Albrecht von Haller (1708-1777) [1]

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Victor Albrecht von Haller [5] was an 18th century scientist who did extensive work in the life sciences, including anatomy and physiology, botany, and developmental biology. His embryological work consisted of experiments in understanding the process of generation, and led him to adopt the model of preformationism called ovism (the idea that the new individual exists within the maternal egg [6] prior to conception [7]). Haller was born in Bern, Switzerland, on 16 October, 1708. His mother was Anna Maria Engel, and his father was Niklaus Emanuel Haller. The Hallers were an old family in Bern, and Haller spent the majority of his life there. During his life, Haller made many important contributions to medicine, botany, anatomy, and physiology. Haller became one of the most outspoken supporters of preformationism, and the long debate between Haller and Caspar Friedrich Wolff [8], who supported the competing theory of epigenesis [9] in which form emerges gradually, is a hallmark of this time period in developmental biology. Haller also formulated an accurate model of the rate of fetal growth [10] during gestation [11], demonstrating statistically that development at the beginning is more rapid than growth later on.

Haller's life encompassed both scientific disciplines and political careers. In early life Haller was educated by a tutor, attended public school, and received instruction from his step-uncle Johann Neuhaus, a physician. He studied medicine at the University of Tübingen in January of 1724, leaving in April 1725 to attend the University of Leiden [12]. Haller studied there under the famous Hermann Boerhaave [13], and graduated as a doctor of medicine 23 May 1727. He then spent a year abroad, traveling to universities across Europe, studying mathematics under Johann I Bernoulli at the University of Basel [14], and hiking in the Alps to collect specimens for his botanical work.

He returned to Bern in 1728, but spent that winter at Basel, lecturing on anatomy. Upon his return to Bern in 1729, Haller attempted to begin a medical practice, but was unsuccessful. He supported himself by tutoring until 1736, when he accepted a professorship in medicine at the newly established University of Göttingen. He taught at Göttingen until 1753, when he left academia in order to enter politics. He held various political offices in and around Bern for the remainder of his life. He married three times, each of his first two wives succumbing to early deaths, and raised eight children to adulthood.

It was in Bern, in 1728, that Haller began the anatomical and botanical research that he would pursue even after he began his political career. Haller held an iatromechanical view of anatomy and physiology, in which the body works by mechanism, according to the laws of physics, as opposed to a vitalist view in which the soul or anima drives the body. Building on Boerhaave's theory that the basic units of organic material are fibers, Haller made important discoveries in the action of muscles and nerve and was the first to give an account of their physiology as a function of their structure. He made studies of teratology [15] (birth defects [16]) and notably used the anatomy of Siamese twins who shared a heart to prove that the blood did not carry consciousness or will. His research into the heart's function produced an accurate description of the order of contraction of atria and ventricles. Haller also formulated an explanation of how the heart automatically beats. According to Haller, the muscles of the heart became irritated when filled with blood, and contracted to pump the fluid out again. Haller performed similar investigations into the lungs, vascular system, and nervous system, always explaining the observed physiology as a function of anatomical structure.

Haller's views on embryo development changed dramatically twice in his life. Boerhaave's instruction influenced Haller early in his career to adopt the spermist preformation [17] model of embryological development. However, Haller never published any scientific work supporting spermism, nor performed any research in that area. His attitude towards spermism was that of a student following his teacher's guidance, and Haller wrote that he had been "brought up on" spermism in the footnotes of a collection of Boerhaave's lectures. Yet while employed at the University of Göttingen, Haller learned of the discovery of reproduction by regeneration in polyps/hydras by Abraham Trembley [18], and Charles Bonnet [19]. It seemed clear to Haller that no miniature embryo could exist in the parts of the polyps that had been severed and grew back into whole animals, and he wrote in 1746 that based on this new research, any scientist who was not unreasonably devoted to the theory of preformationism would be similarly convinced that development occurred as emergence of form as the theory of epigenesis [9] states, not as the growth of miniature preformed parts.

And yet, after doing extensive microscopic research on chicken [20] embryos, Haller became just such a devotee of ovist preformationism. In 1757, Haller produced what he and others felt was proof that the chick [21] existed within the egg [6] prior to fertilization [22] by the male. His proof rested on " membrane continuity," that is, the evidence that the yolk [23] sac of the egg [6] was

an outgrowth of the chick [21] embryo's small intestine. If the yolk [23] sac, which is present in unfertilized eggs, is of one piece with the developing chick [21], then Haller alleged that they must be created at the same time. Wolff ultimately proved that the continuity did not exist as Haller observed, through the use of more skilled microscopy [24] than Haller, who suffered from poor eyesight.

Haller suggested that fertilization [22] of the egg [6] by sperm [25] spurred the tiny and transparent heart of the preformed offspring to beat, pumping fluid through the tiny embryo and causing structures to enlarge and unfold. It was therefore very important to Haller's theory to prove that the heart existed and beat at the very earliest stages of the embryo's development. Because the chicken [20] embryo heart actually does not begin to beat until about 29 hours of incubation, Haller could not have observed this or proved it. However, based on the fact that preparing specimens with alcohol or vinegar often revealed structures earlier than they were able to be seen otherwise, Haller maintained that the heart was simply too transparent to see before this time.

Albrecht von Haller [5] contributed extensively to several branches of science. His work in embryology [26] provided future naturalists with arguments in support of both of the theories of epigenesis [9] and preformationism, and also raised important problems with each theory. Haller left behind a wealth of observational data in the field, useful in understanding how he arrived at his final conclusion. In some ways, Haller, as an influential and venerable scientific patriarch, may have stymied the growth of the science of embryology [26] by being so insistent towards the end of his life in support of ovist preformationism. However, his novel approach to anatomy and physiology, describing organ and tissue as a function of structure, would assure him a place in scientific history even aside from his embryology [26] work. Haller died in Bern in 1777 on December 12, at the age of 69.