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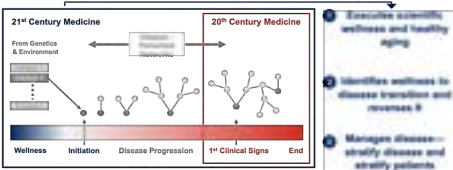
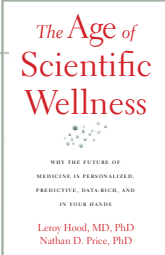
Actionable Microbiome Insights for Health, Disease, Aging, and Drug Responses

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



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Defining 'The Health Phenotype'
 Challenges, Opportunities, and Technologies of the 21st century Necessitate and Enable Focus on Wellness and Prevention





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Thorne Pillars Cover Breadth of Healthy Aging

Microbiome
(Gut Health)




Example: **Digestive diseases** affect 60 million to 70 million Americans

Biological Age
(Health of Body Systems)



Example: **Metabolic Health** 25% of healthcare spending in US for **diabetes**

Brain Health



Example: **Dementia** costs \$500B a year in US

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Scientific Wellness Pilot: Pioneer 100

PIs: Nathan Price and Lee Hood

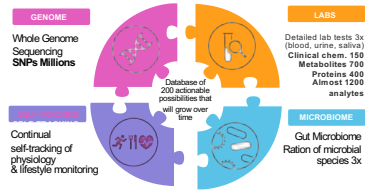


Price et al, Nature Biotechnology, 2017 Thorne HealthTech

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Assays / Measurements—108 Pioneers

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



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

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Longitudinal datasets from ‘healthy’ population

| | DATA TYPE | UNIQUE MEMBERS | TOTAL SAMPLES |
|------------------------------------|--------------------------|----------------|---------------|
| Genomic Data | Whole Genome Sequencing | 2,876 | 2,876 |
| | SNP Genotyping (MEG/GSA) | 1,948 | 1,948 |
| Clinical Data | Clinical Blood Tests | 4,879 | 11,162 |
| | Salivary Cortisol | 2,946 | 4,148 |
| | Weight/BMI | 5,722 | 285,319 |
| | Blood Pressure | 4,868 | 16,955 |
| Precision Medicine Data (Research) | Health Assessments | 4,948 | 6,838 |
| | Gut Microbiome | 3,691 | 5,229 |
| | Blood Metabolomics | 1,999 | 3,223 |
| Digital Health Data | Blood Proteomics | 2,811 | 6,014 |
| | Activity | 3,752 | 3,070,797 |
| | Sleep | 3,643 | 1,491,049 |
| | Heart Rate | 3,151 | 1,385,888 |

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Lessons from longitudinal multi-omic profiling on thousands of people
Microbiome

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Tomasz Wilmanski
Postdoctoral Fellow

Christian Diener
Postdoctoral Fellow
(Gibbons Lab)

Sean Gibbons
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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

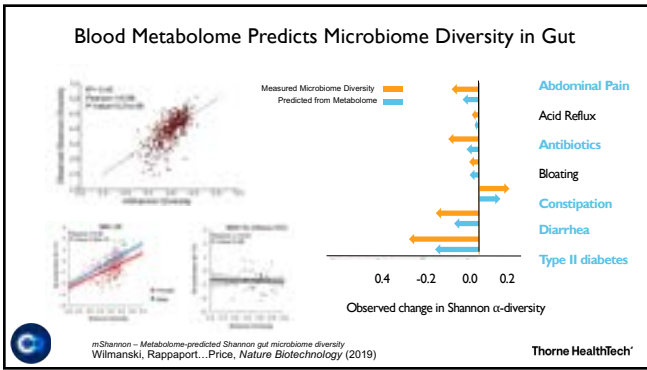
Caucasians

Hunter-Gatherers

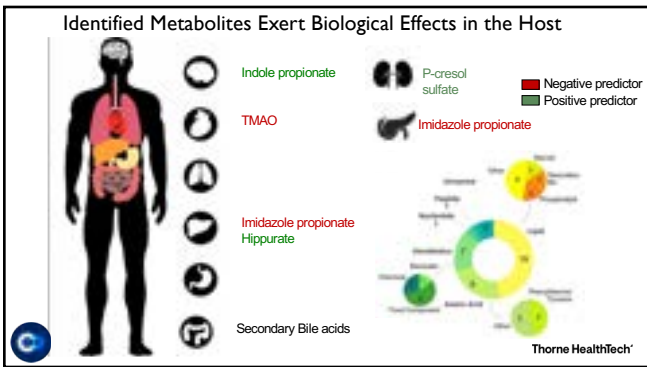
Constipation

Brooks et al., PLOS Biology (2018); 16(12): e2006942
Schnoor et al., Nature Communications (2014); 5:3654

