

NOBEL CONFERENCE 53 | OCTOBER 3&4 2017 | GUSTAVUS ADOLPHUS COLLEGE

REPRODUCTIVE TECHNOLOGY

HOW
FAR DO
WE GO?

THE
NOBEL
CONFERENCE
GUSTAVUS ADOLPHUS COLLEGE



Welcome Nobel Conference 53



REPRODUCTION. TECHNOLOGY. RESEARCH. BUSINESS.

Rebecca M. Bergman
President, Gustavus Adolphus College

I know a bit about these topics.

Before I began my tenure as Gustavus president, I was a research scientist and then an executive at a biomedical company. During that time, I also gave birth to and mothered four children. For decades I lived at the intersection of medical technology, medical ethics, business, and family.

The science we will explore in this year's Nobel Conference goes far beyond what I (and most of the world) have dreamt possible. Gene editing, mitochondrial transfer, and male contraception are now possible, and the ethical dilemmas of pursuing them are at the forefront of the conversation. The science we explore this year seems the stuff of science fiction—but it is very real, and it is here.

In my work with the National Academy of Engineering, I served on the Committee on Responsible Science, where we discussed integrity in the conduct of research. One key question we addressed: How can we ensure that clinical trials are grounded in good science?

This question leads to a host of others we must ask with regard to reproductive technologies:

What is the rest of the world doing? Who makes these decisions? Who benefits from these decisions? What are the human consequences of all of this?

I invite you to open yourself to this most human of topics—the creation of children and families. Join me as we examine the ethical significance of leading-edge technology and marvel at the wonders of science.



THE NOBEL PRIZE

stands for enlightenment, humanism, and international cooperation. These values are more important now than ever. We live in a time when prejudice and outright fabrications are gaining ground at the expense of knowledge. Critical investigation and questioning is an important part of the essence of science. Alfred Nobel understood the power of example. Good role models demonstrate in word and deed that it is possible to understand the world and make it better. They confirm that we can take on the greatest challenges of our time. The Nobel Foundation is proud to provide the on-going endorsement of the Nobel Conference at Gustavus Adolphus College. The conference continues to align with Alfred Nobel's vision of utilizing science to promote the greatest benefit to mankind.

Lars Heikensten
Executive Director, Nobel Foundation

If you are reading this, you were conceived and born—

perhaps via in vitro fertilization, a gestational carrier, or “the old fashioned-way.” Who you are at this very moment and who you become are the results of your successes and failures, your challenges and resilience. Each of these, in turn, was influenced by some combination of biology, individual temperament, upbringing, social environment, and just plain chance.

But what if your parents or society had been able to choose a “you” that was different in fundamental ways—different features for your body, a different kind of intelligence, a different health profile? What would you have gained and what would you have lost in being “customized?” What would society have gained or lost as a result of widespread choosing? Would it matter if a change that you wanted was available to others but not to you? And who should bear the burden and the responsibility of making these decisions?

While questions such as these have long been staples of science fiction and fantasy, they’ve come a few steps closer to reality as a result of recent scientific developments that include the **gene-editing** technology known as CRISPR and the **mitochondrial transfer** technique. These technologies give us a glimpse of a world in which we may **eradicate inheritable genetic diseases**, but may introduce new and unforeseen medical problems. A world in which we may be able to choose particular characteristics for our children, but may usher in a new era of **eugenics and genetic discrimination**.

Cutting edge technologies, as earth-shaking as they may be, are not the only ones that have the power to change the way we reproduce. **Contraception**, the other face of reproductive technologies, may not present us

with science fiction scenarios, but the ability to prevent conception (via condoms, the birth control pill, IUD’s, and other methods, temporary and permanent) has drastically changed the way individuals and societies reproduce. And while hormonal contraception has been available to women for more than 60 years, contraceptive options for men have not changed for more than a century. Why is hormonal contraception not available for men? And how might the reproductive landscape change when it is?

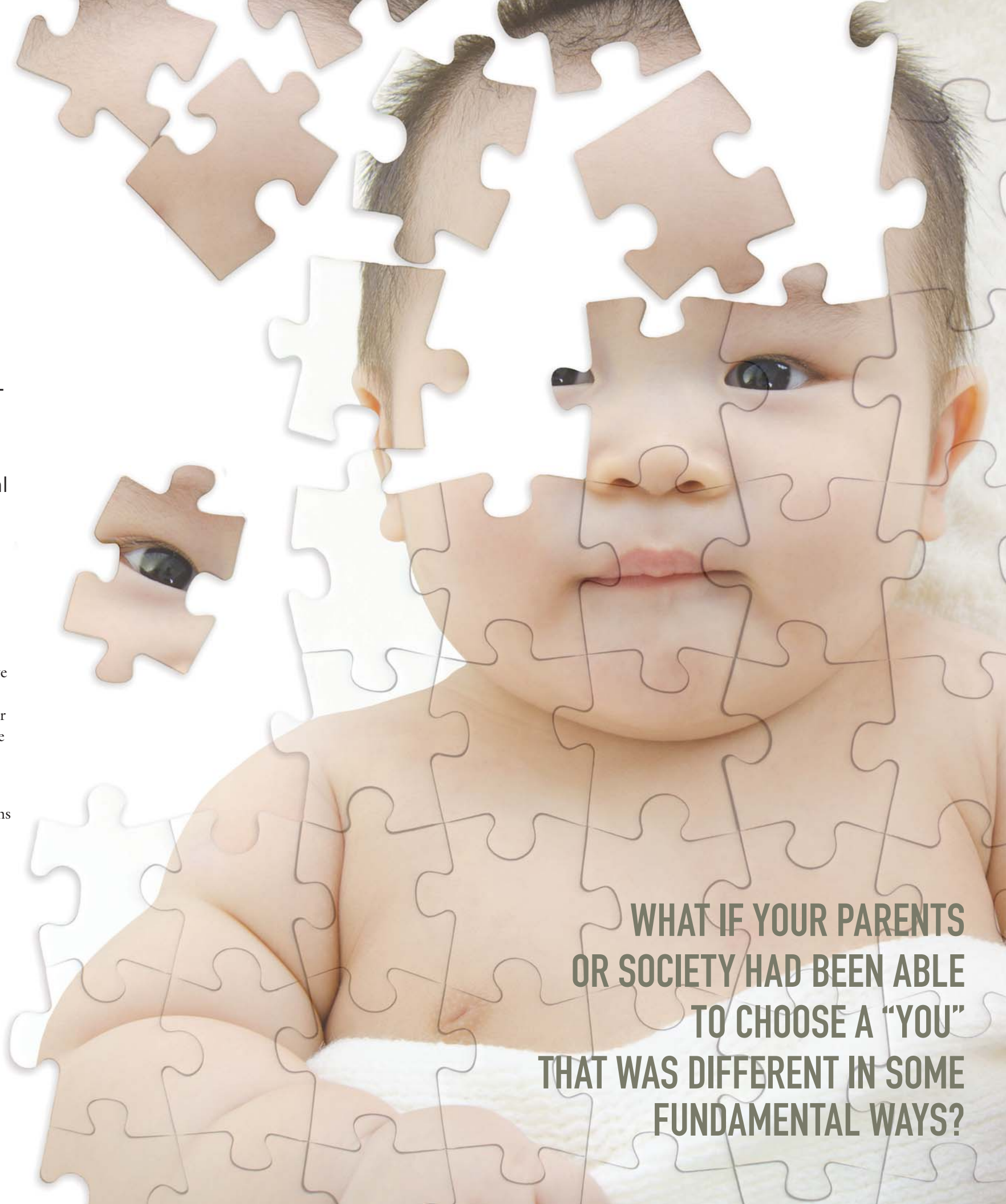
Science emerges in conversation with the societies in which it is embedded. The questions it asks, the problems it identifies, and the solutions it develops all reflect, challenge, and shape the **values, desires, and beliefs** of those societies. For the next two days, we have an opportunity to think, together with leading scientists, ethicists, and social theorists, about the directions in which reproductive technologies are heading. What role does each of us play—scientist, ethicist, member of the general public—in helping to determine just how far reproductive technologies take us?

