The Future Digital Health Consumer Here Today – Toward Personalized Preventive Medicine

Invited Talk

Johnson and Johnson Pharmaceutical Research & Development Center

La Jolla, CA

February 4, 2011

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

Follow me on Twitter: lsmarr

UCSD

UCIrvine

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

- **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

www.bodymedia.com



- **Post-Genomic Individualized Medicine**
  - Combine
    - Genetic Code
    - Body Data Flow
  - Use Powerful AI Data Mining Techniques

UCSD
UCIrvine

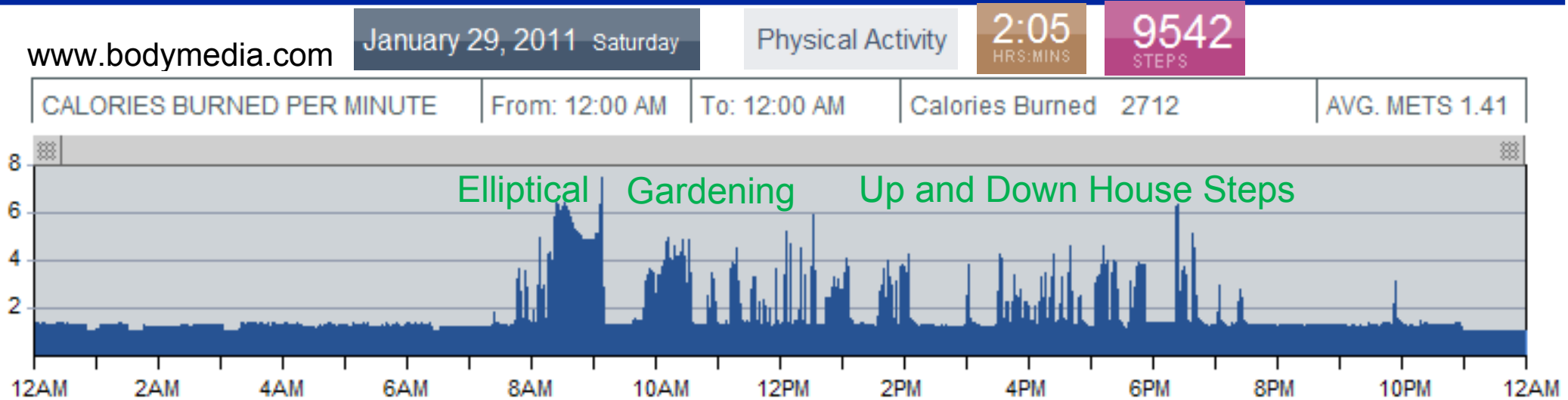
The Content of This Slide from 2001 Larry Smarr
Calit2 Talk on Digitally Enabled Genomic Medicine

it²

Nine Years Later I Am Recording My Metabolic Self

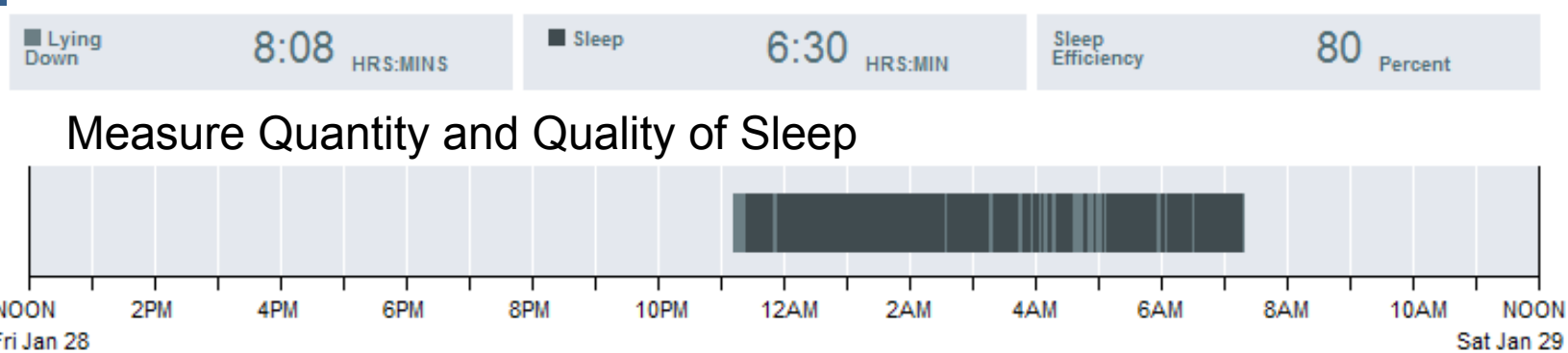
BODYMEDIA®
Know your Body. Change your life

www.bodymedia.com





25 Week Average:
2473 Calories Burned/Day
1:19 hr Physical Activity/Day (>3 METs)
6887 Steps/Day (~3.4 Miles)

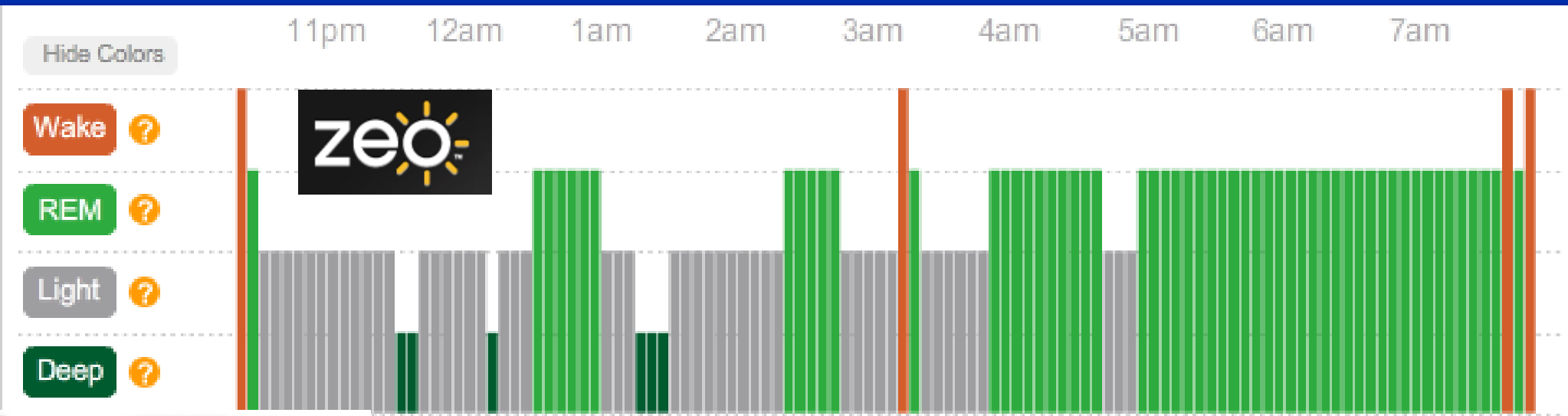


25 Week Ave: 6:51 hrs with 81% Efficiency

UCSD
UCIrvine

it²

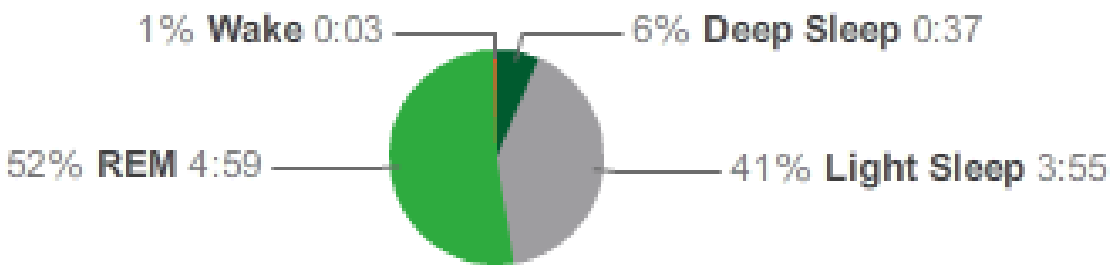
Quantifying My Sleep Pattern Using Zeo - Surprisingly About Half My Sleep is REM!





Total Z: 9 hr 31 min

Time to Z: 0 hr 2 min



Why are these numbers different from the sleep graph above?

