

FETAL DEVELOPMENT

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NO ISSUE on abortion would be complete without a chapter on the fetus. He or she (in the absence of knowledge of the sex, we shall use the neutral "it") is, after all, one of the subjects in the debate. Frequently in the discussions on abortion, the physician is asked when life begins. Some seem to imply that there would be no problem of abortion if only a definitive statement could be made about the beginning of human life. This, however, is far from so, for the presence of human life has never precluded our taking it if we felt justified in doing so. In this issue on abortion the question (when life begins) is therefore asked not to endorse or prohibit abortion, but rather because the layman is baffled by the fetus, since he cannot see it.

Since society has imagery and definitions of its own, which it has inherited from the past, it may be well in the description which follows to highlight those stages of development to which, for one reason or another, men have attached importance in the past.¹

I

First, let us ask in what way the ovum, or female egg, and the sperm, or male eggs, differ from the fertilized ovum. The essential difference is that an ovum or a sperm will inevitably die unless they are combined together in the process of fertilization, while the fertilized egg will automatically develop unless untoward events occur. The first definition of life, then, could be the ability to reproduce oneself, and this the fertilized egg has while the individual ovum and sperm do not.

How is this process of fertilization brought about? At intercourse, about 300,000,000 sperm are deposited in the vagina and will begin their journey upwards through the uterus, or womb, and up into the

¹I shall stress heavily the new biology on the developmental processes in the first seven days, while the "fetus" is in the tube. This is crucial, I believe, (1) by reason of its own biological interest; (2) because of the action of the pill and intrauterine devices, which may act during these seven days; (3) because this stage precedes the period when a diagnosis of pregnancy can be made, i.e., it is the stage commonly described as "the normal second half of the normal menstrual cycle"; (4) because it is the stage when the "morning-after pill" may act; (5) because it is not presently covered under abortion laws, inasmuch as it precedes the stage when the woman knows she is pregnant (for she has not yet missed a period) and precedes the stage when a diagnosis can be made; (6) because it is a stage upon which the Catholic Hospital Association has not yet reflected, since we frequently do operations after ovulation but before a period is missed, i.e., during these seven days.

tube leading from the uterus towards the ovary. If an ovum has been released from the woman's ovary, it in turn will pass from the ovary down the same tube towards the uterus. The survival time of this ovum will be about twenty-four hours. If fertilization has not occurred in that time, both the ovum and the sperm will die. From a variety of mammalian species it has been learned that the sperm, as ejaculated, are not capable of immediately fertilizing an ovum. They must undergo a chemical change called "capacitation," without which they cannot fertilize the ovum.² The process is as yet little understood, but it is thought that a substance in the female uterus or tube changes the sperm in such a way that they gain the ability to fertilize. In most species this process occurs in a matter of hours, say six or eight. Although the process has not yet been proven in the human, it is commonly assumed to exist, since it occurs in other mammalian species studied. Following intercourse, there would therefore be a period of several hours in which interference with reproduction would fall under the generally recognized heading of contraception rather than abortion, since no ovum would yet have been fertilized. Several hours after intercourse, then, fertilization may occur. The significance of this event lies in the fact that a totally new genetic package is now produced. The fertilized ovum contains genetic information brought from the father through the sperm, and from the mother through the ovum, so that a new combination of genetic information is created. This newly fertilized egg, sometimes called a zygote, has within it the hereditary characteristics of both the father and the mother, one half from each. The characteristics are derived from the genetic thread of life called DNA, contained in each.

This single fertilized cell will then proceed to divide into two cells, then four, then eight, etc., and this it will do at a rate of almost one division per day.³

It is well known that in this early stage of development the sphere of cells may split into identical parts to form identical twins. Twinning in the human may occur until the fourteenth day, when conjoined twins can still be produced. Less well known is the fact that it is also in these first few days that twins or triplets may be recombined into one single individual.

Experiments carried out in mice by Mintz showed that it was possi-

² Cf. C. E. Adams, "The Influence of Maternal Environment on Preimplantation Stages of Pregnancy in the Rabbit," in *Preimplantation Stages of Pregnancy*, ed. G. E. W. Wolstenholme and M. O'Connor (Boston, 1965) p. 345; K. A. Rafferty, "The Beginning of Development," in *Intrauterine Development*, ed. A. C. Barnes (Philadelphia, 1968).

³ Cf. Rafferty, *op. cit.*

ble to recombine the early dividing cell stages from black parents and from white parents into a single black-and-white-striped mouse.⁴ The significance of this phenomenon would seem to be that up until this stage the new individual mammal is not as yet irreversibly an individual, since it still may be recombined with others into one new, final being.

In the last few years this phenomenon has also been found in man. From the genetic make-up of these human individuals and from the make-up of their red blood cells it is clear that these human so-called chimeras, whose genetic type is XX-XY, are in fact recombinations into one human being of the products of more than one fertilization. The subject has recently been extensively reviewed by Benirschke,⁵ and a prototype case can be found in the report of Myhre *et al.*⁶ It is not as yet clear up to precisely what stage of development this can occur in the human, but in mice the recombination can still be performed at the 32-cell stage. The diagnostic criteria for such cases are that their genetic karyotype is XX-XY, that they are gonadally disturbed consisting as they do of a genetic mixture of male and female, that they can contain two different populations of red blood cells, and that they may have heterochromia of the eyes. Six human cases meeting these requirements have been reported up to the present time.

