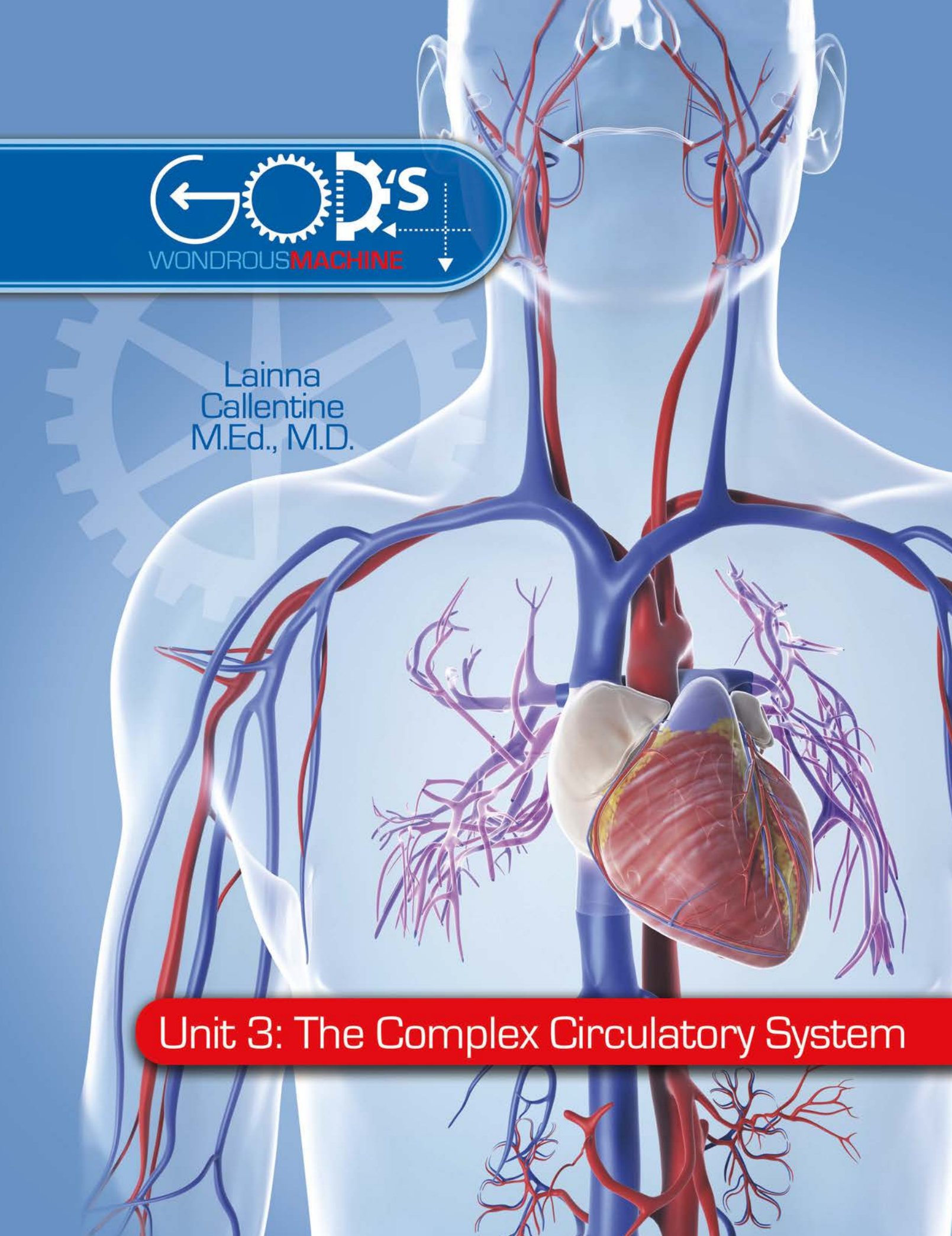
GOD'S WONDROUS MACHINE

Lainna
Callentine
M.Ed., M.D.



Unit 3: The Complex Circulatory System

VOCABULARY LEVELS

Choose the word list based on your skill level. Every student should be able to master Level 1 words. Add words from Levels 2 and 3 as needed. More proficient students should be able to learn all three levels.

Level 1 Vocabulary

- Anemia
- Aorta
- Arteries
- Arterioles
- Atrium
- Bone marrow
- Closed circulatory system
- Fetus
- Hemoglobin
- Open circulatory system
- Prothrombin
- Red Blood Cells
- Stethoscope
- Valves
- Veins
- White blood cells

Level 2 Vocabulary

Review and Know Level 1 Vocabulary

- Antibodies
- Antigens
- Buffy coat
- Capillary
- Coronary
- Epicardium
- Erythrocytes
- Hematophagic
- Hemophilia
- Hemostasis
- Malaria
- Myocardium
- Pericardial sac
- Platelets
- Sickle cell anemia
- Stem cell
- Syncope
- Systole
- Tachycardia
- Universal donor
- Universal receiver
- Ventricles

Level 3 Vocabulary

Review and Know Level 1 and 2 Vocabulary

- Auscultate
- Bradycardia
- Centrifuge
- Chordae tendineae
- Diastole
- Electrocardiogram
- Endocardium
- Hematopoiesis
- Myocardial infarction
- Prothrombin
- Sinoatrial node
- Tricuspid valve
- Venules

See It, Say It, Know It!

