Applied Christian Ethics in Regenerative Medicine

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Biomedical science in the 20th century was largely a descriptive and reductionist enterprise. The characterization of isolated cellular components produced a series of important discoveries[1], culminating in the sequence of the entire human genome.[2] Modern science, now armed with the ability to isolate, culture, genetically engineer, and transplant living tissue has begun to address the fundamental questions of life. How does a fertilized egg direct its own assembly into a complex organism? What makes a muscle cell different than a neuron? Why are some drugs safe and efficacious in animals but toxic or ineffective in humans? Why can't human beings regenerate severed limbs, but salamanders can?

Several attempts to address these and other fundamental questions empirically have recently received intense criticism from the Christian community. One such issue is the derivation and use of human embryonic stem (hES) cells for basic science research and regenerative therapy. The debate over hES cell research is much more than an abstract philosophical argument or hermeneutical exercise. At stake, on the one hand, is the integrity and intrinsic value of the human embryos from which hES cells are derived. On the other hand, patients suffer from congenital birth defects, heart disease, diabetes, Parkinson's, spinal cord injury, and other degenerative diseases, for which the best chance of a cure may require the use of these cells.

The relative value of human embryos in their earliest stages and the moral status of embryonic tissue derived from *in vitro* fertilization, cloning, embryo biopsy, or adult cell reprogramming cannot be ascertained by science alone. These questions call for thoughtful discourse within a diverse community of scholars. As scientists labor to understand the physical cause of human suffering and disease through the use of hES cells, ethicists struggle to balance the intrinsic moral value of their source with the compelling utilitarian arguments for their use. Some politicians are attempting to legislate various forms of compromise for the use of hES cells in our pluralistic society, while others are wielding this issue as a divisive political lever.

Meanwhile, Christian theologians from various denominations vigorously debate the mechanism of "ensoulment" and what it means to be made "in the image of God." While the Holy Scriptures do not explicitly address hES cell technology, the Scriptures clearly articulate the unique and intrinsic value of human life.[3] For this reason, Christian theologians need to contemplate the complexities of hES cell research and putative regenerative therapies.

Unfortunately, the exponential growth of biotechnology in recent years has made it difficult for Christian ethicists and theologians fully to consider the moral implications of this work without formal training in science. The scientific literature is filled with dense trade jargon. Furthermore, conflicting reports and misinformation abound. Fraudulent data has been published, only to be later retracted.[4] In the media, the potential of stem cell-based therapy is alternately hyped or denigrated, to align with a particular social or political agenda.

All this has left non-scientists confused regarding the potential of these cells. The goal of this article is to provide a basic intellectual framework for Lutheran ethicists and theologians who wish to consider the moral implications of ES cell technology in the context of their moral sensitivities, theological framework, and ethical training.

The Promise of Regenerative Medicine

Since James Thomson's research team at the University of Wisconsin announced in 1998 that it had isolated hES cells,[5] a firestorm of debate has engulfed this technology.

Two remarkable properties of these cells are of great interest to the medical and scientific community. First, unspecialized hES cells can differentiate into any of the approximately 200 functional cell types in the adult human body (a property known as *pluripotency*). Second, under permissive conditions they self-renew for long periods of time in an unspecialized state (a property sometimes referred to as *immortality*[6]). No other human cell line has these two unique properties. An entire industry of "regenerative medicine" is now being constructed around these cells.

While many technical limitations remain to be overcome, early success stories in animal models highlight the breathtaking potential of this burgeoning field. For example, several recent reports indicate that mouse models of myocardial infarct show improved heart function following injection of ES cells.[7] Similar experiments testing the efficacy of these cells for regenerating neuronal tissue have also shown promising results. For example, ES cells injected into the spinal cord of paralyzed rats have repaired the neuromuscular connections required for limb movement,[8] and ES cells injected into the brain of rats with Parkinson's disease restore behavior and brain function.[9]

Scientific Limitations of Embryonic Stem Cells

Three key technological barriers have prohibited hES cell therapies from moving into clinical trials to date. First, the injection of undifferentiated ES cells into animals frequently results in the formation of teratomas.[9] Teratomas are masses of randomly differentiating cells normally restricted to rare cases of ovarian or testicular cancer. To overcome this problem, some have begun to develop methods for coaxing embryonic stem cells to commit to a specific lineage, because differentiated cells are less likely to form tumors.[10]

