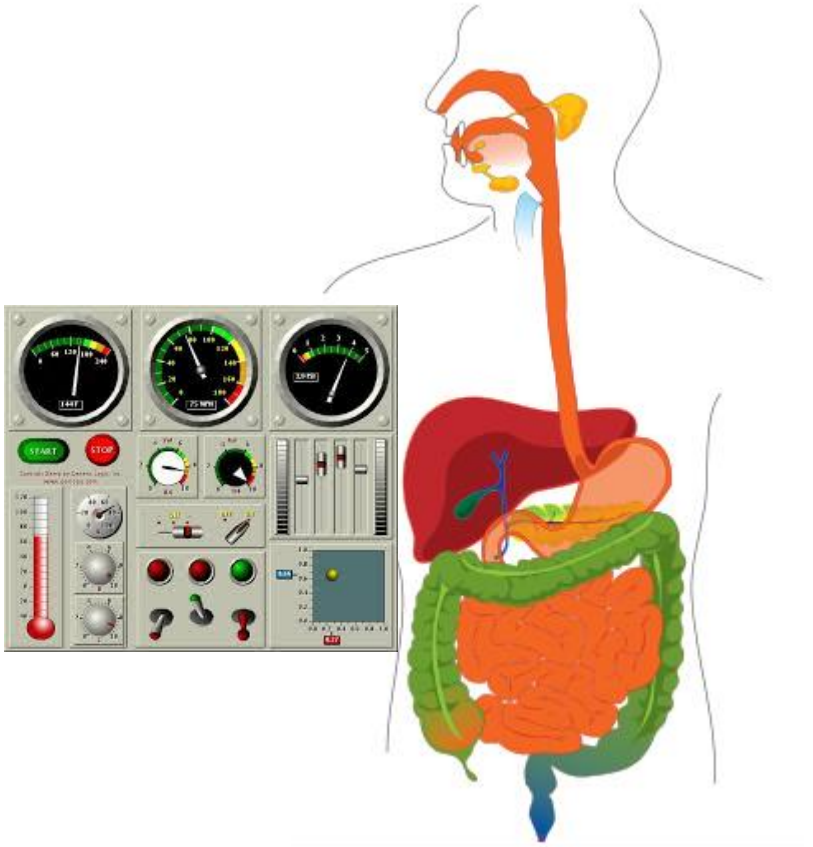
YOUR FOOD RESEARCHERS



# In-silico modeling of the bioregulation of gastrointestinal processing

George van Aken

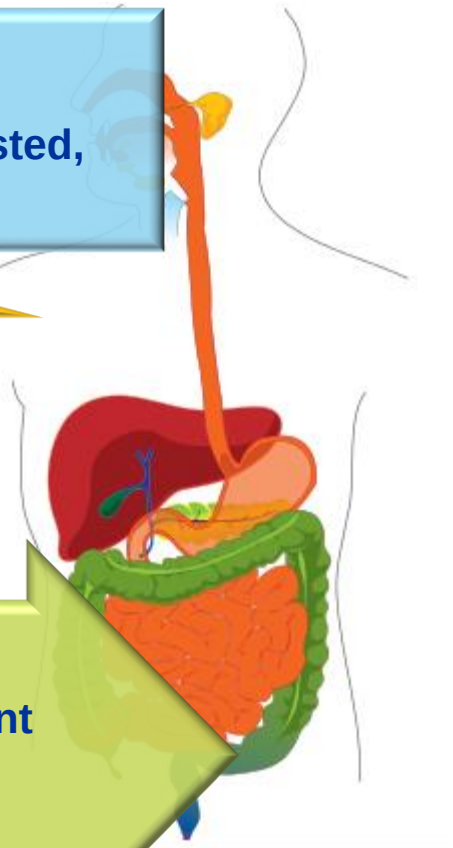
*Together to the next level*

# Interaction of food with the body

**The food's perspective:**
**The food is selected, masticated, digested, absorbed and processed**

**The body a[illegible]nts:**
**rel[illegible]ds,**
**abso[illegible]ve ca[illegible],**
**post-abs[illegible]ve pro[illegible]sing,**

**The body's perspective:**
**The body receives mechanical, nutrient and pharmacological signals;**
**affected by**
**time of day, mood, stress, activity, …**



