

Scientific Wellness and the Future of Health and Nutrition

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American College of Nutrition
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Disclosures



- Dr. Price is a Co-Founder of **Arivale**, which partially funded and may license discoveries resulting from the Hundred Person Wellness Project (to be described).
- Dr. Price is a Scientific Advisor to **Habit**, a new personalized nutrition company

Presentation Learning Objectives



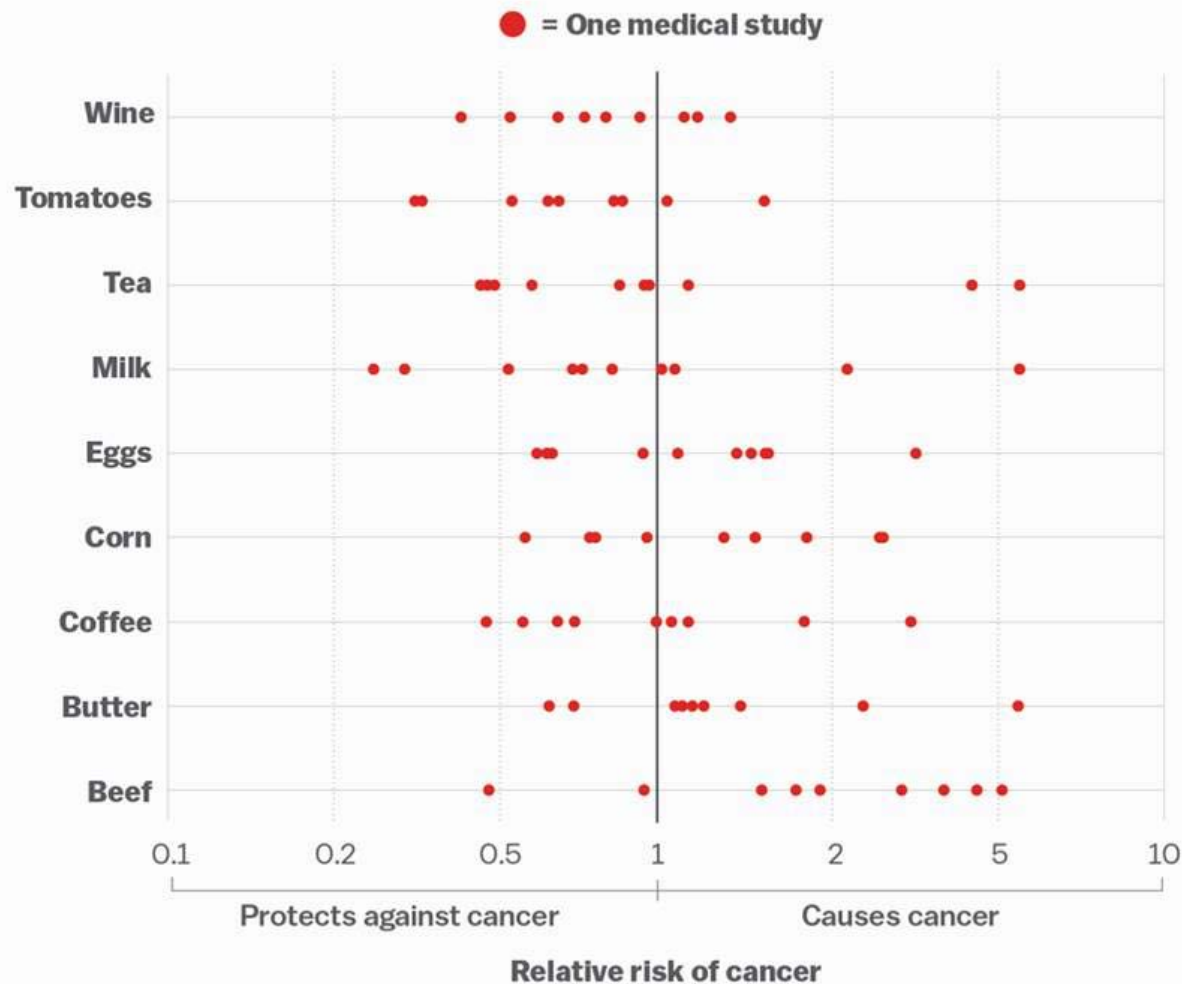
After participating in this presentation, learners should be better able to:

- Understand the scale of omic data collection that can inform nutrition and wellness.
- Understand the role of wellness coaches in interpreting data and motivating action.
- Understand new emerging field of 'scientific wellness'.

Nutrition health effects are complex: Need context and personalization



Everything we eat both causes and prevents cancer



SOURCE: Schoenfeld and Ioannidis, *American Journal of Clinical Nutrition*

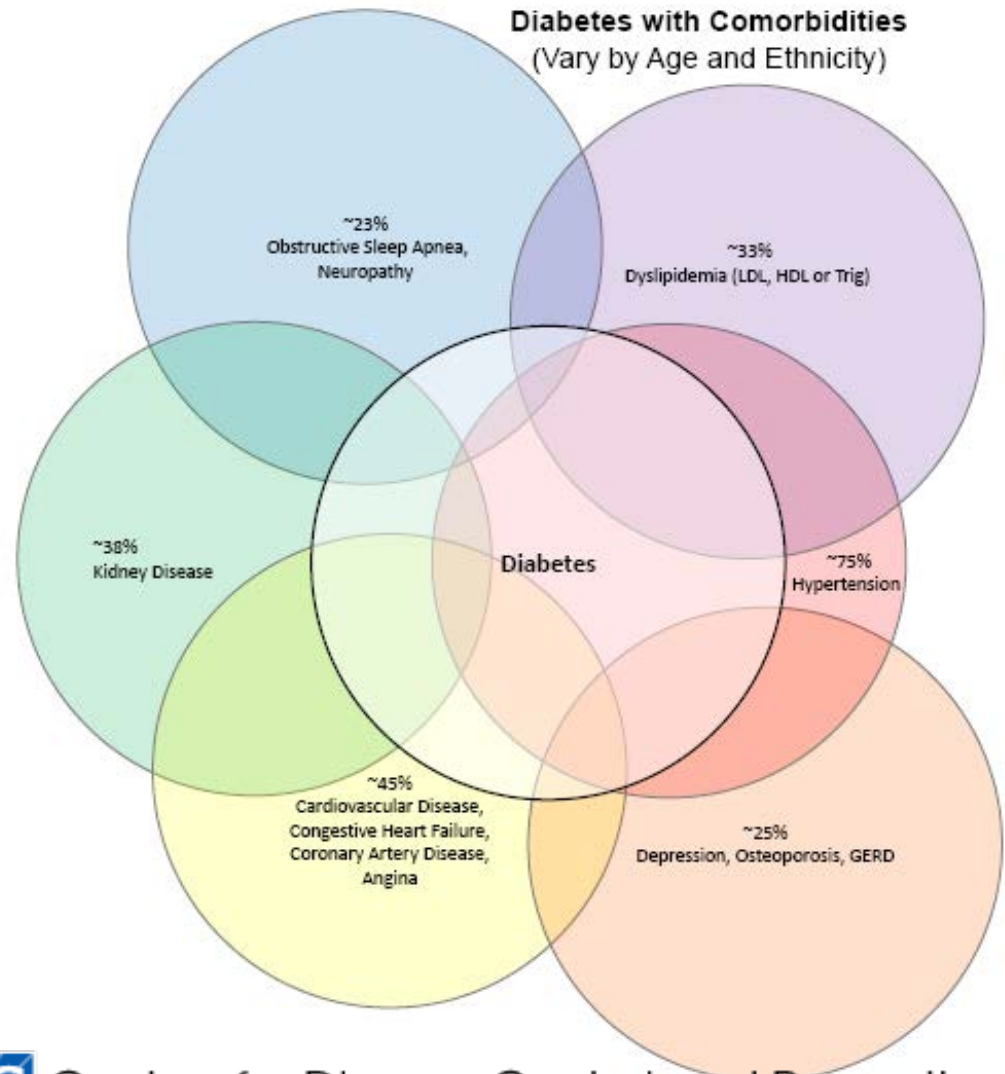
Vox

Institute for
Systems Biology
Revolutionizing Science. Enhancing Life.

86% of Healthcare Costs Treat Chronic Disease

Chronic Diseases		Disease severity	Episodic or Steady state	Opportunities for DX Monitor	Cost Impact
Prevalence (Millions)	Direct Cost (\$ Billions)				
Angina		High	Episodic	High	High
Anxiety disorders (social, etc.)		Medium	Episodic	High	High
Arthritis, Rheumatoid		High	Episodic	High	High
1.3 M	\$12.4 B				
Asthma		Medium	Episodic	High	High
22.2 M	\$14.7 B				
Atrial Fibrillation		Medium	Episodic	High	High
Chronic Kidney Disease		High	Steady Progression	High	High
26.0 M	\$42.0 B				
Congestive Heart Failure		High	Steady Progression	High	High
5.3 M	\$32.0 B				
COPD/Emphysema		High	Steady Progression	High	High
12.1 M	\$26.7 B				
Coronary Artery Disease		High	Steady Progression	High	High
16.0 M	\$87.6 B				
Depression		High	Episodic	High	High
18.1 M	\$80.0 B				
Diabetes		High	Steady Progression	High	High
23.6 M	\$116.0 B				
Gastroesophageal Reflux Disease (GERD)		Medium	Episodic	Medium	High
40.0 M	\$9.6 B				
Hypertension		High	Steady Progression	Medium	High
73.0 M	\$51.0 B				
Inflammatory Bowel Disease		High	Episodic	High	Medium
1.4 M	\$18.8 B				
Lupus (SLE)		High	Episodic	High	High
1.5 M	\$8.0 B				
Migraines		Medium	Episodic	High	High
Multiple Sclerosis		High	Episodic	High	Medium
Osteoarthritis		Medium	Episodic	High	High
Osteoporosis		High	Steady Progression	High	High
10.0 M	\$14.0 B				
Stroke		High	Episodic	High	High
5.8 M	\$43.7 B				

