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Smart design of functional fermented dairy foods

Gwénaél Jan

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AGRO
CAMPUS
OUEST



Smart design of functional fermented dairy foods



STLOpen Days
19-21 March 2019



Gwénaél JAN - Microbio



Food quality & safety



Develop safe, healthy, sustainable and hedonic fermented foods



Food spoilage



Reduce health risks and food losses and waste



The cheese matrix as a delivery vehicle for probiotics bacteria

Animal health



Offer alternatives to antibiotic treatments (probiotics)



Health & wellbeing



Develop functional and designer food against modern lifestyle diseases

Driving functionality

→ through matrices



→ this talk

→ through processes



→ earlier

The concept of « 2-in-1 » bacteria

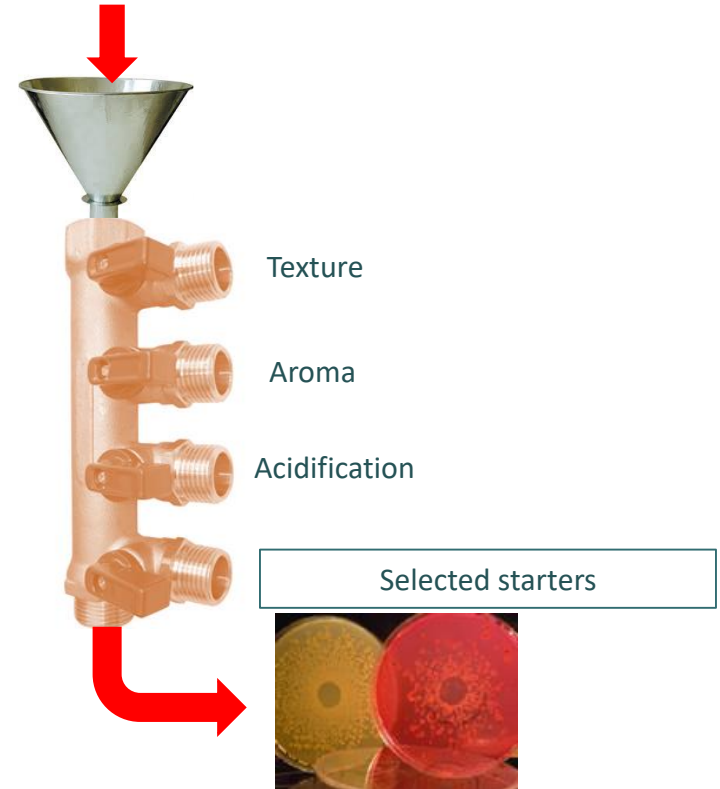


And now we select the bacteria

The technological pathway use to select the bacteria



Historically without added starter!!!!



