Paternity DNA testing is the only way of scientifically establishing whether a given man has biologically fathered a child. The reasons for carrying out such a test are manifold, but in most cases it is to establish a biological link between the alleged father and child in order for the child to be acknowledged as a legal heir to the estate or any assets of the deceased. Although a child’s right of inheritance cannot be denied under any jurisdiction (unless a parent legally relinquishes their parental rights such as in cases of surrogacy or adoption) matters are made difficult to children who are not legally recognized and whose birth certificate does not list the name of the deceased man as the biological father. These illegitimate children may suffer the consequences of illegitimacy and may have to undergo numerous legal battles with the heirs of the deceased to get what is rightfully theirs.

Clearly, a conflict of interest arises between an unrecognized and/or unknown legal heir and the legitimate heirs of the deceased. Any individual turning up and making claims upon the assets and estate of a deceased could claim their share of inheritance from the state of the deceased. The legal heirs are thus not only at risk of losing a portion of their inheritance but also of being roped into lengthy legal battles.

Depending on the case, witnesses, and any records available, the judge will decide how best to proceed and whether to acknowledge the individual as a legitimate heir. In some cases, the individual’s claim could only be upheld if DNA testing shows the dead, alleged father is the biological father of the person claiming to be the biological child.

Unfortunately, in most countries, exhumation of a body can only take place if it is by court order and if the direct blood relatives of the deceased consent to the exhumation. Anyone claiming to be related to the deceased would have to present a convincing case, enough to persuade a judge that their claim might be founded and thus have the judge issue a court order for an exhumation. In cases where the unrecognized children approach the family for a paternity test following the death of an alleged father, it is most likely that the family will refuse consent to an exhumation given the conflict of financial interest that could arise.

Depending on how long the alleged father has been dead and whether he has been buried, the coroner or forensic pathologist can decide on the best sample to collect. If possible, it is best to collect multiple sample types before the burial takes place in case some fail to provide sufficient DNA ergo avoiding the tedious legal process required to exhume a body.

Sometimes exhumation is not possible. In some of those instances, hospital pathology labs may still have samples available. They may still have whole blood, but they typically tend to have formalin fixed, paraffin embedded tissue samples (FFPE). It is possible to obtain viable DNA from FFPE tissue, but this is notoriously difficult. The formalin used to preserve the tissue in these cases is similar to the embalming fluid used on corpses and poses a challenge.

Post-Mortem DNA Testing
Ideally, all DNA samples should be shipped for testing as soon as possible so as to avoid any degradation of DNA. This is all the more true for undried tissue samples due to putrefaction. Putrefaction, the destruction of soft tissues, takes place shortly after death and is due to the action of micro-organisms on the body, which will rapidly cause a breakdown of the cells and the cell nucleus. Undried tissue will decompose more quickly due to its water content. DNA testing laboratories, such as www.easydna.ca[1] often have a forensic sample collection page which explains the probability of successful DNA extraction with various samples as well as the most suitable method to collect and preserve the samples. Although normally presented in a brief table form, these Web sites provide sound, although basic, information for those wishing to carry out paternity testing using forensic samples.

Human decomposition begins just a few minutes after death via a process of self-digestion known as autolysis. Death is the point at which all cell activity ceases. The body itself has a number of enzymes which begin digesting the cell cytoplasm upon death. Temperature and humidity play an important role in autolysis and lower levels of each will slow down the rate at which this takes place. Laboratories may store cells in a cooling isotonic solution, which can help preserve the cell and its DNA. However, not even freezing a body can fully halt the decomposition process.

Fingernails and Toenails
If the person has been deceased for less than one week, nail clippings can be collected from the finger or toes. Although fingernails are not made up of cells but keratin, cells can still be found on the surface of the nails due to the action of scratching or abrasive contact between the nails and the surface of our skin which leads to cell debris attaching itself to the nails—usually the underside.

Cut fingernails are not always ideal because analysis depends on skin cells that are stuck to the underside of the nail. Fingernails and toenails are composed of a fibrous protein called keratin and contain no DNA. As such, using fingernails in this type of analysis runs the risk
For more information about the process used for DNA extraction from bones, click here.
Extracting DNA from Teeth: Molars and Premolars

Teeth can also be a good source of DNA and are often used in post mortem paternity testing; they are usually the only reliable source of DNA along with bones in cases where the alleged father has been buried—especially when a considerable post-mortem interval has elapsed. In terms of DNA, teeth have an added advantage over bones because they remain locked within the jaw bone, which provides an added layer of protection, shielding the DNA from environmental factors which would speed up the decomposition process and to which bones are directly exposed. In terms of extraction, it requires a tooth extraction of the molars or premolars. However, it is a good alternative as it saves having to saw through bone.

