

Enriched food with undigestible fibers; Its stability, biological activity and satiety health benefits

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5th Euro-Global Summit on:

Food & Beverages

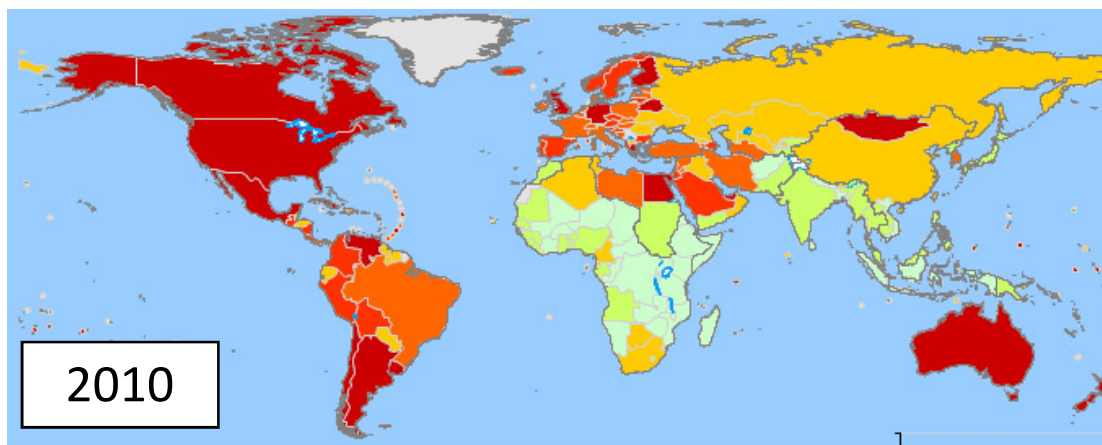
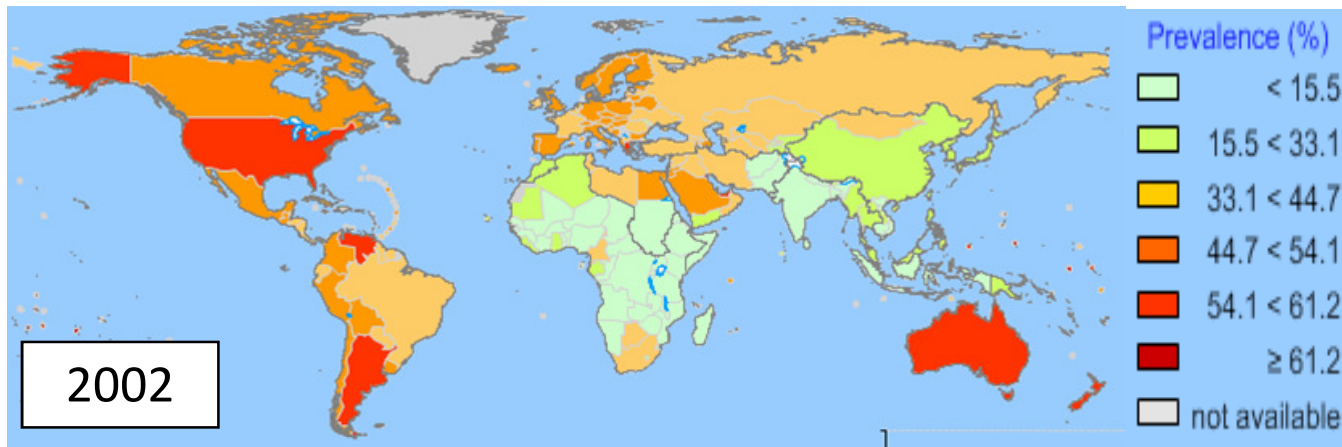
17 June 2015

Alicante



Obesity: a global problem

Overweight (www.who.int)



