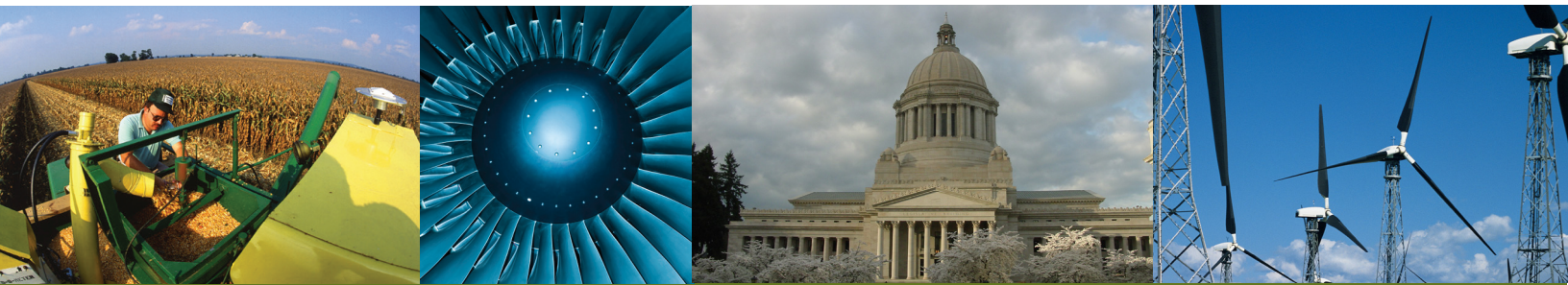


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WASHINGTON STATE  
» Academy of Sciences



# Accelerating Science's Impact: Translating Discoveries into Solutions



Summary of the Proceedings of the Eighth Annual Symposium  
*Held as Part of the 2015 Annual Meeting of the*  
Washington State Academy of Sciences  
September 17, 2015, Museum of Flight, Seattle, WA

March 2016

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## **About the Washington State Academy of Sciences**

WSAS is an organization of Washington state's leading scientists and engineers dedicated to serving the state with scientific counsel. Formed as a working academy, not an honorary society, the academy is modeled on the National Research Council. Its mission is two-fold:

To provide expert scientific and engineering analysis to inform public policymaking in Washington state; and to increase the role and visibility of science in the state. Gov. Christine Gregoire authorized legislation establishing WSAS in 2005. Its 12-member Founding Board of Directors was recommended by the presidents of Washington State University and the University of Washington, and was duly appointed by the governor. In April 2007, WSAS was constituted by the Secretary of State as a private, independent 501(c)(3).

## **Symposium materials**

Source material for the Eighth Annual Symposium may be found on the WSAS website, including:

- Speakers' slides;
- Video of the invited speakers' presentations;
- Symposium handouts;
- Symposium photographs.

Washington State Academy of Sciences  
410 11th Avenue SE, Suite 205  
Olympia, WA 98501  
wsas.programs@washacad.org  
www.washacad.org  
(360) 534-2321



Welcome to the proceedings of our eighth annual symposium, ***Accelerating Science's Impact: Translating Discoveries into Solutions***. In the past, the gap from basic discovery into practical solutions and applications has often taken decades. Translational science involves multi-disciplinary efforts of collaborative scientists to speed the process. From a unique treatment for one cancer patient to a malaria vaccine for millions, translational science initiatives—particularly in areas of biology including agriculture, environmental science and medicine—are benefitting humanity around the globe. The speakers share their experiences of combining innovative ideas with the latest data and technologies to translate discovery as quickly as possible into enhanced health and well-being for as many as possible.

*Robert C. Bates*  
Executive director

*Allan Konopka*  
President

## Translational science, explained ...

For the past two centuries, human progress has often depended upon “*translating*” *fundamental science discoveries* into practical solutions that improve the human condition.

The path from clinical trials and testing to interventions and products has been slow, solitary, and arduous.

*Translational science accelerates* the rate at which discoveries that have great promise are transformed into solutions and products. It involves collaboration that can open completely new fields of technology and help ensure discoveries are fully developed.

*Because of translational science, advances in technology can be utilized to help humanity benefit sooner* from more effective drugs and medical devices, agriculture to feed a global population, improved preventive health services, and more sustainable practices in industrial and natural environments.

*Translational science is important for Washington state, and support is essential.* Universities and research institutes are developing commercial products based on discoveries, and forming many small start-up companies that enhance the state's economic development. All that takes human talent, capital investments, and an environment where scientific research can flourish.

## Executive Summary

We are on the verge of a revolution in the biological sciences. Translational science, the trans-disciplinary approach to shorten the time frame from discovery to application, is changing the way problems in biology are approached. Scientists from a wide variety of disciplines are delving into research and working collaboratively with a new efficiency to find solutions for society's problems. Washington's scientists are at the leading innovative edge.

### Accelerating science to affect millions of people

Keynote speaker Dr. Trevor Mundel discussed the challenges of the Gates Foundation in finding solutions that affect large populations. A matrix of investment versus probability of success helps guide an overview of allocating resources to find the highest-value opportunities at maximum speed. New FDG PET scan imaging for tuberculosis can shorten the time for evaluating success from 18 months to two months. Revolutionary new technologies that sculpt evolution (such as gene drive) could dramatically reduce the rates of malarial infection. However, public acceptance of these technologies requires appropriate education to counter concerns such as the "GMO mosquito" issue. The ability to collect large amounts of data over time enables scientists to do large-scale models of diseases to a degree of granularity never before possible. These computer simulations can provide a tremendous ability to eliminate impractical solutions and provide support for large-scale interventions in a few days instead of years.

### Crop biology increases crop yields and reduces pesticide use

Dr. R. James Cook described genetically modified crops as the perfect example of translational science. Genetically engineered glyphosate-resistant crops enable farmers to spray once for weeds, instead of multiple sprays and chemicals, while eliminating the need to till the soil. Insect-resistant crop plants have been widely effective against boll and borer insects that can destroy entire harvests of cotton and corn, respectively, unless protected by an insecticide. The papaya industry, beleaguered by the aphid-vectored ring spot virus, was saved by a viral coat-protein-mediated resistance. However, much technology sits on the shelf because of the expense of regulatory approval, up to \$100 million per trait. In 2014, according to the International Service For the Acquisition of Agro-biotech Applications (ISAAA), 18 million farmers planted more than 181 million hectares to biotech crops. Over the past 20 years, adoption of GM crops has reduced pesticide use by 37 percent, increased crop yields by 22 percent and increased farmer profit by 68 percent.

### Scientific basis for Hanford Site strategies to protect the environment

Translational science at Hanford has involved the investigation of challenging problems, the creation of process understanding through models, and the revelation of complex groundwater interactions. Dr. John Zachara posed that many issues at Hanford—located along the Columbia River and with more than a thousand

contaminated sites—are critical items for public safety and health. Researchers have used new geophysical imaging techniques to identify the location of radioactive materials, and have quantified the complex interactions of hydrologic and geochemical processes that control the movement of various contaminants including uranium in Hanford groundwaters. Study results provide a scientific basis for monitoring strategies, predictions of future mobility, and corrective decision-making.

### **Protein science generating innovative spin-off companies**

Dr. David Baker's lab investigates and designs proteins, work that frequently evolves into local spin-off companies. The scientists aim to design a new world of proteins to address 21st-century challenges in medicine, energy and technology. The range of their work includes proteins for the flu virus, Ebola and gluten breakdown, along with smart nanoparticles and antigens to make modern, highly-effective vaccines. Research is highly collaborative, and the group tries to work on unique problems that aren't being addressed anywhere else in the world.

### **Data on the cloud for incurable cancer**

A million people a year in the U.S. have cancer and get treatment and therapy, but the interaction of patient data with rapidly evolving research and technologies is challenging. Dr. C. Anthony Blau and his team at the University of Washington Center for Cancer Innovation draw on global experts across fields and institutional boundaries to help patients fighting for their lives. Viewing cancer as a big data problem, they have created a Tumor Crowd Modeling platform with electronic medical records that has the potential to expand to millions of patients.

### **Responsive justice in the translation of health sciences**

Dr. S. Malia Fullerton argued that researchers have a responsibility to ensure that basic science discoveries are taken up in the most broadest, equitable, and just manner. She pointed out that scientists need to proactively anticipate whom they will involve in research, and how communities will benefit in the longer term. Institutional systems can have an attitude of neglect toward the vulnerable and medically underserved. Scientists need to be in dialogue with the public so discoveries will result in applications that actually attend to people's health care needs.

### **Inventing biopharmaceuticals—beneficial work, but highly risky**

Alder Biopharmaceuticals' current lead product is a novel therapy for people afflicted with migraines. Dr. John A. Latham described the development process from primary research discoveries to the marketplace. A new drug may take 20 years to develop and test in clinical trials, all of which is hugely capital-intensive. Problems exist in this country's shortage of trained clinical pharmacologists and the lack of investment in manufacturing. Drug R&D can bring revolutionary new medicines to help people and solve unmet medical needs.



### **Washington aims for global leadership in science innovation**

Life Science and Global Health Development is a sector in the state's Sector Lead program, residing in the Department of Commerce. Director Maura Little described the vision of nurturing innovations outside of academic settings and supporting intellectual property generation. Two major research projects examine the benefits of R&D tax credits and incentives. The sector successfully recruited the annual NIH Small Business SBIR/STTR conference for 2015, giving local entrepreneurs and researchers the opportunity to learn how to obtain some of the program's \$780 million annual grant dollars.

