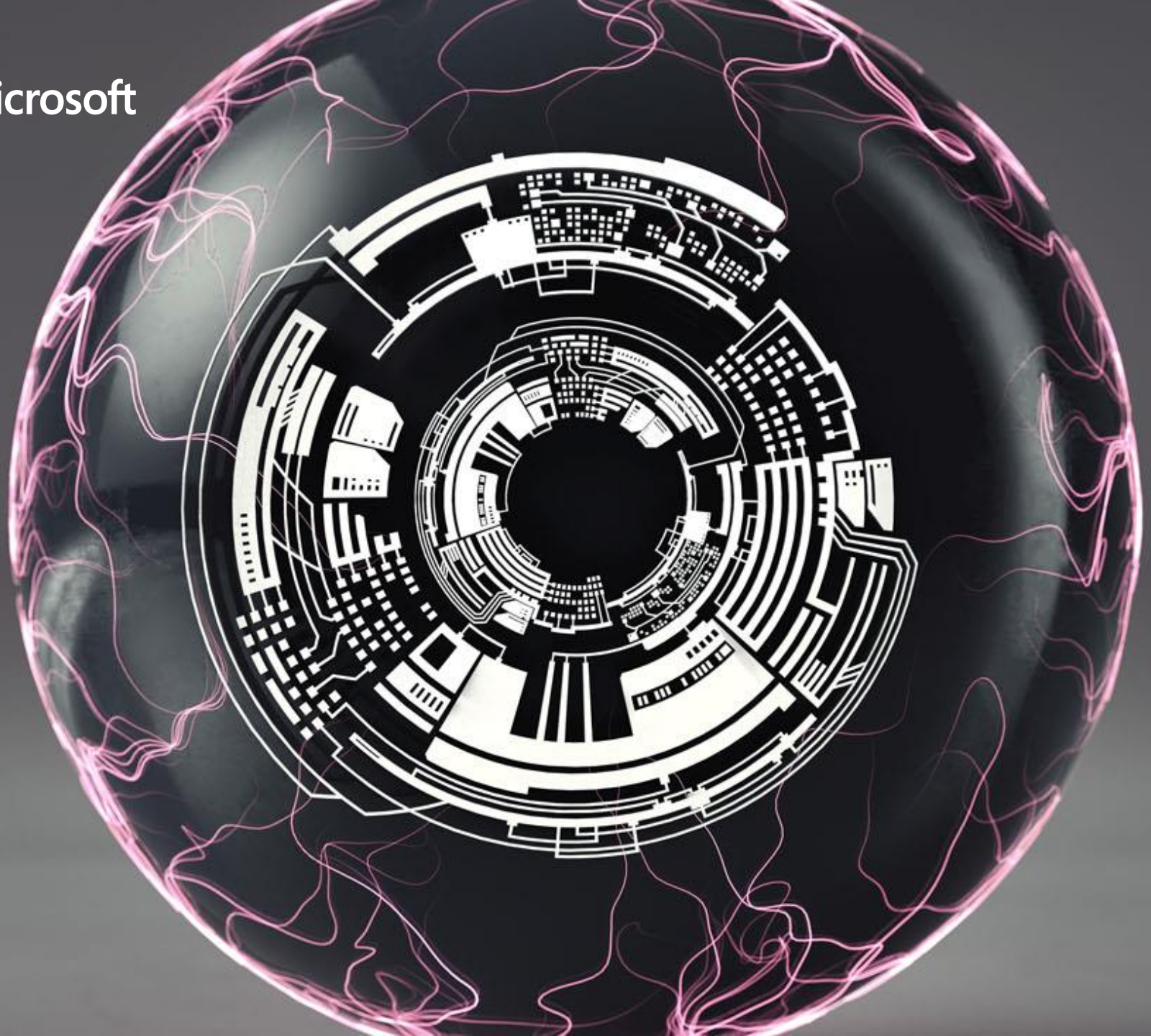
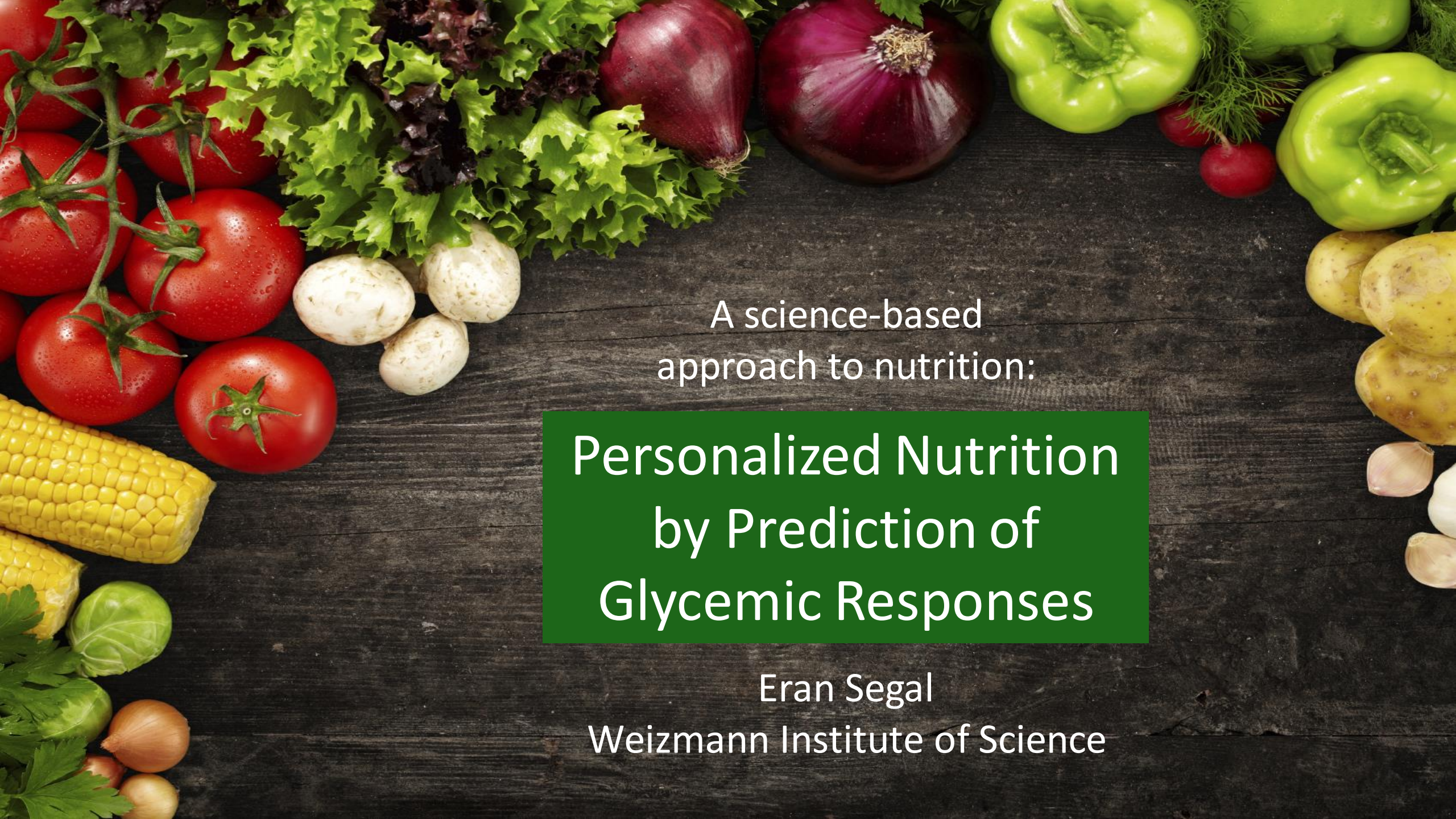
Microsoft



Microsoft Research

Faculty Summit

2016

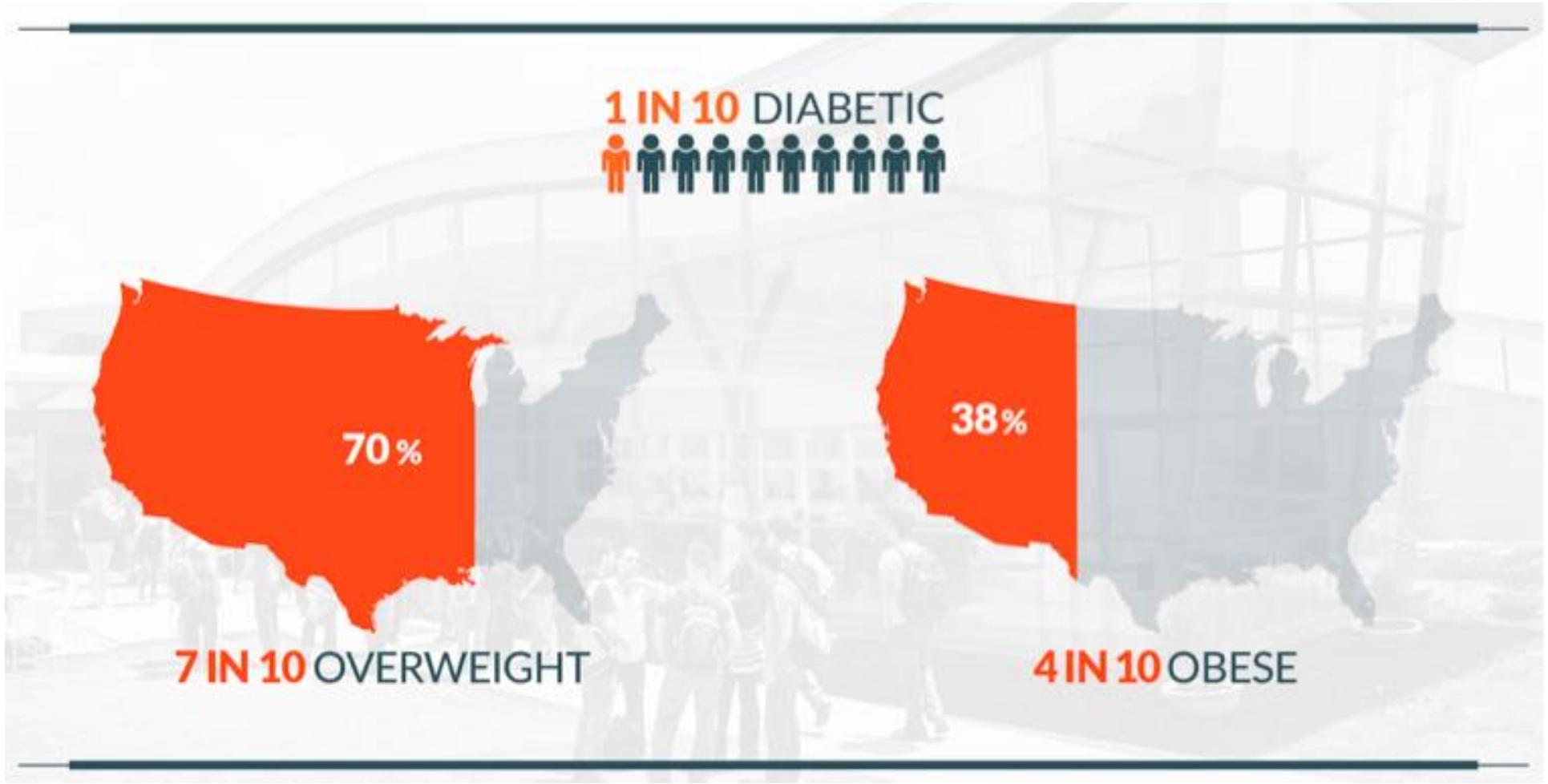


A science-based
approach to nutrition:

Personalized Nutrition by Prediction of Glycemic Responses

Eran Segal
Weizmann Institute of Science

The metabolic disease epidemic



Changes in our nutrition greatly contributed to the recent metabolic syndrome epidemic

Changes in our nutrition greatly contributed to the recent metabolic syndrome epidemic

Reduced fat consumption and increased carbohydrates consumption

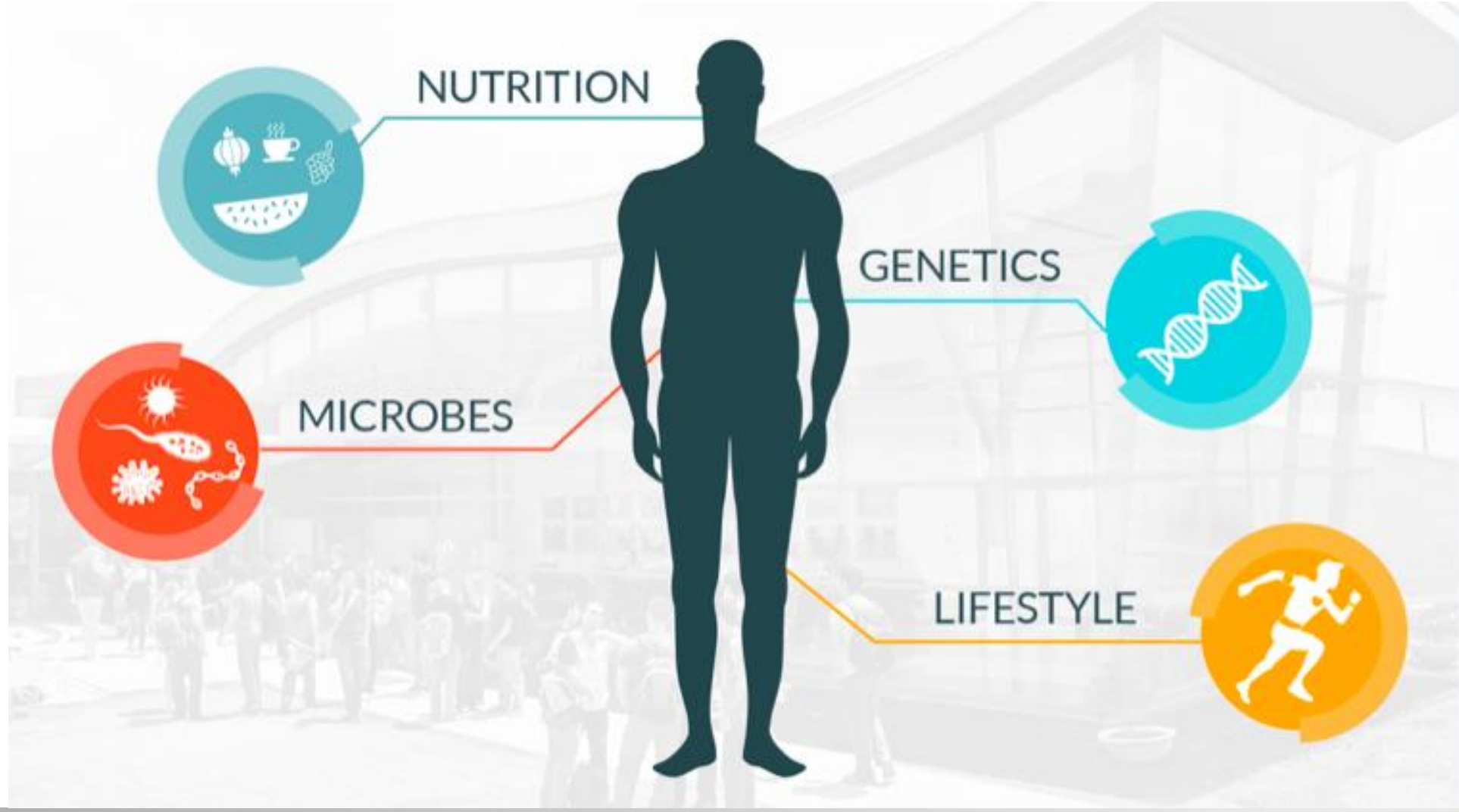
Increased consumption of added sugar

Increased consumption of food additives and artificial sweeteners

Changed meal times and introduced shift working

If nutritional changes drove the metabolic syndrome epidemic, can it be treated by restoring healthy nutrition?

Studying the link between nutrition, lifestyle, genetics, and microbiome



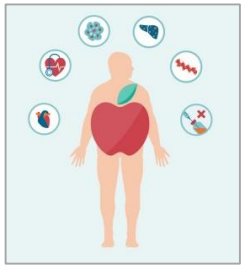
How can we take a science-based approach to nutrition?

Tal Korem

Dudi Zeevi

Science based approach to nutrition:
What should a marker of healthy nutrition satisfy?