Yurie Hong

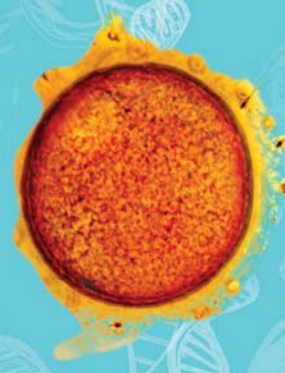
Nobel Conference 53 Chair, Associate Professor of Classics

Lisa Heldke ’82

Nobel Conference Director, Professor of Philosophy



**WHAT IF YOUR PARENTS
OR SOCIETY HAD BEEN ABLE
TO CHOOSE A “YOU”
THAT WAS DIFFERENT IN SOME
FUNDAMENTAL WAYS?**



TUESDAY

OCTOBER 3

9 a.m. PRELUDE

The Gustavus Wind Orchestra
James Patrick Miller, DMA, conductor

- Concert Overture from Colas Breugnon* Dmitri Kabalevsky (1904–1987)
- Mein Jesu, was fur Seelenweh (My Jesus, Oh, What Anguish)* J.S. Bach (1685–1750)
- Passacaglia on BACH* Ron Nelson (b. 1929)

9:30 a.m. ACADEMIC PROCESSION & OPENING CEREMONY

Processional **The Gustavus Wind Orchestra**
The Olympic Fanfare and Theme John Williams

Invocation **The Rev. Siri Erickson**
Chaplain of the College

Welcome **Rebecca M. Bergman**
President of the College

Conference Introduction **Lisa Heldke, PhD**
Nobel Conference Director
Professor of Philosophy

Yurie Hong, PhD
2017 Nobel Conference Chair
Associate Professor of Classics and
Gender, Women, and Sexuality Studies

10 a.m. FIRST LECTURE

Ruha Benjamin, PhD



Associate Professor
of African American
Studies, Princeton
University

Rethinking Reproduction, Re-imagining Technology

Do reproductive technologies benefit everyone equally? Do scientists consider a range of perspectives when conceiving and designing new technologies? How do these cutting-edge tools affect Americans' daily lives and their ideas of what future babies should be like?

As early as the 1980s, feminist scholars worried that reproductive technologies would lead to what Rayna Rapp calls “stratified reproduction.” In *The Mother Machine* (1985), Gena Corea predicted that white women would hire women of color to gestate their babies at low cost. At the beginning of the 21st century, even more advanced reproductive technologies that combine assisted conception with genetic selection threaten to intensify this opposition. Moreover, at a time when the wealthy have access to technologies that assist them in having children who are genetically screened, various laws and policies discourage women of color from having children at all. This disparity is creating a society where some women struggle for basic reproductive tools while others have access to cutting edge genetic technologies. Many scholars worry that the impressive array of reproductive technologies available today is “directed at developing eugenic population control strategies especially for low-income and poor women of color globally” (Marsha Darling, 2004). The absence of a broad and diverse range of voices in the labs amplifies divides and often leads scientists to ignore how gender, race, and class shape who gets access to reproductive technologies, to limit who can benefit from them, and to target genetic diseases that affect only one segment of the population.

Ruha Benjamin is a sociologist who writes, teaches, and speaks widely about the relationships between innovation and equity, science and citizenship, and health and justice. Benjamin is an associate professor of African American studies at Princeton University and a research associate at the Centre for Indian Studies in Africa at the University of Witwatersrand in Johannesburg. Benjamin is the leading expert on the gendered and racialized nature of stem cell research. Her research focuses on the impact of “discriminatory design” in scientific research, namely processes conceived to serve people that do not include diverse perspectives in their planning and incubation and thus perpetuate systemic racism. She calls for a more inclusive, responsible, and open scientific community and offers tools for a more socially-conscious approach to technological development.

Benjamin has published several articles in peer-reviewed journals, is the author of two books (*People's Science: Bodies and Rights on the Stem Cell Frontier* and *Race after Technology*), and is the editor of *Captivating Technology: Race, Technoscience, and the Carceral Imagination*. Her most recent project, *Provincializing Science: Mapping and Marketing 'Difference' After the Genome*, explores genomics in South Africa, India, and the United States, with a focus on how and why racial-ethnic and caste categories are incorporated into research on health disparities. Her body of work addresses debates about how science and technology shape the social world and how people can, should, and do engage technoscience, grappling all the while with the fact that what may bring health and longevity to some may threaten the dignity and rights of others.

An engaged public intellectual, Benjamin has spoken at TedXBaltimore, where she gave a talk titled “From park bench to lab bench—What kind of future are we designing?” Her research has received fellowships and grants from the American Council of Learned Societies, National Science Foundation, Ford Foundation, and the California Institute for Regenerative Medicine, and she has held postdoctoral fellowships at UCLA and Harvard. A committed and inspiring teacher, Benjamin was one of four recipients of the 2017 President's Awards for Distinguished Teaching at Princeton. Benjamin received her doctorate from the University of California, Berkeley.

Introduction

Maddalena Marinari, PhD
Assistant Professor of History

10:45 a.m. PANEL DISCUSSION AND AUDIENCE QUESTIONS

11:30 a.m. LUNCH BREAK

Join a conversation

For those who wish to continue—or initiate—conversations over lunch, head to the Lund Forum. There you'll be able to buy a hot lunch and join a discussion with others interested in a conference-related topic. Tables will be labeled with discussion topics; just pick the topic you're interested in and pull up a chair. You'll find a brief discussion guide that can get your conversation started. If you don't see a group about a topic you're interested in, make a sign and start a new group!

12:45 p.m. MUSICAL PRELUDE

The Gustavus Wind Symphony

Heidi Johanna Miller, DMA, conductor

On a Hymnsong of Philip Bliss

David Holsinger (b. 1945)

Incantation and Dance

John Barnes Chance (1932–1972)

1 p.m. SECOND LECTURE

Jacob Corn, PhD

CRISPR Gene Editing

The fundamental unit of life for all organisms, from bacteria to mosquitoes to humans, is the cell, which is composed of a variety of molecules. Of these molecules, proteins are the “workhorses” of the cell, determining how all the molecules are organized and act. DNA is the molecular code for making these proteins; it provides the instructions each gene uses to make a protein. Yet, only a small portion of the human genome—just two percent—actually codes for protein. The remainder of the DNA in the genome directs where and when each gene should be used. Collectively, the genome is the central instruction manual for the organism.

