

The Carbohydrate Competence Center (CCC) is generating and developing the interdisciplinary science of carbohydrates with an aim to stimulate innovation and contribute to a healthier and more sustainable society. At the heart of all of the projects are both our industrydriven research questions and excellent research capabilities. These activities are outlined in this brochure.

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# HIGHLIGHTS OF DEMAND-DRIVEN CARBOHYDRATE RESEARCH

Towards a healthier and sustainable society



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# 'Ahead of the pack'

# INTRODUCTION

People regularly ask whether investment in scientific excellence is a prerequisite for a viable and vital knowledge economy. My answer to that question is a clear and resounding 'yes'!

The best proof of this is CCC, the Carbohydrate Competence Center. CCC focuses on building knowledge and expertise in the field of carbohydrates with the aim of enhancing innovation and the competitiveness of the carbohydrate processing industries. The knowledge institutions within the CCC have already taken a leading position in this field in the Netherlands. We are the home base of the key academic disciplines and the necessary infrastructure. Together with our industrial partners, we aim to expand our national lead to a front-running position worldwide.

The CCC is ahead of the pack. Over the next few decades, further understanding, knowledge and expertise in the field of carbohydrates will be required. Carbohydrates are important components of cultivated crops and are used not only for our food but also for a range of industrial applications, especially for new and/or renewable raw materials, as well as non-food applications. Investing in excellent carbohydrate research

# Public-Private Partnership: Triple Helix in practice

CCC is a leading national and international Public-Private Partnership in the field of carbohydrate research and, as such, an attractive partner and agent for innovation in all areas where carbohydrate knowledge plays a significant role.

In CCC, knowledge institutes and industries cooperate with each other and together they define the objectives, activities, budget and progress of work packages. They invest on an equal basis but also share joint ownership of the research results. Therefore, partners will only invest if they are really interested in the outcomes of the activities. The local, regional and national government contributes 50% of the research costs.





Prof. dr. Sibrand Poppema, chairman of the Board of the University of Groningen

will offer opportunities in emerging sectors such as healthy ageing, the pharmaceutical industries and the bio-based economy. The universities of Groningen, Wageningen and Utrecht, as well as other knowledge institutes and our industrial partners, are working together closely and successfully. A large number of scientific publications have already been published, and equally importantly, several patents are currently in preparation.

In conclusion: yes, investment in multidisciplinary fundamental research is the most important precondition for a viable and vital knowledge economy.



# towards a healthier and sustainable society

The Dutch Agriculture and agro-food industries are facing enormous challenges. Conventional production is being threatened by high costs and tight regulations. But, at the same time, new technical possibilities are offering huge market opportunities. To lead the way to international success, agriculture and industry must constantly innovate. The Carbohydrate Competence Center (CCC) supports this process by bringing together knowledge about carbohydrates and innovative research.

The uniqueness of CCC is that it unites industry and science in joint research projects on carbohydrates. Nowhere else in the world does this happen on such a scale. As a knowledge centre, CCC aims to increase the added value of its activities in national production chains. CCC also helps to strengthen the Dutch position in the bio-based economy, and contributes significantly to healthy ageing.

The research program of CCC has been developed by intensive consultation between business and research organizations in the (Northern) Netherlands. It is obvious that these kinds of continuous consultations and joint planning will generate new and challenging ideas for scientific research and industrial applications.

## What are carbohydrates?

Carbohydrates are an inexhaustible source of organic material synthesized from carbon dioxide (CO<sub>2</sub>) and water (H2O) by green plants through photosynthesis. The first simple sugar formed is glucose. In plants, glucose is converted to the disaccharide sucrose and the polysaccharide starch, which serve as an energy source for plants and seeds. Plant cell walls, made up of the polysaccharides pectin and (hemi-) celluloses, are also formed from glucose. Along with plants, carbohydrates are also important constituents of algal, microbial and animal raw materials.





# COMMENTARY

Society places increasing pressure on industry asking for quality products at affordable prices. To meet this demand, business needs to innovate constantly. But renewal requires time and knowledge and a mechanism where industry can obtain answers to specific questions.

The Carbohydrate Competence Center offers the agro-food industry a unique meeting place where industry and high-quality research institutions are brought together. CCC creates an intensive form of cross-fertilization between basic research and market-oriented innovation that leads to new products, new processes and new jobs. The Northern Netherlands is the base of CCC because it is an agricultural region and the home to many high-quality processing industries. It is an excellent starting point for a leading role for the region in a bio-based economy.

CCC is not an aim unto itself; it has no static goal. There are always new technologies and solutions to be developed to answer emerging questions from industry and society. The agro-food industry is the heartbeat of societal and socio-economic developments. CCC is grounded in this agro-food and non-food society and, by calling upon its large network, CCC offers an opportunity to strengthen science-based innovation and thereby increase the competitive power of its industry partners.

# Doing something unconventional

Prof. dr. Rudy Rabbinge, chairman Supervisory Board Carbohydrate Competence Center

'The uniqueness of CCC is that industry and science are brought together to jointly carry out research into carbohydrates. Nowhere else in the world does this happen on such a scale.'



# **Carbo Campus Community:** 22 public-private agro-business projects, more than 100 researchers involved

Currently, CCC coordinates 22 public-private agro-business projects. Thirteen research teams are involved which include more than 100 researchers, mainly at the university and higher educational levels. It also cooperates with specialized industrial partners and SMEs in agro-business. Knowledge institutions and industrial partners are working together to develop and to test the practical applications of advanced materials and agro-business products derived by setting up testbeds for applications.

CCC's activities are able to lure top researchers to come to the (Northern) Netherlands from all over the world. Close collaboration between partners generates new knowledge, which is transmitted to staff within the institutions and to other partners within CCC. University and PhD students involved in CCC activities are thus well prepared for a career in a participating or related industry.

CCC is open to new parties, that can participate in existing activities or initiate new.

## **Demand-driven** approach

All CCC activities start with a request from an industrial partner who comes with a practical problem. Together with the appropriate partners, the research approaches to come to a solution, are defined.

After take-off, industrial parties remain closely involved with the research as the industries and knowledge institutes supply one another with real life experience and new knowledge. This exchange ensures that research is perfectly geared to the demand of the industries and it guarantees the practical applicability of the results. It also ensures that each research result is a powerful tool for rapidly implementing innovations with a high probability of success.

## Strategy and opportunities

The Netherlands, and in particular the Northern Netherlands, has a great deal of agricultural land and many high-quality processing industries making it an excellent starting point for playing a leading role in a bio-based economy. Knowledge of carbohydrates is a key factor here. No less than 70% of the dry matter of living plants is made up of carbohydrates. They are used for countless products such as foodstuffs and healthy ingredients but also non-food products such as bio-fuels, plastics, paper, textiles, medicines and cosmetics. CCC provides the high-quality knowledge required to make this possible. Examples of our research are:

- modifying the biosynthesis of the cell walls to develop new and better degradable maize varieties;
- improving the pre-treatment of biomass needed for the retrieval of ingredients;
- investment in projects that have carbohydrate-rich wastes as raw material

# Healthy food and food ingredients

Prebiotics and other non-digestible carbohydrates in our food have positive effects on our health. They help prevent cardiovascular diseases and obesity and boost our immune systems. CCC develops innovative ingredients and foodstuffs on the basis of this natural concept. In the long term these products can help improve public health. Examples of our research are:

- the replacement of sugar by other ingredients;
- developing of rapid laboratory digestibility tests of products;
- developing/selecting healthier potato varieties;
- developing a new generation of prebiotic products.



preconditions.'