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Keynote



# Lost in Translation: Data as the Compass to Success

**Trevor Mundel**

President, Global Health Program  
Gates Foundation

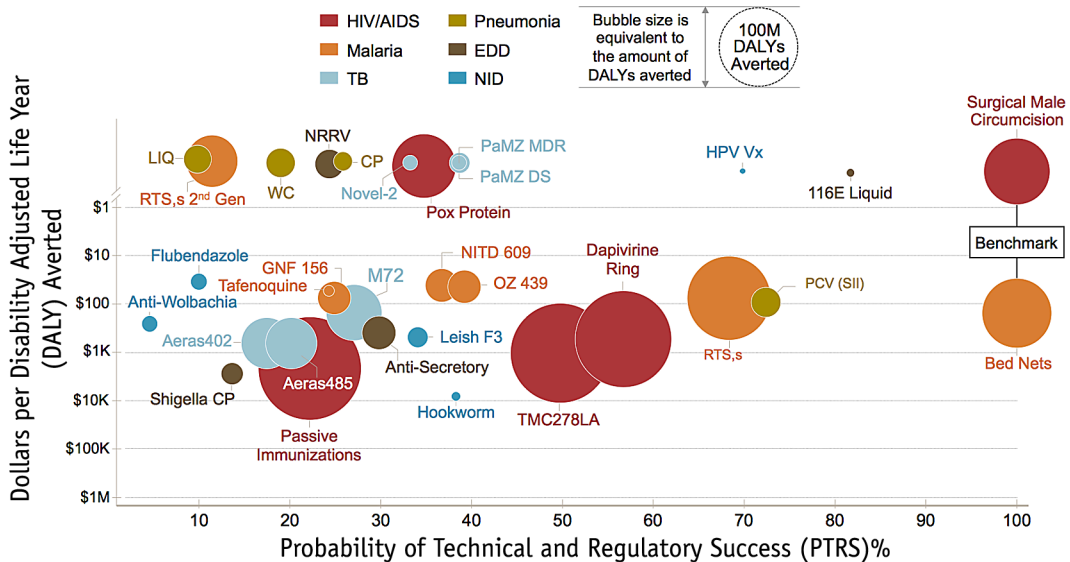
## Synopsis

I head up the program at the Gates Foundation that has a mandate to really accelerate ideas in science to affect large populations, potentially tens of millions of people.

### A matrix to evaluate new therapies and products

To guide our investments in global health, we take a portfolio of ideas for new interventions and compare them to highly-effective ones—for example, bed nets for prevention of malaria, and male surgical circumcision for prevention of HIV/AIDS.

**Figure 1. Guiding Our Investments in Global Health**



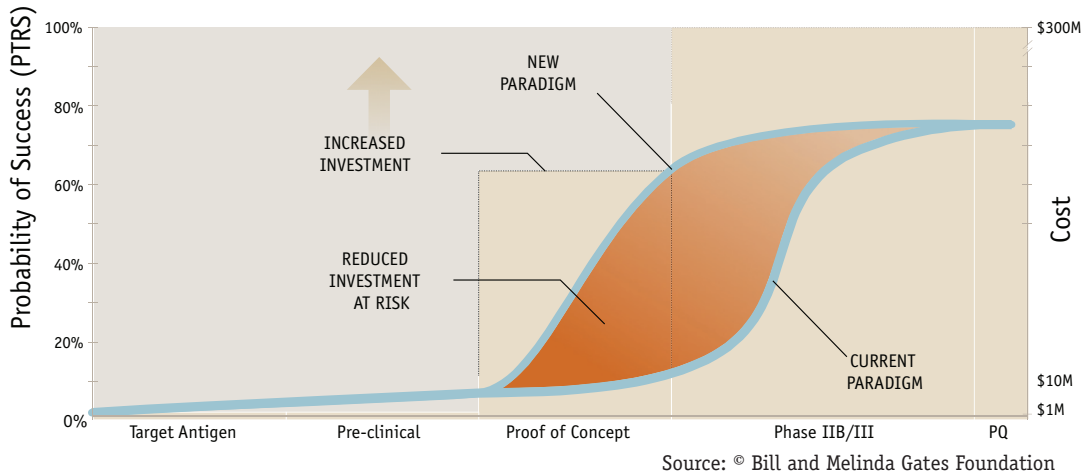
Source: © Bill and Melinda Gates Foundation

If we look at the cost effectiveness of bed nets, the DALY (Disability Adjusted Life Year Averted) is about \$100. The current drug treatment for hookworm the DALY is about \$8,000. We ultimately had to eliminate that hookworm vaccine program. It’s not just a question of whether something works or not. The fundamental challenge is to allocate resources to maximize speed and find the highest value opportunities.

We need real data on whether an intervention—it could be a new drug or a vaccine—actually works. We have to study it in a sizeable population. The difficulty is that the cost of these late stages, where you are treating tens of thousands of people, is astronomical. Most of these things are going to fail, so you are carrying tremendous risk at that late stage at very high cost. The game of translation is to resolve the risk in much smaller, cheaper contexts.

### Figure 2. The Fundamental Challenge

How to allocate resources to progressing the portfolio in a manner that maximizes speed and finds the highest value opportunities (minus risk of late failure).



### Gene drive technology and the “GMO mosquito” issue

Gene drive is a revolutionary new technology that enables scientists to put a gene in a population that defies the usual genetics, introduces characteristics that

you want and propagates a population at a rapid rate. For malaria, releasing mosquitoes with this gene drive would be miraculous, driving down the rates of infection at the level of 600,000 to 700,000 deaths per year, mostly in a belt around central Africa. But when this is taken outside into the media it quickly escalates into the “GMO mosquito.” Gene drive technology is going to be blocked unless we can deal in a very rational and systematic way with the cultural, political, social, and scientific issues.

*“How do you move that portfolio as rapidly as possible to some success?”*

*The game of translation is to resolve the risk in much smaller, cheaper contexts.”*

Trevor Mundel

### Accelerating TB study resolution

Tuberculosis is an old scourge but remains a huge and growing problem. Around 9.5 million people develop TB infections every year, with 1.4 million deaths. Today we have a new portfolio of drugs against the TB organism. The problem has been that the standard treatment takes six to 18 months to get resolution. But now with FDG PET scan imaging, you can have an early readout in about two months that would show the massive inflammation that occurs in TB, shortening the time to see whether drugs and therapies are working.

### The Human Challenge: Testing malaria medicines on volunteers

Malaria has a propensity to resurge, becoming even more dangerous because populations develop a natural immunity. Testing in the field, where infected patients need to come in from the villages, is a long and arduous prospect. In a new model called The Human Challenge, volunteers offer to participate in new therapeutics for malaria. Seattle and Queensland, Australia, are locations where volunteers are working on different models that give a readout of whether a new drug is working or not, which has been very exciting to the field in terms of developing new malaria drugs. However, one of the most promising candidates from the challenge model did not perform well in a real field study of malaria patients. That often happens with many drugs.

### Eradicating malaria by treating those not sick

Another problem with malaria is that unless you can get the parasites out of the asymptomatic 90 percent of the population you will not eradicate the disease. People who are not sick retain parasites in the blood that infect the mosquito populations. In the past, drugs had to be given for three sequential days, which is difficult, either for teams to go and spend three days in villages to dispense drugs or problems with compliance if people are sent home with the drugs, because they feel cured after the first dose. We are working on a single dose curative therapy, but the Human Challenge model has not been completely successful and so we need to go back and improve it.

### New healthy growth and development tools are remarkable

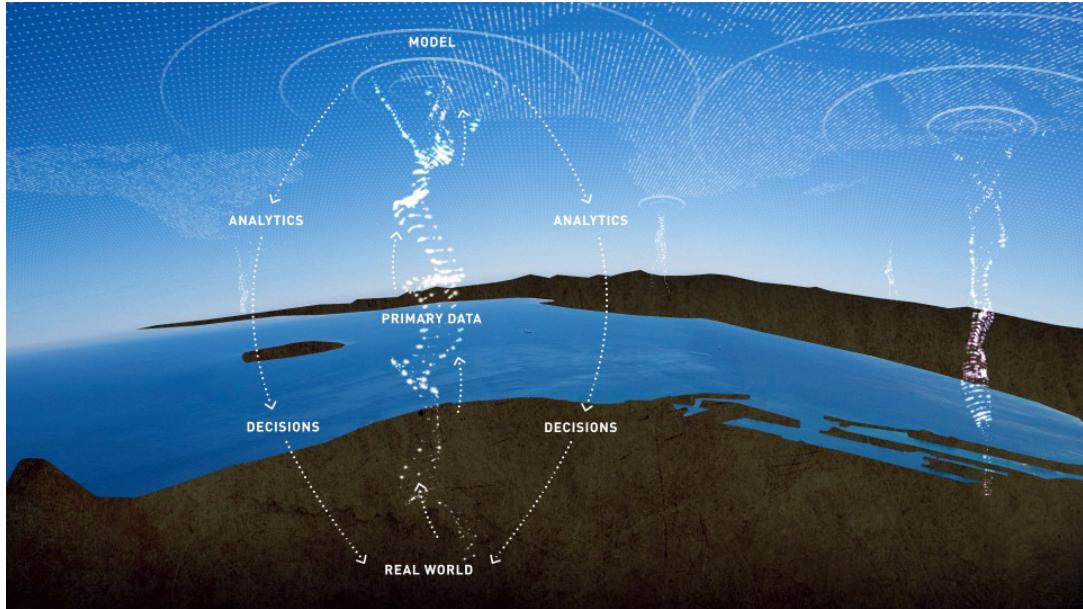
Stunting is a huge issue in the developing world. The Gates Foundation and many groups around the world have collected literally millions and millions of data points plotting the growth of kids—from head circumference and body length to maternal education and *Escherichia coli* rates in water. Without doing any new studies, we can translate the existing body of work into effective interventions.

*“Now we can run a computer simulation that enables us to steer away from things that make no sense and provide large-scale interventions in a couple of days instead of years and years.”*

Trevor Mundel

For example, a mathematical simulation model of a cluster of villages on Lake Kariba, which intersects Zambia and Zimbabwe, includes annual variation in climate, humidity, even down to the different strains of mosquitoes present. It is an amazingly complex model of all the known factors that affect malaria epidemic. We can ask questions and make decisions, for example, on how many treatments we would need in a year, and what times of year. In previous times, we would have to sponsor entire studies that would take eight years to complete.

**Figure 3. Success in Translation**



Source: © Bill and Melinda Gates Foundation

### The complexity of translation

Data and the generation of data are absolutely fundamental, as well as the quality and speed of getting the data out. We ask whether this solution works in the real world with millions of people who take medication one day, may not take it the next day, and have multiple conditions and multiple factors affecting their decision to participate in the health care system. We ask whether we can even make a drug or vaccine at the scale we need and the cost we need, so we can best allocate resources and get above the bar to achieve success.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

## Case Studies in Translational Science



# Crop Biotechnology: From Discovery to Application

**R. James Cook**

Professor Emeritus, Washington State University

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### Synopsis

Crop biotechnology is a perfect example of translational science. What usually comes to mind when we talk about biotechnology is recombinant DNA technology, otherwise known in science as genetic engineering—and what the public and press have come to call genetically modified organisms or GMOs.

Two members of the Washington State Academy of Sciences—Gene Nester and Rob Horsch—played key roles in the discovery of methods and their application to genetically engineered crops.

