

Science Education Collection

# Transplantation Studies

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## Abstract

Many developmental biologists are interested in the molecular signals and cellular interactions that induce a group of cells to develop into a particular tissue. To investigate this, scientists can use a classic technique known as transplantation, which involves tissue from a donor embryo being excised and grafted into a host embryo. By observing how transplanted tissues develop in host environments, scientists have started to dissect the molecular pathways underlying development.

In this video, we first look at the role of cellular interactions in development, and move on to a basic transplantation protocol. Finally, some specific developmental studies utilizing this technique are discussed, which examine the effect of tissue transplantation on the fate of donor and host tissue.

## Transcript

Scientists in the field of developmental biology use transplantation studies as a tool to investigate cellular interactions that are required for proper organogenesis. In this procedure, embryonic tissue is carefully dissected from a donor and transplanted to a host during early embryogenesis. Host embryos are then examined to determine how the transplanted tissue influences the pattern of development.

This video will provide an overview of cellular interactions during organogenesis, a general transplantation protocol, and finally some of the many practical applications of this useful technique.

Before delving into how to perform transplantations, let's briefly discuss some principles of studying cellular interactions during organogenesis. Organs are complex structures comprised of many cell types that must work together to generate a functioning system.

During development, each cell type has a role as either the inducer or the responder. The inducer is a tissue that produces a signal, alters the behavior of another tissue, and often determines its fate, while the responder is a target tissue that receives a signal from the inducer. This entire process is known as tissue induction. Gene expression patterns will determine which cells are responders, since the appropriate cell surface proteins must be present to receive and interpret signals.

Transplantation studies are one way to investigate tissue induction. Donor cells can be transplanted into the host at a different location to see how altering the signals present in the cellular environment changes their fate. Alternatively, genetically diverse tissues can be transplanted between analogous locations to assess how gene expression impacts development.

Now that we know a little more about transplants, let's see some preparations that might be necessary in order to perform this technique.

First, prepare the tools necessary for microscopic surgical techniques. Commonly used tools include tungsten needles, which are flame-polished to a sharp point, or fine glass needles pulled from capillary tubes. In addition, depending on the organism you'll be working with, a stabilization mold may be necessary. This helps in steadying the organism in place during the transplantation procedure.

A number of model organisms can be used in transplantation studies. Here, we will briefly describe the procedure using a quail-chick system. The first step is to remove the donor embryo from the egg and place it on a dish for dissection. Next, under a dissecting microscope, the tissue of interest is carefully excised from donor and placed into appropriate solution and onto ice until the host is ready to receive the transplant.

The host is prepared in the same fashion as the donor. Carefully excise the host tissue, creating a graft site equivalent to the size of the donor tissue. Donor tissue is placed in position and secured to the host graft site. Finally, the embryo is placed back into conditions that mimic its natural environment, and allowed to develop until the desired age is met. Tissue induction can then be studied using various histological and microscopic techniques.

Now that we have gone over a general method of performing transplants, let's examine some downstream applications of this technique.

Transplantation studies can be used to investigate genes that are involved in driving a cell towards a particular tissue fate. In this experiment, a layer of stem cells, known as the animal cap, expressing the gene of interest was transplanted onto the flank of a *Xenopus* embryo. Following a period of incubation, an eye-like structure was seen developing at the transplantation site, suggesting that the gene of interest can direct a stem cell population towards a retinal cell fate.

Transplantation studies can also be utilized to examine how a group of cells can change the fate of host tissue through cell-cell interactions. In this experiment, researchers excise the embryonic structure called the Hensen's node, also known as the "primitive knot" or the "organizer," from the donor chick embryo, and transplant it to a naive region on a host chick embryo. They observe that the transplanted Hensen's node forms a miniature notochord, suggesting that signals from the donor tissue guided the host tissue toward a neural fate.

Taking advantage of structural differences between the quail and duck, researchers perform transplantations to assess species-specific patterning. Here, researchers create a "quack" by taking a specific cell population known as the neural crest from a quail and transplanting it into a duck. Due to the genetic differences, researchers can assess the quail's neural crest contribution in the developed organism.

You've just watched JoVE's video on transplantation studies. This video provided an overview of cellular interactions during organogenesis, a brief introduction into performing transplantations, and some of the many practical applications of this technique in the field of developmental biology. As always, thanks for watching!