

*The*  
**BOOK** *of*  
**BLOOD**

FROM LEGENDS AND LEECHES  
TO VAMPIRES AND VEINS

HP NEWQUIST



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To LEE, ANNE, ROBERT,  
EDWARD, MARGARET,  
JAMES, AND MICHAEL.

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Apparently, blood really  
is thicker than water.

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## Introduction

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### **RED. WET. STICKY. GROSS. MOST OF ALL, RED. BRIGHT RED.**

All of these words are used to describe the most important liquid in your body: blood.

It's not just you, of course. Fish, birds, mammals, insects, and every person on the planet has blood, too.



*The sight of blood from a wound causes many people to feel faint.*

Blood is pervasive. Blood—as a symbol, as a living tissue, even as a word—is important to every culture in the world. It is used in language to describe extreme situations or events. For example, “blood brothers” are people who have a very close relationship, while the phrase “bad blood between them” describes people who are spiteful toward each other. “Blue bloods” are members of a royal or very rich family who are thought to be different from common people—right down to the color of their blood. A “blood oath” is an oath that can never be broken. “Cold-blooded” refers to someone who appears to have no feelings or compassion. “Bloodthirsty” is used to describe the rulers of countries who regularly engage in war, with battles that might end up as “bloodbaths.” Something that makes you extremely angry makes your “blood boil.” And in England, “bloody” is used as a curse word.

Despite its importance to our lives, there has always been an “ick” factor surrounding blood. From vampires to scary movies, the thought of blood outside our bodies still gives most people the shivers. Bloodsucking vampires, blood transfusions in a hospital, and even the blood from a wound make many people queasy. They don't like to think that this red fluid fills up our insides.

Blood does give us a reason to pause, perhaps because of its bright red color. All over the world red is the color of warning and danger. From stop signs and stoplights to fire engines and the flashing lights on ambulances, red is a color that we pay attention to. Similarly, the sight of blood causes us to freeze in our tracks.

There is more to blood than that it's red and kind of gross. It is an extremely complex fluid that moves through you your entire life without ever stopping. Most important, it keeps you alive. Blood delivers fresh oxygen to your cells, protects you from disease, and sweeps the waste from your organs from the moment you are born.

Scientists are still discovering things about blood almost every day. In fact, only in the last one hundred years have scientists come to understand just what blood is and what it does. And what it is, and does, is quite amazing.

## Real Blood

There is probably nothing scarier to many of us than seeing blood suddenly rush out of a wound. But without blood, people couldn't live. That red liquid is keeping you healthy, allowing you to think and play, and making sure your body gets everything it needs to grow and stay alive.

You've seen blood, probably coming out of your own body. This doesn't happen on purpose: You run into someone while playing a game, bang your face, and your nose starts bleeding. You open an envelope with your finger, get a paper cut, and then a razor-thin line of blood rises on your skin. You fall off your bike, and your scraped knee spills blood. You lose a tooth, and blood shows up in your mouth.

You see the blood, and you experience a moment of shock or fright that it has shown up outside your body. But the red liquid stops flowing, hardens, or is wiped off, and then you forget about it. It was there briefly, and then it went away.

There probably wasn't much blood, maybe a tablespoon at most. It was only a small amount of the blood that continued to swirl through your body, rushing as fast as if it were flowing through a faucet. You went back to what you were doing, and your blood kept doing what it has done ever since you were born: keeping you alive.

Blood looks too simple to be so important: just a bright red splash of liquid that seems as if it isn't much different from paint or fruit juice or cherry-colored water. But blood is not a simple red liquid. It is very complex and contains many components, which are so small you need a microscope to see them. Think of these components as being similar to the ingredients in a chocolate milk shake. While a glass of pure orange juice is made up only of the liquid squeezed from an orange, a chocolate milk shake is made up of many different things. There is the milk, sugar, and flavoring that create the ice cream. Then there is chocolate syrup, which has cocoa butter, sugar, corn syrup, preservatives, and a host of other ingredients. When blended together, these unrelated ingredients form one unique liquid: a milk shake.

