

# Michigan Medicine: The health care and technology of tomorrow

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**Marschall S. Runge, M.D., Ph.D.**

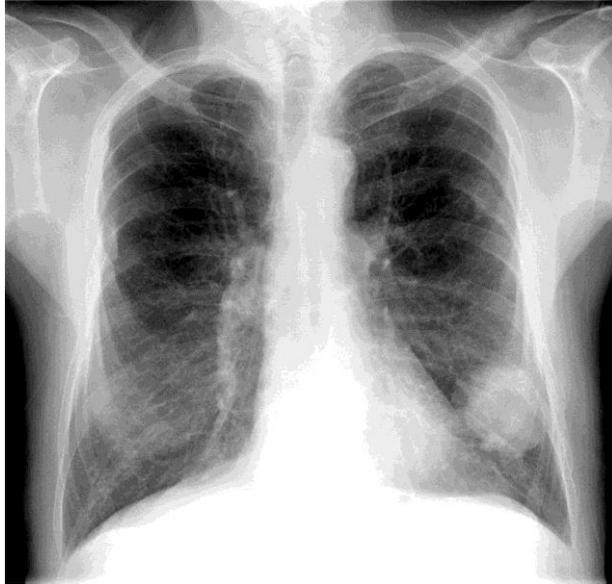
Dean, University of Michigan Medical School  
Executive Vice President for Medical Affairs, U-M  
CEO, Michigan Medicine

Disclosures: Eli Lilly Board of Directors



**MICHIGAN MEDICINE**  
UNIVERSITY OF MICHIGAN

# Can Technology and *Precision Medicine* dramatically improve health? PD-1/PDL-1 pathway inhibitors



# How can we afford these new therapies?

## Many drugs are not an advance

**90%**  
New drugs over last 30 years  
no more effective than  
existing drugs<sup>5</sup>

## Prevention could reduce costs

**40%**  
Annual deaths in US are  
preventable<sup>3</sup>

## Many MDs don't follow guidelines

**Guidelines  
exist for <10%  
of diagnoses**

## Advanced therapies are very expensive

**\$8,000/mo**  
PARP inhibitors only  
effective in cancer tumors  
with BRCA1/2 mutations

**\$3.7B**  
Total savings if 90% use  
of prevention services<sup>4</sup>

**National survey of pediatricians  
about asthma guidelines<sup>2</sup>**

<b>88%</b> Aware	<b>35%</b> Follow
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# Precision Health: what, why and where?

Personalized  
Medicine



Precision  
Medicine

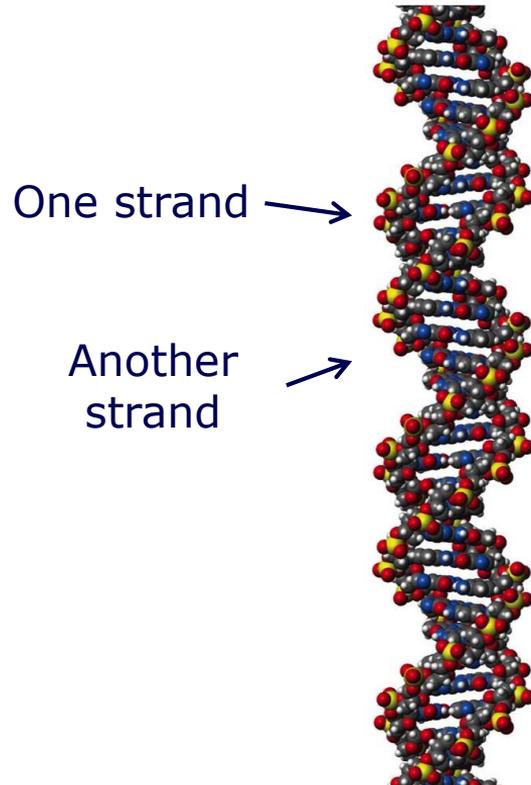


Precision  
Health



Right treatment, right time, right patient

# Is it all about genetics?



“It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.”

J. D. Watson and F. H. C. Crick  
Nature 171, 737-738 (1953)



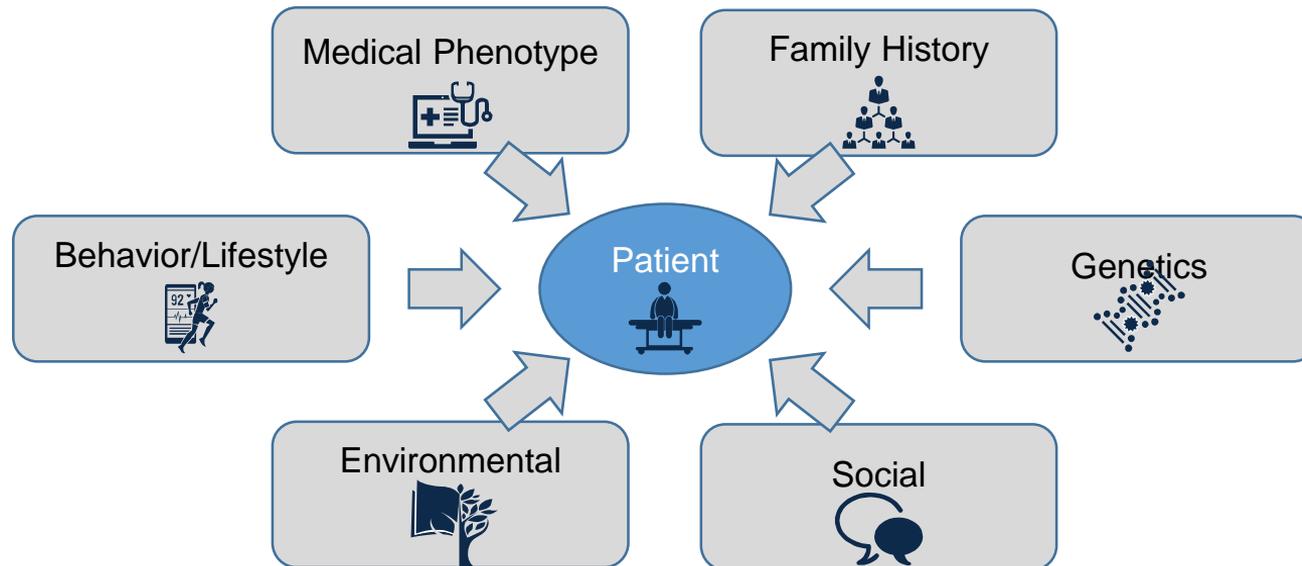
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# Benefits of the Human Genome Project