Until recently, humans' ability to change the information contained in the genome to treat disease has been limited. Gene therapy involves introducing genetic material into cells to counterbalance a defective gene or make a beneficial protein that is absent. However, for the genes to be functional within a cell, they need to be both delivered and integrated into the cell's genome. To date, gene therapy has relied on modified viruses to deliver and insert the



Scientific Director of the Innovative Genomics Initiative of the University of California, Berkeley and University of California, San Francisco

gene payload into cells. This method lacked predictability, which has hampered gene therapy as treatment for disease; no FDA-approved gene therapy treatments exist despite more than 1,500 clinical trials in 25 years.

The discovery of the CRISPR/Cas system has the potential to change this in a dramatic way. CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeat, which are segments of DNA in which the sequence is repeated and “reads” the same forward and backward. Decades ago, researchers discovered small pieces of viral DNA incorporated within the genomes of bacteria. Only after years of research on these segments of invader DNA were they understood to be part of the immune systems that allow the bacteria to recognize and fight viral infections. Specialized proteins, called Cas's, operating within the bacterial immune system use the viral DNA to identify and cut the genomes of infecting viruses, thereby protecting the bacteria from the virus. Thus the name CRISPR/Cas.

Research into the immune system of bacteria opened an unexpected door to understand and treat human disease. Researchers have modified the CRISPR/Cas system to recognize and cut other DNA sequences, and to pair it with the cell's DNA repair systems. The ability to edit genomes with specificity has led to its being explored in a variety of fields, from species conservation, to agricultural plant development, to human disease.

Scientists had used CRISPR only to edit somatic cells. Gene therapy carried out on these cells affects only the individual treated. Any editing of germ cells (including egg and sperm cells) introduces changes that are passed on to the individual's offspring and all future generations. Scientists are presently debating the circumstances under which germ cell editing should be used.

Jacob Corn's research uses CRISPR/Cas to “remedy” sickle cell disease (SCD) in a mouse model of the disease. Corn's research team used CRISPR/Cas to replace the sickle cell disease mutation in human hematopoietic stem/progenitor cells with the normal hemoglobin gene.

Corn is founding scientific director of the Innovative Genomics Institute, a joint venture of the University of California, Berkeley and the University of California, San Francisco. He also serves as a faculty member in biochemistry, biophysics and structural biology at University of California, Berkeley. His research aims to bring about the end of genetic disease through the development and application of next-generation genome editing technologies. His work bridges academia and industry to work in therapeutic areas that include infectious disease, neurobiology, and oncology. Corn received his doctorate from the University of California, Berkeley.

Introduction

S. Brookhart Shields, PhD
Assistant Professor of Biology

1:45 p.m. **THIRD LECTURE**

Marsha Saxton, PhD

Disability Rights meets DNA Research

Scientific technologies present humans with more and greater opportunity to make choices about their offspring. Given their power, it is vital that we ask: how should we use these technologies? What criteria should we use to make choices about future humans? What might be the social and medical consequences—for parents, offspring, and society at large—of our choices?

CRISPR/Cas9 appears to promise a future in which humans can eliminate certain genetic conditions. Such a power is almost inconceivable in its magnitude and scope. Among the many challenges with which that power presents us, consider this one: when faced with the possibility of “choosing” an infant’s health profile, which sorts of physical and mental diversity will we value and support? Although headlines about “designer babies” might suggest that we focus our worries on whether to use these tools to create superhumans with superior IQs, physical powers, and appearance, the more pressing questions are about disability.

While these technologies may be developed to alleviate human suffering, a long and unfortunate history of medical technology finds it used to trample the rights and dignity of marginalized groups, in an effort to achieve an imagined “more perfect” body. For the majority of the 20th century, the United States engaged in coercive and forced sterilization of so-called “undesirables”—the disabled, the mentally ill, the poor, the incarcerated, single mothers, people of color, immigrants, and those who did not conform to gender or heterosexual norms. Members of these groups were deemed “inferior,” a drain on resources, and a drag on social progress. This systematic eugenics program was so effective that it served as the model for Nazi programs in the 1930s and 40s.

While the impulse to “fix” the genes of developing embryos may not be motivated by eugenic ideology, decisions to select for a particular trait or against a specific condition still can reflect and reinforce stigmas and biases, and make implicit statements about the kinds of lives worth valuing and accommodating. For instance, people with disabilities are regularly denied access to the very technologies used to eliminate disabilities. Some physicians refuse reproductive technologies to patients who are HIV-positive, or who have chronic medical conditions. And whereas, in the past, the question might have been “Is it right to terminate a pregnancy if the fetus has Down Syndrome?” in the future, it might become, “If we have the power to eliminate hereditary deafness, should we do so?”

Who defines what constitutes disability? Disabilities are, in part, socially constructed. The challenges associated with them often stem not so much from the body but from the constitution of society. (Consider the different social meanings of a hearing aid and a pair of glasses; which one is a fashion accessory available in hip colors?). Should we use biological tools, whose long term impacts will remain unknown for generations, to address what may be social rather than health challenges?



Director of Research,
World Institute on
Disability

Marsha Saxton addresses such questions as these using a disability rights theoretical framework. As Director of Research at the World Institute on Disability, she has written on the history and present use of eugenics in articles such as “Disability Rights and Selective Abortion,” and “Prenatal Diagnosis and Pregnancy Options.” Saxton’s regular interviews for national media illustrate her power to confront uncomfortable and ethically challenging topics with sensitivity and compassion. She has published three books, two films, and more than one hundred articles and book chapters on topics including disability rights, women’s health, and genetic screening issues. She served on the Ethics Committee for the Human Genome Initiative, and as a board member for the Council for Responsible Genetics. Saxton received her doctorate from the Union Institute in Cincinnati.

Introduction

Michele Rusinko, PhD
Professor of Dance

2:30 p.m. **PANEL DISCUSSION AND AUDIENCE QUESTIONS**

4 p.m. **BREAK**

6 p.m. **ART AT THE NOBEL CONFERENCE RECEPTION**

Hillstrom Museum of Art, Jackson Campus Center
No ticket required

Contemporary American Painting, [1945] is a collaborative exhibition from the Hillstrom Museum of Art at Gustavus Adolphus College and the Perلمان Teaching Museum at Carleton College in Northfield. It features nearly 50 artworks by American artists who were represented in the Encyclopedia Britannica collection, first shown in 1945. Works on exhibit reflect the characteristics of the renowned collection of Hillstrom Museum of Art namesake Richard L. Hillstrom, which concentrates on American art of the first half of the 20th century, mostly in the realist tradition. Works in the Britannica collection—some of which were donated to Carleton by alumnus William Benton, publisher of the Encyclopedia—were also largely in this mode, and the Gustavus and Carleton works together give a view of American art in the mid 1940s when the Britannica collection was published and when Gustavus alum Hillstrom began collecting.

Also on view is *FOCUS IN/ON: Reginald Marsh’s Manhattan Towers*, another of the Museum’s FOCUS IN/ON projects, in which a key work in the Hillstrom Collection is analyzed collaboratively with a campus member from across the curriculum. Marsh’s 1932 watercolor of the New York skyline is considered in a joint study by Elizabeth Jenner of Gustavus’ sociology and anthropology department and Donald Myers, director of the Hillstrom Museum of Art. The exhibitions remain on view through November 5, 2017.



Fifth Avenue Bus #2



Manhattan Towers

6:30 p.m.

