



INRAE



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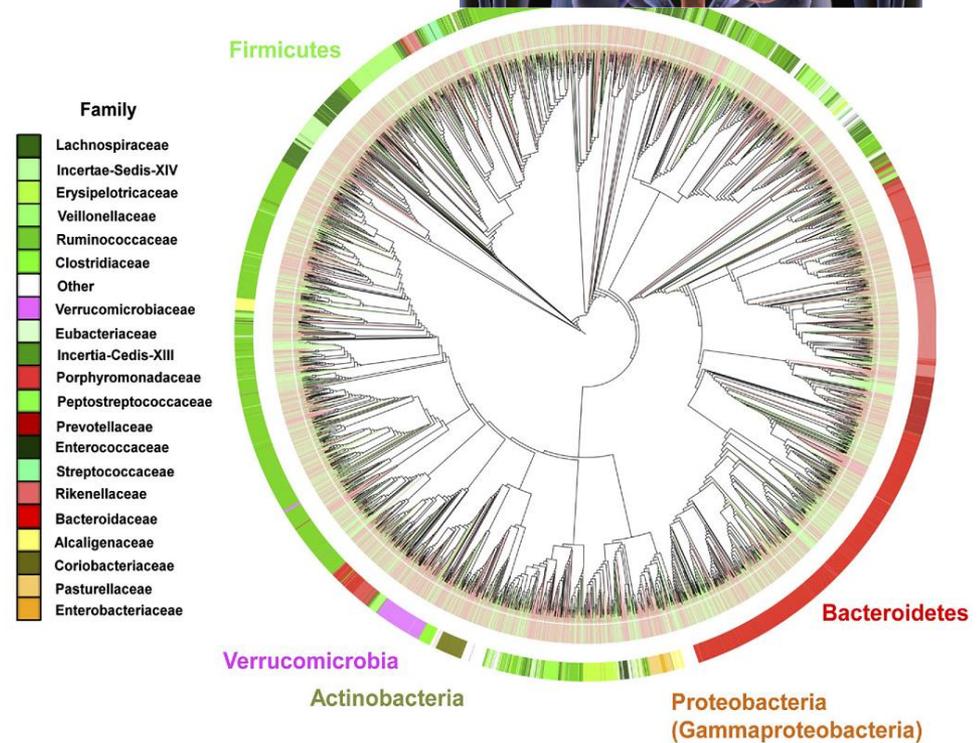
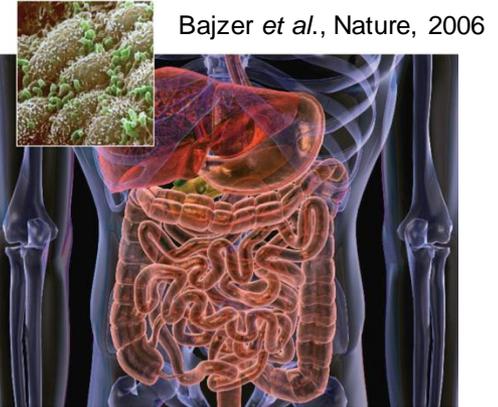
➤ *Importance of the microbiota and
how GI can contribute*

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➤ Gut microbiota – composition

- Human intestine contains about 1.2 kg of bacteria
- Very high bacterial numbers (10^{14} bacteria), 10x more than eukaryotic cells in the body
- >1000 different, mostly strict anaerobic species of which many are not yet identified
- Represented by the 5 main phyla: Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria, Verrucomicrobia

