned and the specimens disposed of safely.

ASSESS

Use your observations of the students' dissection of an animal's heart, participation in the class discussions, and their written responses to Activity Reports 1 and 2 to assess if students can

✓ describe the general size of an animal's heart.

✓ identify the blood vessels (arteries and veins) that connect the heart with the rest of the body.

✓ identify the location and explain the function of the chambers and valves of the heart (vena cava, right atrium, left atrium, pulmonary artery, pulmonary vein, left ventricle, right ventricle, aorta, aortic valve, tricuspid valve, mitral valve, and pulmonary valve).

✓ demonstrate the direction of blood flow through the heart (vena cava, right atrium, right ventricle, pulmonary artery, lungs, pulmonary veins, left atrium, left ventricle, aorta).

✓ compare and contrast an animal heart and a human heart.

Activity 2-1: Exploring the Heart - Activity Reports 1, 2, and 3 Answer Keys

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Explain why the muscle of the left ventricle is thicker than the muscle of the right ventricle.
2. What is the function of the heart valves?

3. What happens to the blood after passing from the right ventricle but before it enters the left atrium? What organ does the blood pass through? What gas does the blood receive? What gas does the blood give up?
4. List in order those parts that determine the direction of blood flow through the heart. Start with the vena cava and include the following: vena cava, left atrium, right atrium, left ventricle, right ventricle, pulmonary artery, pulmonary vein, aorta.
5. On the heart diagram below, label the following structures: vena cava, right atrium, left atrium, pulmonary artery, pulmonary vein, left ventricle, right ventricle, aorta, aortic valve, tricuspid valve, mitral valve, and pulmonary valve.
6. How does the pulmonary artery differ from all other arteries? How does the pulmonary vein differ from all other veins? Why is this distinction important? What does it tell you about how the heart works?

The Right Side of the Heart

7. Find a wavy-edged flap that has an opening on the top. This flap called the auricle (little ear) allows extra blood to collect in the chamber of the heart called the atrium. The vessels entering the right atrium are the superior and the inferior vena cava. These veins bring oxygen-poor blood back to the heart from the rest of the body. Describe the atrium, which is a receiving chamber for the heart.
8. Use your finger to find the opening into the right atrium and push down. If your finger goes completely into the heart, then you have reached the right ventricle. Take your finger out and replace it with a straw. If you push the straw all the way down, it will be in both the right atrium and the right ventricle.
9. Push on the straw until you can see it stretching the wall of the heart. Stick the point of the scissors through the heart wall to meet the tip of the straw. Cut all the way up to the top following the straw. Observe the inside of the heart. Find the inside of the atrium and the ventricle. Is there anything inside the heart?
10. Look between the right atrium and the right ventricle. You can see the thin, transparent membranes that form the tricuspid valve. The tricuspid valve remains open during the filling of the right ventricle. When blood leaves the right ventricle through the pulmonary artery, the tricuspid valve closes (Iub sound). Describe the valve.
11. Look at the open side of the heart. Poke the second finger of your right hand into the back of the lower chamber. After your finger comes out on top, put a straw in the opening. This marks the pulmonary artery. The pulmonary (semi-lunar) valve lies between the right ventricle and the pulmonary artery. Remember that all arteries carry blood away from the heart. This is the only artery in the body that carries blood low in oxygen. What is the reason for this?

The Left Side of the Heart

12. Find the opening on the top of the left side of the heart. The opening leads to the left atrium. Put a straw where your finger was. Push it all the way down. After the blood leaves the lungs it returns to the heart through the pulmonary vein. (Remember that all veins carry blood to the heart.) Pulmonary veins are the only veins in the body that carry oxygenated instead of deoxygenated blood. The pulmonary veins bring oxygen-rich blood back into the left atrium.
13. Poke your scissors through the point where you think the end of the straw would be. Cut until you see the end of the straw. The end of the straw is now in the left ventricle. The straw has passed through the mitral or bicuspid valve. How is the wall of the left ventricle (which you have just cut through) different from the wall of the right ventricle? Explain.
14. Find the opening from the lower left ventricle towards the middle of the heart that leads to the outside. This is the *aorta.* Put a straw in the aorta. Which kind of blood, oxygenated or deoxygenated, flows through the aorta?
15. Cut down the aorta toward the heart and observe the valve. This is the *aortic semi-lunar valve.* Describe the appearance of the valve.
16. Can you find the two coronary arteries in the walls of the ventricles? Locate two tiny holes in the aorta just above the aortic valve. This is where the coronary arteries leave the aorta to transport nutrients and oxygen to the heart.

Is Pumping Hard Work? Students squeeze a tennis ball 70 times to see how often the heart pumps in one minute at rest. You can assign this activity in preparation for *Activity 2-2: Siphon Pump.*

Heartbeats Students time their pulses to determine heart rate and use these data to calculate number of heartbeats per day, per week, and per lifetime.

Word Origins Students research the word origins of anatomical terms related to the heart and lungs.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Your friend tells you that she has a "heart murmur." What do you think this means?

Activity 2-2: Siphon Pump

PLAN

Summary

Students use a siphon pump to explore how the heart functions as a pump. They use a siphon to empty water from a bucket positioned higher into a bucket positioned lower. Then they use a siphon pump to move the water from the lower bucket to the higher bucket. A siphon uses gravity to move water, but the siphon pump can move water against gravity.

Objectives

Students:

✓ demonstrate how to use a siphon and a siphon pump to empty water from a container with and against gravity.

✓ compare the valves of the heart to the valves of the pump.

✓ compare the pumping action of the heart to the siphon pump.

✓ describe how the heart can pump blood throughout the body against gravity.

✓ explain how the heart functions as a double pump.

✓ describe how the heart as a muscle keeps pumping continuously.

Student Materials

- Activity Report

- Siphon pump with inlet and outlet hoses (available at Marine Stores—Tempco fuel pump); siphon pump, split lengthwise; 2 large containers (i.e., buckets, dishpans, etc.), filled 3/4 with water

Teacher Materials

- Activity Report Answer Key
- Split one siphon pump lengthwise so that the valves are visible; Towels or sponges to clean up water spills; Models students produced in Activity 1-1.

Advance Preparation

Cut convenient lengths of plastic tubing to be used for siphons.

Purchase siphon pumps from a local marine store. West Marine has locations across the country and will give you the location nearest you if you call 1-800-538-0775. If there is no store nearby, West Marine will ship you a catalogue from which the siphon pumps can be ordered.

Using a saw or sharp knife, split one pump lengthwise for a demonstration. (The industrial arts teacher may be able to help prepare your model cross section.)

Collect 2 buckets or dishpans for each lab station.

Estimated Time One 50 – minute period

Interdisciplinary Connections

Music Use the rhythm and beat of music to illustrate how the rhythm of the heartbeat is constant over time.

Math Students can calculate pump intake/output and relate that to total volume of water moved and to the intake/output of blood by the heart at rest.

Industrial Arts Students can design and make various one-way pumps.

Health Students can compare and evaluate the kinds of valves used in heart valve replacement.

Prerequisites and Background Information

The Siphon If there is a difference in pressure between the ends of a water-filled tube, water will flow through the tube from the area of greater pressure (head of pressure) to the area of lesser pressure.

The pressure differences depend on the length and diameter of the hoses. In other words, the length and the diameter of the hoses of the siphon tube and the siphon pump determine the rate at which water will flow.

The Siphon Pump The squeeze/fill cycle moves water through the pump from the inlet to the outlet hose. The heart has 2 pumps in it. This is like 2 siphon pumps together.

The heart cycle—fill-squeeze-fill-squeeze-fill-squeeze—is a cycle.

The squeezing of the water in the bulb creates a pressure head between the bulb and the outlet tube. Water moves from the bulb where pressure is high through the tube where pressure is lower.

The valves in the siphon pump keep the water from squirting backwards out of the pump back into the inlet tube.

When the pump is squeezed and released it fills up again with water because the relaxed pump chamber becomes an area of lower pressure compared to the water at the end of the inlet hose. So water flows into the pump from a region of greater pressure to a region of lower pressure until the pump is filled.

IMPLEMENT

Part A: How Does a Siphon Work?

You can do Activity 2-2 as a whole-class demonstration, in lab partner pairs, or divide the class into groups of 3-5.

Introduce Activity 2-2 by discussing the usefulness of siphons and siphon pumps. Some students may have fish aquariums or may be familiar with the use of siphons with mowers, boats, cars, etc.

Steps 1-4

Make sure students have placed their containers at different heights. This can be accomplished by using stools, chairs, lab tables, and the floor. Demonstrate how you can affect flow by moving the tubes or pinching them shut. Remind students that the bubbles need to be out of the submerged tubes for the siphon and the siphon pump to work efficiently.

Step 5

Challenge students to empty all of the water from the upper container into the lower container by using the siphon. Challenge them to not waste or lose any water. With care, they can move the water without any loss or mess.

Part B: How Does a Siphon Pump Work?

Steps 1-4

Demonstrate the difference between a siphon and a siphon pump. Then challenge students to move the water back up from the bottom container to the container on top. Again challenge them to do this without losing any water. Be aware that students may expect the water to move from the lower level to the higher level without pumping as it did when the water was siphoned from higher to lower. Discuss the difference between a siphon and a siphon pump.

Helpful Hints

- Ask students to refer to their models from Activity 1-1 for comparison. Ask students—What part of the model can be compared to the siphon pump?
- Emphasize the difference between the tube for the siphon and the siphon pump.
- Point out that there is an arrow showing direction of flow on the outside of the pump bulb.
- Holding 2 pumps together can demonstrate how the heart is actually a double pump.
- Challenge students to keep the pumping rhythms constant by following the beat of a metronome.

Part C: How Is Your Heart like a Siphon Pump?

Steps 1-3

Demonstrate the similarity of a siphon pump to a fish heart. The fish heart is only one pump. Demonstrate how 2 siphon pumps together model the heart as a double pump. Make sure students are completing their Activity Reports as they progress.

Conclude Activity 2-2 by relating the cardiac cycle (systole and diastole) to the squeezing and filling of the pump. Discuss how the model is similar to and different from the human heart. Emphasize that the heart muscle must pump continuously to do the job of pumping blood to all parts of the body.

ASSESS

Use observations of students' use of the siphon pump and their written responses to the Activity Report to assess if students can:

✓ explain how a siphon uses gravity to move a liquid.

✓ explain how a siphon pump works against gravity to move a liquid.

✓ identify the components of a siphon pump (pump, valves, tubing, and so on).

✓ compare and contrast the siphon pump apparatus and the human heart.

✓ demonstrate how the heart is actually a double pump that pumps continuously.

✓ describe how the squeezing and filling of the pump can be an analogy to systole and diastole in the cardiac cycle.

✓ explain how the valves of the heart prevent blood from moving backwards.

Activity 2-2: Siphon Pump Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

A: **How Does a Siphon Work?**

1. Explain what happens when you plug both ends of the hose with your fingers, keep one end in the water, move the other end of the hose out of the bucket toward the empty bucket on the floor, and release your finger.
2. What determines the amount of water per second that flows through the siphon?
3. Based upon your observations, describe how a siphon works.

B: **How Does a Siphon Pump Work?**

1. What causes water to move out of the siphon pump when you squeeze the bulb?
2. What happens when you plug the outlet hose with your finger while you pump the bulb? Explain your answer.
3. When you squeeze the bulb, why does the water go in only one direction out of the bulb?
4. After you squeeze the pump, what causes it to fill up with water again?

C: **How Is Your Heart Like a Siphon Pump?**

1. Imagine that the siphon pump represents the right side of your heart. What would the squeeze bulb represent? The outlet hose? The inlet hose?
2. Imagine that the siphon pump represents the left side of your heart. What does the squeeze bulb represent? The outlet hose? The inlet hose? The valve?
3. You have just named some similarities between your heart and the siphon pump. Now describe what is different about how the siphon pump and your heart work.

Mini-Activity

What's Your Cardiac Output Today? Students determine their cardiac output by taking their pulse and calculating the volume per pulse per minute per day.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

When exercising your working muscles help return blood to the heart more quickly. Remember that the stroke volume is the amount of blood the heart pumps out with each squeeze. Does exercise increase or decrease the heart stroke volume? Explain.

Why do athletes often have lower resting heart rates than non-athletes? If their hearts don't beat as frequently why don't they faint from a shortage of blood in circulation?

Apply Your KNOWLEDGE

Why can a fish get by with only one pump in its heart when you need two?

Journal Writing

Imagine you are a drop of blood in the left atrium of the heart. Describe your voyage through the heart and body and back to the heart. Include labeled diagrams to illustrate your story.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What is the heart cycle?
2. Describe the four steps in which blood flows through the heart. Draw a picture showing the path of blood from when it enters the right atrium until it leaves the left ventricle.
3. What do heart valves do?
4. How is a siphon pump most similar to a heart?
5. When you hear your heart beat, what exactly are you hearing?
6. What two properties of your heart can change to increase your cardiac output?

Activity 2-1 Report 1: Exploring the Heart (Student Reproducible)

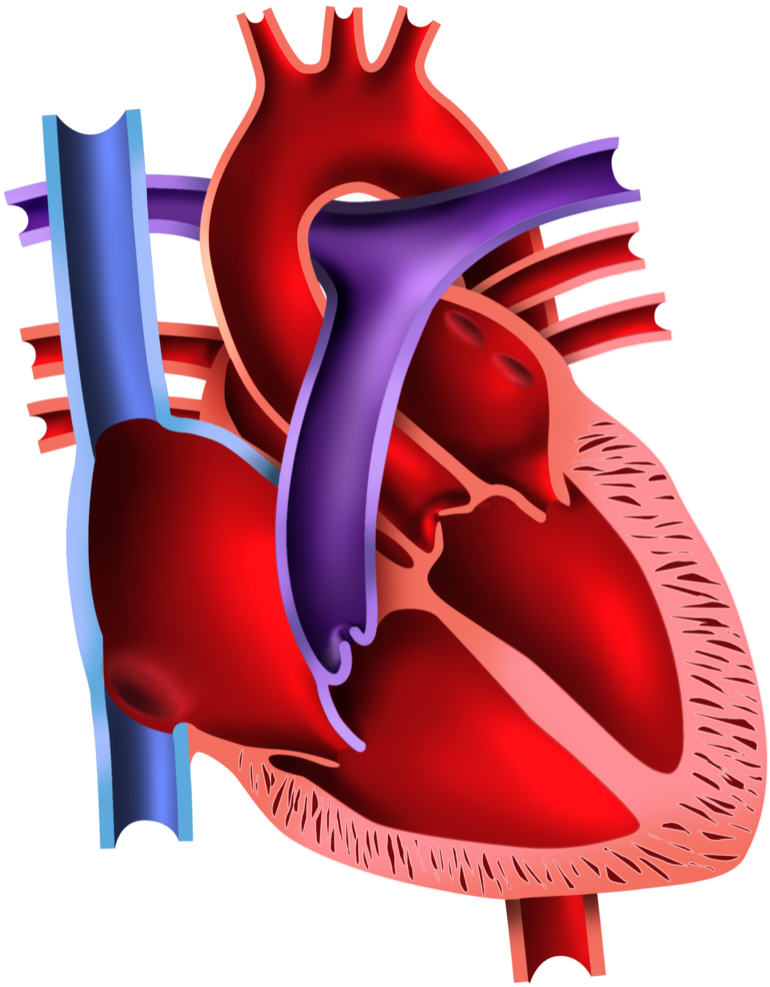
1. Explain why the muscle of the left ventricle is thicker than the muscle of the right ventricle.

2. What is the function of the heart valves?

3. What happens to the blood after passing from the right ventricle but before it enters the left atrium? What organ does the blood pass through? What gas does the blood receive? What gas does the blood give up?

4. List in order those parts that determine the direction of blood flow through the heart. Start with the vena cava and include the following: vena cava, left atrium, right atrium, left ventricle, right ventricle, pulmonary artery, pulmonary vein, and aorta.

5. On the heart diagram below label the following structures: vena cava, right atrium, left atrium, pulmonary artery, pulmonary vein, left ventricle, right ventricle, aorta, aortic valve, tricuspid valve, mitral valve, and pulmonary valve.



6. How does the pulmonary artery differ from all other arteries? How does the pulmonary vein differ from all other veins? Why is this distinction important? What does it tell you about how the heart works?

Activity 2-1 Report 2: Exploring the Heart (Student Reproducible)

The Right Side of the Heart

7. Find a wavy-edged flap that has an opening on the top. This flap is in the chamber of the heart called the atrium. The vessels entering the right atrium are the superior and the inferior vena cava. These veins bring oxygen-poor blood back to the heart from the rest of the body. Describe the atrium, which is a receiving chamber for the heart.

8. Use your finger to find the opening into the right atrium and push down. If your finger goes completely into the heart, then you have reached the right ventricle. Take your finger out and replace it with a straw. If you push the straw all the way down, it will be in both the right atrium and the right ventricle.

9. Push on the straw until you can see it stretching the wall of the heart. Stick the point of the scissors through the heart wall to meet the tip of the straw. Cut all the way up to the top following the straw. Observe the inside of the heart. Find the inside of the atrium and the ventricle. Is there anything inside the heart?

10. Look between the right atrium and the right ventricle. You can see the thin, transparent membranes that form the tricuspid valve. The tricuspid valve remains open during the filling of the right ventricle. When blood leaves the right ventricle through the pulmonary artery, the tricuspid valve closes (Iub sound). Describe the valve.

11. Look at the open side of the heart. Poke the second finger of your right hand into the back of the lower chamber. After your finger comes out on top, put a straw in the opening. This marks the pulmonary artery. The pulmonary (semi-lunar) valve lies between the right ventricle and the pulmonary artery. Remember that all arteries carry blood away from the heart. This is the only artery in the body that carries blood low in oxygen. What is the reason for this?

Activity 2-1 Report 3: Exploring the Heart (Student Reproducible)

The Left Side of the Heart

12. Find the opening on the top of the left side of the heart. The opening leads to the left atrium. Put a straw where your finger was. Push it all the way down. After the blood leaves the lungs, it returns to the heart through the pulmonary vein. (Remember that all veins carry blood to the heart) Pulmonary veins are the only veins in the body that carry oxygenated instead of deoxygenated blood. The pulmonary veins bring oxygen-rich blood back into the left atrium.

13. Poke your scissors through the point where you think the end of the straw would be. Cut until you see the end of the straw. The end of the straw is now in the left ventricle. The straw has passed through the mitral or bicuspid valve. How is the wall of the left ventricle (which you have just cut through) different from the wall of the right ventricle? Explain.

14. Find the opening from the lower left ventricle towards the middle of the heart that leads to the outside. This is the aorta. Put a straw in the aorta. Which kind of blood, oxygenated or deoxygenated, flows through the aorta? Oxygenated blood flows through the aorta.

15. Cut down the aorta toward the heart and observe the valve. This is the aortic semi-lunar valve. Describe the appearance of the valve.

16. Can you find the two coronary arteries in the walls of the ventricles? Locate two tiny holes just above the aortic valve. This is where the coronary arteries leave the aorta to transport nutrients and oxygen to the heart.

17. Complete your examination and exploration of the heart specimen.

18. Follow directions from your teacher to complete your dissection and cleanup. Be sure you wash your hands thoroughly.

Activity 2-2 Report: Siphon Pump

A: **How Does a Siphon Work?**

1. Explain what happens when you plug both ends of the hose with your fingers, keep one end the water, move the other end of the hose out of the bucket toward the empty bucket on the floor, and release your finger.

2. What determines the amount of water per second that flows through the siphon?

3. Based upon your observations, describe how a siphon works.

B: **How Does a Siphon Pump Work?**

1. What causes water to move out of the siphon pump when you squeeze the bulb?

2. What happens when you plug the outlet hose with your finger while you pump the bulb? Exp your answer.

3. When you squeeze the bulb, why does the water go in only one direction out of the bulb?

4. After you squeeze the pump, what causes it to fill up with water again?

C: **How Is Your Heart Like a Siphon Pump?**

1. When you imagine that the siphon pump represents the right side of your heart, what does the squeeze bulb represent? The outlet hose? The inlet hose?

2. When you Imagine that the siphon pump represents the left side of your heart, what does the squeeze bulb represent? The outlet hose? The inlet hose? The valve?

3. You have just named some similarities between your heart and the siphon pump. Now describe what is different about how the siphon pump and your heart work.

3.4 Enrichment

Teacher Activity Notes

What Makes the Heart Beat Faster?

PLAN

Summary

Students observe the effects of the hormone epinephrine (adrenaline) on the beating heart of a brine shrimp by counting the number of times the brine shrimp legs pulse per minute.

Objectives

Students:

✓ predict the affect epinephrine has on the beating heart of a brine shrimp.

✓ observe the effects of epinephrine (adrenaline) on the beating heart of a brine shrimp.

Student Materials

- Activity Guide
- Activity Report
- Plastic drinking straw (small diameter)
- Epinephrine solution (0.01%) ; Medicine dropper; Microscope slide with cover slip; Metric ruler; Brine shrimp; Scissors; Clock or watch with second hand; Hand lens or bioscope (stereoscope $10X$)

Teacher Materials

- Activity Report Answer Key
- Charts and other visual representations that show the heart and circulation of blood. Also visual representations of blood vessels would enhance the learning experience.

Advance Preparation

Obtain the adult brine shrimp from an aquarium store. (The pulsating blood is not noticeable in newly hatched shrimp.) The shrimp can be stored in a container in the refrigerator for a few days without food or a water change. *Daphnia,* or water fleas, can be used in place of brine shrimp. They need to be ordered from a science supply house. Since they need to be kept alive with special food, the specified delivery date must be close to the date of the activity. It is difficult to keep these critters alive for long periods of time. Also order epinephrine.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-334-5551.

Estimated Time

One or two 45 – minute periods

Interdisciplinary Connection

Health Students can relate the observations of the brine shrimp to drug effects on the human body.

Prerequisites and Background Information

Students should know how to use a hand lens and bioscope. They should have practice in formulating hypotheses and designing experiments. It would also be helpful if students had some knowledge of hormone action.

IMPLEMENT

You can chose to conduct this activity as a whole-class demonstration, in pairs, or in small groups of 3 to 5 students. If you choose to conduct this activity as a whole-class demonstration, place the brine shrimp in a petri plate on an overhead projector. Add the epinephrine as students view the reactions on the screen. If you choose to have small groups of students conduct this exploration, here are some ideas for implementing the activity.

Introduce Enrichment 2-1 by discussing the concept of a hypothesis. Have students make a list of hypotheses. Discuss the concept that brine shrimp, like other lab animals, are living organisms. So remind students to be careful when working with them. You might want to post the safety rules for handling laboratory animals.

Steps 1-3

Ask students to think about how epinephrine could affect the heart rate of brine shrimp. Remind them of what a hypothesis is. Remind them to consider their original hypotheses about the effect of epinephrine on brine shrimp as they conduct the activity. Make sure students understand the need for the straw ring to contain the shrimp so that they're easier to find and observe.

Step 4

The medicine dropper, brine shrimp, and slides are very small. So students may need some help in centering their shrimp in the straw ring. Make sure students have the microscope set under low power. Also make sure the mirrors are focused on artificial light source-not on the sun. Remind students of lab safety rules, especially that the sun reflected in a microscope mirror can damage the eyes. Or you can post the safety rules.

Steps 5-6

Show students an example of a tally sheet. Ask them to make a mark every time they see the brine shrimp legs pulsate before the epinephrine is added. Monitor students as they add only one drop of epinephrine solution. Make sure they tally the number of times per minute the legs pulsate after the epinephrine was added. Have student compare the numbers of leg movements before and after they add the epinephrine.

> **Helpful Hint**
> A bronchial inhalator obtained from I a drugstore can be used as a substitute for epinephrine.

Conclude Enrichment 2-1 by comparing students' hypotheses to what was actually observed.

ASSESS

Use the experimental data and the written responses to the Activity Report to assess if students can

✓ explain the effects of epinephrine (adrenaline) on the beating heart of a brine shrimp.

Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. What was your hypothesis about the effect of epinephrine on brine shrimp?

2. Record the number of times the brine shrimp legs pulsed before and after the epinephrine was added.
3.

	Before	After

4. Describe your observations of the brine shrimp.
5. Was your hypothesis confirmed by your experiment? Explain your answer.

Activity Guide: What Makes the Heart Beat Faster? (Student Reproducible)

Introduction

Adrenaline or epinephrine is sometimes called the "fight or flight" hormone. When a person is angry or afraid, epinephrine prepares the body to fight or run away.

You cannot see the beating heart of the brine shrimp. But you can count the number of heartbeats per minute by counting the number of times the brine shrimp legs pulsate per minute.

Materials

- Plastic drinking straw (small diameter)
- Epinephrine solution (0.01%)
- Medicine dropper
- Microscope slide with cover slip
- Metric ruler
- Brine shrimp
- Scissors
- Clock or watch with second hand
- Hand lens or bioscope (stereoscope $10x$)
- Activity Report

Procedure

Step 1

Think about how epinephrine could affect the heart rate of brine shrimp. Write your hypothesis on the Activity Report. Consider your original hypothesis about the effect of epinephrine on brine shrimp as you conduct this exploration.

Step 2

Form a straw ring by cutting about 1 mm from the end of a straw.

Step 3

Place the ring on a slide. The straw ring will act as a container for the brine shrimp on the slide.

Step 4

With a medicine dropper, add one brine shrimp to the straw ring. Observe the slide under low power.

Step 5

Observe the brine shrimp. Use a tally system to determine how many times per minute the legs pulsate. Record your observations. Add a drop of epinephrine solution and repeat the counting. Compare the numbers of leg movements before and after you added the epinephrine. What did you observe?

Step 6

Consider your original hypothesis about the effect of epinephrine on brine shrimp as you conduct this exploration

What Makes the Heart Beat Faster? Activity Report Answer Key

1. What was your hypothesis about the effect of epinephrine on brine shrimp?
2. Record the number of times the brine shrimp legs pulsed before and after the epinephrine was added.

Before	After

3. Describe your observations of the brine shrimp.
4. Was your hypothesis confirmed by your experiment? Explain your answer.

CHAPTER 4 Arteries and Arterioles - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

4.1 PLANNING

4.2 USING ARTERIES AND ARTERIOLES – STUDENT EDITION (HUMAN BIOLOGY)

4.3 ACTIVITIES AND ANSWER KEYS

4.1 Planning

Key Ideas

- Arteries are thick, muscular vessels that carry blood away from the heart. Because arteries are elastic, they expand during systole. Their contraction during diastole propels the blood through the body.
- Arterioles are the smallest arteries and have rings of muscle around them to serve as valves. Arterioles control blood flow into the capillaries by relaxing or contracting the rings of muscle. They also control blood pressure in the arteries.
- Arteries and arterioles help maintain blood flow by maintaining blood pressure.

Overview

In the previous section students learned that the pumping heart moves blood throughout the circulatory system. In this section students explore the structure and function of the arteries and arterioles that carry the blood. Students determine pulse rates and feel the blood being pumped through their own arteries. They build models of healthy and diseased arteries and perform a simulated cut-and-paste coronary artery bypass procedure. Students explore some problems associated with atherosclerosis and discss good cardiovascular health habits. They discuss the important role of arteries and arterioles in maintaining blood pressure. Students investigate how arteries and arterioles help maintain the body's blood pressure by regulating the blood flow from the heart to the cells.

