



CARBOHYDRATE  
COMPETENCE CENTER



# **Carbohydrates for Improving Health!**

## **CarboHealth Research Results**

**Zwolle, 30 November, 2017**



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[www.ccresearch.nl](http://www.ccresearch.nl)

**A demand-driven Public-Private Partnership in the field of carbohydrate research:  
6 private companies and 3 knowledge institutes participate in CarboHealth or CCC 3**



FrieslandCampina

**Contractor**

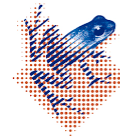


CENTRE FOR SPECIALISED NUTRITION

W I N C L O V E



rijksuniversiteit  
 groningen



umcg



WAGENINGEN UR

For quality of life

***Collaboration Maastricht University and Nijmegen University  
Coordination commissioned to Carbohydrate Competence Center by RFC  
Financial support: Ministry of Economic Affairs***

# CCC3- CarboHealth Project: Novel Technologies (**Toolbox**) to assess Gut Health Claims for Carbohydrates



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Principal Applicant: FrieslandCampina (Dr. Ellen van Leusen)

Management: CCC

Project Leader: Fons Voragen

**SP 1: Oligosaccharide synthesis,  
structural analysis and bioconversions**

Lubbert Dijkhuizen RU Groningen/  
Henk Schols, WUR

**SP 2: Effects on the  
Immune System**

Paul de Vos, UMCG/  
Jurriaan Mes, WUR

Integrated Data Analysis  
Claim Support **SP 5**  
Jurriaan Mes, WUR

CCC  
Mgt

EFSA

**SP 3: Effects on the metabolism**  
Henk Jan Verkade/Uwe Tietge UMCG

**SP 4: Effects on the  
Microbiota**  
Hauke Smidt, WUR



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Management and Supervisory Board

SP 1

Structures, functions and bioconversions of  
(prebiotic) carbohydrates

SP 2

Effects  
on  
the  
Immune  
System

SP 3

Effects  
on  
the  
Metabolism

SP 4

Effects  
on  
the  
Microbiota

Verification of regulations

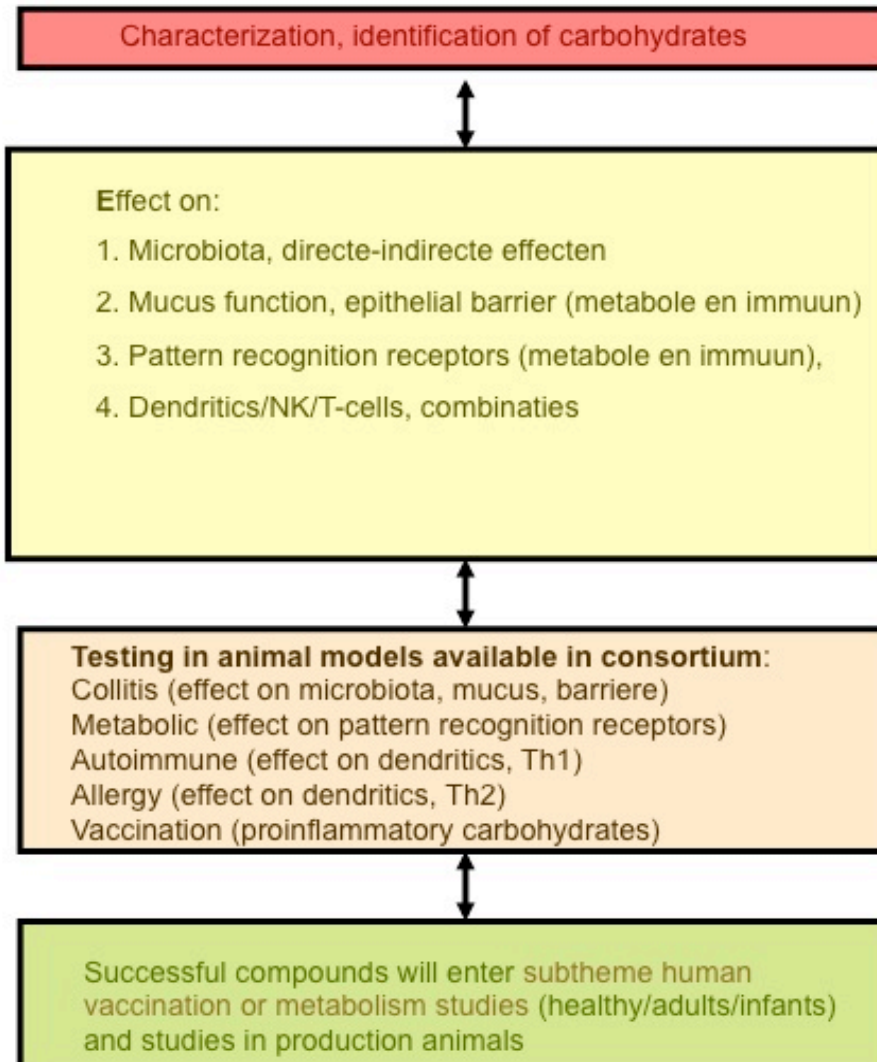
Development of methods "*in vitro*" toolkit

