In vitro and in vivo approaches for investigating gastro-intestinal disintegration of infant formula by the neonate

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In vitro and *in vivo* approaches for investigating gastro-intestinal disintegration of infant formula by the neonate

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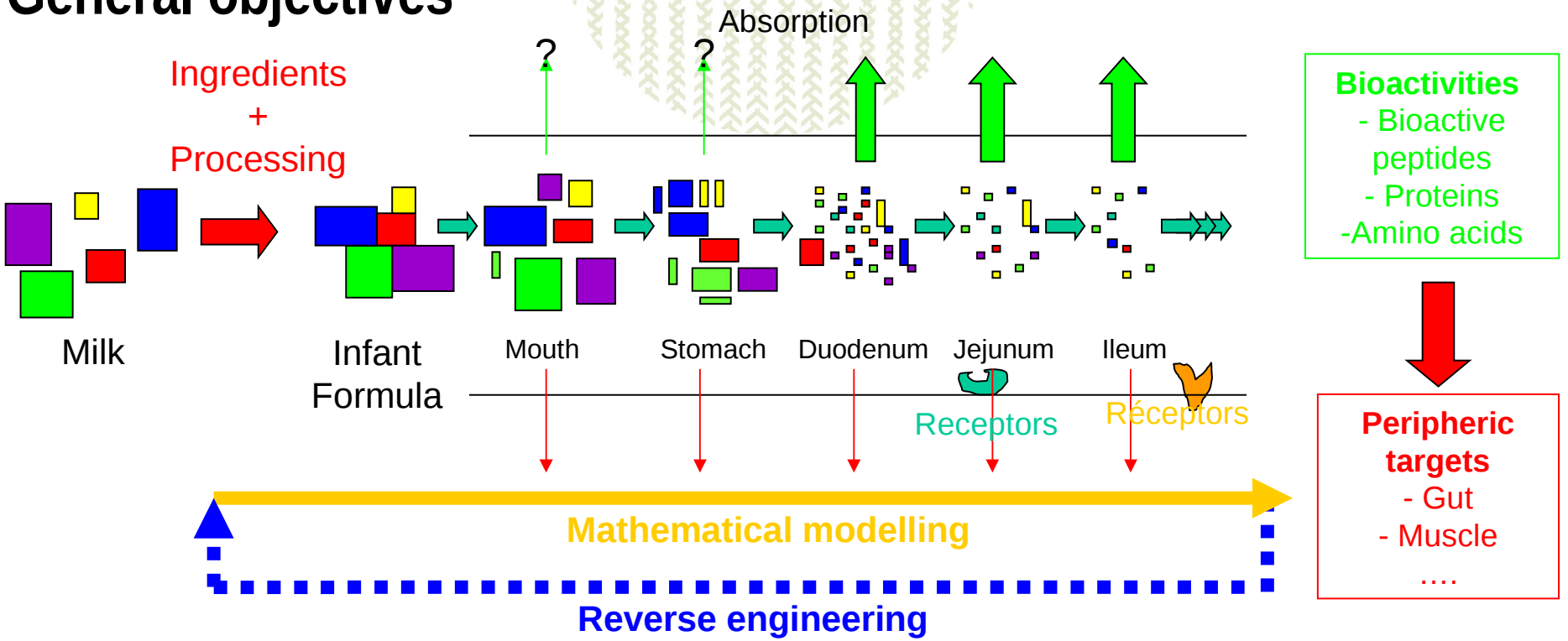
DIET
AGRICULTURE
ENVIRONNMENT

General objectives



☝**To understand the mechanisms of disintegration of infant formula and their proteins in the digestive tract**

☝**To determine the impact of the bioactives released during digestion on the infant health**

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

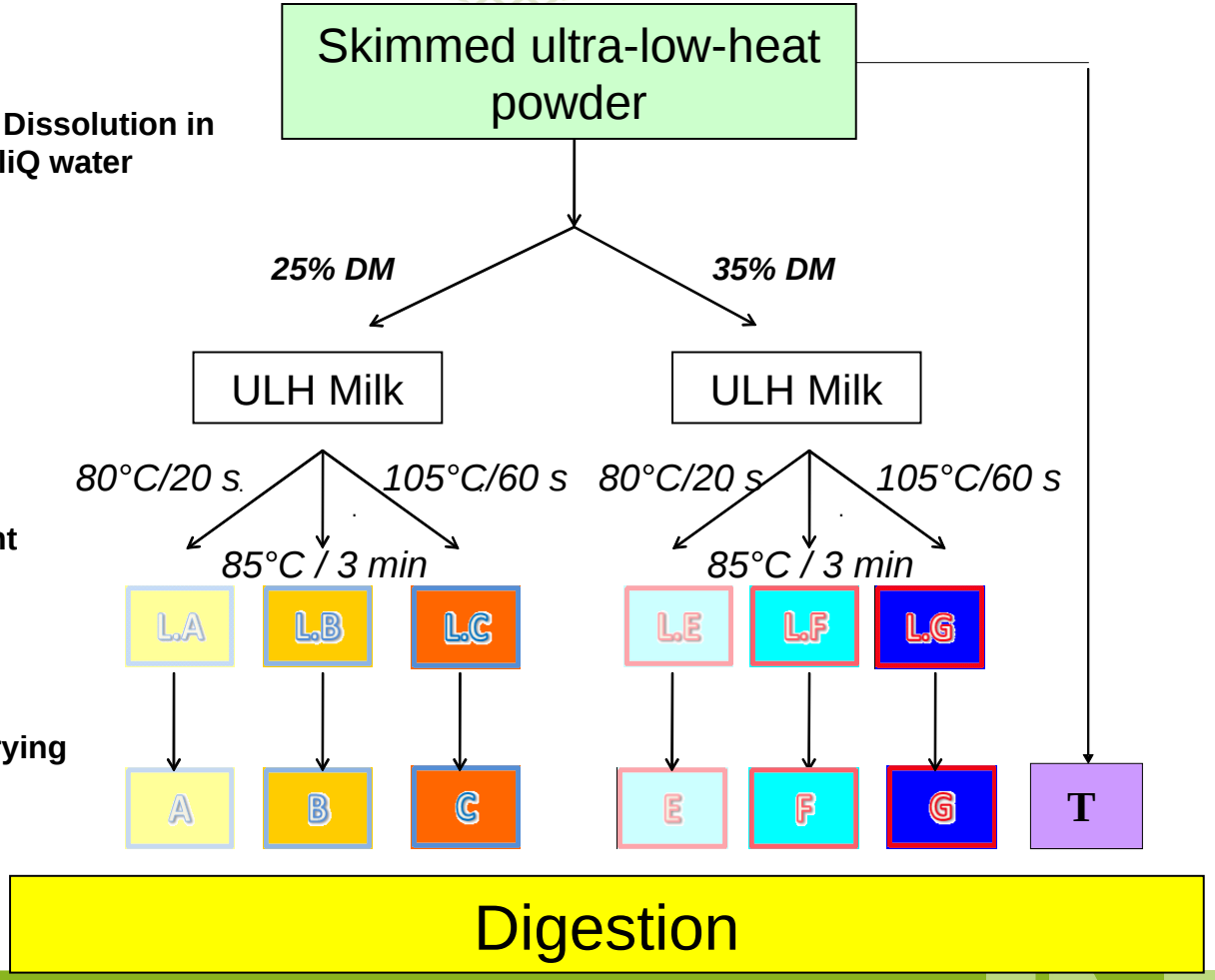
Does heat treatment of milk affect caseins digestibility?

