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by

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Will and Ariel Durant state in the preface to their book, entitled *The Lessons of History,* that their aim in preparing the essay was not originality but inclusiveness.[1] We expect that from historians. But, we also expect it from scientists and, more specifically of late, those writing about human development. Within the past few years, many statements have been published concerning human development which have been misleading, out of context, or outright false.

Human embryology is now in danger of being rewritten as a stratagem statement of current socio-legal, but also of late, even theological, issues. Unless the errors are corrected now, we will be in danger of entering a protracted period of false concepts concerning our own development. History records previous difficult periods; for example, when the theory of recapitulation, conceived by Haeckel in 1866, preoccupied biologists for decades.[2] This became the Biogenetic Law which stated that our embryonic stages telescoped the morphology of lesser vertebrates. The laws of von Baer had been published 38 years earlier, and had precluded such a theory. Correctly stated, embryonic stages of the vertebrates are simply similar in form.[3]

The So-Called Pre-embryo

The Reverend Richard A. McCormick has recently written an essay proposing a "new moral status," for a stage of development of the human embryo, called the "pre-embryo."[4] The pre-embryo theoretically extends from fertilization to a stage about 5 to 6 days post-fertilization and, he states, might be for that period of time not entitled to moral status.[5] His new "moral status" is actually a reconsideration of the time granted for ensoulment by the Catholic Church.[6]

The authenticity for the term pre-embryo is derived from a justification given by Grobstein: "greater accuracy in characterizing the initial phase of mammalian

and human development."[7] McCormick states: "the term pre-embryo was adopted because the earliest stages of mammalian [sic] development primarily involve establishment of the non-embryonic trophoblast, rather than the formation of the embryo."[8] This is an involuted statement and, in the case of the human, is not true. In the human the trophoblast does not appear until the 4th day. In the human the trophoblast and *some,* not all, of its derivatives are involved in establishing the placenta. While this is going on development of the embryo is certainly not arrested but proceeds apace. If in the early stages certain cells not directly involved in development of the embryo justify establishment of a pre-embryo state and possible reconsideration of ensoulment, what status might be established for the embryo, or the fetus, in which multitudes of cells, including massive numbers of brain cells, and others which are organized into whole structures, never become part of the fetus or the infant? Specifically, as nerve cells (neuroblasts) are rapidly dividing, forming the nervous system including the brain, many are dying.[9,10] Additionally, many cells, not just nerve cells, are programmed for cell death in the embryo, many others in the fetus, and still others at all stages of life, post-birth.[11]

It is important to examine what has been, and is, common usage among those who are most familiar with the subject of human development, the embryologists. The most recent edition of Stedman's Medical Dictionary (1990) defines *embryo* as "an organism from conception until approximately the end of the second month," after which it is termed a fetus.[12] None of the established human embryology texts use the term pre-embryo, and it is not to be found in the scientific literature of human development. Bradley Patten, now deceased, but one of the renowned deans of human embryology, regarded the fertilized ovum and subsequent cleavage stages as *the embryo* and stated: "Stages of development are purely arbitrary. Development is a *continuous process* and one phase merges into another without any real point of demarcation."[13]

McCormick contends that a potential new moral status might be considered for the pre-embryo and, specifically, personhood may be related to the establishment of *developmental individuality,* which would mark the end of the pre-embryo period and the new time for ensoulment. He states that personhood cannot be decided by science.[14]

It is not a question as to whether science can or cannot decide the question of personhood. Science is not *interested* in deciding personhood. However, if the socio-legal status of personhood cannot be decided without invoking what is known scientifically, then the *whole* of scientific data should be used and not arbitrarily selected bits and pieces of data.