The second scientific obstacle facing stem cell therapy is rejection by the patient's immune system. ES cells injected into a diseased mouse heart have been shown to be rejected by the immune system of the recipient mouse.[11]

Third, the incorporation of immunogenic molecules from the cow serum and mouse fibroblast feeder cells that are currently used to propagate hES cell lines may exacerbate this immune response.[12] Therefore, some have proposed obtaining immunologically matched hES cells by cloning the patient. This method, known as "therapeutic cloning" or "somatic cell nuclear transfer," involves the injection of the patient's genetic material into a human egg that has had its genetic material removed.[13] The now-fertile egg may be cultured to an implantation stage embryo, from which immunologically matched hES cells may be derived. This method requires the production and subsequent destruction of at least one human embryo for each patient treated. Significantly, this process is very inefficient—even in routinely cloned animals such as mice—and will likely require many embryos for a single ES cell line well into the future.[14] These scientific limitations, while significant, are not in themselves sufficient to forgo the potential therapeutic benefit of hES cells.

The Source of Embryonic Stem Cells

Human ES cells are commonly derived from human embryos created at *in vitro* fertilization (IVF) clinics to treat infertility. To provide affordable IVF procedures for clients and to minimize the risks involved in egg procurement,[15] these clinics routinely fertilize multiple eggs so that if the first transferred embryos fail to implant, cryogenically preserved reserve embryos are available for a second or third round of transfer to the mother's uterus.

What becomes of the frozen embryos if the mother cannot or will not use them all? An estimated 400,000 such embryos are currently cryopreserved in fertility clinics throughout the world.[16] Surplus IVF embryos are routinely discarded to prevent "orphan" embryos and reduce the expense of long-term cryopreservation.

Thomson and his co-workers at the University of Wisconsin obtained embryos scheduled for disposal from such a fertility clinic, then thawed and cultured them for several days to obtain blastocysts (see Figure 1).[17] This hollow sphere consists of several hundred cells. A line of ES cells may be derived by excising the inner cell mass from inside this sphere.

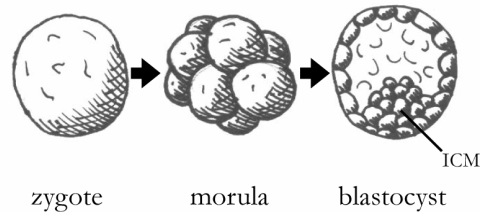

Figure 1. The fertilized human egg (zygote) rapidly divides into a ball of 12-32 cells known as the morula. The embryo then forms a hollow sphere of cells known as the blastocyst. Embryonic stem cells are derived from the inner cell mass (labeled ICM) within the blastocyst. Each of these stages is smaller than the period at the end of this sentence. (illustration courtesy H. Dahlmann)

This process obviously abates the viability of these embryos. The profound moral dilemma at the core of this technology is whether the human blastocyst should be granted the full moral status of an adult human.

Moral Status of the Human Blastocyst

Human ES cell derivation has been the subject of intense debate among state and local politicians, scientists, and ethicists in recent years.[18] The stakes are high. To those who offer limited moral status to the human blastocyst, ES cell research is the most important contribution to medical science since the discovery of antibiotics. To those who bestow the blastocyst with full moral status, regenerative medicine via hES cells amounts to little more than technologically advanced cannibalism. There appears to be little ground for compromise.

To clarify the ambiguous moral status of the blastocyst, conservative Christian thinkers have turned to Scripture for guidance. A general presupposition of many Lutheran scholars is that the entire Bible, in the original Hebrew and Greek, is the inspired and inerrant Word of God.[19] Yet the effort to address modern biotechnological dilemmas on the basis of texts written 2,000 to 3,500 years ago is not without its difficulties. One should approach such a task with great care. The historical and grammatical context of the biblical texts, the unique culture and perspective of their human authors, and subtle nuances in the original languages must all be taken into consideration.[20] This careful approach seeks to obey God's command that we neither add to nor subtract from what has been given to us.[21]

The biblical writers did not possess the same concepts and terms that are prevalent in our science. To have written about blastocysts, implantation, or stem cells would have been nonsense for them and confusing to us.[22] Their understanding of pregnancy and reproduction was more holistic than ours. This is said not to question the inerrancy of Scripture but to warn against manipulating Scripture to support our notions.

