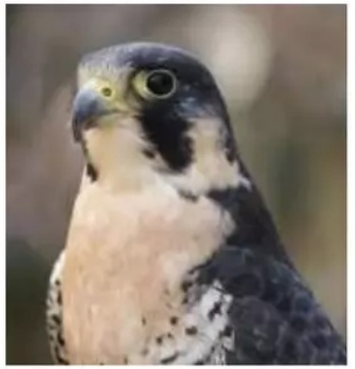
“Connecting Body Time Series to Macro Body Changes”

The American Academy of Osteopathy 2017 Convocation
The Balance Point: Bringing the Science and Art of Osteopathic Medicine Together
Breakout Session
Colorado Springs, CO
March 24, 2017

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
http://lsmarr.calit2.net

When We Think About Biological Diversity
We Typically Think of the Wide Range of Animals




But All These Animals Are in One SubPhylum Vertebrata of the Chordata Phylum

Think of These Phyla of Animals When You Consider the Biodiversity of Microbes Inside You



Phylum
Chordata



Phylum
Porifera



Phylum
Cnidaria



Phylum
Echinodermata



Phylum
Annelida



Phylum
Mollusca

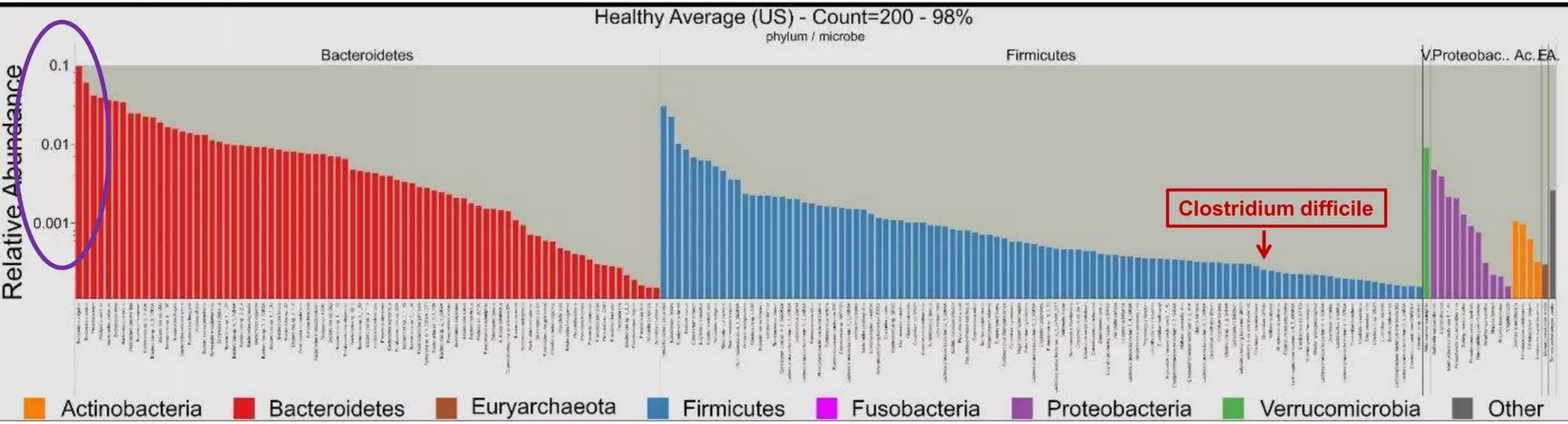


Phylum
Arthropoda

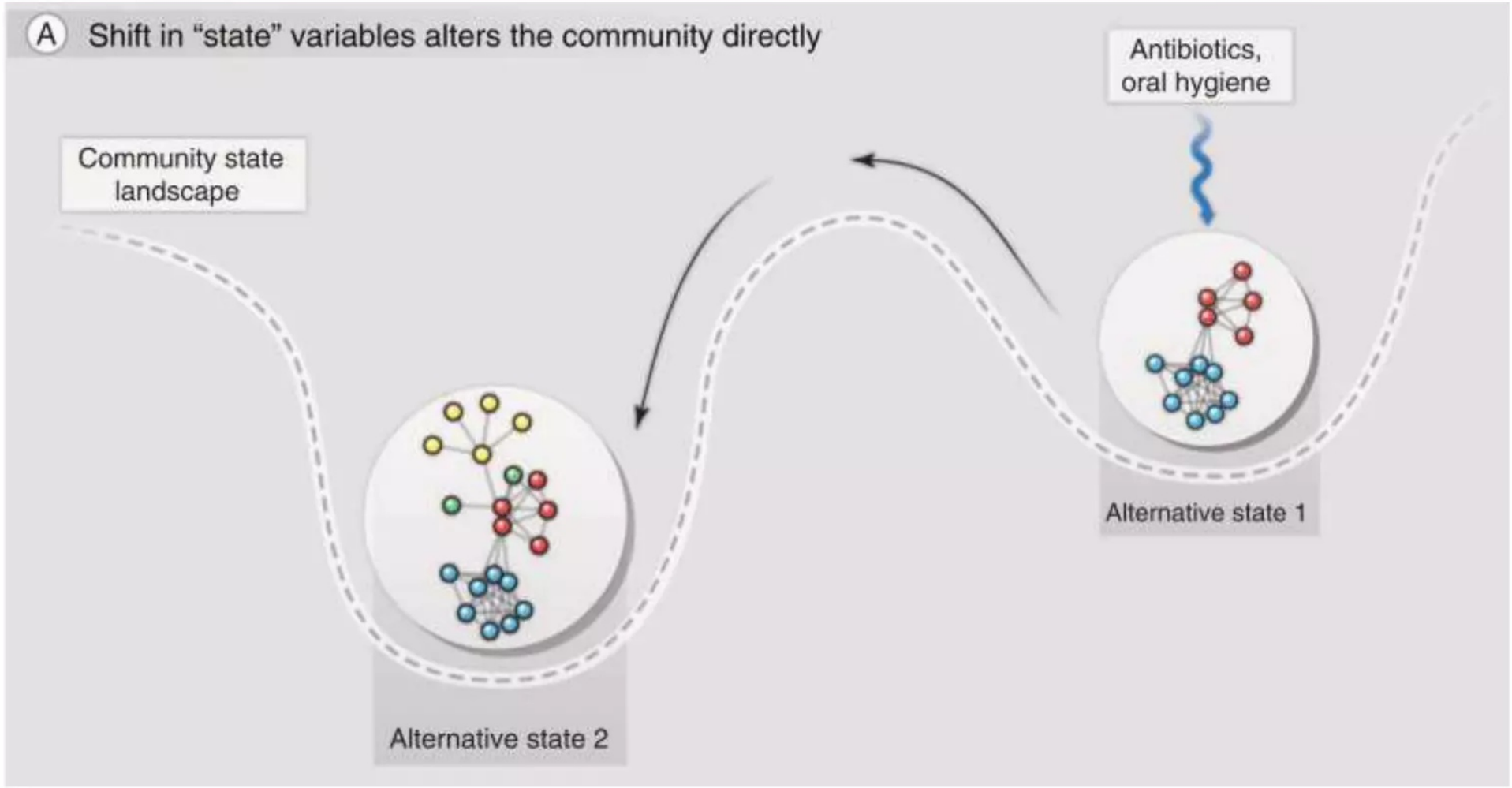
Results Include Relative Abundance of Hundreds of Microbial Species