Texture

Aroma

Acidification

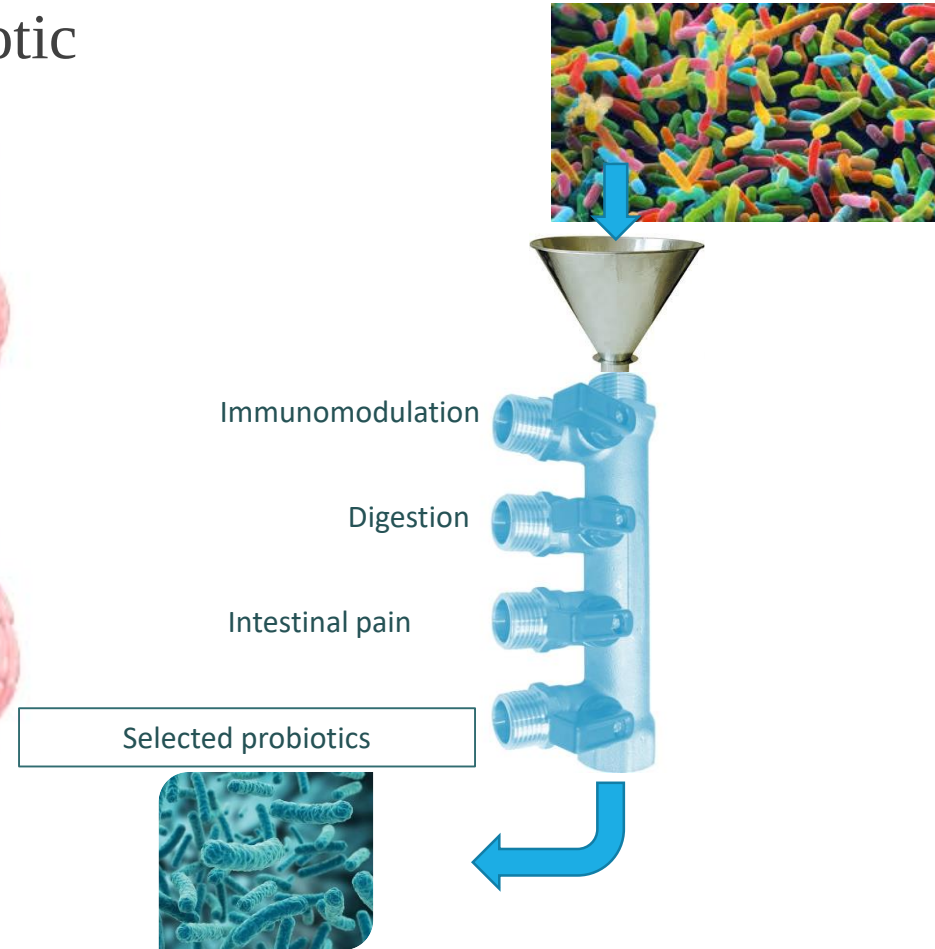
Selected starters



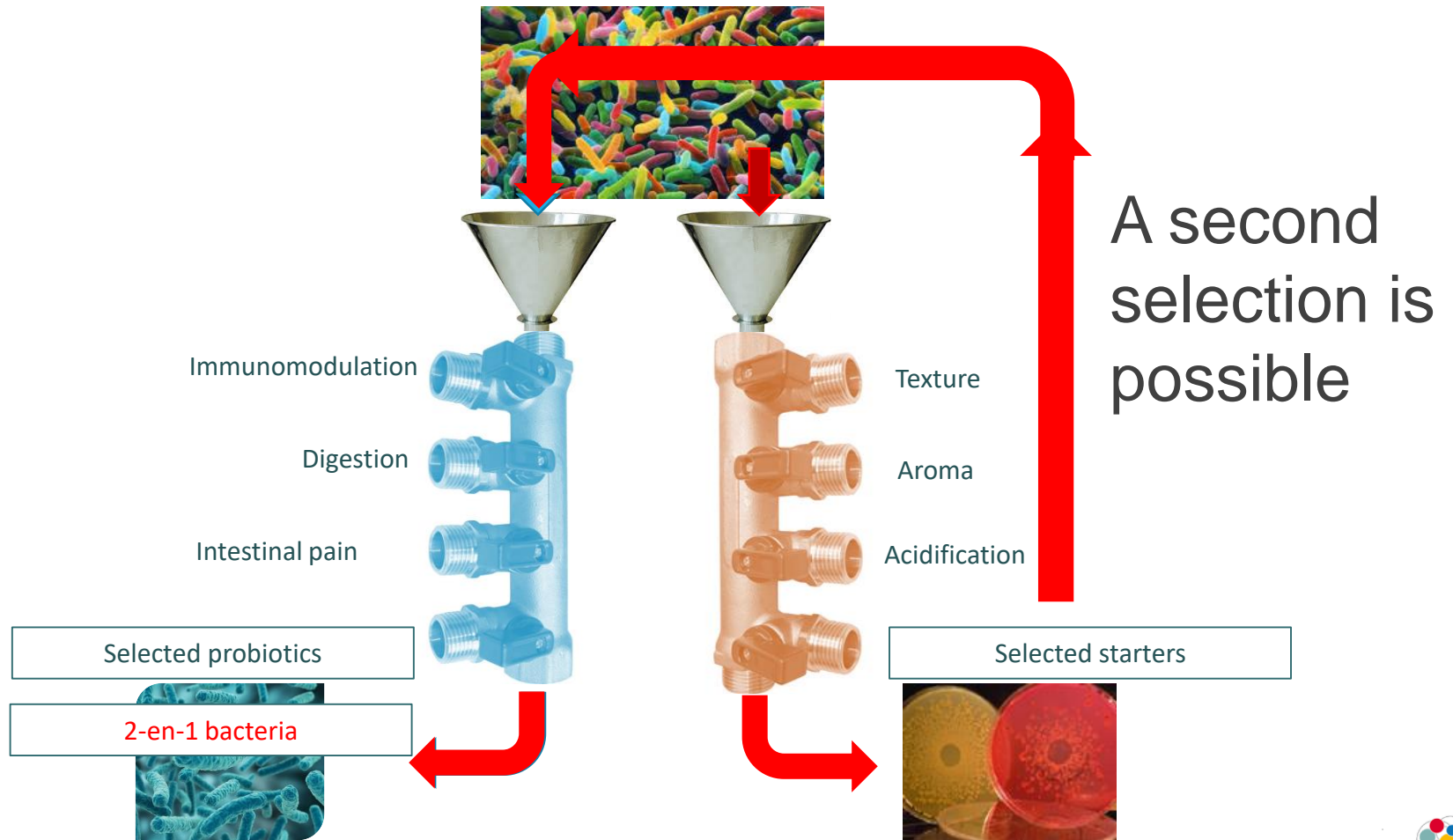
The concept of « 2-in-1 » bacteria

Other bacteria are selected for probiotic properties

IBS, IBD, atopy, intolerance ...



