Theodor Schwann

Lived 1810 – 1882.

Theodor Schwann was an anatomist and physiologist who is best known for developing the cell doctrine that all living things are composed of cells. He established that the cell is the basic unit of all living things. He believed that cells are governed by scientific processes and rejected vitalism which invoked the presence of some special energy or vital spark that only living things possessed.

His classification of different cells is the foundation of modern histology.

Schwann discovered the enzyme pepsin and discovered glial cells in nerves – these are now known as Schwann cells. He also identified the role that microorganisms play in alcohol fermentation.

**Beginnings and Education**

Theodor Schwann was born in Germany’s oldest city, Neuss, on December 7, 1810. He was the fourth son of Elisabeth Rottels and her husband Leonard Schwann, a goldsmith and publisher. Theodor attended the Tricoronatum – a Jesuit college in Cologne. There he was influenced by the religious doctrines of Wilhelm Smets. He remained a devout Roman Catholic throughout his life.

In 1829, aged 18, he began studying medicine and natural sciences at the University of Bonn, where he met and was influenced by physiologist Johannes Müller, a trailblazer in practical methods of physiology and anatomy. Müller would later write *Elements of Physiology*, which became the leading physiology textbook of the 1800s.

Müller believed in science backed by observation, but he was a vitalist, believing that new cells are formed by some vital spark from within an organism. This was the accepted view at that time.

Schwann began his clinical training in Würzburg in 1831. Two years later he moved to the University of Berlin as Müller’s doctoral student.

In 1834, aged 23, Schwann obtained his MD and accepted Müller’s offer to work as his research assistant in Berlin.
Theodor Schwann’s Contributions to Science

Schwann’s first work – and indeed his best work – was carried out in Berlin, where he did experiments over a four year timespan to provide data for Müller’s *Elements of Physiology*.

**Pepsin**

In 1835, while studying digestive processes, he realized that there is a substance in the stomach in addition to hydrochloric acid which aids the digestion of food. In 1836 he successfully isolated and named this additional substance: he had discovered the enzyme pepsin.

**Spontaneous Generation of Life**

Between 1834 and 1838 Schwann carried out experiments to probe the phenomenon of spontaneous generation of life, which was widely believed to be responsible for microorganisms. In one experiment he took a broth of nutrients and sterilized it by boiling. He also heated the air above it to a high temperature. The result was that no microbes grew and no biological or chemical activity were observed in the broth either. This experiment convinced Schwann that he had killed all the microbes and no more could be produced, so the theory of spontaneous generation was incorrect.

**Microbes, Yeast and Fermentation**

Schwann identified the role that microorganisms played in alcohol fermentation and putrefaction. He carried out a variety of fermentation experiments and by 1836 had gathered enough evidence to convince himself that the conversion of sugar to alcohol during fermentation was a biological process that required the action of a living substance (yeast) rather than a chemical process of sugar oxidation.

Unfortunately, Schwann’s explanation of fermentation was ridiculed by other scientists. Acceptance only came with Louis Pasteur’s work over a decade later. Pasteur later wrote in a letter to Schwann:

“For twenty years past I have been travelling along some of the paths opened up by you.”

*Louis Pasteur*

*Letter to Schwann, 1878*

**The Cell Doctrine and Schwann Cells**

Plant cells had been discovered by Robert Hooke in the early 1660s. Blood cells had been seen by Jan Swammerdam in 1668 and then described much more clearly by Antonie van Leeuwenhoek in 1674. Leeuwenhoek had gone on to discover bacteria in 1676.

As increasingly powerful microscopes became more widely available, the structural details in animal and plant cells were seen by ever more scientists, but the fundamental importance of cells remained undiscovered.

In 1838 the botanist Matthias Schleiden, one of Schwann’s academic friends, published an article discussing the structure and origin of plant cells. He made the first, albeit partial, proposal of the cell doctrine. He stated his belief that all plant cells share a common structure and that new plant cells form from the nuclei of old plant cells.
This proposal interested Schwann and the more he thought about it, the more he believed it could be true for animal cells as well as plant cells, although he was uncertain about the status of muscle and nerve cells.

