Jan Evangelista Purkyne (1787-1869) [1]

By: Minai, Mandana Keywords: avian eggs [2] Purkinje [3] germinal vesicle [4] female germ cells [5] Oocytes [6]

Jan Evangelista Purkyně, also called Johannes or Johann Evangelist Purkinje, studied cells in the cerebellum [7], fibers of the heart, subjective visual phenomenon, and germinal vesicle, in eastern Europe during the early nineteenth century. His investigations provided insights into various mechanisms and structures of the human body. Purkyně introduced techniques for decalcification of bones and teeth, embedding of tissue specimens, and eye examinations. He was one of the first to adopt the microtome [8] in his experiments and to use the term protoplasm when describing the contents of young animal embryos. Purkyně identified structures in the eggs of chickens, such as the germinal vesicle, from which he hypothesized the female reproductive cell (ovum [9]) developed, and around which he said an embryo developed. Purkyně's results helped others locate ova in mammals.

Purkyně was born on 17 December 1787 in Libochovice, Bohemia, later called the Czech Republic, to Rosalie Safranek and Josef Purkinje (Purkyně). His father managed one of Karl Johann Alois's, Prince of Dietrichstein, estates in northern Bohemia. Josef Purkyně stimulated his son's to study nature, but he died when Jan was six. Aided by the local schoolteacher and parson, Purkyně at the age of ten attended a Piarist monastery as a choirboy in Mikulov (Nikolsburg), in southern Moravia, at another of the Dietrichstein estates. When admitted Purkyně only spoke Czech, but soon learned both German and Latin. In 1806, in preparation for university studies, such as theology, law, and medicine, Purkyně went to the Piarist Philosophical Institute in Litomyšl, located in eastern Bohemia. After he studied with the Piarist monks, Purkyně took the first step, or orders as a novitiate, to becoming a monk. After he read the work of contemporary philosophers, including Johann Gottlieb Fichte and Friedrich Wilhelm Joseph Schelling, who both lived in Germany between the mid-eighteenth and mid-nineteenth centuries, he abandoned an ecclesiastical career and pursued philosophy at Charles University [10] in Prague, Bohemia. There he studied medicine and natural science. Purkyně´s 1819 inaugural doctoral dissertation focused on the visual phenomena of individuals.

Following Purkyně´s graduation in 1819 with a doctorate in medicine, he worked at the Charles University [10] as an assistant in anatomy and physiology. Professor of surgery, Johann Nepomuk Rust, and, professor of anatomy, Karl Asmund Rudolphi at the University of Berlin [11] in Berlin, Germany, helped him get appointed in 1823 as professor of physiology at the University of Breslau [12], Breslau, Prussia, later called Wrocław, Poland. In the same year, Purkyně published a classification of fingerprints and their use in identification, and later in 1823. In 1827, at the age of forty, Purkyně married Rudolphi´s daughter, Julia Rudolphi, and her death in 1835 eight years later left Purkyně with their two sons.

Between 1818 and 1825, Purkyně researched subjective sensory phenomena by experimenting on his own senses and conducted his work in his home laboratory. University officials´ didn't meet his request for space and equipment. He studied visual sensations after applying pressure on his eyeball. He used galvanic stimulation, in which he applied an electric current to stimulate his muscles to contract. Purkyně observed the blood vessels in retinas [13] by directing a narrow beam of light at the corner or white part of the eye, called the sclara. The light causes shadows of the blood vessels to fall on neighboring sensitive areas. The phenomena is called the Purkinjě tree because of the branching pattern. Purkyně also observed that when the illuminating intensity of light decreases, different colored objects, with equal brightness, appear to be unequally bright. For instance, in dim light or in light of less intensity, a blue object appears brighter than a red object. Furthermore, in bright light or in light of high intensity, the red object appears brighter than a blue object. Researchers later called those phenomena the Purkyně phenomenon, or Purkyně shift. Later Purkinjě described the threefold images of an object that one sees in the eye of another person, known as the Purkyně images. The images are reflections from the cornea and lens of the eye. Purkyně recommended that, to examine the interior of the eye, a concave lens should reflect light into the eye. In 1851 Hermann von Helmholtz [14], at the University of Königsberg, in Königsberg, Prussia, used this method with his ophthalmoscope.

Purkyně also studied vertigo, partly because of reading Erasmus Darwin´s *Zoonomia*. Erasmus Darwin, the grandfather of Charles Darwin [15], lived and worked in Lichfield, England, in the eighteenth century. Erasmus described the effects after viewing, rotating, and translating motions, but he described no after-effects. Purkyně observed such after-effects as the change in the apparent motion of one´s surroundings after stopping the body´s rotation around an axis. Purkyně induced the effect of vertigo by experimenting on himself in a specially designed chair. He found that the position of the head determines subjective motion and that the cerebellum [7] plays a major role in vertigo. His description of the relationship between the position of the head and perceived direction of motion was later called Purkyně´s law of vertigo.