Discretion in Applied Christian Ethics

The moral status of the human embryo was a matter of concern for conservative church bodies long before hES cell research came onto the scene. Conservative Christians have fervently sought a scriptural definition for personhood ever since the abortion of unwanted pregnancies was legalized in the United States in 1973.

Wisconsin Synod (WELS) Lutherans have consistently maintained that life begins at conception. In 1989, the *Northwestern Lutheran* (the official magazine of WELS, since renamed *Forward in Christ*) published an article entitled "The Value of Human Life," in which the author asserted that "the sinful condition of life at conception clearly distinguishes the humanity of that life."[23] Similar statements can be found today on the official WELS web site and other sites affiliated with WELS.[24]

The commonly cited biblical precedent for this claim is Psalm 51:5, in which David writes, "Surely I was sinful at birth, sinful from the time my mother conceived me." However, the use of this passage to condemn hES cell research can be problematic for two reasons. First, using any text in isolation from its historical context or without regard for its grammatical details is questionable. Second, this standard grants *carte blanche* to clever scientists, should they find a method of deriving human embryos in the absence of conception. These issues are addressed in turn below.

Difficulty in Applying Holy Scripture to Modern Science

Some have interpreted David's "sin from the time [his] mother conceived [him]" as recognition of the sinful human condition of the human embryo. Since this condition is unchanged in adults, equivalent moral status is implied. However, the Hebrew word (*yacham*), translated "conceived" in this passage, is more literally translated "be hot," and is used elsewhere in Scripture to indicate the "heat" of sexual intercourse, among animals or among human beings.[25] This passage might also be interpreted to indicate that David is merely acknowledging that his lineage is derived from the adulterous affair of Judah and Tamar (Gen. 38)[26]. Significantly, because the act of sexual intercourse does not necessarily result in fertilization, this passage may not be useful for defining the moral status of the human embryo.

Other Scripture frequently cited in support of conception as the defining moment of the beginning of human life includes Psalm 139:13: "For you created my inmost being; you knit me together in my mother's womb." While this passage does reveal the Creator's intimate and ongoing role in development (through metaphor), it does not address the endowment of personhood or the timing of ensoulment. Attempts to infer the moral status of the embryo from this verse may be extending Scripture beyond its clear and intended meaning.

Another frequently referenced passage is Jeremiah 1:5, "Before I formed you in the womb I knew you, before you were born I set you apart." This text does convey some sense of timing in "before I formed you in the womb," which may be understood to mean "before you were *implanted in the uterus*." This interpretation, however, does not follow from the context of similarly inspired passages, such as Ephesians 1:4: "[God] chose us in him before the creation of the world." These passages more likely refer to the doctrine of predestination and do not reference the timing of ensoulment.

Societal norms and human tradition have been used in the elucidation of such difficult Bible passages. However, traditional beliefs concerning the moral status of the human embryo vary dramatically. The Greek philosopher Plato (ca. 472-347 B.C.) taught in his *Republic* that life begins at birth, when the "rational soul" was thought to first unite with flesh. Plato's student Aristotle (384-322 B.C.) believed that ensoulment occurred about 40-90 days in embryonic development when the first fetal movement occurs, sometimes called "quickening" or "animation."[27] This understanding persisted into the Middle Ages and was eventually incorporated into English common law. It was this very law that the United States Supreme Court cited in its landmark *Roe v. Wade* decision.[28]

Thus neither these scriptural references nor such historical traditions offer compelling evidence for a specific time or event as sufficient or necessary to confer full moral status on an embryo.

What Does "Conception" Mean to a Scientist?

The polarization of scientists and theologians concerning the moral status of human embryos is due in no small measure to semantics. What a theologian has in mind when he speaks of "conception" is often very different from what a scientist envisions as "conception." A theologian or ethicist likely understands conception as "the point at which the sperm contacts the egg."