- CNs = major allergens in infant whereas highly sensitive to digestion

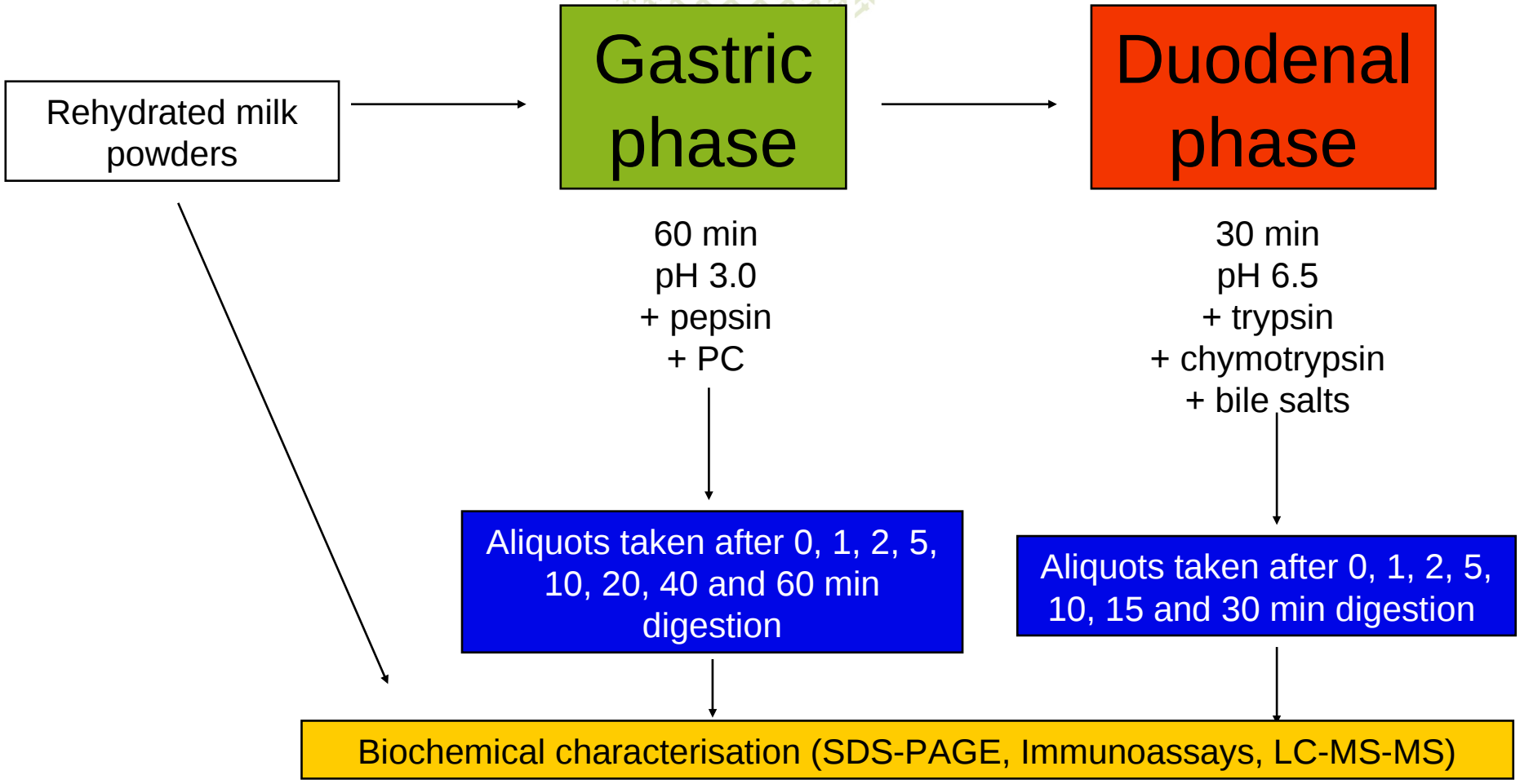
Step 1 : Dissolution in milliQ water

Step 2 : Heat treatment

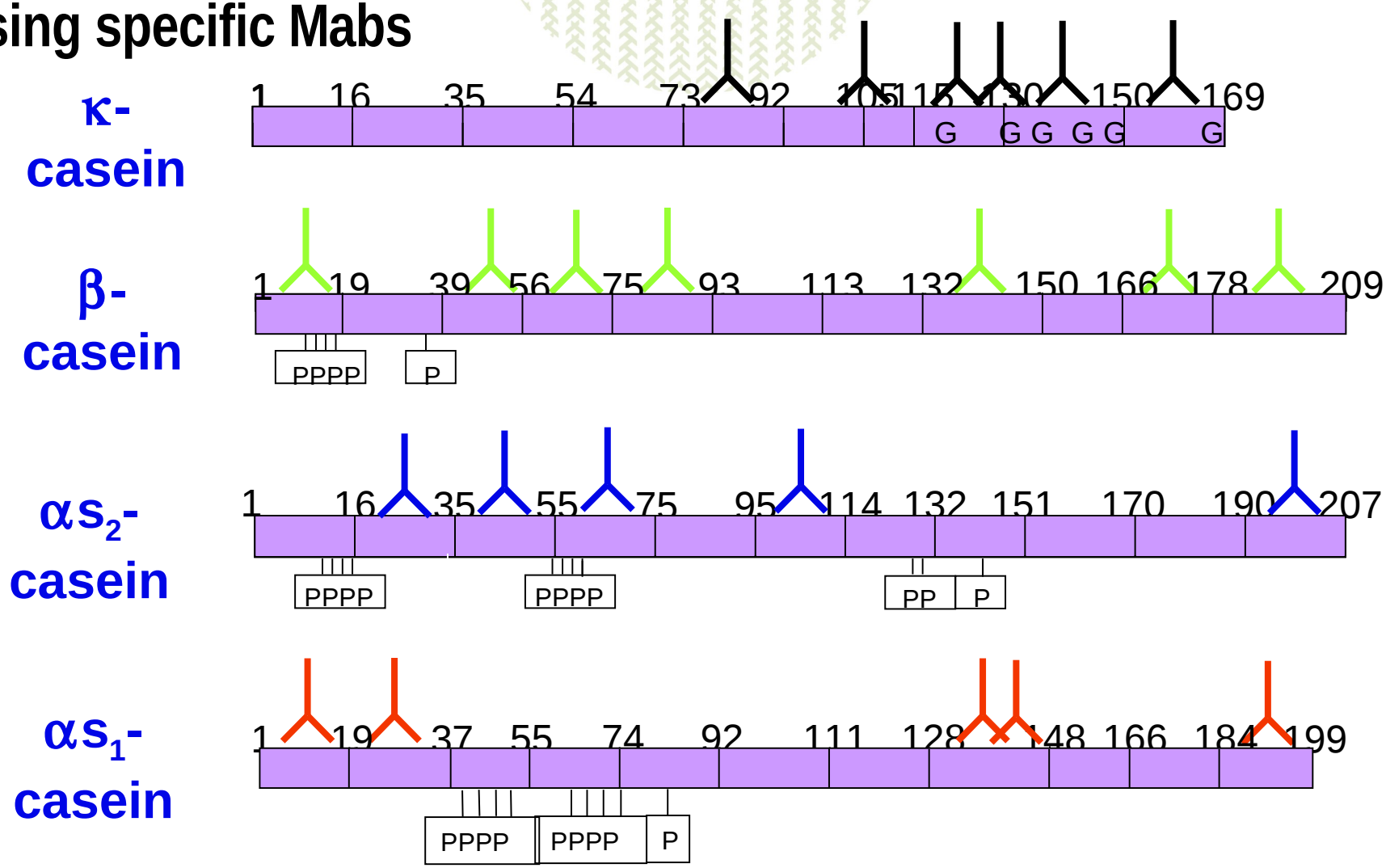
Step 3 : Spray drying



Infant gut Model (Dupont *et al*. Mol Nutr Food Res 2010, 54, 767-780)

