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# Human Gene Transfer: Some Theological Contributions to the Ethical Debate

by

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## I. Introduction

The international scientific community is in the midst of completing one of the most extraordinary endeavors in the history of science. It is seeking to discover the "Holy Grail" of our biological heritage by mapping and sequencing the entire human genetic code through the Human Genome Project. The human genome (i.e., all our genetic material) contains 30,000 to 40,000 genes (or possibly as few as 26,000)<sup>1</sup> that are located along our 46 chromosomes. The chromosomes in the nucleus of our cells are made mostly from a DNA molecule whose structure is a double helix, and our genes, which are comprised of a specific sequence of nitrogenous base pairs of adenine-thymine and cytosine-guanine, are located along this molecule. The smallest gene is comprised of a sequence of about 1,000 nitrogenous base pairs and the largest gene is approximately two million. As one might imagine, mapping and sequencing this number of genes is a time-consuming enterprise. In June, 2000, approximately 90% of the genome was mapped and sequenced, and now the task is to complete the remaining 10%. Francis Collins, the current Director of the Human Genome Project, has stated that the public project should have a highly accurate map of the human genome completed well before 2003.<sup>2</sup>

James Watson, the former director of the U.S. component of this project, recognized early on that there are many important issues of a non-

scientific nature connected with the genome initiative. He urged that, of the \$3 billion (or \$1 per base pair) that will be funded for the U.S. portion of the genome project, at least three percent (\$90 million) should be spent on examining these issues. He succeeded in his efforts, and so the Joint Working Group on the Ethical, Legal and Social Issues Relative to Mapping and Sequencing the Human Genome (ELSI) was formed and began its work in September 1989.<sup>3</sup> Watson was indeed correct about the relevance of the ethical issues connected to this initiative. The scientific breakthroughs that are being made today because of this research, and those that will be made in the future based on the various types of gene transfer, present us with extremely complex and far-reaching theological, social and moral questions.

My interest in the Human Genome Project is principally theological in nature and scope, although it involves many ethical issues as well. I will begin with a claim: none of us enters into the moral evaluation of a complex topic such as this one as if one were a *tabula rasa* or empty slate. Rather, our moral judgments are informed and guided by settled convictions and beliefs of a non-moral nature. For religious believers, these convictions and beliefs are religious in nature. Thus, I want to reflect on the Christian theological tradition and indicate how *moral* judgments that Christians attain on issues of human gene transfer are, or ought to be, informed and shaped by and partially dependent on specifically *theological* beliefs. In other words, I want to suggest that the moral decisions that Christians come to concerning whether or not to support the alteration of our genetic code depend partially on a religious context of meaning. This religious context can inform and authorize certain moral judgments that believers might make. By stating the matter this way, I do not mean to imply that one can separate moral and religious experiences. I intend only to claim that the two are distinguishable and then to indicate how one can influence or qualify the other. Thus, in the case at hand, theological convictions can provide perspectives on and engender attitudes about genetic manipulation. Furthermore, this religious context does not by itself determine moral decision-making for Christians; there are, of course, a number of other background issues that function as presuppositions to moral judgments on human gene transfer. The following list is merely a sample of such issues: the goals and limits of medicine,<sup>4</sup> the meaning of suffering and illness,<sup>5</sup> attitudes about genetic disabilities,<sup>6</sup> and the relation between science and theology.<sup>7</sup> Generally speaking, if one or other of the genetic technologies to be discussed were found to be inappropriate on *theological* grounds because, for example, their use would usurp God's rights over creation, the presumption might be that these same technologies as a consequence would be judged *morally* unjustified. In fact, the claim



would be made in this case that such interventions are arrogant attempts at "playing God."<sup>8</sup> On the other hand, if it can be shown theologically that certain kinds of human gene transfer are not contrary to the divine's final purposes for humanity, then it might be possible, *along with other evidence*, to judge these gene technologies as morally defensible. In the conclusion to my presentation I will state where I would stand morally on the various forms of human gene transfer.

