

DOMINICAN UNIVERSITY OF CALIFORNIA NEWS

STEM CELL CONFERENCE

SPRING 2008



Leading Scientists Discuss Stem Cell Research

In February, Dominican partnered with the Bay Area nonprofit Zero Breast Cancer to present an interactive forum in which scientists, students and community members explored the impact of stem cell research on our society and in our everyday lives.

“The Promise of Stem Cell Research in Human Health” was designed as a public outreach program during which speakers discussed what stem cell research involves, how it may be used, and what scientific, ethical and legal questions it raises. Discussions focused on the potential benefits of stem cells as applied to issues of broad community concern, such as breast cancer, fertility and reproduction, and diseases associated with aging.

“We brought together internationally renowned stem cell researchers, public health professionals, public policy leaders, university students and community members for an interactive exchange of information about the current art and science of stem cell research, social ethics and policy,” said Dr. Sibdas Ghosh, chair of Dominican’s Department of Natural Sciences and Mathematics.

“This forum allowed for meaningful dialogue and reflection among all those present,” said Janice Barlow, executive director of Zero Breast Cancer. “The goal of a participatory approach to research is to build community capacity to contribute, comprehend and, most importantly, use research findings to inform future personal and scientific decision-making and public policy,” she added.

Panelists included Dr Mohammed El Majdoubi, assistant professor, Dominican University of California; Dr. Renee Reijo Pera, director of human embryonic stem cell research and professor of obstetrics and gynecology, Stanford University; Dr. Mary Helen Barcellos-Hoff, head of the Department of Cancer Biology Life Sciences Division at Lawrence Berkeley National Laboratory; Dr. Xianmin Zeng, assistant professor, Buck Institute for Age Research; Dr. Warren Hoeffler, founder, Xgene Corporation; and Dr. Mary Devereaux, director, biomedical ethics, University of California, San Diego.

To view a video presentation of the conference, please visit: www.dominican.edu/stemcellconference

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Dominican transforms lives. We are an independent, international, learner-centered university of Catholic heritage which interweaves Dominican values, the liberal arts and sciences, and the skills and knowledge necessary to live and work in an interdependent world.

Zero Breast Cancer is a nonprofit organization dedicated to finding the causes of breast cancer through community participation in the research process. We focus on identifying environmental factors and the role they play in the development of breast cancer at all stages of life.

An Overview of Stem Cells

Stem cells make the cover of national magazines and newspapers. They're debated in the halls of Congress and state capitols. And yet they are widely misunderstood and shrouded in mystery, even in many of the scientific laboratories that are working on them.

In an attempt to demystify stem cells and bring some light to the debate over the science and ethics surrounding these vital microscopic units of life, Dominican University of California and Zero Breast Cancer sponsored a dynamic all-day conference on The Promise of Stem Cell Research in Human Health on Feb. 9 at Dominican's San Rafael campus.

"In labs world-wide, scientists are turning to stem cells to help with the development of treatments of ailments, including heart disease, diabetes and cancer," said Dr. Sibdas Ghosh, chair of Dominican's Department of Natural Sciences and Mathematics. "The public still knows little of this vital field of research, which holds great promise for therapies and cures. Stem cells are still so new that few people even learn about it in school."

More than 300 people attended the conference, from Dominican students to senior citizens active with the Buck Institute for Age Research.

A range of speakers touched on various aspects of the research. Dr. Mary Helen Barcellos-Hoff, PhD, a senior scientist and deputy director of the Life Sciences Division at Lawrence Berkeley National Laboratory, told how knowledge about stem cells is informing research into how breast cancer develops in the mammary gland, while Dr. Mary Devereaux, PhD, a bioethicist in the Research Ethics Program at the University of California, San Diego, explored the ethical debate, which touches on the question of when human life actually begins.

Dr. Mohammed El Majdoubi, an assistant

professor of biology at Dominican, spoke of his work with Dominican students in solving the mysteries of certain hormone-secreting neurons, while Dr. Warren Hoeffler, the founder of Xgene Corporation, a company commercializing discoveries in tissue engineering, spoke of the role of private enterprise in stem cell research.

And delving into the complex world of embryonic stem cells were Dr. Xianmim Zeng, assistant professor and director of the North Bay CIRM Shared Research Laboratory for Stem Cells and Aging at the Buck Institute for Age Research, and Dr. Renee Reijo Pera, professor and director of the Center for Human Embryonic Stem Cell Research and Education within the Stanford Institute for Stem Cell Biology and Regenerative Medicine at Stanford University School of Medicine.


At the Buck Institute, Zeng said, embryonic stem cell research focuses on four areas:

- Developing cell therapy strategies for neurodegenerative disorders.
- Developing drug screening.
- Studying aging-related processes. "You can find some clues for why we age," she said.
- Modeling human diseases.

What is a stem cell?

In the conference's keynote presentation, Dr. Gilberto R. Sambrano, PhD, the senior officer in charge of peer review for the California Institute for Regenerative Medicine, spoke of the state of stem cell research in California. The institute was established by a 2004 ballot measure that provided \$3 billion for stem cell research, in part a reaction to federal restrictions on such research.

Sambrano started the discussion at the simplest



Dr. Gilberto R. Sambrano, PhD, in his keynote presentation at the Stem Cell Conference.

level: What is a stem cell? "It's important that we are all on the same page," he said.

"A stem cell has two very basic characteristics," he said. "It is a cell that can mature and specialize into other cell types that have very specific functions, and it can renew itself."

Embryonic stem cells, like human embryos themselves, have the potential to grow into something much larger. "Stem cells have the potential to each grow into your entire body," he said. "As we grow, that potential slowly, progressively begins to decline. Adult stem cells have a limited capacity to renew themselves and to produce all the different cell types."

That's why researchers find the embryonic stem cells so attractive, he said. Stem cell research received a major boost in 1998 when Dr. James Thomson at the University of Wisconsin announced the ability to culture stem cells in a laboratory. "This was a tremendous finding," Sambrano said. "For the first time, we could take human embryonic stem cells, in a dish, and culture them. Under specific conditions those cells can be specialized to create different tissues."

Scientists had typically used embryos from in vitro fertilization, in which a sperm and an egg are put together in a laboratory, and allowed to grow into a ball of cells called a blastocyst. The blastocyst contains cells that can produce stem cell lines, and "once you have a stem cell line, those cells can propagate indefinitely," Sambrano said, "and you have the potential to produce in a lab all the different cells in the body."