TO FERTILITY AND BEYOND: INFERTILITY FROM THE VANTAGE POINT OF POLICY AND PRACTICE

Lund Arena

No ticket required

Colleen Casey, MD, Reproductive Endocrinologist/Fertility Specialist, Center for Reproductive Medicine

Debra DeBruin, Associate Professor, Center for Bioethics, University of Minnesota
The Theater of Public Policy

To Fertility and Beyond will begin with a lively interview of two local experts about the personal, practitioner, and policy issues related to fertility. The interview will be hosted by Gustavus alumnus and Theatre of Public Policy co-founder Tane Danger. The conversation will be brought to life on stage by the rest of this nationally known improv comedy troupe that uses unscripted theater to unpack and re-imagine hard issues. A fun and thought-provoking night for anyone who has ever known or been an infant before.

8 p.m.

MUSIC AT NOBEL

Björling Recital Hall

Open to the public without charge; no ticket required.

What reproductive technologies do composers employ when creating a piece of music? What are the devices and processes that take a small initial musical thought and turn it into a fully developed composition? This year's Nobel Concert sounds out these questions in the works of three composers, representing different eras and genres. A Musical Offering by J. S. Bach; a string quartet, *Lady Isabelle Was That Kind of Woman*, by Gustavus faculty member Alexandra Bryant, and T42, an arrangement for jazz combo by Gustavus faculty member Dave Stamps. Performances feature members of the Gustavus music faculty.



9:15 a.m.

MUSICAL PRELUDE

The Gustavus Symphony Orchestra

Ruth Lin, conductor

Carmen Suite No.1

Georges Bizet (1838–1875)

Prélude

Aragonaise

Intermezzo

Séguedille

Les Dragons d'Alcala

Les Toréadors

9:30 a.m.

FOURTH LECTURE

Alison Murdoch, MD

Reproductive Technology Regulation in the UK: 40-Year Review

Assisted reproductive technologies (ART) such as in vitro fertilization (IVF) allow many couples facing infertility to have children. IVF methods fertilize the egg with the sperm in the laboratory, and the resulting embryo is implanted into the uterus of the mother. Mitochondrial transfer technologies are a modified form of IVF that prevent inheritance of mitochondrial diseases.

Since the first IVF infant, Louise Brown, was born in the United Kingdom in 1978, use of ART has increased significantly. In 2014, 1.6 percent of all infants born in the United States were conceived through ART. When ART was initially developed, methods only increased the probability of pregnancy in infertile couples, but several newer technologies, such as pre-implantation genetic diagnosis, allow ART to be used to prevent transmission of inherited conditions such as cystic fibrosis and sickle cell disease. However, some inherited diseases, such as those involving mitochondrial dysfunction, cannot be prevented by screening alone.

Mitochondria are organelles responsible for producing most of the energy cells use. Mitochondrial diseases cause problems in cells with high energy requirements such as neurons and muscle cells, and patients with mitochondrial diseases experience serious symptoms such as heart abnormalities, developmental delays, and digestive difficulties. Mitochondria contain small amounts of DNA encoding 37 genes important for energy production, and mitochondrial



Professor of
Reproductive
Medicine, Newcastle
University

diseases are inherited due to a problem with one of these genes. Mitochondrial transfer modifies the IVF process to transfer the nucleus containing the chromosomal genetic material from an egg with non-functional mitochondria to a donor egg with normal mitochondria, but with the nucleus removed. The chromosomes in the nucleus contain approximately 19,000 genes as compared to the 37 in the mitochondria, so this process allows transmission of the vast majority of genetic material from the mother while preventing transmission of mitochondrial diseases from mother to child.

Because this process involves genetic material from two eggs and one sperm, the media have dubbed offspring from this technology “three-parent babies.” The first baby conceived using mitochondrial transfer IVF technology was born in 2016 in Mexico to a couple working with a U.S. doctor. Preliminary results suggest that the infant is healthy and has low levels of non-functional mitochondria, indicated a low probability of mitochondrial disease. In the United Kingdom, Parliament approved the move to implement mitochondrial transfer methods in human patients in 2015. The country’s Human Fertilisation and Embryo Authority began formally accepting applications for the technique in 2016.

Alison Murdoch is a leader in the development of mitochondrial transfer IVF and other ART. Professor of Reproductive Medicine at Newcastle University and Founder and Head of Newcastle Fertility Centre at Life, she is also one of the first people in the world to have been granted approval to clone human embryos for the purpose of research and has been at the center of developing improved IVF processes that significantly advance available reproductive technologies. More recently, Murdoch has been part of the team of researchers developing mitochondrial transfer IVF technology. She has worked both in the science of the technology and the regulation of the processes.

Murdoch has authored more than 90 publications in journals such as *Nature*, *Human Reproduction*, *Stem Cells* and the *British Medical Journal*. She is the recipient of the Research Impact Award by The Guardian and the NHS Bright Ideas in Health Award. Murdoch appeared in a BBC documentary “Horizon: Who’s Afraid of Designer Babies” in 2005. She is past Chair of the British Fertility Society and a past member of the Nuffield Council on Bioethics. Murdoch received her MD degree from University of Edinburgh, and in 2001 was named a Fellow of the Royal College of Obstetricians and Gynecologists (FRCOG).

Alison Murdoch will serve as a Robert E. and Susan T. Rydell Professor during the 2017-18 academic year.

Introduction

Laura Burrack, PhD
Assistant Professor of Biology

10:15 a.m.

FIFTH LECTURE

Diana Blithe, PhD

Prospects and Pipeline for Male Contraception

Reproductive technology encompasses not only the techniques used to enhance fertility but also those developed to suppress it. While there is an array of contraceptive options for women, there is a pressing need for forms of male contraception that are highly effective, safe, reversible, and pose few or no side-effects.

Globally, half of all pregnancies are unintended, and in developing countries, an estimated 225,000,000 women want to either delay or stop childbearing, but are not using any type of contraception. Unintended pregnancies can pose serious risks to women’s physical, emotional, and economic well-being as well as that of their children. Contraception and family planning lead to greater economic stability and outcomes for families and society at large, as well as contributing to physical and emotional wellbeing of women and their children. Access to safe and effective contraception is important for family planning as well as for women for whom pregnancy poses particularly high health risks.

To meet these needs, research on contraception has thus far focused primarily on the development of reversible, hormonally-based contraceptive options for women. Research suggests, however, that many men would like to share the responsibility for avoiding unwanted pregnancies and are receptive to using hormonal male contraception, if it existed. However, pharmaceutical funding for hormonal contraception is not being seriously pursued. Currently, safe and effective contraceptive options for males are limited to condoms and vasectomy. In the U.S., 16 percent of couples rely on condoms, and 10 percent on vasectomy. (This is compared with approximately 30 percent for women’s oral contraceptive (“the Pill”). There are serious drawbacks to both forms of male contraception: vasectomies take several weeks to result in infertility and are generally considered irreversible, while condoms have a failure rate as high as 18 percent (compared with 9 percent for the Pill). There is a large—and unmet—need for better forms of male contraception that are safe, reversible, and effective.

Diana Blithe is the Program Director for the Contraceptive Development Research Centers Program and the Male Contraceptive Development Program at the Eunice Kennedy Shriver National Institute of Child Health and Development (part of the NIH). She is at the leading edge of research to develop male hormonal methods of contraception. Blithe and colleagues are currently conducting experiments with volunteers on two different formulations of hormonal male contraception. The first, DMAU, interferes with both testosterone and progesterone signaling, resulting in low, or no, sperm production. The second, a combination of testosterone and the progesterone-antagonist nestorone, is similar to DMAU in effect. This work has progressed to clinical trials and has been published.

