# Minnesota Discovery, Research and InnoVation Economy (MnDRIVE)

Board of Regents

October 12, 2012

UNIVERSITY OF MINNESOTA
Driven to Discover℠

## Introduction

Tim Mulcahy

Vice President for Research

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Securing the Global Food Supply

Francisco Diez-Gonzalez
Professor
Department of Food Science and Nutrition

UNIVERSITY OF MINNESOTA
Driven to Discover℠

## Why food?

- Minnesota's economic engine
- $15B agriculture marketing in 2010
- Top 5 states in corn, soybean, sugar beets, hogs and turkeys
- Over 2,300 food companies in MN

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why now?

- Secure a safe, sustainable, affordable and nutritious food supply
- Challenges
  - Globalization
  - Emerging pathogens
  - Changes in food production systems
  - Consumer trends
  - Intentional adulteration – fraudulent, terrorist
  - Climate change
- Food Safety Modernization Act of 2011

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why UMN?

- Long history and tradition of advances in food discoveries
  - Norman Borlaug – green revolution

  - Ancel Keys – health and diet

  - Ben Pomeroy – animal health

  - Larry McKay – cheese microbiology

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why UMN?

- Multi-college initiative
- Leading academic units
  - CVM, CFANS, SPH
- Other colleges and schools
  - MS, CBS, SN, CSE, HIPA
- Over 50 programs, centers and institutes
  - NCFPD, HFHLI, CAHFS, CIDRAP, FIC, BTI, FPRC, MOC, OPC, IonE



# Why UMN?

- Stakeholder partnerships
  - Private sector
    - Cargill, General Mills, Land O' Lakes, Davisco, Hormel, 3M,Ecolab
    - Commodity groups
- Government
  - State – MDA, MDH, BAH, MPCA, DNR
  - Federal – USDA, FDA, DHS, CDC
- International
  - WHO, FAO, OIE (Animal Health)

# What difference can we make?

- Advance science and policy for global food protection
- Proposed diverse research portfolio
  - Supply chain analysis for food industry competitiveness
  - Detection and surveillance for existing and emerging plant, human and animal pathogens
  - Novel food processing and preservation solutions
  - Holistic animal health and welfare studies
  - Integrated policy analyses

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Summary

1. **Why food?** Food is a primary engine of Minnesota's economy and the U of M fuels that engine
2. **Why now?** Critical need for increased production, effective processing, farm-to-table food safety solutions and better supply chains to meet global demand
3. **Why us?** We are uniquely positioned to address the challenges and capture the opportunities for MN
4. **What difference can we make?** Catalyze innovation, empower the future workforce, educate consumers, and be the source for global food system leadership

UNIVERSITY OF MINNESOTA
Driven to Discover℠

## Acknowledgments


- Will Hueston – FPRC Director, CVM
- Becky Beyers – CFANS Comm. Director
- Amy Kirchner – NCFPD Assoc. Director
- Dean Al Levine - CFANS


UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Advancing Discoveries and Treatments for Brain Conditions

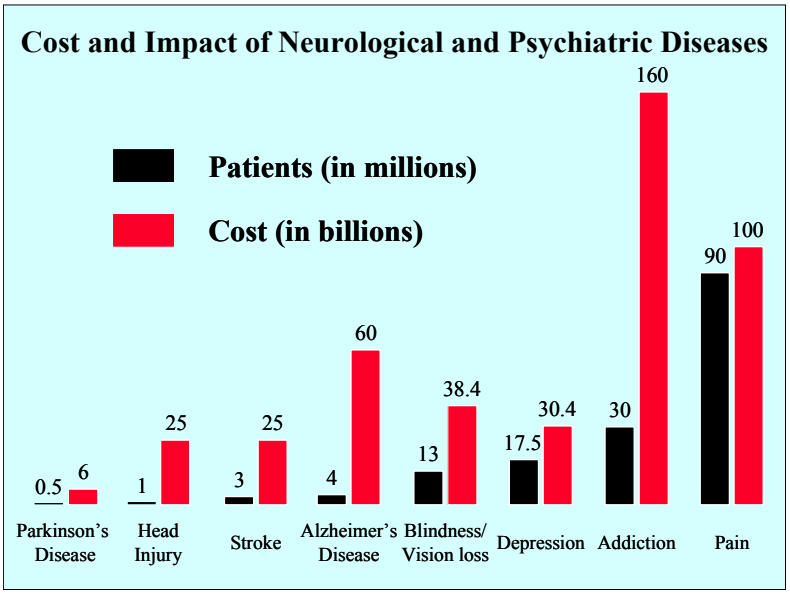
Timothy J. Ebner, M.D./Ph.D.
Professor and Head, Department of Neuroscience

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why Brain Disorders?