*CCC plays an important role in* the transition to the bio-based economy through its innovative expertise and its broad support base in the industry. Our industrial partners represent the agroproduction chains, together *employing some 24,000 people* directly and 45,000 indirectly.'



## Drs. Geert Jan Arends, business manager:

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'The exchange between industry and knowledge institutions is one of the best ways to begin the innovative process. Another option to explore is to bring two companies to the table if we think they have an interesting proposal, such as a development process, even before we have the science to achieve it. It all depends on the specific wishes and



## Work packages

The public private research endeavours of CCC are organized in thematic work packages. The work packages have clearly defined tasks. Added value is created by crossfertilization between the projects as researchers collaborate and communicate about their findings. This way, each project makes a contribution to CCC's result portfolio and increased competence for product development and an optimal flow of knowledge to the scientific and business community is sustained.

The CCC research activities comprise three different themes with separate fields of expertise:

## **Carbohydrates for nutrition and health**

This field of expertise is all about nutrition and health. New methods are developed to accurately determine the effects of carbohydrates on health. Healthy carbohydrates are produced and applied in new healthy or health-promoting products.

## **2** Carbohydrate structure and functionality

The relationship between the structure of carbohydrates and their functionality is studied, leading to more effective and efficient ways of using carbohydrates in a wide range of food and non-food products.

#### 3 Carbohydrate conversion and processing

Sustainable products and production methods are the focus of this field of expertise. Ways to produce cheap fermentable sugars from biomass are explored. These sugars are processed into innovative products in, for example, the field of green (platform) chemicals, new materials and bio-energy.

#### Economic value

The results of the work packages are intended primarily for the participants. Industrial partners will use the findings to develop new products or processes or to improve existing ones. Implementing the work packages creates highly skilled jobs and, indirectly, will be generating employment opportunities.

## CCC's contribution to the Northern Netherlands economy

Carbohydrate related sectors make up one-quarter of the production volume, one-fifth of the added value and one-auarter of the labour volume in the Northern Netherlands economy.

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The share of carbohydrate-related sectors in the Northern Netherlands economy is larger than in the national economy. The carbohydrate-driven agro-industrial sector is by far the biggest job creator within the agricultural and industrial sectors in the region and it ranks second only to mineral extraction when it comes to adding value.

# CCC's contribution to the **Dutch economy**

The carbohydrate sector 'Nutrition' has the largest production volume and highest added value of all the Dutch agricultural and industrial sectors. The carbohydrate-driven sector 'Agriculture' creates the highest number of jobs in the Dutch agricultural and industrial sectors. Carbohydrates and related sectors make up 48% of Dutch export goods.

# **Carbohydrate Competence Chain:**

# showcases WORK PACKAGES IN PROGRESS

Carbohydrates for nutrition and health, Carbohydrate structure and functionality and **Carbohydrate conversion and processing**, are CCC's themes of expertise. They cover the life cycle of industrially produced carbohydrates.

After biosynthesis, carbohydrate-containing materials, such as starch or inulin-containing plants, are processed to obtain the desired carbohydrates. During this process, by-products are also obtained containing carbohydrates such as (hemi-)cellulose and lignin as major constituents. The Carbohydrate conversion and processing expertise theme is focused on this life-cycle step. It is aimed at the development of sustainable methods to produce cheap fermentable sugars from biomass and to process them into innovative products in, for example, the field of green (platform) chemicals, new materials and bio-energy.

After processing, products obtained may need to be modified in order to meet requirements for specific applications. For this, insight in relation between structure and functionality is of major importance. This relationship is investigated in the expertise theme Carbohydrate structure and functionality with an aim to develop knowledge and find more effective and efficient ways of using carbohydrates in a wide range of food and non-food products.

Food and feed are major applications for carbohydrates. In this respect health issues, such as obesity, confronting modern society, pose a major challenge. The expertise theme Carbohydrates for nutrition and health is focused on developing methods to specifically modify carbohydrates and determine their physiological effects on human and animal welfare.

Within the three expertise areas research is performed to solve questions raised by the industrial partners. The cooperation will be described in more detail in the cases.

At present there are 22 public-private agro-food projects running within these three themes. They cover a wide range of interrelated research disciplines, such as:

Microbial Physiology • Glycobiology • Carbohydrate Bioprocessing • Product Technology • Chemical Technology • Pharmaceutical Technology and Biopharmacy • Polymer Chemistry • Bioinformatics • X-ray Crystallography • Biochemicals • Organic Catalysis • Molecular Genetics • Pediatrics • Gastrointestinal and Liver Diseases • Medical Biology • Food Chemistry • Cattle Feed Technology • Process Engineering • Plant Breeding • Sensory Science and Eating Behaviour • Product Development and Quality Management

#### Prof. dr. Lubbert Dijkhuizen, scientific director:

'In CCC the research partners and the industrial partners participate on an equal basis. Both contribute equally to the projects and both are equally owner of the results. These results will be published in scientific journals and PhD theses and presented at national and international conferences. These publications can be delayed, giving the industrial partners the opportunity to protect the intellectual property. All partners in a work package will benefit from commercial advantages of the research, in proportion to their participation.'





Dr. Doede Binnema - Theme coordinato Carbohydrates for nutrition and health



▲ Dr. Gerard Robijn - Theme coordinator Carbohydrate structure and functionality



Prof. dr. Ton Broekhuis - Theme coordinator Carbohydrate conversion and processing

A major focus within the CCC is on health and health-promoting carbohydrates in food and feeds. CCC partners investigate and develop methods to accurately and carefully determine the effects of carbohydrates on health. Existing and new, potentially health-promoting carbohydrates or carbohydrate-protein interactions are developed and analyzed in the complex matrix of novel food and feed. Research focuses on the fate of complex carbohydrates in the intestine and colon and their impact on intestinal function and health, with an aim to maintain health in an aging population. The research activities involve the development of robust methods for the cost-effective in vitro screening of carbohydrate digestibility, new methodologies for the interaction between carbohydrates and lysine and novel possibilities for the replacement of lactose in calf nutrition.

WP 5

# CARBOHYDRATE & LYSINE INTERACTION



# Increasing nutritional value of the food

WP 5 cooperation: MARS Incorporated and Wageningen UR





Reducing the lysine carbohydrate interaction in diets is a major challenge for the pet food industry

'Lysine is an essential amino acid that cannot be made by the body,' says professor dr. ir. Wouter Hendriks, head of the Animal Nutrition Group at Wageningen UR and work package leader of the project. 'The amino acid is necessary for growth, tissue repair, the production of antibodies, hormones and enzymes. Lysine is present in dog and cat food, but can, as a result of storage or processing, form complexes with carbohydrates, thus reducing its bio-availability.'

Knowledge about the interaction between carbohydrates and lysine will allow the minimization of Maillard products and as such increase the nutritive value of the food/ feed. In addition, the minimization of the formation of advanced glycation end-products (AGEs) will benefit animal health. For the industry, it is essential to understand the extent of this interaction and to develop novel ways to reduce the formation of AGEs to improve diets for pets.