<b>Precise diagnosis</b>	<b>Insights about disease mechanism</b>	<b>Disease classification</b>
<b>Animal models</b>	<b>New drugs</b>	<b>Gene therapy</b>

# Precision Health considers individual variability in genes, lifestyle, environment

Traditionally health care only included medical phenotype and family history. Precision Health integrates an interdisciplinary approach to support patient health



# Precision Health at Michigan Medicine: Four specific work streams



## Cohort Development

- Sustain Michigan Genomics
- Collection of new data types
- Electronic consent & enrollment
- Development of new sensors
- Expansion beyond Ann Arbor
- Mobile app for participants



## Analytics

- Integration of genotype, phenotype, social, and sensor data
- Secure, centralized ARC-TS and Cloud storage and compute platform
- Development of novel algorithms and software tools



## Health Implementation

- Real-world execution of Learning Health System concepts
- Integration of clinical decision support tools & visualization
- Policy and dissemination work



## Education

- Curriculum development, certificate program, evaluate degree programs
- Scientific facilitators to support secure data enclaves
- Inter-professional education

# Michigan Genomics Initiative: The historical foundations of our program

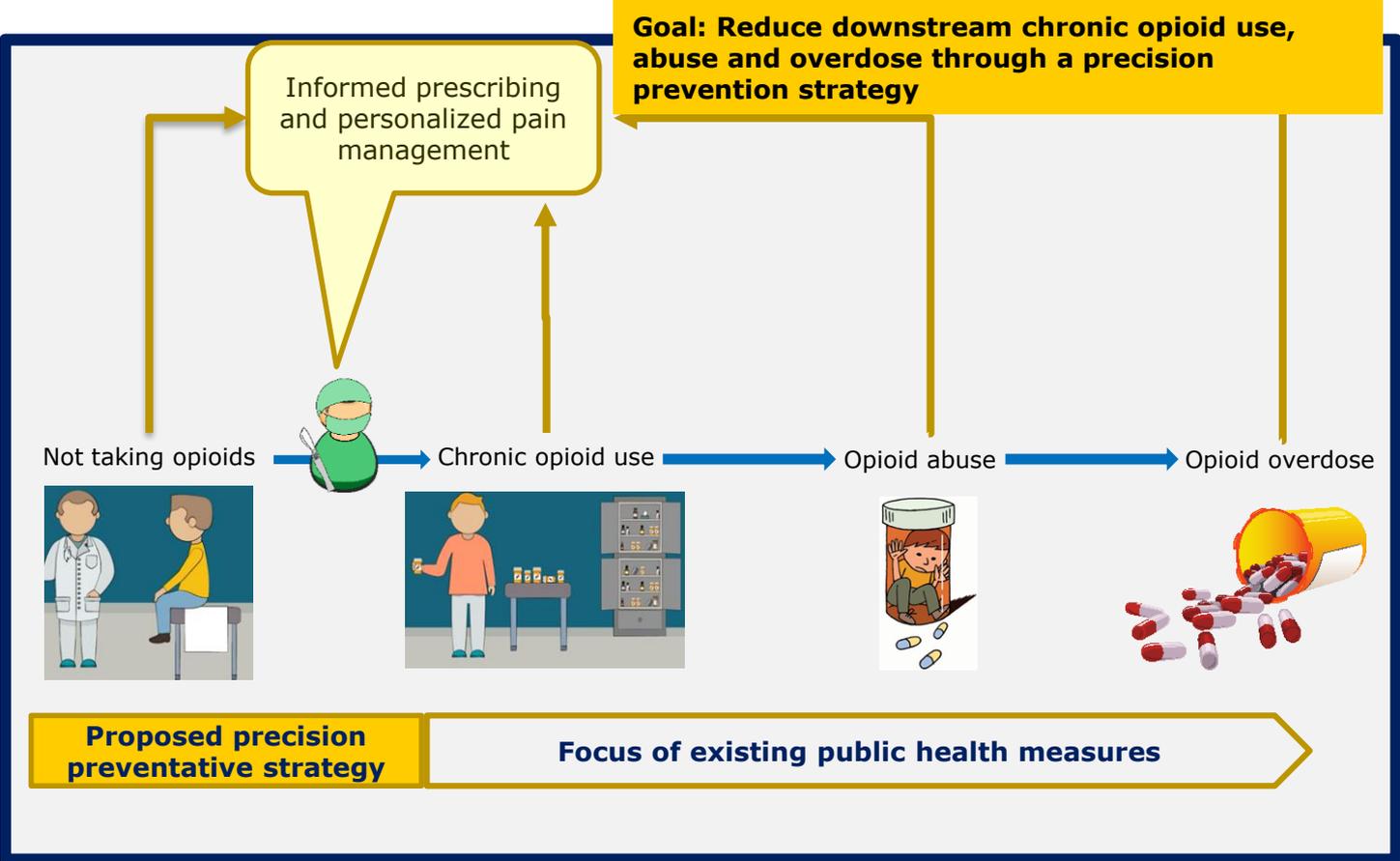
- 42,000 patients enrolled, consented, with biosamples
  - 10,000-13,000 per year added, ~70 per weekday
- Data already integrated
  - Entire U-M health system EHR (labs, diagnoses, vital signs, procedures, etc.)
  - Actively collected patient reports of mood, function, pain at baseline (PROMIS measures)
  - U-M cost data
- Soon to be integrated
  - Surescripts prescription fulfillment data
  - Michigan Death Index
  - BCBSM actual cost data
  - Mobile Health active surveys and passive activity data
- Opportunities
  - Participants can be re-contacted for additional studies
  - Data can be integrated/analyzed without additional consent