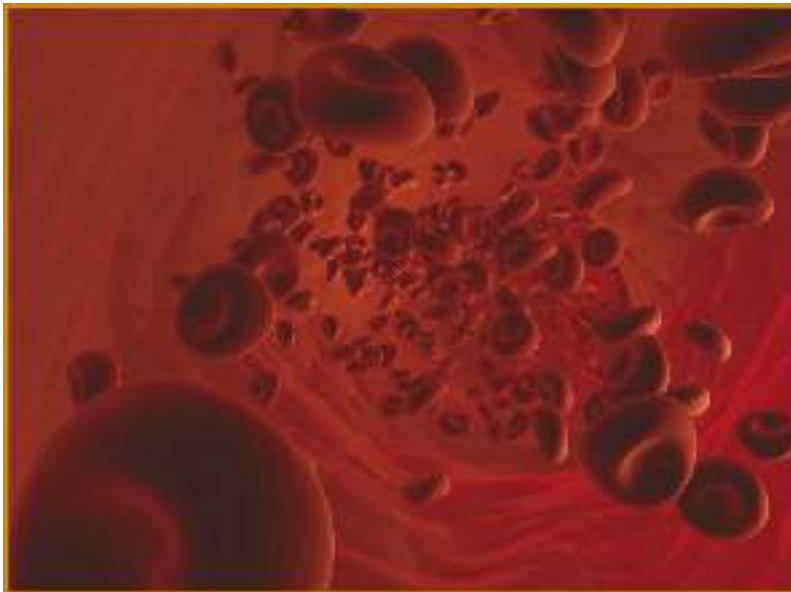
Like a chocolate milk shake, a lot of things go into making your blood. This starts with plasma, a pale, gold-colored liquid that makes up half of your blood. Most of your plasma, about 90 percent, is made up of water. The watery nature of plasma helps blood flow through your body. Think of plasma as the river in which all the other blood parts float along together.





*One drop of blood is mostly plasma, with red blood cells, white blood cells, and platelets floating inside it.*

The next biggest ingredient in blood is red blood cells. These are round, partly flattened cells that carry hemoglobin. Hemoglobin is a protein, and proteins are substances that contain elements such as oxygen, nitrogen, and carbon. Living beings use proteins to carry nutrients and to trigger many biological processes. Hemoglobin, in particular, contains iron atoms that attract oxygen atoms. When red blood cells enter your lungs, the hemoglobin picks up oxygen and carries it to other parts of your body.



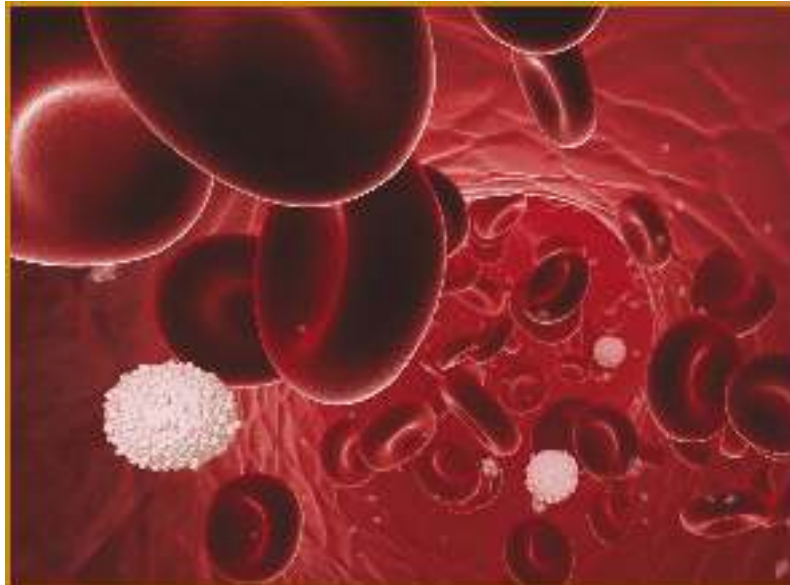
*Red blood cells are shaped like disks with slight depressions in their center. They get brighter red when they fill with fresh oxygen.*

Hemoglobin turns bright red when it is filled with oxygen\* And even though plasma is gold colored, nearly half of your blood is made up of red blood cells, so hemoglobin gives your blood its distinctive color.