Developmental Individuality

McCormick's reliance on *developmental individuality* is derived from Grobstein's recently published "stages".[15,16] Grobstein[17,18] claims the stage of *developmental individuality* is reached when division of the inner cell mass no longer can divide to produce twins or multiple identical individuals. Ancillary support for this contention comes from a report by the American Fertility

Society, which states that at least up to the eight-cell stage the developmental singleness of one person has not yet been established.[22] This, quite simply, is not true. Seventy percent of all identical twins (monozygotic origin, that is, derived from one fertilized egg) are accounted for by division of the inner cell mass. The other 30% are accounted for by division at the two-cell to eight-cell stage of cleavage.[20,21] Multiplicity of birth from dizygotic origin (two different ova) appears to be familial. However, the factors determining the origin of monozygotic multiplicity are not known, but, statistical data does not support a familial origin. The fact that 30% of all monozygotic twinning is determined in early cleavage stages strongly suggests that the singleness of all cases other than monozygotic twinning is determined at fertilization, or, perhaps at the first cleavage division. Compounding the problem explaining the onset of individuation is the fact that multiplicity beyond twinning may include a combination of dizygotic *and* monozygotic-derived embryos.[21]

The fact is, not a shred of evidence exists which would explain the origin of monozygotic multiplicity. The kind of evidence which McCormick needs to support singleness occurring at the inner cell mass stage, and which would justify his "new moral status", is simply not in existence.

The overwhelming majority of individuals on this earth now and since the beginning of homonid development have been, and are, derived from one fertilized egg without further separation of the blastomeres. If exceptions to this fact prompt a new definition for the right of ensoulment, it would be done for a very *small* fraction of the total human population now and in the future. Further, there would be no certain way ethically to withhold ensoulment from stages prior to formation of the blastocyst, because the factors or stimuli which produce monozygotic twins are not known and therefore not predictable.

By designating developmental commitment to a single individual (singleness) as a determining factor for ensoulment, then in cases in which totipotentiality is lost early in development (called determinant cleavage), for example, in the annelids (worms), would there be an entitlement to ensoulment? Certainly there has never been a suggestion that the Catholic Church, nor any traditional religion, should recognize ensoulment for other than humans. Therefore, it would seem that the ***human quality*** would have to exist. This quality is established at fertilization. But, by qualifying this entitlement and restricting it to a later stage, such as the inner cell mass, the human quality is thereby equivocated. Indeed, a stronger case can be made for developmental individuality occurring at the time of fertilization of the ovum rather than at the inner cell mass stage.

McCormick states that the potential for a fertilized egg to become an adult is a theoretical and statistical potential because only a small minority actually achieve this in the natural process.[22] But, so what? What does that have to do with those zygotes which *do* successfully develop? A significant number of zygotes, embryos, fetuses and born individuals encounter biological faults, many of which precipitate early death before and after the inner cell mass stage.

There are other significant facts about human development that are commonly misstated. For example, in the case of human development, we have traditionally believed in the totipotentiality of the cleaving blastomeres (cells) until the inner

cell mass stage (the blastocyst). But, not each blastomere has the same potential as the zygote, not even in cases where subsequently there might be a division of the inner cell mass into multiple copies of the embryo. Some of the blastomeres are destined to assume a peripheral position of the cleaving mass. During the formation of the blastocyst, these peripheral blastomeres will assume the identity of the trophoblast. The innermost blastomeres correspondingly, become distinguished from the peripheral-most cells by forming the inner cell mass. Positional differences are not to be exempted from consideration of totipotentiality.

McCormick states the organization of the inner cell mass into two layers (referred to as the bilaminar embryo) is reflected by the formation of the primitive streak.[23] That is incorrect. The appearance of the streak marks the beginning of the formation of the *trilaminar* embryo.

It has also been reported by Short that it is untrue that identical twins may have progressed through two distinct inner cell masses at the fifth day.[24] They certainly could have and could have been derived from separate earlier stages, which would have been derived from early monozygotic twinning.[20] Short also states if "cleavage of the embryo is delayed until eight or more days after fertilization, the two resulting embryos have come from a single inner cell mass, and share one common set of all placental membranes." If twinning is delayed until eight or more days after fertilization, the two resulting twins *will* share a common placenta, but also a common amnion. They represent an anomalous condition and are rarely born alive.[20]

