"Personal Data Tracking and the Digital Transformation of Healthcare"

Invited Talk

University of Illinois Silicon Valley Round Table

Palo Alto, CA

December 5, 2012

Dr. Larry Smarr

Director, California Institute for Telecommunications and Information Technology

Harry E. Gruber Professor,

Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

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Calit2 Has Been Had a Vision of "the Digital Transformation of Health" for a Decade

www.bodymedia.com



- **Next Step—Putting You On-Line!**
  - Wireless Internet Transmission
  - Key Metabolic and Physical Variables
  - Model -- Dozens of Processors and 60 Sensors / Actuators Inside of our Cars
- **Post-Genomic Individualized Medicine**
  - Combine
    - Genetic Code
    - Body Data Flow
  - Use Powerful AI Data Mining Techniques

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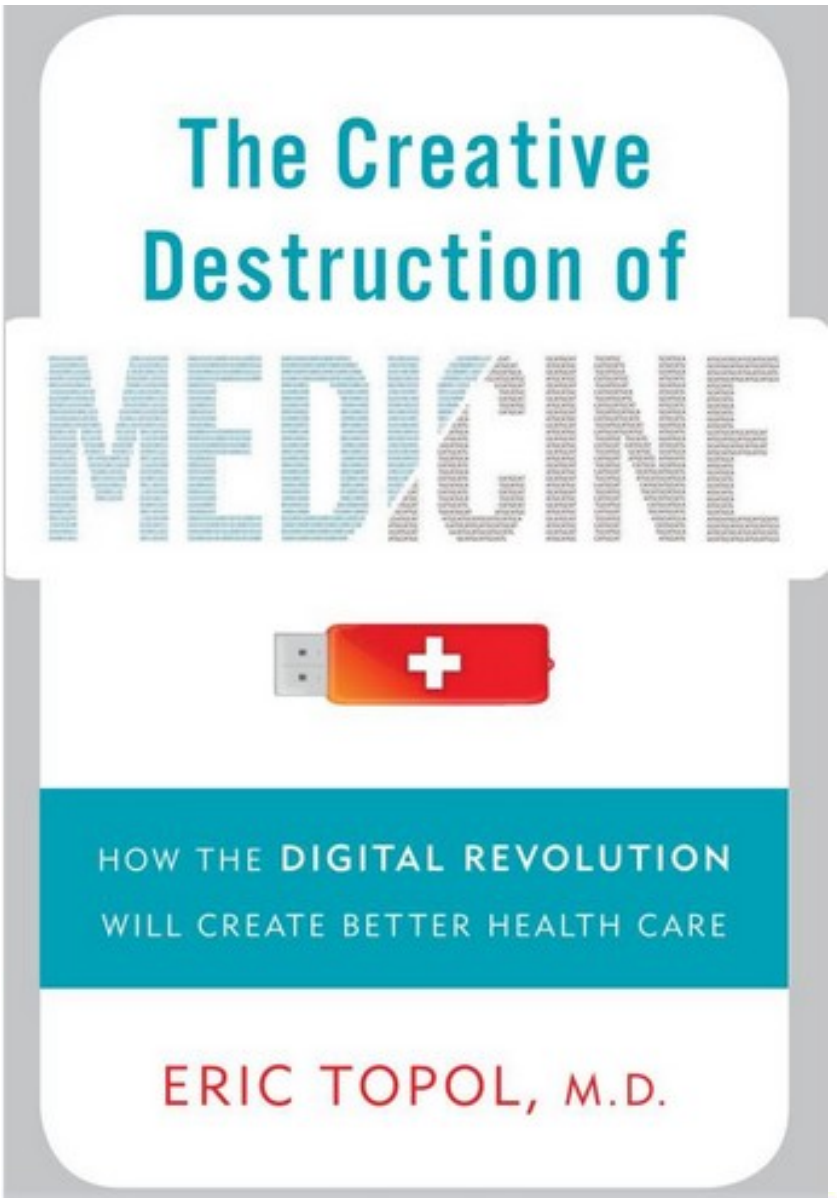
The Content of This Slide from 2001 Larry Smarr Calit2 Talk on Digitally Enabled Genomic Medicine

it²

The Calit2 Vision of Digitally Enabled Genomic Medicine is an Emerging Reality



July/August 2011



February 2012

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I Arrived in La Jolla in 2000 After 20 Years in the Midwest and Decided to Move Against the Obesity Trend

Age 41



Age 51



Age 61



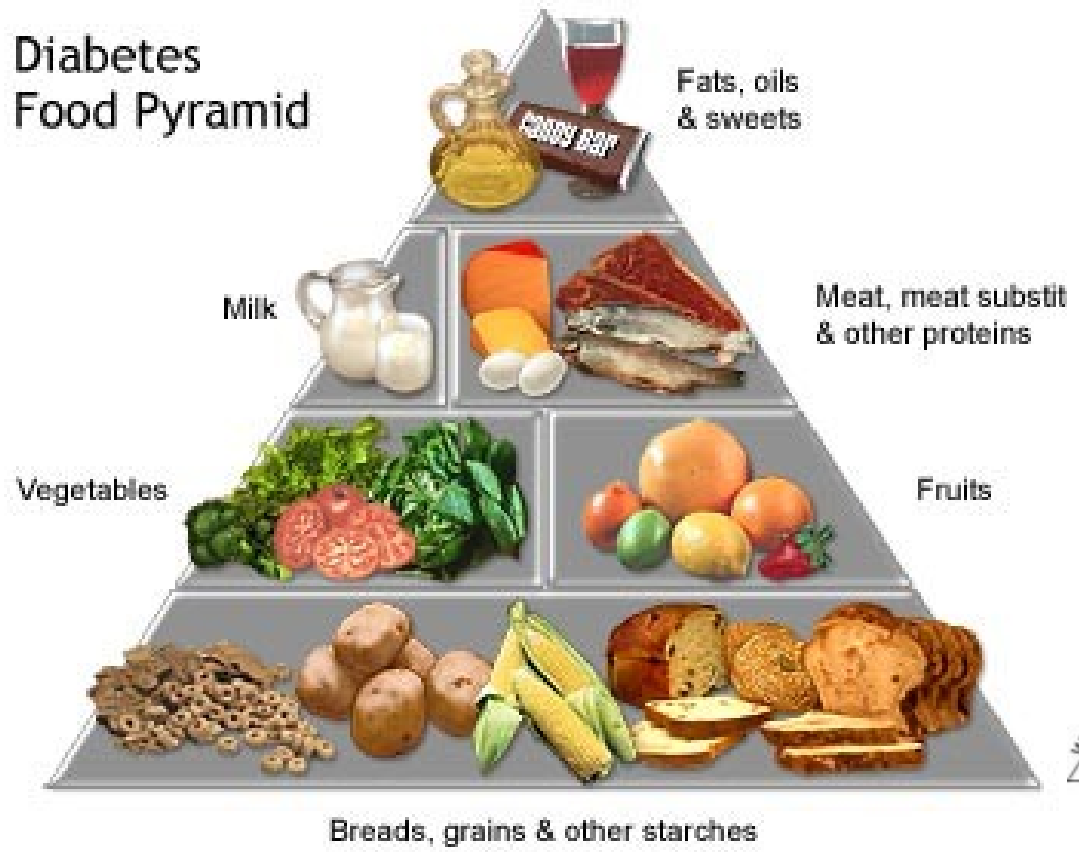
I Reversed My Body's Decline By Altering Nutrition and Exercise