But a developmental biologist's view of conception may vary significantly. To a biologist, "conception" is a rather arbitrary designation meant to indicate the early phase of human development. Upon rigorous observation, measurement, and manipulation of early mammalian embryogenesis, it becomes obvious that no discreet moment of "conception" exists biologically. The process of human conception is better understood as a continuum. The determination of significant biological events involves a choice on the part of the biologist and is frequently dependent on the precision of his instruments.

For example, most modern embryologists now recognize at least four phases of fertilization (chemoattraction, the acrosome reaction, the cortical reaction, and syngamy). Chemoattraction refers to the chemical substance aptly termed "allurin," which is secreted by eggs to attract sperm.[29] One might argue that life cannot begin at this stage because many sperm are attracted to the egg simultaneously through this process. The acrosome reaction is the process through which the sperm burrows into the membrane surrounding the egg. It has been argued that this is not the defining moment of life, as some forms of *in vitro* fertilization bypass this step by injecting the sperm directly into the egg.[30] The cortical reaction is one mechanism by which the egg prevents multiple sperm from entering. The moral significance of this process is diminished by the observation that chemical, electrical, or mechanical stimulation of an egg in the absence of sperm also triggers this reaction.[31] Finally, syngamy refers to the process by which the maternal and paternal chromosomes align to form a genetically unique person with the full complement of 46 human chromosomes. The ethical significance of this event is diminished because failure of this process still results in viable human embryos (individuals with Down syndrome, for example, possess 47 chromosomes). Significantly, technology currently exists that, when applied to human beings, may bypass all of these steps completely.[32]

Each of these phases will be further subdivided as more is learned about the molecular mechanisms of fertilization. Conception (and all human development) should therefore be viewed as a smooth progression rather than a succession of atemporal snapshots. Hence, it is more appropriate to refer to the *process* of conception rather than the *event* of conception.

For many other developmental biologists, however, "conception" has nothing to do with fertilization but refers instead to the implantation of the blastocyst into the mother's uterus. This occurs after the embryo exits the oviduct, up to five days after sperm penetration. These biologists reason that conception must not occur until after the potential for monozygotic (identical) twinning has passed and implantation has occurred. Twinning is significant because until this point one fertilization may result in two concepti or two fertilizations may result in one conceptus.[33] Implantation is also deemed significant by some, due to the high natural mortality rate of preimplantation embryos. It is estimated that 50 to 80 percent of fertilized embryos fail to implant.[34]

This interpretation of human conception resulted in attempts to derive "politically correct" lines of ES cells. For example, a team of prominent developmental biologists at the Whitehead Institute has derived ES cell lines by cloning cells engineered to lack the genetic potential for implantation.[35] They suggest that since embryos derived by means of this "altered nuclear transfer" technology possess no potential for implantation, they are not subject to moral objection from religious conservatives.[36]

So, when Christian ethicists assume full moral status at "conception," they must be prepared to offer a vigorous defense of what they mean. Attempting to "err on the side of caution," some Christian ethicists define conception as equivalent to fertilization. Not only is this position difficult to define scientifically or to defend theologically (as outlined above), but it also encourages clever scientists to find ways of bypassing fertilization in order to produce human embryos, over which Christian ethicists would then have no claims.

Another strategy designed to bypass the moral claims of Christian ethicists is known as embryo biopsy. This method involves plucking a single cell from the early embryo. The excised cell is then used to produce a stem cell line, while the remaining embryo is allowed to recover *in utero* to form a healthy fetus. This strategy has found success recently in mice.[37] If translated to human beings, would this process provide a morally acceptable hES cell line, since the embryo is not sacrificed? What is the moral status of the "induced twin" used to generate these cells?

Applied Christian Ethics in Regenerative Medicine

How then should the Christian ethicist approach such problems? Should Christians scour the Bible in search of "proof passages" to protect the human blastocyst? In our view, such an effort is both scientifically uncontainable and theologically misguided.

Nevertheless, valid and tractable moral objections to the destruction of embryos for research purposes exist on both philosophical and theological grounds. These should be clearly articulated by Christian ethicists in terms that biologists and medical researchers can understand.

We suggest that human conception be viewed not as a single event in time and space but as a continuing process from fertilization to birth. The contemplative scientist will be open to this, knowing that "stages" are created and imposed upon nature by human beings. What scientist has not puzzled over whether a mitotic cell is in late metaphase or early anaphase?

