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Bioactivity & Nutrition

Didier Dupont

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AGRO
CAMPUS
OUEST



Bioactivity & Nutrition



STLOpen Days
19-21 March 2019



Didier DUPONT - STLO



The Bioactivity & Nutrition team



25 people
14 permanent staff

Head

Didier DUPONT - *Scientist*

Scientists

Amélie DEGLAIRE – *Lecturer*
Juliane FLOURY – *Lecturer*
Catherine GUERIN - *Lecturer*
Joëlle LEONIL – *Scientist*
Steven LE FEUNTEN – *Scientist*
Françoise NAU – *Professor*
Frédérique PEDRONO – *Lecturer*

PhD students

Linda LEROUX (2016-2019)
Manon HIOLLE (2016-2019)
Yohan REYNAUD (2016-2019)
Amira HALABI (2017-2020)
Léa SALELLES (2018-2021)
Jun WANG (2018-2021)
Luisa OZORIO (2019)

Post-docs

Ashkan MADADLOU – *Post-doc*
Xaoxi YU – *Post-Doc*
Marek ALJEWICZ – *Post-Doc*

Technicians

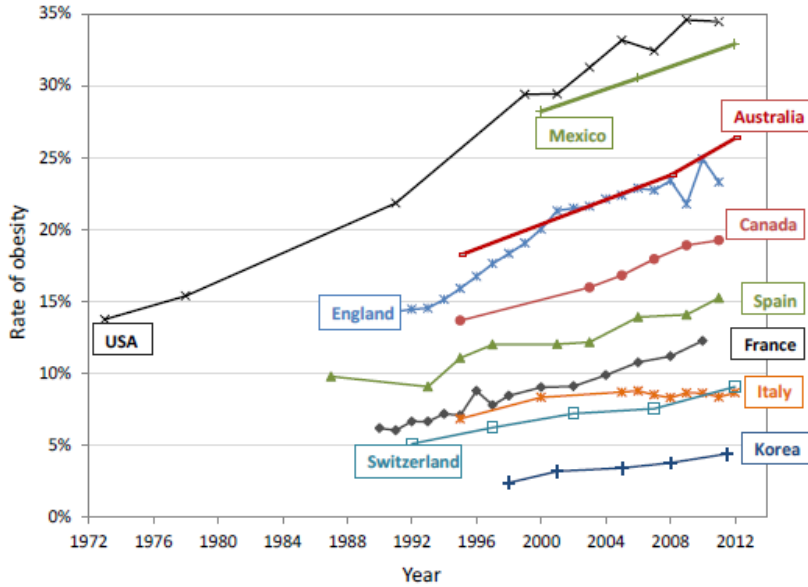
Gwenaële HENRY
Yann LE GOUAR
Nathalie MONTHEAN-BOULIER

Engineers

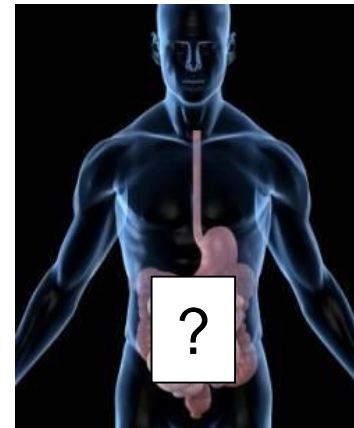
Julien JARDIN
Olivia MENARD
Jordane OSSEMOND