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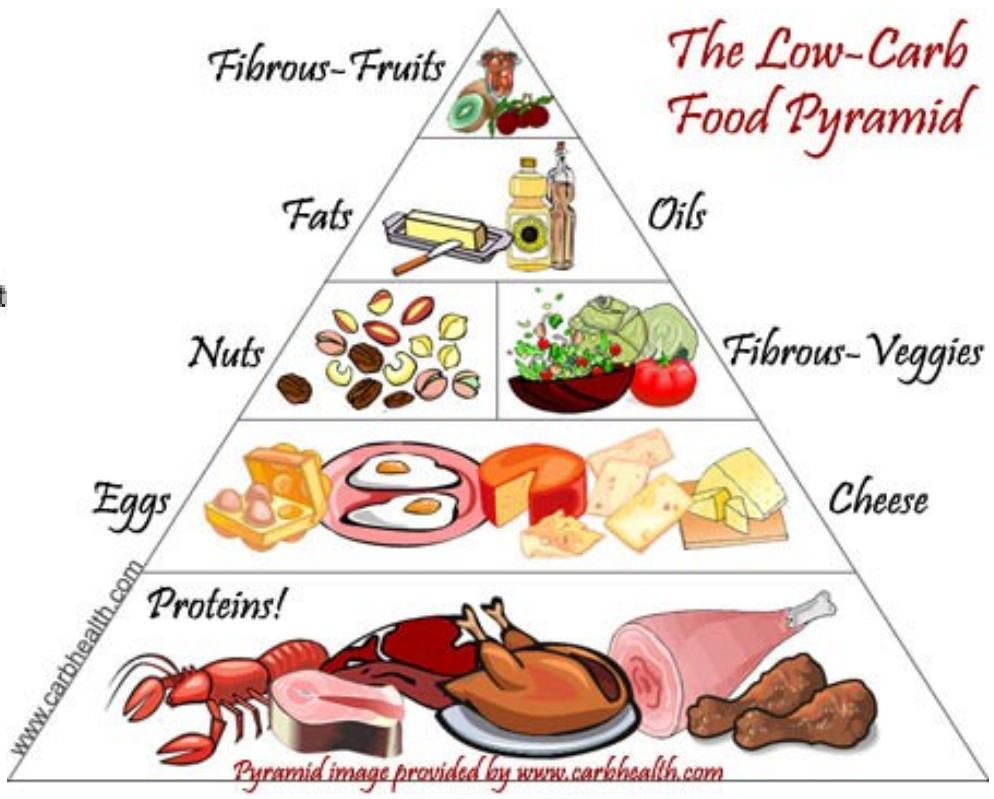
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Is Government and Medical Advice Driving the Obesity Epidemic?

RUSH UNIVERSITY MEDICAL CENTER



The Low-Carb Alternative

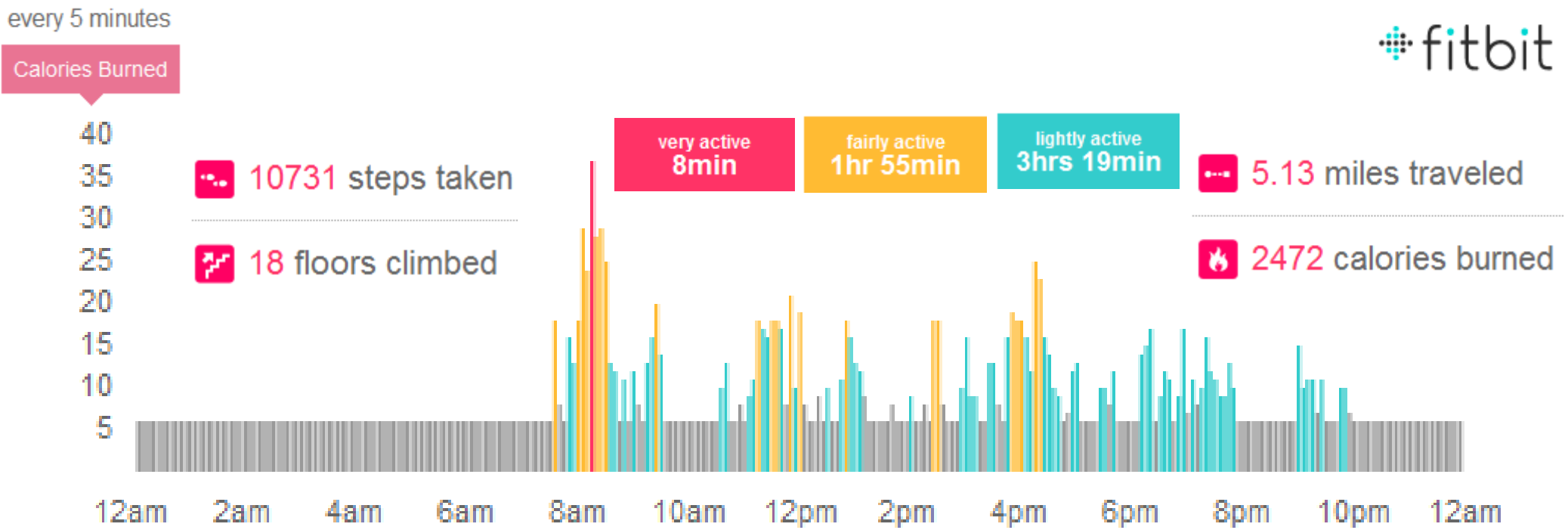


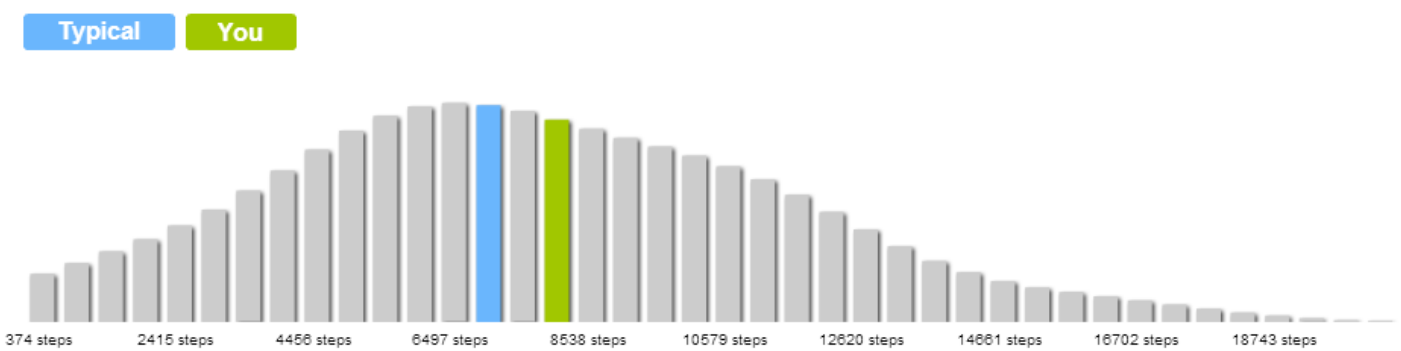
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Avoid High Glycemic Carbs Which Spike Your Glucose-Insulin Cycle

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Wireless Monitoring Helps Drive Exercise Goals