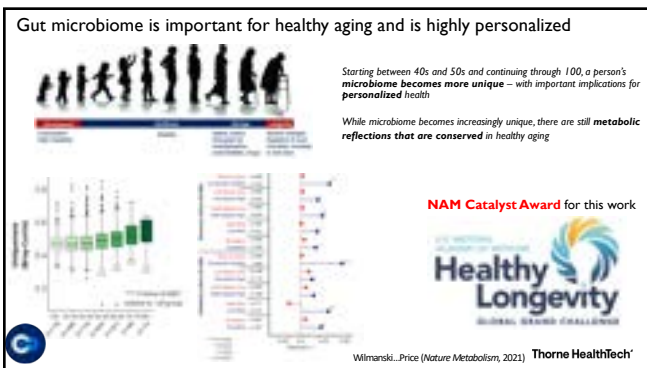
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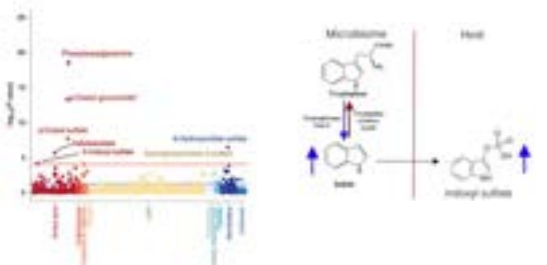


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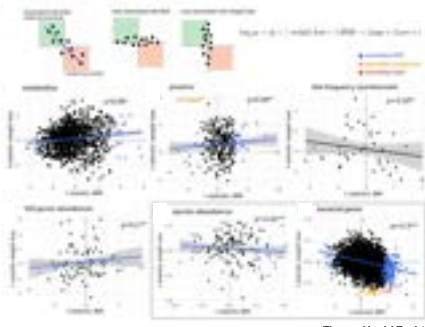
While species become increasingly personalized in healthy aging, the resulting metabolic features are consistent



Wilmanski...Price (Nature Metabolism, 2021) Thorne HealthTech

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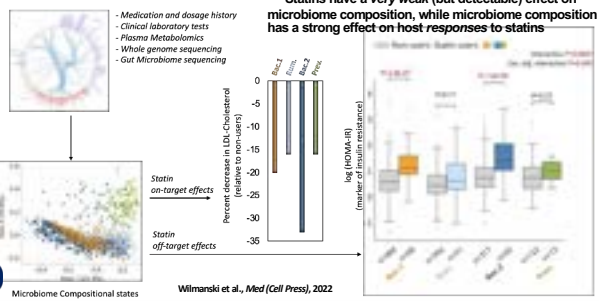
Baseline blood analytes were not predictive of weight loss (independent of BMI), while baseline microbiome was



Diener et al., mSystems, 2021 Thorne HealthTech

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Gut microbiome effects statin efficacy and side effects



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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



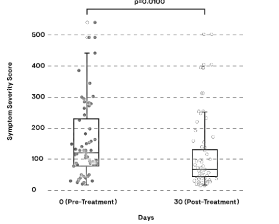
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Personalized recommendations alleviated IBS

Web / Track / Transcribe / Export



Validation of Personalized Interventions for Patients with IBS

- Average symptom score reduction from 150 to 100.0
- Personalized supplements based on microbiome data significantly improved symptoms for patients with IBS




Meydan C, et al. *Precis Clin Med.* 2020 Jun;3(2):136-146

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Thorne Secondary 3/4 Detail Open - Exploded



- Instruction Manual
- Paper Pouch
- 4" x 4" Wipe
- Molded Paper Tray
- Specimen Container
- Gloves
- Finger Hole
- Shipping Envelope & Specimen Bag

Patented 'Microbiome Wipe: Continued Innovation'

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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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Validation of metagenomic sequencing from the wipe

Peer Product Wipe Peer Wipe

CV of alpha diversity

Positive Wipe Peer Negative

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

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

FDA CLEARED ISO 13485

OneDraw is placed on the upper arm

Blood stabilized in removable-cartridge

Cartridge inserted into transport sleeve

1. OneDraw is placed on the upper arm

2. OneDraw is placed on the upper arm

3. OneDraw is placed on the upper arm

4. OneDraw is placed on the upper arm

5. OneDraw is placed on the upper arm

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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."

UNIVERSITY OF CAMBRIDGE

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Implications for the future

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

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Thank You!



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If interested, feel free to reach out:

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