

Ethics and Human-animal Transgenesis

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1. *Is it morally acceptable to transform an animal zygote by introducing human DNA into its genome so that the developing embryo inherits some human biological characteristics?*

In September 2001, the Pontifical Academy for Life issued a discussion paper entitled "Prospects for Xenotransplantation: Scientific Aspects and Ethical Consideration".¹ The editors conclude that they hope that the document "will represent a concrete contribution to the development of discussion on the important theme of xenotransplantation"².

We are pleased that the Academy has thus initiated discussion. We take the issuing of this discussion paper as an invitation to reflect on the matter and to contribute to the ongoing analysis of the issues. One small section of the document deals with the issue of human-animal transgenesis.

The Academy studied the prospects for transplanting animal organs to humans. In order to prevent the human body from rejecting animal tissue, it is thought that by introducing some human genes that will produce human proteins, and by "knocking-out" some of the animal genes, transgenic animals may be developed, from the transgenic zygote, with tissue that may be satisfactorily transplanted without rejection. Cloning that transgenic animal might usefully provide a renewable source of transplantable organs.

The discussion has been about using pigs as a source of organs for transplant to humans. The focus has been on hyperacute rejection. The idea is to add the human gene responsible for producing a protein that inhibits rejection. It is also thought to be necessary to knock-out the pig gene for alpha 1.3 galactosyl transferase antigen to which human antibodies may be directed.

These genetic changes, in the scale of the whole of the pig genome in which there may be as many as 35,000 endogenous genes, are not particularly significant in terms of altering the fundamental nature of the pig formed. The pig will not appear to be a different species from its parents, even though not strictly entirely a pig genomically. The human characteristics that it would have would be at the biological level and not produce changes that would raise questions about whether or not it has gained moral agency. One would not expect it to stand up on its hind legs as an adult and demand the keys of the car.

This line of experimentation at least raises questions about how far such experimentation might go. One might ask, "How many genes might be added and how many "knocked-out" before there is a significant change such that one would recognise that the animal was no longer a pig but another type of organism?" If it is human genes that are being added, then one might question at what proportion of genetic change ought one consider that questions about moral status of the developing animal arise.

This is a very complex topic, both scientifically and ethically, because it involves the generation of new life with a modified genome and because it involves crossing the medical and moral boundary between what is human and what is animal.

The Academy's document mentions ethical conditions for transgenesis in relation to:

- Pain and suffering in the transgenic animals
- Effects on offspring and environmental repercussions
- Not releasing the animals into the environment
- Limiting the number of animals
- Organ and tissue removal
- Evaluation by ethics committees.

¹ The paper was published as a supplement to *L'Osservatore Romano* 26/9/2001.

² Op Cit. p. 18

At no stage in the document do the authors attempt to discuss the intrinsic moral issue of whether human-animal transgenesis is a form of human-animal hybridization. Attempts to achieve human-animal hybridization by fertilization between human and animal gametes were condemned by the Congregation for the Doctrine of the Faith, in *Donum Vitae*, as contrary to human dignity³.

The authors of the Academy's document also do not discuss the significance of the human genome in the formation and in the generation of a human life, and the consequent moral significance of using parts of the human genome to generate a being that is, in part, genetically of human origin.

Thus the Academy, in providing no analysis of these topics, offers no authoritative teaching in this regard. For that reason we thought it important to offer a discussion of the moral aspects of attempting to transform an animal zygote by introducing human DNA into its genome so that the developing embryo inherits some human biological characteristics.

2. Is human-animal transgenesis to be condemned as a form of human-animal hybridization?

A scientist advising the Academy, in response to our queries to the Academy, argued that transgenic animals cannot be defined as human-animal hybrid embryos/animals since they are not derived from the fusion of a human and an animal gamete.⁴

There is a matter of language here. The Oxford English Dictionary defines “hybrid” biologically as the offspring of two plants or animals of different species. In biology, “offspring” does not imply fusion of gametes because it can be used for an individual organism resulting from another by asexual reproduction. An organism is a hybrid organism if its inherited characteristics are from organisms of different species. Being a hybrid does not imply an origin in a fertilisation event.

The Congregation for the Doctrine of the Faith condemns “attempts or plans for fertilisation between human and animal gametes” and describes them as “contrary to human dignity”.