### Discovery: The tumor-inducing principle of the crown gall

Through curiosity-driven research, Gene Nester and his lab team worked on crown gall, an infectious disease that occurs mainly on woody perennial plants such as grapes, almonds, and peaches, and which is caused by the bacterium *Agrobacterium tumefaciens*. Crown gall was a mystery, because a tumor could still form when bacteria applied to a plant wound were subsequently killed.

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**Figure 4. Crown Gall on Grape**



Source: Thomas Burr, Cornell University, Ithaca, NY

Ultimately the transfer of some DNA (T-DNA) from the bacteria to the plant was discovered to be the tumor-inducing principle and the first documentation of stable incorporation of bacterial genes into a plant. Tools were developed exploiting nonpathogenic T-DNA to transfer any gene into a plant genome. This is where genetically-modified (GM) crop plants really started, back in the late 1980s and early '90s.

### **Application: Glyphosate-resistant crop plants**

Several labs in the U.S. and Europe were doing this work, but Monsanto scientists, including Rob Horsch, put the technology to use faster than any of the other multinational companies. Glyphosate kills plants by deactivating the enzyme EPSP synthase. The gene for this enzyme in soybean was replaced by a functional bacterial version for EPSP synthase that was not inhibited by glyphosate. Eventually a modified plant was used in conventional breeding to produce agronomically different GM varieties for use in different soybean-growing areas.

In 1996, the U.S. Department of Agriculture (USDA) approved for commercial production glyphosate-resistant soybeans and corn, and in subsequent years cotton, canola, sugar beets, and alfalfa. These GM crops tolerate applications of glyphosate that kill the surrounding weeds. Farmers can plant directly into the undisturbed soil of the previous crop and later spray once with Roundup to control weeds, with no more need to till the soil for weed control.

### **Application: Insect-resistant crop plants**

Insects can destroy plants and entire harvests, leading farmers to repeatedly spray crops with pesticides. The soil bacterium *Bacillus thuringiensis* (Bt) produces a protein that attacks the gut of susceptible insects, causing their death. Monsanto's genetic modification of cotton with the Bt gene conferred resistance to boll insects, and the Bt gene in corn made it resistant to the European corn borer. Recently, Bt was approved in Bangladesh for use in eggplant. In all these cases, Bt genetic modification has reduced or eliminated the need for insecticide spraying.

*“No-till agriculture saves energy, saves time, and it saves wildlife habitat and machinery.”*

R. James Cook



**Figure 5. European Corn Borer**



Source: National Center for Food and Agriculture Policy, © Marlin E. Rice

The Bt gene has been completely effective against the European corn borer. Bt corn stands straight when mature, making it easy to harvest, as opposed to stalks that have fallen over, with cobs on the ground, because of damage from the corn borer. There is a risk, as with hospital antibiotic use, that the pest will adapt resistance to this protein. Strategies to delay or even prevent this include a double gene, where two genes are deployed simultaneously.

Interestingly, the Bt protein has been approved by the EPA and used for years as an organic insecticide if produced in fermentation culture and sprayed on the plant, but not if produced by the Bt gene expressed in the plant.

#### **Application: Viral coat-protein resistance**

Another example of genetic engineering technology is viral coat-protein-mediated resistance to plant viruses. Even though this application was first commercialized 20 years ago, there are still only two crops currently using it today—cucumber in the Atlantic East and papaya in Hawaii. Some plant virologists say that this technology has the potential to control every virus disease of plants, especially the insect-vectored ones, but the cost of regulatory approval is prohibitive and has inhibited their introduction. It might cost \$40 million to \$100 million dollars to bring a new gene to market.

#### **Market resistance**

Many other plants with resistance to pesticides or harmful viruses have been successfully engineered. However, consumer resistance remains a significant issue. In 2014, fear of consumer reaction led the fast food industry to reject future purchase of the genetically-engineered,

*“The genetically modified papaya plants are already being credited with saving an industry that was on its way out.”*

*N.Y. Times, July 20, 1999*

USDA-approved, insect-resistant Russet Burbank potato. With no market, the potato industry returned to unmodified Russet Burbank and its need for several insecticide applications over the course of the season.

### **The “Gene Revolution”**

What is amazing is that 99 percent of this technology involves just two genes—the EPSP gene for glyphosate tolerance and the Bt gene for insect resistance.

We have 300 different crops in the state of Washington and the only ones that are genetically engineered are corn, canola and alfalfa—and these for tolerance to glyphosate. There are hundreds of applications of crop biotech sitting on the shelf because of market resistance or the cost of regulatory approval.

In 2014, according to the International Service for the Acquisition of Agro-biotech Applications (ISAAA), 18 million farmers in 28 countries planted more than 181 million hectares to biotech crops. ISAAA reports further that, on average, over the past 20 years, the adoption of biotech crops has reduced the use of pesticide by 37 percent, increased crop yields by 22 percent, and increased farmer profits by 68 percent. Genetic engineering has gone global, and the economic benefits have been proven.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

## Case Studies in Translational Science



# Environmental Science and Decision-making at Hanford

**John Zachara**

Battelle Fellow, Pacific Northwest National Laboratory

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### Synopsis

The Hanford Site presents some of the world's toughest challenges for environmental chemists. It exemplifies translational science in a very different context from other Symposium topics like global diseases and crops. Many issues at Hanford emerge and re-emerge as critical items for public safety and public health.

Nearly 56 miles (90 km) long and 37 miles (60 km) wide, Hanford is a very large site, and it lies along the iconic Columbia River in its entirety. This stretch of the Columbia River is termed the "Hanford Reach"; it is fully undammed and is the last remaining free-flowing section of the river in the United States. The Hanford Reach is an iconic salmon fishery that supports the spawning of both native and hatchery-supported runs.

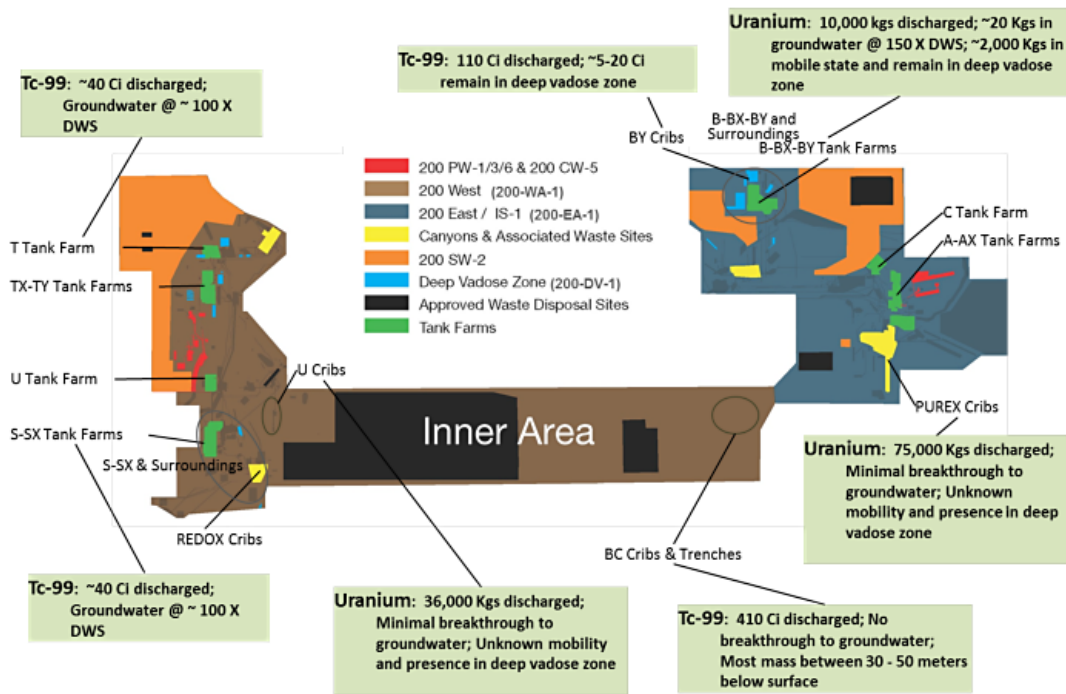
### Highly visible, challenging problems are investigated

Hanford was a historic site of plutonium production in the 1940s and even all the way up into the '80s. It currently contains more than a thousand identified contaminated sites, including more than 170 massive storage tanks with highly radioactive reprocessing waste. Some of these contaminants have influenced groundwater. The site's budget is approximately \$4 billion yearly, extending to 2060. Science, if performed properly, can reduce those costs and contribute to better solutions.

### The belly of the beast

The central part of the site is a remarkable place where nuclear fuels were pulled apart and robotically subjected to chemical treatments. With concrete walls greater than 10 feet (3 meters) thick, the buildings are undergoing slow demolition, while contaminants from nearby waste sites are impacting groundwater right now.

**Figure 6. Mobile Contaminants and Their Inventory in the Hanford 200 Areas**



Source: U.S. Department of Energy

**Major contributions through conceptual models and process understanding**

Determining the locations and amount of contaminants in the vadose zone is very difficult, but a new generation of non-invasive technology applications is helping to define the complex spatial inventories of contaminant plumes through their thermal signatures and contents of ionic solutes that influence subsurface electrical properties. For example, geophysical imaging techniques sensitive to heat or salinity enable identification of the three-dimensional structure of

subsurface contaminant plumes to considerable depth, e.g., 164 feet (50 meters). Analysis using non-invasive imagery can not only find elements like lost uranium through proxy analysis, it can also provide three-dimensional data sets that support robust model validation that identifies time-related changes, and that quantifies rates of movement.

Geophysical surveys drive cost savings and decisions for expedited action. Is the material moving? Is corrective action needed? Models that describe the rates and concentrations of subsurface migration defend corrective action decisions.