# Use cases to test & inform infrastructure

 <p><b><u>Cancer</u></b></p> <p>Establish a network of clinical sites to facilitate the use of genomic sequencing in varied clinical contexts and diverse cancer patient populations</p>	 <p><b><u>Mental Health</u></b></p> <p>Enable, for the first time, incorporation of a large, growing population of individuals with target mental illnesses and matched healthy controls into the registry to better deliver effective therapeutics</p>	 <p><b><u>Metabolic Disease</u></b></p> <p>Leverage U-M leadership and proven track record in precision weight loss management to integrate metabolomics data and further stratify patient populations for better prediction of long-term patient</p>	 <p><b><u>Opioid Misuse</u></b></p> <p>Personalize pain management through a more granular understanding of the phenotypic and genotypic factors associated with opioid misuse among a diverse patient population</p>
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**Common Precision Health infrastructure identified across use cases**

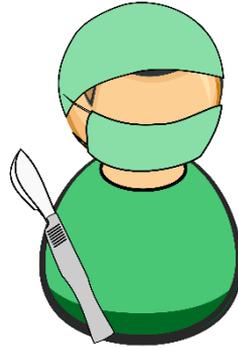
# Precision opioid prescribing



# Acute care prescribing as a model for prevention and precision pain management

**6-15%**

Incidence of NEW  
chronic opioid use  
after surgery



**~70%**

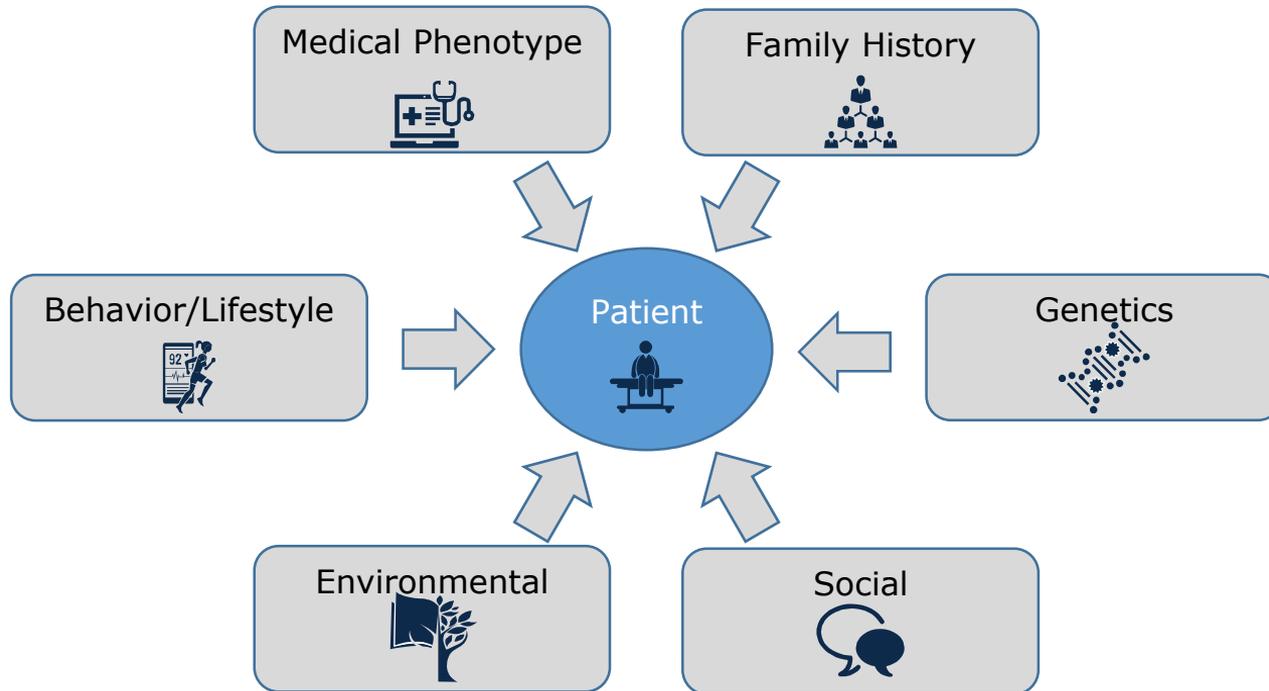
Opioids prescribed  
after surgery are  
unused, enter  
circulation

Opioid prescribing is not tailored to the  
individual – with devastating public  
consequences

