

How structure and assembly across different length scales influence protein digestion

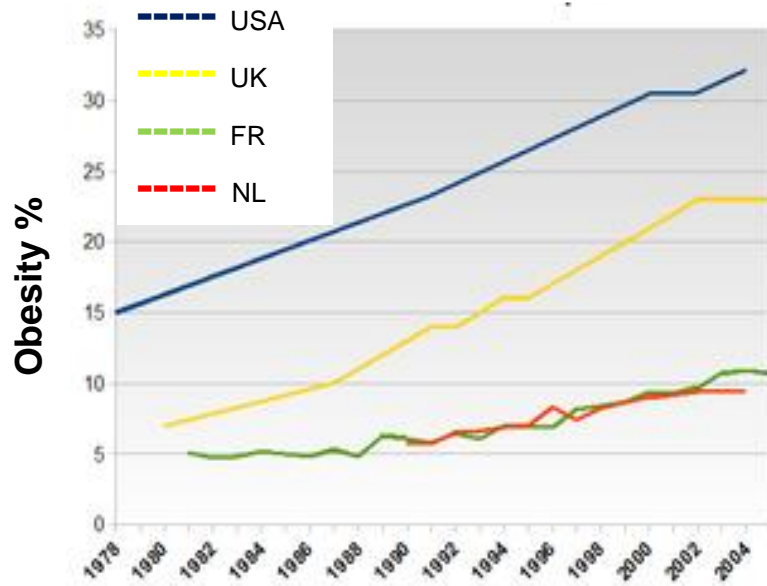


Dupont D., Nyemb K., Guerin-Dubiard C., Nau F.,

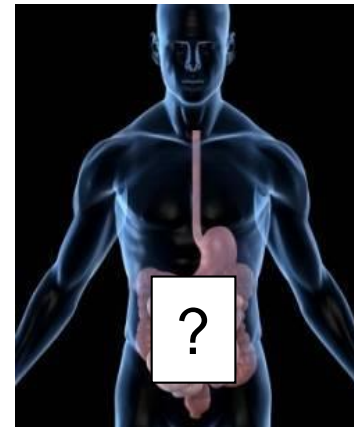
INRA, Rennes, France



Why are we interested in understanding food digestion?



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



Gut = interface between food and human body

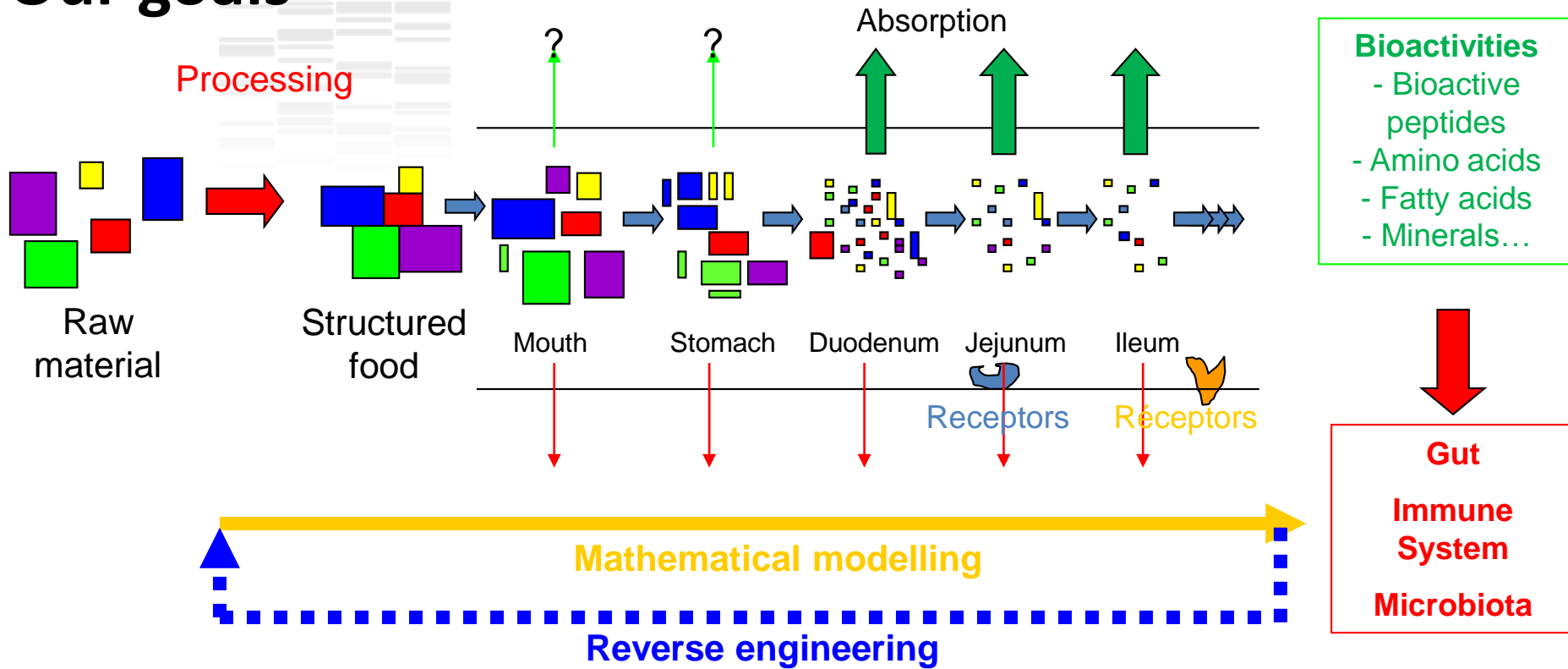
Digestion releases food components that can have a beneficial or a deleterious effect on human health