"This is a very young field," he said. "Scientists are currently trying to understand the mechanisms that allow a human embryonic stem cell to become a nerve cell, or a pancreatic cell, or a blood cell, or a heart muscle cell. There are still many questions that need to be addressed in terms of the science."

Even with the questions, however, stem cells hold great promise for new therapies.

"Stem cell research really is an enabling technology," he said. "It might enable us to replace tissues that are diseased, or to deliver drugs to specific areas of the body."

If a scientist had a diseased cell in a culture dish, he or she could test hundreds or thousands

different drugs. Such research would be difficult if not impossible in living humans, but the same results could come from stem cells.

Yet Sambrano acknowledged that the discussion is not purely scientific, but is layered with issues of politics and religion. The development of the controversial technique known as Somatic Cell Nuclear Transfer (SCNT), in which the nucleus is removed from an egg and another nucleus is inserted, marked the dawn of a “very powerful technique,” Sambrano said. “It gave us the ability to create cells that are specific to a patient.”

“This very basic technique, although powerful, was also used to clone Dolly the sheep (by taking the SCNT blastocyst and implanting in the uterus of a surrogate sheep),” he said. “Will scientists be interested in wanting to clone people? That is not the interest of scientists. It’s not something that scientists want to do. But it did ruffle feathers.”

A blastocyst-stage embryo

A common concern in the public mind is the necessary use of an embryo to derive stem cells, in part augmented by a not-so-clear idea of what a blastocyst-stage embryo is. Some might imagine a blastocyst embryo as one that begins to demonstrate recognizable features like an arm or leg. In fact, a blastocyst-stage embryo has not begun to distinguish itself beyond a small cluster of cells. He showed a dramatic slide, showing the size of a blastocyst-stage embryo used for derivation of stem cells next to a penny. Pointing to the letter “R” in the word liberty on the front of the penny, Sambrano said the embryo could nestle in the little crevice inside the R.

Neither the blastocyst created in a dish, nor the stem cells derived from it, can actually develop into a full organism on their own. The development of an organism from an SCNT blastocyst would require at the very least implantation of the blastocyst into a uterus; a

step that scientists have no desire or reason to take.

“Nevertheless,” he said, “in 2001, there was an executive order by the president that affected human embryonic stem cell research quite deeply. In his mind it was a compromise. It prohibits using federal funds on embryonic stem cell lines that were derived prior to the date of the decree, Aug. 9, 2001.”

Scientists moved quickly to find alternate funding so that the research could move forward. Several states stepped into the breach, with California the first and the largest, but Illinois, Connecticut, Maryland, Massachusetts, Maine, New Jersey, New York and Ohio all following suit.

CIRM

California’s Proposition 71 passed in 2004 with 59 percent of the vote, authorizing \$3 billion for stem cell research over a 10 year period. The measure affirmed the right to conduct research that was not supported by federal funding, and it banned reproductive cloning, which the federal government has not yet done.

The measure created two entities, the California Institute for Regenerative Medicine, or CIRM, which is charged with disbursing the \$3 billion to researchers, and the Independent Citizens Oversight Committee, a 29-member governing board for CIRM. CIRM’s mission is to support and advance stem cell research and regenerative medicine under the highest ethical and medical standards for the discovery and development of cures, therapies and diagnostic tools.

“It’s basically turning stem cells into cures,” Sambrano said, citing patient advocate Roman Reed’s phrase. “That is the goal of the institute.”

CIRM faced some big challenges from the start. It had to build a granting agency from the ground up, Sambrano said, and scientists

already felt that time was being lost due to the federal funding restrictions. It had to meet many state laws that dictate how the public’s money can be spent. It needed to set up a grants management system, so that it could make sure it tracked its grantees’ accomplishments.

And it faced a major legal challenge. As soon as Prop. 71 passed, two lawsuits “challenged our constitutional authority to spend state money,” Sambrano said. “If you can’t spend state money, you can’t fund scientific research.”

A third suit, which said that CIRM was depriving frozen embryos of their constitutional rights, was dismissed.

CIRM’s chairman of the board, Robert Klein, was able to assemble some interim funding in the form of bond anticipation notes to get CIRM off the ground while the legal system sorted out the controversy. In May 2007, the California Supreme Court freed CIRM to start funding research.

CIRM then established a 10-year plan for spending the money, involving 200 people, including scientists, ethicists, clinicians, patient advocates and public interest groups. While it also aspires to make California the worldwide leader in stem cell research, it also includes doses of realism.

“Therapeutic drug development is expensive,” Sambrano said. “It takes time, and it fails more often than it succeeds. It typically takes seven to nine years to bring a drug to patients, and we’re only developing a 10-year plan.”

And in many cases, stem cell research could lead to cellular therapies – replacing diseased cells in the body with healthy ones – a new field that will require close discussion with the federal Food and Drug Administration to get therapies approved. One of CIRM’s goals is to achieve clinical proof of the principle that cells can be used to restore function for at least one disease, Sambrano said.

According to the CIRM Web site, the CIRM governing board has approved 156 research grants totaling almost \$260 million, making CIRM the largest source of funding for human embryonic stem cell research in the world. Sambrano said it is moving forward quickly to move research forward, both in the nonprofit and for-profit sectors.

Many audience members peppered Sambrano with questions. Sambrano assured one woman that CIRM is working with international colleagues on stem cell research. “Even though Proposition 71 is about California, the institute realizes that this effort is worldwide and should not be restricted to California,” he said.

Another questioner wanted to know where current presidential candidates stand on stem cell research, and while Sambrano said they have not clearly outlined their positions, he believes no matter who is elected will ease the restrictions that President Bush has placed on the research. A greater challenge, he said, will be finding the money, as the National Institutes of Health has been cutting its budget every year.

In response to another question, Sambrano said that the institute is not merely funding embryonic stem cell research. It is very interested in other developments – from Japan and from Thompson’s lab in Wisconsin, for instance – indicating that some adult cells, such as skin cells, can behave like embryonic stem cells in the laboratory. If that works, that could help change the entire debate, but the technique is still unproven.

“There’s a lot we can learn, and we won’t learn if we only focus on one thing,” he said. “We need to reach out and look at new technologies that come into play.”

Stem Cell Outreach

Among the audience members at Dominican University of California's Stem Cell conference on Feb. 9, Philip Economon stood out – both for his enthusiasm, and his age. Economon, 90, of Corte Madera, is a World War II veteran and a retired assistant commissioner for Marin County's Department of Agriculture. Since 1993, he's been an active docent with the Buck Institute for Age Research in Novato.

"I work out one and three-quarter hours at the YMCA every day," Economon said. "I want to see how this body will keep up. Many older people feel like they want to quit. I can't see that."