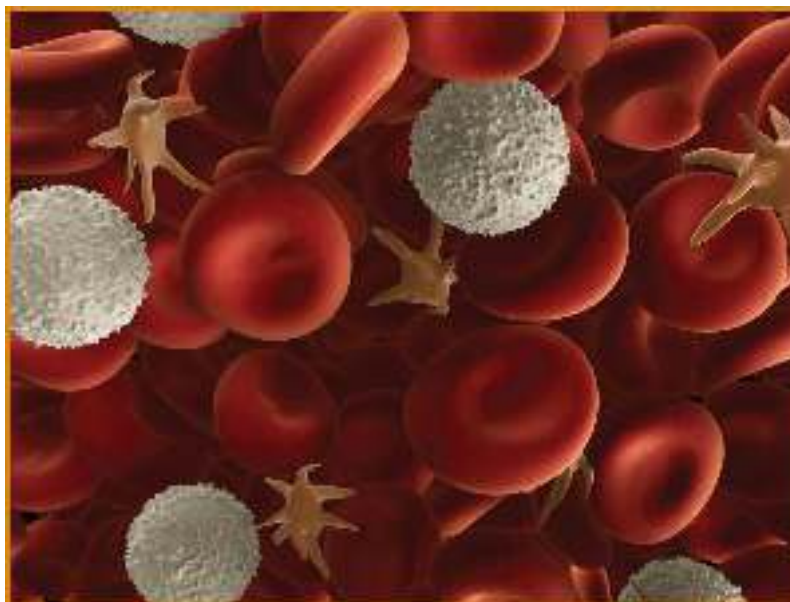
Then we have white blood cells. There is approximately one white blood cell for every six hundred red blood cells—that's approximately 1 percent of your total blood—and they live for just a couple of weeks. Because there are so few of them, the white cells don't affect the color of your blood. (If there were as many white cells as there are red cells, we might be talking about pink blood.) White blood cells are like bodyguards for the inside of your body. They attack and eat bacteria, they eat dead cells in your body, they fight off parasites, and they tell your body when it needs to protect itself.

Think of them as microscopic attack dogs. They also carry your DNA, which is the code to how your body is structured.

Aside from red and white blood cells, there are platelets, the smallest of the blood particles. Platelets are initially shaped like little plates, which makes it easy to remember their name, but when they go to work, they extend in many directions, like a star or a squid. The function of platelets is to stop blood from flowing out of you. When you get a cut or a scrape that starts to bleed, the platelets are suddenly exposed to air. They swell up and begin a chemical reaction that clogs up the blood flow near the cut. If you didn't have platelets, you would bleed to death.



*White blood cells are far outnumbered by red blood cells.*



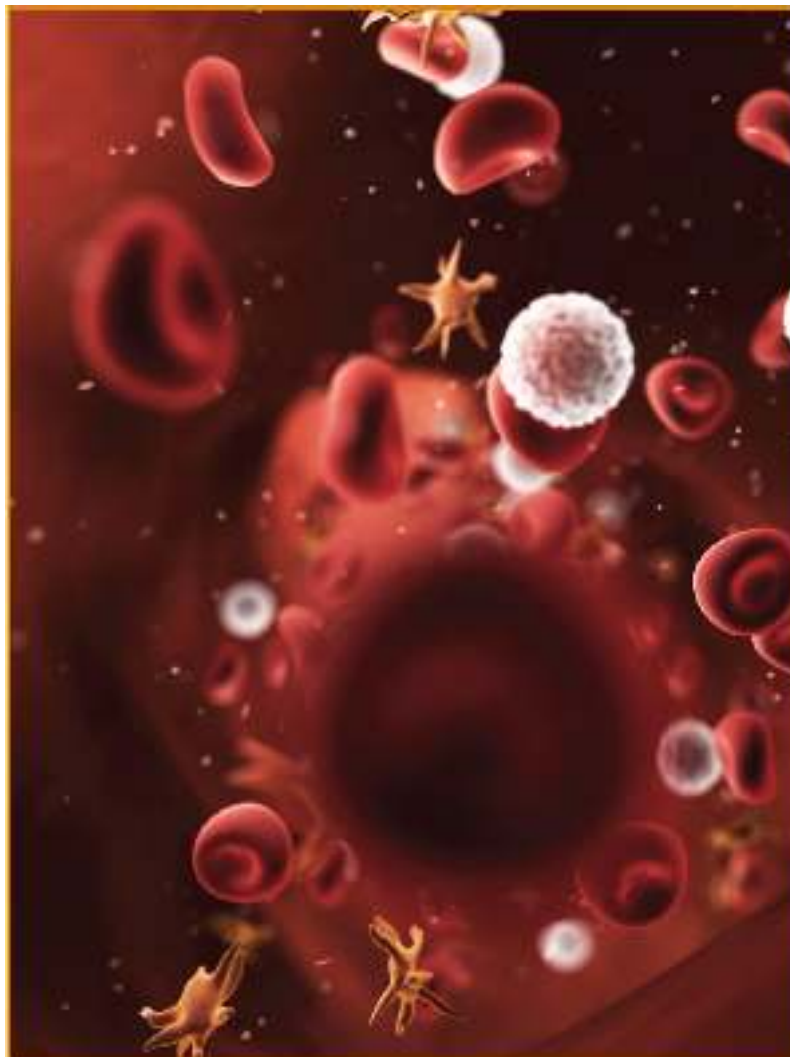
*Platelets help keep your blood inside your body when you are injured.*