Between 1825 and 1832, Purkyně studied the development of avian eggs in the body of female chickens before they laid the eggs. He isolated the germinal vesicle, later identified as the nucleus [16] of the fertilized egg [17]. Prior to his work, researchers argued about whether the embryo originated in the egg [18] or somewhere else. Some hypothesized that the embryo originated in the egg [18] white, or in the yolk [19], or in the white ovalbumin component, called chalazae. After Purkyně obtained an achromatic microscope [20], which eliminates the colored fringes that appear around objects viewed under the microscope [20], he examined female germ cells [21], which he had removed from chicken [22] ovaries that he had dissected. He observed a white elevation on the surface of the yolk [19], and he used a needle to pry the structure apart, revealing the vesicle, or nucleus [16]. He concluded from his observations that the vesicle must be the egg [18] cell, which he called the germinal vesicle, from which the embryo develops. Purkyně proposed that the ovum [9], or egg [18] cell, develops around the vesicle. Moreover, Purkyně theorized that while the vesicle is present in unripe ova, it dissolves after fertilization [23]. He described his observations in his essay entitled *Symbolae ad ovi avium historiam ante incubationem* (Contributions to the history of birds´ ova before incubation), which he published in 1825.

Purkyně's work influenced other scientists. He corresponded about his work with Ernst Karl von Baer in Künigsberg, Germany, who later discovered egg [18] cells in mammals. Purkyně's results, along with his finding of cellular structures he called granules in the animal and plant tissues, contributed to the development of cell theory. To describe the content of cells, Purkyně introduced the term protoplasm to identify the substance first formed in the development of an animal or plant cell. Furthermore, in the 1830s, Theodor Schwann, working in Berlin, Germany, built on these observations to construct the concept of cellular structure.

From 1829 until 1845, Purkyně investigated other phenomena. He introduced the conception [24] of physiological pharmacology in 1829, when he described the experimental effects on humans [25] of camphor, opium, belladonna, and turpentine, and studied the digitalis toxicity on himself. His research of phonetics, through observations on himself, influenced the work of Johann Nepomuk Czermak at Breslau, Prussia, and of Ernst Wilhelm von Brücke, in Berlin, Germany, during the mid-nineteenth century. Purkyně contested what he termed the speculative methods of physiology used by many researchers in central Europe, and he argued that physiology should be an experimental science. In 1839, he created one of the earliest departments of physiology at the University of Breslau [12], and then he created one of the earliest independent physiological laboratories in 1839, later called the Physiological Institute, in Breslau.

Purkyně used microscopes to study various features of bodies. Purkyně and his student Gabriel Valentine, working at the University at Breslau in the 1830s, described ciliary motion in what they called higher animals, along with its independence from control by the nervous system. They published an article about the ciliary motion in 1835. Ciliary motion occurs in tissues and results from hair-like organelles that line the surfaces of some cells and beat in rhythmic waves to move substances along the tissue. In 1837, Purkyně described the branched nerve cells [26] located in the brain of animals like sheep [27], calf, pig [28], horse [29], and human, and he described the fibers that form a network in the heart of those same animals in 1839. He examined the number and distribution of nerve fibers according to their diameters in the roots of both spinal and cerebral nerves in organisms from several animal species. He theorized that thick fibers had different functions than thin fibers.

Purkyně studied the skin of humans [25] and described the skin´s sweat glands. In addition, he studied the structures of bone, teeth and their development, cartilage, arteries, and veins. Purkyně showed that pancreatic extracts digest proteins, and he compared the cellular structures in plants and animals. He promoted the use of microscopes and was one of the first to teach microscopy [30] as part of a university course. Purkyně introduced techniques and tools to examine tissues with microscopes. He constructed an apparatus for flattening tissues between glass plates, called a compressorium, and he developed decalcification and grinding techniques to help the study of bones and teeth. Purkyně was one of the first to adopt the microtome [8], an instrument capable of slicing tissues into thin samples.

Moving to Charles University [10] in Prague in 1849, Purkyně established a second Institute of Physiology in Prague. After 1850, as a professor at Prague, he advocated science and learning among his countrymen who spoke only Czech. As education was available only to those who knew German or another common language, in 1853, Purkyně began publishing a scientific journal called *Ziva* in the Czech language. To make science more accessible to his countrymen, He strove to get Czech accepted as a language of instruction at the University of Prague [31]. In 1850, he was elected as a Foreign Member of the Royal Society of London, England.

Purkyně´s written work is collected in the first twelve volumes of *Opera Omnia* (Total Works). The thirteenth volume contains his autobiography. Several of his works are in *Opera Selecta* (Selected Works). Purkyně died in his eighty-second year on 25 July 1869.

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