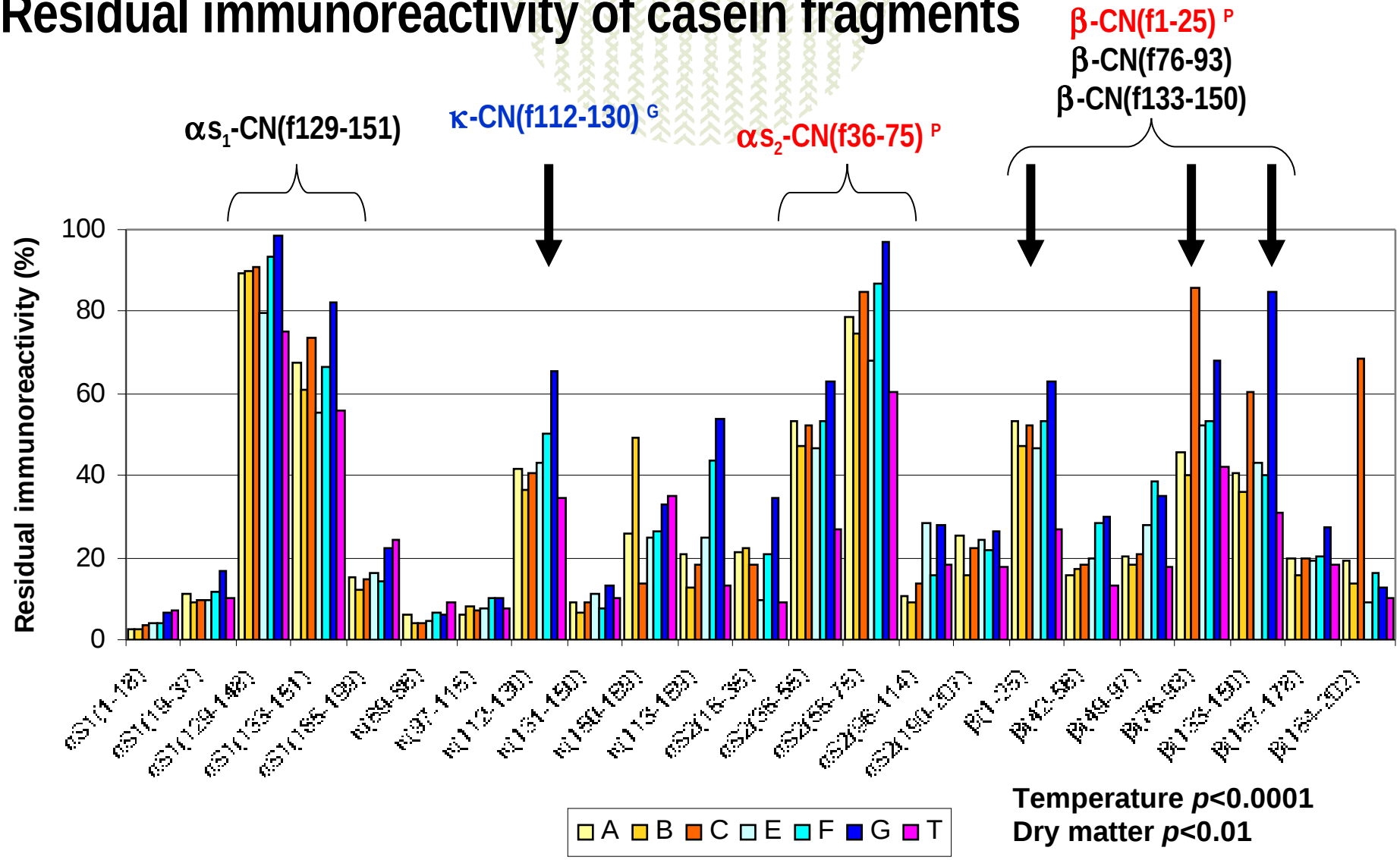


Identification of epitopes resistant to digestion by ELISA using specific Mabs

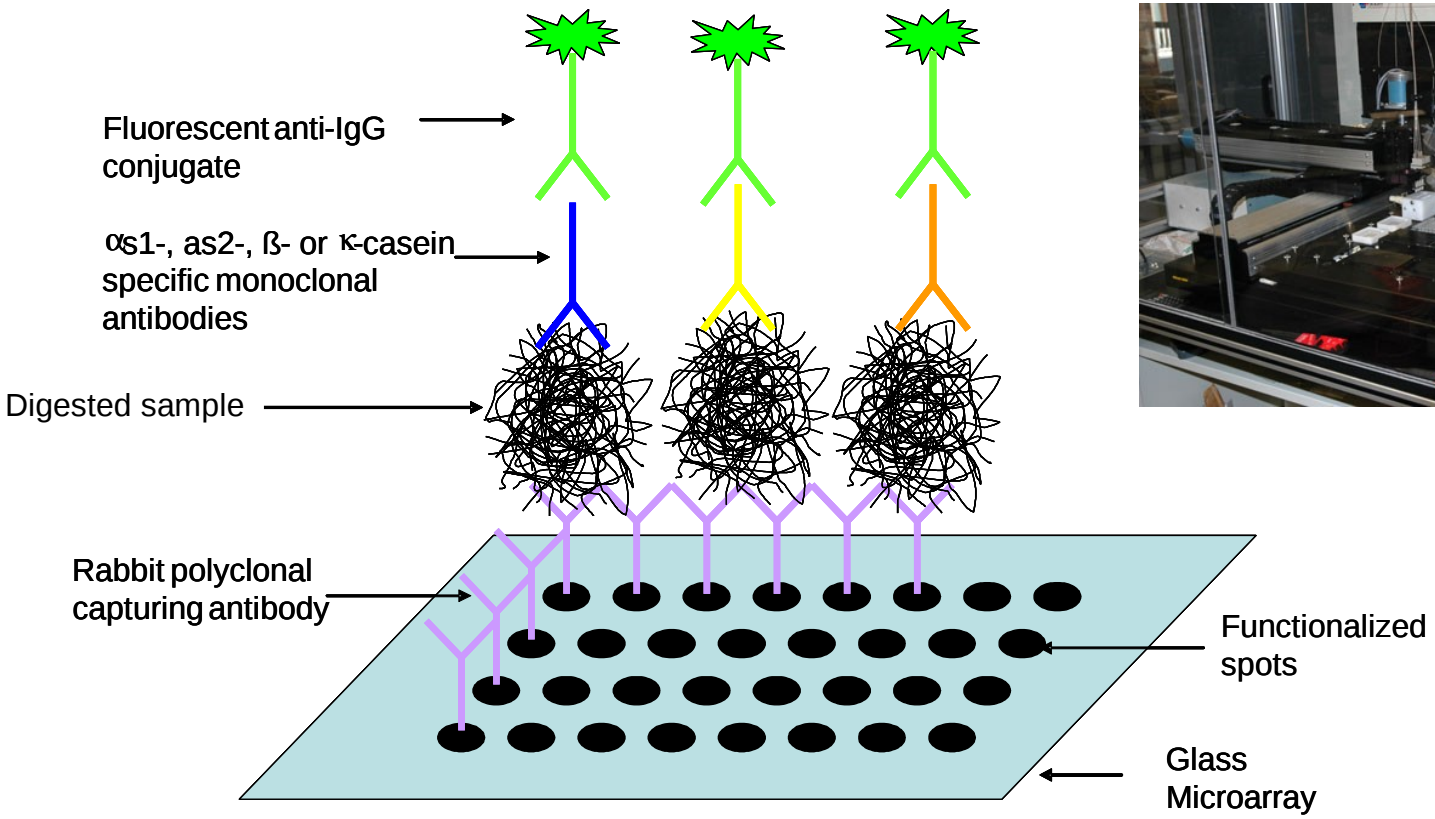


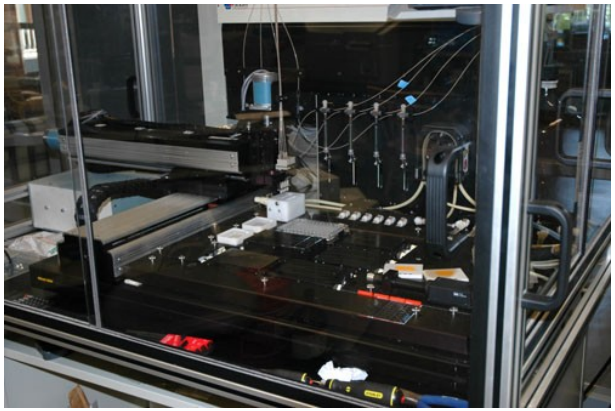
For more information, see poster P26

Residual immunoreactivity of casein fragments

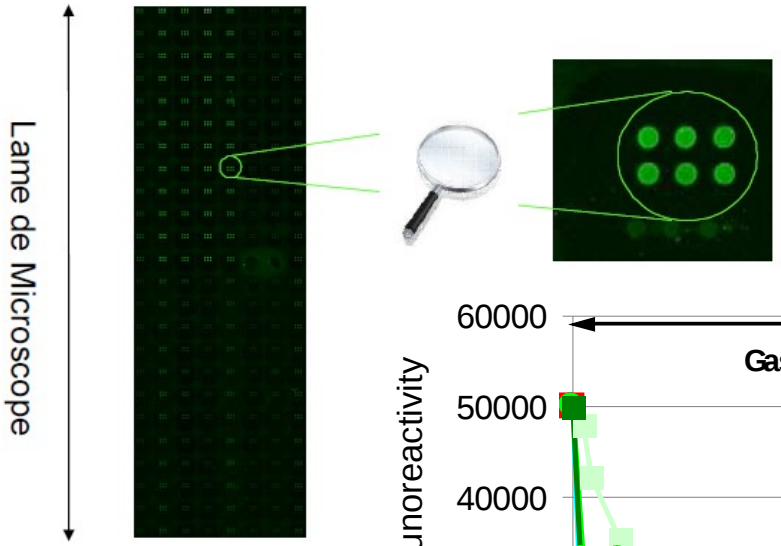


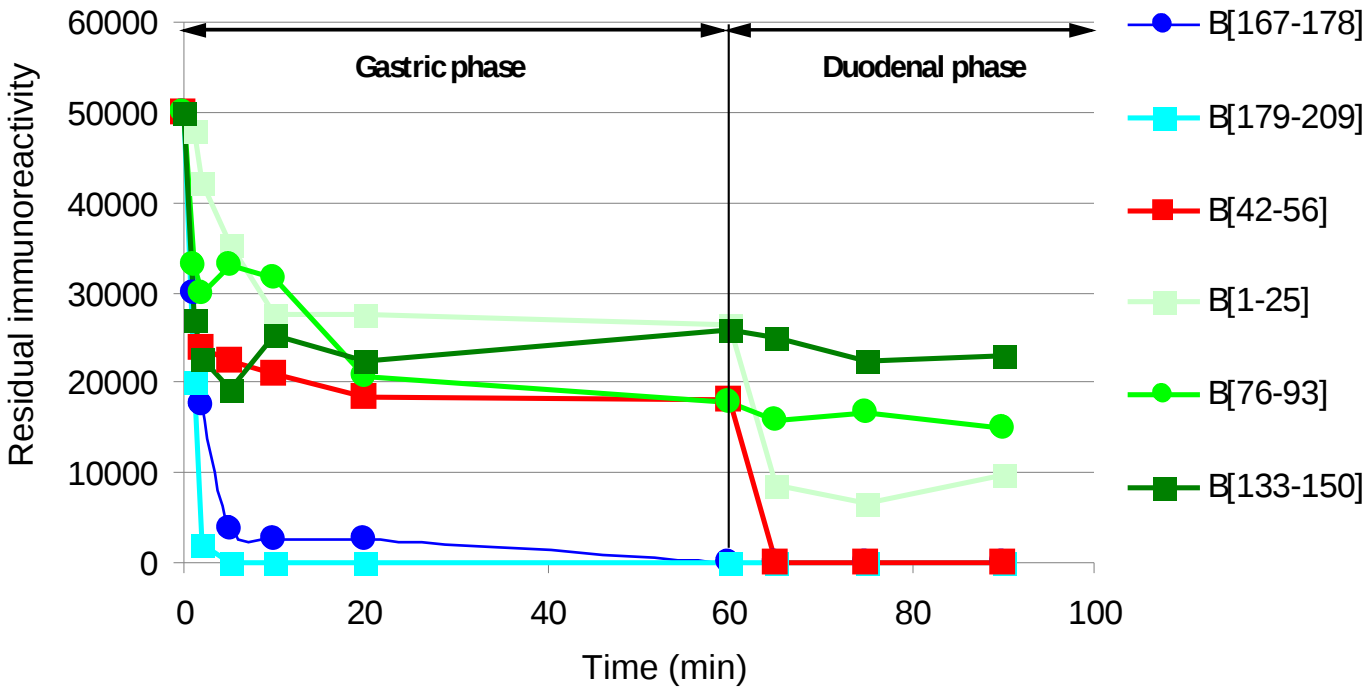
Antibody array technology





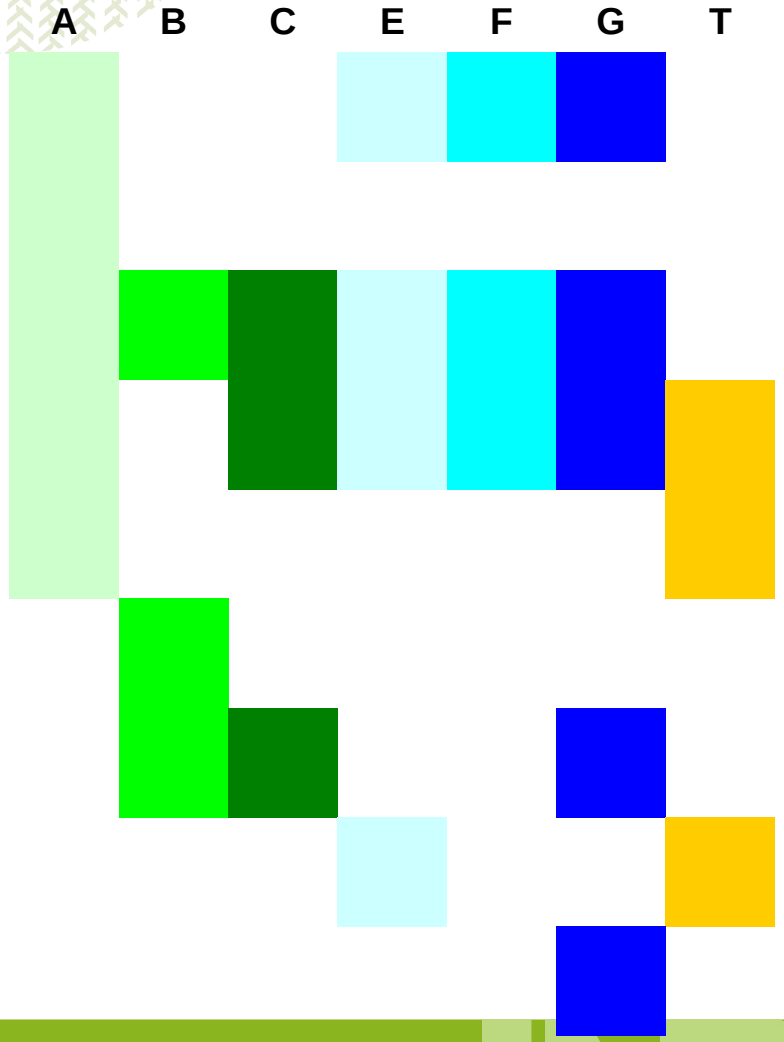
Kinetics of β-casein digestion depend on the area studied





