

➤ Metabolic modelling deciphers interactions in a cheese bacterial community

Maxime Lecomte – INRAE/Inria

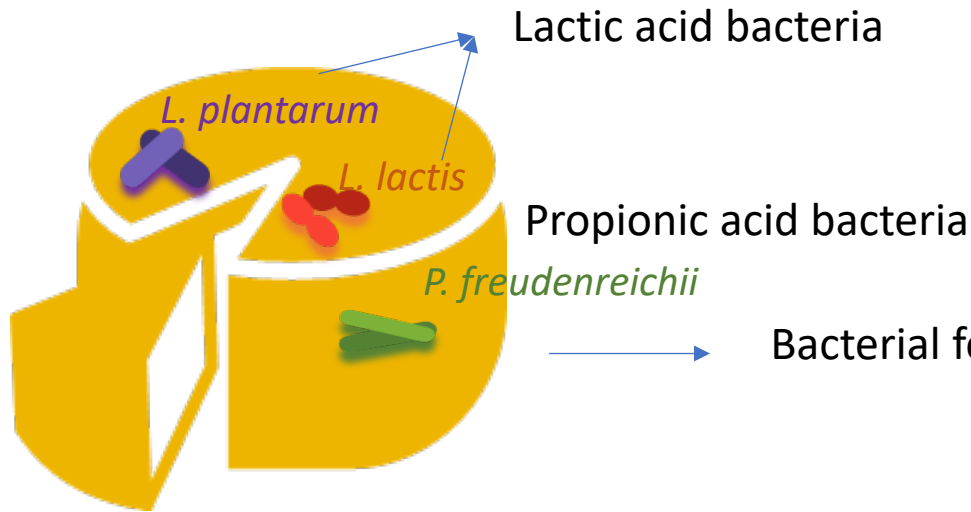
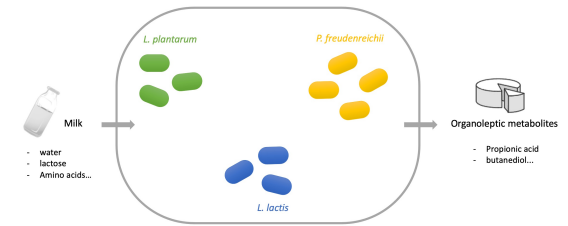
Hélène Falentin – INRAE

David Sherman – Inria

Clémence Frioux – Inria

Simon Labarthe – INRAE

➤ Cheese bacterial community



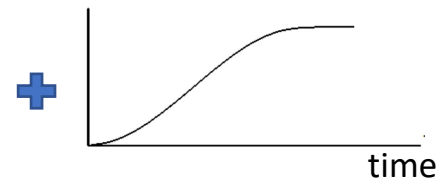
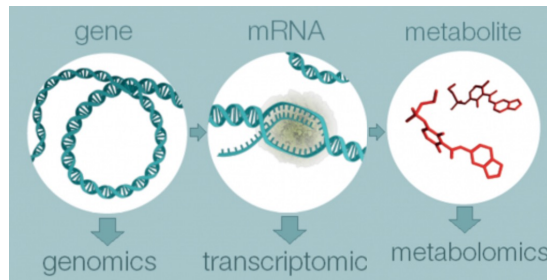
Bacterial fermentation

