

Animal Transgenesis and Cloning: Scientific, Religious and Ethical Considerations

Gary J. Curran and Yuri J. Koszarycz

Abstract: *This paper examines some ethical, cultural and multi-faith religious issues raised by our present knowledge and scientific ability to clone animals and use transgenic animals to better the quality of human life. We focus on how these issues are perceived through the consciousness of religious traditions whose ethical codes are based on writings, moral teachings values and traditions that are buried in antiquity. General principles can be derived from such sources that assist theologians and ethicists to explore contemporary contexts in which ethical decisions have to be made. It may be useful to see how the various ancient religious traditions viewed animals in particular, as they are so often used in contemporary scientific and pseudo-medical experimentation.*

Key Words: Animal transgenesis; cloning; animal rights; xeno-transplantation; bioethics; animals – religious perspectives; animal-human relationships

Some Background Points to Set the Scene

Population growth and ageing is accelerating the need for new and cost effective treatments for human disease. Within one generation, we have already developed techniques to modify experimentally individual genes in animals and plants, and thereby precisely alter inherited traits.

At this point, it is instructive to explain the concept of transgenic animals. Walker and McKay¹ defined a transgenic animal as one that has had foreign genes, usually from a different animal species, inserted into its genome, such that these 'new' genes are in all the cells of that animal. Typically, a transgenic animal is produced either by injecting a desired DNA sequence or genes into the nucleus of a fertilised egg and allowing the egg to develop.

Another method is to introduce the genes into pluripotent embryonic stem cells and allow these cells to grow. In turn, these cells can be injected into a blastocyst. The blastocyst now contains the introduced genes and can be implanted into the uterus of another animal, and this newly developing embryo will be transgenic in nature.²

Through the micro-injection of a gene into the nucleus of a fertilised egg, new transgenically-altered animals and plants are created that are of potentially enormous value in both medicine and agriculture. Breekveldt and Jongerden³ reported that the main uses of transgenic animals would include pharmaceutical products such as human drugs,

¹ M. Walker and D. McKay, *Unravelling Genes* (Sydney: Allen & Irwin, 2000), 95.

² *Ibid*, 95-98.

³ J. Breekveldt and J. Jongerden, "Transgenic Animals in Pharmaceutical Production," *Biotechnology and Development Monitor* 36 (1998): 19-22.

human vaccines, research models and testing kits. While mainly experimental, they reported that before 2020, the biotechnology involved in the use of transgenic animals would be the main source of pharmaceutical products.⁴

Currently, smaller proteins such as human insulin and human growth hormone are produced using genetically-engineered cell-cultured microorganisms. However, more complex proteins are not currently able to be produced using microorganisms, and require the use of larger animals such as the pig, cow, sheep, rabbit, mouse and others.

Table 1 details some examples of these proteins and the transgenic animal used in their production:

Drug	Disease/Target	Animal	Company
alpha-lactalbumin	anti-infection	cow	PPL
alpha1 anti trypsin (AAT)	deficiency leads to emphysema	sheep	PPL
CFTR	cystic fibrosis	sheep, mouse	PPL
human protein C	thrombosis	pig, sheep	PPL
tissue plasminogen activator (TPA)	thrombosis	mouse, goat	PPL
human calcitonin	osteoporosis	rabbit	PPL
factor VIII	haemophilia	pig sheep	Pharming PPL
factor IX	haemophilia	pig, cow sheep	Pharming PPL
fibrinogen	wound healing	cow sheep	Pharming PPL
alpha-glucosidase	Pompe disease	rabbit	Pharming
collagen I collagen II	tissue repair rheumatoid arthritis	cow cow	Pharming
lactoferrin	GI tract infection, infectious arthritis	cow	Pharming
antithrombin 3 (ATIII)	thrombosis	goat	GTC
glutamic acid decarboxylase	type 1 diabetes	mouse, goat	GTC
human serum albumin (HSA)	maintains blood volume	mouse, cow	GTC
msp-1	malaria	mouse	GTC
Pro542	HIV	mouse, goat	GTC

Table 1 R&D of medicine production by transgenic animals⁵

Much of the interest in the development of cloning and genetics is driven by these technological and commercial interests.⁶ The development of transgenic animals is also seen as a means of producing bio-compatible tissue donors for human transplantation. It requires advanced genetic engineering of cultured cells, and has potentially great economic promise for gains in biomedicine. Already many major companies such as Monsanto, Abbott, CSL, Novartis and Aventis have embraced biotechnology as the science of tomorrow.

