

# Gunther von Hagens' Plastination Technique

Plastination is a technique for preserving tissues, organs, and whole bodies for medical purposes and public display. Gunther von Hagens invented a form of the method in 1977 at Heidelberg University in Heidelberg, Germany, after he observed medical students struggle working with cadavers that quickly decomposed. Von Hagens' body models, called plastinates, have since become widely used educational tools not only for those studying anatomy and medicine, but also for public audiences. By accurately preserving tissues for use in research and education, the technique has contributed to the fields of medicine, anatomy, and embryology.

In 1995 the Body Worlds traveling exhibit debuted in Japan and featured greater than 200 plastinates for public viewing. Von Hagens' plastinates show human bodies from different views and display thin body cross-sections as well as full organ systems. Fetuses and embryos are displayed to illustrate early stages of development in detail. Von Hagens' plastination technique combines both durability and realism for the preserved specimens.

Prior to the advent of this technology, other tools were used in attempts to overcome the decomposition problem with cadavers. In the eighteenth and nineteenth centuries, body parts were often suspended in solution within jars, similar to Frederik Ruysch's fetal collections. Before Body Worlds, the Chicago Museum of Science and Industry in Chicago, Illinois, had created a display in the 1930s that featured body cross-sections, in addition to thirty-nine embryos and fetuses. These specimens, however, were fixed in formalin, a chemical tissue preservative. In the early twentieth century, anatomy courses featured plastic models of organs, sometimes combined with real body components. The German Transparent Man display of the 1930s was of a real human skeleton containing plastic models of organs. German medical students also studied anatomy by using organs preserved within plastic blocks. The organs were chemically preserved and then suspended in liquid plastic. The plastic would harden to form a clear block with a visible organ inside.

Von Hagens' technique of plastination originated from his belief that the plastic block preservation method inadequately met the needs of students. The bulky plastic, which could be inches thick, surrounded the specimen and frequently obscured the view and dimensions of the structure inside. Instead of placing the tissue in the plastic, von Hagens attempted to put the plastic in the tissue. Working as a research assistant in the Anatomy Institute of Heidelberg University in the mid 1970s, von Hagens spent almost a decade developing his plastination technique.

Von Hagens' plastination technique follows the same basic sequence of steps for everything from organs to full bodies, with slight polymer variations to account for tissue differences. Plastination involves fixation, dehydration, forced impregnation, positioning, and curing of the specimen. The process should begin between two and ten days after the body dies to ensure that the anatomical features, such as the muscle shape of the plastinate, resemble those of a living organism.

The first step in plastination for any tissue or body is fixation. As with the precursors to plastination, formalin is used to temporarily preserve the tissues. For von Hagens' technique, however, the tissue is directly injected with the formalin solution as opposed to being submerged in it. An anatomist then dissects the specimen in a manner dependent on the structures the anatomist intends to highlight, such as cardiovascular structures. Skin and fat are generally removed in addition to other tissues that hinder the focus of the plastinate. In plastinates featuring the cardiovascular system for example, all surrounding tissues not involved in the system are removed. The next step of the process is dehydration. The specimen, for example an embryo, is placed in an acetone bath where the water and fats dissolve and are replaced by acetone. This step is important because the anatomist cannot swap the body's fluids with the polymers that eventually occupy their spaces in

the final plastinate, but the anatomist can replace the acetone with the final polymers.

Acetone evaporates easily, a characteristic that enables the third step in plastination, called forced vacuum impregnation. The specimen is placed in a vacuum chamber and the pressure is dropped to the point where the acetone changes to its gaseous state. As soon as the acetone changes into a gaseous state of matter, the gas is pumped from the chamber and slowly replaced with a selected polymer. The pressure difference causes the liquid polymer to forcibly enter the tissue, and this transfer can take anywhere from days to weeks to complete. These polymers are all reactive, meaning that when treated with heat, gas, or light, they harden. The specific polymer that the anatomist chooses for this step determines the translucency and durability of the resulting plastinate. Most of the polymers are resins that consist of silicone, polyester, or epoxy. In the case of embryo plastinates, silicone rubber resin is used because it is durable enough to keep the embryo's delicate structure intact, but it also leaves the embryo looking slightly transparent. Polyester resins, however, are used for brain tissue slices because the final specimens show the differences in grey and white matter of the brain. Organ sections are usually cut to between two and eight millimeters in thickness and are held between two plates as they enter the next step of the process.

In the positioning step, full body plastinates are posed. They are sometimes oriented as if engaging in life-like activities, such as running or sitting. The tissues and organs are positioned so that certain parts of the body are highlighted and the specimen is held in place by wires and clamps. Once the desired position is achieved the final step of curing begins. The specimen is treated with the necessary curing agent, such as light, which hardens the polymer. As seventy percent of the specimen is replaced with resin during plastination, it becomes resilient to decomposition once the process is complete. Von Hagens' plastination technique has made it possible to preserve large specimens, such as giraffes, and small specimens, such as embryos.

Today von Hagens has four plastination patents in the US, and other patents in different countries. The specimens are in such high demand that von Hagens founded Biodur Products in 1978, a company that specializes in the distribution of tools and chemicals for plastination to educational facilities. The Heidelberg University Institute for Plastination was created to produce plastinates and further improve the process of plastination. Public displays of plastinates have garnered mixed reviews. Critics have said that it is disrespectful to display the dead in a for-profit public exhibit. The Catholic Church has also spoken out against the prenatal displays, stating that those displays offend the dignity of the embryos and fetuses.

The invention of plastination has given medical students and wider audiences an educational tool for the study of anatomy and embryology. Plastinates are used globally in medical and dental schools and have been viewed by more than 25 million people around the world through Body Worlds exhibits. Embryo and fetus plastinates give people the opportunity to examine the structures present during prenatal development.

## Sources

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