The concept of « 2-in-1 » bacteria



« 2-in-1 » propionibacteria

Anti-inflammatory properties



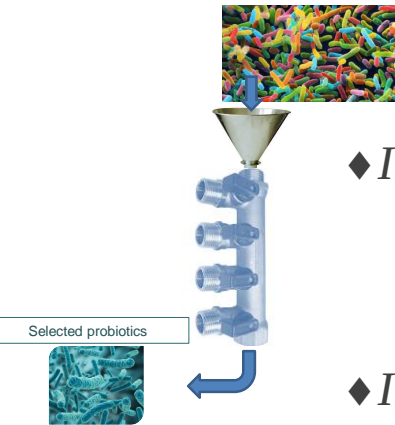
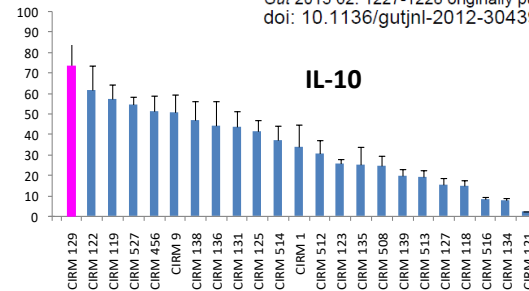
Propionibacterium freudenreichii



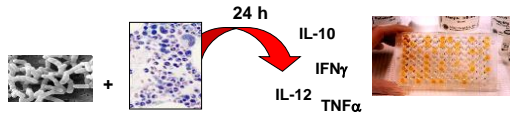
Tracking the microbiome functionality: focus on Propionibacterium species

Benoit Foligné, Jérôme Breton, Denis Mater, et al.

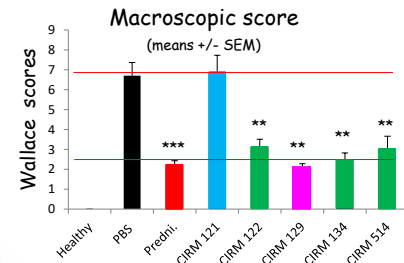
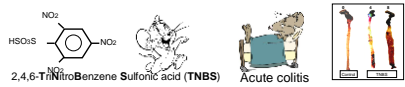
Gut 2013 62: 1227-1228 originally published online February 6, 2013
doi: 10.1136/gutjnl-2012-304393



◆ *In vitro*



◆ *In vivo*



APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2010, p. 8259-8264
0099-2240/10/\$12.00 doi:10.1128/AEM.01976-10
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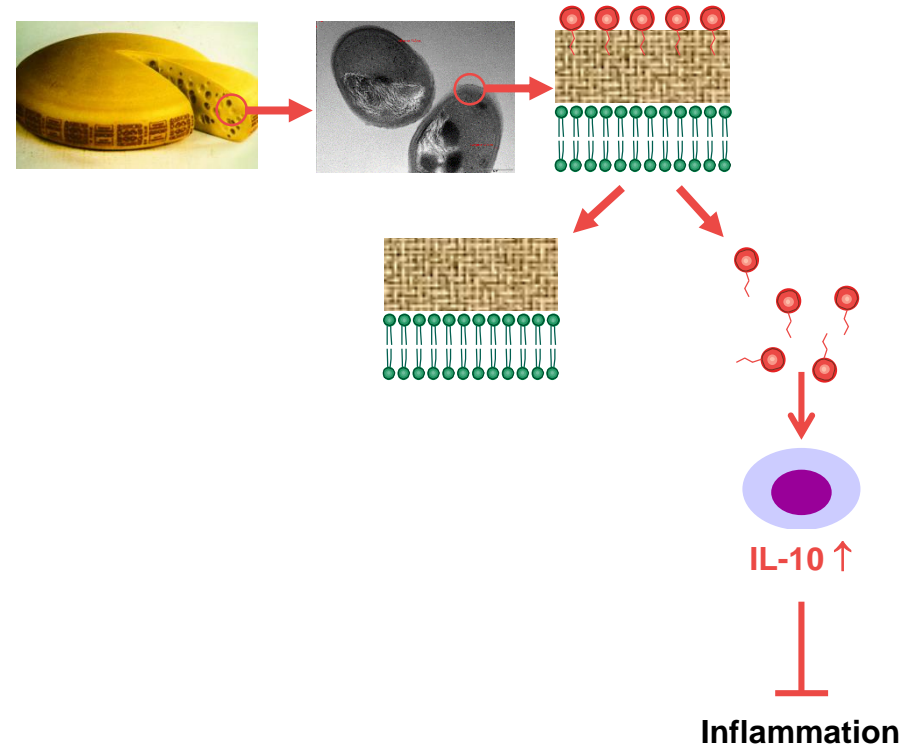
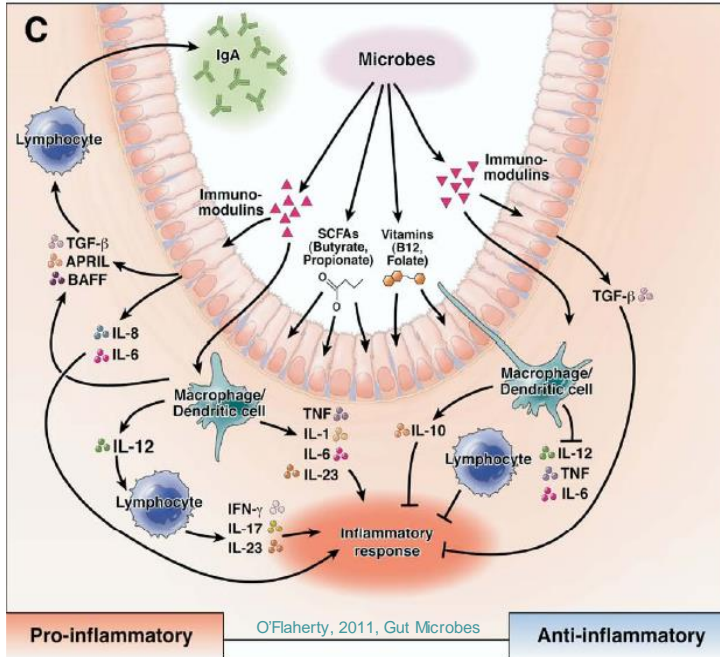
Vol. 76, No. 24