⁴ Ibid.

⁵ Source: Ibid.

⁶ J. Rifkin, *The Biotech Century* (London: Phoenix, 1998).

The critical shortage of human organs available for transplantation in the treatment of end-stage organ disease has greatly accelerated research and development in the field of xenotransplantation. Xeno-transplantation is “the transplantation of an organ or tissue between members of different species.”⁷ At present, the pig seems to be the most likely animal for sustainable use as a xenogenic organ donor given the combination of biological, physiological, and ethical considerations one needs to consider. Nevertheless, despite advances in drug therapy, rejection of any transplant material is always a problem. Even if drugs are used to suppress the immune response, cancer and infections can cause further illness or death due to immune suppression. By modifying the pig genome, through functional deletion of selected pig genes and through the introduction of certain human genes, immunological barriers have been overcome to a great degree in suppressing hyperacute and acute vascular rejection mechanisms particular to xenografts.

Human organ donor schemes seem inadequate to meet the critical global demands for more than 150,000 hearts, livers and kidneys, and therefore:

In closely protected organ farms, scientists are breeding genetically modified pigs whose organs they believe would be suitable for human beings. Early experiments using pig tissue implants have produced remarkable results in stroke and Parkinson’s Disease sufferers. Pig to human organ transplants are within the reach of scientists and could save thousands of lives... But the risks are enormous. If pig viruses attack human cells, they could unleash a new AIDS-type epidemic against which we have no in-built defences. As science fiction becomes science fact, what price will we pay for this medical miracle? This then is the dilemma facing doctors, scientists and ethicists on a grand scale: do the benefits to the few outweigh the risks to the many?⁸

Xenotransplantation is made attractive for Australian health providers who share the worldwide problem of organ donor shortage, with Australia having one of the lowest donor rates among the developed nations. At the end of 2003, the Australian Government reported that 1800 people were on the organ donor waiting lists, with 140 people dying while waiting for a suitable donor.⁹

Implications

Within the foreseeable future we may see the legalisation and acceptance of cloning as a legitimate medical and possibly cosmetic intervention, offering clients cloning services for tissue generation and storage, as a form of insurance against cancer and other degenerative diseases. Stem cells could be created that would be a perfect match in any post aggressive chemotherapy.

We are already hearing of cases where therapeutic cloning is seen as desirable to save the life of other family individuals. We remember reading a media report about a woman with a grown daughter wanting to have another child to serve as a bone marrow donor for her eldest daughter. The questions must be asked, “Will boundaries of ethical acceptance change to accommodate these developments, as moves are made to accelerate research in human cloning for life prolongation? What are the cultural, religious and ethical boundaries of such research?”

⁷ D.K.C. Cooper and R.P. Lanza, *Xeno: The Promise of Transplanting Animal Organs into Humans* (Oxford: Oxford University Press, 2000).

⁸ J. Bryan and J. Clare, *Organ Farm: Pig to Human Transplants: Medical Miracle or Genetic Time Bomb?* (London: Carlton Books, 2001).

⁹ Australian Commonwealth Government (2004):
<http://www.healthinsite.gov.au/content/internal/page.cfm?ObjID=00096F10-F5BD-103B-BD9A83032BFA006D>

The heart of many of these questions lie in the nature of stem cells. The United States National Bioethics Advisory Commission defines stem cells as follows:

Many kinds of stem cells are found in the body, with some more differentiated, or committed to a particular function than others. In other words when stem cells divide, some of the progeny mature into cells of a specific type (eg. heart, muscle, blood or brain cells), while others remain stem cells, ready to repair some of the everyday wear and tear undergone by our bodies. These stem cells are capable of continually reproducing themselves and serve to renew tissues throughout an individual's life.