Organoleptic compounds = Aroma

Acidification

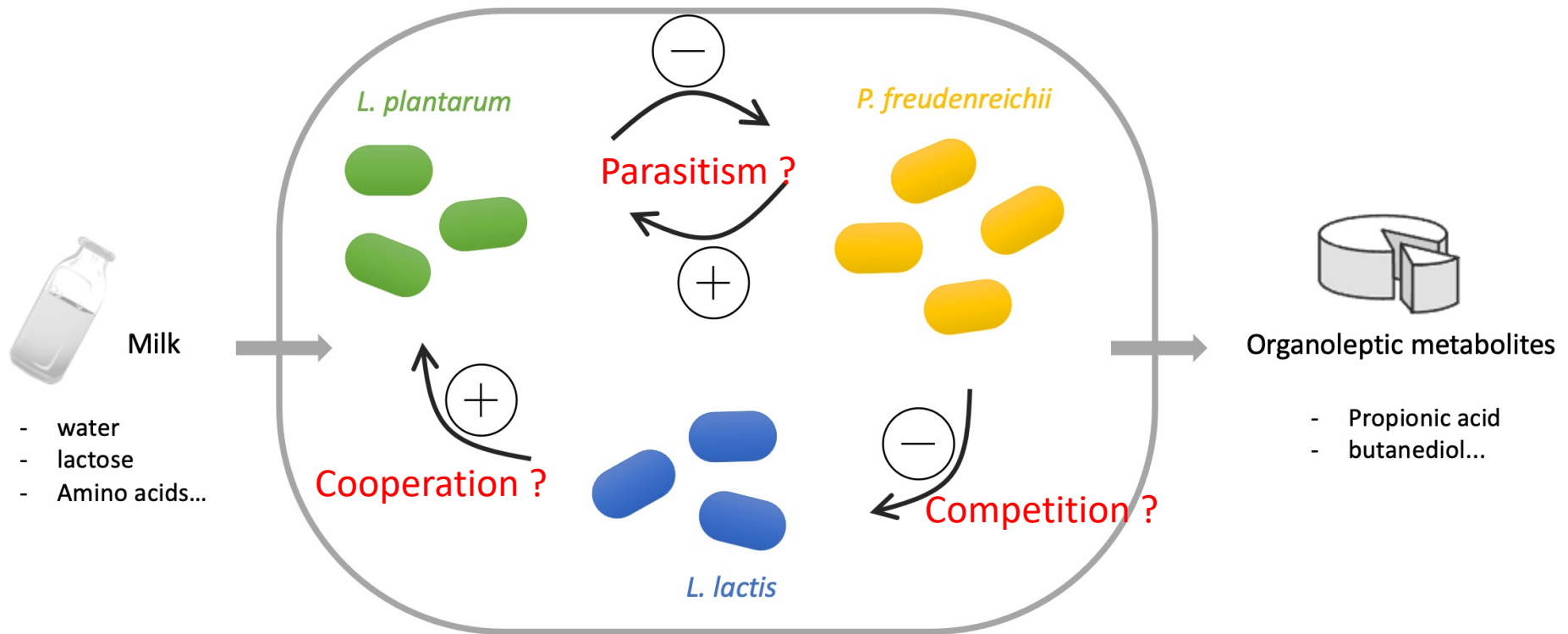
Production of :

- Lactic acid by lactic acid bacteria
- Propionic acid by propionic bacteria



Which elements are involved in the production of organoleptic compounds and responsible for the acidification ?

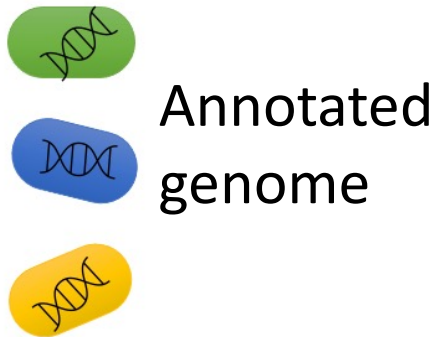
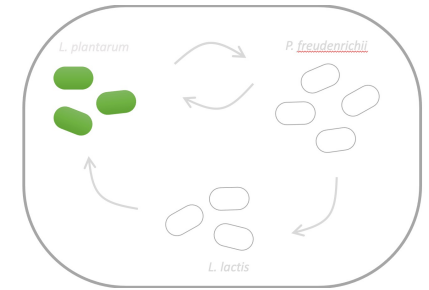
➤ Interactions are responsible for organoleptic metabolites production



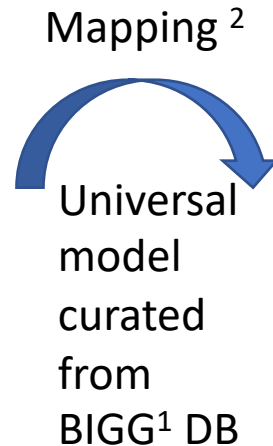
Metabolic modelling can describe these interactions and help us understand the underlying processes in the production of organoleptic compounds

➤ Link between genome and metabolism

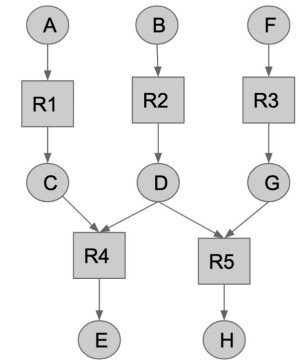
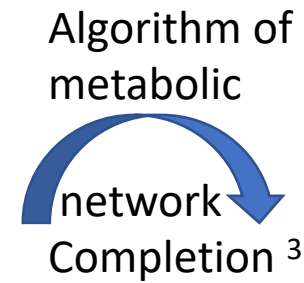
From Genome to GEM, a nontrivial process