Level 1 Vocabulary
Level 2 Vocabulary
Level 3 Vocabulary

Word [Pronunciation]	Definition
Anemia [ah-ne´me-ah]	A problem with the blood in which oxygen delivered to the organs and tissues is decreased. It can be a symptom of many different diseases.
Antibodies [an-ti-bod-eez]	Blood proteins that are made to attack a specific invader, like bacteria or viruses. They set off a cascade of events to assist the body in a stronger defense.
Antigens [an´tĭ-jenz]	A foreign substance, like bacteria or virus, that triggers an immune response and causes antibodies to spring into action.
Aorta [a-or´tah]	The largest artery in the body that originates from the left ventricle and sends oxygenated blood to the body.
Arteries [ahr´ter-ez]	Vessels that carry oxygenated blood from the heart to the body.
Arterioles [ahr-te´re-ōlz]	Small vessels that carry oxygenated blood that connects to capillaries.
Atrium [a´tre-um]	The upper chambers of the heart in which blood enters the heart. There are two atrium, the right and left atriums.
Auscultate [ô´skəl-tāt´]	To listen; to listen to the sounds of the body.
Bradycardia [brady-car-dia]	A slow heartbeat that is typically less than 60 beats a minute for an adult.
Bone marrow [bohn mar´o]	The soft, spongy material in the middle of bones.
Buffy coat [bufé kōt]	When blood is centrifuged, spun in a test tube in a machine, the blood separates into three parts. This middle part is composed of white blood cells and platelets
Capillary [kap´ĭ-lar″e]	Smallest arterial blood vessel; connects the arterioles with the venules.
Centrifuge [cen´trĭ-fūj]	To spin around; a machine used to spin test tubes of blood at high speeds in order to cause the parts of blood to separate.
Closed circulatory system	A blood system composed of vessels of different sizes that encloses the blood at all times. The blood is pumped by the heart and does not fill body cavities.
Chordae tendineae [kor´dah ten di nee a]	Fibrous strings that connect to the edges of the heart valves. They keep the valves from inverting or flipping backwards. Also known as the "heart strings."

Word [Pronunciation]	Definition
Coronary [kôr´ə-nĕr´ē,]	The blood vessels that line the outside of the heart.
Diastole [dī-ăs´tə-lē]	The phase in the heartbeat when the heart muscle relaxes and allows the heart chambers to fill with blood.
Electrocardiogram [ĭ-lĕk´trō-kär´dē-ə-grăm´]	A machine that graphically records the heart's electrical activity.
Endocardium [ĕn´dō-kär´dē-əm]	The inner muscle layer of the heart; the muscle that lines the inside of the heart.
Epicardium [ĕp´ĭ-kär´dē-əm]	The outer muscle layer of the heart that lies under the pericardial sac.
Erythrocytes [ē•rith•rō•sits]	A red blood cell that contains hemoglobin and transports oxygen.
Fetus [fē´təs]	An unborn baby.
Hematophagic [hĕ̆mă-tō-fā̆jē-ă]	The act of an animal or insect like a mosquito drinking blood.
Hematopoiesis [he″mah-to-poi-e´sis]	The formation of blood cells. In the fetus, it takes place at sites including the liver, spleen, and thymus. From birth throughout the rest of life, it is mainly in the bone marrow.
Hemoglobin [he´mo-glo″bin]	A protein housed in red blood cells that contain iron. Hemoglobin facilitates in carrying oxygen.
Hemophilia [*hee-m*uh-*fil-ee*-uh]	Any of several X-linked genetic disorders transmitted from the mother's genes, is a disease that occurs mainly in males. Excessive bleeding occurs due to the absence or abnormality of a clotting factor in the blood.
Hemostasis [he″mo-sta´sis]	Stopping the escape of blood by natural means (either clot formation or vessel spasm).
Malaria [muh-lair-ee-uh]	A disease transmitted by mosquitos in which a parasite infects the red blood cells; can be deadly.
Myocardial infarction [mi″o-kahr´de-al in-fark´ shun]	A heart attack.
Myocardium [mi″o-kar´de-um]	The middle and thickest layer of the heart wall muscle.
Open circulatory system	System in which the blood is pumped by the heart and fills the body cavities. The blood does not stay within the vessels.

Level 1 Vocabulary
Level 2 Vocabulary
Level 3 Vocabulary

Word [Pronunciation]	Definition
Pericardial sac [per″ĭ-kahr´de-al sak]	Fibrous double-layered sac that surrounds the heart. It is filled with a lubricant that allows the heart to move without friction.
Platelets [plat'lits]	Small cells in the blood that are important in hemostasis, forming blood clots.
Prothrombin [pro-throm´bin]	A clotting factor, made in the liver, that is in the blood. It is activated to thrombin for clot formation.
Red blood cells	Cells in the blood that contain hemoglobin, an iron that carries oxygen.
Sickle cell anemia [ah-ne´me-ah]	A blood disease that is inherited in which the red blood cells become misshaped to a sickle-like appearance. Causes long-term problems.
Sinoatrial node [sahy-noh-ey-tree-uh]	A mass of muscle tissue on the top of the right atrium that is the electrical pacemaker of the heart.
Stem cell	A cell that has the ability to differentiate to other specialized cells.
Stethoscope [steth´o-skōp]	A medical device used to listen and magnify the sounds heard in the body.
Syncope [sing´kah-pe]	To lose consciousness; pass out.
Systole [sis´to-le]	The phase in the heart cycle of beating in which the heart chambers contract to expel blood out of the heart.
Tachycardia [tak″e-kahr´de-ah]	A fast heartbeat that typically is over 100 beats a minute in an adult.
Tricuspid valve	The heart valve between the right atrium and right ventricle.
Universal donor	A person who has type O blood.
Universal receiver	A person who has type AB blood.
Valves [valv]	The "door" between the chambers of the heart that prevents blood from flowing backwards.
Veins [vān]	Blood vessels in the body that carry deoxygenated blood. They transport blood to the heart.
Ventricles [ven´trĭ-k'l]	The lower chambers of the heart.
Venules [ven´ūl]	Small blood vessels that carry deoxygenated blood toward the heart. They connect the capillaries to the veins.
White blood cells	Blood cells that are part of the immune system that fight invaders that attack the body.