Techniques of fertilization *in vitro* can open the way to other forms of biological and genetic manipulation of human embryos, such as attempts or plans for fertilization between human and animal gametes and the gestation of human embryos in the uterus of animals, or the hypothesis or project of constructing artificial uteruses for the human embryo. *These procedures are contrary to the human dignity proper to the embryo, and at the same time they are contrary to the rights of every person to be conceived and to be born within marriage and from marriage.*⁵

There would seem to be two aspects of attempting fertilization between human and animal gametes that would draw this condemnation. One is the confusion of the identity and status of any being formed that

³ *Donum Vitae* (1987) I 6.

⁴ “Some Notes on Transgenesis” - Advice from a scientist assisting the Pontifical Academy for Life in relation to Academy’s paper “Prospects for Xenotransplantation”. The advice was provided to one of the authors by Archbishop Elio Sgreccia 11/12/01 in correspondence about the moral permissibility of human-animal transgenesis.

⁵ Congregazione per la Dottrina Della Fede “*Donum Vitae*” *Istruzione e Commenti* Libreria Editrice Vaticana 1990 p. 44 (*Donum Vitae* I 6)

[“Rationes technicae fecundationis *in vitro* aditum patefacere possunt ad alias formas artificiosae tractionis biologicae vel geneticae embryonum humanorum, cuiusmodi sunt, conatus vel proposita fecundationis inter hominum et animaliam gametes, et gestationis embryonum humanorum in uteris animalium; coniecturae vel consilia artificiales uteros fabricandi ad embryones excipiendos. *Huiusmodi procedendi rationes repugnant creaturae humanae dignitati quae ad embryonem spectat, simulque ius laedunt uniuscuiusque personae et concipiatur ut nascatur in matrimonio et ex matrimonio.*]

way. The second is the wrongful use of the human generative capacity of a human gamete to form a being by uniting it with an animal gamete.

It would be a mistake to hold that the Congregation would support human-animal hybridization by processes not involving fertilisation. The Congregation condemns techniques “such as” (“*cuiusmodi sunt*”) attempts or plans to achieve fertilisation between human and animal gametes.

The advent of somatic cell nuclear transfer technology in animals in 1997⁶ indicated that it might be possible to produce a human being other than by fertilization. On November 26 2001, a US biotech company reported the formation of the first cloned human embryo using the somatic cell nuclear transfer technique to an ovum.⁷ Subsequently, there have been claims in the popular media of human pregnancies having been formed following somatic cell nuclear transfer, but, at the time of writing, they had not yet been reported in the peer-reviewed journals.

Because human beings may be produced without fertilization, (asexual and agamic reproduction), we have had to re-examine the question as to what defines the origin of a specifically human being. The contemporary references to fertilisation and conception are no longer sufficient. The Congregation for the Doctrine of the Faith, for instance, defined the beginning of human life to be the fusion of the gametes⁸, but that is not the only way in which a human life may begin. There are human beings who are not the result of fertilisation or conception, but have been produced asexually.

The Pontifical Academy for Life in its “Reflections on Human Cloning” wrote that human cloning “is immoral because even in the case of a clone, we are in the presence of a “man”, although in the embryonic stage”.⁹ There is no doubt that the product of the process known as *human somatic cell nuclear transfer* to a human ovum would be a human zygote and to be respected and treated as a person, even though he or she did not result from fertilisation between gametes.

The transmission of a human genome is a significant consequence of both human fertilization and of human asexual reproduction by somatic cell nuclear transfer (cloning). Scientifically, it is the transmission of a human genome in the formation of the zygote that results in the generation of a new human being. We argue that a zygote with a human genome must be considered a human individual, and thus made in the image and likeness of God, with all the inheritance of human dignity that that implies.

Even more significantly for this discussion of human-animal transgenesis, a Melbourne Company Stem Cell Research P/L has been reported in the popular media as having formed an organism combining a human cell nucleus with an enucleated pig ovum¹⁰. The organism developed in similar fashion to a human embryo up until the stage at which it died at around 32 cells. A team in Massachusetts led by Dr Thomas Murray has reported a similar experiment using a human cell nucleus and an enucleated cow ovum. They reported that the human nucleus took control and displaced cow proteins with human proteins and claimed to have obtained human embryonic stem cells from the embryo formed.¹¹

It seems to us that in this case, given that the new being formed has a human genome, the new being should

⁶ Ian Wilmut, A E Schnicke, J. Mc Whir, A J Kind and KHSL Campbell “Viable offspring derived from fetal and adult mammalian cells *Nature* 1997, 385, p. 810-3

⁷ Special Report: Cloning and Human Stem Cells www.NewScientist.com 29/01/2002 It is, however, open to question whether what was formed was genuinely a human embryo i.e. one capable of gastrulation.