Average Over 250 Healthy People
From NIH Human Microbiome Project

Note Log Scale



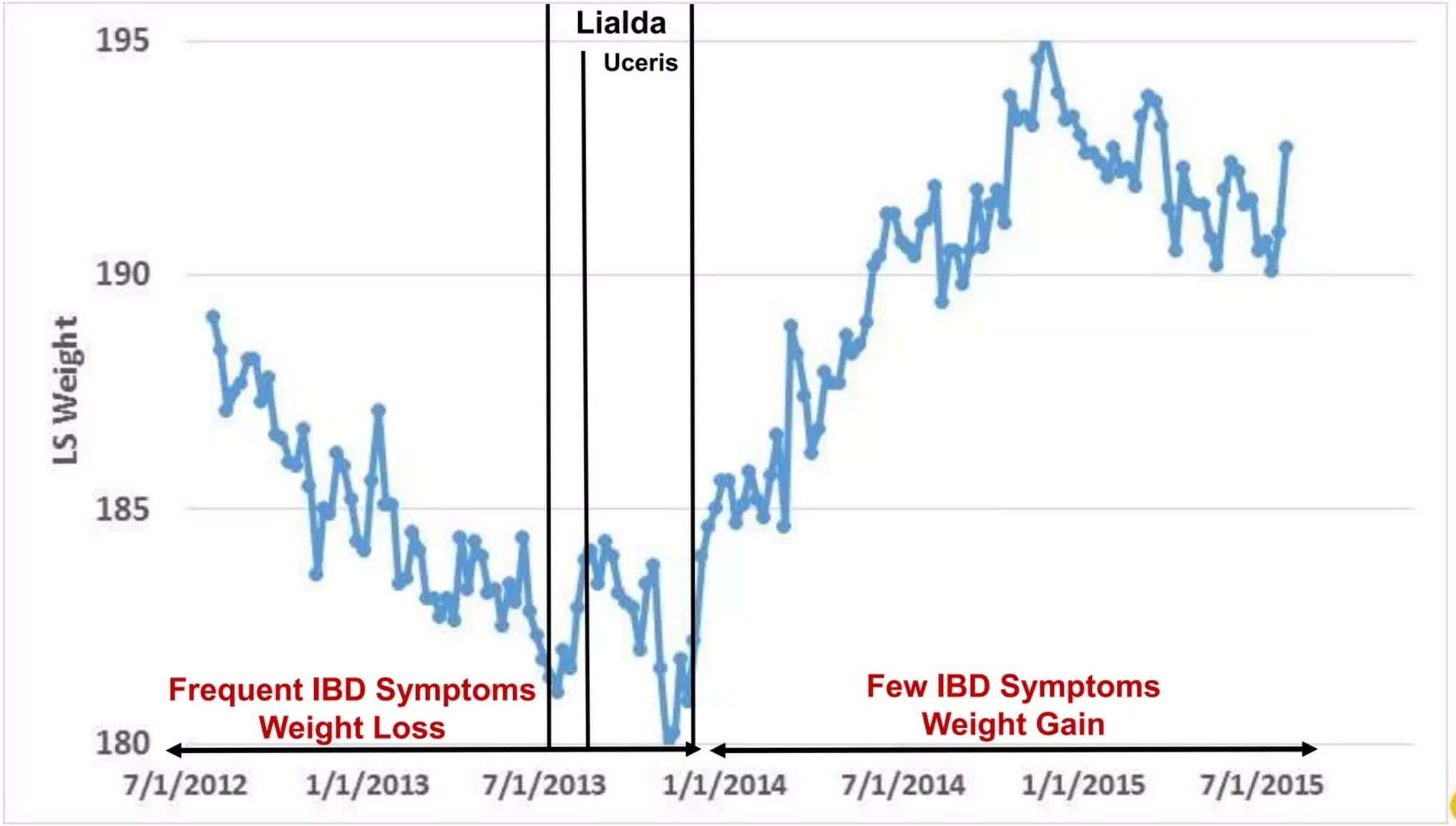
Lessons from Ecological Dynamics: Gut Microbiome Has Multiple Relatively Stable Equilibria



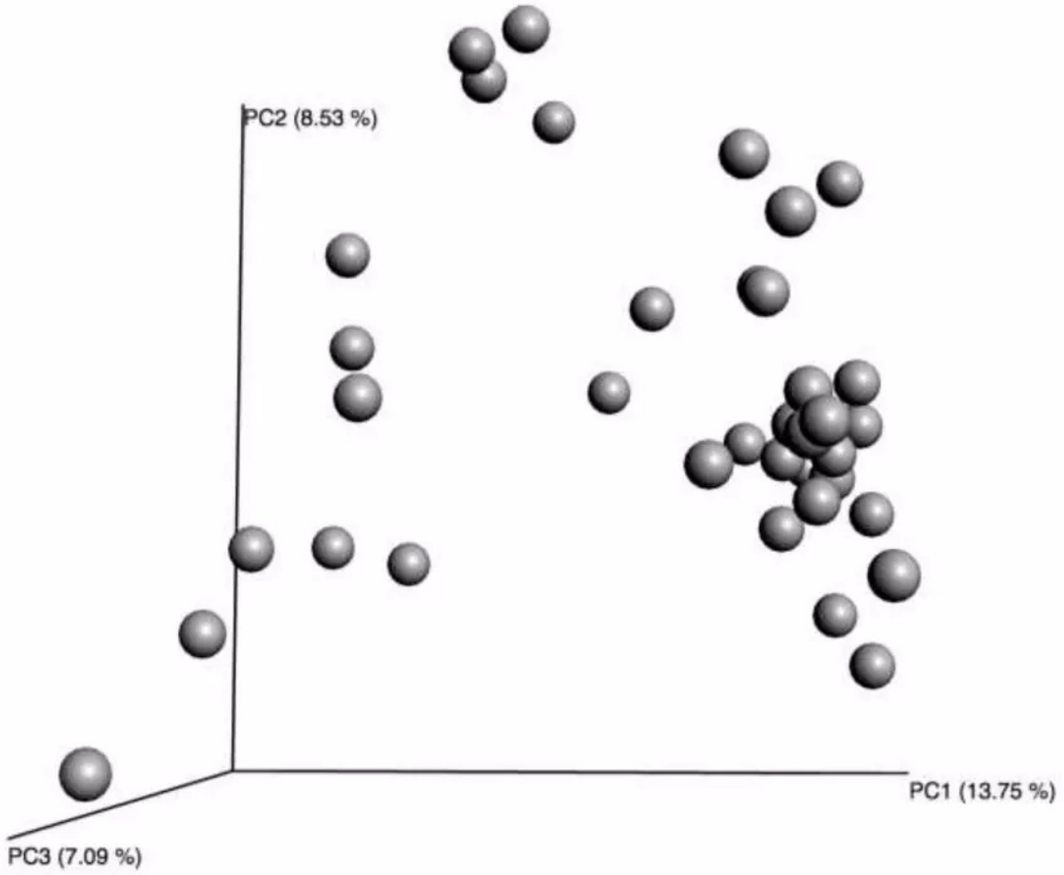
"The Application of Ecological Theory Toward an Understanding of the Human Microbiome," Elizabeth Costello, Keaton Stagaman, Les Dethlefsen, Brendan Bohannan, David Relman Science 336, 1255-62 (2012)