Lab-animals and pigs model experiments

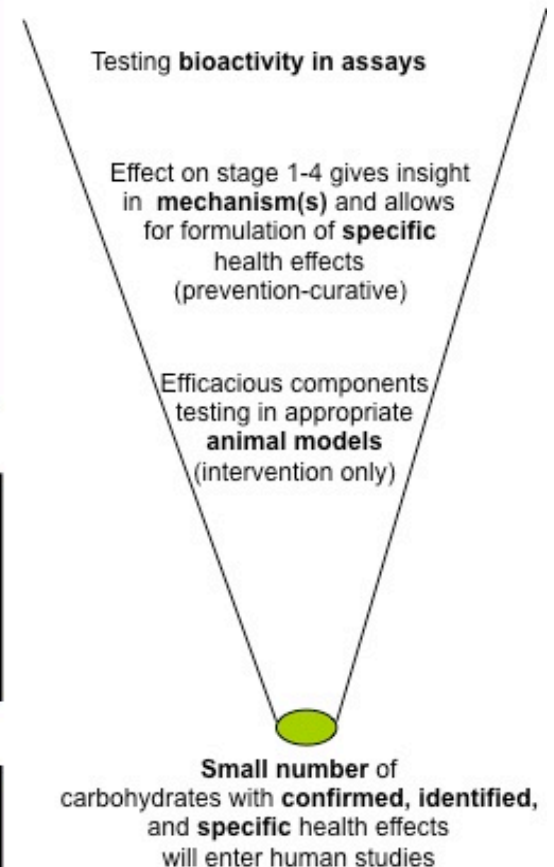
Human conceptual pilot trials

SP 5

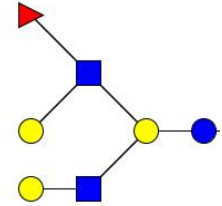
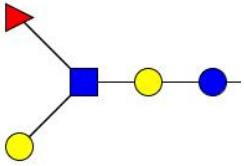
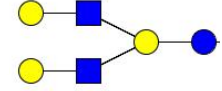
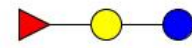
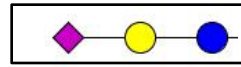
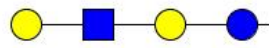
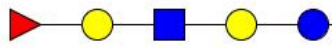
Integrated data analysis. models to predict effects on  
healthy populations aimed at filing and registration



Technology platform:  
**Selection of bioactive carbohydrates**



# Human Milk Oligosaccharides (HMOs)



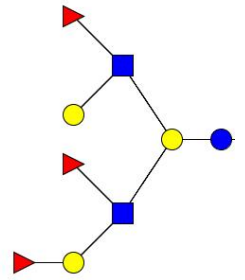
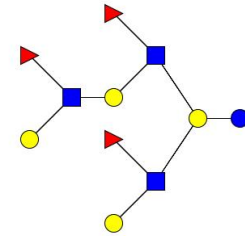
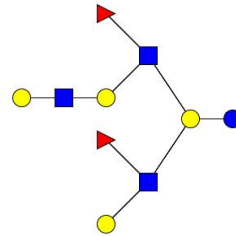
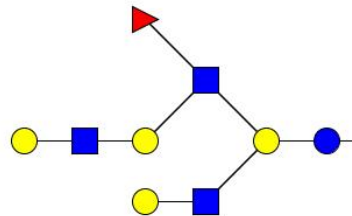
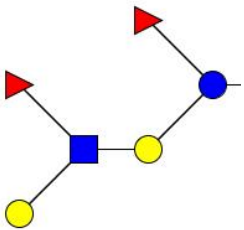
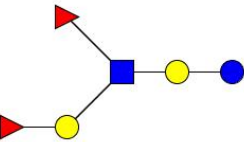
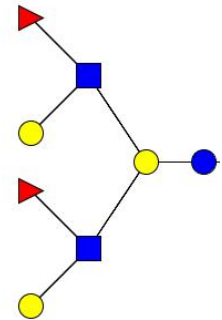
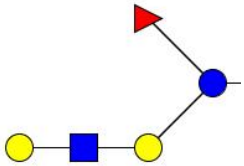
**HMOs complex (ca 200, 116 identified)**

