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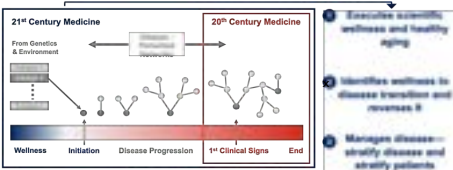
Actionable Microbiome Insights for Health, Disease, Aging, and Drug Responses

Nathan Price
 Chief Scientific Officer, Thorne HealthTech
 Professor (on leave), Institute for Systems Biology



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Challenges, Opportunities, and Technologies of the 21st century Necessitate and Enable Focus on Wellness and Healthy Aging



The Age of Scientific Wellness

WHY THE FUTURE OF MEDICINE IS PERSONALIZED, PREDICTIVE, DATA-DRIVEN, AND IN YOUR HANDS

Leroy Hood, MD, PhD
Nathan D. Price, PhD


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*"For it makes a great deal of difference whether a man is lengthening his **life** or his **death**." – Seneca (65 A.D.)*

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Scientific Wellness Pilot: Pioneer 100

PIs: Nathan Price and Lee Hood



Price et al. *Nature Biotechnology*, 2017

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Assays / Measurements—108 Pioneers

Creating personal, dense, dynamic data (PD3) clouds – “deep phenotyping”

GENOME
Whole Genome Sequencing
SNPs Millions

LABS
Detailed lab tests 3x (blood, urine, saliva)
Clinical chem. 100
Metabolites 100
Proteins 400
Almost 1200 analytes

MICROBIOME
Gut Microbiome
Ration of microbial species 3x

Database of 200 actionable possibilities that will grow over time

Continual self-tracking of physiology & lifestyle monitoring

Price, Mags, Earls...Hood, Nature Biotechnology, 2017

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Baseline characteristics of deeply phenotyped population

Characteristic	Total N=4886
Age, mean years (sd)	45.9 (12.9)
Males, no. (%)	2184 (35.1)
Nonwhite, no. (%), n=6107	1480 (24.2)
Number of people with one or more blood draws, no. (%)	4886 (78.5)
Number of blood draws per person, mean (range) (n=4886)	2.3 (1-10)
Total bloods drawn	11,151
BMI, mean (sd), n=4703	27.5 (6.2)
Obese ^a , no. (%), n=4703	1242 (26.4)
<i>Past and/or current self-report of:</i>	
High cholesterol, no. (%), n=4885	1101 (22.5)
Hypertension, no. (%), n=4897	778 (15.9)
Type 2 Diabetes, no. (%), n=4837	175 (3.6)
Coronary artery disease, no. (%), n=4817	67 (1.4)

^aObese defined as BMI≥30

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What have we learned about the **microbiome** from scientific wellness studies on thousands of people?

Noa Rappaport
Research Scientist

Tomasz Wilanski
Postdoctoral Fellow

Christian Diener
Postdoctoral Fellow
(Gibbons Lab)

Sean Gibbons
Assistant Professor

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Defining a Reference 'healthy' Microbiome In Challenging

Conclusions
 "Localized baseline and disease models need to be built in order to predict metabolic risks"

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Gut Microbial Diversity as marker of Microbiome Health

- Tends to be more consistently associated with disease conditions than specific microbes
- Several metrics: Shannon, PD whole tree, Chao1 (species richness)
- Is there an **optimal range** for gut microbial diversity?

Gut Microbial α -Diversity

Recurrent C. Difficile, Diarrhea, Obesity, Antibiotics, Asian/Pacific Islander, African American, Hispanics, Caucasians, Hunter-Gatherers, Constipation

Brooks et al., PLOS Biology (2018); 16(12): e2006842
 Schnoor et al., Nature Communications (2014); 5:3654

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Blood Metabolome Predicts Microbiome Diversity in Gut

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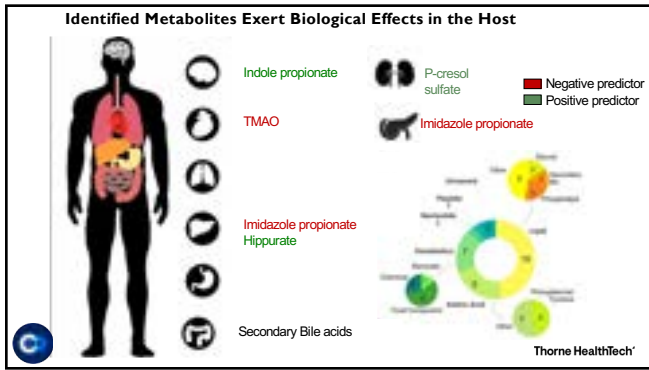
Measured Microbiome Diversity (blue), Predicted from Metabolome (orange)