LS Abrupt Change in Weight and in Symptoms
January 1, 2014

Source: Larry Smarr, UCSD

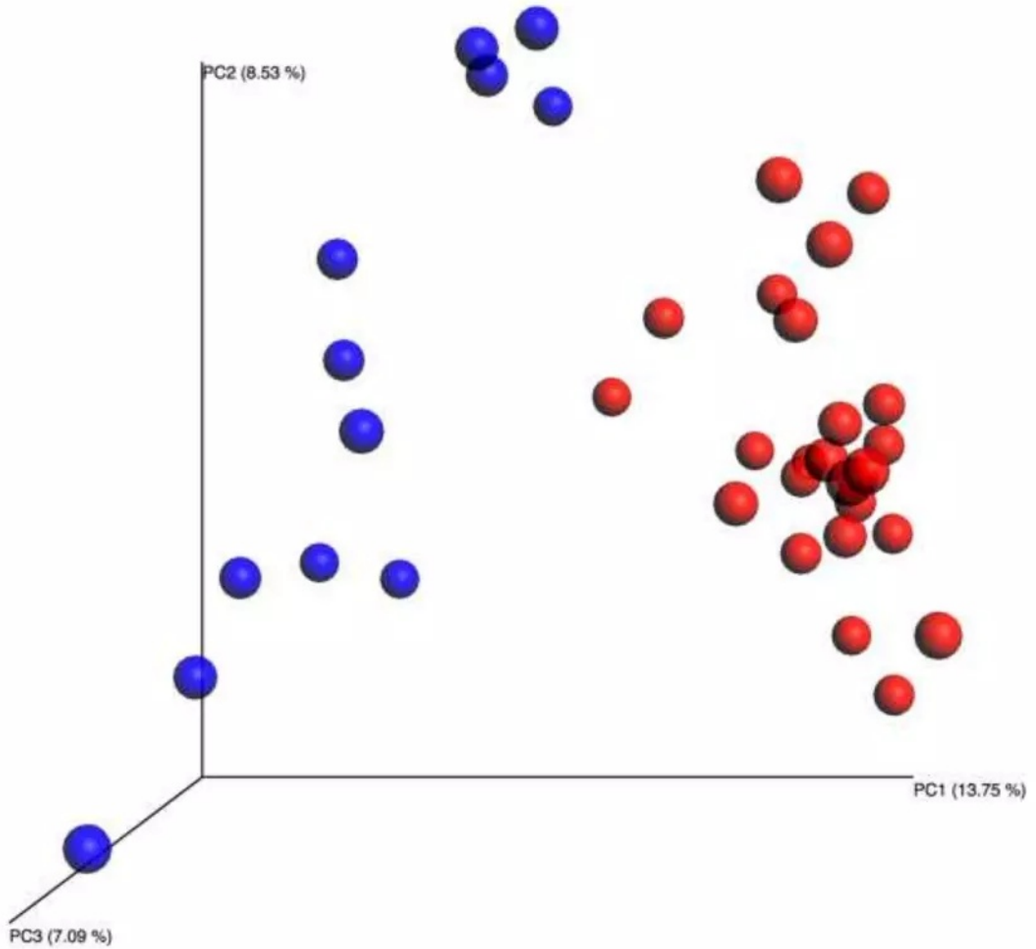


My Microbiome Ecology
Time Series Over 3 Years



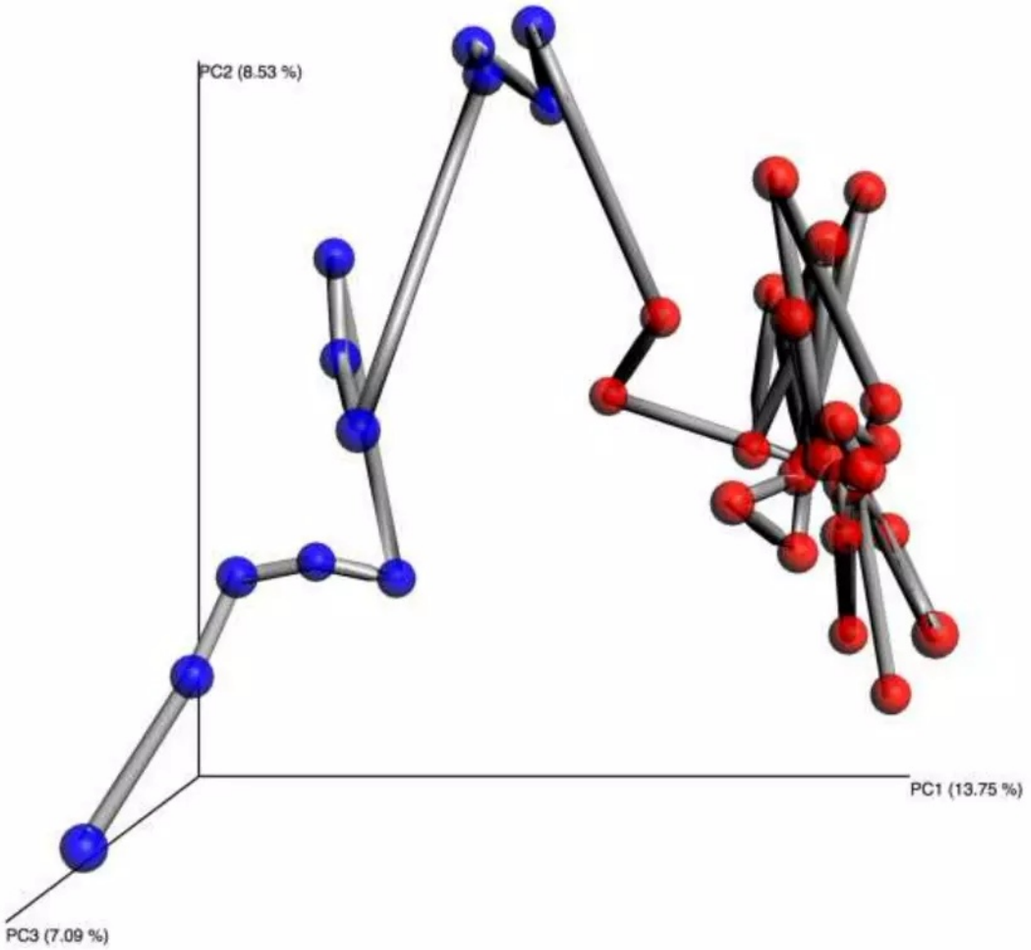
Source Justine Debelius, Knight Lab, UC San Diego

