"Human Life" Testimony

In none of the reporting I have seen on the controversy about when "actual human life" begins (News and Comment, 8 May, p. 648) has anyone pointed out that if human life can "begin" at some point in reproduction, it must have "stopped" at some earlier point. Though haploid, human eggs and sperm are documentably alive and documentably human. The cellular events that allow sexual reproduction interrupt neither life nor humanness. The whole issue is a logical, as well as a biological, red herring.

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. . . "When does human life begin?" like "When do you beat your wife?" is a double question that prejudices the reply. The secondary question, "When?" placed ahead of the primary question introduces the hidden assumption of a positive reply to the primary question. Moreover, the present tense implies that the activity occurs at present.

Consider an alternative supported by the experience that, unless ovum and spermatozoon are both alive and human when they meet, they will neither merge nor propagate human life—much less create it.

At present, human life does not begin. Life began in the very distant past and has continued to the present through a continuity of life cycles. By reproductive processes that are part of the life cycle, life is transmitted—not begun—through the production of new individuals. The continuity of life makes it nonsense to ask or say when life begins, but the production of new individuals permits identification of the step in the human life cycle after which a human individual or person exists. Since the second and not the first is the actual matter of the proposed legislation and is approachable logically, it deserves formal public statement.

An individual (Latin *in* = not, *dividuus* = divisible) is defined as an indivisible single entity. A person or human individual must, therefore, have the characteristic of indivisibility. An egg after fertilization is a zygote, a single cell that divides if development continues. Since not indivisible, a zygote cannot be considered an individual or person.

Confirmation is provided by the observation that each monozygotic twin is a whole individual and not the half individual (a self-contradictory term) that would be implied by a legislated assertion that a zygote is a person.

The division leading to twinning may begin as late as 16 days after fertilization, but even then no individual exists for there is a later major division, and it is characteristic not just of twins but all conceptuses that attain live birth. A conceptus, for which there is no layman's synonym, is a fertilized egg and everything that develops from it until it is born. A conceptus early develops two major components: embryoblast (most of which becomes fetus) and trophoblast (which becomes extraembryonic membranes, placenta, and umbilical cord). The fetus, by definition an unborn offspring, becomes a newborn or baby when it has come out of the mother; it becomes an individual when it has been divided from the trophoblastic part of the conceptus, usually by cutting the umbilical cord.

The trophoblastic parts of the conceptus are alive, are human, and the cells have the same genetic composition as the zygote, fetus, and baby. If any or all of these criteria were used to define personhood in constructing the argument for a legislated assertion that the zygote and its derivatives are a person, then the practice of cutting the cord, interrupting blood supply to the placenta, and letting the expelled placenta die would become murder in the eyes of the law. That seems inappropriate, yet if these normal aspects of birth management were specifically exempted, there would be formal recognition that the legislation rested on a logically unsound foundation.

In summary, if one accepts the definition of a person as a human individual, then careful reasoning and facts of nature compel the conclusion that a person exists after severance of the umbilical cord and not before.

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With one geneticist (LeJeune) reported as stating that "human nature of the human being from conception . . . is plain experimental evidence" and another (Rosenberg) that he "know[s] of no scientific evidence which bears on the question of when 'actual human life' begins," perhaps it is time for a neuroscientist to enter the lists. I suggest that there can be objective, scientific criteria for setting at least certain minimum time requirements for fetal development to reach the beginnings of being a human person. Indeed, the well-known principle that ontogeny recapitulates phylogeny already suggests this.

The criteria for human death may help us in deciding on the advent of human life. We now generally agree that appropriate functioning of the brain is the critical requirement for human existence. When the brain, particularly the forebrain portion, is judged to be irreversibly dead, we agree human life has ceased to exist. Even though the heart, kidneys, muscles, sensory nerves, and so forth, are still functional, an individual with an irreversibly nonfunctional brain is properly regarded as no longer a live human person.

Since we accept the central requirement of a functioning brain that has at least some semblance of what we call human qualities, before admitting that even an otherwise live human body can be a human person we can apply this criterion to the case of the fetus. Admittedly, achieving agreement on the precise criteria and time for the appearance of such a brain in the fetus or even postnatally does present difficulties; the acquisition of the later morphological and physiological cerebral features regarded as human is not a sudden, all-or-none phenomenon. A decision on finally acceptable levels would therefore depend upon cultural and religious factors, as Rosenberg and others argue.

However, the setting of at least minimum limits presents no difficulties. For example, the xygote resulting from union of egg and sperm cells clearly has no brain at all. Therefore, one unassailable conclusion would be that the assignment of human existence to the zygote at conception must be regarded as one based upon a religious preference or a metaphysical belief (for example, that some human spirit enters the zygote), not upon any biologically tenable grounds. Furthermore, there are stages well beyond the zygote for which there can still be easy agreement on an absence of even the beginnings of specifically human-like functions or structures for the primitive brain.

Many antiabortionists confuse a *potentiality* for with an actually developed human existence. But the issue is presumably one of being "pro-life" for the recognizable human person, not for all biological organisms that could potentially become human persons. The human zygote is certainly a potential human being. So are the egg and sperm cells, albeit at a preceding step of poten-

tiality. Indeed, given suitable technology, it is theoretically possible for many if not all cells in the adult human body each to be cloned into an entirely new human individual. Should we confer the status of human beings on each of these potentially capable cells or on some aggregate of them?