## II. Six Central Themes from the Roman Catholic Tradition

Before pursuing the theological concerns, though, I will summarize briefly what I believe are the central themes that inform this issue from the official Roman Catholic perspective, i.e., from the magisterial teachings of recent popes, bishops and the Second Vatican Council. In general, I find most official statements since Vatican II (1965) to be quite hopeful and favorable toward genetic science with respect to the issue of manipulating the human genome as long as certain moral boundaries are respected. What are some of these boundaries or themes that pertain to the specific issue of human genetic manipulation? There are six.

First, we are permitted to pursue various genetic manipulations as long as we respect the natural law, i.e., the moral law that is inscribed in the nature of humans and their moral acts. In the Catholic tradition the order of nature grounds human morality, and this morality is not only objective but also in principle capable of being known by all people of goodwill. As Cardinal Karol Wojtyla (Pope John Paul II) claimed in his book *Love and Responsibility*, a rational acceptance of the order of nature is at the same time a recognition of the rights of the Creator.<sup>9</sup> Concretely, the natural law requires that we respect the dignity of each human being, and thus the natural law would prohibit treating humans and embryos from the moment of conception as a means to some other end. Second, the official teachings from the Roman Catholic church express a strong ethic of stewardship. This ethic points to two things: a) we have a God-given responsibility for and toward all creation, including our bodies; and b) we are *not* the owners of our own bodies but only stewards over them, so we are *not* free to manipulate our genetic heritage (or nature) at will. Third, the human body is not independent of the spirit. Concretely this means that we cannot expect to alter our genes without also altering the body's relation to our spiritual natures, i.e., who we are as a body-soul composite.<sup>10</sup> Fourth, genetic experimentation on human subjects, including embryos from the moment of conception, are permissible as long as "it tends to real promotion of the personal well-being of humans, without harming human integrity or worsening human life."<sup>11</sup> The informed consent from the one

experimented on or from a legitimate surrogate is absolutely required for such experimentations. Fifth, there is a fundamental relationship between scientific research and the common good of society. This clearly indicates that all such efforts to manipulate the human genome involve not only ethical but also public policy implications. Finally, not every scientific advance necessarily constitutes a real human progress. Though John Paul II is not absolutely opposed to all forms of non-therapeutic genetic interventions,<sup>12</sup> there are some statements from the U.S. bishops' NCCB Committee on Science and Human Values that seem to limit genetic testing and genetic manipulation to instances in which there is an effective therapy or cure of a genetic abnormality for a patient or embryo.<sup>13</sup> Thus, genetic manipulation to influence inheritance that is not therapeutic but aimed at producing human beings selected according to sex or other predetermined qualities (eugenics or enhancement manipulation) is judged contrary to the natural law. This last point in particular leads us to a consideration of the various types of what is called human gene transfer.

### III. Types of Human Gene Transfer

Imagine a day when patients with defective genes that cause them great disability can walk into a clinic and be given an injection of engineered cells that contain the proper sequencing of the genes to cure their diseases. Or, imagine a day when prospective patients can simply walk into a clinic for assisted reproductive technology and pre-select the enhanced genetic traits that their future child will have. This is not just science fiction; it will likely become reality in the not-too-distant future. Why? Medical scientists could conceivably develop four different types of human gene transfer from the results produced in the Human Genome Project.<sup>14</sup> In other words, medical science will shortly have the capacity to alter our genetic code in four ways. The first two types are therapeutic in nature because their intent is to correct or prevent some genetic defect that causes disease. The other two types are not therapies at all, and many question whether they are part of medicine's goals as well. Rather, they are concerned with improving either various genetic traits of the patient him/herself (somatic cells) or with permanently enhancing or engineering the genetic endowment of the patient's children (germ-line cells).