⁸ “*Zygotum est cellula orta a fusione duorum gametum*” Congregazione per la Dottrina Della Fede “*Donum Vitae*” Istruzione e Commenti Libreria Editrice Vaticana 1990 footnote to page p. 32 (*Donum Vitae* I 1)

⁹ Pontifical Academy for Life *Reflections on Human Cloning*, 1997 www.vatican.va.

¹⁰ A letter to the President of the Australian Senate from Dr Alan Trounson tabled by Senator Tambling, Government Spokesperson, during debate on the *Gene Technology Bill 2000*, Senate *Hansard* Monday 4th December 2000

¹¹ *International Herald Tribune* 13/11/98

be given the benefit of any doubt as to its human status. That is to say as a matter of science, the genome is determinative of the nature and capacity of the zygote.

It would seem to follow that, in relation to a human-animal hybrid being having been formed by a process other than fertilisation, if part of the wrong of human-animal hybridization is confusion of the identity and status of a being (formed by fertilisation between human and animal gametes to produce a zygote with a mixed human animal genome), then the same conclusion should be drawn in relation to a zygote with a human-animal hybrid genome being formed by transgenesis and not by fertilisation. The outcome, a being with confusion of identity and status because it has a genome that has both human and animal genes, is the same in both instances.

For this reason, we submit that it would be intrinsically immoral to undertake human-animal transgenesis in the formation of an embryo because of the confusion of the identity and status of any being formed that way.

3. Is there an acceptable level or proportion of human-animal hybridization?

A question may arise as to whether there is an acceptable proportion of the human genome, perhaps something less than fifty per cent, that may be added to an animal ovum or zygote. Our view is that the confusion of identity arises as soon as any human genes become formative of the new being. The functions of the genes, especially the multi-chromosomal genes are very complex and may never be fully understood.

It has been argued that the genetic similarity between humans and other species is very high so as to be nearly identical for many genes, thereby diminishing the uniqueness of the human genome. It could be argued that if so many human genes are virtually the same as those found in other species, then there is little unusual about moving genes from one to the other. Of course, there would also be little point in transferring a human gene at all if it is so similar to what already exists in a target species.

But what does genetic similarity really mean? The genetic similarity between humans and our 'nearest neighbour', the chimpanzee, has variously been placed between 96% and 98%. Does this mean that 96-98% of our genes are the same, or that each gene is 96-98% the same.

In fact, the homology between humans and chimpanzees is across the whole genome, so that each and every gene is different between humans and chimpanzees to a varying extent. The degree of homology can be very high so that a given human gene might be only slightly different to a chimpanzee equivalent, or alternatively the homology may be considerably lower so that a gene might be quite dissimilar between the two species or entirely novel in humans.¹² Nevertheless, even tiny differences in the nucleotide sequence of a gene can have a dramatic effect on the protein produced, and therefore on the function served by that protein.¹³ Therefore, a tiny difference at the level of nucleotide bases might give rise to dramatic differences in function, and hence to development and form.

Furthermore, certain control genes in humans may direct development by influencing large numbers of other genes. This hierarchy of gene action means that the addition or modification of just one or a few

¹² This does raise the interesting question concerning how different a gene needs to be, when compared to a similar one in another species, to be considered novel.

¹³ Various single gene disorders result from changes to one or a few nucleotide bases out of hundreds of thousands and yet produce life-threatening conditions. For example, in the most common mutation causing Cystic Fibrosis, just 3 nucleotide bases wrong out of 250,000 (ie a 0.0012% change), leads to a defective protein and all of the serious health consequences of this genetic disorder. (see F. Vogel & A.G. Motulsky, *Human Genetics: Problems and Approaches*, 3rd Edition, Springer, Heidelberg, 1997)

genes very high up in the chain of command can lead to startling differences in form¹⁴. The absence of certain master genes in chimpanzees may be behind at least some of the significant differences in development and therefore functional capacity between humans and chimpanzees.¹⁵

The environment in which a gene is located can have a strong influence not only upon the extent of its expression but also upon the protein that is produced. Post-transcription events modify proteins in particular ways, so that a human gene transferred to an animal may not behave in exactly the same way as it does in the human.¹⁶ Human genes working in the context of human cellular machinery create an environment that functions in a highly integrative and complementary fashion. It is likely that moving certain human genes out of their normal context may mean they will operate quite differently.