Promising Immunomodulatory Effects of Selected Strains of Dairy Propionibacteria as Evidenced *In Vitro* and *In Vivo*[†]

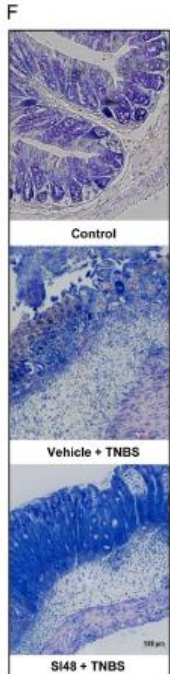
Benoit Foligné,^{1,2,3,4} Stéphanie-Marie Deutsch,^{5,6} Jérôme Breton,^{1,2,3,4} Fabien J. Cousin,^{5,6,7} Joëlle Dewulf,^{1,2,3,4} Michel Samson,⁸ Bruno Pot,^{1,2,3,4} and Gwénaél Jan^{5,6*}



A key role of propionibacteria surface proteins



Other « 2-in-1 » bacteria



APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2010, p. 8259-8264
 0099-2240/10/\$12.00 doi:10.1128/AEM.01976-10
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 Joëlle Dewulf,^{1,2,3,4} Michel Samsoum^{1,2,3,4}



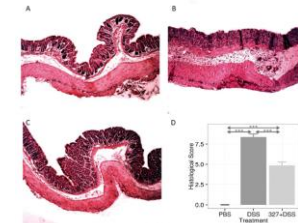
Let's make probiotic cheese!!!

OPEN ACCESS Freely available online



Local and Systemic Immune Mechanisms Underlying the Anti-Colitis Effects of the Dairy Bacterium *Lactobacillus delbrueckii*

Clarissa Santos Rocha^{1,3,4}, Ana Cristina Gomes-Santos², Thais Garcias Moreira², Marcela de Azevedo¹,
 Tessalia Diniz Luerce¹, Mahendra Mariadassou⁵, Ana Paula Longaray Delamare⁶, Philippe Langella^{3,4},
 Emmanuelle Maguin^{3,4}, Vasco Azevedo¹, Ana Maria Caetano de Faria², Anderson Miyoshi^{1*},
 Maarten van de Guchte^{3,4,*}



A reverse-engineered 2-strains cheese



Microfiltr. Milk

↓
Powder 100 g/L

↓
Cream 150 g/L

↓
Sterilisation

↓
Culture *P. freudenreichii*
30°C, 72 h

↓
Pre-cheese

UHT Milk

↓
Culture *L. delbrueckii*
42°C, 4 h

↓
Fermented Milk



↓
Clotting, stirring, cooking, moulding,
pressing, wrapping, ripening

Mol. Nutr. Food Res. 2016, 60, 935–948

Molecular Nutrition
Food Research

935

RESEARCH ARTICLE

**Combining selected immunomodulatory
Propionibacterium freudenreichii and *Lactobacillus delbrueckii* strains: Reverse engineering development of an anti-inflammatory cheese**

Coline Plé¹, Jérôme Breton¹, Romain Richoux², Marine Nurdin², Stéphanie-Marie Deutsch^{3,4},
Hélène Falentin^{3,4}, Christophe Hervé⁵, Victoria Chuat^{3,4,6}, Riwanon Lemée⁵,
m^{3,4}, Maarten Van de Guchte^{7,8} and Benoit Foligné¹