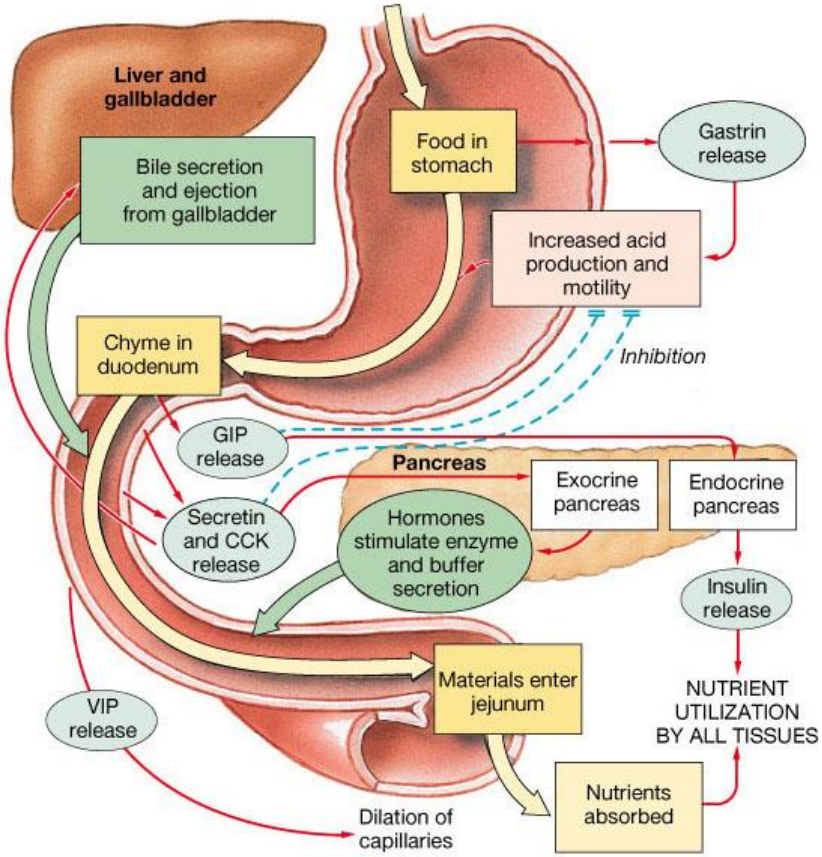
# Complexity handled by IN SILICO modeling

- Tight functional coupling between the digestive organs

Goal: optimal absorption, blood sugar homeostasis, and required food intake; avoid spilling to the large intestine.

- Digestive processing varies in response to the food

Mixing conditions, enzyme activities, bile concentrations, gastric pH profile, transit times, absorption rate.



# In silico digestive physiology modeling

Input parameters:

diet timing and properties

- Timing of meals and drinks
- Speed of consumption
- Proteins, sugar, fat, water, pH
- Other compounds together or separate from meal

Physiology literature

In vitro measurements

Physiological variations (infants, elderly, diseased)

Output: temporal variations

- Gastric pressure
- Gastric pH
- Gastric emptying
- CCK, PYY, GLP-1, GIP
- Digestive enzyme activity
- Bile secretion
- Small intestinal pH
- Absorption
- GI transit

Hunger, fullness, bloating, satiety, reward

Timed release
Bioavailability

# Active in the current model: Bio-control of

- Gastric acidification
- Gastric emptying reacting on volume, solids, nutrients, osmolarity, duodenal pH
- Activities of digestive enzymes (lipases, proteases) in fasted and fed state.
- Absorption rates of fatty acids, aminoacids and small sugars per unit length of small intestine, including competitive absorption
- Intestinal fluid release.
- Bile release
- Gut hormone release (CCK, PYY, GLP-1, GIP).
- Gastric pressure
- Small intestinal transit rate (Ileal brake)
- Fullness, hunger > desire to eat.

