"What’s in a name?” Shakespeare once asked, likely never anticipating just how many ways his simple query might be applied. The term “stem cell” is a perfect example. Most people have heard it. Many even understand the notion that stem cells are a very powerful biological tool and potential therapy. But what is in that name is something more: the kernel of a medical revolution that is only just beginning.

Teaming up for a "man on the moon" effort to cure blindness using stem cell therapies. Left to right, Mandeep Singh, Shelia West, Lutty, Valeria Canto-Soler and Don Zack.
Stem cells are the raw material by which human tissues and, perhaps someday, whole organs might be regenerated in the lab from single cells. Stem cell regenerative medicine offers the prospect of studying and treating injuries and diseases of the eye as never before.

In the most basic sense, the earliest human stem cells that can be derived in the lab have the ability to become every other type of cell—heart cells, blood cells, lung cells, pancreas cells, retinal cells, corneal cells, blood vessels and so forth. Most importantly, and most tantalizingly, stem cells are healthy cells that may someday be used to replace dead, dying or broken cells to cure any number of diseases, including blindness.

In stem cells rest the hopes of millions of medical patients and the aspirations of thousands of researchers the world over.

“Regenerative ophthalmology is one of the most exciting things to come down at Wilmer since Arnall Patz discovered that oxygen therapy was bad for babies,” says Sheila West, Ph.D., Pharm.D., the vice chair for research at Wilmer, harkening to a time when the renowned former director of the Wilmer Eye Institute made his famous discovery that reduced the incidence of childhood blindness by as much as 60 percent in the early 1950s.

One of the most promising parts of the body for stem cells is the eye—and ocular regenerative medicine is a strong point of the Wilmer Eye Institute. Consider these recent headline-grabbing breakthroughs:

Don Zack, M.D., Ph.D., a specialist in molecular biology and genetic engineering at Wilmer, gained international attention recently when his lab was able to utilize genomic engineering technology to regenerate retinal ganglion cells (RGCs). RGCs have fibers, called axons, which make up the optic nerve. The optic nerve acts like a telephone cable, transferring visual information from the eye to the brain. In glaucoma, as well as multiple sclerosis and other forms of optic neuropathy, the optic nerve becomes damaged, and the eye is unable to communicate with the brain. Zack’s research could one day lead to restorative treatments, perhaps even the potential of restoring vision by transplanting retinal ganglion cells.

Valeria Canto-Soler, Ph.D., an assistant professor of ophthalmology at Wilmer, drew headlines worldwide when she mastered the process of generating tiny, light-sensitive, three-dimensional “retinal cups” in her lab. These “miniature retinas” grown from stem cells are structurally identical to the human retina and respond to light as the normal retina does. The hope is that individualized, lab-grown, healthy photoreceptors, retina pigment epithelia and perhaps other types of cells can be harvested from these miniature retinas for transplant.

Gerard Lutty, Ph.D., a professor of ophthalmology at Wilmer and an expert in the development of blood vessels in the eye, collaborated with Elias Zambidis, M.D., Ph.D., an associate professor of oncology at John Hopkins Medicine and an expert in stem cells derived from bone marrow, to co-author a paper in the journal Circulation in which they described their ability to regenerate blood vessels in retina and choroid under retina—a key step in repairing diabetic retina and successful treatment of age-related macular degeneration.

Of course, cell regeneration is only part of the picture of regenerative medicine. Other researchers will be called upon to study the causes and treatment options and to test applications in clinical trials. One of those researchers is Mandeep Singh, M.D., Ph.D., an ocular surgeon at Wilmer and an expert in the surgical transplantation of regenerative cells. As a doctoral student, Singh restored sight to a blind mouse using transplanted regenerated cells. He joined Wilmer to explore and perfect the surgical techniques and technologies necessary to get stem cells to take root and generate new tissues in the eye.