# Advancing the frontiers of scientific research

MARS, the world's largest producer of pet food, has conducted extensive research in the area of Human-Animal Interaction and the nutritional needs of animals. The WALTHAM® Centre for Pet Nutrition, the research hub for MARS Petcare, has been a leading scientific authority in pet nutrition and well-being, advancing the frontiers of scientific research into the nutrition and healthy ageing of companion animals for almost 50 years. Located in Leicestershire, England, the renowned state-of-the art science institute focuses on the nutritional and behavioral needs of companion animals and their benefits to humans, enabling the development of innovative products that meet these needs in a practical way. WALTHAM® has pioneered many important breakthroughs in pet nutrition and, in collaboration with world-leading scientific institutes, supports leading Mars brands, such as, WHISKAS® and PEDIGREE®.



Dr. Lucille Alexander, Nutrition Research Manager at WALTHAM Centre for Pet Nutrition® is the industrial partner for the Lysine project. 'Understanding both the processing effects that cause carbohydrate and lysine reactions and the potential effects on dietary quality is very important for the production of complete and balanced foods,' Alexander explains. 'This research will ensure that the diets we produce not only meet the animals dietary needs but provide constant high quality diets at the forefront of new research areas, something that is a priority for MARS Petcare.'



WP 4

# IN VITRO SCREENING OF CARBOHYDRATE DIGESTIBILITY IN HUMAN DIGESTION



# **Anticipating future needs**

#### WP 4 cooperation:

AVEBE, Royal FrieslandCampina, TNO Healthy Living, Wageningen UR and Hanze University Groningen (Institute for Life Science & Technology)







'In this project we are developing and applying approaches to determine the digestibility of putatively health-promoting carbohydrates in human digestion,' dr. ir. Jan-Peter Nap explains. Nap, professor (Dutch: lector) Life Sciences at the Hanze University Groningen, University of Applied Sciences, is coordinator of the project 'Developing in vitro screening methods for carbohydrate digestibility in the small and large intestine (colon)'.

Issues addressed involve: how to accurately, robustly and reliably measure prebiotic carbohydrates in the complex mixture of food upon digestion? What is the fate in terms of speed of degradation and resulting structural components in known and novel prebiotic food additives? What is the effect of prebiotics on the composition of the microflora? What platform of analysis should be preferred in terms of speed, costs and results? How do new starch varieties survive the enzymatic attacks upon mimicked consumption? Nap: 'Partners agree that this project is a great example of an attractive public-private partnership in the framework of CCC. It supports innovation and expertise development in the participating industry, while the public partners develop relevant and advanced technologies for future applications. All partners see a growing need for evidence-based claims with regard to food and food components, both for existing prebiotics as well as for novel ones. This project anticipates such future needs'.

## **Fine-tuning health needs**

'This CCC project offers us an attractive mix of technology development in terms of screening of novel materials and future demands on efficacy and potential health claims surrounding food ingredients,' acknowledges professor dr. Marc van der Maarel, manager Product and Application Development of AVEBE Food and honorary professor of Carbohydrate Bioprocessing at Groningen University, enthusiastically. 'This cooperation within CCC is an excellent contribution to the strategic goals of my company. AVEBE is the largest potato starch producer in the world, developing novel products based on potato starch for the food, feed and many other industries.'

'I am particularly pleased with the exchange of ideas and expertise within this project which leads to the fine-tuning of healthpromoting properties of nutrition to the particular needs of human beings,' adds dr. ir. Ellen van den Heuvel, senior researcher life science at Royal Friesland-Campina Research, the largest Dutch dairy corporation with a major focus on milk valorisation.'



# WP 21 LACTOSE REPLACEMENT IN CALF NUTRITION



Equally interesting is the scientific challenge of investigating possible replacement of lactose in veal calf nutrition. **Dr. ir. Walter Gerrits** is associate professor at the Animal Nutrition group of Wageningen UR and leader of WP 21. The VanDrie Group, a leading producer of veal in the world, asked CCC for academic partners to take up the challenge. Replacement of lactose by other commodities in calf nutrition can result in large economic benefits and open up new markets. SYRAL, the other industrial partner, are producers of feed ingredients able to take up these benefits.

'Our project is aimed at evaluating the effects of replacing lactose in milk by carbohydraterich ingredients without negative side effects on digestion or on development of insulin resistance in calves,' Walter Gerrits explains. 'Such knowledge can also be useful for understanding the development of insulin resistance in other species, for example humans. A real multidisciplinary project.'

**Professor dr. Roel Vonk** from the University Medical Center Groningen agrees with Gerrits: 'This fits perfectly with the activities of the UMCG (Medical Biomics, **dr. Marion Priebe** and **dr. Han Roelofsen**) concerning their research about lactose and starch digestion and the development of proteomic-based biomarkers of insulin resistance.'

Private partners SYRAL and VanDrie Group agree with the benefits of partnership as well. 'The results of this work package will give us the right tools how to use vegetable carbohydrates without adverse effect on animal (=gut) health,' **Jacques de Groot** head R+D/QA VanDrie Group, indicates. 'VanDrie Group will be able as well to adapt more successfully to fluctuations in prices of feed ingredients.'

'After the development of SOLPRO® (soluble wheat proteins), this project is a new important step for SYRAL and its customers, to develop suitable carbohydrates as a vegetable alternative that brings more cost efficient feed formulas for CMR,' **Jo Van Parys**, product manager at SYRAL concludes.

# Understanding the effects of replacing vegetable alternative that brings more cost efficient product manager at SYRAL concludes.



**WP 21 cooperation:** VanDrie Group, SYRAL, University Medical Center Groningen, Wageningen UR









Dr. ir. Walter Gerrits

CARBOHYDRATES & FARM ANIMALS



#### WP 24 cooperation:

Agrifirm Innovation Center Apeldoorn, DSM, University of Groningen, University Medical Center Groninaen, Waaeninaen UR



To meet the global demand for meat, industry is seeking new methods to increase production efficiency. Thus far, results have been achieved not only by improving the genetic potential through breeding programmes, but also by improving knowledge of raw material and feed evaluation. In this regard, investigating the effects of carbohydrates on the digestibility of feed could be useful.

Developing innovative products and services for feed composition is everyday work for ir. Masja Lensing, industrial researcher in poultry nutrition at Agrifirm Innovation Center, Apeldoorn, the Netherlands. 'Involving knowledge partners is essential', she says. 'Innovation requires solving questions of a fundamental character. Our company, Agrifirm Innovation Center, is not able to perform fundamental research itself. Most R & D budgets are spend for applied research that needs to be implemented with a fair enough speed. What's more, fundamental research, in-depth knowledge and an understanding of underlying metabolic processes can only be obtained at universities and scientific institutions.'

# Feed efficiency

Lensing: 'To give a value to our compound feed for farm animals, it is important to correctly estimate the value of raw materials. Carbohydrates are one of the components of raw materials that satisfy nutritional requirements. They provide energy for our farm animals and are essential for growth and feed efficiency. Carbohydrates are also used as a prebiotic to promote animal health and welfare. Thanks to this research, we can discover new properties of carbohydrates that contribute significantly to feed optimisation and processing. This could open up new markets for Agrifirm Feed.'