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This week you walked

8028 steps

15% more than the median for men 55 to 64 yrs who are normal or underweight

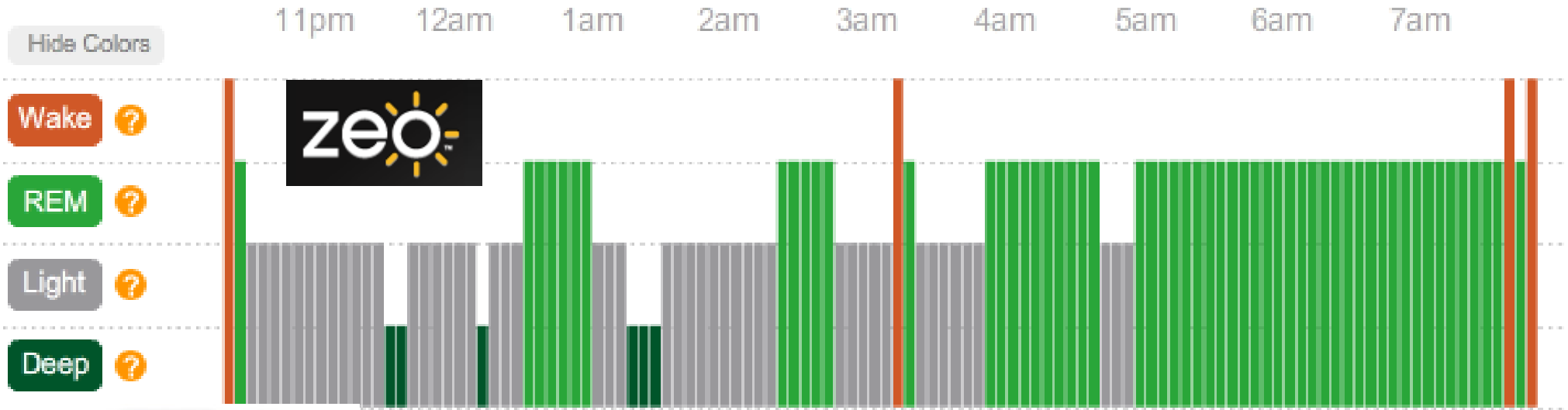
You are in the

60 percentile

of all men 55 to 64 yrs who are normal or underweight

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Quantifying My Sleep Pattern Using a Zeo - Increased My Average to 8 Hours/Night

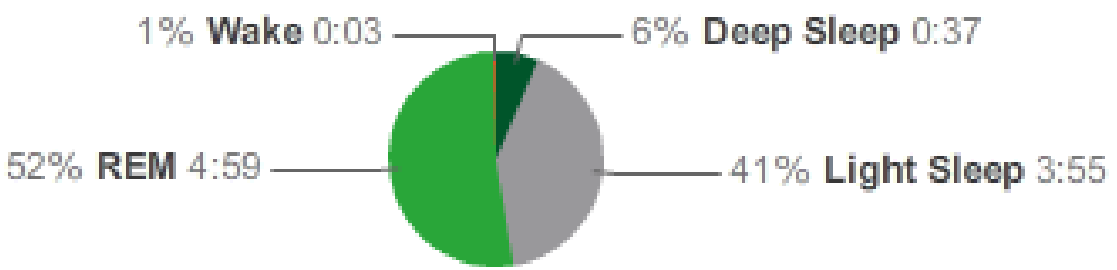




Stroke risk increased by sleeping less than six hours a night
-M. Ruiter, *Sleep* 2012

Total Z: 9 hr 31 min

Time to Z: 0 hr 2 min



Why are these numbers different from the sleep graph above?

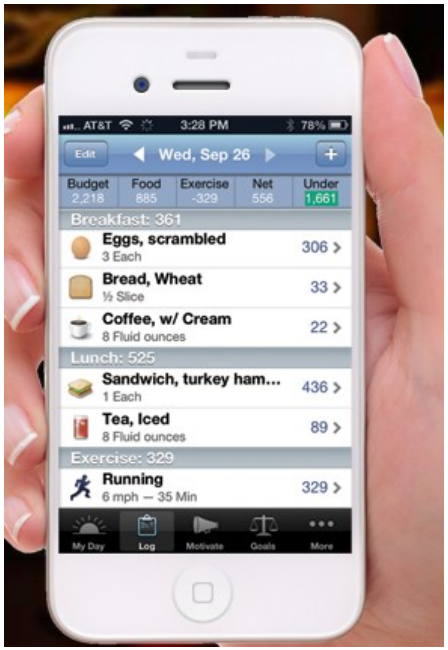
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REM is Normally 20% of Sleep
Mine is Between 45-65% of Sleep

An Infant Typically Has 50% REM

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Challenge-Coupling Personal Sensor Data With Social Networks Across Private Clouds



Lose It-
Calories Ingested



Body Media-
Calories Burned



Withing/iPhone-
Blood Pressure





EM Wave PC-
Stress



Azumio-Heart Rate

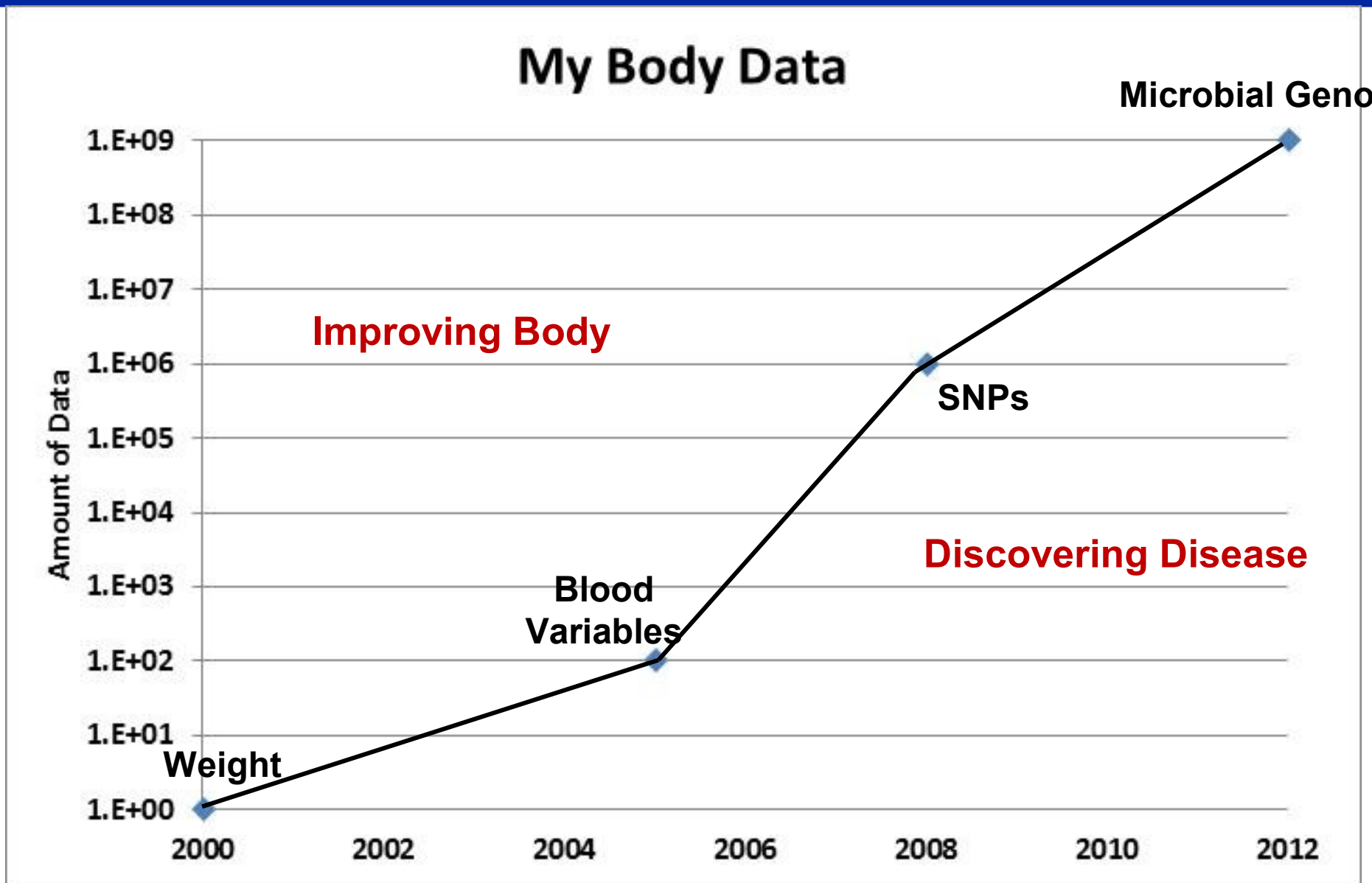


Zeo-Sleep

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From One to a Billion Data Points Defining Me: The Exponential Rise in Body Data in Just One Decade!