There are lots of other things in your blood, many of them floating around in the plasma. They include various proteins, vitamins, and glucose (a form of sugar), all of which are used to either nourish your body or help it fight off disease.

Your blood is a fluid rich with different-colored ingredients that do many things: golden plasma that transports blood cells, red blood cells with hemoglobin, white blood cells for protection, and platelets for clotting and repair. Inside your body there is about a gallon of this blood, the equivalent

of a big jug of milk.

Because it contains living cells, blood is more than just a liquid. It is actually considered tissue. The definition of “tissue” is any grouping of cells that work together to perform a specific function or create a specific organ or part of the body. The heart and lungs and skin are all made of different forms of tissue. In the scientific world, blood is its own kind of tissue, even though it is a very fluid substance.



*Red blood cells, white blood cells, platelets, and plasma are the primary components of blood.*

## **BREAKDOWN OF BLOOD COMPONENTS IN A CENTRIFUGE**

When blood is spun around quickly in a centrifuge, it separates into its three main parts based on how heavy each component is. The top half, or roughly 55 percent, of the separated blood is the almost clear gold-colored plasma. The bottom segment, just 45 percent, is made up of all the heavy elements related to red blood cells and hemoglobin. In the middle is a small layer—barely 1 percent—of white blood cells and platelets. They are slightly heavier than plasma, but lighter than red blood cells. This is called the buffy coat because of its off-white or buff color.



*Blood separates into its different parts when it is processed in a lab: red blood (on the bottom), white blood (thin strip in the middle), and plasma (on the top).*

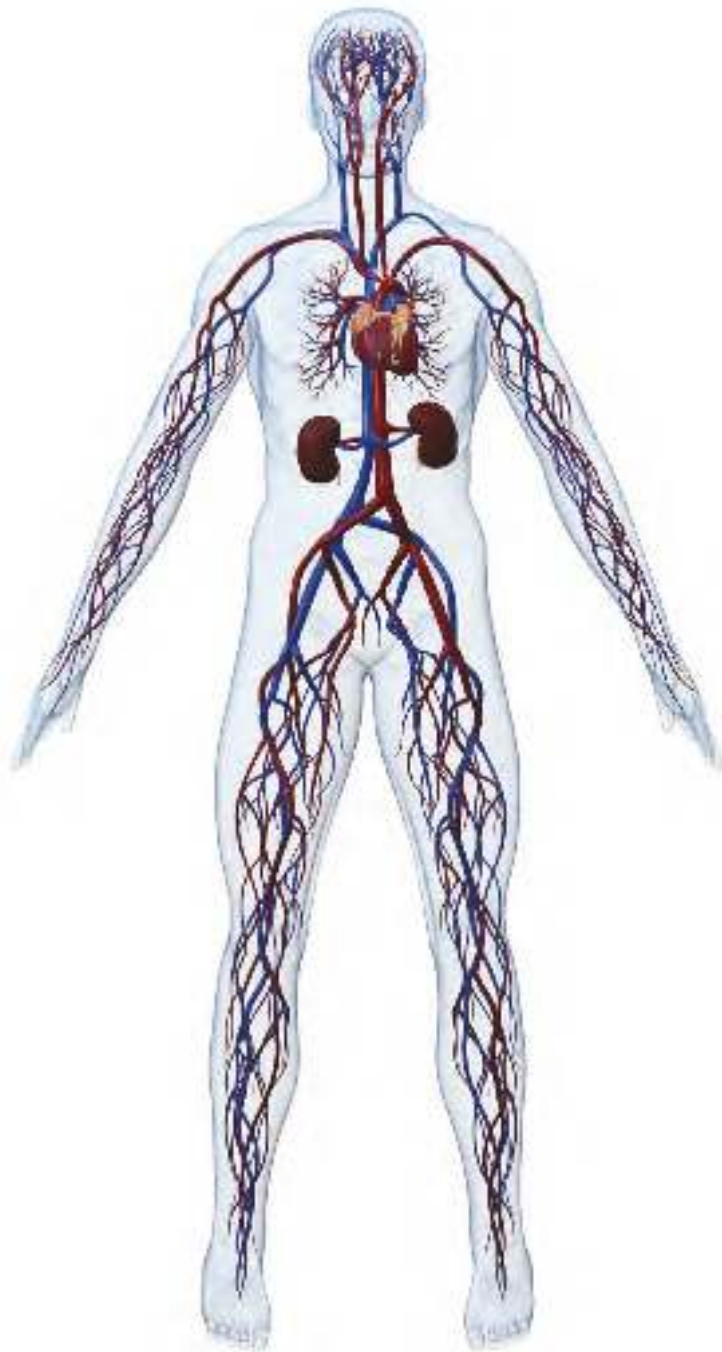
Blood moves around your body through a vast network called the cardiovascular system. This includes your heart, your arteries, your veins, and your capillaries (the really tiny blood vessels). Various scientists refer to this network as the circulatory system. Others use the term “circulatory system” to mean both the cardiovascular system and the lymphatic system, which is part of the immune system and helps drain excess fluids from your organs. To keep it simple, we’re going to use the term “circulatory system” from here on. It’s the most commonly used term, and will help you better understand how blood moves—in a circular manner—throughout the body.

