

CORRESPONDENCES OF THE DEVELOPING HUMAN FORM[†]

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GESTATION AND REGENERATION

Organization: The Formative Force

How does the zygote turn into a human being? How do all the organs form at the right times and places? This is the question of organization, often prompted by stunned amazement that this miracle can happen at all, let alone billions of times. We can approach it at many different levels. The Writings answer it at the theological level, as I showed earlier, by explaining the nature and operation of the soul. But the philosophical level, and the scientific one, which can be divided into physical, mechanical, cytological, molecular and even atomic planes of organization, remain to be examined.

First I would like to cite Swedenborg on the philosophical plane. Swedenborg's pre-theological works are interesting because they show the basis of scientific knowledge from which he worked in setting down revealed truth, and which served as a vessel for it both in his own mind and in his theological Writings. They show an attempt to synthesize scientific, philosophical and theological ideas which we, with the revealed truth of the Writings and modern scientific discoveries, might fruitfully emulate.

In *The Economy of the Animal Kingdom*, first volume, numbers 257-258, Swedenborg speaks of the "formative substance or force" as "the first, the most perfect, the most universal, and most simple, of all the substances and forces of its kingdom." It subordinates and coordinates all things for their uses and ends, insures the general and particular good of all things, and successively compounds all things in the body. "It has assigned to it," he says, "within its own little corporeal world, a certain species of omnipresence, power, knowledge and providence." It encompasses "the mysteries of all the mundane arts and sciences." In fact,

...There is nothing, however deeply involved therein, but it evokes it, and summons it to assist in building and completing its kingdom.... It would seem that to this force or substance, starting from its principles and proceeding from order to order, no possible path were refused, but its course lay through all things.

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It becomes more and more evident that its path does indeed lie through all things, for physical, mechanical, chemical, and electrical forces are all recruited through this formative force to serve in the building of the embryo. And all these forces work, coordinated in space and time, facilitating each other, supporting and building on each other, moderating and providing context for each other, acting in "stupendous concert," to use Swedenborg's phrase. *Concert*, indeed, is particularly fitting, because to me the gestation of the embryo is a fugue whose theme is the human form: its tensions and resolutions are cycles of descent and ascent; its harmonies are conjunctions of love and wisdom. It begins and ends in the tonic key, which is the turning toward and reception of the Lord. The human theme of the fugue, beginning with a single voice and successively joined by others, is played in different keys, at different speeds, on different instruments, in different octaves, inverted and nested inside itself; and each voice says the same thing, and all taken together they say the same thing, and looked at sideways or inside out; and any part is an image of the whole. This fugue of the body prefigures in a physical and limited way the far greater and richer fugue which is the human spirit; and its rhythm sounds everywhere in nature. It is the dance of the Grand Man of Heaven, and the standing forth of God Himself.

Science shows us these awesome forces at work. Two fields which particularly highlight the flexibility and adaptability of them are experimental embryology and the study of limb regeneration. One important device researchers use is to interfere with normal development or regeneration (for example, grafting limbs on backwards), let the organism cope the best it can, and see what happens. In this way they can isolate specific characteristics of organization by forcing them out of context. What Swedenborg says in *Economy I*, 263, seems pertinent to this: "When during the state of formation [the series of] contingents do not present themselves in their just proportion and rightful mode, the parts of the system are connected together in accordance with those contingents which are presented." This is an extremely apt description of what happens in these experiments.

Working from knowledge gained by experiments like this scientists have proposed some intriguing models of organization at the cellular level. Lewis Wolpert, in his penetrating article, "Pattern Formation in Biological Development,"²⁰ points out that develop-

²⁰ Lewis Wolpert, "Pattern formation in biological development," *Sci. Amer.*, Oct. 1978, pp. 154-164.

ment involves both cell differentiation and pattern formation, using the example that the arm and leg both contain the same types of differentiated cells, but their spatial organization is different. "It is this spatial organization of differentiated cell types that is the essence of pattern formation" (p. 154). One of the essential ingredients in the model Wolpert proposes is a mechanism for individual cells to acquire positional information. One way might be a gradient—some property which decreases continually with distance from a certain reference region, so the intensity of that property in a certain location would reflect the distance from the reference region, and transmit this information to the cells. The cells would interpret this information in terms of thresholds. "Above a certain concentration the cells differentiate as one type and below it they differentiate as another type" (p. 157). The way they react to these thresholds is genetically regulated. Another mechanism Wolpert suggests for positional information is a moving "progress zone" (on the end of a limb bud, for example), which leaves cells behind as they divide and proliferate. "If the cells can measure the time they spend in the progress zone, they will have acquired information about their position" (p. 157). There is evidence that special areas of tissue act as organizers for surrounding cells—if they are removed, rotated, or grafted onto a different spot, cell differentiation is affected accordingly.