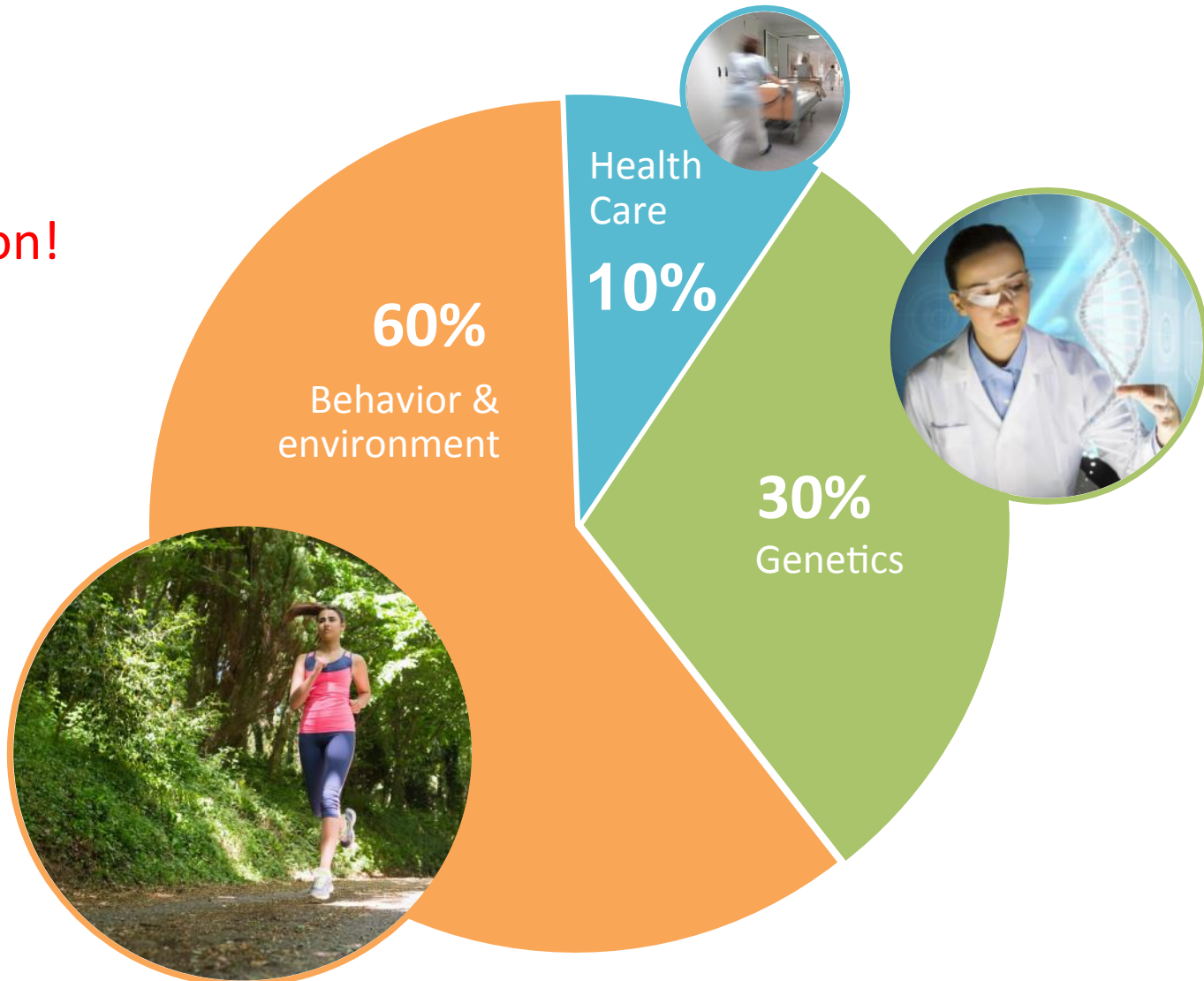
Top 20 examples of chronic diseases out of 91 studied by EAC.
Noted are 9 Chronic Diseases often seen as comorbidities of diabetes.



Determinants of Health in U.S.



Nutrition!

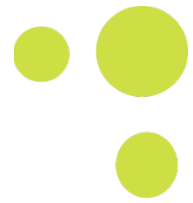




Scientific Wellness → A New Industry



Conceptual Themes of P4 Medicine



P4 Medicine

Predictive
Preventive
Personalized
Participatory



Wellness Quantified



Disease Demystified

Scientific Wellness Industry

Disease Industry

Proposing the 100K Wellness Project



Clinical OMICs INNOVATOR

Promoting Wellness & Demystifying Disease: The 100K Project

Leroy Hood, M.D., Ph.D., and Nathan D. Price, Ph.D.

EDITORIAL



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Nathan D. Price is Associate Director of the Institute for Systems Biology, Seattle, WA 98109, USA. E-mail: nprice@systemsbiology.org

Citation:
L. Hood, N. D. Price, Demystifying disease, democratizing health care. *Sci. Transl. Med.* 6, 225ed5 (2014).

SYSTEMS BIOLOGY

Demystifying Disease, Democratizing Health Care

UNSUSTAINABLE COST INCREASES THREATEN THE GLOBAL HEALTH CARE SYSTEM, and further progress is stymied more by societal than technological factors. Only by engaging health care consumers (that is, patients) as pioneers who provide both health-related data and insights into pathophysiology can we meet these societal challenges and thus accelerate the pace of biomedical innovation.

In March 2014, the Institute for Systems Biology will launch a longitudinal, Framingham-like study (www.framinghamheartstudy.org) of 100,000 (100K) healthy individuals that we believe will be instrumental in bringing predictive, preventive, personalized, and participatory (P4) medicine to patients. Participatory medicine means that patients, researchers, physicians, and the entire health care community join forces to transform the practice of medicine to make it more proactive than reactive—and, in turn, less expensive and more effective (1).

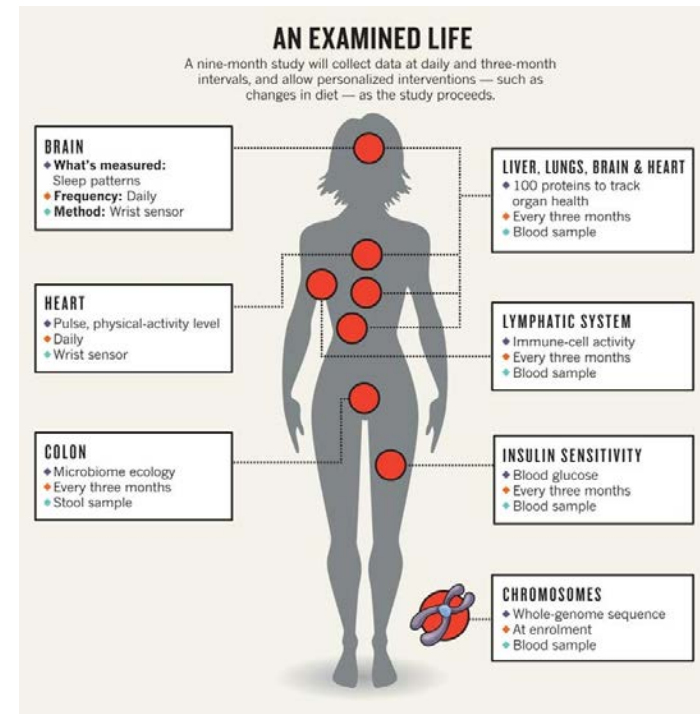
PEOPLE POWER

A systems approach is necessary for the effective management of complex diseases (1). This fundamental component of P4 medicine is built on two central features. The first is a conviction that, in 5 to 10 years, each patient will have a dynamic data cloud consisting of billions of diverse types of data points and that medicine will be informed by computational analyses that reduce high-dimensional data to actionable hypotheses designed with the intent of optimizing wellness and minimizing disease in individual patients. The second feature is that integration of patient data will reveal biological networks that specify health and are altered in disease, and that through an understanding of these differences, one can gain fundamental insights into disease mechanisms. Such insights are essential for developing more effective diagnostic and therapeutic approaches. Indeed, such an approach has already provided powerful new technologies and strategies (2) that have brought us to the brink of P4 medicine (3).

At its foundation, P4 medicine is about quantifying wellness and demystifying disease. Individual data clouds will let us predict future wellness and disease. The preventive element focuses on how well we can improve individual wellness and take actions to stop or de-

Nature,
News
piece,
(2014)

Hood and Price,
Clinical Omics,
(2014)

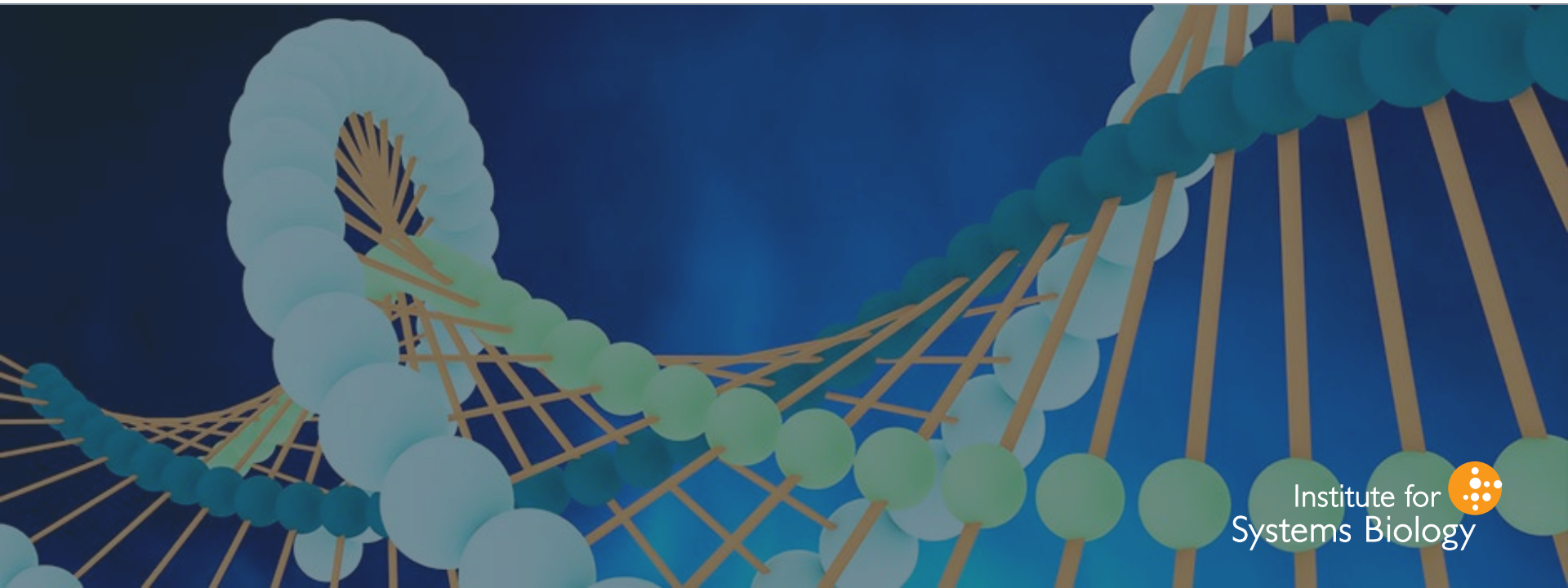


Hood and Price, *Science Translational Medicine* (2014)

PIONEER 100 PROJECT

Principal Investigators: Lee Hood and Nathan Price

The 100K Wellness Project was initiated in 2014 with the generation of dynamic data clouds for 108 individuals. These data provided spectacular insights into what it is to be well and the nature of wellness to disease transitions (and vice versa).