Economon was at the conference so he could learn even more. "I want to know as much as possible about what our researchers are doing," he said. "This field is so complicated."

Scientists wanting to engage in stem cell research have an unprecedented role in educating the public about this recent, confusing and controversial phenomenon. In an age in which science is increasingly politicized, and in which the Internet has made more information available to average people than ever before, scientists want to make sure the facts get out.

Having public forums like the one at Dominican, which community members like Economon can attend for free and hear from top researchers, is a start.

It's also part of the mission of the California Institute of Regenerative Medicine, which the voters of the state authorized with a \$3 billion ballot measure in 2004. Because of CIRM's unique genesis, it remains accountable to the state's citizens, and actively tries to get the word out about stem cells.

"We love to have the opportunity to share with you, the public, what it is that we are about and what it is that we are doing," said Dr. Gilberto

R. Sambrano, PhD, the senior officer in charge of peer review for the California Institute for Regenerative Medicine, and the head of its training grant program.

Sambrano said the mass media has often supplied misinformation to the public. A slide demonstrated the most notable talking points: Headlines declaring, "Elvis was cloned in 1976 – duplicate Kings are roaming all over," and photos of George Bush, John Kerry, Michael J. Fox, Dolly the sheep, and stem cells on the cover of Time magazine.

"It's a challenge to grasp the promise of stem cell research," Sambrano said. "We want to remove the extraneous things and tell you why scientists are excited about stem cell research."

One path to increased understanding would be improved science education in the schools, according to Dr. Renee Reijo Pera, professor and director of the Center for Human Embryonic Stem Cell Research and Education within the Stanford Institute for Stem Cell Biology and Regenerative Medicine in the Department of Obstetrics and Gynecology at Stanford University School of Medicine.

"We need to educate differently," Reijo Pera said. "I was not a good science student in high school. Science was not interesting. We need to make science more interesting."

The questions addressed in stem cell research get to fundamental issues of human life, she said. "They bring us into the realm of who we are," she said. It shouldn't be hard to grab the attention of high school students. After all, she said, "high school students are very interested in eggs and sperm."

The education is critical, she said, in a world in which the issues get painted as black and white, and people are pitted against each other.

"We need to heal," she said. "We have the ability to work together."

Even as the media may hype some of the controversies and scary aspects of stem cell technology, such as cloning, it's equally guilty of over-selling the promise of stem cells, according to Dr. Mary Devereaux, PhD, a bioethicist in the Research Ethics Program at the University of California, San Diego.

"The media likes to say stem cell research will solve everything," she said. "But it will have some significant medical hurdles and ethical issues."

"There's a huge amount of promise," she said. "That's what everybody likes to talk about. But the public needs to know that there are scientific hurdles that are considerable."

At the same time, scientists in the field need to make sure they've thought through all of the ethical implications, to avoid trouble. "The research community needs to be up to speed with the human, legal and ethical questions," Devereaux said.

But don't researchers want to be in the lab, working, one woman asked, instead of trying to teach people about why they should get funding? Isn't that someone else's sales pitch to make?

"In this field, you don't have that luxury," Devereaux said. "It's part of this field. Scientists have to be part of that national conversation. It is very fundamental, what we're doing. It involves cloning, stem cells, basic biological information. I'm not going to let you off the hook. You have to participate in this."



Stem Cells at Dominican

Dominican offers an unusually rich program that allows undergraduate students the chance to engage in state of the art stem cell research, and graduate students to team up with researchers at the Buck Institute for Aging. It's all part of a push at the university to expand its scientific frontiers.

"We are entering a new era of doing science at Dominican University," said Dr. Sibdas Ghosh, chair of the Department of Natural Sciences and Mathematics, referring to the new science center. The center, which opened last year, replaced five outdated labs in two buildings with a two-story, 35,000 square foot building that houses more than 30 teaching, research and computer technology labs for student and faculty use. The science program helps prepare students for a variety of careers, from conservation biologists to nurses, from pharmacologists to veterinarians.

Leading the push in stem cell research is Dr. Mohammed El Majdoubi, an assistant professor of biology at Dominican. His research is focused on investigating the differentiation of mouse embryonic stem cells into hormone-secreting neurons in vitro, part of the larger mystery of reproductive physiology— how do the brain cells that control reproduction develop in the embryo.

Speaking as an undergraduate professor, Majdoubi offered a pertinent analogy: "Stem cells are the students of the body. They're undeclared. They don't know what they want to be."

But then, like students finding their major, they're committed – and scientists can get to work. "The stem cells have brought us a model that was not available before," he said. In his lab, Majdoubi and his students are "trying to coax stem cells into becoming hormone-secreting neurons. We can then study their development under a microscope, without using an embryo, or any invasive techniques."

"This is completely investigative," he said. "The students are learning all the techniques that are necessary to grow, manipulate and maintain stem cells."

Majdoubi is proud of the work that's going on in his laboratory. "My students will be able to find a job upon graduation," he said. "Whoever hires them will not have to spend one second training them."

He boasts that three California colleges were selected to present their work at the Capitol Hill in Washington, D.C.: UCLA, USC and Dominican.

Megan Bell, 21, of Benicia, a senior at Dominican, is a biology major with a molecular cell emphasis. She transferred from Solano Community College largely so she could work on stem cell research with Majdoubi.

"We take embryonic stem cells – mouse cells – and by treating them with certain chemicals, we're able to direct these pluripotent cells into becoming different adult cell types," such as neuroendocrine cells, neurons and muscle cells, she said.

She emphasized that they're not working with mice, but with cell lines. "I don't know the last time it saw the inside of a mouse," she said.

Majdoubi does. "This cell line has been growing since the mouse mom died in 1988," he said. "You can grow them and collect them and have an infinite amount of cells."

They're using the stem cells to make hormone-secreting neurons. "Those actually secrete many hormones that are important in homeostasis" Bell said. "They play a significant role in regulating the body. Potentially, these neurons can be used as treatment for reproductive, metabolic and neuroendocrine diseases."

It may be that certain neuroendocrine cells that



Dr. Majdoubi, PhD, works with Dominican Students.

lack the necessary hormones could be replaced with healthier cells. That sort of potential has researchers excited.

"We look at how to keep the cells growing, and how to push them to differentiate" she said. "If we understand how these embryonic stem cells work, we can apply that knowledge to how adult cells develop in general. And we can study all of that in vitro," or in a test tube.

That sort of enthusiasm has Majdoubi excited. He loves working with younger students. "I choose to work with undergraduates," he said. "I wish I could also go earlier, to high school. If you want to inspire people, you have to reach them early in life. Graduate students are already specialized. I want to inspire someone early on."