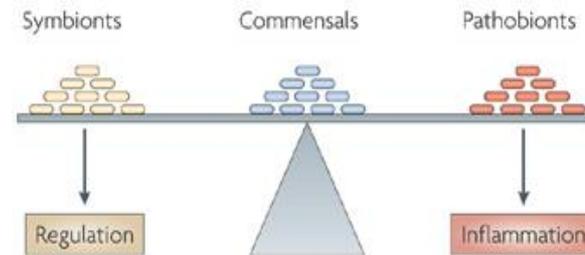


Saulnier *et al.*, Gastroenterology, 2011

➤ Intestinal health: A question of balance

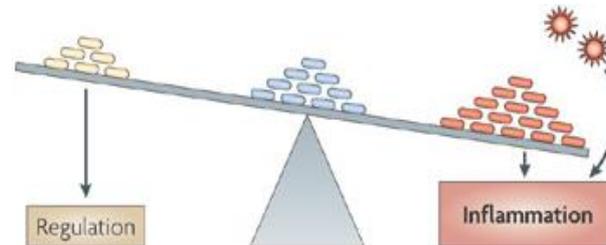
Eubiosis:

The state in which a microbiota interacts with its host in an equilibrated manner

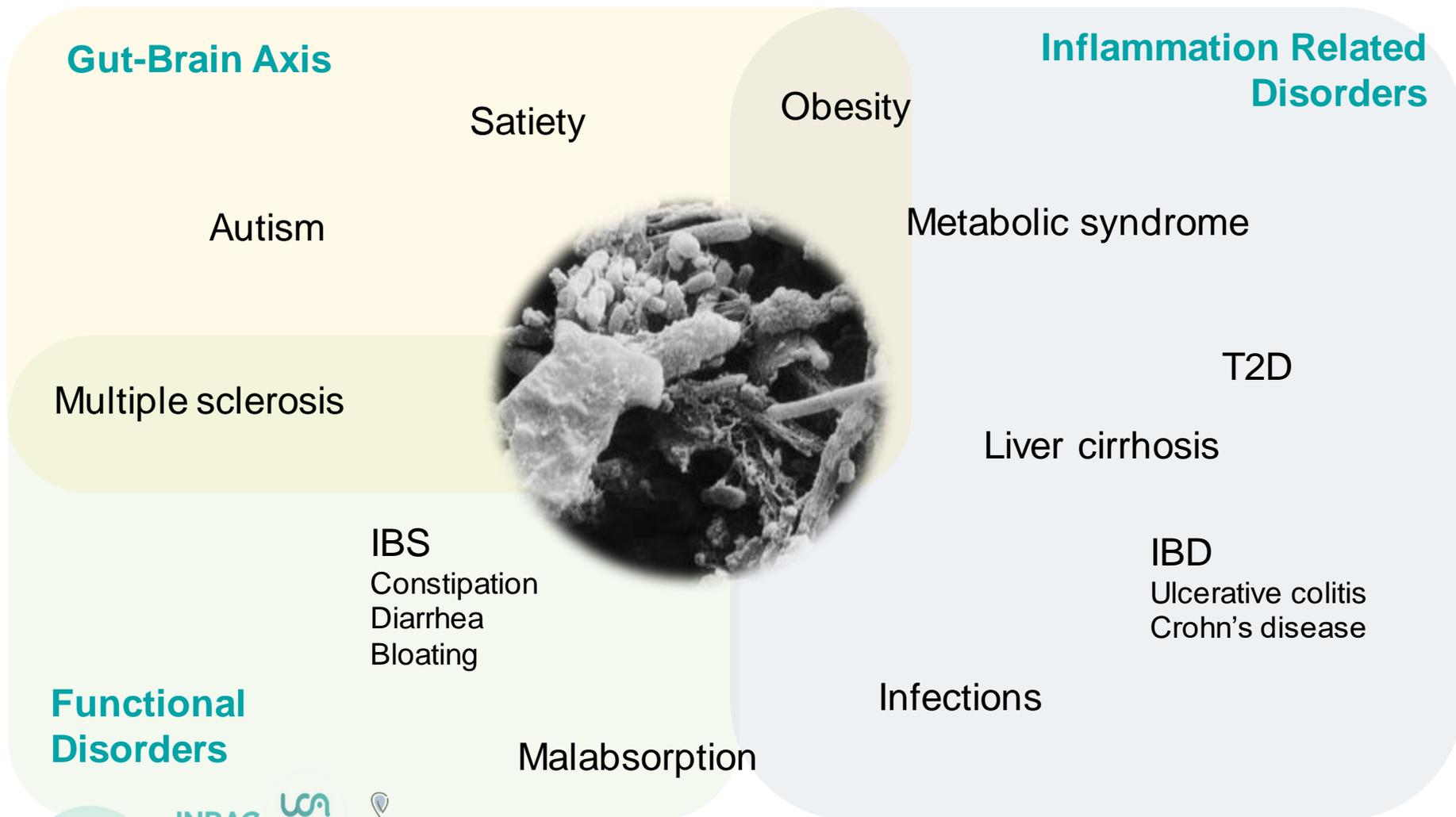


Dysbiosis:

Alteration of the microbiota in comparison to the normal, healthy state.



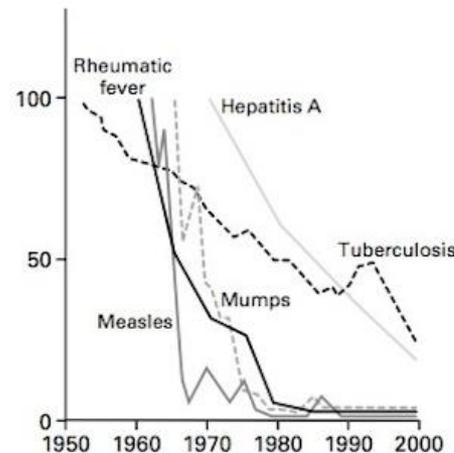
➤ Dysbiosis associated diseases



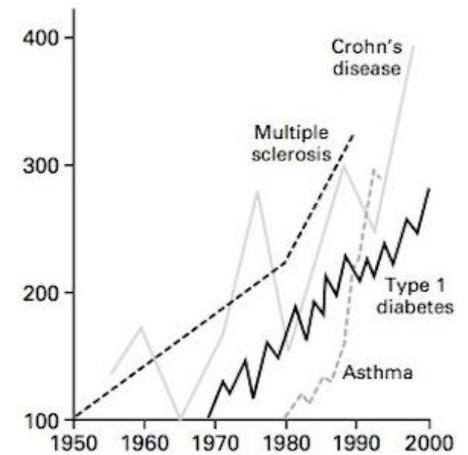
➤ Hygiene Hypothesis and the microbiota

- Modern lifestyle associated with increase in immune diseases
- Less exposure to environmental factors/microbes

Infectious diseases

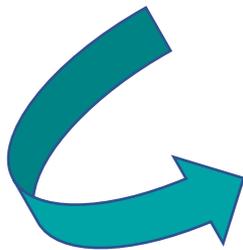


Immune diseases



Bach NEJM 2002

Effect on the intestinal microbiota?



Fermented food, dairy fermented food?
Cheese providing a complex food microbiota?
PDO Cheese?

➤ Cheese microbiota composition and diversity

Lactic acid bacteria/Starters

(Firmicutes)

Lactobacillaceae

Enterococcaceae

Streptococcaceae

Leuconostocaceae

Ripening bacteria

(Actinobacteria, Firmicutes)

Propionibacteriaceae

Staphylococcaceae

Brevibacteriaceae

Corynebacteriaceae

Gram negative bacteria

(Proteobacteria, bacteroidetes)

Eukaryotes

(Fungi, Yeast)



What are the health benefits of cheese microorganisms?

Colonization potential and impact on the gut microbiota?

