

De Formato Foetu

The embryological treatise *De formato foetu* (The Formed Fetus) was written by anatomist and embryologist Girolamo Fabrici. There is no conclusive evidence regarding the first date of publication and what is listed on many copies ranges from 1600–1620, with speculation that the dates were altered by hand. Most forms of the book are dated 1600 and were issued by Franciscus Bolzetta who sold many copies in Venice and whose name appears on the engraved title-page. There is also verification of the book being printed in Padua by Laurentius Pasquatus in 1604. This treatise was the last publication to be issued before Fabrici retired from his teaching position at the University of Padua and it was the last anatomical work of his to be published during his lifetime. The book illustrates Fabrici's views on the anatomy of the fetus and uterus and demonstrates his struggle between accepting traditional authority and relying on his own experience in his investigations in embryology.

In the introduction of *De formato foetu*, Fabrici informed the reader that his studies in embryology had been separated into three parts to cover the topic of generation. Fabrici wrote that the first part of his studies would document the generation of the semen and the organs that produce it, but the intended manuscript, presumably *De instrumentis seminis*, was never published and is considered to have been lost. He wrote that the second part of his studies would be published in the book *De formatione ovi et pulli* and would deal with how the semen interacts to generate the fetus, and the topic of *De formato foetu* would cover the form of the fetus.

De formato foetu is separated into two parts. In part one, Fabrici describes in detail the morphological features of the fetus and the uterus, having performed dissections of both. Fabrici brought to light observations by Aranzio, a contemporary anatomist of his time, and asserted that Aranzio was incorrect in his beliefs that the human fetus lacked an *urachus*, the embryological canal that connects the urinary bladder of the fetus to the allantois, the sac-like feature involved in nutrition and excretion. Fabrici wrote that true cotyledons are found only in the pregnant ruminant uterus, such as in cows. He also took into account the presence of a fetal heart beat. These last two observations proved his predecessor, Leonardo da Vinci, flawed in his embryological annotations where Leonardo assumed that the human uterus had cotyledons as well and denied that the fetus had a heart beat.

In part two of the treatise, Fabrici examined the function of the umbilical vessels, placenta, chorion, allantois, amnion, fetal excretions, and heart vessels. Fabrici's writing conveys a heavy reliance on previous notions of anatomy put forth by Galen. He agreed with Galen that the nourishment of the fetus is delivered from the mother's blood to the fetus's liver via the umbilical cord and vessels. One slight difference in Fabrici's view was that the blood did not require the purification that Galen thought it underwent before reaching the fetal liver. Fabrici reiterated Galen's view of special vital spirits that connected the fetus to the mother through veins and arteries and allowed it to grow and mature within her uterus. Fabrici expressed his belief that the fetus lacked blood in the liver and the vital spirits that the full grown man had in the heart. He believed that the umbilical arteries were responsible for supplying the fetus with the vital spirit from the mother and the umbilical vessels carried out the function of supplying the fetal liver with blood. Fabrici agreed with Galen that the umbilical vein connected directly to the liver and that the liver was the source of all veins. Fabrici noted that if the umbilical cord were to be cut, the vital spirit delivered from the mother via the umbilical vessels would be cut off and the fetus would die, which he thought proved its reliance on the mother for vital spirit. Fabrici also followed the philosophy of Aristotle, which held that every organ served a purpose. He noticed that upon the delivery of the child, the umbilical cord dries up and disintegrates, having performed its function within the womb.

Fabrici gives some original, though mistaken, thought to the placenta, which he studied in greater accuracy than his forerunners in anatomy. Fabrici is considered the first to have articulated a classification among various placentas in different animal species, and he limited the term placenta only to descriptions of the discoidal placenta found in humans. He is also known as the first to have studied the human decidua, the term used to discuss the lining within the uterus during pregnancy. Fabrici contested Aranzio's beliefs regarding the function of the placenta, claiming that the placenta only purified a tiny amount of blood, whereas Aranzio thought the placenta acted like a uterine liver in that it fully purified all of the blood that nourished the fetus.

Fabrici followed the tradition of previous anatomists in thinking that the chorion was the receptacle for fetal urine. In his discussion of the allantois, Fabrici noticed that this structure was not evident in the fetuses of every animal, and he asserted that it was an extra organ in humans that acted as an additional receptacle for urine. Fabrici then noted that the amnion, a membranous sac that surrounds and protects the fetus, was the container for fetal sweat. In his discussion of fetal waste, Fabrici agreed with the principals that Galen endorsed. He restated that the fetus had six waste products including sweat in the amnion, urine in the chorion or allantois, bile, phlegm, feces, and caseous necrosis of the skin. On the fetal heart, Fabrici returns to his thesis on the mother being integral for supplying the vital spirit to the heart of the fetus. He asserts that the heart beats only for its own preservation and has no relevance to the body until the child is born, when it receives its own vital spirits that it must sustain. Fabrici noted that the heart beats and grows while receiving cooling from the mother's body, and after the child is born the heart is then cooled by the process of breathing. On the position of the fetus in the womb, he assumed that perceived differences in the anatomy of the sexes determined orientation, such that males were top heavy and therefore faced down in the womb while females fetuses were positioned upright because they were bottom heavy. He ended the book with an emphasis on how much Nature provided for the development of the fetus.

Included in the book are comparative studies on the morphological details of the uterus and fetuses in dogs, cats, mice, rabbits, goats, guinea pigs, sheep, cows, horses, pigs, birds, sharks, and humans. Fabrici is responsible for accurately describing the umbilical cord and its vessels in great detail, and for asserting the differences in the placenta between animal species. Fabrici also provided an accurate description of the heart and pulmonary vein in the fetus. Fabrici wrote that the circulation of blood was directly connected between mother and fetus, whereas his student William Harvey later claimed that the circulatory systems were separate.

The book is illustrated by an unknown artist and contains thirty-four engraved plates depicting the comparative anatomy of the uterus and the fetuses in humans and other animals. Fabrici is considered the first to study and depict the human decidua of the human uterus, although he did not name the organ or know what to call it other than a thicker membrane that was attached to the uterus. In addition to the black and white engraved illustrations that are found within the volume, some copies of the book are included with a set of colored plates with over ten additional pages of explanation. The colored plates have since been collected and are held in library of the College of Physicians at Philadelphia.

The scope of Fabrici's achievements as an embryologist is evident in his manuscripts and the publication of his book. This treatise displays a gradual evolution of knowledge in embryology as well as how prevalent traditional authority was in the literature and scientific exploration of the time. His writings influenced later scientists like William Harvey and his illustrations present a comparative look at embryology in different animals that is of value now as it was then.

Sources

1. Allen, Garland E. Thomas Hunt Morgan: The Man and His Science. Princeton: Princeton University Press, 1978.
2. Allen, Garland E. "Morgan, Thomas Hunt," Dictionary of Scientific Biography 9: 515-526.
3. Maienschein, Jane. Transforming Traditions in American Biology, 1880-1915. Baltimore & London: Johns Hopkins University Press, 1991.