Majdoubi – who has plenty of youthful enthusiasm in his own demeanor and speech – worked for four years as director of the Cell Imaging Core in the Center for Reproductive Sciences at UC San Francisco. Majdoubi has published 17 scientific papers and has given 18 presentations at international meetings. He also is a reviewer for the journal *Neuroendocrinology*.

In his presentation at the February conference, Majdoubi showed a slide of cells that looked almost like green hills on a topographical map.

"Imagine being a student in the lab," he said. "It's 10 p.m., and no one is around."

He clicked a button and the slide started throbbing. The audience gasped. "These are beating heart cells in a dish," he said. "They can stick to the heart and start beating on their own."

"This shows the promise of stem cells and the pitfalls of stem cells," he said. "If the cells that fail to differentiate are also transferred, we don't know how they would behave. It could be the origin of a tumor."

Majdoubi works with graduate students as well, in collaboration with researchers at the Buck Institute for Age Research in Novato. "That's a high level of intensive research," he said. "My students learn their techniques at an undergraduate level, and then can expand their knowledge at the Buck Institute."

"We're having them go through two different systems, but it's a normal evolution," he said. "You walk before you run."

At the Buck Institute, the students are working five days a week as full-time researchers. "It's a research-based master's degree," he said. "This is the closest you can get to a doctoral school in Marin County."

Stem Cells and Breast Cancer



Dr. Barcellos-Hoff, PhD, gives her presentation at the Conference.

Advocates for people with breast cancer hold great hope that stem cell advances could aid in the treatment of the disease. Researchers have showed that stem cells are involved in the development of the breast and its ability to produce milk, and may provide clues as to the development of breast cancer.

Zero Breast Cancer, a nonprofit based in Marin County, co-sponsored the conference, and believes the general public should be part of the process when it comes to research.

Dr. Martha Nelson, dean of the School of Arts and Sciences at Dominican University of California, recalled when Zero Breast Cancer was founded as Marin Breast Cancer Watch in 1995 by Francine Levien with a small but committed group of women, all with breast cancer, who were concerned about the high incidence rates of invasive breast cancer in Marin County. "From its roots as an activist group, it has matured into a valued community partner," Nelson said. With its name change last year, she said, its "goal is clear to us all: Zero Breast Cancer."

Zero Breast Cancer's work has spread, not only to focus on why the San Francisco Bay Area has higher than normal rates of breast cancer, but also as national advocates for prevention of breast cancer. "We find current rates unacceptable," said Janice Barlow, the executive

director. "We are looking to find causes through community participation in the research process."

The organization's Web site declares: "Community-based research is a process by which members of a community identify a problem, engage outside researchers in a collaborative that promotes co-learning, and achieve a balance between research and action."

"We want to share this information with the women in our community who have breast cancer," Barlow said.

"There are tremendous benefits to involving students, community members and scientists from different disciplines early and often in the research process," Barlow said. "We want you to be able to use research and understand it in a way that helps you make decisions, and in a way that helps us make relevant public policy."

Barlow expects that Zero Breast Cancer will sponsor more conferences like the one at Dominican in February "to keep people up to date on the progress of stem cell research in these various diseases."

"Our vision is to make zero breast cancer a reality for the next generation," she said. "We're passing on a huge economic deficit. We're also passing on our genes. We as adults have a huge responsibility not to pass on these diseases without having a better understanding, and better treatment. We have to understand how to prevent these diseases and to better treat them."

Barlow said Zero Breast Cancer is involved in a major research initiative looking at whether there are periods of vulnerability in the development of the mammary gland that environmental factors may impact on future breast cancer risk.

"I had always just thought of stem cell research as being useful in studying the effects of aging, or on spinal cord injuries," Barlow said. "I now know developments in stem cell research will contribute significantly in increasing our

understanding of the causes of breast cancer."

Among the researchers Zero Breast Cancer is collaborating with is Dr. Mary Helen Barcellos-Hoff, PhD, a senior scientist and deputy director of the Life Sciences Division at Lawrence Berkeley National Laboratory, who spoke at the conference. Barcellos-Hoff is looking for the cellular processes that cause breast cancer, studying mammary gland development, the development of aberrant tissue architecture during cancer, and how a carcinogen such as radiation promotes cancer progression.

"There is an interesting link between cancer in the breast and the origin of stem cells," Barcellos-Hoff said.

Barcellos-Hoff said she studies mammary development in mice, because in both mice and humans the tissue in the breast – the epithelium -- "develops post-natally under hormones of puberty.

"The mammary gland is unique in that regard," she said.

When a woman (or a mouse) has a baby, she said, "there's a huge expansion of the epithelium. Those epithelial cells now can make milk."

When the baby is weaned, those go away, and the breast returns to its original state. "This cycle of differentiation and involution can occur over and over again," she said.

"How do we know it's because of stem cells?" she asked. "With mice we can manipulate cells."

Researchers can cut out the epithelial cells from one animal and implant some from another, over several generations. Through this work, they can see a "reservoir of stem cell activity in the breast that's quite profound," Barcellos-Hoff said.

"We're interested in whether or not these cells are the origin of cancer," she said. "Women who are exposed to radiation, which is a known

carcinogen of human breasts, if they're exposed during puberty, have a much higher risk of breast cancer later in life."

Barcellos-Hoff said her team is investigating two hypotheses. One is that the cancer cells are the result of carcinogen-induced alterations in the stem cells," she said.

"Or, it's also possible that the radiation affects the signals needed for stem cells to self-renew and that's why we see the commonality with radiation in puberty. Intriguingly, some of the signals that regulate stem cell growth, and regulate the decision to proliferate or not to proliferate – are the same for cancer cells."

That leads to a question: "Are stem cells in tumors comparable to stem cells in tissues?"

Barcellos-Hoff described "one of the most stimulating, most provocative experiments of recent years, one that led to a different view of how we might treat cancer."

A group at the University of Michigan took breast cancer cells from different women and injected them into the mammary fat pads of immune-compromised mice. Only certain cells actually formed tumors in the mice, she said, revealing an "important determinant," that "certain aspects of stem cell biology may be recapitulated in cancer development."

If they can prove that hypothesis, she said, then maybe "we could exploit it as a means of controlling cancer."

In treating breast cancer today, doctors typically try to kill all of the tumor's cells. "But if the stem cell hypothesis is true, then we only have to control (focus on?) the cancer cells," she said. The other cells are not as relevant. Killing the non-stem cell like tumor cells will bring "regression but not a cure."