Coloring Samples Before (Blue) and After (Red) January 2014 Reveals Clustering



Source Justine Debelius, Knight Lab, UC San Diego

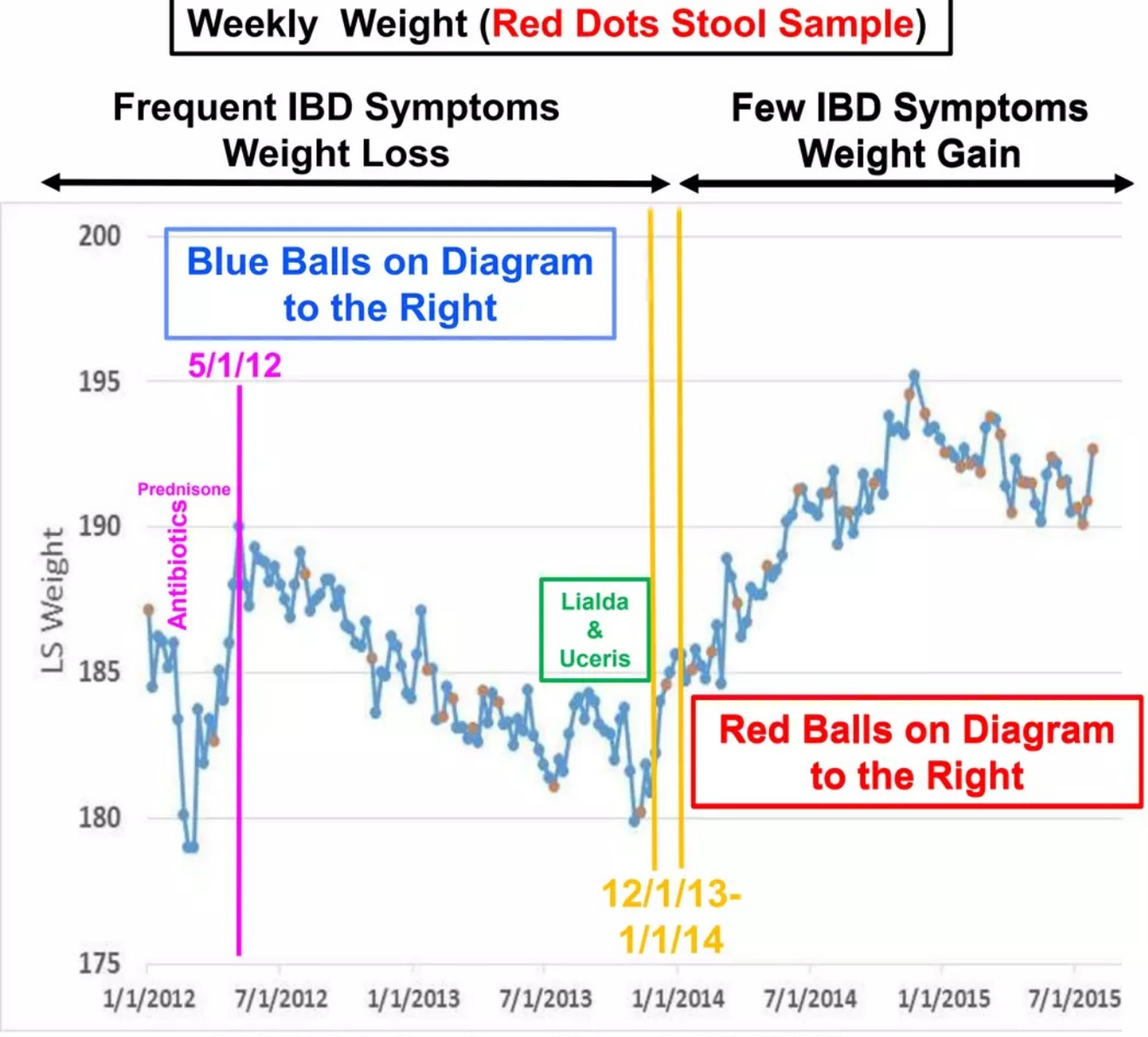
An Apparent Sudden Phase Change Occurs



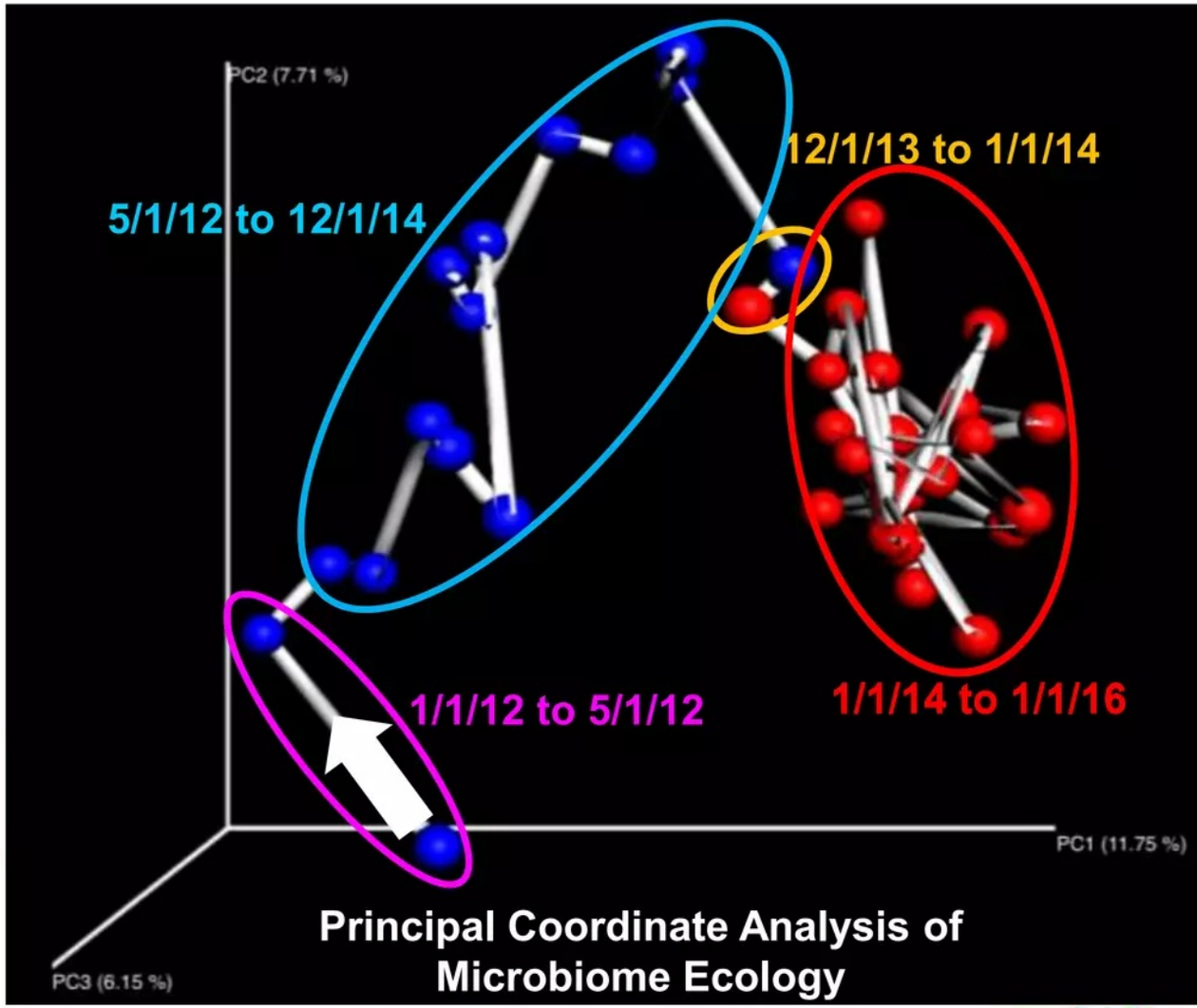
Source Justine Debelius, Knight Lab, UC San Diego

Larry Smarr Gut Microbiome Ecology Shifted After Drug Therapy Between Two Time-Stable Equilibriums Correlated to Physical Symptoms

Weekly Weight (Red Dots Stool Sample)



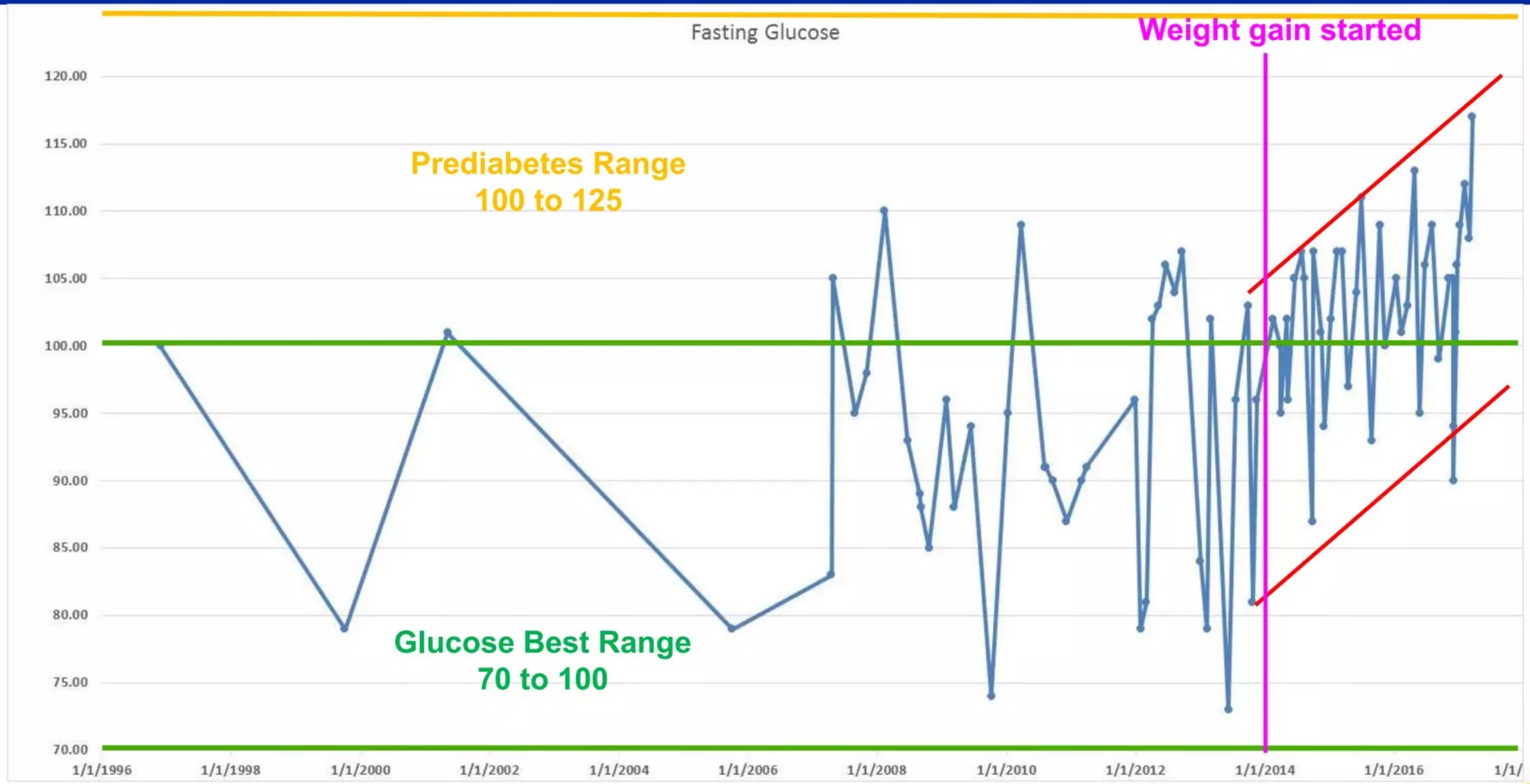
Weight Data from Larry Smarr, Calit2, UCSD