UCSD
UCIrvine

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

An Infant Typically
Has 50% REM

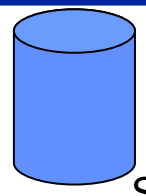
it²

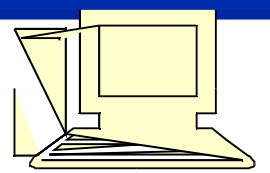
Over the Next Decade an Explosion of Health Sensing: Center for Wireless &Population Health Systems

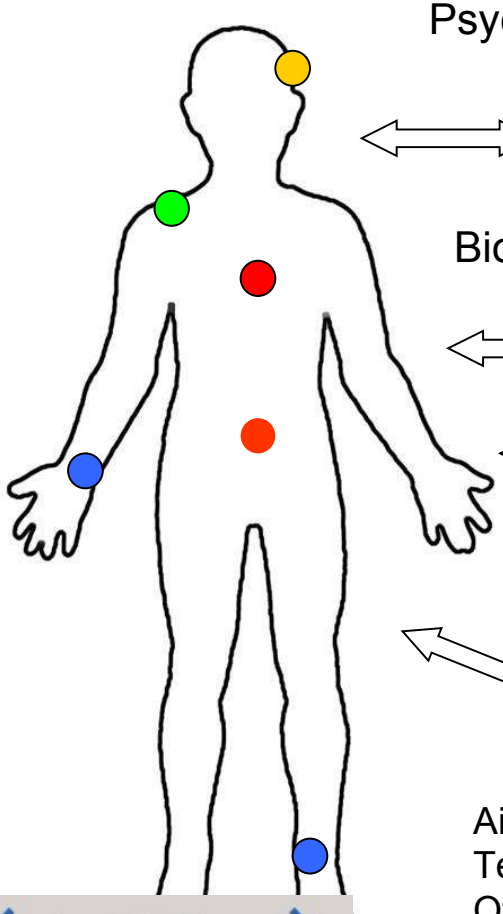
Sensors embedded in the environment

Geocoded data on safety, location of recreation, food, hazards, etc









Psychological & Social sensors
Mood, Social network (peers/family)
Attention, voice analysis

Biological sensors
BP, Resp, HR, Blood (e.g. glucose, electrolytes, pharmacological, hormone), Transdermal, Implants

Diet & Physical Activity sensors
Physical activity (PAEE, type), sedentary
Posture/orientation, diet intake (photo/bar code)

Wearable Environmental sensors
Air quality (particulate, ozone, etc)
Temperature, GPS, Sound, Video,
Other devices & embedded sensors

Sensor data
+
Clinical & Personal Health Record Data
+
Ecological data on determinants of health
+
Analysis & comparison of parameters in near-real time (normative and ipsative)
+
Sufficient population-level data to comprehend trends, model them and predict health outcomes
+
Feedback in near real-time via SMS, audio, haptic or other cues for behavior or change in Rx device

= True Preventive Medicine!

CW PHS
Center For Wireless & Population Health Systems

it²

Center for Wireless and Population Health Systems: Driven by Major Health Challenges

- **Research on Systems of Wireless, Clinical, & Home Technologies to Measure & Improve Lifestyle & Other Health-Related Behaviors In:**
  - **Adolescents**
    - **Healthy & to Prevent Weight Gain**
    - **Overweight & Obese**
    - **At Risk for Type 2 Diabetes**
    - **With Chronic Disease**
    - **Recovering from Leukemia**
  - **Adults**
    - **Depression**
    - **Schizophrenia**
    - **Promoting Successful Aging**
  - **Exposure Biology Research**
  - **Cancer Comparative Effectiveness Research**

CW PHS
CENTER FOR WIRELESS & POPULATION HEALTH SYSTEMS

UCSD
UCIrvine

it²

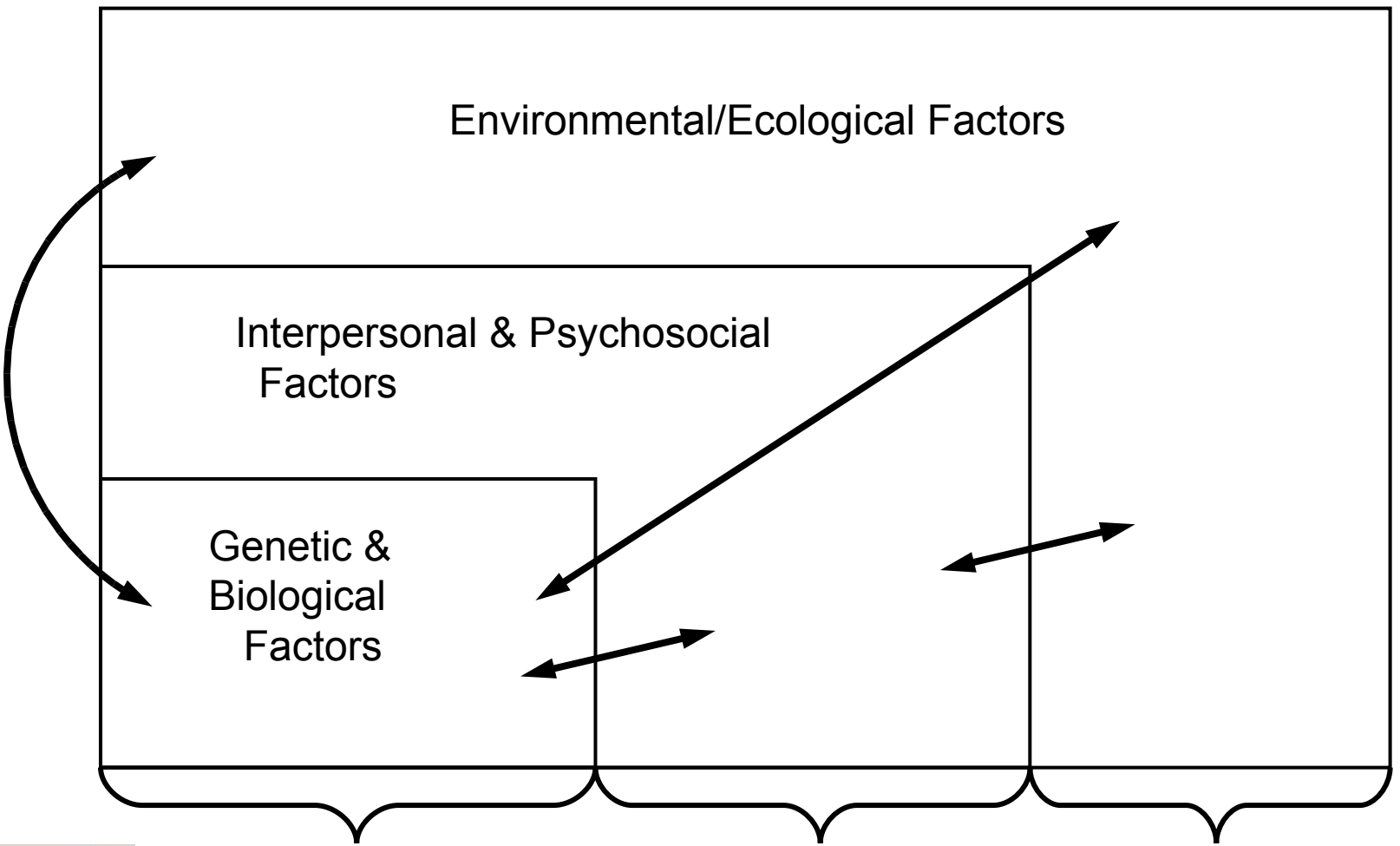
Center for Wireless & Population Health Systems: Cross-Disciplinary Collaborating Investigators