# **Controlled** carbohydrate absorption of nutrients in farm animals





WP 7 ENZYME PROCESS TECHNOLOGY



## WP 7 cooperation:

Agrifirm Innovation Center Apeldoorn, Royal Cosun, Nutreco, Wageningen UR







# Small improvements can have a signi ficant economic value

Improving the utilization of feedstuffs is the scientific challenge that dr. ir. Walter Gerrits is taking on. CCC asked him to coordinate a project investigating the utilization of feedstuffs rich in complex carbohydrates for pigs and poultry using enzyme and processing technologies.

Walter Gerrits: 'The actual idea for the project came after we realized that, in order to improve the digestion of complex carbohydrates by process technology, we need a thorough understanding of the structure of these carbohydrates. Knowledge is being developed in this area at a very rapid pace by dr. Henk Schols of the Food Chemistry Group of Wageningen UR. Collaboration with this group will contribute to new insights that will allow the feed industry to develop enzyme and/or processing technologies to improve the digestive utilization of NSP and other nutrients.'

WP 11 POTATO STARCH AS A DIETARY FIBRE WITH PREBIOTIC EFFECTS AND A LOW GLYCAEMIC RESPONSE (GR)



# A healthier potato can mean entry to a new market

#### WP 11 cooperation:

HZPC Holland b.v., Aviko, Royal Cosun, TNO Healthy Living, University Medical Center Groningen











healthier potato on the market.

Dr. Hans van Doorn, scientific programme leader of HZPC Holland b.v., private partner and WP 11-leader in the consortium, is pleased with the results so far. Van Doorn: 'For our company, a healthier potato can be the entrance to a new market. It is important for HZPC, because our seed potatoes are exported to more than 70 countries.'

# Health effects

Product development and studies are done in collaboration with TNO Healthy Living, the UMCG in Groningen and the private partner Aviko BV (belonging to the Cosun group). Van Doorn: 'The expertise of knowledge institutions is relevant for many questions concerning the nutritional value of potatoes. The potential health effects of potato products developed in WP 11 can be evaluated in human intervention trials. WP 11 is a nice example of a win-win situation between partners. The industry is using the expertise to design and conduct well controlled human intervention trials and the knowledge institutions can use the results of the trials to extend their knowledge about carbohydrate digestion and related health effects.'

# 20



Potatoes have a high content of rapidly digestible carbohydrates and as a consequence eating potatoes results in a rapid rise in blood sugar and a high insulin response. Chronic repeated exposure to high blood sugar and insulin levels is considered to be a risk factor for several chronic diseases. Agro Food industry asked CCC: are their alternatives?

Yes, there are. In consortium WP 11, public and private partners are developing high dietary fibre potatoes and related products which lower the glycaemic response. These potatoes contain starch with a lower digestion rate and have the potency to exert prebiotic effects in the large intestine. By the use of in vitro digestion models and optimally controlled human intervention studies, the effect on starch digestibility and the metabolic response to these products will be evaluated. Evidence from these studies will help to bring a

EEE SHOW CASES

# CARBOHYDRATES FOR NUTRITION AND HEALTH

P 23 POTATO CARBOHYDRATE GENETICS



## WP 23 cooperation:

Averis Valthermond BV, HZPC Holland b.v, University of Groningen, Hanze University Groningen (Institute for Life Science & Technology)









In this project, research institutes and private partners doing research into the relationship between the relevant genes and carbohydrate-related quality characteristics of potatoes are brought together by CCC. Industry will use this knowledge, for example, to optimize the cooking quality of potatoes or increase the starch content.

'New research can lead to improvements in the quality of potatoes,' says **dr. Nick de Vetten**, research manager at Averis Valthermond BV. 'Due to the broad collection of the starch potato varieties, Averis Seeds aims for potato varieties with high yield, high starch and protein content and a broad set of resistance. A better potato means higher margins for our farmers and new markets to explore for AVEBE.'

Averis and HZPC do this in close collaboration with **professor dr. Ritsert Jansen** of the department of Bioinformatics of the University of Groningen, and **dr. ir. Jan-Peter Nap**, professor of Life Sciences at Hanze University Groningen. By cooperating with northern universities, Averis benefits from meeting new highly qualified people.

# Highly skilled personnel available

De Vetten: 'Our company is constantly on the lookout for highly skilled personnel, and they are hard to find. By partnering with the University of Groningen and Hanze University Groningen we come into contact with students who follow internships with Averis. Hopefully some of them will pursue their careers within our company.'

# By cooperating with northern universities we benefit from highly qualified people



Here we investigate the relationship between the structures of carbohydrates and their functionality. The results may provide more effective and efficient ways to apply carbohydrates in a wide range of food and non-food products.

WP1 CHAIN MODEL APPROACH TO POTATO-BASED SNACKS



# **Improving** the quality of snacks

**WP 1 cooperation:** AVEBE, Royal Cosun, Wageningen UR, TNO Healthy Living



Improving the quality of food is the basic principle behind research within this project. What variations in raw materials and process determine the final quality of snacks such as pretzels and crisps?

'Food-producers show variation in the quality of their end products, possibly due to variations in ingredient characteristics,' explains **dr. ir. Jan Broeze**, researcher in Food & Bio-based Research Wageningen UR. 'The important issue to investigate is which properties of the ingredients determine final quality and how that can be controlled. In this way, new research provides a basis for developing new products based on 'healthy' ingredients.'

Royal Cosun U.A., a major Dutch processor of wet arable crops and one of the industrial partners in this work package, is really excited about the joint public-private research. 'Product and process innovation requires access to infrastructure in the area of carbohydrates on a global level. CCC and Dutch universities can provide this,' stresses **dr. Ad de Laat**, General Manager of Cosun Food Technology Center, in the company's letter of intent.











WP 2a **NOVEL FOOD FIBRES** 



## WP 2a cooperation:

Royal Cosun, Wageningen UR, TNO Healthy Living, University Medical Center Groningen



'Our customers are cereal, bakery and dairy producers looking for added value in relation to texture and health,' says ir. Gerdie Pullens, programme manager at Cosun. 'The project results will provide new innovative fibre ingredients, which will enable customers to develop value-added healthy products.'

'And further research should answer questions about the overall production costs, the possible fibre types that can be obtained and the effects on health,' Pullens continues. Partnership with knowledge institutions is therefore essential: 'They can offer both technology and advanced knowledge.'

# **Results wi**ll provide new innovative fibre ingredients

# Replacement of sugar by artificial sweeteners is important to reduce the

energy density of foods. But that of course has consequences for the mouth

feel and perception of food. Dietary fiber and prebiotics offer opportunities to replace the functionalities of sugars. The work packages 2a, 2b and 2c are focusing on research involving sugars





Consumers are looking for better-for-you products and functional foods. This project unites public and private partners in research into the substantial health benefits of fibres from chicory root and sugar beet with/without added prebiotics and seeks to relate these functionalities to chemical and physical properties. An understanding of the relationship between processing conditions, product composition and health benefits is an important tool for the development of new food applications.

> Dr. Paul de Vos, researcher at the UMCG is convinced of the importance of public-private cooperation as well. 'The consortium brings together unique knowledge indeed. The odds are that we will find molecules capable of maintaining and improving the immune barrier in the gut.'

WP 2b PREBIOTICS AND ANTIBIOTICS FOR A HEALTHY COLON



# **Combating negative effects of anti biotics**

WP 2b cooperation: Royal FrieslandCampina, TNO Healthy Living, Wageningen UR











Is it possible to influence health of elderly people and children by taking prebiotics?