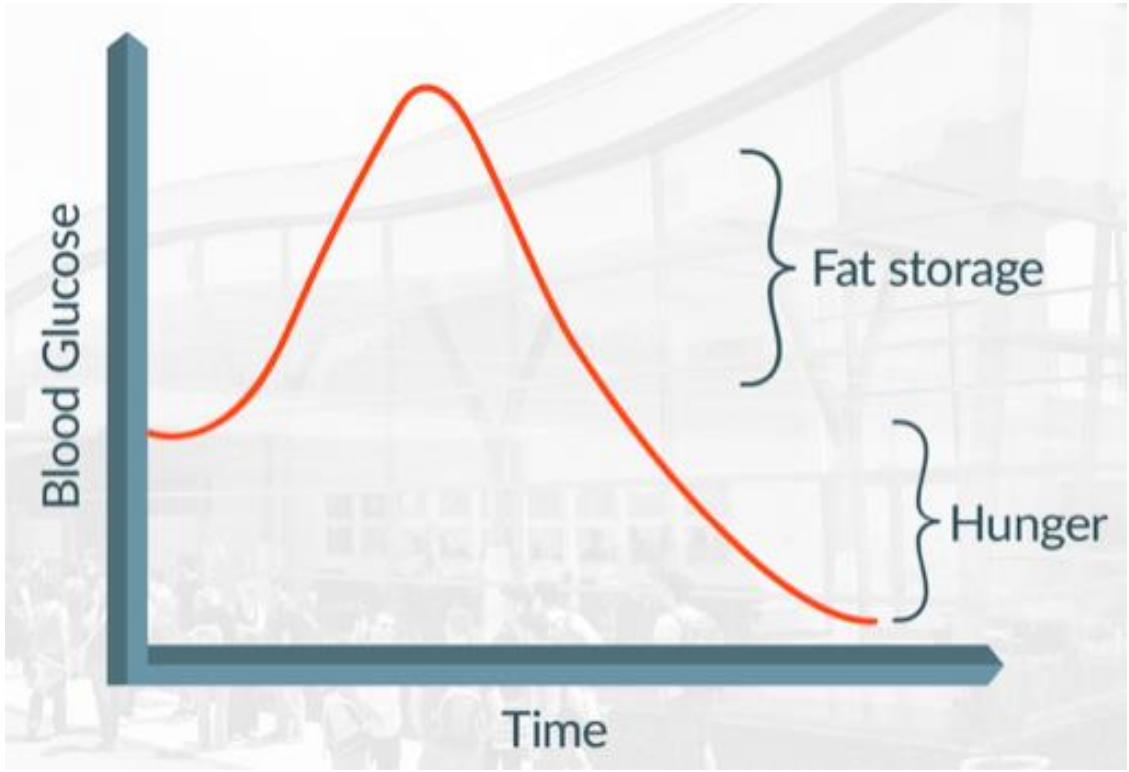
Relevant for weight management



Relevant for metabolic disease

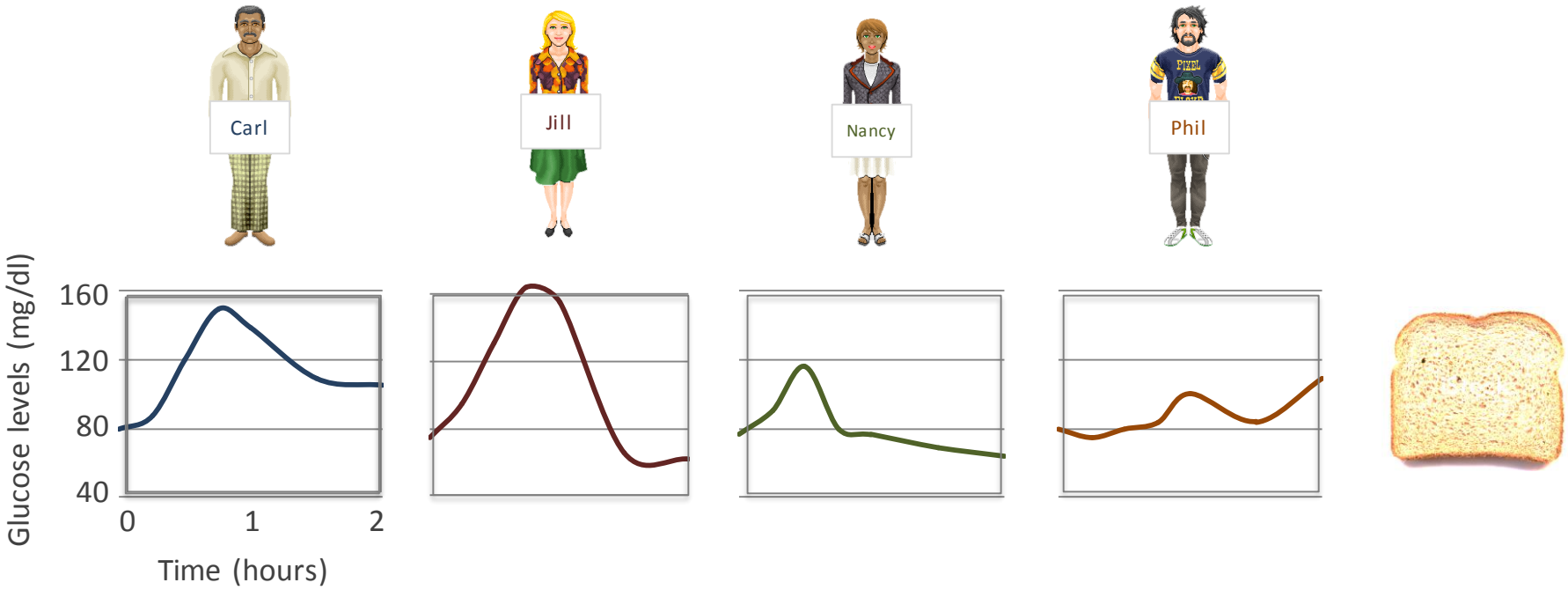
Easily measurable quantitatively

Postprandial (Post-meal) glucose response as a measure of healthy nutrition



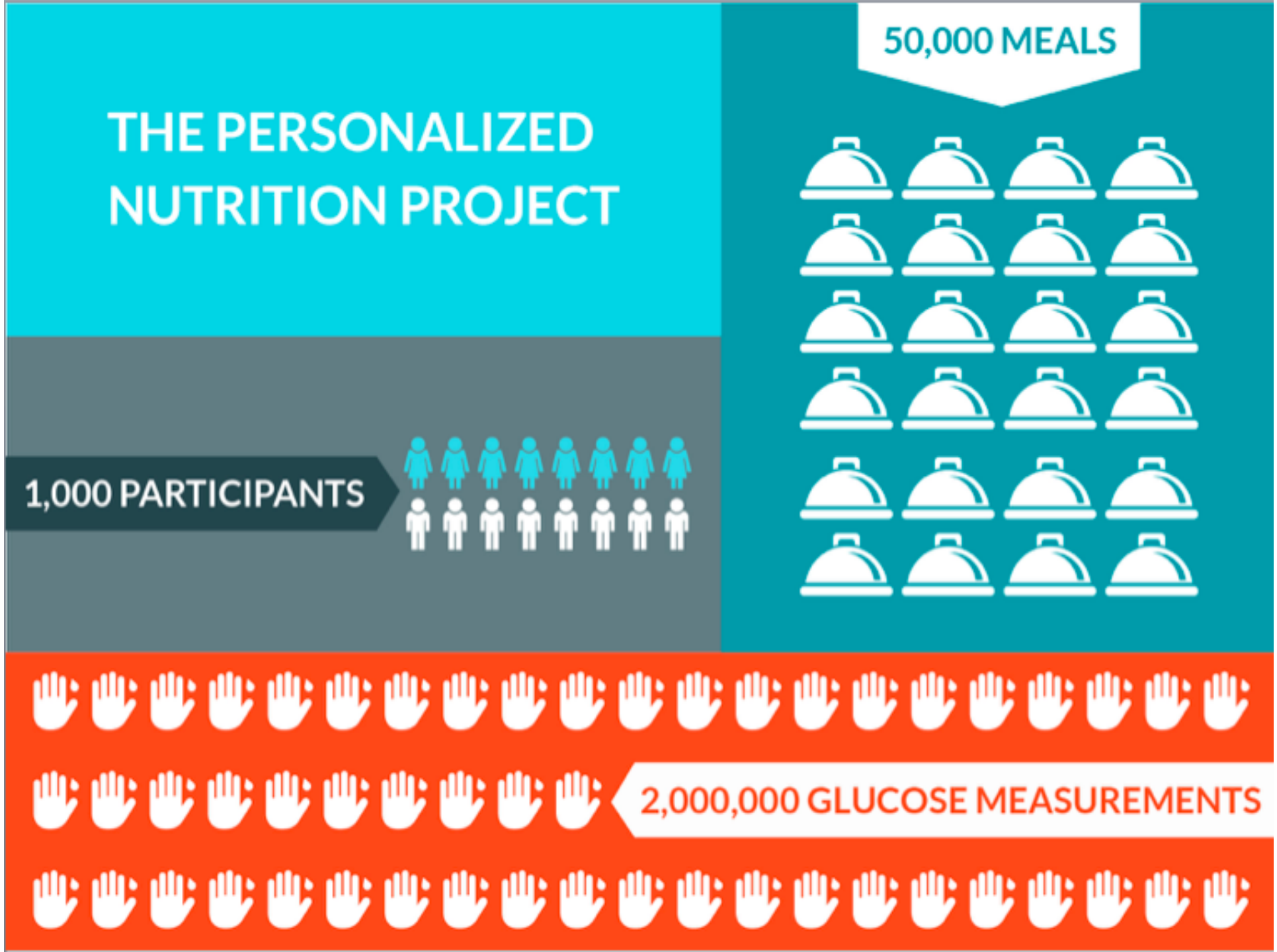
- Directly affects fat storage, weight gain, and hunger
- Strongly associated with obesity, diabetes, CVD
- Easily measurable quantitatively

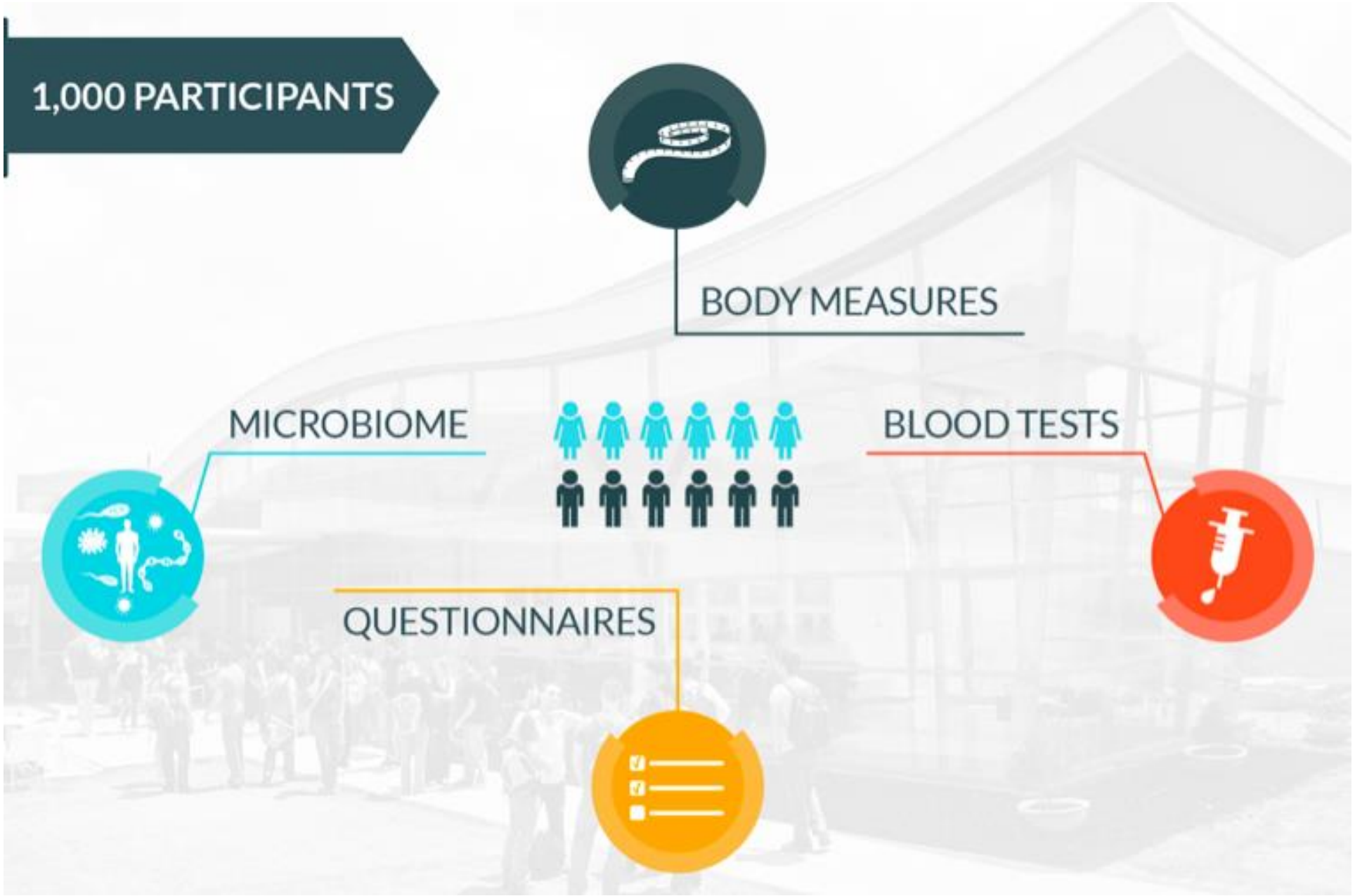
People have widely different glucose responses to the same food



Adapted from Vega-López et al. Diabetes Care 2007

Diets that maintain normal blood glucose levels must be personally tailored


THE PERSONALIZED
NUTRITION PROJECT
50,000 MEALS
1,000 PARTICIPANTS
2,000,000 GLUCOSE MEASUREMENTS



Zeevi *et al*., Cell 2015

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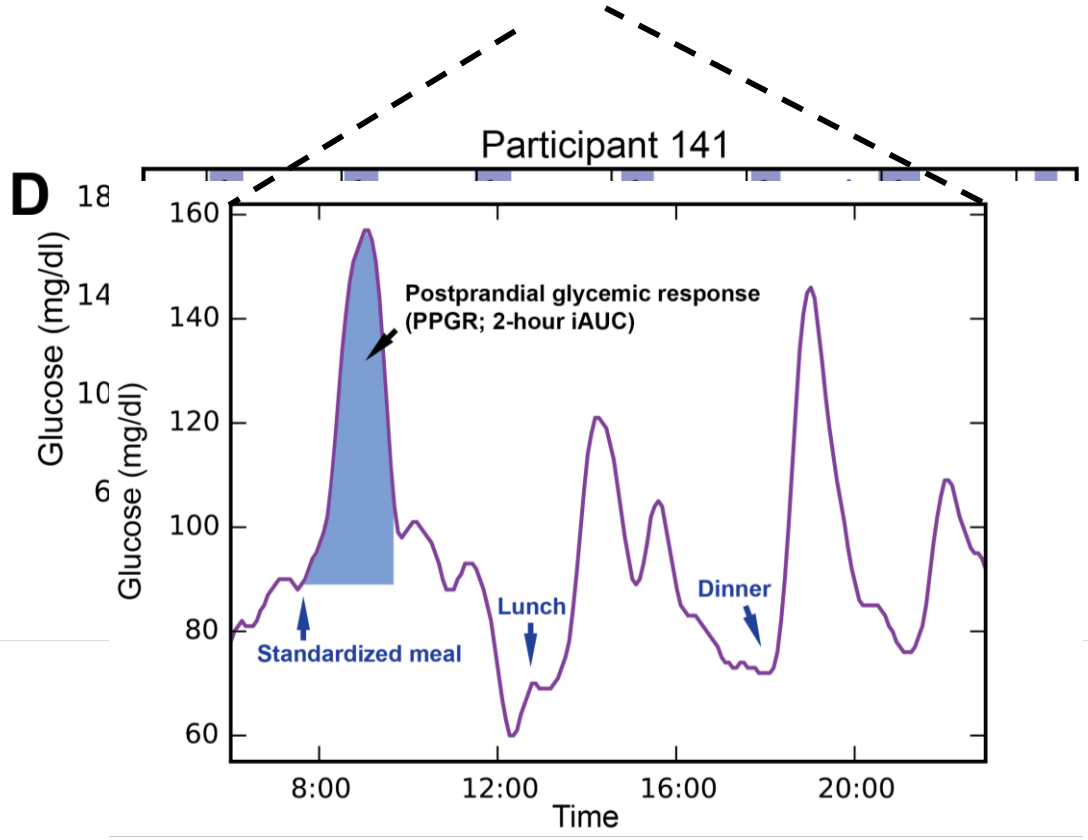
Continuous glucose monitoring



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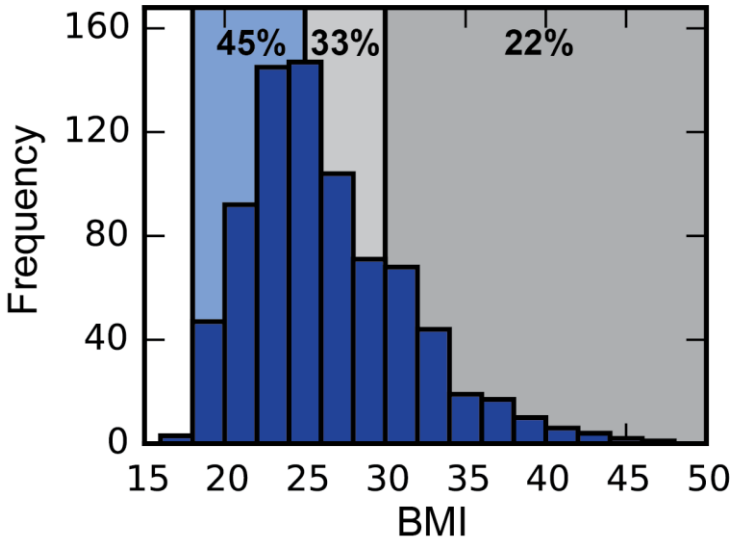
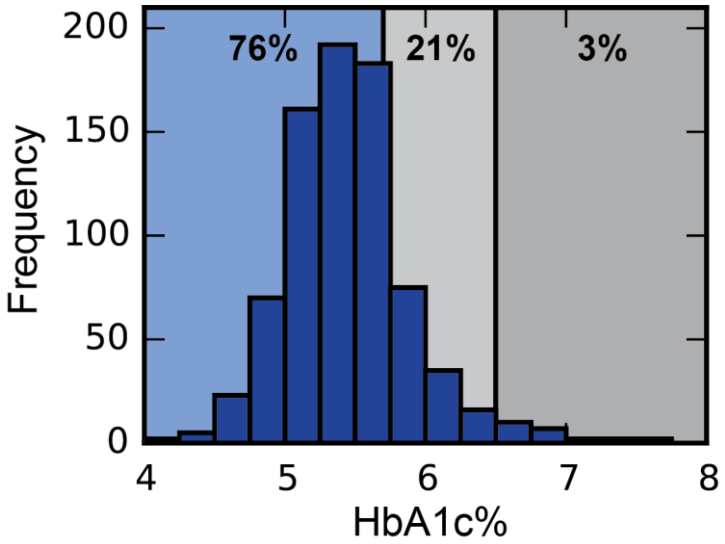
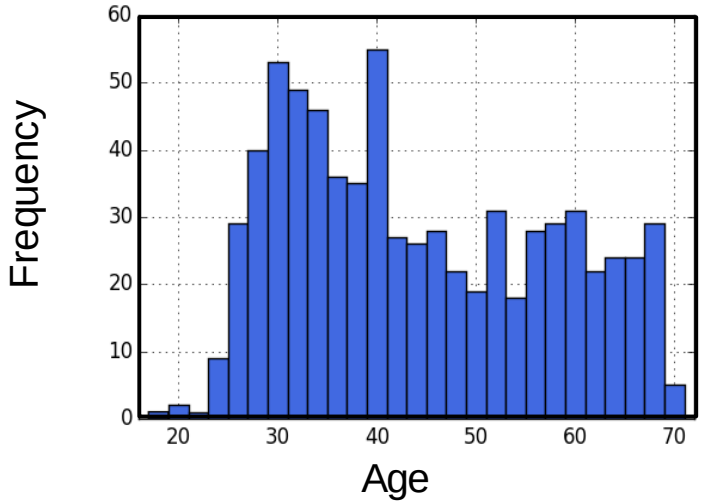
The Personalized Nutrition Project: Cohort statistics