3 Masters students

Food and human health: the key role of digestion



Diet-related diseases ↑
Prevent these pathologies rather than
cure them



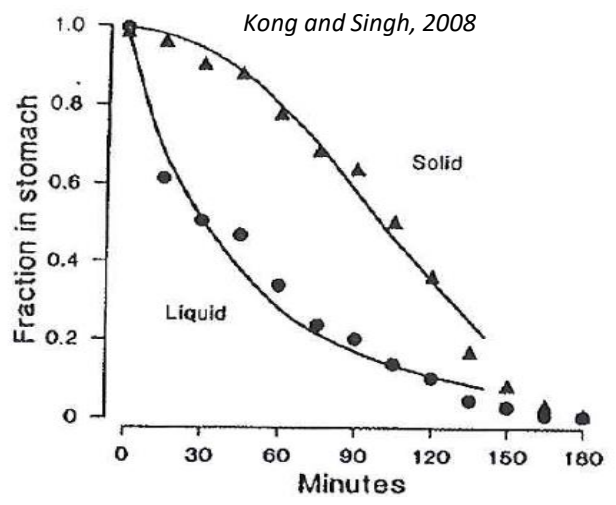
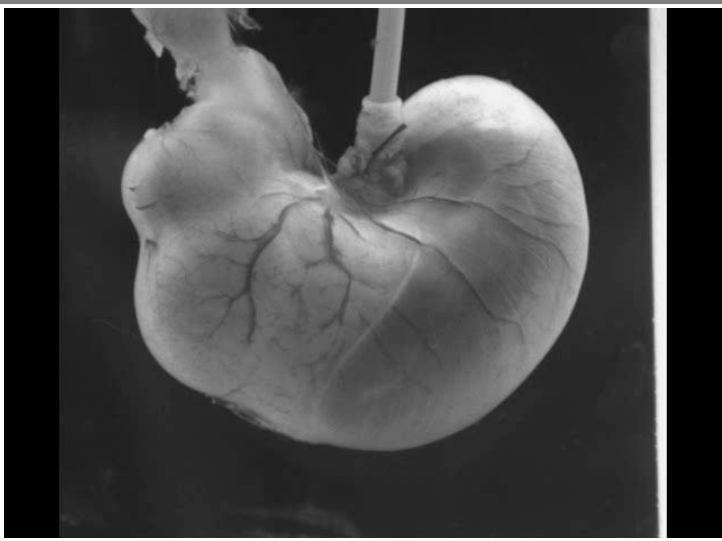
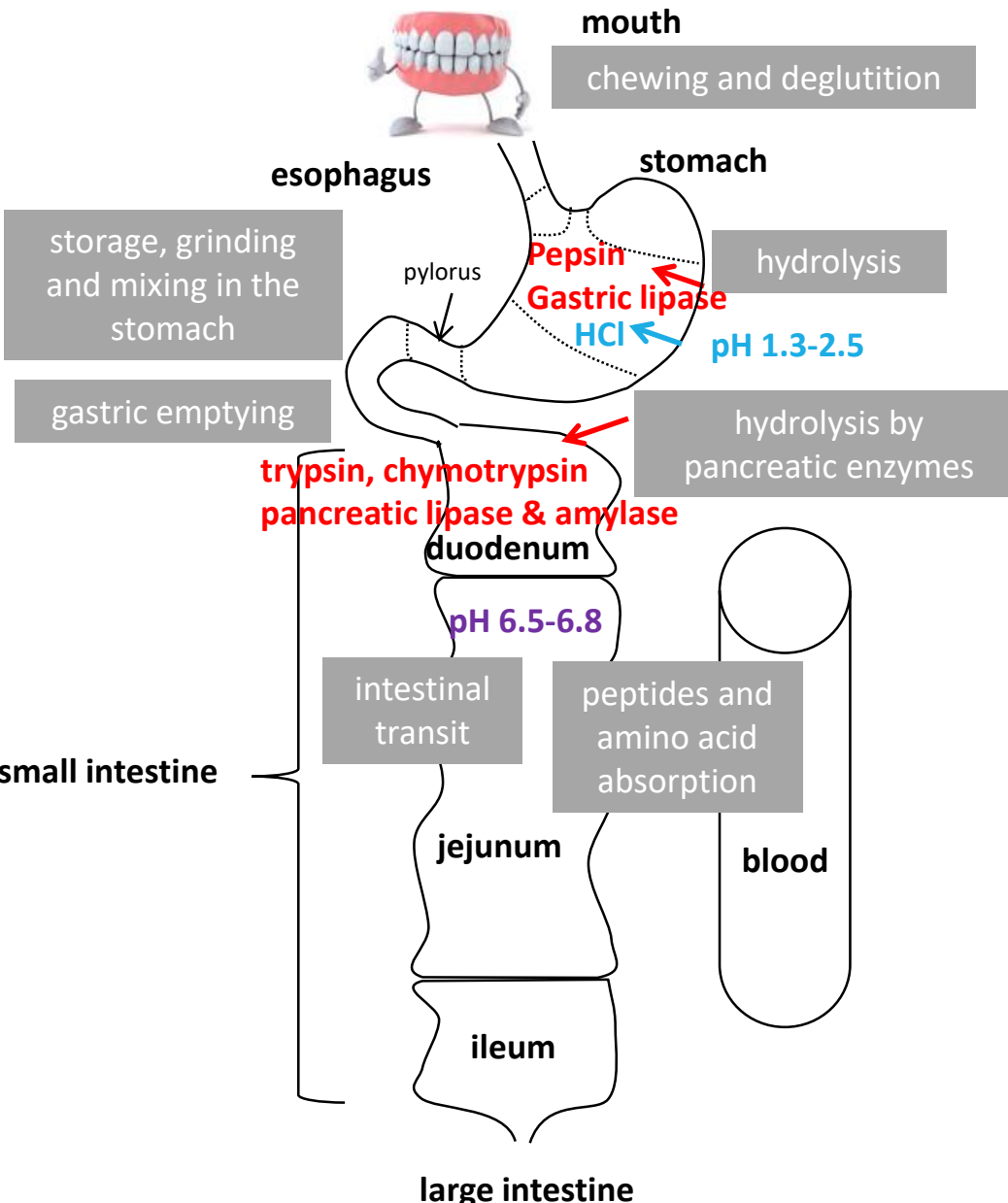
Gut = interface between food and human body