*Pronunciation Keys from http://medical-dictionary.thefreedictionary.com

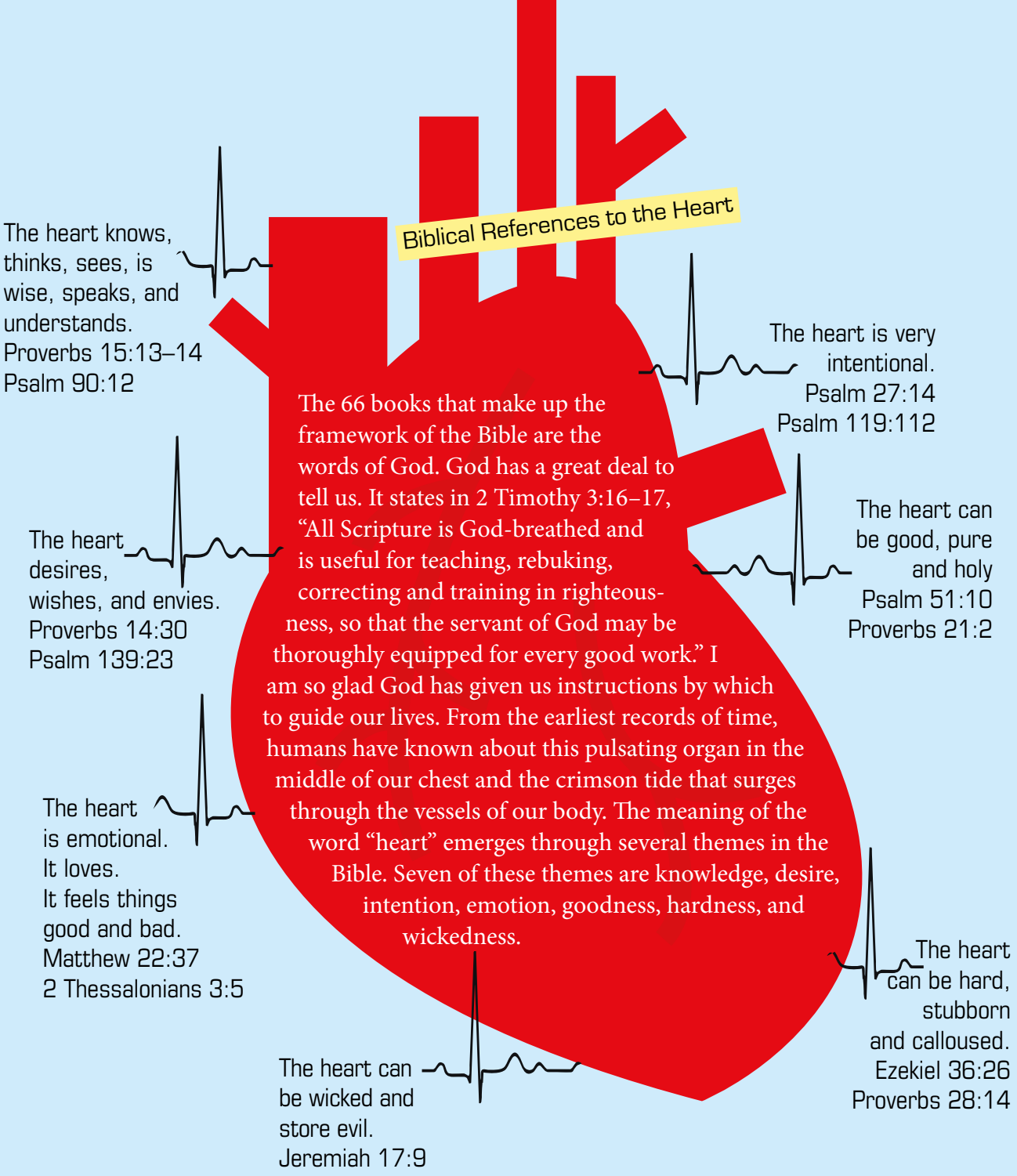
Introduction

Lightning flashed. The cloud hurled its pellets downward. A blood-curdling scream resonated through the cold, dank, and dreary marble halls . . . a suspenseful way to begin a book on *The Complex Circulatory System,* right? Just the mention of the word or seeing blood causes some people to feel woozy and go wobbly in the knees. Some people will even pass out at the very sight of blood. Take heart. There will be no need to be faint of heart.

Our heart beats passionately. It never stops. It never rests. It works around the clock, day and night. It starts to beat after you were conceived in your mother's womb at 3 to 4 weeks (a full-term pregnancy is 40 weeks), and continues until the day God calls you heavenward. Aside from our Heavenly Father, Lord, God, and Jesus, no two words are more heavily mentioned in the Bible than "blood" and "heart." The word blood is mentioned in the Bible over 400 times. Heart is mentioned over a staggering 900 times. We will take a look at some of the powerful images illustrated and represented by these words.