When do human embryos obtain a soul, and therefore moral status? Scripture indicates that we are formed in the womb (Psalm 139:13). Does "womb" mean the uterus? What about events before implantation? Does conception include the development that occurs as the embryo travels down the oviduct? What of fertilization? Might it even include the pre-fertilizational influences present in the egg? The interpretation of these Scripture passages is limited to the understanding of pregnancy at the time of their writing. "It always remains true that you can understand nothing, and also no one, except in the contexts of his time and the cultural presuppositions of the time."[38]

Since we do not know, we must therefore be filled with awe and fear. Luther said repeatedly, "We must fear and love God so that…" As a concept, even in grade school, the "love" part was easy to understand, but "fear" seemed somewhat foreign. Our teachers often took pains in their lessons to emphasize that these words can be understood correctly only when taken together. Likewise, in coming to grips with the science and technology of our beginnings, we do need to be filled with love, humility, respect, awe, and finally, fear. Our inability to fully comprehend God's work in producing a human body and soul instills an awe that rightly makes us afraid. If development is a continuum, as most accept, then "stages" and "landmarks" are artificial and will not help us to pinpoint personhood. To interrupt the process of human development is to interrupt a physical and supernatural process we do not fully understand.[39] What if, in our ignorance, we destroy a person?

To experiment with our beginnings without fear changes our Christian respect for human life. We cannot know if there is a "stage" at which ensoulment occurs. We must be open to the idea that ensoulment could occur how and whenever God pleases. God rules nature; he is not bound by it. The act of ensoulment could vary depending on foreseen outcomes. Perhaps God does not put souls

into embryos that will miscarry, but we do not know. No biological clues exist, and the Scriptures do not speak in scientific terms. This urges us to be humble. There are "things too wonderful."[40]

Immanuel Kant's ethics serve us well here. Kant, the Lutheran Pietist, tells us to make only those rules that you can apply to all embryos.[41] In other words, a rule should apply to all, not just to some but not others; it should be universal. If conception is a continuum, we should not imagine a safe experimental window without soul or personhood.

Second, Kant holds that we should act in such a way that humanity is never treated only as a means, but as an end in itself. He establishes the value of each individual and he urges us not to use each other for gain.

Concluding Remarks

Our wish is for sound and comprehensible argumentation here. Not everything that can be used to counter a practice is justifiable or wise.

But perhaps the Christian community could say more with actions than words.[42] The Apostle James writes: "Who is wise and understanding among you? Let him show it by his good life, by deeds done in the humility that comes from wisdom" (James 3:13). Ethicists would do better not merely to point out what they consider immoral but to nurture moral alternatives.

Might embryo biopsy or altered nuclear transfer offer morally acceptable means of hES cell derivation? Perhaps. While these strategies have found success in animal models, they remain to be thoughtfully evaluated by a diverse community of scholars. Should we choose to proceed with such an approach, painstaking care must be taken in translating this technology for usage in human beings.

Raw material for regenerative medicine may exist outside of the human embryo. These so-called "adult" stem cells can be found in the umbilical cord, bone marrow, hair follicles, testis, and even fat.[43] Some very interesting and meaningful therapies using these resident stem cell populations are being investigated. Great care should be taken, however, not to hype the promise of these cells, as they have yet to show equivalent potential to that of ES cells.

The Christian community needs to move beyond the media sound bite war. Ethical and theological considerations of emerging biotechnology must be predicated on a clear understanding of the science. Stem cell research does not necessitate a "religion vs. science" response. Instead, Christian leaders should promote ethically responsible science to develop alternative strategies to treat human disease.

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[1] Examples include: DNA as the material of heredity (Avery, O.T., et al. (1944) *J Exp Med* **79**: 137-58), the structure of DNA (Watson, J. & Crick, F. (1953) *Nature* **171**, 737-8), the genetic code (Nirenberg, M. & Matthaei, J. (1961) *PNAS* **47**: 1588-602), site-specific restriction endonucleases (Smith, H.O. & Wilcox, K.W. (1970) *J Mol Biol* **51**: 379-91), and polymerase chain reaction (Mullis, K.B. & Faloona, F.A. (1987) *Methods Enzymol* **155**: 335-50).

