Xenotransplantation: The Haunting Possibilities for the Future, within Margaret Atwood's *Oryx and Crake*

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IN 1997, a photograph of a mouse was released with a human ear growing on its back. This caused strong reactions with the press and raised questions concerning the bio-ethical implications of xenotransplantation. Since, interest in the medical possibilities concerning xenotransplantation, have spread across various mediums, including fiction. Margaret Atwood's *MaddAdam* trilogy explores such possibilities for our future; focusing on modifying food, animals and plants all for profit and human benefit. This paper will aim to review contemporary advances of xenotransplantation as well as explore Atwood's futuristic world and the haunting medical possibilities, it feels, she is predicting.

According to the FDA, in 2019,

> Xenotransplantation is any procedure that involves the transplantation, implantation or infusion into a human recipient of either:
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> A) live cells, tissues or organs from a nonhuman animal source,
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> B) human body fluids, cells, tissues or organs that have had *EX VIVO* contact with live nonhuman animal cells, tissues or organs. (U.S. Food and Drug Administration)

According to D.K.C. Cooper in his paper "Xenotransplantation—The Current Status and Prospects," the growing interest and increased research surrounding xenotransplantation comes from the "continuing worldwide shortage of organs from deceased human donors for transplantations into patients with organ failure." Throughout the paper, Cooper discusses these shortages and the problems that follow; "In the USA alone, in 2016, 98,000 patients started the year on the waiting list" for new kidneys, with only 20% transplanted. Since 2005, according to Cooper's research, over 9,000 wait-listed patients died or became too sick to transplant, thus causing the interest and continued efforts to make xenotransplantation a reality.

Whilst the use of xenotransplantation raises concerns regarding infections, Bio-ethical fears and the moral implications surrounding the subject, research and experiments are still going ahead. Particularly in the field of "genetically engineered pigs," which contemporary researchers, such as Cooper, imply could resolve the problems facing the medical community today. Cooper states that, today, research and experiments in "utilizing genetically modified

pig kidneys and other organs are moving towards clinical trials in humans," revealing the rapid progression and enthusiasm in the field.

Xenotransplantation: A History

Xenotransplantation, or "clinical cross species transplantation," has a "long history going back to blood transfusions across species in the 17th century" (Cooper). According to the Science Museum, London:

> Most animals used for [early transplantation attempts] were apes (or nonhuman primates), as they are our closest animal relative. Throughout the 1960s, as organ transplants between humans became more common, the possibility of animal-to-human transplants appeared feasible. It was also seen as a way of getting around the problem of the shortage of donor organs. ("Animal-Human Transplants")

However, numerous attempts at nonhuman primate organ transplantation in patients were carried out in the 1960s, the longest surviving patient of these attempts returned to work for 9 months on a pair of chimpanzee kidneys, before rejection began. However, with new technologies, cloning, genetic engineering and new medication it is perceived that pigs may be the animal most likely to resolve the donor organ shortage problem.

Oryx and Crake

In 2003, Margaret Atwood published the first book of her *MaddAddam* trilogy, *Oryx and Crake*. Sarah Akaws argues that "The book, preferably described by its author as being Speculative Fiction, rather than Science fiction, offers the readers an insightful review of where our world is heading," society is separated into either "rich" or "poor" classes, corrupt governments and corporations, "and the growing, evolving branch of science," revealing a future that we might encounter if humanity stays on its current path of scientific advances. In her article, Akaws focuses mainly on humanity's progression in medicine, xenotransplantation, and genetic engineering. Whilst there are several examples of genetic modification, species splicing and xenotransplantation, the best example of xenotransplantation and speculations concerning such procedures within Atwood's world, would be the Pigoons.

The Pigoons are introduced to the reader by the protagonist Jimmy (25). Jimmy grew up within large corporate compounds, including "OrganInk Farms," which is where he first meets the Pigoons. His father works as a genographer, on "The Pigoon Project," along with a team of "transplant experts and the microbiologists who were splicing against infections" (25). As Jimmy historicizes it, "The goal of the Pigoon project was to grow an assortment

of foolproof human-tissue organs [inside] a transgenic knockout pig host—organs that would transplant smoothly and avoid rejection, but would also be able to fend off attacks by opportunistic microbes and viruses" (25).

However, the team were not only using the Pigoons to grow organs, "they were [also] perfecting a Pigoon that could grow five or six kidneys at a time. Such a host animal could be reaped of its extra kidneys, then, rather than being destroyed; it could keep on living and grow more organs, much as a lobster could grow another claw to replace a missing one. That would be less wasteful, as it took a lot of food and care to grow a Pigoon" (26). As a result, "The Pigoons were much bigger and fatter than ordinary pigs, to leave room for all the extra organs" (29). The more modifications and experiments that were conducted within the text, the more examples and possibilities Atwood presents in terms of xenotransplantation. "The Pigoon organs could be customised, using cells from individual human donors, and the organs were frozen until needed. It was much cheaper than getting yourself cloned for spare parts—a few wrinkles left to be ironed out there" (27). Here Atwood not only reveals a conceivable answer for donor shortages, but she also brushes over the idea that using genetic modification and xenotransplantation are stepping stones towards cloning human beings.