Pattern of bioactive peptides resistant to digestion depends on the process

Peptide	Bioactivity
β-CN(f108-113)	Anti-hypertensive
β-CN(f114-119)	Opioïd agonist
β-CN(f193-202)	Anti-hypertensive
β-CN(f193-209)	Immunomodulatory
αs1-CN(f1-23)	Antimicrobial
αs1-CN(f23-34)	Anti-hypertensive
αs1-CN(f91-100)	Anti-stress
αs1-CN(f144-149)	Antioxidant
β-lg(f9-14)	Anti-hypertensive

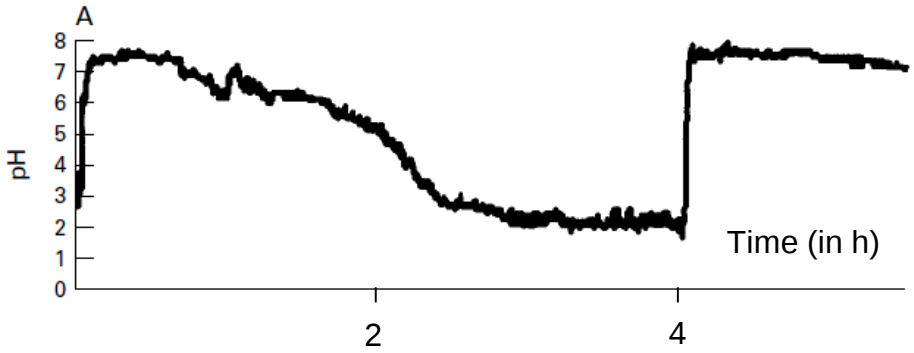


Conclusion 1

- Heat treatment increases caseins resistance to digestion **(Dupont *et al*. 2010, Mol Nutr Food Res 54 ; Dupont *et al*. 2010, Food Dig, in Press)**