Abdominal Pain, Acid Reflux, Antibiotics, Bloating, Constipation, Diarrhea, Type II diabetes

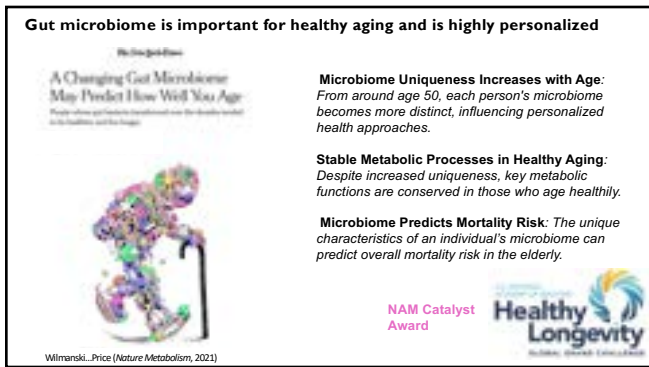
Observed change in Shannon α -diversity

Wilmanski, Rappaport...Price, Nature Biotechnology (2019)

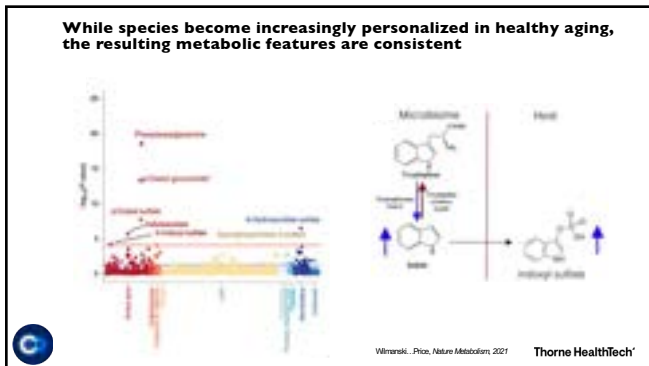
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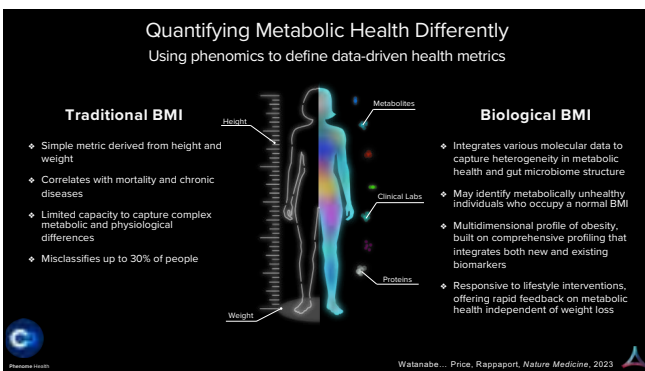
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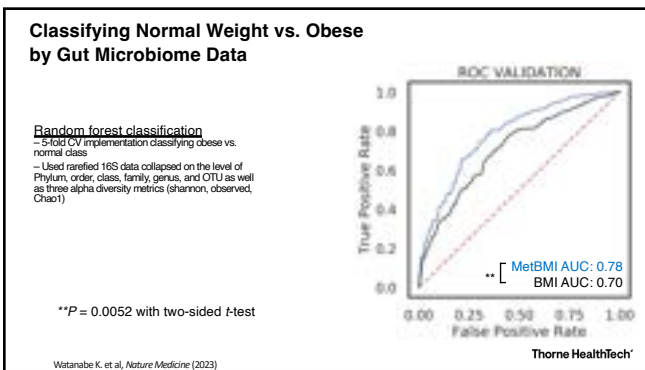
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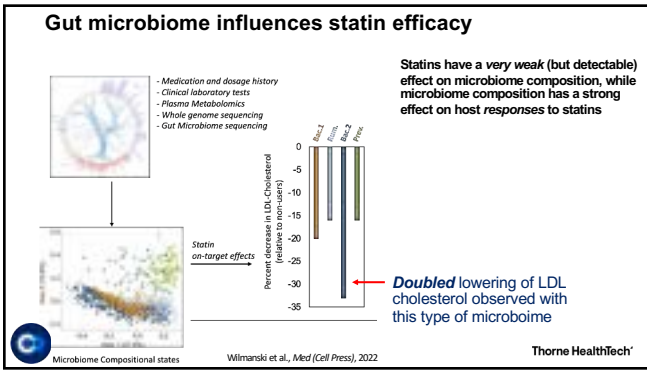
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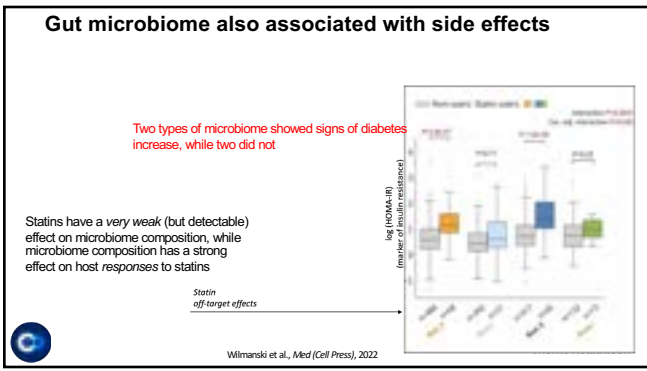
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Thorne Gut Health Test