Objectives

Students:

✓ describe the structure and function of arteries and arterioles.

✓ explain the role of blood pressure in moving blood from the heart to the capillaries.

✓ relate the structure and function of an artery to atherosclerosis.

✓ compare and contrast a healthy and an unhealthy artery.

✓ perform a simulated cut-and-paste coronary bypass procedure.

✓ identify some causes of and prevention for the buildup of plaque in arteries.

Vocabulary

arteries, arterioles, atherosclerosis, capillaries, coronary arteries, heart attack, pulmonary arteries

Student Materials

Activity 3-1: Blocked Arteries

- Resources 1 and 2
- Activity Report
- Clear rubber tubing or toilet paper rolls; Scissors; Water; Paste; Markers; Cotton or clay

Teacher Materials

Activity 3-1: Blocked Arteries

- Activity Report Answer Key
- Materials for constructing models of arteries
- American Heart Association slides of occluded arteries
- "Eat Smart" video produced by MacNeil-Lehrer (optional)
- Photos of occluded arteries (optional)
- Diagram or model of the circulatory system showing the locations of the major arteries

Advance Preparation

See Activity 3-1 in the Student Edition,

Display the models students built in Activity 1-1. Display a siphon pump from Activity 2-2.

Make clay or putty with a light yellow color to represent fats and cholesterol.

Interdisciplinary Connections

Art Students can construct models. They can cut and paste a model of a bypass procedure.

Math Students can design and solve pressure/ volume problems.

Language Arts Students can write a story about moving through the circulatory system, paying special attention to the pulse caused by each heartbeat and the components of the blood.

Background Information

The walls of arteries have many elastic fibers that help maintain a smooth flow of blood. These fibers are stretched during systole, which stores some of the energy. Then during diastole, the elastic fibers propel the blood forward using this stored energy. This ensures an even flow of blood. These elastic fibers also help the arteries withstand the high pressures they are under.

The walls of arteries also contain smooth muscle fibers that control the distribution of blood to the different parts of the body by altering their diameter and changing their resistance.

4.2 Using Arteries and Arterioles – Student Edition (Human Biology)

Begin this section with the *Mini Activity: Taking Your Pulse.*

Draw students' attention to the key ideas by displaying them on posters and/or overhead transparencies.

Activity 3-1: Blocked Arteries is the pivotal activity in this section. A thorough discussion of the activity will help students realize how important the structure and function of healthy arteries are to a healthy circulatory system.

Review the vocabulary terms listed for this section, as well as the following.

- pulse
- pressure
- blood pressure

Review the *Apply Your Knowledge* and the *Review Questions*.

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Why does more blood go to muscles of the ventricles during diastole than during systole?

Mini-Activity

Taking Your Pulse Students take their pulse and compare it with their classmates'.

4.3 Activities and Answer Keys

Activity 3-1: Blocked Arteries

PLAN

Summary Students observe and describe an artery in various stages of atherosclerosis. They build models of healthy and diseased arteries and simulate a coronary bypass procedure.

Objectives

Students:

✓ describe the progressive buildup of plaque in an artery during different stages of atherosclerosis.

✓ demonstrate a coronary bypass procedure using a model.

✓ list some of the causes for plaque buildup.

✓ discuss possible consequences of atherosclerosis.

✓ list some ways to limit the risk of getting atherosclerosis.

✓ explain the structure and function of an artery and the effects of atherosclerosis.

Student Materials

- Resources 1 and 2
- Activity Report
- Clear rubber tubing or toilet paper rolls; Scissors; Water; Paste; Markers; Cotton or clay

Teacher Materials

- Activity Report Answer Key
- Materials for constructing the models of arteries
- American Heart Association slides of occluded arteries
- "Eat Smart" video produced by MacNeil-Lehrer (optional)
- Photos of occluded arteries (optional)
- Diagram or model of the circulatory system showing location of the major arteries

Advance Preparation

Make clay or putty with a light yellow color to represent fats and cholesterol.

Estimated Time One 50 – minute class period.

Interdisciplinary Connection

Art Students can make a model of an artery in various stages of atherosclerosis using cross sections of arteries. Students also can make a model of the coronary bypass surgery procedure.

IMPLEMENT

Steps 1-3

Have students read Resource 1 before discussing the questions that follow. Make sure students read the description of each picture on Resource 1. Note students' answers to the following questions.

- Why is atherosclerosis considered a danger to health?
- What evidence suggests that a high-fat, high-cholesterol diet is linked to atherosclerosis?
- Should you be concerned about your diet at your age? Why or why not? At what age should you become concerned?
- What are two things you can do to prevent atherosclerosis?

Step 4

Discuss the color of the clay with students. Yellow designates fat or cholesterol. Demonstrate how blood flow in the unhealthy artery is reduced and/or stopped.

Step 5

Guide students to the diagram on Resource 2. Using the diagram on Resource 2, students can simulate a coronary artery bypass procedure. Students can cut the model leg vessel and use it as the bypass graft by gluing it directly on the heart on Resource 2. Or students can cut the heart and the leg blood vessel from Resource 2, glue the heart on a piece of construction paper, and glue the leg vessel as the bypass graft onto the heart. Discuss with students the instruments a surgeon uses during a real bypass operation instead of scissors (a scalpel) and instead of glue (stitching thread or staples).

Conclude Activity 3-1 by discussing the kinds of foods students ate yesterday and today. Discuss which of the foods they've eaten are high in fat content. Ask students to keep a food diary. Have them record the amount of fat consumed in a given time period.

Extend Activity 3-1 by asking students to:

- collect food labels and record the saturated fats and cholesterol content. Have students compare their results and list the foods analyzed on a class chart.
- research the following topics.

  How effective is coronary bypass surgery? Are there other ways doctors can help manage plaque buildup in the arteries? (Examples: angioplasty, endarterectomy, and medications.) Write a letter to someone you care about who smokes. In the letter describe why smoking increases the risk of having a heart attack or a stroke.

  Helpful Hints

  - The American Heart Association has slides that show the progression of plaque buildup in atherosclerosis. These can be shown in addition to using the longitudinal sections of arteries included on Resource 1.
  - Monitor time to allow for adequate cleanup.
  - You can spray paint the cotton yellow or use yellow clay to represent fat or cholesterol.
  - Provide red construction paper for students to cover the outside of the paper roll so the model looks more like an artery.

ASSESS

Use the model of a healthy and unhealthy artery as well as the written responses to the Activity Report to assess if students can:

✓ compare and contrast a healthy and unhealthy artery.

✓ explain how too much fat and cholesterol can affect arteries.

✓ describe how the blood flow is restricted in an unhealthy artery.

✓ define the term atherosclerosis.

✓ explain the potential harmful effects of atherosclerosis.

✓ describe the purpose of a coronary bypass.

✓ identify ways to reduce the risk of getting atherosclerosis.

Activity 3-1: Blocked Arteries - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Describe the three pictures on Resource 1.

Picture 1 Picture 2 Picture 3

2. Why do scientists believe a high-fat, high-cholesterol diet is linked to atherosclerosis?
3. Why is atherosclerosis considered a health danger?
4. Does an adolescent need to worry about cholesterol buildup? Explain.
5. What are two ways to help prevent atherosclerosis?
6. What do you think some positive and negative effects of coronary bypass surgery would be?
7. What lifestyle changes would you recommend for a person who has just had his or her first heart attack and coronary bypass surgery?

A Suggested responses will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Why is cutting an artery dangerous?

Apply Your KNOWLEDGE

What do you think happens to the arterioles in your leg muscles when you are running? Explain.

If you are sick or frightened your face may get pale. What's happening in your body?

If you are embarrassed you may blush. What's happening in this situation inside your body?

Journal Writing

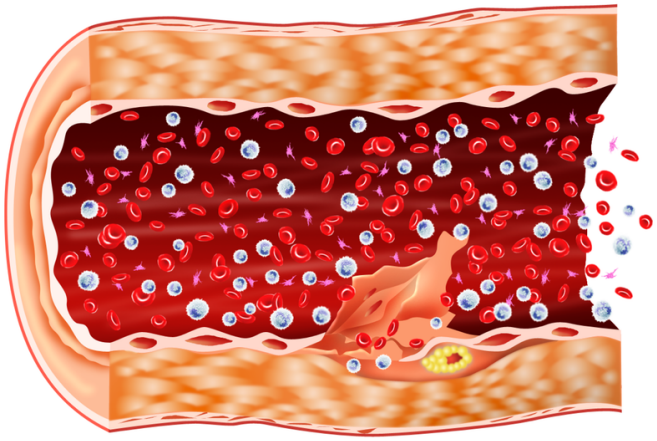
Pretend you are a drop of blood. Describe any differences in passing through a healthy artery and passing through an unhealthy, atherosclerotic artery.

Review Questions/Answers

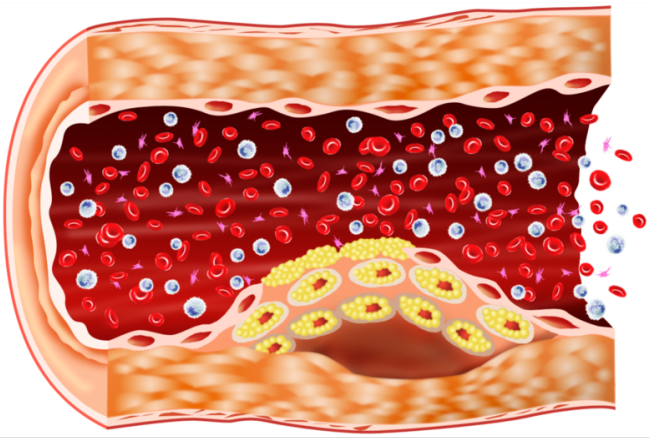
- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Describe three characteristics of arteries.
2. Why doesn't blood stop flowing in your arterioles when the heart relaxes between beats?
3. Describe two characteristics of arterioles. Explain how they work.
4. What happens during a heart attack?
5. What is atherosclerosis? How can you prevent it?
6. Explain the role of blood pressure in moving blood from the heart through arteries to the cells of the body.

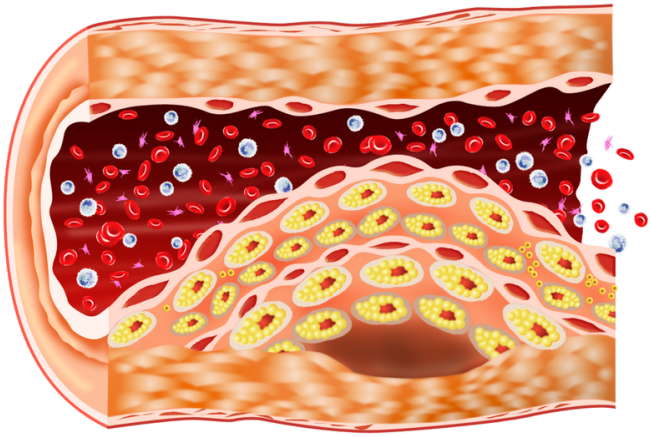
Activity 3-1 Resource 1: Blocked Arteries



Picture #1: A longitudinal section of an artery in which the process of atherosclerosis has begun. Excess fat particles collect under cells lining the artery that have been damaged by smoking, high blood pressure, and other causes. Atherosclerosis may not give a person any trouble until middle age, but it begins to develop earlier. For example, examination of American soldiers killed in the Korean War found that many soldiers had some degree of coronary atherosclerosis. Their average age was 22 . Deposits also have been found in the arteries of adolescents as young as 10 years old.

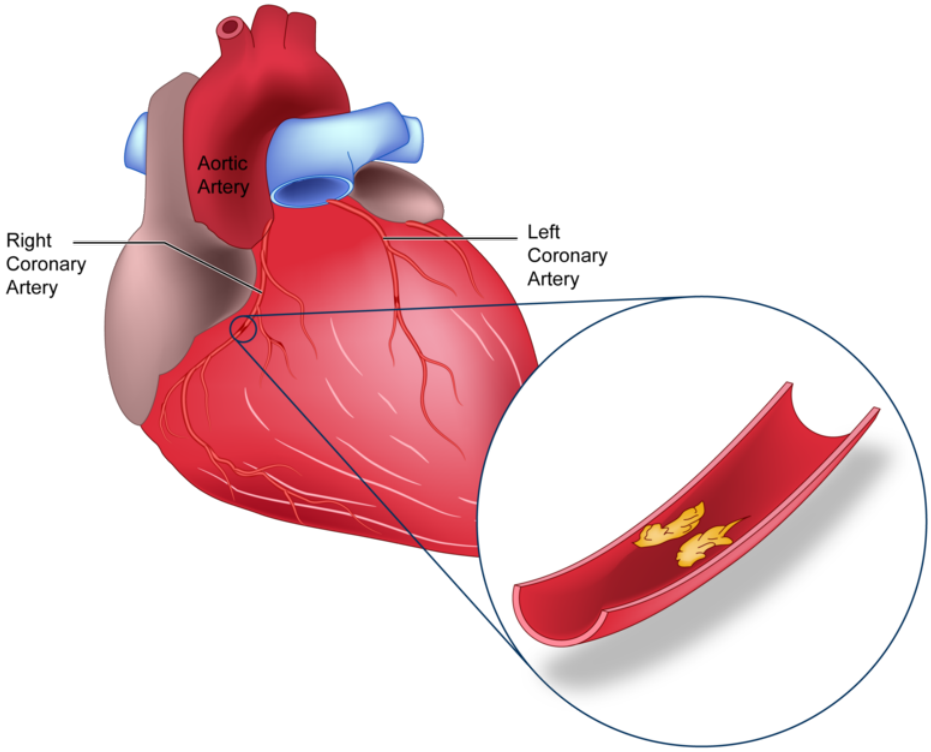


Picture #2: A longitudinal section of an artery narrowed by fatty deposits. Blood platelets form a cap of cells that isolates the plaque within the artery wall. As we age, fatty deposits tend to accumulate. These deposits narrow and roughen the passageway. This narrowing of the vessel can cause a blood clot to form.



Picture #3: A cross section of an almost completely blocked artery. A blood clot that lodges here can be large enough to completely block blood flow in this artery. When an artery is almost or completely blocked, the part of the body it serves is deprived of blood and becomes damaged. If the narrowing or blockage occurs in a coronary artery, chest pains or a heart attack may result. A stroke is possible if a blood clot occurs in an artery leading to the brain.

Activity 3-1 Resource 2: Blocked Arteries



Activity 3-1 Report: Blocked Arteries

1. Describe the three pictures on Resource 1.

Picture 1 Picture 2 Picture 3

2. Why do scientists believe a high-fat, high-cholesterol diet is linked to atherosclerosis?

3. Why is atherosclerosis considered a health danger?

4. Does an adolescent need to worry about cholesterol buildup? Explain.

5. What are two ways to help prevent atherosclerosis?

6. What do you think some positive and negative effects of coronary bypass surgery would be?

7. What lifestyle changes would you recommend for a person who has just had his or her first heart attack and coronary bypass surgery?

CHAPTER 5 Capillaries - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

5.1 PLANNING

5.2 USING CAPILLARIES – STUDENT EDITION (HUMAN BIOLOGY)

5.3 ACTIVITIES AND ANSWER KEYS

5.4 ENRICHMENT

5.1 Planning

Key Ideas

- Capillaries are thin and permeable blood vessels that allow for the exchange of nutrients, gases, and waste.
- This exchange of nutrients, gases, and waste occurs through the process of diffusion.
- The capillary network is extensive. No cell is more than two cells away from a capillary.

Overview

Students explored the structure and function of arteries and arterioles in Section 3. In this section they make a model of a capillary bed. Diffusion is extremely important to the function of capillary beds. Students explore how capillaries and capillary beds work-how the thin walls of the capillaries, the slow movement of the blood, and the process of diffusion allow gases, food nutrients, water, and wastes to pass back and forth between body cells and the bloodstream.

Objectives

Students:

✓ make a model of a capillary bed.

✓ describe the characteristics of capillaries which allow for exchange of gases, nutrients, water, and wastes between body cells and the bloodstream.

✓ design an activity to illustrate the process of diffusion.

Vocabulary

capillaries, diffusion, venule

Student Materials

Activity 4-1: Making a Capillary Bed Model

Activity Report

Construction or drawing paper; Scissors; Glue or clear tape; Marking pens; Materials to represent arteries, veins, capillaries and cells (Examples: string, yarn, thread, rope, and dried beans.)

Teacher Materials

Activity 4-1: Making a Capillary Bed Model

- Activity Report Answer Key
- Photos of capillaries
- Diagrams or a model of the circulatory system

Advance Preparation

See Activity 4-1 in the Student Edition,

Display the models students constructed in Activity 1-1.

Check your local audiovisual service and the resource list included in this unit to select visuals of capillary circulation.

Gather materials students will use in constructing their models, such as rope, yarn, string, and thread.

Interdisciplinary Connections

Physical Education/Sports Capillary function is disrupted by bruised, broken capillaries. Students can investigate methods for applying first aid to bruises caused by sports injuries.

Social Studies Sickle-shaped red blood cells block capillaries, which slows blood flow and reduces the oxygen supply. The gene for sickle-cell anemia is more common in geographic areas where malaria is endemic. Students can investigate the geographic distribution of sickle-cell anemia its cause, the reasons for its prevalence in areas with malaria, and in **Math**, the statistical frequency of sickle-cell anemia, as well as its financial impact.

Enrichment Activities

Enrichment 4-1: Observing Goldfish Capillaries

Enrichment 4-2: Transport of Materials Exploring Diffusion

5.2 Using Capillaries – Student Edition (Human Biology)

Begin this section with *Mini Activity: Transport of Nutrients: Exploring Diffusion.*

Draw students' attention to the key ideas by using posters and / or overhead transparencies.

Activity 4-1: Making a Capillary Bed Model is the pivotal activity in this section because of the critical role of the capillaries in exchanging nutrients, gases, and wastes. Ask students to use the model to demonstrate the role of capillaries in the diffusion of materials.

Use a video clip to show the flow of blood through capillaries.

Enrichment 4-2: Transport of Materials-Exploring Diffusion helps students learn about the process of diffusion and builds on the concepts presented in *Mini Activity: Transport of Nutrients: Exploring Diffusion.*

Review the *Apply Your Knowledge and the Review Questions*.

Review the vocabulary terms listed for this section.

Throughout and at the end of the section refocus students' attention to the key ideas.

Background Information

Diffusion can be defined as the movement of materials from a region of greater concentration to a region of lesser concentration. The energy required for this movement comes from molecular motion of the materials involved. This energy is available to move materials even in systems above $-273^{\circ}C$. Diffusion will continue as long as there is a difference in concentration *and* there is molecular motion within the system. Diffusion will stop when equilibrium is reached. But molecular motion continues once equilibrium is reached even though diffusion stops.

Temperature is a net measurement of the molecular motion of the substances in a given system. For example, water molecules in an ice cube vibrate as they would in any solid. The water molecules in liquid water are moving. They move slower at colder temperatures than at warmer ones, and they move randomly. As a gas, water vapor molecules are moving very rapidly and at greater distances from each other.

Altering the rate of molecular motion can change the rate of diffusion. Molecular motion can be increased by adding more energy to the system in the form of heat energy (raising the temperature) or mechanical energy (stirring). Removing heat from the system (cooling) can slow the rate of diffusion.

The rate of diffusion also can be influenced by concentration. For example, students could change the rate of diffusion by increasing or decreasing the dissolved substance added or the amount of liquid in the system.

5.3 Activities and Answer Keys

Activity 4-1: Making a Capillary Bed Model

PLAN

Summary Students make models of capillary beds. They observe and describe the role of capillaries and capillary beds in bringing nutrients and oxygen to the cells and carrying away waste materials and carbon dioxide from the cells.

Objectives

Students:

✓ show how a small artery brings blood to capillaries and a small vein takes blood away from capillaries.

✓ differentiate between oxygenated and deoxygenated capillaries.

✓ indicate where oxygen and nutrients leave the capillaries.

✓ indicate where wastes and carbon dioxide enter the capillaries.

✓ explain the role of capillaries in the maintenance of homeostasis.

Student Materials

- Activity Report
- Construction or drawing paper; Scissors; Glue or clear tape; Marking pens; Materials to represent arteries, veins, capillaries, and cells (Some examples include string, yarn, thread, and rope.)

Teacher Materials

- Activity Report Answer Key
- Photos of capillaries
- Diagrams or a model of the circulatory system

Advance Preparation

Collect the materials students will need to build their capillary bed models.

Estimated Time One 50 – minute class period.

Interdisciplinary Connection

Art Students can make their capillary bed models in art class.

Prerequisites and Background Information

None

Helpful Hints

Examples of materials that can be used in the models include the following.

Rope: colored/painted red to represent a small artery (arteriole) and colored/painted blue to represent a small vein (venule).

Yarn: red to represent capillaries carrying oxygenated blood and nutrients, and blue to represent capillaries carrying deoxygenated blood and carbon dioxide and other wastes.

Seeds or pasta: to represent body cells.

You can also use drinking straws to represent capillaries and smaller seeds or pasta that can pass through single file.

When representing capillaries in a body region, such as a leg, the direction of blood flow is from oxygenated (red) to deoxygenated (blue).

If they are using yarn, students can untwist ends of the yarn to show the close relationships of capillaries with each other and with neighboring cells. See diagram below.

IMPLEMENT

Steps 1-2

Ask students to develop a key to show which materials represent which structures.

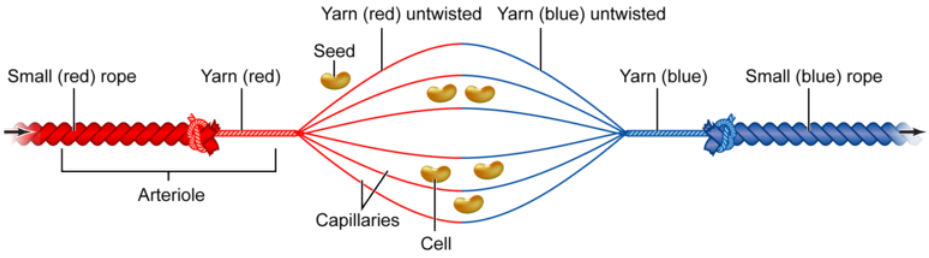
- capillaries carrying oxygen-rich blood and nutrients
- capillaries carrying oxygen-poor blood and wastes including carbon dioxide
- cells nourished by these capillaries
- small artery (arteriole) carrying oxygen-rich blood with nutrients to the capillaries
- small vein (venule) taking oxygen-poor blood with wastes away from the capillaries

Make sure students indicate the flow of blood using arrows.

Steps 3-4

When students have their models constructed, ask them as a Journal Writing assignment to take on the role of a component that travels in the blood through the capillaries (e.g., oxygen, carbon dioxide, food nutrients, hormone, or enzyme). Use the first person to write about a journey through the capillaries.

Conclude Activity 4-1 by having students refer to the models of the circulatory system they made in *Activity 1-1: Pathway of Blood through Your Body* to see where their capillary beds are located. Ask students to compare their models.



ASSESS

Use the capillary bed model to assess if students can:

✓ describe the role of capillaries in bringing nutrients and oxygen to the cells and carrying away waste materials and carbon dioxide from the cells.

✓ compare and contrast oxygenated and deoxygenated capillaries.

✓ identify where oxygen and nutrients leave the capillaries.

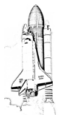
✓ identify where wastes and carbon dioxide enter the capillaries.

✓ explain the role of capillaries in the maintenance of homeostasis.

Activity 4-1: Making a Capillary Bed Model Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. How did you decide on the design of your capillary bed model? In your answer, be sure you reflect the contributions of each lab group member.
2. Identify the materials you selected to represent each part of the capillary bed model. Indicate which material represents which model part.
3. Make a diagram of your constructed capillary bed model.
4. A. Label each part and indicate with arrows the direction of blood flow. B. Indicate where oxygen and nutrients leave the capillaries and where wastes and carbon dioxide enter.
5. Write a summary paragraph explaining how blood moves through capillaries and helps to maintain homeostasis in your body.



Mini-Activity

Transport of Nutrients: Exploring Diffusion

The process of *diffusion* plays an important role in the exchange of materials between the blood and the cells. Gather some materials together that students can use to try to answer one of the following questions. Ask students to design an experiment to answer one of these questions.

- What do you think would happen if you filled a small beaker with tap water and added one drop of food coloring?
- What would happen if you filled a small beaker with tap water and added a cube of sugar?
- How is diffusion affected by temperature?
- What happens when someone opens a container of perfume or uses a spray bottle of room deodorizer?

Ask students to compare this activity to diffusion of nutrients. How is diffusion described here like the diffusion of nutrients and wastes in your cells?

Journal Writing

Pretend you are a red blood cell. Describe your journey as you pass through a capillary bed. How are you different leaving the capillary bed than when you entered the capillary bed?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. How are capillaries different from arterioles?
2. Why do you have capillaries?
3. Describe the process by which substances enter and leave capillaries.

Activity 4-1 Report: Making a Capillary Bed Model

1. How did you decide on the design of your capillary bed model? In your answer, be sure you reflect the contributions of each lab group member.

2. Identify the materials you selected to represent each part of the capillary bed model. Indicate which material represents which part.

3. Make a diagram of your constructed capillary bed model.

a. Label each part and indicate with arrows the direction of blood flow.

b. Indicate where oxygen and nutrients leave the capillaries and where wastes and carbon dioxide enter.

4. Write a summary paragraph explaining how blood moves through capillaries and helps to maintain homeostasis in your body.

5.4 Enrichment

Teacher Activity Notes: Observing Goldfish Capillaries

PLAN

Summary

Students use a microscope to observe the capillaries in the tail of a goldfish. This activity can be done as a whole-class demonstration. However, if you have enough equipment, you may wish to have students work in teams. This activity helps students learn careful handling of and respect for living organisms in the laboratory.

Objectives

Students:

✓ determine the direction of the blood flow in goldfish vessels.

✓ locate and identify capillaries containing blood cells.

Student Materials

- Activity Guide
- Activity Report
- Goldfish; Cotton; Petri dish; Microscope slide; Microscope; Medicine dropper

Teacher Materials

- Activity Report Answer Key
- Photos of capillaries
- Diagrams or a model of the circulatory system showing location of the major capillary beds
- Rules for Safety

Advance Preparation

Set up an aquarium and purchase goldfish.

Arrange to have microscopes available.

Post the safety rules for the care and handling of laboratory organisms.

Estimated Time

One 50 – minute period

Interdisciplinary Connection

Language Arts Students write about the journey of a red blood cell in and out of the capillary bed.

Prerequisites and Background Information

Students need to know how to use a microscope. Discuss with students the rules for the care and handling of living organisms.

IMPLEMENT

Steps 1-3

Remind students that the goldfish must be kept moist. Remind them to keep adding water to the cotton. Make sure they are keeping track of the time the goldfish is out of the aquarium.

Step 4

Make sure students are using the low power. Emphasize that they should never focus the mirror of the microscope toward the sun. Sun's reflection can damage the eye.

Steps 5-6

Remind students that the lenses of the microscope turn the image upside down. Therefore, blood that appears to be flowing from the fin to the body is actually flowing from the body to the tail.