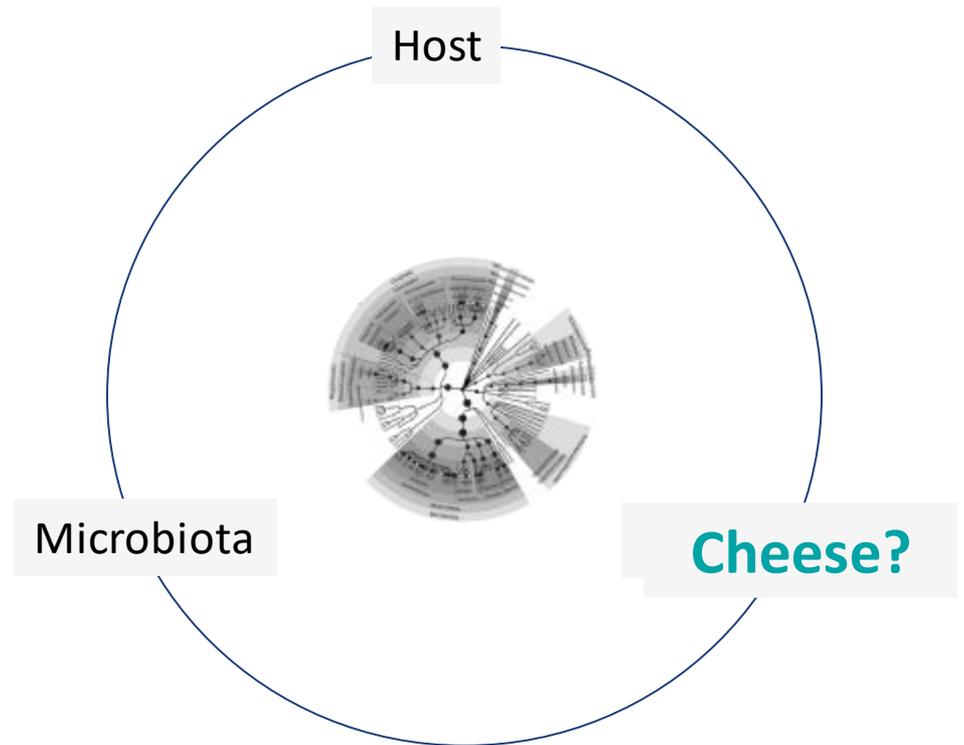
➤ Factors that shape the intestinal microbiota

Host Factors

- Genetics
- Immune response
- Absorption and degradation
- Age
- Health state

Environmental Factors

- Habitat
- Mode of delivery
- Antibiotic use
- **Nutrition**
- **Diet**



➤ Impact of Cheese on the human gut microbiota

Camembert : increase in *Enterococcus* populations, colonization by *Geotrichum candidum* in human fecal samples



Fate and effects of Camembert cheese micro-organisms in the human colonic microbiota of healthy volunteers after regular Camembert consumption

Olivier Firmesse^a, Elise Alvaro^a, Agnès Mogenet^b, Jean-Louis Bresson^b, Riwanon Lemée^c, Pascale Le Ruyet^c, Cécile Bonhomme^c, Denis Lambert^c, Claude Andrieux^a, Joël Doré^a, Gérard Corthier^a, Jean-Pierre Furet^{a,b*}, Lionel Rigottier-Gois^a

Consumption of Camembert cheese stimulates commensal enterococci in healthy human intestinal microbiota

Olivier Firmesse, Sylvie Rabot, Luis G. Bermúdez-Humarán, Gérard Corthier & Jean-Pierre Furet

Unité d'Ecologie et Physiologie du Système Digestif, INRA, Jouy-en-Josas, France

- Only a few studies yet
- Show the **survival** of technological microbes to the digestion process (protection by the cheese matrix) **without colonisation**
- **Modulation of the gut microbiota** after cheese consumption
- **Different responses depending on the cheese type**

Cooked pressed cheese : reduction of the level of amoxicilline-resistant *Enterococcus* after antibiotic treatment (amoxicilline + clavulanic acid)

Journal of Applied Microbiology ISSN 1364-5072

ORIGINAL ARTICLE

Effect of cheese consumption on emergence of antimicrobial resistance in the intestinal microflora induced by a short course of amoxicillin-clavulanic acid



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3 Unité de Recherches en Technologie et Analyses Laitières, Institut National de Recherche Agronomique, Poligny, France

➤ Microbial drivers associated with these responses ?
LAB, other bacteria ? Yeasts ? Microbial associations/cocktail effects ?