Principal Coordinate Analysis of Microbiome Ecology

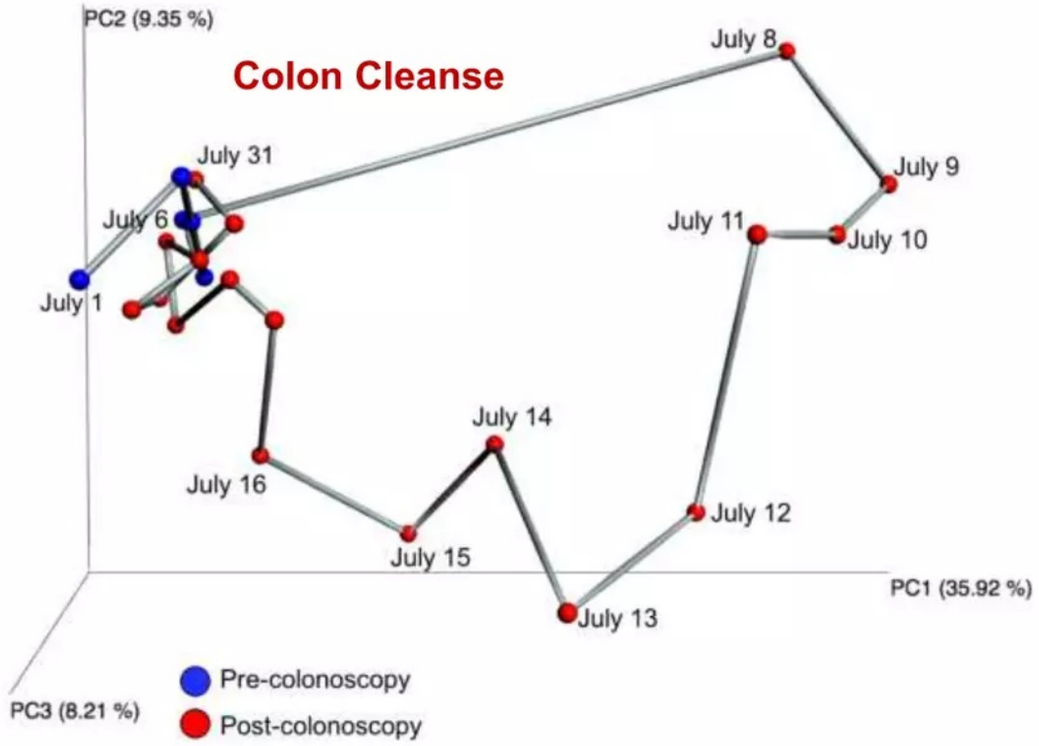
PCoA by Justine Debelius and Jose Navas, Knight Lab, UCSD