- 1) CVD
- 2) Cancer
- 3) Diabetes

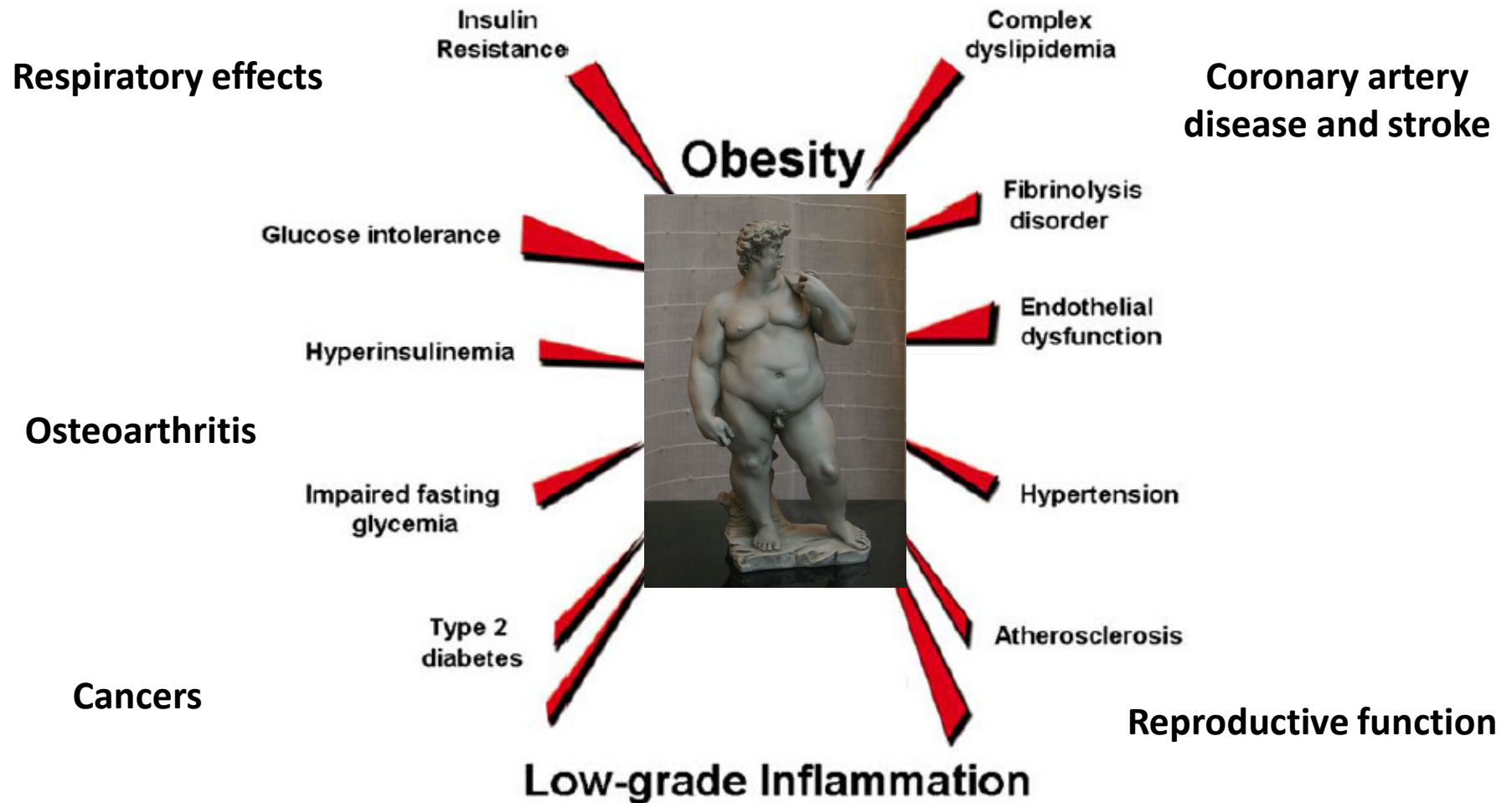
BMI = weight/(length²)

18 < BMI < 25 = normal

≥ 25 = overweight

≥ 30 = obese

Obesity: a global problem



Cani and Delzenne, Current Pharmaceutical Design, 2009, Vol. 15

Etc etc etc...

- High blood pressure, hypertension
- High blood cholesterol, dyslipidemia
- Type 2 (non-insulin dependent) diabetes
- Insulin resistance, glucose intolerance
- Hyperinsulinemia
- Coronary heart disease
- Angina pectoris
- Congestive heart failure
- Stroke
- Gallstones
- Cholecystitis and cholelithiasis
- Gout
- Osteoarthritis
- Obstructive sleep apnea and respiratory problems
- Some types of cancer (such as endometrial, breast, prostate, and colon)
- Complications of pregnancy
- Poor female reproductive health (such as menstrual irregularities, infertility, irregular ovulation)
- Bladder control problems (such as stress incontinence)
- Uric acid nephrolithiasis
- Psychological disorders (such as depression, eating disorders, distorted body image, and low self esteem).

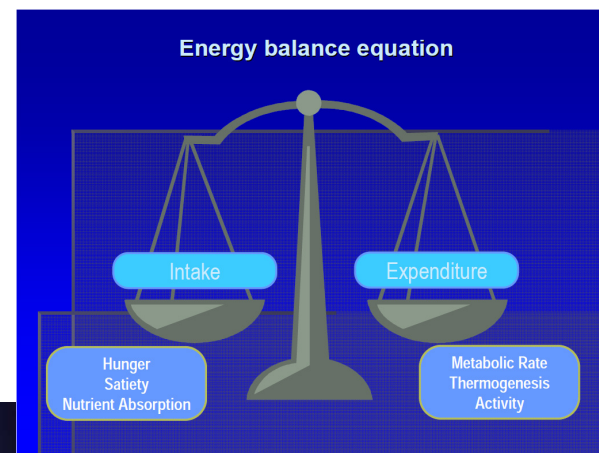
Stunkard AJ, Wadden TA. (Editors) *Obesity: theory and therapy*, Second Edition. New York: Raven Press, 1993.