- **UCSD School of Medicine**
  - Kevin Patrick, MD, MS, Greg Norman, PhD, Fred Raab, Jacqueline Kerr, PhD
  - Jeannie Huang, MD, MPH
- **UCSD Jacobs School of Engineering**
  - Bill Griswold, PhD, Ingolf Krueger, PhD, Tajana Simunic Rosing, PhD
- **San Diego Supercomputer Center**
  - Chaitan Baru, PhD
- **UCSD Department of Political Science**
  - James Fowler, PhD
- **SDSU Departments of Psychology & Exercise/Nutrition Science**
  - James Sallis, PhD, Simon Marshall, PhD
- **Santech, Inc.**
  - Jennifer Shapiro, PhD, Ram Seshan, MS, MBA
- **PhD students and Post-doctoral Fellows (current)**
  - Jordan Carlson, Barry Demchak, Laura Pina, Ernesto Ramirez, Celal Zifti

http://cwphs.ucsd.edu

Center for Wireless & Population Health Systems: Integrative View to Support Interventions

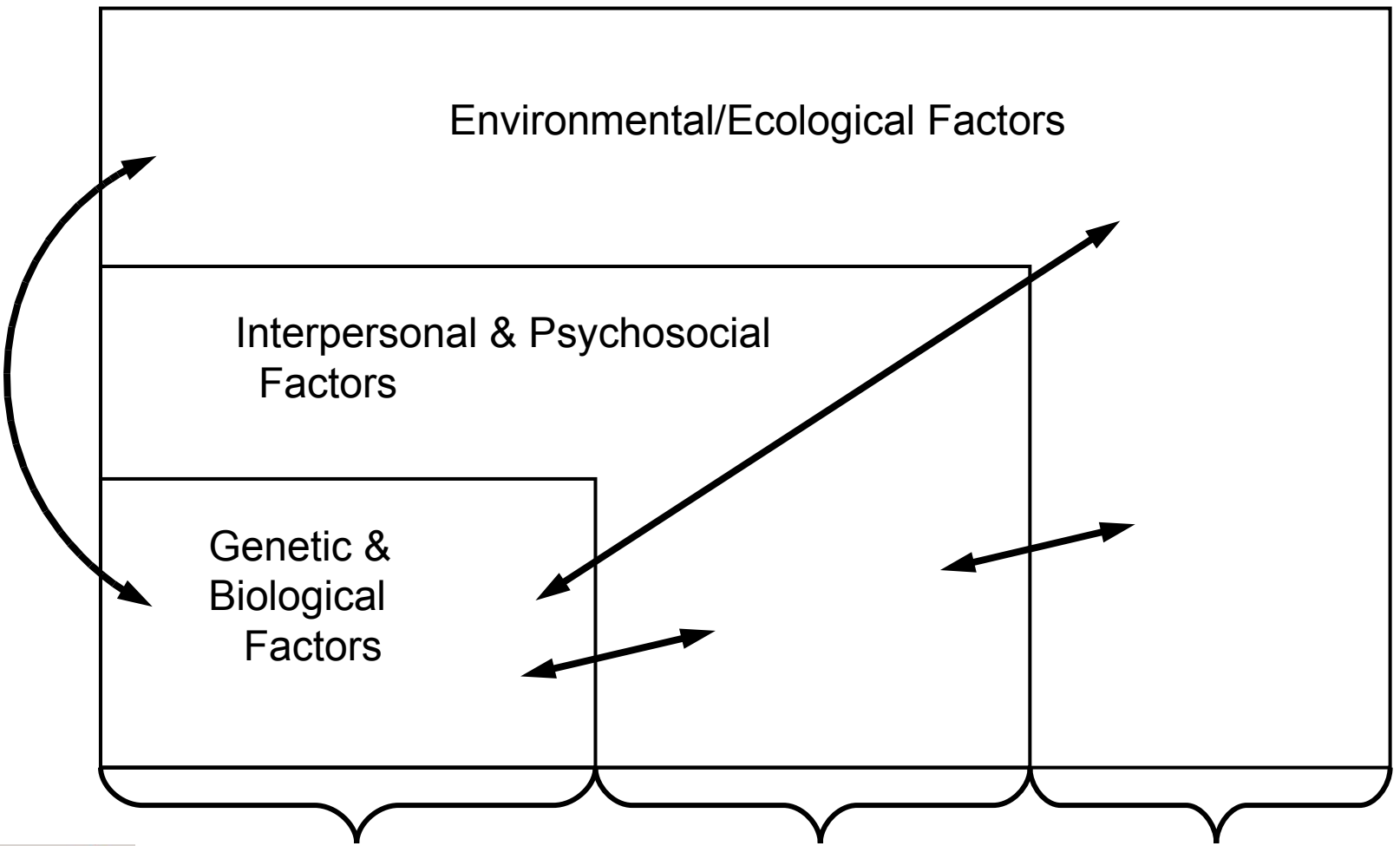
Source: Kevin Patrick, UCSD SOM & Calit2



CW PHS
Center For Wireless & Population Health Systems
it2

Center for Wireless &Population Health Systems: Developing and Testing Engineering-Based Solutions

Source: Kevin Patrick, UCSD SOM & Calit2



NanoTech, Drug Delivery, Sensors, Body Area Networks (BANs)

BAN-to-Mobile-to-Database, SMS/MMS Social networks

Ubicomp, Location-Aware Services, Data Mining, Systems Sciences

CW PHS Center For Wireless & Population Health Systems

it²

Two Projects in the Calit2 Center for Wireless & Population Health Systems

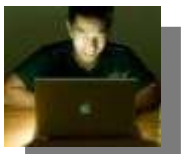
- **CitiSense**
  - Sensing of Individual's Environment
- **SMART**
  - Use of Social Networks to Change Behavior

UCSD
UCIrvine

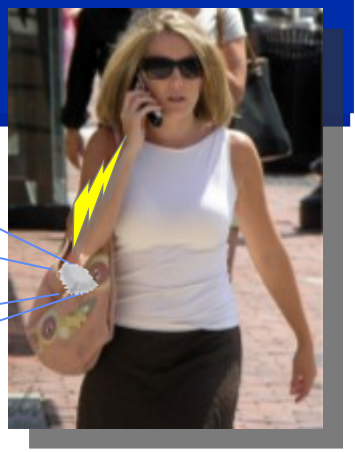
CitiSense –New NSF Grant for Fine-Grained Environmental Sensing Using Cell Phones



4oz
30 compounds













CitiSense Team
PI: Bill Griswold
Ingolf Krueger
Tajana Simunic Rosing
Sanjoy Dasgupta
Hovav Shacham
Kevin Patrick

mobile → social

SMART Social Mobile Approach to Reduce Weight

CW PHS
CENTER FOR WIRELESS & POPULATION HEALTH SYSTEMS

PURPOSE

To leverage social networks, social media, mobile phones, and the web for weight loss among 18-35 year old young adults.
Funded with a 5-year grant from NHLBI/NIH