The first kind of human gene transfer is somatic cell therapy in which a genetic defect in a body cell of a patient could be corrected by using various enzymes (restriction enzymes and ligase) to splice out the defect and to splice in a healthy gene. Medical scientists have already used a variation of this technique to help children who suffer from severe combined immune deficiency (ADA) by modifying bone-marrow cells,<sup>15</sup>



and a similar procedure was used in August 1999 for children who have Crygler Majjar Syndrome, a genetic disease that causes fatal brain damage.<sup>16</sup> Estimates are that between two to five thousand different genetic diseases are controlled by one gene,<sup>17</sup> and these diseases afflict approximately two percent of all live births.<sup>18</sup> Second, there is germ-line gene transfer therapy in which either a genetic defect in the reproductive cells – egg or sperm cells – of a patient would be repaired or a genetic defect in a fertilized ovum would be corrected in vitro before it is transferred to its mother's womb.<sup>19</sup> In either case, the patient's future children would be free of the defect by permanently altering their genetic code.

Next there are the two kinds of non-therapeutic human gene transfer. The first kind is enhancement somatic engineering. In this type, a particular gene could be inserted to improve a normal trait, for example, the insertion of a new gene or an improved one to enhance memory. Second, there is germ-line genetic engineering in which existing genes would be altered or new ones inserted into either germ cells or into a fertilized ovum such that these genes would then be permanently passed on to improve or to enhance traits of the patient's offspring. In this last form of human gene transfer parents could design their children according to their own desires.

#### IV. Theological Themes

Whether or not Christian believers and Christian churches will support *morally* any or all of these types of human gene transfer will partially depend on where they stand on certain theological beliefs about God and humanity. Christians, at least, have regularly made sense out of their experiences of God and then communicated these interpretations to others by reference to a story that has been reformulated into certain doctrinal themes. Traditionally, these themes have been expressed in the Christian tradition in terms of creation, fall, incarnation, redemption, and eschatology.<sup>20</sup> The Christian story tells us that God is the creator of all that is and that we are from God and for God. However, sin or alienation from God, self and others has entered the world due to human misuse of freedom. Yet, God has decided to bind divine history irrevocably to human history by becoming incarnate in human form (Jesus is fully human and fully divine). Through Jesus' preaching of the Gospel and his passion, death and resurrection we are redeemed (redemption) and called to a new future in God's eternal kingdom (eschatology). Though all of these themes are important, for our purposes, I will discuss only three of them, viz., creation, incarnation, and redemption. Again, my purpose in referring to these religious themes is to show how *moral* judgments on human gene

transfer rely on and can be authorized by certain *theological* beliefs and interpretations.

### **Creation and Divine Providence**

The doctrine of creation is actually a complex set of interpretations of who God is and how the divine directs human history and acts within it (divine providence). These theological interpretations have anthropological counterparts that attempt to understand both how we are to evaluate the significance of physical nature and our bodily existence.

Two different theological models of God, creation and divine providence have been historically used in the great Christian tradition. Currently, Christians have used both models as a theological context in arguing morally for or against human gene transfer.

In one perspective God is viewed as the creator of both the material universe and humanity and the one who has placed universal, fixed laws into the very fabric of creation. This view of creation assumes that God's purposes for humanity, which are forever unchangeable, can be known by reflecting on the universal laws governing nature and humanity. As sovereign ruler over the created order, God directs the future through divine providence. As Lord of life and death, God possesses certain rights over creation, which in some cases have not been delegated to humans for their exercise.<sup>21</sup> When humans take it upon themselves to exercise God's rights, for example, those divine rights to decide the future or to change the universal laws that govern biological nature, they usurp divine authority and thus act contrary to God's purposes in creation and "play God."