... Although the term stem cell commonly is used to refer to the cells within the adult organism that renew tissue the most fundamental and extraordinary of the stem cells are found in the early stage embryo.

These embryonic stem (ES) cells, unlike the more differentiated adult stem cells or other cell types, retain their special ability to develop into nearly any cell type.¹⁰

Human stem cells can be derived from embryos or adult sources. Many ethical objections arise from the use of embryonic stem cells as the early embryo, consisting of a ball of undifferentiated cells, is destroyed in the process of obtaining the stem cells. If an individual belief is that human life is defined at the moment of fertilisation of sperm and ovum, then destruction of the early embryo will constitute an unethical procedure.

However a problem arises as not everyone accepts this as when human life is defined. This is the crux of the ethical dilemma in stem cell research. Other ethical questions concern associated procedures involved in reproductive cloning and other genetic manipulation techniques. For example:

Is human cloning permissible?

Is inserting genes from a plant, animal or other human into the genome of early human embryos ethical?

Are there unacceptable dangers for humans conceived through IVF or for embryos that are subject to gene manipulation?

These are some of the ethical questions associated with cloning and reproductive gene technologies that remain controversial. Similar questions are bound to surface if xenotransplantation becomes reality.

Gregory Stock and John Campbell, in a UCLA paper at a recent *Advanced Transgenesis and Cloning* conference, asked a more pointed question:

Does the answer to this question lie in the scientific nature of advanced reproductive technologies and human germline engineering? Judging by today's rapid scientific progress, delivering genetic changes to a human embryo ultimately will be easy enough, safe enough, and cheap enough to be feasible in countless laboratories worldwide. Human cloning provokes considerable debate, but human germline engineering is more significant because its implications ultimately will be more profound. For some philosophers, this act may challenge our basic concepts about what it means to be human. But human germline engineering - poised to make our very biology the object of conscious design - is a step so big in humanity's reach to control its own evolution that no one can presently say where it ultimately will lead.¹¹

It is critical to understand that the time to examine and discuss the realistic benefits and challenges that new reproductive technologies embody is now, while they are still in early stages of development. But lest we digress too far from the theme of our paper, we would like to refocus on the issue of how all this is perceived through the consciousness of

¹⁰ United States National Bioethics Advisory Commission, "Ethical Issues in Human Stem Cell Research" (1999): <http://www.georgetown.edu/research/nrcbl/nbac/pubs.html>.

¹¹ <http://www.ess.ucla.edu/huge/Stockatc.html>.

religious traditions whose ethical codes are based on writings, moral teachings, values and traditions that are buried in antiquity.

General principles can be derived from such sources that assist theologians and ethicists to explore contemporary contexts in which ethical decisions have to be made. It may be useful to see how the various ancient religious traditions viewed animals in particular, as they are so often used in scientific and pseudo-medical experimentation. How can a sense of reverence for creation and respect for animal species be maintained within cultures that have traditionally viewed non-human animals as inferior beings, like slaves, and condoned the most horrific abuses? Again, can theology and multi-faith perspectives provide a new insight and a new consciousness with which we can address present contemporary scientific and biomedical ethical dilemmas?

Here is an example by analogy: In his writings St. Thomas Aquinas (1224-1274) defended slavery as instituted by God in punishment for sin, and sees the buying and selling of human beings as justified, as being part of the 'right of nations' and natural law. Aquinas, who is considered the greatest of all Catholic theologians, even proclaimed that children of a slave mother are rightly slaves even though they have not committed personal sin! This deft piece of medieval theology was then quoted by many later Popes particularly in justifying the taking of slaves from the New World after the discoveries by Columbus and other conquistadors.