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From Measuring Macro-Variables to Measuring Your Internal Variables



The Patient of the Future

Internet pioneer Larry Smarr's quest to quantify everything about his health led him to a startling discovery, an unusual partnership with his doctor, and more control over his life.

www.technologyreview.com/biomedicine/39636

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I Track 100 Variables in Blood Tests Done Quarterly to Annually

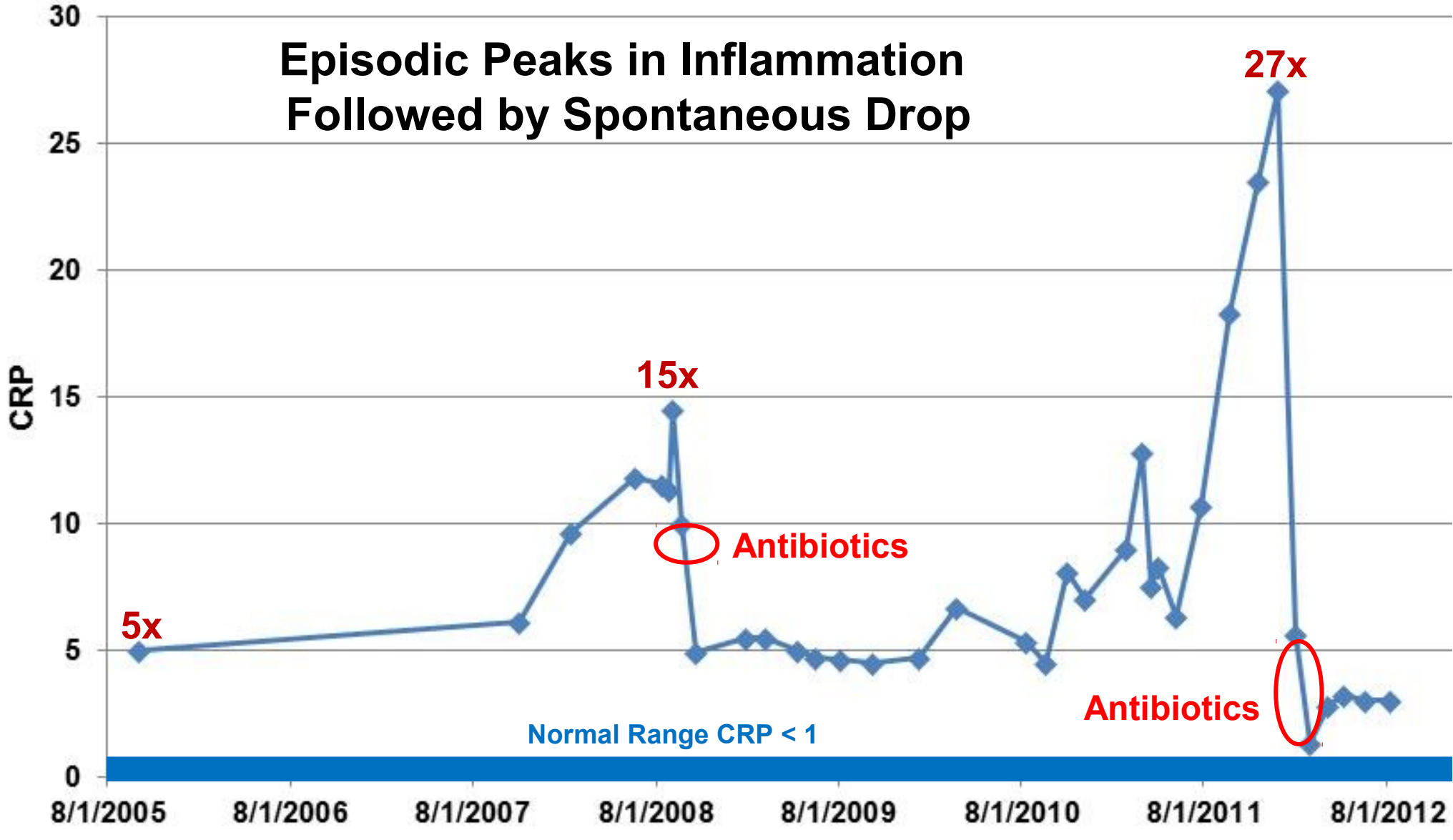
- **Electrolytes**
  - Sodium, Potassium, Calcium, Magnesium, Phosphorus, Boron, Chlorine, CO_2
- **Micronutrients**
  - Arsenic, Chromium, Cobalt, Copper, Iron, Manganese, Molybdenum, Selenium, Zinc
- **Blood Sugar Cycle**
  - Glucose, Insulin, A1C Hemoglobin
- **Cardio Risk**
  - Complex Reactive Protein
  - Homocysteine
- **Kidneys**
  - Bun, Creatinine, Uric Acid
- **Protein**
  - Total Protein, Albumin, Globulin
- **Liver**
  - GGTP, SGOT, SGPT, LDH, Total Direct Bilirubin, Alkaline Phosphatase
- **Thyroid**
  - T3 Uptake, T4, Free Thyroxine Index, FT4, 2nd Gen TSH
- **Blood Cells**
  - Complete Blood Cell Count
  - Red Blood Cell Subtypes
  - White Blood Cell Subtypes
- **Cancer Screen**
  - CEA, Total PSA, % Free PSA
  - CA-19-9
- **Vitamins & Antioxidant Screen**
  - Vit D, E; Selenium, ALA, coQ10, Glutathione, Total Antioxidant Fn.

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Only One of These Was Far Out of Normal Range

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My Blood Measurements Revealed Chronic Inflammation