- Increased resistance is associated to the formation of heat-induced aggregates between casein micelles and whey proteins

- Limits of the study:
  - Model matrix with no lipids
  - Static *in vitro* digestion model that does not consider the flow of the food and pH variations



  - Need to develop dynamic *in vitro* and *in vivo* approaches

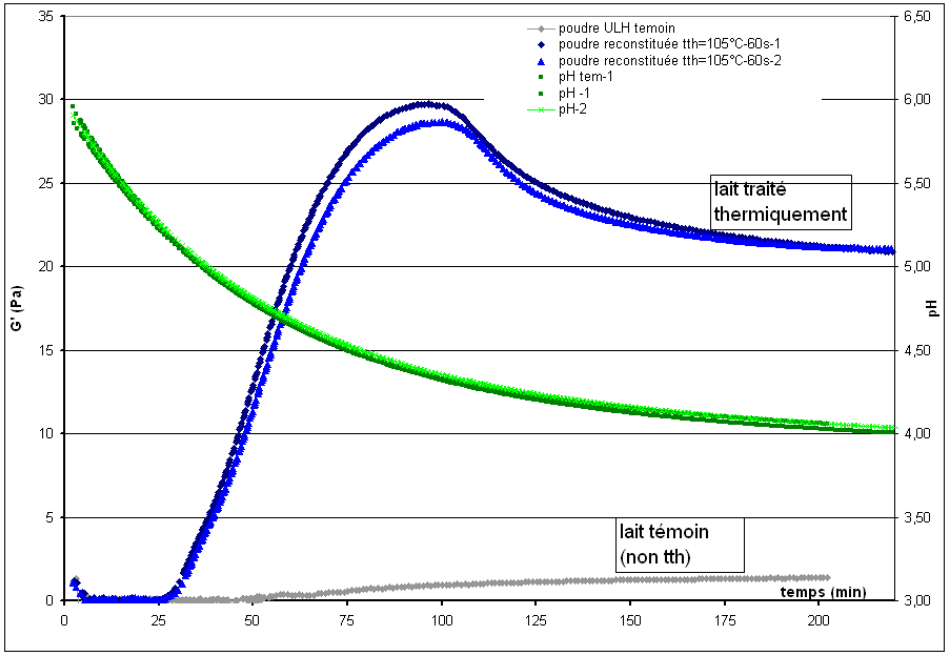
Predicting matrix viscosity in gastric conditions