A Team Approach

Once, these researchers at Wilmer worked alone or in small collaborations, usually in isolation. Now, they are all members of the newly formed Center for Stem Cells and Ocular Regenerative Medicine, or STORM.

Led by Wilmer, STORM is a multidisciplinary team of specialists from across Johns Hopkins who are pursuing the dream of studying and eventually curing vision loss and blindness through regenerative medicine. STORM will also
I believe there is no other institution than Wilmer better positioned to bring regenerative therapies to reality. But, as exciting as the possibilities are, they are also expensive. To take STORM and Wilmer to the next level in regenerative medicine, we need sufficient funding. It’s critical to the future.

—Valeria Canto-Soler
*assistant professor of ophthalmology at Wilmer*

collaborate with experts in regenerative medicine at other research institutions.

“There has been a lot of enthusiasm lately throughout the medical world about advances in stem cell research, but the eye has been a particular exciting and promising area for many reasons,” says Zack.

STORM, he says, was formed to capitalize on synergies among disciplines and to integrate the considerable expertise found in-house at Wilmer and Johns Hopkins more broadly.

“I’m not aware of another similar regenerative medicine program that unites such a diverse group of disciplines,” Zack says. “Wherever the best people are, we want to work with them.”

One of STORM’s first areas of focus is a multidisciplinary regenerative approach to curing retinitis pigmentosa, a degenerative disease of retinal photoreceptors and retinal pigment epithelial (RPE) cells caused by various genetic mutations. RP causes vision loss—and often blindness. Early efforts at replacing photoreceptors have not yet succeeded because the transplanted cells have failed to thrive and integrate. STORM’s innovative approach will attempt to transplant a collection of photoreceptors and RPE cells to encourage survival and function of the transplanted cells.

### ‘Man on the Moon’ Effort

STORM is a result of a new five-year strategic research planning process at Wilmer. West, who is leading the research strategic planning process, says that, despite Wilmer’s clear leadership in regenerative ocular medicine, the impressive research to date had not been coordinated and integrated. It was driven individually by various faculty members based on their own research interests and funding resources. Now, she says, “we are working toward a team effort,” with each team building upon the work and success of the other teams.

“In the simplest terms, we’re interested in using stem cell therapies to cure blindness,” Zambidis says. “This is a ‘man on the moon’ effort for Wilmer—a daring goal,” West says. “Wilmer benefits simply by thinking big and setting the goal. This is the first time we’ve set out a Wilmer-wide research goal that stretches from the lab bench to patient bedside.”

So much has been written and said about the promise of stem cells that Zack sounds a cautious note. Sometimes fiction can get ahead of fact. Zack notes that with all the lofty potential rewards, there are risks, both technically and ethically. Even the most rosy scenarios put potential cures multiple years into the future, he says. An important consideration is to shield patients from unrealistic expectations and from potentially dangerous and unproven treatments.

“With so much hype, it’s easy for patients to get overly excited,” Zack says. “STORM is on the cutting edge, of course, but it will study new therapies in an ethically and scientifically sound way, using state-of-the-art clinical trial approaches.”

While STORM was founded to unite complementary disciplines into a focused team, it was also founded to generate all-important, difference-making donor interest in the remarkable breadth of the effort and the potential for good.

“I believe there is no other institution than Wilmer better positioned to bring regenerative therapies to reality,” Canto-Soler says. “But, as exciting as the possibilities are, they are also expensive. To take STORM and Wilmer to the next level in regenerative medicine, we need sufficient funding. It’s critical to the future.”

For Zack, an ophthalmologist who recently gave up his 25-year clinical practice to focus full time on his research, the bigger goal is always on the horizon.

“Maybe not tomorrow, but someday, regenerative medicine has the potential to allow us to not only preserve vision but to restore it,” he says. “As a clinician, I learned how important sight is to people and what happens when it’s lost. Helping those people is what keeps us going. That’s what keeps us working so hard. We know we will get there.”