UCSD
UCIrvine

Source: Kevin Patrick, UCSD SOM & Calit2

mobile → social

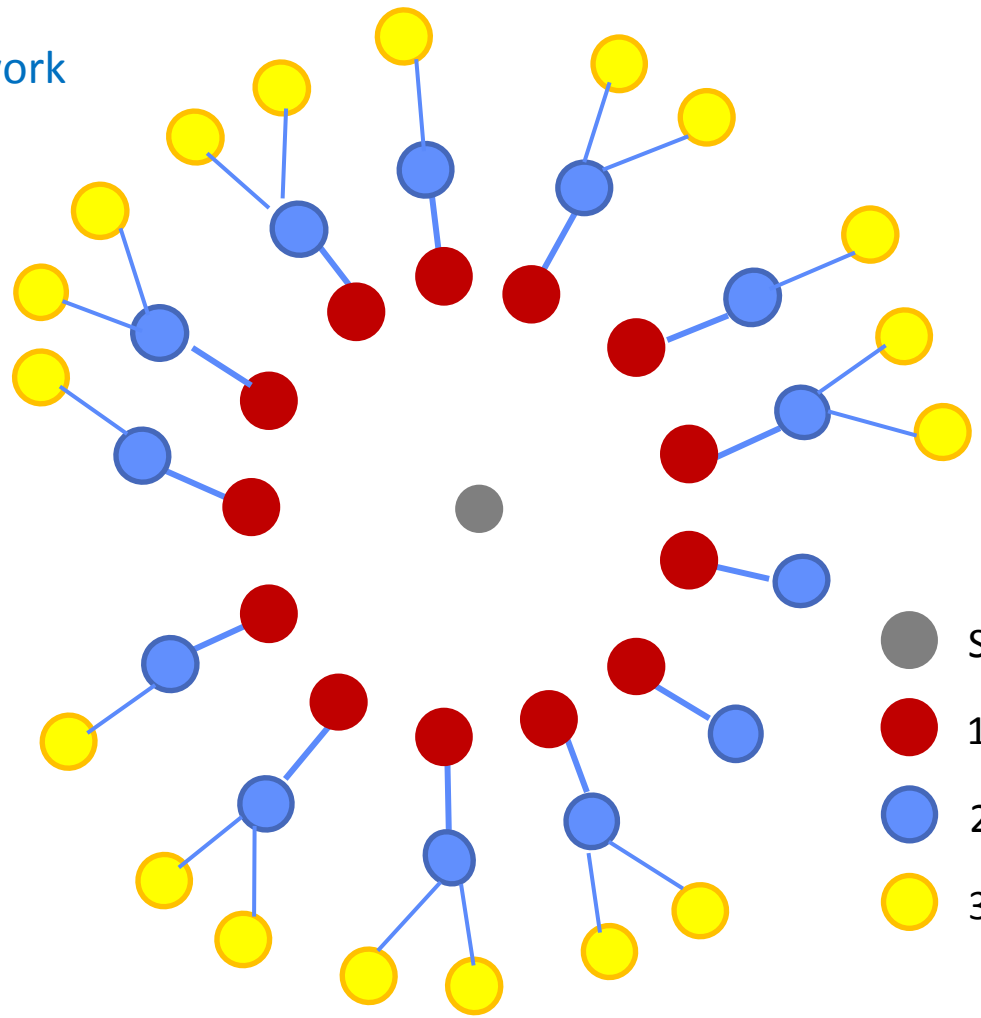
SMART

Social Mobile Approaches to Reduce Weight

CW PHS
CENTER FOR WIRELESS & POPULATION HEALTH SYSTEMS

INTERVENTION

Facebook an Intact Social Network
+
Mobile Phone txt Messaging
+
Smartphone Mobile Apps
+
Website



UCSD
UCIrvine

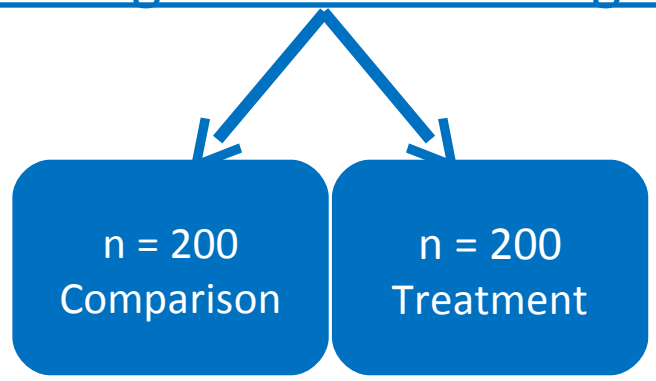
Source: Kevin Patrick, UCSD SOM & Calit2

it²

Study Design:

CENTER FOR WIRELESS & POPULATION HEALTH SYSTEMS

400 Subjects, 18-35 years old
male & female,
Weight: 25 < BMI ≤ 34.9
University students
at four colleges in the San Diego area



- Owns a personal computer
- Owns a mobile phone and uses text messaging
- Facebook user / willing to start using Facebook

- RECRUITMENT BEGINS: March 2011

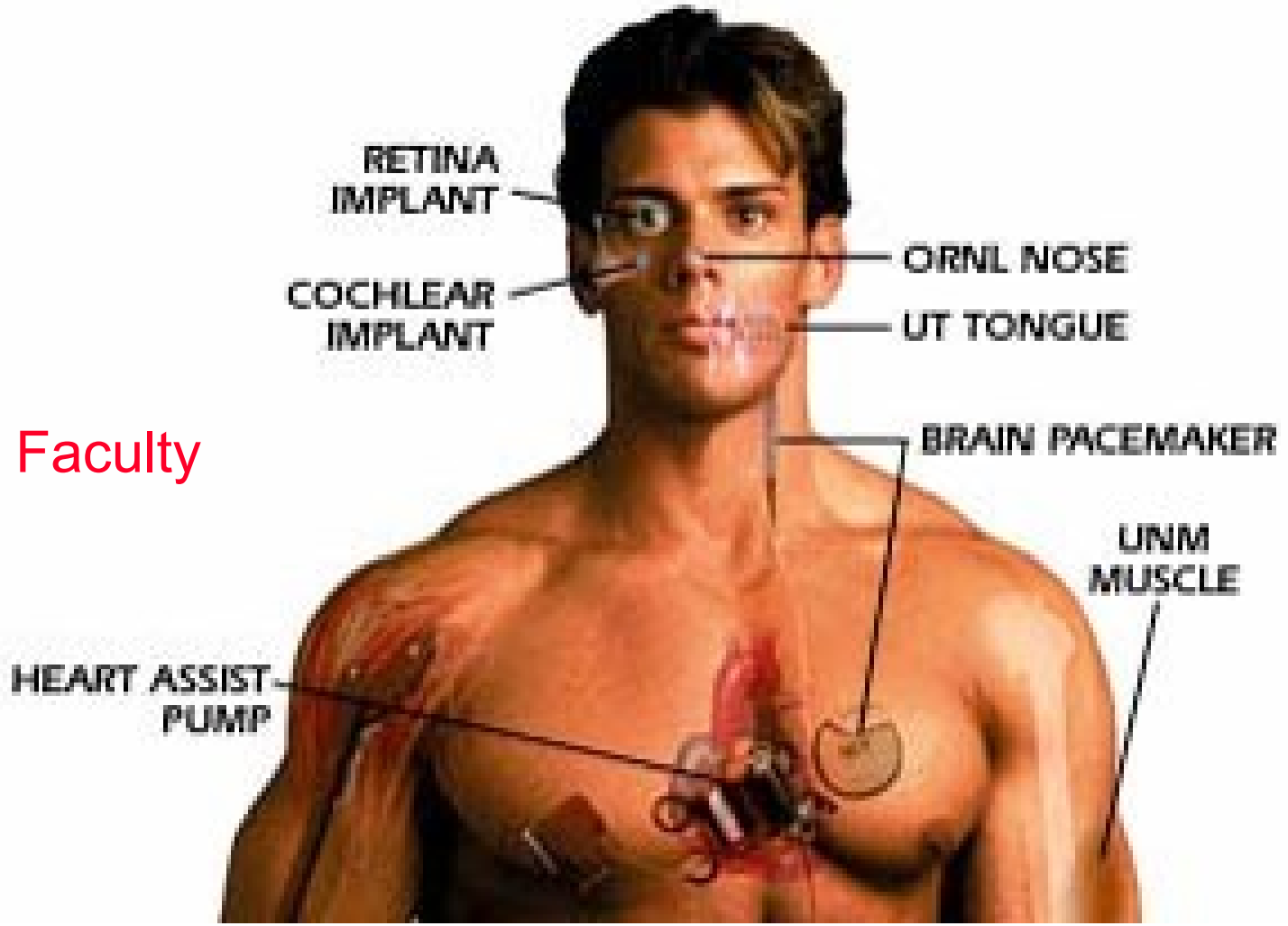
- ENROLLMENT BEGINS: April/ May, 2011

Collaborators and platforms:

UCSD UCIrvine facebook NOKIA Connecting People STANFORD SCHOOL OF MEDICINE Stanford University Medical Center it²

Lifechips--Merging Two Major Industries: Microelectronic Chips & Life Sciences

65 UCI Faculty



UCSD
UCIrvine

lifechips
university of california, irvine
www.lifechips.org

it²

I am the Future Digital Health Consumer: Measuring the State of Your Body and "Tuning" It

I Arrived from 20 Years in the Midwest in 2000 and Decided to Move Against the Obesity Trend

Age 52





Age 62

HEALTH IT, PEOPLE, WIRELESS

How Internet Pioneer Larry Smarr Lost 20 Pounds by Becoming a "Quantified Self"