The Complex Circulatory System will catapult you into a whole new dimension. First, we will take an historical excursion through the pages of time and see how our knowledge of the circulatory system has expanded. We will learn all about blood, where it comes from, and how clots develop. Next, we will wade through the life-giving fluid that courses through the highways of your body. We will explore bloodsucking critters and enter the atrium of the heart and peer into the heart's many rooms. My prayer is that as we journey through the tributaries of your body, you will gain a deeper understanding of the magnificent artistry God has fashioned in you.

Trust in the Lord with all your heart, and do not lean on your own understanding. In all your ways acknowledge him, and he will make straight your paths (Proverbs 3:5–6).

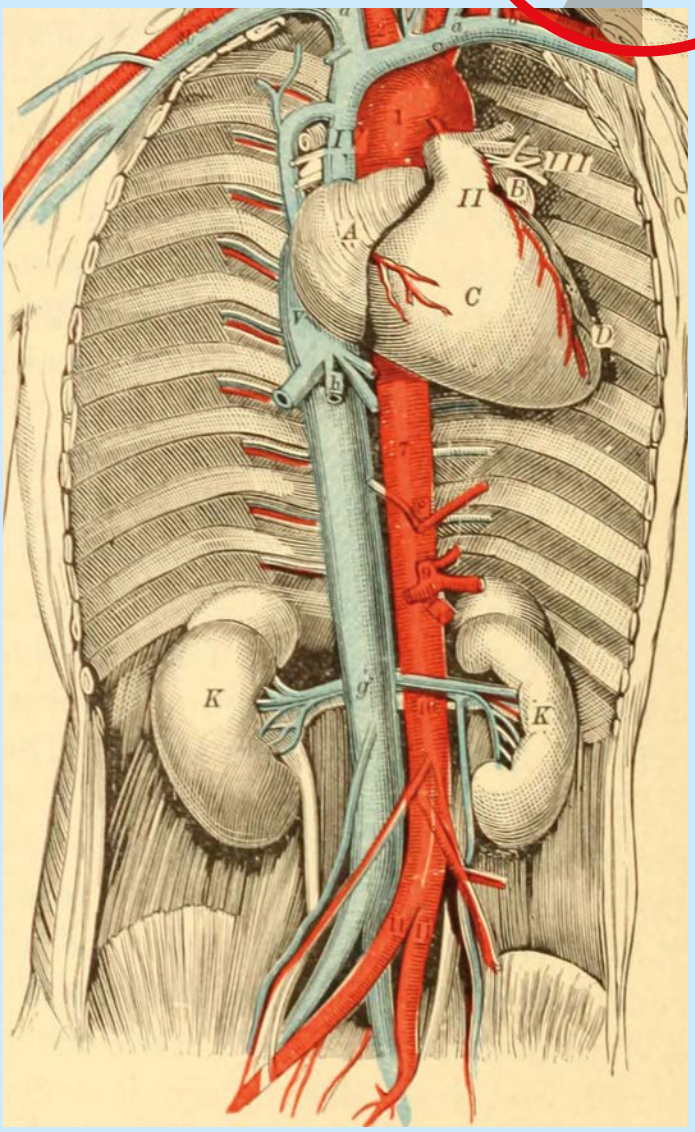


It has taken us many generations to acquire the understanding of the heart in the context of our biological processes. Our Lord amazes me. Before man made these "great" discoveries, God's creation and order already existed. We have just begun to understand some of the complexities of His handiwork, to put words and descriptions to this order. We continue to gain increasing understanding of this order. Never will our understanding and intellect put us on equal footing with our Lord. May our hearts become tender to the soothing words and guidance of our Heavenly Father.

1 Historical Timeline of Circulatory System

Any time when we peek back at the timelines of history, it is important to remember that it is an account of the past. People's accounts can differ depending on that particular person's perspective. The context in which an historical event occurs is important to take in consideration. Context is the circumstances or situation in which something happens. These discoveries did not happen inside an airless and weightless vacuum. Our progress in science builds on our prior knowledge. Each intellectual discovery provides a foothold to reach up to further our understanding. Scientific reasoning can be very delicate and at times silenced depending on a person's or culture's worldview. We will take a look at this as we tour the historical timeline of the circulatory system.

We begin in the year 384 B.C. with Aristotle who was born in Macedonia. He was a Greek philosopher and scientist. He believed the heart was the center of a person. The heart was where the soul dwelled and was where blood was manufactured in the body. In 340 B.C., Praxagoras was the first to differentiate between arteries and veins. He believed that the arteries had their origin in the heart and carried "pneuma." Pneuma has its origins in Greek. It means to "breathe" and is related to the "spirit" and the "soul" in the religious context. Arteries were full of "spiritual" air. Erasistratus, a Greek anatomist (one who studies the body) and royal physician, described the heart as being a pump. He also in 250s B.C. saw the heart as a source of both arteries and veins. This was the wisdom of the times. This set the stage for one of the most influential physicians of the middle ages. Claudius Galenus, was born in Pergamum, Asia Minor (Western Turkey), during the peak of the Roman Empire in the approximate year of A.D.



129. He was better known as Galen. Galen left an indelible mark on the anatomical world. So deep was his impact that his view of the circulatory system was believed for 15 centuries!

Word Wise!

TOURNIQUET is any device that uses pressure to stop the flow of blood, usually through the arteries of an arm or leg, as after a serious injury.