- Nervous system disorders affect 1 in 5 Americans at an annual cost of ~$500 billion
- Understanding the fundamental causes of most neurological/psychiatric diseases remains a challenge
- Need new therapeutic interventions to improve quality of life and lessen economic impact






UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why Brain Disorders?

- Nervous system disorders affect 1 in 5 Americans at an annual cost of ~$500 billion
- Understanding the fundamental causes of most neurological/psychiatric diseases remains a challenge
- Need new therapeutic interventions to improve quality of life and lessen economic impact

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# What is neuromodulation?

- Therapeutic intervention that changes (modulates) the activity of brain circuits to decrease symptoms and restore normal functions
- Deep brain stimulation (DBS) for Parkinson's disease as a successful example
- Transcranial magnetic or direct current stimulation are newer, non-invasive approaches

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why Minnesota?

- Great strengths in basic and clinical neurosciences


- Great strengths across the University




# Why Minnesota?

- Minnesota industry is a world leader in neuromodulation
  - Medtronic has 59% of world share in neurostimulation systems
  - Boston Scientific and St Jude Medical have growing neuromodulation programs
  - Combined neuromodulation revenues of $2.3 billion in 2011
- We cannot be complacent
  - Sapiens Steering Brain Stimulation (Germany)
  - Aleva Neurotherapeutics (Switzerland)
  - Brainway Ltd (Great Britain)
  - Each are launching new products that claim to offer more precise, versatile and efficient neuromodulation

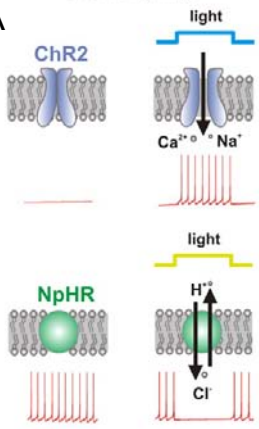
# What is future of neuromodulation?

- Growing list of neurological/psychiatric diseases being treated with neuromodulation: dystonia, tremor, depression, obsessive-compulsive disorder, and chronic pain
- Identify new disease targets: addiction, stroke recovery, obesity, Alzheimer's?
- Define new/optimal regions in the brain for neuromodulation
- More precise and controlled stimulation
- Can neuromodulation alter disease course?



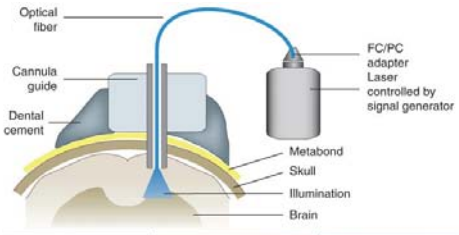
# Future of neuromodulation: Optogenetics

A




From: Knöpfel T et al., 2010
J. Neurosci. 30:14998-15004

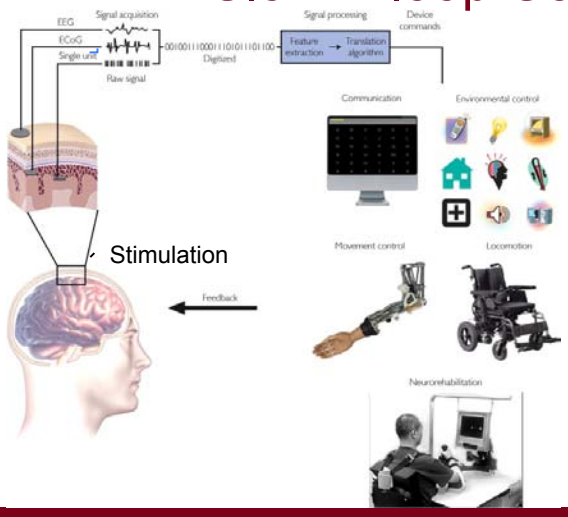
B




From: Zhang F et al., 2010 Nature Protocols 5: 439 - 456

- Use genetically engineered proteins that can be controlled by light
- Allows for precise control of the cells of interest
- Allows for excitation or inhibition of brain cells
- Allows for precise temporal and spatial control over brain cells