**Science reveals complex interactions**

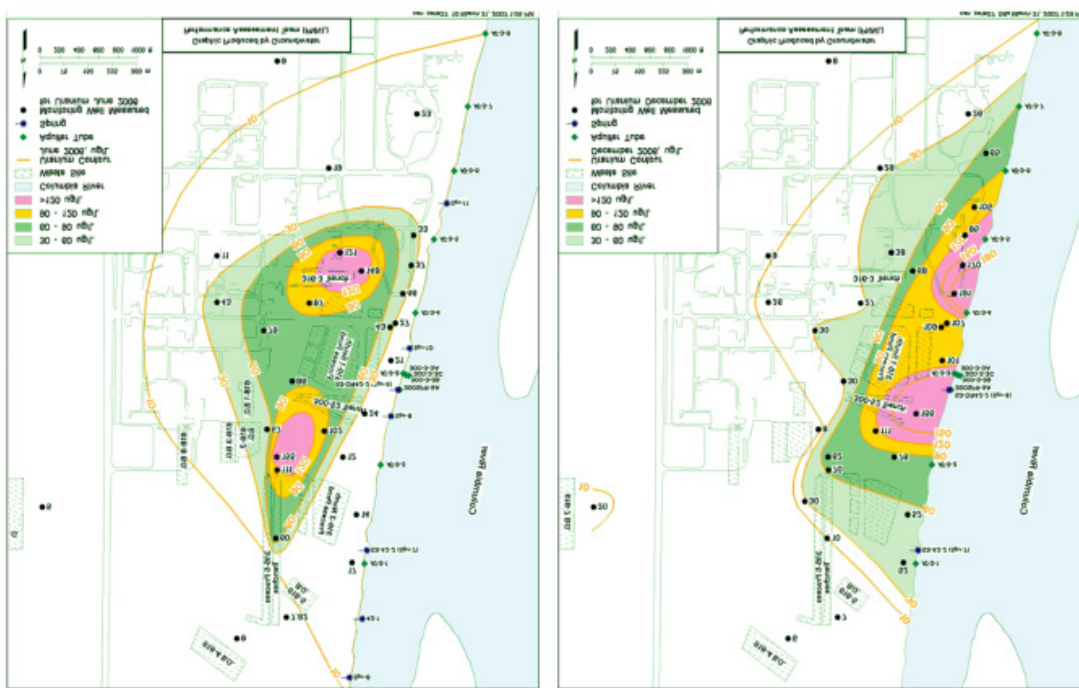
Another area where science has really contributed is along the Columbia River corridor where groundwaters and surface waters interact. Multiple contaminant plumes exist with the Columbia River corridor because historic nuclear fuels fabrication facilities and associated nuclear reactors

*“This fascinating site has been used extensively for fundamental research in many different domains, and its impact for science has been huge.”*

John Zachara

were located close to the river shoreline. Contaminant concentrations within plumes located within the groundwater-surface water interaction zone display very strong seasonal dependence and enigmatic behaviors. At some times of the year the concentrations are below the regulatory level, while at other times they're much higher. These behaviors are generally atypical of contaminant plumes and are complicated to interpret, leading to challenges for both regulators and the Department of Energy because they're dynamic, and future behaviors are highly uncertain.

**Figure 7. Seasonal Changes to 300 A U Plume Concentrations Have Been Enigmatic**



Source: Pacific Northwest National Laboratory

Why does the plume change so dramatically between spring and fall? What controls the location of high concentration points, and why do they change location seasonally? Our team monitored the wells over short time intervals and correlated observed changes with water table elevation and river stage. These observations revealed that Columbia River waters moved inland during spring, diluting the groundwater and redirecting its flow direction. Financial support from DOE's Office of Science allowed us to perform groundwater sampling and analyses over much more frequent time periods than Hanford could afford. The more robust data that resulted enabled the development of a process-based model for this complex system that well-described the observed seasonal concentration trends.

As it turns out, 10 plumes lie along the Columbia shoreline, and they are all driven by this complex interaction between groundwater and the powerful forces of the river. The results of our investigation enabled the design of an effective monitoring strategy that honors the complexity of the system and its inherent variations, in addition to yearly variations resulting from climate.

### Scientific basis for decisions and strategies

Scientific research has had a large impact at Hanford. It has provided process understanding and conceptual models for water movement and biogeochemical reactions. These provide a scientific basis for decision-making, strategies for monitoring, and research models for verification of regulatory model predictions to better help protect the environment.

*“Predicting where the water goes is not trivial. If you can’t predict that, you can’t predict what the risk is, you can’t predict anything.”*

John Zachara

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

Panel: Translational Science for Health and Disease:



# Barriers and Solutions

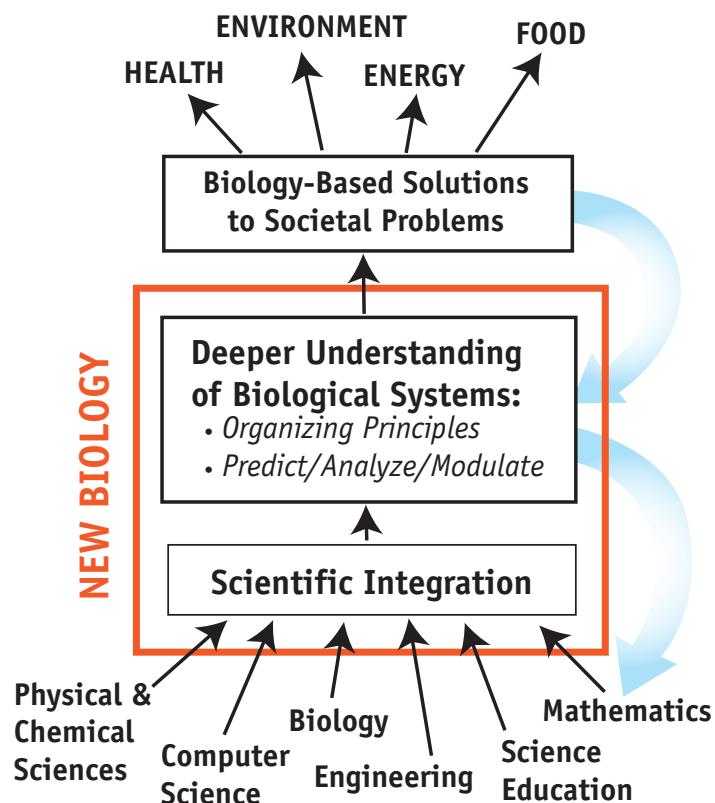
**Moderator: Vikram Jandhyala**

Vice Provost for Innovation and Executive Director of CoMotion, University of Washington  
Professor of Electrical Engineering, University of Washington

## Synopsis

Today's panel will take an innovative look at translational science in the life sciences and biotech. There are many aspects to be considered, including health and disease barriers and solutions, investment, talent, state support, learning from other regions and ecosystems, and our uniqueness and strengths.

**Figure 8. A New Biology for the 21st Century**



Source: National Research Council (2009)

New biology applies to both traditional and non-traditional approaches. It's interdisciplinary, looking at applications and learning from computer science, the engineering fields, physical sciences, and social sciences.

*Seattle is going through a tech boom. What can scientists do more of for the state of Washington?*

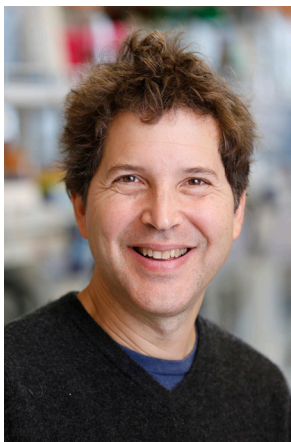
Vikram Jandhyala

This is a great time for such interaction to happen. Seattle is going through a tech boom. We want to discuss what the life sciences sector can contribute to that boom and how we can grow something that is very sustainable here in the state of Washington.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).



## Panel: Translational Science for Health and Disease



# Barriers and Solutions

## David Baker

Professor of Biochemistry, University of Washington  
Investigator, Howard Hughes Medical Institute

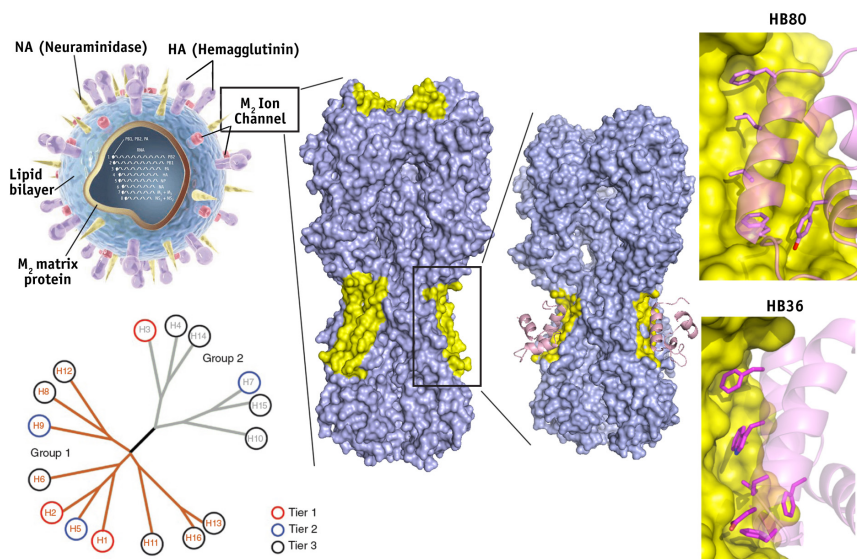
### Synopsis

Naturally occurring proteins that evolved over billions of years solved the challenges that arose during evolution. In the world today we face new challenges: new health issues, we're heating up the planet, new toxic compounds are being released. At the University of Washington's Institute for Protein Design, our translational investigators aim to design a whole new world of proteins to address 21st-century challenges in medicine, energy, and technology.

### Proteins and flu viruses

One of the applications we're working on is the flu virus. Because it's highly variable, we need new vaccines all the time. We've designed very small proteins—the example with ribbons—that bind tightly and specifically to the virus.