... but the mechanisms of food disintegration during digestion remain unclear since the gastrointestinal tract 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

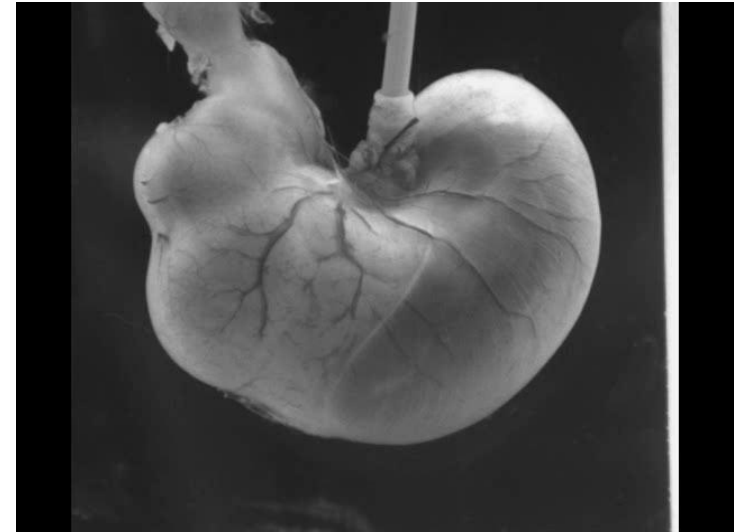
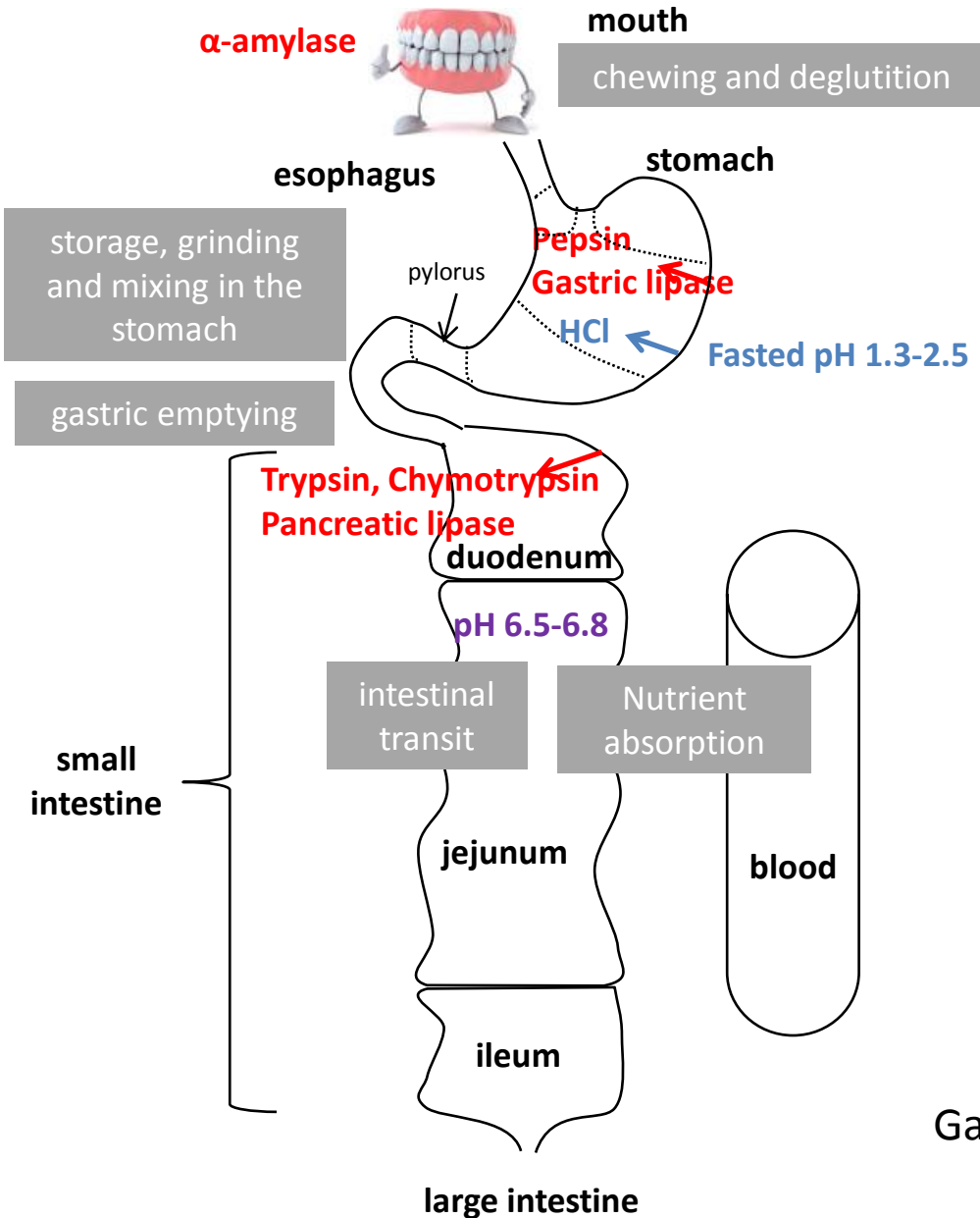
Our goals