- 25-70 years of age
- 55% overweight
- 22% obese
- 21% pre-diabetic

Zeevi *et al.*, Cell 2015

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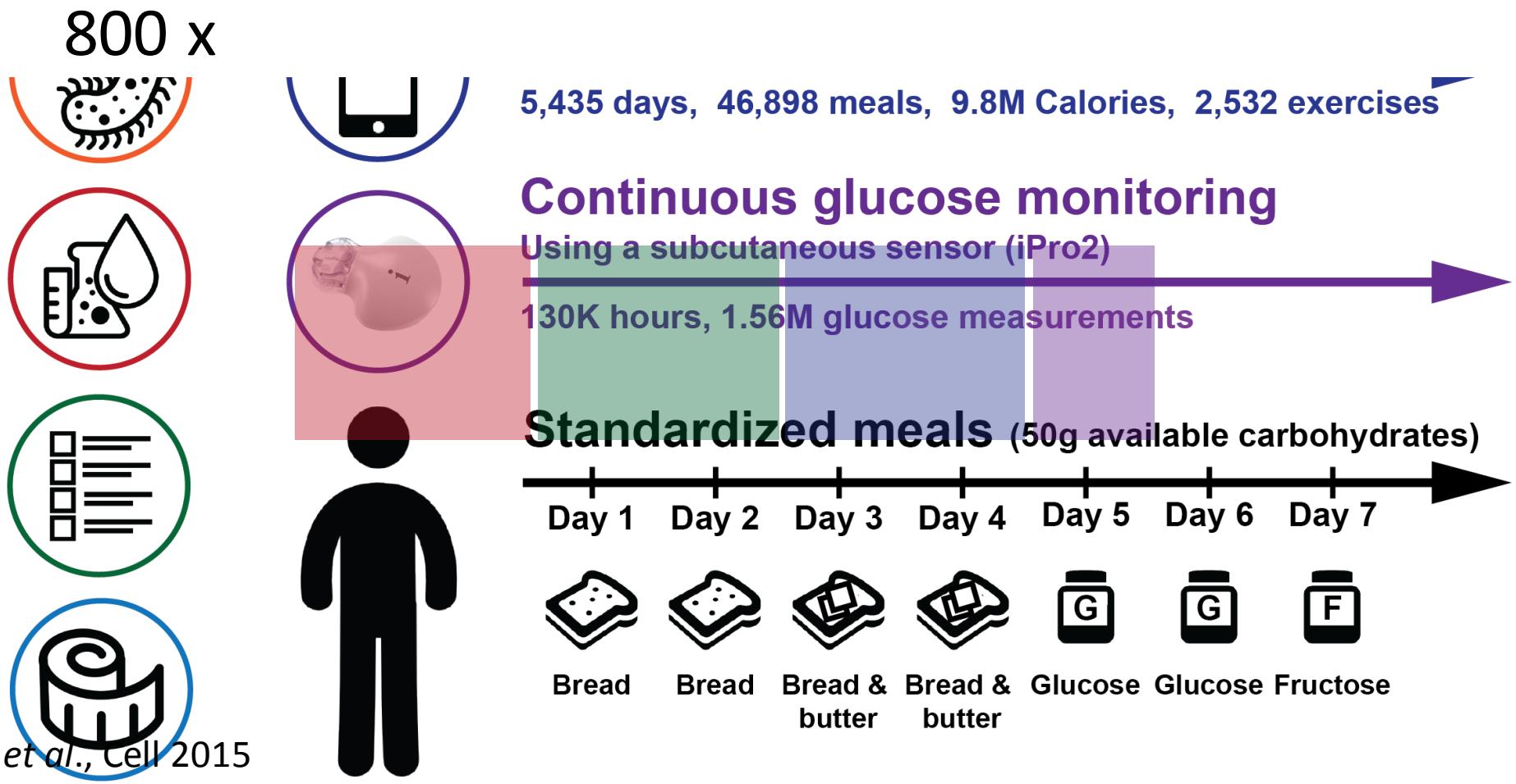
What is the variability across people in the response to the same food?

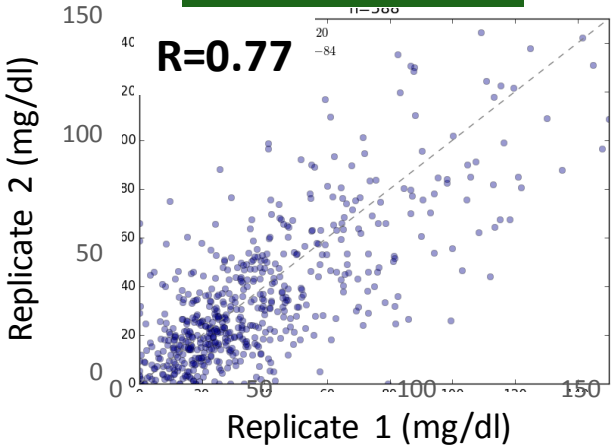
Testing the cohort response to standardized meals



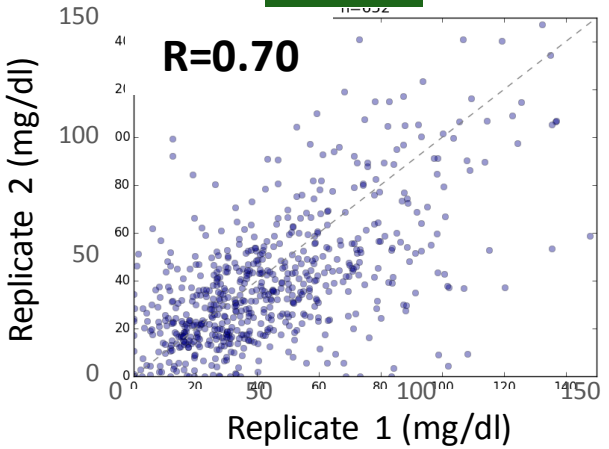
Zeevi *et al.*, Cell 2015

The same person has a highly similar post-meal response to the same standardized meal across different days

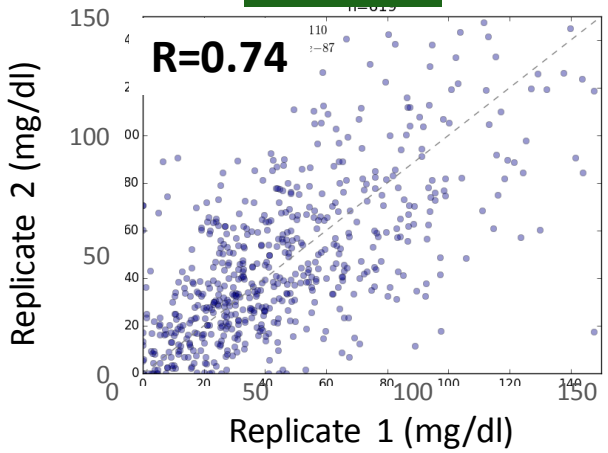
Bread & Butter



Bread



Glucose



Zeevi *et al.*, Cell 2015

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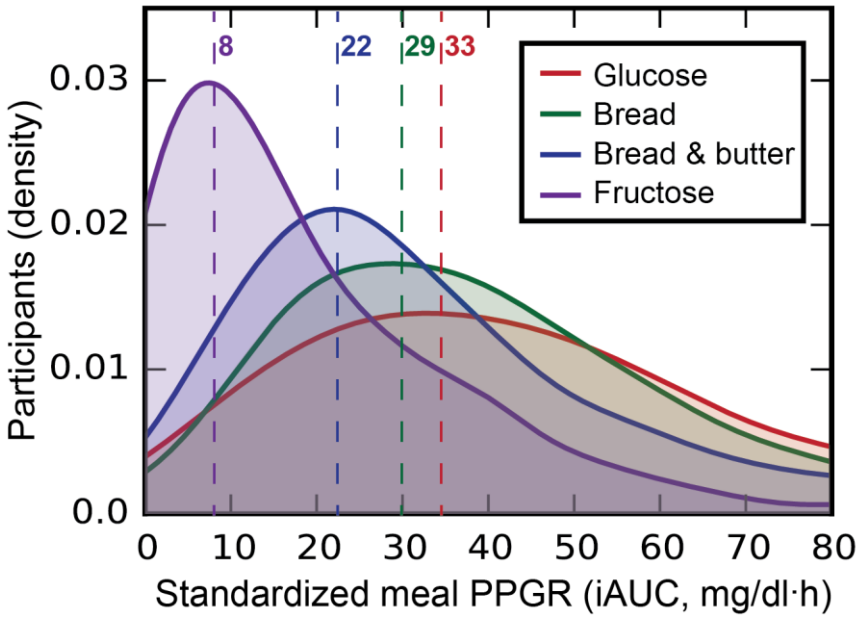
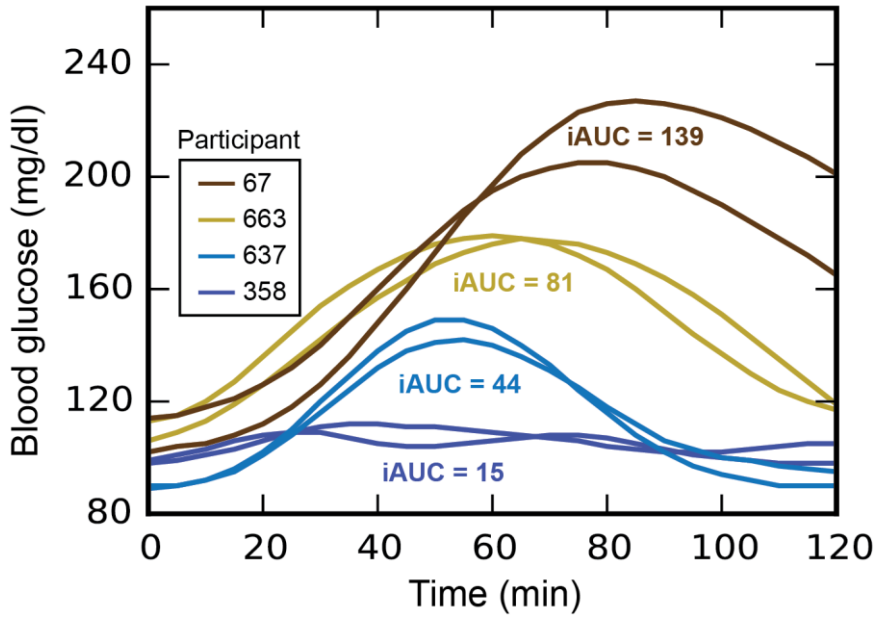
Different people have widely different post-meal responses to the same standardized meal

Population Responses to Standardized Meals



Four Individual Responses to Bread



Zeevi *et al.*, Cell 2015

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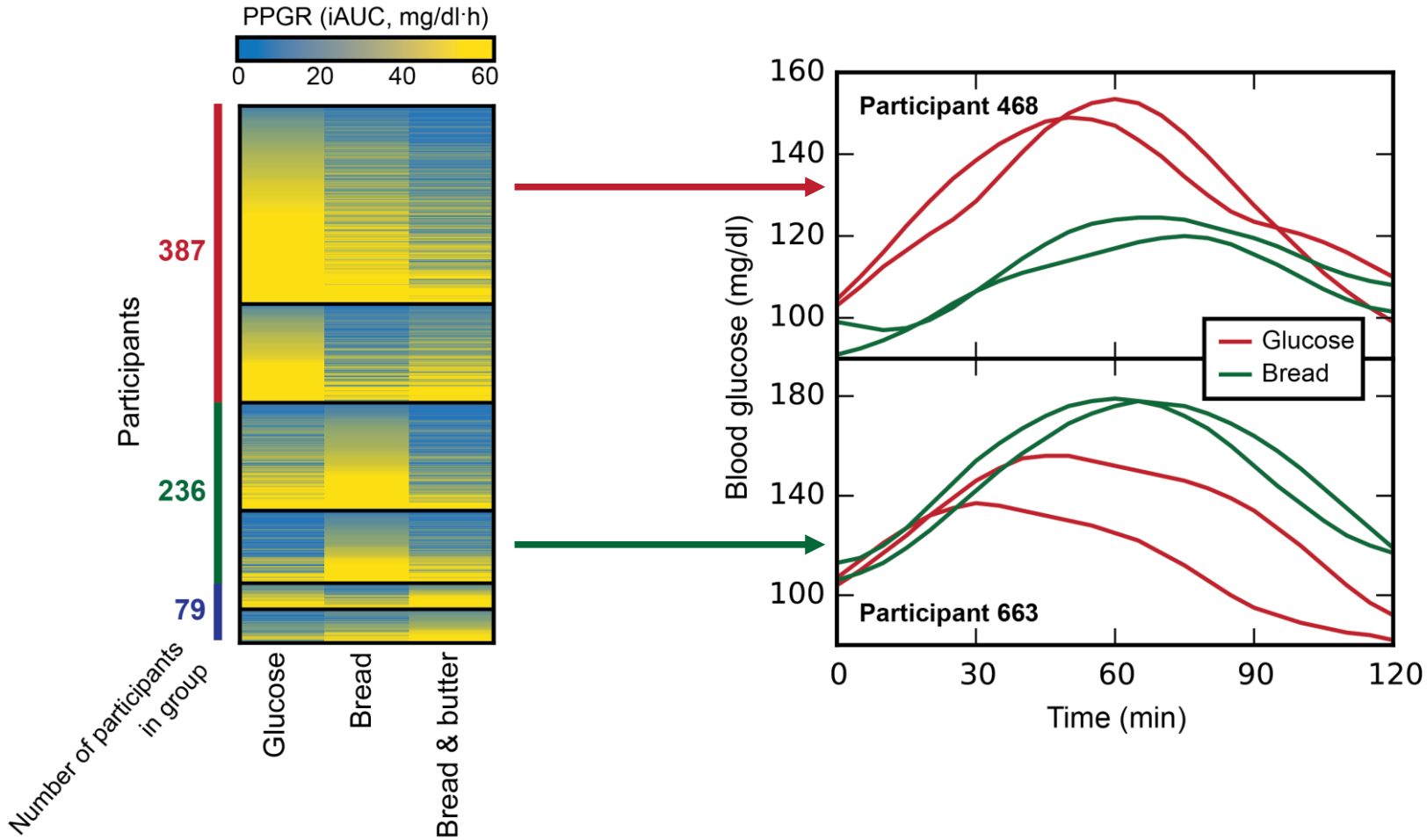
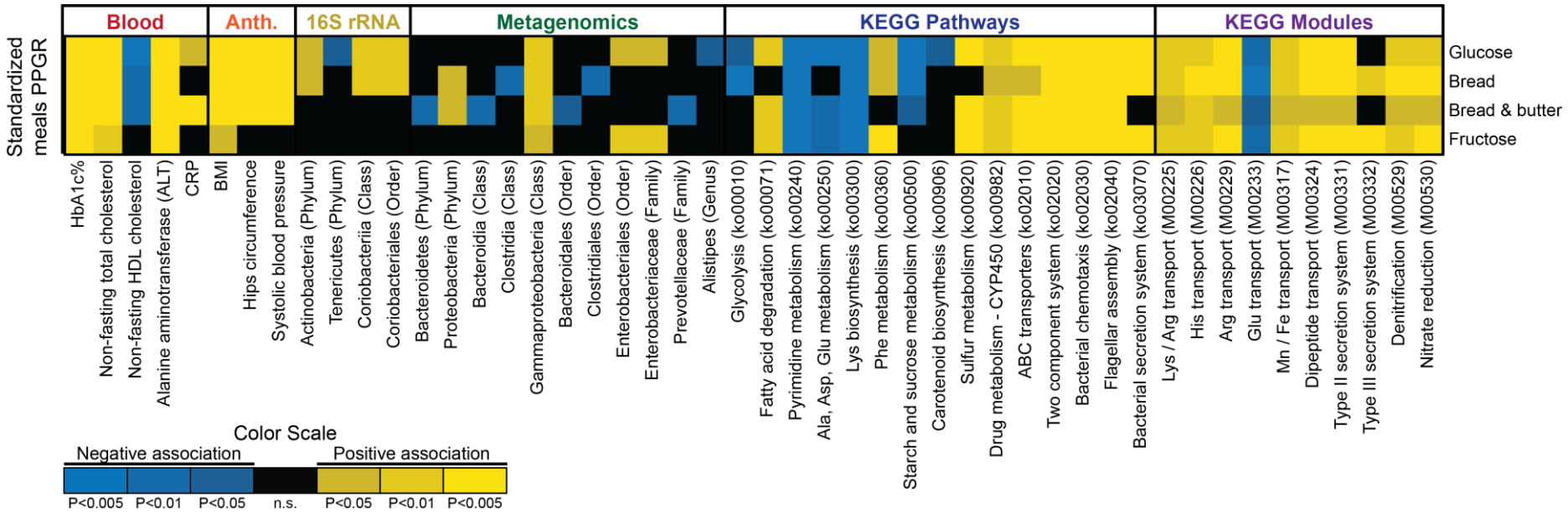
Different people have widely different post-meal responses to the same standardized meal



What explains the variability in people's response to the same food?