This is especially important when treating with antibiotics, since part of the intestinal flora will be unintentionally slain. The idea underlying this project is that, through the use of prebiotics, the intestinal microbiota recovers more rapidly.

'The aim of this work package is to better understand the ability of several prebiotics to stimulate a recovery of the microflora after an antibiotic treatment dr. Henk Schols, Food Chemistry Group of Wageningen UR, explains. 'The results of this research will be used to develop new applications for prebiotics to counteract the negative effects of antibiotics on intestinal health.'

# I-chip technology

Well-known prebiotics such as Galacto-oligosaccharides (GOS) but also new potential prebiotics like acetylated glucomannan oligosaccharides originating from the tuber of the Asian plant Amorphophallus konjac, will be studied. The TNO I-chip technology will be used for the high throughput screening of the microbiota and state-of-the-art LC/CE-MS will be used to monitor the degradation of individual prebiotic oligosaccharides in fermentation studies.

and well-being.

Research on prebiotics is important to the industrial partner within the work package, Royal FrieslandCampina, as well. The company provides people around the world with all the good things milk has to offer; products that play an important role in people's nutrition

WP 2C

# **DECORATING** STARCH/MALTODEXTRINS WITH ISOMALTO-OLIGOSACCHARIDES



This work package aims to explore the production and characterization of a new generation of prebiotic oligosaccharides. GTFB is a novel enzyme, structurally closely related to glucansucrases, from the probiotic bacterium Lactobacillus reuteri strain 121. The GTFB enzyme is expected to produce a new generation of starch derivatives called IMO-MALT. which will degrade more slowly in the small intestine. They have a lower glycaemic index, which serves to reduce blood glucose levels after food consumption. IMO-MALT is also expected to exert beneficial effects on colon health by stimulating the bifido bacteria living in the human colon, thus acting as probiotic compounds.

Professor dr. Lubbert Dijkhuizen from the Department of Microbiology, University of Groningen is coordinating the project. 'Industry informed me that they were looking for modified starch products, resulting for example from the action of bacterial enzymes on starch. At the University of Groningen we are making these new products with a recently discovered novel enzyme (GTFB), which provides a completely unique way to introduce modifications in starch. The function of this enzyme is described in patent WO 2010/128859 University of Groningen, published on 11 November 2010.'

'Such modified starch products can potentially be used in foods,' Dijkhuizen continues. 'We expect that these new products will be digested more slowly than native starches in the human digestive system and that they will help prevent peaks in blood glucose levels. The results of our research basically offer a health-promoting property, opening up new markets in the agro-food business. Together with AVEBE, Hanze University Groningen and our Department of Microbiology, we are investigating the properties of these novel modified starch products.'

# **Economic opportunities**

In addition to economic opportunities, the project offers real scientific challenges, not the least for Dijkhuizen himself. 'In this public-private cooperation within CCC, we have an opportunity for more intensive investigations of the properties of several other GTFB-type enzymes and their starch products. A range of related enzymes are currently being characterized. Through this project I am learning new things about the properties of (modified) starch molecules and their applications. It's fascinating.'



# 'Industry informed me that they were looking for modified starch products'

## WP 2c cooperation:

AVEBE, University of Groningen, Hanze University Groningen (Institute for Life Science & Technology)



CEE SHOW CASES

# CARBOHYDRATE STRUCTURE AND FUNCTIONALITY

WP 12

# **NOVEL CARBOHYDRATE-PROTEIN CONJUGATES THROUGH** CHEMO ENZYMATIC SYNTHESIS



## WP 12 cooperation:

AVEBE, Royal FrieslandCampina, University of Groningen, Wageningen UR, TNO Healthy Living



This work package aims to produce a new class of block bio-polymers by cross linking proteins with carbohydrates of various size, structure and number of oligosaccharide units. Structural and functional characterization of these carbohydrate-protein conjugates will tell us more about the structure-function relationships.

'We were approached by industry,' explains dr. Carmen Boeriu, senior scientist Food & Bio-based Research Wageningen UR, 'to investigate the possibility of modifying proteins for new or improved applications. The modifications should take place in a food-grade process.'

# Better products make a better market share

'Results will enable the industry to design and produce new functional materials derived from proteins and carbohydrates and to fine-tune the properties of the products to specific applications in the food and non-food industry,' Boeriu continues. 'The economic value of this project is the production of new bio-polymers. By enhancing the properties of these bio-polymers or finding new properties, the industry can increase its market share. In addition, better products will be available. The scientific challenge is to develop new techniques for improved biopolymer characterization, to study how certain changes in occurring in the protein relate to the enhanced or new properties.'







# **Results enable the industry to design and produce new materials**

WP 25 IMMUNOMODULATION OF OLIGOSACCHARIDES



## WP 25 cooperation:

Danone, Royal FrieslandCampina, Wageningen UR, Utrecht University





This CCC project seeks to identify, characterize and synthesize oligosaccharides that improve gut physiology and balance the immune system.

'The major aim is to acquire knowledge about the effects of oligosaccharides on inflammatory processes and to discover and test newly defined immunomodulatory carbohydrates for use in infant nutrition as well as medical nutrition,' explains **professor dr. Johan Garssen**, director of the immunology platform at the Danone Research Centre for Specialised Nutrition.

'Danone incorporates many different carbohydrate structures in its infant formulae and medical nutrition,' Garssen adds. 'A number of specific oligosaccharide-containing formulae have already been patented and are widely used. Given the fundamental nature and broad scope of this field, it is virtually impossible for Danone Research to do this research alone. So we are really delighted to work together with academic partners within our CCC project.'

# A number of specific oligosaccharides - containing formulae have been patented



# WP<sub>6</sub>

# ENZYMATIC MODIFICATIONS OF PREBIOTICS







Royal FrieslandCampina and VION Food Group are interested in new generations of healthy food and feed products. In this context, possibilities to give an added value to some of their regular waste stream products have been examined. This work package focuses on the enzymatic modifications of regular and promising new prebiotics starting from relatively cheap carbohydrate donors from animal sources, using transglycosidases as catalysts, and prebiotics as acceptors.

'If we succeed, we will have contributed to the development of novel carbohydratebased food and feed products with broad health functionalities,' professor. dr. Hans Kamerling, Honorary Professor of Chemical Glycobiology of the University of Groningen, explains. 'And for myself, as a researcher, I will have learned to look more critically to the possibilities of using easily available animal raw materials for high-level carbohydrate research.'

# **Added value to** regular (waste stream) products

# WP 6 cooperation:

VION Food Group, Royal FrieslandCampina, University of Groningen









# COMMENTARY

Our bodies need fuel in order for us to produce lots of energy, day in and day out. We ingest this fuel through our food, with carbohydrates being an important source of energy. Economic development works on the same principle. To function competitively, a strongly growing economy requires regular refueling, or economic energy. Partnership and entrepreneurship are key here. That's because the planned strengthening of the economy cannot happen without the involvement and interests of the business community. Crossovers and alliances play a pivotal role, giving rise to a powerful content mix that leads to sustainability and innovation.

