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BASICS

The Wonders of Blood

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You're born with a little over a pint of it, by adulthood you're up to four or five quarts, and if at any point you suddenly shed more than a third of your share, you must either get a transfusion or prepare to meet your mortician.

Human cultures have long recognized that blood is essential to life and have ascribed to it a vast array of magical powers and metaphorical subroutines. Blood poultices and blood beverages were said to cure [blindness](#), headaches, [gout](#), [goiter](#), worms and gray hair. The Bible mentions blood more than 400 times, [William Shakespeare](#) close to 700. It's "all in the blood," your temperament, your fate. Are you a blue-blooded Mesopotamian princess or a red-blooded American male?

Yet to scientists who study blood, even the most extravagant blood lore pales in comparison to the biochemical, evolutionary and engineering marvels of the genuine article.

The fluid tissue we call blood not only feeds us and cleans us, delivering fresh oxygen and other nutrients to all 100 trillion cells of the body and [flushing](#) out carbon dioxide, ammonia and other metabolic trash. It not only houses the immune system that defends us against the world.

Our blood is the foundation of our very existence as multicellular animals, said Andrew Schafer, a professor at Weill Cornell Medical College and the outgoing president of the American Society of Hematology. Blood is the one tissue that comes into contact with every other tissue of the body, and it is through blood that our disparate parts communicate, through blood that our organs cooperate. Without a circulatory system, there would be no internal civilization, no means of ensuring orderly devotion to the common cause that is us.

"It's an enormous communications network," Dr. Schafer said — the original cellphone system, if you will, 100 trillion users strong.

Blood can also be thought of as a private ocean, a recapitulation of what life was like for all the years we spent drifting as microscopic, single-celled organisms, "taking up nutrients from sea water and then eliminating waste products back into sea water," Dr. Schafer said. Not only is blood mostly water, but the watery portion of blood, the plasma, has a concentration of salt and other ions that is remarkably similar to sea water.

Of course, we can't rely on wind and weather to keep our hidden seas salubriously churned and aerated, so we have evolved an active respirator and pumping mechanism, the lungs and heart.

Our eight pints of blood circulate through the powerhouse duet maybe 60 times an hour, absorbing recently inhaled oxygen from the honeycombed fabric of the lungs and proceeding into the thickly muscled heart, which then shoots the enriched fluid outward.

Oxygen allocation is the task of the red blood cells, which hematology researchers refer to with a mix of affection and awe. “Red cells have enormous capabilities,” said Stanley Schrier of [Stanford University](#)’s School of Medicine. They give up so much to make room for their [hemoglobin](#), the proteins that can latch onto oxygen and that give blood its brilliant grenadine sheen. Alone among body cells, red cells at maturity jettison their nucleus and DNA to accommodate their cargo.

And oh how roughly they are treated. A red cell at rest looks like a plump bialy and measures about 8 microns, or .0003 inches, across. Yet to reach every far-flung, oxygen-hungry customer, the cells must squeeze through capillaries less than half their width, which they accomplish by squashing down into threads that then crawl in single file along the capillary wall, pulling themselves forward, Dr. Schrier said, like tank treads gripping the road.

Blood is also a genius, able to sustain two contradictory states without going mad. To ceaselessly shuttle along the body’s 60,000 miles of arteries, veins and capillaries, blood must be fluid, our trusty souvenir sea.

Yet even though we constantly replace components of our blood, directing the aged and the battered to the spleen and liver — the “graveyards for blood cells,” Dr. Schafer said — and replenishing them with fresh blood cells forged in the bone marrow, the turnover cycle is gradual and we can’t afford to lose everything in one big gush wrought by a predator’s gash. Blood, then, departs from sea water, or, for that matter, from [breast milk](#), another prized body fluid, in one outstanding way: it is always poised to clot, to relinquish liquidity and assume solidity.

In deciding whether to flow or clot, blood takes its cues from its surroundings. As blood glides through the bulk of its tubular circuitry, the comparatively heavy red cells are driven toward the center of the swirl, said James N. George, a hematologist at the [University of Oklahoma](#) Health Sciences Center, while two other, lighter characters are pushed out to the periphery: the white blood cells that operate as immune warriors, and the platelets, tiny cells that have been called the Band-Aids of the body. Their marginalization is no accident. “They’re surveillance cells,” Dr. George said. “It’s almost like they’re scouting for trouble.”

White blood cells look for signs of invasive microbes, while platelets scan for leaks. As long as the platelets detect the Teflon-like surface of unbroken endothelium, the tissue with which blood vessels are lined, they keep moving.

But even the tiniest cut or gap in the smooth vessel wall will expose some of the fibrous strands beneath, and the platelets are primed to instantly detect the imperfection. A passing platelet will stick to the raggedy strand and change shape, from round to octopoid, which in turn attracts other platelets, forming a little clump. “If the cut is small, that’s all you need,” Dr. George said. If not,

the next phase of flood control begins. Signals from the platelets arouse the blood's clotting factors, free-floating proteins that can cross-link together into bigger, better Band-Aids.

“Platelets and clotting factors,” Dr. Schrier said. “It’s a marriage made in heaven.”

Up to a point. Just as our immune cells can go awry and begin attacking our own body tissue, so an overzealous clot response can have dire consequences. Should a clot happen to cut off blood flow to a vital organ like the heart or brain, the only one playing the harp will be you.

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