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In This Issue

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Footnotes are discouraged. If they are necessary, citations should be incorporated into the body of the paper. Contributions may deal with any area of the critical study of religion but must be written in an accessible literary style. Articles previously published will not normally be considered by the editors.

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A Step Toward Resolving the Abortion and Embryonic Stem-cell Debates

A Scientific and Philosophical Update

RICHARD T. HULL AND ELAINE M. HULL

Anyone observing the last presidential campaign and listening to subsequent speeches of president George W. Bush will know that the debates over abortion and fetal stem cells continue to rage. The tension surrounding social policy of both issues is severe: on the one hand, the interests of women and chronically ill adults push toward liberal abortion policies and the use and even purposeful creation of human embryos in developing treatments employing embryonic stem cells. On the other hand, the political pressure for pro-life policies as representative of the highest values of our nation pushes us toward reduction and elimination of both practices. Add to this the contamination of existing cell lines permitted for use under President Bush's August 2001 policy, and the conflict becomes excruciatingly acute.

A notable feature of the debates on both issues is the failure to even attempt to find common ground between the divided sides and reconcile their positions with current scientific knowledge about embryonic development. A movement toward common ground can be achieved by reviewing the current understanding of the physiology of human reproduction and applying the metaphysical foundations of biology to the earliest period of human development: the first sixteen days. Understood in terms of scientific fact, prevention or disruption of a fertilized ovum's implantation during this period cannot be scientifically characterized as the destruction of a human life. Furthermore, human embryonic stem cell research does not involve destruction of human lives, nor does the deliberate fertilization of human eggs with human sperm for the purpose of obtaining fetal stem-cells involve the creation and destruction of human lives. It follows that "Plan B" morning-after pills, as well as devices that prevent implantation of pre-embryo materials in the uterus, are not reasonably characterized as abortive agents in the sense found to be morally troublesome by conservatives and that research on early human stem cells should be morally permissible even within conservative thought. Claims of human destruction should be removed from the discussions of "Plan B" abortion, stem-cell research, and pharmaceutical contraceptive practices. If the facts can be accepted by all sides, we can move in the direction of resolving elements of these heated debates through the application of science and reason.

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Conservative Objections

There are three conservative claims that must be considered. The first is that the penetration of the sperm into the ovum constitutes the "moment" of fertilization and conception, at which point a single, genetically individual human being has come into existence. The second is that the product of fertilization is genetically identical with the infant who would be born if the natural course of gestation were not interrupted. And the third is that anything genetically identical with a human infant is itself that human being (or a part of it).

Conservatives derive many of their conclusions from these claims: contraception methods that prevent implantation involve the killing of human beings; early abortion involves the killing of human beings; the creation of fertilized ova as sources for stem cells is the creation of individual human beings to be exploited and ultimately killed without their consent. These powerful conclusions thus classify medical and research procedures as acts of homicide and slavery, and individuals who uncritically accept these conclusions, and the claims from which they derive, understandably feel outrage at those practices.

In order to find common ground, the three basic claims of the conservative view must be examined by applying current scientific understanding of the event and process of fertilization and development. It is scientifically indefensible to classify the immediate products of fertilization, and cell division during the first two weeks after fertilization, as human organisms. The scientific view regards these products as pre-organisms that are accurately characterized by reference to their potential.

The Process of Fertilization

The claim that fertilization takes place as the sperm penetrates the ovum and releases its genetic material goes hand in hand with the claim that genetic identity is fixed at this point for the duration of the resulting individual's life. These claims rest on several scientifically demonstrable errors.

It takes about sixty days after the last mitosis for the sperm to become fully functional. It can be stored in the epididymis for some time before being ejaculated. By contrast, what we call a woman's eggs, or her ova, have been kept in incomplete readiness for fertilization (called "prophase") for ten to fifty years. In this earliest phase, the oocyte's chromosomes have been duplicated and are lined up with like maternal and paternal chromosomes adjacent to each other. The first meiotic division occurs just before ovulation, and it produces two sets of chromosomes, randomly mixed from the maternal and paternal chromosomes. One of these resultant sets of chromosomes "inherits" all of the cytoplasm of the oocyte; the other becomes a tiny polar body. But neither of the products of the first meiotic division is yet capable of joining the sperm's genetic material. The polar body will never have that capability, and another meiotic division has to occur in the other set of chromosomes before the chromosomes from the sperm can join them.