As a Journal Writing assignment, have each student in the group represent a component that travels in the blood through the capillaries (e.g., oxygen, carbon dioxide, food nutrients, hormone, enzyme). Have them use the first person to write about a journey through the capillaries.

Helpful Hints

Post the safety rules, or point them out if they are already posted.

Remind students to be careful when handling the goldfish, such as when they are placing the goldfish back in the aquarium.

Make sure students do not use direct sun as the light source for the microscope.

ASSESS

Use your observations of students' working in groups and their written responses to the Activity Report to assess if students can

✓ identify capillaries in the goldfish tail.

✓ determine the direction of blood flow in goldfish vessels.

✓ compare the structure of the goldfish-tail capillary bed to their model capillary bed.

✓ determine the direction of blood flow in goldfish vessels.

Observing Goldfish Capillaries - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Draw a small section of the tail showing 1 or 2 capillaries, along with some blood cells. Label: an arteriole, a venule, and a capillary.
2. Compare what you observed in the goldfish tail to your model of a capillary bed.

Activity Guide: Observing Goldfish Capillaries (Student Reproducible)

Introduction

You can observe the movement of blood in the tail of a goldfish. The tail is so thin that you can see the blood moving through the capillaries. But remember that goldfish are living organisms and should be handled carefully.

Materials

- Goldfish
- Cotton
- Petri dish
- Microscope slide
- Microscope
- Medicine dropper
- Activity Report

Procedure

Step 1

Saturate a 5 – cm square piece of absorbent cotton or $\frac{1}{2}$ of a tissue with water. Place the cotton on the bottom of a petri dish with a small amount of water.

Step 2

Carefully place the head of a goldfish on the wet, absorbent cotton. Remember to handle the goldfish gently. Saturate another 5 – cm square piece of absorbent cotton with water. Place this piece cotton over the head and gills of the fish.

Step 3

Now put a clean microscope slide under the tail fin of the fish. Hold another slide gently on top of the tail fin to permit observation of the blood vessels in the tail fin. Periodically add fresh water.

CAUTION: The goldfish should not be out of the aquarium for more than 10 minutes **at a time. After** 10 minutes **, carefully place the goldfish back in the aquarium.**

Step 4

Place the petri dish on the stage of your microscope. Use the low power focus. Focus on a section of tail fin that shows blood flowing through blood vessels. Locate and identify an arteriole, a venule, and a capillary. Examine the thickness of each. Determine if the blood flow is toward the tail, from the tail, or in both directions.

Step 5

Observe the capillaries in the tail. Note how the blood flows through them. Draw a small section of the tail showing 1 or 2 capillaries along with some blood cells. Remember that the lenses of the microscope turn the image upside down. Therefore, blood that appears to be flowing from the fin to the body is actually flowing from the body to the fin.

Step 6

When you are through with your observations, place the goldfish back in the aquarium.

Activity Report: Observing Goldfish Capillaries (Student Reproducible)

1. Draw a small section of the tail showing 1 or 2 capillaries along with some blood cells. Label: an arteriole, a venule, and a capillary.

2. Compare what you have observed in the goldfish tail with your model capillary bed.

Teacher Activity Notes: Transport of Materials - Exploring Diffusion

PLAN

Summary

Students observe the diffusion of potassium permanganate $(KMnO_4)$ crystals and water in a graduated cylinder.

Objectives

Students:

✓ describe what happens when several crystals of potassium permanganate are placed at the bottom of a column of water in a graduated cylinder.

✓ explain the effect of stirring on the rate of diffusion.

✓ explain the effect of heating or cooling on the rate of diffusion.

Student Materials

Activity Report

Teacher Materials

- Activity Guide
- Activity Report Answer Key
- Two $50-1,000$ ml (milliliter) graduated cylinders
- One $2-$ foot long piece of clean, dry glass tubing with an internal diameter of about 3 mm
- 1 container of potassium permanganate $(KMnO_4)$ crystals
- Water

Advance Preparation

Obtain the $KMnO_4$, graduated cylinders, and glass tubing. If you don't have these available, they can be borrowed from the science department of your local high school. Or they can be ordered from a scientific supply house.

Carolina Biological Supply Company, 2700 York Rd., Burlington, NC 27215. Call 1-800-334-5551.

Estimated Time

20 minutes to set up the demonstration. Setup can be done before class. $5-10$ minutes will be needed each period over several days. Allow enough time for students to observe the diffusion.

Interdisciplinary Connection

Math Tables and rate determination of diffusion could be completed in math class.

Prerequisites and Background Information

SAFETY CAUTION: Potassium permanganate is poisonous. Be sure that students do not come in contact with it at any time.

Diffusion can be defined as the movement of materials from a region of greater concentration to a region of lesser concentration due to random motion. The energy required for this movement comes from the molecular motion of the materials involved. This energy is available to move materials in systems above $-273°C$. Diffusion will continue as long as there is a difference in concentration *and* molecular motion within the system. Diffusion will stop when equilibrium is reached. Once equilibrium is reached, although diffusion stops, molecular motion continues.

Temperature is a net measurement of the molecular motion of the substances in a given system. For example, in an ice cube, water molecules are vibrating as they would in any solid. In liquid water, molecules are moving slowly and randomly. In water vapor, a gas, water molecules are moving very rapidly.

Altering the rate of molecular motion can change the rate of diffusion. Molecular motion can be increased by adding more energy to the system in the form of heat energy (raising the temperature) or mechanical energy (stirring). Removing heat from the system (cooling) can slow the rate of diffusion.

Also, the nature of the substance determines its rate of diffusion. For example, perfume diffuses more rapidly than motor oil.

Helpful Hints

- It is important that the glass tubing is dry.
- It is best to select two or three medium-size crystals of potassium permanganate.

IMPLEMENT

Steps 1-4

If you set this demonstration up in advance, you may want to encourage students to try to explain how you put the potassium permanganate in the bottom. As a contrast, take a second cylinder, fill it with water, and drop some crystals into the water. These will dissolve and diffuse on the way down to the bottom.

The rate of diffusion also can be influenced by concentration. For example, you can change the rate by increasing or decreasing the substance added or by increasing or decreasing the amount of liquid in the system.

You may wish to do the demonstration at different temperatures, with varying concentrations or amounts of mechanical energy (stirring). Encourage students to record the time required for diffusion and to make a drawing, table, or graph of the results.

Step 5

You and your students should see a clearly distinct band of the purple dye at the bottom of the cylinder. Over a period of several days, have students observe the process of diffusion. Have them record their observations each day. The size and number of crystals will influence the time necessary for diffusion.

ASSESS

Use observations of the diffusion of potassium permanganate $(KMnO_4)$, crystals and water in a graduated cylinder and the written answers or the Activity Report to assess if students can:

✓ describe what happens when potassium permanganate crystals are placed at the bottom of a column of water in a graduated cylinder.

✓ explain the effect of stirring on the rate of diffusion.

✓ explain the effect of heating or cooling on the rate of diffusion.

✓ explain the process of diffusion.

Transport of Materials Exploring Diffusion Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Explain the process of diffusion.
2. Draw the apparatus.
3. Describe the color of the water in the cylinder.

4.

Day 1	Day 2	Day 3	Day 4

5. How long did it take for the diffusion process to reach equilibrium?

Activity Guide: Transport of Materials - Exploring Diffusion (Student Reproducible)

Introduction

SAFETY CAUTION: Potassium permanganate is poisonous. Be sure that you do not come in contact with it at any time. Because of the poisonous nature of potassium permanganate, it is recommended that this Enrichment be done as a whole-class demonstration.

The diffusion of potassium permanganate $(KMnO_4)$ crystals in water can be used as a colorful (purple) and simple demonstration.

In this demonstration a few crystals of $KMnO_4$ are placed by your teacher at the bottom of a column of pure water in a graduated cylinder. The diffusion of the $KMnO_4$ is easily observed as it diffuses throughout the column of water.

Predict what will happen to the crystals when placed at the bottom of the cylinder of water and how long it will take for equilibrium to be reached.

Describe why and how the process of diffusion occurs.

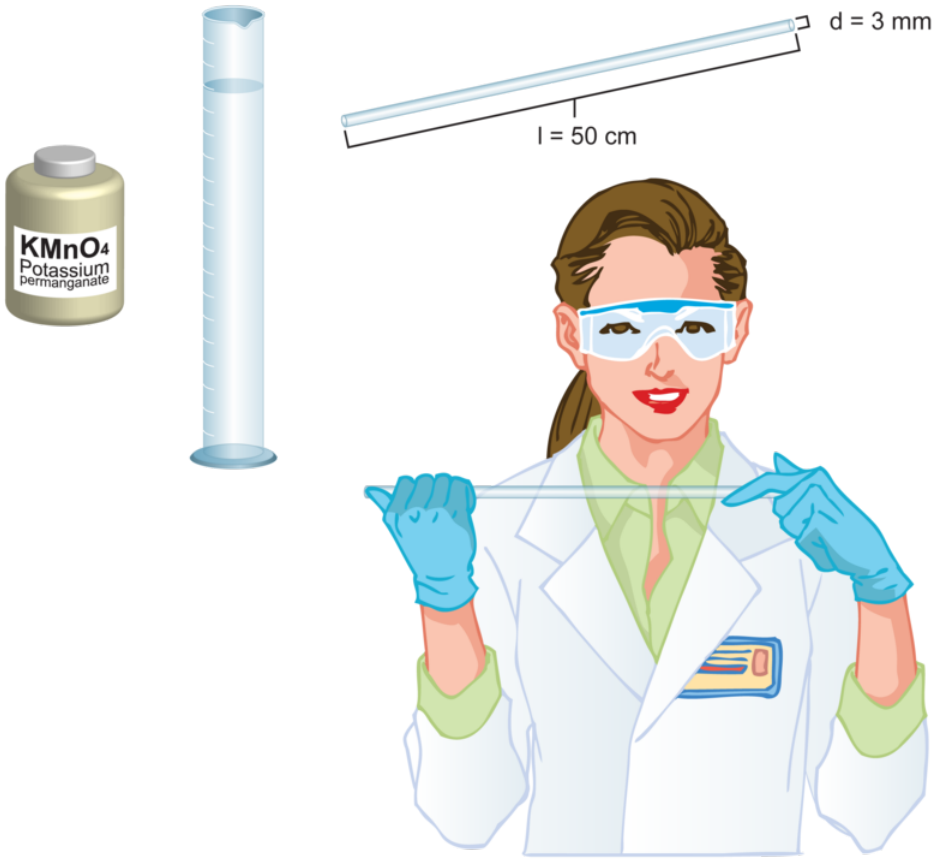
Procedure

Step 1

Fill 2 graduated cylinders $(50-1,000\text{ ml})$ with water. One cylinder will serve as a control. The potassium permanganate $(KMnO_4)$ will be placed in the bottom of the other. Discuss the value of controls in experiments.

Step 2

Select a $2-$ foot long piece of clean, dry glass tubing with an internal diameter of about 3 mm . The teacher places a thumb over one end of the tube and puts several crystals of $KMnO_4$ into the other end of the tube. The teacher inverts the tube, allowing the Crystals to fall down to the other end of the glass tube where the teacher's thumb is positioned.

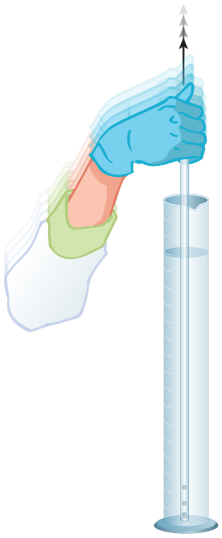


Step 3

The teacher's thumb is tight against one end of the tube while it is placed into the graduated cylinder. It is important that the cylinder is tipped slightly without spilling the water as the tube is placed carefully into the cylinder. The end of the tube is in contact with the bottom of the cylinder.

Step 4

Once the tube is on the bottom of the cylinder, the cylinder is returned to an upright position to allow the crystals to fall to the bottom. Then the teacher quickly removes the tube from the cylinder without removing the thumb from the end of the tube.



Step 5

You should see a clearly distinct band of the purple dye at the bottom of the cylinder. Over a period of several days, observe the process of diffusion. The size and number of crystals will influence the time necessary for diffusion.

Activity Report: Transport of Materials - Exploring Diffusion (Student Reproducible)

1. Explain the process of diffusion.

2. Draw the apparatus.

3. Describe the color of the water in the cylinder.

Day 1

Day 2

Day 3

Day 4

4. How long did it take for the diffusion process to reach equilibrium?

CHAPTER 6 Veins and Venules - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

6.1 PLANNING

6.2 USING VEINS AND VENULES – STUDENT EDITION (HUMAN BIOLOGY)

6.3 ACTIVITIES AND ANSWER KEYS

6.1 Planning

Key Ideas

- Veins and venules are the counterparts of arteries and arterioles. They carry blood away from the capillaries back to the heart.
- The walls of veins are thinner than those of arteries and can expand and collapse according to how much blood is in them.
- The pressure in veins is lower than the pressure in capillaries. So blood flows in one direction—from capillaries to venules to veins. One-way valves and the action of muscles help carry blood back to the heart.

Overview

Students explored the exchange of materials in the capillary beds in Section 4. In this section, students investigate the structure and function of the veins and venules. They explore the effect of gravity on the blood flow in veins, which are the vessels that return blood from the capillaries back to the heart. Students observe the valves in the veins of the hand. They investigate the one-way flow of blood by recreating and extending some experiments conducted by William Harvey. They construct a graph representing the distribution of blood within the circulatory system.

Objectives

Students:

✓ investigate the one-way flow of blood in the veins.

✓ compare the structure and function of veins and venules to those of arteries and arterioles.

✓ describe the differences in pressure in veins and capillaries.

✓ explain how blood gets back to the heart from the feet when walking.

✓ make a circle graph showing the percentages of blood found in different parts of the circulatory system.

✓ observe the valves in veins of the hand.

✓ explain how valves help to maintain the one-way flow of blood in the veins.

Vocabulary

veins, venules

Student Materials

Activity 5-1: The Direction of Blood Flow

- Activity Report
- Clock or watch with a second hand

Teacher Materials

Activity 5-1: The Direction of Blood Flow

- Activity Report Answer Key
- Model from *Activity 1-1: The Pathway of Blood through Your Body*
- Siphon pump from *Activity 2-2: The Siphon Pump*
- Heart drawings from *Activity 2-1: Exploring the Heart*
- Models and charts of the heart and circulatory system

Advance Preparation

See Activity 5-1 in the Student Edition.

Make sure students have their models from *Activity 1-1: Pathway of Blood through Your Body* and their heart drawings from *Activity 2-1: Exploring the Heart.* Display several siphon pumps.

Background Information

Blood pressure in veins is too low to propel the blood back to the heart. Veins above the heart return blood to the heart with the help of gravity. But the veins below the heart must work against gravity. The blood in these veins is propelled by the milking action of skeletal muscle contractions. One-way valves insure that the blood is propelled in the correct direction—toward the heart.

Vein walls are expandable, and blood tends to accumulate in veins. Up to 80% of the blood's volume can be found in the veins at anyone time. Occasionally veins become so stretched that these one-way valves no longer prevent backflow of blood. This backflow can result in varicose veins. Raising the feet above the head or using support hose can help drain these veins.

Problems can occur if a person returns too little blood to the heart and there is not enough blood in circulation. In these instances, blood accumulates in the lower portion of the body, and the person can faint (a result of too little oxygen going to the brain). Fainting causes a person to fall, which corrects the blood accumulation problem by reducing the affect of gravity on the flow of blood toward the heart.

6.2 Using Veins and Venules – Student Edition (Human Biology)

Begin this section with *Activity 5-1: The Direction of Blood Flow.* This activity effectively illustrates what veins are and what they do.

Review the vocabulary terms artery, arteriole, capillary, venule, and vein. Discuss how they work together to get blood with nutrients and oxygen to cells, transfer nutrients and oxygen to and remove wastes from cells, and then transport wastes, such as carbon dioxide away from the cells.

Review the *Apply Your Knowledge* and the *Review Questions.*

Throughout and at the end of the section, refocus students' attention to the key ideas using posters or overhead transparencies.

Mini-Activity

Observing Veins Students observe the veins in their hands after swinging and holding one of their hands at their side and above their head.

6.3 Activities and Answer Keys

Activity 5-1: The Direction of Blood Flow

PLAN

Summary Students recreate some of the experiments William Harvey performed. They use their hands and arms to investigate the one-way flow of blood from the body back to the heart. Students investigate the role of gravity and valves in the veins.

Objectives

Students:

✓ investigate the role of gravity as it affects blood flow in arms and hands.

✓ observe valves in the veins of the hand.

Student Materials

- Activity Report
- Clock or watch with a second hand

Teacher Materials

- Activity Report Answer Key
- Model from *Activity 1-1: The Pathway of Blood through the Body*
- Siphon pump from *Activity 2-2: The Siphon Pump*

Advance Preparation

Gather the models and materials noted in Teacher Materials.

Estimated Time One 45 – minute period

Interdisciplinary Connections

Language Arts or Social Studies You may want to share with the language arts or social studies teacher that your students are learning about the contributions of William Harvey, the 17th-century scientist who studied the human circulatory system.

Prerequisites and Background Information

Students should be able to describe the circulation of blood. They should have some knowledge about the roles of arteries and of veins in circulation.

IMPLEMENT

Steps 1-3

Divide the class into lab partners. Refer students to Figure 5.3. Have one student do the experiment, while the other records the observations for Steps 1-5. Then have students exchange roles and repeat Steps 1-5.

Steps 4-5

Remind students how to take a pulse. You can refer them back to Figure 2.5 on page 24 in their books. Emphasize the importance of the one-way valve.

Steps 6-7

Make sure each member of the pair does the experiment described in Steps 1-5 while the other records the observations.

Extend Activity 5-1 by having students

- research the work of William Harvey and other scientists who studied the circulatory system.
- investigate valve abnormalities of the heart, which can cause heart murmurs and reduce circulation efficiency.

Helpful Hints

- Students should work in pairs allowing sufficient time for all students to participate actively.
- Students who have difficulty locating their own surface vessels can make observations on those of other students.
- Allow ample time for discussion. This is a powerful opportunity for students to summarize, connect, and reinforce key concepts of the unit.
- Relate this activity to the excessive distention of veins causing varicose veins and explain how to prevent and treat these problems.
- Connect this activity to the experience of being light-headed as a result of standing up too quickly from a resting position, which causes insufficient flow of blood to the head region.

ASSESS

Use the results of the activity and written responses to the Activity Report to assess if students can:

✓ explain how blood flows through the blood vessels.

✓ describe the one-way valve mechanism in the veins.

✓ explain how gravity affects blood flow in the arms and legs.

Activity 5-1: The Direction of Blood Flow - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Record your observations of the differences between your two arms and hands.
2. Explain the observed differences between your two arms and hands.
3. Attach a sheet of plain paper with a drawing of your hand showing the pattern of surface vessels.
4. You observed the blood flowing in one direction in the veins as it returns to the heart. Name and describe as many features of the circulatory system as you can that help keep blood flowing in one direction throughout the circulatory system. (Hint: You may wish to refer to *Activity 1-1: Pathway of Blood through Your Body*.)
5. Name additional factors responsible for the movement of blood through the circulatory system.
6. How does the one-way system of blood flow help maintain homeostasis?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

The soldiers who guard Buckingham Palace in London, England do not move when they are on guard. They are known for their ability to stand still for very long periods of time. Some guards have fainted after only 30 minutes on duty. Why do you think this happened? What happened? How could the guard have prevented it?

Why is it more important for leg veins to have valves than neck veins?

Mini-Activity

Percentages of Blood Students make a circle graph that demonstrates the percentages of blood in different parts of the circulatory system.

Apply Your KNOWLEDGE

At rest your heart pumps only 20 **to** 25 percent **of the total blood volume in your body. What is the purpose of the other** 75 **to** 80 percent **of the blood? Where is this blood?**

In which blood vessels does blood travel the most slowly? Why?

Journal Writing

Pretend you are a drop of blood. What differences would you feel going to the heart through a vein than going from the heart through an artery?

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. In Section 3 you learned about arteries. In this section you learned about veins. Compare an artery and a vein. List four differences.
2. Explain how blood gets back to your heart from your feet when you are walking. What factors help the return of venous blood to the heart? What makes it more difficult to return venous blood back to the heart?
3. When you are resting, a greater percentage of your total blood volume is in your veins than when you are exercising. How is this possible?
4. How is blood output from the heart related to blood return?
5. Describe William Harvey's famous experiment. Include what he did and what conclusions he reached.

Activity 5-1 Report: The Direction of Blood Flow (Student Reproducible)

1. Record your observations of the differences between your two arms and hands.
2. Explain the observed differences between your two arms and hands.
3. Attach a sheet of plain paper with a drawing of your hand showing the pattern of surface vessels.

4. You observed the blood flowing in one direction in the veins as it returns to the heart. Name and describe as many features of the circulatory system as you can that help keep blood flowing in one direction throughout the circulatory system. (Hint: You may wish to refer to *Activity 1-1: Pathway of Blood through Your Body.*)

5. Name additional factors responsible for the movement of blood through the circulatory system.

6. How does the one-way system of blood flow help the body maintain homeostasis?

CHAPTER 7 Pressure, Flow, and Resistance - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

7.1 PLANNING

7.2 USING PRESSURE, FLOW, AND RESISTANCE – STUDENT EDITION (HUMAN BIOLOGY)

7.3 ACTIVITIES AND ANSWER KEYS

7.4 ENRICHMENT

7.1 Planning

Key Ideas

- Blood pressure is an important indicator of how hard the heart is working to circulate blood, through the body. High blood pressure can lead to health problems.
- Friction builds up resistance in blood vessels, contributing to an elevation of blood pressure.
- The endocrine and the nervous systems provide feedback that regulates basic functions, such as breathing, heart rate, and blood pressure.

Overview

In Section 5 students investigated how veins control the direction of blood flow with valves. In this section students explore the question of how the body controls the amount of blood passing through the blood vessels. They investigate how a control system of the body regulates pressure and resistance, and complete an activity introducing the concept of negative feedback. These systems control basic body functions, such as breathing, heart rate, and blood pressure. Students then measure their own blood pressures using a sphygmomanometer and cuff or a blood pressure meter.

Objectives

Students:

✓ explain the idea of pressure, resistance, and flow of blood through the heart and the blood vessels

✓ demonstrate chat narrower tubes have more resistance than wider tubes, thus decreasing rate of flow, and relate this finding to vessels in the human circulatory system.

✓ compare “systolic” and “diastolic” blood pressure readings.

✓ identify the effects of a specific change on the regulation of a system.

✓ graph the results of the activity dealing with negative feedback.

✓ explain how a control system can regulate a body function.

Vocabulary

blood pressure, controllers, endocrine system, friction, hypertension, negative feedback, nervous system, pressure head, resistance, sensors

Student Materials

Activity 6-1: Pressure, Resistance, and Flow

- Activity Report
- 2 large containers or beakers; 2 equal lengths of flexible tubing of different inside diameters; Clamp; Metric ruler; Plastic bottle; Tape; Large nail; Water; Sink or container to collect water

Activity 6-2: How a Controller Works

- Activity Report
- *Resources 1,2, and 3*
- Water bath (1,000 ml beaker); Thermometer; Crushed ice in container; Hot plate or other heat source; Paper towels

Teacher Materials

Activity 6-1: Pressure, Resistance, and Flow

- Activity Report Answer Key
- Materials for cleanup

Activity 6-2: How a Controller Works

- Activity Report Answer Key
- Additional supply of water, ice, and towels; Examples of other controllers, such as a thermostat (demonstration); Extension cords; Hot pads
- Diagram of the brain showing hypothalamus, pons, and medulla

Advance Preparation

See Activities 6-1 and 6-2 in the Student Edition.

Part A: Find tubing with differing diameters. The diameters must be different enough to clearly demonstrate a difference in the rate of flow.

Part B: Collect plastic gallon milk bottles ahead of time.

Activity 6-2: How a Controller Works

Be sure to have a custodian confirm that the electrical outlets will handle electrical load.

Prepare containers of ice water in advance.

Position hot plates so the cords are not a hazard.

Interdisciplinary Connections

Language Arts/Arts or Health Education Create a poster describing high blood pressure as a cardiovascular risk factor.

Math Develop and solve math problems connecting pressure and resistance.

Social Studies Contact the American Heart Association for demographic data on vascular disease which can be used to construct graphs.

Enrichment Activity

Enrichment 6-1: Your Blood Pressure

7.2 Using Pressure, Flow, and Resistance – Student Edition (Human Biology)

Begin this section with *Activity 6-1: Pressure, Resistance, and Flow.*

Draw students' attention to the key ideas using posters or overhead transparencies.

Review the vocabulary terms listed in this section and the following:

- force
- gangrene

Review the *Apply Your Knowledge* and the *Review Questions.*

Throughout and at the end of the section, refocus students' attention to the key ideas.

Background Information

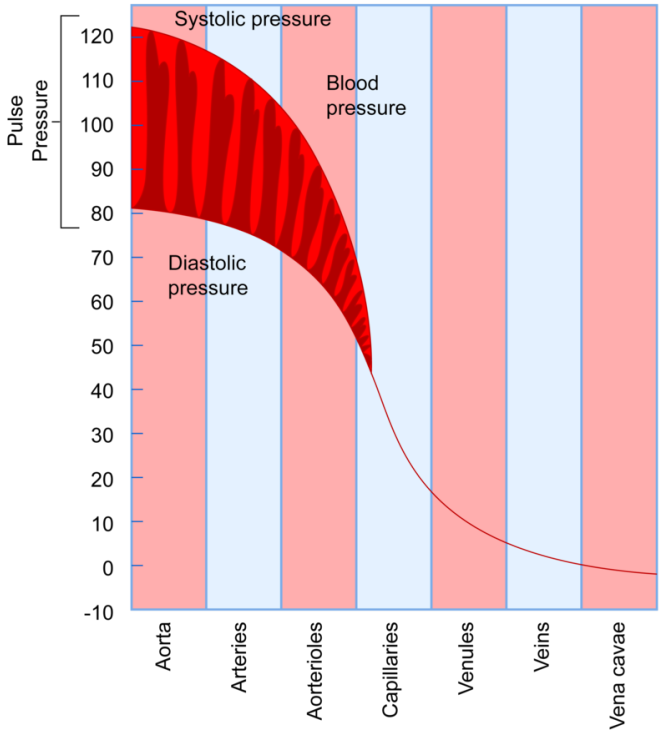
Blood pressure is the result of two forces. One force is created by the heart as it pumps blood into the arteries. The other force is created by the arterial blood vessels as they create resistance to the blood flow from the heart. The arterioles maintain the blood pressure in the arteries to keep the flow moving and to regulate the distribution of blood to where it is needed.

The nervous system and hormones adjust the diameters of the arterioles to control how much blood goes to each tissue in the body. Arterioles keep the upstream blood pressure in arteries higher, while distributing lower-pressure blood to capillaries. The walls of the arterioles can contract or expand, which changes the resistance to blood flow. Contraction reduces blood flow through the arterioles, while increasing blood pressure in the arteries upstream from them. If the arterioles remain constricted they can create a condition of hypertension or high blood pressure.