Another group of researchers, building on Wolpert's earlier work, has developed a polar coordinate system to account for patterns of limb regeneration, which in many ways recalls embryonic development.²¹

The organizing forces in the embryo have an amazing sense of direction and context, and a high degree of ability to compensate for error and mutilation. This capacity reflects that the Lord is constantly bending our natural desires in the direction of regeneration, while still leaving us in complete freedom. In fact, developing organisms seem to have a clear destination. In *The Problem of Organic Form*, Edmund Sinnott points out that the fact that organisms reach the same formative end by different routes reveals a built-in purpose. "Unity lies in the end, not the beginning, of development."²² Swendenborg also addresses this point:

²¹ Peter J. Bryant, *et al*, "Biological regeneration and pattern formation," *Sci. Amer.*, July 1977, pp. 66-81.

²² Edmund W. Sinnott, *The Problem of Organic Form*, Yale Univ. Press, 1963, p. 205.

...In no living subject do any of the several vessels, nerves, nerve fibers, and so forth, run through exactly the same courses; yet notwithstanding their differences in this respect, they all live in unanimity, and the life of all is suitable to the state....

...When distant and ultimate ends are kept in view as if they were present, intermediate ends are comprehended at once, and are carried onwards with a fixed aim and unerring direction....

No condition of the organism is primarily the cause of the internal faculties, but that formative force or substance is the cause, whose nature, and the nature of whose representations, determines the form of all things in the body. Hence no condition of the organism is the cause of our enjoying reason-but the soul is the cause (*Economy I*, 255, 260, 269).

When looking at a series of embryos of different creatures, all looking so similar (fig. 15), one can well believe that the final end is

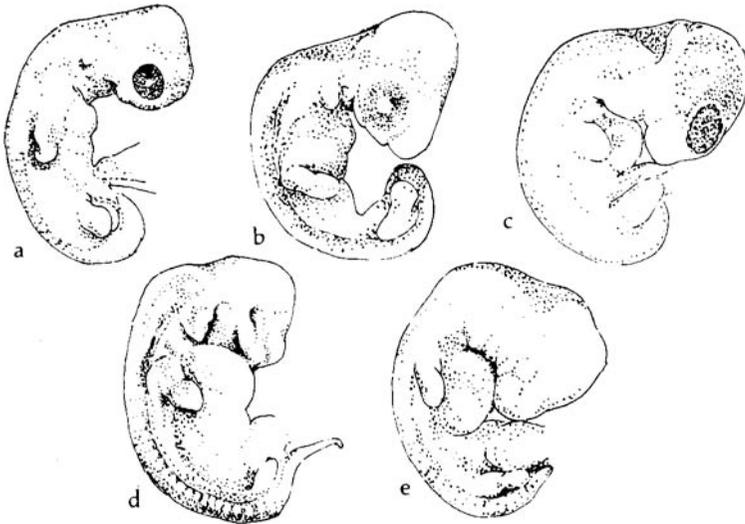


Fig. 15. Embryos of different vertebrates at similar stages of development, (a) turtle; (b) chick; (c) mouse; (d) pig; (e) human. Note the similarity of the limb buds and the differences in the shapes and sizes of the heads. Drawn from photographs in Curtis, *Biology*, figs. 23-44.

not determined by the present state of a living thing. It depends on it, builds on it, refers to it, but is not determined by it. Creatures resemble each other because their genes make use of the same physical laws and phenomena for their expression. But it is obvious that mechanical forces are not the only ones at work. It is the influx of life from the Lord working through the purest substances of nature that produces living beings. About this interaction of inner and outer forces the Writings say:

On the outside the human body is kept in form by atmospheres...; and unless it were also kept in form within by some acting or living force, it would fall to pieces.... The Grand Man...is that prior thing by which man...is connected with the First, that is with the Lord. There are always two forces which...keep everything in its connection and in its form, namely, a force acting from without, and a force acting from within, in the midst of which forces is that which is kept in connection and form (AC 3627, 3628²).