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Auvergne

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➤ Raw milk, cheeses and immunomodulation: epidemiological studies

The protective effect of farm milk consumption on childhood asthma and atopy: The GABRIELA study

Georg Loss, MSc,^{a,b} Silvia Apprich, PhD,^c Marco Waser, PhD,^{a,b} Wolfgang Kneifel, PhD,^c Jon Genuneit, MD,^d Gisela Büchele, PhD,^d Juliane Weber, MD,^a Barbara Sozanska, MD,^f Hanna Danielewicz, MD,^f Elisabeth Horak, MD,^g R. J. Joost van Neerven, PhD,^h Dick Heederik, PhD,ⁱ Peter C. Lorenzen, PhD,ⁱ Erika von Mutius, MD,^g Charlotte Braun-Fahrlander, MD,^{a,b} and the GABRIELA study group* *Basel, Switzerland, Vienna and Innsbruck, Austria, Ulm, Munich, and Kiel, Germany, Wrocław, Poland, and Deventer and Utrecht, The Netherlands*

Consumption of unprocessed cow's milk protects infants from common respiratory infections

Georg Loss, PhD,^{a,b,c} Martin Depner, PhD,^a Laurien H. Ulfman, PhD,^d R. J. Joost van Neerven, PhD,^{d,e} Alexander J. Hose, MPH,^a Jon Genuneit, MD,^f Anne M. Karvonen, PhD,^g Anne Hyvärinen, PhD,^g Vincent Kaulek, PhD,^h Caroline Roduit, MD,^{i,j} Juliane Weber, MD,^a Roger Lauener, MD,^k Petra Ina Pfefferle, PhD, DrPH,^{l,m} Juha Pekkanen, MD, PhD,^{n,o} Outi Vaarala, MD, PhD,^o Jean-Charles Dalphin, MD, PhD,^h Josef Riedler, MD,^p Charlotte Braun-Fahrlander, MD,^{b,c} Erika von Mutius, MD,^{a,q} Markus J. Ege, MD,^{a,q} and the PASTURE study group* *Munich, Ulm, and Marburg, Germany, Basel, Zürich, Davos, and St Gallen, Switzerland, Amersfoort and Wageningen, The Netherlands, Helsinki and Helsinki, Finland, Bergamo, Brescia, and Schio, Italy, and*

◆ Raw milk consumption would contribute to the child protection against:

Asthma

Allergies

Respiratory infections

◆ Cheese consumption would contribute to the child protection against:

Atopic dermatitis

Food allergies

Impact of the food microbiota?

Allergy

EUROPEAN JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY



12-18 months



6 years old



Cheese consumption



↘ Atopic dermatitis
OR=0.64 [.48,.85]

↘ Food allergy
OR=0.55 [.33,.92]

Nicklaus S, Divaret-Chauveau A, Chardon M-L, et al. ; Pasture Study Group. The protective effect of cheese consumption at 18 months on allergic diseases in the first 6 years. *Allergy*. 2018;00:1–11. <https://doi.org/10.1111/aal.13650>

EFRAIM PASTURE birth cohort Protection against Allergy: Study in Rural Environment




➤ Potential benefits for human health

Cheese matrix

proteins (caseins), lipids (PUFA),
minerals (Ca, P), vitamins

Fermentation

bioactive peptides,
vitamines

Microbiota

Living microorganisms, potential
interactions with the immune
and digestive systems

Raw milk cheeses/PDO Cheeses

Unprocessed raw material
→ preservation of proteins,
lipids, vitamins



Microbial diversity
Sensory richness of the product
Increased potential of interactions with
immune and digestive systems

*Protection against
cardiovascular diseases ?*

*Anti-microbial/anti-inflammatory
properties ?*

Reducing blood pressure ?

Anti oxydative activities ?

➤ Unité Mixte de Recherche sur le Fromage UMRF 0545 UCA INRAE VetAgro Sup

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Université Clermont
Auvergne/IUT
Aurillac



VetAgro Sup
Campus Agronomique
de Clermont-Ferrand



Thanks for your attention!

