In early January, two teams of researchers announced their success in genetically modifying pigs via a cloning technique. Scientists from the University of Missouri and Immerge Bio Therapeutics published details of their achievement in the journal Science; the other company, PPL Therapeutics of Blacksburg, VA, announced the results of their experimentation at a news conference.

The rationale for the research was to produce pig organs with greater compatibility for human transplantation. Pig organs have long been viewed as a potential solution to the limited supply of transplantable organs because of their physiological and anatomical similarities to human organs. The supply of pig organs is also far less limited than the supply of human organs. However, the threat of rejection has diminished the favorability of transplanting pig organs into humans. Scientists have identified two molecules that play a key role in triggering rejection. One is a sugar molecule (called alpha-1-galactose) that coats pig cells. Scientists who achieved the cloning breakthrough took cells and inactivated, or "knocked out," one of the copies of the gene that directs this sugar molecule's production. They then used these cells as nuclear donors to create embryos via a cloning technique. The resultant cloned pigs now carry one inactivated gene for this sugar molecule, as will their offspring. Ultimately scientists hope to breed animals in which both copies of the gene are inactivated. It is important to note that whether or not the genetically engineered pig organs will result in less rejection has yet to be empirically demonstrated.

What are the ethical concerns behind this recent breakthrough? Some of the fear associated with xenotransplantation stems from the prospect of creating a human-animal hybrid such as those in
The Island of Dr. Moreau. The repugnance invoked by such organisms is consistent with the biblical conviction that breeding between humans and animals is wrong. Scripture declares that God created species to reproduce "after their own kind." Therefore, human beings should not attempt to create human-animal hybrids by blending different species at the genetic level. However, simply transplanting an animal organ into a human patient will not alter his or her genetic make-up in a manner that will affect the genetic constitution of future generations. Such a procedure would be similar to the accepted practice of injecting bovine-derived insulin into a diabetic. On the other hand, some scientists have begun trying to make pig-human hybrids for xenotransplantation, defending their pursuit with the persuasive outcome-based justification that such hybrids may alleviate the critical shortage of human organs. Christians must wrestle with the fact that the creation of pigs that pass on human genetic material to subsequent generations runs counter to God's design for each species to reproduce after its own kind.

Another major ethical concern associated with xenotransplantation is "zoonotic transmission," which is the transmission of pathogens across traditional species barriers. For example, some have suggested that the porcine endogenous retrovirus (PERV), or other viruses which presently do not cause disease in humans, might mutate and cross the traditional species barriers as the result of transplanting a pig organ into a human recipient. This possibility has caused the American Medical Association to propose ethical guidelines for animal-to-human organ transplantation. Subjects enrolling in these experiments would be required to waive their traditional right to drop out of the study in order that potential public health concerns could be monitored in an ongoing manner.

Those concerned with animal welfare are also troubled by the purposeful genetic manipulation of animals in order that they may serve as organ sources. As Christians, we understand that human beings have been given dominion over the created order. However, we must also be responsible stewards. Selective breeding and animal husbandry techniques can be ethical means of improving our food and medical products. The type of genetic manipulation required to "knock out a gene" would be very similar to selective breeding practices for low fat content or coat color. The major difference is the gross inefficiency associated with the former type of genetic modification. For example, scientists at the University of Missouri and Immerge Bio Therapeutics implanted three thousand genetically-modified pig embryos into 28 surrogate sows, but only seven piglets were born, with just four surviving.

The most pernicious aspect of technologies such as xenotransplantation may be their lure to idolize the power of science and scientific achievements. We need to exercise caution and recognize that selective breeding and genetic manipulation can produce unintended and unexpected results, which may not always be immediately evident. God's design is amazingly interlinked and delicately balanced so that single genetic changes may have far reaching consequences. We should never allow the race to develop therapies to outstrip ethical consideration. PPL scientists chose not to undergo the peer-review process before publicly announcing their achievement, justifying this decision as one motivated by pressure from their stockholders to announce breakthroughs in a timely fashion. Immerge Bio Therapeutics should be applauded for submitting to the peer-review process before announcing its breakthrough.

As we seek to analyze science's "advances" through a "Christian lens," our duty is to determine if the means as well as the ends are ethical. Selective breeding for certain characteristics that are
beneficial to humans, sacrificing animals' lives for the welfare of humans (as long as it is done in a humane way), and transplanting animal organs into humans are compatible with a Christian ethic. Although some might disagree on grounds of prudence, using a pig organ to meet human needs would not run counter to God's created order. However, if scientists seek to create human-animal genetic hybrids for xenotransplantation, this should give us pause.

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