Even as late as 1866, we see the Holy Office, in an instruction signed by Pope Pius IX, declaring:

Slavery itself, considered as such in its essential nature, is not at all contrary to the natural and divine law, and there can be several just titles of slavery, and these are referred to by approved theologians and commentators of the sacred canons. It is not contrary to the natural and divine law for a slave to be sold, bought, exchanged or given.

It was not until 1888 that Leo XIII condemns slavery in more general terms, and supports the anti-slavery movement.¹²

By the time of the Second Vatican Council we see a vigorous defence of basic human rights and the denouncement of all violations of human integrity, including slavery.¹³

Perhaps this analogy is symptomatic of the need for a new contemporary consciousness to emerge with regard to the way animals are too often maltreated in our own age – a modern *metanoia* and change of heart towards which some animal liberationists, theologians and ethicists such as Andrew Linzey, Peter Singer, and Richard Wade are calling us. We are being challenged to reassess certain physiological and psychological processes, and to reconsider that we may have grossly underestimated and minimised animal abilities and cognitive-emotional processes.

Animals

The weight of the neuropsychological, cognitive, ethological, and socio-biological evidence suggests that some animals, in particular, mammals, in varying degrees, have the ability to formulate concepts, feel and experience emotions, understand causality, quantify, and demonstrate object permanence, intentionality, planning, self-recognition and awareness. In their book, "Organ Farm" we read the following quote from Jenny Brian and John Clare:

¹² <http://www.womenpriests.org/teaching/slavery1.htm>

¹³ Vatican II, *Gaudium et Spes*, nos. 27, 29, 67.

...research has demonstrated that chimpanzees are aware, they experience pain, and have rich mental and social lives. There is also evidence that they can express a broad range of emotions usually associated with humans – joy, sadness, grief, rage, fear, and even a sense of humour. They can reason, plan, make and use tools, be curious and inventive, engage in sophisticated non-verbal communication and learn over 300 signs in American Sign Language. Inevitably these traits do produce a feeling in humans that chimps are “like us” and that’s why we feel close to them.... With this weight of evidence only the most insensitive supporter of xenotransplantation would suggest that apes should be used as sources for organs....

In the UK, regulators and advisory bodies seem to have reached the same opinion when one reads in the Kennedy Report on the ethics of xenotransplantation, “Animals vary a great deal in their complexity and presumably their capacity for suffering.”¹⁴

Despite these human – animal similarities that narrow the human-animal divide, our ethical divide is widening when we consider the monumental proportion of animal suffering perpetrated by their human relatives.

In 2002, Anderegg et al.,¹⁵ argued that the idea that animals are needed in experimentation is not necessarily correct, noting that trials to demonstrate the link between lung cancer and tobacco was unsuccessful in animal models. Furthermore, this possibly led to the public being informed of this link much later as a result of the lack of data from animal experimentation when other sources of human data could have been exploited. However, millions of animals are likely to be killed, sometimes very brutally during biomedical research and, this year alone, millions of animals will legally have toxic or noxious products sprayed or rubbed on their skin, mouth and eyes; be burnt alive; experience devastating blows to the head and deep cuts while being vivisected¹⁶ be injected with fatal bacterial and viral infections; poisoned and isolated in depraved conditions – cages so compact and crowded that they are totally immobilised and subsequently killed for human consumption. The factory-farm industry is exempt from anti-cruelty laws.

Peter Singer, the renowned Australian ethicist and author of ‘Animal Liberation’ questions our right as humans to exploit animals for transplantation. Singer argues:

The traditional sanctity-of-life ethic forbids us to kill and take the organs of a human being who is not, and never can be, even minimally conscious; and it maintains this refusal even if the parents of the infant favour the donation of organs. At the same time, this ethic accepts without question that we may rear baboons and chimpanzees in order to kill them and use their organs. Why does our ethic draw so sharp a distinction between human beings and all other animals? Why does species membership make such a difference to the ethics of how we may treat a being?¹⁷

Singer highlights the ethical problem of using higher chordates for various medical procedures and experimentation such as xenotransplantation in light of the realisation that these non-human animals suffer pain as humans do, as well as share other characteristics of human animals.