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Fertilization takes place in four discrete steps. In the first step, sperm in an ejaculate, each one containing a single set of the male's chromosomes, move up the fallopian tube to the vicinity of the oocyte. As they are swimming, they begin a process known as capacitation. In this second step, the sperm are stripped of proteins, which have protected them from attack by the female's defense mechanisms. This reorganization of the sperms' membranes exposes receptors that recognize the sugar molecules of the oocyte's outer covering. Holes appear in the forward end of the sperm's membrane through which enzymes are released that can drill through this outer covering; the sperm then attach themselves and begin efforts to penetrate to the interior.

Once a single sperm has penetrated the oocyte, the third step occurs: the outer membranes of both sperm and oocyte fuse and harden, rendering the oocyte impervious to any additional sperm penetration. At this point, the nucleus of the sperm enters the cytoplasm of the oocyte. This in turn triggers a developmental process in the oocyte so that it completes a second division. Again, one set of the oocyte's chromosomes "inherits" the cytoplasm; the other forms another polar body that is usually ultimately discarded. After this division, the mitochondria of the sperm and the membrane around its genetic material degrade, and the sperm's and oocyte's respective chromosomes, come together. Only when this point is reached is fertilization complete.

One might argue that we have only replaced a supposed "point of fertilization" with a process, the end of which is the point at which the future human has its genetic identity fixed forever. But the problem with this way of thinking is that "the future human" is not yet an appropriate phrase to use: the fertilized ovum has several potential futures, only some of which involve one or more possible human beings.

Consider the oak tree's seed, the acorn, the product of union of the equivalent of oak sperm and oak egg. An individual acorn is a potential oak. It is also a potential meal for a squirrel or a bear or a wild pig. Many acorns decay and become part of the forest humus we call soil. The acorn has the potential for several possible outcomes; realizing any one of these depends on intervening conditions and events. The possibility of any given acorn becoming an oak tree is very small. Similarly, the fertilized human ovum has several potential futures. It may become implanted in a woman's uterus and develop into an embryo that then may become a fetus that eventually may be born as a human infant, but this must depend upon the fertilized ovum or the subsequent bundle of unspecialized cells that we call the "blastocyst" being implanted in a receptive uterus. Absent from this implanting, the fertilized ovum's potential to give rise to one or more human infants won't be realized—at least, not naturally.

The fertilized human ovum also has, thanks to various technological developments, other potential endings: to give rise to lines of stem cells that may in the future have their developmental potentials directed to give rise to a specific organ or tissue. Even if it is implanted in a uterus, it could turn out to be a phenotypic female but a genetic male. It could be born with various deformities, as happened with offspring of women given thalidomide during the early stages of pregnancy to control nausea. It could develop an Rh factor reaction to the mother's blood and be born in need of a total transfusion. But the most likely outcome is that it will spontaneously abort. By analogy with the acorn, the fertilized ovum has many possibilities, the realization of which depends on what happens around and inside it in the days and weeks following fertilization.

It is still tempting to say that the potential to give rise to a human baby is the dominant, "natural" outcome. However, consider that over 50 percent of fertilized ova simply pass out of the body without initiating a pregnancy. About 31 percent of all pregnancies, defined as the implantation of the product of fertilization into the wall of some uterus, end in spontaneous abortions. So the probability that a particular fertilized ovum without unnatural interference will give rise to a human being is about 51 percent out of 69 percent—substantially smaller than its potential *not* to give rise to a human infant. For every 100 naturally fertilized ova, no more than forty-nine of them will implant; of those forty-nine, only thirty-four will naturally result in births. The statistics for pregnancies of women over age thirty-five are even more severe: in them, 75 percent of all fertilized ova and 31 percent of all implanted embryos are lost.[1]

Hence, the most likely future for a given fertilized human ovum, if the process of fertilization is "natural" and not interrupted by human actions, is *not* to give rise to a human being, just as most acorns never give rise to oak saplings, but rather end up either as food for squirrels and other animals or as decaying humus on a forest floor. The likelihood of any fertilized ovum giving rise to a baby is thus only about one in three. Given these statistics, it strains credulity to identify a fertilized ovum as a future human person. The conservative might find grounds for much sadness in these statistics, for if a human being dates from the completion of fertilization, the failure of most of those humans to implant and come to term is a very serious medical challenge.