There is also the matter of so-called 'junk' DNA. A typical figure for the percentage of the human genome that goes by this unfortunate label is approximately 95%, although it may be higher. That is, 5% or less of the human genome is composed of genes that code for proteins. The rest has typically been considered uninteresting. Packing at best, refuse at worst. However, that is rapidly changing and researchers are discovering roles for this overlooked 'junk' or non-coding DNA. And while there is much to learn, according to recent findings non-coding DNA is active in cellular function.¹⁷ Indeed, it has been suggested that as much as 50% of transcription going on inside cells may be from non-coding DNA.¹⁸ Furthermore, and possibly importantly, the amount of 'junk' DNA varies greatly from species to species and, depending on its possible role(s) in a given species, may contribute to the complexity of function demanded by higher organisms. Or it may not. Not enough is yet known.¹⁹

There is an additional and related argument that might be used to argue for the legitimacy of transgenesis. If genes are transferred in the natural course of events from humans to other species and *vice versa*, then the human genome is undergoing a form of 'natural transgenesis', making artificial transgenesis hardly out of the ordinary.²⁰

The natural transfer of genes between species, independent of reproduction, is typically referred to as horizontal gene transfer. Do genes move in this way from one genome to another, and to what extent?

Humans as well as other species continually consume foods that contain large amounts of the genomes of other species. The DNA and RNA are digested and our stable genomes do not incorporate any of that genetic material, remaining unchanged.

An exception is when viruses enter the body by various routes and become incorporated into our genomes, often with dramatic results. Some of those viruses can remain dormant for a long time before any effect is exerted. But the incorporation of viral material into the human genome does not change the integrity of the human genome, and not in a way that influences identity. If anything, viruses are considered to be foreign invaders that disrupt normal processes and leave the essential nature of the host unchanged.

¹⁴ One rather bizarre expression of this principle in action can be found in the genetic manipulation of the fruit fly *Drosophila melongaster*. The manipulation of control genes gave rise to the development of eyes on the ends of wings or limbs.

¹⁵ For a discussion of some chimp/human genetic differences see David Elder, Human Vs Chimps: Small steps for DNA, Giant Leaps For Us. *Bioethics Research Notes* **14(2)**:13-14, June 2002.

¹⁶ Simon Bawden, Geneticist with the South Australian Research and Development Institute, personal communication.

¹⁷ For a recent review of the possible roles played by non-coding 'junk' DNA, see, *Challenging the dogma: the hidden layer of non-protein-coding RNAs in complex organisms* by John S. Mattick, *BioEssays* 25(10):930-939, 2003.

¹⁸ Simon Bawden, Geneticist with the South Australian Research and Development Institute, personal communication.

¹⁹ It is puzzling to note that the onion genome, for example, is 12 times the size of the human genome, presumably because of its large amount of 'junk' DNA.

²⁰ This argument however, if used to justify human/animal transgenesis, would be an example of the naturalistic fallacy.

However, horizontal gene transfer has been shown to occur between bacteria, and while this may present a special concern for the safety of genetically modified foods²¹, the transfer of genes to higher species has not been convincingly shown.²²

It was recently reported that approximately 100 genes from bacteria were found to be very similar to sections of the human genome, and that the way they got there in the first place was via horizontal gene transfer.²³ That is, it was proposed that genes were directly transferred from the bacterial genome to the human genome by virtue of the presence of the bacteria within the human body. Subsequent studies showed that this was not the case and if horizontal gene transfer does occur between humans and other species, then it is exceedingly rare.²⁴

The issue of transgenesis is clearly complicated. In the type of project currently being discussed, the changes being made to the pig's genes are said to be minor. Nevertheless, the experiment does raise the question whether humanness is a matter of degree. At what point would substitution of human genes into a pig result in a being who was less a pig but rather deserving of greater moral status.

There would seem to be an apparently unanswerable question:

How much or for which genes, for which functions, would transfer of human genes to an animal ovum or embryo warrant considering that animal embryo to have a greater status than an animal embryo?

It is tempting to answer this question in terms of function. A being is "human" in status when he or she has those genes which cause him or her to have those capacities that we particularly value in human beings, for instance, the ability to doubt, reason, wonder, love, be self-constructive of one's own character. In fact, we might be prepared to give such a protected status to a being who still looked like a pig, but exhibited human rationality.