If one adopted the theological positions held in this model, one would likely judge as human arrogance any attempt to alter the genetic structure of the human genome, possibly even for the therapeutic purpose of curing a serious disease. This assessment is confirmed in a TIME/CNN poll (January 1994) on people's reaction to genetic research. Not only were many respondents ambivalent about genetic research but a substantial majority of the respondents (58%) thought that altering human genes *in any way* was against the will of God.<sup>22</sup>

In a second theological model God is not interpreted as the one who has created both physical nature and humanity in their complete and final forms. Rather, the divine continues to create in history (*creatio continua*). Consequently, God is not understood as having placed universal, fixed laws into the fabric of creation, and so the divine purposes are not as readily discernible as in the first model. God's actions both in creation and in history continue to influence the world process, which is open to new possibilities and even spontaneity.<sup>23</sup> Though there is some stable order in the universe, creation is not finished, and history remains indeterminate.



Because creation was not made perfect from the beginning, one can discern certain elements in the created order, like genetic diseases, that are disordered. Because these disordered aspects of creation cause great human suffering, they are judged to be contrary to God's final purposes and so can be corrected by human intervention. Thus, therapeutic types of human gene transfer could conceivably be justified in this interpretation, though it might be difficult to justify morally the two enhancement types (somatic and germ-line).

As an anthropological counterpart to their interpretations of the divine, Christians have consistently understood all humanity to be created in the image and likeness of God (Gen. 1:26-27). However, the great Christian tradition has used at least two different interpretations of how humans stand in that image, and these diverse models almost inevitably lead to different moral evaluations about interventions into the human genome.

The first interpretation defines humanity as a steward over creation. Our moral responsibility, then, is primarily to protect and to conserve what the divine has created and ordered. Stewardship is exercised by carefully respecting the limits placed by God in the orders of biological nature and society.<sup>24</sup> It is easy to see how this model is consistent with the understanding of God as the creator who has placed universal, fixed laws into the very fabric of creation. If we are stewards over both creation and our own genetic heritage, then our moral responsibilities do not include the alteration of what the divine has created and ordered through nature. Our principal moral duties are to remain faithful to God's original creative will and to respect the laws that are both inherent in creation and function as limits to human intervention. In this scenario, most, if not all, forms of human gene transfer would be morally prohibited, though some room might be permitted for somatic cell therapy.

The second interpretation of the *imago dei* defines humans as created co-creators or participants<sup>25</sup> with God in the continual unfolding of the processes and patterns of creation. As created co-creators, i.e., as beings who do not create *ex nihilo* as God does,<sup>26</sup> we are both utterly dependent on God for our very existence and simultaneously responsible for creating the course of human history. Though we are not God's equals in the act of creating, we do play a significant role in bringing creation and history to their completion.<sup>27</sup> Proponents of this interpretation would almost certainly support somatic, and possibly even germ-line, gene transfer aimed at therapeutic ends, though it is highly questionable whether they would also justify attempts at enhancement gene transfer at either the somatic or germ line.



A Christian interpretation of the significance and value of both physical nature and human bodily existence also plays an important role in arriving at moral judgments on genetic interventions. There are several different models of material nature that can shape one's moral position on human gene transfer, and Christian authors have made use of all of them. Each model attempts not only to interpret the nature of all material reality but also to understand the extent to which we can use human freedom to change our genetic heritage.

Daniel Callahan has argued that one of the most influential models of nature that operates in contemporary society is the power-plasticity model. In this view, material nature possesses little or no inherent value, and it is viewed as independent of and even alien to humans and their purposes. All material reality is simply plastic to be used, dominated and ultimately shaped by human freedom.<sup>28</sup> Thus, the fundamental purpose of the entire physical universe, including human biological nature, is to serve human purposes. What is truly human and valuable are self-mastery, self-development, and self-expression through the exercise of freedom. The body is subordinated to the spiritual aspect of humanity, and humans view themselves as possessing an unrestricted right to dominate and shape not only the body but also its future genetic heritage. This view would be strongly inclined to justify morally almost any intervention into the human genome, regardless of whether its intent is therapeutic or enhancement.