Genetic Identity Does Not Determine Individuality

Within conservative religious views, what individuates the human organism is the attachment of the soul to a unique developing individual. Christian thinkers, when they have attended to the facts of biology, have typically conceded that the point at which twinning is no longer possible is the earliest point at which ensoulment can occur. For, if the multiplying bundle of cells has a soul from the end point of the process of fertilization, but splits after fertilization to form two or more developing bundles of cells, very difficult questions arise concerning the dividing-up of said soul.[2]

Individuation occurs only after the original fertilized ovum cleaves into two cells, called "blastomeres," which undergo mitosis and cytokinesis together, producing a series of stages of two, four, eight, then sixteen cells. The cells become progressively smaller; after reaching the sixteen cell stage, the blastomeres form tight junctions in a process called "compaction," giving rise to the morula. Everything is still inside the zona pellucida: there is no new cytoplasm and no interaction with "outside" structures, and the morula is simply floating through the fallopian tube and into the uterus. Each of the blastomere cells of the morula is totipotent—undifferentiated—and each remains capable, if properly manipulated, of giving rise to a full human being.

The morula undergoes initial differentiation during the next several days. This cluster of cells, now termed a "blastocyst," has been traveling down one of the fallopian tubes toward the uterus. After about six days, the blastocyst reaches the uterus and implantation begins. The zona pellucida breaks, and the blastocyst affixes to the uterine wall.

The next distinctive events occur at about two weeks of gestational age. At this time, the implanted embryo still consists of a disk of undifferentiated cells, surrounded by early placental material. Within this embryonic disk, a small cluster of cells forms an organizing center that soon becomes a line down the disk's middle, the so-called primitive streak. This marks the beginning of the process known as gastrulation, in which the cells of the blastocyst lose their totipotency, and cellular specialization begins in such a manner that the origins of the cranial axis and dorsal and ventral sides can finally be identified. Now the boundaries of a discrete, coherent organism have been formed; biology calls this entity the "embryo." Until that process of cellular differentiation begins, the blastocyst is more a community of possible individuals held together by a gelatinous membrane.

The process of gastrulation takes a couple of days; its completion marks the emergence of the very early human organism out of the morula cluster of totipotent cells. The organism now possesses a continuous external boundary and an internal connection of its parts, so that events transpiring within it constitute cyclic sequences (digestion, respiration, elimination) and a range of allowed values (temperature, fluid pressure), outside of which the entity will die.[3] With this in mind, we conclude that the earliest point from which the unique individual human organism may reasonably be dated is sixteen days after the process of fertilization is complete.

Consequences for Ethics and Social Policy

The consequences of the scientific understanding of the processes between fertilization and cellular specialization outlined above are considerable. First, one must realize that physical and chemical measures that prevent the implantation of the cluster of pre-embryonic cells in the lining of the uterus do not involve destruction of any human beings, since all such preventives—from the Lippes loop to the morning after pill—act during the days and weeks before gastrulation begins.

Second, chemical and surgical procedures that cause the lining of the uterus to slough off after implantation do not destroy any human beings, provided they occur within the first sixteen days after fertilization.

". . . while cloning of human beings is one possible technology that we may well want to avoid, cloning human cells for medical purposes should not be objected to on the grounds that it involves the destruction of any human being."

Third, the discarding of frozen embryos does not constitute destruction of any human beings, since embryos are frozen well in advance of gastrulation; spare embryos whose parents do not want them to be implanted are not orphaned humans with any rights to be born.

Fourth, embryos that are used to generate stem-cell lines, whether in the group accepted by President Bush's executive order (all of which we now know are impure because of contamination with certain mouse proteins) or sources of future embryonic stem-cell lines in California or some other country, are not human beings that have been sacrificed for human purposes.

Finally, while cloning of human beings is one possible technology that we may well want to avoid, cloning human cells for medical purposes should not be objected to on the grounds that it involves the destruction of any human being. ◆

Notes

1. J. A. Mcfalls, "The risks of reproductive impairment in the later years of childbearing." *Annual Review of Sociology*, 16 (1990): 491–519.

2. For a sustained effort to deal with many of these issues, see Rose Koch-Hershenov, "Totipotency, Twinning, and Ensoulment at Fertilization." *The Journal of Medicine and Philosophy* 31, no. 2 (April 2006): 139–164.

3. Barry Smith and Berit Brogaard, "Sixteen Days," *The Journal of Medicine and Philosophy* 28 (2003): 45–78; also see Cohnitz, Daniel, and Barry Smith. "Assessing Ontologies: the Question of Its Ethical Significance." In E. Runggaldier and C. Kanzian, eds., *Persons: An Interdisciplinary Approach*. Vienna, Austria: Hoelder-Pichler-Tempsky und Österreichischer Bundesverlag, 2003, pp. 243–59.