Annotated genome



Metabolic network Draft



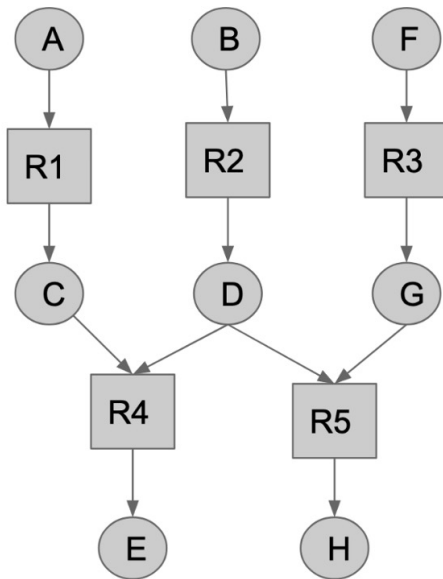
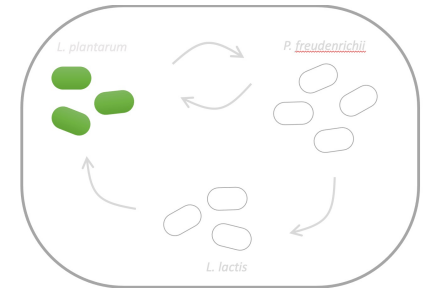
Describe all functions associated to each genome

¹ Zachary A. King et al, 2016

² Machado et al, 2018

³ Thiele I, Palsson BØ, 2010 – Frioux et al, 2018

➤ Flux balance analysis (FBA) calculates optimal growth in a metabolic network under a series of flux constraints



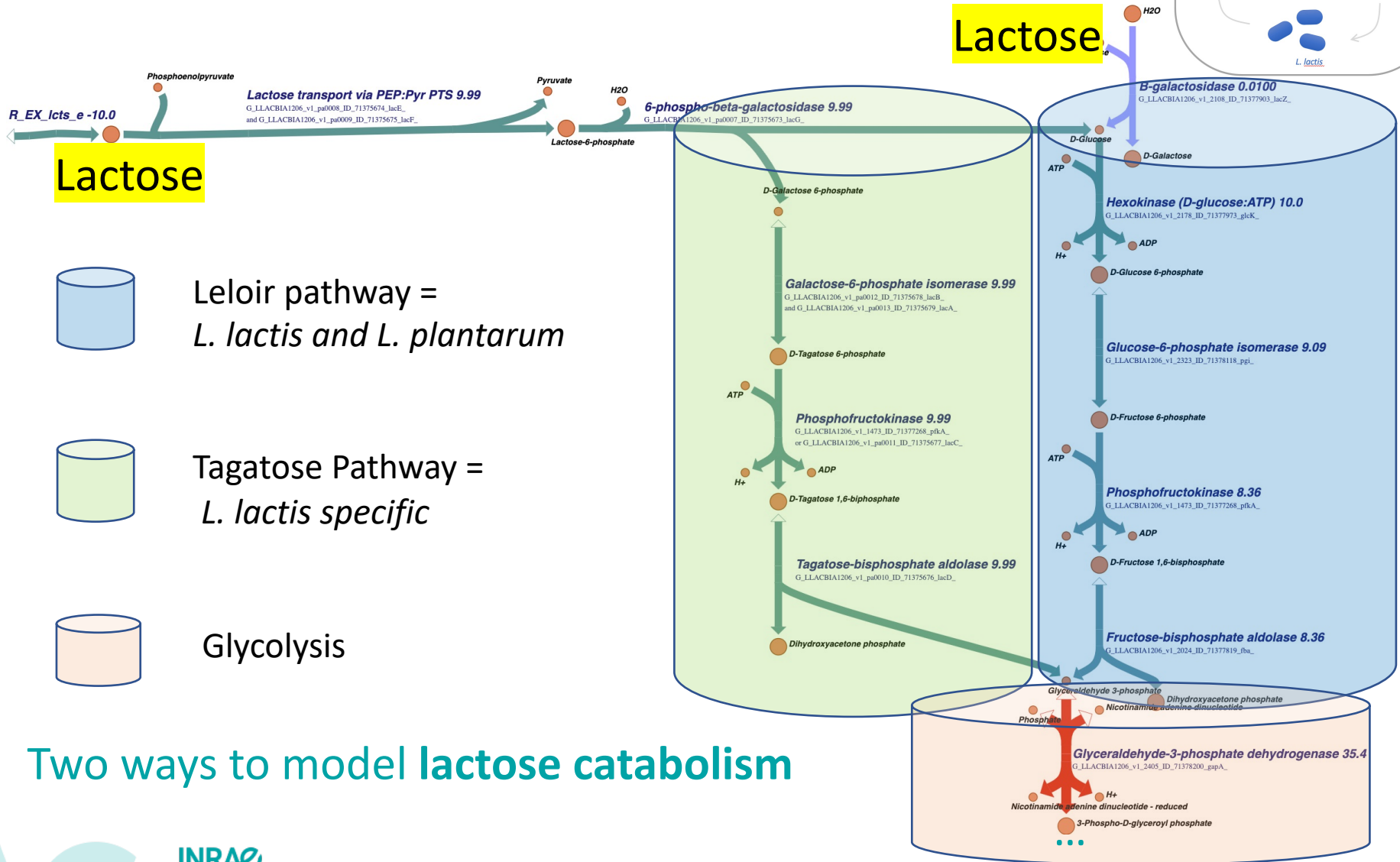
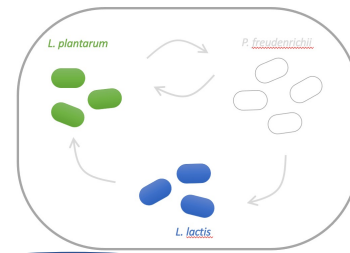
Construction of the stoichiometry matrix