The view of nature at the opposite extreme is the sacral-symbiotic model in which all material nature, including our genes, is viewed as created by God and thus considered as sacred. As created and originally ordered by God, human biological nature is static and normative in this understanding, and the laws inherent in it must be respected. Humans are not masters over nature but stewards who must live in harmony and balance with our material nature. Biological nature remains our teacher that shows us how to live within the boundaries established by God at creation. Since physical nature is considered sacrosanct and inviolate, any alteration of the human genetic code, even to cure or prevent a serious genetic disease, would probably be morally prohibited.

The final solution construes material nature as evolving. Whereas there is some stability to nature and there are some laws that do govern material reality, neither this stability nor these laws are considered absolutely normative in moral judgments. Change and development are considered more normative than other aspects of nature, and history is seen as linear rather than cyclic or episodic.<sup>29</sup> The relation between material nature and human freedom appears as a dialogue that dynamically evolves over time. It is within this dialogue that humans learn how to use responsibly material reality as the medium of their own creative self-

expression.<sup>30</sup> This model would seem to grant to humans the freedom and responsibility to intervene into our evolving biological nature to correct serious diseases even at the germ-line level. The reason is because such human efforts would not necessarily be judged as usurping God's final prerogatives or purposes in creation.

### **Incarnation**

The fact that God took on human bodily form in the person of Jesus Christ has several implications for the discussion of genetic medicine. First, this doctrine serves as a context both for assessing the relation between body and spirit and for evaluating the significance of the body in moral decision making. In turn, these considerations have an impact on the question of what we judge to be uniquely or normatively human in moral analysis. Both issues function as presuppositions to moral judgments about the permissibility of human gene transfer.

If one separates, or even grossly distinguishes, body and spirit, there is the tendency to view our spiritual part as more normatively important or even as the solely unique characteristic of the human person. In addition, such a view will tend to hold that permanent alterations of the body, which would occur through the various types of human gene transfer, do not and cannot actually change the fundamental nature of humans. Dr. W. French Anderson, arguably the most influential human gene therapist in the U.S., once remarked that he had been worried for years that we might end up altering our very humanness by methods of human gene transfer, especially those aimed at the germ line. However, he has recently decided that Plato was correct to view the soul and the body as two distinct entities.<sup>31</sup> By adopting this Platonic framework, Anderson now believes that we cannot alter our fundamental humanness because, as much as we might permanently change our biological genetic code through gene transfer, we cannot change that which is uniquely or normatively human about us, viz., our soul or that which is beyond our "physical hardware."<sup>32</sup> Thus, ostensibly Anderson would justify morally both somatic and germ-line therapeutic interventions to alter permanently the human genome.

An opposing view is the position that holds that there is an intimate relation between body and soul. In this construal humans are viewed as embodied spirits or ensouled bodies.<sup>33</sup> Such an interpretation, then, would be far more cautious than the first about making a claim that we cannot permanently alter the nature of humanity through human gene transfer. The relation of body and spirit is one, but not the only, element of what makes up our fundamental human nature. Thus to alter radically this relation of body and spirit would imply the possibility of changing our nature in this view. Though proponents of this interpretation could support



morally gene transfers aimed at the prevention or curing of disease, they would neither encourage nor support enhancement techniques. The reason would probably be that in the latter cases of enhancement interventions the chances of altering the body-spirit relation might be greatly increased.

### **Redemption**

Christians believe not only that we are created, though fallen, beings but that we are also redeemed by God through the suffering, death and resurrection of Jesus Christ. Thus, besides God's *creative* purposes or ends, the divine also has *redeeming* purposes for all creation, i.e., to bring all creation fully into God's kingdom. Christians have sometimes grossly separated the creative and redeeming purposes of God. One way to understand the relation between these divine activities has been to interpret redemption as not only a continuation of creation but the means by which creation itself is brought to completion by God.<sup>34</sup>

This framework raises the question of whether the technologies to alter our genetic code can ever be viewed as potential participations in God's redeeming actions toward humanity. Since Christians have interpreted humankind as created in the divine image, it has been possible to view genetic interventions as possible acts of *co-creation* with the divine. However, now the question is whether it is also possible theologically to view our technological activities as potential participations in or mediations of God's *redemptive* purposes? To answer this question requires a brief discussion of various theological evaluations of technology in general.