Digestion releases food components that can have a beneficial or a deleterious effect on human health

... but the mechanisms of food disintegration in the gastrointestinal tract remain unclear and the digestive process has been considered as a black box so far

By increasing our knowledge on food digestion, we will increase our knowledge on the effect of food on human health

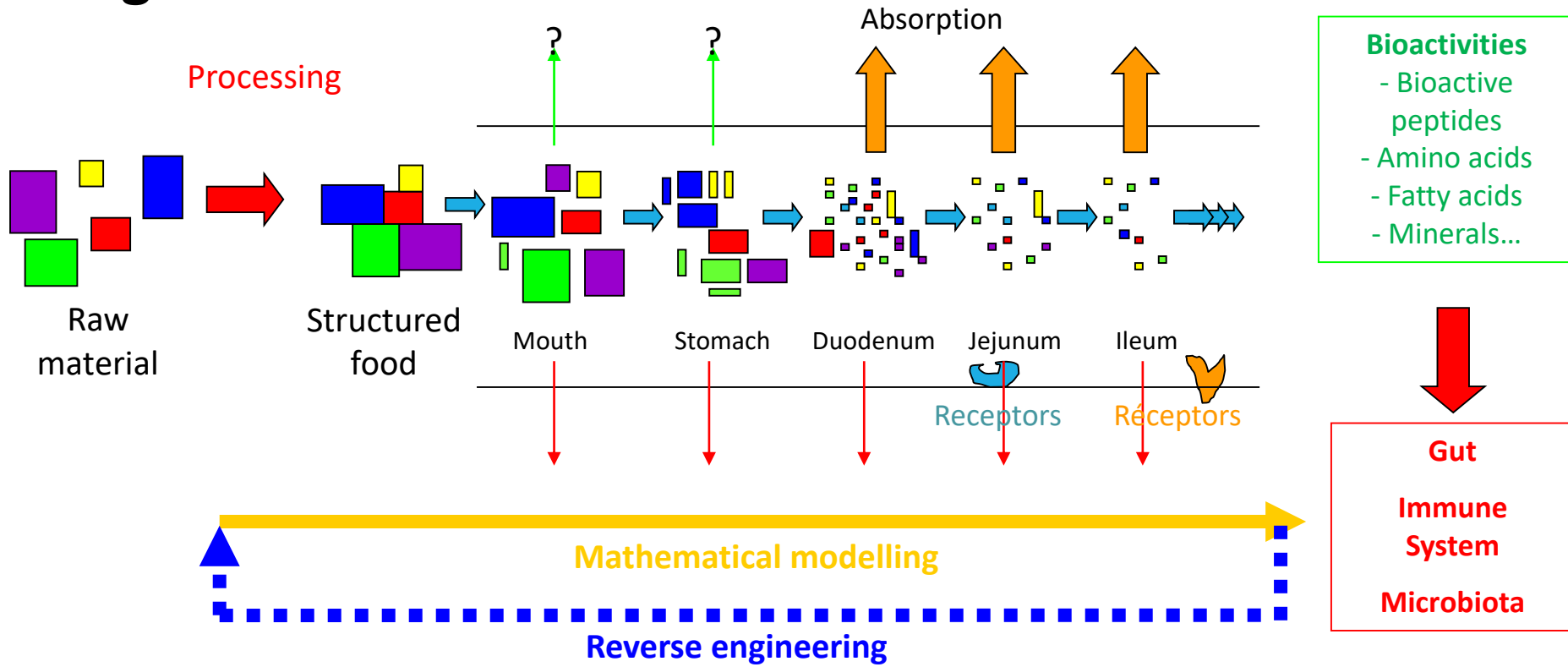
The digestive process



→ Gastric phase = key step for the whole digestion process

Our goals

Healthy Adult/ Neonate/ Elderly



☞ To understand the mechanisms of breakdown of food matrices and their constituents in the gut and identify the beneficial/deleterious food components released during digestion

☞ To determine the impact of the structure of food matrices on the nutrient bioavailability

☞ To model these phenomena in order to develop a reverse engineering approach

Models available at INRA for simulating digestion

Dupont et al. 2010ab,
Mol Nutr Food Res
Minekus et al. 2014
Food Funct



Olivia Menard

*In vitro static models
(infant, adult, elderly)*

Le Feunteun et al. 2014
Food Bioprocess Tech

*In silico
models*

$$\Phi_{12} = k_{12\text{whey}} \times (V_1 - m_{\text{caswpd1}} \times \alpha) + k_{12\text{aggr}} \times m_{\text{caswpd1}} \times \alpha$$