[2] The human genome sequence was concurrently published by two groups (Lander, E.S., et al. (2001) *Nature* **409**: 860-921) and (Venter, J.C., et al (2001) *Science* **291**: 1304-51).

[3] Frequently cited examples include: "So God created man in his own image, in the image of God he created him" (Gen. 1:27); "Whoever sheds the blood of man, by man shall his blood be shed; for in the image of God has God made man" (Gen. 9:6); and "You shall not murder" (Exod. 20:13).

[4] Hwang, W.S., et al. (2005) *Science* **308**, 1777-83.

[5] Thomson, J.A., et al. (1998) *Science* **282**, 1145-7.

[6] Choice of the word *immortal*, while common in the popular literature, is inappropriate here as this would imply potential for infinite cell division. While the self-renewal capacity for hESCs is impressive in comparison to other primary cell lines, some have reported the accumulation of genetic lesions during prolonged culture. See Cowan, C.J., et al. (2004) *N Engl J Med* **350**(13), 1353-6 for a more detailed discussion.

[7] Singla, D. K., et al. (2006) *J Mol Cell Cardiol* **40**(1), 195-200. Nelson, T.J., et al. (2006) *Anat Rec A* **288**(11), 1216-24. Kolossov, E., et al. (2006) *J Exp Med* **203**(10), 2315-27.

[8] Deshpande, D. M., et al. (2006) *Ann Neurol* **60**(1), 32-44.

[9] Bjorklund, L.M., et al. (2002) *Proc Natl Acad Sci.* **99**, 2344-2349.

[10] Rudy-Reil, D., and Lough, J. (2004) *Circ Res* **94**(12), e107-16.

[11] Swijnenburg, R. J., et al. (2005) *Circulation* **112**, 166-72.

[12] Martin, M. J., et al. (2005) *Nat Med* **11**(2), 228-32.

[13] Wilmut, I., et al. (1997) *Nature* **27**, 810-3.

[14] Blelloch, R., et al. (2006) *Stem cells* **24**(9), 2007-13.

[15] Ovarian hyperstimulation syndrome (OHSS) and the other risks associated with oocyte retrieval are reviewed in Mertes, H. & Pennings, G. (2006) *Hum Reprod* [Epub ahead of press].

[16] Hoffman, D., et al. (2003) *Fertil Steril* **79**(5), 1063-9.

[17] Thomson, J. A., et al. (1998) *Science* **282**(5391), 1145-7.

[18] Broder, D.S. (2006) Stem Cells Back in Political Spotlight. *Washington Post*, Washington, D.C. Walters, G. (2006) Doyle bombarding Green on stem cells. *Milwaukee Journal Sentinel*, Milwaukee, WI. Green, R. (2005) *Am J Bioeth* **5**(6), 44-46. Boehlke, P. (2002) *CHARIS* **2**(1), 47-50.

[19] In 2 Tim. 3:16 the Apostle Paul writes "all Scripture is God-breathed."

[20] For a historical review of this approach to scriptural interpretation in WELS see Braun, M. (2004) *CHARIS* **3**(2), 21-35.

[21] The command to refrain from adding to Scripture is found in both the Old and New Testament. For example: "Every word of God is flawless; he is a shield to those who take refuge in him. Do not add to his words, or he will rebuke you and prove you a liar" (Prov. 30:5-6) and "I warn everyone who hears the words of the prophecy of this book: If anyone adds anything to them, God will add to him the plagues described in this book" (Rev. 22:18).

[22] Surely an omnipotent God could have caused the inspired writers to understand reproduction and development "more fully" and then to write accordingly. However, three problems would then remain. One is a lack of terminology for the yet-to-be discovered concepts. Second, early readers would have puzzled over the meaning of these writings. Science only has meaning when placed into the context of contemporary assumptions and theory. Third, we must remember that science is in a constant state of change and revision. Modern scientific understanding remains seriously flawed. If the Bible were to speak in modern biological terms, we, too, would be puzzled by revelations of things that we have not yet discovered and likely distracted from the purpose of Scripture, which is the message of salvation. The beauty of Scripture is that it speaks across all generations with a holistic concern and respect for life.