If you lived in these times you would believe the following about the body:

> The body's function was to refine the food you ate. Natural spirits had their beginnings in the food and drink you consumed. Vital spirits were derived from the air. Veins carried natural spirits. Arteries carried vital spirits.
>
> Food was transformed in the liver. Veins originated at the liver. These veins contained the four humors or liquids of the body: yellow and black bile, blood, and phlegm. The blood of the veins went to the heart, and air and blood mixed in the left side of the heart. The heart was like a burning cauldron that produced heat and provided body warmth. (The brain cooled the body.) The humors naturally flowed around the body and went only where they were needed. The blood was consumed.

Why was this view so important? This theory guided the ideas about the origin of disease. Illness and disease were seen as functions of an imbalance of humors or a shift in its flow in the body. Treatment was aimed at restoration of this natural balance. Bloodletting was the practice of bleeding someone to restore this "healthy" balance. (We will talk a bit more about this later.) Tourniquets, which stop blood flow in an artery or vein, were also applied to parts of the body in attempts to redirect the flow of blood to other areas of the body. Today, we only use tourniquets in emergency situations to stop the bleeding from a wound.

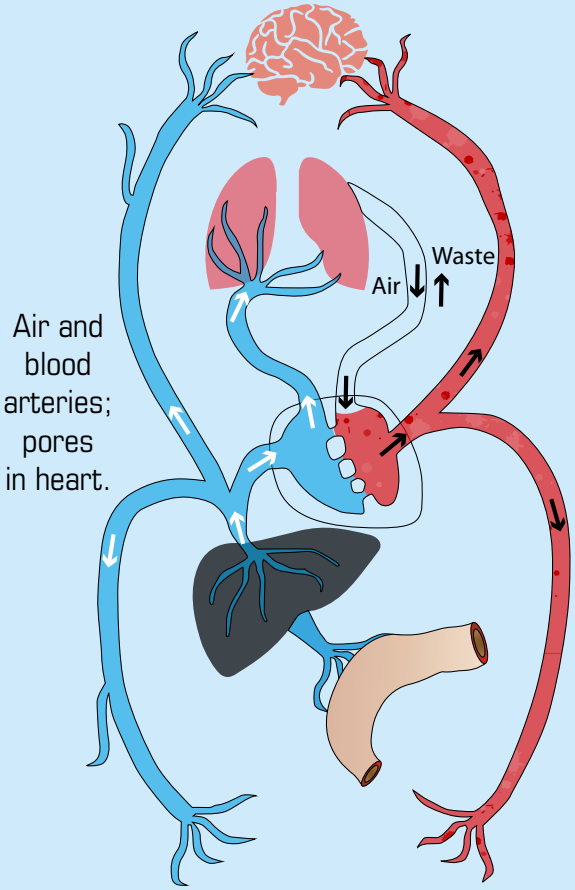
Galen began his study of medicine at the age of 16. At the age of 28, he was appointed to the post of surgeon to the gladiators. He received a great deal of on-the-job training patching up wounded gladiators. In the year A.D. 162, he became the leading authority on medical knowledge and was appointed to the position of physician to the emperor. Galen left the world a legacy of these essential views:

	Galen's View	Modern View
1.	Veins contained blood. These veins were open ended, and the blood bathed the organs.	Veins do in fact carry blood. They are not open ended or bathe the organs. They carry deoxygenated blood.
2.	A small amount of the blood provided nourishment to the lungs.	All the blood in the body is transported to the lungs to obtain oxygen.
3.	The heart pulsated.	The heart does beat and therefore it could be considered to "pulsate."
4.	Breathing cooled the heated body and yielded the vital spirits.	Breathing is not the essential way that the body cools itself. "Vital" spirits are not taken up by the lungs.
5.	Arteries contained air and blood.	Arteries do contain blood. Oxygen is dissolved in the blood and is transported on hemoglobin in the red blood cells.
6.	Arteries were located deep in the body and pulsated. The blood in the arteries was hotter, thinner, and more "spirituous." Veins were located close to the surface.	Arteries can lay deep and superficially in the body. They do pulsate with each beat of the heart.
7.	The whole body breathes in and out.	The lungs do the breathing.

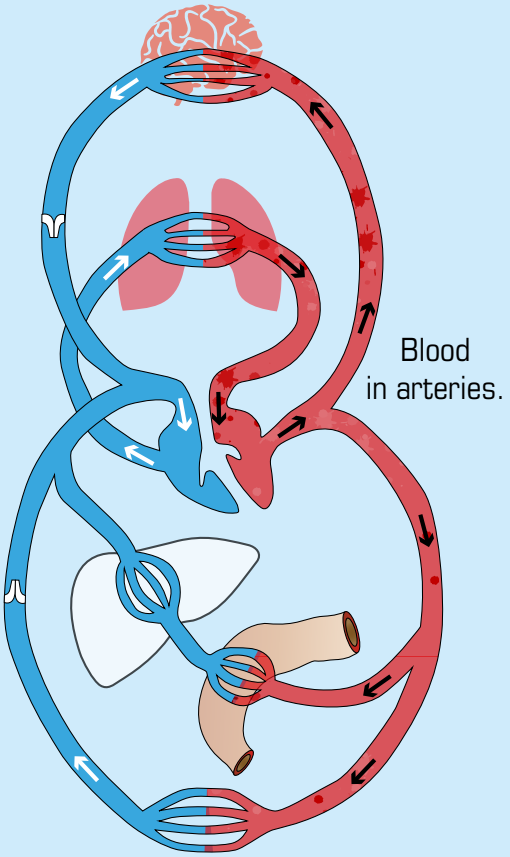
This accepted view of the body did not advance for nearly 15 centuries. History and science discovery was guided by the worldview of the times. Over the course of these 15 centuries, the Roman Catholic Church dominated the attitudes and direction of the world of medicine. In essence, anyone who disagreed with the established church was labeled a heretic and was severally punished. A heretic is someone who dissents or disagrees from the established views or what is thought as the revealed truth. Illness was seen strictly as punishment from God. Today we have a process called the scientific method in which one asks questions, develops a hypothesis, and tests this hypothesis through experimentation. During this time, there was no tradition in the way scientific knowledge was acquired. People feared testing commonly held beliefs proposed by Galen. They also feared the church. It wasn't until the Reformation, among other events, when Martin Luther on October 31, 1517, nailed his *95 Theses* on the door of the All Saints' Church in Wittenberg. He challenged the church. The two over-arching points of his theses were that the Bible was the center of religious authority and that we reach salvation by our faith and not just by our deeds.