Simulation of pH decrease in the stomach using gluconodeltalactone (GDL) in a rheometer

by oscillation :

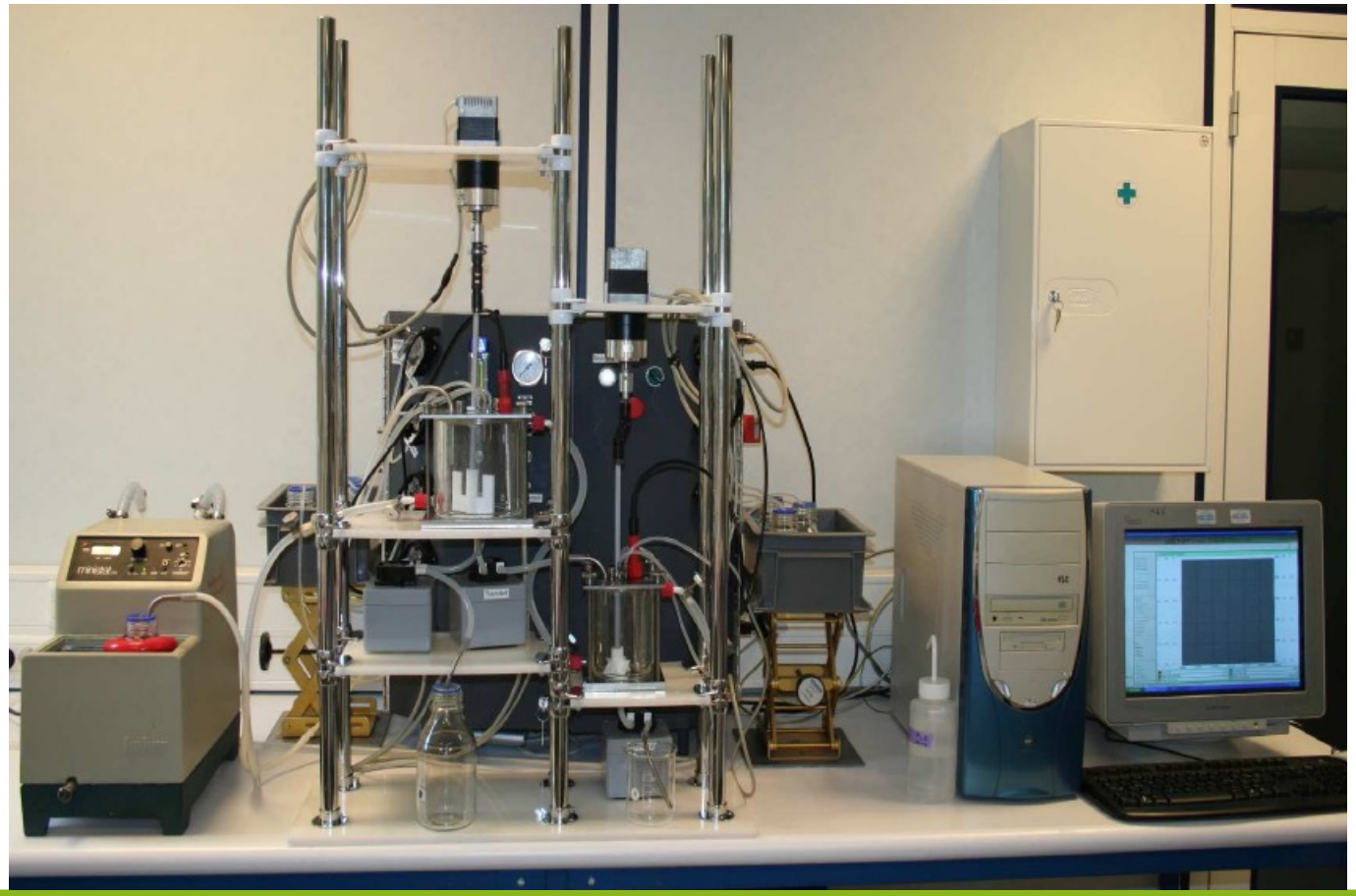
- determination of the viscoelastic properties of gels formed by acidification of rehydrated milk powders with GDL

- determination of the coagulation time and the firmness of the gel.



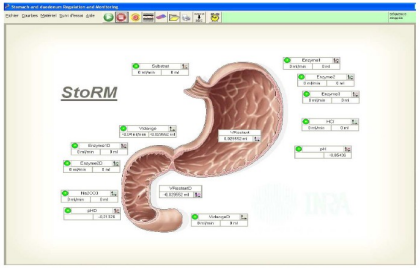
Development of dynamic digestion models

Cooperation with INRA UMR GMPA (D. Picque *et al*.)