Consider the blood pressure readings in which the higher numbers indicate it is harder for blood to flow.

The chart below shows some normal pressure for adults throughout the circulatory system. Pressure ranges from 0 to 120 mm Hg in the left ventricle. In the aorta and other arteries of the body, pressure ranges between systolic pressure 120 and diastolic pressure 80 . The pulse pressure in arteries drops fast to just above 25 in the narrow arterioles. Blood flows "downhill," down the pressure curve from the capillaries through the veins to a few mm Hg at the right atrium. Pressure in the right ventricle is much less than pressure in the left. Right ventricle systole only gets up to 25 mm Hg . But this pressure drops to $5 - 12$ mm Hg at the left atrium. Pressures in the pulmonary circulation are $\frac{1}{5}$ of the pressures in the body (systemic) circulation.

Most physiological systems utilize negative feedback in which the system counteracts a change with a response in the opposite direction that brings the system back to a set point. A sensor recognizes a rise or fall from the set value of the variable being measured. The controller compensates for the change.


Systolic pressure
Blood pressure
Pulse Pressure
Diastolic pressure
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Aorta
Arteries
Aorterioles
Capillaries
Venules
Veins
Vena cavae

7.3 Activities and Answer Keys

Activity 6-1: Pressure, Resistance, and Flow

PLAN

Summary Students investigate the relationships among pressure, resistance, and flow using tubes, containers, and water. The water represents the blood, while the tubes represent the blood vessels. In Part A, students explore resistance by using tubes of differing diameters to demonstrate that the rate of flow in the narrow tube is less than the rate of flow in the wider tube. In Part B, students explore pressure and flow by using a large water reservoir with holes at three levels to demonstrate that the greater the pressure (hole closest to the bottom), the greater the flow of water.

Objectives

Students:

✓ demonstrate that narrower tubes have more resistance than wider tubes, thus decreasing rate of flow.

✓ describe how greater pressure means increased rate of flow.

✓ describe pressure, resistance, and flow of blood from the heart and through the blood vessels.

Student Materials

- Activity Report
- 2 large containers or beakers; 2 equal lengths of flexible tubing of different inside diameters; Clamp; Metric ruler; Plastic bottle; Tape; Large nail; Water; Sink or container to collect water

Teacher Materials

- Activity Report Answer Key
- Towels and sponges for cleanup

Advance Preparation

Part A: Find tubing with differing diameters. The diameters must be different enough to clearly demonstrate a difference in the rate of flow.

Part B: Collect plastic containers. Gallon milk bottles work well.

Estimated Time One 50 – minute class period

Interdisciplinary Connection

Math In the class, students can calculate the rate of flow for each of the containers. The volume and time must be measured, and the rate calculated by the following formula.

$$\text{Rate} = \frac{\text{Volume}}{\text{Time}}$$

Prerequisites and Background Information

Students need some experience with the development of line graphs. Students should have some knowledge of pressure heads and resistance, concepts studied earlier in this unit, and how they affect the flow of water from a container.

Like the inside wall of blood vessels, the walls of the tubes create friction that decreases the flow in the tubes. If resistance is lowered in a tube, the flow will increase unless the pressure is decreased. When the pressure is increased, as it is for the holes on the bottom of the large container of water, the rate of flow is increased. The heart must work harder to provide the pressure necessary to push the blood through the tubes in order to maintain the blood flow in diseased arteries that are narrower.

Helpful Hint

Monitor time to allow for adequate cleanup.

IMPLEMENT

Part A

Steps 1 - 8

Place the setups for Parts A and B so that the water can flow into the sink or into a large tray or container.

Make sure the same amount of water is in each beaker. Also make sure no water leaks out as students submerge their tubes.

Make sure students organize the tasks. Make sure someone is timing the flow and someone is recording the data. Monitor the location of the tubes. This activity can get messy if the tubes are not pointed into the container or the sink.

Part B

Steps 1-6

Review the safety rules. Remind students to be careful when making the holes with the nails. Make sure the holes are at different heights. It is helpful if the holes are slightly at a downward angle as well. Again, make sure the holes are facing the container or sink. Make sure someone is timing the flow and someone is recording the data.

Guide students in effective and timely cleanup.

Extend Activity 6-1 by suggesting possible variations that can demonstrate the relationships among pressure, resistance, and flow in the circulatory system.

ASSESS

Use the results of the experiment and written responses to the Activity Report to assess if students can:

✓ explain the effect of different diameters of tubes on the rate of flow.

✓ describe the relationship between resistance and rate of flow.

✓ describe the relationship between pressure and rate of flow.

✓ make connections between the experiment and the heart and blood vessels.

✓ explain how their predictions compared to the actual results.

Activity 6-1: Pressure, Resistance, and Flow - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

Part A

1. How many seconds did it take to empty Beaker A?_____ Beaker B?_____
2. From which beaker does the water flow the fastest? _____ the slowest?
3. a. From which beaker does the flow go the farthest out of the tube? b.The difference in the stream of water is due to resistance. Explain.
4. What is one thing that this experiment tells you about how vessels in the circulatory system function?
5. How do you think the heart compensates for arteries narrowed by fat and cholesterol deposits?
6. What happens if the vessel (artery) becomes completely clogged with fat?

Part B

7. How does the flow from each of the three holes differ? Why?
8. In Part A you saw that increasing the resistance (the narrower tube) decreased the flow. In Part B the resistance provided by all three holes is the same since their diameters are the same. Why is there a difference in the flow from each of the three holes?
9. What do you predict will happen if you replace one of the rubber tubes with a glass tube of the same length and inside diameter? Explain.

The You in You Students draw the circulatory system in an outline of their body.

- A Suggested responses will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Remember that your heart is two pumps working together. Which pump is stronger? You know both pumps have to pump the same amount of blood. Why does one have to be stronger than the others?

Cold Toes Students do a library search to explore frostbite, gangrene, and circulation.

In which blood vessels is the rate of blood flow the slowest? In which blood vessels is blood pressure the lowest?

Activity 6-2: How a Controller Works

PLAN

Summary Students learn how controllers work in their bodies by regulating the temperature of a water bath. Students control the temperature of a water bath around a set point of 37° Celsius $(98.6°F)$, which is also their body temperature. When disturbances occur, they add ice or heat. They graph the results and study the effects of the overshoot and delay of a variable on a control system.

Objectives

Students:

✓ identify the effects of a specific change (adding ice or heat) on the regulating system of the water bath.

✓ explain how the control system of the body regulates temperature and relate the system to the way the heart and blood vessels are controlled.

Student Materials

- Activity Report
- Resource Sheets 1, 2, and 3
- Water bath $0,000$ ml beaker); Thermometer; Crushed ice in container; Hot plate or other heat source; Paper towels

Teacher Materials

- Activity Report Answer Key
- Additional supply of water, ice, and towels; Examples of other controllers, such as a thermostat (demonstration); Extension cords; Hot pads
- Diagram of the brain showing hypothalamus, pons, and medulla

Advance Preparation

Be sure to have a custodian confirm that the electrical outlets will handle the necessary electrical load. Prepare containers of ice water in advance. Position hot plates so the cords are not a hazard. Prepare safety rules for using hot plates, electricity, and water.

Estimated Time One 50 – minute period

Prerequisites and Background Information

Students need some experience with reading a thermometer. They needs some skills in creating tables and graphs.

IMPLEMENT

Introduce Activity 6-2 by discussing with your students the following questions: What makes your heart beat faster? What makes it beat slower?

Steps 1-2

Make sure you model safe behavior in the lab by wearing goggles. Make sure the students wear goggles during this activity. As a part of your introduction to the activity, you may want to;

- demonstrate how to position the thermometer so that it doesn't rest on the bottom of the water bath. A ring stand works well to secure the thermometer.

- review safety procedures with students including turning off the hot plate when finished.
- review with students the information in the text. You may want them to summarize the information in their own words either as an oral presentation with a partner or in writing. It is essential that they are familiar with the concept of a variable prior to completing the activity.

Divide the class into groups of four. Remind students of the following four jobs in each group.

Student 1 watches the thermometer and tells the others to add ice or heat in order to keep the temperature at 37° Celsius.

Student 2 adds ice water to the bath if the thermometer reads greater than $37°C$.

Student 3 turns on the hot plate if the thermometer reads less than $37°C$.

Student 4 is the recorder and completes the temperature table.

Steps 3-7

At beginning of each class, be sure the water bath is less than one-fourth full of ice water. Remind students of the safety rules for using hot plates, heat, and electricity. Post the safety rules.

Make sure students are taking the temperature at $2-$ minute intervals for 20 minutes . Model for students how to plot the data.

Allow enough time for cleanup.

Extend Activity 6-2 by asking students do one or more of the following.

- Design and build a thermostat.
- Role-play a control system.
- Research other control systems of the body.
- Create a drawing illustrating how a control system works.

Helpful Hints

- This activity works well in groups of $2, 3,$ or 4 students. However, if students are in groups of fewer than four, one or two students will have to function in more than one role.
- Monitor the use of ice.
- For safety considerations, DON'T substitute alcohol or Bunsen burners for hot plates.
- Identify students who can help set up for the next class.
- Coordinate with math teachers regarding table and graph skills. Students may make their table and graph in math class prior to doing the activity.
- As an option you may want to provide the table (Resource 2) and graph (Resource 3) after the activity and compare the students' data for these.

ASSESS

Use the results of the activity and written answers on the Activity Report to assess if students can:

✓ observe and read a thermometer.

✓ construct and read a table and graph.

✓ explain the importance of an efficient regulating system.

✓ describe how the water bath example relates to the negative feedback regulation of blood pressure to keep the cardiovascular system in homeostasis.

Activity 6-2: How a Controller Works Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Was your group able to keep the temperature constant (close to 37°*C*) over the 20 minutes ? Explain.
2. What adjustments did you make to keep the temperature constant?
3. Describe your graph.
4. Where in your brain is the controller for blood pressure?
5. On the diagrams of control systems below, add the terms *temperature, your role, water temperature, add ice, turn up heat,* and *thermometer* where appropriate. Write a brief paragraph to explain how a control system works. Use Resource 1 to check your answers.

- A Suggested responses will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

Why might doctors watch diastolic pressure more carefully than systolic pressure?

Apply Your KNOWLEDGE

Suppose you find a person who has cut himself and lost a lot of blood. He may be unconscious. He's pale. His heart beats fast but his pulse is weak and hard to find. Put all these observations together to explain what you have observed.

His skin is pale. Why? The body closes down nonessential capillary systems so those more important ones, such as those to the heart and brain, can be filled with what little blood is left. The heart beats faster and harder because the control system is trying to restore blood pressure in the aorta. The pulse is weak because there is too little blood in the arteries to give a fuller pulse. The blood that should have been in the arteries is now on the pavement. The person is in shock and needs help immediately.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Describe two factors that affect cardiac output.
2. Why is the muscular wall on one side of the heart thicker than on the other side?
3. What is the difference between systolic and diastolic pressure?
4. How does a controller work?
5. What does the term homeostasis mean? How does it relate to blood flow?

Activity 6-1 Report: Pressure, Resistance, and Flow

Part A

1. How many seconds did it take to empty

Beaker A?_____

Beaker B?_____

2. From which beaker does the water flow the fastest? _____ The slowest?_____

3. a. From which beaker does the flow go the farthest out of the tube?

b. The difference in the stream of water is due to resistance. Explain.

4. What is one thing that this experiment tells you about how vessels in the circulatory system function?

5. How do you think the heart compensates for arteries narrowed by fat and cholesterol deposits?

6. What happens if the vessel (artery) becomes completely clogged with fat?

Part B

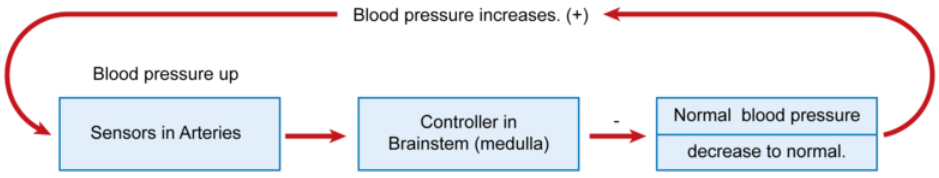
7. How does the flow from each of the three holes differ? Why?

8. In Part A you saw that increasing the resistance (the narrower tube) decreased the flow. In Part B the resistance provided by all three holes is the same since their diameters are the same. Why is there a difference in the flow from each of the three holes?

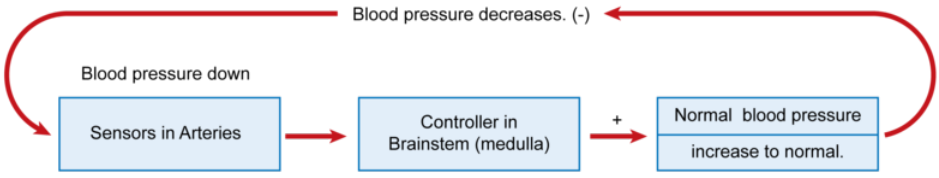
9. What do you predict will happen if you replace one of the rubber tubes with a glass tube of the same length and inside diameter? Explain.

Activity 6-2 Resource 1: How a Controller Works

If blood pressure increases, sensors in arteries send nerve impulses to the medulla. The medulla sends fewer signals to the heart. This decreases the heart rate and force of contraction, lowering blood pressure.



If the blood pressure decreases, sensors in arteries send nerve impulses to the medulla. The medulla sends more signals to the heart. This increases the heart rate and force of contraction, raising blood pressure.



Activity 6-2 Resource 2: How a Controller Works

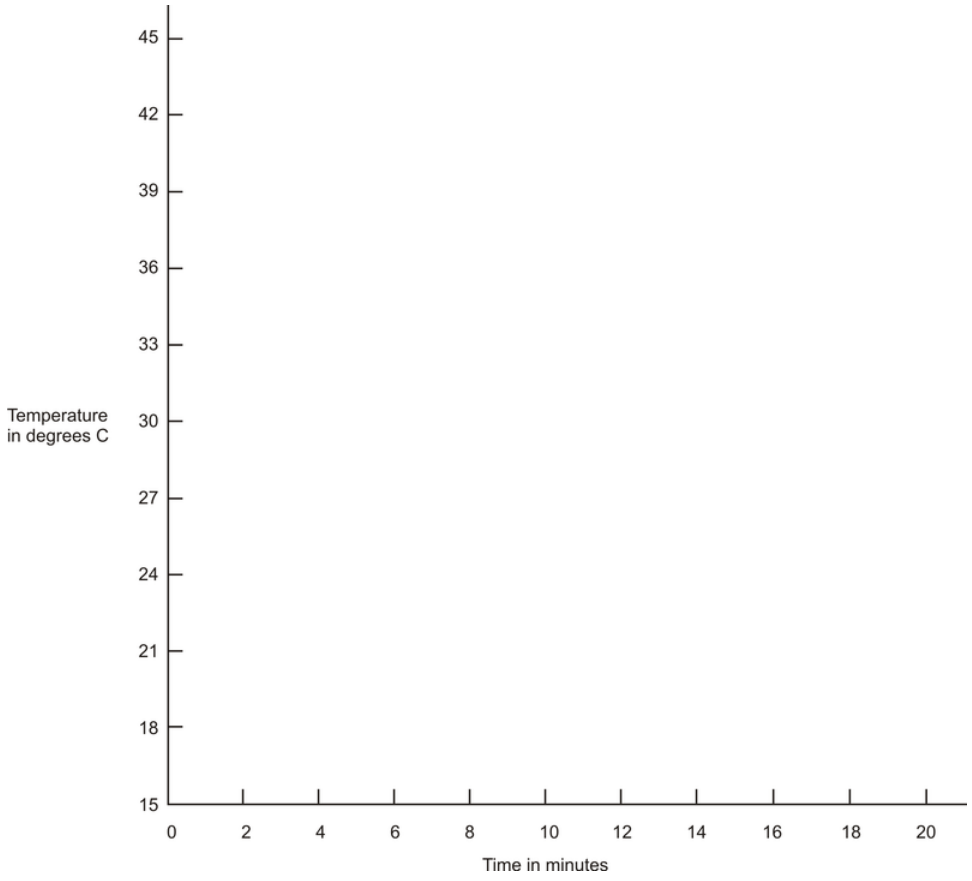
Use this table to record your observation data.

TABLE 7.1:

Time	Water temperature $^{\circ}C$
0	
2	
4	
6	
8	
10	
12	
14	
16	
18	
20	

Activity 6-2 Resource 3: How a Controller Works

Graph your data.



Activity 6-2 Report: How a Controller Works

1. Was your group able to keep the temperature constant (close to $37^{\circ}C$) over the 20 minutes ? Explain.

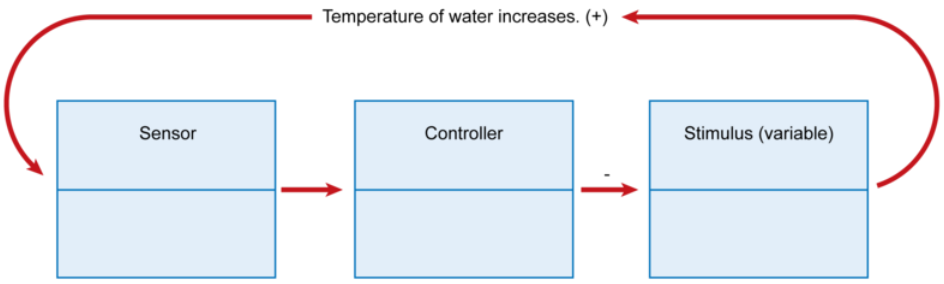
2. What adjustments did you make to keep the temperature constant?

3. Describe your graph.

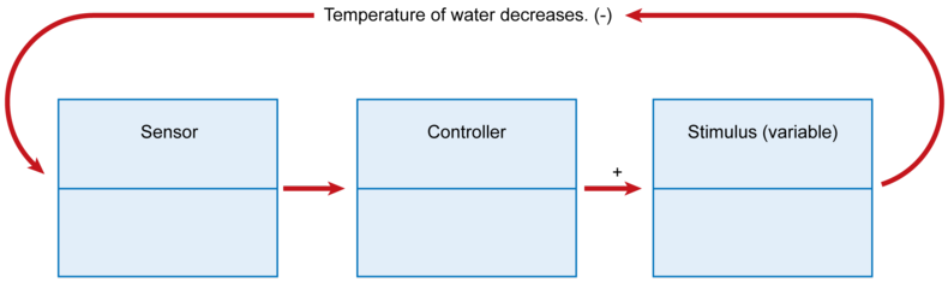
4. Where in your brain is the controller for blood pressure?

5. On the diagrams of control systems below, add the terms *temperature, your role, water temperature, add ice, turn up heat,* and *thermometer* where appropriate. Write a brief paragraph to explain how a control system works. Use Resource 1 to check your answers.

a.



b.



7.4 Enrichment

Teacher Activity Notes

Your Blood Pressure

PLAN

Summary

Students measure their blood pressure using a sphygmomanometer and cuff or a digital blood pressure meter. **Caution:** Some students may have heart problems, blood pressure problems, or other concerns and may not wish to participate. This is certainly the student's decision.

Objectives

Students:

✓ use a sphygmomanometer and cuff or a digital blood pressure meter to measure their blood pressure.

✓ explain the difference between the systolic and diastolic pressure.

✓ describe the normal ranges of blood pressure for their age group.

Student Materials

- Activity Guide
- Activity Report
- Blood pressure cuffs or sphygmomanometers; Stethoscopes
- Optional: Digital blood pressure meters

Teacher Materials

- Activity Report Answer Key
- Charts and other visuals showing the heart and circulation of blood
- Illustrations of arteries

Advance Preparation

Arrange with a health professional to come to the classroom to take students' blood pressures as an alternative to students taking the readings.

Become proficient in reading and using a sphygmomanometer or in the use of the blood pressure meter.

Estimated Time

One or two 45 – minute periods

Interdisciplinary Connection

Health Students research what normal blood pressure readings are at different ages (infants, children, adolescents, young adults, and older adults). Then they can determine how regular exercise affects blood pressure readings.

Prerequisites and Background Information

Knowledge of the cardiac cycle-systole and diastole-will help students with the terms "systolic pressure" and "diastolic pressure." Knowledge of the function of the arterioles in the regulation of blood pressure is helpful.

> **Helpful Hint**
>
> The American Heart Association video, Item No. 65-7011 "What Is High Blood Pressure Anyway?" (9.54 minutes), provides an explanation of high blood pressure that is appropriate for middle school students.

IMPLEMENT

Remember to be cognizant of any students with heart problems. Some students may not want their blood pressures taken. This is certainly their choice. If an adult measures the blood pressure for students, a station rotation is a good idea. One possibility is to set up three lab stations. Each station will be visited for about 15 minutes .

- Station A: Students work with the health professional who is taking the blood pressure readings. As the adult takes the readings, he/she will talk about what is being done and what the pressure readings mean.
- Station B: Students watch the video "What Is High Blood Pressure Anyway" followed by a discussion. (See Helpful Hint.)
- Station C: You can assign the text sections and *Apply Your Knowledge* questions on blood pressure.

If you choose to help students take their own blood pressure, they will need close guidance. It is a good idea to demonstrate the steps with one of the students.

Steps 1-4

Demonstrate these steps to make sure students know where to place the cuff and where to take the pulse.

Steps 5-7

Tell students they will follow the same steps. They will use the stethoscope to listen for the pulse pressure sounds. Emphasize the need to listen very carefully. Remind students that the cuff is cutting off the blood to the lower arm. They should not keep the cuff inflated more than one minute. One minute is enough time to read the systolic pressure-when the tapping sound begins-and then read the diastolic pressure-when the tapping sound stops.

- A demonstration of barometric pressure using a barometer can help students learn more about how blood pressure is measured.
- A demonstration using straws and string can show how the arterioles constrict, thus increasing the blood pressure.

ASSESS

Use the students' blood pressure and the written responses to the Activity Report to assess if students can

✓ use the proper procedure for measuring a person's blood pressure using a sphygmomanometer and/or digital blood pressure meter.

✓ define the terms "systolic" and "diastolic" blood pressure.

✓ identify the two numbers that make up a blood pressure reading.

✓ explain the normal ranges of blood pressure for students' age group.

Your Blood Pressure Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Record your systolic/diastolic pressures and your age. Your Blood Pressure Your Age Use the table below to find out what the range of systolic and diastolic pressures are for someone of your age and sex. For example, the systolic blood pressure of a 6 -year-old female should be between 78 and 113 . However, your reading today is not necessarily accurate. So do not be concerned if it does not fall within the normal range for your age and sex.

TABLE 7.2:

Age (years)	Sex	Systolic BP	Diastolic BP
6	M	78 – 115	48 – 78
6	F	78 – 113	48 – 79
12	M	93 – 135	58 – 88
12	F	94 – 133	59 – 85
14	M	98 – 143	60 – 90
14	F	97 – 139	61 – 90
16	M	103 – 148	60 – 95
16	F	100 – 143	62 – 92

2.

2. Taking someone's blood pressure is not that easy, and sometimes mistakes are made. Name two things that could be done wrong causing an inaccurate blood pressure reading.
3. What do the two numbers that make up a blood pressure reading mean?
4. Scott and Jeremy are both 14 years old. Scott's blood pressure measured $\frac{98}{65}$. Jeremy's blood pressure was $\frac{120}{80}$. The nurse took both measurements under the same conditions. Which of these statements explains the results?

a. Something is probably wrong. Boys the same age should have the same pressure.

b. Something is probably wrong. Scott's blood pressure is too low for a 14 -year-old boy.

c. The measurements are reasonable. Normal is a range of blood pressures, and blood pressures vary from person to person.

d. The measurements are reasonable. Something is wrong only if the difference is more than 40 .

5. What happens if blood pressure is too low?
6. Which blood vessels control the blood pressure in the arteries?

Activity Guide: Your Blood Pressure (Student Reproducible)

Introduction

Blood pressure is the force that drives blood through the vessels in the body. In this activity you or a professional measure your blood pressure. There may be some errors in measurement, but remember that normal is a range of blood pressure.

Materials

- Blood pressure cuffs and sphygmomanometers
- Stethoscopes
- Optional: Digital blood pressure meters
- Activity Report

Procedure

This activity can be done with the help of an adult.

Step 1

Roll up the sleeve on the right arm. Make sure the sleeve is well above the elbow. Rest the arm on a table or desk with the palm of the hand up.

Step 2

Center and secure the deflated cuff in the middle of the upper arm. Begin to inflate slowly and steadily. Feel the pulse as you inflate slowly. Stop inflating when the pulse disappears. This is an estimate of the systolic blood pressure. Deflate the cuff completely.

Step 3

Now you're ready to measure the blood pressure. Place the bell of the stethoscope firmly over the artery right above the crook of the elbow. Then locate the pulse at the wrist. Now inflate the cuff to 20 millimeters above the point when the radial pulse disappeared in Step 2.

Step 4

Release the air from the cuff slowly. The pressure should drop about 2 or 3 millimeters per second. Faster or slower deflation will cause errors.

Step 5

When the air pressure in the cuff is slightly lower than the blood pressure in the artery, the blood begins to flow through the artery with each heartbeat. You will be able to hear this rhyt11ffiic escape of blood through the stethoscope. These will be faint tapping sounds of increasing intensity. When the faint tapping sounds begin, record the pressure. This is the systolic pressure-the maximum pressure produced by the heart. When the tapping sounds stop or disappear completely, record the pressure. This is the diastolic pressure.

Step 6

After you record the diastolic pressure, deflate the cuff quickly and completely.

Step 7

Record your blood pressure reading on the Activity Report.

Activity Report: Your Blood Pressure (Student Reproducible)

1. Record your systolic/diastolic pressures and your age.

Your Blood Pressure_____

Your Age _____

Use the table below to find out what the range of systolic and diastolic pressures are for someone of your age and sex. For example, the systolic blood pressure of a 12 -year-old female should be between 94 and 133. However, your reading today is not necessarily accurate. So do not be concerned if it does not fall within the normal range for your age and sex.

TABLE 7.3:

Age (years)	Sex	Systolic BP	Diastolic BP
6	M	78 – 115	48 – 78
6	F	78 – 113	48 – 79
12	M	93 – 135	58 – 88
12	F	94 – 133	59 – 85
14	M	98 – 143	60 – 90
14	F	97 – 139	61 – 90
16	M	103 – 148	60 – 95
16	F	100 – 143	62 – 92

2. Taking someone's blood pressure is not that easy, and sometimes mistakes are made. Name two things that could be done wrong causing an inaccurate blood pressure reading.

3. What do the two numbers that make up a blood pressure reading mean?

4. Scott and Jeremy are both 14 years old. Scott's blood pressure measured $\frac{98}{65}$. Jeremy's blood pressure was $\frac{120}{80}$. The nurse took both measurements under the same conditions. Which of these statements explains the results?

a. Something is probably wrong. Boys the same age should have the same pressure.

b. Something is probably wrong. Scott's blood pressure is too low for a 14 -year-old boy.

c. The measurements are reasonable. Normal is a range of blood pressures, and blood pressures vary from person to person.

d. The measurements are reasonable. Something is wrong only if the difference is more than 40 .