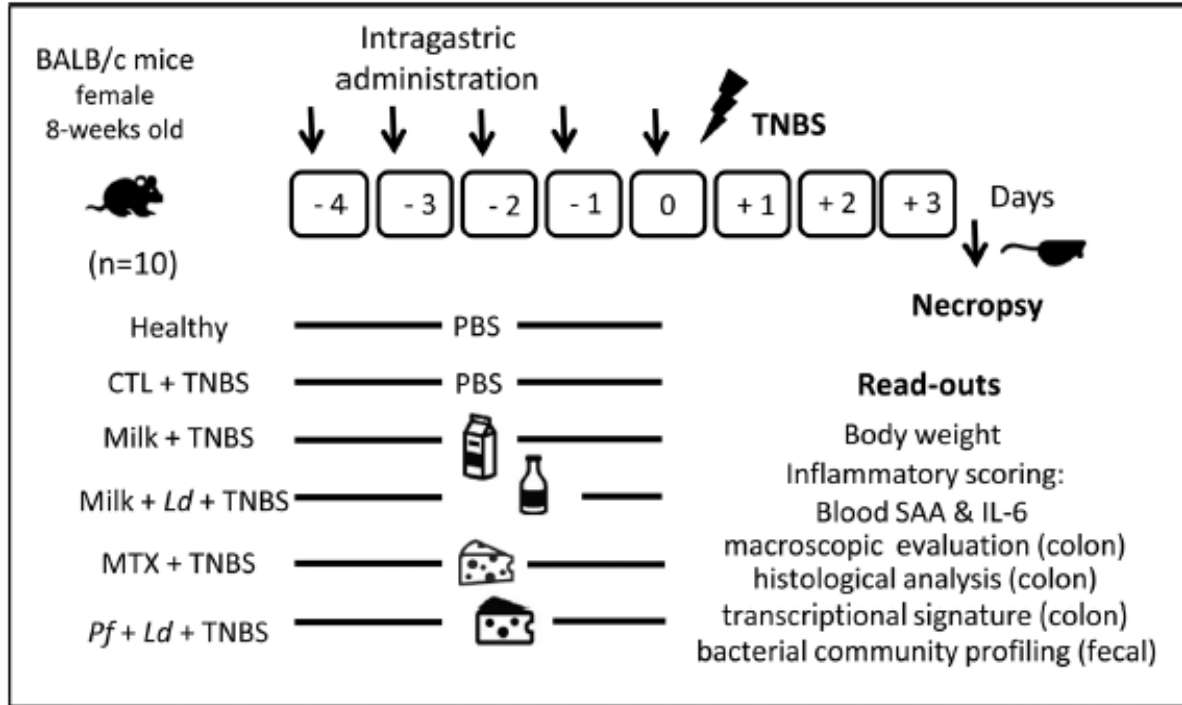
Dairy Platform



Starter Surface
against Inflammation of the Gut

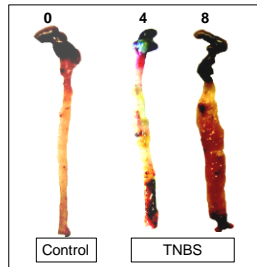


A reverse-engineered 2-strains cheese challenged *in vivo*

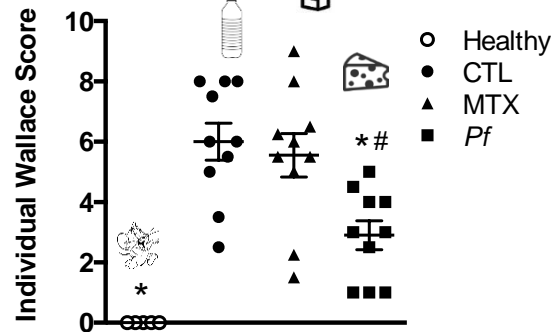
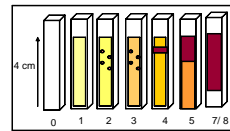


A reverse-engineered 2-strains cheese protects from colitis

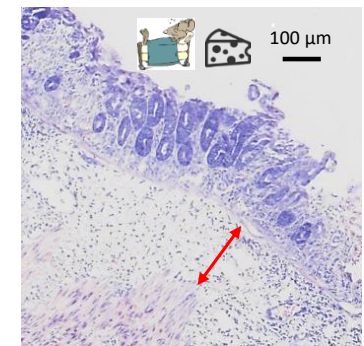
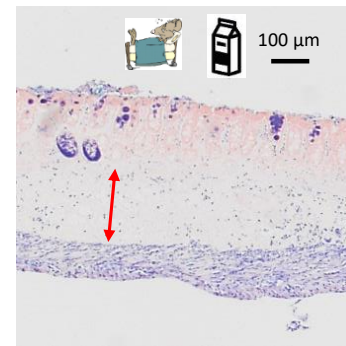
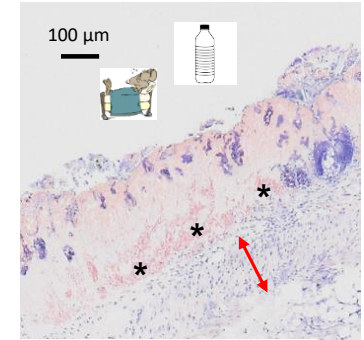
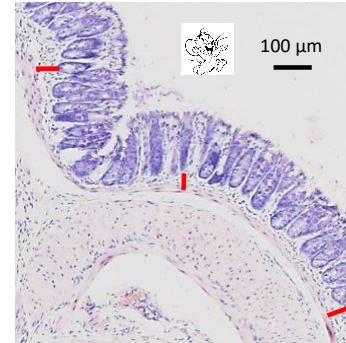
Macroscopic level