Healthy Adult/ Neonate/ Elderly

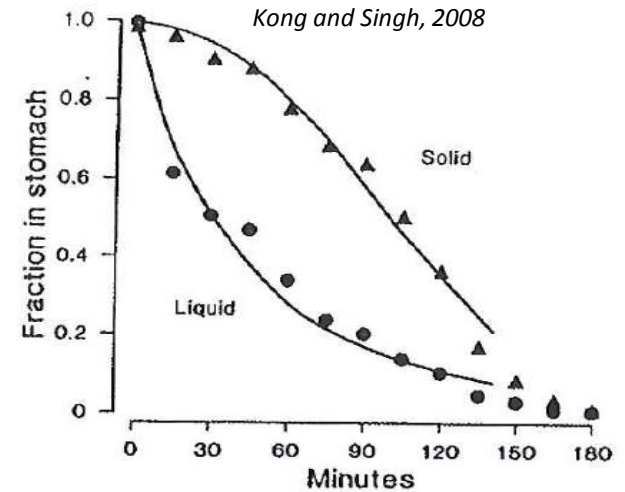


- ☞ To understand the mechanisms of breakdown of food matrices and their constituents in the gut and identify the beneficial/deleterious food components released during digestion
- ☞ To determine the impact of the structure of food matrices on these mechanisms
- ☞ To model these phenomena in order to develop a reverse engineering approach

The digestive process

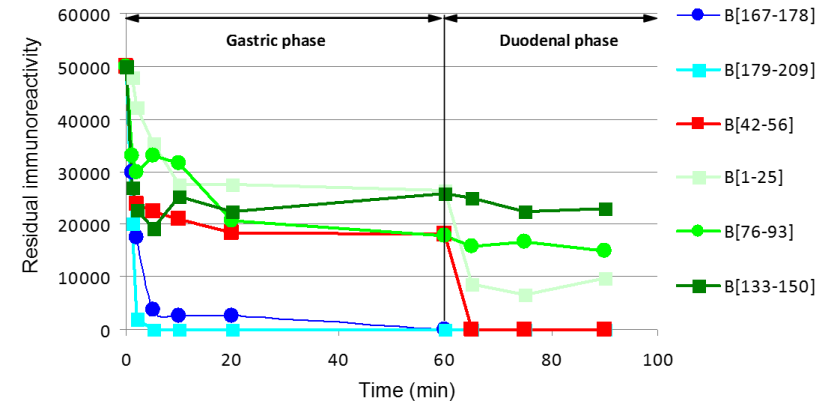
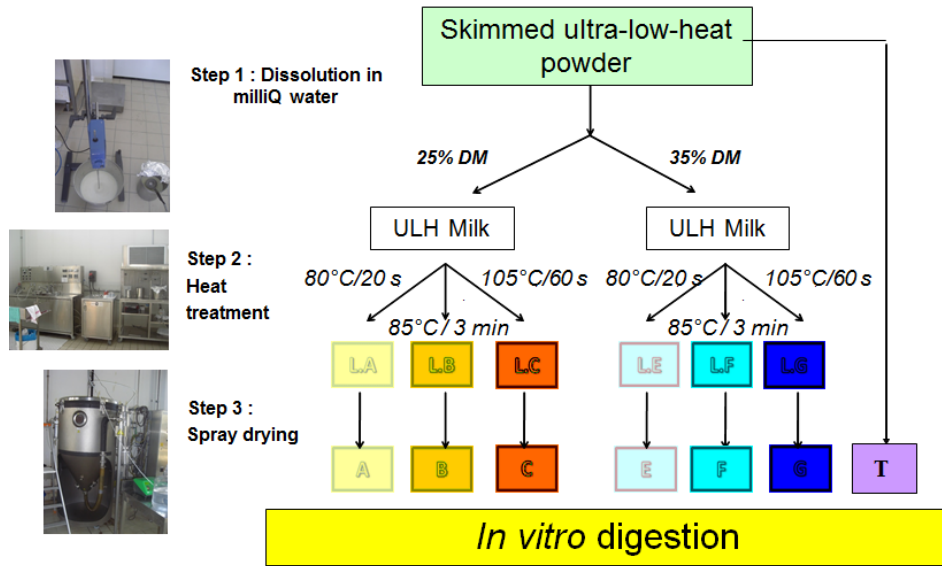