## **BLUE BLOOD?**

While it is in your body, your blood is always red. It is never blue, although some people think that blood is blue because some veins look blue underneath our skin. The fact is that oxygen-rich blood is bright red, and when red blood cells give up oxygen—and instead carry waste from your body—they lose that brightness. Blood turns dark red as it travels through you, becoming almost maroon or burgundy colored, before lightening again when it absorbs air in the lungs. The idea that blood is blue in your body is a myth.

In fact, your veins aren’t blue, either. Veins appear blue under your skin because of the way light interacts with various layers of your skin, with the area around your veins taking on a darker color. And when you see blood vessels next to other parts of your skin, you perceive them as bluish in color.

Think of the circulatory system as a highway or a waterway. Blood flows through it like traffic, carrying everything your body needs, as well as most of what your body wants to get rid of. Like a busy highway in a big city, traffic never stops: it crisscrosses over itself and loops around and up and over, and eventually everything gets to its proper destination.



*The circulatory system reaches into every part of your body. You have so many blood vessels that they would stretch 100,000 miles.*

The circulatory system is so completely spread out over the human body that if you poke a needle into any part of your skin, you will draw blood. This is because there are approximately a hundred thousand miles of veins, arteries, and capillaries in your body. If all of these blood vessels were stretched out in a line, they would circle the Earth four times. You can see capillaries—large ones—by looking at your eyeball in the mirror or by looking up close at a friend's eye. Those little red vessels in the white part of your eyeball are carrying blood right into your eye from your heart.

Each day, your heart beats about a hundred thousand times, pumping blood to every single corner of your body. Your heart pumps your blood over and over so many times over the course of twenty-four hours that it is pumping the equivalent of two thousand gallons a day. Two thousand gallons is enough to fill a swimming pool.

Unlike with many other systems in your body, you can actually see and feel the circulatory system at work. You can feel your heart pumping, you can sometimes see your arteries pulsing (especially in your wrists and arms), and you've seen blood come out of your body, probably through

cuts, loose teeth, or a bloody nose.

~~That brings us to the big question: what does blood actually do?~~

We're fortunate to be living in an age when we can answer that question. Before the 1900s, there were a lot of misconceptions about blood. It was misunderstood and frightening, part of monster stories and mythology. And not so long ago, doctors believed that curing diseases meant injecting animal blood into people ... or taking as much blood out of a person as they could.

To find out what blood does, we'll start by looking at why blood has always been so mysterious.

### The Mystory Inside

Creatures have bled since the dawn of time. Dinosaurs bled, mammoths bled, and the Neanderthals (sometimes referred to as cavemen) bled.

Modern humans, who have been around for a little over two hundred thousand years, saw blood regularly. It poured from the animals they hunted. It flowed from their own bodies when they were injured. This might have happened when they fell or when animals attacked them. A savage animal attack—by a predator such as a lion—would have been very dramatic and involved a great deal of blood.