Both the brain and blood are important links between these forces:

The very forms of man's organs, members, and viscera...are from fibers that arise out of their beginnings in the brains, but they are fixed by means of such substances and matters as are in the earths, and from the earths in the air and ether and...this is effected by means of the blood (DLW 370).

On the importance of the blood:

As the life of the body consists in the blood, this is its ultimate soul, so that the blood may be said to be the corporeal soul, or that in which is the corporeal life of man;...the soul or celestial life [is] represented by the blood (AC 1001⁵).

In *Divine Wisdom* II:iii and in many places in Swedenborg's scientific works, it says that all things are formed in the womb by means of fibers. In possible connection with this it is interesting to note that the glial cells are among the first to form in the embryonic nervous system, and the growing neurons twist around them like the tendrils of a climbing vine (fig. 16). Similarly, in primitive muscle tissue, it appears that the connective tissue cells organize the form of the future muscles.²³

²³ Wolpert, *loc. cit.*, p. 160.

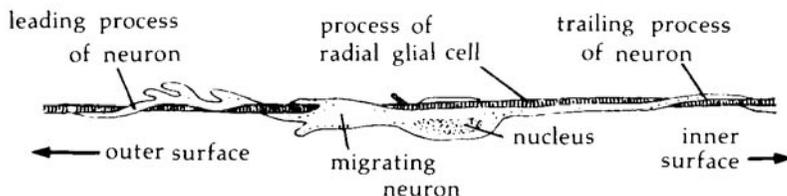


Fig. 16. Migration of a neuron on a radial glial cell, which arises early in embryonic development to guide and support growing neurons. The neuron grows from the inner to the outer surface of the neural tube. (Redrawn from Cowan, "The Development of the Brain," *Sci. Amer.*, Sept. 1979, p. 124.)

It is hard not to anthropomorphize the formative forces in the embryo because they so fully and powerfully embody the wisdom of the Creator. In speaking of them we use such terms as "decode," "interpret," "decide," "recognize," "discriminate," "infer," and "know," which are usually considered to be activities of a conscious mind. Knowing, though, is more than containing information, or even applying it appropriately; and it is the Supreme Consciousness who confers this information.

Much remains to be uncovered about the mechanism of organization in development. Incomplete answers are tantalizing, and useful despite their incompleteness. The connection between these finely tuned mechanisms of physical development and the way the Lord imperceptibly guides us to eternal happiness has yet to be explored.

Other Parallels

That there is a correspondence between human gestation and regeneration has been well established doctrinally (see Appendix B, part I), and abundantly illustrated above. I would now like to show how they are also related to the larger sequences of biological evolution and human history, which might be considered spiritual evolution.

Gestation, Regeneration and Human History

That man in his lifetime goes through the stages passed through by the human race is indicated in *True Christian Religion* 762:

Divine order...requires that there be a beginning and then its end before a new beginning starts in.... It is the same with

churches;...the first which was the Most Ancient was like morning, spring and the east; the second or Ancient Church was like day, summer and the south; the third was like evening, autumn and the west; and the fourth like night, winter and the north.... In the Lords sight the church is seen as a single man, and this larger man must pass through his stages of life like an individual...from infancy to youth, from this to manhood, and finally to old age; and then, when he dies, he will rise again.

This parallel refers not only to man's whole earthly life, but also to each cycle of death and rebirth; for example, from birth to maturity. In man's infancy he is surrounded by celestial angels, as the Most Ancient Church was a celestial church; in childhood he associates with spiritual angels, as the Ancient Church was spiritual; and in youth he is influenced by natural angels, and his state is like the natural state of the Jewish Church. At maturity there is a renewed influx of spiritual things, and the ascent to regeneration begins.

Since regeneration reflects human history, gestation does also, as it prefigures regeneration. A clue to the correlation between gestation and human history is furnished by Nebuchadnezzar's statue, also mentioned in *True Christian Religion* 762, of which the head was gold, the chest and arms silver, the belly and thighs brass, the legs iron, and the feet iron mixed with clay. The different metals represented the successive churches whose ages were named for them. The embryo grows from the head down,²⁴ and this statue might illustrate its descent through successive degrees of formation, as it represents the descent of the churches.