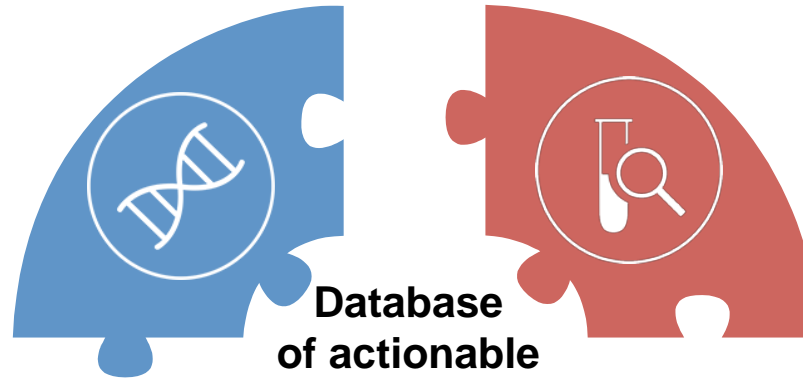
- 108 participants
 - Age range: 20s to 88+
 - 9-month study launched March 2014
 - IRB approved
 - Evaluation / insights for next phase
- Whole genome sequence
 - Detailed blood, urine, saliva measurements 3x
 - Gut microbiome 3x
 - Continual self-tracking and lifestyle monitoring
 - Data integration & correlations
 - Monthly coaching sessions on actionable data
 - Discovery research
 - Events and education

Assays / Measurements—108 Pioneers

Creating dense and dynamic personal data clouds

GENOME

Whole Genome Sequencing.
SNPs Millions



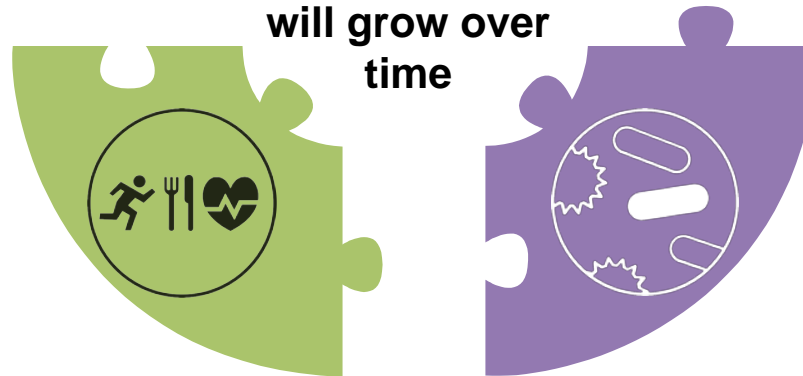
**Database
of actionable
possibilities that
will grow over
time**

LABS

Detailed lab tests 3x
(blood, urine, saliva)
Clinical chem. 150
Metabolites 700
Proteins 400

SELF-TRACKING

Continual
self-tracking
& lifestyle
monitoring



MICROBIOME

Gut Microbiome
3x



Wellness coaching for participants



Wellness Coach



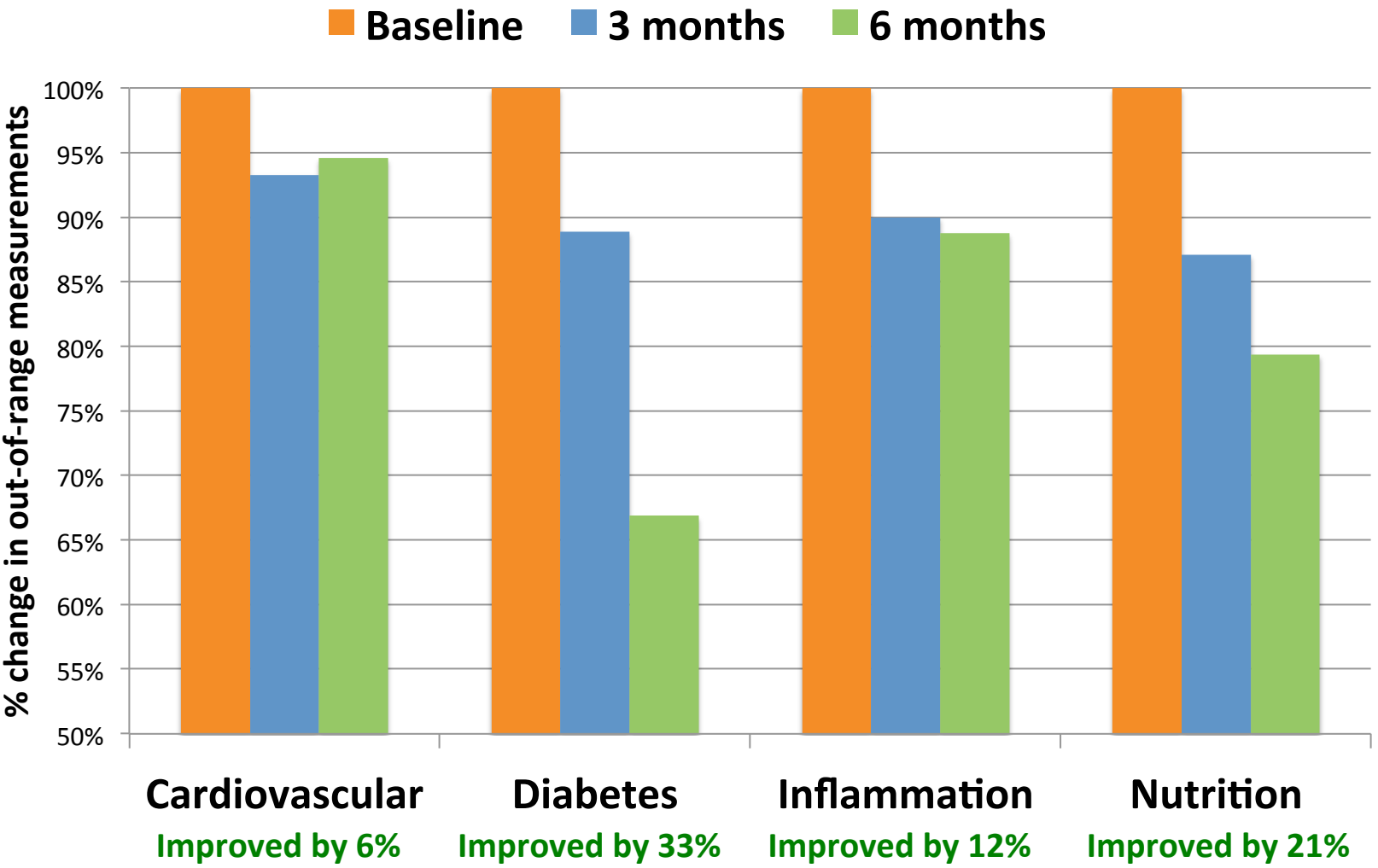
Sandi Kaplan, MS, RD

Study Physician

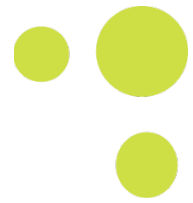


Craig Keebler, MD

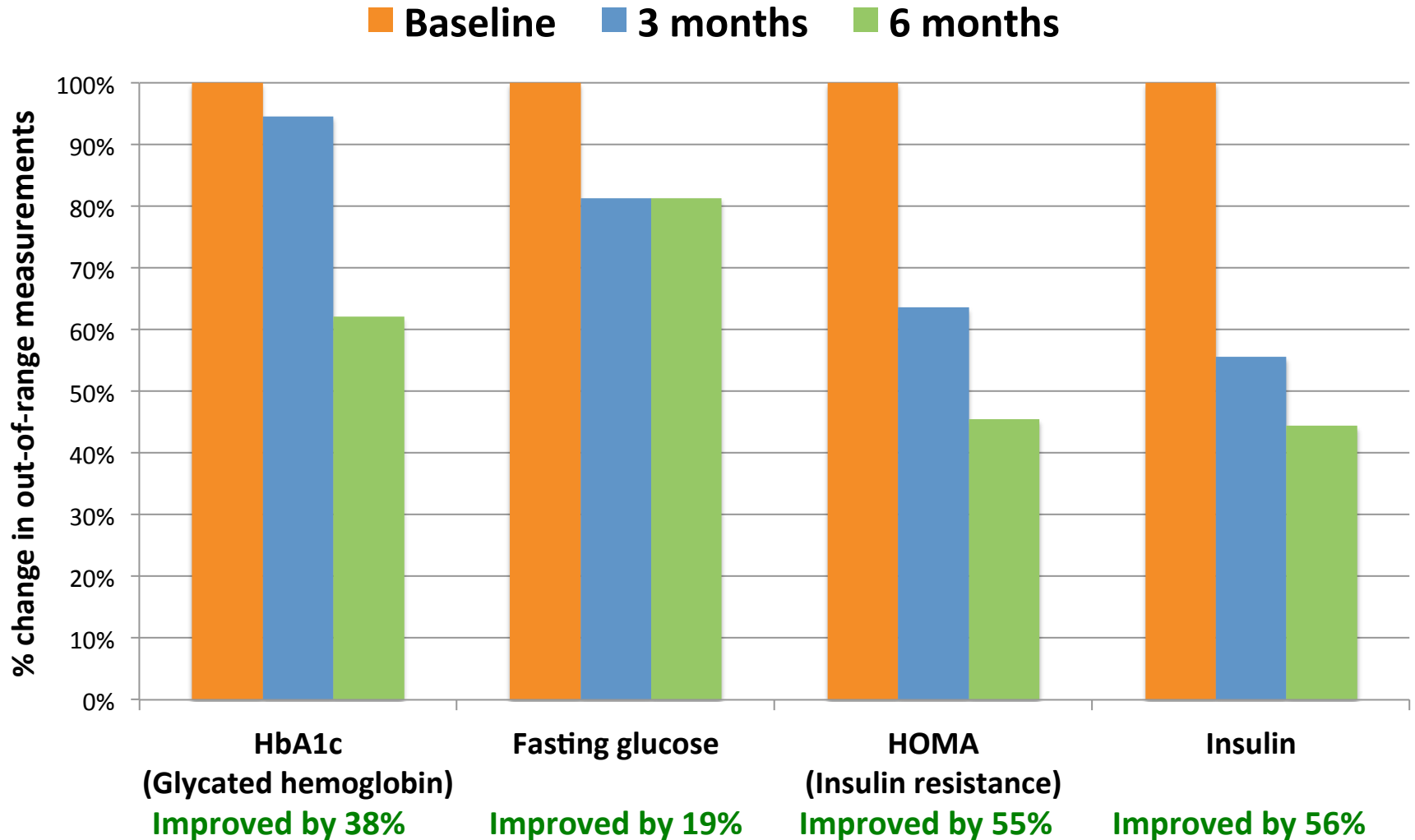
Clinical Labs Discovery: Improvements in blood health with behavioral coaching



