Preformationism in the Enlightenment [1]

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Preformationism was a theory of embryological development used in the late seventeenth through the late eighteenth centuries. This theory held that the generation of offspring occurs as a result of an unfolding and growth of preformed parts. There were two competing models of preformationism: the ovism model, in which the location of these preformed parts prior to gestation [6] was the maternal egg [7], and the spermism model, in which a preformed individual or *homunculus* was thought to exist in the head of each sperm [8]. Preformationism was a widely-held theory by Enlightenment-era scientists, but by the early 1800s, most scientists had abandoned it, in part because higher magnification in microscopes enabled them to see the very earliest stages of embryos as small collections of cells. Prior to preformationism, naturalists who studied embryo development favored the theory of spontaneous generation [9] in lower animals, such as flies, which appeared to arise from manure. In higher animals, however, scientists used the theory of epigenesis [10] as put forth by Aristotle [11], who said that maternal and paternal fluids came together in the uterus [12] and solidified during early gestation [6] into a fetus [13]. Preformationism was the first theory of generation and development that applied to all organisms in the plant and animal kingdoms.

The philosophical roots of preformationism are in the metaphysics of Descartes, who introduced the concept ofmaterialism [14]. Cartesian philosophy [15] demands that the world be thought of as completely mechanistic and deterministic, with no intangible force driving or interfering with the interactions of physical objects. To the materialists, epigenesis [10] seemed to require the introduction of a vital force [16] or intelligence (*vis essentialis* [17]) that knew how to organize the parental fluids into the physical structure of the offspring. Spontaneous generation also implied the metaphysical necessity of some non-physical force that created life from non-life.

Ovism [18] was the first conceptual model ofpreformation [19]. Spermatazoa were not observed until the invention of the microscope [20] and even afterwards, were initially considered to be parasiticworms [21] and not important to fertilization [22]. The naturalists of the time were familiar with the concept of young animals hatching from eggs, and it followed that animals that gave birth to live young might also have an egg [7] stage in their early development. William Harvey [23] is sometimes credited with the beginning of the ovist model with his statement, “ex ovo omnia” (from the egg [7], all) in 1651. However, Harvey himself was a proponent of the epigenetic theory of generation.

Jan Swammerdam [24] and Marcellus Malpighi [25] are more likely the scientific fathers of preformationism than Harvey. Swammerdam worked with insects [26] like silkworms, mayflies, and butterflies in the 1660s in an attempt to better understand the process of metamorphosis [27]. His work contributed to the preformationist concept by showing that the rudiments of adult structures like legs and wings exist within the larval stages of these insects [26]. Malpighi, in the 1670s, worked with metamorphic insects [26] as well, but is also well-known for his illustrations ofchicken [28] embryos at various stages of growth. Under a microscope [20], Malpighi saw tiny fully-formed organs and tissues that needed only to grow in size to become infant chickens. Later scientists and philosophers drew the conclusion that those tiny, pre-formed parts must exist from the very beginning, though it is interesting that neither Swammerdam nor Malpighi seemed to state this explicitly.

Preformationism rose to greatest prominence in the early eighteenth century. This time period saw the beginning of the concept of *emboîtement*, meaning encasement: the idea that each offspring is contained pre-formed within the gonads of its parents. Nicolas Malebranche [29], a Catholic priest and French Cartesian philosopher writing at the same time Swammerdam and Malpighi were conducting their experiments, contributed greatly to this model by formulating a fully reasoned explanation of it based on the Cartesian principles of mechanism and infinite divisibility. Malebranche was the first to state that every life that would exist on earth was created at the moment of Creation and that future members of each species were present in the ovary [30] of the first female of that species. This idea is often explained with the metaphor of a Russian nesting doll with an infinite number of smaller dolls inside. Naturalists at the time were captivated by the rational simplicity of this image.

Under the ovist model of preformationism, it was assumed that the seminal fluid from the male parent was only required to begin the process of growth in the preformed embryo. This idea was challenged by scientists such as Nicolaas Hartsoeker [31] and Anton Leeuwenhoek when they were first able to observe sperm [8] cells moving in semen [32]. These animalcules [33], as they were called then, seemed a perfect delivery system for little offspring, and to the spermist preformationists, their existence in itself indicated that the homunculus was contained in the sperm [8]. Hartsoeker is most famous today for a sketch he published in 1694 of a curled-up infant human in the head of a sperm [8], an image that became iconic of preformationism as a whole.

Preformationism was an important development in generational theory because it got rid of the confusing dichotomy of spontaneous generation [9] for some species and epigenetic development for others. It captivated naturalists and philosophers alike because it agreed with the prevailing metaphysical philosophy of the time, Cartesian mechanistic materialism [14]. The

preformationism model eventually lost favor as developments in embryology [34] called its basic premises into question. As better microscopy [35] tools and techniques became available, naturalists such as Caspar Friedrich Wolff [36] were able to observe earlier and earlier stages of embryonic development, including spermatazoa actually entering ova, leading to a revival in interest in the theory of epigenesis [10].

Sources

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