Blithe has published in leading professional journals such as *Lancet*, *PLoS One*, *Contraception*, *Journal of Clinical Endocrinology and Metabolism*, and *Fertility & Sterility*. She has also advocated for and popularized the concept of Green Contraception: limiting the ecotoxic effects of contraceptives through ecofriendly manufacturing, reduction of waste products, and minimizing the release of steroidal estrogens that interfere with natural populations of freshwater animals.



Diana Blithe
Program Director,
Male Contraceptive
Development
Program, National
Institutes of Health

In addition to her research, Blithe serves as the Co-Director of the Contraceptive Clinical Trials Network, overseeing clinical trials to evaluate the safety and efficacy of new contraceptive agents for men and women. Blithe is the Principle Investigator on a Collaborative Research and Development Agreement with HRA Pharma to develop a Progesterone Receptor Modulator for contraceptive and therapeutic applications. A respected scholar in her field, Blithe currently serves on the editorial board of the journal *Endocrine*. She has been featured on NPR's Science Friday. Blithe received her doctorate in biochemistry from the University of Pennsylvania.

Introduction

Margaret Bloch Qazi, PhD
Assistant Professor of Biology

11 a.m. PANEL DISCUSSION AND AUDIENCE QUESTIONS

12 p.m. LUNCH BREAK

Lunch time conversation tables will happen again in the Lund Forum.

1:15 p.m. MUSICAL PRELUDE

Blues in Hoss' Flat

Harlem Nocturne

Song for Bilbao

Gustavus Jazz Lab Band

Dave Stamps, DMA, director

composed and arranged by Frank Foster

composed and arranged by Earle Hagen

composed by Pat Metheny

arranged by Alan Baylock

1:30 p.m.

SIXTH LECTURE

Charis Thompson, PhD

The End of the World as We Know It? Human Technology Futures in a Time of Automation, Augmentation, and Deselection



Charis Thompson
Chancellor's
Professor and Chair
of Gender and
Women's Studies,
and Director, Chau
Hoi Shuen Program
in Gender &
Science, University
of California,
Berkeley

What lies on the horizon for reproductive technologies? What's next? Will these technologies become parts of the standard toolkit of future reproductive medical practitioners the way in vitro fertilization has become for today's? What still-more-speculative scientific developments will be developed? What technologies, newer even than these, will further reshape the way we reproduce, live, age, and die? How will these technologies intersect with the changing landscape of scientific and technological research? With the funding and regulatory structures that support and shape them? What might we learn about relations between science and society more generally, by reflecting on the developments in reproductive technologies in particular? Charis Thompson will address the emergence of reproductive technologies, as it takes place alongside regenerative technologies (aimed at repairing or replacing human cells, tissues and organs), and genomic technologies (which detect genetic inheritance and susceptibility to diseases). CRISPR, for instance, is a technology currently being explored for all three such uses. In August, for instance, a company announced that it was using CRISPR as a way to eliminate one of the major obstacles that has thwarted efforts to grow organs in pigs. And Jacob Corn's research is exploring the use of the technology to combat sickle cell disease. How do we manage these technologies in an age of artificial intelligence and machine learning? How do humans live well with these technologies, regardless of the circumstances of our birth?

In *Making Parents: The Ontological Choreography of Reproductive Technologies*, Charis Thompson explores the ways in which today's "miraculous" technologies become tomorrow's "normalized" ones in the world of assisted reproductive technology (ART). Thompson coins the phrase "ontological choreography" to describe the intricate dance that takes place in an ART clinic, among biology, technology, finance, law, emotion, and kinship, that remakes both babies and their parents. ART, she suggests, transforms our understanding of what it is to be a human being. *Making Parents* won the 2007 Rachel Carson Prize from the Society for the Social Study of Science.

Thompson, a social theorist, studies the ethics and socio-politics of the environmental and life sciences; her published works all explore the relationship between science and democracy. Her second book, *Good Science: the Ethical Choreography of Stem Cell Research*, explores the interplay between scientific research using human pluripotent stem cells and public criticism of that research. The early days of this research saw considerable public controversy over the procurement of stem cells, which initially could be obtained only from human embryos. Thompson argues that scientists' efforts to respond to, and "invent around" these ethical roadblocks to their work ultimately led to significant discoveries. She argues that such "ethical choreography" is needed for "good science"; that good science is the product of just such interplay between science and ethics.

Thompson is currently completing *Getting Ahead: Inequality and Meritocracy in the Age of Technology Elites*, a comparative research project on machine learning cultures in the US and the UK. She is the Chancellor's Professor and Chair of Gender & Women's Studies, and a founding director of the Science, Technology, and Society Center at the University of California, Berkeley, as well as Professor of Sociology, London School of Economics and Political Science. She serves on the Nuffield Council on Bioethics Working Group on Genome Editing, and on the World Economic Forum's Global Technology Council on Technology, Values, and Policy, as well as UC Berkeley's Stem Cell Research Oversight Committee, and the faculty advisory board of the Center for Race and Gender.

Introduction

Elizabeth Jenner, PhD
Associate Professor of Sociology and Anthropology

2:15 p.m. AUDIENCE Q&A

2:45 p.m. CLOSING PLENARY

Future Challenges, Future Questions in Reproductive Technology

What's next for reproductive technologies and the big unanswered questions? Each conference presenter will have an opportunity to speak briefly about future possibilities and problems.

6:30 p.m. NOBEL BANQUET

Alumni Hall, Johnson Student Union
Separate ticket required

7:30 p.m. CLOSING LECTURE

Jad Abumrad

Reproductive Technology and the *Radiolab* Podcast

Alumni Hall, Johnson Student Union

Those not attending the banquet may view a simulcast of the lecture in the Jackson Campus Center Banquet Rooms.

Jad Abumrad isn't a scientist, but he knows a thing or two about experiments.

Abumrad is the creator and co-host of *Radiolab*, the syndicated public radio program and podcast that has shifted the paradigm for the way millions of Americans learn about science and other complex topics. *Radiolab* found its sudden start in 2002, when public radio station WNYC restructured its program schedule. "[WNYC Program Director] Mikel Elcessor was like, 'You, with the curly hair, come here. We're going to do this thing on Sunday night. We're going to call it *Radiolab*,'" Abumrad explained in a 2014 interview with *IndyWeek*. With no budget to produce a three hour episode every week, his lone charge was to "just make it different." "The 'lab' was because we didn't know what the [expletive deleted] was going to happen. It was an experiment."

Though its origins were humble and virtually nobody was listening (Abumrad later learned that WNYC dropped the power on its transmitter so low during his nighttime slot that "you literally [had] to be hugging the transmitter to get the show"), *Radiolab* has grown to become one of the most innovative and admired programs in broadcast media.



Founder, producer, and co-host, *Radiolab* on National Public Radio

With his co-host Robert Krulwich, Abumrad honed a blend of storytelling, journalism, and original audioscapes to communicate abstract scientific concepts to a general audience. "We structure our stories at *Radiolab* so that every single one is an act of getting lost and then being found. Hopefully we have moments of epiphany and insight, but those only propel us toward more questions and uncertainty. That's why people like it, because they feel like it's two guys genuinely getting confused and lost."