Figure 9. Anti-flu Protein Design



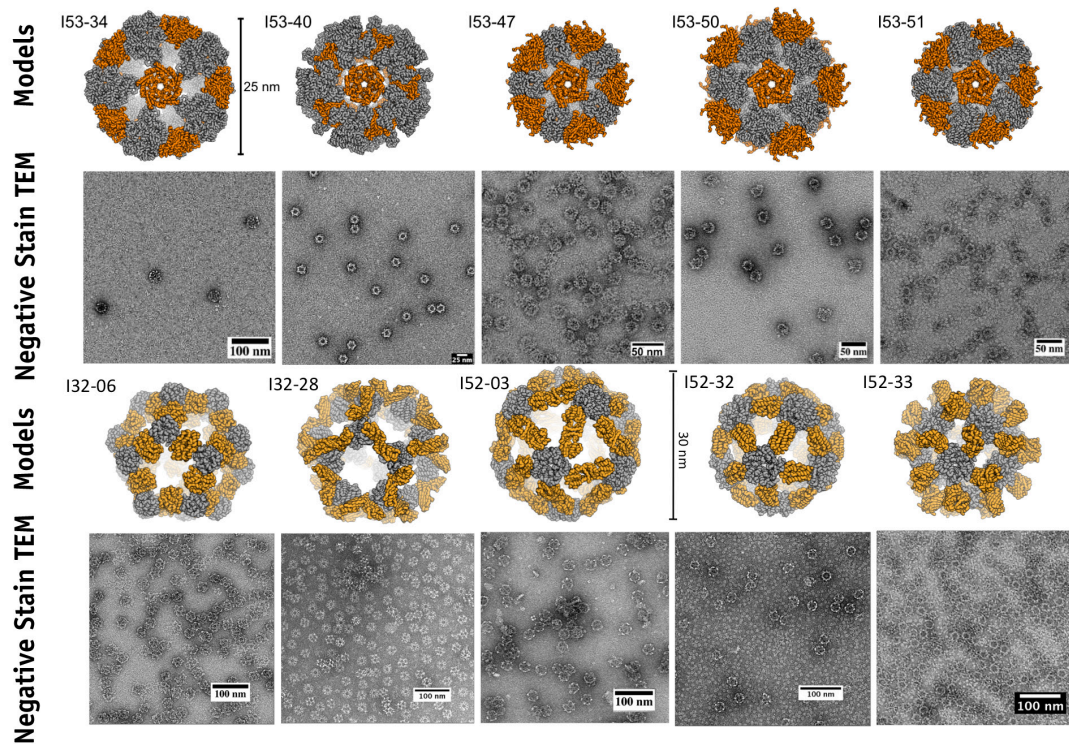
Source: Institute for Protein Design, University of Washington

Binding proteins also have general infectious disease-type applications. We’re working on similar binding proteins for other diseases like Ebola. These kind of proteins could also be useful as therapeutic sponges to soak up toxic compounds.

### Proteins and vaccines

Another promising application is the design of smart nanoparticles made out of proteins that have room on the inside for cargo—such as DNA, or a small molecule to be delivered to part of the body. Institute researchers are also working on putting antigens on the outside to make modern highly-effective vaccines.

**Figure 10. Designed Nanoparticles for Drug Delivery and Vaccines**



Source: Jacob Bale, Chantz Thomas, Will Sheffler, Neil King, Shane Gonen, Tamir Gonen; Institute for Protein Design, University of Washington

*“The more we master the rules of protein-building and protein design, the more we’ll be able to design proteins for many different applications.”*

David Baker

When proteins are made inside bacteria, what gets produced are these very homogenous fields of nanoparticles. For vaccines, we’re putting these drugs inside nanoparticles, and putting HIV proteins on the outside.

### Proteins and gluten

Another translational investigator has developed a protein that very effectively breaks down gluten, which is the causative agent of celiac disease. The protein she designed completely destroys gluten in bread, and she expects to spin out a company within the next months.

### Support, collaboration, and follow-through

A number of very exciting programs make this all possible. The Washington Research Foundation Innovation Fellows program supports post-doctoral fellows working in labs around the Seattle area, bringing expertise together.

Our lab can design proteins but can't do the follow-up experiments; another program fosters collaboration with testing and diagnostics.

For translation, what used to happen in my group until a few years ago is that someone would design a protein that was really exciting, write a paper published in *Science*, and then move on to an academic job. That's great for *Science*, but it doesn't really build companies locally. We're very fortunate to have a grant from the Life Sciences Discovery Fund that exclusively funds our translational investigators from the point of writing the paper to the point where they can raise money and start a company.

Collaboration is important, because no one group has the expertise to make an impact and do something that is truly a step forward. Innovation is critical. What we try to do in my group are things that aren't being done at all anywhere else in the world.

*“We’ve spun out a number of companies over the years and more are in the works. They span a really wide range of ideas.”*

David Baker

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

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## Panel: Translational Science for Health and Disease



### Barriers and Solutions

#### C. Anthony Blau

Professor in the Division of Hematology, Department of Medicine

Adjunct Professor in the Department of Genome Sciences  
University of Washington

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#### Synopsis

A million people a year in this country have cancer and get treatment with some type of therapy. But collectively, we're no smarter for their experiences. Toward that end, the University of Washington Center for Cancer Innovation was created. We're working toward a time when every cancer patient's experience adds to an ever-growing body of knowledge that makes us progressively smarter about how cancer works.

#### Aggregating experts and transcending institutional boundaries

We aggregate experts from many areas of expertise, seeking out people who are superb in their fields and finding ways for them to cross chasms into an effective force. No single institution has the wherewithal to cure cancer. We need to transcend institutional boundaries and find ways to work with anyone in the world who has advice, technology, or expertise.

#### Options from the latest research and technologies

We also need to view cancer as a big data problem. When you're a patient, you're in either the world of research or the area of clinical care—and there has not been a lot of interaction. That's in part to protect clinical care patients from researchers who want to do crazy things. But for patients fighting for their lives, making the latest research available to them can offer options they wouldn't otherwise have.

#### Clinical trial for metastatic triple-negative breast cancer

Two years ago, we began a clinical trial for this incredibly aggressive cancer, which is generally considered to be incurable. We now have 12 patients. We sampled their tumors with biopsies at multiple sites and put this information on the Internet's storage-sharing cloud. From there it's accessible to biologists and

*“We are bringing the world’s expertise to bear on individual cancer patients: leading clinical trials, following the course of their disease longitudinally, and placing this information on the cloud.”*

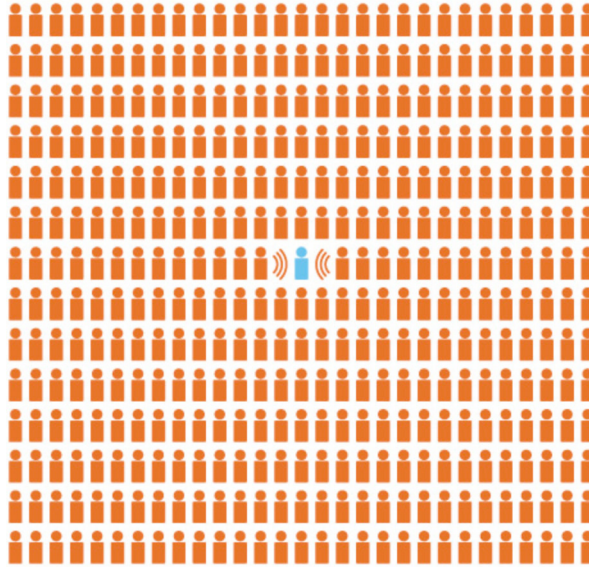
C. Anthony Blau

computational experts from many different organizations, who help to synthesize the data and look for a vulnerability that might be targetable with a drug.

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### Figure 11. Patient’s Data

One patient’s data is accessible for research and potential application worldwide.



Source: University of Washington Center for Cancer Innovation

Sometimes getting the patient on a drug predicted to work is remarkably difficult. Perhaps the drug is FDA-approved but not for that type of cancer. That means the insurance company won’t pay, and these drugs can cost up to \$15,000 a month. We try to make connections that allow the patient to get the drug for free.

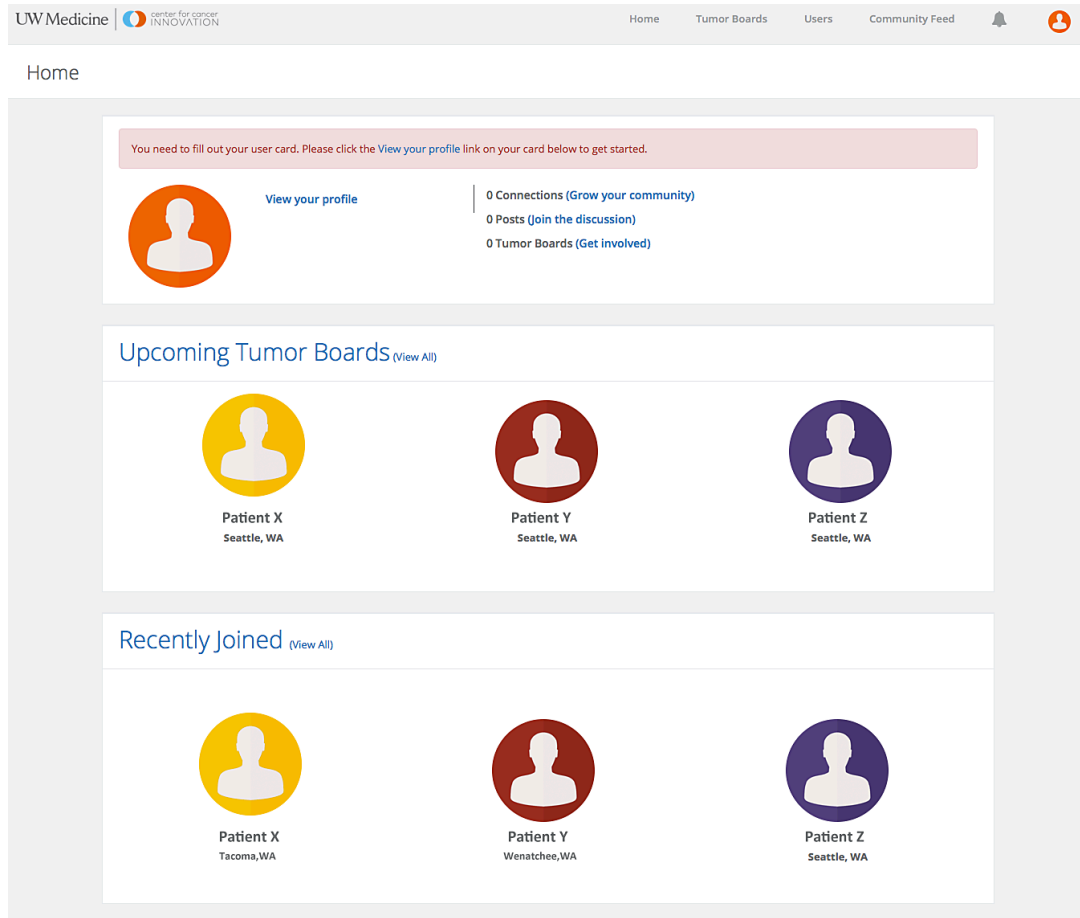
Every cancer is unique, so almost every patient will have mutations that have happened in very few others. Some of these affect genes that we know to be important cancer drivers. We find the world’s experts on that gene’s function—whether in Taiwan, or Lawrence, Kansas.

*“Eventually we ought to be able to assemble thousands of patients to really learn the rules of how cancers evolve and escape treatment.”*

C. Anthony Blau

## Figure 12. Anonymous Website Data Entry

A simple website crowd modeling platform allows tumor patients to anonymously share their data and potentially help others.