Gestation and Evolution

The idea that gestation recapitulates the stages of evolution has lost credibility from exaggeration and misapplication, but I find a great deal of truth in it. An organism does not go through the adult stages of all its ancestors, and certainly not in order; but it does use the embryonic development of its ancestors as a jumping-off point, retaining those features which are most useful. The different organ systems mature at different rates according to the necessity for their function, which obviously precludes a strictly chronological

²⁴ As Stephen Gladish points out in "A new conception of marriage: angel-making" *New Church Life*, Feb. 1981, pp. 92-94.

recapitulation. The embryo never reaches a stage where it resembles one of its ancestors as a whole, at one time. For example, the human heart is distinctly a mammal's heart months before birth, when the baby begins to breathe air (more on this later).

The following are some features in the human embryo that clearly suggest recapitulation: the one-celled zygote reflects descent from protozoa; the two-layer stage resembles the two-layered hydra; the notochord is common to some life stage of all chordates; the branchial arches become gill slits in the fish, and in fact the system of blood vessels in these arches is very similar in the human embryo and the fish (fig. 17). Other fish-like features are the single heart and a characteristic called segmentation. Fish have rows of W-shaped muscles, all alike, running down their entire bodies; each muscle has an identical vertebra and rib for bony support and a similar nerve system (fig. 18). This segmentation is preserved especially in the vertebrae, ribs, and associated muscles of mammals, but much of it has been extensively modified in the course of evolution, particularly for the construction of neck, limbs and jaws. In the embryo this segmentation is much more conspicuous, taking the form of mesodermal somites (fig. 19), which eventually turn into bones and muscles. At one time there may be as many as 44 somites. The top four are incorporated into the occipital bone of the skull; the bottom eight to ten somites, which form the "tail" (another evolutionary relic) regress and fuse to form the coccyx, leaving enough for the usual number of vertebrae. Other ancestral traits are the cloaca, or single alimentary-genital orifice, and the yolk sac, reminiscent of egg-layers.

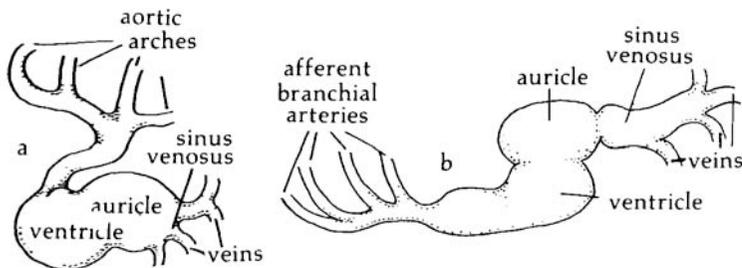


Fig. 17. Comparison of (a), human embryonic heart and aortic arches, and (b), heart and branchial (gill) arches of a fish. (Redrawn from Moody, *Introduction to Evolution*, fig. 4.16.)

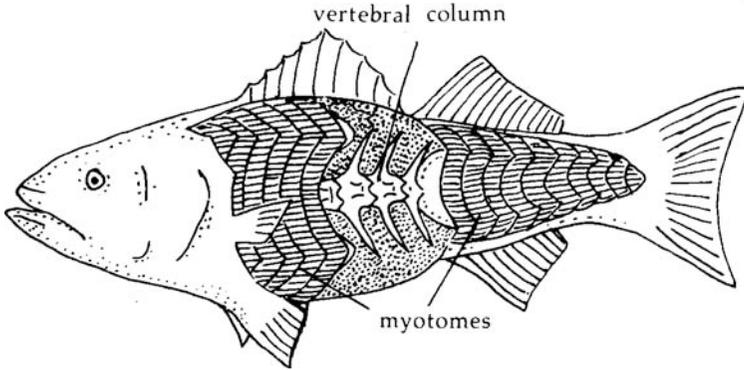


Fig. 18. Segmental skeleton and musculature of a typical fish. (Re-drawn from Moody, fig. 4.9, after Gregory and Roigneau, *Introduction to Human Anatomy*, American Museum of Natural History, 1934.)