From Roger Lentle, Massey Univ. NZ



Gastric phase = a very complex but crucial step for the whole digestion process

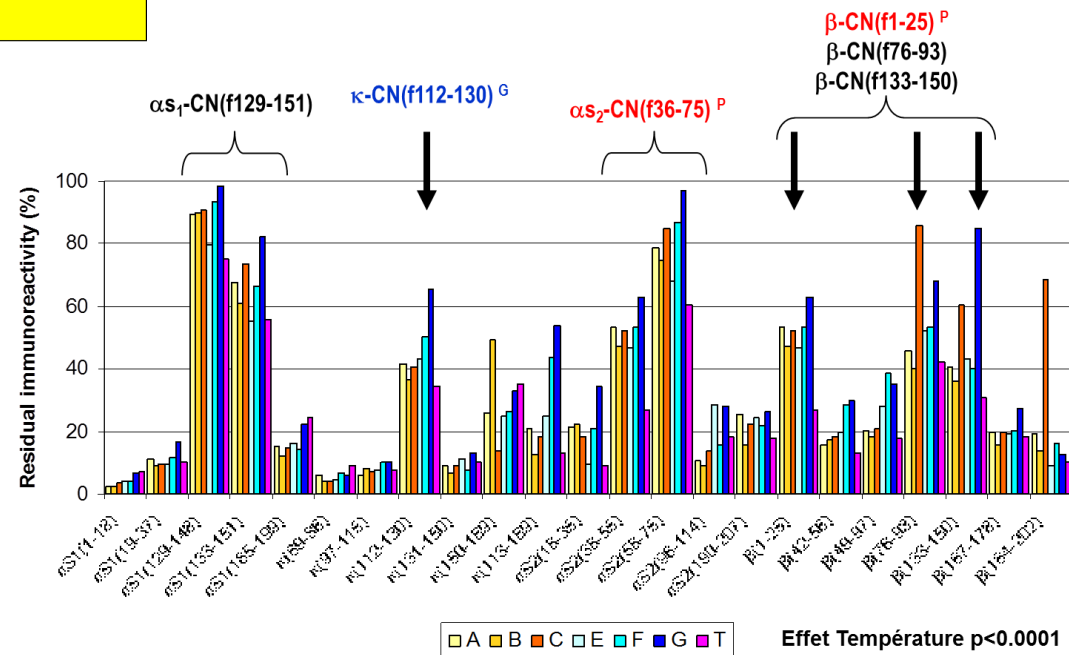
Thermal aggregation of natively unfolded proteins **slows down** their kinetics of hydrolysis during digestion



Kinetics of proteolysis of different domains among one specific protein



Design of model infant formulas with different heat-treatments and *in vitro* digestion using an infant model

- Dupont *et al.* 2010. Mol Nutr Food Res, 54, 767-80
- Dupont *et al.* 2010. Mol Nutr Food Res, 54, 1677-89
- Dupont *et al.* 2010 Food Digestion, 1, 28-39



Identification of the resistant areas

Thermal aggregation of globular proteins **accelerates** their kinetics of hydrolysis during digestion

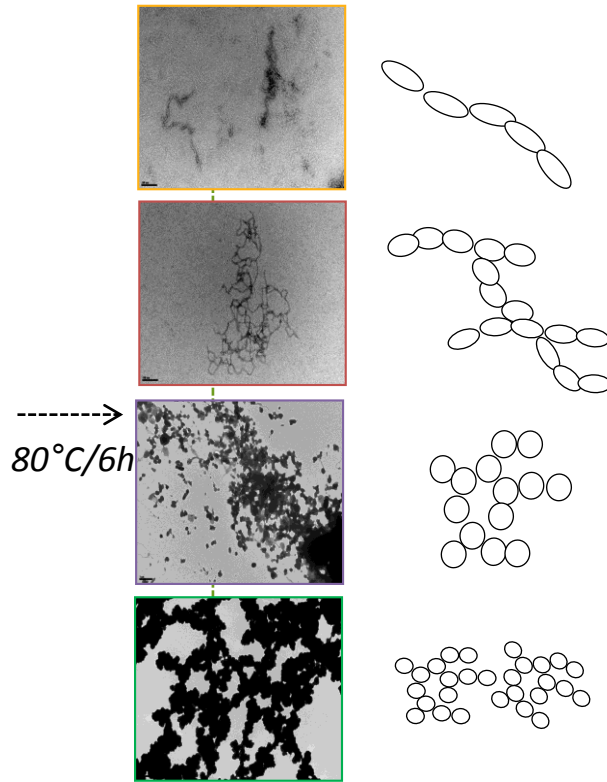
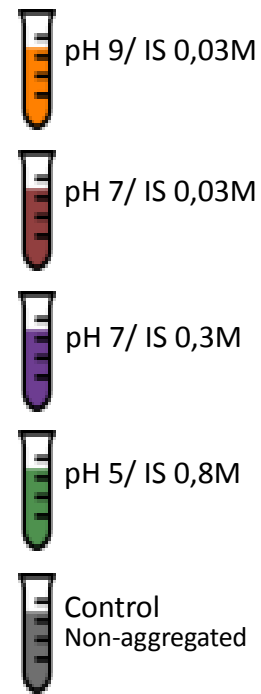
 Nyemb et al., 2014. Food Chem, 157, 429-38
 Nyemb et al., 2014. Food Res. Int., 63, 192-202

