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The persistence of potential: The life of Sir John B. Gurdon

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The death of Sir John Bertrand Gurdon in October 2025 marks the passing of one of the most influential biologists of the modern era. A developmental biologist, Sir Gurdon's best-known experiments were performed with frog eggs and nuclear transfer, leading to discoveries that transformed our understanding of how genes control animal development and established the principles that underpin animal cloning, nuclear reprogramming, and regenerative medicine. These classical experiments paved the way for advances in induced pluripotent stem cells and energized thinking of new ways to treat diseases with cellular therapies. Sir John Gurdon's legacy endures through his transformative discoveries, institutional leadership, and the scientists he inspired.

John Gurdon is best known for demonstrating that nuclei from fully differentiated cells retain the complete genetic information required to generate an entire organism. In a series of elegant and technically demanding experiments, he transplanted nuclei from differentiated intestinal cells into enucleated eggs of the frog *Xenopus*. These reconstructed embryos developed into normal tadpoles and, ultimately, fertile adult frogs. From these results, Gurdon concluded that the egg cytoplasm can unlock the potential of dormant genes and reprogram a differentiated nucleus. This conclusion set the challenge of understanding how cells decide which genes to express. Gurdon's experiments paved the way for animal cloning and, decades later, the development of induced pluripotent stem cells by Shinya Yamanaka, with whom he shared the Nobel Prize in Physiology or Medicine in 2012.

When Gurdon began his PhD studies at Oxford under the supervision of Michail Fischberg, a central question in biology was whether genes were lost or permanently inactivated during development. Earlier nuclear transfer experiments by Briggs and King in the frog *Rana* suggested that nuclear totipotency declined as development progressed. By refining nuclear transfer techniques and using *Xenopus*, Gurdon showed that nuclei from differentiated cells could support full development, including the production of mature, fertile animals. Subsequent lineage tracing and molecular analyses provided compelling evidence that nuclei from differentiated adult skin cells retained totipotency. Gurdon's findings decisively established that genes are not lost during development and that cell differentiation arises from differential gene expression.

The nuclear transfer experiments set the agenda for Gurdon's scientific career. For more than five decades, his research focused on the molecular mechanisms by which oocyte cytoplasm reprograms adult nuclei to a totipotent state. In his Nobel lecture, he memorably described this process as the "battle for supremacy" between nucleus and cytoplasm (1).

After completing his doctorate at Oxford and a brief post-doctoral period studying phage genetics at Caltech, Gurdon



John B. Gurdon. Image credit: Wellcome collection.

returned to Oxford, where he embarked on an extraordinarily productive career. He later moved to the Medical Research Council Laboratory of Molecular Biology in Cambridge, where his stature as a leader in developmental biology was firmly established. He went on to help found the CRC/Wellcome Trust Institute in Cambridge, later named the Gurdon Institute in his honor. Remarkably, Gurdon continued to perform experiments himself until his retirement at the age of 90.

The Gurdon laboratory made numerous fundamental contributions beyond nuclear transfer. These included pioneering studies of cell cycle differences between oocytes and zygotes, and the innovative use of frog oocytes as "living test tubes" for the translation of microinjected mRNAs. Injection of cloned DNA into *Xenopus* fertilized eggs and oocytes helped identify eukaryotic promoters and determine the protein products of cloned cDNAs at a time when gene cloning was still in its infancy.

Gurdon often recounted, with characteristic humor, that his early academic record gave little hint of his future achievements. Educated at Eton, where he studied Greek and Latin,

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Albino clone generated by nuclear transplantation from a single donor embryo into eggs of a pigmented mother (shown). All resulting frogs were male, albino, and carried the 1-nucleolus mutation. Reprinted with permission from ref. 1.

he performed poorly in science. John famously preserved his Eton school report declaring that pursuing science would be “a waste of his time and others.” That judgment stands today as one of the great miscalculations in the history of education.

Beyond his experimental achievements, Gurdon exerted a profound influence on developmental biology through his teaching, writing, and service. He was a gifted lecturer whose talks were models of clarity and intellectual focus. He believed deeply that experiments should be driven by fundamental questions rather than convenience or fashion. His keynote lectures often featured deceptively simple experimental designs that led to transformative conclusions. Even when

he was the featured speaker at conferences, he attended talks and poster sessions throughout, engaging students and trainees with incisive and encouraging questions. And his own lab spawned a pool of developmental biologists who left with a sense of admiration and gratitude, moving on to populate leading universities and institutions.

Gurdon's commitment to science extended to leadership and service. He played major roles in the Company of Biologists and the International and British Societies of Developmental Biology, served as a governor of the Wellcome Trust, and was Master of Magdalen College, Cambridge. Through these roles, he helped shape institutions and policies that continue to support scientific discovery.

Personally, John Gurdon was known for his modesty, courtesy, and generosity. His laboratory was open and nonhierarchical, marked by shared purpose and camaraderie. He took genuine pleasure in the work of others and delighted in thoughtful scientific discussion. Outside the laboratory, he was fiercely competitive in squash, an adventurous skier—including heliskiing—and an enthusiastic traveler, sometimes in pursuit of rare butterflies for his collection.

Sir John Gurdon was an exemplary scientist and gentleman. Through a single, revolutionary insight early in his career, he reshaped biology, and he spent the rest of his life repaying that good fortune by advancing institutions, mentoring generations of scientists, and pursuing discovery with unquenchable curiosity. His work permanently altered our understanding of animal development and opened new possibilities for regenerative medicine. He met success without arrogance, competition without unkindness, and recognition without self-importance. He leaves behind a scientific legacy that will endure for generations and a personal legacy of kindness, curiosity, and dedication. He died peacefully at the age of 92, surrounded by his family.

1. J. B. Gurdon, The egg and the nucleus: A battle for supremacy. *Development* **140**, 2449–2456 (2013).