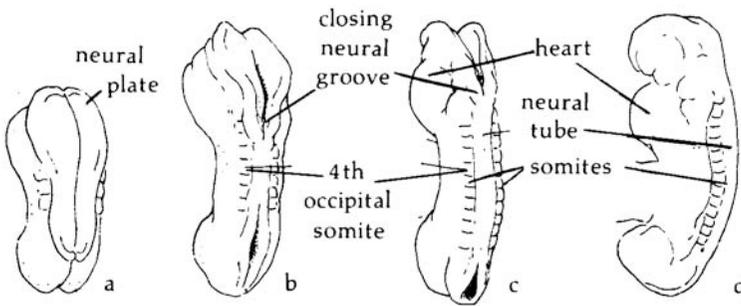


Fig. 19. Early human embryos showing mesodermal somites. (a)-(c) back views; (d) side view, (a) 3 somites, 20 days; (b) 7 somites, 22 days; (c) 10 somites, 23 days; (d) 14 somites, 25 days, (a) modified from Crelin, "The Development of the Nervous System," fig. A in *Clinical Symposia*; (b-d) from Hamilton, *et al*, figs. 113-115.)

New Church doctrine seems at least to imply a relationship between these two processes. If the single man in his regeneration recapitulates both his own embryonic development and the history of the human race, as the Writings do state, then it follows that his prenatal development would mirror the history of life—if we believe this history to be biological evolution as it is commonly understood.

Evolution and Regeneration

Now it remains to pair evolution off with the other two processes—the spiritual ones, regeneration and human history. For an idea on how to proceed with the connection between evolution and regeneration, we turn to the Creation story and correspondences of different animals. On the fifth day of Creation the birds and fishes are made, signifying that man first begins to live (AC 39); fish correspond to memory-knowledges of the external man, and birds to rational and intellectual things of the internal man (AC 40). The beasts, creeping things, and wild animals created on the sixth day signify things of the will (AC 44). In AC 674 we read that beasts signify celestial affections, or things of the will; birds signify spiritual affections, or things of the understanding; and creeping things of the ground the lowest of both of these, or natural knowledges and desires.

As for invertebrates, the Writings say that insects represent the most external truths and falsities. Insects are called the "lowest flying things" (AC 776).

There seems to be a correlation between higher animals and higher affections, and between lower animals and lower affections. Mammals represent the higher things of the will, whether good or evil, and reptiles the lower things. Birds are intellectual, fish signify memory-knowledges, and insects the most ultimate truths.

Here I am obviously stressing the animal correspondences which seem to agree with the evolutionary trend. But in fact there are many discrepancies: whales are classed with fish, and birds appear to come before reptiles in the Creation story. Besides, many of the correspondential series in the Writings are between closely related groups of animals, different kinds of birds or mammals for example. At any rate, the diversity of the animal world reflects the varieties of affection and thought in man, which the Lord orders and bends toward good and truth in regeneration.

One striking element in evolution is the way the mode of reproduction changes in vertebrates: from the jellylike eggs laid in water by fish and amphibians, to the hard-shelled, yolk-filled, amniote eggs of reptiles and birds, to viviparity in higher mammals. This strikes me as significant. There is a possible connection between the amount of yolk in the eggs and the extent of instinctive knowledge in the animals that hatch out of them. In embryonic development, whether of fish, bird or mammal, the

yolk sac is connected with the digestive system, both being of endodermal origin, and both being concerned with nutrition. This implies an association of yolk with knowledges of truth. Man has so little yolk in his egg that it is used up before the yolk sac is even formed; the ovum's dependence on the mother for nourishment begins only a few days after conception, and does not end until long after birth. In a similar way, the child has a minimum of instinct at birth and must spend a great deal of time learning. A reptile or bird, on the other hand, starts out with a great quantity of yolk in a complete support system that requires only warmth, and is correspondingly equipped with a good deal of innate knowledge. However, the analogy seems to break down when we get to fish and amphibians, which rely on instinct even more than birds and reptiles, and generally have less yolk.²⁵ They probably need less of it in an aquatic environment; fish live in water and amphibians hatch at a relatively undeveloped stage, limbless and water-breathing.

The less instinct a creature is born with, the more capacity it has for learning and intellectual growth, and thus for free choice. As the extra-embryonic mesoderm might represent remains of good, the yolk sac, which originates in the endoderm, could signify remains of truth.