Obesity: a global problem

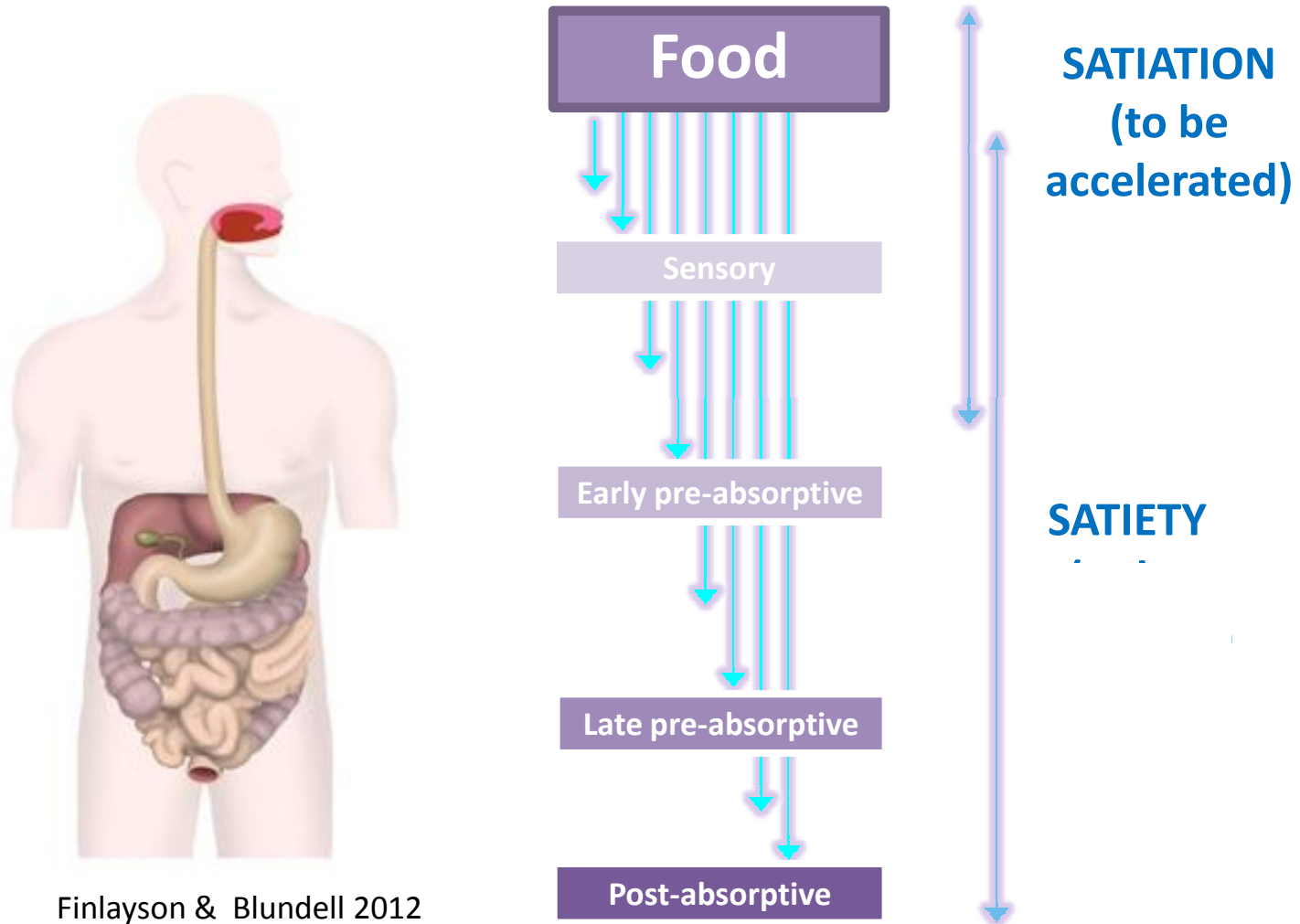
Is there a quick answer to the question, "what contributes to overweight and obesity?"

Overall there are a variety of factors that play a role in obesity.

- Behaviour
- Energy imbalance
- Environment
- Genetic factors
- Metabolism
- Culture, and socioeconomic status