Radiolab seeks to make esoteric science cogent and compelling. The website explains, "*Radiolab* is a show about curiosity. Where sound illuminates ideas, and the boundaries blur between science, philosophy, and human experience." Its success hinges on its uncanny ability to engage science, philosophy, and other big ideas by connecting them to more tangible, even carnal elements. "It's about taking these sort of beautiful abstractions, and making them feel like they have blood and guts and flesh," Abumrad told *The Guardian* newspaper. "It's about making them hit you—you want the information to just collide with someone."

Those collisions have taken many memorable forms in exploring the science and ethics of reproductive technology. The episode "Antibodies Part 1" finds its entry point in the braggadocio of a drunk biologist, considers eugenics through a discussion that includes flying pigs and dragons, and deploys an extended assassin metaphor—complete with action-movie music score—to explain the gene editing technology CRISPR. In "Fetal Consequences," the hosts use Mother's Day to frame the mother-child bond as they explore the role of fetal cells that linger in utero for years after birth. The Audio Extra attached to "Birthstory" captures, live, the moment when a wealthy gay Israeli couple in Nepal pays an under-the-table tip to the poor Indian woman they meet only briefly after she has birthed their newborn surrogate twins. This vignette, which crystallizes the episode's ethical interrogation of reproductive technology, globalization, homophobia, and economic privilege, epitomizes *Radiolab*'s capacity to explore science through a prism, bending the invisible light to reveal the interrelated and observable ways it falls upon the human experience.

In 2010 and 2014, *Radiolab* earned Peabody Awards (the Pulitzer Prize equivalent for broadcast media) honoring its achievement in broadcast journalism. In 2011, Abumrad was awarded a MacArthur Fellowship, for a creative process that "often mimics the scientific process itself, complete with moments of ambiguity, digressions, reversals, and surprising conclusions that evoke in audiences a sense of adventure and recreate the thrill of discovery."

Introduction

Martin Lang, PhD

Associate Professor of Communication Studies

HONORING THE STORIES BLOG

"Honoring the Stories" is a Nobel Conference 53 blog dedicated to sharing the reproduction stories of the Nobel community. Joy and pain weave through these stories of surrogacy, adoption, infertility, pregnancy, and delivery. Read the stories and submit your own at gustavus.edu/nobelconference.



ABOUT THE IMAGE

Who can choose a favorite child? Would it be the one you've designed? As our abilities to genetically engineer advance, where will we stop? The posters for Gustavus Adolphus College's Nobel Conference on reproductive technology combine renderings of reproductive cells (blastocysts hatching, mitochondria, ova suffering injection, schools of spermatozoa) and genetic nuts and bolts (double helix) intruding on images of babies. This conference offers three separate posters, each featuring a delightfully unique baby, because even we couldn't choose a favorite.

Sharon Stevenson, Designer

Frankenstein, Prometheus, and Nobel Conference

Frankenstein, Mary Shelley's tragic novel about a scientist's quest to create life, is this year's selection for Gustavus' Reading in Common program. Written in the early 19th century during a time of rapid scientific discovery, with its attendant anxiety, the novel offers a way to explore the themes of the Nobel Conference through a literary and historical lens.

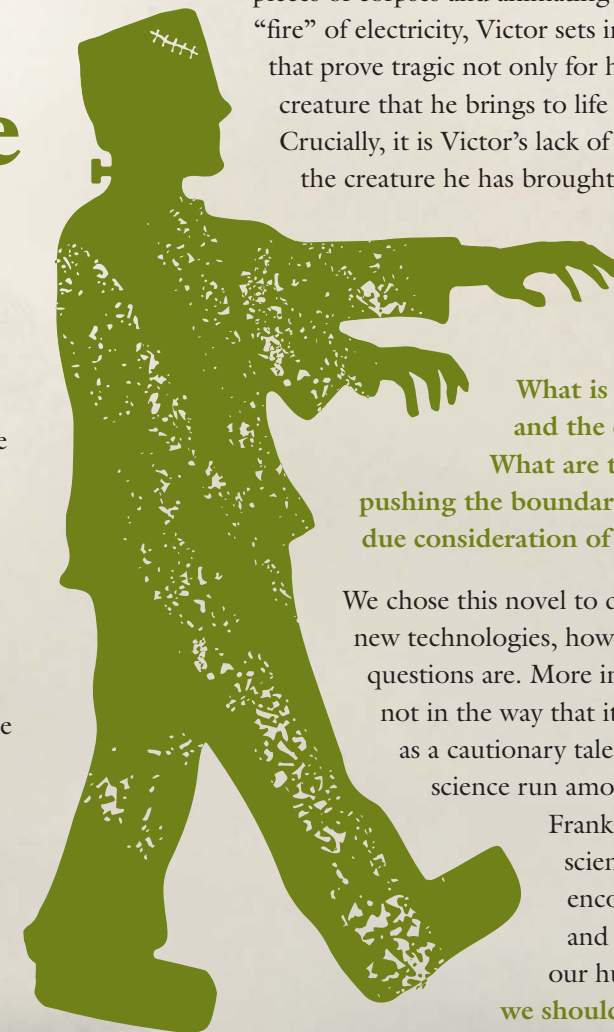
Thanks to an endless stream of movies, television shows, parodies and Halloween costumes, Frankenstein's "monster" is a cultural icon recognized around the world. Less well known is the fact that the complete title for the novel is *Frankenstein, or The Modern Prometheus*.

Who was Prometheus and what does he, or Frankenstein, for that matter, have to do with this year's Nobel Conference?

According to Greek mythology, the Titan Prometheus stole divine fire against the wishes of Zeus, the new king of the gods, and bestowed it upon humans. This fire provided them with heat and light and the ability to cook, make tools, and develop all manner of skills (*techmai*) that allowed humans to thrive. But there were grave repercussions for this theft. Prometheus was chained to a rock and tortured for generations, while humans were presented with a counter-gift to balance out the gift of fire—the woman Pandora, whose intractable curiosity compelled her to open the jar of evils and release sickness, conflict, and death into the world of men.

The Greek tragedy, *Prometheus Bound*, which was much admired by Mary Shelley and her husband Percy, explicitly raises questions about the boundaries of knowledge, technology, and power and both the positive and negative consequences of transgressing those boundaries.

These same questions are raised by the character of Victor Frankenstein, who sets out to create the "perfect" being against the advice of his mentor and outside of the proper bounds of his scientific community. Crafting a body from pieces of corpses and animating it with the newly harnessed "fire" of electricity, Victor sets in motion a series of events that prove tragic not only for himself and others but for the creature that he brings to life and immediately abandons. Crucially, it is Victor's lack of forethought, his neglect of the creature he has brought to life that, more than the transgression of natural law that causes the tragedy that unfolds.



How do we create life?

What is owed to the lives we create and the ones already in existence?

What are the consequences of pushing the boundaries of knowledge without due consideration of what might follow?

We chose this novel to demonstrate, in the face of new technologies, how old and fundamental these questions are. More importantly, we chose it—not in the way that it's commonly understood, as a cautionary tale about the dangers of science run amok (remember, Victor

Frankenstein acts outside of his scientific community)—but as an encouragement to think deeply and empathetically about what our humanity consists of and **how we should maintain that humanity in the face of what is different and unfamiliar.**

As you learn about reproductive technologies and their potential impacts, we hope that the power of literature and the scope of history will not be far from your mind. While science, humanities, and the arts are often perceived as completely separate fields of inquiry and expression, in reality, they are simply different ways of asking and responding to similar questions: Who are we? Where do we come from? How do we live together? What is this world we are living in? By considering these questions from multiple perspectives, we gain not only a deeper understanding of the world and our place in it but perhaps a clearer picture of where we want to go.



