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A Scientific View of When Life Begins

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Questions about the very beginning of human life continue to surface in the media, usually in the context of a public policy issue like contraceptives vs. abortifacients, conscience policy, or cloning and related techniques. Recently, in an interview on Fox News, the issue was brought up by a public figure, Sen. Marco Rubio of Florida, who, in response to a question about climate change, cited it as an example of political liberals refusing to recognize long-established science about human biology. "Facts are stubborn things," the adage goes, but, unfortunately, so are politically or morally useful attempts to tailor the facts. CLI is pleased to publish this slightly updated version of Dr. Maureen Condic's fine essay on the science of new life. The original version was published by Human Life International (HLI) and we offer it here with thanks to Dr. Condic and HLI for their permission to do so. For more information about HLI publications, please visit www.hli.org/resources.

The question of when human life begins has been answered in a variety of ways by different religious and philosophical traditions throughout the ages, leading many to conclude the question cannot be definitively answered. Yet what does science tell us about when life begins?[1] One of the basic insights of modern biology is that life is continuous, with living cells giving rise to new types of cells and, ultimately, to new individuals. Therefore, in considering the question of when a new human life begins, we must first address the more fundamental question of when a new *cell*, distinct from sperm and egg, comes into existence.

The scientific basis for distinguishing one cell type from another rests on two criteria: differences in what something is made of (its molecular composition) and differences in how the cell behaves. These two criteria are universally agreed upon and employed throughout the scientific enterprise. They are not "religious" beliefs or matters of personal opinion. They are objective, verifiable scientific criteria that determine precisely when a new cell type is formed.

Based on these criteria, the joining (or fusion) of sperm and egg clearly produces a new cell type, the zygote or one-cell embryo. Cell fusion is a well studied and very rapid event, occurring in less than a second. Because the zygote arises from the fusion of two different cells, it contains all the components of both sperm and egg, and therefore this new cell has a unique molecular composition that is distinct from either gamete. Thus the zygote that comes into existence at the moment of sperm-egg fusion meets the first scientific criterion for being a new cell type: its molecular make-up is clearly different from that of the cells that gave rise to it.

Subsequent to sperm-egg fusion, events rapidly occur in the zygote that do not normally occur in either sperm or egg. Within minutes, the zygote initiates a change in its internal state that will, over the next 30 minutes, block additional sperm from binding to the cell surface. Thus, the zygote acts immediately to oppose the function

of the gametes from which it is derived; while the "goal" of both sperm and egg is to find each other and to fuse, the first act of the zygote is to prevent any further binding of sperm to the cell surface. Clearly, the zygote has entered into a new pattern of behavior, and therefore meets the second scientific criterion for being a new cell type.

What is the nature of the new cell that comes into existence upon sperm-egg fusion? Most importantly, is the zygote merely another human *cell* (like a liver cell or a skin cell) or is it something else? Just as science distinguishes between different types of cells, it also makes clear distinctions between *cells* and *organisms*. Both cells and organisms are alive, yet organisms exhibit unique characteristics that can reliably distinguish them from mere cells.[2]

An organism is defined as "(1) a complex structure of interdependent and subordinate elements whose relations and properties are largely determined by their function in the whole and (2) an individual constituted to carry on the activities of life by means of organs separate in function but mutually dependent: a living being." (Merriam-Webster) This definition stresses the interaction of parts in the context of a coordinated whole as the distinguishing feature of an organism. Organisms are "living beings." Therefore, another name for a *human* organism is a "human being"; an entity that is a *complete* human, rather than a *part* of a human.

Human beings can be distinguished from human cells using the same kind of criteria scientists use to distinguish different cell types. A human being (i.e., a human organism) is composed of human parts (cells, proteins, RNA, DNA), yet it is different from a mere collection of cells because it has the characteristic molecular composition and behavior of an *organism*: it acts in an interdependent and coordinated manner to "carry on the activities of life."

Human embryos from the one-cell (zygote) stage forward show uniquely integrated, organismal behavior that is unlike the behavior of mere human cells. The zygote produces increasingly complex tissues, structures and organs that work together in a coordinated way. Importantly, the cells, tissues and organs produced during development do not somehow "generate" the embryo (as if there were some unseen, mysterious "manufacturer" directing this process), they are produced *by the embryo* as it directs *its own* development to more mature stages of human life. This organized, coordinated behavior of the embryo is the defining characteristic of a human organism.

In contrast to human embryos, human cells are alive and, under some circumstances, they can assemble into primitive tissues and structures. Yet under *no circumstances* do mere human cells produce the kind of coordinated

interactions necessary for building a fully integrated human body. They do not produce tissues in a coherent manner and do not organize them so as to sustain the life of the entity as a whole. They produce tumors; i.e., *parts* of the human body in a chaotic, disorganized manner. They behave like *cells*, not like *organisms*.

The conclusion that human life begins at sperm-egg fusion is uncontested, objective, based on the universally accepted scientific method of distinguishing different cell types from each other and on ample scientific evidence (thousands of independent, peer-reviewed publications). Moreover, it is entirely independent of any specific ethical, moral, political, or religious view of human life or of human embryos. Indeed, this definition does not directly address the central ethical question surrounding the embryo: What value ought society place on human life at the earliest stages of development? A neutral examination of the evidence merely establishes the onset of a new human life at a scientifically well-defined "moment of conception," a conclusion that unequivocally indicates that human embryos from the one-cell stage forward are indeed living individuals of the human species; i.e., human beings.

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[1] Condic, M.L. (2008). "When does human life begin? A scientific perspective." Westchester Institute White Paper. 1(1): 1-18. Westchester Institute for Ethics & the Human Person, Thornwood, NY. (available at: http://www.bdfund.org/whitepaperst/). [Reprinted in: Natl Cathol Bioeth Quart. 9(1):127-208.]

[2] Condic, M.L. (2014). Totipotency; What it is and what it is not. Stem Cells and Development, 23(8): 796-812 (available at: http://online.liebertpub.com/doi/pdf/10.1089/scd.2013.0364).