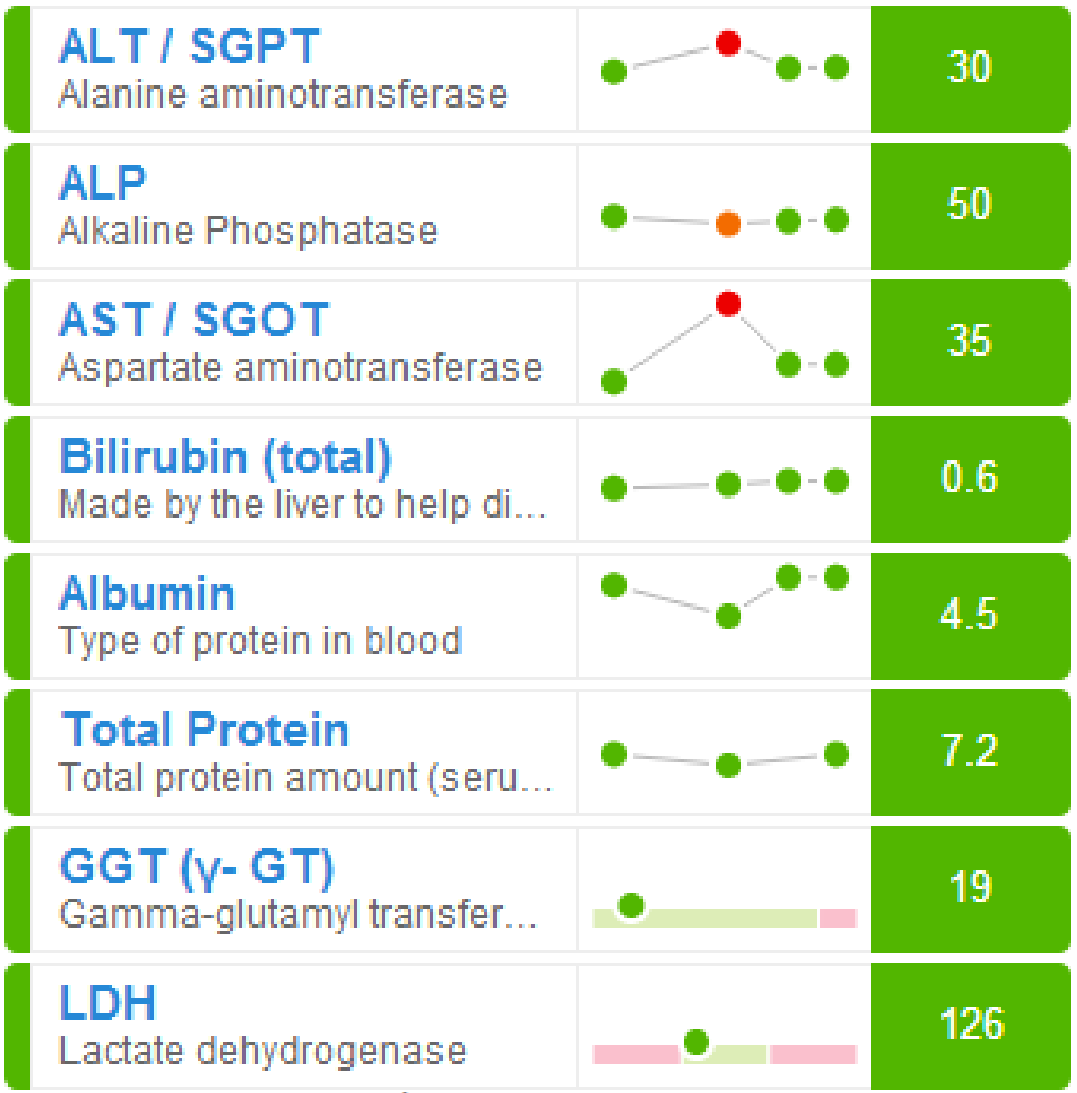


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Complex Reactive Protein (CRP) is a Blood Biomarker for Detecting Presence of Inflammation

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Startup WellnessFX Enables You to Track Your Own Blood Variables



Liver Enzymes and Function Tests

WellnessFX Baseline includes:

- A blood draw at a partner lab
- A 20-minute health consultation with a practitioner you choose from our network*
- Your lab results loaded into your private WellnessFX dashboard
- Your satisfaction guaranteed

Get Started Today

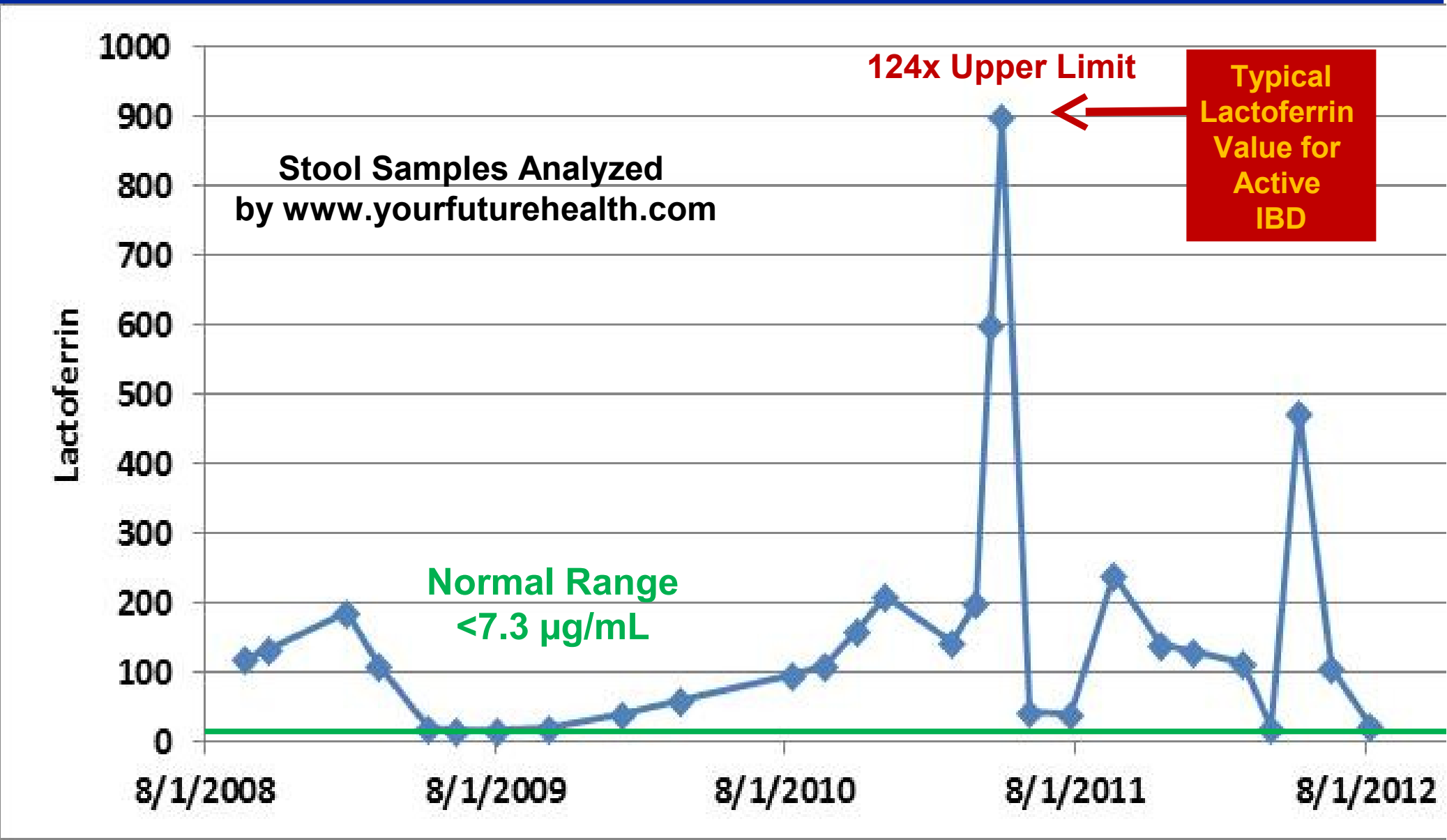
Only $199*

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LS Values from WellnessFX.com

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By Quantifying Stool Measurements Over Time I Discovered Source of Inflammation Was Likely in Colon

