Blood analysis

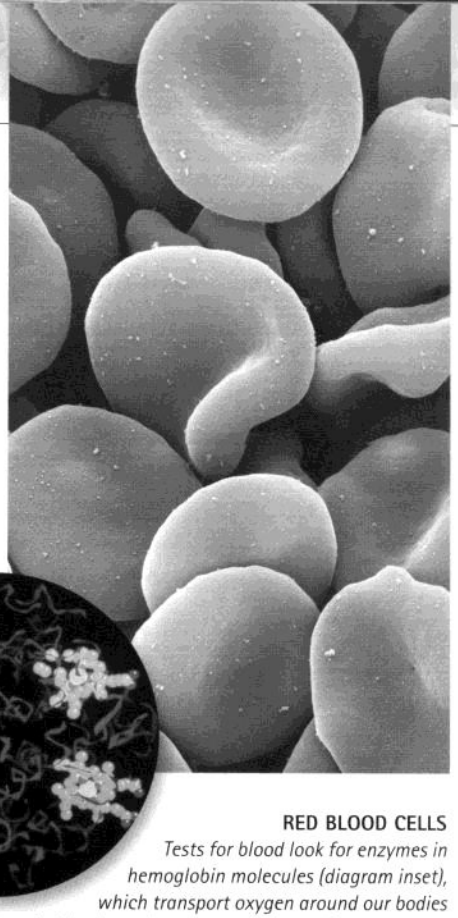
By defining identity in a single drop, blood and other bodily fluids can link a suspect to a victim, a crime scene, or a weapon in a potentially undeniable chain of proof. Though DNA profiling is the best-known procedure for establishing such an incriminating link, it is simply the most exacting test of the much wider discipline of forensic serology.

If DNA analysis can identify with near-certainty whether or not a sample came from a particular individual, why bother with less precise tests? The answer is simple. DNA testing is still relatively slow and expensive. Less sophisticated tests are cheap and almost instantaneous, and some are so straightforward they can be carried out at the crime scene, with enormous cost and efficiency benefits.

Is it actually blood?

Whenever a suspicious-looking stain is found at the crime scene, investigators first carry out a simple presumptive test—one that gives reasonable grounds for supposing that the sample is blood if the result is positive. Most tests are solutions that change color when they come into contact with either hemoglobin or a blood enzyme called peroxidase. One common presumptive test is a luminol spray (see p. 84), which makes blood residues glow in total darkness. Luminol is also sensitive enough to reveal traces of scrubbed-away blood.

These presumptive tests are not absolutely specific for blood: horseradish and potato contain the same enzyme, so a spilled shrimp cocktail would test positive.