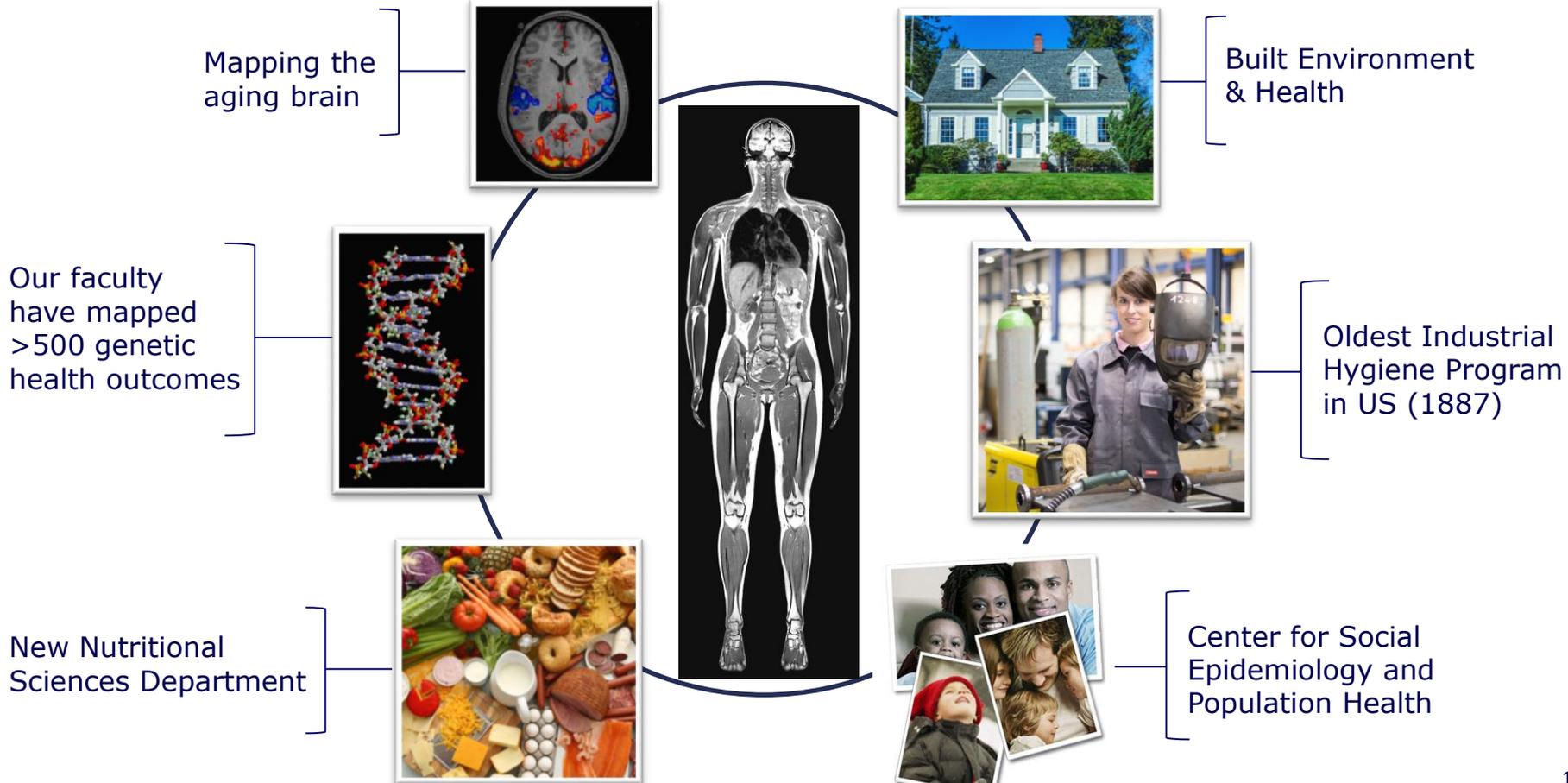
Source: Hill et al. *Ann Surg.* Sept 2016

# Precision Medicine/Health considers individual variability in genes, lifestyle, and environment

Traditionally health care only included medical phenotype and family history. Precision Health integrates interdisciplinary approach to support patient health.



# “Local collaboration” in precision health: University of Michigan



# Precision Health: genetics + environment + other factors

## The complexities of epigenetics

The metamorphosis: caterpillar to tree nymph butterfly



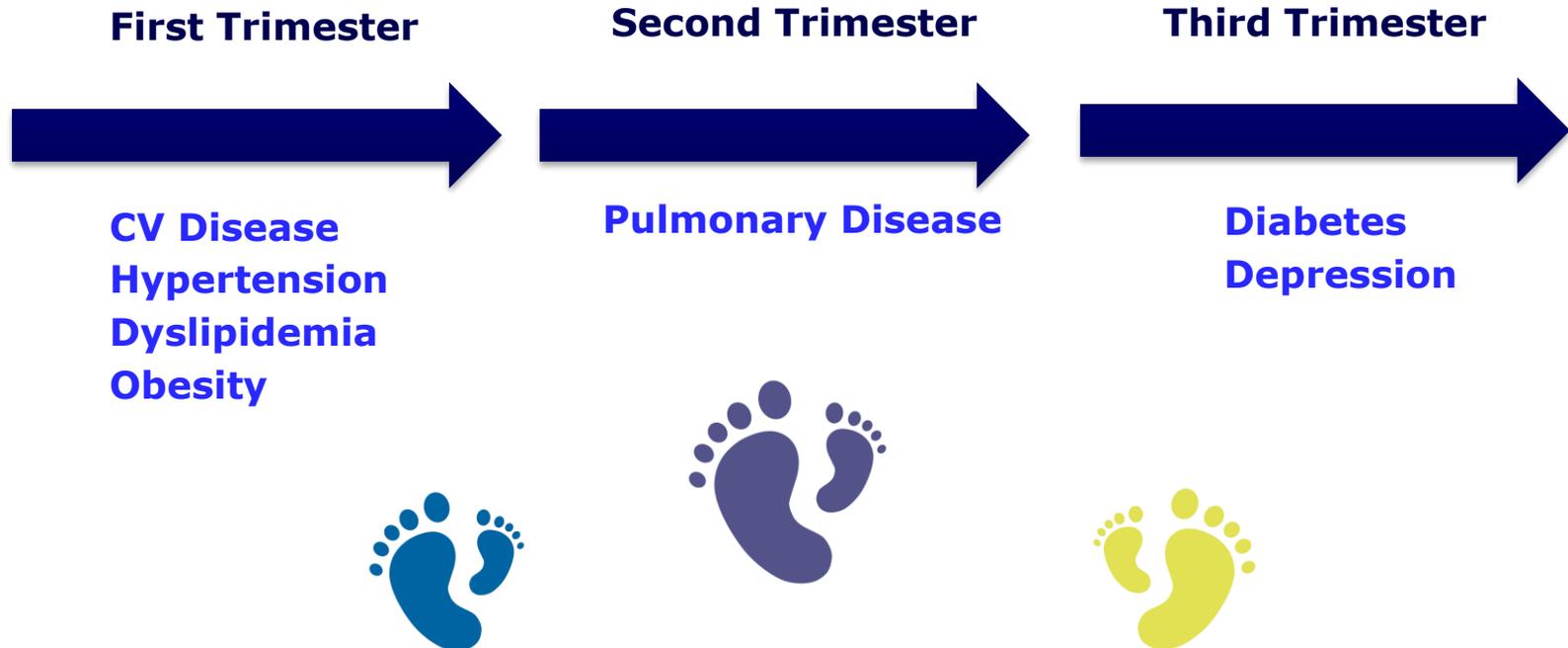
But, the genetic sequence remains the same

## **Dutch Famine WWII**

Children of pregnant women exposed to famine were more susceptible to diabetes, obesity, cardiovascular disease and other health problems.