# Applications


Gastric discomfort, bloating, impaired digestion, gastrointestinal surgery, hospital food, elderly, infant formula

Obesity, Anorexia
Liking, Quick energy

Allergic to protein digestion fragments (peanuts, nuts, egg),

Digestive insufficiency (threshold levels dairy, chocolate, ingredients)

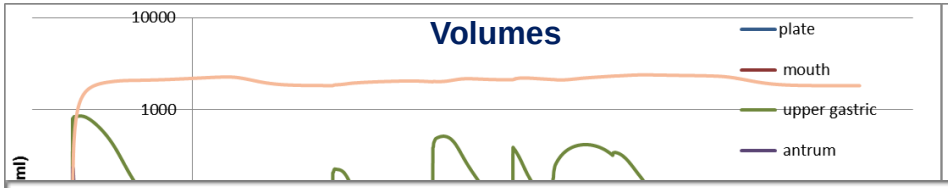
Insulin resistance
Sugar craving
Muscle protein accretion
Sugar types, starch types and modifications

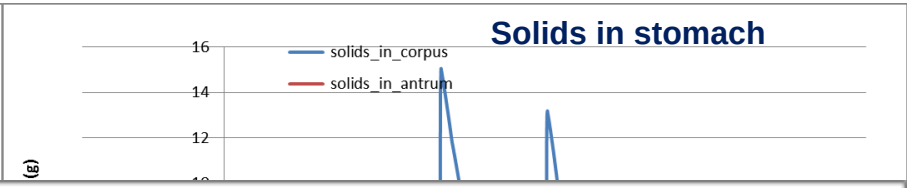
Muscle protein accretion
Glycation of poteins
Protection and targetted release,
Timed release