Clinical Labs Discovery: Significant pre-diabetes improvements



Seven participants with pre-diabetes were completely normalized in six months



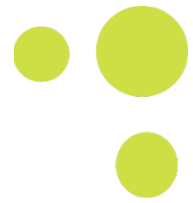
Diet modification to reduce heavy metal toxicity

Toxic Elements		
Element	Reference Range	Reference Range
Lead	0.027	<= 0.048 mcg/g
Mercury	0.0180	<= 0.0039 mcg/g
Antimony	0.002	<= 0.002 mcg/g
Arsenic	0.019	<= 0.071 mcg/g
Cadmium	0.000	<= 0.001 mcg/g
Tin	<dl	<= 0.0009 mcg/g

Toxic Elements		
Element	Reference Range	Reference Range
Lead	0.026	<= 0.048 mcg/g
Mercury	0.0097	<= 0.0039 mcg/g
Antimony	0.001	<= 0.002 mcg/g
Arsenic	0.019	<= 0.071 mcg/g
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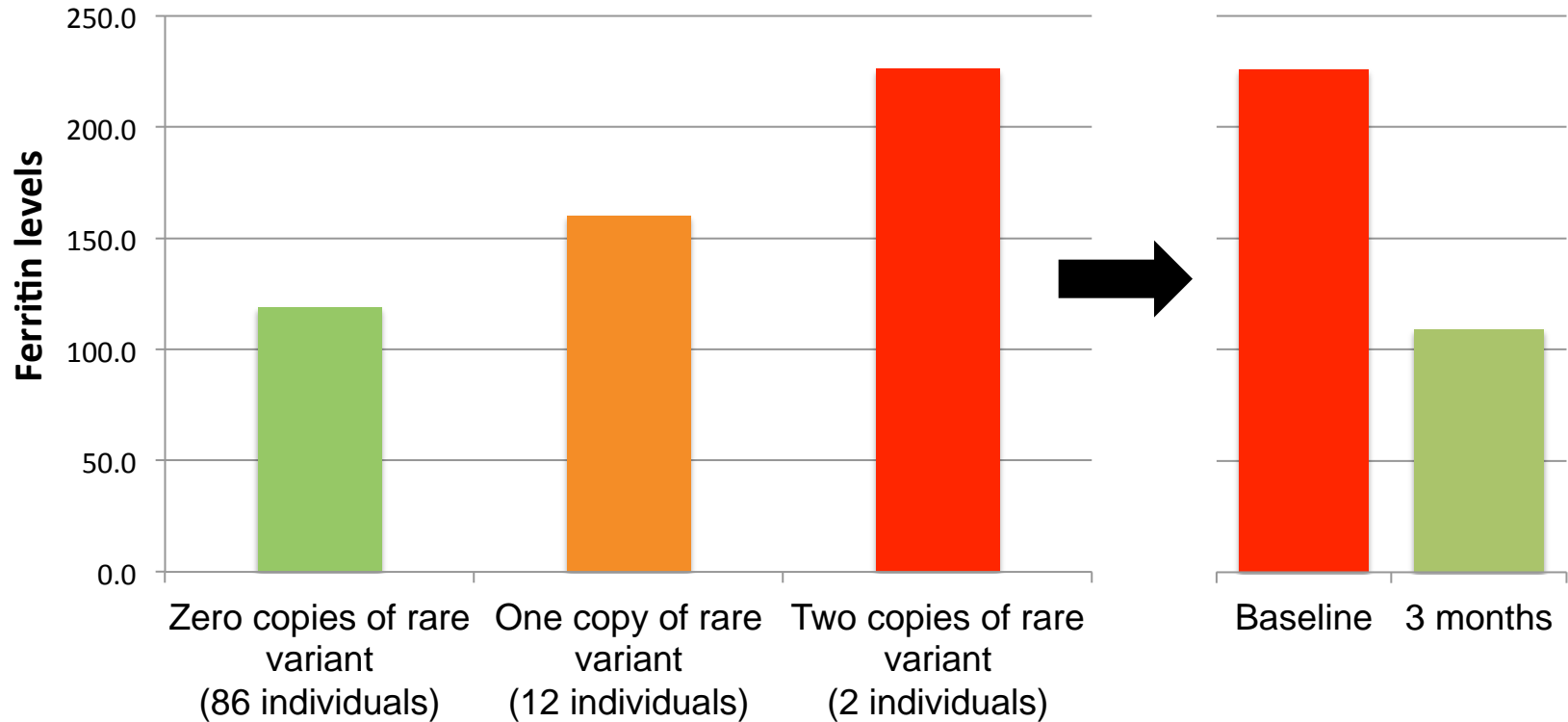
1. Baseline: High mercury levels in blood
2. Coached to modify diet - eight weeks of eating salmon sushi vs. tuna sushi (3x a week)
3. Reduced mercury levels in three months



A wellness to disease transition—genetics
plus environment—an actionable
possibility

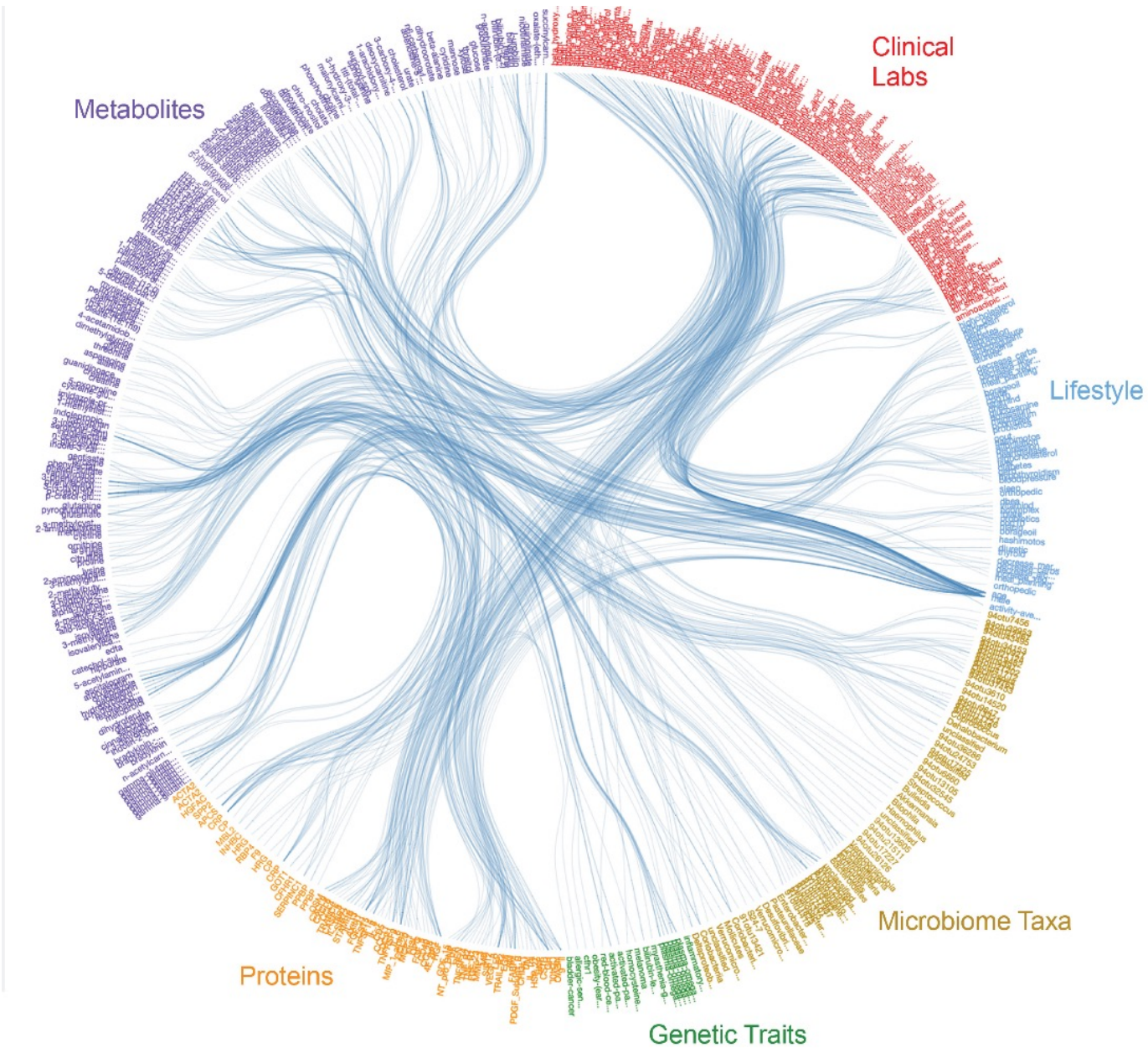
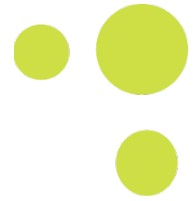
Genetics and Clinical Labs: Hemochromatosis

Detected risk of a deadly disease in two participants

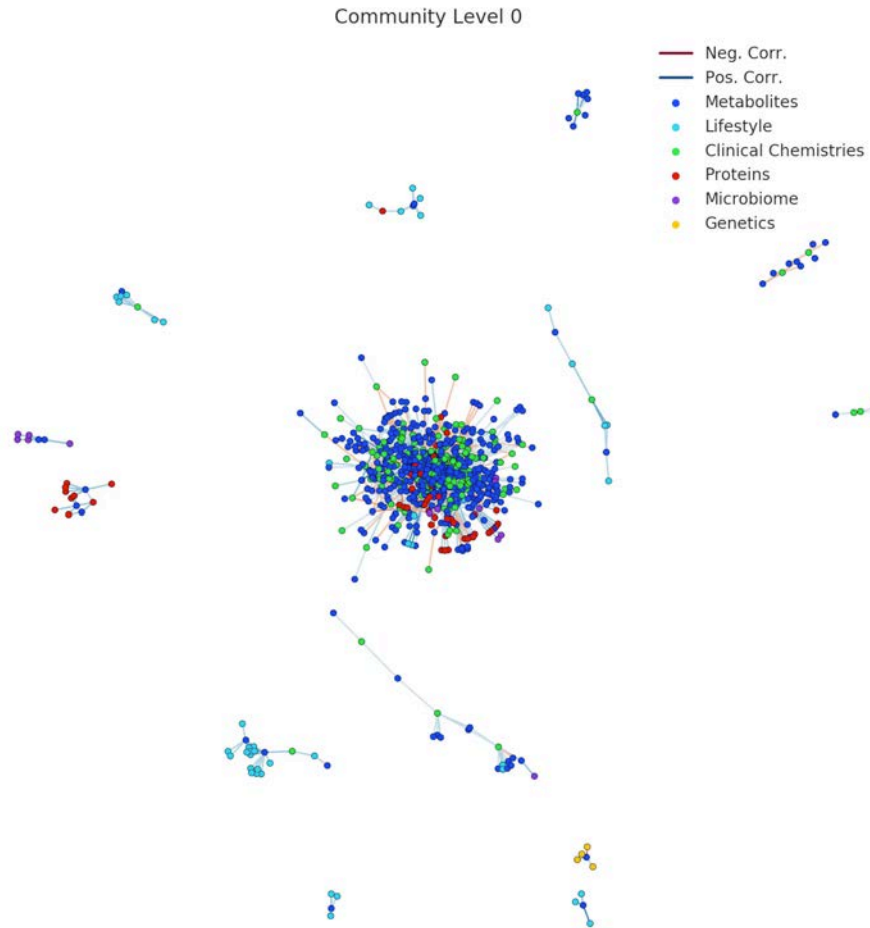


- Blood + Genetics illuminated the effects of increasing copies of the Hemochromatosis variant
- Left untreated, this disorder could lead to cartilage damage, liver cancer, diabetes, and heart disease: Easily treated by regular blood donations to reduce the iron stores
- One participant ALREADY had cartilage damage from his undiagnosed disease
- Subsequent family genetic testing detected other family members at risk