# The complexities of epigenetics

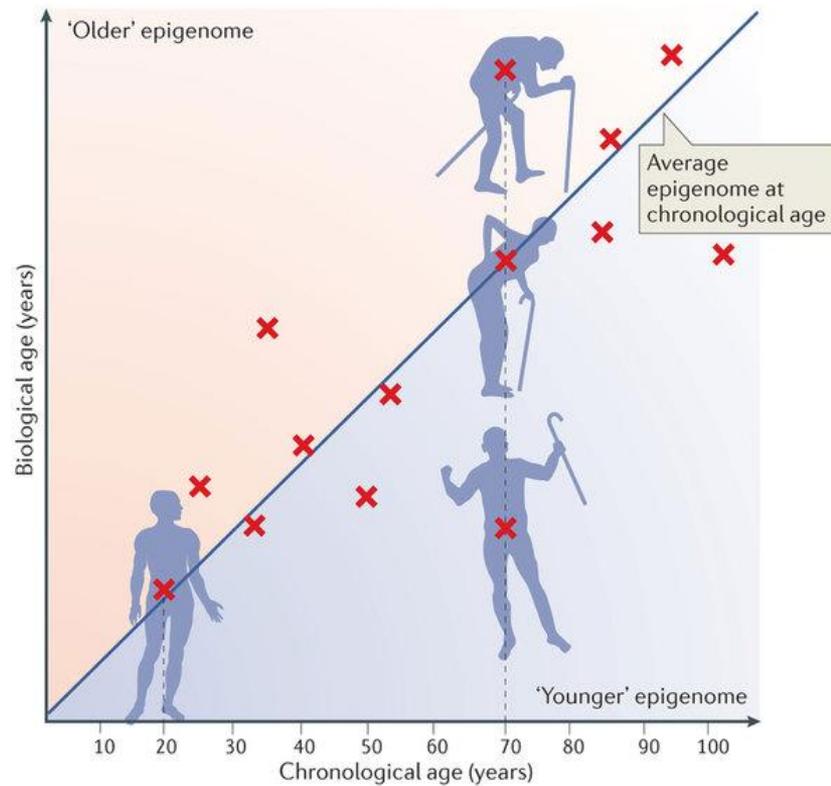


# The epigenome changes across a lifetime

Mother-Fetus	↔	BPA, Chemical Exposures, Hypertension...
Infant	↔	Lead, BPA, Diet, Infections...
Child	↔	Heavy Metals, Infections, Diet, Stress...
Adolescent	↔	Anxiety, Obesity, Sugar, Discrimination...
Adult	↔	Smoking, Mental Health, Nutrition, PTSD...
Older Adult	↔	Cancer, Depression, Dementia...



# Your epigenome is a marker of biological age



Investigators in the UM SPH have identified hundreds of genes that are markers of biological age

*A key Precision Health question:*

Are there interventions that could slow down the aging process?

**Cancer**



**Cystic Fibrosis**



**Heart Disease**



# Precision Health in heart disease: 60 years in gestation

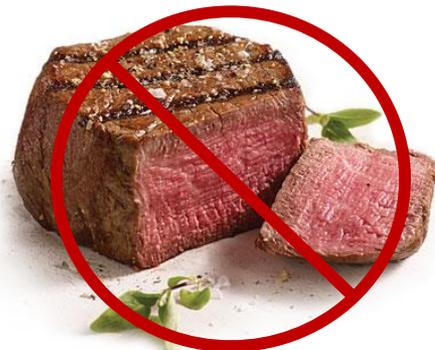
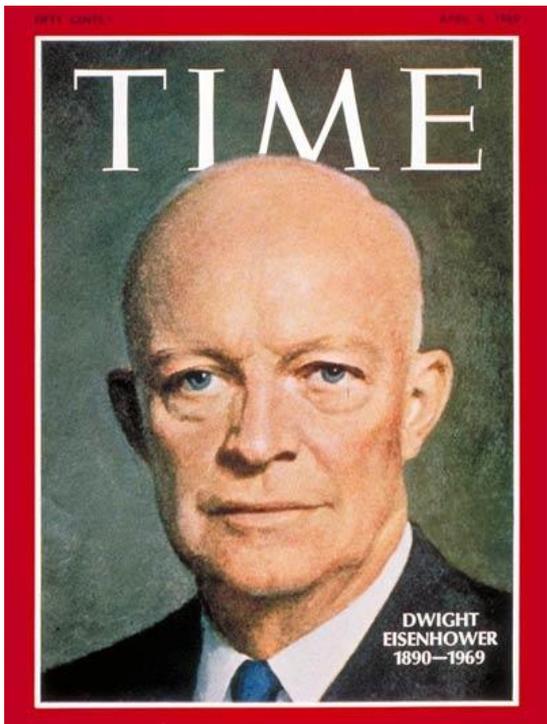