Ovalbumin (OVA) was taken as a model

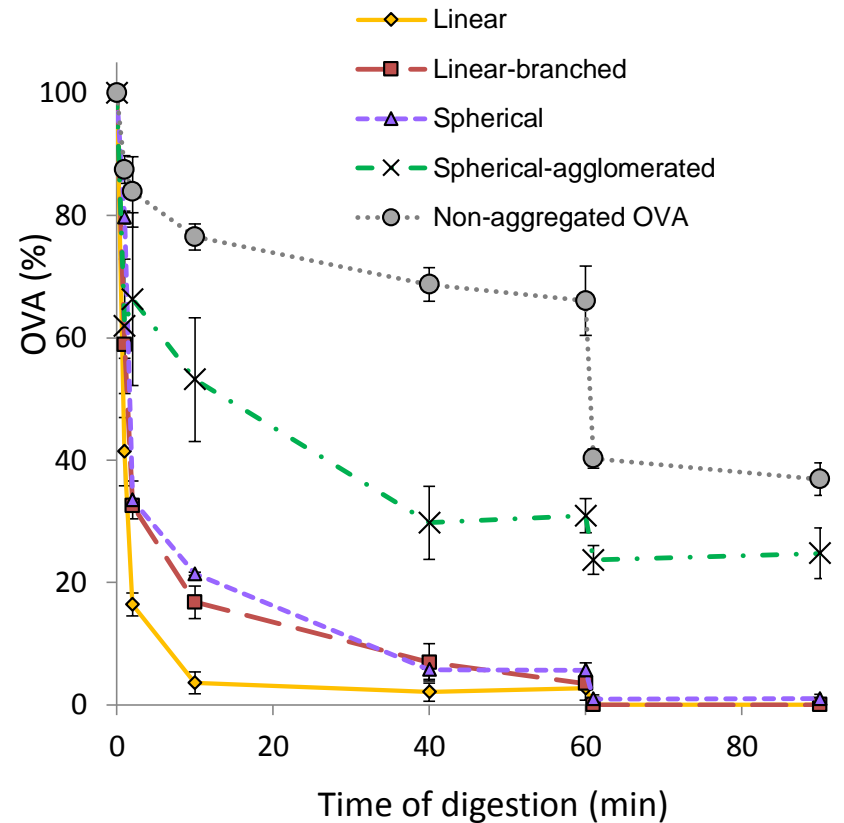
Heat-treatments at different pH and and ionic strength (IS)

Linear Aggregates

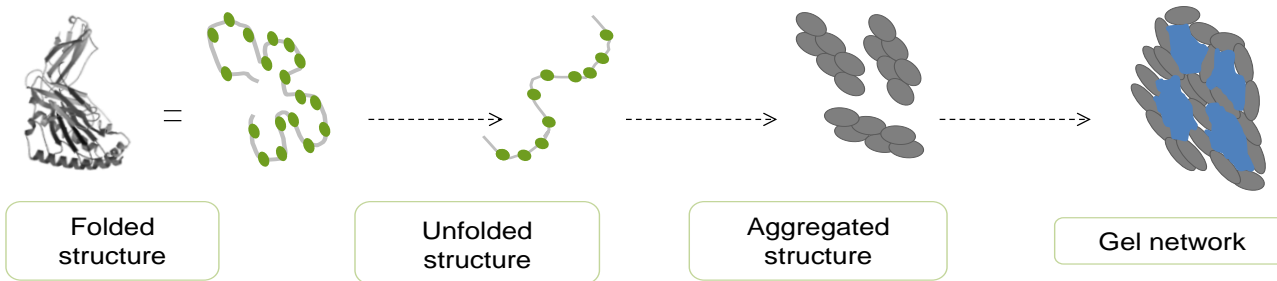
In vitro digestion



Spherical Aggregates



The microstructure of egg-white gels made from different types of aggregates affects the kinetics of proteolysis