Variability in post-meal glucose response across people associates with microbiota composition and function



Zeevi *et al.*, Cell 2015

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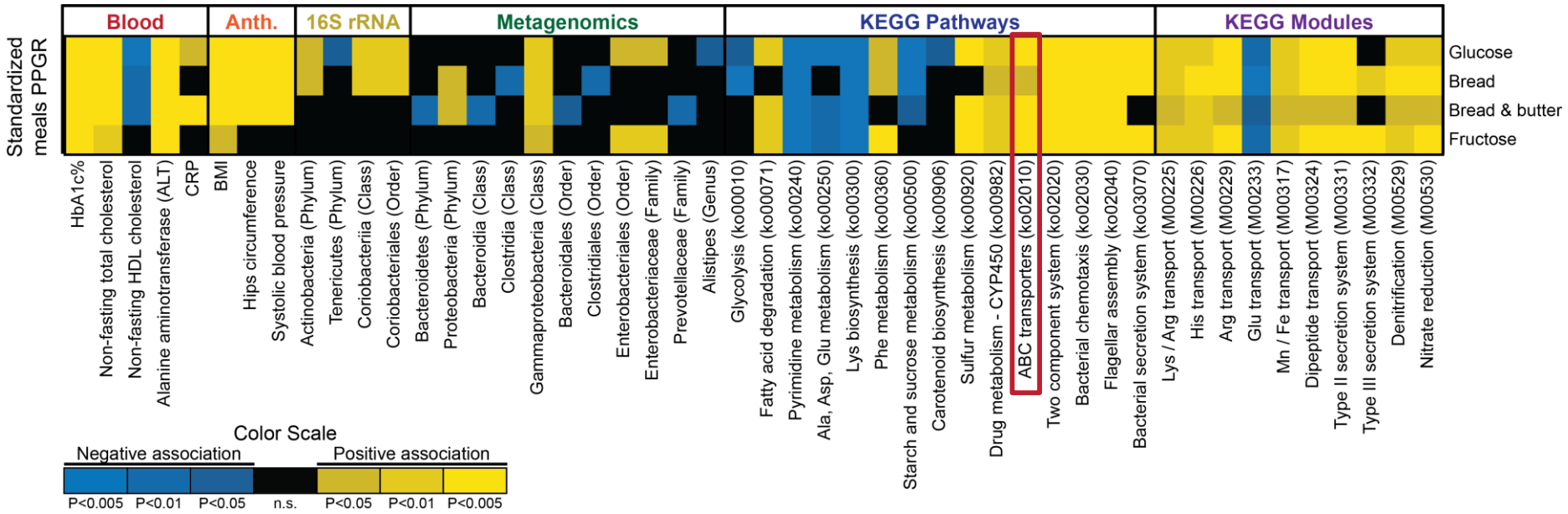
Positive association between ABC transporters and post-meal glucose response to all standardized meals

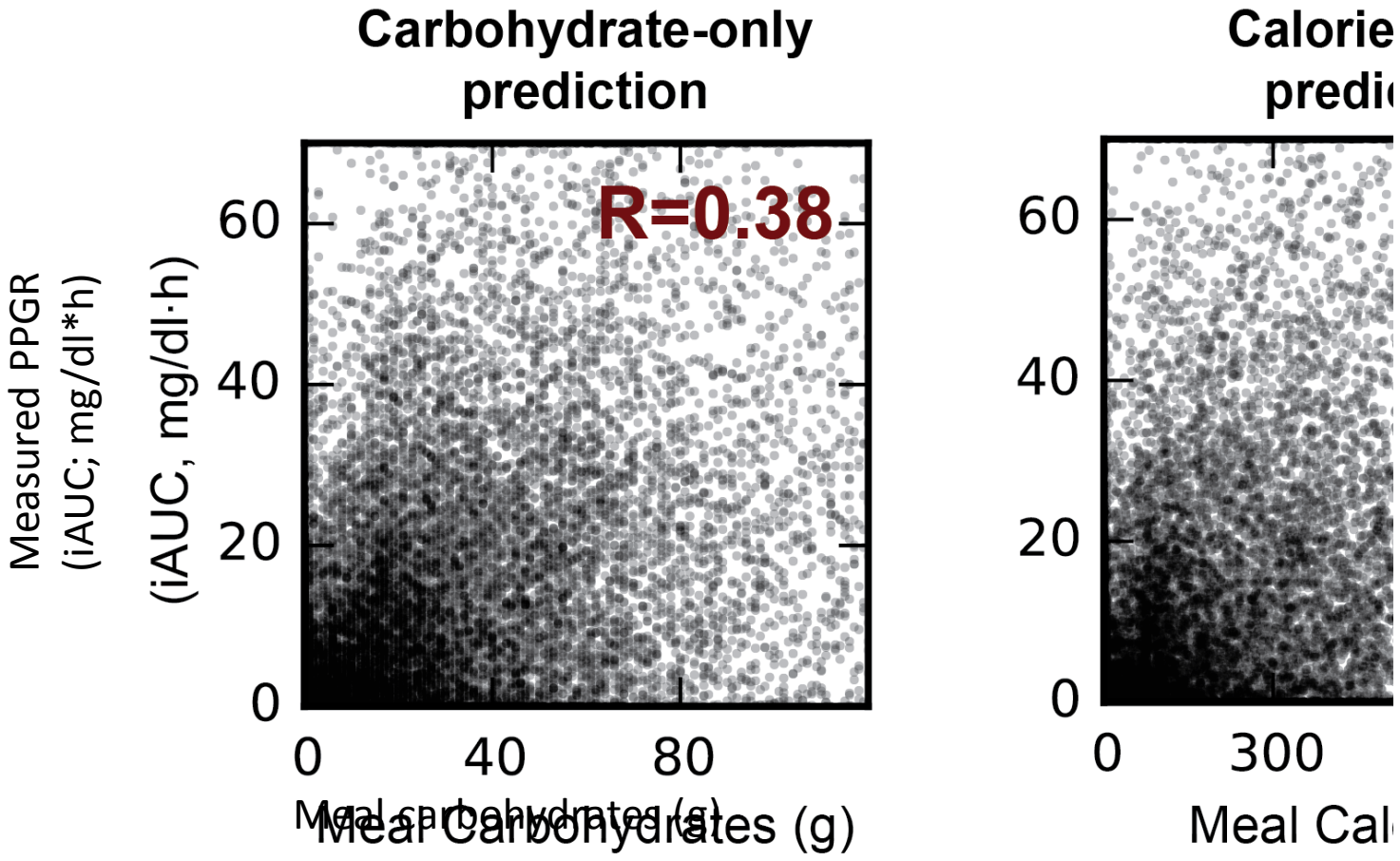


- Positive association with **TIIDM** (Karlsson et al., 2013)
- Positive association with **western high-fat/high-sugar diet** (Turnbaugh et al., 2009)

Can we predict the personal post-prandial glucose response to any complex meal?

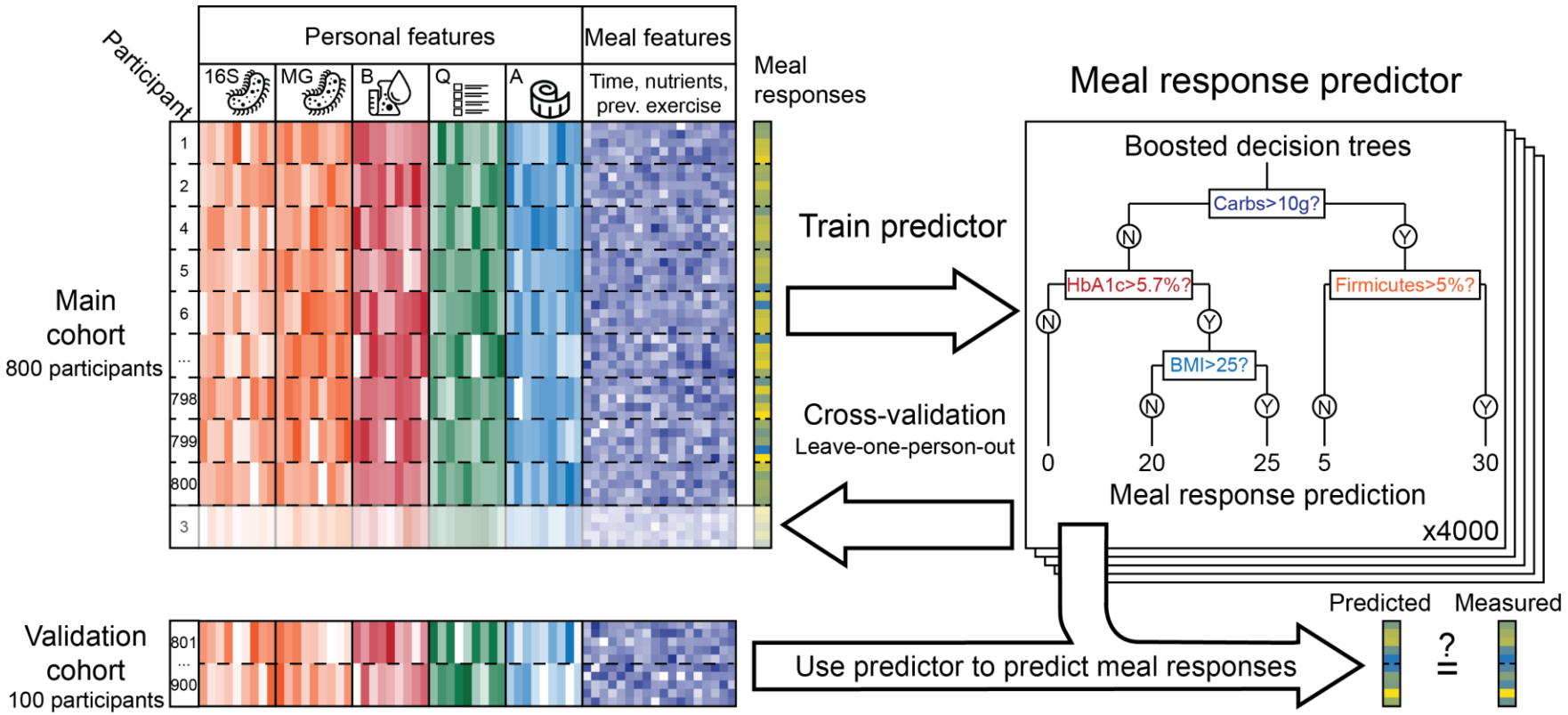
Meal Carbohydrates: State of the art in predicting post-meal glucose responses

State of the art



Zeevi *et al*., Cell 2015

Prediction scheme



Zeevi *et al.*, Cell 2015

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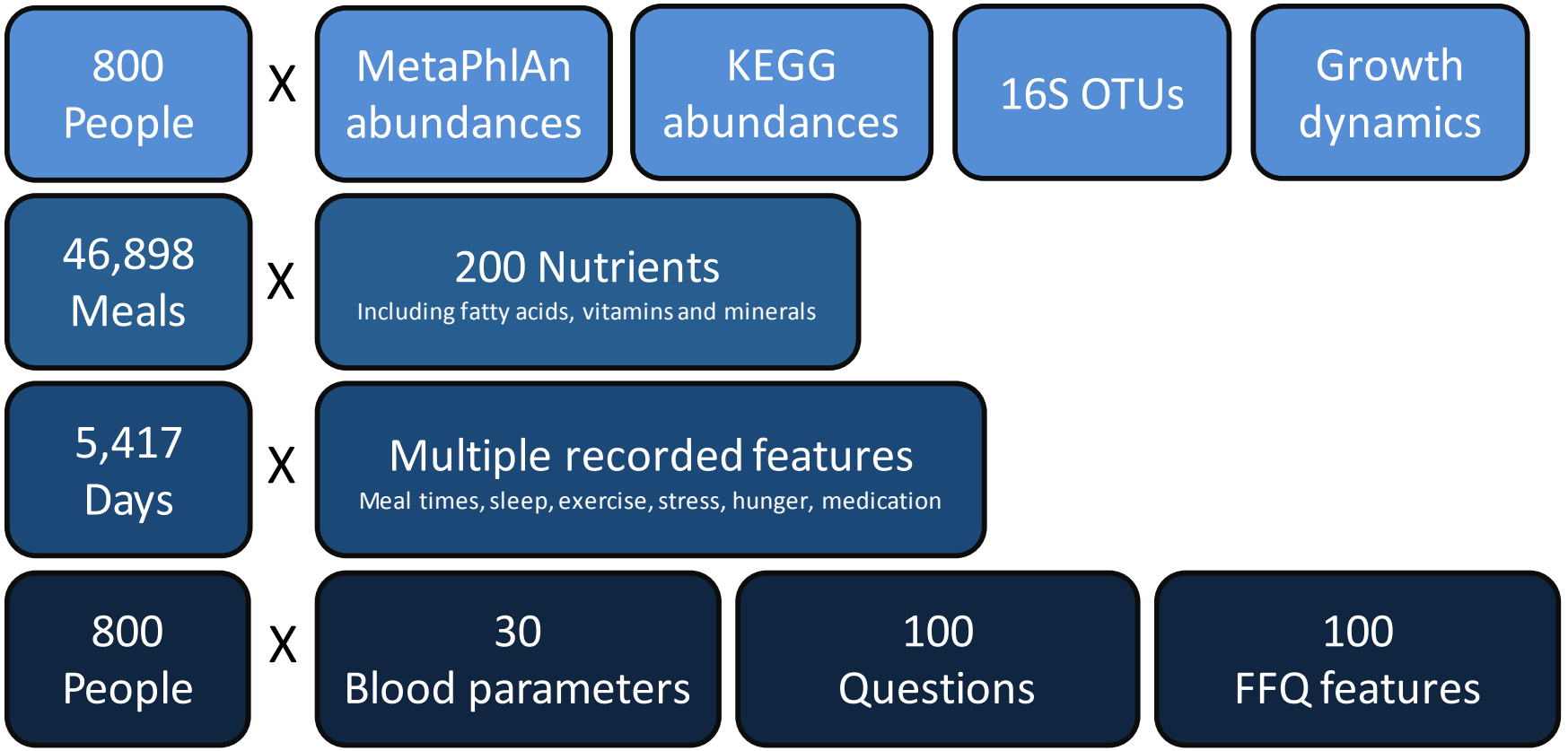
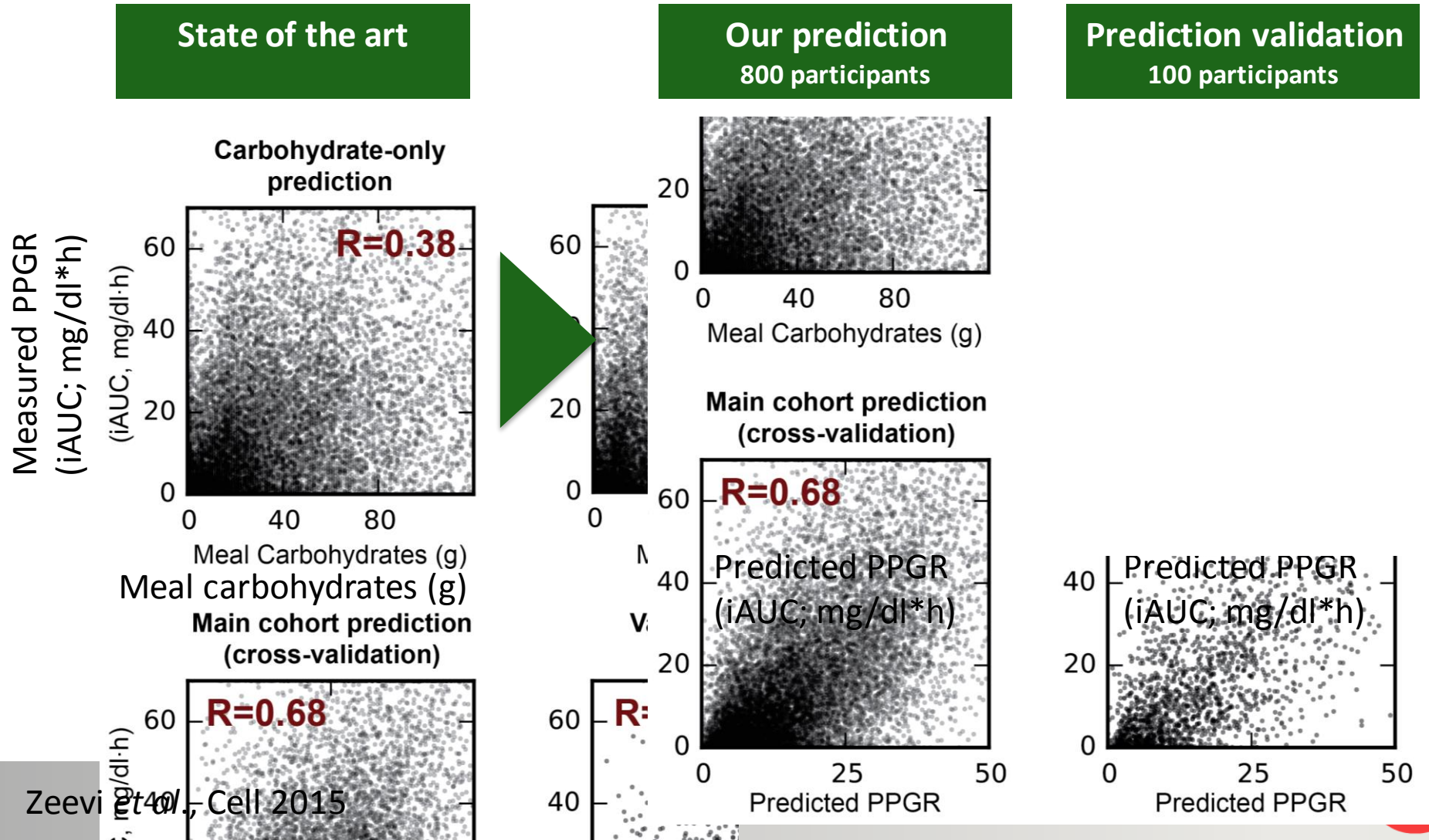
Model features



Zeevi *et al.*, Cell 2015

Accurate predictions of personalized glucose responses



Zeevi *et al.*, Cell 2015

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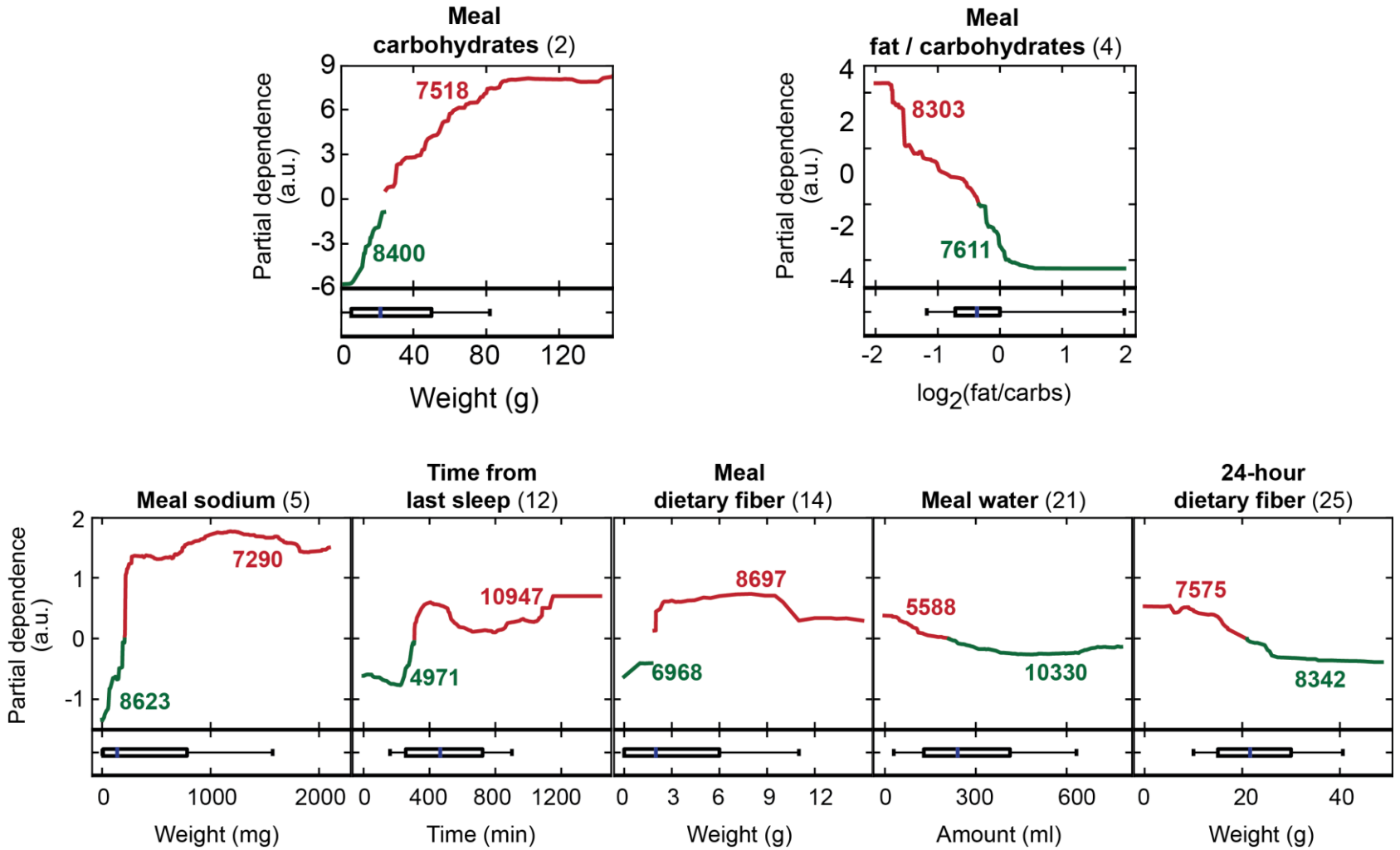
Meal and lifestyle factors affect the post-meal glucose response