# **Economic synergy**

The Carbohydrate Competence Center is the national platform par excellence in the field of agro-business. It is a place where entrepreneurs and scientists come together to jointly develop new ideas, products and markets in the area of carbohydrates; in other words, economic synergy. Agro-business will play a leading role in the northern economy of the future. The agrarian sector in the Northern Netherlands has an added value of EUR 5.7 billion and provides 69,000



jobs. Twenty-eight percent of Dutch agricultural activity takes place in the Northern Netherlands, with agro-business accounting for 15% of the employment and occupying 70 to 75% of the rural land.

Active cross-pollination of themes and stakeholders within the carbohydrates industry is the ideal fuel for generating a sound and strong economy based on regional, national and international food clusters. This is a mission for which the NOM lends active support to CCC.

Sustainable products and production methods are the focus in this field of expertise:

how can we produce cheap fermentable sugars from biomass and how can these be processed into

*innovative products, for example in the field of green chemicals, new materials and bio-energy?* 

# WP 3 OPTIMIZATION OF MAIZE CELL WALL CARBOHYDRATE COMPOSITION FOR EFFICIENT CONVERSION INTO BIO-FUELS



# **Bio-based** breeding brings benefits

## WP 3 cooperation:

IMEnz Bioengineering, Limagrain Nederland BV, Genencor, Wageningen UR, University of Groningen, Hanze University Groningen











Is it possible to develop maize varieties with cell walls that are more easily degradable, so that they can ultimately be more readily converted to sugars and bio-fuels via saccharification and fermentation? It is important to explore this question because the processing cost of converting cell walls into alcohol is currently still too high to make cellulosic ethanol a commercially attractive proposition.

'The goal of this project,' explains **dr. Luisa Trindade** Plant Breeding Group Wageningen UR, 'is to optimize the cell wall carbohydrate composition of maize in order to improve the efficiency of polysaccharide conversion into monosaccharides, an application that can also be used in fermentation processes for either bioethanol or biomethane production.'

'Plant breeding can play a major role in the transition to an economy,' Trindade continues. 'By modifying plants we can obtain energy more efficiently and affordably. Plant breeding contributes to the transition to a sustainable bio-based economy. And more importantly, we can give industry new materials for making new and better products.'

# Innovative enzyme solutions

**Dr. Casper Vroemen**, R&D director at Genencor International B.V. Leiden, agrees with Luisa Trindade. 'Public-private partnership is essential,' explains Vroemen in the company's letter of intent. 'We need each other. Although our company is a global player in the field of industrial enzymes, it is impossible for us to cover the entire spectrum of knowledge extending into fields such as plant breeding and plant genetics. Participation in the CCC consortium gives us access to a broader field of science and technology and, at the same time, provides our partners with early access to our innovative enzyme solutions for the second generation bio-fuel market.'



**WP 8** ADVANCED PRETREATMENT OF COMMON BIOMASS FEEDSTOCKS



# We need new pretreatment technologies

WP 8 cooperation: Royal Cosun, AVEBE, Duynie, Wageningen UR

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The cell wall composition and structure of many primary feedstocks and by-products lead to limited workability and extractability, and limited conversion to intermediates or end-products. To increase the market potential of these feedstocks, we need to develop new pretreatment technologies that lead to higher quality products with increased value for new outlets while reducing processing costs.

'This project aims to develop a number of new, advanced pretreatment technologies on model feedstocks,' says dr. Robert Bakker of Food and Bio-based Research Wageningen University. 'These new technologies will be developed for commonly used feedstocks like potato and potato fibres, sugar beet pulp, and others.'

'The results will indeed lead to a reduction in the processing costs of common feedstocks,' Bakker continues. 'In addition, we will improve our knowledge of the effects of pretreatment on cell wall properties, and the type of polysaccharide structure modifications needed for specific product functionalities.'







WP 9

LACTOSE HYDROLYSIS AND ENZYME IMMOBILIZATION



## WP 9 cooperation:

Royal FrieslandCampina, Wageningen UR, University of Groningen



'The conversion of lactose into galactooligosaccharides (GOS) is the main theme of the present work package,' dr. Ellen van Leusen, senior research manager at FrieslandCampina Domo says.

'The research activities aim at extending the technological know-how and understanding of the reaction of B-D-galactosidases as such, and potential of enzyme immobilization technology in relation to the use of these enzymes in industrial processes. The characterization of the kinetics and thermodynamics of B-D-galactosidase, on one hand, is essential to optimize processes and products. The use of immobilized enzymes, on the other hand, may improve production efficiency by enabling continuous operation procedures. We are doing this fundamental research in close collaboration with university researchers.'

# A challenge for fundamental research

**Professor dr. Ton Broekhuis**, Department Product Technology at the University of Groningen, is one of the academic partners within the consortium. He stresses the importance of public-private cooperation as well. 'It offers new challenges for fundamental research,' Broekhuis explains. 'This is new research involving knowledge from existing chemistry disciplines extended to unknown areas. We work, therefore, at the interface of two different scientific disciplines. It's often a good basis for new innovations. You could say that both disciplines learn from it and benefit from it.'

'Finally, the research not only contributes to the strengthening of our knowledge about our current process, but also contributes to future product and concept development,' stresses Van Leusen.

# Working on GOS at the interface of disciplines





#### **WP 10** CARBOHYDRATE-BASED POLYMERS



# **Developing** applications outside of the known and existing application areas

## WP 10 cooperation:

AVEBE, Royal Cosun, Wageningen UR, University of Groningen, TNO Healthy Living



Naturally occurring bio-polymers like starch have a limited application scope in the non-food area since they are watersensitive and labile upon heating. Can we develop new applications to expand their possibilities?

'This work package aims at developing new chemical and polymer blending technologies to create carbohydratebased polymers that have reduced water absorption characteristics compared to the current starch and hemicellulosesbased polymers,' explains dr. Jacco van Haveren, programme manager Sustainable Chemistry at Food & Bio-based Research Wageningen UR. 'Our project aims to develop uses outside of the known and existing application areas.'

## **Reducing costs**

Novel potato starch and/or waxy potato starch-based products are potentially suitable for non-food applications such as adhesives or paper coating and furan-based polymers have the potential to replace e.g. PET bottles, fleece textile or aramid fibres. Such products are now being produced at million tonnes/year quantities, from fossil resources. For industrial



partners AVEBE and Royal Cosun, finding new applications can offer opportunities to reduce their raw material production costs and expand their portfolio to new bio-based products.













WP 26

# UPGRADING THE CARBOHYDRATE FRACTION IN INDUSTRIAL SIDE-STREAMS



WP 26 cooperation: AVEBE, Smurfit-Kappa, TNO Healthy Living





'In this work package we are developing new processing steps to improve the functionality of complex carbohydrates in potato pulp,' ir. Maurice Essers scientist TNO Healthy Living, explains. 'We want to reach an optimal utilization of available components using integrated separation techniques within the bio-refinery processes.'

Industrial processing of agricultural products such as leaves, potato pulp and peels results in side streams which could yield valuable carbohydrates if additional bio-refinery steps were applied.

# **Fiber functionality**

AVEBE and Smurfit Kappa play a key role to make this project industrial credible and sustainable. Essers: 'Developing new bio refining processes will lead to optimization of fiber functionality and provide the industry with a wealth of new scientific knowledge, new improved products, new potential markets and new jobs.'