Why Music?

Each year the Nobel Conference opens with a musical prelude, followed by an academic procession accompanied by the festive strains of musical fanfare. Each day, music, dance, and visual and other arts intersect with the activity of scientific discussion in a counterpoint of inspired creativity and inquiry. In the great tradition of the liberal arts, this joining of art and science reveals an important aspect of our humanity: We are enriched as humans when we keep the wonders of intellectual inquiry and creative expression together in one place.

Medieval scholar Boethius identified music as part of the quadrivium, the four mathematical sciences that also included geometry, arithmetic, and astronomy. Along with the verbal disciplines of the trivium, all comprised the seven liberal arts. **Music was science and considered an essential means for understanding the workings of the universe.** Plato called this unheard, theoretical music the “harmony of the spheres,” emphasizing its astronomical component. By contrast, we now value music as a sounded expression of our emotional creativity—primarily something to be heard. In our cultural treasury, music functions as a means for knowing ourselves. We hear in music our passions, our emotions, our concerns, our societal expectations. In music, we give voice to our humanness. Either as science or as art, we need music as a means for understanding our world.

Music expresses who we are as individuals and as a community. At Gustavus, music is a deeply embedded part of who we are. We are a community of scientists and artists, researchers and writers, athletes and poets, activists and actors. This list could go on, an innumerable expression of individual talents and interests that come together in one common pursuit. We seek truth and beauty in our activities, and we realize, as Gustavus President Edgar Carlson once said, “We need each other to become ourselves.” We value tradition and ceremony, made manifest in our grand processional music. We embody our diversity when students of many academic disciplines join together in the orchestra or jazz band. This happens every day at Gustavus—athletes, scholars, and artists interact each day in the classroom, on the field, in the rehearsal space, and in the lab. We are many parts of one body, united in the rich activities of a liberal arts education. This is why we have a music at Nobel—without it we are not wholly ourselves.

WHAT'S IT LIKE TO BE A CONFERENCE SPEAKER?

Nobel Conference not only challenges and inspires those of us in the audience; it also sometimes has a profound effect on the researchers and scholars who present at the conference. Here's what a few of them have to say about their experience at the Conference and the impact it had on their own work.

“The Nobel Conference, H2O Uncertain Resource. was a unique and special event that had a **major impact on my career:** After the meeting, I spent the next five years turning the approach that I took for the Nobel talk into a book (*Water 4.0*). The book brought my ideas to many audiences that would have never learned about them and greatly increased the impact of my research.” **2009 speaker David L. Sedlak, professor, Department of Civil and Environmental Engineering, University of California, Berkeley.**

“The 2011 Nobel Conference, The Brain and Being Human, was a highlight among my many speaking engagements over the last 10 years. Scientists have few occasions to experience how the public views ‘their science’ and the Nobel Conference provided a unique opportunity to engage in a true dialogue with a large cross section of people who like and respect science and scientists. The Nobel Conference 2011 was a **lollapalooza for brain science.**” **Helen Mayberg, Professor of Psychiatry and Neurology and the Dorothy Fuqua Chair in Psychiatry Imaging and Therapeutics in the School of Medicine at Emory University.**

“As an oceanographer and climate scientist **I have given public lectures all over the world, but none have compared to the Nobel Conference.** Rock stars often comment on how they feed off the audience when they perform and how that makes them better musicians. I never fully appreciated how true that could be until I went to speak at the Nobel Conference. The people I interacted with leading up to my talk; the insightful questions and interest in exploring the different angles of the topic through small gatherings with students and conference organizers reignited my excitement over the topic I was discussing.” **Chris Sabine, Director, Pacific Marine Environmental Laboratory at the National Oceanic and Atmospheric Administration.**

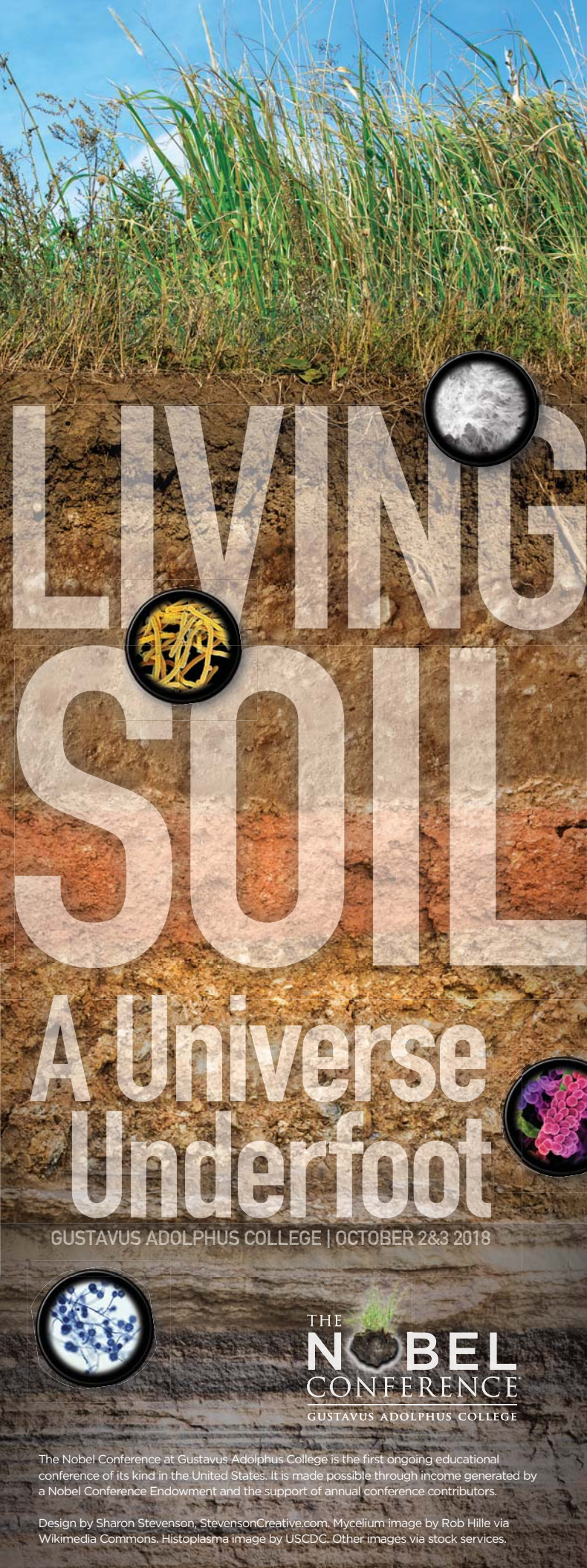


HIGH SCHOOL STUDENTS

Welcome! Take advantage of some special features of the conference created particularly for you.

- Visit **Beck Hall**, where a variety of interactive exhibits can give you a closer look at some of the scientific technology being discussed at the conference. See an ultrasound machine in action!
- There, you'll also find a **timeline** featuring important people and discoveries in the history of reproductive technology.
- View an assortment of **research posters** created by Gustavus students from a variety of disciplines. Come get a glimpse into life as a Gustavus student researcher!
- Play the “**Game of Life**” **scavenger hunt** to navigate your way through a series of challenges. Complete the hunt and submit your game card for a chance to win a Bluetooth speaker.
- Following the conference, **enter the Nobel Conference essay contest** for a chance to win a \$1,000 scholarship to Gustavus.