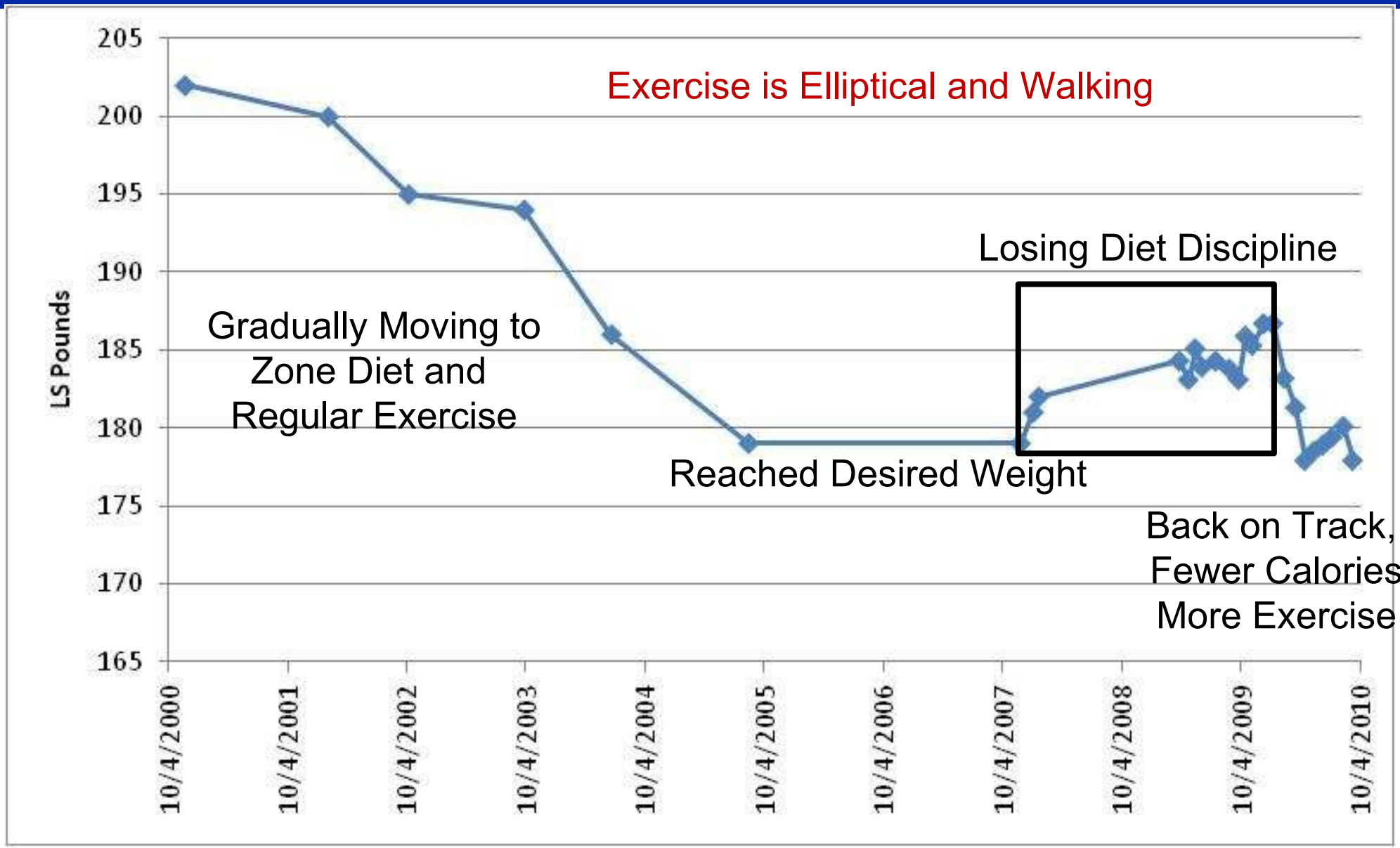
Luke Timmerman 5/12/10

UCSD UCIrvine

www.xconomy.com/san-diego/2010/05/12/how-internet-pioneer-larry-smarr-lost-20-pounds-by-becoming-a-quantified-self/

it²

Goal: Lose Weight by Changing What &How Much I Eat, While Increasing Aerobic Exercise

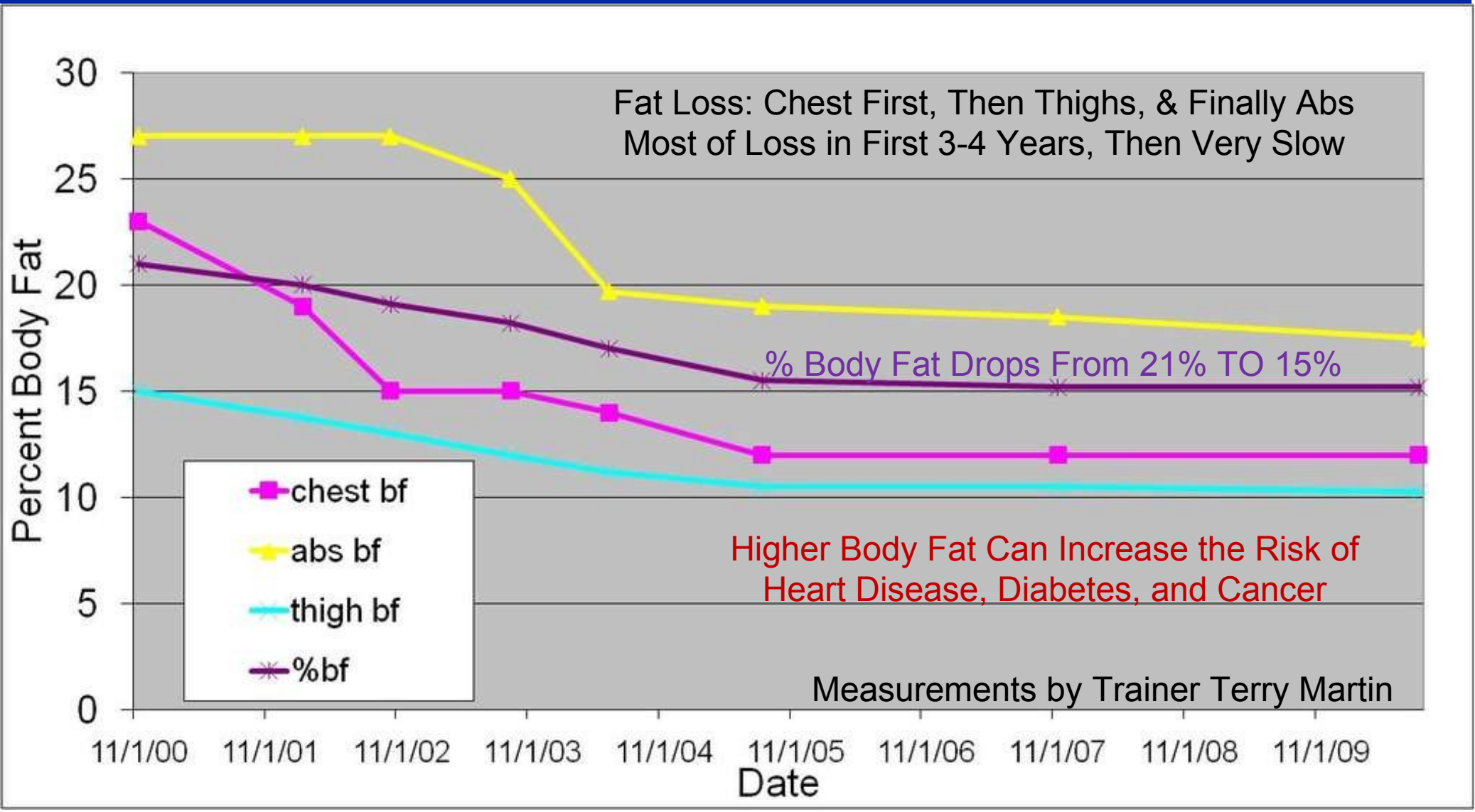


UCSD
UCIrvine

Blood Pressure 134/73 Pulse 55
Resting Pulse Lowered to 45

it²

Goal: Reduce My Body Fat Through Nutrition and Exercise



UCSD
UCIrvine

I Lost More Than 1/3 of My Original Body Fat

it²

Goal: Quantify Your Food Intake So You Can "Tune" Your Glucose/Insulin System and Lower Inflammation