5. What happens if blood pressure is too low?

6. Which blood vessels control the blood pressure in the arteries?

CHAPTER 8 Cardiovascular Health - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

8.1 PLANNING

8.2 USING CARDIOVASCULAR HEALTH – STUDENT EDITION (HUMAN BIOLOGY)

8.3 ACTIVITIES AND ANSWER KEYS

8.4 ENRICHMENT

8.1 Planning

Key Ideas

- Cardiovascular disease is the leading cause of death in adults in this country.
- Cardiovascular risk factors can be genetic and/or the result of personal choice.
- Making healthy choices can reduce the risk of getting cardiovascular disease.

Overview

In this section students apply what they have learned about the circulatory system by investigating the causes of cardiovascular disease. Cardiovascular disease is the leading cause of death in this country. Keeping the heart strong and arteries clear are achievable goals for most people. Some risk factors are easy to control by making informed choices. Becoming aware of these risk factors helps students learn different ways of controlling them, leading to improved cardiovascular health.

Objectives

Students:

✓ design and implement an experiment to determine pulse rate under different conditions.

✓ describe how each of the following risk factors can contribute to cardiovascular disease—smoking, cholesterol level, high blood pressure, obesity, genetic predisposition, and lack of exercise.

✓ construct a food pyramid to show healthy eating choices.

✓ distinguish between aerobic activities and non-aerobic activities.

✓ list examples of aerobic activities.

✓ evaluate and determine their own risk profiles and Cardiovascular Disease Risk Scores.

Vocabulary

aerobic exercise, aneurysm, heart attack, stroke, target heart-rate zone

Student Materials

Activity 7-1: Pulse Rate

- Activity Report
- Clock or watch with a second hand

Teacher Materials

Activity 7-1: Pulse Rate

- Activity Report Answer Key
- Clock with a second hand

Advance Preparation

See Activity 7-1 in the Student Edition.

Obtain a clock with a second hand.

Interdisciplinary Connections

Math Students compare pulse rates and target heart rate zones among classes and summarize results in charts, in graphs, and on a computer program.

Language Arts Students write persuasive letters encouraging good heart health regarding diet, exercise, stress, and smoking.

Health Education Students can contact the local Heart Association to ask for ideas for service projects in the community that promote good cardiovascular health.

Visual and Performing Arts Students role-play various stressful situations and how to respond in order to minimize stress on the cardiovascular system.

Physical Education Students explore the effects of training and regular exercise on maintaining a healthy cardiovascular system.

Enrichment Activity

Enrichment 7-1: Cardiovascular Disease Risk Scoring

Background Information

According to the American Heart Association approximately 954,000 Americans die each year of cardiovascular disease. That number is over half of the total number of deaths each year in the United States. Atherosclerosis,

sometimes called the "silent killer," is ultimately responsible for these deaths. Atherosclerosis takes several years to develop as the artery walls become lined with fatty, cholesterol-rich deposits. Healthy arteries are lined internally with smooth endothelial cells that, when damaged, accumulate fatty deposits or plaque. Platelets stick to the plaque, and a fibrous cap forms over the site, but the plaque continues to grow, narrowing the artery. Hardening of the arteries, or arteriosclerosis, occurs when calcium deposits in the plaque reduce the elasticity of the arteries. If part of the cap over the plaque breaks off, a blood clot or thrombus can form. The coronary arteries are susceptible to atherosclerosis. When plaque forms in these arteries, it reduces the flow of blood to the heart, resulting in chest pains and shortness of breath. If the plaque completely blocks the vessel, a heart attack results. Strokes are the result of a thrombus (called an embolus when dislodged in the bloodstream), which breaks loose and lodges in a blood vessel in the brain, blocking the flow of blood. This causes the brain cells fed by the artery to die. Depending on the location of the artery, the result can be memory loss, speech impairment, or paralysis.

Atherosclerosis can be reduced and even prevented by avoiding the risk factors that contribute to it. Smoking, high-fat and high-cholesterol diet, sedentary lifestyle, hypertension, obesity, and diabetes are all well-known risk factors.

This section helps students apply what they've learned in this unit to real-life situations and to ways they can improve their health habits and reduce the health risks to their cardiovascular systems.

8.2 Using Cardiovascular Health – Student Edition (Human Biology)

Begin this section with *Activity 7-1: Pulse Rate* to help students focus on their own pulse.

Review the vocabulary terms listed in this section.

Draw students' attention to the key ideas using means such as posters and/or overhead transparencies.

Assign Mini Activity: Your Target Heart-Rate Zone.

Discuss the question, "How can I keep my heart strong and my arteries clean and clear?"

Complete *Mini Activity: Risk Profile* to help students apply knowledge of good cardiovascular health.

Assign students to construct a food pyramid for themselves similar to the one in Figure 7.4. Discuss the pyramids they construct.

Time permitting select from Enrichment and Projects. *Mini Activity: Sources of Stress* is a good activity to determine ways to deal with stressful situations. *Enrichment 7-1: Cardiovascular Disease Risk Scoring* is a good activity for reinforcing the need to determine potential risks students are now taking and ways to improve their own life-long health.

Throughout and at the end of the section, refocus students' attention to the key ideas.

What Do You Think?
Do you think teenagers take more risks than other age groups? Why or why not?

A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

Apply Your KNOWLEDGE

What can happen if cells don't receive enough oxygen?

Mini-Activity

Your Target Heart-Rate Zone Students find their target heart-rate zone. Reviewing the formula can be helpful.

1. Subtract your age from 220 .
2. Multiply this number by 60 percent (0.60) . This is the low end of your zone.
3. Multiply the number from Step 1 by 85 percent (0.85) . This is the high end of your zone.
4. Can you find the middle of your zone? Use 75 percent as an estimate of the middle.

Apply Your KNOWLEDGE

Why does aerobic exercise help you develop and maintain cardiovascular fitness?

8.3 Activities and Answer Keys

Activity 7-1: Pulse Rate

PLAN

Summary Students measure their pulse rates under different conditions and then compare pulse rates with their classmates'.

Objectives

Students:

✓ measure their own pulse rates.

✓ collect and analyze pulse rate data to compare pulse rates with those of other class members.

Student Materials

- Activity Report
- Clock or watch with a second hand

Teacher Materials

- Activity Report Answer Key
- Clock with a second hand

Advance Preparation

Hanging a clock with a second hand that everyone can see is helpful.

Estimated Time One 50 – minute period

Interdisciplinary Connections

Math Students can chart and graph the results of pulse rates under the differing conditions that they set up.

Physical Education Students can perform variations on this activity during and after various sports activities.

Prerequisites and Background Information

Students should know the meaning of the words *pulse, variable,* and *prediction.* Students should have basic skills in making tables and graphs.

Helpful Hints

- Review the best ways to record data and to represent those data in tables, graphs, and/or other types of graphic organizers.
- Make sure that students who have conditions such as asthma, which could be exacerbated by vigorous exercise, participate only in activities that are safe for them.

IMPLEMENT

Introduce Activity 7-1 by demonstrating how to take the pulse using the wrist or the carotid artery.

Discuss the collection of data and how to graph the results.

Steps 1-4

Divide students into lab pairs. Remind them to follow the steps they used in the activities they conducted in this unit. Make sure they develop a materials list, a prediction of the results, procedures for conducting the experiment, and tables, charts, or graphs to demonstrate the results.

Steps 5-8

Make sure students show you their experimental design. Make sure nothing they are proposing is dangerous or requires materials and/or space that is unavailable. If the experimental design can be done effectively in the classroom, guide students in conducting their experiment. Make sure they record the data and present it accurately.

Conclude Activity 7-1 by asking the groups to share the results of their experiments with the class.

ASSESS

Use data and written responses to questions and teacher observations to assess if students can

✓ measure pulse rates and compare pulse rates of different individuals under different conditions.

✓ collect and analyze pulse rate data.

Activity 7-1: Pulse Rate - Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Why do you feel a pulse in an artery and not in a vein?
2. What is the role of arteries?
3. What happened to your pulse rate after you exercised? Explain why exercise affects pulse rate.
4. What do you think would happen if your pulse rate was too fast? What would happen if it was too slow? What prevents this from happening in a healthy body?

- A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

How does exercise help the body maintain good health?

Sources of Stress This activity is a good Journal Writing prompt. After students list some of the factors that create stress in their lives and what helps them to relieve that stress, ask them to write an essay on what they can do to alleviate stress.

Mini-Activity

Risk Profile Students rate themselves on each of the risk factors presented in Figure 7.8.

Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Describe the most common cardiovascular disease.
2. What happens during a heart attack?
3. What is risk?
4. Describe five risk factors for cardiovascular disease and explain what you can do to minimize them.
5. What kind of risk-taker are you? How does your willingness to take risks affect who you are? What isn't so good about being a risk taker in certain situations? What might be the consequences of any risks you are taking?

Activity 7-1 Report: Pulse Rate (Student Reproducible)

1. Why do you feel a pulse in an artery and not in a vein?

2. What is the role of arteries?

3. What happened to your pulse rate after you exercised? Explain why exercise affects pulse rate.

4. What do you think would happen if your pulse rate was too fast? What would happen if it was too slow? What prevents this from happening in a healthy body?

Helpful Hint

Remind students that they need not be complacent just because they scored well on the inventory. Healthy habits should be started early, maintained for a lifetime, and shared with friends and family.

8.4 Enrichment

Teacher Activity Notes: Cardiovascular Disease Risk Scoring

PLAN

Summary

Students complete a personal inventory to determine their own Cardiovascular Disease Risk Score in order to address ways of improving long-term cardiovascular health.

Objectives

Students:

✓ estimate their present health rating.

✓ determine the actual rating by completing the personal inventory.

✓ discuss ways of improving cardiovascular health

Student Materials

- Activity Guide
- Activity Report 1
- Activity Report 2

Advance Preparation

Review the concept of homeostasis.

If not yet completed, have students do *Enrichment 6-1: Your Blood Pressure* instead of having blood pressure taken in the community.

Estimated Time

One 45 – minute class period

IMPLEMENT

Step 1

After students have completed their own health inventories, have them invite parents, guardians, or other family members to complete the inventory. Discuss lifestyle changes at home with participating family members. Students may wish to report their experiences with the class.

Step 2

You may want to collect results for all students and determine an average total for the class. The results could be displayed in graph form by male/female or grade level comparisons.

Step 3

You may wish to follow up this activity with a *Personal Fitness Commitment Plan.*

ASSESS

Use this culminating activity to assess if students can:

✓ identify the factors that contribute to a healthy cardiovascular system.

✓ explain the effects of cholesterol level, exercise, stress, and smoking on the cardiovascular system.

✓ demonstrate how to rate their overall cardiovascular fitness.

✓ explain how the change of certain behaviors can improve their cardiovascular fitness.

Activity Guide: Cardiovascular Disease Risk Scoring (Student Reproducible)

Introduction

There are many factors that contribute to your cardiovascular health. Now that you know what some healthy and some unhealthy behaviors are, take a look at your own lifestyle. Do you think you lead a heart-smart life?

Materials

Activity Report 1

Activity Report 2

Procedure

Answer the questions below to determine your own score regarding each of the risk factors or characteristics currently associated with cardiovascular disease. Record the scores for each section on your Activity Report.

I. Blood Pressure

Do you know your blood pressure? If not, it only takes a few minutes to have it taken. The test is free at most health clinics. If you know your blood pressure, give yourself the following number of points:

1 point if your systolic blood pressure is between 93 and 143 and your diastolic pressure is between 58 and 90 .

3 points if your systolic blood pressure is between 144 and 150 and your diastolic pressure is between 91 and 100 .

5 points if your systolic blood pressure is above 150 and your diastolic pressure is above 100 .

-OR-

If you don't know your blood pressure, there are ways you can guess if it is at a healthy level. Give yourself the following number of points:

1 point if you are not overweight for your age and height, have no family history of high blood pressure, use little or no salt in cooking or at the table, and avoid processed food.

2 points if you are not more than 10 pounds overweight, have little or no family history of high blood pressure, rarely use salt at the table or in cooking, and avoid the saltiest processed foods.

3 points if you are 10 to 25 pounds overweight, have a close relative with high blood pressure, often salt food at the table and use an average amount in cooking, and eat a lot of processed food.

5 points if you are more than 25 pounds overweight, salt food regularly, and eat a lot of salty snacks and prepared food.

II. Cholesterol

Do you know your cholesterol level? Many people don't. But it's a good idea to have it checked. You can gauge your cholesterol level by analyzing your diet. Give yourself:

1 point if you use non-fat dairy products and/or seldom eat egg yolks, red meat, fat or oil, or your cholesterol level has been checked and is normal for your age.

2 points if you eat only 3 egg yolks a week; eat lean red meats, chicken or fish; little cheese; drink non-fat or low-fat milk; and eat little fat or oil, or your cholesterol level has been checked and is within the normal range for your age.

3 points if you eat 4 – 6 egg yolks a week; eat red meat and cheese or ice cream often; drink whole milk; and eat fast food and other high-fat food frequently, or your cholesterol level has been checked and is slightly above the normal range for your age.

4 points if you eat more than 6 eggs a week and red meat or cheese more than once a day; drink whole milk; and eat a lot of cream, butter, and high-fat processed foods and fast foods, or your cholesterol level has been checked and is well above the normal range for your age.

III. Exercise

Do you lead an active life? Aerobic exercise that strengthens your heart is exercise that keeps your whole body moving enough to make you sweat slightly and breathe deeply. You should do this type of exercise for at least 20 minutes , without stopping, at least four times a week. There are many exercises that strengthen your heart, such as brisk walking, jogging, running, swimming, dancing, racquetball, basketball, and bicycling. Golf, softball, baseball, bowling, bodybuilding, and tennis are not heart-building exercises. Give yourself:

1 point if you exercise aerobically 4 or more times a week.

2 points if you exercise aerobically 1 to 3 times a week.

3 points if you seldom exercise aerobically.

4 points if you never exercise aerobically.

IV. Stress

Stressful situations don't necessarily increase your risk of heart disease. The most important factor is how you respond to the stressful situation. Sometimes stressful situations can be positive experiences for you. However, they are likely to be harmful if you are often worried, find it hard to relax, feel constantly rushed, or are afraid you will never get everything done on time. Give yourself:

1 point if you are seldom stressed.

2 points if you are sometimes stressed.

3 points if you are often stressed.

4 points if you are almost always stressed.

v. Cigarette Smoking

Do you smoke? Smoking contributes to heart disease because it damages your blood vessels and increases your blood pressure. Give yourself:

1 point if you don't smoke.

4 points if you smoke.

Activity Report 1: Cardiovascular Disease Risk Scoring (Student Reproducible)

Recording Your Score

Add up your points to get your total score. You may want to copy this score sheet into your notebook.

Part I: Blood Pressure Score_____

Part II: Cholesterol Score_____

Part III: Exercise Score_____

Part IV: Stress Score_____

Part V: Smoking Score_____

Total Points _____

Interpreting Your Score:

Score:

5-8 Congratulations! You are in great shape. Your risk of heart disease is well below average.

9-13 There is always room for improvement. Your risk of heart disease is near the national average, which is already too high. Identify those aspects of your lifestyle that you can change to lead a healthier life.

14-17 Your lifestyle shows lots of room for improvement. Your heart will someday show the effects of your lifestyle. Take careful stock of your behavior, and bring your score down.

18-22 Your lifestyle will put you in a high-risk category for heart attacks when you are an adult. It may be vitally important for you to change your lifestyle. See a doctor for ways to improve your cardiovascular health and reduce your risks of heart disease.

No matter what your score, identify the changes you can make in your lifestyle in order to increase your overall cardiovascular fitness.

Your Score Sheet:

Fill in the following blanks with your score from the previous page:

Part I: Blood Pressure Score_____

Part II: Cholesterol Score_____

Part III: Exercise Score_____

Part IV: Stress Score_____

Part V: Smoking Score_____

Total Points_____

How did your results compare with your prediction? Explain.

Activity Report 2: Cardiovascular Disease Risk Scoring (Student Reproducible)

Risk Inventory and Goals for Improving My Health

1. According to my Cardiovascular Disease Risk Score, the following are risk factors that I have identified in my life and that I believe I can reasonably and possibly change. Identify each risk factor and what a healthy goal for reducing this risk factor would be.

a.

b.

c.

d.

2. Think about how you can reach the goals mentioned above. Below, address each specific goal and the steps

needed to achieve it. It may be helpful to work with a friend on a particular goal. If you choose to do this, indicate it on the form.

My goals for modification of these risk factors are:

a. By _____ (date) I will_____

_____

My plan for accomplishing this is:

_____

_____

b. By_____ (date) I will

_____

_____

My plan for accomplishing this is:

_____

_____

c. By_____ (date) I will

_____

_____

My plan for accomplishing this is:

_____

_____

d. By_____(date) I will

_____

_____

My plan for accomplishing this is:

_____

_____

3. If you are satisfied that you have put in your best effort to design a fitness program that:

- incorporates what you have learned about the circulatory system,
- takes into consideration what your risk factors are,
- provides several ways to reduce your risk factors, and
- offers a stepwise, workable plan to modify and monitor your risk factors one step at a time, sign and date your Personal Fitness Commitment Plan.

Signed _____ Date _____

4. Why should you try to modify your lifestyle to eliminate or reduce these risk factors?

5. What possible obstacles do you foresee that may make it difficult to accomplish your goals?

6. What can you do if you find yourself falling back into unhealthy behaviors or neglecting your Personal Fitness Commitment Plan?

CHAPTER 9 Additional Resources - Circulation - Teacher's Guide (Human Biology)

CHAPTER OUTLINE

9.1 USING GROUPWORK ACTIVITIES
9.2 PROJECTS
9.3 ADDITIONAL RESOURCES
9.4 CIRCULATION GLOSSARY

9.1 Using GroupWork Activities

Learning science is a process that is both individual and social. Like researchers, engineers, mathematicians or physicians who work in teams to answer questions and to solve problems, students in science classrooms often need to interact with their peers to develop deeper knowledge of scientific concepts and ideas. The GroupWork activities were developed to foster an environment in which groups of students work cooperatively to:

- plan experiments,
- collect and review data,
- ask questions and offer solutions,
- use data to explain and justify their arguments,
- discuss ideas and negotiate conflicting interpretations,
- summarize and present findings,
- and explore the societal implications of the scientific enterprise.

The GroupWork environment is one in which students are "doing science" as a team. Suggestions about when to introduce these group activities are included in the Teacher Activity Notes.

Format and Organization of GroupWork Activities

Each GroupWork activity includes teacher activity notes, an activity guide, an individual report, resource materials, and at times, data sheets. The activity guide contains instructions for the group's task and questions to be discussed as students plan for and work on a group product. Resource materials are varied. They might include textual information, visual resources such as photos, drawings, graphs or diagrams, video, or audiotapes. Individual reports by students are an integral part of each activity to be completed in class or as part of a homework assignment. Planning information for the teacher is found on the Teacher Activity Notes page.

Sets of GroupWork activities are organized around a central concept or a basic scientific question-a "big idea." Ideally, as students rotate to complete these activities, they encounter this central idea, question, or concept in different scientific contexts or in different social settings. These rotations provide students with multiple opportunities to grapple with the material, explore related questions and dilemmas, look at different representations, and think of different applications. Figure 1 shows how students rotate from activity to activity around the "big idea." The GroupWork activities were designed to be open-ended to foster the development of higher-order thinking skills. Such open-endedness allows students to decide as a group how to go about completing the task, as well as what the final group product might be. Open-ended group activities increase the need for interaction as students serve as resources for one another, draw upon each other's expertise and knowledge, and take advantage of their different problem-solving strategies. When groups are heterogeneous and include students with many different intellectual abilities, the repertoire of strategies and previous experiences is rich and diverse. As students interact with their peers, they learn how to communicate effectively, justify their arguments when challenged, and examine scientific problems from different perspectives. Such interaction scaffolds students' knowledge of scientific concepts and principles.

These GroupWork activities then are quite different from traditional lab activities that include more step-by-step procedures and are crowded with details. In addition to reading, writing, and computing (the traditional academic abilities), students use many different intellectual abilities to complete their task. They make observations, pose questions, plan investigations; they use and create visual models, access and interpret scientific information from different sources and from different media, and convey scientific findings in diagrams, graphs, charts, or tables. The use of a wide array of resource materials provides students with additional ways to access and use information, as well as with additional opportunities to demonstrate their intellectual competence and be recognized for their contributions. We have included in the Teacher Activity Notes a partial list of some of the multiple abilities students might be observed using in these group activities.

When group activities are open-ended, rich, and intellectually demanding, a single student will not be able to complete the task in a timely fashion by himself or herself. Making students responsible as a group to interpret a challenging task and to design a common product or group presentation increases group interdependence. Teachers know, however, that it is also important to hold each student personally accountable for contributing to the group's success and for mastering the concepts or the big idea of the activity. To do so, students are required to complete individual written reports in which they respond in their own words to key discussion questions and summarize what they have learned in the group activity. These written responses can be useful for teachers in gauging and monitoring student understanding and progress.

Role of the Teacher Planning ahead and organizing the classroom for GroupWork is important for the successful implementation of group activities. We suggest that you refer to Elizabeth Cohen's book, *Designing GroupWork: Strategies for Heterogeneous Classrooms,* published by Teachers College Press in 1994. (See also Lotan, R.A.,J.A. Bianchini, and N. C. Holthuis (1996). "Complex Instruction in the Science Classroom: The Human Biology Curriculum in Action," in R. J. Stahl, (Ed.) *Cooperative Learning in Science. A Handbook for Teachers*, Addison-Wesley Publishing Company.)

Many teachers have realized that when students work in groups, direct instruction is no longer practical. The teacher can't be everywhere at once, telling students exactly what to do and how to do it. Thus, teachers delegate authority to students and students take responsibility for their own behavior and their own learning. Rather than constantly turning to the teacher for help, students talk with each other to find out what they should be doing and to solve the challenging problems assigned to them. Teaching students to work collaboratively and to be responsible to one another as a group is an important prerequisite for successful GroupWork. Students also Support the smooth operation of groups when they have learned to play different roles in their groups effectively. For example, the facilitator sees to it that everyone in the group knows what has to be done and gets help when necessary. The recorder keeps notes of the group's discussions and checks to see if individual reports have been completed. The materials manager sees to it that the group has all the equipment necessary and that the tables are cleared at the end of the lesson. The reporter presents the findings of the group during wrap-up time. When the activity involves hazardous materials, a safety officer might be needed. Every student must have a role to play, and roles rotate so students learn how to perform each role competently.

Delegating authority doesn't mean that the teacher withdraws from the class or completely stays out of the action. Instead of being the focal point of the classroom, the teacher carefully observes the students as they work in the groups, stimulates and extends their thinking, and provides specific feedback.

Equalizing Participation among Members of the Group Making sure that all members of the group have access to the materials and that one group member doesn't take over or dominate the group while another withdraws are among the principal challenges of GroupWork. Teachers can increase participation of students by explaining how the different intellectual abilities are relevant to the successful completion of the task. The teacher states that while no one group member has all the abilities, everyone in the group has some of the intellectual abilities necessary to complete the task successfully. Furthermore, after careful observation of the students' work in groups, the teacher can publicly acknowledge those students who have made relevant contributions and explain specifically how these contributions made the group move forward and become more successful. It is important that the teacher be able to notice the intellectual contributions of students who have low academic or peer status, and who are frequently left out of group interactions. These strategies are particularly relevant in untracked classrooms, where students have a wide range of previous academic achievement (mainly in reading) or where significant proportions of students are English-language learners. Teachers, classmates, and the low-status students themselves need to understand that when many different intellectual abilities are necessary to complete a task successfully, everybody's contribution becomes critical to the success of the group. As more previously low-achieving students feel and are expected to be competent, their participation in the group increases, and subsequently their learning achievements increase as well.

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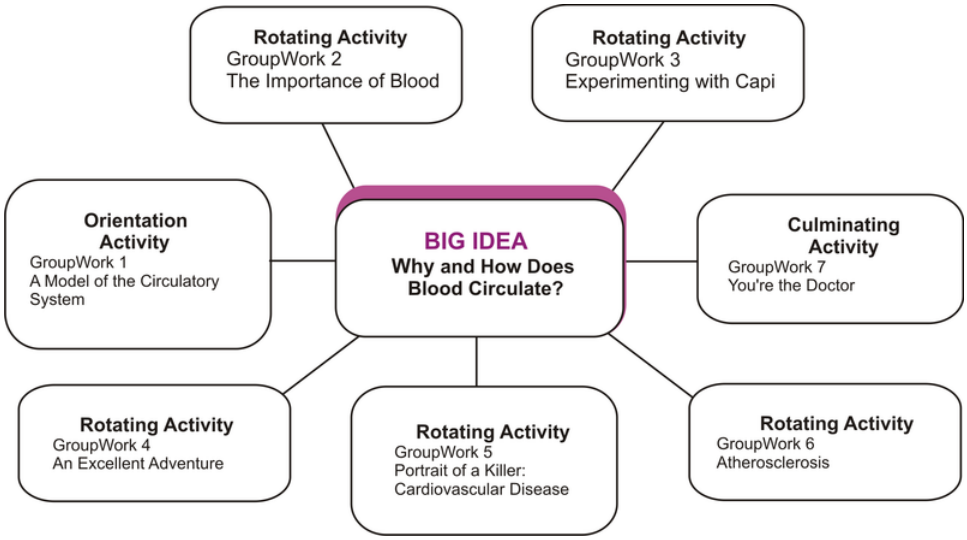


Figure 1: Activity Rotation in GroupWork

TABLE 9.1:

Activity	Estimated Time	Materials	Activity Summary
1. Orientation Activity: A Model of the Circulatory System	50 minutes	To be determined. Materials to keep on hand for this and other creative activities include poster paper, construction paper, glue, cardboard, milk containers, straws, scissors, egg cartons, cans, markers, and toilet paper tubes.	Students are asked to create a model of the circulatory system. They are expected to carefully consider how the structure of the circulatory system is related to its primary purpose: the transport of nutrients and gases.
2. The Importance of Blood	40 minutes	Prepared slides of human blood (stained), 2 microscopes, props, and art supplies-markers, paper, poster board, and paints.	Students explore the structure and function of one component of the circulatory system-the blood. They are asked to create a cartoon showing the structures of blood and their function.
3. Experimenting with Capillaries	50 minutes	Dialysis tubing (at least 25 mm in diameter and 25 cm long), string, starch and water solution, funnel, iodine solution, graduated cylinder, 250 ml beaker, and art supplies.	Students first experiment with dialysis tubing, starch and iodine solutions to learn about the process of diffusion. They then create a model of a capillary/cell system to demonstrate how gases and nutrients are transported to and from capillaries and cells.