Evolution and Human History

Perhaps the most influential event in the progression of the churches was the fall of the Most Ancient Church and the subsequent separation of the will and understanding, which affects the nature of our present existence profoundly. The occurrence in evolution which seems to reflect this most faithfully is the transition from water-breathing to air-breathing in fishes, which involved a major modification in the heart and circulatory system. Both of these events have a parallel in the individual: in embryonic development, the septation of the heart, a most vivid example of recapitulation, and the change in circulation with the first breath at birth; in regeneration, the separation of the will and understanding which is necessary to self-compulsion and reformation. As stated in *Arcana Coelestia* 2256:3:

As the will of man, which is the one part of his life, has been utterly destroyed, the Lord separates this destroyed part from

²⁵ Hamilton, *et al*, pp. 436-437.

the other which is his intellectual part, and in those who are being regenerated, implants in this intellectual part the good of charity, and through this a new will; these are they who have conscience.

Therefore all these dynamic processes, evolution, gestation, human history, and regeneration, come together in the study of how fish learned to breathe air.

In his article "Air-breathing Fishes,"²⁶ Kjell Johansen describes some of the problems and processes associated with this event:

The typical gills of a fish, although well-suited for gas exchange in the water, are totally unsuited to performance of that function in the air. In order to breathe air fishes had to develop air-holding chambers of one kind or another. Some species became air-breathers by adapting the stomach or a segment of the intestine to this purpose; they swallowed air and expelled it again at the mouth or cloaca. [This illustrates the similarity of function between the lungs and digestive tract.] The lungfishes have an air bladder that developed originally as a diverticulum from the gut. [This is the way the lungs originate in all embryos of land-dwelling vertebrates] (p. 103).

One thing which probably necessitated the change from water-breathing to air-breathing was a lack of oxygen in the water. When the fishes' source of oxygen changed, their circulation had to change too, and this had to happen gradually. There are several species of lungfish and other less advanced air-breathers alive today which illustrate this progression (fig. 20). These fish had two sources of oxygen—water and air—and two bodily mechanisms for obtaining it. To avoid confusion and to keep the gills from undoing the work of the lungs by dissipating oxygen in depleted water, some fish developed double circulations which are the forerunners of the circulatory pattern we share with birds and mammals. We need double circulations simply because we are lung-breathers. As Johansen says, "For fish the single circulation is perfectly adequate; the gills are highly efficient gas exchangers, and the blood flowing freely through them needs no extra input of energy in order to travel on through the arterial system" (p. 105). This is not true of lung-breathing; the blood from the lungs does need an extra push to send

²⁶ *Sci. Amer.*, Oct. 1968, p. 102-111.

it through the system. However, even though true lungfish have double circulations, they are not completely separate and there is some mixing of blood; this is simply unavoidable with two sources of oxygen.