Funded by The Mankato Area Foundation.



NOBEL CONFERENCE 54

LIVING SOIL

A Universe Underfoot

Scientists and farmers have long recognized soil as the source of food—and thus life—for humans, but also as a living entity in its own right: a community of micro- and macro-organisms interacting with the Earth’s mineral resources. As microbial and molecular science expand the microfrontiers, and as ecosystem and geo-scientists disentangle global processes, we also are discovering new ways in which terrestrial organisms depend on living soils, and in turn, shape the life of the soil. Our Nobel Conference invites participants to consider the vast diversity and complexity of soils and the threats facing this most fundamental resource.

What is soil health, and what processes sustain healthy soils? How do the organisms in soil interact and communicate with each other, and how do forests and other plant communities benefit? How will climate change affect soils, and can soils be used to mitigate rising levels of carbon in the atmosphere? How do we develop or rediscover agricultural practices that will protect against soil erosion and promote soil health? How might we re-imagine our relationship to soil culturally and socially, as well as biologically and medically? These are just some of the questions we’ll tangle with during Nobel Conference 54.

2018 CONFIRMED SPEAKERS

Raymond Archuleta, conservation agronomist, Natural Resources Conservation Service (retired) **Claire Chenu**, professor of soil science, AgroParisTech, U.N. Special Ambassador for the International Year of Soil in 2016 **Jack Gilbert**, professor in the department of surgery; the Committee on Microbiology; Group Leader, Argonne National Laboratory, University of Chicago **Rattan Lal**, Professor of Soil Sciences, Ohio State University, member of the Intergovernmental Panel on Climate Change (IPCC) including during the time when that body won the 2007 Nobel Peace Prize **David Montgomery**, Professor of Earth and Space Sciences, University of Washington **Suzanne Simard**, Professor of Forest Ecology, University of British Columbia **Frank Uekotter**, Reader, Environmental Humanities, University of Birmingham

The Nobel Conference at Gustavus Adolphus College is the first ongoing educational conference of its kind in the United States. It is made possible through income generated by a Nobel Conference Endowment and the support of annual conference contributors.

Design by Sharon Stevenson, StevensonCreative.com. Mycelium image by Rob Hille via Wikimedia Commons. Histoplasma image by USCDC. Other images via stock services.

Nobel Conference Sponsors

The Nobel Conference is the only education conference in the United States to be authorized by the Nobel Foundation in Stockholm, Sweden. Core endowment funding for the conference was permanently secured through the generosity of the late Adeline and the Rev. Drell Bernhardson. The Bernhardson’s recognized and celebrated the historic relationship between the Nobel Foundation in Stockholm, Sweden and Gustavus Adolphus College. By establishing this endowment, they secured the core funding for the success of the conference and established a platform on which the conference can expand its reach and impact. The Nobel Conference Endowment Fund also includes gifts from Russell and Rhoda Lund; the Mardag Foundation, in memory of Edgar B. Ober; and the UnitedHealth Group.



Each year’s conference is supported by annual contributors. **Contributors to the 2017 conference include:**



The Rydell Professorship

The Rydell Professorship at Gustavus Adolphus College is a scholar-in-residence program designed to bring Nobel laureates and similarly distinguished scholars to the campus as catalysts to enhance learning and teaching. The Rydell Professorship was established in 1993 by Drs. Robert E. and Susan T. Rydell to give students the opportunity to learn from and interact with leading scholars.

2017 Rydell Professors

Dr. Alison Murdoch and Dr. Helen King

Helen King, PhD, is emeritus professor of history of classical medicine at the Open University in England and head of the department of classics at the University of Reading. King is considered an expert historian of medicine, specializing in the history of obstetrics and gynecology.

Dr. Murdoch and Dr. King will be engaging with several first-term seminar classes this fall linked to this year’s Nobel Conference theme and will return to campus in the spring to be of part of classes including a team-taught class on eugenics and genetic testing.

Information

INFORMATION & MESSAGE CENTER

Located in the lobby outside the southeast doors of Lund Center Arena, the Nobel Conference Information Desk may be reached during conference sessions by calling 507-933-7981. At other times, questions may be directed to the College operator at 507-933-8000.

AUDIENCE QUESTIONS

Our audience members ask great questions, and we'd like to give those questions a bigger presence in the conference. That will happen in two ways. First, you'll notice that that discussion sessions have been made longer to allow time for more questions. Second, a representative sampling of questions will be shown on the screens. We invite you to use these questions as the basis for your own discussions over the lunch table, on a walk in the Arboretum, or on the car ride home.

Questions may be submitted in the following forms:

At nobel.voicehive.com

On Twitter, using hashtag #Nobel53

In writing, using cards distributed by the ushers

DISABILITY ASSISTANCE

A limited number of assisted listening devices are available at the Conference Information Desk. Wheelchair seating is available in the arena.

OPEN-CAPTIONING

Open-captioning services are offered during the live stream of each lecture.

RESTROOMS

Restrooms are on both levels of Lund Center and in the Jackson Campus Center. Gender neutral restrooms are on the upper level of Jackson Campus Center and on the main floor of the library.

FOOD AND BEVERAGES

Beverages and snacks may be purchased at the concession stand in the Johns Family Courtyard and at the Courtyard Café, in the lower level of the Jackson Campus Center. Complimentary cookies and coffee will be served in the Johns Family Courtyard just before the afternoon sessions each day.

PREORDERED LUNCHES

Those who ordered buffet lunches with their advance registration may claim them in the Lund Center Forum (north of the arena). A limited number of buffet lunches may be available for purchase at the Forum entrance.

WEB ARCHIVES

Nobel Conference 53 proceedings will be archived on the Gustavus website (gustavus.edu).

CONFERENCE BOOKSTORE

Books written or edited by this year's Nobel lecturers (as well as other titles relating to the topic) are for sale in the Book Mark, located in the lower level of the Jackson Campus Center, open 8 a.m.–6 p.m. Inquire about discounts on selected Nobel-related titles and other Book Mark specials during the conference.

CERTIFICATION OF ATTENDANCE

Certificates of attendance and continuing education credits are available at the Nobel Conference Information Desk.

WEDNESDAY BANQUET TICKETS

Tickets for Wednesday evening's closing banquet, which includes the lecture by Jad Abumrad, may be purchased from the Nobel Conference Information Desk until Wednesday noon. Tickets are \$30 each. Abumrad's lecture will be simulcast in the Jackson Campus Center Banquet Rooms at 7:30 p.m.; the simulcast is open to the public without charge.

SOCIAL MEDIA

If you are posting photos or talking about The Nobel Conference on social media (Twitter@nobelconference, facebook.com/nobelconference, Instagram, etc.), we invite you to use the hashtag #Nobel53.

HOSPITALITY ROOMS

The Nobel Conference Hospitality Rooms are for Gustavus alumni, parents, and friends to come together during the Conference. Members of the Gustavus faculty and staff will be available for College updates and questions throughout the day. Check out the daily schedule posted outside the room for more information on programming. Located on the second floor of the Lund Center and in the Career Development Office in the Jackson Campus Center.

LEARN BOLDLY

There's a liberal arts college, acclaimed and accessible, that invites you to be courageous and ignite your ideas.

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