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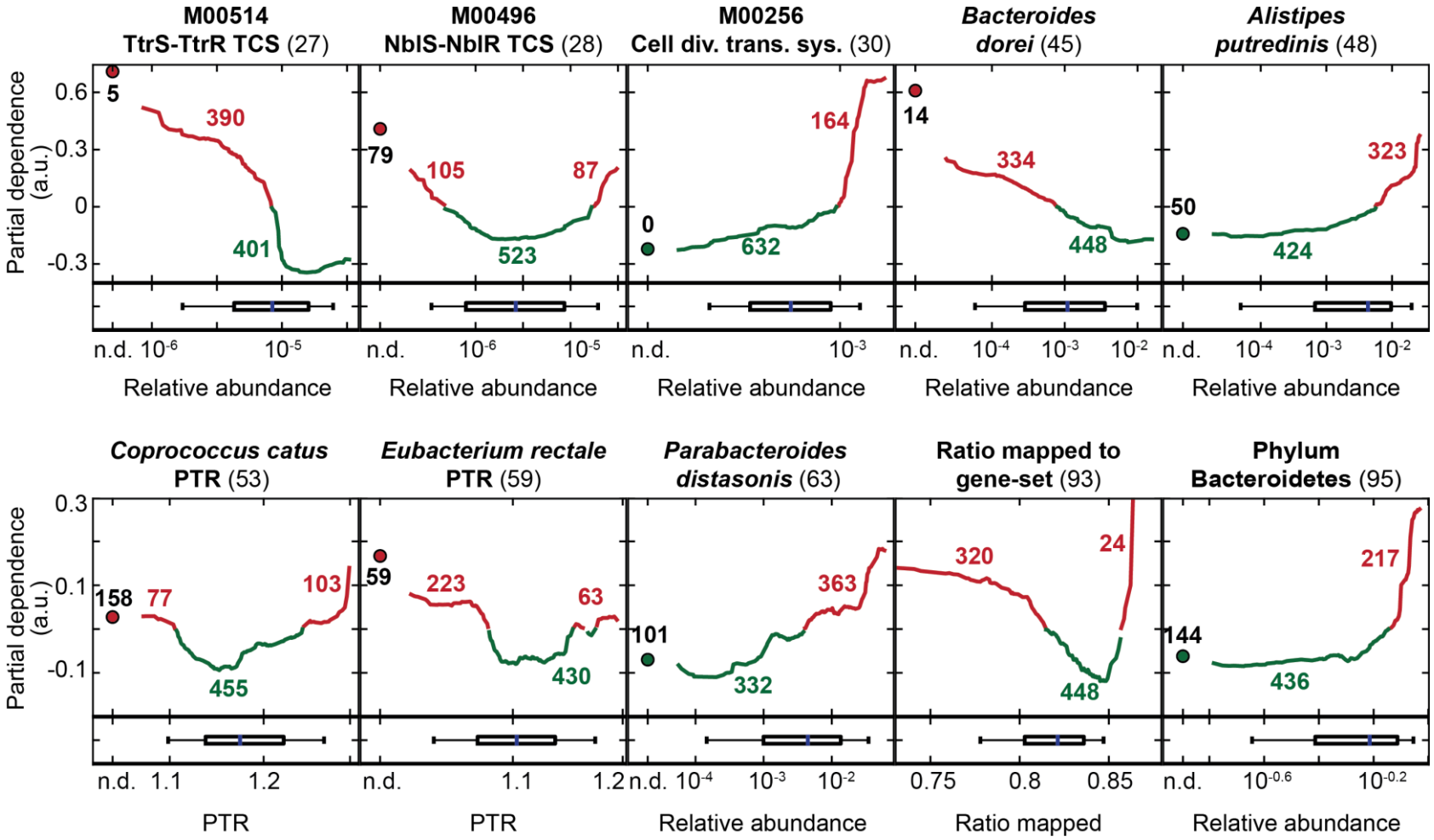
Microbiome features affect the post-meal glucose response



Zeevi *et al.*, Cell 2015

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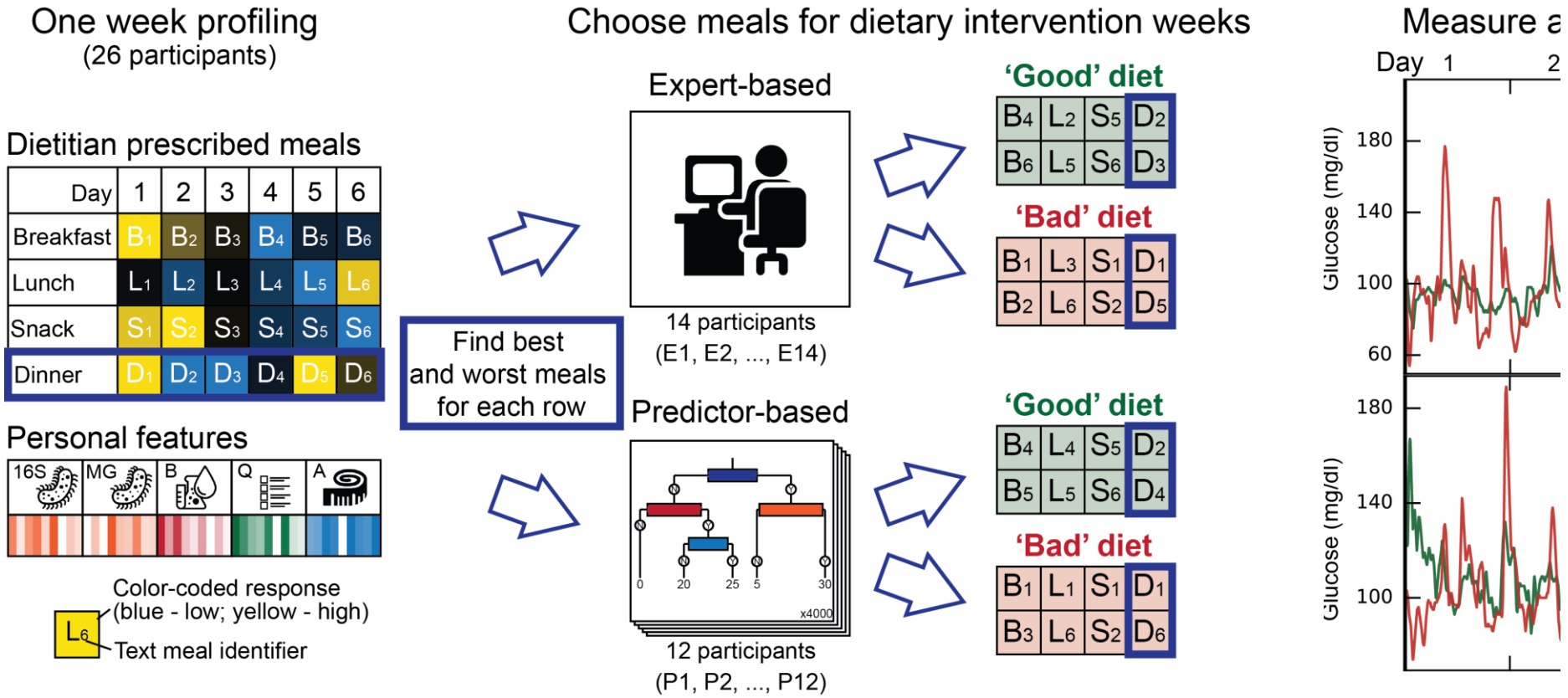
Can personally tailored dietary interventions improve post-prandial glucose responses?

Daphna Rothschild

Orly Ben-Yaacov

Michal Rein

Constructing personally tailored diets that achieve normal post-prandial glucose responses



Zeevi *et al.*, Cell 2015

The Personalized Nutrition Project

Can you distinguish between the good and bad menus?

	"Bad" Diet / "Good" Diet ?	"Bad" Diet / "Good" Diet ?
Breakfast	 Muesli	 Egg with bread and coffee
Lunch	 Sushi	 Hummus and pita
Snack	 Marzipan	 Edamame
Dinner	 Corn and nuts	 Vegetable noodles with tofu
Night snack	 Toblerone and coffee	 Ice cream

Zeevi *et al.*, Cell 2015

The Personalized Nutrition Project

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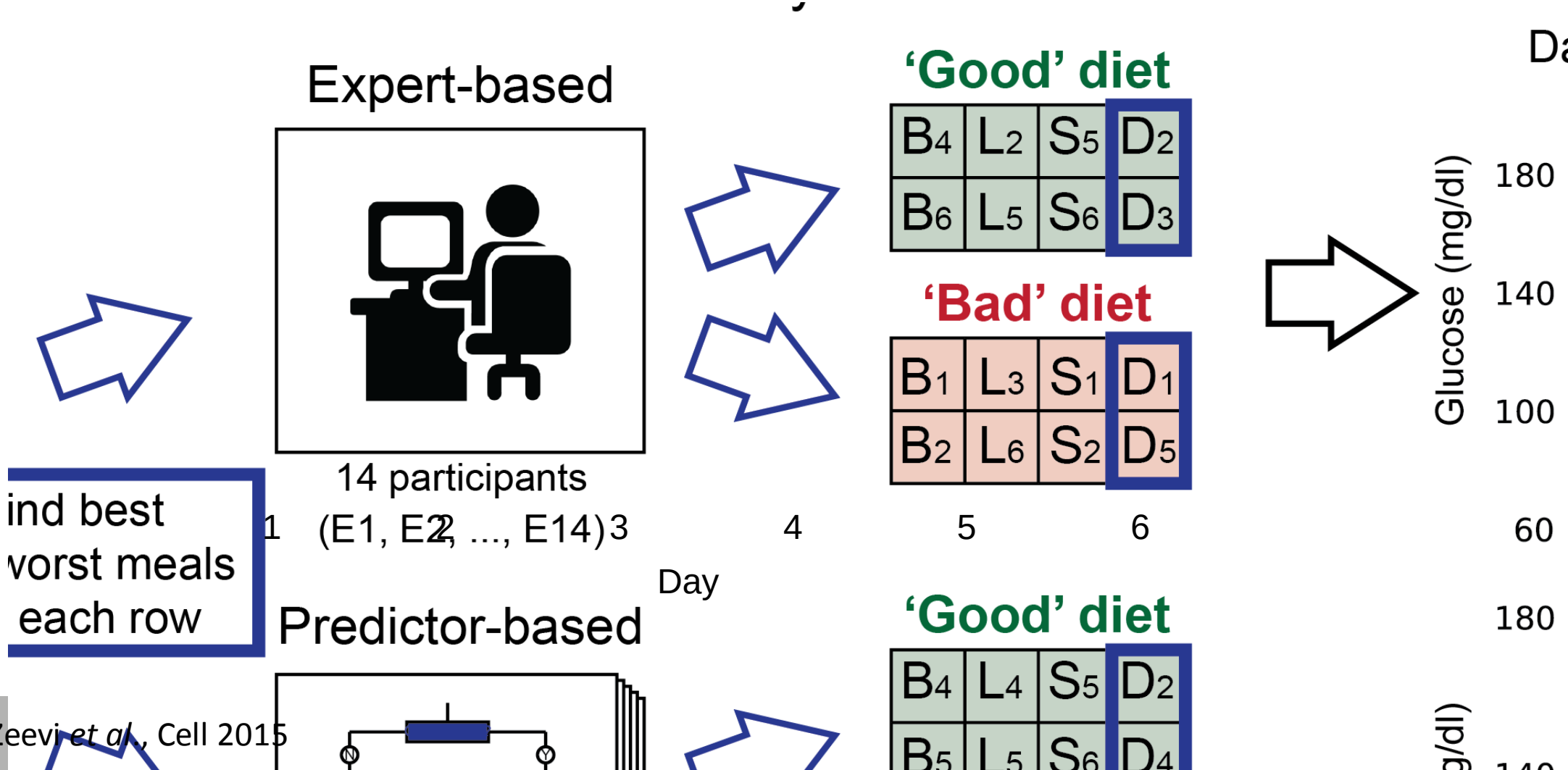
Zeevi *et al.*, Cell 2015

The Personalized Nutrition Project

Personally tailored diets reduce the post-prandial glucose response



Zeevi *et al.*, Cell 2015

Can you distinguish between the good and bad menus?

	"Bad" Diet	"Good" Diet ?	"Bad" Menu	"Good" Diet ?
Breakfast		Orange juice		Croissant
Lunch		Schnitzel		Goulash with rice
Snack		Peach		Halva
Dinner		Bread with butter		Hummus
Night snack		Grapes		Red wine

Zeevi *et al.*, Cell 2015

The Personalized Nutrition Project

Can you distinguish between the good and bad menus?

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Breakfast	 Orange juice	 Croissant
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Zeevi *et al.*, Cell 2015

The Personalized Nutrition Project

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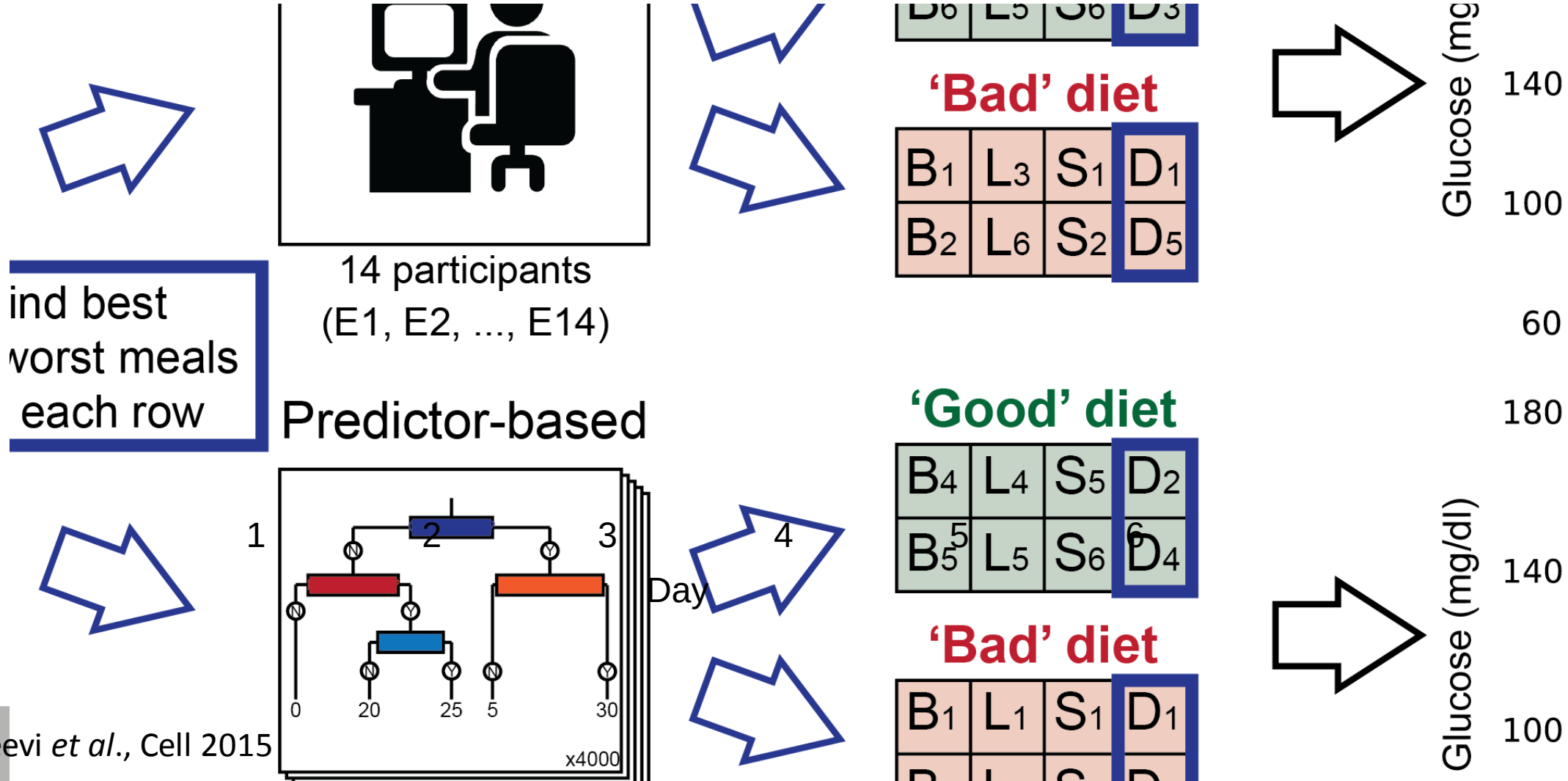
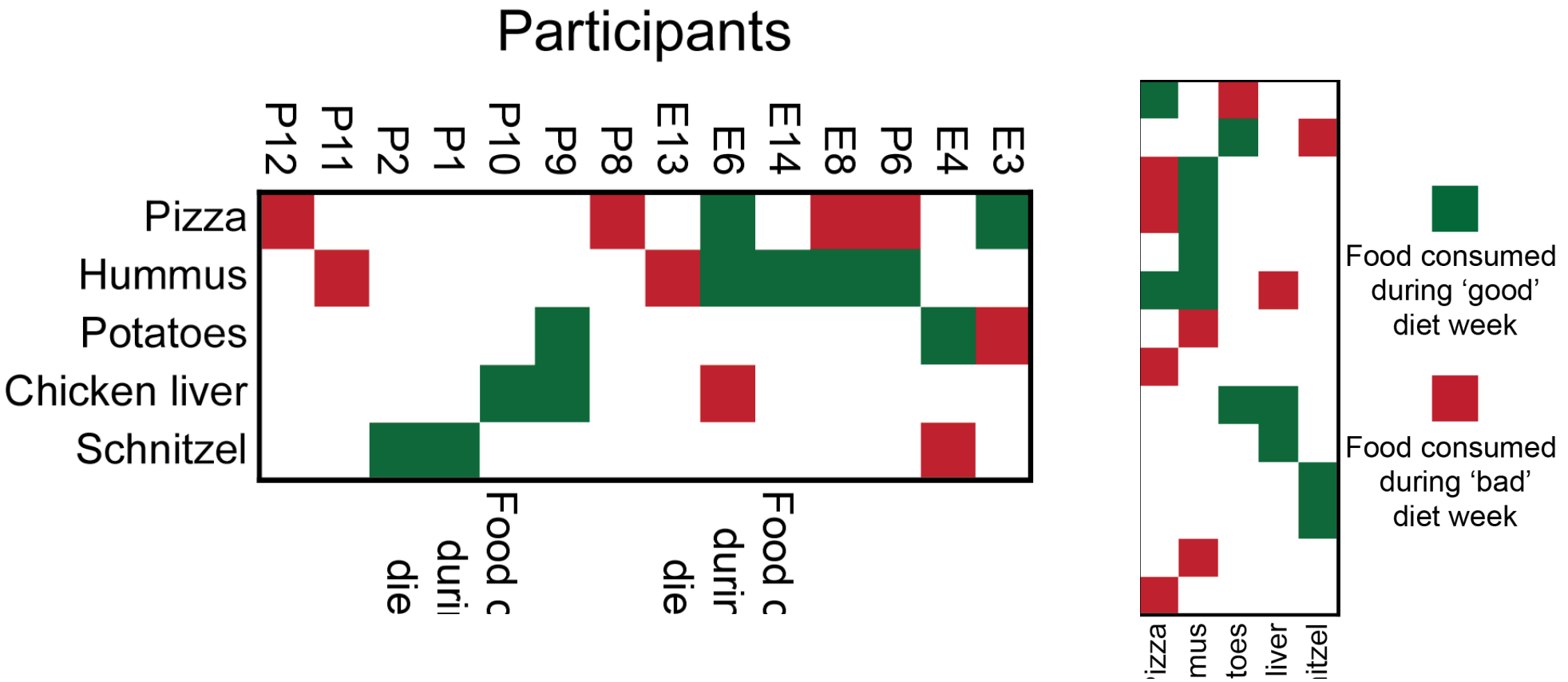