# **Offering new potential markets and new jobs**









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WP 27 ADVANCED TECHNIQUES FOR ENCAPSULATION AND COATING



# New products are the solution



This project focuses on the design of coatings for important, unstable nutrients such as vitamins and probiotics so that they will be optimally delivered in the body. Questions to be answered include: which new materials are available for encapsulation; what are their properties; how can they be measured; how can the right materials be selected?

'Friesland Campina, the industrial partner in this project, requires that the encapsulated ingredient should be in such a form that the taste and texture of the food product are not compromised,' professor dr. ir. Kees van der Voort Maarschalk, and Anko Eissens, Research Analyst, from the department Pharmaceutical Technology and Biopharmaceutics at the University of Groningen explain. 'It's a real scientific and engineering challenge for our team.'

# Added value

WP 27 is a project with considerable potential added value for FrieslandCampina. Van der Voort Maarschalk: 'The development of new products is the answer to our demands. These products will have high added value and may open new markets.' **WP 27 cooperation:** Royal FrieslandCampina, University of Groningen









WP 28 cooperation: AVEBE, TNO Healthy Living



#### **WP 28 PLASTICS FROM CARBOHYDRATES**



The main purpose of work package 28 is to develop innovative solutions for the development of generic green processes for producing cheap and green bio-polymers.

'It's a real challenge,' says dr. Ted Slaghek, product manager Ingredients and Functionality at TNO Healthy Living. 'Our aim is to develop a cheap and clean semi-solid process for the modification of starch by etherification. This process leads to a green bio-polymer product.'

# People, Planet, Profit

'Many chemists are needed to modify materials,' adds dr. Lizette **Oudhuis**, senior scientist at TNO. 'In our project we are looking into methodologies where the chemicals can be replaced as much as possible by environmentally friendly technology. Indeed, a challenge.'

By looking for new environmentally friendly technologies, the partners take into account ecological and social performance in addition to financial performance. Lizette Oudhuis: 'The demand for sustainable products and technologies is increasing dramatically. Taking responsibility for environmental and/or social issues will lead to enhanced profitability.'



# This process leads to a green bio-poly mer product





Dr. Ted Slaah





# **PARTNERS** CARBOHYDRATE COMPETENCE CENTER

#### **Knowledge Partners**



The University of Groningen provides high quality teaching and research, is internationally oriented, respects differences in ambition and talent, works actively with business, the government and the public, and ranks among the best universities in Europe. www.rug.nl



The University Medical Center Groningen (UMCG) is one of the largest hospitals in the Netherlands and the largest employer in northern Netherlands. The more than 10,000 employees working in patient care and leading scientific research, which focuses on 'healthy and active aging. www.umca.nl



Under the heading 'Healthy Living', TNO carries out research aimed at providing concrete solutions to problems encountered by industry and government bodies. TNO develops knowledge for important national and international market clusters such as 'Agriculture and Nutrition' and 'Chemistry and Pharmaceutics'. www.tno.nl



# **Universiteit Utrecht**

University of Utrecht aims to sustain its position as a research institution of the highest international quality, to provide clear research focus areas with a particularly interdisciplinary approach, and to take the lead in implementing the Bologna principles into its teaching programmes. www.uu.nl



Hanze University Groningen, University of Applied Sciences is the largest organization for applied research, consultancy and modern education in the north of the Netherlands. With its 24,000 students, almost 3,000 staff and a steadily growing research portfolio focusing on energy, healthy ageing and more, it is evolving into a mainstream European University of Applied Sciences. www.hanze.nl



Wageningen UR (University & Research centre) explores the potential of nature to improve the quality of life'. WUR has a staff of 6,500 and 10,000 students from over 100 countries work everywhere around the world in the domain of healthy food and living environment for governments and the business community-at-large. www.wur.nl



Our curricula focus on nature and environment, human and animal health and responsible entrepreneurship. We are not just a university, but also a knowledge company for social and economic questions. Van Hall Larenstein is part of Wageningen UR. www.vanhall-larenstein.nl

# **Industrial Partners**



#### Averis Seeds B.V. / Valthermond

Averis Seeds focuses on the development, multiplication and trade of starch potato varieties. Averis Seeds represents varieties that are grown in all starch potato growing areas in the Netherlands, Germany, France and the Scandinavian countries www.avebe.com/averis



The cooperative AVEBE U.A. is a global company that delivers products based on potato and potato protein for use in food, animal feed, paper, construction, textiles and adhesives, AVEBE has offices in Foxhol, Ter Apelkanaal and Gasselternijveen. Some 3,500 farmers are connected to AVEBE, divided into six districts: two in Germany, four in the Netherlands and one in Sweden, www.avebe.com



Aviko / Steenderen

#### Since 2002 Aviko is a 100% subsidiary of Royal Cosun. Aviko is the second largest potato processing company in Europe and fourth worldwide. Furthermore Aviko is the largest producer of chilled chips in the world. Currently Aviko employs around 1.600 people. Our production units process about 1.7 million tonnes of potatoes per year. The group now has about 20 Aviko subsidiaries around the world. www.aviko.nl



#### Agrifirm Innovation Center / Apeldoorn

Agrifirm Innovation Centeris a cooperative in which more than 20.000 Dutch farmers and horticulturalists have combined their purchasing power. We offer you maximum purchasing advantage on high quality products like animal feed, seeds, fertilisers and pesticides. But we offer more than just products. We invest a great deal of time in knowledge and innovative power. So that we can optimally contribute to successful crop cultivation and livestock farming. www.agrifirm.com/agrifirm-group

#### DANONE RESEARCH OR SPECIALISED NUTRITION

## Danone Nederland B.V. (Research) / Wageningen As a prominent player in the sector of fresh milk, water,

baby food and clinical nutrition, Danone was closely involved in the relationship between diet and health. Danone aims to bring health through nutrition for many people. We believe that nutrition plays a fundamental role in the welfare and health of everyone. Danone is proud to continue delivering high quality, healthy and delicious products. www.danone.nl



Duynie / Alphen aan de Rijn

food industry. www.duynie.nl

GENENCOR®

Genencor® / European contact: Leiden

A Danisco Division

Duynie is for over 40 years a well known name in the livestock sector. With our activities we work on improving the feed efficiency of our customers' businesses. Duynie's customers are cattle farmers, pig, goat, rose calf breeders and energy producers in the Netherlands and abroad. We specialize in high quality, high-moisture feed from the



#### AVEBE / Veendam

Genencor®, a division of Danisco A/S, is a world leading enzyme supplier and a pioneer in enzyme innovation and metabolic pathway engineering. Genencor improves processes and product performance, and creates new products, for a spectrum of industries. The sectors we serve range from biofuels and laundry detergents to animal nutrition and food.www.genencor.com



#### HZPC Holland B.V. / Joure

HZPC Holland B.V. is one of the worlds largest private seed potato companies focusing on potato varieties in the sectors retail, traditional, french fries, crisps and peeled convenience products. HZPC is exporting potato seeds to more than 70 countries worldwide. A significant part of HZPC varieties is produced in local markets often according to license agreements. To support the core business (seed potatoes) HZPC also markets ware potatoes. www.hzpc.nl



#### IMEnz Bioengineering / Groningen

IMEnz Bioengineering is a biotech company that carries out applied research of Industrial Microorganisms and Enzymes. IMEnz develops processes to improve the sustainable production of biobased chemicals from renewable raw materials. These organic sources can be the widespread byproducts from the agri-related industry. including food and feed producers, and the paper industry. www.imenz.com