A problem with this reasoning is that, in terms of our Christian tradition and the human rights movement, particularly that part of the human rights movement that deals with disability, it is membership of the human family that is significant, not capacity. While we might concede that a pig-like being with human intelligence was deserving of human status, are we prepared to say that only human beings who approach normal standards of human intelligence are deserving of moral status? In the Christian tradition, we make no such moral distinction between human beings.

Already there are scholars, evaluating the inherent dignity of an animal purely in terms of sentience and function, who have claimed that chimpanzees are more worthy of respect as 'persons' than new born babies, that a normal adult pig is of greater moral significance than a defective newborn baby. These claims might well be enhanced when the chimpanzee or pig in question has a genome that is, in part, human.

We hold that an endorsement of procedures to transform an animal zygote by introducing human DNA into its genome, so that the developing embryo inherits some human biological characteristics, would undermine respect for the human zygote, because, in the created order, it is possession of a

²¹ See "Horizontal transfer – an introduction. Gene transfer between organisms without reproduction." A short paper by Physicians and Scientists for Responsible Application of Science and Technology (<http://www.psrast.org/hrtintr.htm>)

²² Some agrobacteria are able to transfer genes to plant chromosomes.

²³ For a discussion of the relevant papers and a review of horizontal gene transfer see C.G. Kurland, B. Canback, & Otto G. Berg, Horizontal Gene Transfer: A Critical Review, *Proceedings of the National Academy of Sciences*, **100(17)**:9658-9662, August 19, 2003.

²⁴ *Ibid.*

human genome, even if damaged or incomplete, that sets a human zygote apart from animals. Human-animal transgenesis undermines that very notion of human dignity and sacredness which determines the moral status of every human being, however immature or damaged he or she may be.

4. Is human-animal transgenesis involving an animal zygote morally different from established procedures involving bacteria?

It is argued by scientific advisers to the Academy, that it is not an offence against human dignity to insert a small part of the human genome (one or few genes) into the genome of another organism, because the practice of inserting human genes into bacteria such as the human insulin gene in *E. Coli* to be used for the treatment of diabetes is well established and indeed accepted²⁵.

A bacterium is a unicellular micro-organism which lacks an organised nucleus²⁶. It has no capacity to form a blastocyst, to gastrulate, to undertake cell differentiation and to form a complex organism. The significance of altering the DNA of a bacterium would seem to be on a par with altering the genome of somatic cells in culture.

By contrast, altering the genome of a zygote means altering every cell in the complex being that the zygote may become and, by altering the genome, changing, at least to some extent, the nature of the animal who may develop. A crucial difference is the zygote's capacity for embryogenesis. A bacterium remains a single cell organism lacking an organised nucleus. Because of its capacity to form a blastocyst and to gastrulate, a zygote is the first cell of a very complex being and its genome determines how it will develop and what kind of organised development can occur. Essentially, the genome of the zygote determines who or what that being is, not just as a cell but also as a complex being composed of many differentiated cells. Further, the change in the animal is inheritable by its offspring.

The scientific advice to the Pontifical Academy for Life appears to have drawn an equivalence between a bacterium and a zygote or embryo. In fact a zygote, with its enormous capacity to form a blastocyst, to gastrulate and differentiate so that eventually a complex being will form capable of integrated autonomous activity, is vastly different from a bacterium.

In the case of human-animal transgenesis, the capacities to form a blastocyst and to gastrulate, (the first stages of differentiation), are present in the animal zygote to which the human gene or genes are added.

In the process under discussion, no human gamete is used. However, the generative capacity of the animal zygote is used as a vehicle for developing a being that develops and expresses and may reproduce parts of the human genome.

We are strongly opposed to the practice for the philosophical reason that by adding human DNA to an animal zygote we transform the zygote so that it has some human biological characteristics. Given that as human beings we are a psychosomatic unity, we cannot make a satisfactory distinction between which genes are thus acceptably added and which not. There is no acceptable extent to which a human-animal transgenic being may be created or generated.

5. Is it permissible to introduce human DNA into an animal such that the change is inheritable and affects organs that are crucial to identity, such as the brain?

²⁵ "Some Notes on Transgenesis" - *OP. Cit.*

²⁶ Concise Oxford English Dictionary 1999; cf. Dorland's Illustrated Medical Dictionary 27th edition, 1988 Philadelphia: WB Saunders and Co., p.182 and p1362

There is an issue of identity that is being ignored in attempts to achieve human-animal transgenesis.