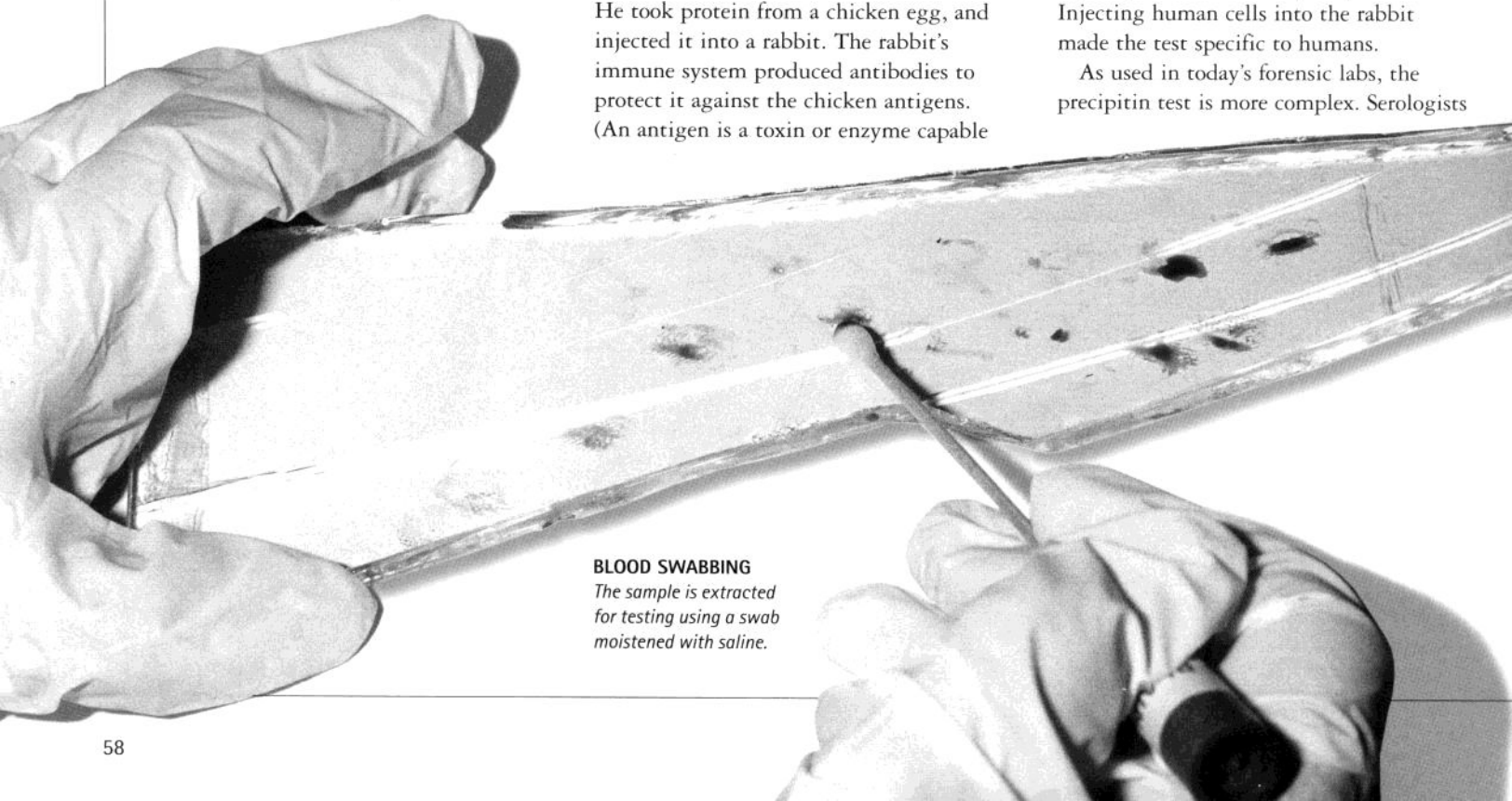


RED BLOOD CELLS
Tests for blood look for enzymes in hemoglobin molecules (diagram inset), which transport oxygen around our bodies inside plate-shaped red blood cells (shown above).

Is it human blood?

The most common test for confirming that a sample is blood also establishes whether it is human. German biologist Paul Uhlenhuth devised the test in 1901. He took protein from a chicken egg, and injected it into a rabbit. The rabbit's immune system produced antibodies to protect it against the chicken antigens. (An antigen is a toxin or enzyme capable of stimulating an immune response.) When Uhlenhuth mixed the rabbit's blood with egg white, the antibodies in the blood reacted with antigens in the egg, making it separate in a cloudy deposit, which he called precipitin. Injecting human cells into the rabbit made the test specific to humans.

As used in today's forensic labs, the precipitin test is more complex. Serologists



BLOOD SWABBING
The sample is extracted for testing using a swab moistened with saline.

put the sample and the testing solution containing antibodies into wells on a gel-covered glass plate, and the two diffuse toward each other. If the sample is human blood, it will contain appropriate antigens, and where the two solutions meet on the plate, a distinctive precipitin band forms. Applying a voltage turns the test into electrophoresis (see p. 60), driving antigen and antibody together to hasten the result.

The recent development of monoclonal (synthetic) antibodies has made possible a field test that provides immediate confirmation that a sample is human blood.

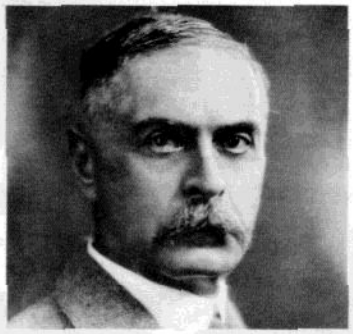
Whose blood is it?

Human blood contains around 100 different antigens, but not every individual has them all. By determining which are present, it is possible to show whether blood found at the crime scene might have come from a suspect. Testing for every antigen is possible, but it would hardly be practical. Instead, serologists check for just a few. There are more than a dozen such blood-typing systems in use, but by far the most common is the ABO system, which also tests for transfusion compatibility between donor and recipient. The system is explained in detail in the box below.

Other fluids

Blood is not the only bodily fluid tested in the serology lab. Investigators also send semen, saliva, urine, vaginal secretions, and excrement. DNA extracted from some of these may prove a match between a suspect and a crime scene sample. However, before running a DNA test serologists first confirm that what is actually on the swab corresponds to what is on the evidence label.

In rape cases, they often need to verify that a swab or stain contains semen. Presumptive color-change field tests show the presence of several components of semen—seminal acid phosphatase (SAP), spermine, and choline. Serologists confirm the test by using a microscope to spot sperms, though semen will not contain any if a rapist has had a vasectomy or is sterile. The most common alternative is to test for a protein, P30, that is produced by the prostate, using an antigen/antibody test that is similar to the precipitin test.



Karl Landsteiner 1868–1943

Working in Vienna, Austria, immunologist and pathologist Karl Landsteiner demonstrated in 1901 that there were at least three types of human blood, which he called A, B, and O, distinguished by the presence of antigens on the red cells. The year after, he identified AB. Landsteiner received the Nobel Prize in Physiology or Medicine for his discovery and for his development of the ABO system of blood typing, which made blood transfusion a safe practice.

TESTING FOR BLOOD TYPE

The ABO blood-typing system checks for two antigens, A and B, on the surface of red blood cells. The test usually uses two solutions, containing antibodies to either type A or type B antigens. The first makes blood containing A antigens clump together, thus identifying A and AB groups. The second reacts the same way to B antigens, identifying AB and B groups. O blood clumps with neither. This example (right) includes a third solution that reacts with both A and B. (These substances have been colored for easier distinction.)

Blood groups are not distributed evenly: 45% of white Americans, for example, are O, 41% A, 10% B, and 4% AB. These proportions perhaps suggest that blood typing is futile: most white suspects will be either O or A. However, the test is quick and cheap, and if suspect and crime scene samples do not match, further investigation is pointless.