Fast forward hundreds of years to modern times, and we still have a battle of worldviews. Faith and belief in the Bible do not suppress scientific ideas and advancement. In fact, they are supported more and more with each new discovery, which furthers us to magnify the great designer in our Heavenly Father.

Galen's open-ended vascular system



Harvey's closed circulatory system



This symbol for the barber's pole began during the Dark Ages; the red represented the bloody bandages wrapped around a pole. Early versions had a brass wash basin on the top and bottom. The top basin was a representation of where the leeches were kept. The bottom one was the symbol for the basin used to collect the blood. The staff was the item that a patient would grasp to encourage the flow of blood after a bloodletting procedure.

2000 B.C.

to A.D.1500

Mayan kings and queens who ruled in Central America would open their own veins so that their blood could be used in ceremonies.

460-370 B.C.

Ancient Greek doctor Hippocrates (460–370 B.C.), was considered the father of medicine. He is credited with the idea of the four humors.

335 B.C.

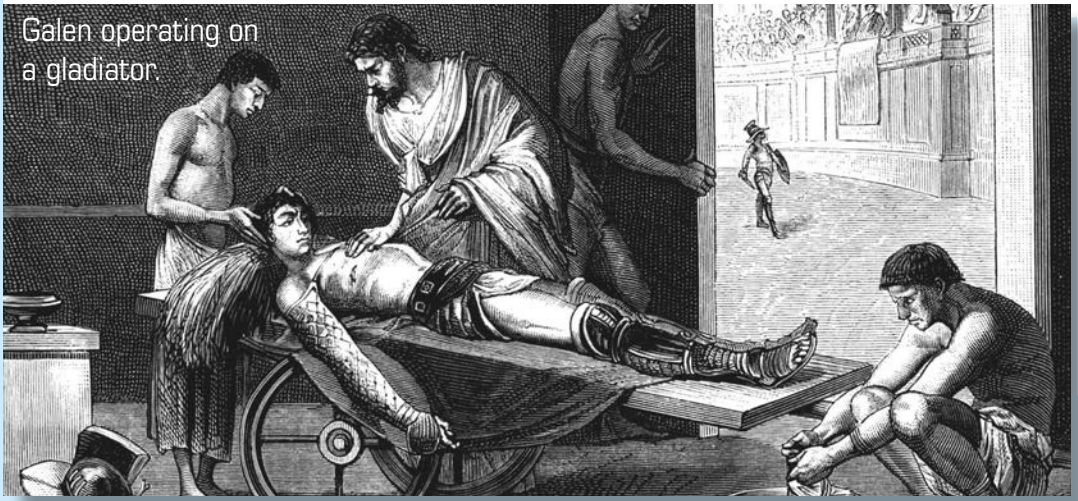
Herophilus (335–280 B.C.), a Greek doctor, was considered to be the father of anatomy.

129-200

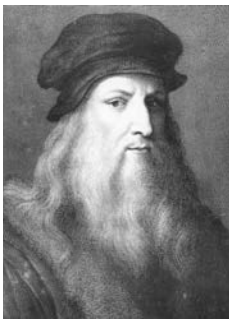
Claudius Galen of Pergamon (129–200) operated on gladiators. He greatly influenced the understanding of medicine and anatomy in the middle ages based on Hippocrates theory of the four humors.

410-1095

In medieval times, barbers were also surgeons. Doctors of the time considered surgery messy and beneath them. Barbers were good with a sharp blade, not only could they cut hair, but they would practice procedures from bloodletting to amputation of limbs. The barber pole was originally red and white striped.



Galen operating on a gladiator.



1500

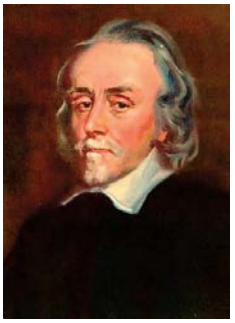
Leonardo Da Vinci (1452–1519) noted tiny "hairs" in tissues. He was interested in the link between form and action of the body. He made the first accurate drawing of the body as well as the heart and its valves.

1553

Michael Servetus (1511?–1553) was a theologian and physician who was burned at the stake. He was considered a heretic for his description of the circulation of the blood through the lungs.

1543

Andreas Vesalius (1514–1564) wrote one of the first books on the human anatomy entitled *De Humani Corporis Fabrica (On the Fabric of the Human Body).*



1578

William Harvey (1578–1657), an English physician, was the first to describe blood circulation in the body. He stated that blood flowed in a closed circuit — it was conserved, which means that the blood was not consumed by the organs. His discovery caused him much concern because it went against centuries of medical thought. He said, "Not only do I fear danger to myself from malice of a few, but I dread lest I have all men as enemies."