Computed Average Over 12 Days When at Home for Maximum Accuracy
Measure All Food and Drink Components,
Then Use USDA Lookup to Compute Each Item

calories	fat	carb	protein		fiber	sugar	sodium
kcal	g	g	g		g	g	mg
1441	46	122	80	0	26	53	1358

Still Need to Lower Sugar &
Increase Protein and Decrease Fat by 15%

- **Quality of Food**
  - **All Organic and Mostly Locally Grown**
  - **Carbs are Low Glycemic Index**
    - **No Added Sugar or Refined Flour – Mostly Fruits and Vegetables**
  - **Proteins are Lean**
    - **Meat is Grass Fed – No Corn or Antibiotics**
    - **Fish is Wild, Often Locally Caught**
  - **Fats are Omega-3 Rich**
    - **Supplemented by 7g Daily Pharmaceutically Purified Fish Oil Pills**

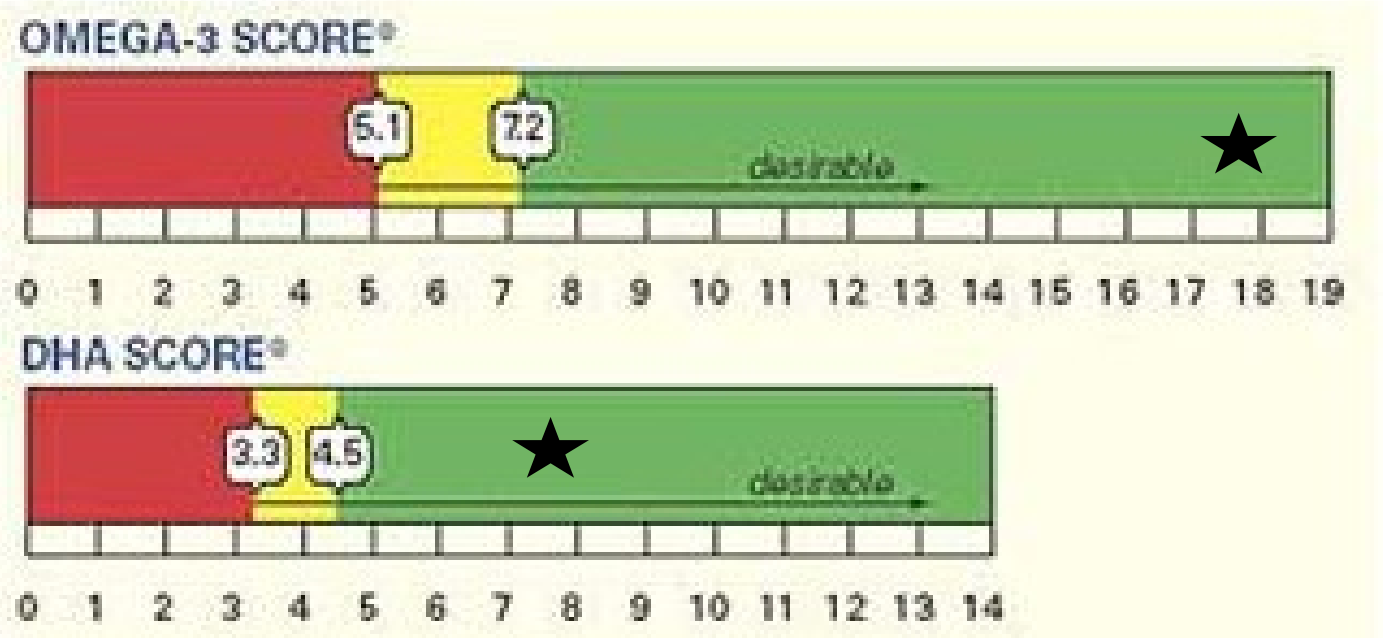
UCSD
UCIrvine

it²

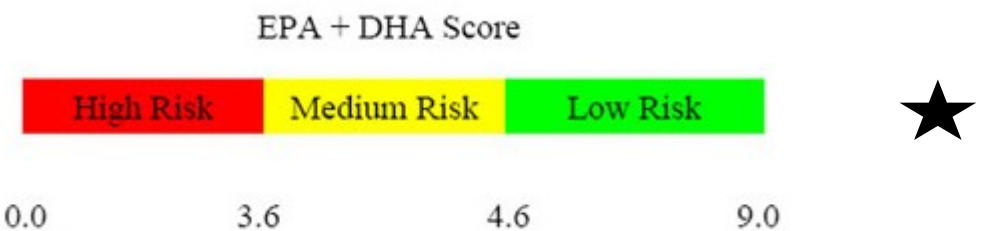
Goal: Improve My Omega-3 ScoresTo Reduce Inflammation & Protect Against Future Heart Disease

Graphics from www.anne-marie.ca/ratiokits/

If your Omega-3 Score is at least 7.2 and your DHA Score is at least 4.5, you are 32% less likely to develop heart disease



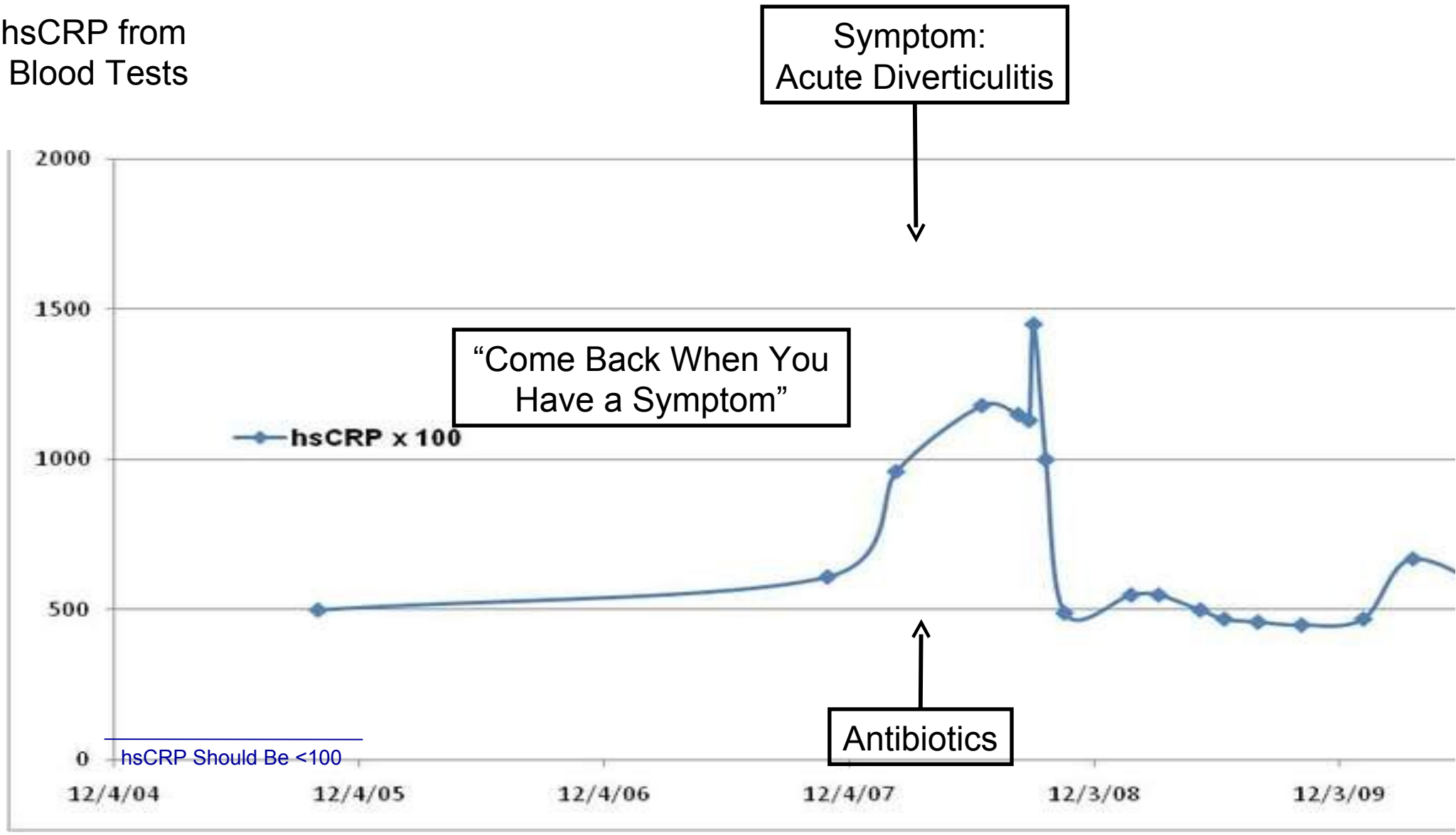
If your EPA+DHA Score is at least 4.6, you are 70% less likely of dying from a heart attack.