Not only are the Pigoons being used to grow organs and offer those in need an opportunity to get well and live longer, but they are also used to grow new human skin. At another compound, called NooSkins, there were also Pigoons, "just as at OrganInc farms, but these were smaller and were being used to develop skin-related biotechnologies" (62). This compound appears to be working on making anti-wrinkle/anti-aging creams obsolete, "'NooSkins for olds' said the snappy logo" (62-63). "The main idea was to find a method of replacing the older epidermis with a fresh one, […] a genuine start-over skin that would be wrinkle—and blemish—free" (62). However, even within the text this is a work in progress, as human trials have started and people came out "looking like the mold creature from outer space," with green and peeling skin (63).

Atwood presents these possibilities in a defamiliarized and almost phantasmagorical manner, to force the reader to think about the possibilities for the future. Although the world of *Oryx and Crake* is fiction built from the assumptions surrounding certain scientific advancements and speculative theory, there is certainly contemporary truth within her work.

Skin

For the first time "xenotransplantation allows modifications of the donor and not only treatment of the recipient" (Cooper). This is viewed as positive progression in the field, as:

> genetic engineering may also contribute to overcome any of the physiological barriers that might be identified as well as in reducing the risks of transfer of a potential infections within the organ […] With the new technology now available, it is becoming quicker and cheaper to achieve multiple genetic manipulations in pigs, thus accelerating progress towards clinical implementation of the technology. (Cooper)

Whilst within Atwood's work the implication appears to be "NooSkin" for older customers, or people attempting to achieve immortality in appearance and health, there is an indication that the new pig skin could be good for those in need a skin graph—once the method has been perfected (62). In reality, obtaining sufficient autologous skin is a challenge. "Skin allografts from deceased donors, various artificial dermal substitutes, or skin xenografts may be transplanted to provide temporary coverage," but little more (Cooper). Attempts have been made to transplant genetically engineered pig skin, however this is still at the stage of failure, but does provide adequate skin covering whilst an alternative cover is found (Dooldeniya and Warrens). As in Atwood's text, in reality:

> the immune response to a xenograph is generally more extreme than that seen in same species transplantation and it ultimately results in xenograph rejection, or in severe cases, recipient death. Pigs have molecules on their cell surfaces […] that humans do not have. (Dooldeniya and Warrens)

Thus, when "pig organs are transplanted into humans, the immune system recognises these molecules as non-self and begins to attack the pig tissues, leading to immediate rejection of the organ" (Tena). The two main issues with Pig organs and xenographs are size and longevity. Atwood confronts this issue within her text by growing actual human organs within the Pigoons, whilst contemporary researchers, such as Adesa Tena, are attempting to use organic pig organs as they "are a similar size and physiology to human organs," this makes them ideal "candidates" for transplant and would be readily available when needed (Tena).

Another issue that has been encountered recently concerns the body temperature of pigs. "The body temperature of pigs is roughly 39°C, whereas human body temperature is about 37°C," the functional implications of this for the activity of certain enzymes, within organs and skin, at the lower temperature of the human body remain unclear at this time (Tena).

Making Xenotransplantation a Reality

According to a research paper published in 2015 by Aseda Tena, "if we could eliminate the pig proteins that humans don't have and introduce necessary human proteins into the pigs via genetic engineering, the chances of rejection could be minimised. The creation of such genetically modified pigs could solve the problem of organ availability." Here, Tena indicates that with these changes, if they were possible, risks of infection, rejection and potential issues caused by the differing body temperature would be diminished.

Since this time, according to a paper published in 2018 by Parsia Vagefi, researchers have been creating such genetically engineered pigs, concentrating on kidneys. These pigs are not quite as modified as Atwood's Pigoons, but the modifications made include successfully replacing "pig kidney proteins with human proteins," which has reduced the severity of immune responses and incompatibilities between the human and the pig, thus allowing humans to accept pig organs. Vagefi ends his paper: "With each advancement, researchers are approaching human trials for xenotransplantation. The ongoing research is extensive, and it is hard to predict when it will become a reality—but it appears to be coming."

Reading the current research and progression surrounding xenotransplantation feels almost like reading Atwood's work. Her hauntingly realistic speculations of where medicine may potentially lead are uncannily parallel with current research. Even those in the field of xenotransplantation are astounded by the progress that has been made in recent years. Whilst there are still issues to be ironed out, recent experiments have given them nothing but encouragement and enthusiasm. Muhammad Mohiuddin, a lead researcher, was quoted in a paper on the subject, amazed by how close they are to human trials and stated "this is not Science Fiction, this is really for real now." (qtd. in Chen). Statements such as Mohiuddin's, alongside experiments and research that are actually happening, brings humanity and modern medicine closer to the haunting and thought provoking ideas that Atwood presents within *Oryx and Crake*.

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