He invited Schleiden to the operating theater and they jointly considered the similarities between plant nuclei and nuclei in the animal notochord.

Schwann then studied peripheral nerve cells and in doing so he discovered a new type of cell surrounding the axons and neurons of nerve fibers – the cells he discovered are now called Schwann cells.

In 1838, aged 28, Schwann felt confident enough about his evidence for the cell doctrine to present it to the Academy in Paris.

The following year he published his momentous book, *Mikroskopische Untersuchungen über die Übereinstimmung in der Struktur und dem Wachstum der Thiere und Pflanzen. (Microscopical researches into the Accordance in the Structure and Growth of Animals and Plants.)*

His book described the cellular structure of plants and animals and the development of adult cells from their embryos. It proposed the cell doctrine or cell theory – that all living things are made of cells: all animal tissues are built up from a basic cell structure in the same way as plants are. He also noted that all animal cells contain a nucleus.

“*The development of the proposition, that there exists one general principle for the formation of all organic productions, and that this principle is the formation of cells, as well as the conclusions which may be drawn from this proposition, may be described by the term cell-theory…*”

*Theodor Schwann*
*Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants*

“*The cause of nutrition and growth resides not in the organism as a whole, but in the separate elementary parts — the cells.*”

*Theodor Schwann*
*Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants*

In his book, Schwann also coined the word *metabolic* to describe chemical changes taking place in cells and tissue.

**Schwann’s Big Mistake**

Schwann scored a big hit with cell-theory – it was accepted by the scientific world unusually quickly. However, his book also contained a significant error, because Schwann did not recognize that new cells are formed by pre-existing cells. He wrote:

“*A structureless substance is present… which lies either around or in the interior of cells already existing; and cells are formed in it in accordance with certain laws…*”

*Theodor Schwann*
*Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants*

He called this non-existent structureless substance *blastema.*
In 1855 Rudolph Virchow published an essay in which he asserted that:

“Every cell arises from another cell.”

This was the beginning of the end for Schwann’s non-existent blastema.

**Histology**

Schwann made a significant contribution to histology – the anatomy of cells and tissues on the microscopic scale – when he placed adult animal tissues into five distinct groups:

- separate independent cells, e.g. blood
- compacted independent cells, e.g. skin, nail, feathers
- cells whose walls have coalesced, e.g. cartilage, bones, and teeth
- elongated cells which have formed fibers, e.g. tendons and ligaments
- cells formed by the fusion of walls and cavities, e.g. muscles, tendons and nerves

**Some Personal Details and the End**

In 1839 – the same year as *Microscopical Researches* was published – Schwann, aged 28, became professor of anatomy at the University of Louvain, Belgium.

In 1845 he was awarded the Royal Society Copley Medal for his cell work. This was the most prestigious prize in science, previously awarded to scientists such as Benjamin Franklin, Alessandro Volta, and Michael Faraday. Later recipients would include Rudolph Virchow, Charles Darwin, and Louis Pasteur.

In 1848 Schwann become professor of anatomy at the University of Liege, Belgium. In 1858 he was appointed to the chair of physiology. At Liege he invented a portable closed system breathing apparatus for use in the mining industry. He demonstrated the system in 1876 at the health and safety Exhibition in Brussels.

By all accounts Schwann was an excellent, conscientious teacher well-liked by his students.

In his later years he became more deeply concerned with religious thought.

In 1879 Schwann was elected to the Royal Society and also to the French Academy of Science.

Schwann lived a very simple life. He never married. He did not become involved in scientific controversy and avoided the petty jealousies that can be encountered in academic life. He retired in 1880

Theodor Schwann died aged 71 while visiting his sister in Cologne on January 11, 1882.

**Reference**