	A	B	C	D	E	F	G	H
R1	-1	0	1	0	0	0	0	0
R2	0	-1	0	1	0	0	0	0
R3	0	0	0	0	0	-1	1	0
R4	0	0	-1	-1	1	0	0	0
R5	0	0	0	-1	0	0	-1	1

Metabolism simulation with FBA represents the quantity of molecules transformed through a metabolic pathway



Lactose consumption by lactic acid bacteria



Lactose

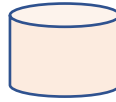
Lactose



Leloir pathway =
L. lactis and *L. plantarum*



Tagatose pathway =
L. lactis specific



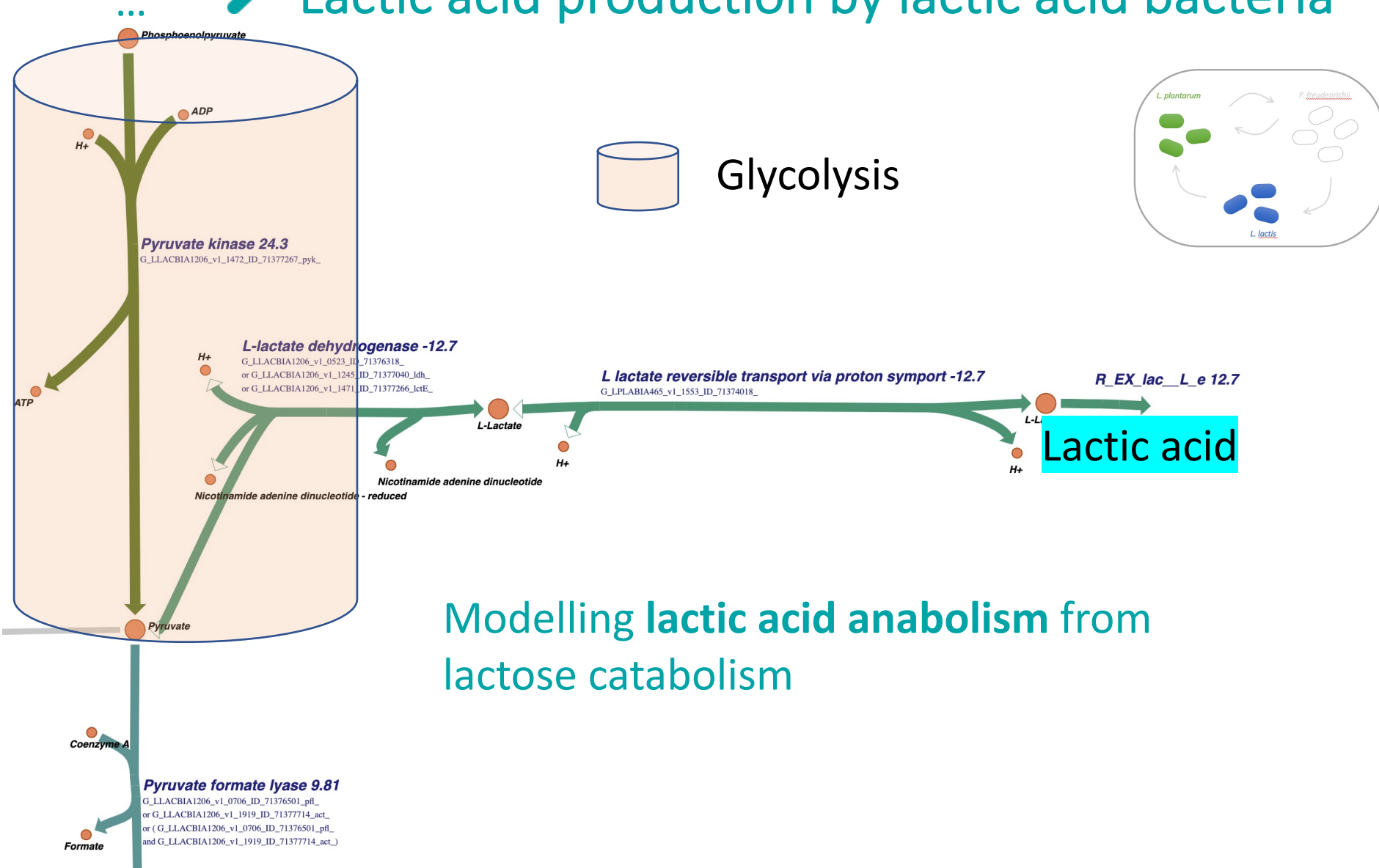
Glycolysis

Two ways to model lactose catabolism

Lactose

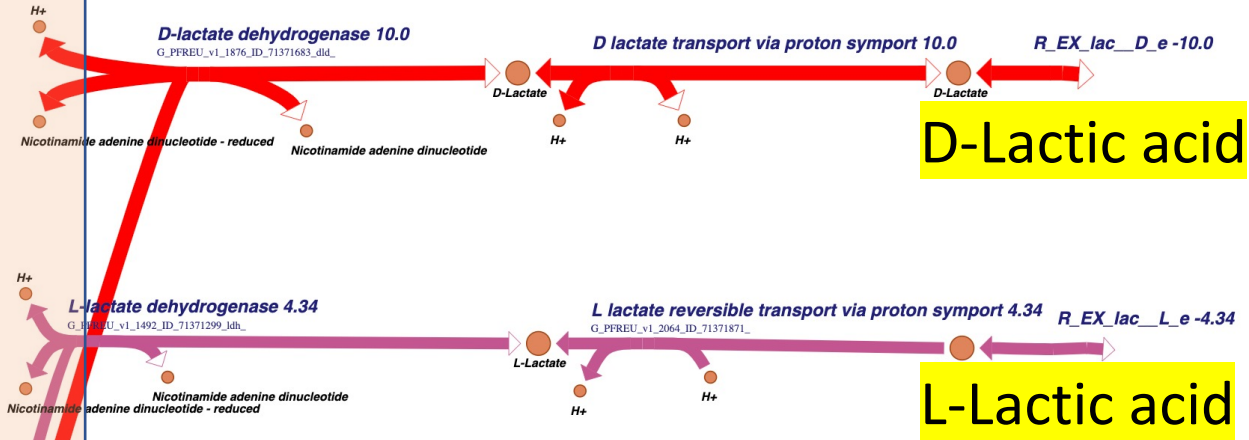
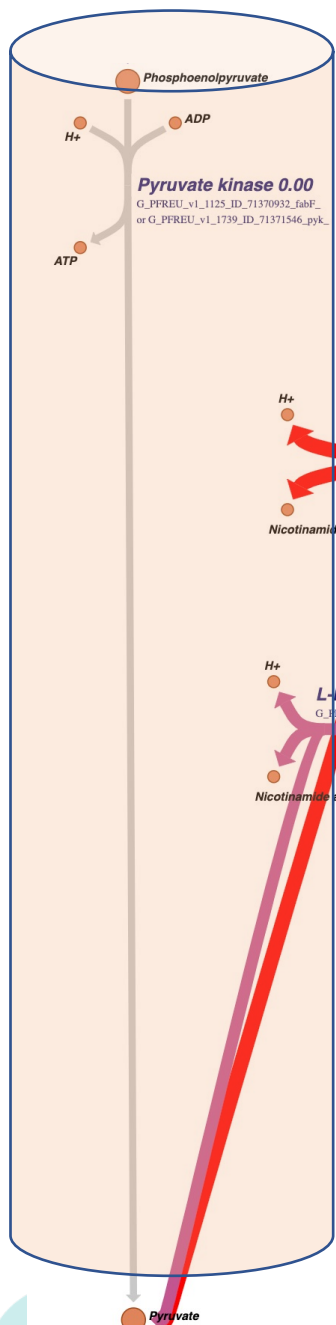
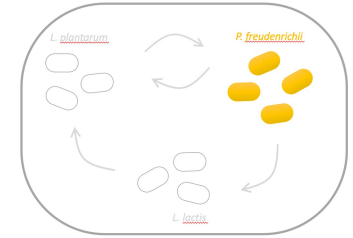