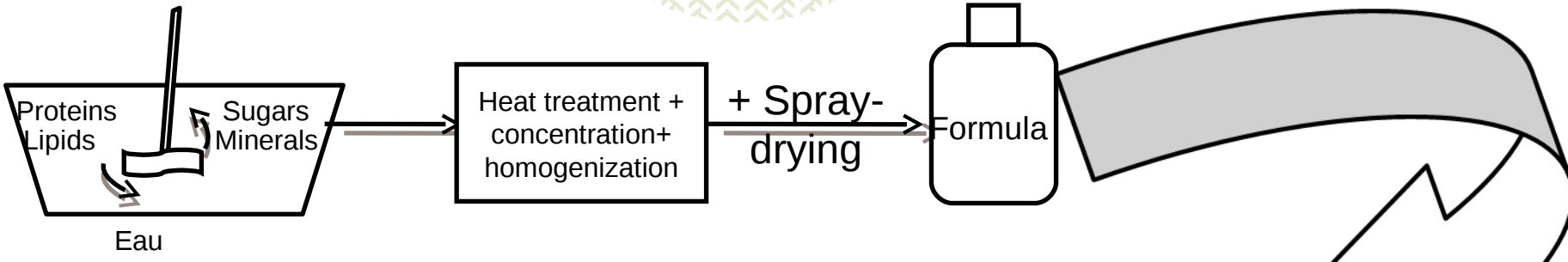
- Logiciel SToRM

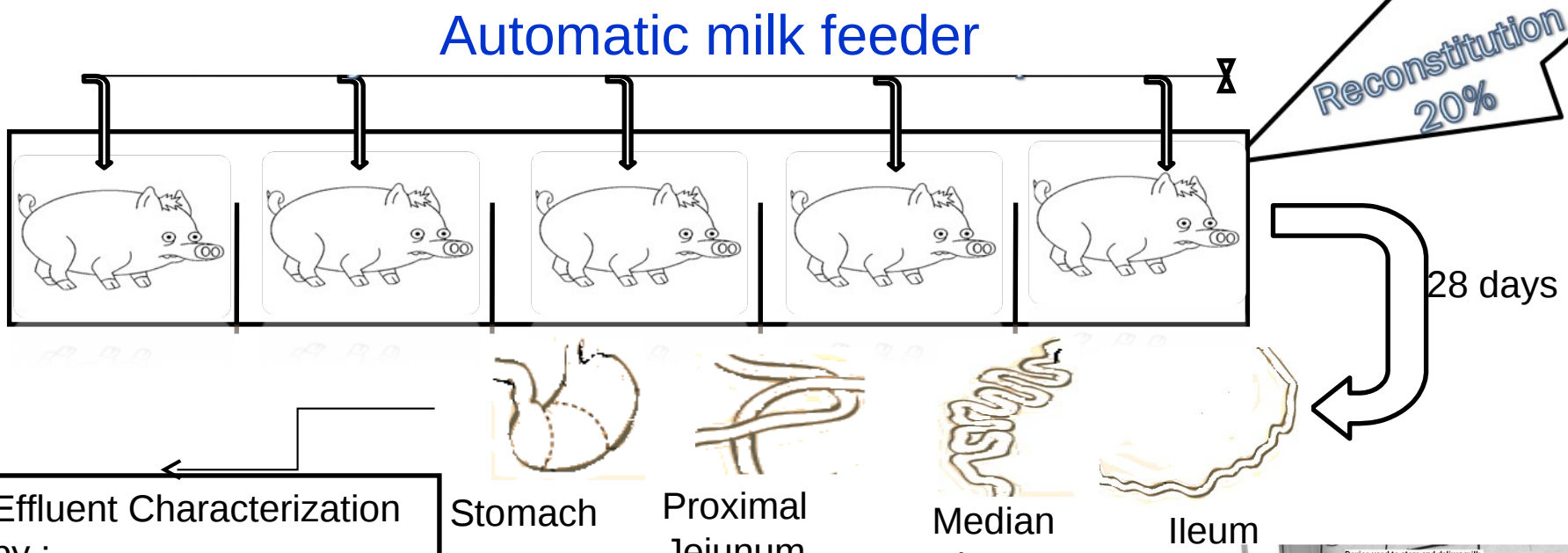
Acquisition des données, stockage, représentations graphique, commandes,…



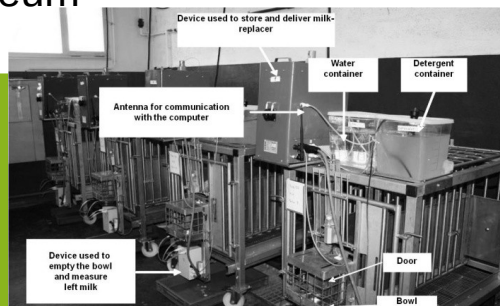
In vivo digestion using the piglet as model

Cooperation with INRA UMR SENAH (I. Luron et al.)