Deriving Insights from Data: New Frontiers

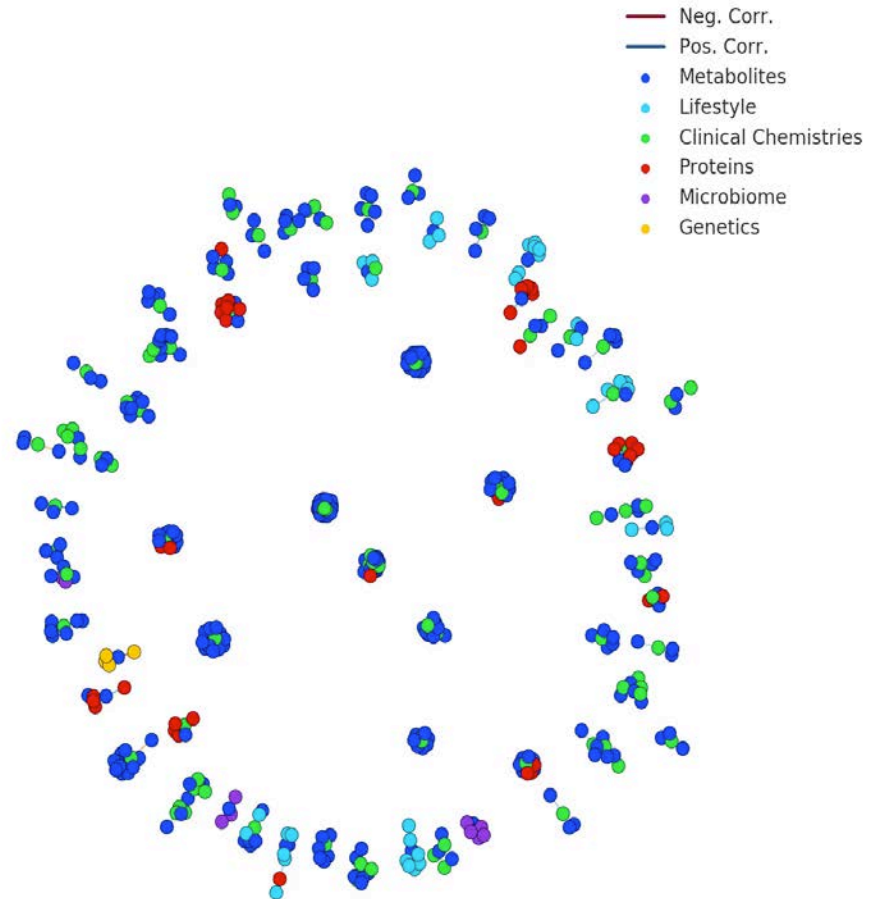


Identifying inter-related molecular modules

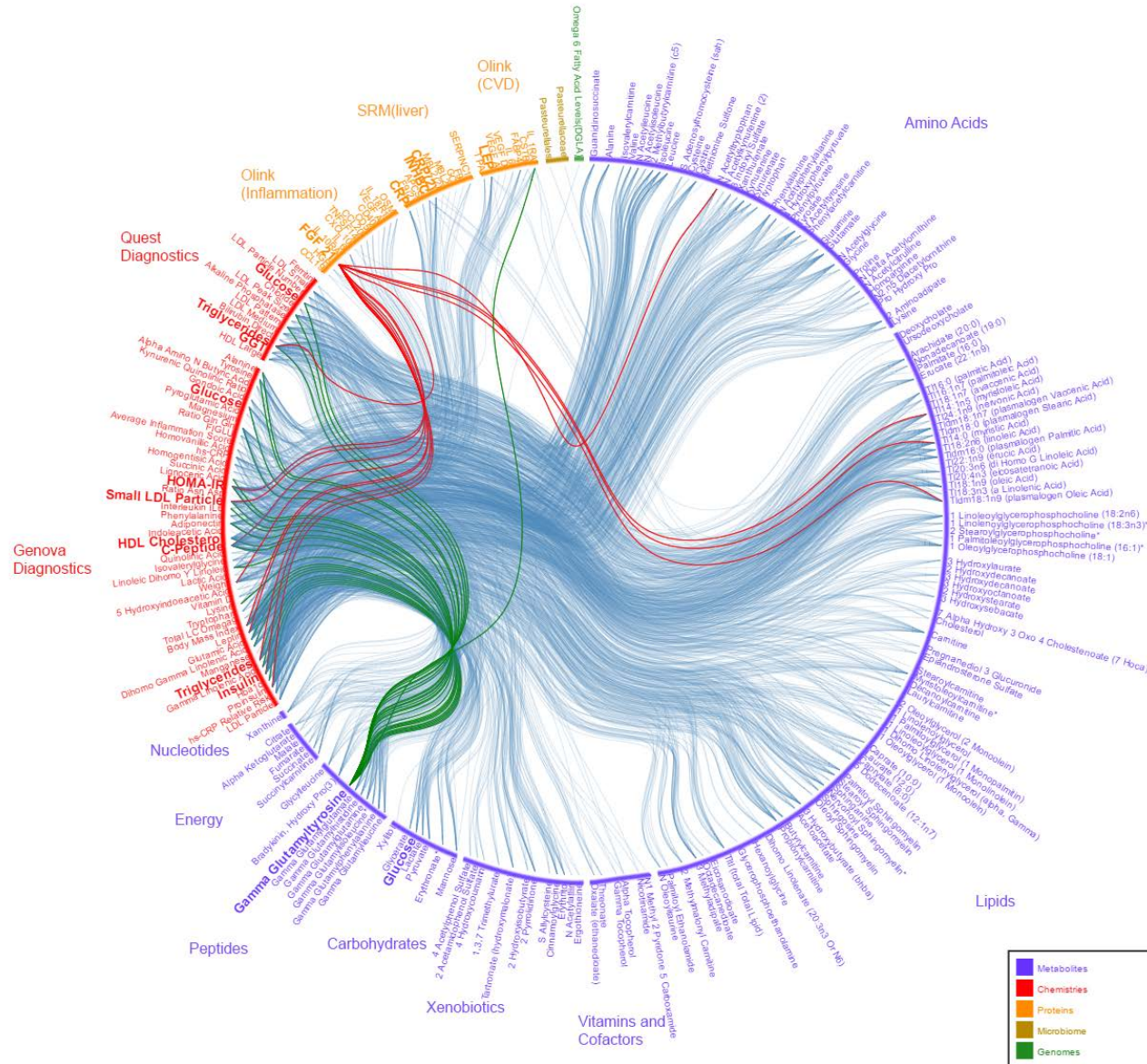
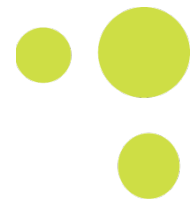