Aggregates	linear	branched	spherical
Rate of <i>in vitro</i> hydrolysis	+++	++	+

Gels	linear	branched	spherical
			SEM
			CRYO-TEM

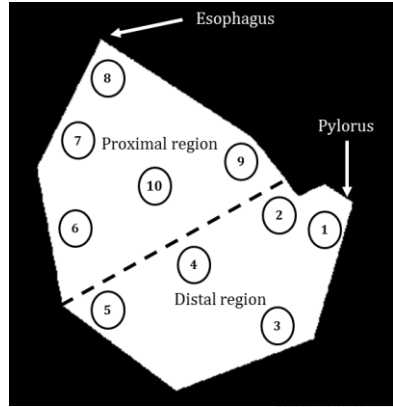
Rate of <i>in vitro</i> hydrolysis	+	++	+++
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Nyemb et al., 2016. Food Hydrocolloid, 54, 315-27

Nyemb et al., 2016. Food Res. Int., in Press

Spatio-temporal evolution of pH during an *in vivo* digestion

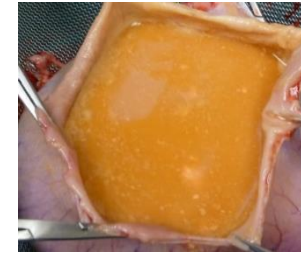
pH 7.0



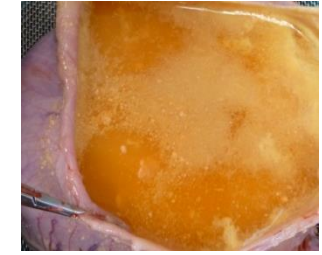
20 min



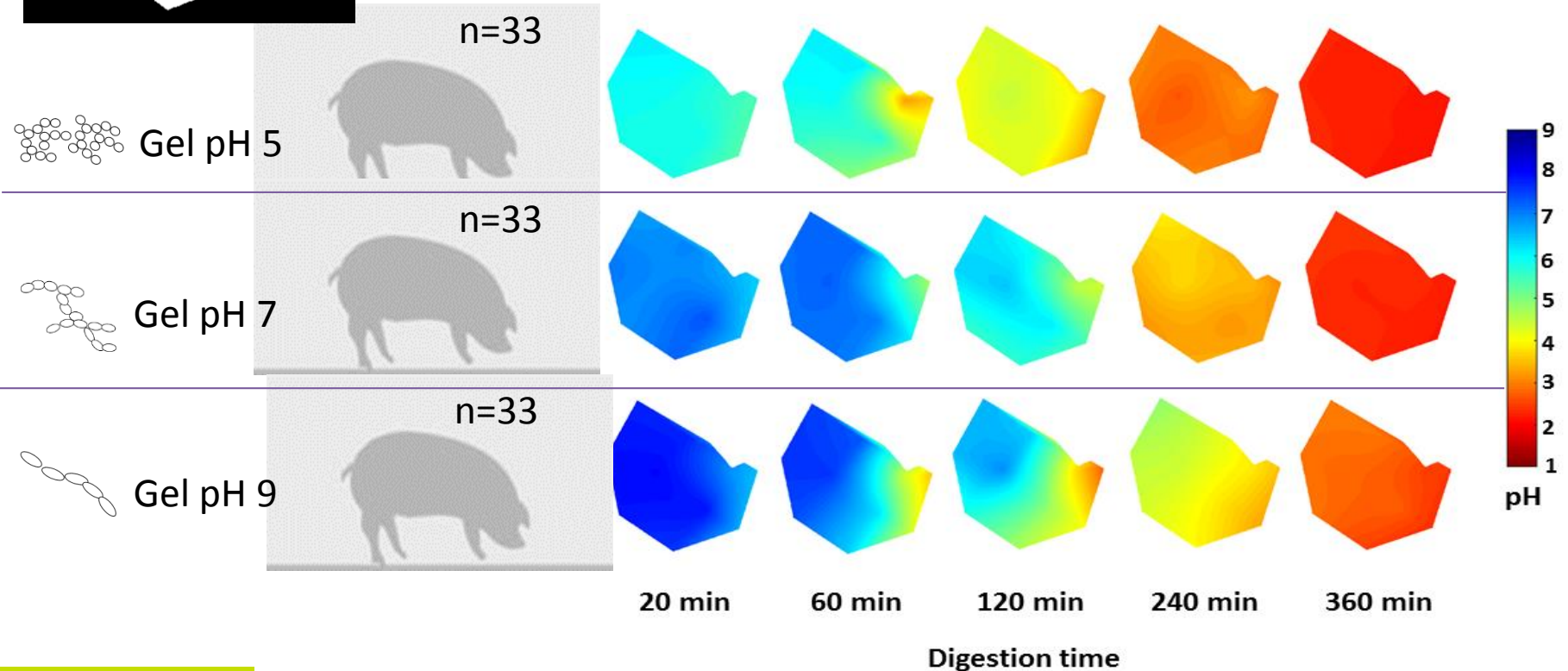
60 min



120 min

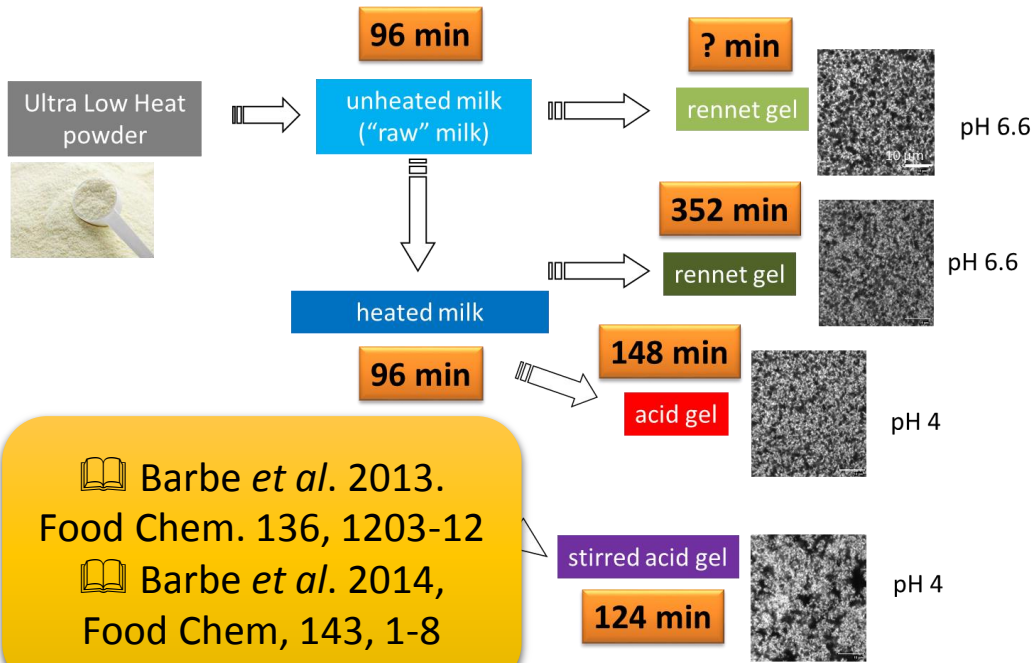


240 min



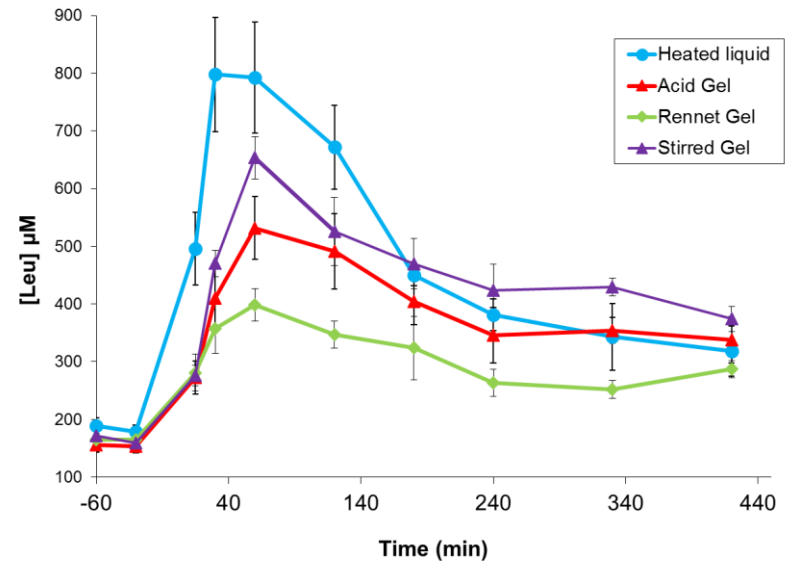
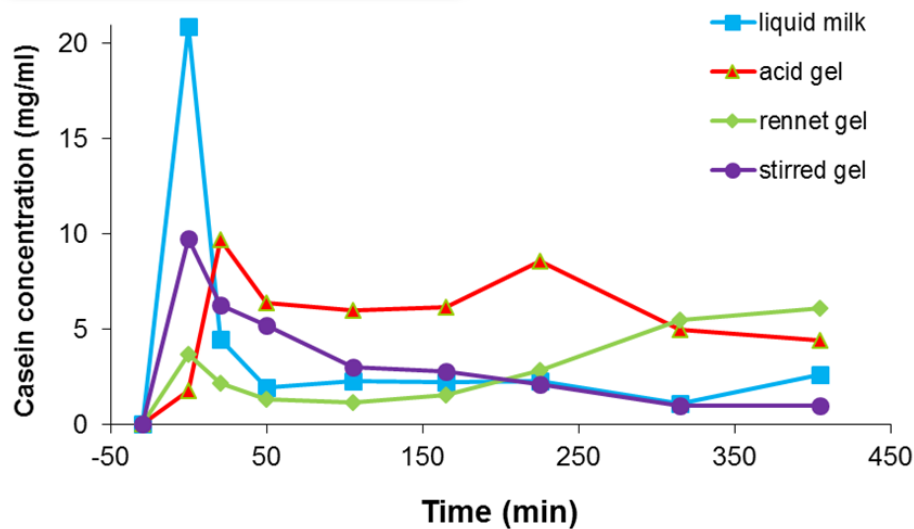
Digestion time