**Each has a Lactose unit at the reducing end.**

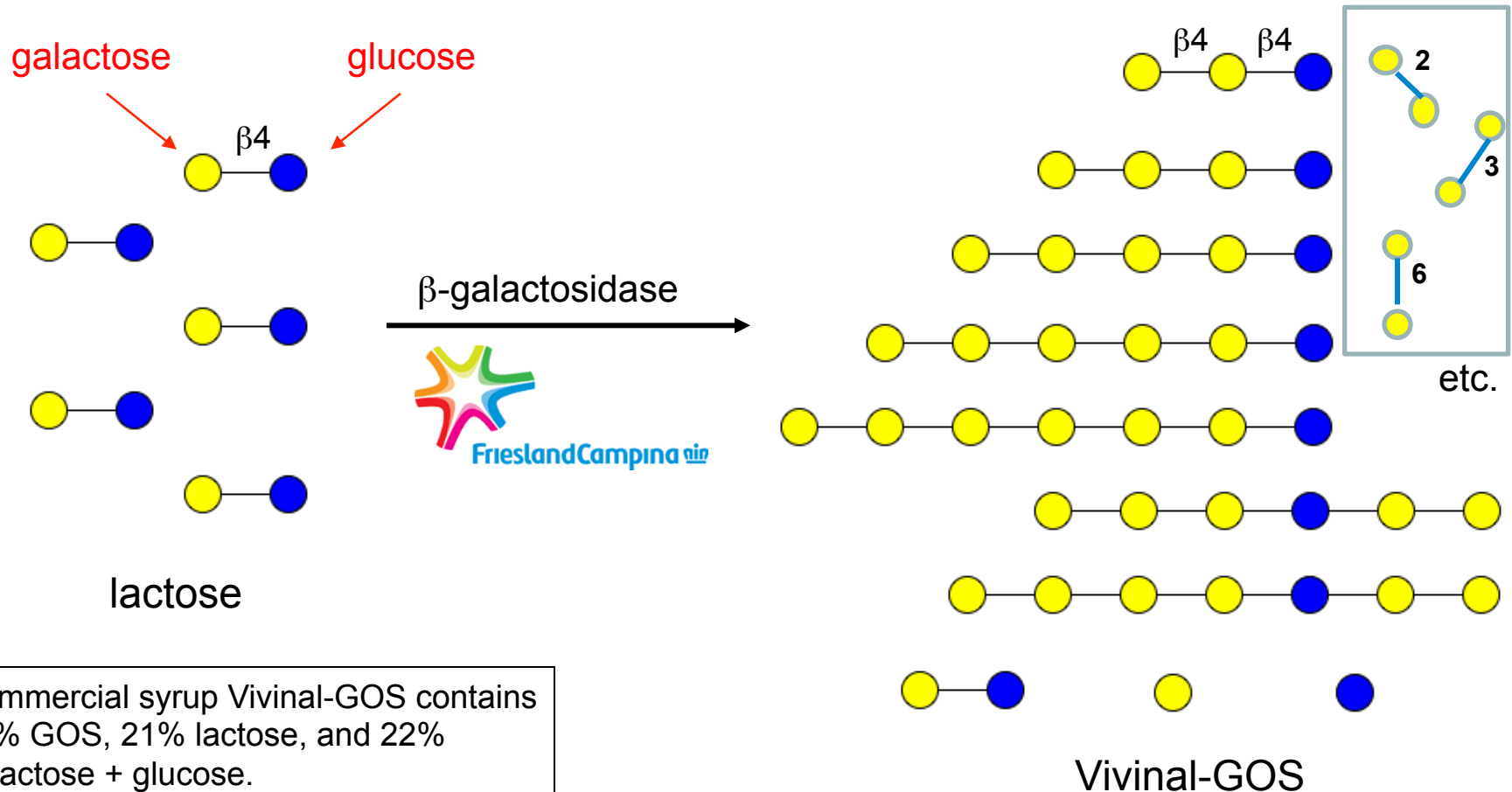


Neutral oligosaccharides (10 g/L)

Acidic oligosaccharides (1 g/L)