By changing the DNA in a zygote we make an inheritable change that affects every cell in the body of the being who eventuates, including brain cells and reproductive cells.

It should be noted here that the Pontifical Council for Pastoral Assistance to Health Care Workers addressed the issue of brain and gonad transplantation and concluded that such transplants would be unethical.²⁷ The reason given was that the brain and the gonads “ensure the personal and procreative identity. These are organs which embody the characteristic uniqueness of the person, which medicine is bound to protect.”

A human-animal transgenic being has, in effect, had human DNA transplanted to its brain cells and to its gonads, as well as every other tissue in the body. The human DNA will be inherited by its offspring, and the brain, when it develops, will have those changes. What is being altered thus has profound significance for identity.

If we deliberately create beings that have DNA from both human and animal sources, then we have violated the sacredness of all human beings. The distinction between human and animal identity, so vital for the protection of basic human rights, would have been blurred.

6. *Is the generation of an embryo that is part human and part animal a misuse of the human generative capacity contained within the human genome?*

6.1 *Science and the Human Genome*

In 1996, UNESCO’s International Bioethics Committee (IBC), the drafters of the *Universal Declaration on the Human Genome and Human Rights (1997)*, after protracted debate, decided not to define “the human genome”. Instead, the *travaux préparatoires* record eight alternative meanings of the term:

- the genetic substrata of human beings
- the total genetic material of humanity
- all the genes of every individual
- the genome in its tangible aspect (DNA and RNA molecules)
- the genome in its immaterial aspect (genetic information)
- the genetic programme which is the source of the vital functions of every individual
- the genes that can be detached from the body of every human individual;²⁸
- the values attached to human identity.

The web-site for the human genome project defines a “genome” as all the DNA in an organism, including its genes.

It would seem to us that it is not enough to say that the human genome is all the DNA in an organism, including its genes. The human genome is also the genetic information that may be transferred by copying the DNA sequences in a cell. Thus, *the genome is all the material that constitutes the DNA sequences or genes in an organism, and it is the information that those DNA sequences express or represent. The genes are the DNA sequences that determine the inherited characteristics of a cell or an individual.*

²⁷ *Charter for Health Care Workers* 1995 n. 88

²⁸ Noelle Lenoir *Presentation of the preliminary draft of a Universal Declaration on the Human genome and Human Rights*, 11 September, UNESCO: Paris 1996 n. 20

The scientific significance of the human genome is that it is determinative of the inherited characteristics of the individual.

6.2 *Is the Genome Related to Human Dignity?*

In the cloning process the basic relationships of the human person are perverted: filiation, consanguinity, kinship, parenthood²⁹, precisely because the genome that is formed is not formed as a unique new genome that originates equally in the genomes of both parents.

The new genomic technologies and development of the scientific understanding of what it is to be human, and the function of the human genome in that respect, necessitate an answer to the question - what is it that gives all human members of the human family inherent dignity and equal and inalienable rights? Historically, western culture has been based on the Christian tradition. The Tradition has held (with some notable historical aberrations) that the protected status or inviolability of human beings does not depend on individuals, nor is it a concession made by society and the state. Inviolability or sacredness belongs to human nature and is inherent in the person by virtue of the creative act from which the person took his origin³⁰.

No doubt, this claim gives cause for theological reflection on the nature of creation, and God's law for humanity, especially the fifth commandment of the Decalogue and Christ's "new" commandment that we love one another.

Aristotle supplanted the Platonic idea of man as incarcerated soul with the notion of man as rational animal. Aquinas through adopting Aristotle's *naturalism* placed confidence in our ability to reason and this included our ability to reason about morality and to discover and know moral truth. In this, Aquinas envisaged that the Christian thinker would not divide allegiances between Christian and non-Christian thinkers but engage in a common project with others to discover the meaning of reason and the conditions of true thinking. This is a point that is most relevant to contemporary society. Is there an appeal to reason that would be a common basis for upholding the notion that all members of the human family, that is, all human beings, have inherent human dignity and equal and inalienable rights?

It is true that rationality is normally a feature, even a characteristic feature, of a mature human being. Rationality, as we experience it, is the capacity not just to set ends and to determine means to achieve those ends, it is also the capacity to wonder, doubt, speculate, imagine, abstract, hypothesise, deduce, and love.

If it is accepted that we recognise the dignity of those who are demonstrably rational, and the question is whether there is a basis for recognising the dignity of those who belong to the human family but are not demonstrably rational, then a response the authors propose is that members of the human family are interconnected and that sense of familial connection is a basis for recognising the dignity of each, even if an individual member at a given moment may not be capable of expressing or realising the qualities upon which respect for dignity is founded.