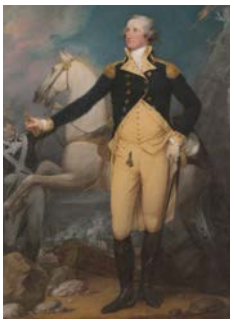
1666

Richard Lower (1631–1691), a physician, followed the works of William Harvey. He pioneered the idea of blood transfusions. He experimented on transfusing dogs. He even transfused a lamb's blood into a human — but such practices were very dangerous so laws in both England and France were created to stop it!

Lower transfusing blood into a man's arm from a lamb.

1670

Marcello Malpighi of Bologna (1628–1691), a biologist and physician, utilized a primitive microscope and discovered a network of tiny vessels called capillaries in the lung of a frog. This discovery linked the arteries and veins.



1799

George Washington (1732–1799) died due to bloodletting. After a day of riding his horse out in the cold, he returned to find his throat sore. Soreness and the swelling in his throat advanced. He became short of breath, and a team of doctors were called. They utilized the most "effective" treatment of the times, bloodletting. It is said nearly 40 percent of his blood volume was removed, and he died. Before dying, George Washington thanked the doctors for their excellent care.

1818

James Blundell (1791–1878) became the first in the United States to perform a successful blood transfusion. The transfusion was performed on a woman who had just delivered a baby. She immediately suffered from severe bleeding. He took 4 ounces from the woman's husband and transfused it into her. Today we know it's not that simple. People have one of four different types of blood, and it can be deadly if you receive the wrong kind during a transfusion.

1823

The first medical journal, *The Lancet,* was published. *The Lancet* still exists today. It is one of the leading medical journals. Thomas Wakley (1792–1862) first published it on October 5, 1823. As the journal was going to press he stated, "A lancet can be an arched window to let in the light or it can be a sharp surgical instrument to cut out the dross and I intend to use it in both senses." A lancet was the indispensable tool utilized in bloodletting. It was used to cut the skin and blood vessels.

1832

The laws were changed, and medical professionals could legally use donated bodies for study and dissection.

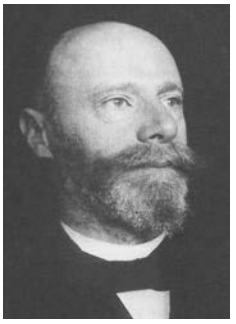
The picture above is Rembrandt van Rijn's *The Anatomy Lesson of Dr. Nicolaes Tulp,* completed in 1632. Dissection was not limited to the eager learning eyes of apprentice doctors of the day; dissections were also held for public "amusement." You could even buy tickets for these events.

1893

Daniel Hale Williams (1856–1931) was an African American general surgeon who performed the first successful open heart surgery and founded the first non-segregated hospital in the United States. He operated on James Cornish at Provident Hospital in Chicago. Mr. Cornish had been stabbed in the heart. Today's common practice of blood transfusion and the use of blood products was not safely utilized at that time. Even without this life-saving practice, he was able to suture (sew) the covering around Cornish's heart, saving his life.

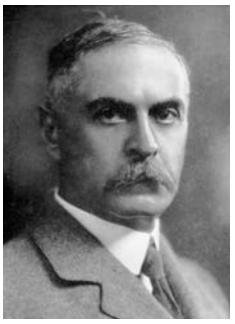
1896

Ernest Henry Starling (1866–1927), an English physiologist (a person who studies the body's processes), was the first to explain the maintenance of a fluid balance in the body. It is called Starling's Law. The law states that the stroke volume (the amount of blood pumped into the left ventricle per a heartbeat) of the heart will increase with additional blood filling into the ventricle. The more the heart wall stretches due to increased blood flow, the more force the heart muscle will use to contract.



1903

Willem Einthoven (1860–1927) was a Dutch doctor and physiologist who invented the first electrocardiogram (EKG or ECG). It was already understood and accepted in medicine that the heart generated electrical activity. However, prior to Einthoven's invention, the only way to record this activity was placing electrodes directly on the heart muscle. This was impractical. He won the Nobel Prize in Physiology or Medicine in 1924.



1900's

Karl Landsteiner (1868–1943) an Austrian-born biologist and physician was the first to identify the major blood groups: A, B, AB, and O. He discovered that agglutinins were found on blood red blood cells that caused an immune reaction in which blood clumps when two different types of blood are mixed.

1919

Jules Bordet (1870–1961), physician, was awarded the Nobel Prize in Physiology or Medicine for his discovery of factors in blood that destroy bacteria and how the blood breaks apart (called hemolysis) due to foreign blood cells in the body.

1920s

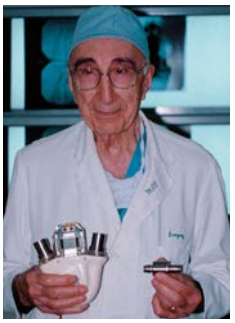
Werner Forssmann (1904–1979), a physician born in Berlin, used himself as a test subject to prove the medical procedure for cardiac catherization was possible. He inserted a catheter, a type of tube, threading it into a vein at the fold of his arm and pushed the tube deeper and deeper until the top was inside the right side of his heart. With the tube still in, he went to the hospital radiology department and took x-rays to confirm his findings. He was awarded the Noble Prize in Physiology or Medicine in 1956.