The initial stages of cell division of the fertilized egg do not seem to be dependent on any paternal genetic material brought to the fertilized egg by the sperm. It would seem as if genetic material brought to the fertilized egg in the mother's ovum suffices to take the fertilized egg through the earliest stages of cell division.

All these matters are brought forth to point out that, although at fertilization a new genetic package is brought into being within the confines of one cell, this anatomical fact does not necessarily mean that all of the genetic material in it becomes crucially activated at that point, or that final irreversible individuality has been achieved.

Modern genetic studies therefore suggest that, in old standard Catholic language, one could say: "If by means of two fertilizations two souls are infused, and if a single body only contains one soul, then we are beginning to see cases in which one of the two souls must have disappeared without any fertilized egg having died."

⁴ Cf. B. Mintz, "Experimental Genetic Mosaicism in the Mouse," in *Preimplantation Stages of Pregnancy* (n. 1 above) p. 194.

⁵ Cf. K. Benirschke, *Current Topics in Pathology* 1 (1969) 1.

⁶ Cf. A. Myhre, T. Meyer, J. N. Opitz, R. R. Race, R. Sanger, and T. J. Greenwalt, "Two Populations of Erythrocytes Associated with XX-XY Mosaicism," *Transfusion* 5 (1965) 501.

It is also important to realize that in these first few days of life it is quite impossible for the woman to know that she is pregnant, or for the doctor to diagnose the condition by a pregnancy test.

The fact that the first seven days of the reproductive process take place entirely in the tube, and not in the uterus itself, has several major implications for the subject of abortion. These should be fully understood. If within seven days of intercourse, as for instance following rape, the lining of the uterus is removed by curettage, abortion, in its legal sense, has not taken place. It would be impossible to prove that an abortion had been performed when all pregnancy tests were shown to be negative and the lining of the uterus was shown, under the microscope, to have contained no pregnancy. Indeed the operation of curettage is a common gynecological one, which is frequently carried out in the second half of the menstrual cycle, when a fertilized ovum may well be present in the tube. There has never been a medical tradition to perform the curettage only immediately following menstruation, in order to assure that no fertilized egg could be present in the tube (since ovulation would not as yet have occurred). By the same token, women scheduled to undergo a curettage are not instructed to forgo intercourse lest there be present in the tube a fertilized ovum which would be unable to implant into the uterus due to the removal of its lining. Moreover, there is some evidence that modern "contraceptive" techniques such as the intrauterine loop, and even some of the steroid pills, may well exert their effect in pregnancy prevention by acting after fertilization of the ovum has occurred, but before implantation in the uterus.⁷ Although the action of these agents is not yet fully understood, there has never been a suggestion that they would be considered abortifacient under the civil law, since no evidence of pregnancy could possibly be obtained.

II

After approximately six or seven days of this cell-division process (all of which occurs in the tube), the next critical stage of development starts. The sphere of cells will now enter the uterus and implant itself into the uterine lining. This process of implantation is highly critical, for it is during these days that one pole of the sphere of cells, the trophoblast (later to become the placenta), burrows its way into the lining of the uterus. The opposite pole of this sphere will become the fetus. The part which becomes the placenta produces hormones.

⁷ Cf. P. A. Corfman and S. J. Segal, "Biologic Effects of Intrauterine Devices," *American Journal of Obstetrics and Gynecology* 100 (1968) 448; also "Hormonal Steroids in Contraception," *WHO Technical Report Series*, 1968 (Geneva, 1968) p. 386.

These enter the maternal blood stream and serve a critical function in preventing the mother from menstruating. Since the time interval between ovulation and menstruation is approximately fourteen days, and since the first seven days of the new life have been passed in the tube, it is obvious that the implanting trophoblast only has about seven days to produce enough hormone to stop the mother from menstruating and thus sloughing off the fetal life. These same hormones, circulating in the mother, form the basis for the chemical tests which enable us to diagnose pregnancy. After this second week of pregnancy the zygote rapidly becomes more complex and is now called the embryo. Somewhere between the third and fourth week the differentiation of the embryo will have been sufficient for heart pumping to occur,⁸ although the heart will by no means yet have reached its final configuration. At the end of six weeks all of the internal organs of the fetus will be present, but as yet in a rudimentary stage. The blood vessels leading from the heart will have been fully deployed, although they too will continue to grow in size with growth of the fetus. By the end of seven weeks tickling of the mouth and nose of the developing embryo with a hair will cause it to flex its neck, while at the end of eight weeks there will be readable electrical activity coming from the brain.⁹ The meaning of the activity cannot be interpreted. By now also the fingers and toes will be fully recognizable. Sometime between the ninth and the tenth week local reflexes appear such as swallowing, squinting, and tongue retraction. By the tenth week spontaneous movement is seen, independent of stimulation. By the eleventh week thumb-sucking has been observed and X rays of the fetus at this time show clear details of the skeleton. After twelve weeks the fetus, now 3½ inches in size, will have completed its brain structure, although growth of course will continue. By this time also it has become possible to pick up the fetal heart by modern electrocardiographic techniques, via the mother.