Some scientists claim that the cardinal difference between animals and humans is that humans have a capacity for moral judgments and thought. We are ethical sentient beings whereas certain animals are only sentient beings. This unquestionably suggests

¹⁴ Bryan and Clare, *Organ Farm*, 78-79.

¹⁵ C. Anderegg, M.J. Cohen, S.R. Kaufman, R. Ruttenberg, and A. Fano, “A Critical look at Animal Experimentation” (2002): <http://www.mrmcmed.org/Critcv.html>.

¹⁶ PETA (People for the Ethical Treatment of Animals), “Animal Experimentation: Sadistic Scandal” (2004): <http://www.peta.org/factsheet/files/FactsheetDisplay.asp?ID=94>; P. Singer, *Writings on an Ethical Life*. (London: Fourth Estate, 2000), 21-65.

¹⁷ Singer, *Writings on an Ethical Life*, 21-65.

that humans have a moral obligation not to inflict suffering to animals that are clearly capable of experiencing suffering.

Historically, some of the most renowned thinkers had little regard for animals. Kant noted, "So far as animals are concerned we have no direct duties... animals are not self-conscious... they are merely a means to an end. That end is man."¹⁸

Descartes advocated for the superiority of the human race over "lower" forms of life. He denied any sentience in animals and essentially dismissed them as machines. He was a staunch advocate for animal experimentation.

Richard Wade, a theologian from the Aquinas campus of the Australian Catholic University, Ballarat, Victoria, summed up the traditional Christian ethic that was due to animals in this way:

avoid cruelty to animals and treat them with kindness; animal lives are not considered sacred and hence they have no significant right to life; as they lack reason, animals may be reasonably used for human benefit (food, companionship, transport, work, recreation and so on).¹⁹

The great thinkers of the Church affirmed the lowliness of animals. St. Thomas Aquinas opposed animal cruelty, as he also opposed needless cruelty to slaves, because he thought that would lead to cruelty to humans. St. Augustine, eight centuries before Aquinas, provided little challenge to the cruelty perpetrated on animals during his time. The present Roman Catholic Catechism says nothing of significance in relation to animal welfare, stating the following about the purpose of animals: "Non-human animals, like plants and inanimate things, are by nature destined for the common good of the past, present, and future community."²⁰ Despite the fact that "human animals" are seen within the eternal and redemptive context of the Old and New Testament, other animals do not figure strongly within this domain.

Most Judaic and Christian perspectives on the human-animal divide stem from the Old Testament Genesis account (1:1-2:4) of creation where God bestowed human dominion over animals. Humans, made in the image of God, should exercise this dominion "with wisdom and love." From the very first book of the Old Testament we witness that all animals share in the divine creative process having being made from God's goodness to share in the abundance of creation as a witness to God's love. We see that in the story of the flood in Genesis 6, animals are precious and saved with the human species for the glorification of God. Animals are seen as instrumental in fulfilling God's will, as in the mythological story of Jonah and the whale.

It is also interesting to note that the Genesis account ends with the statement that God declared his creation "good." Could this mean that his entire creation was sacred – not one species over another? Isaiah 11:6-8 states that all life is sacred. Ecclesiastes 3:18-20 affirms that humans and animals all draw the same breath.

Domestic animals have a special place within the scriptures, and the lasting image of the Good Shepherd who cares and even lays down his life for his sheep (John 10:1-18) is one engrained in Christian consciousness. This scriptural perspective should lead to a love of animals within creation and at least to an ethic of care for all creatures: the avoidance of cruelty in husbandry and experimentation.

Animals, historically, culturally and traditionally have a special status in all religions. In Hinduism and within Buddhist religious traditions, suprahuman realities – both divine

¹⁸ <http://www.scu.edu/ethics/publications/iie/v4n1/counts.html>.

¹⁹ R. Wade, "Animal Theology and Ethical Concerns," *Australian eJournal of Theology* 2 (2004): aejt.com.