Source: University of Washington Center for Cancer Innovation

### Tumor Crowd Modeling platform

We created a Tumor Crowd Modeling platform that enrolls willing patients and extracts information from their electronic medical records to create updated anonymous summaries of their data. This platform has the potential to expand to millions of patients.

What I used to say was that if someday I got cancer, the platform would allow me to have my tumor profiled and compared to a million other patients. That's what I used to say. It turns out that six months ago I was diagnosed with a blood cancer called myeloma. I've done to myself what we've done to our patients—biopsy sequencing and adding data to the modeling platform. My experiences can add to theirs in that ever-growing body of knowledge.

Video for this talk is available at [www.washacad.org](http://www.washacad.org).

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## Panel: Translational Science for Health and Disease



# Barriers and Solutions

## S. Malia Fullerton

Associate Professor of Bioethics and Humanities, University of Washington

Adjunct Associate Professor in the UW Departments of Epidemiology and Genome Sciences

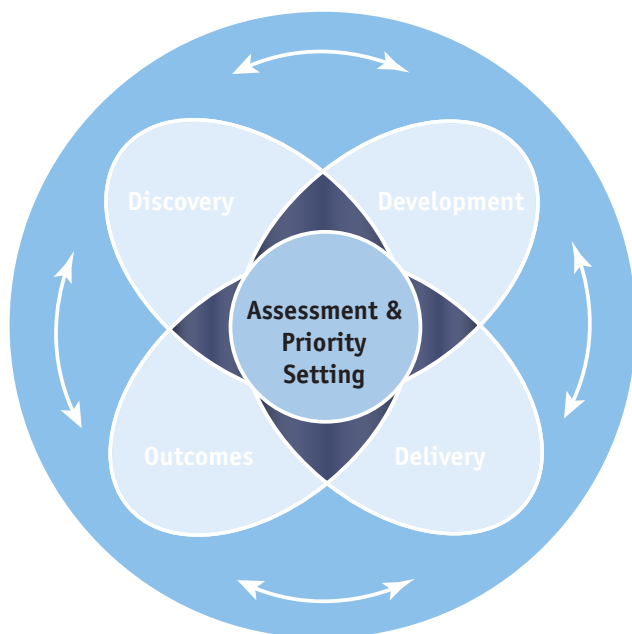
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### Synopsis

The Department of Bioethics and Humanities at the University of Washington looks at the role of values and ethical reasoning in research translation, particularly translation in the health sciences. Recently, a subset of faculty in the department published a book, *Achieving Justice in Genomic Translation: Rethinking the Pathway to Benefit*. This book examines the ways in which choices made at the earliest stages of research (discovery) can affect the development and delivery of later-stage genomic health applications. The clinical and public health outcomes that result then play a role in prioritizing subsequent discovery efforts.

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**Figure 13.** Translational Science as a Cycle with Intersecting Phases



Source: University of Oxford Press

*“Is a measure of translational success the number of startup companies? Or the market share? Or is it how the fundamental underlying health measures that we are concerned about actually move over time?”*

S. Malia Fullerton

### Who will benefit?

In the genome sciences, there has been a concern of how to more effectively and efficiently translate basic science discoveries into applications that will promote public health and community benefit. A central consideration is how we think about who is going to benefit from our translational efforts and what counts as a benefit. Who gets a say in how well researchers have done and how the products that arise from that research are evaluated?

We often forget the many complications that can occur when we move an application from the lab into the real world. Tests that looked promising in a controlled trial may not work as well when introduced into a busy clinic, or may meet other obstacles because they conflict with community values. As we produce these applications, we need to anticipate whom we involve in our research, whether they are participating on a volunteer basis, and how they and their communities are going to benefit in the longer term.

**Figure 14. Successful Translational Efforts at UW Medicine**



Source: University of Washington

### Responsive justice

Incentives for participation differ, for example, between terminally ill cancer patients and members of a chronically underserved community who may not have access to any kind of health care at all. The notion of responsive justice looks at whether an application is going to actually attend to people's health care needs, and not just reach the largest number of people. What is the responsibility of researchers to ensure that basic science discoveries are taken up in the broadest, most equitable and most just manner?

Researchers need to acknowledge that we are part of a system that in general does not aim to translate our discoveries for the benefit of the marginalized. We need to work proactively with communities to better understand how our scientific discoveries can be redirected to maximize the health benefit to the population.

It is difficult to engage in meaningful, comprehensive conversation with the public, even when we are sure that the science that we are doing is good. It is hard, but it is essential if we want our discoveries to go out and maximally benefit the public and have maximum translational impact. We need to anticipate their concerns and to stand in dialogue with the public. And best still, we need to invite diverse members of the public in as partners as we pursue our research.

*“The relative privilege of researchers increases their responsibility to marginalized populations because of their position within an institutional system that has an attitude of neglect toward the vulnerable and medically underserved.”*

*Achieving Justice in Genomic Translation*

Video for this talk is available at [www.washacad.org](http://www.washacad.org).

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## Panel: Translational Science for Health and Disease



# Barriers and Solutions

## John A. Latham

Chief Scientific Officer, Co-founder, Alder  
BioPharmaceuticals

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### Synopsis

I am fundamentally interested in taking primary research discoveries and bringing them to the marketplace to help people. Right now, the lead product for our company is a novel therapy to help people who are afflicted with migraine. My wife is a chronic migraineur, and they don't have good medicine to use. Even if something helps with pain, there's nothing to stop the migraine from happening.

In our business sector, we invent technologies and make products like antibodies, which are the largest-selling products in the world. Our products are revolutionary and very beneficial to a huge number of people.

### Tremendous investments of time and capital

Every day, day in and day out, whatever our scientific data look like, it has to perform extremely well, otherwise we're not going to be able to make the next HIV or the next hepatitis C drug. We have to have reproducible pieces of science. Developing a new drug takes a tremendous amount of time. The program for a novel gene that we have been working on was started in 1996 and will wrap up in 2016.

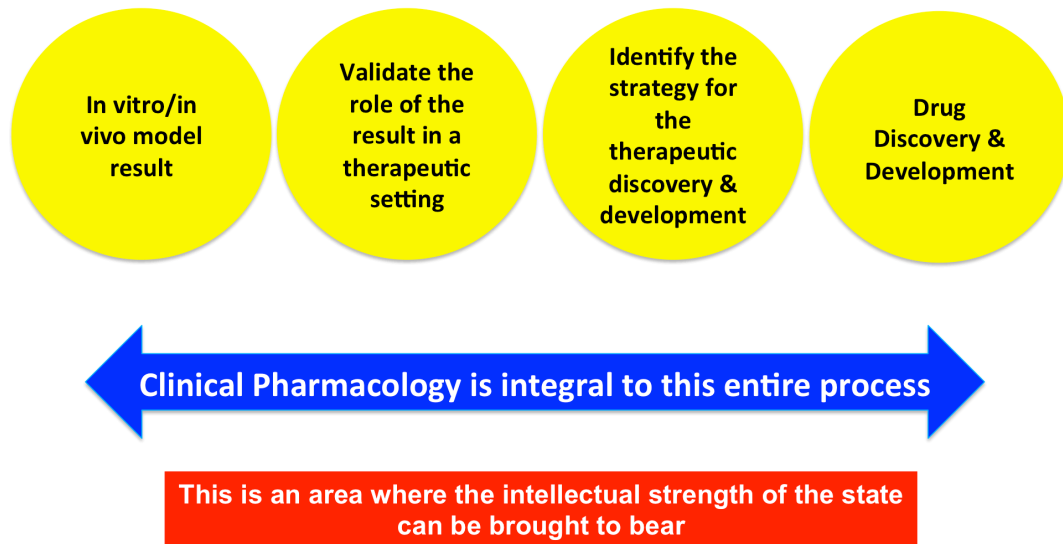
### Really important, but highly risky

The migraine drug we're working on is phenomenal. With a single shot, a person who's had on average nine migraines a month will have no migraines for up to six months. Such discovery is hugely capital-intensive. I routinely make \$5 million and \$10 million decisions. From toxicology to characterization, manufacturing, clinical trials, and dealing with all the regulators, it really is very expensive.

*"A decision to go to the clinic with a novel compound for therapy is instantly a \$10 million bet."*

John A. Latham

Figure 15. Translational Interface



Source: Alder BioPharmaceuticals

### Shortage of trained clinical pharmacologists

Translational medicine involves a very broad spectrum of interactions. It begins in basic research and ends with clinicians, and physicians who interact with patients. A significant and specialized field in the process is clinical pharmacology—understanding the basic science with how to develop drugs. Very few people in the U.S. are being trained sufficiently.

*“It’s amazing as a scientist to be able to interact with a patient who has been in pain and hear how their lives have changed.”*

John A. Latham

### More investment needed in manufacturing

The manufacturing expertise and facilities in the U.S. are very limited. Right now, it’s in the hands of a small subset of companies. Manufacturing, and people trained to do it, are critical elements, absolutely essential in getting a new product to market. Making a drug and getting it in a form for patients is really the most challenging part of the development process. Manufacturing needs to be able to make reliable products day in and day out, and they always have to work the same way.

### Sometimes there’s a reward, sometimes there isn’t

When we kicked off Alder in the Seattle area, it was horrendously difficult. I went without a salary for two years and bought all our equipment on a credit card. If you take the average early stage trial, you’re looking at costs for those enrolled in the study from \$50-75,000 upwards to \$250,000 per patient. You have to get the drug to them, monitor in the right way, and deal with the economics of the doctor’s office. It really is a very expensive undertaking.

## **Accelerating Science's Impact: Translating Discoveries into Solutions**

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The flip side is that drug research and development can bring revolutionary new medicines to help people and solve unmet medical needs. When you get to do that, it's very revolutionizing. It gets you up to work every day.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

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## Panel: Translational Science for Health and Disease



### Barriers and Solutions

#### Maura Little

Director of Life Sciences and Global Health Development,  
Washington State

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#### Synopsis

Life Sciences and Global Health is a sector in Washington state's Department of Commerce. Governor Jay Inslee identified this sector as a cornerstone of economic development, designed to accelerate growth in a key area that is vitally important to the growth of our state's economy as a whole. Our metrics are associated with Results Washington, where we're measured by two very precise metrics—gross business income and employment within the state. The governor's vision is for Washington state to be the global leader in life sciences innovation and health delivery by 2025.

The vision is structured around an ecosystem-building approach with five components: Research, Technology Transfer, Early State Capital, Business Climate, and Workforce. We are looking at how to nurture innovations outside of academic settings and support intellectual property being generated within our geographic territory. From the state perspective, we have three levers we can pull: The state can legislate, regulate, or communicate.