1930s

Charles Richard Drew (1904–1950), was an African American physician and surgeon who is credited for blood banks. He studied how blood transfusions were given, and invented better techniques for storing blood. During World War II, he utilized this new knowledge to help provide life-saving blood storage to help wounded soldiers in the field.

1944

Helen Brooke Taussig (1898–1986), physician, is credited with being the founder of pediatric cardiology. She assisted in the development of the Blalock-Taussig Shunt. This is a surgical procedure that helps children born with heart defects, "blue baby syndrome," that cause them to be blue. She was awarded the Medal of Freedom from President Lyndon Johnson. In 1965, she became the first woman president of the American Heart Association.



1952

Michael DeBakey (1908–2008) invented a new kind of graft for repairing torn arteries. In 1932, he invented a part for the first heart-lung machines. These machines are utilized for heart surgery. He was the first person to identify the smoking of cigarettes as a connection to lung cancer. In the 1950s, the DeBakey Dacron Graft was used in repairing damaged blood vessels.

1967

Christiaan N. Barnard (1922–2001), a South African cardiac surgeon, was a pioneer who performed the first successful human heart transplant. Although his patient lived only 21 days after, it was still considered a great success.

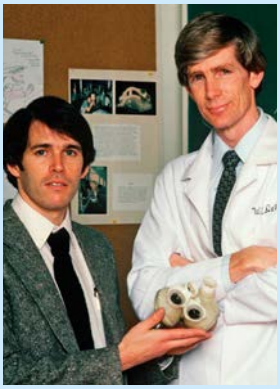
1982

Barney Clark at 61 years of age survived a Jarvik-7 artificial heart for 112 days. Dr. William DeVries (1943–) performed the surgery. Clark knew that his chances for long-term survival were not likely, but he agreed to the heart to help further medicine.

1991

Dr. Drew Gaffney (1946–), physician, flew on NASA's space shuttle as a "payload specialist." A payload specialist is someone who rides as an expert in a particular field. While on board, he studied how the heart and the circulatory system adapted to flight in space. This was the first mission to explore the human body in space. A catheter, a long tube, was inserted into his elbow prior to lift off and threaded to his heart. This allowed close measurement of his heart functions.

A number of artificial hearts were proposed and experimented with since the first one by Vladimir Demikhov in 1937, who transplanted it into a dog. There were limited successes in tests with animals, but this helped to advance understanding of the challenges. Here you can see the major blood vessels on the Jarvik-7, an aluminum and plastic artificial heart used during the first successful human implant in 1982 at the University of Utah Medical Centre in Salt Lake City. The Jarvik-7 heart relied on external power for compressed air and electricity. The patient had a six-foot lifeline to the support equipment.



Dr. Robert Jarvik, developer of the Jarvik-7 artificial heart, and Dr. William DeVries who, with Dr. Tom Kessler (not pictured), performed the first successful permanent artificial heart surgery.

The first total artificial heart implanted in a human body was developed by Domingo Liotta and placed by surgeon Dr. Denton Cooley in 1969 at St. Luke's Episcopal Hospital in Houston. (Dr. Liotta joined the staff at the hospital in Texas in 1961 as the director of the Artificial Heart Program. He was hired by Dr. Michael DeBakey.) The patient lived for sixty-four hours with the artificial heart pumping oxygenated blood through his body until a human heart could be available for transplant. The patient died soon after receiving a real heart, and there was criticism about the use of the Liotta-Cooley plastic heart. However, it did show how artificial hearts could be used until real hearts were donated.

Word Wise!

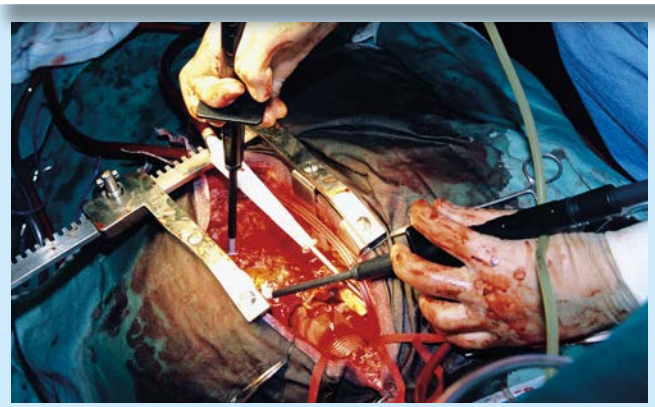
The HIPPOCRATIC OATH, named after Hippocrates, is an oath that doctors are required to swear upon upholding professional standards in practicing medicine and the care of the patients.

Our knowledge of medicine continues to march on.

Today, we are looking at new ways to diagnose heart disease much earlier. An item with great promise is the Computed Tomography Angiography or CTA. It helps to find small blocks in the arteries that surround the heart. A dye is injected in a vessel in a patient's arm. A special x-ray machine called a CT scanner takes images of the heart and the dye flowing through the blood vessels. It can show where blockage exists in the vessels.

A new artificial blood is being tested in the United Kingdom. If successful, it could provide an answer to blood shortages. Perhaps it can be used in patients who refuse blood transfusion on the grounds of religious objection.

Maybe God has a plan for you to make contributions to the field of cardiology. He has given you unlimited potential. Walk boldly. Keep your eyes on Him. Look for ways to magnify His wonder.



Racial segregation existed in the United States and even existed in the donation of blood. Charles Richard Drew resigned from his position with the American Red Cross over this issue. The American Red Cross did not change its position on this policy of segregation until 1950.