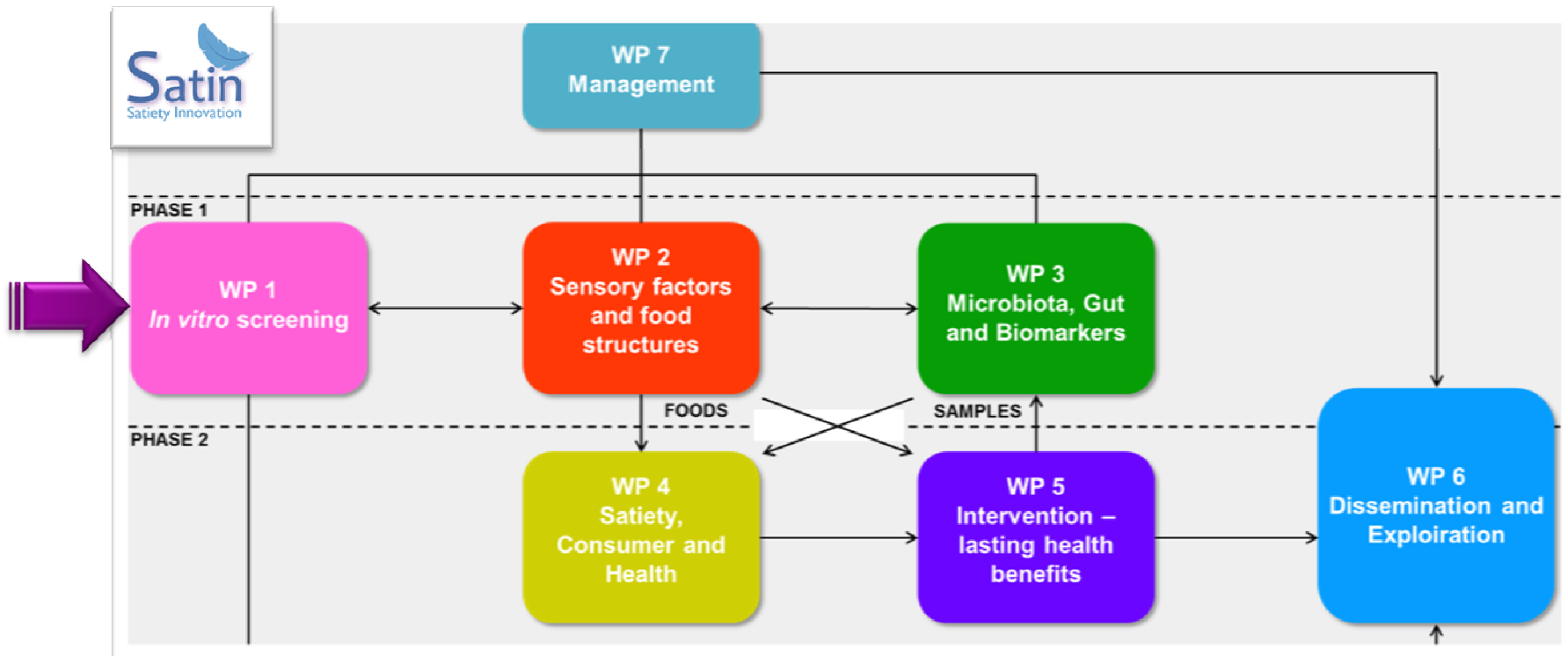


EU-funded SATIN project



Finlayson & Blundell 2012

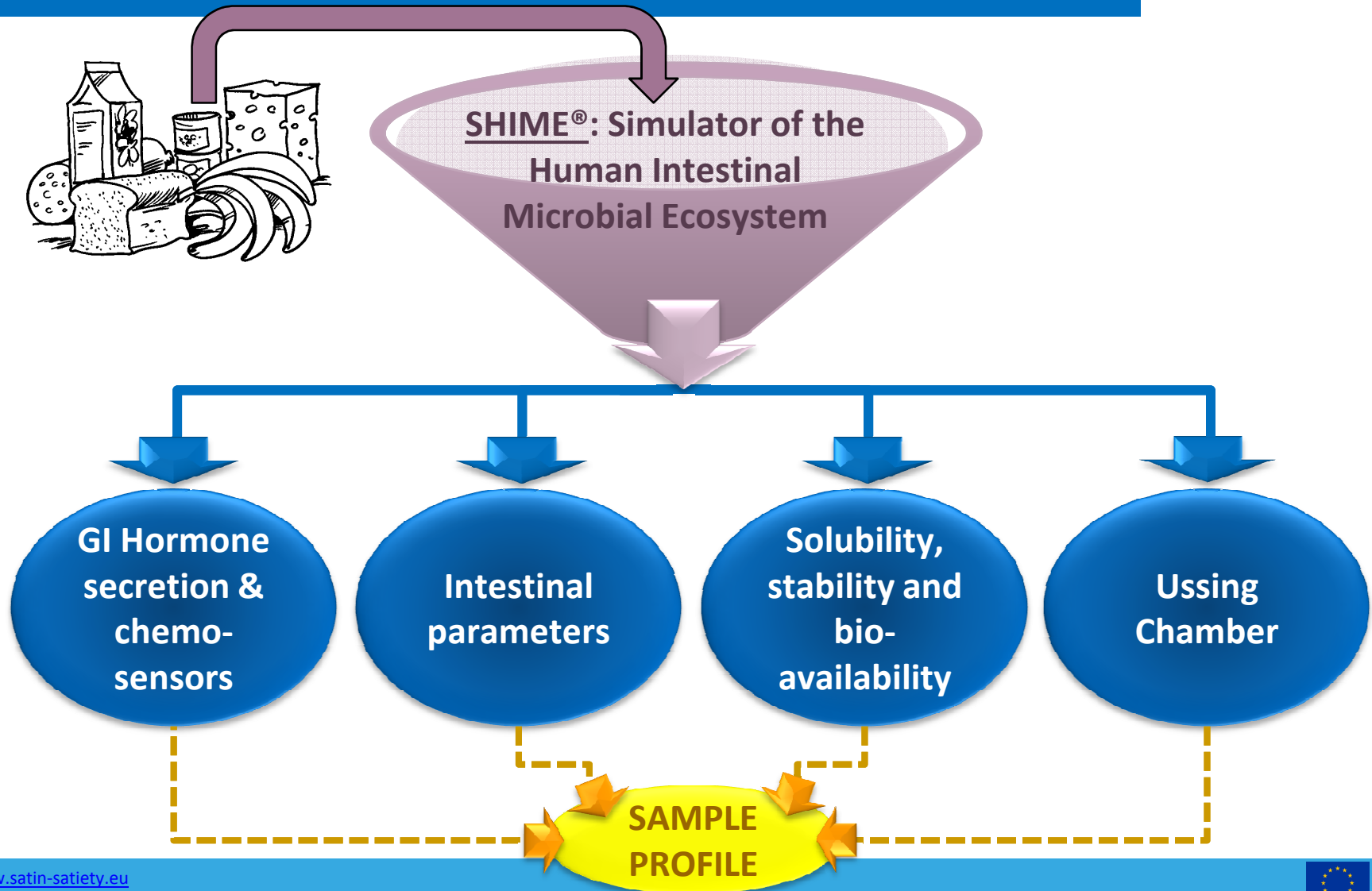
SATIN FLOW CHART



SATIN objective:

use novel food processing technologies to alter the structure of foods to accelerate satiation, enhance satiety and reduce appetite.