**Death and disability in CV disease  
is far from “cured”**

**Research in CV disease leads  
“evidence-based” guideline  
development and “EBM”**

**Where do we stand today?**

# “Therapy” for heart attack circa 1960



# How can advancing knowledge dramatically reduce deaths and disability from CV disease?



Tim Russert, May 7, 1950 – June 13, 2008

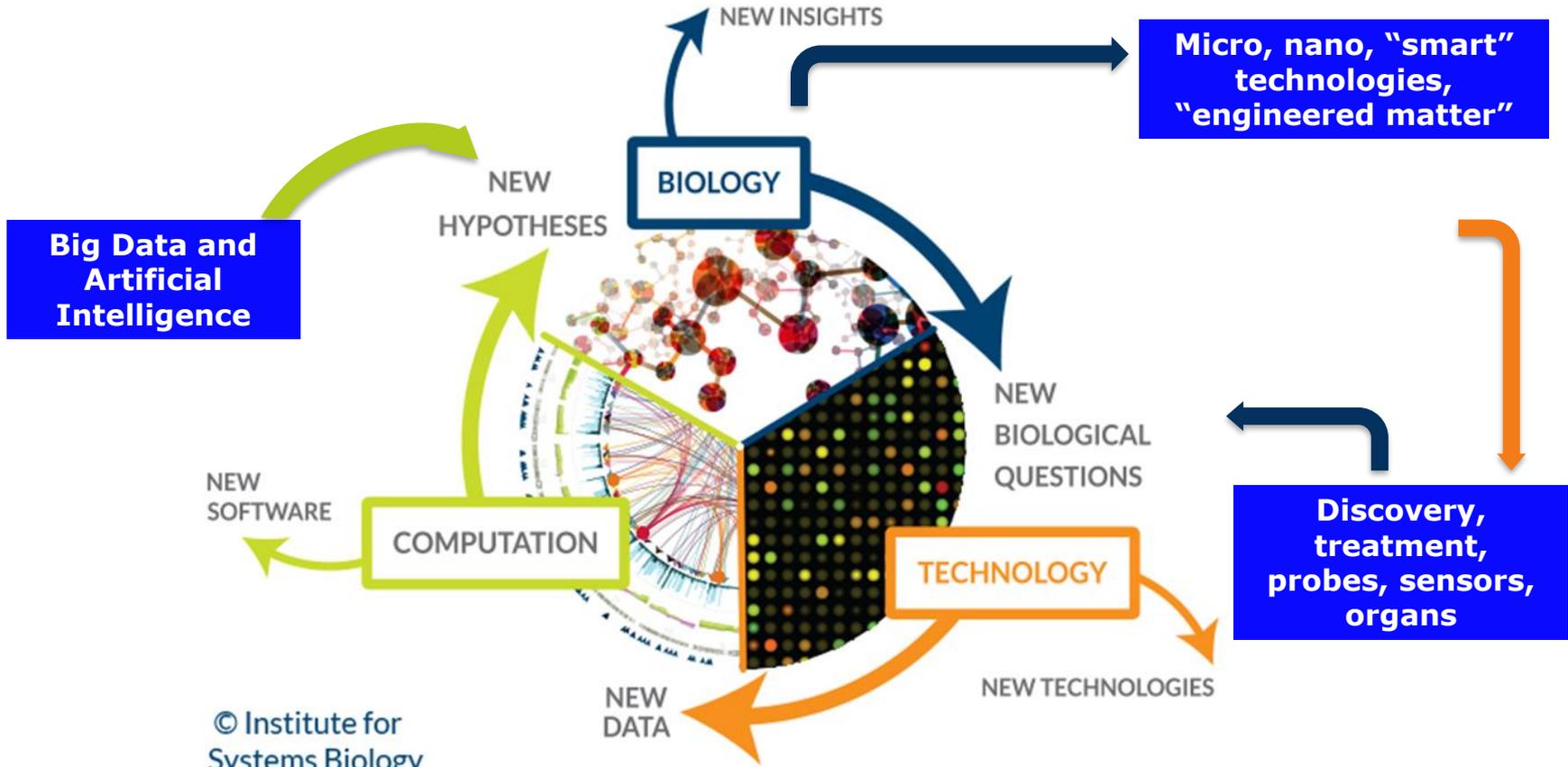
# Every institution can benefit the whole of Precision Health by focusing on their unique assets: Michigan



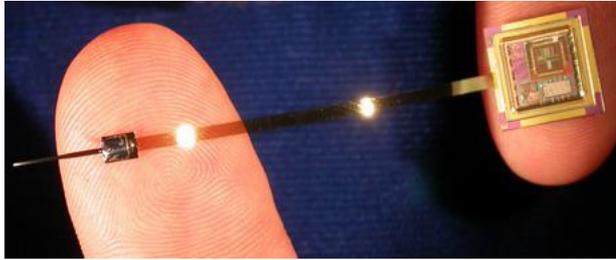
We have breadth in areas not typically considered as part of Precision Health

- Technology
- Public Health
- Engineering
- Patient Care
- Ethics
- Social Research
- Clinical Trials

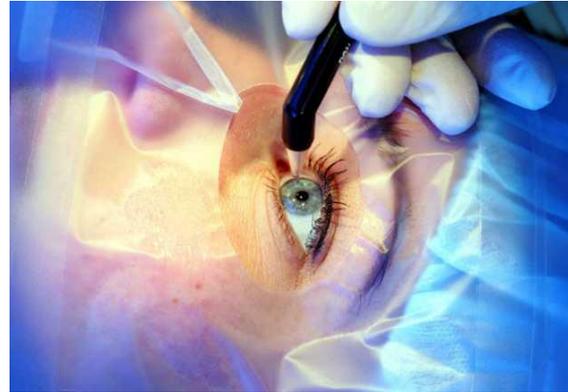
# The design cycle driving biomedical technology



Today, engineers and health professionals collaborate to advance medical treatments and improve patient outcomes