*In vitro dynamic models
(infant, adult, elderly)*



Steven Le Feunteun



*Human
models*



Animal models

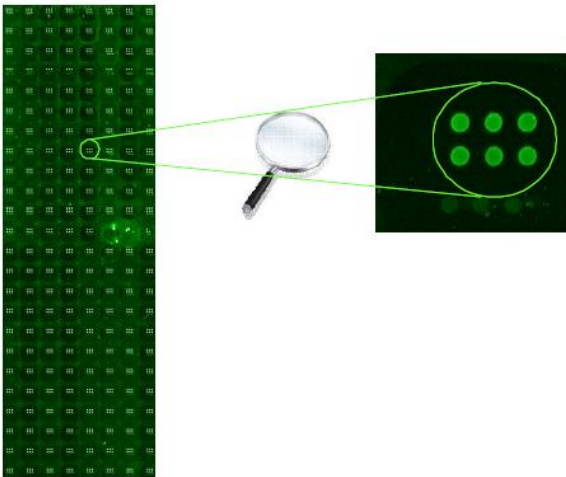


Barbé et al. 2013, 2014
Food Chem
Le Huerou-Luron et al.
2016 Eur J Nutr

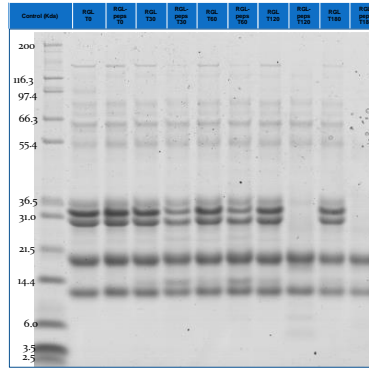
Menard et al. 2014, Food
Chem
Sanchez et al. 2015
Food Res Int

Multi-scale characterization of digested food

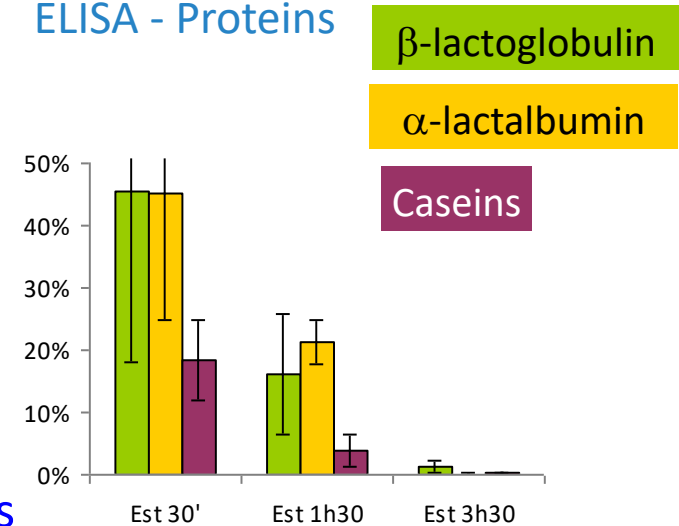
Antibody arrays - Proteins



SDS-PAGE - Proteins

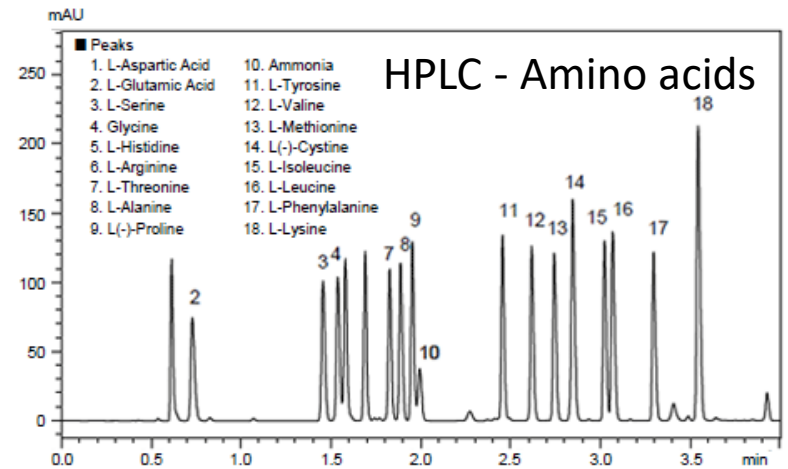
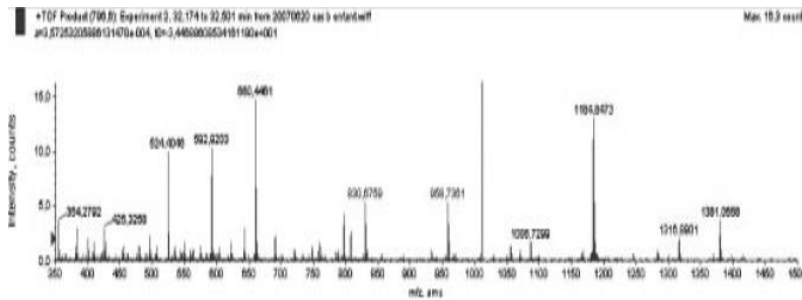