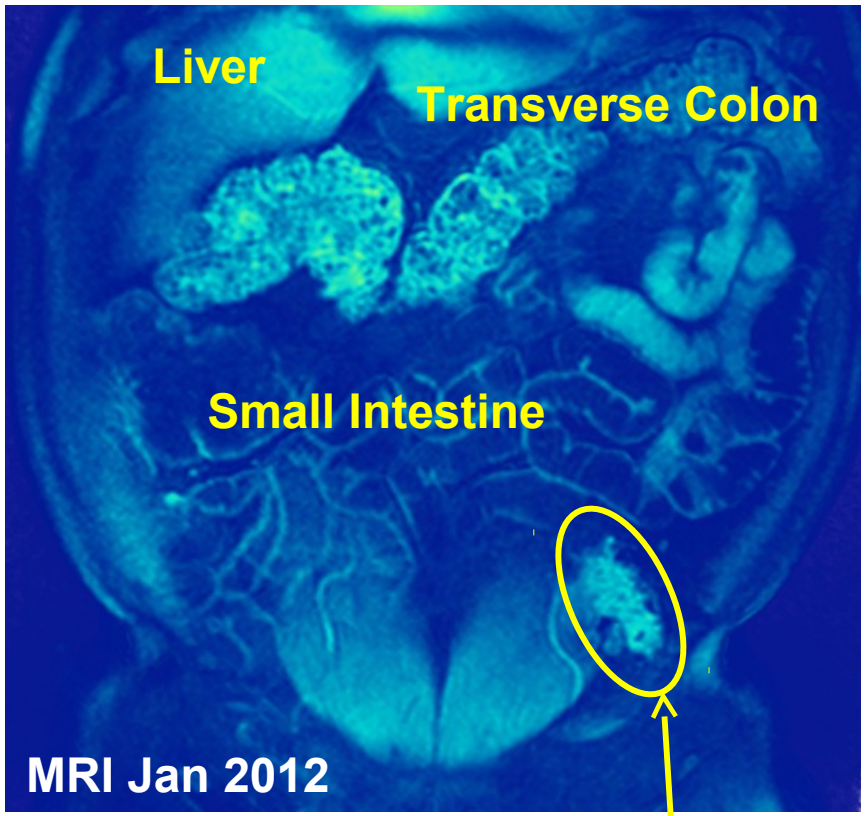


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Lactoferrin is a Sensitive and Specific Biomarker for Detecting Presence of Inflammatory Bowel Disease (IBD)

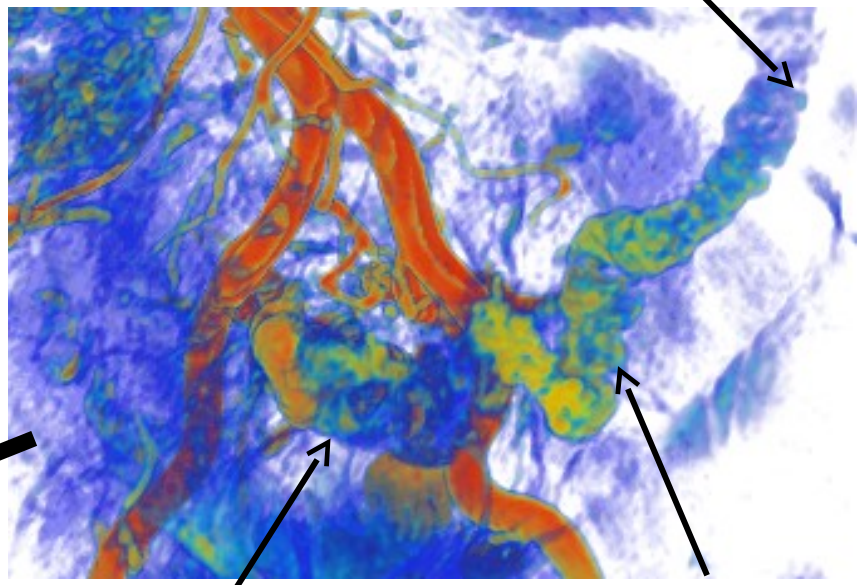
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Confirming the IBD (Crohn's) Hypothesis: Finding the "Smoking Gun" with MRI Imaging



I Obtained the MRI Slices From UCSD Medical Services and Converted to Interactive 3D Working With Calit2 Staff & DeskVOX Software

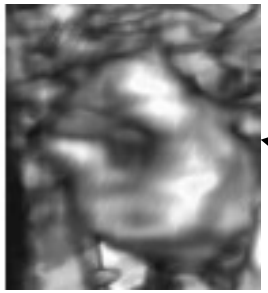
Descending Colon



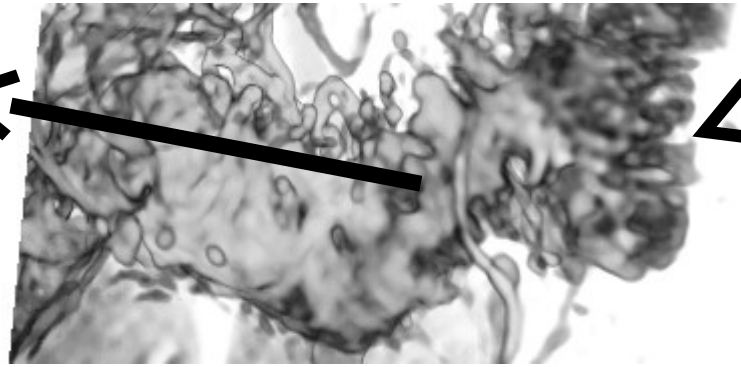
Major Kink

Sigmoid Colon
Threading Iliac Arteries

Cross Section



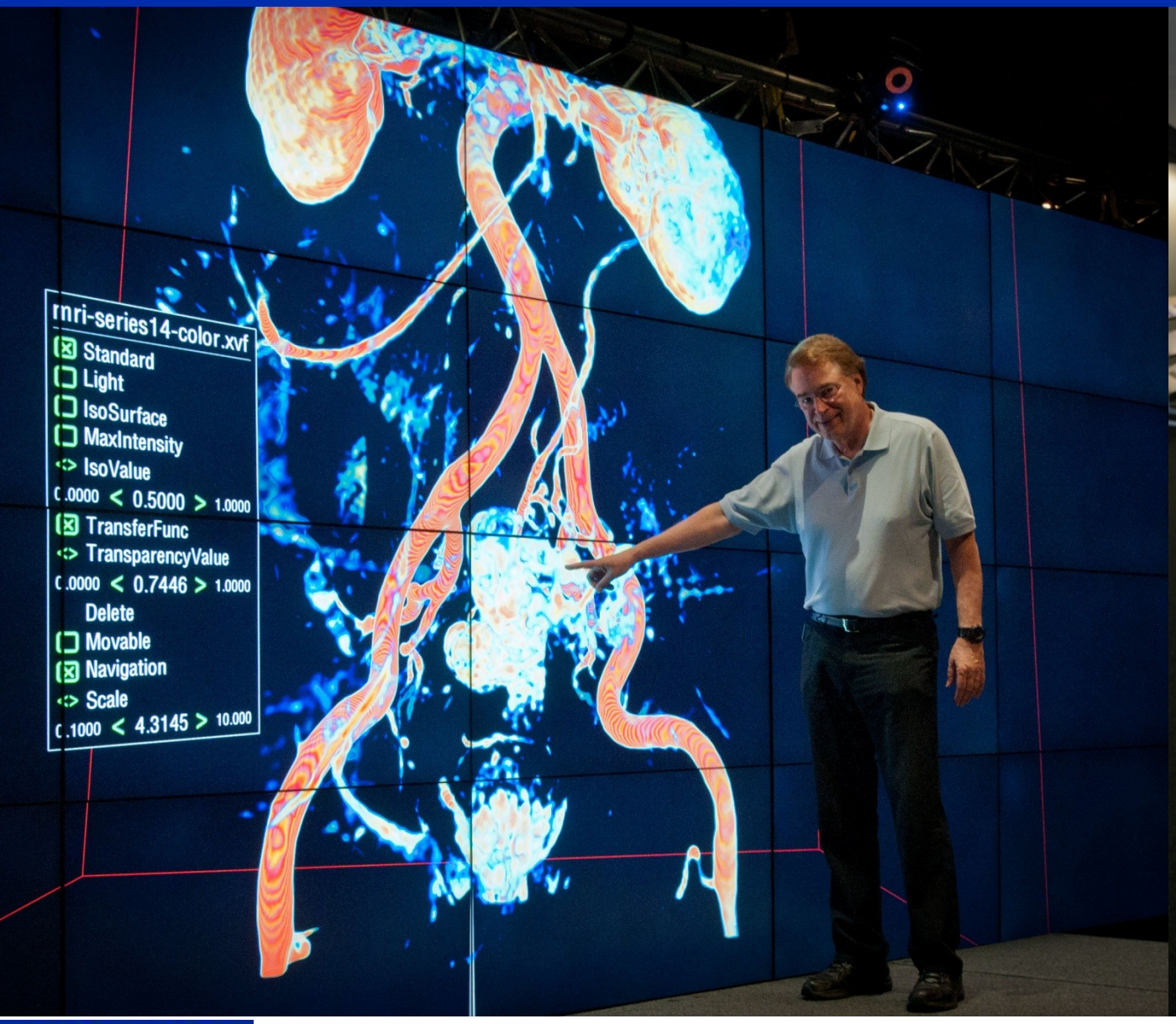
Diseased Sigmoid Colon



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Interactive Visualization and 3D Hard Copy from LS MRI Data





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Research: Calit2 FutureHealth Team

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Why Did I Have an Autoimmune Disease like IBD?