*Cochlear Implants*



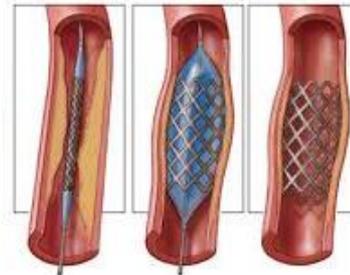
*Laser Eye Treatment (LASIK)*



*Robotic Surgery  
(Da Vinci)*

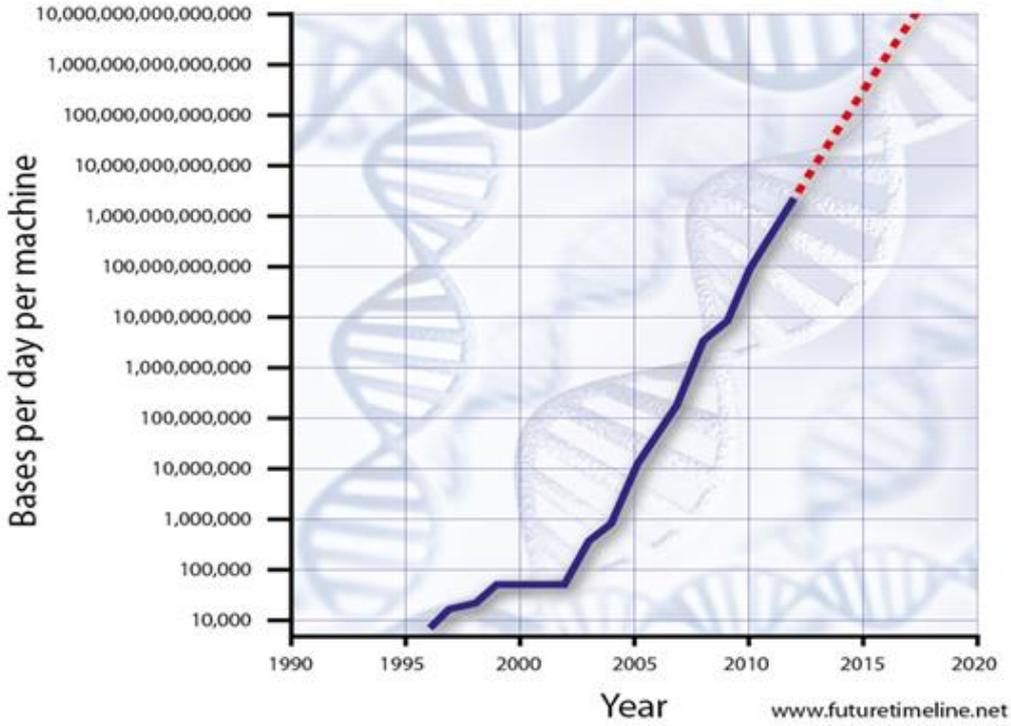
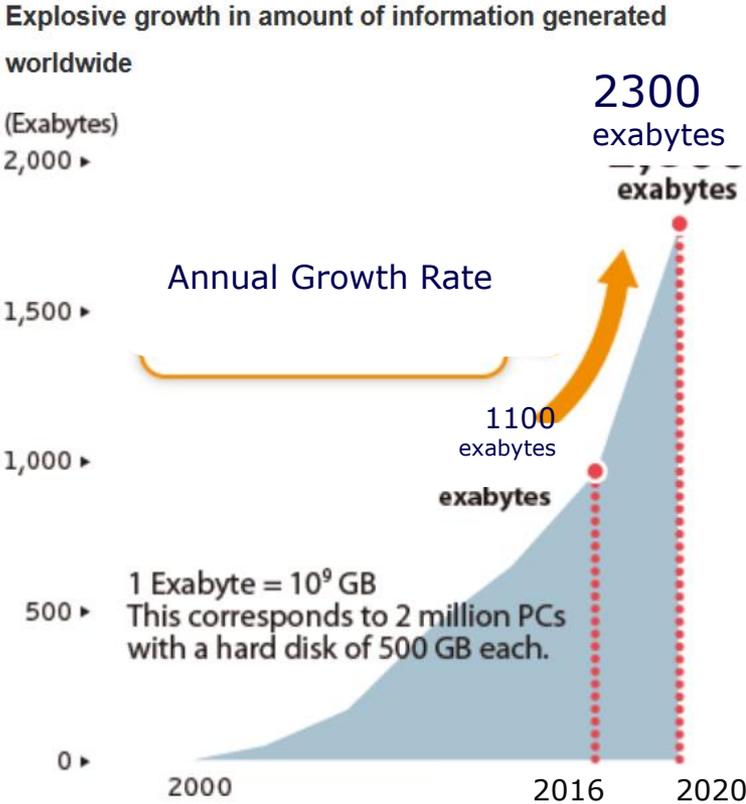


*Magnetic Resonance Imaging  
(MRI)*



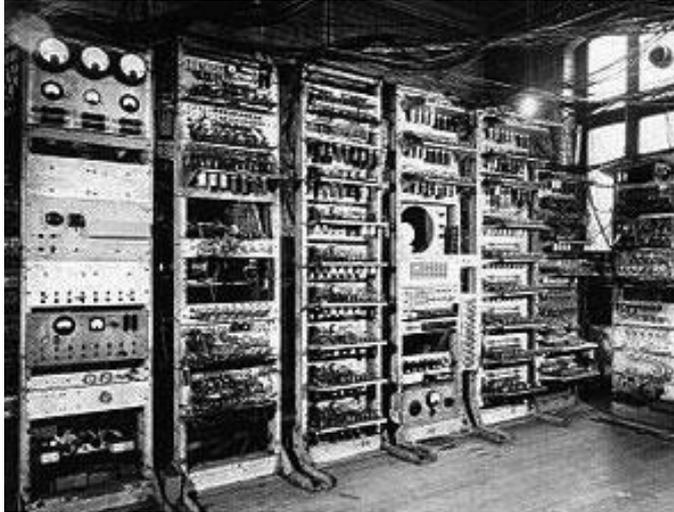
*Stents*

# Big data and health care



Source: Abecasis, Nature (2015)

This information will require new data approaches...

