

Lynn Margulis

(1938–2011)

Biologist who revolutionized our view of early cell evolution.

Lynn Margulis was an independent, gifted and spirited biologist who learned as early as the fourth grade to “tell bullshit from ... real authentic experience”, as she put it in a 2004 interview. With courage, intellect, a twinkle in her eyes and considerable fortitude, she changed our view of cellular evolution.

In 1967, she made the revolutionary case that simple bacteria were incorporated into some early cells to produce the organelles that let plants photosynthesize and animals consume oxygen. This process of endosymbiosis altered Earth by providing plants for animals to eat and additional oxygen for them to breathe.

Her success did not come easily. She had to stand up for her ideas and accept repeated rejections. She submitted her radical paper to a dozen journals before it was published. Remarkably, she developed her theories without training in molecular biology — RNA sequencing was just being developed, and DNA sequencing was years away. Her discovery of the endosymbiotic origins of animals and plants was ahead of the field. She got there on her own terms, and her main insights have been proven correct.

Margulis, who died of a stroke at home on 22 November, was the oldest of four girls born to Leona and Morris Alexander in Chicago, Illinois. She described herself as a bad student who had to stand in the corner a lot. Her parents enrolled her in the University of Chicago Laboratory Schools, with their unique focus on reading original scientific literature. Initially, she didn't like her Lab School and walked out. But after two years back in her local inner-city school, she was glad to return to the University of Chicago. There, she immersed herself in the works of Isaac Newton and Gregor Mendel.

She attributed her scientific success in part to one course: MathSci 2. Biologically oriented, it centred on the material basis of heredity and what connects generations. MathSci 2, she noted, also contributed to the discovery of the structure of DNA — because James Watson also took the course.

When she was 16, while walking up the stairs of Chicago's Ruth Eckerd Hall, she met a tall, handsome, extremely talkative young

man who claimed that he was going to find life in the Universe. That was Carl Sagan. They married when she was 19. She has acknowledged that he had a big intellectual influence on her, claiming gracefully that it would be unfair to say she did it all herself.

The couple went to the University of Wisconsin–Madison, where she obtained

prokaryotes, eukaryotes, mitochondria, and chloroplasts, hot off the press. That paper concluded: “The chloroplasts share a recent ancestry with the blue-green algae”, and that “the mitochondrion shares a recent ancestry with certain respiring and photosynthetic bacteria, the Rhodospirillaceae”. Margulis' proposals for endosymbiotic chloroplast and mitochondrial origins had both been proven in the same paper.

Her research earned her the US President's National Medal of Science, the Darwin–Wallace Medal of the Linnean Society of London, and election to the US National Academy of Sciences and to the Russian Academy of Natural Sciences (as one of only three American members). She could lecture in several languages and was a prolific author and popular speaker. She excelled at balancing research, teaching and raising four children while leading her field. Her second marriage, to crystallographer Thomas Margulis, which had begun in 1967, ended in 1980.

Lynn's sometimes contrary persona was summed up during an interview while recalling her school days at Chicago: “Classes were not required, that's why I went to them all!” She also liked to shock. According to Ann Hirsch of the University of California, Los Angeles, when summarizing bacterial-harboring, nitrogen-fixing root nodules, Lynn referred to them as providing a place for bacterial “food and sex”.

My favourite memories of Lynn were her lengthy calls to kick ideas around (she abhorred e-mail). She was always upbeat and ready to explore. Her visit to our home in 2007 was full of adventure and laughter. She told us about her travels, loved our visit to the Getty Center in Los Angeles, California, and its travertine fossils, and always had a ziplock bag of yerba maté on hand. She'll be greatly missed. ■

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her MA in zoology and genetics, and then to the University of California, Berkeley, where she began a PhD in genetics. Their marriage ended before her doctorate was awarded, and Lynn moved to Massachusetts in 1963 with her two sons to take up a biology lectureship at Brandeis University in Waltham. She received her PhD from Berkeley in 1965, and then moved to Boston University, where she remained for 22 years. There, she published her paradigm-changing book, *Origin of Eukaryotic Cells* (1970). In 1988, she moved to the University of Massachusetts, Amherst.

As Boston University's Douglas Zook, then an undergraduate in one of her classes, recalled, it was an emotional moment in 1978 when her ideas on endosymbiosis were confirmed. She strode into class beaming, holding Robert Schwartz and Margaret Dayhoff's classic paper, ‘Origins of