Despite decades of research,
the etiology of Crohn's disease
remains unknown.
Its pathogenesis may involve
a complex interplay between
host genetics,
immune dysfunction,
and microbial or environmental factors.
--The Role of Microbes in Crohn's Disease

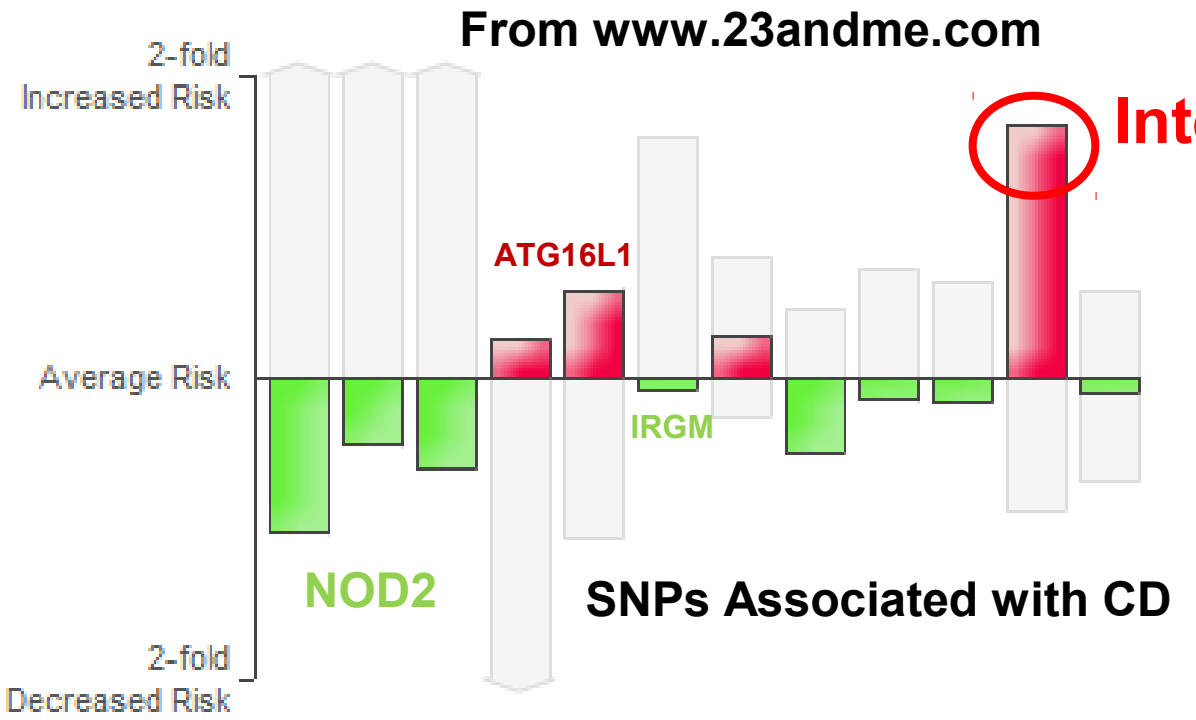
So I Set Out to Quantify All Three!

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Paul B. Eckburg & David A. Relman
Clin Infect Dis. 44:256-262 (2007)

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I Wondered if Crohn's is an Autoimmune Disease, Did I Have a Personal Genomic Polymorphism?



Polymorphism in Interleukin-23 Receptor Gene — 80% Higher Risk of Pro-inflammatory Immune Response

News and Views

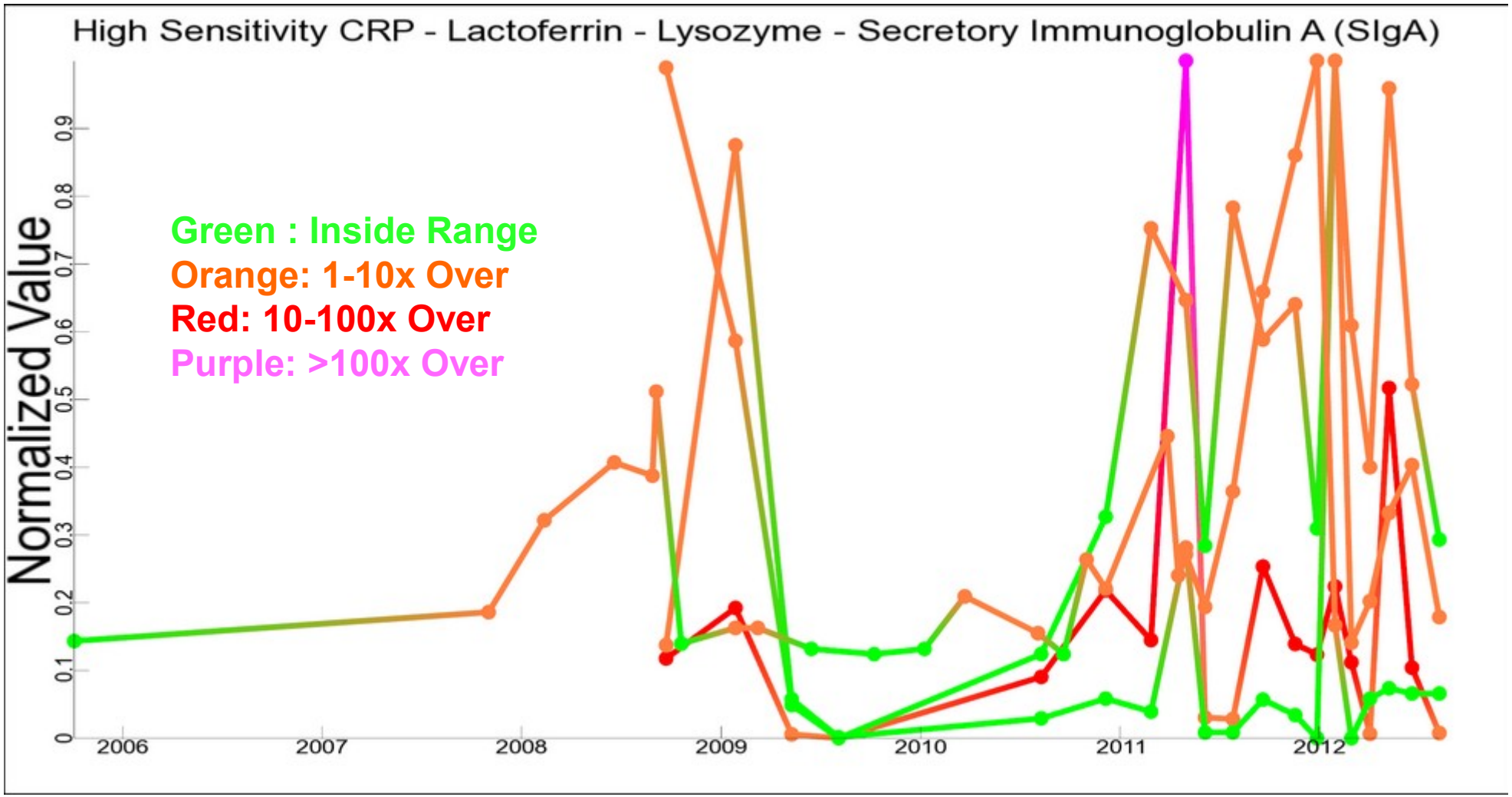
Nature Medicine **13**, 26 - 28 (2007)
doi:10.1038/nm0107-26

IL-23: a master regulator in Crohn disease

Markus F Neurath[1]

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Putting Multiple Immunological Biomarker Time Series Together, Reveals Major Immune Dysfunction



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Source: Calit2 Future Health Expedition Team

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Determining My Gut Microbes and Their Time Variation



Shipped Stool Sample
December 28, 2011

I Received
a Disk Drive April 3, 2012
With 35 GB FASTQ Files

Weizhong Li, UCSD
NGS Pipeline:
230M Reads
Only 0.2% Human

Required 1/2 cpu-yr
Per Person Analyzed!