Lactic acid production by lactic acid bacteria



Modelling lactic acid anabolism from lactose catabolism

➤ Lactic acid consumption by *P. freudenreichii*



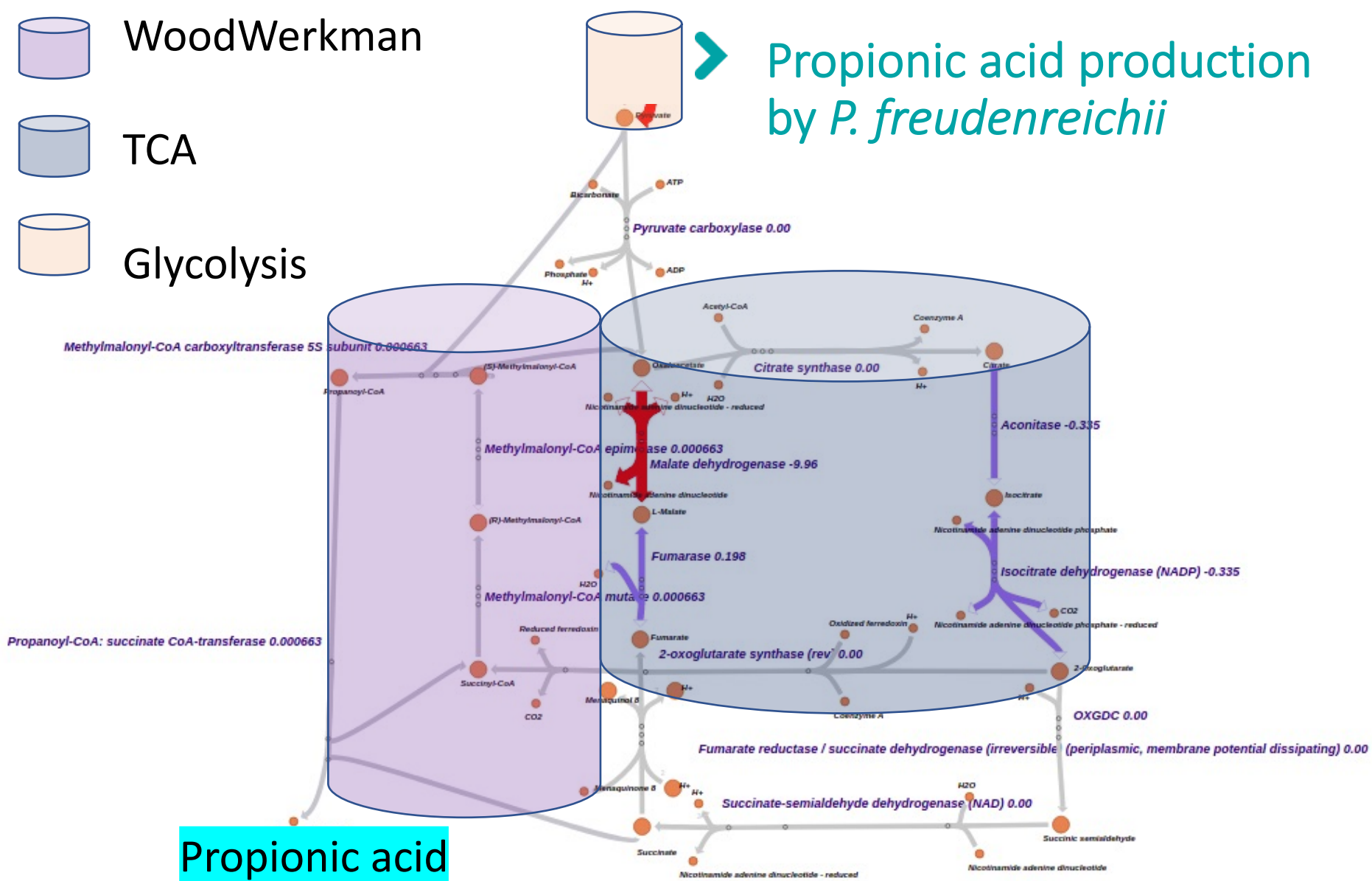
Modelling lactic acid catabolism

WoodWerkman

TCA

Glycolysis

Propionic acid production by *P. freudenreichii*



Propionic acid

Modelling propionic acid anabolism

INRAE

Metabolic modelling of a bacterial community involved in the organoleptic qualities of a cheese