And the cure is what she, and other researchers, are after.



Dr. Xianmim Zeng, PhD, begins her presentation on the applications of embryonic stem cells.

Embryonic Stem Cells

Some people are uncomfortable allowing the use of embryonic stem cells, because of their potential to grow into human life. While scientists say other cells are less controversial -- adult stem cells and skin cells, for instance -- those cells also lack some of the properties of embryonic cells, and are less useful in research.

The advantage of adult stem cells is largely that they are from adults, and we know what they are comprised of, said Dr. Mohammed El Majdoubi, PhD, an assistant professor at Dominican.

In addition, "adult stem cell research has never been excluded from federal funding," said Dr. Renee Reijo Pera, professor and director of the Center for Human Embryonic Stem Cell Research and Education within the Stanford Institute for Stem Cell Biology and Regenerative Medicine in the Department of Obstetrics and Gynecology at Stanford University School of Medicine.

Dr. Warren Hoeffler, PhD, the founder of Xgene Corporation, a company commercializing discoveries in tissue engineering, agreed, with a caveat. "I see a lot of potential for adult stem cells, but embryonic stem cells, because they are more durable, are very appealing," he said. "Adult stem cells are difficult to isolate. They lose their 'stem-ness' in passing from one Petri dish to another. They lose a lot of their stem cell ability."

Those were among the many disadvantages Dominican's Majdoubi cited. "We have difficulty in growing them or isolating them," Majdoubi said. "They have limited longevity. We cannot make a lot of cells out of them. They have questionable quality due to age, toxins, and diseases."

Neurons can live in the body for 80 years or more, but they stop dividing, said Dr. Xianmim Zeng, PhD, assistant professor at the Buck

Institute for Age Research. "This is called senescence, or aging."

A cell from an infant, on the other hand, will divide 50 times, she said. "Human embryonic stem cells can self-renew indefinitely," Zeng said. "They can bypass senescence."

Embryonic stem cells have many more advantages to researchers, Majdoubi said. They're easy to grow in cell culture, they can be maintained for a long time, and they have the potential to be useful in clinical medicine for a wide array of diseases.

Since they can be grown in a dish, Majdoubi said scientists hope that the nerve cells, heart cells, liver cells, blood cells they are making in the lab can be used some day in a variety of transplantations.

Scientists have some indications those cells might be used in humans battling diabetes, Parkinson's, spinal cord disease, or stroke. "Imagine injecting pancreatic cells into a patient to replace the pancreatic cells that were lost or damaged in a disease of Type I Diabetes," he said.

But to achieve such dreams, scientists like Majdoubi first want to dispel some of the misperceptions.

"Stem cells themselves cannot make humans. They cannot implant themselves. They can only create other cells," he said. "The myth of making human clones from embryos from a hospital is just that, a myth."

There can be several sources of embryonic stem cells, he said. Most common are the embryos from in vitro fertilization. In that process, sperm from a man is used to fertilize an egg from a woman, and because of the uncertainty involved, couples usually choose to fertilize more than

one, but not transplant more than one or two, Majdoubi said.

“There are always embryos left over from the IVF procedure,” he said. “Four hundred thousand are frozen in hospitals around the country. When their use is over, they’re discarded.”

“Because this procedure involves destruction of embryos, there are groups opposed to it,” he said.

Doctors in Wisconsin have developed a new procedure that shows promise in using skin cells as a substitute for stem cells. But those are still far from perfect, Majdoubi said. “In order to reprogram skin cells, we have to introduce viruses, and we still don’t know very well how to control viruses in the body” he said.

“There’s still a long way to go to use this approach.”

Other workarounds include Somatic Cell Nuclear Transfer, but that procedure – used in cloning Dolly the sheep – is highly controversial.

“Therapeutic cloning – cloning for the purpose of making cells – involves an egg from which the pronucleus has been removed and replaced with an adult nucleus,” Majdoubi said. “What you have in the end is a little embryo that does not involve sex. That embryo can make stem cells custom-made for a patient who gave that nucleus.”

Reijo Pera, from Stanford, gave a dramatic account of the early life of embryonic stem cells, one that unflinchingly cast their journey in human terms.

She started her slide show on “day zero.”

“Here’s an egg that’s been retrieved from a woman,” she said. “It’s 100 microns in size. It’s smaller than the point of a pin. It’s a single

nucleus containing the mother’s DNA. This is the maternal pronucleus.

“This can be put in a dish with a sperm,” she said. “The sperm will find the egg. The sperm has the male DNA – the male pronucleus.”

“What’s interesting about the first day of human life? It seems like not much has happened,” she said. In reality, “this is one of the most eventful days you can imagine. As these two pronuclei migrate towards each other, it’s like a movie where you see two people running across a field toward each other. It’s the same thing. Here you have a male and a female, and they meet and they fuse.”

As they do that, Reijo Pera said, they’re being reprogrammed. “What has to happen on the first day of life is, we have to have a complete reprogramming of the egg and the sperm nucleus. Erase the hard drive.”

“The DNA is erased, but a couple of marks are left to track where it came from.”

And then the egg starts dividing. It doesn’t grow, it just cleaves. “On day two,” Reijo Pera said, “it becomes two cells. On day three, it’s four cells early, and later on, there’s eight. This is incredibly slow growth. It’s incredible that on day three there are just eight cells.”

This activity takes place in what Reijo Pera called “a sea of transcriptional silence.” Her slides looked like photos of craters on the moon, but the little circles were actually cells dividing.

“What’s interesting on day three is, suddenly the embryo turns on its own genome,” she said. “The embryo starts relaying messages. That cell is truly an embryonic cell. We call it the oocyte, or egg-to-embryo transition. It has to become an embryo in order to survive and go on to develop.”

There are many mysteries of human development, Reijo Pera said. “Why does human embryonic genome activation occur on day three? It’s like a clock. It’s very mysterious.”

“It’s things like these decisions at a cell-based level that we failed to learn much about in human biology,” she said.

That process takes only 12 hours in mice, and does not have nearly the “transcriptional silence” evident in human embryo development.

“Humans are special this way,” Reijo Pera said.

And yet it’s a fragile time. “A lot of errors can occur here,” she said. The loss of embryos derived from in vitro fertilization exceeds 75 percent. There’s an incredible rate of miscarriage in in vitro fertilization clinics. There are failures to get pregnant, and the first three days expose us to birth defects. It shows how much we don’t understand about this process.”

On day four, the embryo is making its own genetic material. On day five, the outer layer attaches the embryo to the uterus. The inner layer – from which embryonic stem cell lines are derived – begins to give rise to the fetus.