#### R&D tax credits and deferrals to accelerate growth in life sciences

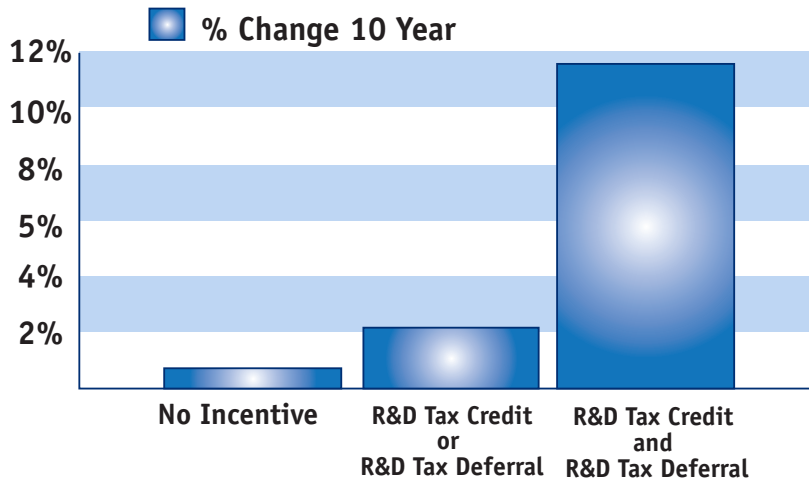
I've focused on two major research projects. A team of interns is helping me decipher exactly what each of the 50 states offers in terms of research and development tax credits. We examine multiple components of this incentive, including whether credits are tied to education and whether they are transferrable.

States that don't have either have about a zero percent growth rate. It showed us that R&D credits and deferrals are very important to life sciences to build a more robust sector here.

*“We found a preliminary correlation that states that have both the R&D credit and deferral have grown their life sciences employment numbers on average 12 percent from 2003 to 2013.”*

Maura Little

**Figure 16. R&D Tax Incentives in Washington State**



Source: Washington State Department of Commerce

**R&D incentives**

The second research project is focused on a competitive analysis of what other states are doing in terms of incentives in their life sciences and global health industries. Looking at what each state offered in terms of the five ecosystem components, we examined how much the incentives cost the state, who is driving the process, and who is involved. Our preliminary findings reveal that to build a stronger ecosystem, a state must provide an additional three out of five target incentives on top of the baseline R&D tax incentives.

*“A hundred program managers from NIH, CDC, FDA and 30 other sub-agencies will be available for one-on-ones with our local entrepreneurs and researchers to help them learn how they can obtain SBIR/STTR dollars.”*

Maura Little

delivers about \$780 million annually to translate basic research to commercial products.

**\$65 million ACA grant and new website**

Last January, Washington state won a \$65 million dollar grant to implement the Affordable Care Act. We are looking at how we can innovate using the data that we’re capturing through the state Health Care Innovation Plan. We also created a new website, Washington Life Sciences Global Health Center, to aggregate all the different programs that the state offers to our life sciences and global health communities.

**NIH national conference**

We recruited, for the first time ever, the annual NIH Small Business Innovation Research and Small Business Technology Transfer conference. The SBIR/STTR program

## **Accelerating Science's Impact: Translating Discoveries into Solutions**

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My role as the lead of the Life Sciences and Global Health sector is a brand new position created by the governor, and I am looking forward to meeting Washington state's bold, strong, 10-year vision for this key economic sector.

Slides and a video for this talk are available at [www.washacad.org](http://www.washacad.org).

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## Panel: Translational Science for Health and Disease

# Barriers and Solutions

### Q & A Highlights



**Vikram Jandhyala Question:** *A lot of research still focuses on individuals. How have you been able to bridge that gap between individual excellence and team-based collaborative work?*

“In our lab, team-building happens even in the very early stages, so people get experience working with very different kinds of teams. Projects require many different types of expertise, both the experimental side and the computational side.”

David Baker

“It’s a major challenge for academic researchers to be promoted based on their participation in groups. I think that’s a reflection of the increasingly antiquated way that research is done that is going to have to change.”

C. Anthony Blau

**Vikram Jandhyala Question:** *We talk about the digital divide, where people don’t have access to high speed internet. That gap is growing. Is there a life sciences equivalent and, if so, what should we be doing about it?*

“Technology has a way of disenfranchising, and it has a way of empowering. There are people who have different access to the Internet, but at the same time smart phones and cellphones have completely changed things. There is a lot of exciting research going on at the moment in the life sciences, but it is not clear whether that is going to

be accessible to people of limited means. Is there a way for researchers to apply their work to reduce disparities, rather than exacerbate them? We assume that everyone who needs a particular drug will have access to it. That's not always the case. For example, those who have the means can get cancer treatment, but other people never make it to the doctor's door. We need to think about those folks as well."

S. Malia Fullerton

"If you look at how HIV treatment evolved, there was an incredibly limited resource available to very small numbers of people that did eventually manage to find a way to trickle out to the poorest countries. But do you really think that had it been designed differently from the beginning, the process would have happened faster?"

C. Anthony Blau

"A lot of things changed in HIV research when AIDS activists became actively involved in the testing and actually started pressuring scientists to think about these issues. Trickle-down works to a degree. But wouldn't it be nice if, even in the earliest stages, we were thinking about whether, for example, a vaccine we're developing can be manufactured cheaply enough to get it to the poorest places in the world that need it the most."

S. Malia Fullerton

"It's changed the conversation between entrepreneurs and investors of new drugs. There have been a couple of drugs coming out of here that had strong promise, but Medicare decided not to reimburse them. The Affordable Care Act is trying to get to that triple aim of accessibility, affordability, and quality. It will take time, but I'm excited about the notion of bringing different communities into the research."

Maura Little

**Vikram Jandhyala Question:** *We have Amgen closing shop, and Expedia moving to the Amgen location. What does that mean for life sciences?*

"Before you had the altruistic, 'I'm going to cure AIDS,' looking to solve problems. What we find now is that reimbursement is a very big business decision. Medical economics is very important. There's pragmatism, but there's also always going to be a place where offshoots peel off from one area and get applied innovatively to something else where it is used in a new way."

John A. Latham

"In conversations with venture capitalists, it comes down to the location of the company. I say of course it has to be in Seattle, but they say it has to be in Boston or the Bay Area, and the conversation ends. What needs to happen in Seattle to overcome this?"

David Baker

"I've probably had 50 of those conversations. There's a two-sided coin: Seattle lost Amgen, but our company has benefitted tremendously from their closure. We have been able to add 25 people from Amgen, bringing unprecedented expertise to our organization."

John A. Latham

"The big three are capital, talent, and space. It is a chicken and the egg, which is why you have to do it all at the same time. Last year, we had a record 18 companies spin out of the University of Washington's CoMotion, 12 of them in life sciences. To stay here, they need physical space. Right now, the greater Seattle area is teetering on a zero to three percent vacancy rate in lab space."

Maura Little

**Academy Member Question:** *Ethics in science makes a lot of sense in biosciences, but I don't think it's very useful across the broader range of scientific disciplines. An example is the laser, which started out simply as discovery science but turned into critical technology that helps mankind.*

"There's an enormous role for curiosity-driven science. But all science—physical science, natural science, even science conducted in the private domain—is basically funded by people who base it on the public having an interest in funding our work. We need to be thinking about the ways the science we are pursuing is actually advancing the broader public interest."

S. Malia Fullerton

**Academy Member Question:** *It worries me that the discussion today is taking a fairly narrow view of what is important to communicate. Most of my work is research in behavioral ecology. It's not going to give anybody any jobs or improve health. Scientists' discoveries are inspiring. They tell us about ourselves and the world.*

"One of the things going on now is the increasing involvement of lay public in our scientific endeavors. We are asking them to be citizen scientists. People love to participate, and when they are part of the discovery, when later someone asks them to stick out their arm and give a

blood sample, they're going to be thinking in a different way about their participation in that research as a consequence of having been a citizen scientist."

S. Malia Fullerton

"If you look at the biggest threats to the survival of the world, the people who will drive the decisions, like the politicians, are not people who embrace a real knowledge of science. I think we as scientists do an incredibly poor job in translating and crossing that chasm."

C. Anthony Blau

"I wanted to present a more optimistic view. We've had close to 300,000 people try our science puzzle game Foldit. It's a competitive online game where you have to fold proteins and design new proteins. I've been blown away by how smart people are who know nothing about science and do really amazing things."

David Baker

**Academy Member Question:** *The Washington Center for Cancer Innovation has developed a very compelling approach to optimizing both the learning and therapeutic approaches to individual patients. But life sciences believes in large, statistically-powered studies with carefully designated end points, carried out at great scale and extraordinary expense. That's why placebo-control, double-blinded studies were invented. Does the Center's novel approach coexist with or complement the established approach to therapeutic evaluation?*

"The established approach isn't worthless. It's helped us get where we are. What we know now is that cancer is so incredibly complex that the established approach is probably reaching the point of diminishing returns. Doing more of this or more of that is not going to get us to the next dramatic stage of advances. It bears a lot of similarities to other areas of science inquiry where the initial step is deep observation. It will require a scale that will be large, perhaps a hundred thousand. What we aspire to is to look for patterns that we reproducibly identify between profiles and responses. Once we have some strong patterns, we'll test those in trials, and hopefully those trials will need far fewer patients."

C. Anthony Blau

Video for this talk is available at [www.washacad.org](http://www.washacad.org).



## K-12 Special Guests

### American Junior Academy of Sciences Award Winners

The Washington State Academy of Sciences continues to support high school science students with our sponsorship of American Junior Academy of Sciences award winners. This is the fifth year for the WSAS award program, and two students were selected to travel with a mentor to represent Washington at the 2016 AJAS convention in Washington, D.C. The students were chosen based on their academic record, with strong scientific merit and a strong interest in science or engineering and research. The winners and two of the four finalists set up project boards and reviewed them with Academy members. Parents and teachers were also present to witness their students receiving WSAS certificates and awards. K-12 Committee member George “Pinky” Nelson presented the awards and commented, “We have amazing students in this state and equally amazing teachers. It’s a humbling experience to read the submissions from the students who participate in the local science fairs.”

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**Figure 17.** 2016 AJAS Award Student Winners



Mehar Nallamalli (left) and Surabhi Mundada (right) with K-12 Committee Chair George “Pinky” Nelson (center).