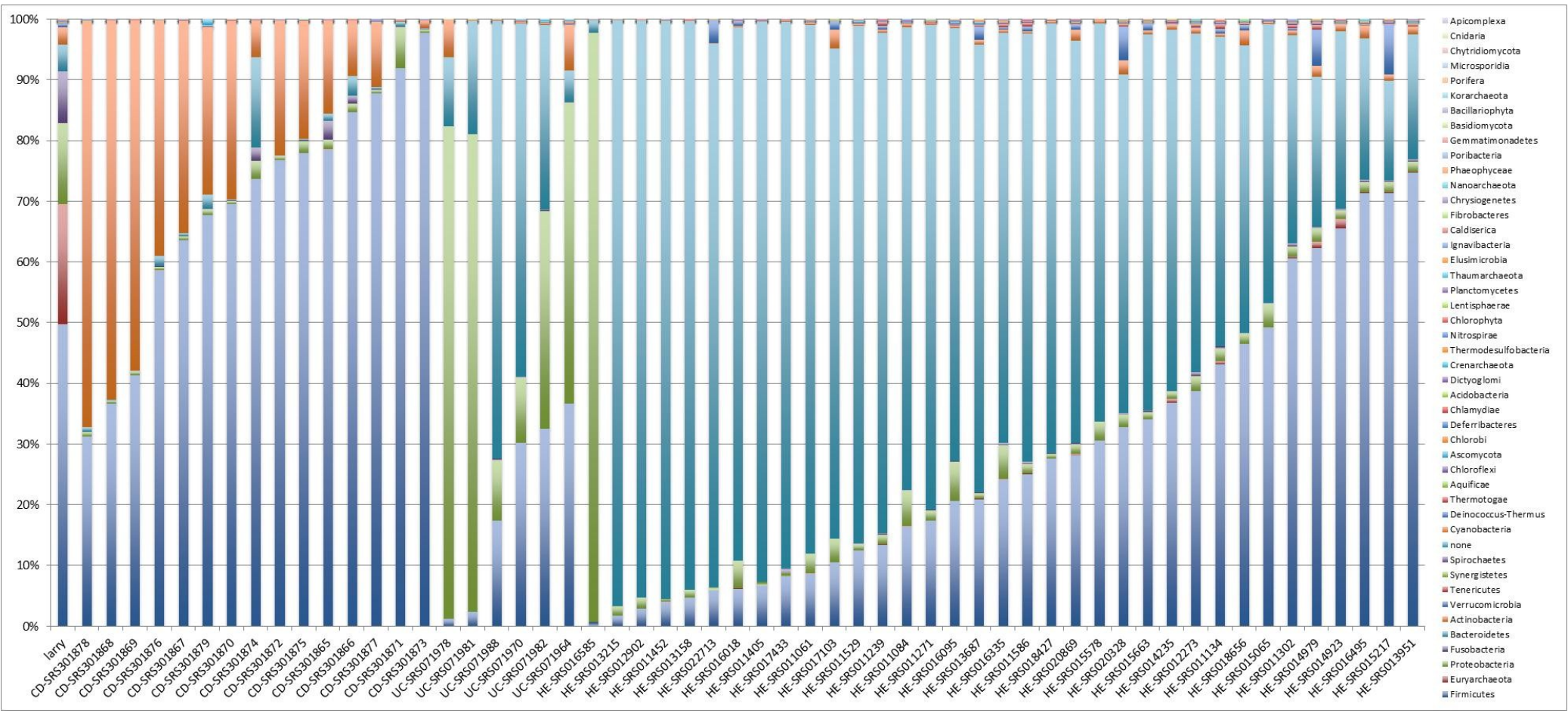
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UC San Diego
HEALTH SCIENCES

J. Craig Venter
INSTITUTE

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Phyla Gut Microbial Abundance: LS, Crohn's, UC, and Healthy Subjects



LS **Crohn's** **Ulcerative Colitis** **Healthy**

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Startups Are Enabling Genomic Sequencing of Your Microbiome

uBiome -- Sequencing Your Microbiome

Be a citizen scientist and help us sequence the human microbiome. Learn about your health, advance science, and CHANGE THE WORLD!

Health – San Francisco, United States

SECOND GENOME
THE MICROBIOME COMPANY



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Where I Believe We are Headed: Predictive, Personalized, Preventive, & Participatory Medicine

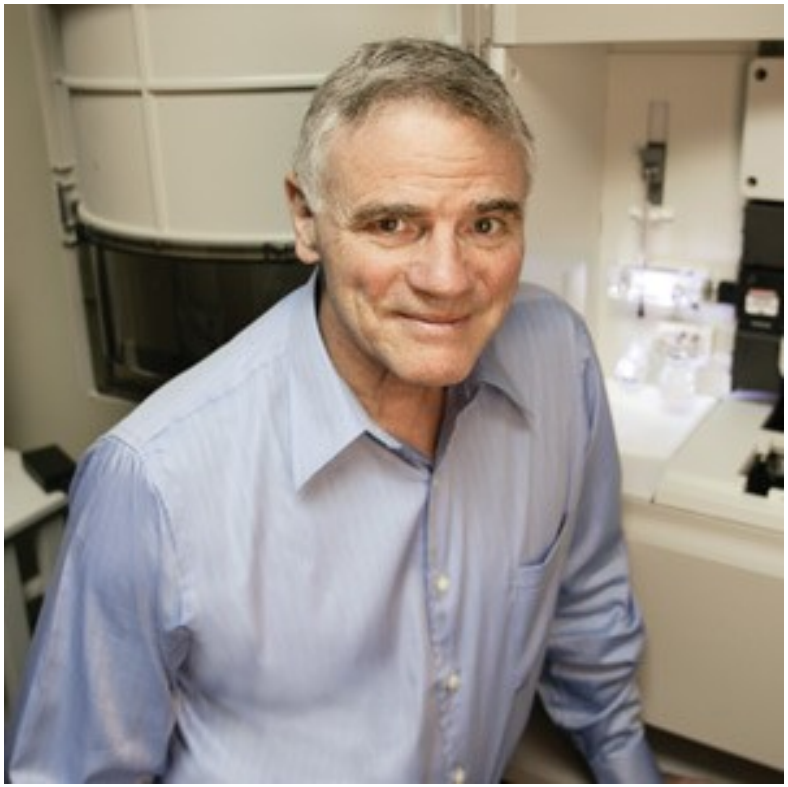
Newsweek

I am Leroy Hood's Lab Rat!

A Doctor's Vision of the Future of Medicine

Leroy Hood
NEWSWEEK

From the magazine issue dated Jul 13, 2009



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www.newsweek.com/2009/06/26/a-doctor-s-vision-of-the-future-of-medicine.html

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