20 Years of Smarr's Fasting Glucose: Directional Shift at Same Time as Weight Gain and Microbiome Ecology Shift

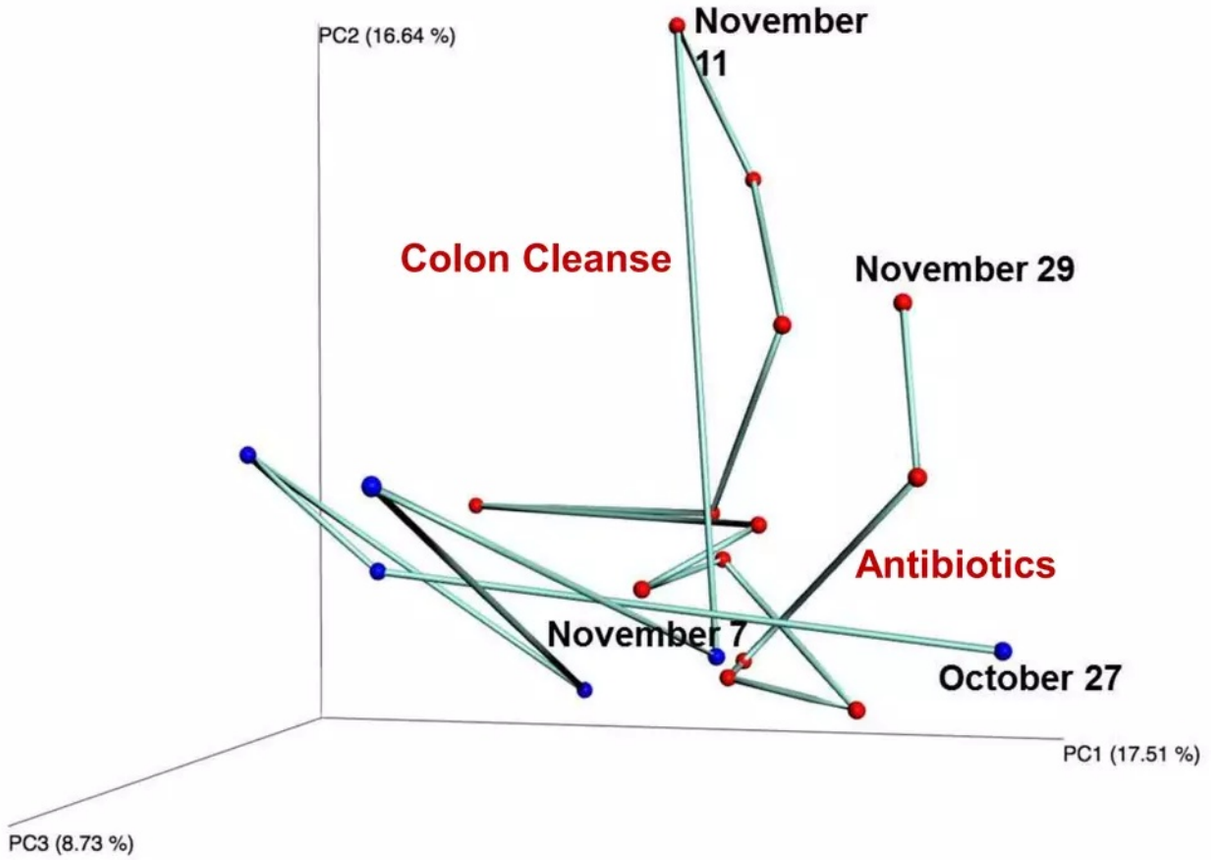


Microbiome Ecology Highly Disrupted by Medical Interventions

July 2015 Colonoscopy

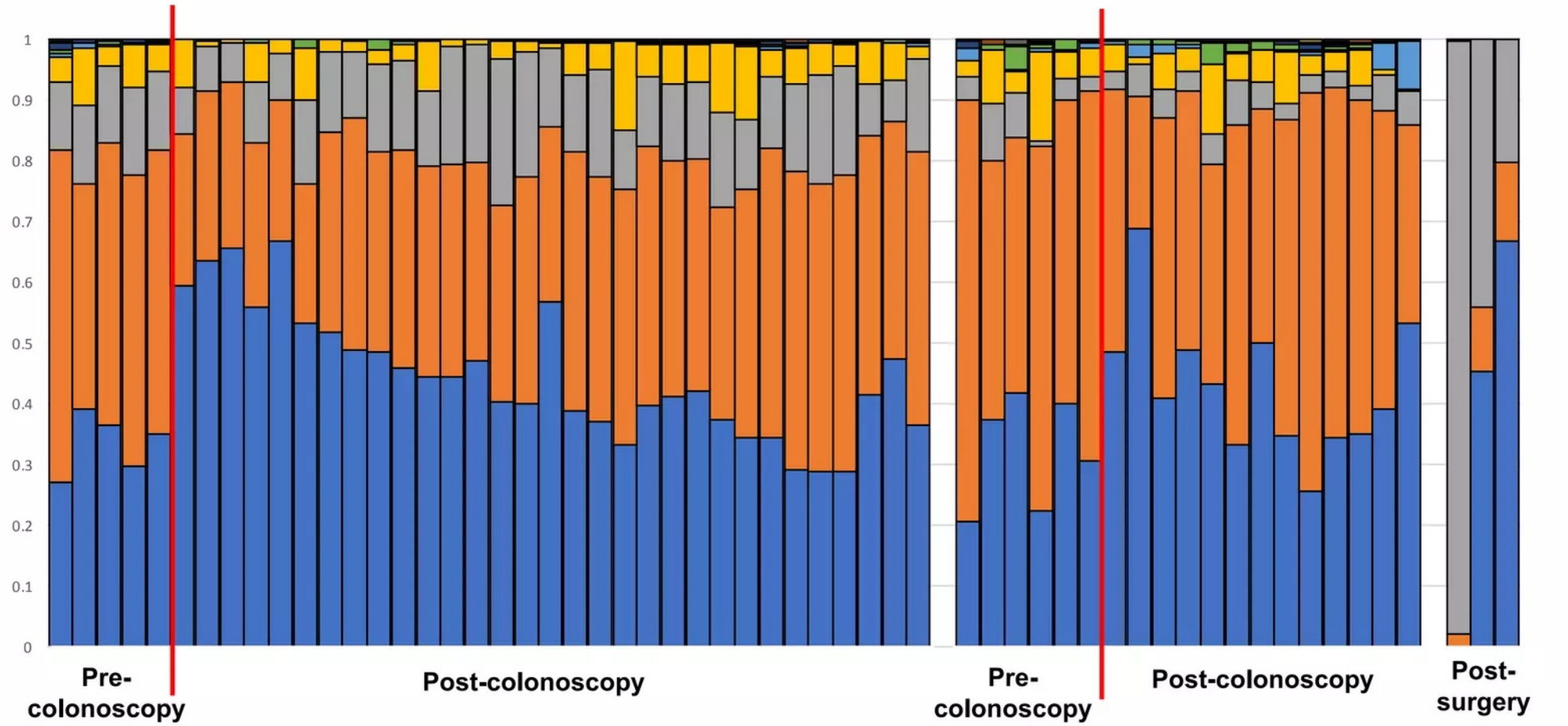


November 2016 Colonoscopy



Data from Dr. Embriette Hyde,
Rob Knight Group, UCSD

Phylum Level Changes
Associated with Colonoscopy and Surgery



Data from Dr. Embriette Hyde,
Rob Knight Group, UCSD

Massive Research is Underway to Discover A Wide Range of New Techniques for Manipulating Your Microbiome

AJG The American Journal of Gastroenterology Supplements

Am J Gastroenterol Suppl (2012) **1**:41–46; doi:10.1038/ajgsup.2012.8

Manipulation of the Gut Microbiota as a Novel Treatment Strategy for Gastrointestinal Disorders

Amy E Foxx-Orenstein DO[1] and William D Chey MD[2]

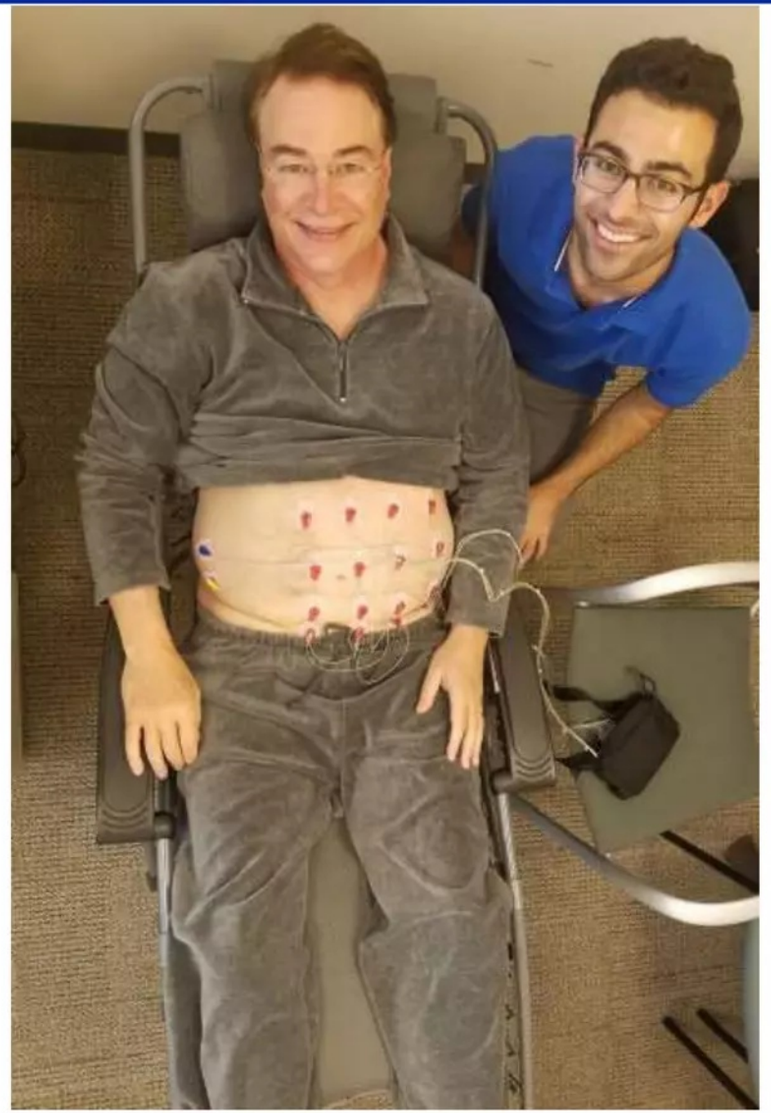
Hacking Gut Bacteria Could Be The Future Of Medicine

MIT biologists are reprogramming gut bacteria as “live therapeutics.”

04/11/2016 11:42 am ET

www.huffingtonpost.com/entry/gut-bacteria-microbiome-disease_us_57068c55e4b053766188f383

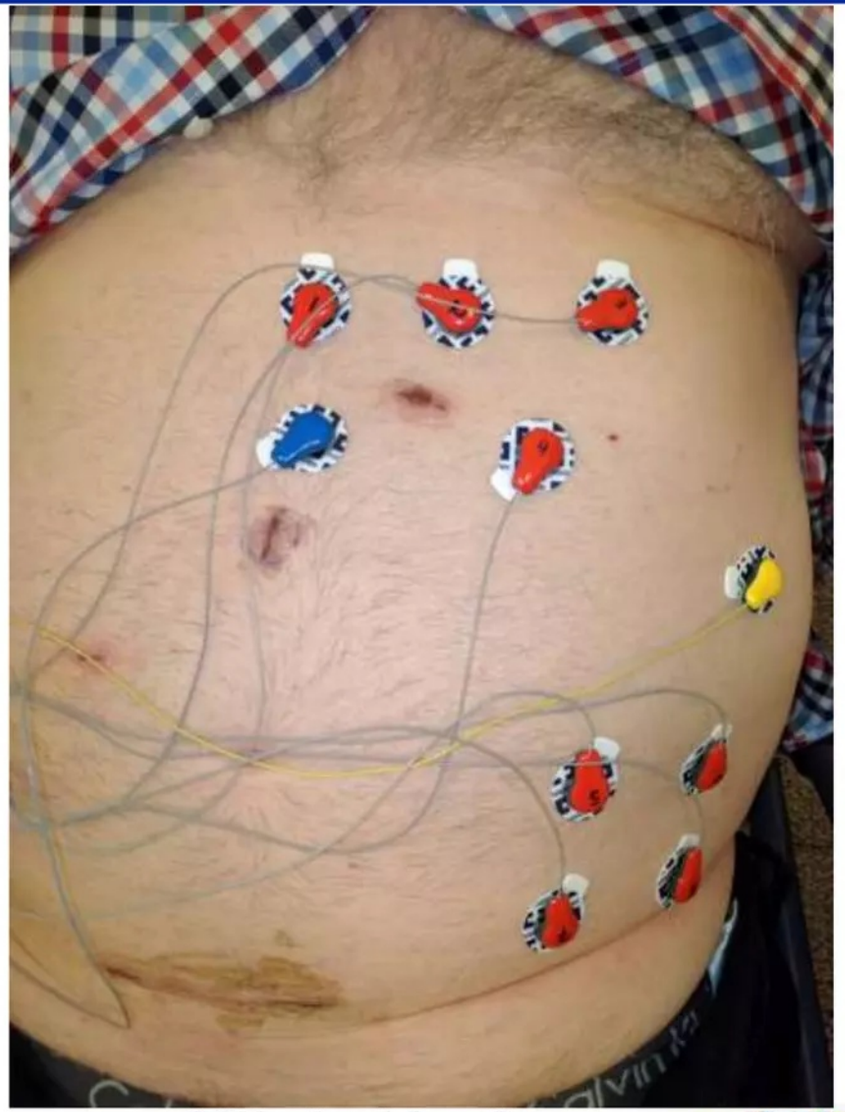
EGG Array in UCSD Professor Todd Coleman's Lab Experiment with PhD Student Armen Gharibans