There are several evaluations of modern technology that could serve as the context for our moral judgments on therapeutic techniques to cure serious genetic diseases. First, there is the rather pessimistic view of technology, an example of which was the position taken by the late Jacques Ellul.<sup>35</sup> Its characteristics include a very skeptical attitude to the potential evils that will come from its development and use. Technology is viewed as threat, impersonal, manipulative and alienating, and thus it does not and cannot possess the inherent potential to share in the divine purposes of redemption, which are viewed as personal, salvific and holistic. In the end, this view would probably not support morally any attempt to alter our genetic heritage.

The opposite extreme is an overly optimistic view of technology and its potential achievements. Its hallmarks are a focus on the liberating function of technology through progress and human fulfillment and an emphasis on greater freedom and creative expression. Some, like the Jesuit paleontologist Pierre Teilhard de Chardin,<sup>36</sup> have closely linked technology and spiritual development and thus have viewed technology as clearly

possessing the potential to cooperate with God's work. Some who have adopted this position have been quite supportive morally of most forms of human gene transfer, including those forms whose primary purpose is to enhance or engineer our genes.

The final position seeks to steer a middle course between the two extremes of pessimism and optimism. Similar to the first view, proponents are cautious about and critical of many features of modern technology. However, like the second view these proponents also offer hope that technology has the potential to be used for humane moral ends, but technology must be redirected in its uses for these ends to be realized. There are two forms of this moderate position currently held by theologians that I would like to analyze quickly. Among other things, these views are distinguished by how they connect causally sin with disease and death. In other words, these positions differ depending on how one interprets St. Paul's passage in the Letter to the Romans (5:12): "It is just like the way in which, through one man, sin came into the world, *and death followed sin*, and so death spread to all men, because all men sinned."

The first position links causally the introduction of both death and all disease, including genetic disease, to the entrance of sin into the world. The role of medicine, then, is to intervene to overcome these effects of sin, and these medical interventions, including those aimed at genetic therapy, are construed as mediations of God's redemptive activity. In this same view, however, all forms of human gene transfer whose primary purpose is to enhance or engineer the human would be at least morally problematic on theological grounds. Why? Because these interventions would not alleviate any condition that can be linked causally to the entrance of sin into the world. Their purpose would be to enhance the patient or his/her progeny, not to overcome the effects of the Fall.<sup>37</sup>

The second form of the moderate position does not link causally sin with disease and thus does not identify disease as such as one of the effects of the Fall. Rather, it understands diseases (and for that matter, death) as the natural results of being part of the material world where decay and entropy are facts of the created world, though sin may very well adversely affect our experiences of these realities.<sup>38</sup> That does not mean that God wills or permits these ill effects *as part of the final divine ordering* of the universe; in fact, they are judged to be contrary to God's ultimate purposes. The Protestant theologian Ronald Cole-Turner has adopted a position similar to this one.<sup>39</sup> He has argued that modern technological developments in genetics can have the potential for participating in God's redemptive activities. He has reasoned that, when this technology is *aimed at preventing or curing serious genetic diseases* that are deemed contrary to God's final purposes for humanity because they cause great human



suffering, this technology can participate in God's redemptive purposes by making whole and healthy what was once disordered and destructive. Cole-Turner, like the first form of this position, however, does not seem to support morally human gene transfer whose primary purpose is enhancement, not therapy.