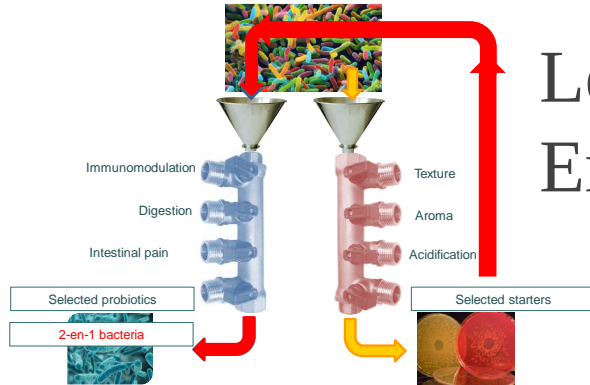
Macroscopic score (Wallace)



Microscopic level



But it is still a lab cheese!



Let's make a real
Emmental cheese!

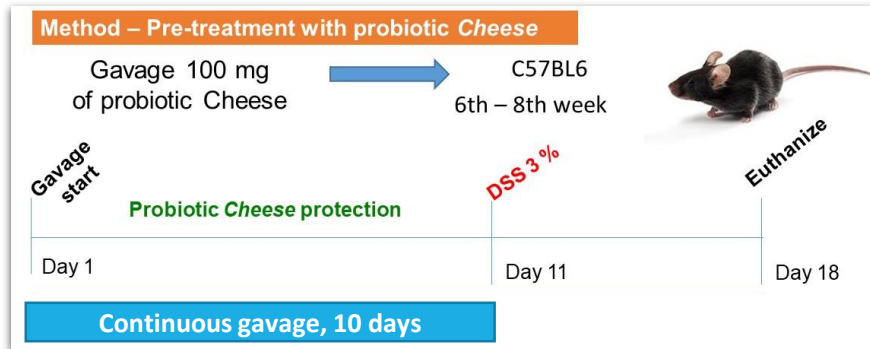
Propionibacterium freudenreichii

Streptococcus thermophilus

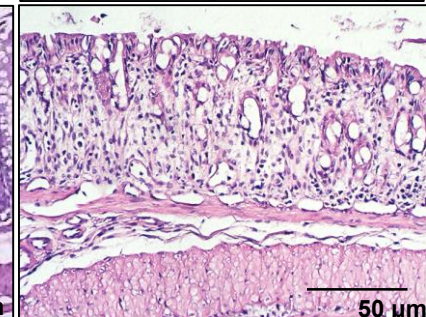
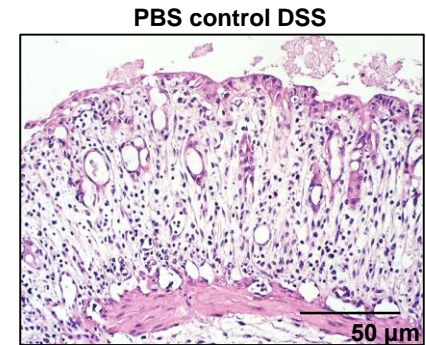
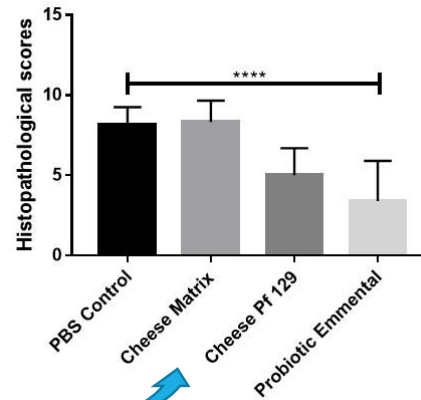
Lactobacillus delbrueckii



This Emmental cheese protects from colitis



Probiotic Emmental x Colitis



Noninflamed control

Probiotic Emmental

Another example of application: fighting mucositis

GI inflammatory diseases

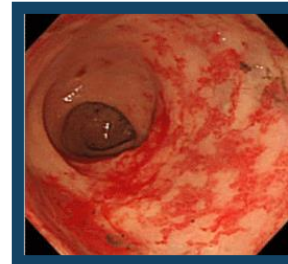
IBD

- GIT Chronic inflammation

Ulcerative
Colitis



Mucositis



GI Mucositis



Oral mucositis

5-Fluoracil (5-FU)

- Head, neck and colon cancer.