★ = My Values Tested by yourfuturehealth.com

Ref: Based on Lemaitre et al., n-3 Polyunsaturated fatty acids, fatal ischemic heart disease, and nonfatal myocardial infarction in older adults: the Cardiovascular Health Study. Am. J. Clin. Nutr. 77:319-325 (2003).

In Spite of My High Levels of Omega-3s, Blood Measurements Show Chronic Inflammation

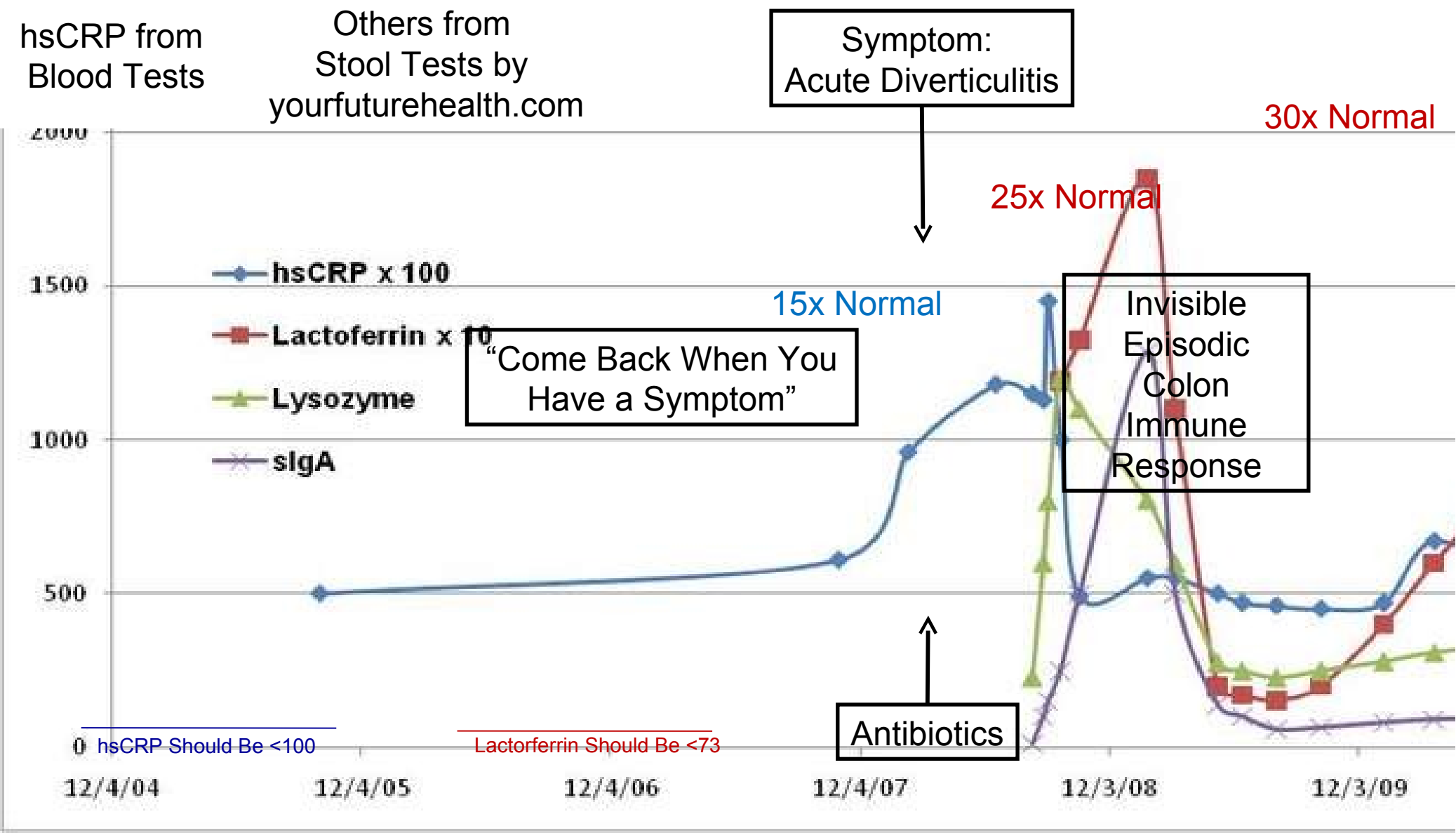


UCSD UCIrvine

High Sensitivity Complex Reactive Protein is the Standard Blood Test for Inflammation

it²

Blood Tests Did Not Reveal Colon Immune Response-- Stool Tests Provide Additional Insight



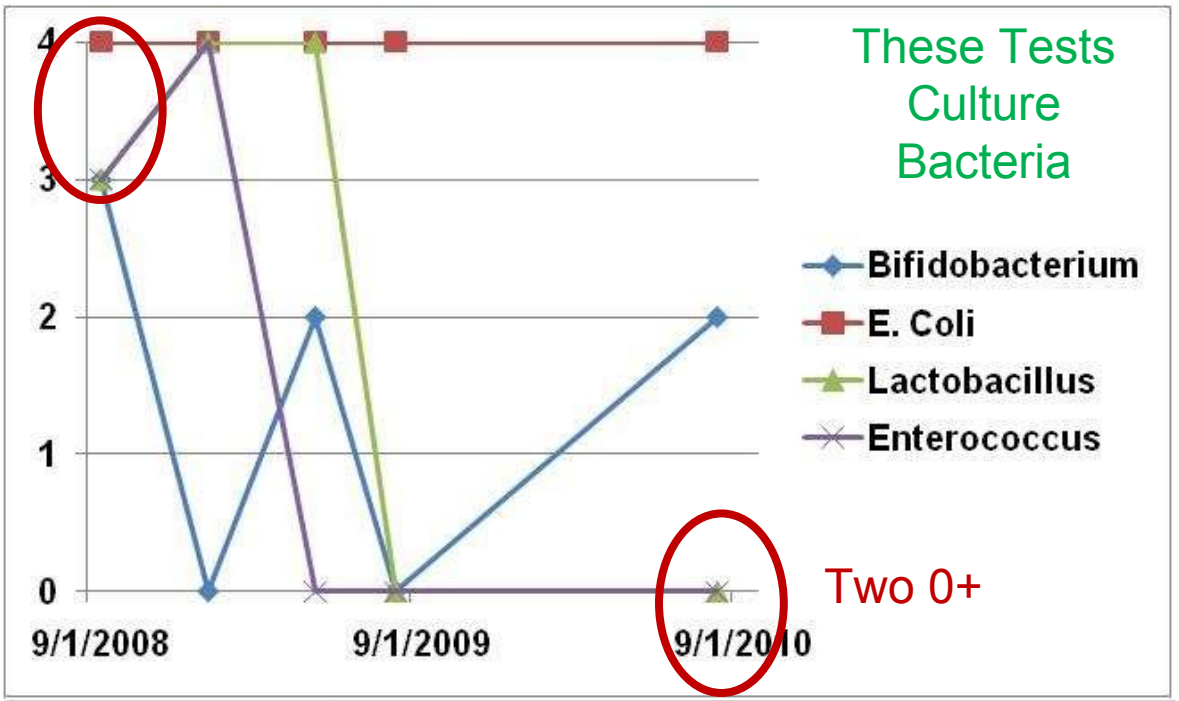
UCSD UCIrvine

Future Challenge: Danger of Persistent hsCRP Inflammation and Destabilized Microbiome

it²

Goal: Monitor the Colon Microbiome- an Ecological Battle Between Beneficial and Harmful Bacteria