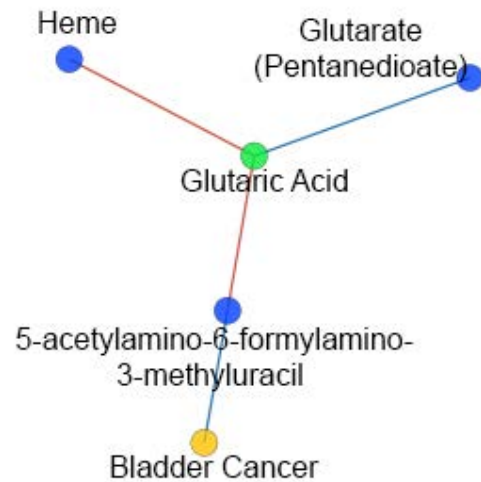
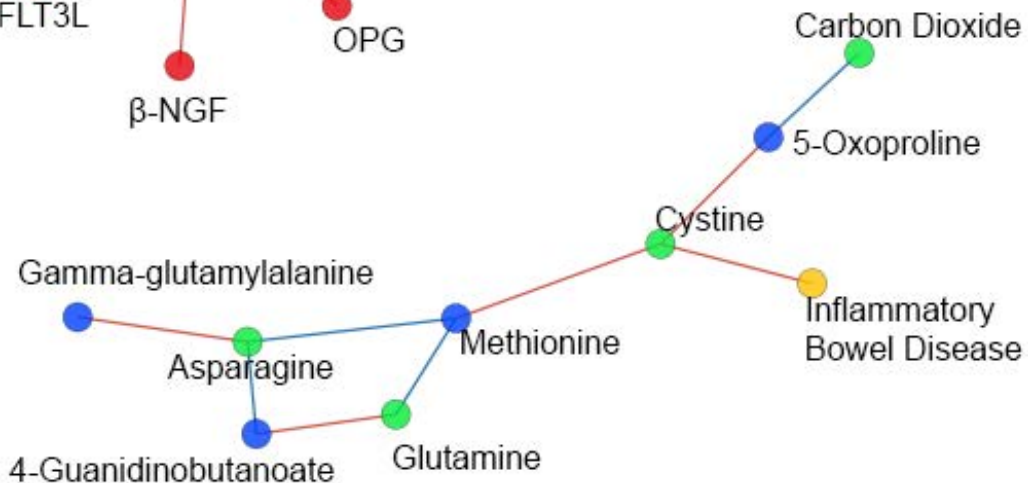
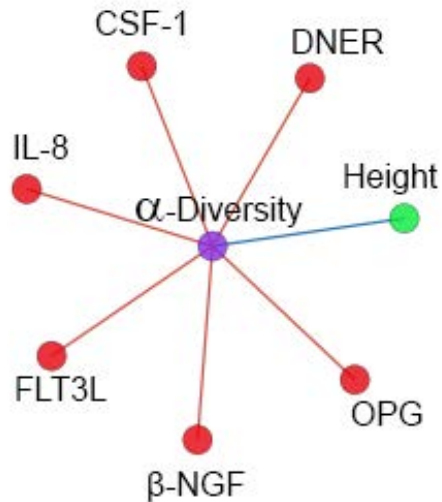
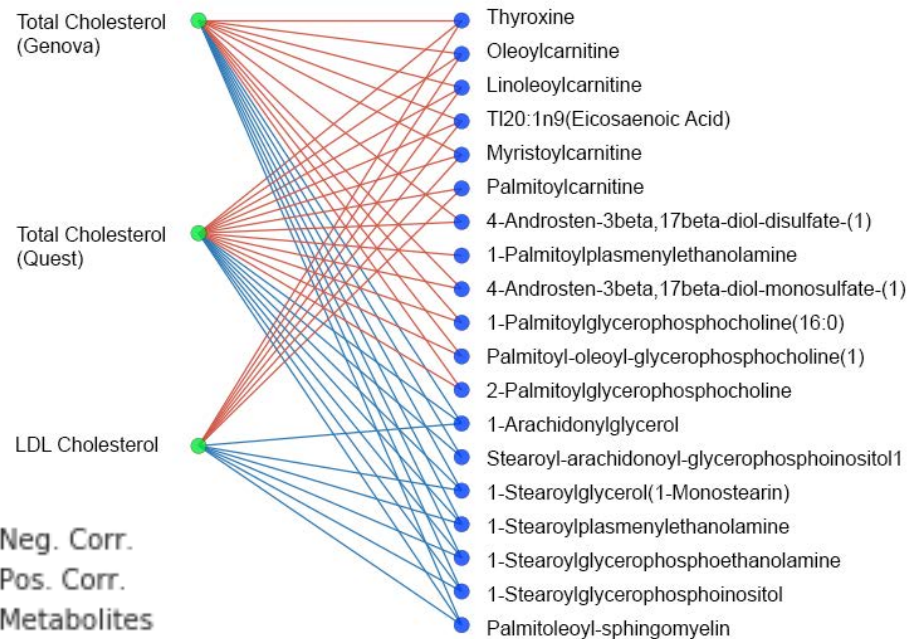
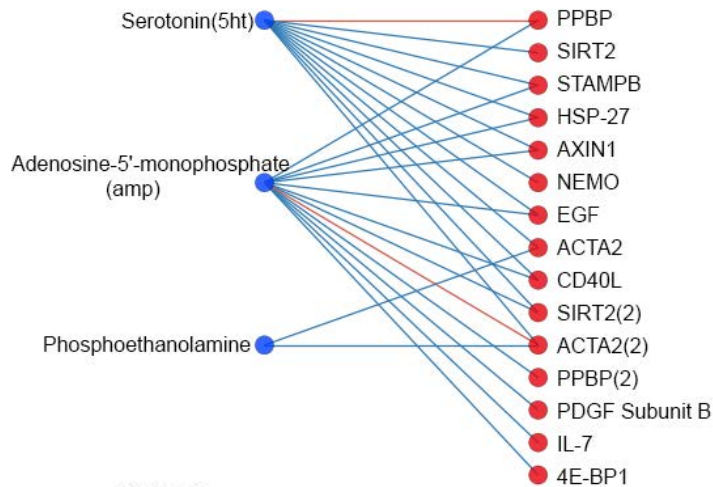
Total cholesterol community

- Cholesterol is **positively associated with alpha-tocopherol (Vitamin E)**
- Cholesterol is **negatively associated with endogenous thyroxine**
- A beneficial side effect of **the drug thyroxine (Synthroid)** is lowering LDL cholesterol



The largest molecular community: related to cardiometabolic health





**We can determine
your genetic risk for
at least 60 diseases.**

GWAS variants have been determined for about 60 diseases and traits

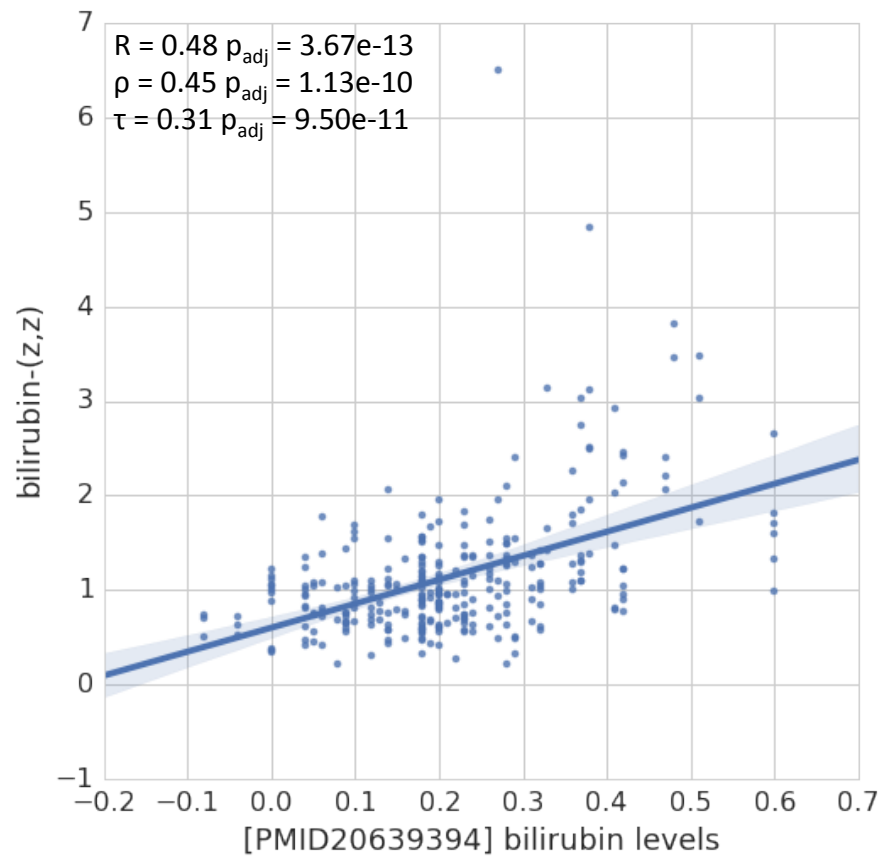
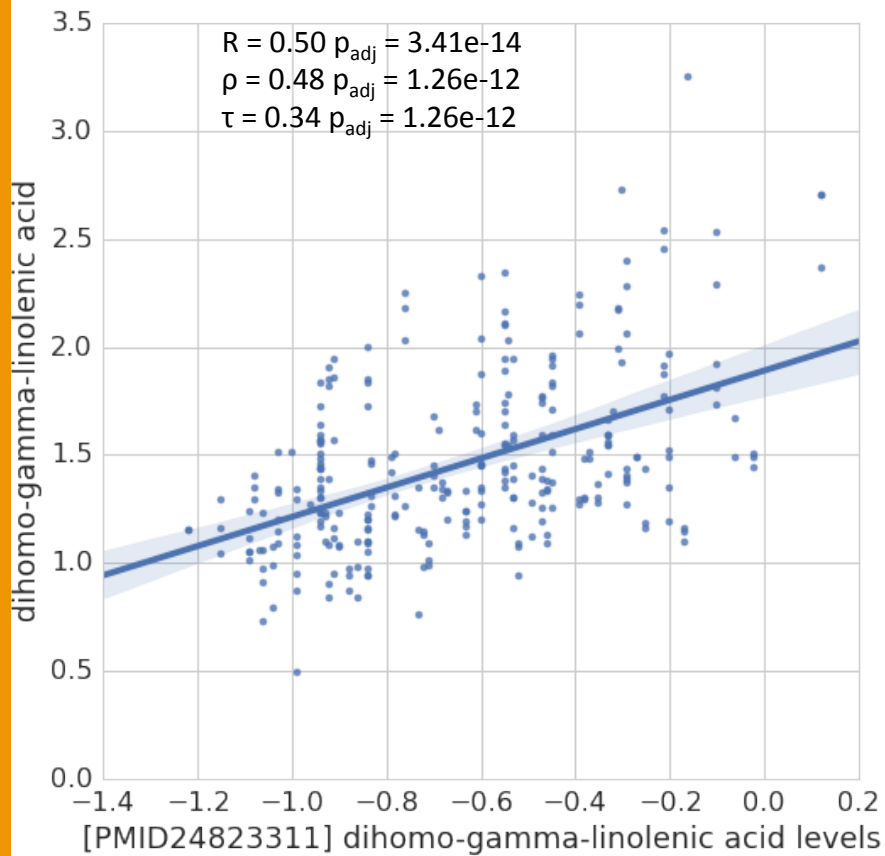
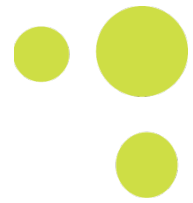
ADHD	COPD	Myopia
Alzheimer's disease	Crohn's disease	Obesity
Anorexia	Esophageal cancer	Osteoarthritis
Asthma	Gout	Osteoporosis
Atrial fibrillation	Grave's disease	Ovarian cancer
Breast cancer	Hematocrit	Pancreatic cancer
Bipolar disorder	Hypertension	Parkinson's disease
Blood pressure	Hypothyroidism	Primary biliary cirrhosis
Bone mineral density	Inflammatory bowel disease	Prostate cancer
Inflammation	Iron levels	Psoriasis
Calcium	Lung Cancer	Rheumatoid arthritis
Cardiovascular disease	Lupus	Schizophrenia
Celiac disease	Macular degeneration	Stroke
Cholesterol levels	Magnesium levels	Type 1 Diabetes
Chronic kidney disease	Metabolic syndrome	Type 2 Diabetes
Colorectal cancer	Migraine	Ulcerative colitis
Coronary heart disease	Multiple sclerosis	Urate levels

Variant
rs85

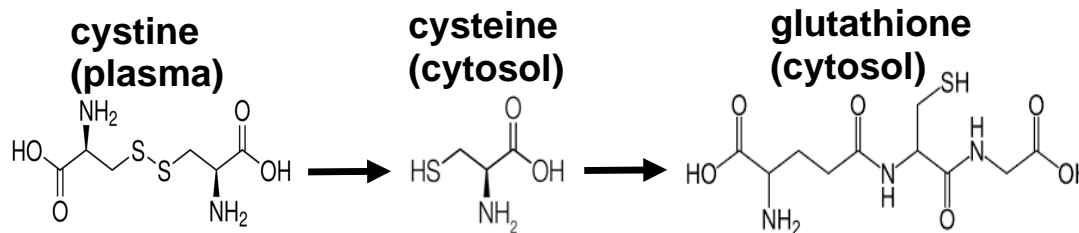
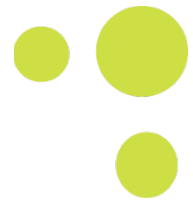
Variant
rs6827

