Franz Julius Keibel (1861-1929) [1]

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Franz Keibel [5] studied the embryos of humans [6] and other animals in Europe at the turn of the twentieth century. He lived and worked in several different parts of Germany and France. Keibel drew illustrations of embryos in many stages of development. Keibel used these illustrations, which he and others in the scientific community called normal plates, to describe the development of organisms in several species of vertebrates [7]. His illustrations are published in the sixteen-volume text *Normentafeln zur Entwicklungsgeschichte der Wirbelthiere* (Normal Plates of the Developmental history of Vertebrates [8]), published in 1895, and in the *Manual of Human Embryology*, which he edited with Franklin Paine Mall [9] of the US, published in 1912. Keibel's plates showed human embryos in different stages of development between the twelfth day and the second month after fertilization [10].

Keibel was born 6 July 1861 in Adelig Dombrowken, Poland. His parents were landowners Anna Scharlock and Hermann Keibel, and he had one sister, Sophie. Keibel went to three different secondary schools for his early education in Gdańsk and Grudziadz, Poland, and in Berlin, Germany. He then went to the University of Freiburg [11] in Freiberg im Breisgau, Germany, to study law for a semester. Afterwards, he instead pursued medicine, first at the University of Berlin [12] in Berlin, and then at the University of Strasbourg in Strasbourg, France. On 25 September 1887 he married Susanna Wehrenpfennig in Berlin. They had four children: three sons and one daughter. He finished his dissertation in 1887 on skulls with the anatomist and anthropologist Gustav Schwalbe [13]. He became a prosector at the University of Freiburg [11] in 1889 and in 1892 he became professor at University of Strasbourg.

Keibel started to work with Wilhelm His [14] in the 1880's at Strasbourg and they collaborated until 1904 when His died. His was attempting to complete a chronological map of the typical stages of human embryological development. Keibel already had experience in creating normal plates of pig [15] development in the mid 1880s. Normal plates are detailed drawings of embryos lined up at different stages of development. Embryologists used these tools to compare the normal developmental processes of embryos from different species within a taxon to ascertain the typical developmental history of a member of that taxon. Keibel's plates were accompanied with tables that included descriptions of the inner anatomy of the developing animal. Keible employed his plates and tables to distinguish normal variations in the course of development from developmental abnormalities. Keibel's plates contributed to Wilhelm His [14]'s work on the normal progression of human development.

By the early 1900's Keibel had focused on embryology [16]. He used his plates to test the biogenetic law [17] proposed by Ernst Haeckel [18], at the University of Jena [19] in Jena, Germany. According to the biogenetic law [17], each stage in the embryological development of an animal corresponds to the adult form of one of that animal's evolutionary ancestors. For example, as dogs descended from fish [20] at some point in their evolutionary history (phylogeny [21]), then according to the biogenetic law [17], dog [22] embryos would resemble adult fishes at some point during the dog [22] embryos' development (ontogeny [23]). The biogenetic law [17] held that ontogeny [23], the developmental pathway of some organism, recapitulates phylogeny [21], the evolutionary history of that organism's species. Keibel, after he detailed the process of pig [15] development in 1897, inferred from his results that the biogenetic law [17] must be false because when he attempted to identify a fish [20] stage in the ontology [23] of the pig [15], he didn't succeed.

Keibel's publication *Normentafeln zur Entwicklungsgeschichte der Wirbelthiere* (Normal Plates of the Development of the Vertebrates [8]) filled 16 volumes from 1897 to 1938 and mapped, in an encyclopedic style, the development of different species of vertebrates, such as humans [24], pigs [25], fowls [26], lungfishes [27], rabbits [28], and tarsiers [29]. Keibel created this publication in collaboration with some other contemporary anatomists, for example Karl Peter and Ambrosius Hubrecht, and he edited the volumes from 1897 to 1909.

In 1900 Keibel received the title of Extraordinat Professor at Strasbourg, which meant that he was a professor without an official chair, and then in 1912 he became an honorary professor. However, with the title of honorary professor he still was not officially appointed a chair. From 1910 through 1912 Keibel collaborated with one of Wilhelm His [14]'s other students, Franklin Paine Mall [9], at Johns Hopkins University [30] in Baltimore, Maryland. Together, they edited two volumes of *Manual of Human Embryology*. In 1914 Keibel and Mall were funded by the Carnegie Institution of Washington [31] to establish a department of human embryology [16] in Baltimore, Maryland. Keibel and Mall's The Carnegie Institution of Washington [31] Department of Embryology eventually became a center of embryological research that remained active into the twenty-first century.

In 1914 Keibel's youngest son fought in the Alsace-Lorraine battle of World War I [32] and was reported missing in August of that
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