30,000

Number of children and adults in the U.S. affected by cystic fibrosis. Source: Cystic Fibrosis Foundation

Basic stem cell research holds incredible promise for understanding disease mechanisms. From left to right: JAMIE GRIFO, MD, PHD, professor of obstetrics and gynecology; director, Division of Reproductive Endocrinology; program director, NYU Fertility Center (seated); CHRIS HANSIS, MD, PHD, assistant professor of obstetrics and gynecology; IANNIS AIFANTIS, PHD, associate professor of pathology; co-director, Cancer Stem Cell Program at the NYU Langone Medical Center's Cancer Institute; RUTH LEHMANN, PHD, director, Skirball Institute of Biomolecular Medicine; director, Helen L. and Martin S. Kimmel Center for Stem Cell Biology; Laura and Isaac Perlmutter Professor of Cell Biology.

Fruit Flies, Blank Slates, and Incurable Diseases

Stem Cell Research at NYU Langone

You can learn a lot from fruit flies with unusually notched wings. Or roundworms that cannot lay eggs. Or young mice that develop leukemia.

As Dr. Ruth Lehmann and colleagues in the Helen L. and Martin S. Kimmel Center for Stem Cell Biology have discovered, many genes implicated in these deformities and disorders are essential for our normal development and reproduction. "For 70 percent of all disease genes known in humans, there's an exact homologue in the fly," Dr. Lehmann says.

Stem cells, the "blank slates" that can become any cell in an embryo, are essential mediators of development and potential gold mines for therapeutic interventions. Adult stem cells are more restricted but have similarly untapped promise. The strong grounding of Kimmel Center scientists in developmental biology and their pursuit of disease models with different stem cell types, Dr. Lehmann says, provide a solid foundation for a burgeoning field of research. "All of that is very basic research with clinical relevance to understand disease better," she says. "And that's very exciting."

Two of Dr. Lehmann's colleagues, Dr. Jamie Grifo and Dr. Chris Hansis, are modeling human disease using stem cells from embryos otherwise discarded in the in vitro fertilization clinic.

Dr. Grifo, an expert in what's known as preimplantation genetic diagnosis, has helped uncover incurable diseases like cystic fibrosis and Tay-Sachs in early-stage embryos in an effort to select the most viable ones for implantation in a mother's womb. Clinics throughout the world have used the technique to test for more than 300 genetic disorders. "The fate of these embryos in the past was to discard them," Dr. Grifo says. "It's kind of a natural progression to say, 'Maybe we can learn something about these diseases using these cells.'"

Dr. Hansis has used 10 embryos diagnosed with genetic mutations and voluntarily donated by patients at NYU Langone's Fertility Center to grow embryonic stem cells. "A lot of frequent, fatal, and incurable diseases currently do not have disease models," Dr. Hansis says, "and yet you need that to develop new therapeutic approaches."

Another team in stem cell research is focused on leukemia. Dr. Iannis Aifantis studies how hematopoietic stem cells, or adult stem cells that live in the bone marrow and give rise to a variety of blood cells, can renew themselves or transform into other cells as needed. When underlying mechanisms are disrupted, cancer is a potential consequence. "It is very interesting to see that the same molecules that are important for leukemia are also important for stem cell function," Dr. Aifantis says.

One common denominator is a famous gene called Notch, so named because its disruption yields notched wings in fruit flies. In mice, a genetic counterpart named Notch1 is essential for telling stem cells to become the immune system's infection-fighting T cells. If the gene is overactive and the body produces too many T cells, leukemia can result.

Two molecules controlled by Notch1, Dr. Aifantis has found, allow a kind of childhood leukemia to invade the body's central nervous system, with devastating consequences. The genes associated with the molecules are highly conserved, or found in many organisms, so he may be able to call upon fruit flies—or roundworms—in the hunt for more information about a critical stem cell regulator and disease culprit.