Functional Individuality

The arbitrary nature of Grobstein's "stage of developmental individuality" may be seen in his other examples: He defines the onset of *functional individuality* "by the beating of a simple two-chambered heart."[18] In the human, the first beats are irregular and occur prior to the presence of any blood to be moved. This occurs by the 22nd day post-fertilization;[25] some texts may indicate it occurs a bit later. The first *contraction* may be considerably earlier, perhaps 4 to 5 days earlier.[26] As development proceeds more blood corpuscles are formed, accumulate in the fusing blood channels, and the beats (contractions) become progressively more regular and stronger due to the formation and arrangement of more cardiac muscle cells. By this time, the beat of the heart becomes detectable. At what point would it be most appropriate to assign functional individuality? Can a case be made for functional individuality occurring when the first contractile unit in the first myoblast cell is formed? Or when the paired endocardial tubes are formed? Or when the cardiogenic cords are differentiated? Or when the first potential cardiac cell migrates to the presumptive heart area?

Are these important questions? Not to the embryologist. The simple reason is that we recognize that all of development is a *continuum,* and any point in development derives its significance from the most previous point in development.

Psychic Individuality

McCormick ties his argument for a reassessment of the time of ensoulment to the "light of scientific data."[27] But the "scientific data" he cites has been highly selected and leaves out the overwhelming amount of "data." Another example of Grobstein's stages is that of *psychic individuality* (1989, p. 44) which, he states, occurs at 26 weeks, but admits that point in time is "arbitrary."[18] He claims that time may change with more knowledge. He identifies this stage as *sentience* and relates it to the onset of thought. Those claiming sentience in the human fetus usually cite as evidence the recordings of brain waves. What studies have been made demonstrating brain wave recordings at 26 weeks of fetal age? A search of the literature within the last 11 years indicates that *no* studies have been conducted on 26 week old fetuses. Those *studies* using electroencephalogram (EEG) recordings have been done during labor on full-term fetuses. Actually, these are not *studies.* They are either case reports or highly selected data. Some recordings have apparently been made at approximately 28 weeks presumably on premature births, but possibly on elective abortions.[28] The waves are anarchic and asymmetric. They are different from the newborns which, in turn, are very different from a juvenile or an adult.

Sentience, awareness of one's self, is a concept born of psychology. Thought must have an historical component, such as a record or interview. The newborn does not respond to vocal commands. On that basis, a newborn does not reveal thought. If one is testing alertness by an EEG, then *psychic individuality* is reduced to the ability of enough neurons developing enough electrical potential to move a stylus on a graph. Further, one would be recording "alertness' of neurons, not necessarily the individual, one of the reasons being that many interneurons are added post-birth up to two years of age. Those who regularly perform EEGs on newborns will admit it is not an easy task and interpretation is not a simple matter. Brain wave recordings might be refined later with microstructuring of the detection apparatus and perhaps could be eventually the result of the very first synapse formed, which would then place the time in the embryo stage at 8 to 9 weeks post fertilization, or before. But, what about the preparative events prior to production of detectable electrical potential, the growth of axons, dendritic connection and synthesis of appropriate enzymes? Have they no significance?

Conclusion

In sum, for the human embryo, a new stage of human development, which would be excluded from a moral status (ensoulment) should have full scientific support for such a new stage. Such is not the case. Church documents used in recognizing the rights of the conceptus have not had their scientific bases, as yet, abrogated. If moral reconsiderations of ensoulment are based on scientific data, as McCormick states they should be, *all* available scientific data should be used and not be selective or arbitrary.

The scientist, in this case the human embryologist, should have no political

or theological agenda. There is no dilemma such as accounting for doctrinal or moral error when defining scientific data. Yet, we recognize from time to time the importance of what we observe, not just with respect to the next scientific question but with respect to our place in all of creation and within the order of all things in the universe.

To that end, present Catholic doctrine appears to recognize the supreme significance of fertilization, that of the "new individual" being an extension of the unbroken continuum of life which began some 4.5 billion years ago. More than that, each fertilized egg represents the consequence of a biological history of all of the sucesses of that continuum and its survival against unceasing environmental assaults. Minor exceptions notwithstanding, our biological redemption lies within our biological history which is unified at the moment of fertilization.