Variant
rs9769

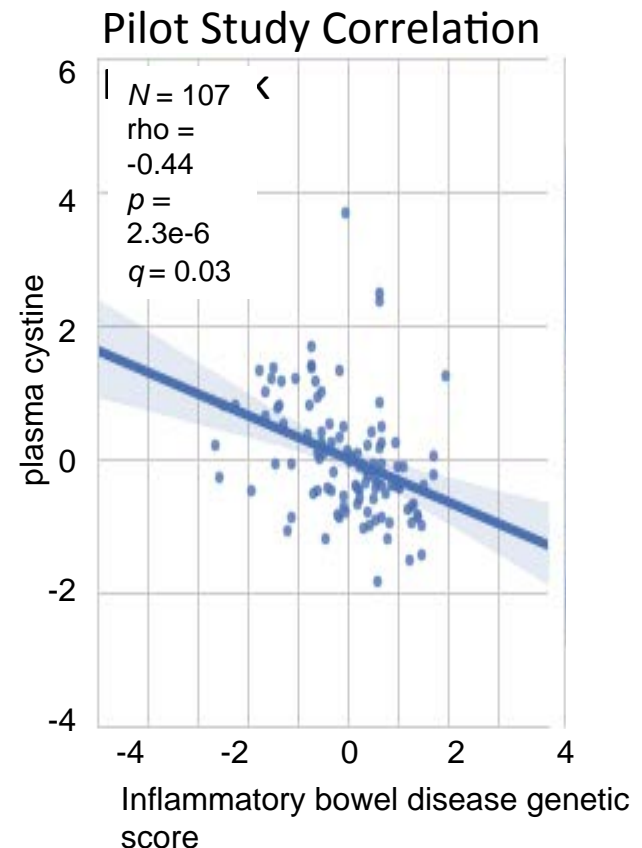
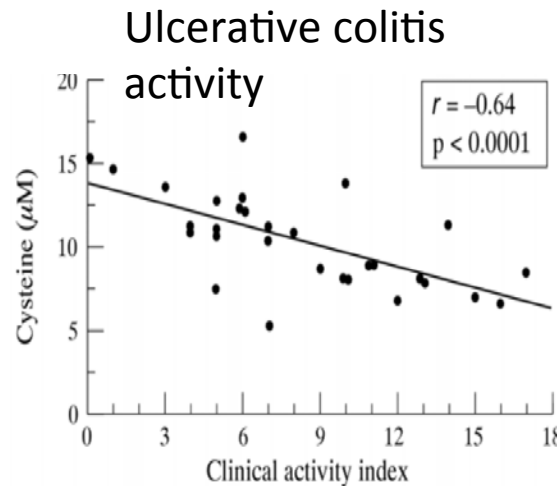
Your genome affects metabolite concentrations in your blood



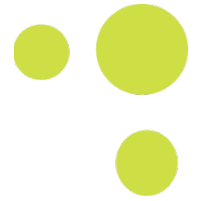
Nutrient measurements correlate with genetic predisposition for IBD



	Cystine
Control (n=65)	61.3 (1.7)
Crohn's disease (n=33)	
Before surgery	42.8 (2.4)***
10 days after surgery	56.0 (3.0)
3 months after surgery	52.7 (2.8)1-160
Ulcerative colitis (n=33)	
Before surgery	47.3 (1.8)***
10 days after surgery	64.3 (2.4)
3 months after surgery	64.5 (3.6)

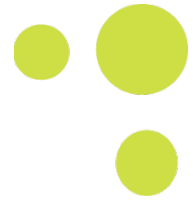


Sido, B., Hack, V., Hochlehnert, A., Lipps, H., Herfarth, C., and Dröge, W. (1998). Impairment of intestinal glutathione synthesis in patients with inflammatory bowel disease. *Gut* 42, 485–492.



Where are we going?

Scientific Wellness: Two Integrated Directions



Arivale

- A consumer facing scientific wellness company
- 5,000 individuals in the first 18 months
- Transform how biotech industry operates

ISB-Providence

- Dense, dynamic, personal data clouds
- Research to validate wellness metrics
- Research for better assays
- Optimize wellness
- Study wellness to disease transitions
- Study disease [progression, response to therapy and transition to wellness



Arivale: Scientific Wellness at Scale

Founders



Clayton Lewis, CEO and Co-founder
Maveron, MarketLeader, Harborview Medical Center, Capitol Hill





Lee Hood, MD, PhD, Co-founder, SAB Chair
ISB, Amgen, National Academies, Presidential Medal

Nathan Price, PhD, Co-founder, BOD
ISB, University of Illinois, Urbana-Champaign, UCSD, UW

Customer Acquisition & Engagement



Grant Ries, Chief Revenue Officer
Founder: Bluekai; Oracle, AdReady, YuMe



Alicia Nakamoto, Director, Community
RealSelf, Amazon, Bing, HP

Stewart Meyer, Director, Client Experience
Amazon, Razorfish, Kinetix, Best Buy

Computational Bioscience & Software Development




Bryan Wheeler, MS, Director, Software Development
Amazon, MSNBC.com, Microsoft



Andrew Magis, PhD, Senior Bioinformatics Scientist
ISB, University of Illinois, Urbana-Champaign

Behavioral Coaching



Jennifer Lovejoy, PhD, Chief Translational Science Officer
Alere/ Free & Clear, Bastyr Dean, Pennington Biomedical Research Center (LSU) Endowed Professorship




Sandi Kaplan, MS, RD, Director, Coaching Services
Alere / Free & Clear, founder Zing Bars

Operations & Finance



Sean Bell, Chief Business Officer
ISB, Alere / Free & Clear, LexisNexis



Kern Maresca, Director of Finance
Alere / Free & Clear, MindMyBody

External Affairs

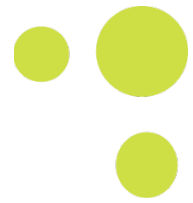


Gretchen Sorensen
ISB, Clinton Administration, Turner Broadcasting, Capitol Hill

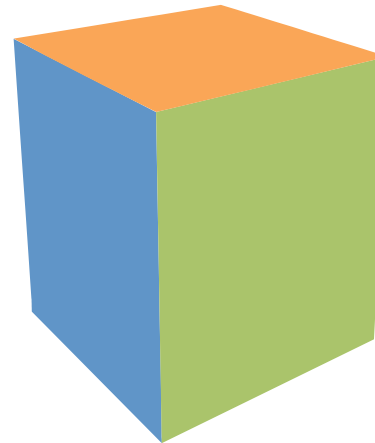
Capital Raised: \$39M



Scaling Up: Building the Research Portal



From 108 to Thousands to Millions



**Scientifically
Validated
Metrics**



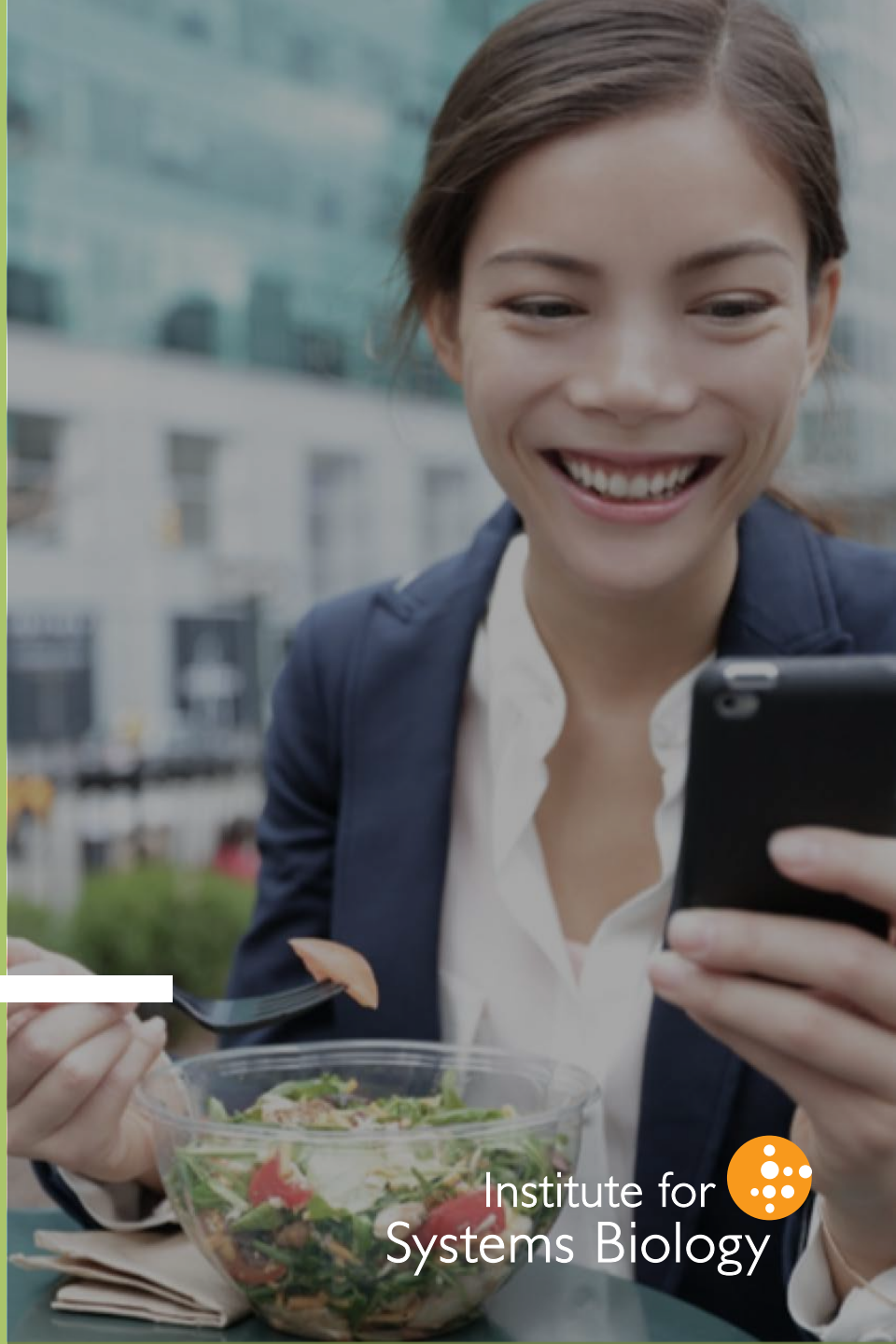
PROVIDENCE-ISB AFFILIATION

**Tens of millions of EMRs
Have access to patient samples
Can work with Providence to design clinical trials
Provides avenue to implement P4 Medicine**

A background image of a molecular structure with dark blue spheres and rods, set against a dark blue gradient background.

