* Due @ the end of class!

FORENSIC SCIENCE

Forensic pathology
World of Anatomy and Physiology. Gale, 2007. From *Science In Context*.
Full Text:

Forensic **pathology** is a branch of medicine that applies investigative anatomical and medical science to matters of law. Forensic pathologists are particularly skilled at determining cause of death and establishing the identity of deceased individuals. This work often involves examining wounds and other features of dead bodies, as well as tissue samples. Most forensic pathologists work closely with a coroner or medical examiner. They also sometimes serve as expert witnesses in criminal trials.

Forensic pathologists also work with a variety of other forensic scientists, who collect data and evidence such as fingerprints. Although crime investigators have collected fingerprint data for more than a century, these marks remain one of the most sought after pieces of evidence in criminal investigations. All human beings are born with a distinctive set of ridges on their fingertips. These ridges form a pattern that remains fixed for life, barring significant injuries (such as burns). Some of the typical patterns found in fingerprints are arches, loops, and whorls.

Fingerprints are generally produced by oils from **sweat glands** that collects on these ridges. When a person touches an object, oils and other materials on the fingers remain on the surface of the object. The pattern left by these substances is a fingerprint, which can also be taken from clean fingers using ink or other substances. Fingerprints are often used to identify criminals, but they are also important in establishing the identity of deceased individuals.

Fingerprints are not the only patterns that can help identify a person. Footprints, tire tracks, bite marks, toe prints, and prints left by bare feet can also provide useful evidence. The identity of a deceased person can be obscured by **tissue** decomposition; identity is also often uncertain when **death** results from an explosion or a violent collision. In these cases, forensic pathologists can compare the person's teeth with the dental records (if they exist), which often show a unique pattern of fillings and other dental work. X-rays can be used in a similar way because they record distinctive marks left by healed breaks and individual skeletal variations.

DNA also plays an important role in forensic pathology. This material carries the genetic information that directs the body's cells in growth, maintenance, and other biological processes. Except for identical twins, no two people have exactly the same DNA. As all human beings belong to the same species, large amounts of DNA are the same in different individuals. Nonetheless, each person's DNA includes sequences that make it distinctive. It is these distinctive sequences that are of interest to forensic scientists. Investigators can extract strands of DNA from cells, which are then analyzed using a variety of techniques that reveal a characteristic pattern, which amounts to a genetic fingerprint. The technology used to analyze DNA includes electrophoresis, radioactive markers, and x-rays. The methods of DNA analysis have evolved considerably since its introduction. Restriction fragment length polymorphism analysis (RFLP) was the first method, but it is now rarely used. RFLP was replaced in the late twentieth century by polymerase chain reaction analysis (PCR) and amplified fragment length polymorphism analysis (AmpFLP). As of 2006, the most common type of DNA analysis is short tandem repeat analysis (STR).

DNA analysis is not always possible. Sometimes, the amount of DNA available is not sufficient for testing, as in the case of a very small blood stains or bone fragments. In addition, very old samples may not provide viable DNA for testing.

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As of 2006, there remains controversy surrounding the use of DNA in forensic analysis. The likelihood of a coincidental DNA match is very low, but this risk is compounded by the possibility of laboratory error. Test results can also be affected by the conditions under which the testing is conducted. Some defense lawyers claim that prosecutors overestimate the value of DNA testing in identifying defendants. They argue that because DNA analysis involves only a fraction of the DNA, a match does not establish guilt, only a probability of guilt. On the other hand, many other people claim that DNA analysis can provide probabilities that establish guilt beyond reasonable doubt. Improvements in the technology used to analyze DNA, as well as improved testing procedures, continue to decrease the risk of false matches.

Forensic science also includes an array of tests for identifying and analyzing **blood**. Most of the tests that investigators use to determine whether a substance is blood rely on blood's chemical makeup. In many of these tests, peroxidase (an enzyme found in blood) acts as a catalyst for a reagent added to the substance; if that substance is blood, this reaction produces a characteristic color change. For example, when benzidine is added to a solution made from dried blood and water, the solution turns blue. When phenolphthalein is used as a reagent, the solution turns pink. Investigators can then use more specific tests to determine whether the blood is human.