# Future of neuromodulation: Closed-loop Control




**Brain-machine interface (BMI)**

- Use to control external devices
- Extract signals from the brain to control stimulators
- Novel systems to couple brain to implanted systems



# What will we do?

- Pioneer new technologies and applications for deep brain stimulation (DBS)
  - Define optimal brain targets and stimulation approaches
  - Advance understanding of how DBS works
- Develop optogenetics
  - Use optogenetics to understand optimal ways to control brain circuits
  - Test new approaches in animals models of disease
- Closed-loop control
  - Identify the needed signals in the brain
  - Solve interface problem of coupling feedback signals to stimulation systems
- Clinical applications
  - Integrated approach to treating patients
  - Identify additional disorders that could benefit from neuromodulation

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# What is the impact?

**Make Minnesota the world leader in neuromodulation**

- Improve health and reduce suffering of Minnesotans
- Strengthen the medical device industry
- Increase federal funding for research
- Attract the very best trainees and faculty



# Supporting Robotics, Sensors and Advanced Manufacturing

Maria Gini
Department of Computer Science and Engineering

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Why? Unique opportunities

- Make Minnesota a key player in this growing area that will provide high-quality jobs for the people of Minnesota
- Educate and excite students to become engineers and scientists in STEM disciplines (Science, Technology, Engineering and Mathematics)



# Why Minnesota?

- Existing strengths in local industry and in academia, with unique niches, a broad base of excellence in STEM disciplines, and vibrant interdisciplinary collaborations
- Existing strong K-12 and college-level educational activities in robotics

# Long history of excellence

The first bilateral master slave manipulators to handle plutonium for the Manhattan project were built in 1949 by Central Research Labs in Red Wing, MN



UNIVERSITY OF MINNESOTA
Driven to Discover℠

# ReconRobotics

- World leader in miniature robots for reconnaissance and surveillance. Technology comes from Center for Distributed Robotics at the U
- Successes in using Scout robots in war operations and civilian rescue
  - Example: French police in Toulouse used two Scouts to reconnoiter Mohamed Merah, a terrorist who killed 7 people and injured 5, during a siege in his apartment (March 22, 2012).

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Potential for jobs, economic growth

- Worldwide in 2011 vs. 2010:
  - Industrial robot sales up 38%
    166,000 robots sold (34% for automotive sector)
  - Service robot sales up 9%
    16,408 units (32% for the defense sector)
    Market worth $18.39B, expected to reach $46.18B by 2017
  - Personal and domestic robot sales up 15%
    2.5 million units, $636M in sales (toys and robot vacuums)
- Rethink Robotics raised $74M in venture capital
- Kiva acquired for $780M by Amazon for automated warehouses
- Evolution robotics acquired by iRobot for $74M

** Data from International Federation of Robotics and marketsandmarkets.com*

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Existing strengths in Minnesota

- Leading sensor and automation industries (Honeywell, PaR Systems, MTS, ATK)
- A tradition of innovation in computer and software design
- An emerging robotics and intelligent vehicles community built in part on University-generated technologies
- Strength in many areas:
  - agricultural robotics (corn growers and soybean)
  - reconnaissance and surveillance (ReconRobotics)
  - medical robotics (UMN, Mayo, MRI Robotics, etc.)
  - environmental monitoring (St. Anthony Falls Lab)
- Robotics Alley™, an initiative by ReconRobotics and the Minnesota High-Tech Association

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Role of robotics in education

- FIRST Robotics engages K-12 students to pursue STEM degrees
  - 2 teams in 2006, 153 in 2012, over 170 in 2013
  - 46% of MN high school students had access to a team last year
  - 3rd-largest state by number of teams, after Michigan and California

Photo: Adriana M. Groisman



# Role of robotics in education

- Robotics Technology Day Camp (Center for Distributed Robotics)
- Research opportunities for undergraduates at UMN
- Outcome: more college graduates in robotics and STEM fields -- valuable for many industries

Photo: Argenis Apolinario

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Advancing Industry, Conserving Our Environment

Michael Sadowsky
Distinguished McKnight Professor
Director, BioTechnology Institute

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Advancing Industry, Conserving Our Environment

Vision:

Enhance opportunities for Minnesota's energy, agriculture and mining industries through the use of science and technology to solve environmental challenges and make more efficient use of current and future energy sources.