After a predator had finished eating another animal, the only thing left may have been blood on the dirt.

Early humans had no understanding of what blood was or what it did, but they understood that it was important. They knew that when a lot of blood was spilled on the ground, death was nearby. By being associated with death, blood was certain to have caused fear. It was given the same respect as death.

Like other powerful images, symbols, and elements of the natural world that weren't understood (such as thunder, lightning, floods, predatory animals, and death), blood was incorporated into the lives of ancient cultures. It became part of their legends, part of their rituals, and part of their ceremonies. Blood was essential to myths, legends, and religious traditions long before humans knew what blood was.



*Lamashtu attacked citizens and drank their blood. In this ancient plaque, she is depicted devouring the people around her.*

As far back as 5000 B.C., the people of Mesopotamia (the area of present-day Iraq) had a female goddess known as Lamashtu. She was an evil creature who was jealous of human women, stole their babies, and sucked the blood from the mothers and their newborns. Her existence was used to explain the deaths of infants and of pregnant women. Other evil, blood-drinking beings, like the Babylonian goddess Lilitu and the Hebrew Lilith, are believed to be related to the story of Lamashtu.

The Hindu goddess Kali, who was associated with change and destruction, was said to drink the blood of her enemies after defeating them on the battlefield. Sekhmet, the warrior goddess of Egypt, also drank the blood of her enemies and was said to drink from the Nile River when the water became bloody. It is likely that some of these female deities were the inspiration for early vampire legends.





*Kali and Sekhmet were ancient deities who were believed to drink blood.*

Blood also played a large part in the Bible, and it was used frequently as a symbol of fear, power, and life—especially when God was involved. In the Old Testament book of Exodus, the Egyptians held the Israelites as slaves. When God demanded that the Israelites be freed, the Egyptians refused. As punishment, God unleashed ten plagues upon Egypt, beginning with the Plague of Blood:

*Thus says the LORD, “By this you shall know that I am the LORD: behold, I will strike the water that is in the Nile with the staff that is in my hand, and it will be turned to blood. The fish that are in the Nile will die, and the Nile will become foul, and the Egyptians will not be able to drink its water.*

*Exodus 7:17–18*



*A picture of the Nile River “turning to blood,” killing all the fish. (From the 1300s, artist unknown, British Library)*

Scientists think that the “river of blood” identified in the Bible and in the legends of Sekhmet may have been caused by the red ash of a volcano or by the spread of algae that is red in color. The Nile also takes on a reddish color when it floods and red soil seeps into it.

Rivers running with blood are pretty horrific. Yet, this plague didn’t persuade the Egyptians to free the slaves, nor did the next eight plagues, which included frogs, lice, locusts, and darkness. But the tenth plague did change the Egyptians’ minds, and it too involved blood. For the tenth plague, God sent an angel to kill all the firstborn male children in Egypt. However, God warned the Israelites ahead of time to mark their doors with lambs’ blood. This would be a sign to the angel not to harm the children inside.

After all this blood, the Egyptians gave up and let the Israelites go.

Later in the Old Testament, the book of Leviticus states that blood is to be used only as part of sacrifices to God. It is to be sprinkled on altars, but no one is ever to drink it. Modern researchers think this might be a reference to other cultures of the time—primarily in North Africa and in Egypt—where people drank blood for medicinal purposes.

The biblical importance of blood extends into the New Testament, where Jesus Christ tells his disciples during the Last Supper that the meal is representative of his life. In Mark 14:23–24 the Bible says: “And he took the cup, and when he had given thanks, he gave it to them: and they all drank of it. And he said unto them, This is my blood of the new testament, which is shed for many.”

In John 19:34, as Christ is on the cross, a soldier stabs him in his side with a spear. According to the Bible, both blood and water flowed from the wound. This is interpreted to represent death, in the form of blood, and new life and purity, in the form of water.

## **BLOOD SACRIFICE**

The reverence for blood appears to have extended to almost all ancient religions, cultures, and civilizations. Its mentions in the Old Testament date from two thousand years ago. The Chinese legend of P'an ku, the creature whose blood formed the Earth's rivers, is over three thousand years old. The importance of blood in ancient Egyptian mythology dates from nearly six thousand years ago.