Physical state of food controls gastric emptying and amino acid bioavailability in mini-pigs

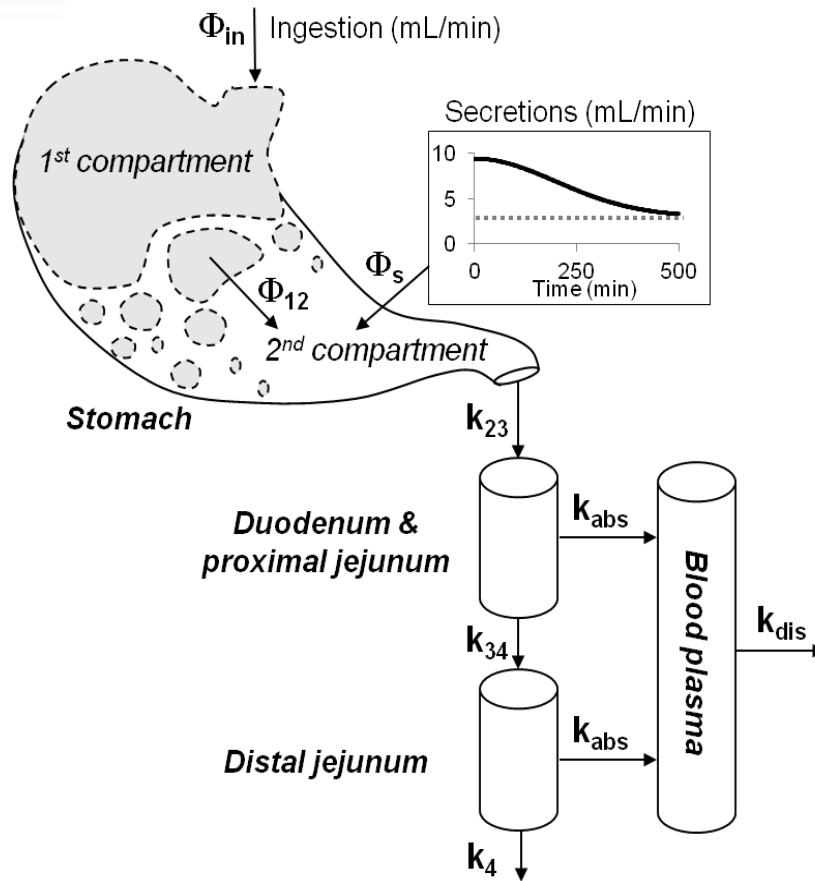
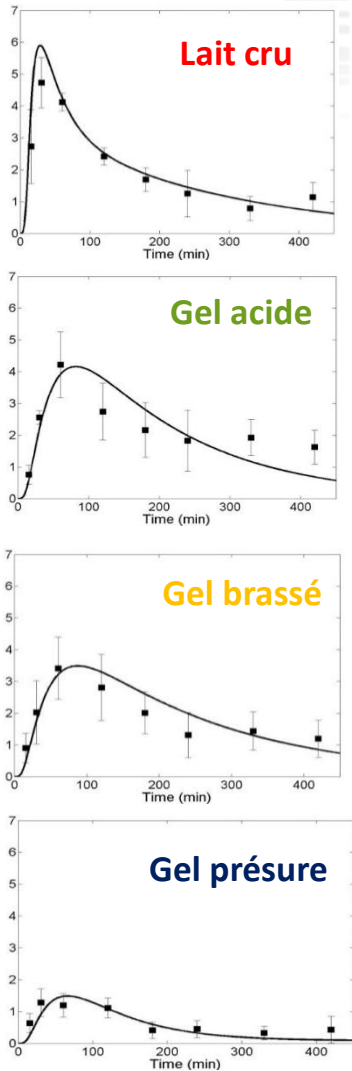


Barbe *et al.* 2013. Food Chem. 136, 1203-12

Barbe *et al.* 2014, Food Chem, 143, 1-8



Mathematical model of transit and absorption



Le Feunteun *et al.*
 2014. Food Bioprocess
 Tech. 7, 1099-1113

Conclusion

- The effect of heat treatment on protein kinetics of digestion directly depends on the structure of the protein:
 - ↳ natively unfolded
 - ↗ globular
- The trends determined for protein aggregates sensitivity to digestion cannot be extended to gels made with these aggregates
- The physical state (liquid/gel) of dairy products drives the kinetics of protein digestion and amino acid bioavailability
- The structure of food can be a way to control nutrient release and make it adapted to specific populations (infant, elderly, overweight...)

The Bioactivity & Nutrition team



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INFOGEST
International Conference
Rennes, France
April 2017

We are pleased to announce the next

5th International Conference on Food Digestion



in Rennes, France, 4-6 April 2017