

When does life begin? Here are 17 points in time to consider

[Editor's note: This article originally ran in 2013, but is being republished to encourage public discussion following the recent [proclamation](#) by the US Department of Health and Human Services that 'life begins at conception'.]

I rerun this most-read post about when human life begins every time that the discussion resurges, which is usually in the shadow of proposed restrictions on women's reproductive rights. Strong feelings always seem to trump biological facts. Confusion among politicians appears to be apparent concerning when certain events begin or structures appear; whether to track development from fertilization (conception) or the last menstrual period; and even the distinction between an embryo and a fetus. A 4 or 6 week prenatal human is *not* a fetus — the difference is not arbitrary, it has biological meaning.

From October 3, 2013

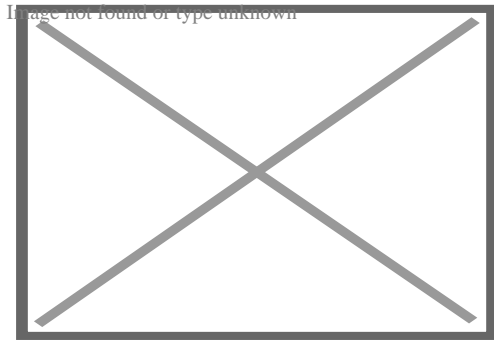
I'm the author of several college-level textbooks, on human genetics, human anatomy and physiology, and intro biology. I've been in this business for decades.

Life science textbooks from traditional publishers don't explicitly state when life begins, because that is a question not only of biology, but of philosophy, politics, psychology, religion, technology, and emotions. Rather, textbooks list the characteristics of life, leaving interpretation to the reader. But I can see where the disingenuous idea comes from that textbooks define life as beginning at conception — it requires a leap off the page. Consider a report from the Association of Pro-life Physicians. After a 5-point list of life's characteristics from "a scientific textbook," this group's analysis concludes with "According to this elementary definition of life, life begins at fertilization, when a sperm unites with an oocyte."

~~As~~ Being a biologist, a textbook author, and a mother, I've thought a great deal about the question of when a human life begins. So here are my selections of times at which a biologist might argue a human organism is alive. I'll save my opinion for the end.

1. *Life is a continuum.* Gametes (sperm and oocyte) link generations.
2. *The germline.* As oocytes and sperm form, their imprints – epigenetic changes from the parents' genomes – are lifted.
3. *The fertilized ovum.* Of the hundreds of sperm surviving the swim upstream to the oocyte, one jettisons its tail and nuzzles inside the much larger cell, which becomes an ovum, completing its own meiosis. A fertilized ovum = conception.
4. *Pronuclei merge, within 12 hours.* After fertilization, the packets of DNA from male and female — the pronuclei — approach, merge, and the intermingling chromosomes pair and part, as the first mitotic division looms. A new human genome forms. Following that first division, some genes from the new genome are accessed to make proteins, but maternal transcripts still dominate development.
5. *Cleavage.* Divisions ensue. The cells of an 8-celled embryo (day 3) have [not yet committed](#) to

becoming part of the embryo “proper” (one with layers) or the supportive membranes. Such a cell can still, on its own, develop. An 8-celled embryo whose cells are teased apart could lead to an octamom situation.



A human fertilized ovum. (Spike Walker, Wellcome Images)

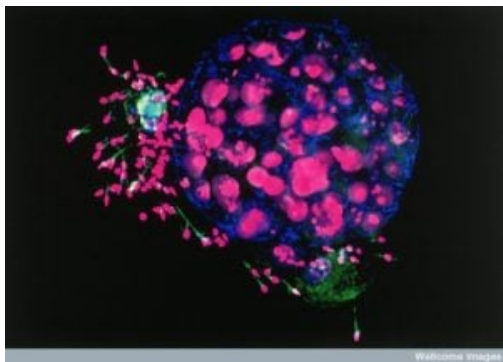
6. *Day 5.* The new genome takes over as maternal transcripts are depleted. The inner cell mass (icm) separates from the hollow ball of cells and takes up residence on the interior surface. It will become the embryo proper, distinguishing itself from the remaining part of the ball fated to become the extra-embryonic membranes. The icm is what all the fuss about human embryonic stem (hES) cells is about — the stem cells aren’t the icm cells, but are cultured from them.

7. *End of the first week.* The embryo implants in the uterine lining.

8. *Day 16.* The gastrula. Tissue layers form, first the ectoderm and endoderm, then the sandwich filling, the mesoderm. Each layer gives rise to specific body parts.

9. *Day 14.* The primitive streak forms, classically the first sign of a nervous system and when [some nations set](#) the deadline for no longer using human embryos in experiments.

10. *Day 18.* The heart beats.



A day 5 human embryo, at upper left. (David Becher, Wellcome Images)

11. *Day 28.* The neural tube closes, within which the notochord, preliminary to the spinal cord, will form, while the bulge at the top will come to house the brain. If the tube doesn't close completely, a neural tube defect (anencephaly, spina bifida, and a few others) results.

12. *End of week 8.* The embryo becomes a fetus, all structures present in rudimentary form. Attention anti-choice advocates: before this the prenatal human is *not* a fetus.

13. *Week 14 or thereabouts.* "Quickening," the flutter a woman feels in her abdomen that will progress to squirms and kicks from within.

14. *Week 21.* A fetus has a (very slim) chance of becoming a premature baby if delivered.

15. *Birth.*

16. *Puberty.* The Darwinian definition of what matters on a population and species level, when reproduction becomes possible.



A human embryo on the brink of becoming a fetus.

17. *Acceptance into medical school.* I don't know where this came from, a joke about Jewish mothers, but in some circles it might now apply to acceptance into preschool. Or when one's grown offspring leave home.

My answer? #14. The ability to survive outside the body of another sets a practical, technological limit on defining when a sustainable human life begins. That limit may of course change.

Having a functional genome, tissue layers, a notochord, a beating heart ... none of these matter if the organism cannot survive where humans survive. Technology has taken us to the ends of the prenatal spectrum, yet not provided too much for the middle, other than fetal surgeries for a handful of conditions. We can collect and select gametes, now thanks to [patent no. 8543339](#). We collect and select very early embryos in pre-implantation genetic diagnosis, allowing those without a specific disease to continue development. And although the gestational age at which a premature infant can survive has crept younger, it hasn't by much, not since I starting thinking about these things back when I was a stage #16.

Until an [artificial uterus](#) becomes a reality, technology defines, for me, when a human life begins.

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