ELISA - Proteins



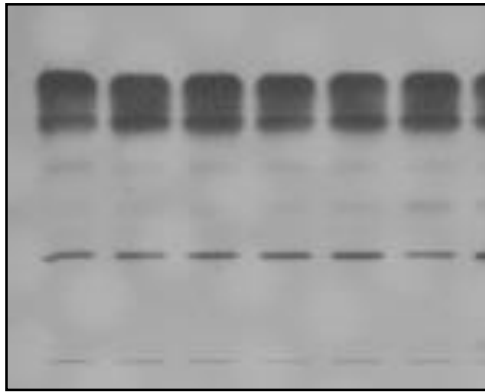
Molecular scale - Proteins

LC-MS-MS - Peptides

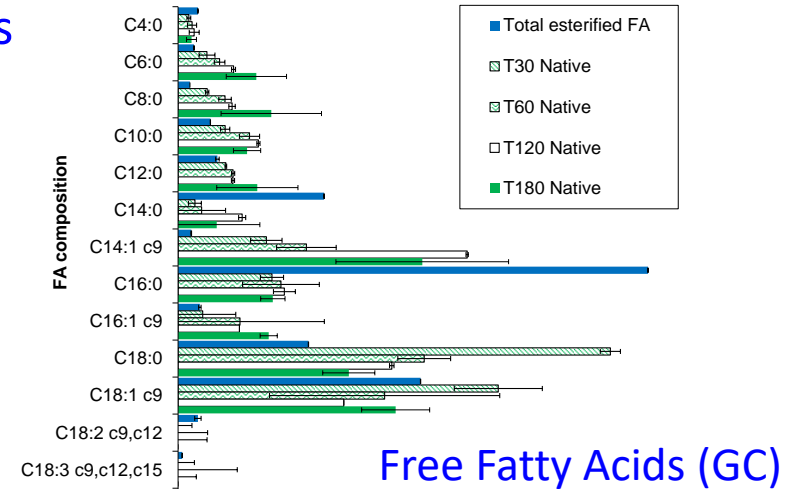


Multi-scale characterization of digested food

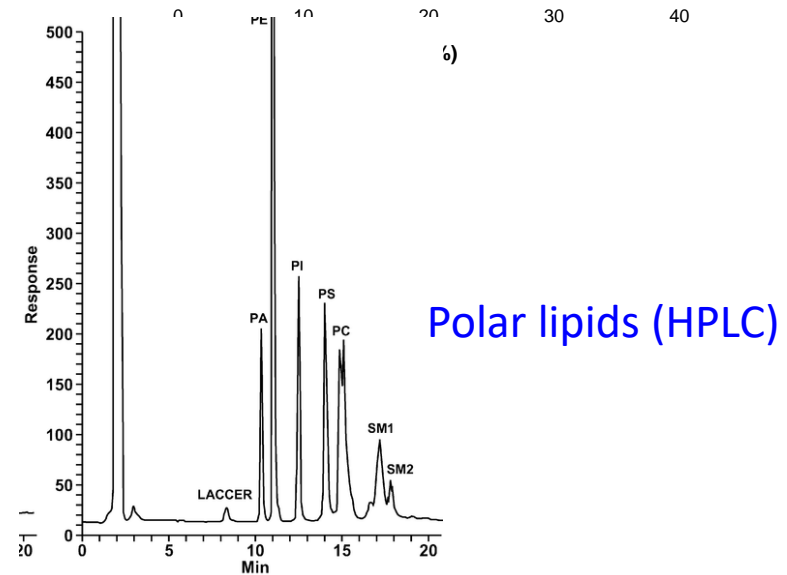
Molecular scale - Lipids



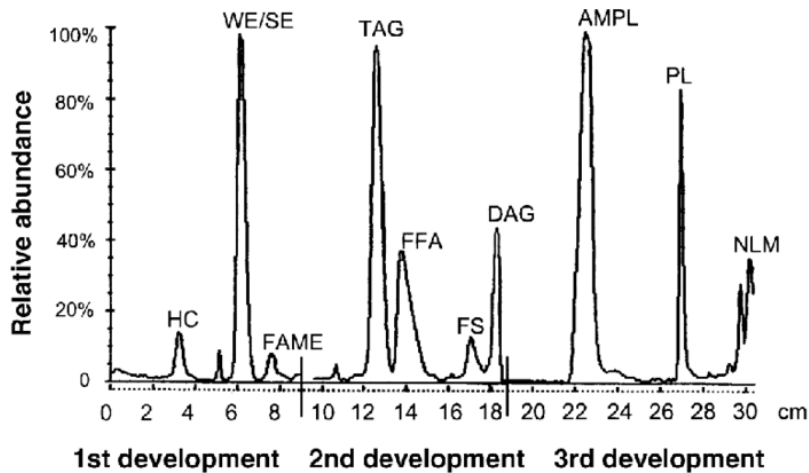
Lipid classes by TLC and by Iatroscan



Free Fatty Acids (GC)



