Elaine Fuchs, Ph.D.

INVESTIGATOR, HOWARD HUGHES MEDICAL INSTITUTE • REBECCA C. LANCEFIELD PROFESSOR, ROBIN CHEMERS NEUSTEIN LABORATORY OF MAMMALIAN CELL BIOLOGY AND DEVELOPMENT

Adult stem cells reside in all tissues, where they replenish dying cells and repair wounds. Using mammalian skin as model, Fuchs studies the remarkable properties of these stem cells, including how they know which tasks to perform and when. She explores how stem cells sense and communicate with other cells in their tissue environment. Aiming at advancing therapeutics, she dissects how communication networks malfunction in inflammation, aging, and cancer.

At the interface between our body and the environment, the skin epithelium must continually rejuvenate to survive the barrage of daily stresses. Fuchs's lab focuses on the stem cells that balance self-renewal with tissue regeneration in the skin. They investigate how stem cells make tissue and repair wounds and how this changes in inflammation and tumorigenesis. Her research employs high throughput transcriptomics and genomics, live imaging, cell biology, and functional approaches to unravel the complexities of tissue biology in health and disease. Her team investigates how skin stem cells establish unique chromatin landscapes and programs of gene expression and how this shifts in response to changes in their local environment. They seek to discover the molecular crosstalk between stem cells and their neighboring tissue cells (such as immune cells, fibroblasts, vasculature, and neurons) that instruct the stem cells to make epidermis or hair, or repair wounds, and how that molecular crosstalk changes upon inflammation, mechanical stress, aging, and cancer.

The team also discovered that epithelial stem cells acquire and retain epigenetic memories of their past encounters, including inflammation. These changes persist within the stem cell's chromatin long after pathology is restored. While these memories can be beneficial and result in faster wound repair and broader pathogen resistance, they can also be maladaptive and casue chronic inflammation and increased susceptibility to cancer. Fuchs hopes that unraveling the underlying mechanisms will guide the discovery of new therapeutic routes to erase bad memories without losing good ones.

Fuchs's group also learned that cancer cells hijack the basic mechanisms that enable stem cells to replenish dying cells and to repair wounds. They focus on squamous cell carcinomas, which are among the most common and life-threatening human cancers worldwide. Using high throughput genomics in mice, they have identified and characterized features of the cells that propagate these cancers in skin. They devised methods to mark and track the behavior of these tumor-initiating stem cells and discovered that not only are these cells at invasive fronts of the cancers, but they are also responsible for tumor relapse following chemo- and immune-therapies administered to mice with tumors. By dissecting the underlying mechanisms, performing high-throughput functional screens for oncogenes and tumor suppressors in mice, and relating their findings to humans, Fuchs hopes her research will lead to new therapeutic approaches that target the cancerous stem cells without affecting tissue stem cells.

Overall, Fuchs studies tissue biology at multiple levels, from its stem cells and the signals that control them to the epigenetic, transcriptional, and translational programs that maintain an orchestrated balance of tissue growth. While the foundations of normal tissue homeostasis and injury repair are still unfolding, the fundamental discoveries that Fuchs's lab has made already provide insights into how skin and its stem cells cope with different environmental stresses, including aging, inflammation, and cancer.

EDUCATION

B.S. in chemistry, 1972
University of Illinois, Champaign-Urbana

Ph.D. in biochemistry, 1977
Princeton University

POSTDOC

Massachusetts Institute of Technology, 1977–1980

POSITIONS

Assistant Professor, 1980–1985
Associate Professor, 1985–1988
Professor, 1989–2002
University of Chicago

Professor, 2002–
The Rockefeller University

Associate Investigator, 1988–1993
Investigator, 1993–
Howard Hughes Medical Institute

AWARDS

White House Outstanding Scientist, 1985
Women in Cell Biology Senior Career Achievement Award, 1997
Cartwright Award, Columbia University, 2002
Richard Lounsbery Award, National Academy of Sciences, 2001
Novartis/Drew Award, 2003
Dickson Prize, 2004
Federation of American Societies for Experimental Biology Award for Scientific Excellence, 2006
Bering Award, 2006
National Medal of Science, 2008
Charlotte Friend Award, 2010
L'Oréal-UNESCO Award, 2010
Madison Medal, 2011
Passano Award, 2011
Albany Medical Center Prize, 2011
March of Dimes Prize, 2012
Lifetime Achievement Award, American Skin Association, 2013
Kligman-Frost Leadership Award, 2013
Pasarow Award, 2013
Pezcoller Foundation-AACR International Award, 2014
E.B. Wilson Medal, 2015
Vanderbilt Prize in Biomedical Science, 2016
Howard Taylor Ricketts Award, 2017
McEwen Award for Innovation, 2017
AACR G.H.A. Clowes Memorial Award, 2019
Canada Gairdner International Award, 2020
Bert and Natalie Vallee Award in Biomedical Science, 2021
Benjamin Franklin Medal in Life Science, 2023
Memorial Sloan Kettering Medal for Outstanding Contributions to Biomedical Science, 2024

Honorary Societies

National Academy of Sciences
National Academy of Medicine
American Academy of Arts and Sciences
American Philosophical Society
Fellow, American Association for the Advancement of Science
Associate Member, European Molecular Biology Organization
Foreign Member, The Royal Society

SELECTED PUBLICATIONS

Tierney, M.T. et al. Vitamin A resolves lineage plasticity to orchestrate stem cell lineage choices. *Science* 383, eadi7342 (2024).

Liu, S. et al. A tissue injury repair pathway distinct from host pathogen defense. *Cell* 186, 2127–2143 (2023).

Yuan, S. et al. Ras drives malignancy through stem cell crosstalk with the microenvironment. *Nature* 612, 555–563 (2022).

Naik, S. and Fuchs, E. In sickness and in health: Inflammatory memory and tissue adaptation. *Nature* 607, 249–255 (2022).

Gonzales, K.A.U. et al. Stem cells expand potency and alter tissue fitness by accumulating diverse epigenetic memories. *Science* 374, eabh2444 (2021).