1 Week Before Surgery



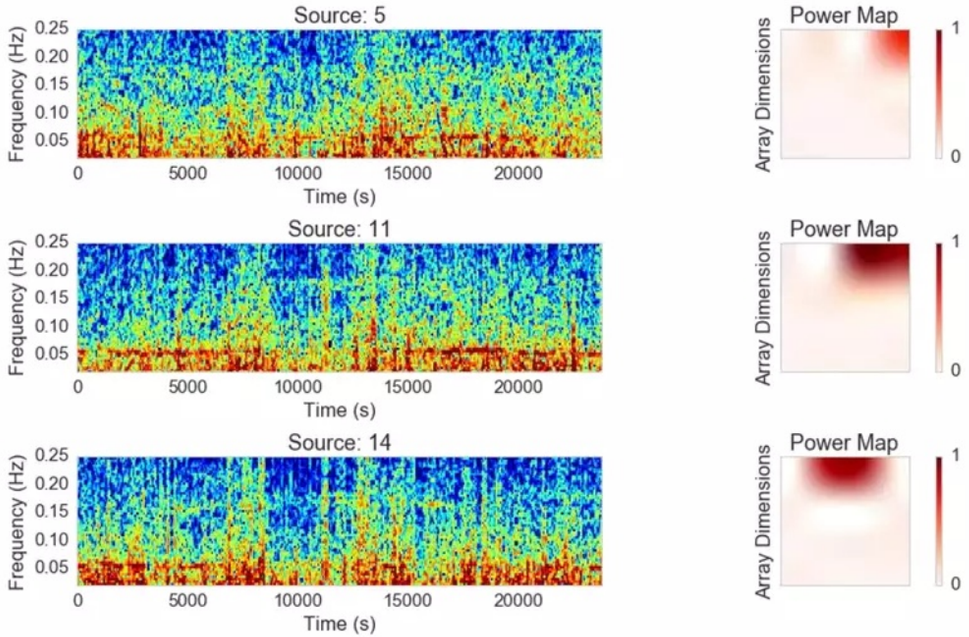
2 Days After Surgery

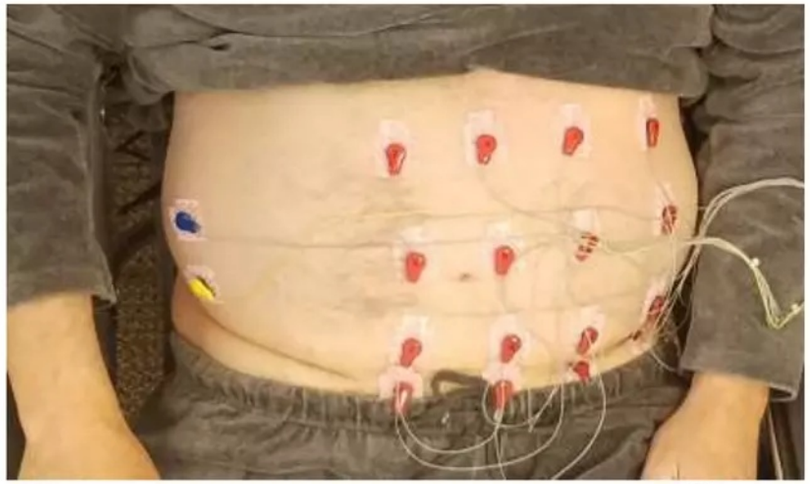


2 Weeks After Surgery

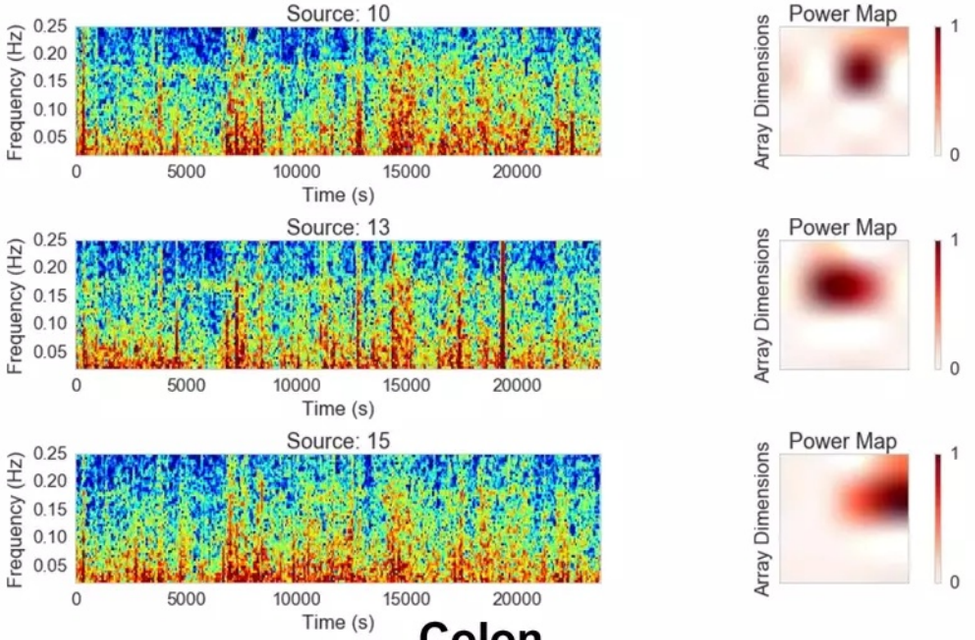
Using EGG to Separate Out the Components of the GI Tract

Stomach (0.05 Hz)

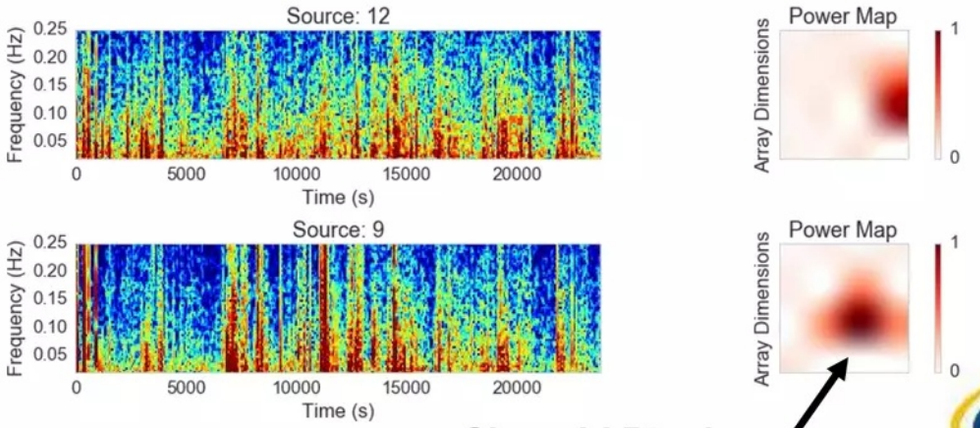




Small Intestines (0.18 Hz)