WP1: Selection of Improved Satiating Food Components by *in vitro* Screening



In vitro gut simulator: TWINSHIME®



SHIME®: Simulator of the Human Intestinal Microbial Ecosystem

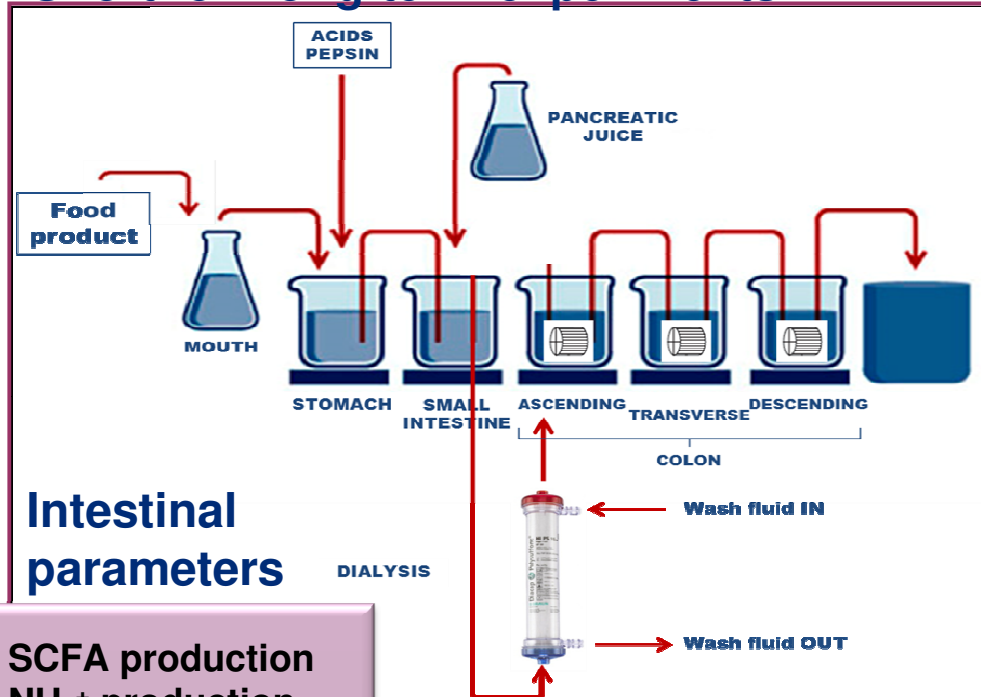
www.satin-satiety.eu



SHIME®: Simulator of the Human Intestinal Microbial Ecosystem



Short- or Long-term experiments



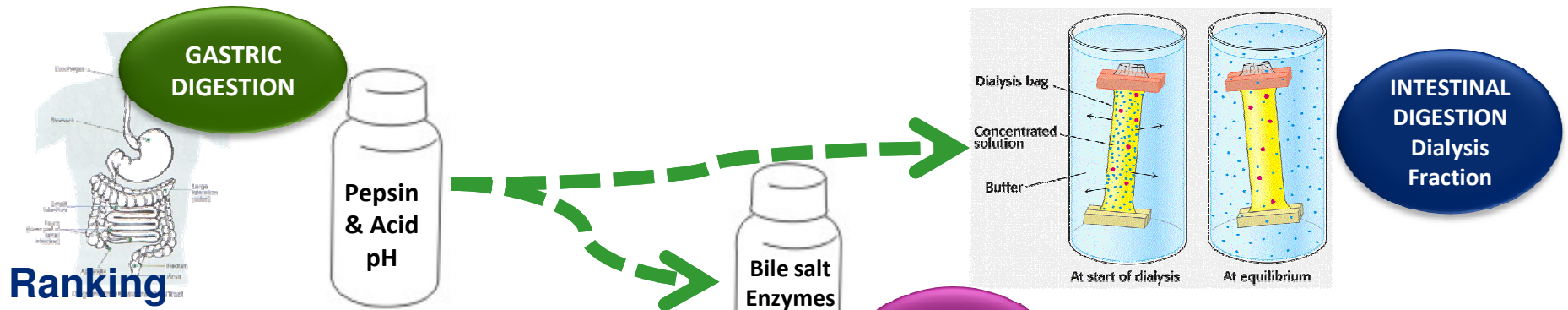
Intestinal parameters

- SCFA production
- NH₄⁺ production
- Lactate production
- qPCR
 - Total bacteria
 - Firmicutes
 - Bacteroidetes
 - Bifidobacteria
 - Lactobacilli
- DGGE

Ranking

Parameter	Positive Effect
SCFA	Butyrate and proprionate > acetate (B-glucans and AX)
SCFA	Acetate (RS)
Ammonium	Ammonium production
GAS	Low to moderate
Lactobacilli (LAB)	Due to icrease of GABA and β-phenyl ethylamine
Bifidobacteria	Bifidogenic effect