2021 march 23rd / INRAE-Inria / Maxime Lecomte

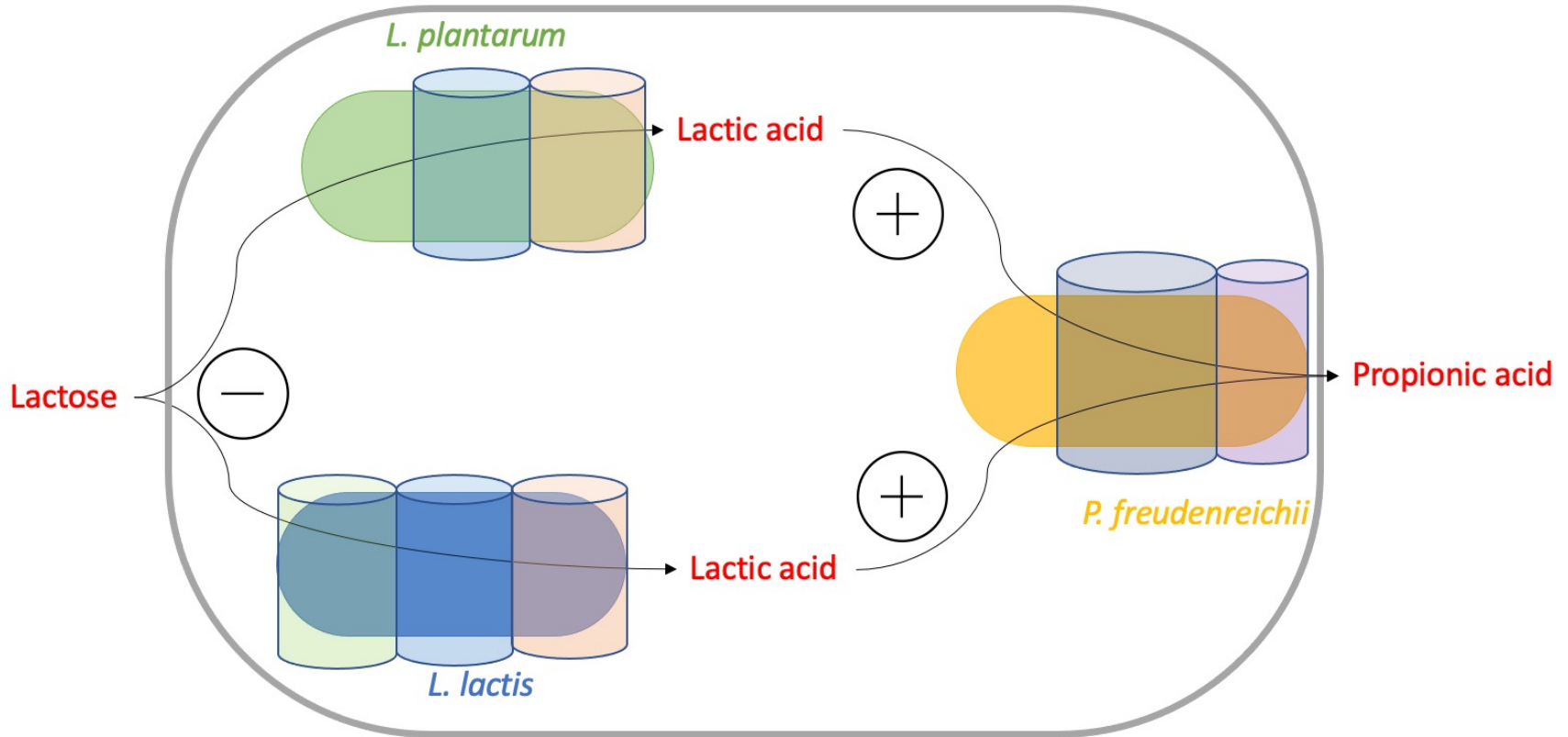
Interaction highlighted at community scale

Methods **without a priori knowledge**:

M2M¹

Smetana²

Three metabolic networks



We found the same interactions

INRAE

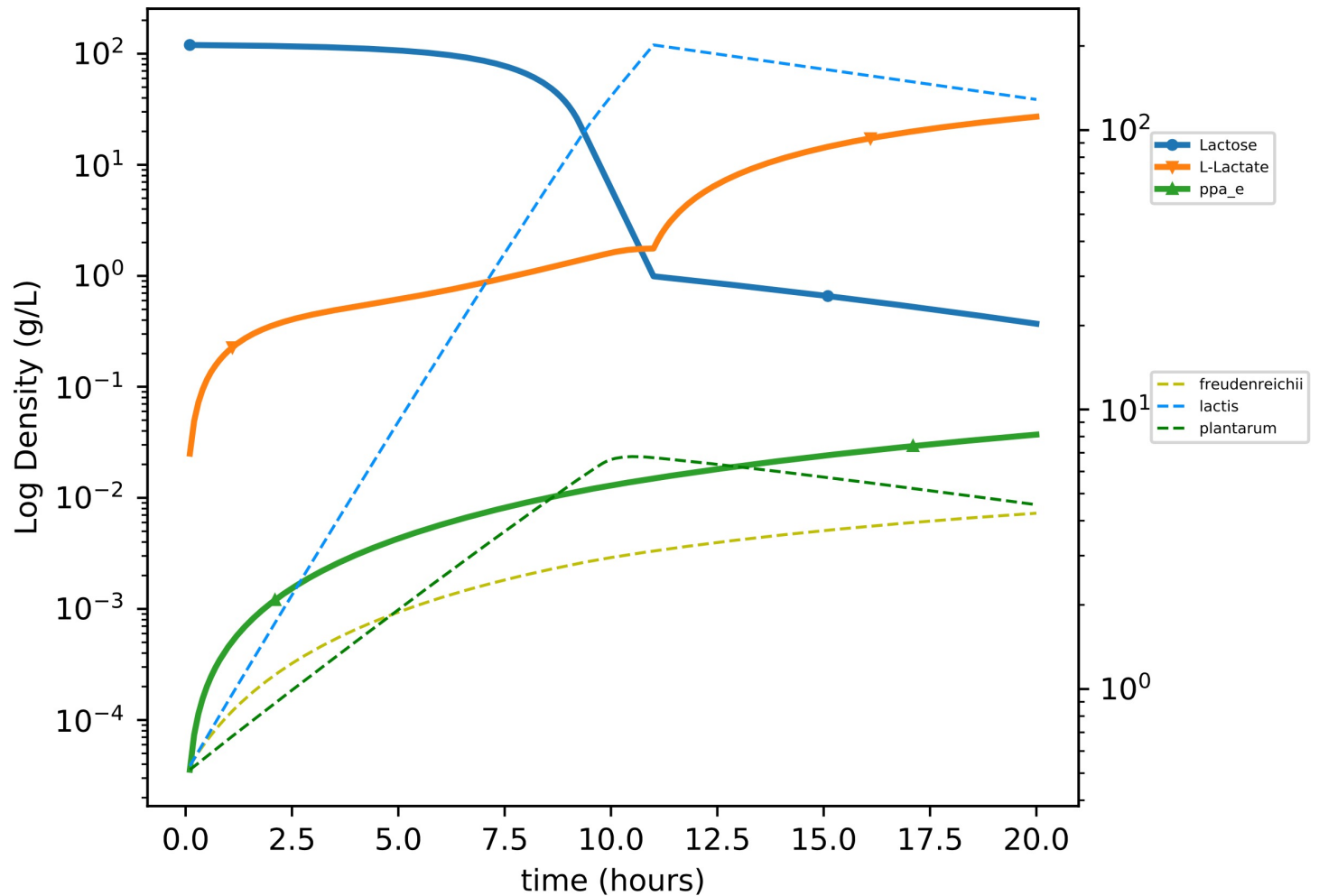
Metabolic modelling of a bacterial community involved in the organoleptic qualities of a cheese
2021 march 23rd / INRAE-Inria / Maxime Lecomte

