

Elaine Fuchs: Stem cells and development in the skin

Rebecca C. Lancefield Professor of Mammalian Cell Biology and Development
Howard Hughes Medical Institute
Rockefeller University, New York, (NY)

Elaine Fuchs is renowned for her work on the biology and molecular mechanisms of mammalian skin and skin diseases, and has led the modernization of dermatology. She also pioneered reverse genetics approaches. In particular, Fuchs researches skin stem cells and their production of hair and skin. Fuchs began her career-defining work on skin biology during her postdoctoral work with Howard Green at MIT (Boston, MA). In Green's lab she studied the mechanisms underlying growth and differentiation in epidermal keratinocytes. Then Fuchs accepted a faculty position at the University of Chicago in 1980, as the first woman in the biochemistry department. Fuchs is currently an HHMI investigator at Rockefeller University, as the Rebecca C. Lancefield Professor of Mammalian Cell Biology and Development.

Elaine Fuchs is fascinated by skin and hair—two very distinct structures that develop from the same skin stem cell. By unraveling the biology of skin stem cells, she hopes to answer a question that has intrigued her for more than two decades: How does a skin stem cell decide to become skin or hair? Understanding skin stem cells' normal behavior is also helping Fuchs learn what happens when their growth goes awry. Her studies have already uncovered the genetic basis of blistering skin diseases and clues to the way skin cancers and inflammatory skin disorders develop.

Fuchs uses the mouse and mammalian epithelial stem cell culture as model systems. Unlike most other adult stem cells, skin stem cells can be easily grown in the laboratory. Studies by Fuchs have shown that multiple signaling pathways, including the Wnt and BMP pathways, influence how stem cells develop into mature hair follicles. Together, positive Wnt signals and antagonistic BMP signals lead to activation of transcription factors, which induce the formation of a hair follicle bud. In the absence of these signals, stem cells develop into skin epidermis. This line of research may eventually lead to new ways to restore or inhibit hair growth. By exploring how the stem cell reservoir (niche) forms and how stem cells are activated to proliferate and differentiate, Fuchs' work is having an impact on understanding skin and hair regeneration. Her recent work delineating the differences between normal stem cells and cancer-causing stem cells (cancer stem cells) has begun to shed light on how defective stem cells can cause cancers.

Selected Publications (last 3 years)

1. Beronja S, Janki P, Heller E, Lien WH, Keyes BE, Oshimori N, Fuchs E. "RNAi screens in mice identify physiological regulators of oncogenic growth." **Nature** 501(7466):185-90 (2013).
2. Chang CY, Pasolli HA, Giannopoulou EG, Guasch G, Gronostajski RM, Elemento O, Fuchs E. "NFIB is a governor of epithelial-melanocyte stem cell behaviour in a shared niche." **Nature** 495(7439):98-102 (2013).
3. Lu CP, Polak L, Rocha AS, Pasolli HA, Chen SC, Sharma N, Blanpain C, Fuchs E. "Sweat glands grown from newly identified stem cells." **Cell** 150(1):136-150 (2012).
4. Fuchs E. "The impact of cell culture on stem cell research." **Cell Stem Cell** 10(6):640-1 (2012).
5. Chen T, Heller E, Beronja S, Oshimori N, Stokes N, Fuchs E. "An RNA interference screen uncovers a new molecule in stem cell self-renewal and long-term regeneration." **Nature** 485(7396):104-8 (2012).
6. Oshimori N, Fuchs E. "Paracrine TGF- β Signaling Counterbalances BMP-Mediated Repression in Hair Follicle Stem Cell Activation." **Cell Stem Cell** 10(1):63-75 (2012).
7. Lien WH, Guo X, Polak L, Lawton LN, Young RA, Zheng D, Fuchs E. "Genome-wide Maps of Histone Modifications Unwind In Vivo Chromatin States of the Hair Follicle Lineage." **Cell Stem Cell** 9(3):219-32 (2011).
8. Ezratty EJ, Stokes N, Chai S, Shah AS, Williams SE, Fuchs E. "A role for the primary cilium in Notch signaling and epidermal differentiation during skin development." **Cell** 145(7):1129-41 (2011).
9. Schober M, Fuchs E. "Tumor-initiating stem cells of squamous cell carcinomas and their control by TGF- β and integrin/focal adhesion kinase (FAK) signaling." **Proc Natl Acad Sci U S A** 108(26):10544-9 (2011).
10. Fuchs E. "Reflections of an ISSCR president, 2010-2011." **Cell Stem Cell** 8(6):629-30 (2011).
11. Zhang L, Stokes N, Polak L, Fuchs E. "Specific MicroRNAs Are Preferentially Expressed by Skin Stem Cells To Balance Self-Renewal and Early Lineage Commitment." **Cell Stem Cell** 8(3):294-308 (2011).
12. Luxenburg C, Amalia Pasolli H, Williams SE, Fuchs E. "Developmental roles for Srf, cortical cytoskeleton and cell shape in epidermal spindle orientation." **Nat Cell Biol** 13(3):203-14 (2011).
13. Williams SE, Beronja S, Pasolli HA, Fuchs E. "Asymmetric cell divisions promote Notch-dependent epidermal differentiation." **Nature** 470(7334):353-8 (2011).
14. Wu X, Shen QT, Oristian DS, Lu CP, Zheng Q, Wang HW, Fuchs E. "Skin Stem Cells Orchestrate Directional Migration by Regulating Microtubule-ACF7 Connections through GSK3 β ." **Cell** 144(3):341-52 (2011).
15. Hsu YC, Pasolli HA, Fuchs E. "Dynamics between stem cells, niche, and progeny in the hair follicle." **Cell** 144(1):92-105 (2011).