Static Digestion Model and Cell Platform for Bio-availability

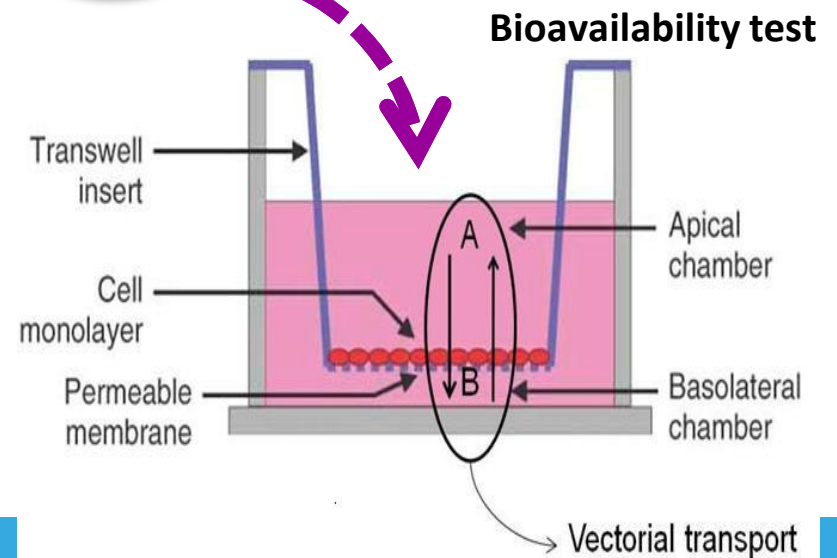


Ranking

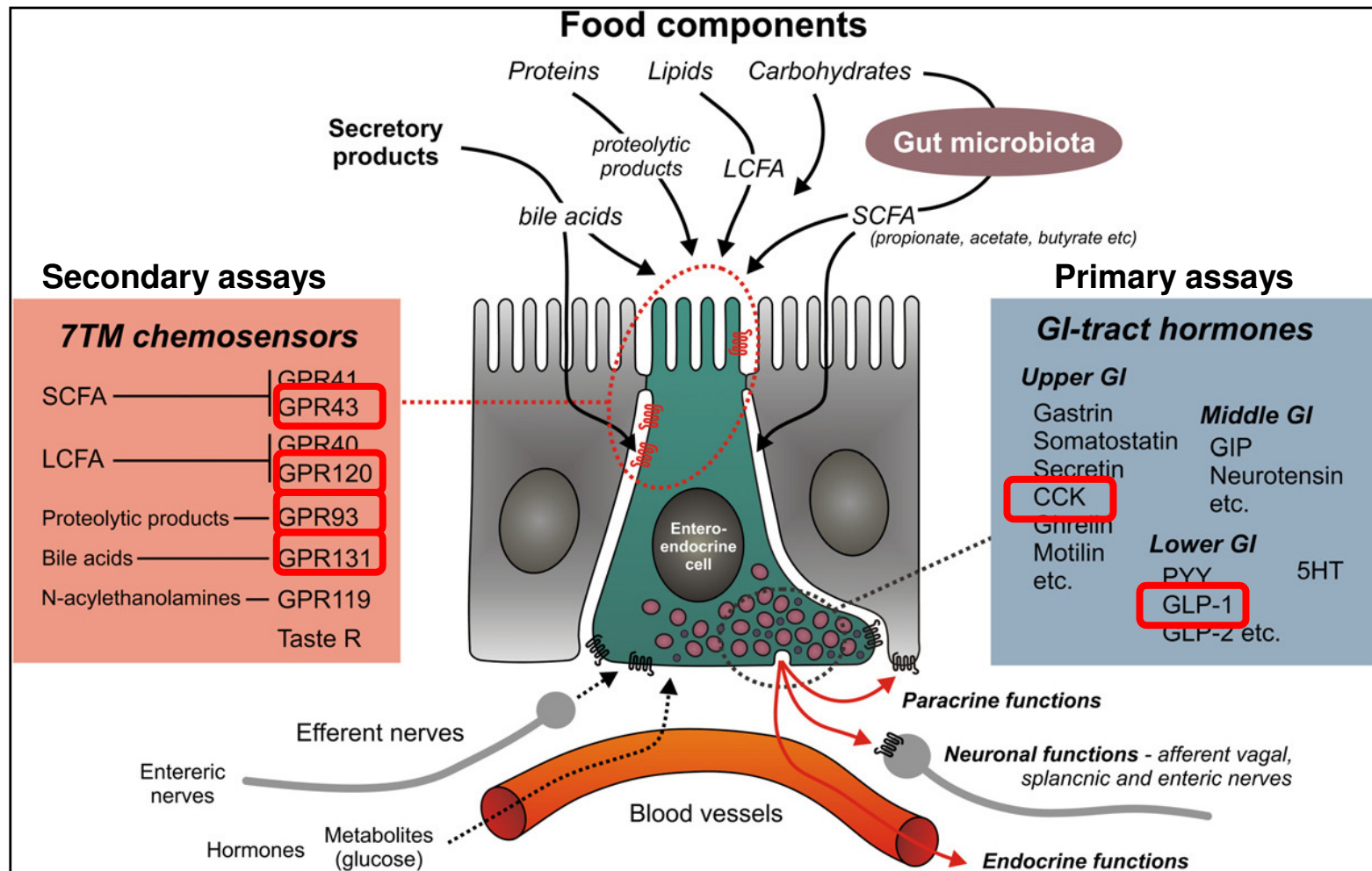
MS-HPLC analysis

Parameter	Positive Effect
Gastric	↑ Stability
S. Intestine (SF)	↑ Stability (80% ingredients)
S. Intestine (DF)	↑ Availability
AP Chamber	↑ Stability
BL Chamber	↑ Bioavailability
Colon	↓ Stability (AX 25%, RS and BG 70%)