Epilogue

There is no stage in human development as the *pre-embryo.* No such stage (or any stage) exists which could be the basis for equivocating the presence of a *living* entity, its quality of being *human,* its status as a human *individual,* or, in the case of religious consideration, time of ensoulment. The reason why this is true is the following: from the moment when the sperm makes contact with the ovum, under conditions we have come to understand and describe as *normal,* all subsequent development to birth of a living newborn is a *fait accompli.* That is to say, after that initial contact of sperm and egg there is no subsequent moment or stage which is held in arbitration or abeyance by the mother, or the embryo or fetus. Nor is a second contribution, a signal or trigger, needed from the male in order to continue and complete full development to birth. Human development is a *continuum* in which so-called stages overlap and blend one into another, even after birth and unto death.

References

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2. Haeckel, E. 1866. *Generelle Morphologie der Organismen.* Berlin.
3. Baer, K. E. von. 1828. *Uber Entwicklungsgeschicte der Thiere, Beobachtung und Reflexion.* Konigsberg.
4. McCormick, Richard A. 1991. Who or What is the Pre-embryo? *Kennedy Instit. Ethics J.,* 1:1-15.
5. This stage is called the blastocyst. It is composed of cells of the embryo proper and cells destined to become part of the placenta and fetal membranes.
6. McCormick, pages 5 & 8. These references to edicts from Pope Pius IX (1869) and Pope John Paul II (1982) leave no doubt.
7. Grobstein, Clifford, 1988. *Science and the Unborn.* p. 61. New York: Basic Books.
8. McCormick, Page 1.
9. Sidman, R. L. 1970. Cell proliferation, migration and interaction in the developing mammalian central nervous system. *In,* The Neurosciences, Second Study Program. Ed., F. O. Schmidt, pp. 100-107, New York, Rockefeller Univ. Press. See Discussion.
10. Angevine, J. B. 1970. Time of neuron origin in the diencephalon of the mouse. An autoradiographic study. *J. Comp. Neurol.,* 139:129-188. See Discussion.

11. This is a process called apoptosis by which certain cells are programmed genomically to die. This is a method invoked during development which, in significant manner, accounts for sculpturing and modeling of different tissues and organs in the embryo and fetus.

12. Stedman's *Medical Dictionary.* 1990. Baltimore: Williams and Wilkens.

13. Patten, Badley, 3rd Ed. 1968. *Human Embryology.* p. 49. New York: McGraw-Hill.

14. McCormick, p. 2.

15. Grobstein, 1988, p. 61.

16. Grobstein, Clifford. 1989. When does life begin? *Psychology Today,* September, pp. 43-46.

17. Grobstein, 1988, p. 25.

18. Grobstein, 1989, p. 44.

19. American Fertility Society, Ethics Committee of the. 1986. Ethical Considerations of the New Reproductive Technologies. Fert. & Ster. 46(Suppl. 1):265.

20. Thompson, James S. and Margaret, W. 4th ed. (Rev., M. Thompson) 1986. *Genetics in Medicine.* p. 274. Philadelphia: W. B. Saunders.

21. Moore, Keith, 4th Ed. 1988. *The Developing Human.* pp. 122-126. Philadelphia: W. B. Saunders.

22. This is called atresia. It is a degenerative process for ova, fertilized ova (zygotes), and further stages alike. The exact reasons why this occurs are not known; however, development relies on a synchrony of events, prior to and after fertilization. Therein, most probably lie the answers.

23. McCormick, p. 4.

24. Short, R. V. 1990. Letters: Ethics, Science and Embryos. *The Tablet* (Feb. 3):141.

25. Moore, p. 294.

26. Patten, p. 100.

27. McCormick, p. 12.

28. Tuchmann-Duplessis, H., M. Auroux and P. Haegel. 1975. *Illustrated Human Embryology* Vol. III Nervous System and Endocrine Glands. New York: Springer-Verlag.