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# To help achieve our goals we will:

- Deploy newly developed University of Minnesota technologies on microbiological systems to diagnose, treat, and prevent water contamination arising from mining, agricultural activities, and natural gas exploration.



# Bioremediation

The use of microorganisms to render hazardous wastes non-hazardous or less hazardous to human health.

## Bioremediate:

- Water
- Soil
- Air
- Humans: personal bioremediation

UNIVERSITY OF MINNESOTA
Driven to Discover℠

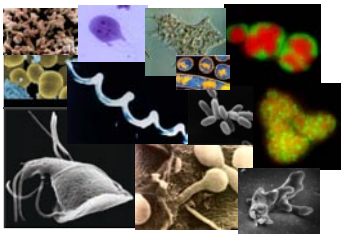
## Examples of "currently stalled industrial and agricultural processes" that could benefit from microbial remediation strategies

- Reuse of mine pits for aquaculture (fish farming) via microbial bioremediation of nitrate contamination.
- Enable copper/nickel mining in the Iron Range via microbial bioremediation of acids and heavy metals.
- Development of bioremediation strategies for fracking waste water.



## Microbes are versatile

Due to their varied and vast metabolism, they degrade many compounds – *They are the engines that drive the planet*



- In mining, microbes can transform metals from toxic to less toxic and inert states, remove metals from waste streams, and enable clean mining processes.
- In energy, microbes are providing 3rd and 4th generation biofuels, capture and convert waste products into useful compounds, and remediate chemical contaminants in water used in fracking for enhanced recovery of natural gas from shale formations.

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Harnessing microbial bioremediation for clean mining

Mining projects in Northern Minnesota will be underway soon – our initiative will help minimize environmental impact of these activities.

Home › Local

Battle waged over mining firms' plans in northern Minnesota

Article by: JOSEPHINE MARCOTTY , Star Tribune | Updated: May 22, 2012 - 11:22 PM

Mineral riches - and risky byproducts - lie in northern Minn. Environmentalists want Minnesotans paying attention to proposed mines. The companies say discussion is healthy.

MPR News Primer: Copper-nickel mining

by Paul Tosto, Minnesota Public Radio

April 11, 2012

*Last updated on June 4, 2012*

Mining runs deep in the culture and economy of northern Minnesota. So why are people drawing battle lines over plans to build copper-nickel mines in the Iron Range? It's a new kind of mining for Minnesota and there are plenty of potential rewards -- and risks. Can a middle ground be found between economic, environmental and quality of life concerns?

**Who wants to build new mines in northern Minnesota?**

*Trucks and a drill rig drill into the ground near the Boundary Waters Canoe Area Wilderness Thursday morning near Ely, Minn. The trucks were doing exploratory drilling for Duluth Metals. (MPR Photo/Derek Montgomery)*

View full slideshow (2 total images)

Home › Local

Minnesota's mining boom: New riches or new threat?

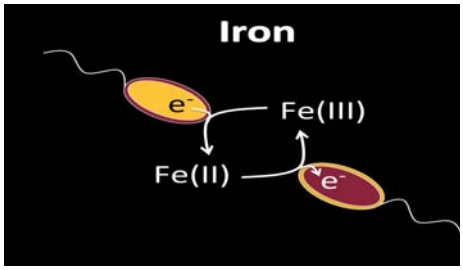
Article by: JOSEPHINE MARCOTTY , Star Tribune | Updated: September 30, 2011 - 1:10 PM

The North Woods is being targeted for lucrative, but dangerous, mineral mining.