This notion of familial connection obviously makes sense in relation to immediate family. We would argue that more than that, that interconnectedness makes sense not just within immediate family but, in fact, in regard to all those individuals who share the human genome. The human genome provides, in essence, a capacity for rationality, that rationality which we consider so significant in determining that a being is a moral agent and capable of being fully autonomous. When an organism comes into existence formed, as it were, by the human genome we know empirically that unless it is damaged in some way or it is denied a favourable environment, rationality will come to be without any further information or organisation being added. Intrinsically, all that the being is capable of being is present in embryo. Later when we see the adult being, we can look back to the origin of this being when the first cell was formed with his or her completed individual genome.

²⁹Pontifical Academy for Life, "Reflections on Human Cloning" www.vatican.va.

³⁰The Holy See *Catechism of the Catholic Church* St Paul Publications 1994 n. 2273

6.3 *The Human Genome and the Moral Status of the Human Zygote*

This line of thought concerning the significance of possessing the human genome has implications for the status of very immature human individuals and furnishes material for what may be a novel argument in the debate over the status of human embryos which has become a particular issue now that there is, for example, the possibility of creating human embryos by somatic cell nuclear transfer (cloning) specifically for the purpose of harvesting stem cells from them for medical purposes.

Briefly, the argument seeks to explain the major premise of the human rights movement that

(1) *All members of the human family, (including those who may not be rational especially the developmentally disabled and the mentally ill, children, and the elderly), have inherent dignity and equal and inalienable rights.*

On exploration of the above, the authors offer that this principle need not be arbitrary, nor divorced from most of the philosophical accounts of human worth. We accept that possession of dignity and rights is related to rationality, but, that rationality and that autonomy are not instantiated at all times by those who are considered rationally autonomous. Inherent dignity and equal and inalienable rights are possessed by all and not in relation to the extent to which we are rational. We do not pass in and out of a state of dignity and possession of rights depending on whether at that moment we are rational. The authors suggest that significance is attached to human beings because they are of a kind of being which is rational even though we are not always rational. The capacity for rationality, which confers moral status and rights, is kind-essential to human beings. Thus, the authors offer the alternative proposition:

(2) *Being of the kind of being which has the capacity for rationality is a basis for an individual to be recognised as having inherent dignity and hence the bearer of equal and inalienable rights.*

This links theories of dignity and rights based on rationality to the proposition that all members of the human family, even though we may not be rational at any given moment of our existence, have dignity and are the bearers of rights, and it removes the arbitrariness of simply saying “all members of the human family”. “All who are of the kind of being who have rational autonomy” is not arbitrary or speciesist if dignity and rights-bearing are understood in terms of rationality. Members of the human family are interconnected, we argue, through sharing in being of a kind of being who has a capacity for rationality, because it is rationality that forms the basis of the kind of relationships and those ways of being and flourishing that we particularly value.

We offer that

(3) *The human genome contains information, which determines that a living individual who possesses and is formed according to the human genome is of the kind of being which has the capacity for rationality.*

On that basis, we argue that

(4) *Those living individuals who possess and are formed according to the human genome have inherent dignity and are the bearers of rights.*

This leads us to the claim that

(5) *Embryonic human beings are living individuals who possess and are formed according to the human genome;*

therefore,

(6) *Embryonic human beings have inherent dignity and equal and inalienable rights.*

6.4 *The Human Genome and the Human Soul*

New developments allow us to expand the Congregation for the Doctrine of the Faith's teaching

"Certainly no empirical datum can be, in itself sufficient to bring us to recognition of a spiritual

soul; nevertheless, the conclusions of science regarding the human embryo provide a valuable indication for discerning by the use of reason a personal presence at the moment of the first appearance of a human life..."(Footnote DV I 1).