Over the course of thousands of years, blood took on a prominent role as an offering to gods. After all, if blood was part of death, and the gods were responsible for life and death, then these gods must like blood. Perhaps giving them blood more often would keep them happy and make them look more favorably on their worshipers.

This belief cropped up in civilizations around the world. Almost every ancient culture created some sort of blood sacrifice as part of its rituals for its gods. The Hebrews used the blood of lambs to protect them from an avenging angel. Ancient Romans spilled the blood of cattle to purify their towns and drive away evil spirits. Warrior kings during the Shang dynasty in China offered the blood of their people to their dead ancestors in the hope of being victorious in war.



*Lambs' blood was used as protection in Old Testament stories, as depicted in this stained glass window.*

Ancient paintings from Greece and pottery from Mayan civilizations—two cultures that existed on separate continents—depict ritual bloodletting, a process whereby blood was taken from an animal or a human as part of a ritual or ceremony.

In these ceremonies, the human being who was being sacrificed for his or her blood usually died since it required that throats be cut, stomachs opened up, or heads removed. Taking blood for ceremonies was not a pretty sight. It involved quite a bit of struggling and screaming. And lots of blood.



*A special knife used for cutting open sacrificial victims.*

Ritual bloodletting—which is different from medical bloodletting, a procedure we’ll explore in later chapters—was practiced by civilizations such as the ancient Egyptians and Mayans. It was

performed by a priest or tribal chief who took the spilling blood from the severed throat or stomach of the victim. The blood was collected in a special bowl, and then sprinkled over an altar or over members of the tribe to bless them. Some priests actually drank it.

Many of these rituals had very strict rules and could be carried out only by prominent members of the tribe—those considered worthy enough, powerful enough, or wise enough to take a life. Performing the rituals often involved the gathering of the entire tribe, who would watch the action. Like today's religious ceremonies, these were very serious occasions, and sacred objects would be used to carry out the ritual. These included finely carved blades used only for drawing blood and bowls fashioned from the tops of skulls to collect the flowing blood.

Sometimes the human sacrifice was a person from a neighboring tribe who had been captured in battle or kidnapped for the event. These people must have been horrified at the thought of being killed in an enemy's ritual. At other times, the sacrifice was someone from within the tribe who willingly offered him- or herself up. That person might have felt honored to be chosen by the tribe as a gift to the gods. The most important thing, as far as the tribe was concerned, was that these victims were giving their lives for the benefit of many others.

Blood rituals occurred all over the world. Mayan kings and queens, who ruled in Central America from nearly 2000 B.C. to A.D. 1500, would cut open their own veins so that their blood could be used during ceremonies. The Greek leader Alexander the Great (356–323 B.C.), ruler of Macedonia, was said to have started each day by sacrificing an animal with a knife and then praying to the gods over the animal's blood.

Perhaps no society was as fond of spilling blood as the Aztecs. In the late 1400s in what is now Mexico, the Aztecs took blood sacrifice to a new level. They built pyramid temples that had altars on top. Sacrificial humans were taken up to the altars on eighteen festivals during the year to celebrate everything from the oldest members of the community to crop harvests.



*An image from a sixteenth-century Spanish document showing the Aztecs performing a human sacrifice on a pyramid.*

Once those to be sacrificed were on the altars, their hearts were cut out and their blood was

allowed to flow down over the temple steps. The Aztecs were thought to have killed thousands of people in this way every year. They believed it was important to honor the gods with this blood because the gods had sacrificed much to create the universe. The Aztecs were just paying the gods back.

One of the unusual things about all this bloodletting is that very few cultures learned much about how the human body worked from all of the slicing and cutting that was done on sacrifices. In fact, it was considered immoral and illegal to cut open a body, alive or dead, unless this was done for purely religious purposes. The Aztecs, for instance, took the heart out of the chest of their sacrifice, but they immediately disposed of the body. They did not worry about all the parts that the heart was connected to. The body was sacred (even when it belonged to an unwilling victim) and was not to be touched for any purpose other than making the gods happy.



*Making dead people into mummies was a way of preparing those people for the afterlife.*

Only the Egyptians, who turned their rulers into mummies after death, were interested in what was going on in the human body. Their method of creating mummies relied upon extracting organs through tiny slits made in the skin. They wanted to preserve bodies for this trip to the afterlife (the Egyptian version of heaven and hell), so they didn't open people up and look inside. People needed their bodies in the afterlife, and cutting up their flesh would have disfigured them.