The root of the tooth contains more DNA than the crown—an important point to keep in mind. Teeth are composed of four main tissue types: the enamel over the crown of teeth, dentine (the layer beneath enamel forming the tooth crown and tooth roots), cementum (the tissue over the surface of roots), and the pulp at the center of the tooth and roots. The enamel is almost completely inorganic, composed mainly of hydroxyapatite, with a small amount of organic matrix (collagen).

Dentine has a large inorganic matrix component but a larger organic component compared with enamel. Because it is cellular in places, it is capable of repair and more dentine is deposited in teeth with age. Pulp is the vital part of teeth containing the blood vessels and neural tissues. Cementum is a thin layer covering root surfaces and is similar to dentine. More DNA is present in the root as enamel is completely acellular and dentine is mostly acellular. This is unlike the roots where cells overlie cementum. Rubio et Al (2009, p.1413) clearly explain the reason for the higher concentration of DNA in pre-molars and molar stating that, “As expected in healthy teeth, molars and premolars yield more DNA due to the number of roots and the increasing size of the pulp chamber in distal positions”.

Once the entire tooth is extracted, it will then need to be ground into a fine powder. The grinding process increases the amount of material, which then needs to be cleaned out.

Cases of Cremation: Is there any Viable DNA?

Cremation uses extremely high temperature to pulverize human remains, reducing them to their basic chemical constituents. No human tissue can survive the high temperatures and very little is left behind once a body has been cremated. The principal chemical constituent of cremated remains is calcium phosphate. No DNA can generally be extracted from cremated remains; the high temperatures to which the body is exposed to for the prolonged period in the furnace will destroy all DNA. This said, advanced DNA testing capabilities using Duplex PCR may yield some genetic markers from cremated remains but studies have proved inconclusive and highly unreliable. Research has suggested that any DNA found in the analysis of cremated remains is possibly due to post-cremation handling. In any type of forensic analysis, cremated remains would very unlikely be subject to DNA testing with the scope of human identification. Even if a few genetic markers are produced, these would not be enough to identify the person or derive kind of meaningful conclusions in terms of human identification and profiling. It is unlikely that any DNA testing company will accept cremated remains for a paternity test.

Testing Family Relationships as an Alternative

DNA testing for familial relationships has made huge leaps forward. In some cases, post-mortem paternity testing using samples from the deceased father may not even be required as a DNA test can be carried out between the alleged father’s direct blood relatives (such as brothers, sisters, or biological offspring). Males with an alleged, common paternal line can have a Y chromosome test; thus, if the child claiming to be related to the deceased is male, this individual can carry out a Y chromosome test with a living male relative of the alleged father in order to determine whether or not this individual is truly related to the deceased. Y chromosome testing is accurate because all males from the same paternal line will share a common male ancestor. These male biological relatives will also all share the same Y chromosome.

Alleged female siblings can carry out an X chromosome test to determine whether they share the same father. This type of test is more complicated as females inherit an X chromosome from their father and an X chromosome from their mother. In order to be able to accurately determine whether females have the same biological father, the mother’s sample will need to be included in cases where the alleged relatives share the same biological mother. This is necessary because should scientists confirm a matching X chromosome profile, they cannot determine whether this is the X chromosome inherited from the mother or the X chromosome inherited from the father. X chromosome mutations are infrequent but can arise; in such cases, mismatches could occur when comparing the X chromosome profiles of test participants and could provide an inconclusive result.

The alleged father’s DNA profile can be reconstructed in what is called a missing parent DNA test. It is possible to reconstruct the DNA profile of the deceased father by having access to DNA samples from his mother and father—in other words, a sample from the grandmother and grandfather of the child whose paternity has been put into question. A reconstruction is only possible if both parents are available. Once the deceased alleged father’s profile has been reconstructed, this can be compared to the profile of the child.

Importantly, for relationship testing that seeks to confirm a relationship between alleged living relatives so as to confirm the biological relationship to the deceased father (basically, establishing paternity without testing samples from the alleged father), samples can only be collected from first degree relatives.

Karl M. McDonald is a freelance writer specializing in the field of DNA and genetics. The author is a graduate in forensic science who has received his education in both the U.S. and the UK. Karl has currently taken a backseat in the world of academia and dedicated himself to his two kids. He currently works as a freelance writer from home during his free time. The author normally specializes in writing about genetics and forensic science.

Works Cited