## V. Conclusion

Given the specifically theological context discussed, it is now time for me to state where I would stand morally on the various types of human gene transfer that will no doubt result from the Human Genome Project. It is my judgment that significant scientific and technical difficulties remain to be solved with most forms of human gene transfer. For example, the fatal experiment in September 1999 on Jesse Gelsinger, the eighteen-year-old who had been injected with engineered genes by the University of Pennsylvania researchers to cure the boy's rare liver disease, and the recent National Institutes of Health order to toughen the rules on the reporting of deleterious side effects of gene therapy<sup>40</sup> only indicate again that we may well be years away from when many of these therapies can be shown to be both safe and effective. In addition, there is a number of public policy problems with these interventions as well. Consequently, *at the present time*, I am opposed morally to all types of gene transfer, at either the somatic or germ-line level, whose only purpose is to enhance or engineer human traits. On the other hand, I can support morally therapeutic gene transfers on somatic cells, when and as long as these scientific techniques can be shown to be safe and effective. In addition, I would also argue on Christian theological grounds that once the scientific, public policy and moral difficulties can be resolved with germ-line therapeutic interventions, we may cautiously move forward with this type of genetic therapy as well, i.e., as long as they can be proven to be both safe and effective. In other words, based on my theological interpretations of the Christian doctrinal themes and their anthropological counterparts already discussed, I conclude that in principle the two types of human gene transfer aimed at therapy or prevention, viz., somatic and germ-line interventions, are not fundamentally contrary to God's purposes for humanity. To use them is not necessarily to arrogate to ourselves various functions and tasks that properly belong only to the divine. Rather, they have the potential or capacity to mediate God's final purposes for humanity. Consequently, their use for the moral ends of preventing or curing serious genetic diseases can be a means of properly exercising human responsibility.<sup>41</sup>

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28. Daniel Callahan, "Living with the New Biology," *Center Magazine* 5 (1972): 4-12.
29. Shannon, *What Are They Saying*, p. 37.
30. W. Norris Clarke, S.J., "Technology and Man: A Christian Vision," in Ian G. Barbour, Ed., *Science and Religion: New Perspectives on the Dialogue*. New York: Harper & Row, 1968, pp. 287-288.
31. W. French Anderson, "Genetic Engineering and Our Humanness," *Human Gene Therapy* 5(1994): 758.
32. *Ibid.*, p. 759. The reverse type of reductionism of the normatively human, of course, is the one adopted by a research biologist at UC San Diego. When the drosophila fly's entire genome was recently mapped and sequenced and then its genes likened to the Rosetta stone for the mapping and sequencing of the human genome, Dr. Charles S. Zukor stated, "We are nothing but a big fly." See Robert Lee Hots, "Full Sequence of Fly's Genes Deciphered," *Los Angeles Times* (March 24, 2000).
33. See John Paul II, "Biological Research," p. 342; *Idem.*, "The Ethics of Genetic Manipulation," p. 388; and Johnstone, "La tecnología genética," pp. 307-308.
34. For example, see Karl Rahner, S.J., "The Order of Creation and the Order of Redemption," in Gerald A. McCool, Ed., *A Rahner Reader*, New York: Seabury Press, 1975, 1975, pp. 190-196.
35. Jacques Ellul, *The Technological Society*, New York: Knopf, 1964.
36. Pierre Teilhard de Chardin, *The Phenomenon of Man*, New York: Harper & Row, 1959.
37. See Scott B. Rae & Paul M. Cox, *Bioethics: A Christian Approach in a Pluralistic Age*, Grand Rapids: Wm. B. Eerdmans, 1999, pp. 118-127.



38. This position is more informed by St. John's Gospel than St. Paul's epistle. In John 9: 1-3, the evangelist writes, "As he went along, he saw a man who had been blind from birth. His disciples asked him, 'Rabbi, who sinned, this man or his parents, for him to have been born blind?' 'Neither he nor his parents sinned,' Jesus answered, 'he was born blind so that the works of God might be displayed in him.'" I would like to thank my colleague, Jeffrey S. Siker, for pointing out this biblical text to me.

39. Ronald Cole-Turner, *The New Genesis: Theology and the Genetic Revolution*, Louisville, KY: Westminster/John Knox Press, 1993, pp. 80-97.

40. Marlene Cimon, "NIH to Order New reports on Past Gene Therapy Cases," *Los Angeles Times* (February 24, 2000): 1 & 14.

41. An earlier version of this article was published by the *New Theology Review*.