INTESTINAL DIGESTION Soluble Fraction



Sensory and Secretory Functions of Entero-endocrine Cells of the Gut



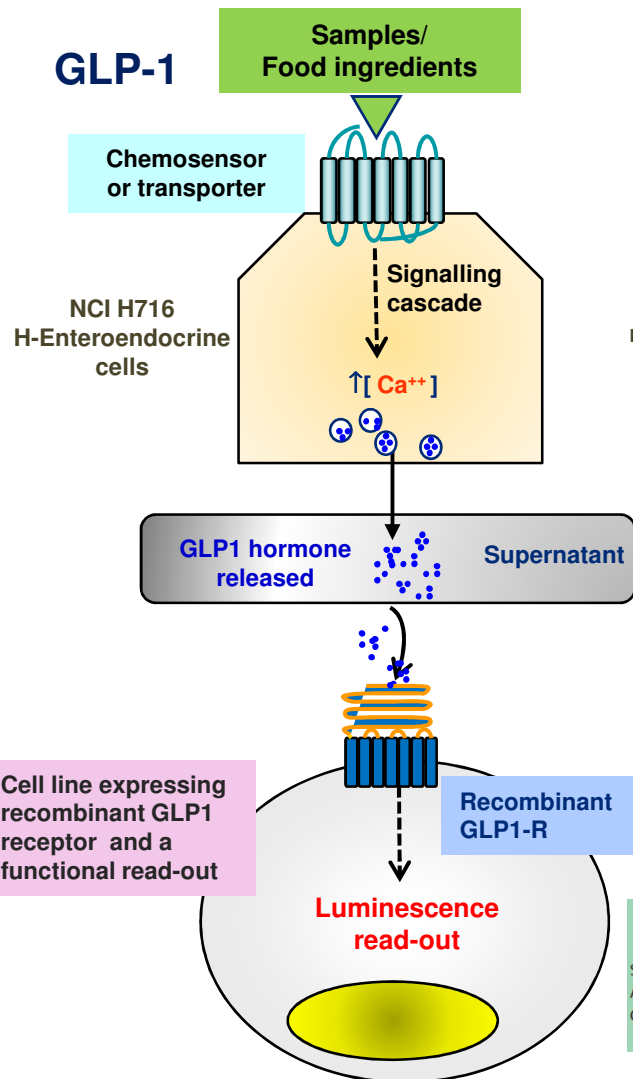
Cell Metabolism Vol.8, December 2008



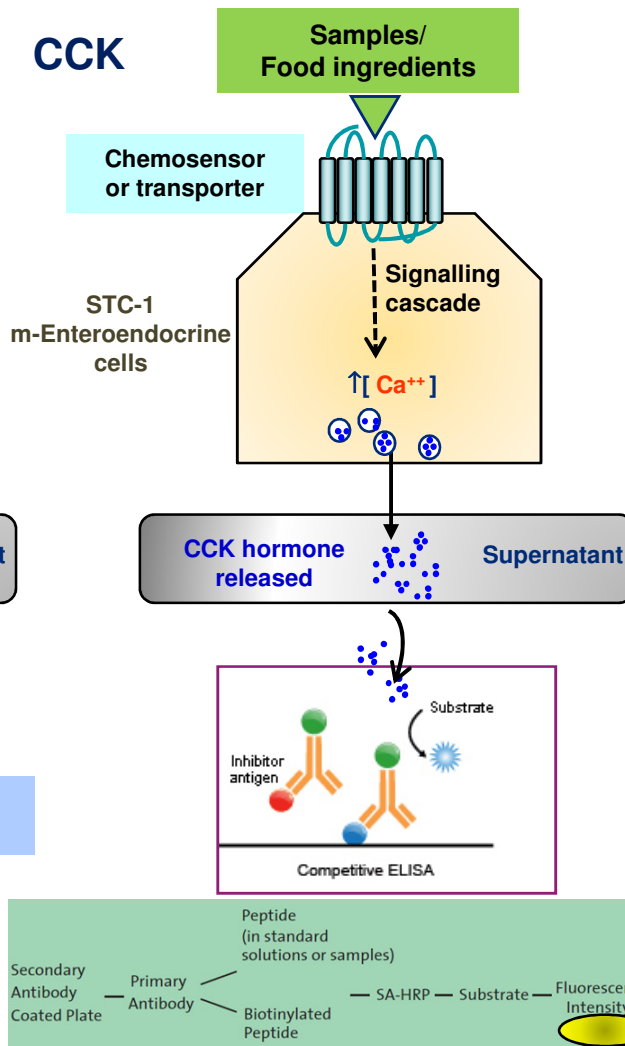
Cell-based Platform for GI Hormone Secretion and Chemosensor Assays



GLP-1

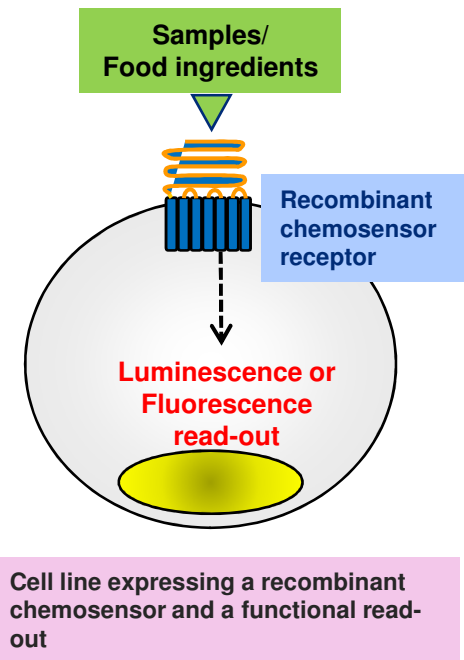


CCK



7TM CHEMOSENSORS

- GPR120: LCFA
- GPR43: SCFA
- GPR93: peptides and LPA
- GPR131 (TGR5): bile acids