TABLE 9.1: (continued)

Activity	Estimated Time	Materials	Activity Summary
4. An Excellent Adventure	45 minutes	Art supplies and large poster paper or poster board.	Students explore the structure and function of the circulatory system from a unique perspective-from inside the system.
5. Portrait of a Killer: Cardiovascular Disease	40 minutes	Video clip on heart disease, VCR, and art supplies, such as poster paper, scissors, glue, markers, and crayons.	Students investigate, via video, the causes and consequences of cardiovascular diseases. They apply this information to create a pamphlet or print advertisement encouraging others to be "heart smart".
6. Atherosclerosis	50 minutes	Clear rubber tubing, funnel, 2 beakers, water (with red food coloring added if desired), butter, straw or pipe cleaner to use as a spreader, and art supplies, such as clear rubber tubing or toilet paper rolls, clay, scissors, glycerin on corn syrup, glue, markers, and cotton.	Students examine the causes and physical manifestations of atherosclerosis. They create physical models of a healthy and unhealthy artery.
7. Culminating Activity: You're The Doctor	50 minutes	For Activity Guide: Reference materials on the anatomy of the heart, cardiovascular disease, and medical solutions. For Activity Guide 2: Scissors, glue or stapler, and blue crayon. For Activity Guides 3,4, and 5: Art supplies and/or paper may be necessary.	Students imagine they are a team of doctors. They must decide the best treatment for a patient with cardiovascular disease.

Groupwork 1: Teacher Activity Notes

Orientation Activity - A Model of the Circulatory System

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students create a model of the circulatory system. They are expected to carefully consider how the structure of the circulatory system is related to its primary purpose: the transport of nutrients and gases.

Group Size 4 to 5 students

Objectives

Students:

- create a model that accurately represents the circulatory system.
- explain the purpose of the circulatory system.
- compare the model with actual circulatory system.

Student Materials

To be determined. Materials to keep on hand for this and other creative activities include poster paper, construction paper, glue, cardboard, milk containers, straws, scissors, egg cartons, cans, markers, and toilet paper tubes.

Multiple Abilities

- Making connections between ideas/concepts, logically analyzing the problem (reasoning ability).
- Drawing an idea, creating a model (spatial/visual ability).
- Organizing the group, breaking a task into its parts, focusing on a goal (ability to make plans).
- Thinking of new uses for familiar objects, conceiving of an idea for an illustration (artistic/creative ability).

Estimated Time 50 minutes

Suggested Use

This set of activities works well near the end of the unit.

IMPLEMENT

1. Students need the resource that provides a city as a model of the circulatory system. Note that the city model is somewhat incomplete. For example, there is no explanation for what part of the city represents the heart. On the one hand, if students know they are expected to fill in gaps in the city model, the model's incompleteness may foster additional discussion and debate among group members. On the other hand, if students are uncomfortable with such uncertainty or lack sufficient background knowledge about the circulatory system, you may want to create a more detailed drawing or description of the city model and place it on a resource card.
2. Before students begin this activity, discuss how models are used in science to learn about and explain phenomena. One example of the important role models play in science can be found in James Watson's book, *The Double Helix.*

Extension Questions

- What other models did you reject before settling on this one? Why?
- Would you use your model to explain the circulatory system to third graders? Why or why not?
- Why do scientists use models?

ASSESS

Use the group discussion, group presentation, and individual report to assess if students can:

- identify the parts of their model and how each represents a part of the circulatory system.
- explain the primary purpose of the circulatory system.
- evaluate the strengths and lin1itations of their model.

Groupwork 1: Activity Guide (Student Reproducible)

Orientation Activity - A Model of the Circulatory System

Big Idea: Why and How Does Blood Circulate?

Introduction

Scientists often use models to simplify their work. They compare something that is difficult to understand to something familiar. For example, on your resource card the circulatory system is compared to a city. What other model might you use to learn more about the purpose of the circulatory system?

Materials

- To be determined

Procedure

1. As a group, study the city model described on your resource card. Answer the following questions:

- According to this model, what is the circulatory system's primary purpose?
- What part of the city represents the body cells? The blood vessels? The red blood cells? The heart? Oxygen? Carbon dioxide? Explain.

2. What are the strengths and limitations of the city model? Based on your discussion, fill in the table on the data sheet.

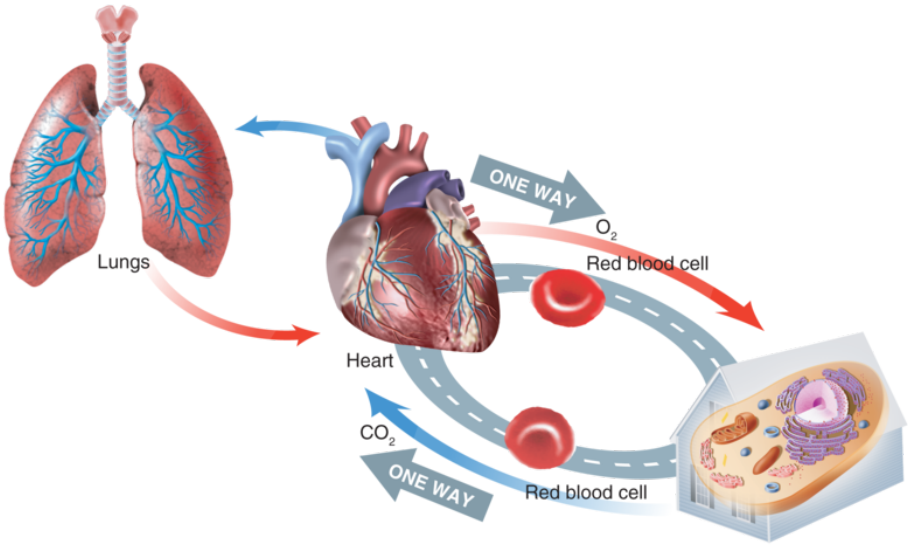
3. Build or draw a different model of the circulatory system and present it to the class. In your presentation be sure to include:

- the primary purpose of the circulatory system and how your model highlights this purpose,
- the parts of your model and what each part represents, and
- the strengths and limitations of your model.

Groupwork 1: Resource (Student Reproducible)

Orientation Activity - A Model of the Circulatory System

Big Idea: Why and How Does Blood Circulate?



Groupwork 1: Individual Report (Student Reproducible)

Orientation Activity - A Model of the Circulatory System

TABLE 9.2: TABLE OF STRENGTHS AND LIMITATIONS (Add additional rows it necessary.)

Strengths City Model	Strengths Your Model	Limitations City Model	Limitations Your Model

Big Idea: Why and How Does Blood Circulate?

1. What part of the city represents the body cells? The blood vessels? The red blood cells? The heart? Oxygen? Carbon dioxide? Explain.

2. Describe your team's model of the circulatory system.

3. In your model, where does the exchange of gases (carbon dioxide and oxygen) occur?

Groupwork 2: Teacher Activity Notes - The Importance of Blood

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students explore the structure and function of one component of the circulatory system—the blood. They are asked to create a cartoon that illustrates the structures of blood and their function.

Group Size 4 to 5 students

Objectives

Students:

- identify the three components of blood.
- explain the structure and function of each component of blood.

Student Materials

Prepared slides of human blood (stained), two microscopes, art supplies-markers, paper, poster board, paints, and props.

Multiple Abilities

- Drawing carefully and precisely and/or creating a cartoon (artistic/creative ability).
- Explaining clearly and fully, using words precisely (communication skills).

Estimated Time 40 minutes

Suggested Use

This set of activities works well near the end of the unit.

IMPLEMENT

If neither microscopes nor stained slides of human blood are available, use the resource card provided.

Extension Question

What should you consider about your readers as you plan your cartoon?

ASSESS

Use the group discussion, group presentation, and individual report to assess if students can:

- identify the three components of blood.
- explain the specific function of each component of blood.
- compare and contrast the structure and function of the red blood cells, white blood cells, and platelets.

Extensions

- Why are blood banks needed? First, ask students to research what blood banks do and why they exist. Then either take them to visit a nearby blood bank or ask a blood bank representative to speak to the class.
- You may want to obtain brochures, articles, or information packets from local blood banks about the importance of blood donations and the important role blood banks play in the community.

Groupwork 2: Activity Guide - The Importance of Blood (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

Introduction

You already know a lot about blood. You know what blood looks and feels like: At some point blood has oozed from a scratch on your finger or a cut on your knee. You also know that blood is necessary for human life. You probably have seen requests on the news for people to donate blood after a large disaster. In this activity you take a closer look at blood's structure and purpose.

Materials

Prepared slides of human blood (stained), 2 microscopes, props, and art supplies-markers, paper, poster board, and paints.

Procedure

1. Examine the prepared slides of human blood under the microscope. Discuss and record on your data sheet:

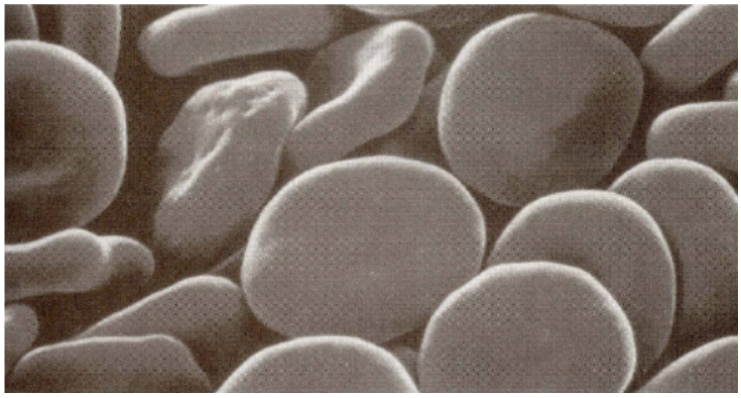
- what red blood cells look like and what they do.
- how does the structure of a red blood cell help it perform its function?
- what white blood cells look like and what they do.
- what platelets look like and what they do.

2. Create a cartoon strip that illustrates:

- the structure and function of the three major components of blood.
- where and how the exchange of gases (oxygen and carbon dioxide) occurs.
- why each component is important.

Groupwork 2: Resource - The Importance of Blood (Student Reproducible)

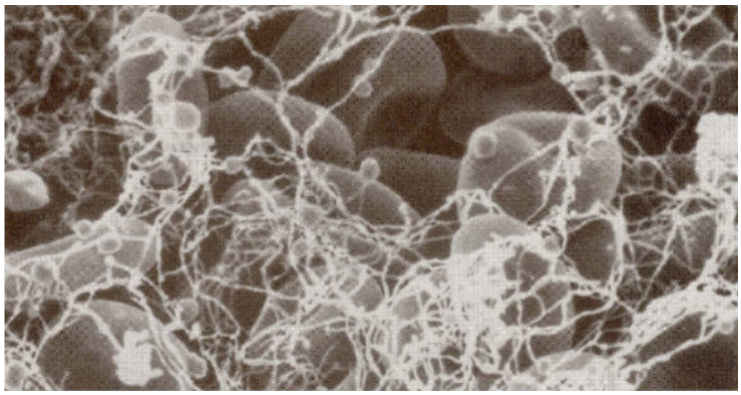
Big Idea: Why and How Does Blood Circulate?



Red blood cells have no nuclei. Their shape resembles a flattened donut.

White blood cells are fewer in number than red blood cells.

All white blood cells have nuclei. Some may also have fine granules within them.



Platelets are smaller than red blood cells. Although platelets are round or oval in shape, they often appear clumped together in blood smears.

Groupwork 2: Individual Report - The Importance of Blood (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

1. How are red blood cells different in appearance and function from white blood cells?
2. Why is knowledge of the composition of blood important? Give one example from real life.
3. How do all the parts of the blood help maintain homeostasis in the body?

Groupwork 3: Teacher Activity Notes - Experimenting with Capillaries

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students first experiment with dialysis tubing and starch and iodine solutions to learn more about the process of diffusion. They then create a model of a capillary/cell system to demonstrate how gases and nutrients are transported to and from capillaries and cells.

Group Size 4 to 5 students

Objectives

Students:

- simulate the process of diffusion using dialysis tubing, starch solution, and iodine solution.
- explain how nutrients, gases, and waste products diffuse across capillaries and body cells.

Student Materials

Dialysis tubing (at least 25 mm in diameter and 25 cm long), string, starch and water solution, funnel, iodine solution, graduated cylinder, 250 ml beaker, and art supplies.

Multiple Abilities

- Solving a problem experimentally, making connections between ideas, hypothesizing (reasoning ability).
- Creating a 3− dimensional object from a 2− dimensional diagram (spatial/visual ability).

Estimated Time 50 minutes

Suggested Use This set of activities works well near the end of the unit.

Background Information

- Diffusion is the movement of molecules from an area of higher concentration to one of lower concentration, until the concentration everywhere is the same. How does diffusion occur? The molecules in a gas or liquid are in constant motion. Moving molecules continually collide and the higher the concentration of molecules the greater the number of collisions. These collisions cause the molecules to change direction and to spread out until they eventually become uniformly distributed. Diffusion is responsible for the movement of a large volume of substances, such as gases and cellular waste, into and out of cells.
- Osmosis is the diffusion of water through membranes. Water may constantly pass into and out of cells through their plasma membranes. For example, if a living cell is placed in a solution that has a concentration of water lower than that inside the cell, water diffuses out of the cell from higher to lower concentration and the cell shrinks. A good example of this phenomenon is what happens when you sit in the bathtub too long-you begin to look like a prune!

IMPLEMENT

1. It is important to know that the dialysis tubing is a selectively permeable membrane. Starch will not pass through it. Water, iodine, and glucose will pass through. In order to speed up the process of diffusion and allow starch to pass through, you need to prick tiny holes in the dialysis tubing with a pin.
2. Model lab safety by pointing out the safety rules and by wearing goggles. Iodine dust and vapors are toxic and irritating. Avoid body contact and inhalation. Should body contact occur, flush immediately with water. Caution students about using iodine safely. If you use procedural roles (e.g., facilitator, materials manager, etc.), you might choose to have a safety manager whose job is to keep track of the iodine and ensure it is being used safely.
3. The starch solution can be made by dissolving 100 grams of corn starch in 250 ml of distilled water, forming a paste. Pour the paste into 650 ml of boiling (distilled) water. Cook for several minutes, stirring constantly. Cool and refrigerate.
4. The iodine solution can be made by dissolving 10.0 grams of potassium iodide and 3.0 grams of iodine crystals in 1 liter of distilled water. Store in brown bottle or other glass container that shields the liquid from light.
5. You will most likely need to introduce or follow-up this activity with a discussion about diffusion. Many students have difficulty with the concept of diffusion. Some, for example, do not realize that individual molecules can move back and forth across a membrane several times during the process of diffusion. Other students do not realize that higher versus lower concentrations of materials are determined by the type of molecule. If oxygen and sugar molecules are both found in a cell, oxygen molecules will move from higher to lower concentration irrespective of the sugar molecules and vice versa. You could demonstrate diffusion by placing a drop of food coloring in water, a drop of perfume in one corner of the room, or a lump of sugar in a glass of water. In each of these instances, the molecules will soon be evenly distributed through the medium.

Extension Questions

- Regarding the dialysis tubing experiment, explain what would happen if there were an equal concentration of starch inside and outside the tube. What if the dialysis tubing was placed in a salt solution?
- Why do only certain molecules diffuse into or out of a cell? Why, for example, don't DNA molecules diffuse out into the capillaries?
- What are the limitations of your capillary/cell system? What are its strengths?

ASSESS

Use the group presentation, individual report, and group discussion to assess if students can:

- construct a diagram model to demonstrate how gases and nutrients are transported across cell walls.
- explain the process of diffusion and its importance in circulation.

Groupwork 3: Activity Guide - Experimenting with Capillaries (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

Introduction

Every second, blood full of oxygen and nutrients flows past the cells in your body through the capillaries. Nutrients, gases, and waste products are exchanged between the capillaries and cells by *diffusing* across the cell membrane. In this activity, you learn more about the purpose and process of diffusion.

Materials

Dialysis tubing (at least 25 mm in diameter and 25 cm long), string, starch and water solution, funnel, iodine solution, graduated cylinder, 250 ml beaker, and art supplies.

Procedure

SAFETY CAUTION: Iodine dust and vapors are toxic and irritating. Avoid body contact and inhalation. Should body contact occur, flush immediately with water. Always wear goggles when working with substances, such as iodine and use the iodine carefully and safety.

1. To learn more about how diffusion works, do the following:

- Before you start this experiment, you'll need to know a few facts:

1. Iodine changes from a yellowish color to blue when it comes in contact with starch (a form of sugar).
2. Dialysis tubing is selectively permeable (like a cellular membrane) in that it has tiny holes that allow certain things to pass through.

- In order for nutrients, gases, and waste products to get to and from the cells in your body, they need to pass through the capillary and cell membranes. You can see how some things flow across these membranes by observing how starch passes through dialysis tubing with the additional holes poked through it. Dialysis tubing is not normally permeable to large starch molecules. Set up the following equipment:

1. Fill the beaker with about 75 ml of water and add about 75 ml of iodine.
2. Tie a tight knot at the bottom of a piece of dialysis tubing. Open the other end of the tubing and fill it with the starch and water solution. Tie the other end with a string.

- Predict what will happen when you place this dialysis tubing full of starch solution in the beaker of water and iodine. Come to a group consensus as to *what* will happen and *why.* Write your prediction and explanation on the data sheet.
- Then try the experiment. Observe what happens when you put the dialysis tubing in the water. Then describe what happens and why on your data sheet.

2. The above experiment is a model of the diffusion that occurs between your cells and the capillaries. In this model, what does the starch represent? What does the dialysis tubing represent? What does the water represent?

3. As a group, construct a diagram or model of a capillary system. In your presentation:

- identify the different parts of the model or diagram.
- illustrate how and where gases are exchanged.
- illustrate how the structure of the capillary membrane allows this exchange to take place.

Groupwork 3: Data Sheet - Experimenting with Capillaries (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

1. Prediction: What do you think will happen?

Explanation: Why?

2. Observations: What happened?

Explanation: Why?

Groupwork 3: Individual Report - Experimenting with Capillaries (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

1. What is diffusion?

2. How is this dialysis tubing model like a capillary system? Complete the following by filling in the part of the capillary system that is represented by each part of the model.

TABLE 9.3:

Model	Human Capillary System
Starch	
Dialysis tubing	
Water	
Beaker	

3. Capillaries allow food, water, and oxygen to pass from the blood to the body cells. They also allow the body cells to release carbon dioxide and waste into the blood. How does the structure of the capillary membrane allow these exchanges to take place?

4. What gases pass through your cell membranes? In which direction? Why?

Groupwork 4: Teacher Activity Notes - An Excellent Adventure

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students explore the structure and function of the circulatory system from a unique perspective-from inside the system.

Group Size 4 to 5 students

Objectives

Students:

- trace the path that blood takes starting and ending at the heart.
- identify the structure of a major component of blood and emphasize its importance in the circulatory system.
- predict what would happen to the rest of the circulatory system if the component they studied failed to function properly.

Student Materials

Art supplies and large poster paper or poster board.

Multiple Abilities

- Taking the role of an imaginary person and creating a dramatic role and vivid dialogue for a skit (creative/dramatic ability).
- Visualizing the circulatory system from a different perspective (spatial/visual ability).

Estimated Time 45 minutes

Suggested Use This set of activities works well near the end of the unit.

IMPLEMENT

1. There are three activity cards. They differ only in the "vehicle" that students use during their adventure. In A, students are asked to enter a red blood cell-in B, a white blood cell-in C, a platelet.
2. A storyboard is a type of presentation commonly used in ad agencies. It is a large board divided into smaller panels or boxes. The smaller panels are shown chronologically. Each contains a picture and script. Together, they are intended to represent the major scenes of a commercial, video, or show. Therefore, students might first show a picture of the inside of the heart (right side), then the pulmonary artery, the lungs, the pulmonary vein, the heart again (left side), the aorta, an artery, a vein, etc. The pictures and descriptions should be from the point of view of someone in or on a red blood cell, white blood cell, or platelet.

Extension Questions

- If you were in the circulatory system of a person with clogged arteries, how might your experience be different?
- How does this "inside" perspective differ from the perspective provided in the text? How is each useful in learning about the structure and function of the circulatory system?

ASSESS

Use the group presentation, individual report, and group discussion to assess if students can

- trace the path that blood takes starting and ending at the heart.
- identify the structure of a red blood cell, white blood cell, or platelet and its importance in the circulatory system.
- predict what would happen to the rest of the circulatory system if the component they studied failed to function properly.

Extension

Students might "act" out their journey based on the storyboard they create.

Groupwork 4: Activity Guide 1 - An Excellent Adventure (Student Reproducible)

Introduction

The text and activities provide a wealth of information about the structure and function of the circulatory system. In this activity, you investigate the circulatory system and its parts from a unique perspective—from inside the body. Prepare yourselves for an excellent adventure.

Materials

- Art supplies and large poster paper or poster board.

Procedure

1. Imagine you and your teammates have shrunk to microscopic size, *boarded a red blood cell,* and are now riding inside it. In other words, imagine you are traveling through a person's circulatory system.

2. Discuss the path you would take through the circulatory system if you started and ended your trip in the right ventricle of the heart. Answer the following questions as part of your discussion:

- What major parts of the circulatory system do you pass through?
- What do you see, hear, taste, smell, and/or feel at each point?
- What does the red blood cell do when it's at the lungs? Near a body cell?

3. Create a storyboard that shows your team's incredible journey and present it to the class. Each piece of the storyboard should:

- provide a picture and a written description of each part of your journey.
- show when and how the red blood cell exchanges gases.

Groupwork 4: Activity Guide 2 - An Excellent Adventure (Student Reproducible)

Introduction

The text and activities provide a wealth of information about the structure and function of the circulatory system. In this activity, you investigate the circulatory system and its parts from a unique perspective—from inside the body. Prepare yourselves for an excellent adventure.

Materials

- Art supplies and large poster paper or poster board.

Procedure

1. Imagine you and your teammates have shrunk to microscopic size, *boarded a white blood cell,* and are now riding inside it. Imagine you are traveling through a person's circulatory system.

2. Discuss the path you would take through the circulatory system if you started and ended your trip in the right ventricle of the heart. Answer the following questions as part of your discussion:

- What major parts of the circulatory system do you pass through?
- What do you see, hear, taste, smell, and/or feel at each point?
- What does the white blood cell do when an infection occurs in the body?

3. Create a storyboard that shows your team's incredible journey and present it to the class. Include in your storyboard:

- pictures and written descriptions of each part of your journey.
- descriptions of what the white blood cells do when an infection occurs in the body.

Groupwork 4: Activity Guide 3 - An Excellent Adventure (Student Reproducible)

Introduction

The text and activities provide a wealth of information about the structure and function of the circulatory system. In this activity, you investigate the circulatory system and its parts from a unique perspective—from inside the body. Prepare yourselves for an excellent adventure.

Materials

- Art supplies and large poster paper or poster board.

Procedure

1. Imagine you and your teammates have shrunk to microscopic size, *boarded a platelet,* and are now riding inside it. In other words, imagine you are traveling through a person's circulatory system.

2. Discuss the path you would take through the circulatory system if you started and ended your trip in the right ventricle of the heart. Answer the following questions as part of your discussion:

- What major parts of the circulatory system do you pass through?
- What do you see, hear, taste, smell, and/or feel at each point?
- How do you know what part of the circulatory system you are in?
- What does the platelet do if the person starts to bleed?

3. Create a storyboard that shows your team's incredible journey and present it to your class. Include in your storyboard the following:

- pictures and written descriptions of each part of your journey.
- descriptions of what the platelets do when a person starts to bleed.

Groupwork 4: Individual Report - An Excellent Adventure (Student Reproducible)

1. Describe the path you took as you traveled through the circulatory system.

2. What role does the "vehicle" your team traveled in-red blood cell, white blood cell, or platelet—play in the circulatory system?

3. What would happen to the rest of the circulatory system if your "vehicle" failed to function properly? How do you know?

Groupwork 5: Teacher Activity Notes

Portrait of a Killer: Cardiovascular Disease

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students investigate, via video, the causes and consequences of cardiovascular disease. They apply this information to create a pamphlet or print advertisement encouraging others to be "heart smart."

Group Size 4 to 5 students

Objectives

Students:

- identify the causes and consequences of cardiovascular disease.
- explore ways to become heart smart.
- consider the obstacles people face in reducing the risk of cardiovascular disease.

Student Materials

Video clip on heart disease (any videotape on heart disease), VCR, and art supplies, such as poster paper, scissors, glue, markers, and crayons.

Multiple Abilities

- Writing persuasively (conventional academic ability)
- Conceiving of ideas for illustrations (creative ability)
- Careful choice of words, explaining clearly and fully (ability to be precise).

Estimated Time 40 minutes

Suggested Use

This set of activities works well near the end of the unit.

IMPLEMENT

Any film or video that explains what cardiovascular diseases are and how they can be prevented can be used. However, make sure the clip is approximately 10 minutes long.

Extension Questions

- What happens to the body during and after a heart attack? Why?
- Why is cardiovascular disease often called a "killer"? What are reasons such a word is used?
- Do you think scientists know more about cardiovascular diseases than they did twenty years ago? Explain.
- Do you think people know more about cardiovascular diseases than they did twenty years ago? Do you think they are generally healthier? Explain.

ASSESS

Use the group presentation, individual report, and group discussion to assess if students can:

- explain how a high-fat, high-cholesterol diet contributes to cardiovascular disease.
- identify ways to reduce the risk of cardiovascular disease.
- describe the obstacles people face in reducing the risk of cardiovascular disease.

Extensions

How heart smart are students right now? To help answer this question, students can keep a record of their daily diet; have their blood pressure, cholesterol level, and percentage of body fat measured by a nurse; and test their fitness level by performing various exercises. They also can research the causes and consequences of cardiovascular disease in greater detail.

Activity Guide

Big Idea: Why and How Does Blood Circulate?

Introduction

Cardiovascular diseases often strike people when in their forties or older. However, the process of disease starts early on. What current behaviors increase your risk of heart disease? What can you do right now to lead a healthier life? In this activity, you explore the causes and consequences of cardiovascular disease, as well as steps you can take to prevent its development.

Materials

- Videotape, VCR, and art supplies, such as poster paper, scissors, glue, markers, and crayons.

Procedure

1. Watch the video clip on cardiovascular disease.

2. As a team, discuss the following questions:

- How does a high-fat, high-cholesterol diet contribute to a heart attack or stroke?
- Many people have a hard time changing harmful eating habits. What eating habits do you have that you might want to change to protect your cardiovascular system?
- What are ways to become more heart smart? What would help you adopt these healthy behaviors?

3. Create an eye-catching pamphlet or print advertisement to inform others about cardiovascular diseases and how to prevent them. Present it to the class, making sure to include the following:

- information about the causes and consequences of cardiovascular disease,
- reasons for your approach to cardiovascular disease prevention, and
- discussion of how convincing you think your pamphlet or ad will be to others.

Individual Report

Big Idea: Why and How Does Blood Circulate?

1. How does a high-fat, high-cholesterol diet contribute to a heart attack or stroke?

2. Do you think you are at risk of developing heart disease? Why or why not?

3. Briefly describe your team's pamphlet or advertisement. How did you encourage people to change their behaviors?

Groupwork 6: Teacher Activity Notes - Atherosclerosis

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students examine the causes, consequences, and prevention of atherosclerosis. In preparation for their presentation, they create physical models of a healthy and unhealthy artery.

Group Size 4 to 5 students

Objectives

Students:

- compare and contrast blood flow through clogged and unclogged arteries using a model.
- apply what they learned from the model to what happens in their circulatory system.
- identify the causes, consequences, and prevention of atherosclerosis.

Student Materials

Clear rubber tubing, funnel, 2 beakers, water (with red food coloring added if desired), butter, straw or pipe cleaner to use as a spreader, and Art supplies, such as clear rubber tubing or toilet paper rolls, clay, scissors, glycerin or corn syrup, glue, markers, and cotton.