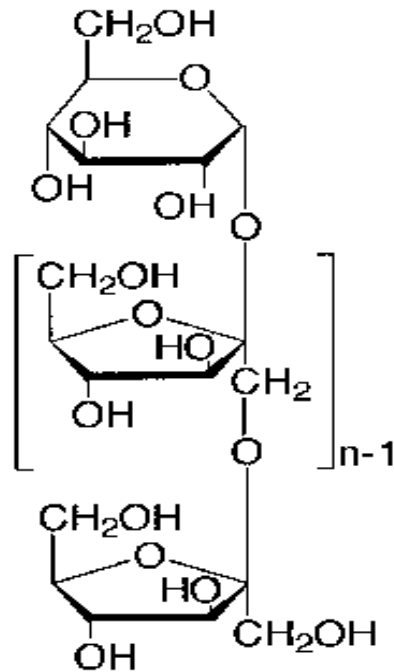
Galacto-oligosaccharides (GOS), DP2-10, are produced by [FrieslandCampina](#) on industrial scale from [lactose](#) via a transglycosylation reaction with  $\beta$ -galactosidase of *Bacillus circulans*.



Commercial syrup Vivinal-GOS contains 57% GOS, 21% lactose, and 22% galactose + glucose.



# Structures of variety of Prebiotics



Inulin  
derived  
FOS

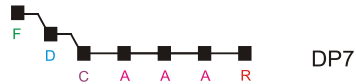
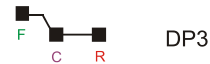


# Structures of GTFB products

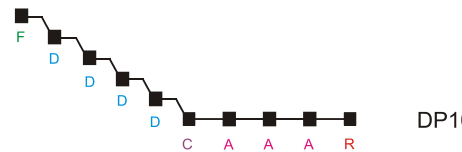
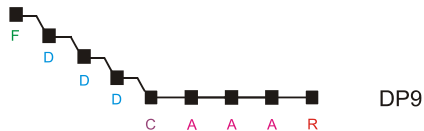
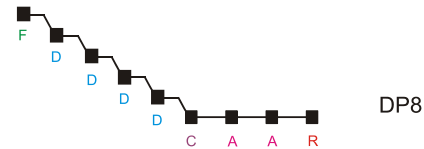
■ :  $\alpha$ -D-Glcp

↘ : 1-6 bond

— : 1-4 bond



substrate



These are the major compounds, but glucans of up to DP 35 are formed

A  $-(1\rightarrow4)\text{-}\alpha\text{-D-Glcp}\text{-}(1\rightarrow4)\text{-}$   
 C  $-(1\rightarrow6)\text{-}\alpha\text{-D-Glcp}\text{-}(1\rightarrow4)\text{-}$   
 D  $-(1\rightarrow6)\text{-}\alpha\text{-D-Glcp}\text{-}(1\rightarrow6)\text{-}$   
 F  $\alpha\text{-D-Glcp}\text{-}(1\rightarrow6)\text{-}$   
 R $\alpha/\beta$   $-(1\rightarrow4)\text{-D-Glcp}$