Cell-based Platform for GI Hormone Secretion and Chemosensor Assays



Ranking

Parameter	Positive Effect
GLP-1	↑ Secretion (AX)
CCK	↑ Secretion (AX)
GPR43	↑ Activation (AX)
GPR93	↑ Activation (AX)
GPR120	↑ Activation (AX)
GPR131	↑ Activation



Ranking of Six Tested Prototypes: Matrix + Ingredient

PROTOTYPE	CELL LINES (AXXAM)	SHIME (ProDI)	SOLUBILITY, BIOAVAILABILITY (UMUR)	USSING CHAMBER (BioAct)
A	1	5	2	1
B	2	3	4	4
C	3	2	4	3
D	4	4	4	5
E	5	1	2	/
F	5	6	1	1

**Selected for
Clinical trials**



The rank order is from 1 to 6;
where 1 corresponds to the best position

Conclusions



In WP1 a complementary and comprehensive *in vitro* platform, suitable to perform **preliminary and high throughput tests on the activity of new food components with potential satiety effects** has been developed and validated.

Specifically:

- ❖ The existing **SHIME model** has been adapted for nutrient absorption, with the inclusion of a mouth step and a dynamic dialysis step to simulate absorptive processes in the small intestine.
- ❖ The **static digestion model** has also been implemented with a mouth step
- ❖ Cell-based assays have been established to assess ingredient **solubility, stability and bio-availability**.
- ❖ An *in vitro* cell based platform comprising primary assays, **GI hormone secretion assays** and secondary assays for **chemosensors** has been developed, optimized and validated with reference controls.
- ❖ An *ex-vivo* gut tissue based **GI hormone secretion** assay panel using Ussing Chamber technology has been optimized

Acknowledgments



- Massimo Marzorati, ProDigest BVBA, Belgium
- Carmen Frontela-Saseta & Gaspar Ros-Berruezo, University of Murcia, Spain
- Hans van der Saag, BioActor, The Netherlands
- Jason Halford & Joanne Harrold, University of Liverpool, UK
- Laura Stucchi & Lia Scarabottolo, Axxam S.p.A., Italy

Thank You

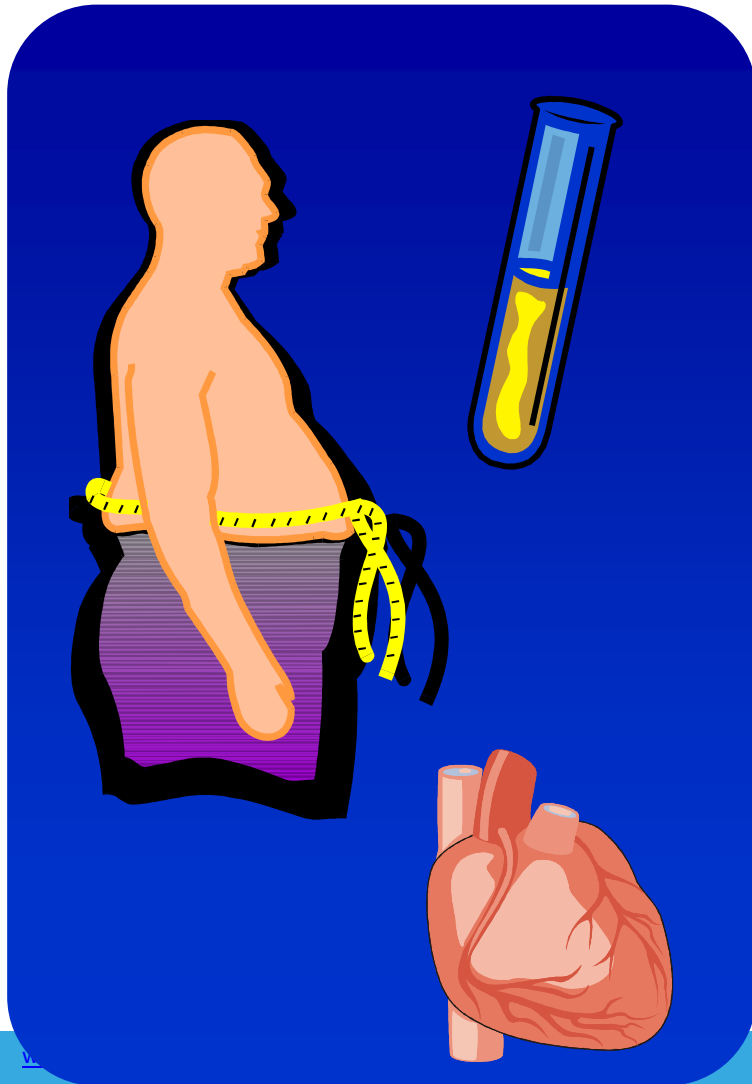


Sample Tested



- **Pure ingredients**
- **Digested ingredients** processed through **short-term SHIME** batch experiments and collected from different SHIME compartments
- **Digested matrices** processed through **short-term SHIME** batch experiments and collected from different SHIME compartments
- **Digested prototypes (matrix + ingredient)** processed through **long-term SHIME** experiments and collected from different SHIME vessels

Metabolic Syndrome



- Abdominal obesity
- Hyperinsulinemia
- High fasting plasma glucose
- Impaired glucose tolerance

- Hypertriglyceridemia
- Low HDL-cholesterol
- Hypertension