We reject the tendency in some circles to reduce the human soul to simply being the human genome. The genome in relation to the body is more like the brain, essential, integrative but material not spiritual. The genome is part of the body that is formed by the soul. We are led by the scientific evidence to assert:

- a) Biologically, the human genome directs the formation of the zygote so that it is the kind of being who inherently³¹ has the capacity for rationality. That is to say, given a favourable environment and nourishment, and barring misadventure, the zygote will progress to human adulthood and possess the rationality that is normally an attribute of mature human beings.
- b) The human genome is therefore evidence of a *radical contingent capacity for rationality*. By “radical”, we mean that the presence of a human genome is indicative of the presence of a formative cause of rationality. By “contingent” we mean that the human genome on its own or even in a cell that lacks totipotency is not formative of rationality. It needs the context of a totipotent cell to form a being that has the capacity to develop rationality. Totipotency is the inherent capacity to differentiate and form the dynamic organisation, involving many different types of cell, which constitutes the body. Biologically, the formation of the blastocyst, which precedes gastrulation, is the first step towards differentiation into all the parts of the body. The inherent capacity to form a blastocyst is indicative of totipotency. (Somatic cells are incapable of forming a blastocyst.)
- c) No empirical datum can be, in itself, sufficient to bring us to recognition of a spiritual soul. Nevertheless, the conclusions of science regarding the human genome and its determining role in the developing human being are a valuable indication for discerning a personal human presence from the moment that a cell is formed that contains a human genome and is inherently capable of forming a blastocyst.

On that basis, we argue that *those living individuals who possess and are formed according to the human genome have inherent dignity and are the bearers of rights*.

In this respect the human genome has a particular moral significance, it is the biological means by which human inheritance is transferred in the formation of a new individual, including the continuity of a protected status for that individual from the earliest moment that that new genome occurs in the formation of the first cell of the zygote. It is that which determines biologically that this is a being with the inherent capacity for rationality.

The formation of a being that is a combination of human and animal genomes is morally repugnant to many people. There is a strong moral intuition that rejects the practice. That moral intuition is well-founded because transgenesis is an *act of generation* that uses part of the human genome in the process.

The human genome has a singular significance in the transmission of human life and the transpecies use of it, or of parts of it, to generate a new human-animal hybrid being, is an offence against the sacredness of the generative faculty that subsists in the human genome. The moral wrong is in the same category of immorality involving misuse of the sexual faculties in which there is an offence against the sacredness of the human procreative capacity. We hold that human-animal transgenesis undermines the sacredness of human generation, that by which we cooperate with God in the creation of a new human being.

³¹ “Inherent” means existing as a permanent feature or characteristic, and not acquired. A human being does not acquire the capacity for rationality, he or she has that capacity inherently from the moment the first cell is formed.

7. *Are attempts to transform an animal zygote by introducing human DNA into its genome so that the developing embryo inherits some human biological characteristics intrinsically evil?*

In 1987, the Congregation for the Doctrine of the Faith wrote:

“From the moment of conception, the life of every human being is to be respected in an absolute way because man is the only creature on earth that God has “wished for himself” and the spiritual soul of each man is “immediately created” by God; his whole being bears the image of the Creator. Human life is sacred because from its beginning it involves “the creative action of God” and it remains forever in relationship with the Creator, who is its sole end. God alone is Lord of life from its beginning until its end: no one can, in any circumstances, claim for himself the right to destroy directly an innocent human being.”³²

Scientifically we are able to distinguish a human being from other beings at the moment that the first cell is formed. We can so distinguish because a human zygote has a human genome. In the natural order, it is its genome that determines that it is a human being and not an animal. It is through the genome that God creates a new human being. In the union of a man and a woman, we have the perfect way in which that act of divine creation is continued in their “responsible collaboration with the fruitful love of God”.³³ But the biological effect of the union of a man and a woman, in creating a new life, is the formation of a new human genome to which each have contributed equally, and it appears, as a matter of evidence, that it is through that human genome that the offspring is created as a human being, a being made in the image and likeness of God.

The human genome directs the cell reproduction process in such a way that growth does not happen in an amorphous or undirected way, but a complex structure forms which, given a favourable environment and nourishment will exhibit those characteristics that we acknowledge to be particularly human and capable of love, wonder and reason and able to form a relationship to God.

It seems to us that when a scientist fragments the human genome and adds parts of it to an animal genome in the formation of a hybrid zygote, he or she has begun to confuse the identity of what is or is not human and what or who is or is not made in the image and likeness of God, and does or does not count as my neighbour.

It is on that ground that the authors would hold that such a project would represent a failure to respect the sacredness of the human genome and the sacredness of human generation.

Reflecting on the mystery of the Incarnation, we note that it is the human genome that the Second Person of the Blessed Trinity has taken to himself. This decisive event fundamentally alters the way in which we should respect the sacredness of the generative capacity of the human genome when it is used to form a zygote.

³² *Donum Vitae* I 5

³³ *Gaudium et Spes* n.5