²⁰ *Catechism of the Catholic Church*, no.2415.

and diabolic - often manifest themselves in animal form. These can epitomise, in the form of totems, the networks of relationships which constitute a human society. As vital energetic beings, symbolising energy and life, many types of animals have been a major part of sacrifice offering a symbol of the relationship that exists between created humanity and their creator.

Muslim ethics is necessarily grounded in the Qur'an. But as with all revelations, not every conceivable circumstance is covered in the Qur'an. A second major source of guidance, therefore, lies in hadith which is a narration about the life of the prophet, or what he has approved, but which nevertheless does not have the same category of authority as the Qur'an. The controlling concept of Muslim ethics is *tawhid*, the absolute unity of God. Life as God desires it was eventually formulated more systematically in the schools of shari'a (law), which detail the things which are lawful and prohibited for a Muslim. However, the principle applies that whatever God has not forbidden is allowed (as a mark of his generosity), though always within the boundaries of "what God wills" as revealed in more general terms in the Qur'an. Thus although Islam is regarded often by outsiders as an inflexible religion, there is much openness. Some religions, e.g. Islam, have retained animal sacrifice but others have reacted strongly against the efficacy of such acts e.g., Buddhism and Jainism.

Among Hindus, there is a controlling sense that that which alone is truly real whether conceived of as Brahman or as God, underlies and guarantees the subsistence of all appearance. This form is the source and indestructible seed of innumerable incarnations within the cosmos, and from it the appearances of all different living beings are created, heavenly beings, animals, humans, and all other kinds. Hindus see divinity in all living creatures. Therefore, animals also occupy an important place in Hindu Dharma. These animal gods appear as independent divine creatures as well as means of transport for Gods and Goddesses. Many of the gods and goddesses have particular animals associated with them, often expressed as their mounts - thus, the lion and Durga, the elephant and Ganesa (and Indra), the bull and Siva, the owl and Laksmi, *etc.* To mention just a few:

The white elephant, *Airaawat* which has four tusks and is the vehicle of Vedic God Indra.

We are more familiar with *Garuda* which is a bird deity with the head and wings of an eagle. He is the vehicle of Lord Vishnu. His image is placed at the entrance of any Vishnu Temple.

Kaamdhenu is the sacred cow of gods, who can fulfil all desires and wishes and is considered the mother of all cows.

The serpent god, *Sheshanaaga*, who is the king of the infernal regions and upon whom Lord Vishnu sleeps over the bed of its coils during intervals of creation.

Ucchiahrava is the god born from the churning of the ocean, and is seen as the prototype of the whole race of horses.

Nandi is the white bull and represents strength and virility and is used as a means of transport for Lord Shiva. Its image is usually placed at the entrance of any Shiva Temple where devotees usually touch the testicles of Nandi on entry to the Shrine.

Thus you should regard deer, camels, monkeys, donkeys, rats, reptiles, birds and flies as though they are your own children (Srimad-Bhagavatam). This underlying attitude

is epitomised in the sacred cow. Not surprisingly, animals can be the focus of worship and in particular can be the forms of incarnation (avatara).²¹

Conclusion

Finally, let us return once again to the words of one of the great Fathers of the Early Christian Church, St. John Chrysostom who expressed: "Surely we ought to show other species great kindness and goodness for many reasons, but above all because they are of the same origin as ourselves."²² This is a theme taken up by some contemporary theologians.

Richard Wade reflects on this theme as expressed in the work of Andrew Linzey, an Anglican animal theologian:

...in his writings [Linzey] has been at the forefront of challenging religious traditions to shift their theological thinking from an all-consuming human-centred focus to a more inclusive celebration of God's universal creativity. This shift in thinking is grounded in a theology that gives a particular account of the value and purpose of animals as God's creatures.