Winner Surabhi Mundada's project, *MyGlove: Assisting Hand Movements, Grip and Tremor*, is aimed at helping a wide range of people who are healthy, aging, and have essential tremor, to people with conditions such as cerebral palsy, arthritis, Parkinson's disease and stroke. She said, "I'm interested in biomedical engineering and wanted to learn more about engineering and programming while helping to solve some current big issues. Currently, there are many prosthetic hands—these help if you don't have a hand—but there wasn't really anything that you could wear on your hand that would assist with hand movements and tremors. So I got inspired to develop a glove that would address these issues. I successfully tested the features of MyGlove and I'm working on making things like the battery more efficient so that the glove can be productized and mass-produced."

Mehar Nallamalli's winning project, *Safety Alert Mobile Application*, was motivated by the death of a high school friend whose early-morning car crash was determined to be the result of lack of sleep. He commented, "That accident would have been very preventable, and there are 100,000 accidents like that every year in the U.S. My project began as a warning system, but evolved into determining drowsiness, heart rate, and cardiac abnormalities, as well as external features such as swerving and lane detection. I'm now working on a sensor for the steering wheel itself."

## AJAS finalists

**Naveena Bontha, Mahalaxmi (Mahi) Elango, Bilal Manzer, Sriharshita (Harshu) Musunuri**

Two of the finalists attended the symposium and presented their project boards.

Naveena Bontha has been working on her project, *Removing Carbon Dioxide from our Atmosphere: Using Porous Crystalline Materials for CO<sub>2</sub> Capture*, for about two years. She noted, "All the current strategies we have today for CO<sub>2</sub> capture are huge, energy-intensive machines. Carbon dioxide affects all of us. I really wanted to figure out a way to start working with these gases so we could protect our environment." Sriharshita Musunuri's project is *Application of Tetrahedrite and Magnesium Silicide on a Novel Thermoelectric Unicouple to Generate Electricity from Industrial Waste Heat*. She explained, "Up until now, thermoelectrics have been inaccessible to most industries because of their high costs. With this cost-efficient design, there's a chance to recover a large fraction of the waste heat that is simply going unused. These modules have the potential to boost fuel efficiency as well when applied in the exhaust systems of automobiles."

**Figure 18. 2016 AJAS Award Student Finalists**



Siharshita Musunuri (left) and Naveena Bontha (right) with K-12 Committee Chair George "Pinky" Nelson (center).

### Special Recognition

The Academy also honored a group of students for their project, *Optical Ion Reflector: Investigating the Elastic Collision Relationship between Ions and the Chamber Walls during Nuclear Fission in order to Enhance Plasma Density by Focusing a Plasma Beam*. The students include team lead Cameron Beardsley, along with Hyrum Bock, Daniel Christensen, Michaela Fennel, and Darryl Worcester. The project won 4th overall at the Washington State Science & Engineering Fair and a trip to the international fair, plus a 4th Grand Award in the Physics and Astronomy category at the Intel International Science & Engineering Fair.

### Program sponsors

The Boeing Company, Pacific Northwest National Laboratory, and Alder BioPharmaceuticals.

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## Speaker bios

**Dr. David Baker** is a Professor of Biochemistry at the University of Washington and Investigator with the Howard Hughes Medical Institute. As a biochemist and computational biologist, his research focuses on the prediction of macromolecular structures and functions. He is the director of the Rosetta biomolecular structure prediction and design program, which has been extended to the distributed computing project Rosetta@Home and the online computer game Foldit. He received his Ph.D. in biochemistry at the University of California, Berkeley, and did postdoctoral work in biophysics at the University of California, San Francisco. Dr. Baker has received numerous awards in recognition of his work, including the AAAS Newcomb Cleveland Prize, the Sackler International Prize in Biophysics, the Overton Prize from the International Society of Computational Biology, and the Feynman Prize from the Foresight Institute. He is a member of the National Academy of Sciences and the American Academy of Sciences.

**Dr. C. Anthony Blau** is a Professor in the Division of Hematology, Department of Medicine, and Adjunct Professor in the Department of Genome Sciences, at the University of Washington. Originally from Ohio, Dr. Blau was drawn to Seattle because of its legacy as the birthplace of bone marrow transplantation—an intense form of leukemia treatment—and the first stem cell therapy. His work focuses on stem cells and on applying personal approaches to the treatment of cancer. He is co-director of the UW's Institute for Stem Cell and Regenerative Medicine and leads the UW's recently-created Center for Cancer Innovation. Dr. Blau has served on numerous advisory panels for the National Institutes of Health. He received his medical degree from Ohio State University and completed his residency in internal medicine at Duke University.

**Dr. R. James Cook** is Professor Emeritus at Washington State University. From 1965 to 1998, he served at WSU as a research plant pathologist with the U.S. Department of Agriculture. From 1998 to 2003, he held the R.J. Cook Chair in Wheat Research, a position endowed with a \$1.5 million gift from the Washington Wheat Commission. WSU's research farm was named the R. James Cook Agronomy Farm in his honor. He has served as president of the American Phytopathological Society, the International Society for Plant Pathology, and the Washington State Academy of Sciences. He has co-authored three books and more than 200 research publications. He was elected to the U.S. National Academy of Sciences and the U.S. Agricultural Research Service Science Hall of Fame. He holds honorary doctorates from North Dakota State and the University of Turin. In 2001, he was named co-winner of the Wolf Prize in Agriculture, awarded in Israel by President Shimon Peres.

**Dr. Stephanie Malia Fullerton** is Associate Professor of Bioethics and Humanities and Adjunct Associate Professor of Epidemiology and Genome Sciences at the University of Washington. She holds a Ph.D. in population genetics from the University of Oxford and retrained in bioethics at Penn State University with a fellowship from the National Human Genome Research Institute. Dr. Fullerton currently works in close collaboration with genome scientists at the University of Washington and across the United States to explore the ethical, legal, and social implications (ELSI) of genomic research and its clinical translation for public health benefit. She is affiliated with the UW Center for Genomics and Healthcare Equality (Burke, PI) and directs the Ethics and Policy Core of the Partnership to Understand and Eliminate Disparate Outcomes (PUEDO) in Latinas Center for Population Health and Health Disparities at the Fred Hutchinson Cancer Research Center (Thompson, PI).

**Dr. Vikram Jandhyala** is Vice Provost for Innovation, Executive Director of CoMotion, and Professor of Electrical Engineering at the University of Washington. He received the BTech in electrical engineering from the Indian Institute of Technology, Delhi, and M.S. and Ph.D. degrees from the University of Illinois at Urbana-Champaign. His research, which has led to more than 200 papers, has been funded by DARPA, semiconductor industries, national labs, Department of Defense, Department of Energy, and the National Science Foundation. Honors include an NSF CAREER award and awards from UIUC, IEEE, UW, and NASA. With his students, he founded Nimbic, a venture-backed simulation company that was acquired by Mentor Graphics. He was chair of the UW EE Department from 2011 to 2014 and was an inaugural UW presidential entrepreneurial faculty fellow in 2011. Current interests include the science and art of innovation, entrepreneurial and design thinking, educational innovation, and computational and data science.

**Dr. John A. Latham** is Co-founder and Chief Scientific Officer of Alder BioPharmaceuticals. Dr. Latham has served as CSO since founding Alder BioPharmaceuticals in January 2004. From 1998 to 2004, he served as a director, senior director, and most recently as Vice President of Gene Function and Target Validation for Celltech Group plc. In 1994, Dr. Latham was a founding director of Darwin Molecular Corporation, a first-generation gene-to-drug biotechnology company, where he served from 1994 to 1998. He was one of the early scientists hired by Gilead Sciences, Inc., a biopharmaceutical company. From 1989 to 1994, he was a member there of a core group established to exploit novel oligonucleotide-based technologies. Dr. Latham holds a Ph.D. in Biochemistry from Massachusetts Institute of Technology and a B.S. in Chemistry from Colorado State University.

**Maura Little** is the Washington State Director of Life Sciences and Global Health Development. Appointed in December 2013 as one of seven Sector leads, she supports the development and expansion of the life science and global health industry in the state, with a goal to recruit, retain, and expand the sector. Little brings 10 years of experience working on policy and community development. During her time as legislative assistant for then-Congressman Jay Inslee, she

served as point of contact for the congressman in the state for trade associations, business leaders, government agencies, and elected officials. She later served as the Washington State Director of Government Relations for the American Cancer Society Cancer Action Network. She worked with the state Legislature and Insurance Commissioner to ensure patient access and safety during implementation of the Affordable Care Act. Little has a Bachelor of Science degree from the University of Washington.

**Dr. Trevor Mundel, Keynote Speaker**, is president of the Global Health Program of the Gates Foundation. He leads the foundation's efforts in research and development of health solutions including vaccines, drugs and diagnostics, focusing on health problems that have a major impact in developing countries but get too little attention and funding. He oversees the Global Health Program's work, which harnesses innovations in science and technology to fight diseases such as HIV/AIDS, tuberculosis, and malaria. Mundel joined the foundation in 2011. Mundel's professional background is in health care. He earned his bachelor's and medical degrees from the University of the Witwatersrand in Johannesburg, South Africa. He also studied mathematics, logic, and philosophy at Balliol College, University of Oxford as a Rhodes Scholar, and earned his Ph.D. in mathematics at the University of Chicago.

**Dr. John Zachara** is the Battelle Fellow and Senior Chief Scientist for Environmental Chemistry in the Fundamental and Computational Sciences Directorate at Pacific Northwest National Laboratory. He served as an associate director of the Environmental Molecular Sciences Laboratory at PNNL, and for the past 10 years has been a leader in fundamental research for the resolution of complex subsurface contamination issues at DOE's Hanford Site. Dr. Zachara has performed extensive research on geochemical, biochemical, and reactive transport processes that control the concentrations, fate, and transport of organic, metal, and radionuclide contaminants in subsurface environments. Research has ranged from fundamental surface chemical studies of mineral and microbial suspensions in the laboratory, to comprehensive studies of solute mobilization and transport in the field. He has made important contributions to understanding how microorganisms interact with mineral surfaces and create new bio-mineral phases. Dr. Zachara has authored or co-authored more than 175 scholarly publications.

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Donna Matrazzo, The Writing Works  
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WASHINGTON STATE  
Academy of Sciences

Washington State Academy of Sciences  
410 11th Avenue SE, Suite 205  
Olympia, WA 98501  
[wsas.programs@washacad.org](mailto:wsas.programs@washacad.org)  
[www.washacad.org](http://www.washacad.org)  
(360) 534-2321