Polar lipids (HPLC)



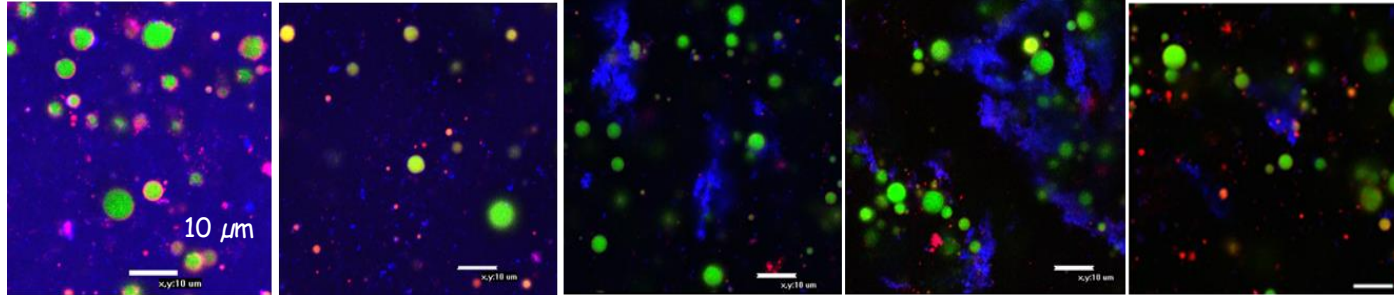
Multi-scale characterization of digested food

Proteins

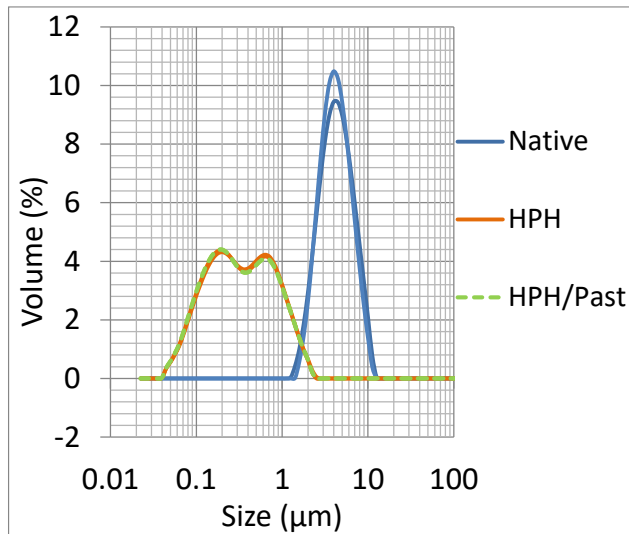
Lipids

Amphiphilic

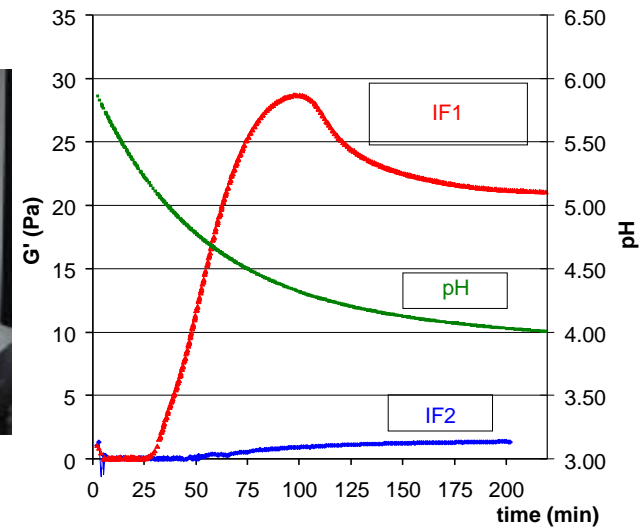
Microscopic/macroscopic scale



Confocal Microscopy



Particle size



Rheological properties e.g. infant formula
coagulation in gastric conditions

Unravelling the mechanisms of dairy and egg products disintegration in the gastrointestinal tract and its consequences on human health

For the 2017-2021 period, 3 priorities have been defined:

Priority 1 Understanding the mechanisms of action of digestive enzymes (proteases, lipases) on their respective substrates

Priority 2 Relationship between food structure at different length scales, their digestion and the bioavailability of nutrients