Linzey proposed what he calls "theos-rights" for animals. Behind this notion of rights is the view that creation exists for God, and that God is for animal creatures. In other words, the Creator has rights to have animals treated with respect. As such, if the rights of animals are violated, then the Creator is "wronged in his creation."²³

Knowledge about and reinforcement of compassion and kindness towards animals can be a profound impetus for ethical activism. We believe that we must radically overhaul our ethical standards and techniques of biomedical research and adopt more penetrating laws that will truly protect the most vulnerable and innocent.

We have to adopt a more profound, transcendent, kinder, empathic and compassionate ethic toward the less powerful and find spiritual meaning and connectedness with other living things.

Thus every modern movement toward reinterpretation of humanity as a holistic body-soul unity contains the possibility of according a high place to animals. Every tendency to see the universe as a single process of nature and history, every understanding of the biblical drama as a single story of creation and redemption, every account of human reality that stresses other aspects than rationality, as in our valuing of those who cannot yet or can no longer think, are so many moves in this direction. At a minimum they should lead to a "chastened anthropocentrism" with a "consciousness of belonging to the whole" or "being members of one another," even as we "manipulate" nature

There are both words of promise and caution and reflected by Robert Lightner, a reviewer of *Xeno*, the text by physicians David K.C. Cooper and Robert P. Lanza:

If you are what you eat, what do you become after accepting a pig heart transplant? look carefully at the scientific, ethical, legal, economic, and political issues appended to the promise of nearly unlimited organs and tissues for the needy. Ever since doctors transplanted monkey glands into elderly men--to questionable effect--early in the century, the prospect of using healthy animal organs to replace our own has fascinated and frustrated the medical profession...

²¹ An informative site on "Religious Thought about Animals," compiled by Dr Ron Epstein can be accessed here: <http://online.sfsu.edu/~rone/Religion/religionanimals.html>.

²² R. Preece and D. David Fraser, "The Status of Animals in Biblical and Christian Thought: A Study in Colliding Values," <http://www.psyeta.org/sa/sa8.3/fraser.shtml>.

²³ Wade, "Animal Theology and Ethical Concerns."

Cooper and Lanza present compelling arguments that this future might literally come tomorrow, with advances in genetic engineering and sensitive immunological hacking that could extend the lives of transplant patients many years without the use of cruelly immunosuppressive medications. Some problems are a bit bizarre--pigs might have to be exercised regularly for their hearts to be in good condition for transplant, and will have to live in such pristine, germ-free conditions that several major religions might have to reconsider the pig's status as an unclean animal. With animal rights crusaders, technophobic alarmists, and uncertain patients to contend with in addition to challenging immunological and physiological problems, transplant surgeons have their work cut out for them, but the authors of *Xeno* are optimistic that pigs will soon replace dogs as man's best friend.²⁴

Cute, eh? One could envisage, perhaps a follower of Islam, ending up with a pig's stomach, but no pork within it. As we tentatively move from an ethic of anthropocentrism towards an ethic of biocentrism in which we celebrate the principle of respect for all sentient beings (including the transgenic pig) we still need to address how best to embrace biomedical advances that will assist in the enhancement of human life. One possibility may come from within stem cell research itself which may be able to insert modified pig genes in a medical situation rather than sacrificing the whole animal; in this way a cluster of embryonic pig cells, with no capacity to feel or experience pain, may be used; or that the bone marrow from pigs may one day be used as a source of stem cells for human use; we certainly are not at this stage of technological development yet for the science is still in its infancy but, given good-will, the possibilities are endless.

Authors: *Gary Curran holds graduate and post-graduate qualifications in science, education and theology. He has extensive experience in both science and educational employment having worked as a Medical Technologist, Microbiologist and Laboratory Manager. Currently he is Head of Science at St. Columban's College and is completing his Master of Arts (Theology) at Australian Catholic University.*

Yuri Koszarycz is a Senior Lecturer in the School of Theology, McAuley Campus, Australian Catholic University. He has degrees in philosophy, theology and education and holds a postgraduate qualification in biomedical education. He lectures in bioethics, ethics and church history at undergraduate and postgraduate levels at ACU.

²⁴ <http://biologybooks.net/0195128338.html>.