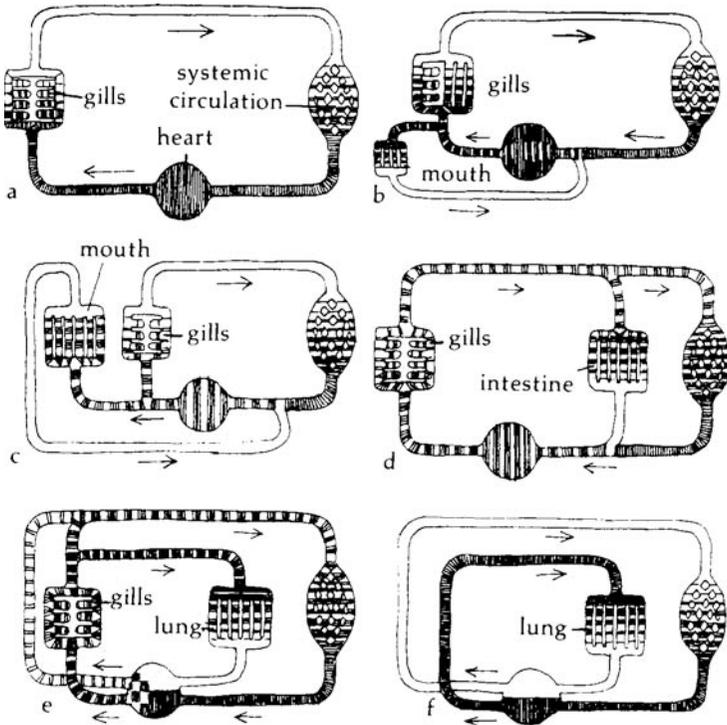


Fig. 20. Diagrams of vascular systems, (a) typical fish; (f) birds and mammals; and various air breathing fishes: (b) *symbranchus*; (c) *eledrophorus*; (d) *hoplosternum*; (e) lungfish. "Water-breathing fishes have a single circulation with no mixing between oxygenated [light] and deoxygenated [dark] blood (a). Birds and mammals have a double circulation with no mixing (f). In the others there is more or less mixing of blood. The lungfish arrangement (e) was conducive to development toward the vertebrate condition: two circuits are arranged in parallel, with variable mixing." (Redrawn from Johansen, "Air-breathing Fishes," *Sci. Amer.* Oct. 1968, p. 104.)

The circulation of the human fetus is subject to the same kind of ambivalence, because the baby receives oxygenated blood through the umbilical cord while at the same time the circulatory system is preparing for the major adjustment it must make when the lungs assume their function at birth. There are two possible paths the blood can take through the fetal heart. Blood from the inferior and superior venae cavae both enter the right atrium; most of the fresh blood from the inferior vena cava, supplied by the placenta through the umbilical cord, crosses the heart through the foramen ovale, leaves by the left ventricle and enters the system; but it is slightly mixed with used blood from the superior vena cava, supplied by the upper body and head, which flows into the right ventricle and thence to the lungs (fig. 21). Before birth, receiving no oxygen, the lungs only deplete it further, but this pulmonary circulation is a necessary preparation for birth.

Those fish which breathe both water and air resemble a newborn infant who has begun to breathe air and yet still receives oxygen through the umbilical cord. The stimulus which initiates breathing is similar in the fish and the newborn:

The response [breathing] is probably triggered by the sudden translation of the fish from its weightless condition in the water to the exposure to net gravitational force in the air. This represents a massive physical stimulus that may well jolt the animal into a burst of rapid breathing.... [There is a] phylogenetic parallel to mammalian ontogeny. The newborn baby's first breath after it emerges from the amniotic pool of its mother's womb seems to be triggered by the massive impingement of physical stimuli to which it is suddenly exposed in the air (*ibid.*, p. 109).

Like the baby still attached to a functioning umbilical cord, lung-fish cannot have completely efficient and unmixed circulation while they still depend in part on aquatic respiration. In fact, amphibians and reptiles have incompletely septated hearts, with resultant mingling of bloodstreams. This aspect of the evolution from fish to mammal consists of a functional division of the heart (fig. 22) which foreshadows the separation of the will and understanding in the Most Ancients. Air-breathing in fishes was apparently stimulated by lack of available oxygen in stagnant, swampy water due to organic impurities and hot sun,²⁷ which might represent the self-

²⁷ Kjell Johansen, "Air-breathing fishes," *Sci. Amer.*, Oct. 1968, p. 103.

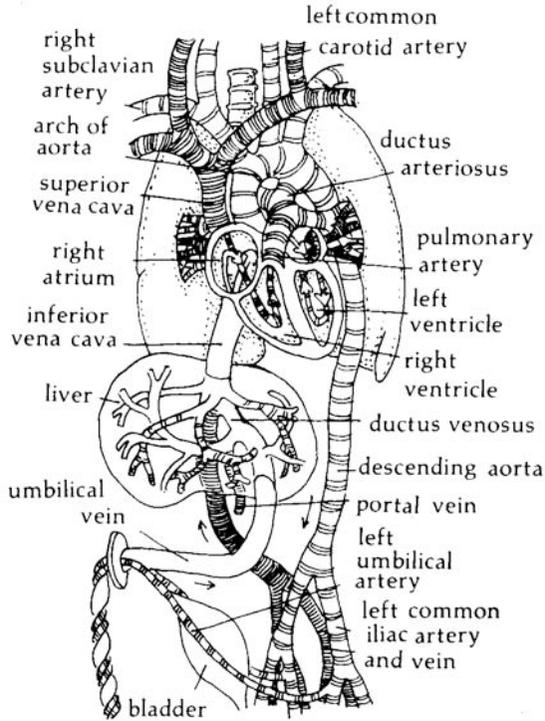


Fig. 21. Scheme to show the fetal circulation. Oxygenated blood—light; deoxygenated blood—dark. Blood is detoured past the lungs in two places: the foramen ovale, between the right and left atria, and the ductus arteriosus. After birth both of these channels will close, allowing all the blood to circulate through the lungs at each cycle. (Redrawn from Hamilton, *et al*, fig. 190.)

