



PORTRAITS OF SCIENCE

A Polish, Jewish Scientist in 19th-Century Prussia

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Remak showed that new animal cells arise by binary fission of existing cells. Yet despite his scientific contributions, he was denied a full university professorship.

Modern biology rests on three 19th-century pillars. Darwin and Mendel are strongly associated with natural selection and the laws of inheritance, respectively, but no single individual can be credited with a central role in the development of the third pillar: cell theory. Of the scientists who contributed to its development, Robert Remak is one of the most remarkable and least known (1–3). Polish by geography and patriotism, Jewish by tradition, Remak pursued his scientific career for 32 years in Berlin.

Remak was born in Poznan (Posen) to a family of modest means in 1815, the year the Duchy of Poznan was ceded to Prussia by the Congress of Vienna. By a decree of 1833, Jews of the Duchy qualifying for naturalization were granted the same rights as other Prussian Jews, including the privilege of attending the Prussian universities (4).

After graduating from Berlin's Friedrich-Wilhelm-Universität as a doctor of medicine, Remak worked as an assistant first to Johannes Müller, professor of anatomy and physiology, and then to Johann Schönlein, professor of medicine at the Charité Hospital. He carried out his microscopic studies in his home, supporting his research from his medical practice and teaching fees.

Remak was nevertheless highly productive as a microscopist. His major contribution to cell theory was the evidence that new animal cells arise by binary fission of pre-existing cells. Yet, "his scientific achievements, although of great significance, were not enough to earn him the place in medical history he had done so much to deserve" (5) nor the professorship he so ardently sought.

In his early research in Müller's laboratory, Remak studied the microscopic anatomy of the nervous system. He described the

unmyelinated nerve fibers, their connection with neuronal cell bodies, and the existence of a structure rather than an empty space or fluid in the center of the myelinated nerve process. These observations were subject to widespread disbelief and controversy, and were denied even by Müller, who published the papers. Confirmations came, and Müller was finally convinced in 1842. This reluctance to accept Remak's work, extending to outright antagonism, was repeated when he

later provided evidence for cell division and proposed that tumor cells arose by cell formation from existing specific tissues.

Theodor Schwann had argued in 1839 (6) that most and probably all tissues of plants and animals were composed of cells, each having a nucleus and a nucleolus, and that all animal and plant cells formed in the same way. According to Matthias Schleiden, new cell formation in plants was initiated by the formation of a nucleus (a "cytoblast") in an existing cell. Schwann was convinced that a similar

sequence occurred in animal tissues, but placed the formation of most animal cells in the extracellular milieu (the "cytoblastem").

Contradicting Schwann, Remak placed animal cell division at the forefront of cell theory. In 1841, he described forms suggestive of cell division in red cell formation in the chick embryo. This was followed by an examination of muscle development in the tadpole and observations of the division of the fertilized chick ovum (7).

Between 1850 and 1855, Remak produced a treatise on embryology (8), in which he established the formation of cells in the embryo by divisions that occurred in the ovum, provided the microscopic evidence for three distinct germ layers, and traced the derivatives of the layers of the chick embryo.

Remak concluded his book with an extended presentation of the evidence for cell division as the predominant if not exclusive means for generating new cells. Yet,

his evidence and arguments for the division of animal cells were poorly received, and animal cell division failed to achieve general acceptance until it was forcefully promulgated by Rudolf Virchow.

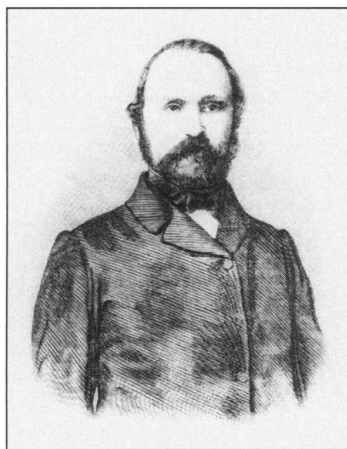
Virchow, widely recognized then and now as the foremost proponent of cell division, commenced his conversion from Schwann's doctrine in 1850 but apparently remained ambivalent as late as 1854, particularly in regard to tumor growth. When he finally issued his resounding pronouncement in favor of cell division in 1855, he did not acknowledge the contributions of Remak (9). Three years later, Virchow grudgingly acknowledged Remak's evidence for cell division in the ovum (10).

Despite his scientific contributions, Remak was repeatedly denied a full university professorship. His university appointments came late and carried with them neither salary nor laboratory. His habilitation—the prerequisite for a university appointment—required the intervention of Alexander von Humboldt with the Prussian king to overcome the obstacle of Remak's refusal to forsake his religion.

Remak became increasingly embittered by his repeated rejections by the academic establishment. He later turned to clinical studies of galvanotherapy for neuromuscular diseases. Denied again, this time the clinic he sought at the Charité, Remak nevertheless made important contributions to the field. He died in 1865 at the age of 50, probably of sepsis, perhaps secondary to diabetes.

References and Notes

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2. H.-P. Schmiedebach, *Robert Remak (1815–1865): Ein jüdischer Arzt im Spannungsfeld von Wissenschaft und Politik* (G. Fischer, Stuttgart, 1995).
3. H. Harris, *The Birth of the Cell* (Yale Univ. Press, New Haven, CT, 1999).
4. The required qualifications included speaking High German, having a hereditary family name, and the exercise of a civil occupation.
5. N. Kampe, H.-P. Schmiedebach, *Leo Baeck Institute Yearbook* **34**, 95 (1989).
6. T. Schwann, *Mikroskopische Untersuchungen über die Übereinstimmung in der Struktur und dem Wachstum der Thiere und Pflanzen* (G. Reimer, Berlin, 1839).
7. R. Remak, *Arch. Anat. Physiol. Wiss. Med.* **47** (1852).
8. ———, *Untersuchungen über die Entwicklung der Wirbelthiere* (G. Reimer, Berlin, 1855).
9. R. Virchow, *Virchow's Arch. pathol. Anat. physiol. Klin. Med.* **8**, 3 (1855).
10. ———, *Die Cellular-Pathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre* (A. Hirschwald, Berlin, 1858).



Robert Remak
(1815–1865)