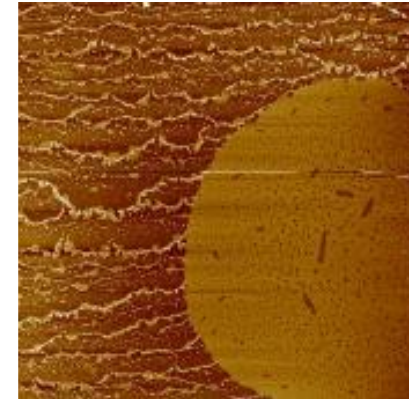
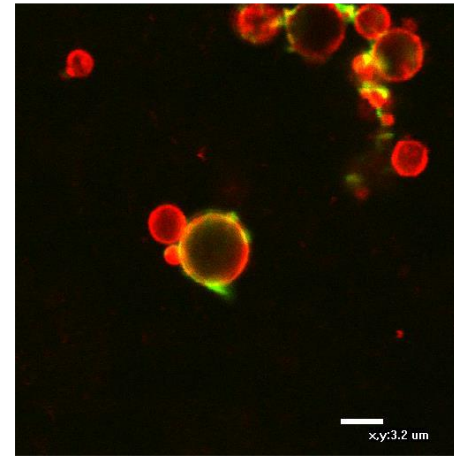
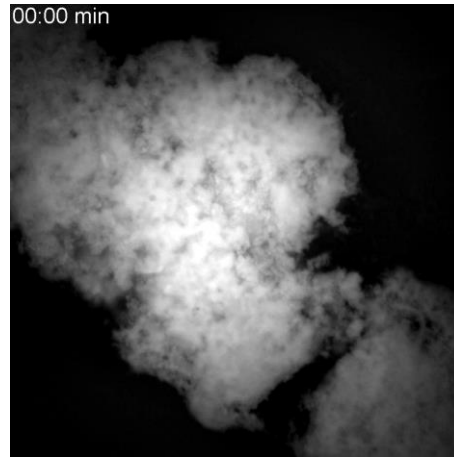
Priority 3 Design of functional food adapted to the nutritional needs of specific population (infant, elderly)

Priority 1 Understanding the mechanisms of action of digestive enzymes (proteases, lipases) on their substrate

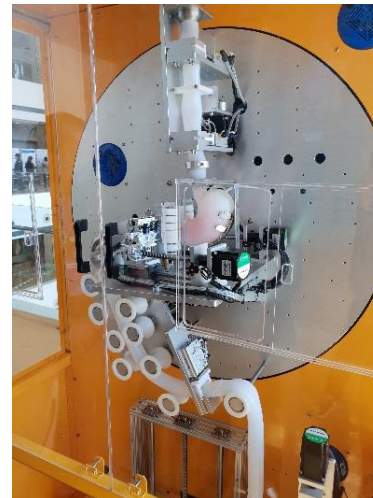
- What are the **mechanisms of hydrolysis** of protein gels by **digestive proteases** (diffusion within the gel or surface erosion)? Mechanisms of action of **lipases** IATE et ISF)



Juliane Floury



P14 Léa Salleles



Collaboration
with Soochow
University



* What is the impact of **biomechanical contractions** in food disintegration?

Priority 2: Relationship between food structure, digestion and the nutrient bioavailability

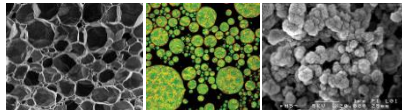
Design of model matrices

Egg + Plant Proteins



Model Micronutrients :

Vitamin D & caroténoïds (lipophilic)
Vitamin B9 and B12 (hydrophilic)



Multi-scale Characterisation

Selection & Production of



4 model matrices

MicroNut Project

In vivo oral processing and comfort



In vitro mastication



In vitro digestion

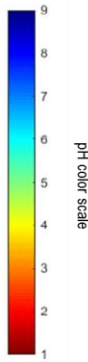
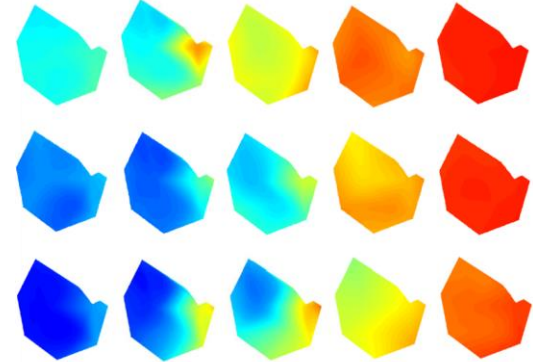
DIDGI®

Granula-spongy EWG

Intermediate EWG

Smooth-rigid EWG

20 min 60 min 120 min 240 min 360 min



Gastric breakdown of structurally different egg white gels



Françoise Nau

P11 Manon Hiolle & P12 Jun Wang

Priority 3 Design of food adapted to specific populations (infant, elderly)

Objective: integrating our knowledge on digestion to design new **functional foods** with **targeted biological property**