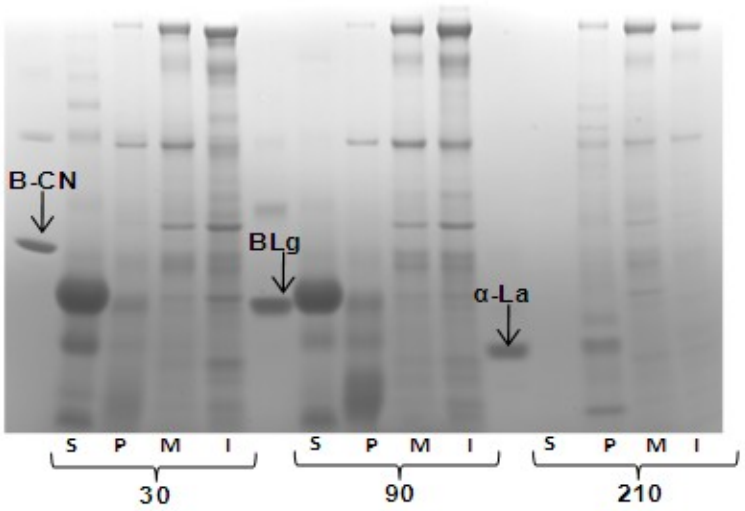


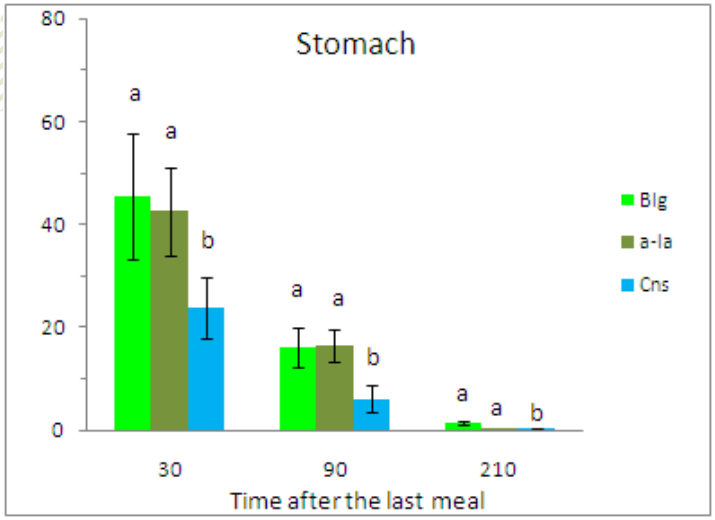


Effluent Characterization by :
*SDS-PAGE
*Immunoassays
*LC-MS-MS

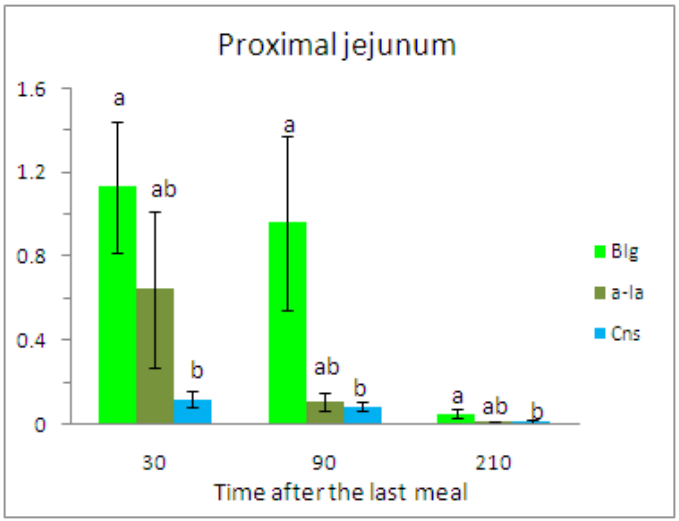


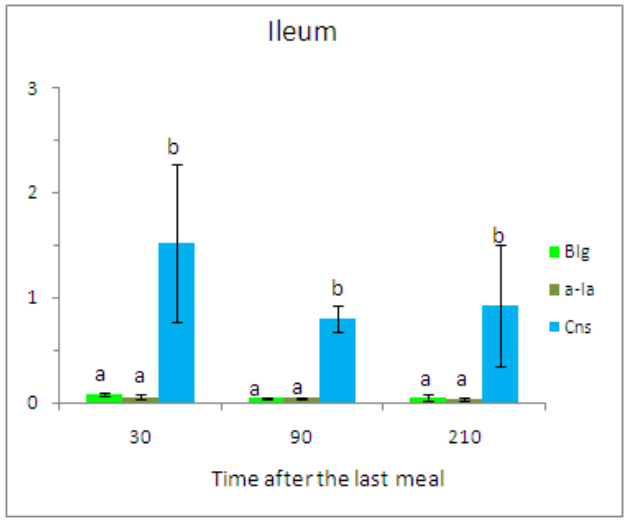
Kinetics of Infant Formula proteins digestion





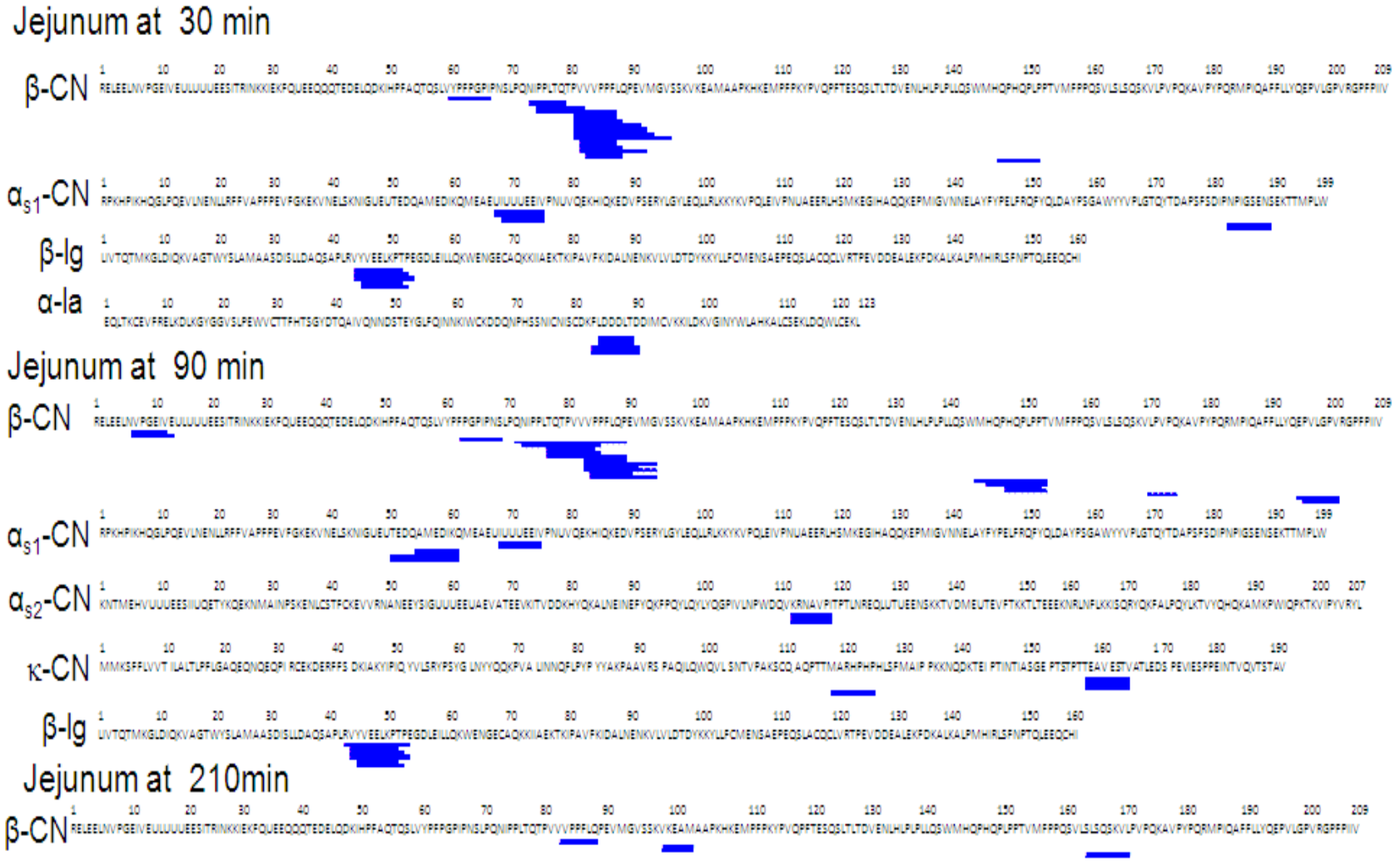
In g/100g of ingested protein





Peptides identified *in vivo*

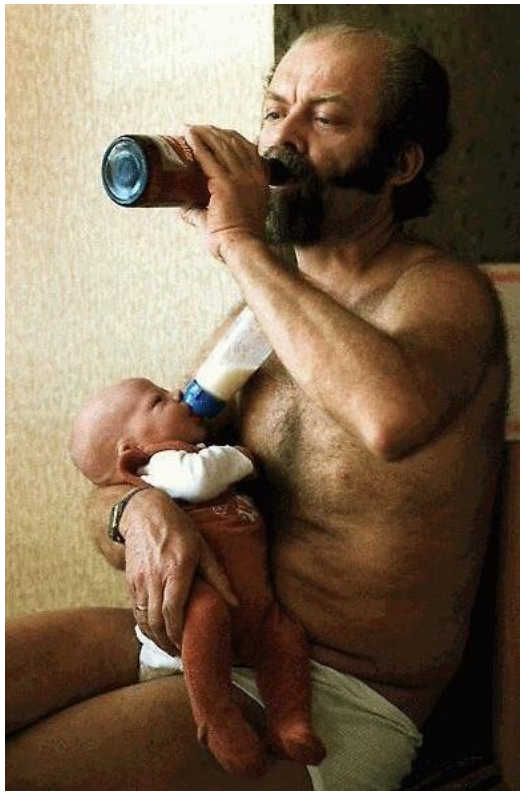
For more information, see poster P22



Conclusion 2

- Caseins are rapidly digested in the stomach compares to whey proteins but caseins fragments are still present in the ileum
- Are these findings compatible with the slow/fast proteins concept of milk???
- One of the key factor might be the ability of the caseins to coagulate in the stomach (depends on their concentration, buffering properties of the matrix…)
- Combination of *in vitro* and *in vivo* approaches are necessary to better understand the mechanisms of milk proteins digestion
- Diversity of analytical techniques allows a sharp characterization of the hydrolysis of proteins in different complexe media (food matrices, effluents…)

Improving infant formula for improving human life



Thanks for your kind attention !!!