The twelve-week stage is also important for an entirely different reason. It is after this stage that the performance of an abortion by the relatively simple D&C (scraping of the womb) becomes dangerous. Thereafter abortion must be performed either by abdominal operation or by the more recently developed technique of the injection of a concentrated fluid into the amniotic cavity.

Sometime between the twelfth and sixteenth week "quickening"

⁸Cf. J. W. C. Johnson, "Cardio-Respiratory Systems," in *Intrauterine Development* (n. 1 above).

⁹Cf. D. Goldblatt, "Nervous System and Sensory Organs," in *Intrauterine Development* (n. 1 above).

will occur. This event, long considered important in law, denotes the fact that fetal movements are first felt by the mother. Quickening, therefore, is a phenomenon of maternal perception rather than a fetal achievement. It is subjective and varies with the degree of experience and obesity of the mother.

Sometime between the sixteenth and twentieth week it will also become possible to hear the fetal heart, not just by the refined EKG, but also by the simple stethoscope.

The twentieth-week stage again has definite importance. Before this date delivery of the product of conception is called an abortion in medical terminology. After this date we no longer speak of abortion but of premature delivery. The fetus at this stage will weigh about one pound. Between the twentieth and twenty-eighth week fetuses born have an approximately 10% chance of survival. At twenty-eight

Some Major Normal Stages in Fetal Development

| Time | Cardiovascular system | Nervous system | Other criterion |
|----------------|-----------------------|---------------------------------------|--|
| -Some Hours | — | — | Intercourse followed by "capacitation" |
| 0 Hours | — | — | Fertilization; 1 cell, often called zygote |
| About 22 hours | — | — | 2 cell |
| About 44 hours | — | — | 4 cell |
| About 66 hours | — | — | 8 cell |
| About 4 days | — | — | 16 cell |
| | | | } Possible recombination until day ?. Possible twinning until day 14 |
| | | | "Morula" stage |
| About 6-7 days | — | — | Implantation—often called "blastocyst" stage |
| 2 weeks | — | — | Name changed from zygote to embryo |
| 3-4 weeks | Heart pumping | — | — |
| 6 weeks | — | — | All organs present |
| 7-8 weeks | — | Mouth or nose tickling = neck flexing | — |
| 8 weeks | — | Readable brain electric activity | Name change from embryo to fetus |
| | | | Length 3 cm. |
| 9-10 weeks | — | Swallowing, squinting, local reflexes | — |
| 10 weeks | — | Spontaneous movement | — |
| 11 weeks | — | — | Thumb sucking |
| 12 weeks | Fetal EKG via mother | — | Brain structure complete |
| | | | Length 10 cm. |
| 13 weeks* | — | — | D & C contraindicated hereafter |
| 12-16 weeks* | — | — | "Quickening." Length 18 cm. at 16 weeks |
| 16-20 weeks* | Fetal heart heard | — | Length 25 cm. at 20 weeks |
| 20 weeks* | — | — | Name change from abortus to premature infant |
| 20-28 weeks* | — | — | 10% survive |
| 28 weeks* | — | — | Fetus said to be "viable" in some definitions |
| 40 weeks* | — | — | Birth |

* Calculated from the first day of the last menstrual period.

weeks the fetus will weigh slightly over two pounds. In former days the medical profession defined fetuses of less than twenty-eight weeks of age as abortions, but this was impossible to maintain when 10% of such infants might survive. As a consequence, a discrepancy may now exist between possible definitions of viability in legal and in medical circles; at least the ability to ensure survival of fetuses has progressively occurred at earlier stages.

After the twenty-eighth week little change in outward appearance of the fetus occurs, although growth obviously continues, and with this growth the chances of survival also increase.

These, then, are the major stages of fetal development in the order of their occurrence. Grouped systematically, and therefore rather arbitrarily, by genetic factors, by cardiovascular or nervous system development, and by chances of survival, they can be summarized as in the accompanying Table.

Throughout the analysis of the beginning of life it is important to bear several factors in mind. First, the understanding of the processes described is the understanding of today. The eliciting of fetal responses depends on the methods available today. Second, it is not a function of science to prove, or disprove, where in this process *human* life begins, in the sense that those discussing the abortion issue so frequently use the word "life," i.e., human dignity, human personhood, or human inviolability. Such entities do not pertain to the science or art of medicine, but are rather a societal judgment. Science cannot prove them; it can only describe the biological development and predict what will occur to it with an accuracy that depends on the stage of development of the particular science. In the ultimate analysis the question is not just to forecast when life begins, but rather: How should one behave when one does not know whether dignity is or is not present in the fetus?