TRANSLATIONAL MEDICINE
PILLAR:

SCIENTIFIC WELLNESS



Institute for 
Systems Biology

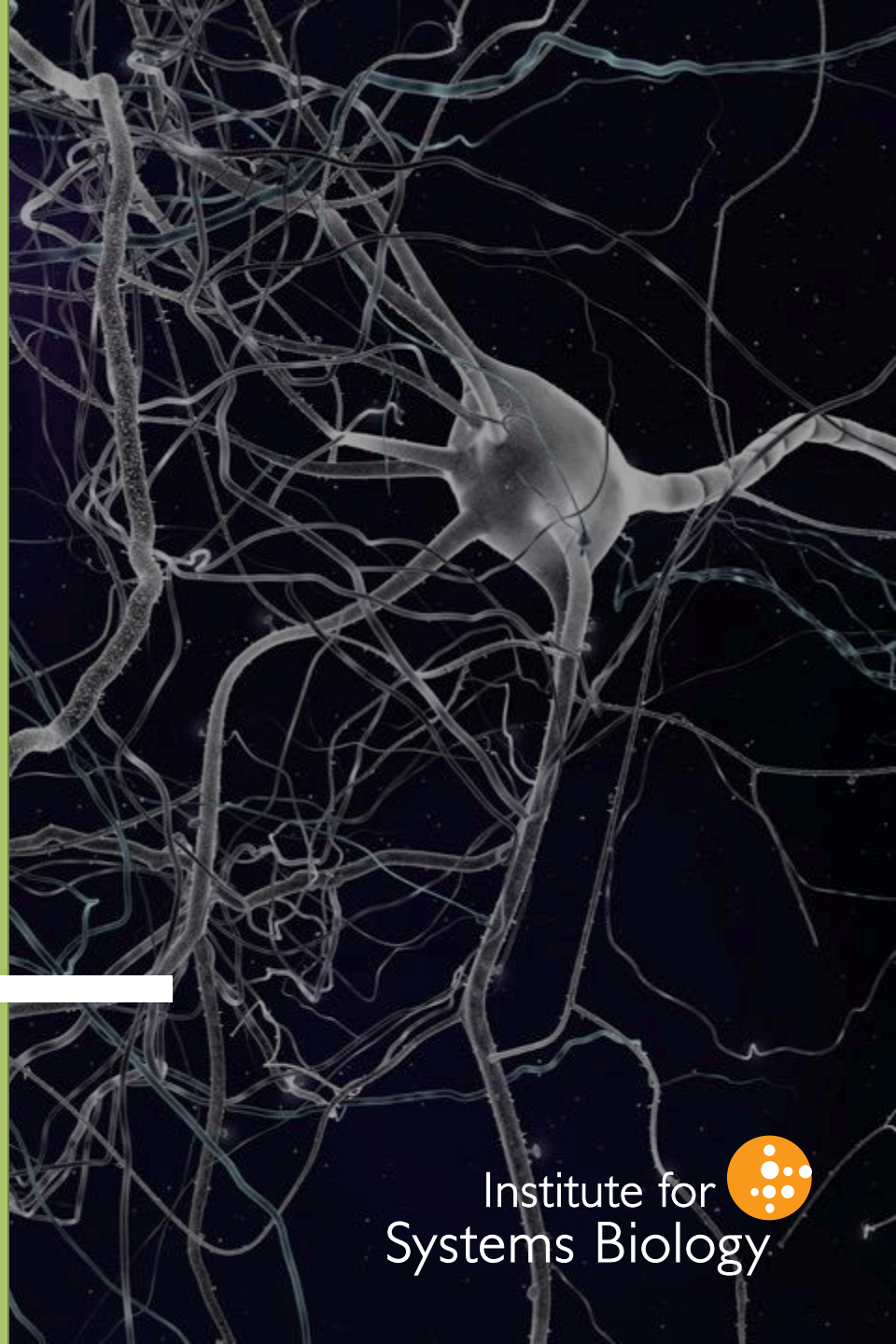
TRANSLATIONAL MEDICINE
PILLAR:

**BREAST
CANCER
SURVIVOR
WELLNESS**



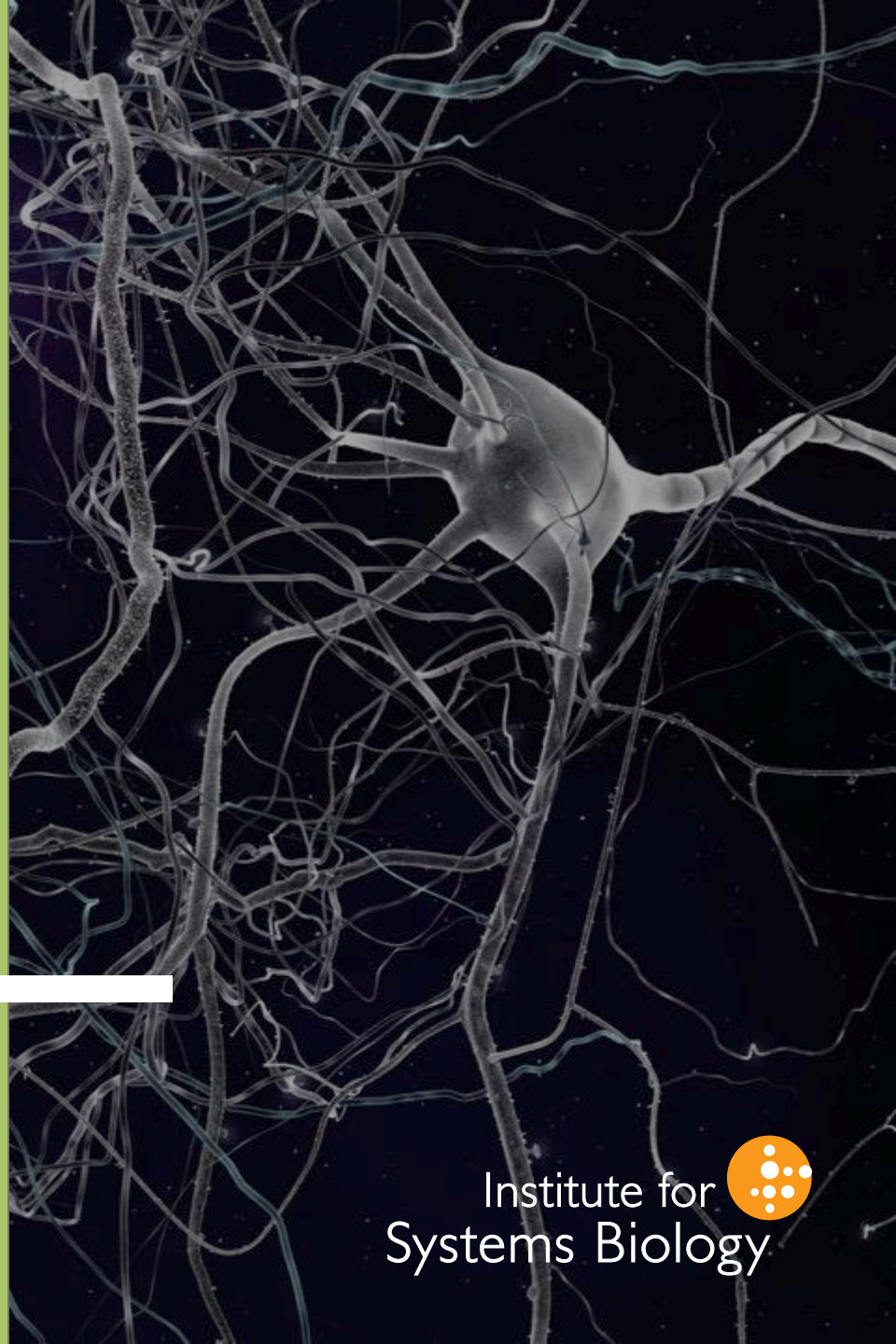
TRANSLATIONAL MEDICINE
PILLAR:

ALZHEIMER'S DISEASE



TRANSLATIONAL MEDICINE
PILLAR:

(PRE)DIABETES



Dense, Dynamic Personal Data Clouds

iPS CELLS

0100101011010101101
0110101010101011010
1010101101010101010

GENOME

GCGTAGTC
ATGCGTAG
GGCATGCT
ATGCCATG
ATAGCTGC

CUUAGUGC
UAUGCGUA
GCUAGGCG
CAUGCUUC
GAGUGAUA

TRANSCRIPTOME

TRANSACTIONAL

0100101011010101101
0110101010101011010
1010101101010101010

SINGLE CELL

0100101011010101101
0110101010101011010
1010101101010101010

PROTEOME

arg-his-pro-val-
gly-leu-ser-thr-
ala-trp-tyr-val-
met-phe-arg-

Na 143 K 3.7
BP 110/70
HCT 32
BUN 12.9
Pulse 110
PLT 150
WBC 92

PHENOME

METABOLOME

0100101011010101101
0110101010101011010
1010101101010101010

EPIGENOME

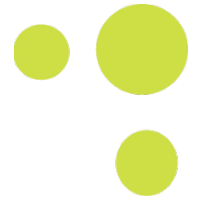
0100101011010101101
0110101010101011010
1010101101010101010

SOCIAL MEDIA

11010100010
10101011010
10101001000
10110100111
10110101010

These personalized data clouds are the foundation of Precision Medicine and Precision Nutrition.

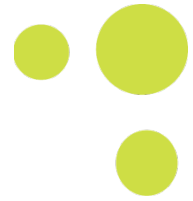
Enabling Individuals to take Responsibility for their Own Wellness (and Disease)



Individuals taking responsibility for their own health – with informed personalized nutrition – will dramatically reduce the cost of healthcare

ISB Hundred Person Wellness Project: Team

Special thanks to our funders: Robert Wood Johnson Foundation and M.J. Murdock Charitable Trust



Project Leadership

- Leroy Hood, MD, PhD
- Nathan Price, PhD
- Sean Bell, Business Director

Participant Engagement

- Jennifer Lovejoy, PhD, VP Clinical Affairs
- Sandi Kaplan, Wellness Coach
- Craig Keebler, MD, Study Physician

Data Analytics

- Nathan Price, PhD – Analytics Lead
- Gustavo Glusman, PhD, Genomics
- Andrew Magis, PhD, Multi-omics
- John Earls, Data integration

Project Management

- Kristin Brogaard, PhD Project Manager
- Sara Mecca, Project Assistant
- Mary Brunkow, PhD, Project Coordinator

Communications

- Gretchen Sorenson, Consultant
- Hsiao-Ching Chou, Commun. Director

Medical Advisory Board

- Robert Green, MD
- Jane Gultinan, ND
- Michael Raff, MD
- Sarah Speck, MD

[@ISBNathanPrice](#)

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Presentation Clinical Actions



After participating in this presentation, clinicians should be better able to:

- Discuss the power of data in driving clinical focus towards disease prevention and wellness optimization.