Blood types can play an important role in forensic investigations. The evidence available through blood typing is not as conclusive as that provided by genetic fingerprinting. Nonetheless, blood typing can readily prove innocence and it can offer evidence that increases the probability of a defendant being guilty. All human beings belong to one of four blood groups--A, B, AB, or O. These blood groups are based on genetically determined **antigens** that are either present or absent in blood. Type A blood contains the A antigen, while type B blood carries the B antigen; type AB blood carries both antigens. Type O blood, the most common, carries neither antigen. These antigens are attached to a person's red blood cells. By adding specific antibodies (anti-A or anti-B) to a blood sample, investigators can identify the presence or absence of A and B antigens. If blood cells carry the A antigen, they will clump together in the presence of the anti-A antibody, and blood cells carrying the B antigen will clump in the presence of the anti-B antibody.

Blood type evidence is used in a variety of ways. For example, consider a person accused of a homicide who has type AB blood, which matches blood found at a crime scene. Assuming that there is other evidence to tie the person to the crime, the evidence for that person's guilt is more convincing than it would be if he or she had type O blood. This is the case because only 4% of the population has type AB blood, which makes it relatively unlikely that someone else with type AB blood left the blood found at the crime scene.

Red blood cells split open when blood dries. These open cells make it more difficult to identify blood because it is more difficult to asses the clumping of cell fragments, as opposed to whole red blood cells. Since the antigens of many blood-group types are unstable when dried, the Federal Bureau of Investigation routinely tests only for the ABO, Rhesus (Rh), and Lewis (Le) blood-group antigens. Were these blood groups the only ones that could be identified from blood evidence, the tests would not be very useful in forensic science, apart from proving the innocence of a suspect whose blood type does not match the blood found at a crime scene. Fortunately, forensic scientists are able to identify many other substances in dried blood samples, including blood proteins and enzymes. These can also function as genetic markers, and identifying a number of them, particularly if they are rare, can be statistically significant in establishing a suspect's guilt. For example, a type O blood match is not very convincing evidence of guilt, because a large proportion of the population has type O blood. However, suppose this type match is accompanied by specific matches for two blood proteins that are inherited on different **chromosomes** appearing in 10% and 6% of the population, respectively. If there are no significant mismatches, the blood evidence in this case is considerably more convincing. If 45% of the population has type O blood, this evidence now suggests that only a small percentage of individuals could have left the blood found at the crime scene: 0.45 x 0.10 x 0.06 = 0.0027, or 0.27% of the population. The larger the number of unusual blood factors in a sample, the more useful that blood evidence is for establishing identity.

Autopsies are another major part of forensic pathology. These procedures involve a close examination of the body and the internal organs, which can often establish the cause and approximate time of death. Bodies examined shortly after death may have stiff jaws and limbs. This stiffness, called **rigor mortis**, is evident about ten hours after death; in normal conditions, it gradually disappears after about a day, as body tissues begin to decay. Rigor mortis, internal body temperature, and characteristic patterns of decay all help establish time of death. Wounds, marks, and typical effects of injury or disease all play a key role in establishing cause of death. For example, a **drowning** victim will often have waterlogged **lungs**, water in the stomach, and blood diluted with water in the left side of the **heart**. A person who was not **breathing** when he or she entered the water will not show this dilution of blood in the heart, which can suggest that the person was dead, unconscious, or seriously injured prior to that time.

Each case is different, of course, and a variety of factors (such as temperature) can greatly influence the appearance of a dead body. However, a skillful forensic pathologist combines detailed technical knowledge with sensitivity to the contextual particulars of a case. This approach often allows a forensic pathologist to arrive at relatively certain conclusions about the circumstances surrounding someone's death.

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