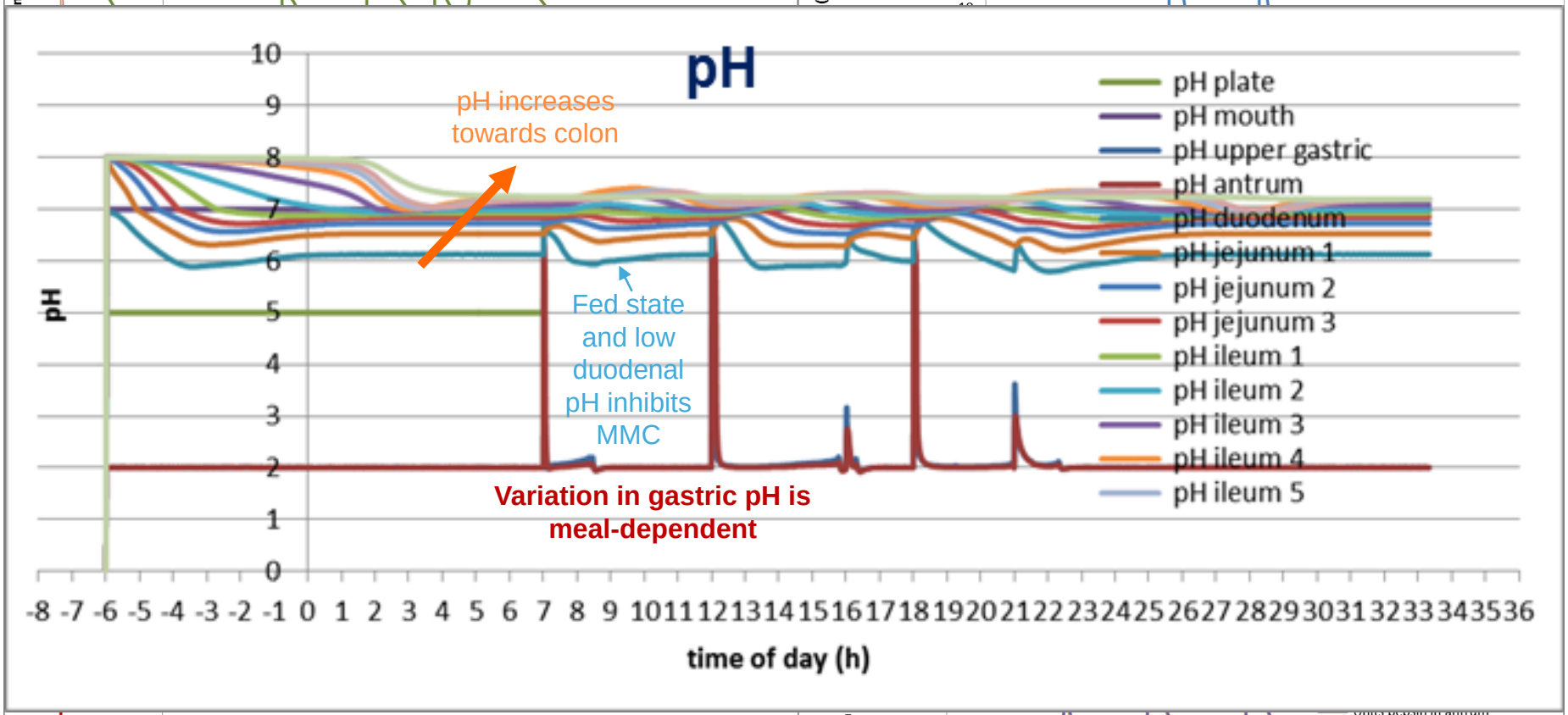
Intestinal microbiotics

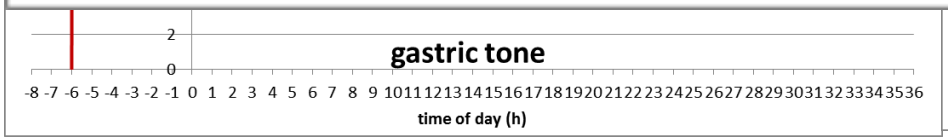
Pathogen growth and survival

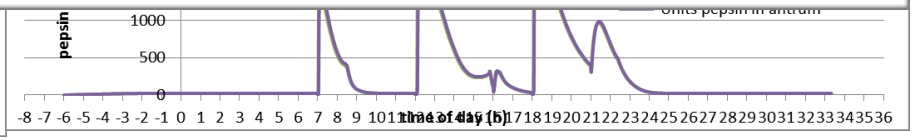
# Mixed meals during 1 day



# *Eat2Move*

**IN-SILICO MODELING OF PROTEIN DIGESTION AND AMINO ACID ABSORPTION**

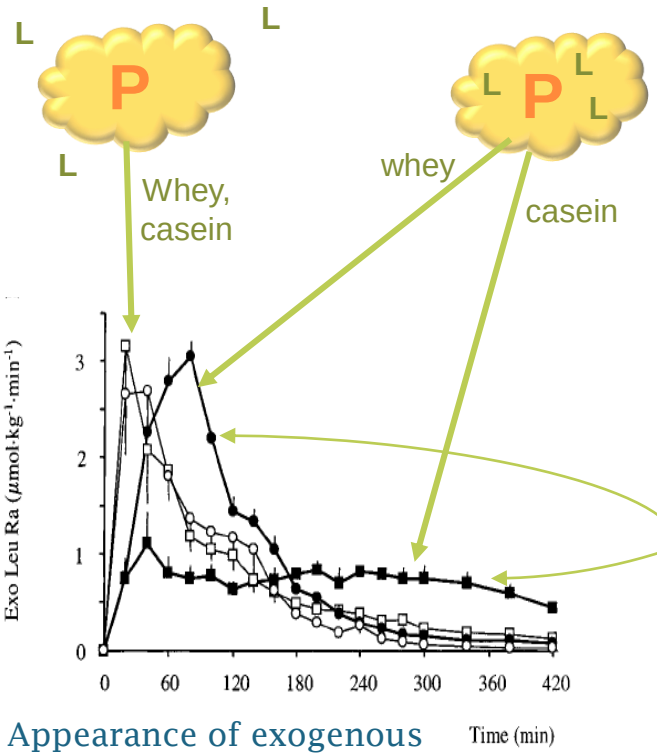
muscle mass maintainance and accretion

# PROTEIN UTILIZATION

FrieslandCampina

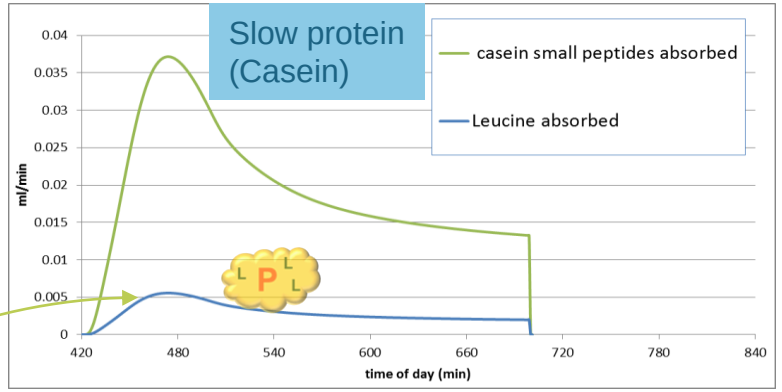
# Appearance of Leucine in the blood plasma.