Zeevi *et al.*, Cell 2015

Foods that appear in the ‘good’ diet of one person may appear in the ‘bad’ diet of another



Zeevi *et al.*, Cell 2015

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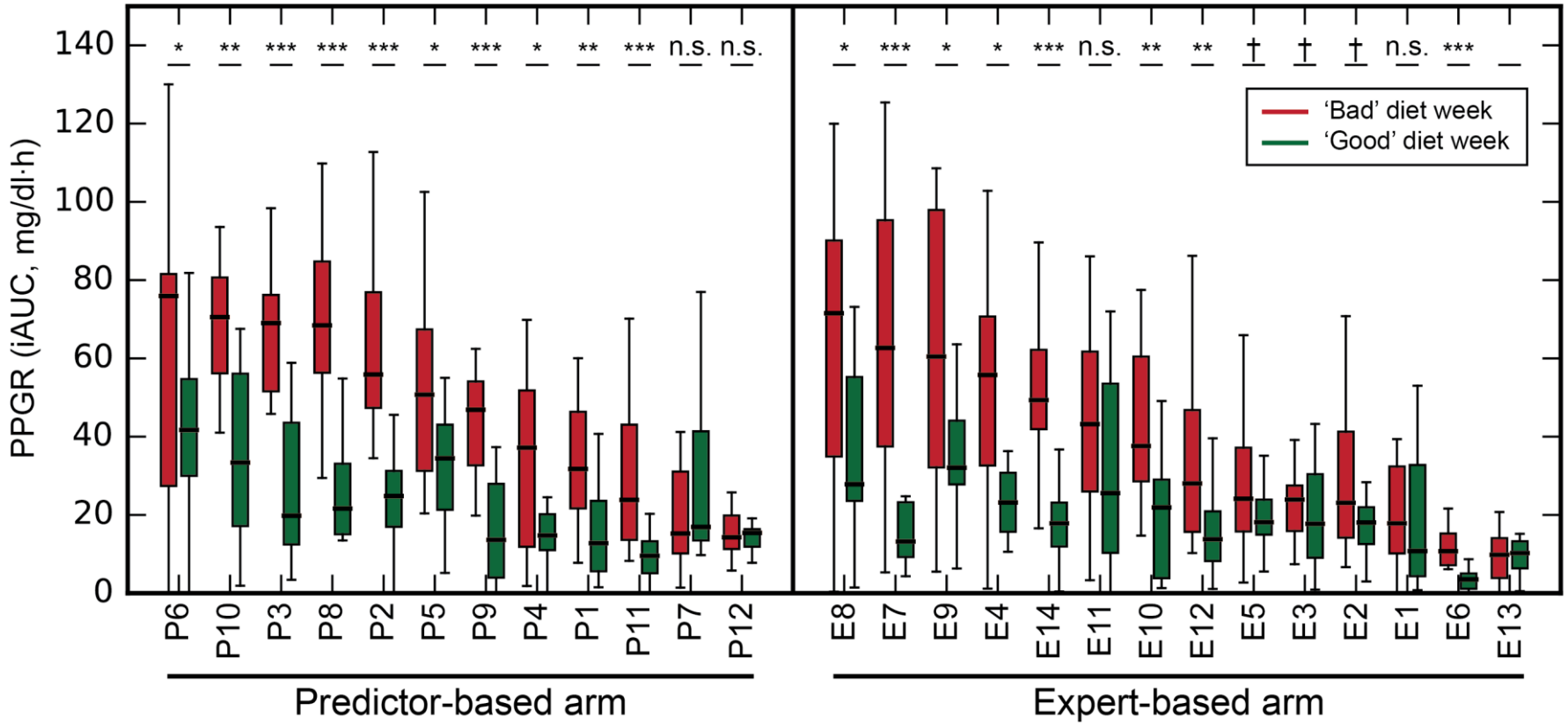
Personally tailored diets improve post-meal responses



Zeevi *et al.*, Cell 2015

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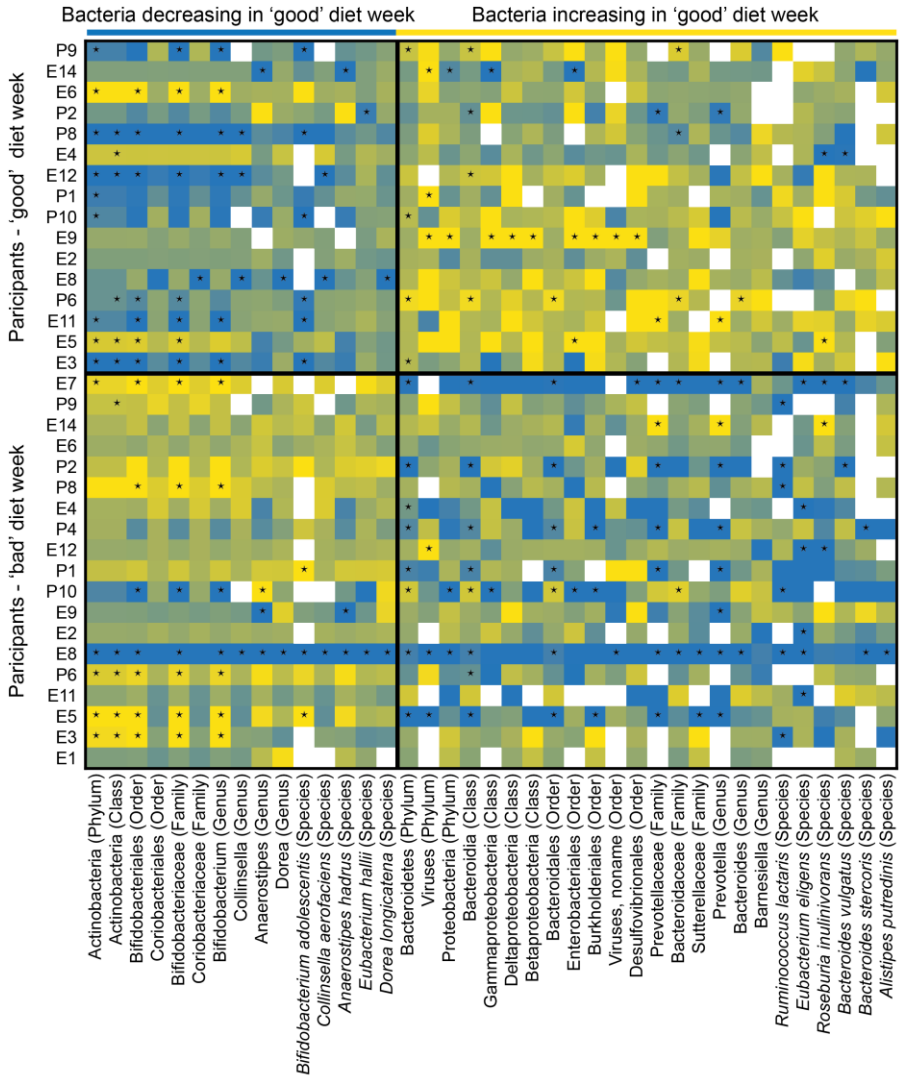
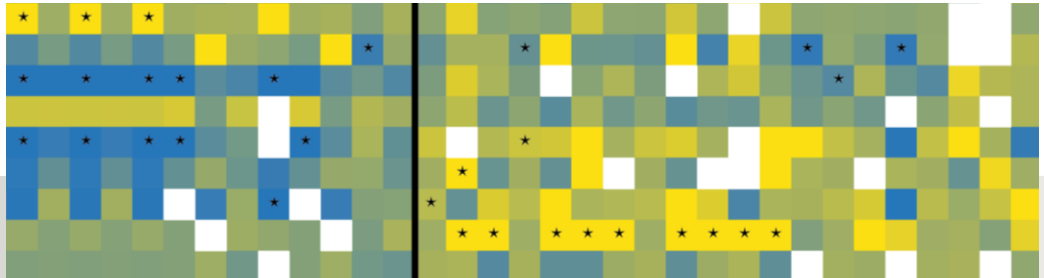
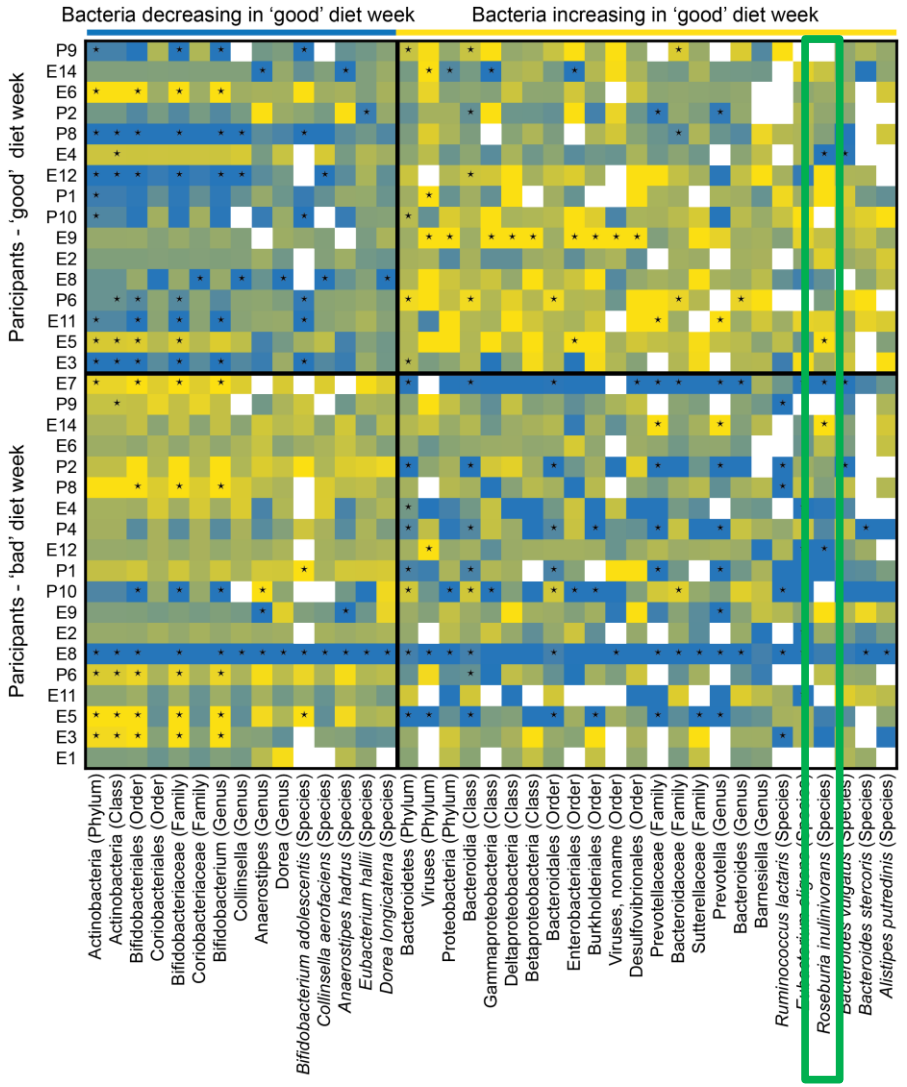
Dietary interventions targeting post-meal glucose responses induce consistent changes in microbiota

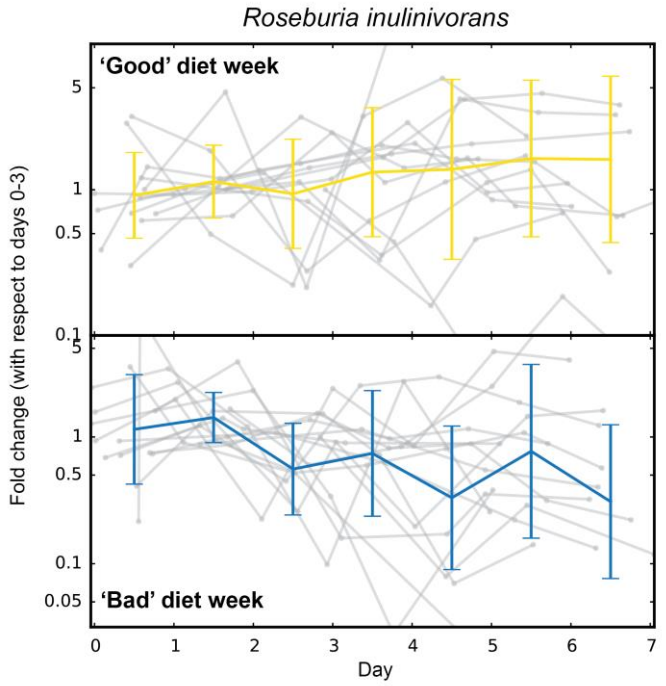




Zeevi *et al.*, Cell 2015

Dietary interventions targeting post-meal glucose responses induce consistent changes in microbiota



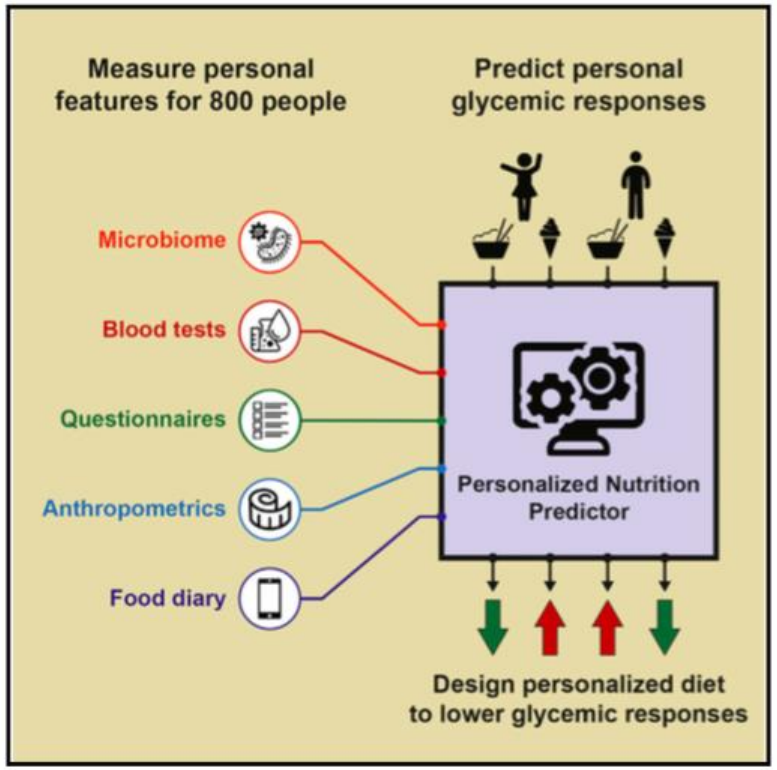


- *Roseburia inulinivorans* increases following the 'good' diet week
- Low levels associate with TIIDM (Qin et al., 2012)

Zeevi *et al*., Cell 2015

The Personalized Nutrition Project

Personalized nutrition project summary



- High interpersonal variability in post-meal glucose response to identical meals
- Personal and microbiome features enables accurate glucose response prediction
- Short term personalized dietary interventions successfully lower post-meal glucose

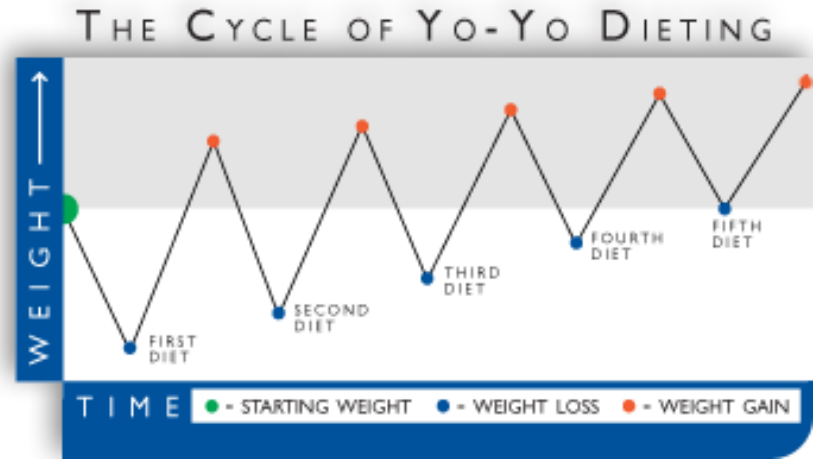
Why can’t we maintain our weight after dieting?