[23] Fleischmann, R. (1989) *Northwestern Lutheran* **76**(14).

[24] Statements such as "Scripture reveals that life begins at conception" can be found on the official WELS web site: Anonymous, *WELS Topical Q&A*, accessed November 8, 2006; available from http://www.wels.net. Similar claims such as "the Bible confirms that life begins at conception" are found on the *Christian Life Resources* web site: (2004) Anonymous, "Embryonic Stem Cell Research: People's Arguments and A Christian's Response," accessed November 8, 2006; available from http://www.christianliferesources.com.

[25] Strong, J. (1995) *The New Strong's Exhaustive Concordance of the Bible*. Nashville: Thomas Nelson Publishers.

[26] This alternative interpretation, while also tenuous, finds support in similar Old Testament passages such as Deut 23:2: "No one of illegitimate birth nor any of his descendants may enter the assembly of the Lord, even down to the tenth generation." Interestingly, David is 10 generations removed from Judah. This interpretation may be expanded to also include other illicit affairs in David's lineage, for example Salmon and Rahab, or Boaz and Ruth (Matt 1:3-6).

[27] Aristotle, translated by Hett, W.S. (1975) *On the Soul*. Cambridge: Harvard University Press.

[28] United States Supreme Court. (1973) *Roe v. Wade, 410 U.S. 113*.

[29] Eisenbach, M., and Giojalas, L.C. (2006) *Nature* **7**: 276-85.

[30] Ramalho-Santos, J., Schatten, G., and Moreno, R.D. (2002) *Biol Reprod* **67**, 1043-51.

[31] Sun, Q.Y. (2003) *Microsc Res Tech* **61**, 342-8.

[32] For examples see: Wilmut, I., et al. (1997) *Nature* **27**, 810-3, and Tesarik, J., and Mendoza, C. (2003) *Reprod Biomed Online* **6**, 60-5.

[33] Early human embryos may split into two embryos with equivalent developmental potential. This process is known as monozygotic (or identical) twinning. The opposite may also occur. In rare instances two fraternal twins may combine *in utero* to form a composite known as a chimera. These individuals are cellular mosaics of two genotypes. For example, the erythrocytes in these individuals may have multiple blood types. For a documented case of this rare phenomena in humans see: Strain, L., et al. (1998) *N Engl J Med* **338**, 166-9.

[34] Human preimplantation mortality rates are notoriously difficult to measure. The most reliable estimates indicate that most fertilized eggs spontaneously abort before the mother is aware of pregnancy. For a more detailed discussion see Roberts and Lowe (1975) *Lancet* **1**, 498-9; Biggers (1979) *Report to the US Ethics Advisory Board* **8**, 1-50; and O'Rahilly, Ronan, and Muller (1992) *Human Embryology and Teratology*, 56.

[35] Meissner, A., and Jaenisch, R. (2006) *Nature* **439**, 145-7.

[36] Jaenisch, R., and Meissner, A. (2006) *N Engl J Med* **354**, 1208-9.

[37] Klimanskaya, I., et al. (2006) *Nature* [Epub ahead of print].

[38] Koehler, J. (1914) *The Wauwatosa Theology III*. Milwaukee: Northwestern Publishing House, p. 509.

[39] See also Prov. 14:26-27: "He who fears the LORD has a secure fortress, and for his children it will be a refuge. The fear of the LORD is a fountain of life, turning a man from the snares of death."

[40] Job 42:3

[41] Ashmore, R., & Starr, W. (1994) *Teaching Ethics: An Interdisciplinary Approach*. Milwaukee: Marquette University Press, p. 17.

[42] If the 2006 midterm elections are any indication, the position of conservative Christians on hES cell research has been widely perceived as inconsistent and obstructionist. For more information see Saletan, W., (Nov. 12, 2006) *Washington Post* B02.

[43] Assmus, B., et al. (2006) *N Engl J Med* **355**(12), 1222-32. Kogler, G., et al. (2004) *J Exp Med* **200**(2), 123-35. Sieber-Blum, M., et al. (2006) *Mol Cell Neurosci* **32**, 67-81. Guan, K., et al. (2006) *Nature* **440**, 1199-203. Zuk, P.A., et al. (2002) *Mol Biol Cell* **13**(12), 4279-95.