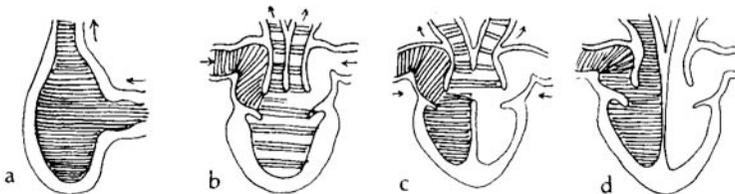


Fig. 22. "The hearts of four classes of vertebrates." (a) fish; (b) amphibian; (c) reptile; (d) mammal. "There is increasing separation between the two sides of the heart, with consequent decrease in the amount of mixing between oxygenated [light] and deoxygenated [dark] blood." (Redrawn from Keeton, *Biological Science*, fig. 7.23.)

love of the Most Ancients⁷ descendants changing truth into falsity. They were suffocated until the will and the understanding were separated and a new route of breathing was established (AC 1119). In this connection it is significant that reptiles are the lowest animals to have coronary arteries²⁸—a separate blood supply just for maintaining the heart. This relates to the purification of the will by the understanding, which was not necessary for the Most Ancients. In lower animals diffusion from the blood flowing through the heart on its way to the rest of the body is sufficient for its nourishment. Again, this is well-illustrated by the change in circulation at birth. The closing of the foramen ovale in the heart means that the good of love (right atrium) cannot flow directly into the truth of faith (left atrium), but must itself be purified by truth from without (oxygen from the lungs). This change also graphically demonstrates mans passage at birth from the kingdom of the heart to the kingdom of the lungs (AC 4931:3).

It may seem odd to consider cold-blooded, water-breathing fish, which correspond to external memory-knowledge, as representing the Most Ancients, who were the most celestial of earth-dwelling men. I see those suffocating fish as demonstrating that, at the fall, the Most Ancients were corrupted even to externals, and these had to be modified to preserve the human race from damnation. Not only did their breathing change, but their facial nerves were also re-routed to the cerebrum (AC 4326:3). The single hearts of most fish evoke the simplicity and innocence of the Most Ancient Church, and their inability to separate any part of themselves from their corrupted wills after they had turned from the Lord to self-worship.

Those enterprising fish who acheived air-breathing have something to say about regeneration too. Since gas exchange in air is less efficient than in water, and air is a "higher atmosphere" than water—more rarefied, less limited—perhaps this reflects that spiritual truth is harder to perceive than natural truth. The fact that gills are too fragile to survive out of water and collapse under their own weight²⁹ suggests that receptacles of natural truth cannot attain to spiritual truth, but are bogged down by ideas of space and time. And yet natural knowledge paves the way for the reception of spiritual truth. Again turning to human birth for an example, we find that the fluid in the lungs, by distributing surface tension, facilitates their expansion in the first breath.³⁰

²⁸ *Encyclopedia Britannica*, 1975, 3:876-878.

²⁹ Johansen, *loc. cit.*, p. 103.

³⁰ John A. Clements, "Surface tension in the lungs," *Sci. Amer.*, Dec. 1962, pp. 121-130.

But after all, the history of vertebrates is only a tiny part of evolution. Who knows what dramatic events we would find if we looked at protozoa, nematode worms, molluscs, annelids, insects, starfish? They also strive toward the human form; they also unite love and wisdom in use. And what about plants? They, too, made the transition from aquatic to terrestrial life; they too had to evolve structures that would support their weight in air, and develop vascular systems.

Those branches of organic beings which have not culminated in man are yet, in their way, continually drawing near to the human form, and this continual approach is the essence of their own reflection of humanity. This is also true of man, who always has the capacity to ascend to a closer and closer union with God, for in heaven he is being perfected to eternity; love and wisdom in him are more fully married, and each conjugal union grows more intimate. The Grand Man of Heaven grows more perfect as more people join it and perform their individual and beautifully complementary uses. And to think that each human being began as a single cell—and the remote ancestor of a protozoan gave rise to the entire Grand Man!■

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