Organs were removed so that bodies could be treated with herbs and oils, and then stuffed with dry cloth. The heart, lungs, kidneys, and other organs were placed in sealed jars to preserve them separately. By removing these organs through surgical slits, the Egyptians became familiar with the placement of organs and the movement of fluids through the body.

Even doctors in Greece and Rome, where the great classical philosophers lived, did not examine bodies after death. It was considered inappropriate and disrespectful of the dead person. Because of this ban, doctors had little sense of how things worked inside the human body. Most of them thought that blood just floated under the skin like water in a jar.

## **THE FOUR HUMORS**

The first ideas about what blood might actually do came from Hippocrates, a physician and teacher who lived in Greece from 460 to 377 B.C. Little is known of Hippocrates' personal life, but he wrote extensively about the way doctors should treat their patients. Prior to his teachings, doctors were as

likely to trust in magic as they were to give treatments that would help sick patients.

Hippocrates taught that doctors needed to do everything they could to heal a patient, and that they needed to always act with the patient's health in mind. This included never knowingly doing harm, prescribing deadly drugs, and performing surgery that they were not trained for. So important were Hippocrates' ideas that even today doctors take what is called the Hippocratic oath, a promise to treat their patients as best as they can.

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## HIPPOCRATIC OATH

I swear by Apollo the Physician and Asclepius and Hygieia and Panacea and all the gods, and goddesses, making them my witnesses, that I will fulfill according to my ability and judgment this oath and this covenant:

To hold him who has taught me this art as equal to my parents and to live my life in partnership with him, and if he is in need of money to give him a share of mine, and to regard his offspring as equal to my brothers in male lineage and to teach them this art—if they desire to learn it—without fee and covenant; to give a share of precepts and oral instruction and all the other learning to my sons and to the sons of him who has instructed me and to pupils who have signed the covenant and have taken the oath according to medical law, but to no one else.

I will apply dietetic measures for the benefit of the sick according to my ability and judgment; I will keep them from harm and injustice.

I will neither give a deadly drug to anybody if asked for it, nor will I make a suggestion to this effect. Similarly I will not give to a woman an abortive remedy. In purity and holiness I will guard my life and my art.

I will not use the knife, not even on sufferers from stone, but will withdraw in favor of such men as are engaged in this work.

Whatever houses I may visit, I will come for the benefit of the sick, remaining free of all intentional injustice, of all mischief and in particular of sexual relations with both female and male persons, be they free or slaves.

What I may see or hear in the course of treatment or even outside of the treatment in regard to the life of men, which on no account one must spread abroad, I will keep myself holding such things shameful to be spoken about.

If I fulfill this oath and do not violate it, may it be granted to me to enjoy life and art, being honoured with fame among all men for all time to come; if I transgress it and swear falsely, may the opposite of all this be my lot.

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Hippocrates, like many doctors before him, thought that blood was just one of four important liquids in the body. These were called the four humors and included blood, phlegm, yellow bile, and black bile. (The word "humors" doesn't have anything to do with being funny, although it sounds that way. Once upon a time "humors" referred to liquids.) This belief in four humors tied in with the Greek view that nature was made up of four primary elements: fire, water, earth, and air. There was even a relationship between the four humors and the four elements. The essence of fire was thought to be part of yellow bile, earth was supposed to be contained in black bile, water was a component of phlegm, and all four elements—including air—were considered components of blood.

Each of the humors—or body fluids—controlled the body and kept it healthy. Too much of one

fluid would cause particular kinds of sickness and disease. The body needed to keep the humors in perfect balance in order for people to be both healthy and happy.

The humors were defined like this:

Blood controlled general health and well-being. Too much blood caused fevers or ailments in the body.

Phlegm (mucus and saliva) controlled the body's activity level. Too much phlegm, and a person became sleepy or lazy.

Black bile controlled emotions. Too much of it made a person sad, depressed, or irritable.



*A drawing of Hippocrates, one of the world's first great doctors.*

Yellow bile controlled a person's temper. Too much of it made him or her angry, excitable, or out of control.

Even though real bile is a form of stomach acid, it's possible that the Greeks based their notions of bile on different blood forms: black bile could have been the dark form that clotted blood takes, and yellow bile could have been the light gold of blood plasma. Hippocrates might have seen these colors when blood stored in a container separated over time into its various parts (the way that salad dressing or fruit smoothies separate into different levels of liquid when they have been sitting around for a while).



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