Multiple Abilities

- Interpreting a 2− dimensional picture of a 3− dimensional object (spatial/visual ability).
- Observing carefully and accurately (ability to be precise).
- Creating a model, thinking of new uses for familiar objects (creative ability).

Estimated Time 50 minutes

Suggested Use This set of activities works well near the end of the unit.

IMPLEMENT

The butter must be sufficiently soft so that students can spread it on the inside of the clear tubing. The straw or pipe cleaner must be of sufficient length for students to reach the middle of the tube.

Extension Questions

- What do you think is the most effective way to convince people to become healthier? Why?
- What are some reasons people adopt at-risk behaviors in the first place? What role does the family play? The media? Culture? Scientific information?
- As a result of this activity, are you planning to eliminate any of your at-risk behaviors? Why or why not?

ASSESS

Use the group presentation, individual report, and group discussion to assess if students can:

- identify the causes and consequences of atherosclerosis, as well as ways to prevent the development of this disease.
- compare and contrast blood flow through clogged and unclogged arteries using a model.
- explain the consequences of decrease blood flow on the body.

Extension

To extend Procedure 2 of this activity ask students to compare the volume of water that flows through the tube holding time constant or the amount of time it takes water to flow through the tube holding volume constant.

Groupwork 6: Activity Guide - Atherosclerosis (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

Introduction

You have learned that too much fat and cholesterol are unhealthy, that they cause your arteries to narrow and roughen. How do doctors know that fat and cholesterol cause atherosclerosis? What do arteries with atherosclerosis look like? Why is atherosclerosis considered dangerous? In this activity, you learn more about atherosclerosis-its causes, effects, and prevention.

Materials

Clear rubber tubing, funnel, two beakers, water (with red food coloring added if desired), butter, straw or pipe cleaner to use as a spreader, and art supplies, such as clear rubber tubing or toilet paper rolls, clay, scissors, glycerin or corn syrup, glue, markers, and cotton.

Procedure

1. Examine the resources. They present information about and illustrations of atherosclerosis.

2. To see what happens to blood flow when arteries become narrow and clogged, compare the flow of water through clean tubing to the flow through tubing lined with butter.

3. In your team, discuss the following questions:

- How do fatty deposits affect blood flow through the arteries? How do you know?
- Why is atherosclerosis considered a health danger?
- What are several steps you can take to help prevent atherosclerosis?

4. Create a presentation to teach other students in your class about the causes and consequences of atherosclerosis. Include the following in your presentation:

- physical models of a healthy and an unhealthy artery,
- a description of how your two arteries differ as well as of how blood flow in the unhealthy artery is reduced and/or stopped,
- the causes and consequences of atherosclerosis, and
- what steps people can take to reduce their risk of developing this disease and why they should want to do so.

Groupwork 6: Resource 1 - Atherosclerosis (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

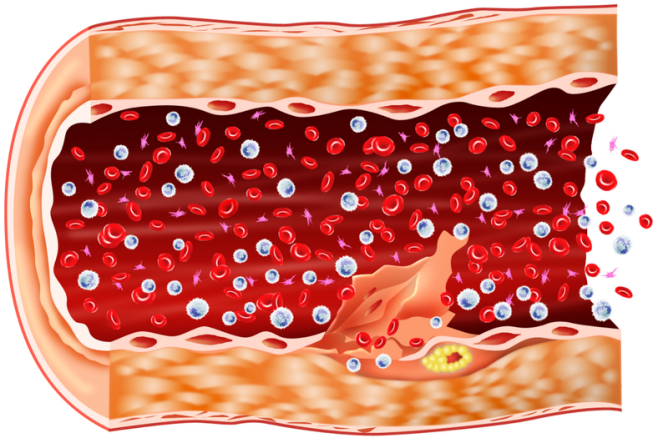
In brief, cholesterol is one type of fat normally found in the blood. Cholesterol enters the bloodstream in one of two ways: The body manufactures it, or the foods we eat contain it. Daily and animal products contain cholesterol; plants do not. The body needs cholesterol for several reasons: (1) to package fats and carry them through the bloodstream, (2) to build cell walls, (3) to produce hormones, and (4) to line the outside of nerve cells with material needed for them to function.

Too much cholesterol, however, is unhealthy. Cholesterol collects on the insides of arteries and eventually narrows them. Atherosclerosis is a progressive disease. Atherosclerosis is the main cause of heart disease and the leading cause of death in adults in the United States. Atherosclerosis can lead to a heart attack or a stroke. Ways to reduce the risk of developing atherosclerosis include the following:

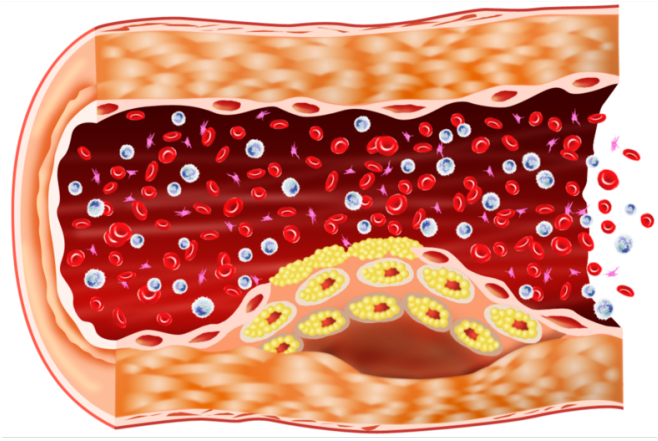
- decreasing stress
- regular aerobic exercise
- not smoking
- and avoiding foods high in fat and cholesterol.

Groupwork 6: Resource 2 - Atherosclerosis (Student Reproducible)

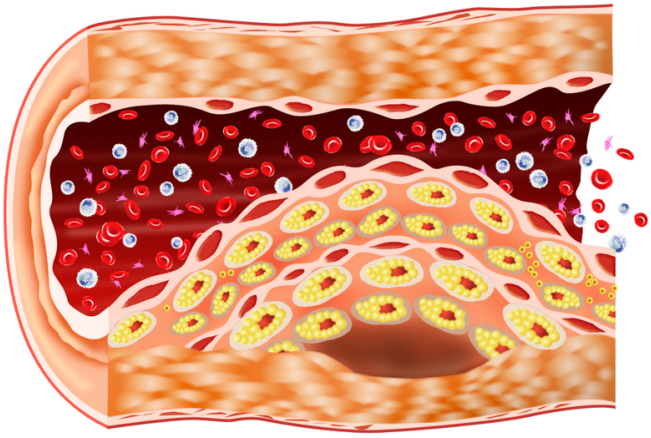
Big Idea: Why and How Does Blood Circulate?



1. **An artery at the beginning stages of atherosclerosis:** Excess fat particles begin to collect under cells lining the artery. The cells have been damaged by smoking, high blood pressure, and/or other causes. Although atherosclerosis may not give a person any trouble until middle age, it begins to develop early. For example, many U.S. soldiers killed in the Korean War were found to have some degree of atherosclerosis. Their average age was 22 . Deposits have been found in the arteries of children as young as 10 years of age.



2. **An artery narrowed by fatty deposits:** Fatty materials, called plaque, build up along the walls of the arteries. As we age, these fatty deposits tend to accumulate. They narrow and weaken the passages through which blood flows.



3. **An artery almost completely blocked:** Sometimes an artery becomes so narrow that blood flow is almost completely blocked. When an artery is blocked, the part of the body that it serves fails to receive blood and becomes damaged. If the blockage occurs in a coronary artery (one that supplies the heart), chest pains or a heart attack may result. If the blockage occurs in an artery leading to the brain, a stroke may occur.

Groupwork 6: Individual Report - Atherosclerosis (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

1. Using your model, describe how fatty deposits affect blood flow through the arteries.
2. Why is atherosclerosis considered a health danger?
3. Why should you be concerned about atherosclerosis? What are two reasonable ways you could help prevent it?

Groupwork 7: Teacher Activity Notes

Culminating Activity: You're the Doctor

Big Idea: Why and How Does Blood Circulate?

PLAN

Summary Students imagine they are a team of doctors. They must decide the best treatment for a patient with cardiovascular disease.

Group Size 4 to 5 students

Objectives

Students:

- identify the symptoms, causes, and consequences of cardiovascular disease.
- explore the treatment options available to those with various cardiovascular diseases.
- explain what happens when there is damage to anyone component of the circulatory system.

Student Materials

- For Activity Guide 1: Reference materials on the anatomy of the heart, cardiovascular disease, and medical solutions.
- For Activity Guide 2: Scissors, glue or stapler, and blue crayon.
- For Activity Guides 3, 4, and 5: Art supplies and/or paper may be necessary.

Multiple Abilities

- Hypothesizing, logically analyzing the problem, considering as many solutions as possible, applying previous knowledge, making connections between ideas/concepts and the scenarios (reasoning ability).
- Creating/using a model (spatial/visual ability).
- Writing persuasively (conventional academic ability).
- Taking the role of person other than oneself (creative ability).
- Organizing suggestions/ideas for the group, breaking a task into its parts, focusing on what the group must accomplish (ability to make plans).

Estimated Time 50 minutes

Suggested Use This set of activities works well near the end of the unit.

IMPLEMENT

1. At the beginning of the activity, give students in each group student Activity Guide 1, the Individual Report, and ONE of four student Resources. Each Resource 0, 2, 3, and 4) represents different patients. Each group decides on an appropriate procedure for its patient.

For example, a group in your class is given student Activity Guide 1, Individual Report, and Resource 2 (Patient B). After reviewing their materials, referring to their text, and discussing the questions, they decide that their patient needs a coronary bypass operation. The materials manager should notify you of the group's decision, and you would then give them Activity Guide 2 and Resource 5.

2. Although choosing the right procedure for a patient is not the primary goal of this activity, there is a logical choice for each patient:

Patient A: Pacemaker

Patient B: Coronary bypass or angioplasty

Patient C: Angioplasty or coronary bypass

Patient D: Heart transplant

Extension Questions

- Do patients always agree with their doctors? In what instances may a patient make decisions based on culture or values rather than the medical opinion of doctors?
- How would a patient go about researching for him or herself the best medical treatment?
- Why do doctors sometimes make mistakes?

ASSESS

Use the group discussion, group presentation, and individual report to assess if students can

- identify the symptoms, causes, and consequences of cardiovascular disease.
- evaluate four treatment options for heart disease including why they are used, how they are performed, and what their costs and benefits are.

- explain what happens when there is damage to anyone component of the circulatory system.

Extension

- Ask a cardiovascular surgeon or cardiologist to speak to your class, or take your students on a tour of a local hospital.

Groupwork 7: Activity Guide 1 (Diagnosing)

Culminating Activity: You're the Doctor (Student Reproducible)

Introduction

You're the doctor. Pretend your group is a team of cardiovascular surgeons and cardiologists at a famous hospital. Your team regularly meets to discuss the conditions and diagnoses of its patients, and to determine effective strategies for treating them. In this activity, you need to use much of what you have learned about the circulatory system to help treat your patient.

Materials

- Reference materials on the anatomy of the heart, cardiovascular disease, and medical solutions.

Procedure

1. Examine your Resource. It describes the condition and diagnosis of one of your patients. As a group, discuss what should be done to help this patient and why. Consider each of the four procedures listed on the Resource.

- How is each procedure performed?
- What is its outcome? Its cost?
- How would each procedure help solve the patient's problem(s)?

2. As a group, decide to recommend one of these four procedures to your patient. Tell your "Chief of Staff" (the teacher) your decision. He or she will provide you with the additional information needed to carry out this decision.

Groupwork 7: Resource 1 (Patient A)

Culminating Activity: You're the Doctor (Student Reproducible)

Patient A Medical Record

Sex: F

Age: 68

Weight: 145 lbs

Height: 5′6[U+0080][U+009D]

Blood Pressure: $\frac{105}{60}$

Description: Patient A was complaining of dizziness and fainting spells when admitted to the hospital two days ago. An electrocardiogram (EKG) indicates that the patient has an abnormally slow heartbeat. The condition is severe enough that without a medical procedure she is at high risk of sudden death.

Discuss the case with the doctors in your group. Decide which of the following procedures you think should be performed:

- Coronary Bypass
- Heart Transplant

- Pacemaker
- Angioplasty

Refer to your text and other books if you need additional information about these procedures.

Tell your "Chief of Staff" (the teacher) your decision once you have all agreed on it. He or she will provide you with a second student Activity Guide corresponding to the procedure you have chosen.

Groupwork 7: Resource 2 (Patient B)

Culminating Activity: You're the Doctor (Student Reproducible)

Patient B Medical Record

Sex: M

Age 49

Weight: 275 lbs

Height: 5′9[U+0080][U+009D]

Blood Pressure: $\frac{150}{90}$

Description: Patient B suffered a major heart attack five days ago. He was admitted to the hospital immediately following the attack. Since then, he has been doing poorly. Tests show that his heart is not receiving an adequate supply of oxygenated blood. His right coronary artery appears to be almost entirely blocked.

Discuss the case with the doctors in your group. Decide which of the following procedures you think should be performed:

1. Coronary Bypass
2. Heart Transplant
3. Pacemaker
4. Angioplasty

Refer to your text and other books if you need additional information about these procedures.

Tell your "Chief of Staff" (the teacher) your decision once you have all agreed on it. He or she will provide you with a second student Activity Guide corresponding to the procedure you have chosen.

Groupwork 7: Resource 3 (Patient C)

Culminating Activity: You're the Doctor (Student Reproducible)

Patient C Medical Record

Sex: M

Age: 69

Weight: 192 lbs

Height: 6′0[U+0080][U+009D]

Blood Pressure: $\frac{140}{80}$

Description: Patient C recently visited the hospital for a routine cholesterol check. The results of the check showed an extremely high cholesterol level. The patient does not watch his diet (although he is not extremely overweight). He also does little to no exercise. Moreover, when he does do something strenuous, he notices slight pains in his chest. His high cholesterol level prompted an examination of his coronary arteries. This test indicates that the patient has intermediate stages of arteriosclerosis. The left and right coronary arteries are approximately 80% blocked.

Discuss the case with the doctors in your group. Decide which of the following procedures you think should be performed:

1. Coronary Bypass
2. Heart Transplant
3. Pacemaker
4. Angioplasty

Refer to your text and other books if you need additional information about these procedures.

Tell your "Chief of Staff" (the teacher) your decision once you have all agreed on it. He or she will provide you with a second student Activity Guide corresponding to the procedure you have chosen.

Groupwork 7: Resource 4 (Patient D)

Culminating Activity: You're the Doctor (Student Reproducible)

Patient D Medical Record

Sex: F

Age: 55

Weight: 166 lps

Height: 5′3[U+0080][U+009D]

Blood Pressure: High

Description: Patient D has recently suffered her second heart attack. Tests show an arrhythmia: The patient's heart's electrical signals are causing an irregular heartbeat. Tests also show that the damage to her heart muscles is severe. The muscles contain a tremendous amount of scar tissue. It is estimated that she has only 3 to 6 months to live unless a surgical procedure is performed.

Discuss the case with the doctors in your group. Decide which of the following procedures you think should be performed:

1. Coronary Bypass
2. Heart Transplant
3. Pacemaker
4. Angioplasty

Refer to your text and other books if you need additional information about these procedures.

Tell your "Chief of Staff" (the teacher) your decision once you have all agreed on it. He or she will provide you with a second student Activity Guide corresponding to the procedure you have chosen.

Groupwork 7: Activity Guide 2 (Coronary Bypass)

Culminating Activity: You're the Doctor (Student Reproducible)

Materials

- Scissors, glue or stapler, and blue crayon.

Procedure

1. Your team has recommended that the patient undergo a coronary bypass operation. Attached are two diagrams of the human circulatory system. Diagram B shows the venous circulatory system. Diagram A is a close-up of the heart and its coronary arteries. Discuss with your group how to perform a coronary bypass. Refer to your text and other resource materials if necessary.

2. Using the scissors as a "scalpel," perform a simulated coronary bypass operation using the diagrams provided. Use glue or a stapler to "stitch" the blood vessel into position. After you have performed the bypass, use a blue crayon to color in the heart tissue that may have been damaged as a result of the blocked artery.

3. Discuss with your group the following questions:

- What are the positive and negative consequences of this surgery?
- What lifestyle changes would you recommend for this patient? Why?

4. Prepare to describe your patient's condition and the surgical procedure performed to the class. In your presentation, include the following information:

- your patient's initial condition, diagnosis, and recommended procedure,
- your answers to the questions posed in Procedure 3 above,
- any additional information the class will need to decide if you performed the correct surgical procedure, and
- how this activity relates to the big idea of the Circulatory System unit (Why and how does blood circulate?)

Groupwork 7: Resource 5 (Coronary Bypass)

Culminating Activity: You're the Doctor (Student Reproducible)

Big Idea: Why and How Does Blood Circulate?

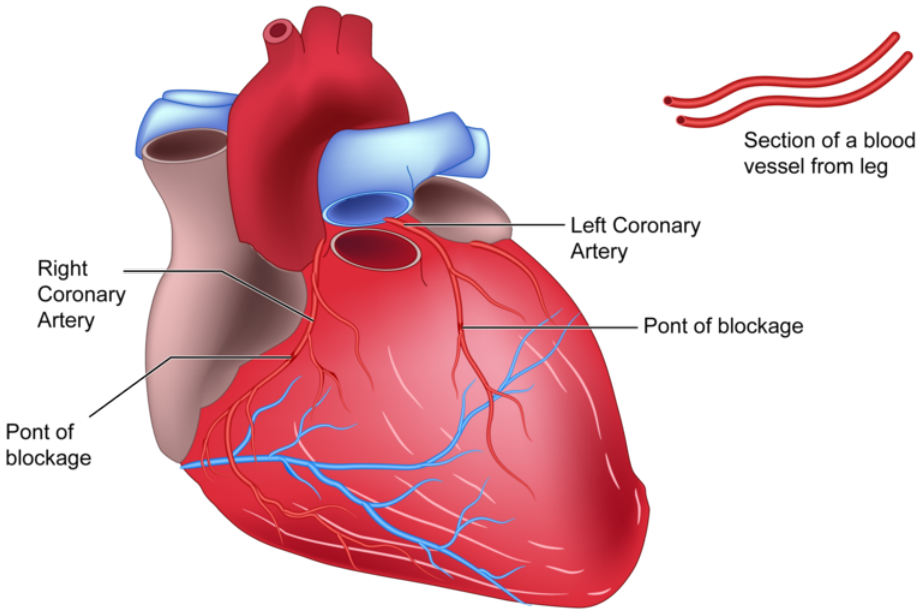
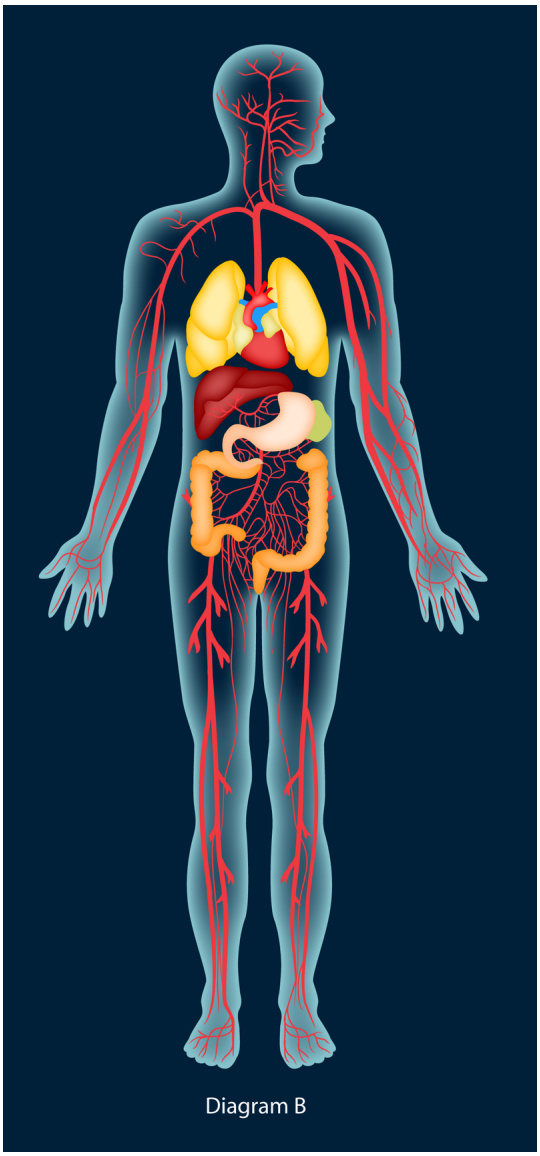


Diagram A



Groupwork 7: Activity Guide 3 (Heart Transplant)

Culminating Activity: You're the Doctor (Student Reproducible)

Materials

- None

Procedure

1. Your team has recommended that the patient receive a heart transplant if he/she is to live more than a few months. You are now waiting for an available heart.

2. Finally, you get word that there is a heart available in a nearby city. However, there is another patient in another hospital also in need of the very same heart. An outside group of medical personnel (the transplant committee) will decide which patient receives it. They will do so within 24 hours . In order for the transplant committee to make an informed decision, your group must write a letter, as well as make a presentation.

3. Write a letter to the transplant committee. Make sure to include answers to the following questions:

- Why does your patient need a new heart?

- Why should he or she have priority over another patient?
- Why is a heart transplant the best alternative?

4. Then, create a presentation for the transplant committee explaining the main points of your letter. Remember, your goal is to persuade the committee that your patient should receive the heart. Prepare to perform your presentation for the class.

Groupwork 7: Activity Guide 4 (Pacemaker)

Culminating Activity: You're the Doctor (Student Reproducible)

Materials

- None

Procedure

1. Your team has recommended that the patient receive a pacemaker. However, when you tell the patient your recommendation, he/she becomes extremely upset. Your patient is afraid that he/she will not survive the procedure. In truth, your patient understands neither why he/she needs the procedure nor what exactly the procedure entails.

2. As a group, discuss the following questions:

- Why does the patient object to the procedure?
- How would you best describe the procedure to him or her?
- What reasons could you give him or her for using a pacemaker? Why is it the best solution to the patient's problem(s)?

3. Create a role-play in which one team member plays the patient; another, a family member; and the rest, doctors. Explain to the patient and family member what the patient's symptoms are, their causes, why the patient should undergo this particular surgery, and how the surgical procedure is performed. Attempt to convince the patient that a pacemaker is the best option at this time.

4. Prepare to perform your role-play for the class.

Groupwork 7: Activity Guide 5 (Angioplasty)

Culminating Activity: You're the Doctor (Student Reproducible)

Materials

- None

Procedure

1. Your team has recommended that the patient undergo angioplasty. However, when you tell the patient your recommendation, he/she becomes extremely upset. He/she fears not surviving the procedure. The patient understands neither why he/she needs the procedure nor what exactly the procedure entails.

2. As a group, discuss the following questions:

- Why does the patient object to the procedure?
- How would you best describe the procedure to him or her?
- What reasons could you give him or her for undergoing angioplasty? Why is it the best solution to the patient's problem(s)?

3. Create a role-play in which one team member plays the patient; another, a family member; and the rest, doctors. Explain to the patient and family member what the patient's symptoms are, their causes, why the patient should undergo this particular procedure, and how the procedure is performed. Attempt to convince the patient that angioplasty is the best option at this time.

4. Prepare to perform your role-play for the class.

Groupwork 7: Individual Report

Culminating Activity: You're the Doctor (Student Reproducible)

1. Why did you choose your procedure? On what did you base your decision?

2. Do you think your group's decision-making process is similar to the decision-making process of "real" doctors? Explain.

3. What are the positive consequences of the procedures that your group performed? The negative consequences? (You can discuss consequences for the patient, the doctors, and/or society at large.)

4. What sorts of fears and questions might your patient have for you? How would you respond?

5. How does this activity relate to the big idea of the unit: Why and how does blood circulate?

9.2 Projects

The following Projects are an assortment of long-term activities that can be completed individually, in groups or as a class. We have provided starting points for research and development; you and the students can work together to create a more detailed plan of action. Consider the following two recommendations. First, because of the amount of work involved in a Project, students should choose one of great interest to them. Second, to encourage excellence and promote student-student learning, students should present their finished projects to the rest of the class, to the school and to the community, if appropriate.

Project 1: Research Questions and Action Projects

Project 1 differs from the others: it is a list of possible research topics organized according to some key ideas and addressed to students.

In assigning a Research Question or Action Project, we ask that you allow students to choose their topic—either one provided or one of their own. You might also:

1. Specify length of piece.
2. Make clear the purpose and the audience.
3. Suggest sources and ideas for information.
4. Provide in-class time for compiling information and writing.
5. Require students to exchange papers and provide written feedback.
6. Provide a breakdown of due-dates for the following stages: choice of topic, outline, rough draft and final draft.
7. Permit students to supplement a written report with a skit, a piece of artwork, a piece of music, a dance, a Video, or a multimedia presentation.

ASSESS

Provide the students with evaluation criteria that include:

- accuracy of the content based on guiding questions.
- clarity of writing.
- effective organization of main ideas.
- use of detailed examples or citing evidence to support their conclusions.

Project 1: Teacher Activity Notes - Research Questions and Action Projects

Human Respiratory and Circulation Systems

1. How does a fetus receive oxygen and nutrients while in the uterus? What changes occur in the heart and lungs at birth? Why? How does premature birth affect the circulatory and respiratory systems? How is a baby's blood different from that of an adult?

Structure and Function of Blood, Heart, and Vessels

2. How is the human circulatory system different from other animals'? Choose two animals, one vertebrate and one invertebrate. Compare and contrast the circulatory system of each animal with the other and with the human

circulatory system. Use the theory of evolution to help explain your findings.

3. How is human blood similar to and different from blood of other animals? Choose two other animals, one mammal and one nonmammalian species. Compare and contrast the physical and chemical properties of their blood with those of human blood. Use the theory of evolution to help explain your findings.

4. Scientists did not always know as much about the circulatory system as they do today. Choose a period in the past. Explain the following.

- How did scientists at that time explain the function of the circulatory system, the production of blood, and the function of the heart?
- What kinds of evidence did they use to support their claims?

Note: Limit your study to only one country or culture.

Integration within and between Systems

5. Use your knowledge of the circulatory system, respiratory system, and digestive system to explain how their functions are integrated.

Staying Healthy

6. Cholesterol level-What is a cholesterol level? How is it determined? What is a healthy level for adults? For adolescents? Why? How can your cholesterol level be raised or lowered?

7. Hypertension-What is hypertension? What causes it? What are its effects on the body? How is it prevented and treated? What can adolescents do to prevent the onset of hypertension later in life?

8. HIV-How is the circulatory system involved in the transmittal and spread of HIV? What are ways adolescents can help prevent the spread of HIV? What will you do to reduce your own risk of getting this virus?

9. Choose one of the following diseases: Leukemia-anemia-sickle-cell anemia. What is the disease? How does it affect the circulatory system and the body? How is this disease treated?

10. Blood donation-Why are blood donations needed? How safe is it to give or receive blood? Why must adolescents wait until they are 16 to give blood? How is the blood screened and stored? How is it used? Will you give blood when you're old enough? Explain.