Christoph Thaiss

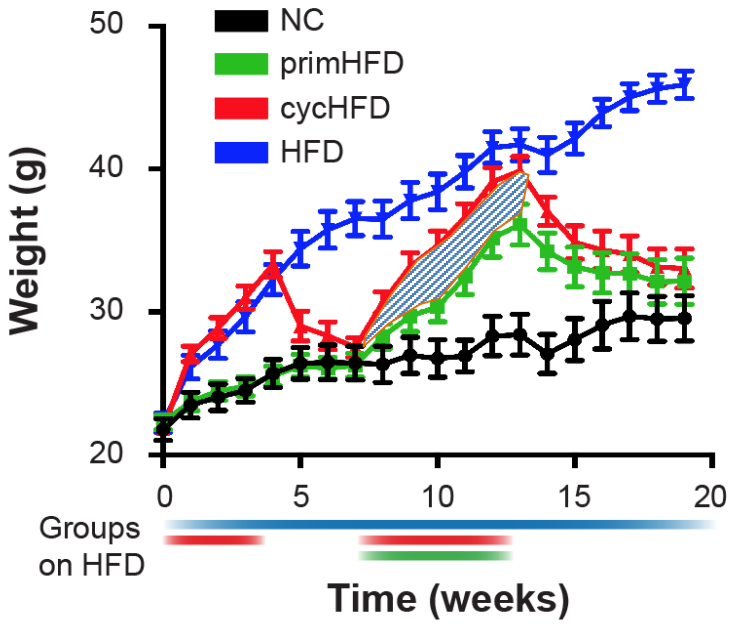
Shmulik Motola

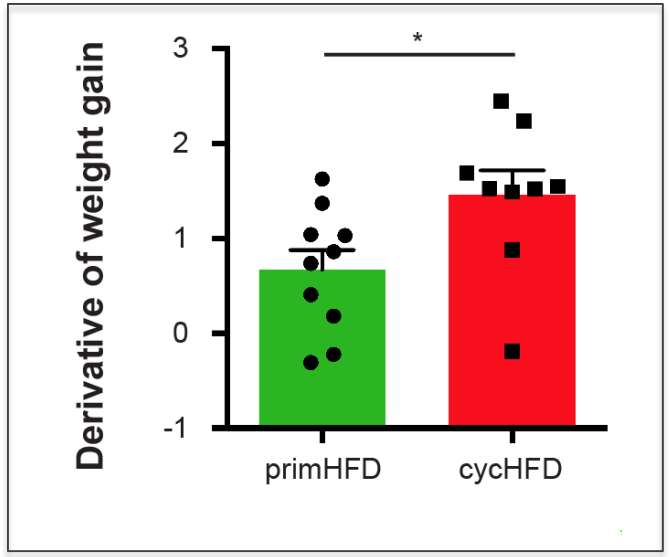
Daphna Rothschild

People tend to regain their weight after a successful diet



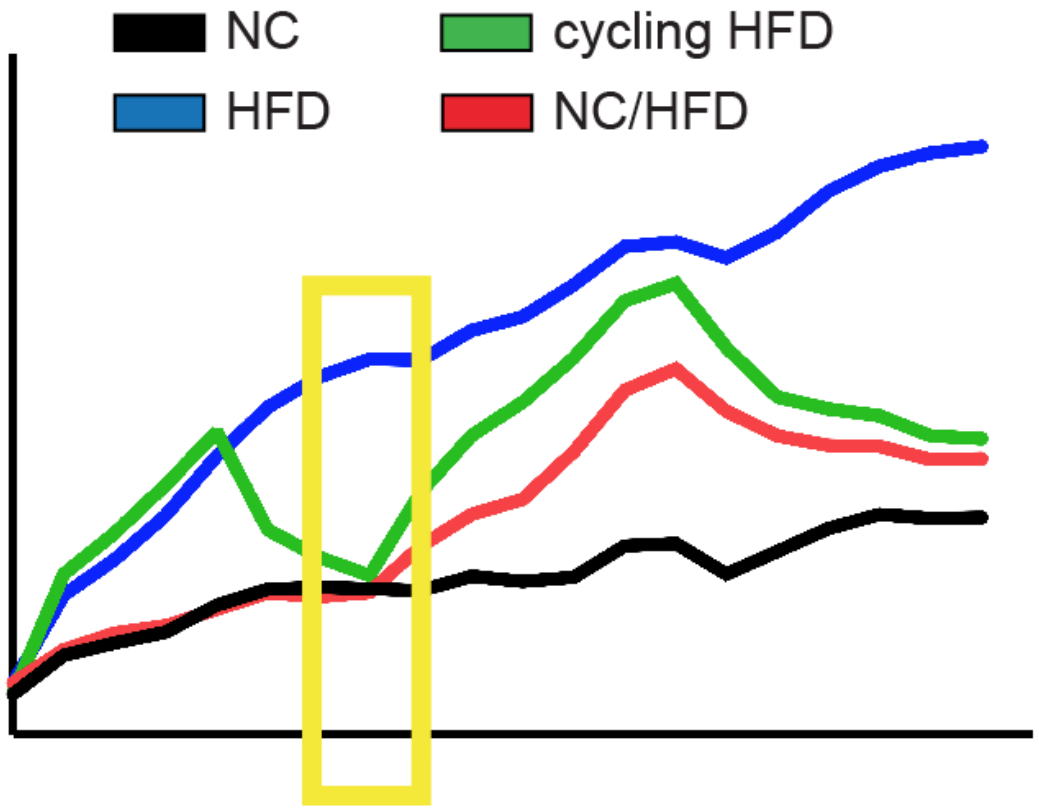
A mouse model of recurring obesity



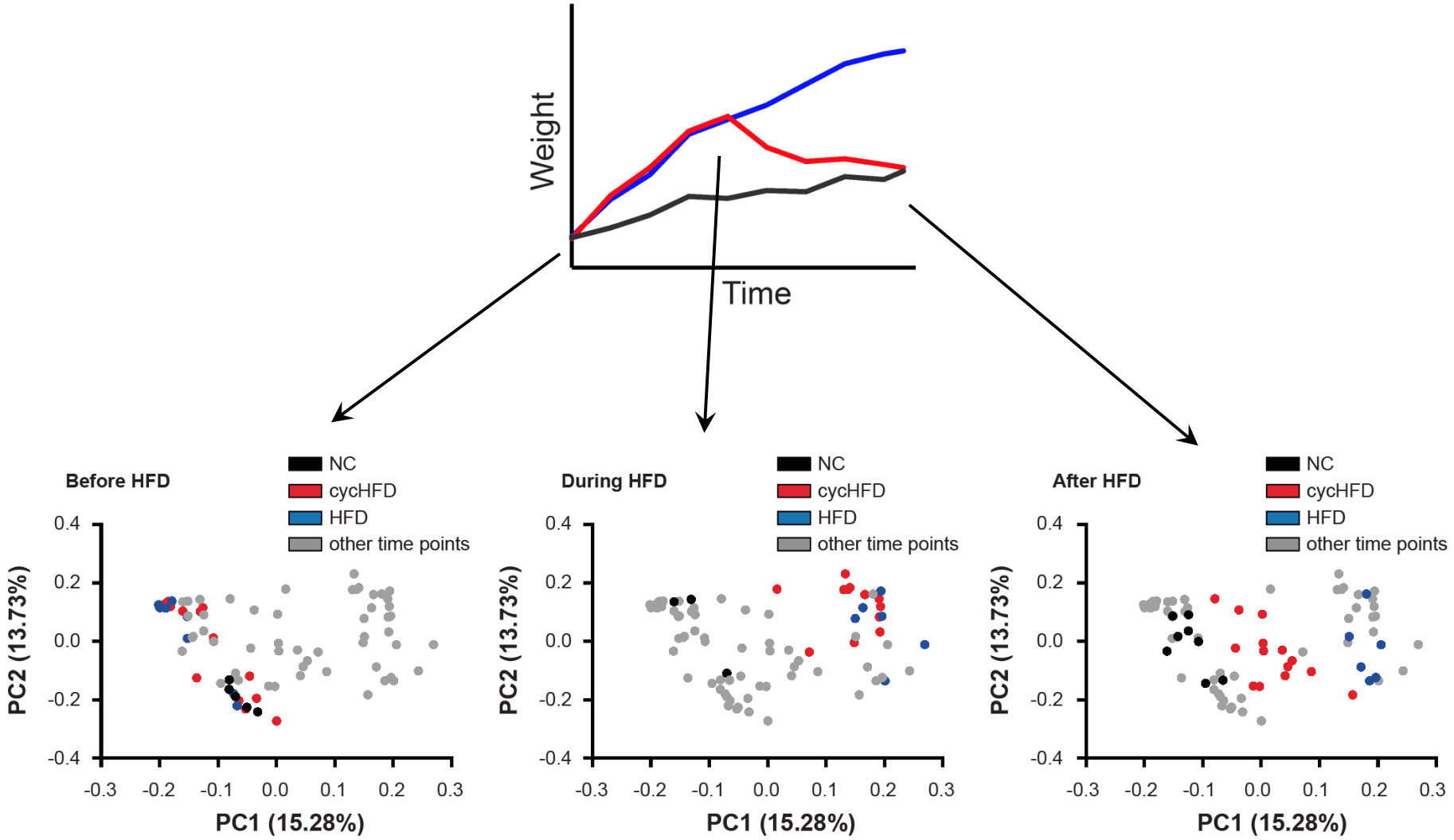


Is there a “memory” of previous obesity?

Is there a memory of previous obesity?

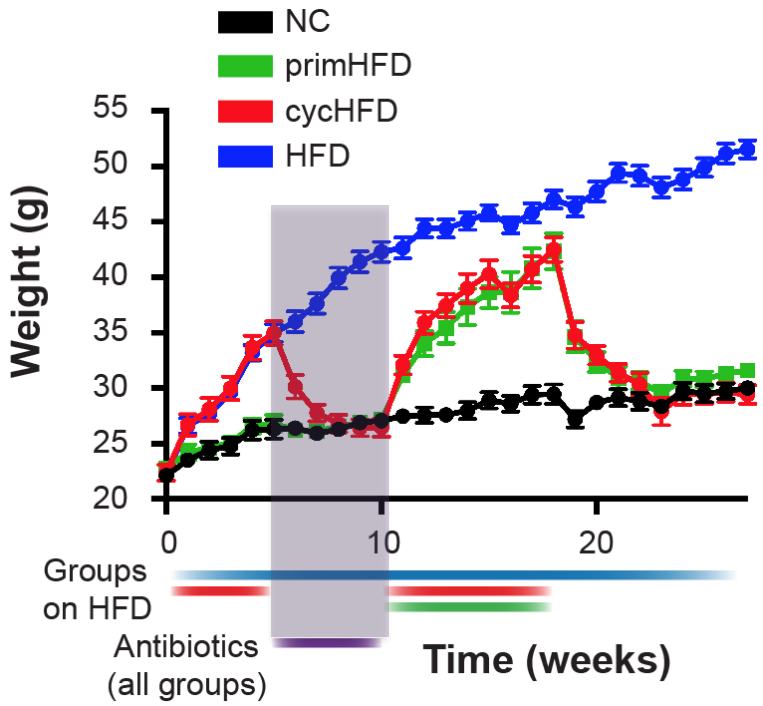


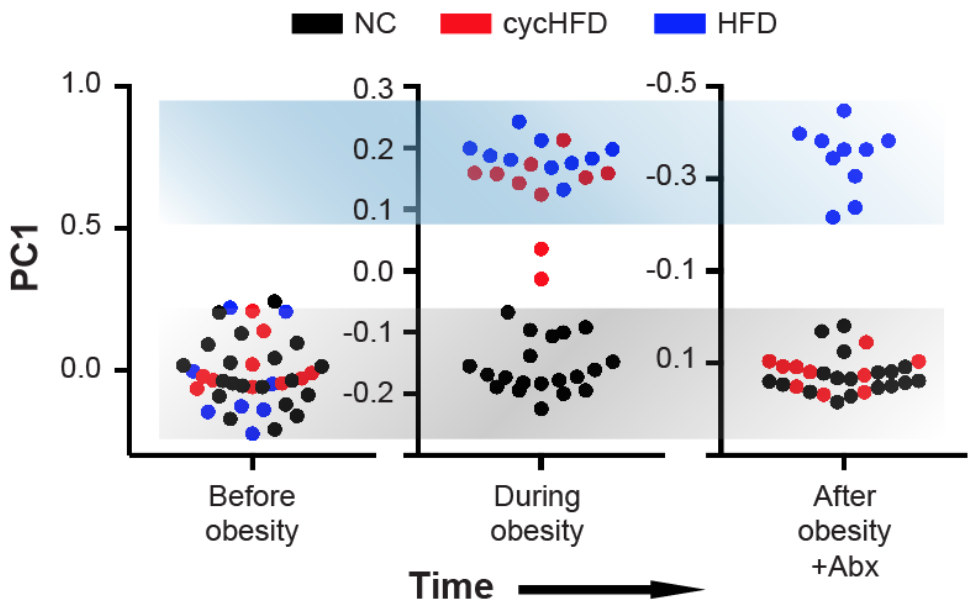
Some differences in 16S microbiome composition are retained after weight loss



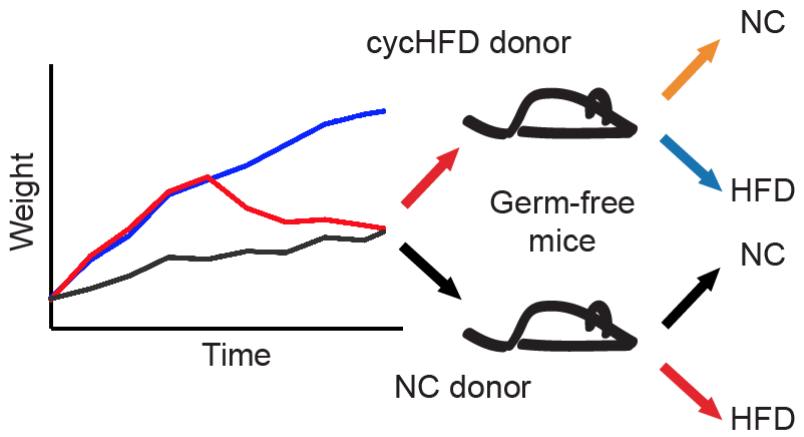
Does the microbiome have a causal role in enhanced weight regain?

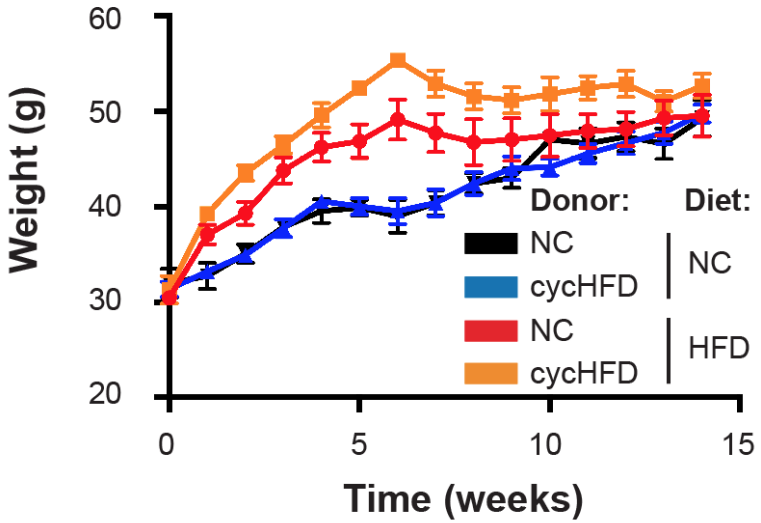
Antibiotic treatment abolishes effect of previous obesity

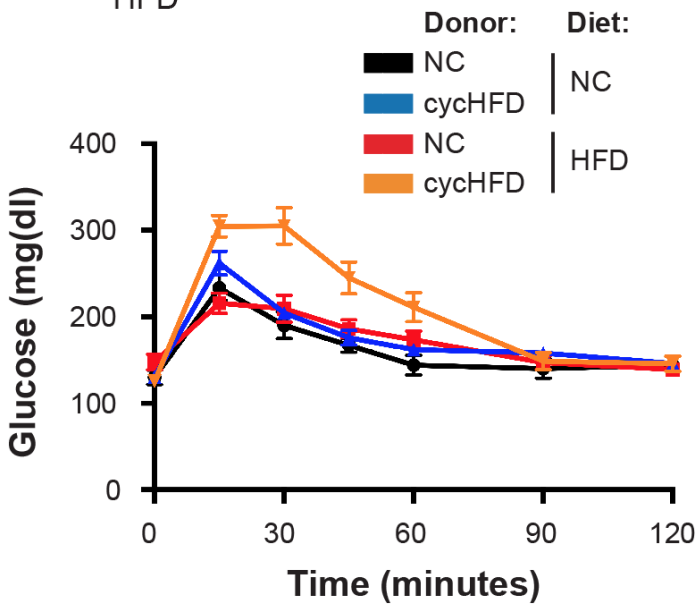




Microbiome transfer to germ free mice transmits enhanced weight regain phenotype

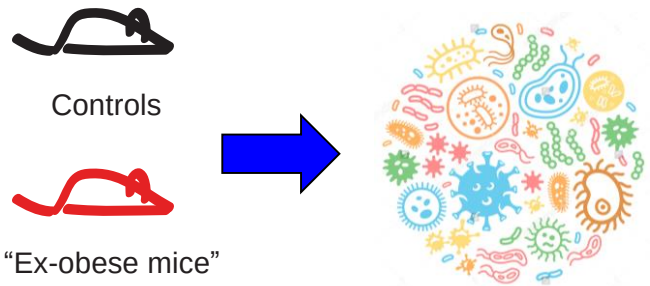


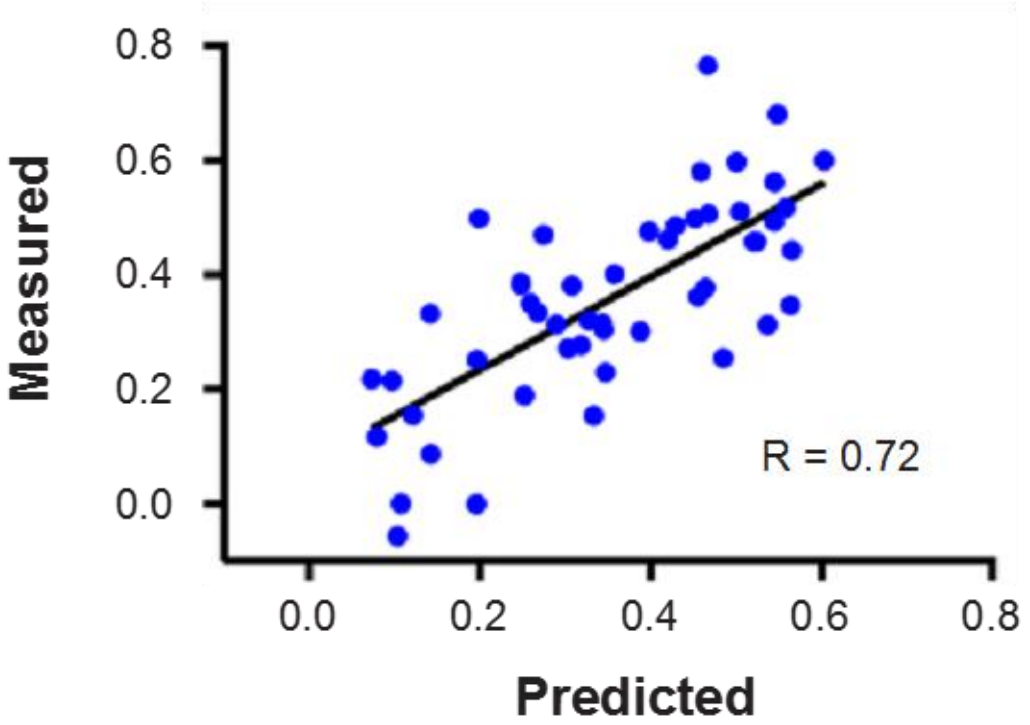




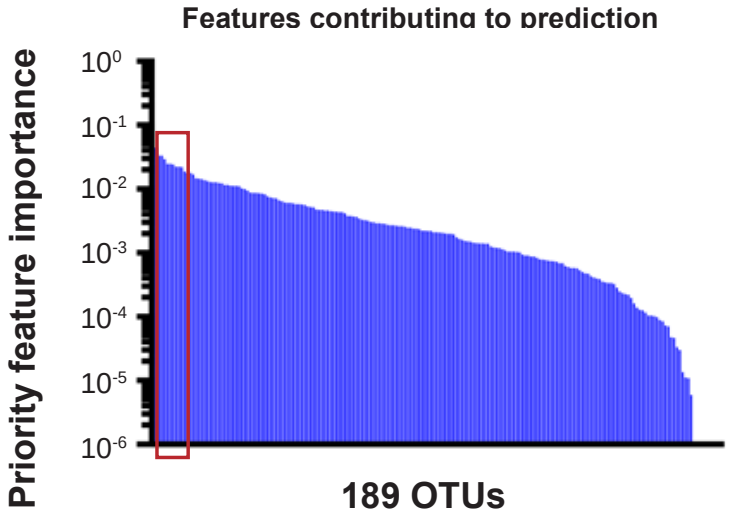
Can we predict weight regain using only microbiome composition?