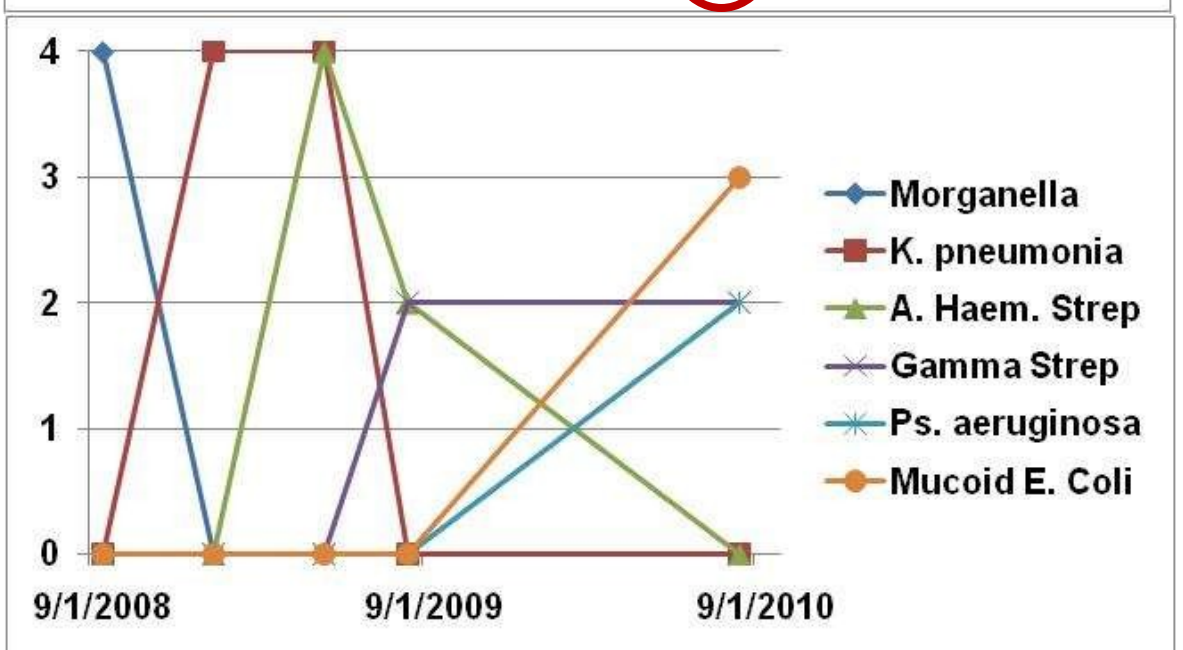
All 3+ or 4+ Three Weeks Before Taking Antibiotics



These Tests Culture Bacteria

Two 0+

Two Years After 10 Days of Antibiotics Levaquin & Metronidaloze



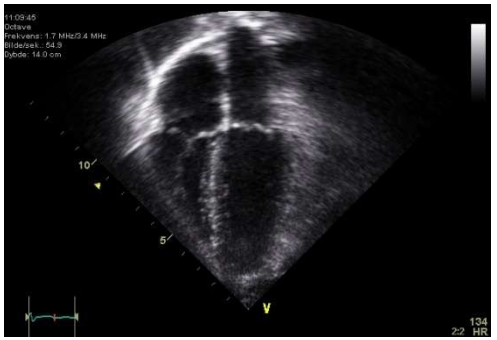
Next Step Get DNA Microbe, Parasite, Yeast Test

UCSD
UCIrvine

Goal: Determine the Structural State of Each Internal Organ and Major Body Subsystems



Carotid Ultrasound Imaging
Plaque Thickness



Stress Test with Echocariogram
Heart Fitness
Structural Weakness

Physical Colonoscopy
Detect Polyps
Colon Disease



64 Slice Heart CT Scan
Plaque Sites
Valve Anomalies





3D Full Body Scan
mm Accuracy
Small Tumors
Organ Damage
Plaque Sites
Virtual Colonoscopy



UCSD
UCIrvine

it²

Amazing Improvements Are Possible Through Nutrition, Exercise, and Stress Management

The Quantified Body of Professor Ramesh Rao,
UCSD Division Director, Calit2

	Mar-08	May-08	Dec-08	Feb-09	Jun-09	July-10	*Target*
LDL	151	103	89	82	86	56	< 130
HDL	42	42	62	59	71	64	≥ 40
Triglycerides	223	100	57	81	60	53	< 150
hsCRP		3.4		0.5	0.7	0.6	< 1
Homocysteine		21.5		8.5		7.5	< 15

Broad Spectrum Amino Acid Vegetarian Diet,
1000 Miles of Running, 1000 Hours of Yoga

UCSD
UCIrvine

Should You Keep Your Health Data Private or Share to Gain the Most Knowledge?

U.S. Department of Health & Human Services
HHS.gov *Improving the health, safety, and well-being of America*

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy and Security Rules

trusera

Trusera is an online health network platform where you can find and share real-world experiences. Share your story and experience the Power of Been There™.

patientslikeme®

Share Your Health Profile

By openly sharing your health profile with the community, you can learn more about yourself while helping other patients like you.

Social Networks and Health NEXT

Medicine 2.0 #10 – Medicine and the Second Generation of Internet-based Services

by Walter Jessen

Quantified Self
tools for knowing your own body and mind

UCSD
UCIrvine

it²

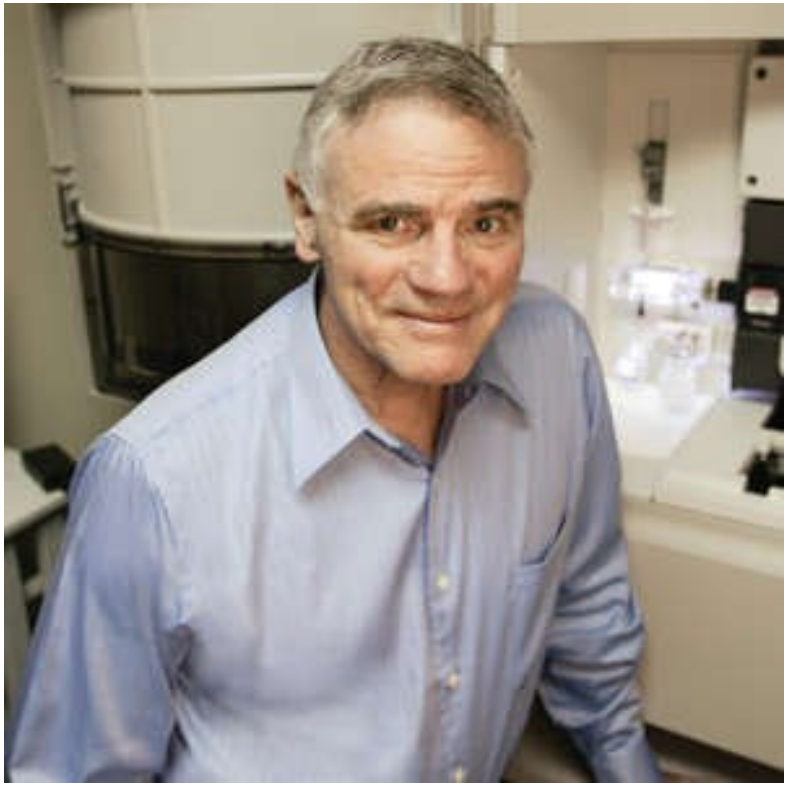
Where I Believe We are Headed: Predictive, Personalized, Preventive, & Participatory Medicine

Newsweek

A Doctor's Vision of the Future of Medicine

Leroy Hood
NEWSWEEK

From the magazine issue dated Jul 13, 2009



Quantify ~2500 Blood Proteins,
50 Each from 50 Organs or Cell Types
from a Single Drop of Blood
To Create a Time Series

UCSD
UCIrvine

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

it²

You Can Download This Presentation at lsmarr.calit2.net



ABOUT LARRY SMARR

Larry Smarr is the founding Director of the California Institute for Telecommunications and Information Technology (Calit2), a UC San Diego/UC Irvine

WHAT I'M READING

Complete List of Larry's Recommendations

RECENT TWITTER POSTS

Twitter?
Click To Follow Me