→ GTFB forms isomalto / malto-oligosaccharides

Dobrurowska et al. Glycobiology 2012

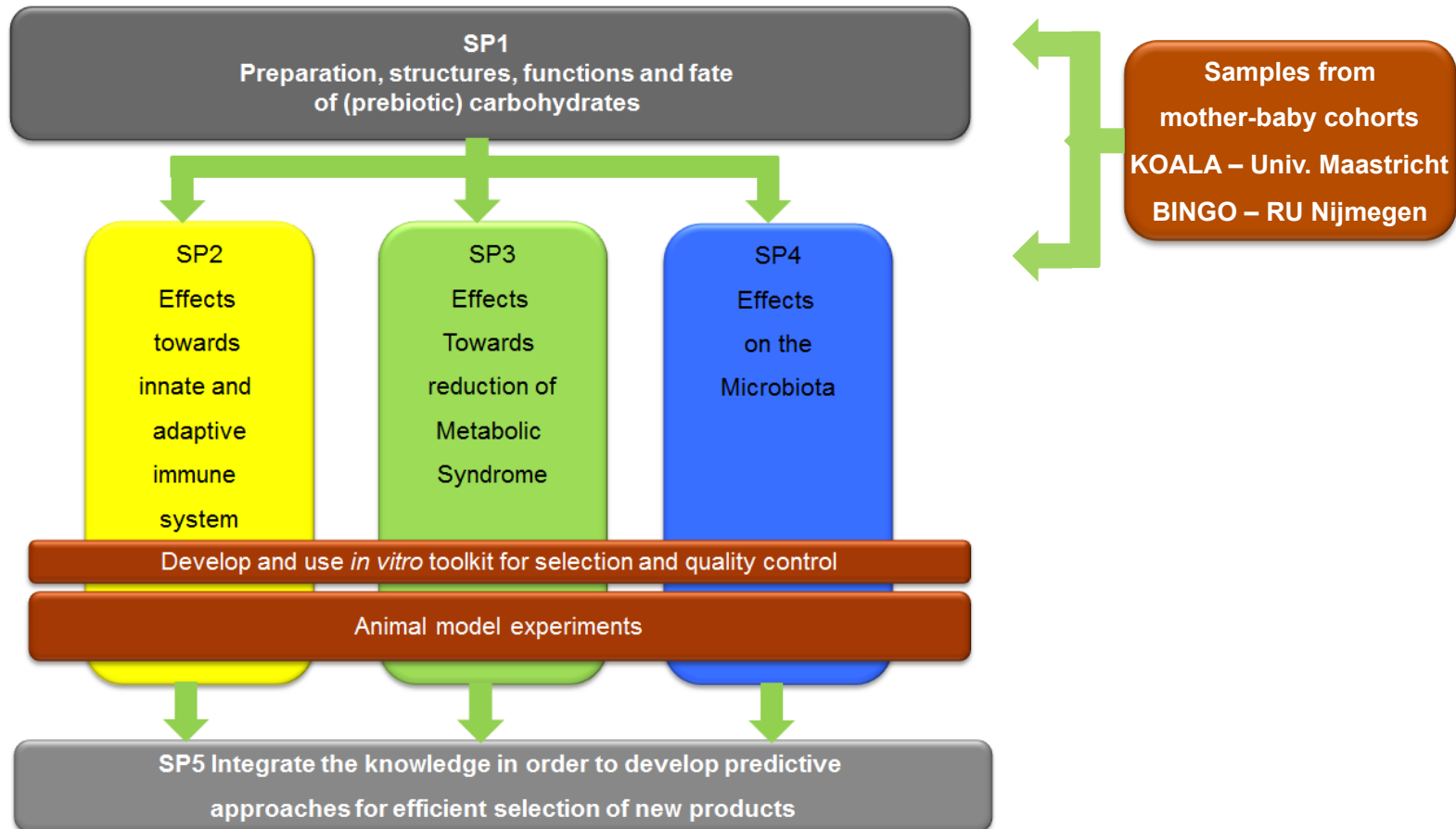




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# What did we do?



# Morning session

- 09.30 h.** Opening by **Fons Voragen** and **Ellen van Leusen**
- 09.40 h.** Keynote 1: **Ardythe Morrow**, Cincinnati Children's Hospital Medical Center  
*Human milk oligosaccharide and the rationale for testing it as a medical food*
- 10.25 h.** **Sander van Leeuwen**, University of Groningen  
*Analysis of human milk oligosaccharides in mother milk and infant faeces in the Dutch KOALA cohort*
- 10.45 h.** Coffee and tea break, poster session 1
- 11.15 h.** **Fangjie Gu**, Wageningen University  
*Consumption patterns of human milk oligosaccharides by 1-month-old infants*
- 11.35 h.** **Klaudyna Borewicz**, Wageningen University  
*Prebiotics in infant formulas promote gut microbiota similar to that of breastfed infants*
- 11.55 h.** Keynote 2: **Geert-Jan Boons**, Chemical Biology and Drugs Discovery, Utrecht University  
*Functional glycomics through chemical synthesis*
- 12.40 h.** Lunch, poster session 2

# Afternoon session

- 13.55 h.** **Alexia Lépine**, University Medical Centre Groningen/  
Food and Biobased Research Wageningen  
*Immune effects of pre- and probiotics: case study of a winning duo*
- 14.15 h.** **Rima Mistry**, University Medical Centre Groningen  
*Metabolic health effects of carbohydrates in vivo*
- 14.35 h.** **Markus Böger**, University of Groningen  
*The role of selected probiotic bacteria in degradation of (prebiotic) carbohydrates*
- 14.55 h.** Coffee and tea break, poster session 3
- 15.25 h.** **Nicole de Wit**, Food and Biobased Research Wageningen  
*Exploring the impact of pre- and probiotics on intestinal barrier function*
- 15.45 h.** Keynote 3: **Hauke Smidt**, Microbiology, Wageningen University  
*How to groom our guts – early life microbiome dynamics and its consequences throughout life*
- 16.30 h.** **Jurriaan Mes**, Food and Biobased Research Wageningen  
*CarboHealth for Improving Health!, an overview*
- 16.45 h.** Closing remarks and drinks, poster session 4