Science, Technology, and Society

11. Besides school, what influences your attitudes and behaviors regarding health? Family, friends, the media, culture? What behaviors and attitudes regarding health have you adopted as a result of this influence? Why? How are your attitudes and behavior similar to and different from what you have learned in school?

12. Heart transplants-Why are heart transplants performed? How does the donor/recipient system work? Who gets a heart transplant? Is the system fair?

13. What is a recent innovation in the world of cardiovascular medicine? Describe where, when, how, and why it was developed.

14. Research the education/training required for these careers: dietitian, nutritionist, cardiologist, cardiovascular surgeon. What do these professionals do? What type(s) of technology do they use? Would you want to become one of them? Why or why not?

15. During the American Civil War, doctors and nurses treated many injured soldiers. What was their knowledge of the structure and function of the circulatory system? What kinds of surgical procedures and medicines did they use to treat gunshot wounds? Refer to the poems of Walt Whitman who was a nurse during the Civil War.

Project 2: Teacher Activity Notes - Be Heart Smart

PLAN

Summary Students learn what it means to be "heart smart." They distinguish between healthy and unhealthy behaviors, consider why it is important to practice healthy behaviors, and devise strategies to improve and maintain good cardiovascular health.

Suggested Materials

Scale, Yardstick, Stethoscopes, Sphygmomanometers, Charts of height and weight, Dietary tables, and Resource materials on cardiovascular health and fitness

Interdisciplinary Connections

Health, Social Studies, Physical Education

Estimated Time

- One week for initial research and sharing of information
- One week for development of action plans
- Several class periods for students to prepare and present their projects

Product

- Research presentation defining what it means to be heart smart
- Written action plans which identify and eliminate unhealthy behaviors
- Written report of completed action plan describing methods and results

IMPLEMENT

1. Divide students into research groups of three to five students. Ask them to define what it means to be "heart smart." Have them brainstorm a list of important factors related to heart disease and explain how these factors affect the circulatory system. Give them the option of consulting some or all of the following sources-textbooks, reference books, the Internet, CD-ROMs, a health professional, a representative of the American Heart Association, a coach, and/or a physical trainer. Provide students with additional sources of information on cardiovascular health and disease or with time to conduct their own research.

2. Using the information they have collected, have students assess their own health by answering the following questions.

- How healthy am I?
- Am I at risk for heart disease?

Students also may determine some or all of the following information about themselves.

Weight-height-pulse rate-blood pressure-cholesterol level-stress level-amount of fat and cholesterol in diet-amount of daily exercise-unhealthy habits.

Provide equipment to measure weight, blood pressure, and pulse rate. Provide charts to determine healthy ranges for weight versus height and amount of fat and cholesterol in foods. Many of the labs and activities under "Staying Healthy" can be modified for use here. Also arrange for students to have their cholesterol levels checked, if at all possible.

NOTE: You may choose to assign each student an ID number to be used when collecting personal health data. The ID number will allow students to examine and analyze data from the entire class while protecting students' privacy.

3. Ask each student to identify a personal behavior that is considered unhealthy. Individually or in groups, have them devise a plan of action for the next several weeks to eliminate or alter this unhealthy habit. During this period, allot time for students to describe in a daily journal what they did to change their behaviors.

4. After completing their respective action plans, have students reflect on changes in their lives. Do they feel differently? How have their attitudes changed? In their journals or in a written report, have students describe the unhealthy behavior, their plan of action, what they actually did or did not do, and their results so far.

They should be able to answer the following questions.

- Why is this targeted behavior believed to increase the risk of heart disease?
- What physical and/or psychological changes did you note while implementing your plan of action?
- Do you plan to continue being heart smart? Why or why not?

Suggested Follow-up Activities

- As a class, watch a film or video on heart disease-its causes, prevention, and treatment.
- If students are enthusiastic about the project and their results have them create an educational program or session to be taught to their schoolmates or families. The presentation should answer the following questions. What does it mean to be heart smart? Why is being heart smart important?

Note: Be sensitive to situations at home that may negatively impact on programs for parents or guardians.

- Arrange for students to visit a hospital, clinic, or research institution that specializes in the treatment and/or prevention of heart disease. Or ask a person from one of these organizations to come to speak to the class.
- At the end of the year, have students review their health habits. What habits have they been able to change? What habits have they been unable to change? Are they healthier and why or why not?
- At the completion of the project, students can follow up with a parent or guardian.

Project Assessment

Use the students' products to assess if students can:

- define and describe the major risk factors for heart disease.
- describe how these risk factors are a result of specific behaviors and/or lifestyles.
- distinguish between healthy and unhealthy behaviors.
- present an organized action plan with realistic time lines for changing a personal unhealthy behavior.
- clearly express the methods they used and what they learned.
- organize and present data in a written format to the class in a meaningful way.

Project 3: Teacher Activity Notes - A Cafeteria Case Study

PLAN

Summary Students conduct a case study of the school cafeteria, assessing how much fat and cholesterol are served on the daily menu and if the cafeteria promotes healthy eating habits. They make recommendations on how the cafeteria can become more health-conscious.

Suggested Materials

A nutritional table or Diet Analysis Plus® program, Version 3.0. You can obtain the Diet Analysis Plus program from ITP Distribution Center, 7625 Empire Drive, Florence, Kentucky, 41042, ATTN: Order Fulfillment. The telephone number is 1-800-824-5179. When ordering, indicate the following order number-for IBM WIN, ISB 0534538207 and for Macintosh, ISBN 0534538223.

Interdisciplinary Connection Health

Estimated Time

- One class period for research on the fat and cholesterol content of the cafeteria menu
- At least two class periods for students to prepare and present their presentations

Product

- Written assessment of cafeteria food
- Written report of the study's results and recommendations to the cafeteria staff
- Presentations of the assessment and recommendations

IMPLEMENT

1. Before beginning this project, discuss it with the principal and the head of the cafeteria in order to ensure cooperation on their parts, as well as respect and consideration on the part of the class.

2. Ask the cafeteria supervisor for a printed menu of what is se1ved over the course of two weeks. Divide the class into teams of four or five. Have each team study one of the following.

- the kind and frequency of different types of foods served over those two weeks,
- descriptions of how meals were prepared,
- estimates of the amount of fat and cholesterol present in the foods served,
- the opinions of the cafeteria staff, and
- the cafeteria budget.

3. Allow each team an opportunity to present its findings orally to the rest of the class.

4. The class should then write a report to the head of the cafeteria listing any problems with the food se1ved and recommendations on how to make the meals healthier. Facts about heart disease and diet should be used to support any comments and suggestions.

Suggested Follow-up Activities

- A few months later ask students to repeat their analysis of the cafeteria's menu. How does it compare with their initial analysis? Has the cafeteria's menu improved sufficiently from a nutritional point of view? If not, why not? Is their analysis faulty in some way? Does the cafeteria lack the funds to provide healthier food? Are there federal or state laws controlling the cafeteria's choices? Have students' concerns or recommendations fallen on deaf ears?
- Ask students to assess what they learned in doing this project. Have them write about these experiences in a reflective paper.
- Ask the class to synthesize all that the groups learned in the form of an article. Submit this article to the school and/or local newspaper for publication.
- Have a professional nutritionist or nurse working with a cardiologist visit the class and discuss his or her job as it relates to cardiovascular health.

Project Assessment

Use the students' products to assess if students can:

- identify the fat and cholesterol content of foods on a cafeteria's daily menu.
- make practical/reasonable recommendations for changing the menu based on cost and availability of specific foods.
- evaluate the impact of their recommendations for a) students, b) cafeteria staff, c) the budget manager, d) outside vendors, e) parents/guardians, and f) school staff.
- clearly express their assessment and recommendations to the class.
- make a convincing presentation using the facts.
- effectively answer questions from the class.
- use visuals to illustrate major points.

Project 4: Teacher Activity Notes - Tasty Tidbits

PLAN

Summary Students create and share healthy recipes to eat and enjoy.

Suggested Materials

Non-copyrighted recipes from home, magazines, or cookbooks, nutritional table or Diet Analysis Plus® program.

Interdisciplinary Connections Health, Social Studies, Visual and Performing Arts, Home Economics

Estimated Time Two to three class periods spread over approximately 2 weeks. Students will need to complete some work at home; they should assign themselves homework in order to complete the project on time.

Product

Collection of recipes with written dietary assessment of how healthy the recipes are.

IMPLEMENT

1. Provide students with a nutritional table or a computer program, such as Diet Analysis Plus® in order to calculate the calories, fat content, cholesterol, protein, carbohydrates, and vitamins for each recipe.
2. As a class, create a recipe book of dishes and desserts that are easy to prepare, novel, low in both fat and cholesterol, and taste good. Ask students to bring in and examine cookbooks and/or recipes from home or from magazines. Parents or guardians may need to help gather recipes, so send a letter home with students one week before beginning the project. This is a good opportunity to look at the diversity of the foods that different cultures prepare.
3. Divide the class into groups of three to five students. Have each group choose or create three to five "heart smart" recipes. For each recipe, they should include the name of the dish, needed ingredients, how to prepare it, a drawing of the finished product, and reasons that the dish is healthy.
4. Have students combine and organize the recipes into a class cookbook. They should include a cover, a table of contents, illustrations, and a rationale for using the recipes.

Suggested Follow-up Activities

- Publish the cookbook for parents, guardians, and the community. Money for this project may be obtained from the school district, or the cookbooks may be sold. **CAUTION:** Do not distribute the books if they contain copyrighted recipes.
- Ask students to assess what they learned in doing this project. Have them write about their experiences in a reflective paper.

Project Assessment

Use the students' products to assess if students can

- define what it means to have a "heart smart" recipe.
- clearly write the instructions so that the recipe is "easy to prepare."
- evaluate how nutritious the recipe is based on calories, fat content, cholesterol, protein, carbohydrates, and vitamins.
- organize the recipes into a cookbook that has a professional appearance.
- convince the reader that the recipe is healthy.

Project 5: Teacher Activity Notes - Past vs. Present

PLAN

Summary Students compare knowledge about and influences on health behaviors of adolescents today with those in the past 50 years. Students devise a plan of action for promoting healthier behavior with regard to maintaining cardiovascular health among their peers.

Suggested Materials

If possible, provide students with magazines such as *Time, Life, Newsweek,* or *The Saturday Evening Post* from previous decades.

Interdisciplinary Connections Health, Social Studies, Physical Education, Visual and Performing Arts

Estimated Time

- Two to three weeks. Allow for occasional group work in class. Students are expected to assign themselves homework in order to complete the project on time.
- Allot time during class for team presentations.

Product

- Written responses to discussion questions
- Written action plan of how teams will promote healthier behavior among their peers
- Team presentations of their promotional efforts and the results of those efforts

IMPLEMENT

1. Divide the class into groups of three to five to discuss if adolescents today are more informed and more conscious about health than adolescents in the past. Have them choose a decade in the recent past (within the last 50 years). Then ask them to compare adolescents of their decade to those in the past. To help them in-their discussions, provide magazines, newspapers, television shows, CD-ROMs, Internet sites, movies, photographs, memorabilia, and reference books. Encourage groups to interview people who were adolescents during the decade under study. Groups also should interview their peers.

2. Each group will use the information collected to discuss and write answers to the following questions:

a. In general, do you think today's adolescents are more knowledgeable about health and more health-conscious than adolescents in the past were? Why or why not?

b. What social, monetary, and/or educational factors are involved?

c. How could today's adolescents be *more* health-conscious and knowledgeable with respect to the aspect of health you researched?

Help students avoid right/wrong dichotomies about their parents', guardians', or friends' behaviors-that certain practices are "wrong" and others are "right." Also help students examine the past decade with respect. People had different information and lived with different societal expectations and norms, in different decades.

3. In their groups, have students consider their responses to Question c above. Ask them to pick ONE thing that they could do to help today's adolescents lead a healthier life. It is important that they consider what they learned, how to convey the information to adolescents, and how to convince them that it is important to lead a healthy life with respect to this aspect of cardiovascular health.

4. Have students devise and write up a plan of action to accomplish their goals.

5. For final presentation have students explain what they did, why they did it, and their results. Encourage them to present their information in creative ways that are both interesting and educational. They may want to use slides, video, posters, or a multimedia presentation.

Suggested Follow-up Activities

- At the end of the year ask students to assess what they learned in this project. Have them write about these experiences in a reflective paper.
- Arrange for students to visit an advertising agency, newspaper publisher, or a TV station to see how information and/or images of health are created and portrayed.
- Ask students to use the information they have collected to change one aspect of their own behavior. Have them keep a weekly journal of their progress. Evaluate this change in behavior after a quarter, after a semester, or at the end of the year.
- Ask the class to synthesize all that the groups have learned in an article. Submit this article to the school and/or local newspaper for publication.

Project Assessment

Use the students' products to assess if students can:

- identify the media's influence on adolescent health issues.
- create an action plan for promoting healthy behaviors among their peers.
- use primary sources like magazines, newspapers, CD-ROMs, the Internet, interviews, and surveys to obtain information on adolescent health issues.
- use visual and/or multimedia presentations to promote healthy behaviors.
- clearly explain what they did, why they did it, and their results.
- compare and contrast recent adolescent health issues with those encountered by teens during the decade they selected to research.

9.3 Additional Resources

For all readers-Parents, teachers, and children:

- Asimov, Isaac. *How Did We Find Out About Blood?* (Walker, 1986). Details the structure and function of the circulatory system. Describes the discovery of the purpose and makeup of blood.
- DeBakey, M. et al. *The Living Heart* (Raven Press/Simon and Schuster, 1984). Reviews early modern knowledge about the heart and circulation. Explains the function of the heart, blood, and metabolism. Discusses congenital abnormalities, coronary heart disease, stroke, and hypertension. Reviews prevention and treatment.
- Harvey, William. *The Anatomical Exercises: De Motu Cordis and de Circulatione Sanguinis in English Translation* (Dover Publications, Inc., 1995).
- Heath, D. *Open Heart* (R and E Research Associates Inc., 1982). One man's "diary" of his severe heart problems and quadruple bypass surgery. Describes his feelings and troubles while in the hospital.
- Lister, Clair and Baldwin, Dorothy. *Your Hem1 and Lungs* (Bookwright Press, 1984). Describes the cardiovascular and respiratory systems.
- McGowen, Tom. *The Circulatory System: From Harvey to the Artificial Heart* (Watts, 1988). Details the early theories about the Circulatory system held by the ancient Egyptians and traces the development of those ideas to the medical miracles of today.
- Pagem Haje, *Blood: The River of Life* (U.S. New Books, 1981). Explains how blood transports essential substances, disposes of waste, and protects the body from infection.
- Richards, N. *Heart to Heart* (Atheneum, 1987). Explanation of heart disease and open-heart surgery from the informed patient's perspective. Includes discussion of risk factors for coronary heart disease and how to change one's lifestyle to eliminate such risks.
- Settel, Joanne and Bagett, Nancy. *Why Does My Nose Run? (And Other Questions Kids Ask About Their Bodies)* (Atheneum, 1985). Answers children's common questions about the workings of the human body.
- Wertenbaker, L. *To Mend the Heart* (The Viking Press, 1980). Chronicles the history of heart surgely, including discussions of important surgeons and inventors.

For the younger or less-able reader

(Sixth-grade reading level and below)

- Allison, L. *Blood and Guts: A Working Guide to Your Own Insides* (Little, Brown, and Co., 1976). Easy to read, step-by-step explanation of the cardiovascular system. Covers the anatomy and physiology of the circulatory system. Includes suggested experiments for children.
- Allison, Linda and Ferguson, Tom, M.D. *The Stethoscope Book and Kit* (Addison-Wesley, 1991). An easy-to-assemble stethoscope and more than 60 activities. Includes information about healthy behavior.
- Baldwin, D. and Lister, C. *Your Heart and Lungs* (The Bookwright Press, 1984). Explains blood type groups, the function of blood cells, and the anatomy and function of the heart and lungs. Great illustrations!
- Gaskin, John. *The Heart* (Watts, 1985). Simple presentation of the circulatory system.
- Kalina, S. *Your Blood and Its Cargo* (Lothrop, Lee, and Shepard Co., 1974). Explains concepts of blood pressure and how oxygen and nutrients are transported by the blood.
- LeMaster, Leslie *Jean. Your Heart and Blood* (Children's, 1985). Easy introduction to the functions of the heart and blood.
- Parker, Steve. *The Heart and Blood* (Watts, 1990). Discusses blood vessels, the heal1 as a pump, how the heart beats, the pacemaker, arteries, blood pressure, oxygen carriers, white blood cells, plasma and platelets, lymphducts system, and artificial hearts.
- Showers, Paul. *Drop of Blood* (Crowell, 1989). A simple introduction to the composition and the functions of blood.

- Vevers, G. *Your Body 2: Blood and Lungs* (Lothrop, Lee, and Shepard Books, 1984). Explains the anatomy of the heart and the path of circulation. Compares the work of the heart during rest and during exercise.
- Ward, Brain R. *The Heart and Blood* (Franklin Watts, 1982). A simple introduction to the circulatory system with clear diagrams and pictures.

For the advanced reader

(Seventh-grade reading level and above)

- The American Heart Association. *Heartbook: A Guide to Prevention of Cardiovascular Diseases* (Dutton, 1980). Discusses heal1 function and cardiovascular disease. Explains the hazards of smoking and the importance of diet, nutrition, and exercise. Details and differentiates the various types of cardiovascular problems.
- Limburg, P. *The Story of Your Heart* (Coward, McCann, and Geoghegan, Inc., 1979). Presents the anatomy and function of the heart and blood. Explains common problems with the heart, such as heart attack and arrhythmia. Discusses solutions to these problems—heart surgery, transplants, and prevention.
- Silverstein, A. and Silverstein, V. *Heart Disease: America's Number One Killer* (Lippincott, 1985). Traces the history of heart disease in America. Explores possible causes and methods of prevention and treatment, including the artificial heart and heart transplant.

Magazines

Current Health 1

- Edit: Curriculum Innovations Group, 60 Revere Dr., Northbrook, IL 60062
- Subs: 4343 Equity Dr., Columbus, OH 43228 Monthly during school year: September-May (9 issues)
- A health magazine intended for students in grades 4 to 7. Major areas addressed in each issue are "Nutrition," "Drugs," "First Aid and Safety," "Psychology," "Disease," "Fitness and Exercise," "Personal Health," and "Your Healthy Environment."

Current Health 2

- Intended for grades 7 to 12. Covers the same broad subject areas as the magazine for younger children, but discussions are in keeping with the abilities and interests of adolescents.

Current Science

- Edit: 245 Long Hill Rd., Middletown, CT 06457
- Subs: 4343 Equity Dr., Columbus, OH 43228 Biweekly during school year (18 issues)
- Alerts students in grades 6 to 10 to news in the sciences. Reports recent developments in earth, physical, and life sciences. A special point is made of covering health.

Films and Videos

Films

- *Human Body: Circulatory System.* Coronet Films, 12 minutes , 1980
- *Incredible Voyage (Human Body).* MGHT, 26 minutes , 1969

Videos

- *Blood: The Microscopic Miracle.* Encyclopedia Britannica
- *Eat Smart.* A MacNeil/Lehrer Special Production, PBS Home Video

- *Heart Disease.* Films for the Humanities and Sciences, INC *Hearts and Arteries in Trouble.* 11.5 minutes ; Churchhill Films, 662 North Robertson Blvd, Los Angeles, CA 90069
- *The Silent Killer*. NOVA, KQED
- Smith, Becky. *Choices.* (Stanford: Stanford Adolescent Heart Health Program, Stanford Heart Disease Prevention Program, 1984). Short video depicting a group of adolescents; their eating habits at school, at home, and at a party; and their parents' eating and drinking habits. Follows four main characters throughout video.
- *What We Eat.* American Heart Association

Laserdisks

- *Bio Sci II. Videodiscovery*

Slides

- *Photomicrographs of Atherosclerosis in Arteries.* American Heart Association

Models

- Pumping Heart Model: Operating Plastic Model Construction Kit, Linberg Kit #1332

Posters

- The Circulatory System: corresponding student worksheet also available; American Heart Association

Pamphlets/Booklets/Leaflets

- "Up and Down-All About Blood Pressure": Temco

Pamphlets From the American Heart Association

- "The Heart and How it Works"
- "The Heart and Blood Vessels"
- "Your Heart Is Just About the Strongest Part of Your Body"
- "Smoking and Heart Disease"
- "About Your Heart and Blood Pressure"
- "Risko"
- "Understanding Angina"
- "Facts About Stroke"
- "Stroke-Why Do They Behave That Way?"

CD-ROMs

- *A.D.A.M. The Inside Story*, A.D.A.M Software, Inc. 1996
- *Body Works,* SoftKey Multimedia Inc., 1995
- *How Your Body Works, Mindscape,* AW Publishing Group, 1995
- *Mayo Clinic: The Total Heart,* IV! Publishing, 1993
- HumBio: *How the Heart and Lungs Work,* Program in Human Biology at Stanford University, 1997

Internet Resources

- American Heart Association Home Page: http://www.amhrt.org/newhome.html

- The National Heart, Lung and Blood Institute (a part of NIH): http://www.nhlbi.nih.gov/nhlbi/nhlbi.htm

Toll-Free Hot lines

- Child Abuse Hot Line 1-800-422-4453
- American Diabetes Association 1-800-232-3472
- National Institute on Drug Abuse 1-800-662-HELP
- National Help Line 1-800-DRUG-HELP
- Just Say No Kids 1-800-258-2766
- Epilepsy Foundation of America 1-800-332-1000
- National Hearing Aid Help Line 1-800-521-5247
- U.S. Consumer Product Safety Commission 1-800-638-CPSC
- Center for Drug Control National STD Hot Line 1-800-227-8922

9.4 Circulation Glossary

aerobic (ayr-OH-bik) exercise an activity that makes you breathe faster and deeper and an activity that you can sustain for 20 minutes or more.

anemia a condition resulting in reduced oxygen transport by the blood that may be caused by a reduced number of red blood cells or not enough hemoglobin.

aneurysm (ANN-yur-ism) a bulge outward of a vessel when the vessel wall weakens.

antibodies germ-fighting proteins.

blood the fluid containing cells that circulates through the heart and blood vessels transporting nutrients, gases, chemicals, and wastes through the body.

arterioles very small arteries.

artery a blood vessel that carries blood away from the heart.

atria plural form of atrium. The fish heart has one atrium, but the human heart has two atria.

atrium the top chamber of each side of the heart. The atrium receives blood from a vessel and sends blood down to the ventricle.

atherosclerosis (ATH-uh-roh-skluhr-OH-sus) a build up of fatty deposits, called plaque, on the walls of arteries leading to narrowing and blockage of the arteries.

blood platelets cell fragments smaller than red blood cells that circulate with the blood and help in clotting.

blood vessel a tube through which blood flows.

bone marrow the spongy tissue inside bones. It is one of the places in the body where red blood cells are produced.

capillaries very tiny vessels at the ends of the smallest arteriole and leading to the smallest venules.

circulatory system a system that includes the blood, the heart, and the system of blood vessels that distributes blood throughout the body.

controllers mechanisms that control automatic body functions such as breathing and heart rate within certain limits.

diastole (dy-AS-toe-lee) the relaxation period when the heart is filling with blood.

diffusion (dih-FYOO-shun) the random movement of molecules from a region of higher concentration to a region of lower concentration.

edema (eh-DEE-muh) swelling caused by the accumulation of fluids in spaces outside of blood vessels and between cells.

endocrine system a system of organs and glands that releases chemicals (hormones) into the bloodstream or directly into tissue to cause some reaction.

fibrinogen (fy-BRIN-oh-jin) a protein circulating in the blood that is meshed in forming blood clots.

gene a portion of DNA that contains the information code for a protein such as hemoglobin.

heart the muscular pump of the circulatory system.

heart attack a condition that occurs when the coronary arteries that serve the heart become clogged with plaque and/or a blood clot.

heart rate the number of times your heart beats in one minute.

hemoglobin (HEE-muh-glow-bihn) a reddish protein that carries oxygen.

hemophilia (hee-moh-FEEL-ee-uh) a hereditary condition in which the blood in people who have the gene for hemophilia takes longer than normal to clot. People with the disease are called hemophiliacs.

homeostasis (hoh-mee-oh-STAY-sis) the condition of stability of the internal environment of the body.

hormones (HOHR-molms) chemicals that stimulate cells to respond in certain ways.

hypertension. (hi-per-TEN-shun) high blood pressure.

leukemia (loo-KEE-mee-uh) a disease in which there are more than a normal number of white blood cells produced because cell division is out of control.

lymph nodes oval or bean-shaped structures in the lymphatic (lim-FAT-ik) system that produce lymph.

lymphatic system network of vessels that carries watery fluid called lymph.

lymph a liquid made up of water, salts, nutrients, waste products, white blood cells, proteins, and other chemicals.

mononucleosis (mah-noh-noo-clee-OH-sis) a disease of the white blood cells caused by a virus.

negative feedback a reaction to a change that will cause a reversal.

nervous system the brain, spinal cord, and a network of nerve cells that send and receive messages about the body's inside and outside environments.

nucleus (NOO-klee-us) the information and control center found in most cells.

organ a part of a living organism that has a specific function, such as the heart or brain.

pacemaker specialized muscle cells in the right atrium. The pacemaker makes the heart beat faster or slower when it receives messages from the nervous system or from chemical "messengers" called hormones.

phagocyte (fAY-go-site) a type of white blood cell that can change shape and wrap around unwanted or foreign substances.

phagocytosis (fay-go-sy-TOH-sis) the process that occurs when a phagocyte "eats up" foreign substances such as bacteria or viruses.

plasma (PLAS-muh) the liquid part of blood.

pressure head the pressure buildup in the outlet tube of a siphon pump.

red blood cells doughnut-shaped cells with a flat, filled center.

resistance the ability to hold back. In blood vessels, resistance is the slowing of blood flow through the vessels.

respiratory system the system in animals that brings in needed oxygen and releases carbon dioxide.

sensors specialized cells that, when stimulated, send messages to the brain.

sickle-cell anemia (uh-NEE-mee-uh) a hereditary condition in which a gene produces an abnormal type of hemoglobin that results in a reduced amount of oxygen carried by red blood cells. The abnormal hemoglobin tends to form crystals inside the red blood cells that produce the sickle shape.

siphon pump a pump that uses gravity, valves, and a squeeze bulb to move fluid from one place to another.

stroke a condition in which too little oxygen gets to the brain due to a blockage or a leakage in a vessel.

stroke volume the amount of blood pumped with each squeeze of the heart.

systole (SIS-toe-lee) the contracting of the heart muscle when it squeezes and squirts out the blood.

target heart-rate zone a specific range of heartbeats per minute considered best for an individual.

thoracic duct a large vessel that empties into a vein at the base of your neck returning fluids to the circulatory system.

valve a device that controls the flow of a liquid or gas

vein a blood vessel that carries blood to the heart.

ventricle the bottom chamber of each side of the heart. The ventricles receive blood from the atria and squirt it into blood vessels.

venule (VEEN-yool) a small vein that receives blood from the capillaries.

white blood cells blood cells that do not contain hemoglobin and attack unwanted organism such as bacteria, and unwanted materials such as a splinter.