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Genetic Influence on Behavior

Roger Lewin in his recent article on *Genes, Mind, and Culture* by C. J. Lumsden and E. O. Wilson (Research News, 22 May, p. 908) quotes me as saying that human behavior is not "genetically guided in any important way" (p. 910). Unfortunately, in my brief telephone conversation with Lewin, I misstated myself. I meant to say that I am skeptical that cultural differences *between populations* are caused or maintained, to any important degree, by genetic differences *between populations*. This statement does not imply a total absence of genetic influence on behavior, and I did not mean to imply a total absence of such influence.

While I am skeptical about some of the assumptions on which Lumsden and Wilson's gene-culture theory is built, I think they have done the scientific community a service by developing an explicit, testable model. It now remains for those who doubt their assumptions to build alternative testable models.

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Hubbert's Estimates

I can find no mention in Richard A. Kerr's article "How much oil? It depends on whom you ask" (Research News, 24 Apr., p. 427) of the oil and gas estimates by the preeminent expert in the field, M. King Hubbert.

In his 1962 paper, Hubbert's estimate of ultimate production of crude oil from the lower-48 states was 170 to 175 billion barrels. After 18 years of additional data on exploration and production, Hubbert's 1980 estimate is 170 billion barrels, or essentially the same as his published figure of 1962, this represents a remarkable achievement in forecasting and a vindication of his method of analysis. It is the more remarkable, when it is recalled that from 1961 to 1974 the U.S. Geological Survey repeatedly issued figures of about 600 billion barrels for the ultimate amount of crude oil to be produced from the lower-48 states and adjacent continental shelves, a figure for ultimate production some 3½ times the 170 billion barrels of Hubbert. Of those 170 billion barrels, Hubbert shows that, through 1979, 117 billion barrels represent cumulative production, 27 billion barrels proven reserves, and 26 billion barrels recoverable oil yet to be discovered at the end of 1979.

Hubbert's mathematical method of arriving at these figures has been described in detail in several publications (*1*).

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References

1. M. K. Hubbert, *Energy Resources, A Report to the Committee on Natural Resources* (publication 1000-D, National Academy of Sciences–Natural Research Council, Washington, D.C., 1962), available from National Technical Information Service, Springfield, Va.; in Committee on Resources and Man, National Research Council, *Resources and Man* (Freeman, San Francisco, 1969), pp. 157–242; *U.S. Energy Resources, A Review as of 1972* (Government Printing Office, Washington, D.C., 1974); paper presented at the Symposium on Oil and Gas Supply Modeling, sponsored by the Department of Energy and the National Bureau of Standards, Washington, D.C., 18 to 20 June 1980.

¡Graphs, Not Punctuation!

Gina Bari Kolata's succinct explanation of clicks (Letters, 1 May, p. 495) is perfectly okay, but in two respects readers of *Science*, more than many others, deserve a bit more. Certain symbols, which include !, are features (that is, letters or parts of digraphs) of some alphabets of southern Africa; these signs are not elements of punctuation, which they superficially resemble.

1) Good information on these languages, and their sounds, is now relatively accessible. The general reader could consult the *Encyclopaedia Britannica* (*Micropaedia*, under *Khoisan languages*; *Macropaedia*, vol. 1, page 228 and continuation). A classic phonetic description of clicks is to be found in D. M. Beach, *The Phonetics of the Hottentot Language* (Heffer, Cambridge, England, 1938). Note that this work uses a different set of symbols, which although current in technical literature, reflects the vacillation in notation that these unfamiliar sounds have given rise to.

2) These points of phonetics underlying the perhaps surprising graphs are not arcane and deserve much wider appreciation by an educated public. Clicks such as these occur only in southern Africa; they are a precious and instructive remnant, and a reminder to us. Today, we search hard for generalizations and possible universals, and properly so. But if these language residues had got erased a little earlier by even more insistent and crueler intrusions than those we know, we never would have guessed that human beings might speak routinely with such "unnatural" sounds. If the muse of history had ordained that an Alexander and a Roman empire radiate from a different center . . . !

I would say to any school principal: Not to have heard of clicks is worse than not having read about a platypus; it is not to know a part of yourself, in a deeply Socratean sense.

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Nicholas P. Christy implies that the use of exclamation points to mark alveolar-palatal clicks is "exotic" and should be explained to the reader "in order to communicate scientific !information [sic] clearly. . . ." The usage is not exotic. Even if it were, understanding it would not appreciably increase the information conveyed in the article. I don't have to know how electron nuclear double resonance works to be able to derive information from a report that physical chemists expect it to provide a cheaper means of analyzing protein structure. I would be rightly criticized for protesting to the editor that resonance phenomena ought to be explained to me. What are libraries for?

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Erratum: The citation "Editorial note concerning News and Comment" in the quarterly index to volume 212 (26 June 1981, p. iii) should have read as follows: "Editorial note re B. H. Kean, M.D., and the Shah of Iran news articles previously published (Mark Bloom, v207 p282 18 Jan 80, and Nicholas Wade, v209 p1000 29 Aug 80). v212 p1004 29 May 81."

Erratum: The location given for the distributor of *The Sahara and the Nile*, reviewed in the issue of 22 May (p. 911), should have been Salem, N.H.

Erratum: The computer-processed image of wave propagation in aggregating slime mold cells shown on the cover of the 24 April 1981 issue was incorrectly attributed. The image was produced by M. J. Potel in the computer graphics facility of the Department of Biophysics and Theoretical Biology at the University of Chicago.

Erratum: In William Shea's review of Maurice A. Finocchiaro's *Galileo and the Art of Reasoning* (15 May, p. 780), the third symbol in the passage quoted from the book should have been "A12." The first sentence of the passage quoted from Galileo's *Dialogue on the Two Chief World Systems* should have read, "The art of demonstration is learned by reading works which contain demonstrations."