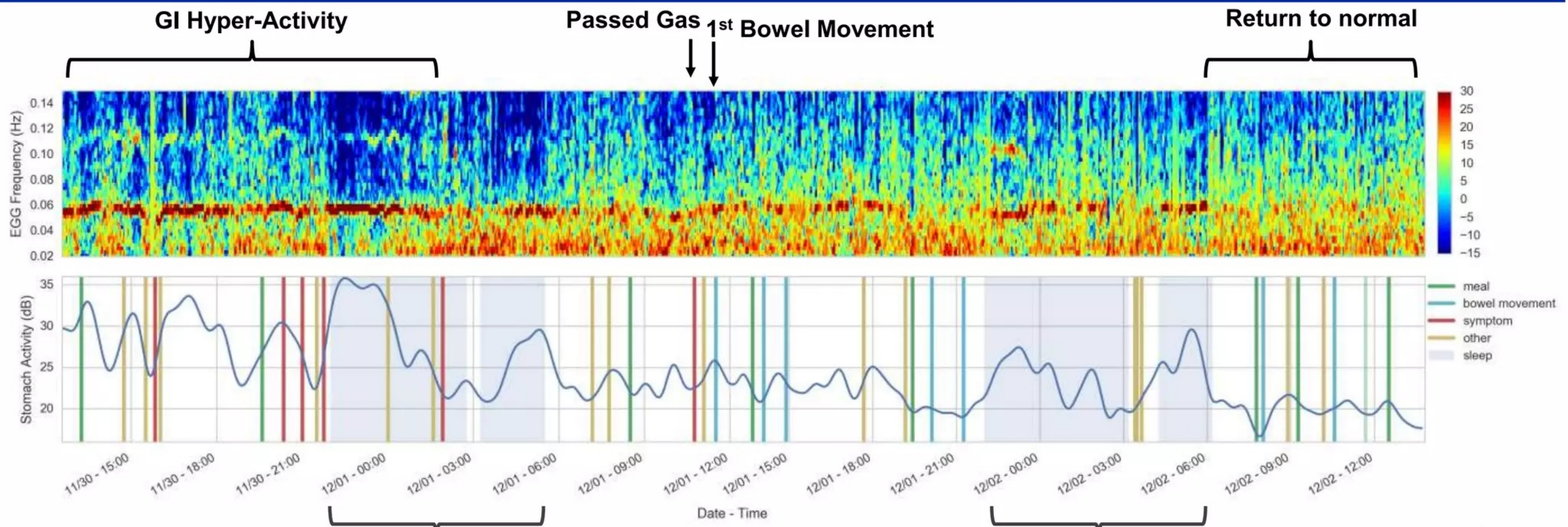
Colon



Sigmoid Blockage

Source: Armen Gharibans, UCSD

48 Hours EGG on Larry Smarr: When Does the Colon Restart After Surgery?



2nd Night of Sleep

3rd Night of Sleep

High power, irregular

Low power, periodic

Low power, regular

Source: Armen Gharibans, UCSD; Analysis by Benjamin Smarr, UCB

Carcinoembryonic Antigen (CEA) Screening Test for Cancer Was Elevated and Increasing, Dropped After Surgery, But Is Now Increasing

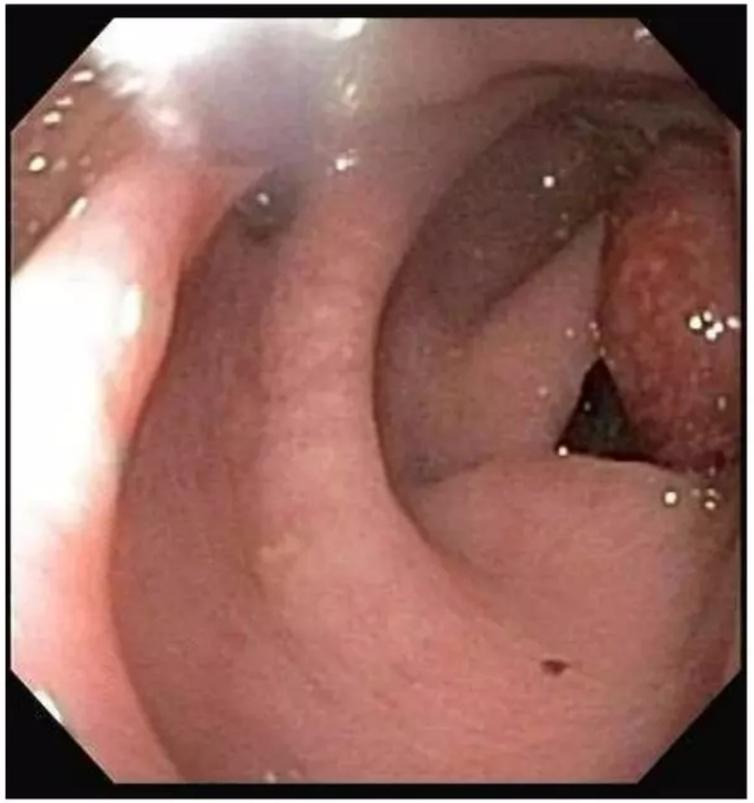


Ranges from Exeter Clinical Labs www.exeterlaboratory.com/test/carcinoembryonic-antigen-cea/

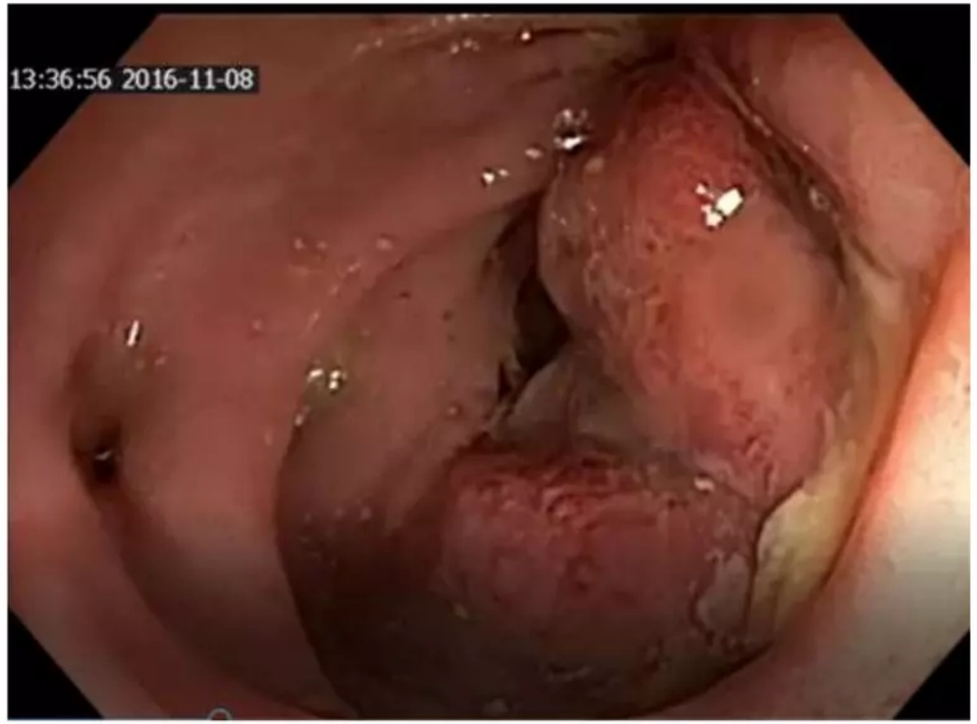
Colonoscopy Images Show Inflamed Pseudopolyps in 6 inches of Sigmoid Colon Over Six Years



Dec 2010



Jan 2012



Nov 2016

Note how the one polyp gets progressive bigger and then grows a twin…

Pathology Report on Resected Colon: "No Dysplasia Identified"