¹ Belcour et al, 2020

² zelezniak et al, 2015

➤ Temporal data integration

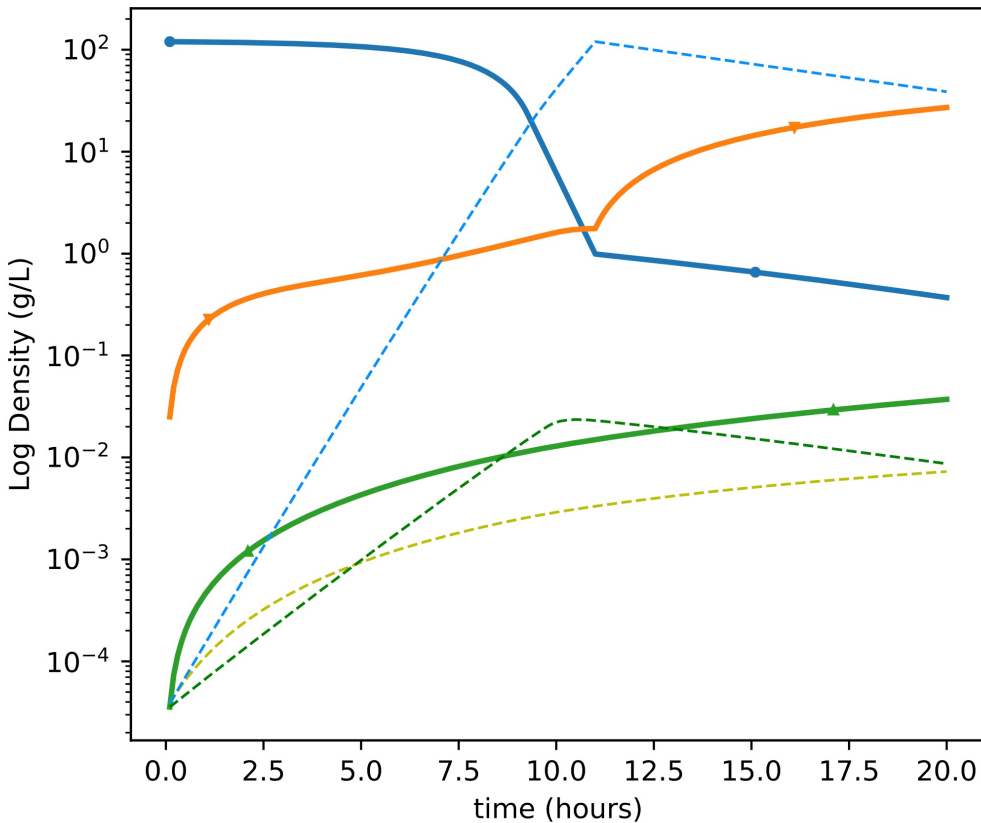
Bacterial growth



Follow
interest
compounds
in time

➤ Future work

Bacterial growth



- Fitting data with metabolomics data (temporal data) → improve precision

- Constraint with meta-transcriptomic data (more accurate predictions)

- Expand to other organoleptic compounds

Thanks for your attention !