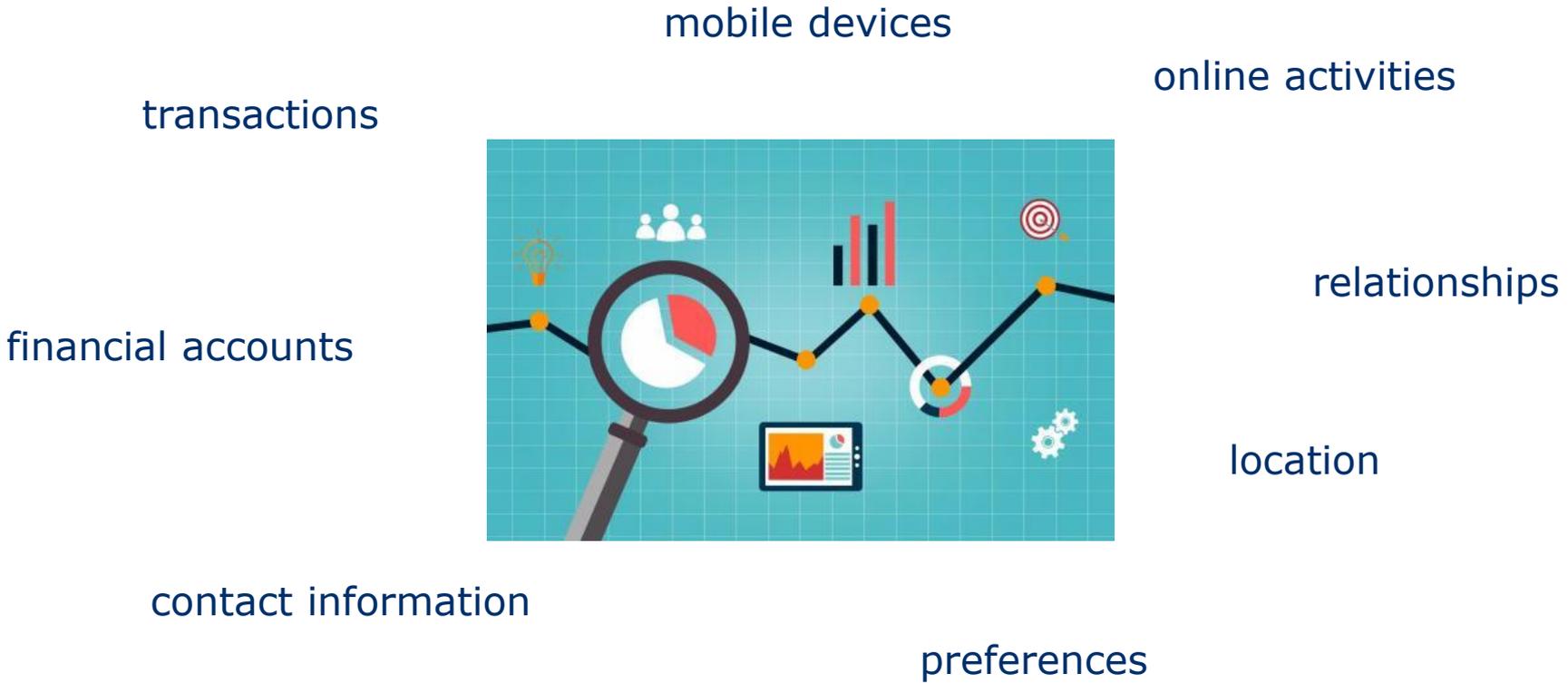


Genomics Initiative: A single query  
takes 20% of the University's  
computing bandwidth



- University of Michigan: 60 cores
- NSA: Nobody knows for sure... >2M cores

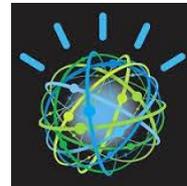
# Groupon customer data – for 80 billion subscribers



# Artificial intelligence is critical for precision health



IBM Watson



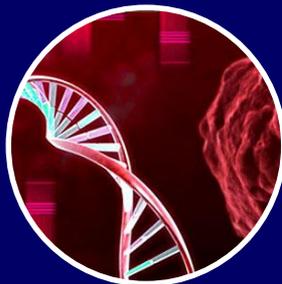
# Precision Health at Michigan: what can we uniquely do?



**Opioid  
Misuse**



**Mental  
Health**



**Cancer**

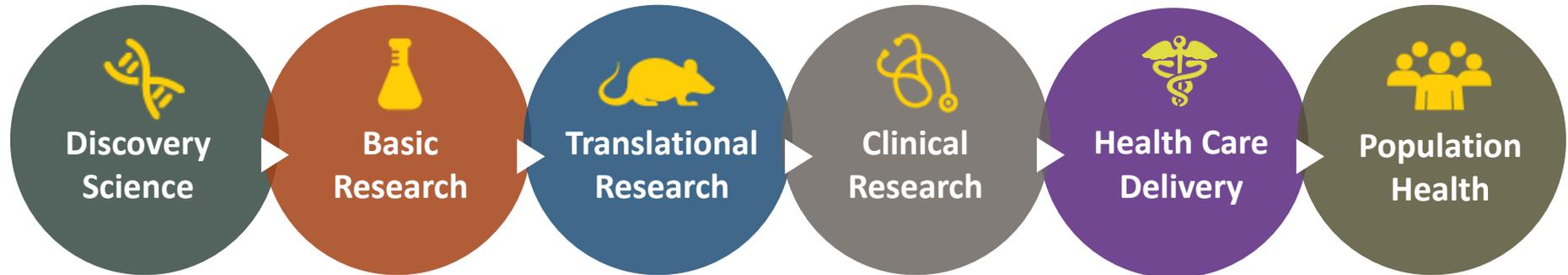


**Metabolic  
Disease**

*Common Precision Health infrastructure identified across use cases*

# Between our two institutions we have broad expertise: can we align these to uniquely advance *Precision Health*?

- Molecular, Cellular, & Developmental Biology
- Ecology & Evolutionary Biology
- Life Sciences Institute
- Engineering
- Chemistry
- Physics
- Computer Science
- Math/Statistics
- Medicine
- Dentistry
- Pharmacy
- Nursing
- Psychology
- U-M health system
- State-wide care network
- Social Services
- Public Health
- IPHI
- ISR



# Precision Health: what, why and where?

## Personalized Medicine



## Precision Medicine



## Precision Health



**Right treatment, right time, right patient**

# Comments and Questions

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