Infant

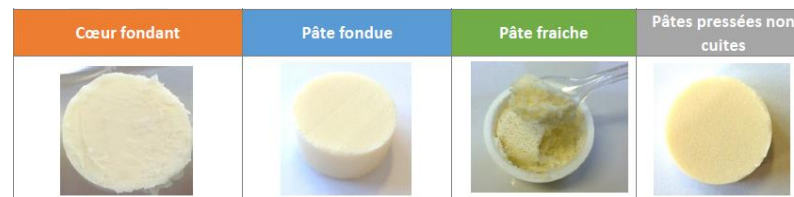
- * What are the **parameters** explaining the differences in behaviour of infant formula and human milk in the gastrointestinal tract?
- * How to design new generations of infant formulas better adapted to the nutritional needs and the health of infant?
 - By reducing the heat treatments during manufacture (P8 Xiaoxi Yu, P9 Amira Halabi)
 - By identifying new sources of alternative proteins (P10 Linda Le Roux)
 - By using lipid structures coming from plants like oleosomes



Amélie Deglaire

Elderly

- * Which food structures allow to regulate the kinetics of nutrient release (amino acids, calcium) in the elderly? How to deliver digestive enzymes to elderly (P13 Ashkan Madadlou)



Scientific production

For 2010-2019

213 articles in peer-reviewed journals

(21 publications / year)

18 citations / article

More than 3800 citations

4 highly cited papers

2 book coordinations
18 book chapters
3 « Special issue » coordination
3 patents

84 conferences (46 invited)

56 international and 28 national

Over 100 posters

International Conference on Food Digestion

Cesena, 2012

Madrid, 2013

Wageningen, 2014

Naples, 2015

Rennes, 2017

Granada, 2019

Joint publications with **23 countries**

N > 9 with USA, UK, NZ, IT, CH, ES



Improving health properties of food by sharing our knowledge on the digestive process

International Network

Dr. Didier DUPONT, Senior Scientist, INRA, France

●
INFOGEST
●





Tech Univ Denmark Univ Aarhus Univ Copenhagen MTT Univ Oulu Univ Eastern Finland
 Norwegian Univ Life Sci Chalmers Univ Tech VTT Nofima Riga Stradin Univ Univ Ljubljana
 Univ Zagreb
 NIZO TNO Lund Univ

Wageningen UR Anabio
 Teagasc Univ Reading James Hutton Inst
 Univ College Cork Univ Birmingham
 Cent Rech Lippmann Univ Greenwich
 Univ Ghent Agroscope Posieux
 Inst Food Res Agrocampus Ouest
 Leatherhead Food Res ACW
 FIBL Univ Greifswald Univ Sevilla
 IRD Max Rubner-Institut
 INRA Univ Valencia
 AgroParisTech CNRS Univ Basque Country
 Univ Murcia CTCPA
 CSIC Univ Granada

NIH Ricardo Jorge
 Univ Alto Douro

ITQB Milan State Univ
 FEM CNR
 Univ Milan Univ Naples

Univ Buenos Aires
 CONICET
 Univ Queensland
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 Soochow Univ

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 Chile

Brazil

Norway
 Sweden

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 Estonia

Germany
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 Ukraine

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 Rep. of Serbia
 Slovak.
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Laval Univ
 Univ Guelph

Czech Univ Prague
 Inst Chem Technol

KTU Food Inst
 Lithuanian Univ HS
 Gdansk Univ Tech
 Maize Res Inst
 NGO

Polish Academy of Sci
 Univ Belgrade
 Univ Novi Sad

Aristote Univ Thessaloniki
 Centr Food Res Inst
 Ben Gurion Univ
 Technion

Pom Med Univ

Ege Univ
 Univ California Davis

USA
 Riddett Inst
 Plant Food Res
 Nagoya Univ
 Japan

400 scientists - 140 institutes - 43 countries

Industry involvement

☞ ~ 50 private companies are following INFOGEST





Chair
Didier Dupont - France

INFOGEST



Vice-chair
Alan Mackie - UK



www.cost-infogest.eu

**In vitro
models of
digestion
WG1**

**Food
interaction –
meal digestion
WG2**

**Absorption
models
WG3**

**Digestive
lipases and
lipid digestion
WG4**

**Digestive
amylases and
starch
digestion
WG5**

**In silico
models of
digestion
WG6**



Didier Dupont



Pasquale Ferranti



Milena
Corredig



Linda Giblin



Myriam Grundy



Nadja Siegert



Choi-Hong Lai



Brigitte Graf



Frederic Carriere



Caroline Orfila



Steven Le Feunteun



Alan Mackie



Uri Lesmes



We are pleased to announce the next
6th International Conference on Food Digestion



in Granada, Spain, 2-4 April 2019



MERCI



***THANK YOU FOR
YOUR ATTENTION***