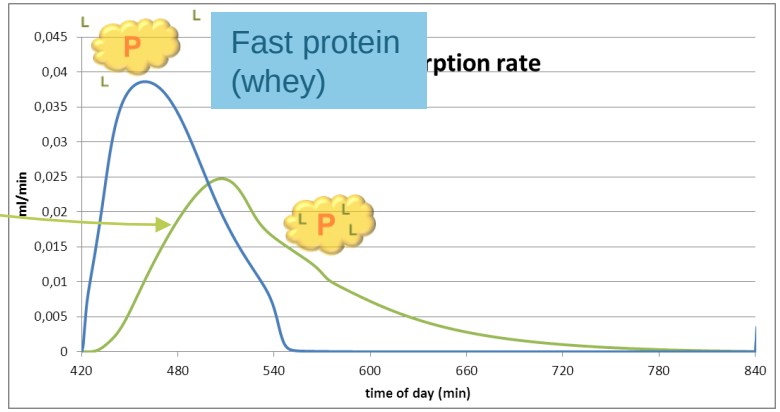
Skeletal muscle growth is stimulated by high peak levels of Leucine

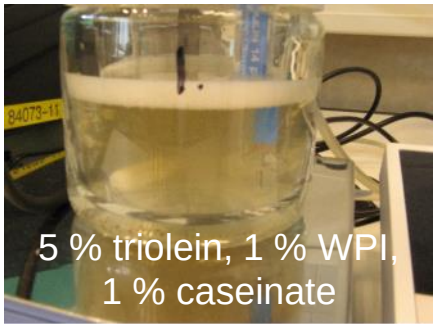



Appearance of exogenous Leucine

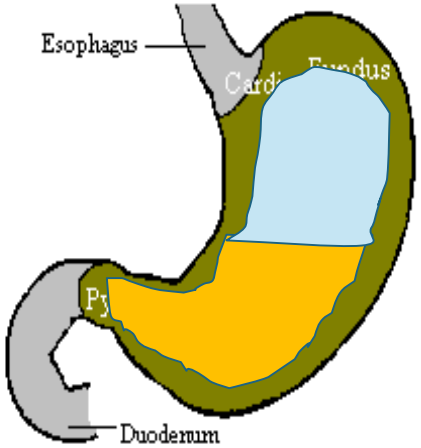
Experimental work in publications by Dangin 2001, 2002 and 2003



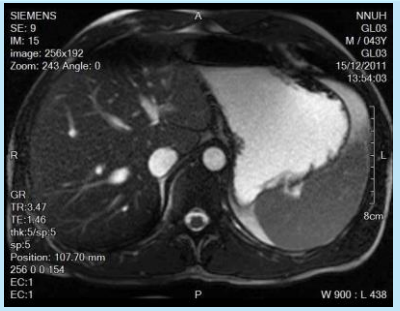





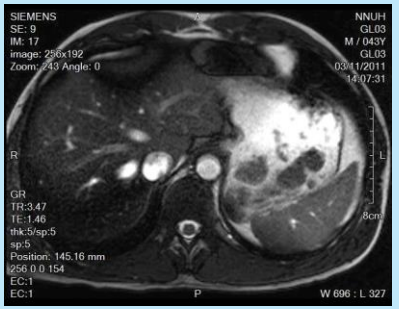





**Control meal:**
Yoghurt with emulsified fat



**Active meal:**
Yoghurt with grated cheese



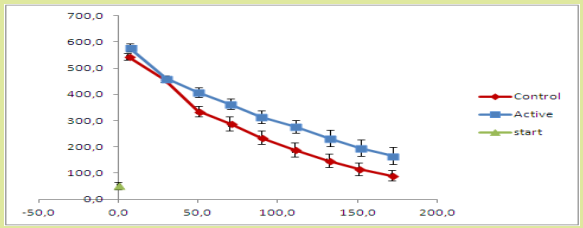
Similar nutrient composition
and energy content