On day six, the blastocyst – which becomes the embryo -- has hatched. “It’s worked up some pressure and the cells spill out,” she said. “It wants to get closer to the tissues of the mother. Here, there’s a question of how you can have a foreign object invade the body of the female. It’s not quite the same, but there’s no rejection.”

This begins a dramatic period, with the formation of different structures like the hypoblast, the epiblast, and the yolk sac. That period is known as gastrulation, and it involves cells moving, caving in on each other, and transforming themselves.

“The hardest thing you’re ever going to do in your



Dr. Reijo Pera shows the early stages of development in embryonic stem cells.

life is gastrulation,” Reijo Pera said. “The worst is over, that’s the way I look at it.”

As the cells move, some will become the ectoderm, or the outer surface of our body. Others will be the mesoderm – the heart, the muscles. And those on top will be the endoderm – the gut and the pancreas.

Although Reijo Pera spelled everything out on a daily basis, she said much remains unknown about those first days. “The rules have obviously been written because we exist,” she said. “We have beating hearts and beautiful skin, yet we don’t know the rules.”

“We need to understand how a cell makes a decision,” she said. “Today we really do have the opportunity not only to isolate embryonic stem cells, but also to understand our beginnings. Those are the decisions that make us uniquely human. We start out with a program that’s uniquely human.”

“We need to pursue these studies in understanding our development. We need to understand and embrace the beauty of the programs that make us who we are and dictate how we develop,” she said. “Two cells come together, a sperm and an egg, and the rest is history.”



Dr. Warren Hoeffler, founder of Xgene Corporation, discusses the company's advances in the field.

Stem Cells Inc.

Stem cell research is expensive, and researchers can't count on government grants. President Bush limited federal funding for stem cell research, and the National Institutes of Health budget is shrinking. Even though California voters authorized spending \$3 billion over 10 years, the California Institute of Regenerative Medicine still needed to raise money to help get projects going in the short run.

"There's an overall crisis for scientific research that is incredible right now," said Dr. Renee Reijo Pera, professor and director of the Center for Human Embryonic Stem Cell Research and Education at the Stanford University School of Medicine. "Eight percent of applications are funded. Ten years ago, it was 22 to 25 percent. We've reduced the level of funding to a level that is unsupportable. There is a tremendous need for funding for medical research."

But there is another source. Biotech companies see some promise in stem cells, with the hope that breakthroughs in the lab could lead to new drugs and therapies. Private enterprise is kicking in millions of dollars in the effort.

"We definitely need private companies in this area," Reijo Pera said. "Even at Stanford University, it's extraordinarily difficult to fund an FDA clinical trial."

Dr. Warren Hoeffler, PhD, the founder of Xgene Corporation, a company commercializing discoveries in tissue engineering, told the Dominican University of California conference on Feb. 9 that in Northern California alone, 800 life sciences companies employ 80,000 people, paying \$5.8 billion in wages.

This region accounts for 10 percent of the world's 8,000 life sciences companies, he

said, and of those, 180 are dedicated stem cell companies.

"There's a lot of momentum in the business environment toward stem cell companies," Hoeffler said.

Because of the powerful nature of what stem cells accomplish in the body, the research is critical, Hoeffler said. "This is not going to go away," he said. Yet so much is unknown, and the research is so expensive and time-consuming, that businesses are really taking a chance when they place their bets on stem cells.

"In business, there's a strong relationship between risk and reward," he said. "If you take a lot of risks, you often expect a big reward," if the risks pay off. "If you reduce your risks at the beginning, you're more likely to bring products to market," he said.

The biotech industry has already shown it can hit home runs, such as Tenofovir, a drug from Gilead Sciences of Foster City that is used in AIDS cocktails and has "alleviated a lot of suffering and is a great generator of wealth," Hoeffler said, or Gleevec, from Novartis Pharmaceuticals of Switzerland, which saved the life of one of Hoeffler's friends who had gastrointestinal tumors.

"Stem cell research has the promise of curing diseases," he said. "Blockbuster drugs can bring in \$1 billion a year in revenue, and can reduce human suffering. California's investment in Stem Cell Research is to be \$3 billion over 10 years, so the size of the investment is reasonable in terms of the earnings potential of leading therapies."

Yet the risk is great.

"Currently, the number of applications for any kind of cell therapy are very limited," Hoeffler said. "How does one treat patients using cells? We're used to drugs. The idea of cell therapies is quite new."

Hoeffler cited some of the key companies working on stem cell therapies:

- Geron Corp. of Menlo Park is developing cell-based therapeutics for several diseases based on differentiated cells derived from human embryonic stem cells, including cells for spinal cord injury and Parkinson's disease, cardiomyocytes for heart disease, pancreatic cells for diabetes, osteoblasts for osteoporosis, and other cells for osteoarthritis, for blood diseases and to prevent immune rejection of the other cell types. Because investors are so taken with the promise of stem cells, Geron, which is publicly traded, has a market capitalization of more than \$370 million even though it lost \$27 million in the first three quarters of 2007. "Geron has the ability to issue new shares and fund the things they think are important," Hoeffler said.
- OncoMed Pharmaceuticals of Redwood City is focused on cancer stem cells. OncoMed believes that cancer stem cells in tumors grow in the same way as regular stem cells, but that differences between the cells can be exploited to attack the cancerous cells. OncoMed last year announced a partnership with pharmaceutical giant GlaxoSmithKline that could pay OncoMed \$1.4 billion if it successfully discovers, develops and markets novel antibody therapeutics to target cancer stem cells.

- Advanced Cell Technology, in Alameda, is a publicly traded company investigating using adult stem cells to fight heart disease, and embryonic stem cells to fight retinal degenerative disorders. It lost \$16 million in the first three quarters of 2007.
- StemCells Inc. of Palo Alto, another publicly traded firm, is focused on the discovery and development of stem cell therapeutics to treat damage to or degeneration of major organ systems such as the central nervous system, the liver and the pancreas. It lost \$17 million in the first three quarters of 2007, and has a market capitalization of more than \$120 million.
- Xgene, which is Hoeffler's firm, concentrates on tissue engineering. It is based in Sausalito and remains privately held. Hoeffler's research interests focus on 3-D organ models that work on the inner and outer layers of tissue.

Hoeffler has worked on both the academic and the financial side of the equation. Hoeffler has served on the faculty at the Department of Dermatology at Stanford University School of Medicine. He conducted postdoctoral research at Genentech.