(Chang *et al.*, 2012; Falvey *et al.*, 2015)



Another example of application: fighting mucositis

→ NO CURE AVAILABLE

IBD available treatment

Mucositis available treatment

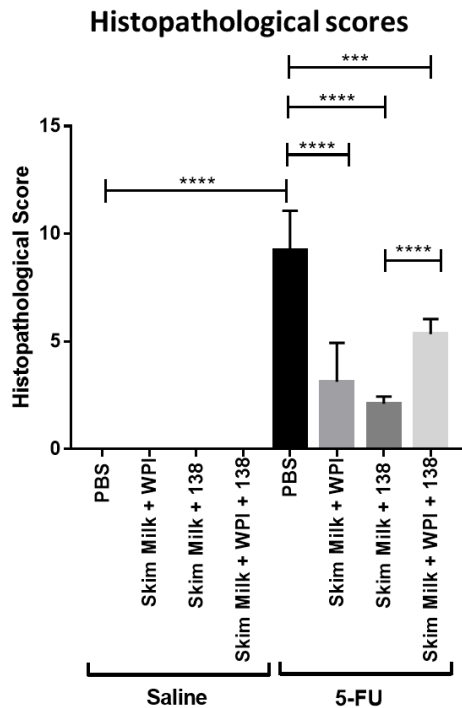
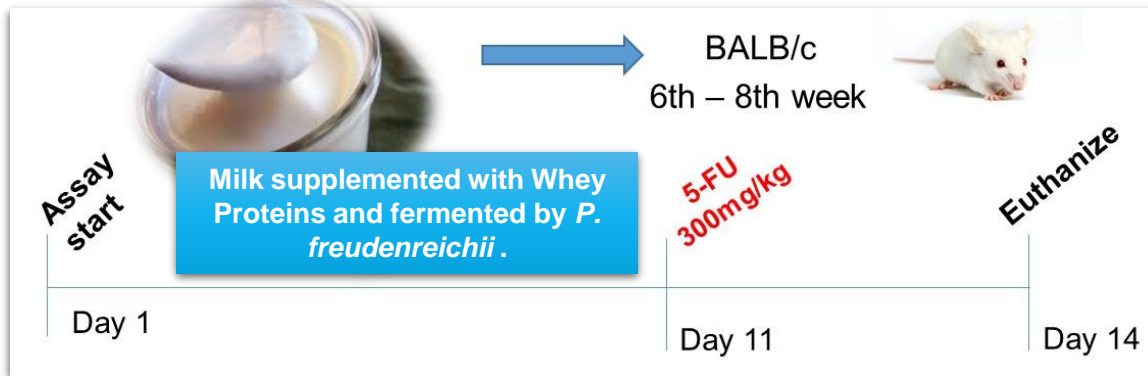
- Treatment for **mucositis** and **IBD** are limited;
- Development of **new therapies** is **necessary**.

Strong side effects!!!

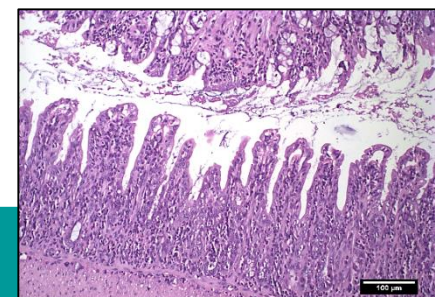
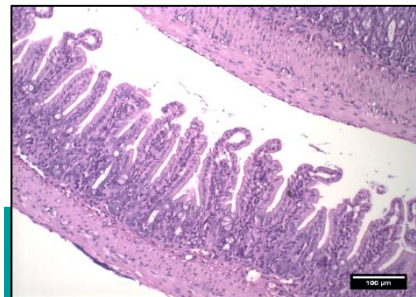
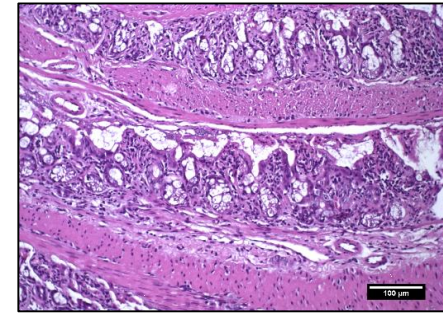
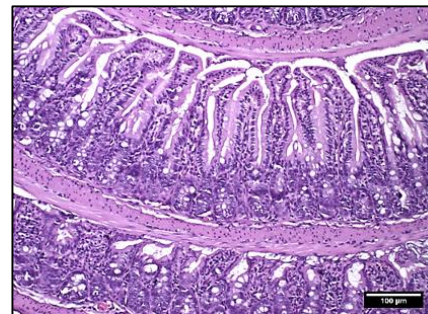
Temporary benefit!!!



