**Blood does a body good**

Studies of the superfluid aid in the prevention and treatment of diseases

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Each time a human heart beats, blood rushes out of the muscular pump and winds through 60,000 miles of blood vessels. That network of tubes connects every cell of the body, each of them dependent on blood. This vital fluid delivers essential nutrients, carts away waste products, fights infection and heals wounds.

Blood is an amazing mixture of three different types of cells suspended in liquid called plasma. If you weigh 80 pounds (36 kilograms), your body probably contains at least 2 liters of blood — the volume of a large soda bottle.

Though scientists understand the primary jobs of blood’s contents, they’re learning that a variety of cells work together in complicated ways, says Donna DiMichele, deputy director of the Division of Blood Diseases and Resources at the National Heart, Lung, and Blood Institute, part of the National Institutes of Health located outside Washington, D.C. Blood cells and even blood vessels respond to situations within the body by releasing a range of chemicals. Those chemicals serve as signals that prompt reactions from different types of cells in the bloodstream.

**Blood basics**

When you scrape your knee, you bleed red because of red blood cells. A single drop of blood contains millions of these. Shaped like a tiny doughnut with a depression instead of a hole in the center, each cell rushes through the widest blood vessels and squeezes through the slimmest vessels, known as capillaries.

The red color comes from heme, an iron-based chemical. Heme is a part of the protein hemoglobin, a workhorse chemical that transports oxygen. As red blood cells circulate throughout the body, iron latches onto oxygen brought in by the lungs. Red blood cells deliver oxygen to tissues and organs, such as muscle, the liver and the brain.

Blood also contains white blood cells. These help the body fight disease. If viruses or bacteria enter your bloodstream, white blood cells strike back.

Their first punch, called innate immunity, will send in cells that are programmed to attack any kind of invader. Neutrophils, one type of attacking white cell, can gobble up invading bacteria. Other white blood cells called lymphocytes deliver a second punch in the attack, known as acquired immunity. Once the body recognizes an invader, lymphocytes produce antibodies, special chemicals tailored to fight a specific kind of invading microbe or material.

Blood also contains platelets, specialized cells that promote clotting. Platelets move along the walls of blood vessels like border guards, says Keith Hoots, the director of the Division of Blood Diseases and Resources. If platelets reach a break in a blood vessel, such as occurs when you get a cut, they’ll plug the leak. Clotting proteins that circulate in the plasma then glom onto the platelets to form a clot.

Plasma is a yellowish fluid made mostly of water. It shuttles a variety of other chemicals around the body. Nutrients such as amino acids (the building blocks of proteins) and sugars and chemical signals such as hormones hitch a ride in the plasma and are carried throughout the body.

**“Spiderweb” to trap germs**

If you cut your finger with a knife, chemicals within the wall of your blood vessels summon platelets and clotting proteins to stem the flow of blood. But white blood cells respond to some of those same signals, interpreting them as a sign that disease-causing invaders, such as bacteria, may be on the way. One important communication chemical — called tissue factor — is produced by the blood vessels and by a type of white blood cells called monocytes.

When your body senses an invader, tissue factor tells the clotting proteins to form a chemical “spiderweb” that traps bacteria, explains Charles Esmon, a researcher at the Oklahoma Medical Research Foundation in Oklahoma City. It’s not a foolproof net, as some bacteria will try to chew through this web. As clots form, other signals go out that tell the body to stop making clot-busting proteins.

Humans and other animals probably evolved an ability to make these germ-trapping chemical webs as one way to efficiently wipe out infections, Esmon says. In such cases, blood clots can be helpful.

However, a blood clot in the wrong place or at the wrong time can be dangerous. For instance, developing too many clots in the heart can cause heart attacks, and clots in the brain’s blood vessels can cause strokes. So it’s important that the body clears clots as soon as they’re no longer needed.

The risk of clots forming at the wrong time increases with age. In 2010, Esmon and his colleagues compared how young and old mice developed clots in response to an infection. The team found that, over time, young mice made clot-busting proteins more quickly than old mice.

Just like older mice, older people can’t bust blood clots as quickly. Esmon suspects that this slowdown explains part of the reason why heart attacks become more common as people get older.

Keeping the balance between clotting and clot busting within blood is important, Esmon says, so that blood flows when it should and isn’t lost when the vessels are breached.

**Blood-making factories**

Blood cells work hard, and the body replaces them within a few days or a few months. It’s a complicated process and scientists are still not completely sure how it works.

Factories that produce all types of blood cells reside in the squishy tissue inside your bones. This region is called the bone marrow. One of the biggest mysteries about blood is why cells that make it lie buried deep inside the bones, says Gregor Adams, a researcher at the Keck School of Medicine at the University of Southern California in Los Angeles.

Blood contains a mixture of cells suspended within a liquid called plasma. In this scanning electron microscope image, the doughnut shapes with depressions instead of holes in the center are red blood cells. Also shown are white blood cells, such as lymphocytes, and small, disc-shaped platelets.

NATIONAL CANCER INSTITUTE/BRUCE WETZEL, HARRY SCHAEFER

One family of special cells within bone marrow is known as stem cells. They possess the instructions needed to morph into any type of new blood cell. When stem cells divide, they sometimes form new stem cells. Most of the time, however, stem cells form new red blood cells, white blood cells or platelets.

How stem cells decide what type of cell to become is another mystery, but scientists are finding clues to the answer. For instance, stem cells seem to pick up chemical signals from surrounding bone cells about when to divide and what types of cells to create.

In mice, Adams found one type of bone cell produces important chemicals that boost the number of blood-producing stem cells. Adams and other scientists are trying not only to find ways to tag these stem cells with glowing molecules but also to develop new methods to peer inside the bone without disturbing the marrow. Watching what cells do inside the bone is tricky: Blood-producing stem cells are rare, and bones block many of the tools that scientists would use to spy on the cells.

Doctors use blood-producing stem cells to treat diseases. Maybe you know someone who had a bone marrow transplant? In diseases like leukemia, a kind of cancer, the bone marrow produces abnormal blood cells. Doctors can treat a patient by first getting rid of the faulty blood-making stem cells and replacing them with new ones. Doctors perform nearly 20,000 bone marrow transplants in the United States every year.

**Feed your blood**

When you visit your doctor, she can use a blood test to see if you’re healthy. By taking a small blood sample, doctors can check for particular chemicals in the blood or look at the blood cells under a microscope.

It’s important to keep blood healthy because it sustains the body. What you eat nourishes your blood. If, for example, you don’t have enough iron in your diet, your body might not be able to make enough healthy red blood cells, DiMichele says. A deficiency in red blood cells can cause a condition called anemia, which can leave you exhausted.

Blood flowing to your brain makes possible everything you do, including reading this article. As researchers continue to uncover blood’s mysteries, the superfluid will help people live longer, healthier lives.

POWER WORDS

**cell** Tiny compartments of the body that carry out biological functions. When groups of cells work together to perform a specific function, they form a tissue. Tissues working together to achieve a common goal form an organ.

**red blood cell** Red-colored cells that carry oxygen from the lungs to all the tissues of the body.

**white blood cell** Blood cells that help the body fight off infection.

**platelet** Blood cells that stop bleeding, which is caused by a break in a blood vessel wall.

**plasma** A component of blood. The yellowish fluid that blood cells float in.

**clot** A collection of blood cells and chemicals that stops the flow of blood in a small region.

**stem cell** Special cells in the body that can make any of several different types of new cells, including blood cells.

**leukemia** A type of cancer in which the body makes abnormal blood cells.

**anemia** A disease caused by not having enough red blood cells to carry oxygen efficiently throughout the body.