Xgene is working on skin cells, which have drawn increasing interest since James Thompson's announcement at the University of Wisconsin last year that some skin cells can mimic stem cells, without destroying embryos.

Skin cell work has already taken place in the form of skin grafts. "Now, in hospitals, if you're lacking skin in one area, they can take it from another area and graft it on," Hoeffler said. "They can take skin from your buttocks and put it on your torso."

Building on that work, Xgene has developed something it calls AccuSkin, in which it has "re-created skin from skin cells packaged in an incubator," he said.

AccuSkin is built on Xgene's patented platform AccuOrgan, which harnesses cell mechanisms to accurately re-create cell layers from a variety of sources representing organs from throughout the body. Other Xgene products include AccuGraft, an upside-down version of AccuSkin that's used for skin grafting studies, and AccuCornea, a three-dimensional human corneal equivalent.

Some of Xgene's experiments have led it into therapies that it did not anticipate. "Sometimes when you do science you come up with some pretty amazing things," he said. "We set out to make skin, and we ended up with a structure we didn't quite understand."

This new structure had an epithelium, a tissue composed of layers of cells that normally are on top of the skin, instead at the bottom. Xgene scientists saw a spongy material formed that "creates a scaffold that may be crucial for establishing the blood supply during wound healing," Hoeffler said, and they were able to harness this into AccuGraft, a proprietary therapy. Harnessing this method may be crucial for grafting stem cells back onto patients too.

"It's quite spectacular that by doing experiments mixing cells, you can come up with an understanding of how wound healing works," Hoeffler said.



The panelists answer questions and discuss the ethical issues surrounding stem cells. From left: Mohammed El Majdoubi, Reijo Pera, Mary Helen Barcellos-Hoff, Warren Hoeffler, and Xianmim Zeng.

The Ethics of Stem Cells

The discovery of stem cells has presented many thorny ethical issues for scientists, most notably the age-old question of when human life begins.

Dr. Renee Reijo Pera, professor and director of the Center for Human Embryonic Stem Cell Research and Education within the Stanford Institute for Stem Cell Biology and Regenerative Medicine in the Department of Obstetrics and Gynecology at Stanford University School of Medicine, painted a vivid picture of the earliest hours and days following fertilization, when a whirlwind of activity sets human life in motion.

Yet Reijo Pera said that, even knowing all that, and even considering herself a Christian, she has weighed the ethics and comes down on the side of using embryonic stem cells for research that could help save lives. "When I read the bible, I see as much emphasis on helping your neighbor and doing good as there is on sex and pregnancy," Reijo Pera said. "It's a simple decision. We allow in vitro fertilization. Embryos are being thrown away. What is the best use?"

There is a potential to really help that offsets, for me, the moral dilemma of those first few days."

When the first in vitro fertilization baby, Louise Brown, was born in 1978, Reijo Pera said, "It was not universally heralded as something that was desirable." In 1995, Congress passed the Dickey Amendment, prohibiting federal funds on embryo research. She said that 1.5 million embryos are produced in in vitro fertilization clinics each year, and 400,000 to 500,000 are "destined to be thrown away. Is this our best use? I think not." "We have a solution that doesn't serve the right to life community very well, and it doesn't serve women very well," Reijo Pera said. Society is comfortable with in vitro fertilization, she said, so it should be comfortable allowing the unused embryos to go to research. "They have to be used responsibly for research that is well-regulated and conforms to ethical principles," she said.

"It's not a decision I came to easily," said Reijo Pera.

The California Institute for Regenerative Medicine maintains a working group of 19 prominent ethicists, scientists, and patient advocates to wrestle with issues of standards and ethics in stem cell research, according to Dr. Gilberto R. Sambrano, PhD, the senior officer in charge of peer review for CIRM. All researchers in California who receive grants from CIRM have to participate in ethical training regarding stem cells.

Dr. Mary Devereaux, PhD, a bioethicist in the Research Ethics Program at the University of California, San Diego, addressed the ethical challenges of stem cell therapy in a lunchtime talk.

Among the challenges, she said, is where researchers will get their materials -- namely, oocytes, or human eggs. Like Reijo Pera, she sees a bright spot in the embryos left over from in vitro fertilization, saying their use in science "solved an ethical dilemma for couples who don't want to freeze them, throw them away, or give them to someone else." The eggs could be donated, but that's tricky, she said. "Under what conditions is it okay to ask a young healthy woman to undergo the process of giving eggs for in vitro fertilization?" Devereaux asked. "To get oocytes, you have to hyper-stimulate a woman's system, and she has to undergo surgery." Complications can arise. And when scientists want to test their findings in humans, the early trials will carry risks. "We can't eliminate all risks," she said. Scientists need to follow basic ethical principles in human experimentation, she said:

- Respect for people, through informed consent.
- The basis for all medicine: "Do no harm."
- Fairness, or justice. "Make sure, in the therapies we develop, that the risks are fair."

Another dilemma are criteria of inclusion and exclusion -- "who can and can't participate," Devereaux said, "and the issue of which diseases we're going to turn to first. That's an ethical question and a scientific question. It depends on the fruitfulness of particular kinds of research."

Even patients who already have a disease are entitled to the utmost respect and ethical considerations.

"When people volunteer for clinical trials, they have the view that it's going to help them, even in Phase I and Phase II trials," she said. "They're generally not going to get any therapeutic benefit."

They might get a psychological boost from feeling that they're contributing, but the odds are they won't truly benefit.

Still, doctors have "an assumption that we can't make a person who's dying any worse off, and that's not true," she said. "If you have to spend the last six months of your life in a hospital, getting infusions, then you can reduce the quality and quantity of life."

In experimenting with cellular therapy, doctors have a whole new realm of sticky issues. "If I give you a new drug and it makes you nauseous, you'll be uncomfortable for a few hours," but it can be treated, Devereaux said. "If I put in a mechanical heart and it makes you uncomfortable, I can take it out. It's not trivial, but it can be done."

But if a doctor gives a patient an experimental cellular therapy, what, Devereaux asked, is the exit strategy?

Doctors also need to be sure to get donors to sign consent forms that will give the doctors the ability to go back and get more information later on. If your cells are donated to someone, and you later find that you had a genetic disorder, shouldn't the person who received your donated cells know that?

"It's imperative that scientists look ahead," Devereaux said. "The pace of research is very fast. Sometimes it's better to get these issues resolved in advance. Without that, you get confusion, and you may even get delays in your research."

On the issue of whether the tiny cells represent human life, Devereaux, like Reijo Pera, has thought long and hard.