Metal transformation by these microbes influences:

- Solubility
- Toxicity

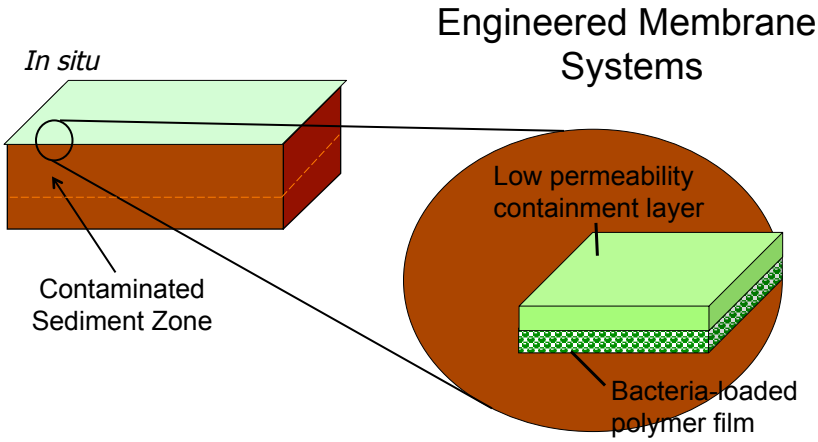



Reactivity with many metals…

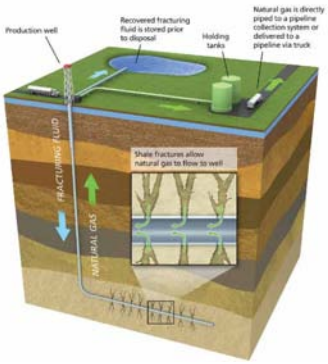
| | | |
|---|---|---|
| Cr | U | |
| Mn | Pu | |
| Fe | As | |
| Au | S | …and more! |

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Engineered bioremediation treatment options





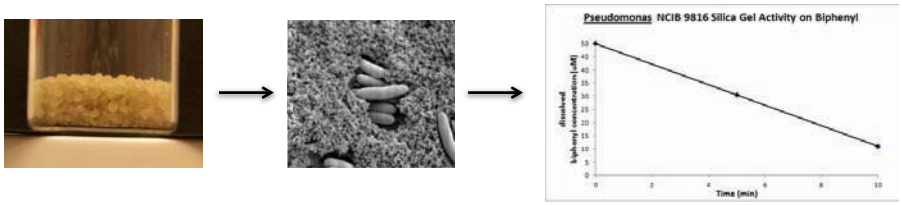

**[illegible]**

[illegible]

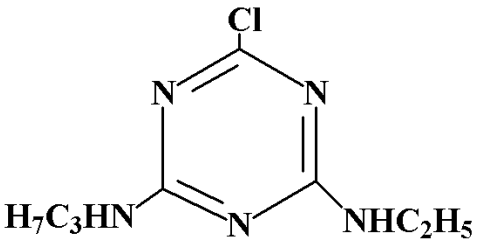
- [illegible]
- [illegible]
- [illegible]

[illegible]

**Bacteria Encapsulated in Porous Silica Gels**



Atrazine




*The most widely used s-triazine herbicide in the United States.*

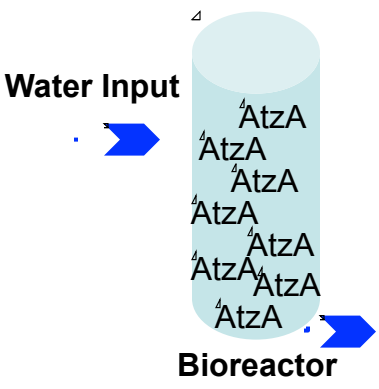
*Pseudomonas* sp.Strain ADP

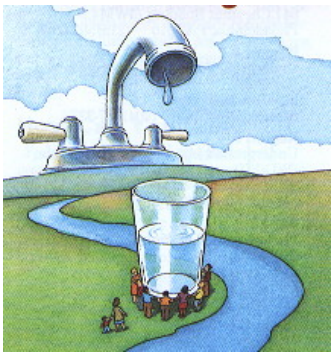
*Degrades atrazine to carbon dioxide and ammonia.*

Was successfully used to bioremediate an atrazine spill site in South Dakota

UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Remediation of drinking water



UNIVERSITY OF MINNESOTA
Driven to Discover℠

# Impacts

This initiative may lead to:

- More permits for currently stalled mining, industrial and agricultural processes requiring environmental remediation.
- Improvement in water quality throughout the Iron Range and Mississippi watersheds.
- Increased employment and commerce in these vital Minnesota industries.

UNIVERSITY OF MINNESOTA
Driven to Discover℠