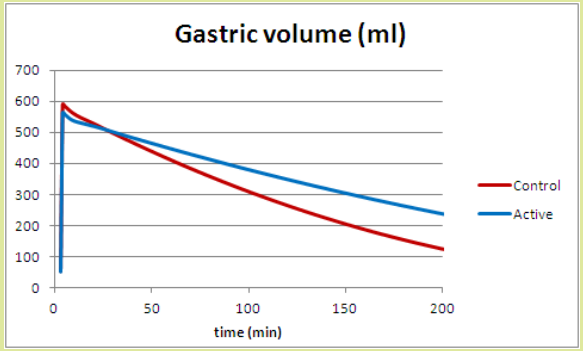
# EXPERIMENTAL VALIDATION

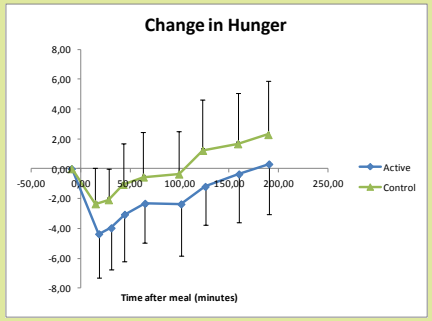
## PHASE SEPARATION IN THE STOMACH

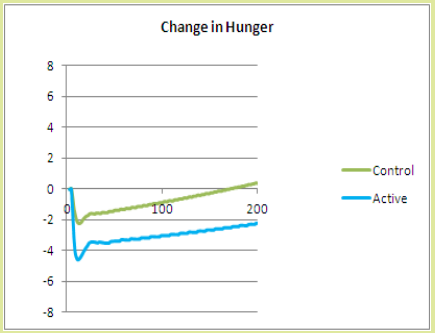
**In collaboration with IFR:** Mackie, A.R., Rafiee, H., Malcolm, P., Salt, L., van Aken, G.A., Specific structuring of food emulsions leads to increased satiation and hunger suppression. Am. J. Physiol. Gastrointestinal and Liver physiology (2013), 304, G1038-G1043.

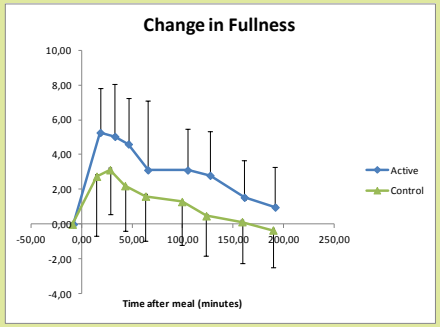
# Experimental data versus simulation

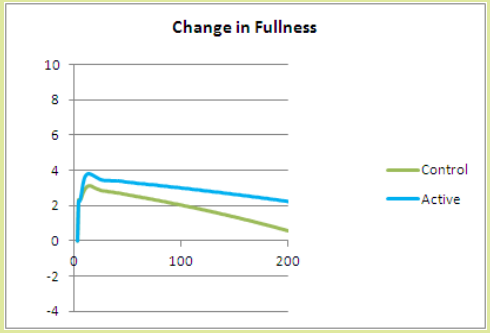


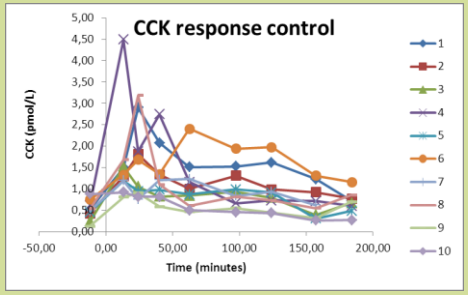



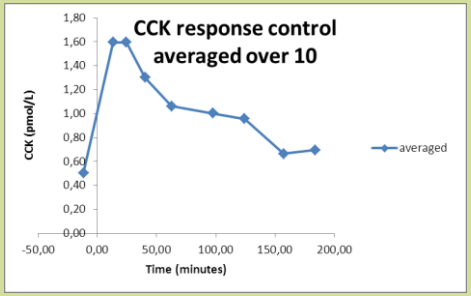



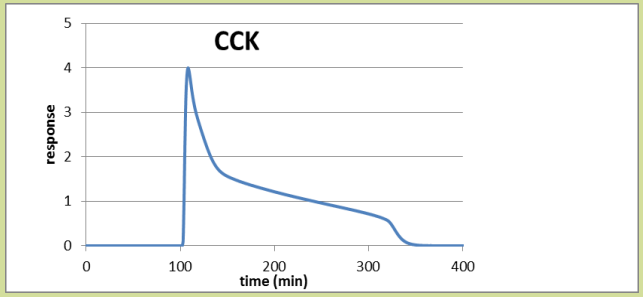



# Development and applications

Introduce and further develop this aproach in gCOAS

YOUR FOOD RESEARCHERS

# Creating the future together

*Together to the next level*

# In-silico model