"We develop as human beings not just as biological persons, but also as moral persons," she said. With cells, "you have something that cannot perceive, cannot feel, and is not conscious. Many Americans have decided that destroying early cellular life is not permissible."

"I ask you to try an experiment. Imagine you have somebody doing embryonic stem cell research. They have 1,000 embryos, sitting on a bench. Suddenly, there's a smoke alarm. Everybody runs out. An asthmatic person is in there and passes out.

"A firefighter comes in and sees these 1,000 blastocysts. If it's true that each of those are human souls, which do you save?

"I hold a developmental view of personhood," Devereaux said. "As we develop, we become more and more what it is we are as persons."



Dr. Mary Devereaux, PhD, addressed the ethical challenges of stem cell therapy in a lunchtime talk.

ABOUT THE PRESENTERS

Keynote Presenter



Dr. Gilberto R. Sambrano, PhD

Dr. Sambrano joined the California Institute for Regenerative Medicine in 2005 as its first scientific officer. He is currently the senior officer in charge of peer review and heads the CIRM Training Grant Program. Dr. Sambrano trained with the Cardiovascular Research Institute at the University of California, San Francisco, and he later accepted a faculty position in the department of Cellular and Molecular Pharmacology. In 2001, Dr.

Sambrano took on a notable position to coordinate efforts of the Alliance for Cellular Signaling, a multi-institutional and multi-disciplinary consortium. For several years he served on the UCSF Chancellor's Committee on Diversity and as president of the UCSF Postdoctoral Scholars Association. Dr. Sambrano earned a PhD in biomedical sciences from the University of California, San Diego.

Panel Presenters



Dr. Mohammed El Majdoubi, PhD

Dr. El Majdoubi is an assistant professor of biology at Dominican University of California. His research is focused on investigating the differentiation of mouse embryonic stem cells into hormone-secreting neurons in vitro. Before joining Dominican in 2005, Dr. El Majdoubi held several research scientist positions in the field of reproductive physiology. At the University of Pittsburgh (1997-1999), he investigated the neurobiological trigger of puberty in primates. At the University of California, San Francisco (2000-2005), he studied the reproductive and metabolic consequences of altered secretion of GnRH, the main hormone of reproduction. Dr. El Majdoubi has published 18 scientific papers and has given more than 20 presentations at international conferences. Dr. El Majdoubi earned his MS and PhD in Neuroscience & Pharmacology from the University of Bordeaux, France.



Dr. Renee Reijo Pera, PhD

Dr. Reijo Pera is professor and director of the Center for Human Embryonic Stem Cell Research and Education within the Stanford Institute for Stem Cell Biology and Regenerative Medicine in the Department of Obstetrics and Gynecology at Stanford University School of Medicine. Dr. Reijo Pera is an internationally recognized leader in embryonic stem cell research and is highly regarded for her scientific accomplishments as well as for her achievements as an educator and mentor. Her laboratory is focused on understanding key cell fates in the embryo, including the generation of pluripotent stem cells, somatic and germ cell lineages. Dr. Reijo Pera was a Damon Runyon Fellow at the Whitehead Institute at MIT before joining the faculty at the University of California, San Francisco in 1997. She was recruited to direct Stanford's Center for Human Embryonic Stem Cell Research and Education in April 2007. In September 2006, Dr. Reijo Pera was cited by *Newsweek* as one of the 20 most influential women in the United States. Dr. Reijo Pera received her PhD from Cornell.



Dr. Mary Helen Barcellos-Hoff, PhD

Dr. Barcellos-Hoff is a senior scientist and deputy director of the Life Sciences Division at Lawrence Berkeley National Laboratory. The overarching goal of her research is to understand multi-cellular processes that cause breast cancer. Dr. Barcellos-Hoff studies normal mammary gland development, the development of aberrant tissue architecture during cancer, and how a carcinogen such as radiation promotes cancer progression. Dr. Barcellos-Hoff earned a BA in Biopsychology in 1978 from the University of Chicago. She received a PhD in Experimental Pathology from the University of California, San Francisco in 1986.



Dr. Xianmim Zeng, PhD

Dr. Zeng is assistant professor and director of the North Bay CIRM Shared Research Laboratory for Stem Cells and Aging at the Buck Institute for Age Research. Dr. Zeng started her research in human embryonic stem cells (hESCs) while conducting her postdoctoral training at the National Institute of Aging and the National Institute on Drug Abuse. One of her major contributions to the stem cell field was the successful generation of dopaminergic neurons from hESCs. Dr. Zeng and her colleagues showed that these neurons could be grafted into the brains of Parkinson's disease model animals. Dr. Zeng joined the faculty of the Buck Institute for Age Research in California in 2005. Dr. Zeng earned a PhD in molecular biology from the Technical University of Denmark.



Dr. Warren Hoeffler, PhD

Dr. Hoeffler is the founder of Xgene Corporation, a company commercializing discoveries in tissue engineering. His research interests focus on 3-D organ models (AccuOrgans™), created by spontaneous cell sorting, a process that taps into cell motility and adhesion to form multiple tissue layers. Skin epithelial stem cells are routinely isolated for inclusion in AccuSkin™, and in collaboration progenitor clones derived from embryonic stem cells incorporated into 3-D models showed superior remodeling capability. Dr. Hoeffler has served on the faculty at the Department of Dermatology at Stanford University School of Medicine. He conducted postdoctoral research at Genentech. Dr. Hoeffler's research interests are tissue engineering 3-D organ cultures created by spontaneous cell sorting for use in wound healing, disease, aging, and for animal-free testing; stem cell incorporation into engineered tissue; genome organization; and regulation of gene expression by DNA binding proteins.

Luncheon Presenter



Dr. Mary Devereaux, PhD

Dr. Devereaux holds a PhD in philosophy. She specializes in biomedical, research, and stem-cell ethics. She is director of Biomedical Seminars in the Research Ethics Program in the Department of Pathology at the University of California, San Diego (UCSD) and is responsible for stem cell ethics training at both UCSD and the San Diego Research Ethics Consortium, a multi-institution core resource created to support the ethical conduct of stem cell and other research programs. Dr. Devereaux also serves as a faculty associate at the Center for Ethics in Science and Technology and is co-founder and director of the UCSD Biomedical Ethics Seminar Series, a monthly meeting of research scientists, medical clinicians, philosophers, and administrators to discuss issues such as human subject research, informed consent, and conflict of interest. Dr. Devereaux serves on the Hospital Ethics Committee at UCSD Medical Center. Recent publications address ethical issues raised by embryonic stem cell research, cosmetic surgery and other forms of medical enhancement, and prenatal testing.