What it Measures

5 Pillars:

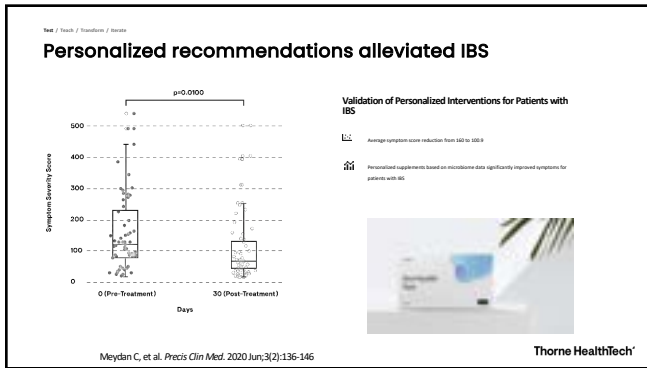
- | Digestion
- | Inflammation
- | Gut Dysbiosis
- | Intestinal Permeability
- | Enteric Nervous System Imbalance

Along with:

- | Pathogens and DNA content
- | Beta Diversity
- | Immune Readiness
- | Good, Bad, and Conditional Bacteria
- | Short-Chain Fatty Acids
- | Micronutrients
- | Total Fungi
- | Probiotics

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Gut microbiome: Innovations in collections and analysis

New "Microbiome Wipe"

Hua, H. et al, *Frontiers in Immunology* (2022)

STEP 1 Read the instruction booklet

STEP 2 Collect Stool Sample with Wipe

STEP 3 Place wipe in container and shake until dissolved

STEP 4 Release saline into lower container

STEP 5 Place container in specimen bag and shipper envelope

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Where we are headed: At home measurements and coupling microbiome and metabolome measurements at scale

Blood sample volume
 Needle transport
 5 min. wait time after OneDraw
 No cold chain necessary
 Near pain-free

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Large-scale Research Projects using Thorne's OneDraw blood measurement devices

"76% [preferred] the OneDraw Device over other blood collection methods"
 "Due to its ease-of-use and acceptability the OneDraw device is particularly useful in telehealth approaches where multiple samples need to be collected."

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Take home points

- We should evaluate the contributions of the microbiome based on reflections in the host – especially in the metabolome
- We will need to map how diet and microbiome interact to fill in health-enhancing niches
- Microbiome is a key component in healthy aging – and becomes increasingly unique to each individual
- Microbiome wipe should provide a much-improved sample collection experience – and making measurements easier and cheaper is key

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Acknowledgements

Hood-Price Lab @ISB



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Chris Mason, Ph.D.
Co-Founder, Onegevity
(Merged with Thorne)



Joel Dudley, Ph.D.
Co-Founder, Onegevity
(Merged with Thorne)




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Funding



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Thank You!

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