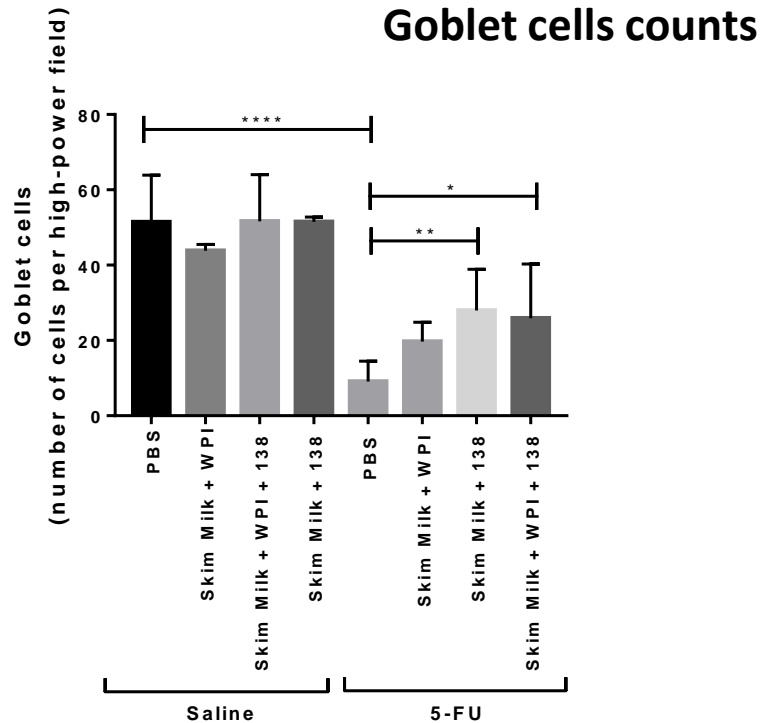
Fermented milk protects from mucositis



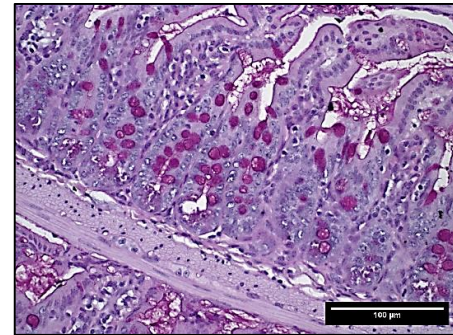
Representative images from mucosal histopathology (H&E)



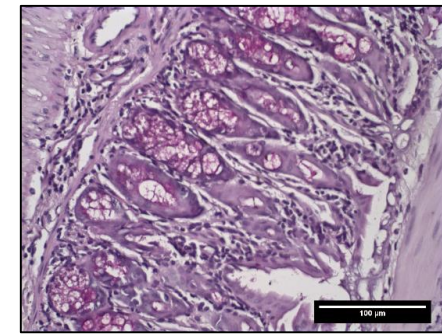
Fermented milk preserves mucus



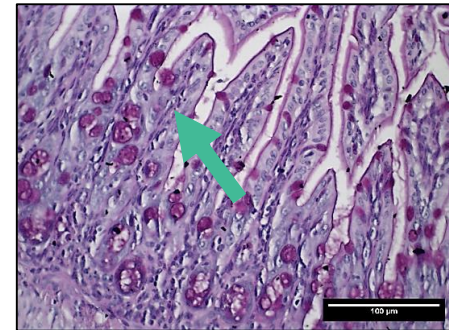
Representative images of stained goblet cells (PAS)



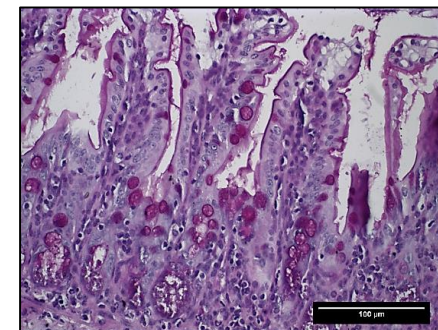
Healthy Ileum



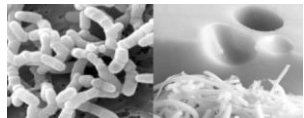
PBS + 5FU



LDF + 138 + 5FU



LDFWPI + 138 + 5FU



Conclusion:

- ✓ Fermented foods: a source of immunomodulatory bacteria
- ✓ Molecules and strains involved are being identified

Perspectives :

- ✓ Preclinical and clinical studies with fermented products
- ✓ Fermented food for specific populations



STLO



Benoit Foligné

Institut Pasteur de Lille



UFMG
UNIVERSIDADE FEDERAL DE MINAS GERAIS



Vasco Azevedo



Houem Rabah

Song Huang

Fillipe Rosa do Carmo



Thank you for your attention

Don't ask tough questions

THANK YOU FOR YOUR ATTENTION



Valorial
OSONS L'ALIMENT PLUS INTELLIGENT



Agence Nationale de la Recherche
ANR

ID2Santé
Innovation and Development of the health Sector in BRETAGNE



STLOpen Days
19-21 March 2019

Please visit http://www.rennes.inra.fr/stlo_eng