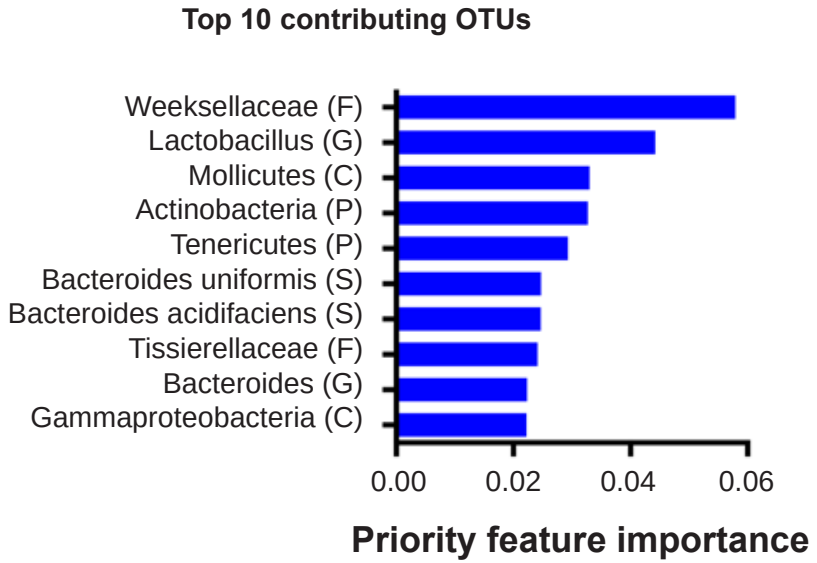
A microbiome-based predictor accurately predicts the degree of future weight gain





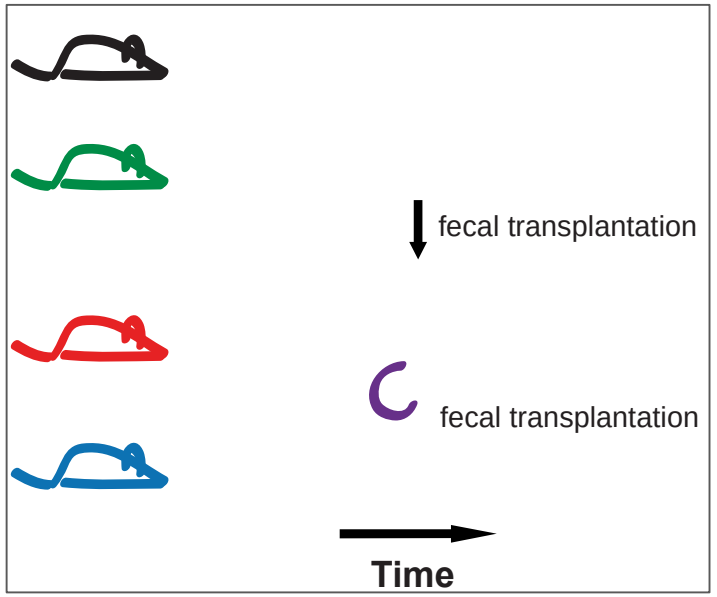
Multiple microbiome factors contribute to predictions

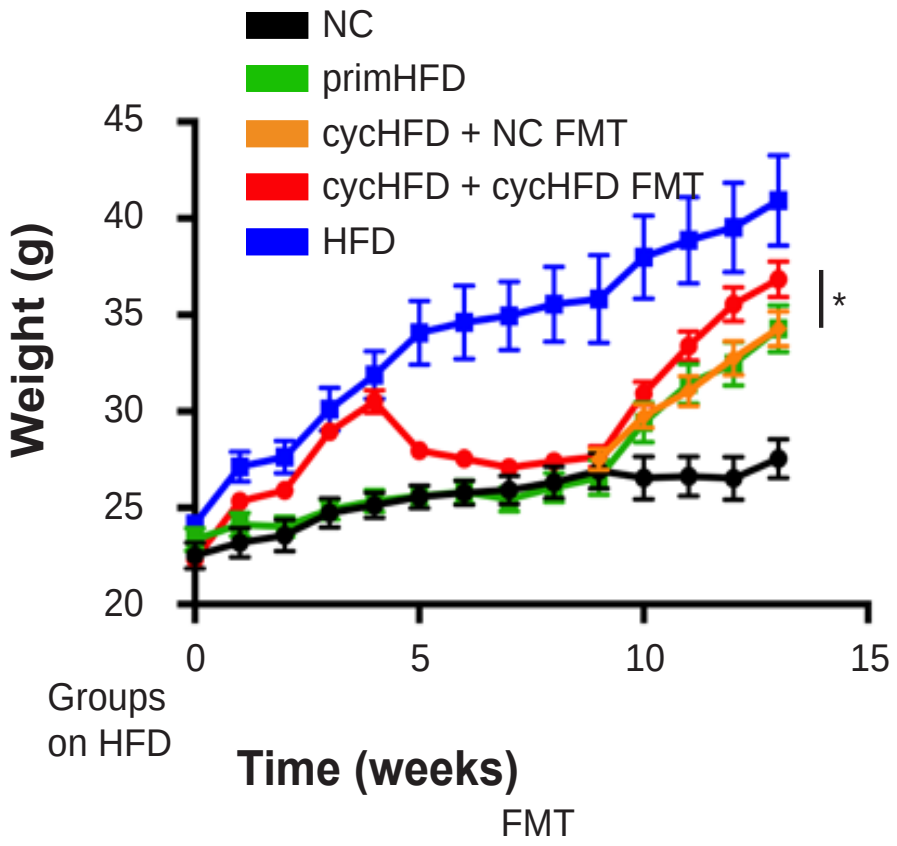




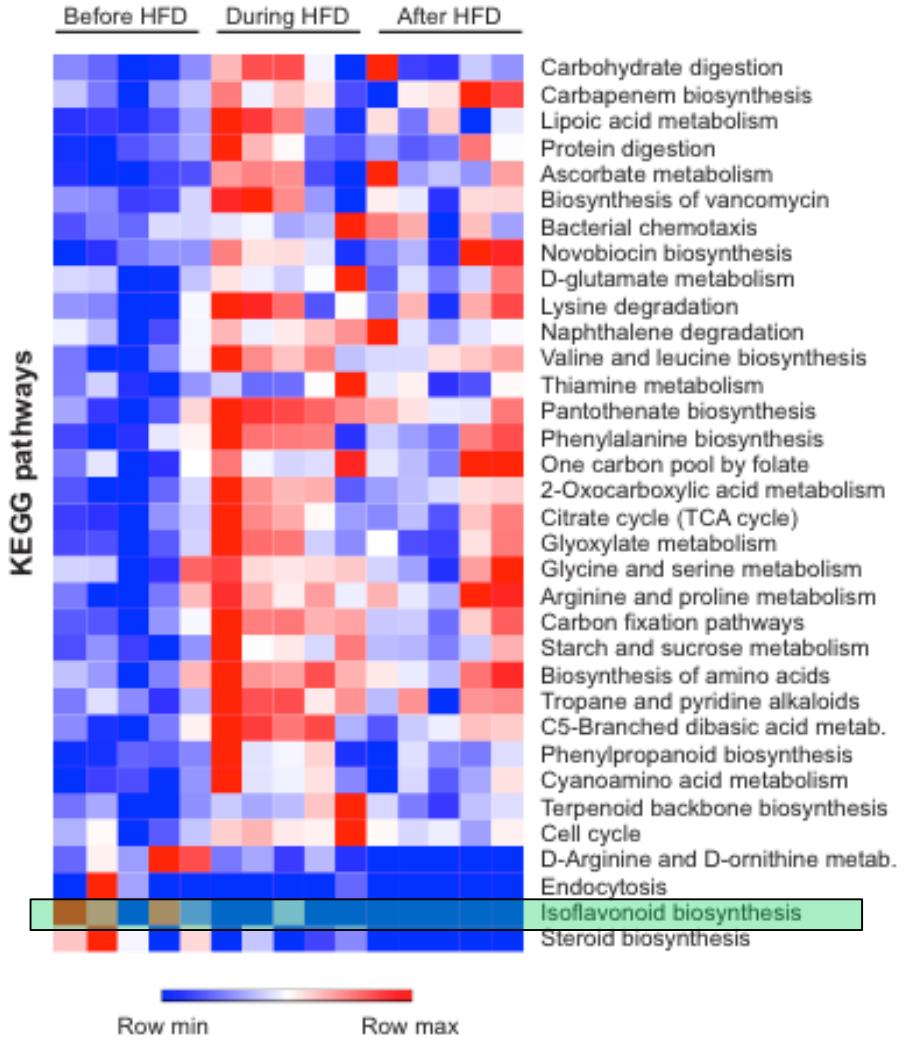
Can we treat relapsing obesity by targeting the microbiome?

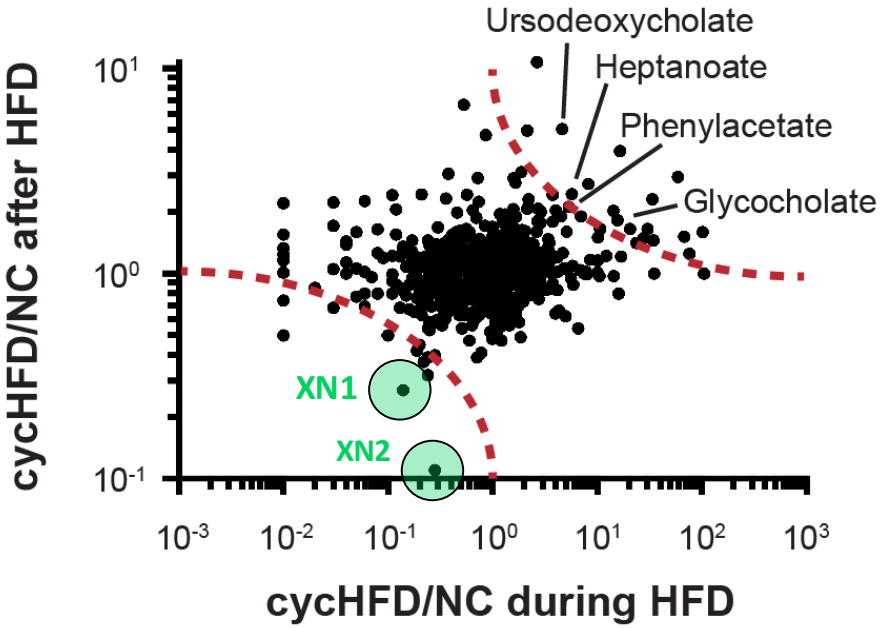
Fecal Microbiome Transplantation (FMT) abolishes microbiome-driven metabolic memory



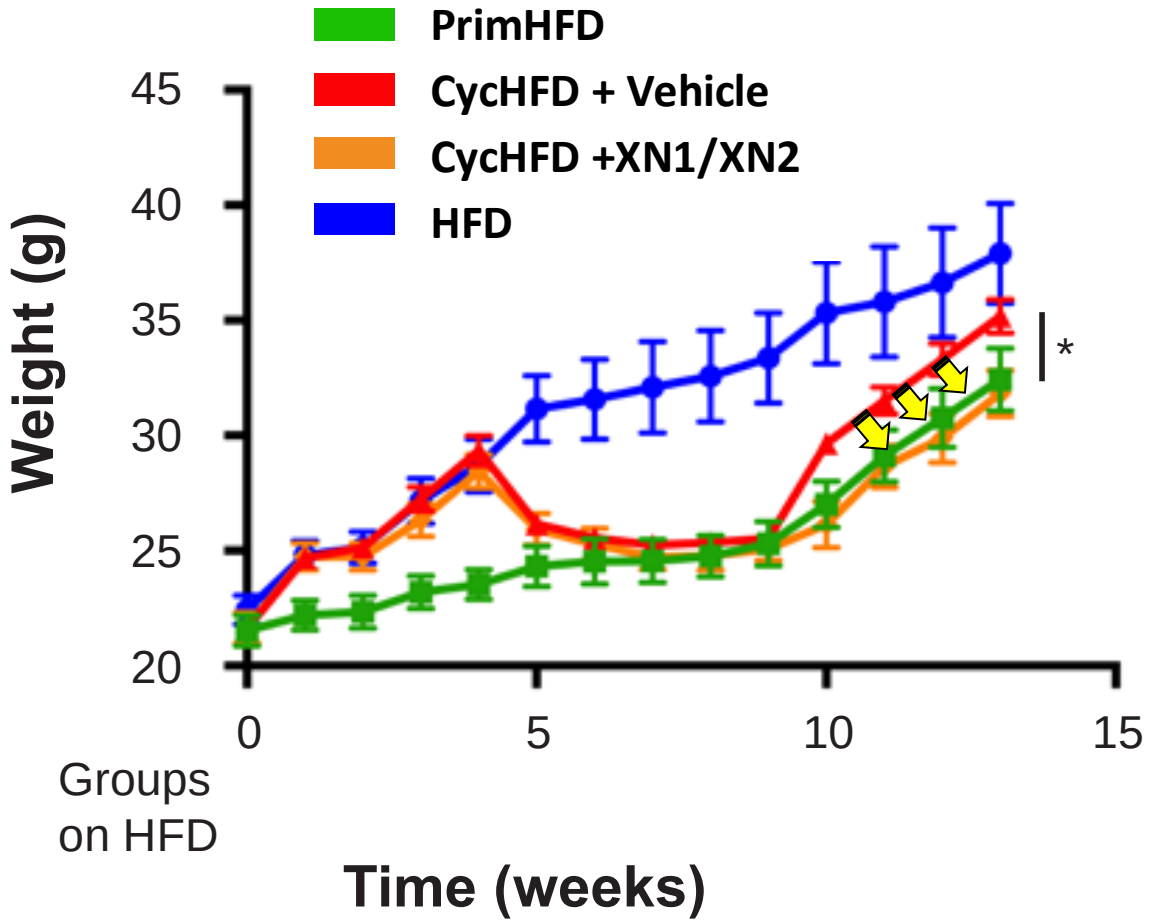


‘Post-biotic’ therapy abolishes microbiome-driven metabolic memory

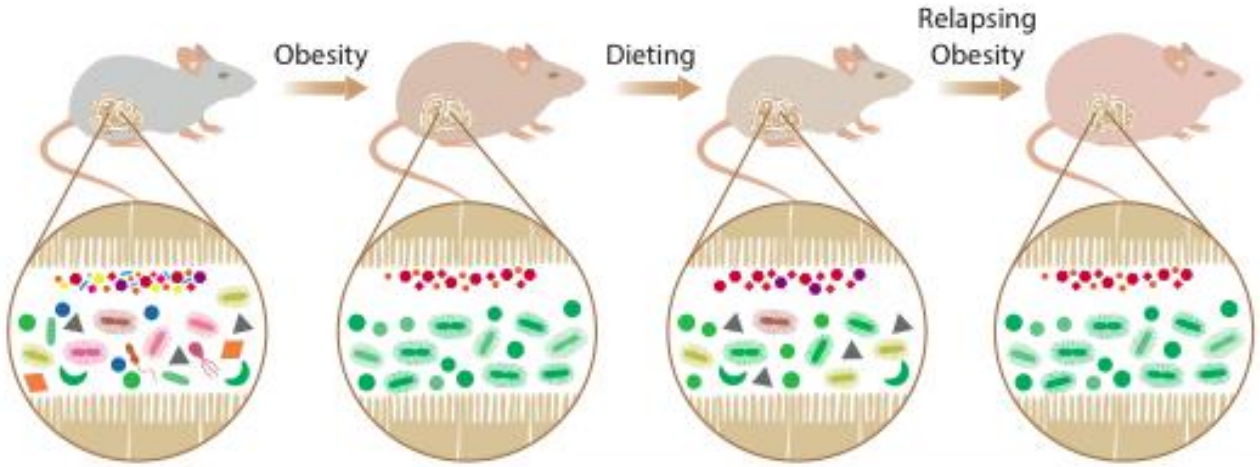


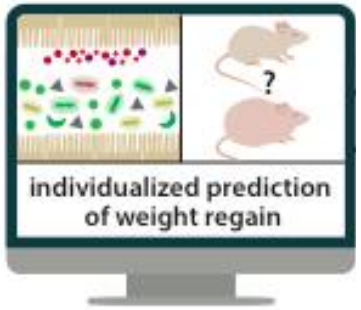


‘Post-biotic’ therapy abolishes microbiome-driven metabolic memory



Relapsing obesity summary





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