#### Limagrain Nederland BV / Rilland

Limagrain is the largest Dutch plant breeder and supplier of agricultural seeds for professional use in the food and agriculture and green industry. Limagrain offers a comprehensive set of plant varieties with the latest know-how into their custody and deliver evidently financial benefits. www.limagrain.nl



#### MARS Company / Veghel

Mars. Incorporated has grown into a company of global scope with six business segments including Chocolate, Petcare, Wrigley Gum and Confections, Food, Drinks and Symbioscience, generating annual revenues of more than \$28 billion. As a family-owned company for nearly a century, we are guided by our Five Principles: Quality, Responsibility, Mutuality, Efficiency and Freedom. www.mars.com



#### NOM / Groningen

N.V. NOM - Investment and Development Agency for the Northern Netherlands. As an independent company. NOM strives to develop employment in the Northern Netherlands by stimulating sustainable and profitable economic activities. www.nom.nl



#### Nutreco Holding N.V. / Amersfoort

Nutreco Holding is a global leader in animal nutrition and fish feed. Our advanced feed solutions are at the origin of food for millions of consumers worldwide. Quality, innovation and sustainability are guiding principles, embedded in the Nutreco culture from research and raw material procurement to products and services for agriculture and aquaculture. Experience across 100 years brings Nutreco a rich heritage of knowledge and experience for building its future. Nutreco employs almost 9.900 people in 30 countries, with sales in 80 countries. Nutreco is listed on the NYSE Euronext stock exchange in Amsterdam and with annual revenues of EUR 4.5 billion in 2009. www.nutreco.com



Cosun produces and sells natural ingredients and foodstuffs for the international food industry, foodservice channel (restaurants, caterers and wholesalers) and retail outlets. The group also processes organic residues into products for non-food applications. We work in the first links of the food chain through the collection and large-scale processing of farm products into high quality ingredients and foods, www.cosun.com



#### Roval DSM N.V. / Heerlen

Royal DSM N.V. creates solutions that nourish, protect and improve performance. Its end markets include human and animal nutrition and health, personal care, pharmaceuticals, automotive, coatings and paint, electrical and electronics, life protection and housing, DSM has annual net sales of about €8 billion and employs some 22,700 people worldwide. The company is headquartered in the Netherlands, with locations on five continents. www.dsm.com



Roval Friesland Campina / Amersfoort Royal FrieslandCampina provides people around the world

#### with all the good things milk has to offer. Friesland-Campina produces baby and infant food, milk-based drinks, cheese, milk, yoghurts, desserts, butter, cream, milk powder, dairy-based ingredients and fruit-based drinks - products that play an important role in people's nutrition and well-being. www.frieslandcampina.com

# Smurfit Kappa

#### Smurfit Kappa Group / Roermond

The Smurfit Kappa Group wants to be recognized as the most successful paper-based packaging company in its chosen market sectors. To achieve this means providing innovative packaging solutions, outstanding customer service, maintaining low costs and remaining fast, flexible and always ahead of changing demands - creating tangible value in many different ways. www.smurfitkappa.nl

# **SYRAL** Formulae of the future

#### Syral Belgium NV / Aalst Belgium

Syral is a leading producer of starches, starch sweeteners, alcohol and proteins in Europe. Syral processes corn and wheat to manufacture a wide range of value added products in compliance with the current and future requirements of the food, pharmaceutical, green chemistry, animal nutrition, paper and corrugated board industries www.syral.com



#### VanDrie Group / Mijdrecht

The Dutch-owned VanDrie Group is not only the world market leader in yeal, but also a company built on the best family traditions. In the early 1960s, Jan Van Drie purchased his first newborn calf for fattening. Today, with more than 20 companies, the group is the largest integrated veal producer in the world. The VanDrie Group has a market share of ± 25% in Europe. www.vandriegroup.com



# VION Food Group / Eindhoven

VION Food Group, headquartered in Eindhoven (the Netherlands), is a global food company that produces high quality foodstuffs and ingredients for people and animals. We specialize in fresh meat, processed meat, frozen vegetables and vegetarian products, as well as ready-tocook meals and convenience food. We also produce the best possible ingredients for the food and pharmaceutical markets. www.vionfoodgroup.com



WALTHAM® Centre for Pet Nutrition / Leicestershire (UK) The WALTHAM® Centre for Pet Nutrition is the hub of our global research activities, where we work with dogs, cats, birds, fish and horses. In collaboration with global scientific institutes, our unique team of carers, scientists and research staff supports leading Mars Inc petfood brands, amongst others: PEDIGREE, WHISKAS, SHEBA, CESAR, Our team has pioneered some of the most important breakthroughs in pet nutrition, and has shared the results of the Centre's research via more than 1,500 publications, and regular communication with scientific and pet care community. www.waltham.com

Roval Cosun / Breda





# At a glance

CCC is a national and international leading institution in the field of carbohydrates research and as such an attractive partner (and agent) for innovation in all areas where carbohydrates knowledge plays a significant role

# For the bio-based economy as a whole. **CCC activities** support a sustainable,

innovative and competitive carbohydrate industry sector by exploiting product-market combinations that have a high added-value.

# For a Healthy Society,

**CCC activities** enhance consumer welfare and well-being, reducing healthcare costs, by contributing to the development of products that support a healthy diet and healthy lifestyle.

**CCC activities** foster innovation in Europe by creating high quality, integrated food and nutrition knowledge through research and information transfer between companies and universities and between universities themselves.

**CCC activities** create opportunities for spinning out of technology and researchers into new start-up companies. CCC is open to new members for participation in existing activities or initiation of new activities.

#### For more information:

www.cccresearch.nl

# **Research and partnership**



# **Heading** for the highest peaks!

# COMMENTARY

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Groningen and the Northern Netherlands have a knowledge-based economy where innovation comes first. The Carbohydrate Competence Center is an excellent example of knowledge transfer, cooperation, innovation and ambition!

. . .

It, therefore, comes as no surprise that the Carbohydrate Competence Center received an Excellence Award for Agro-business in 2009 from Minister Maria van der Hoeven. This ceremony took place during the 'Pieken op Koers!' [Headed for the highest peaks] event organized by the Northern Netherlands Assembly.

CCC received this award for the northern project with the greatest appeal. According to the jury's report: 'Carbohydrates are a niche area within knowledge development, offering great opportunities for innovative new products such as novel foods and future raw material for the chemical industry. CCC conducts strong market-driven research with both international appeal and social relevance, particularly in relation to combating obesity through sugar substitutes.'

A northern model of synergy working to produce value.



TARGETING **CURRENT SOCIAL** AND ECONOMIC CHALLENGES



# The future and beyond

The activities of the Carbohydrate Competence Center are already receiving recognition. In 2009 the Committee of Trustees of the Northern Netherlands awarded CCC an Excellence Award in the agro-business sector. The award recognizes projects that excel in learning innovation and cooperation as well as projects that make a major contribution to economic and social welfare of the region.

# **STEPPING STONE TO NEW CHALLENGES**

CCC research binds new partners in innovation and strengthens the network in carbohydrate research at various levels. At the regional level, CCC is working together with new agro-food orientated institutions, such as:

## Food Circle Northern Netherlands - Food for Healthy Ageing

Food Circle works on behalf of the food industry, converting trendsetting ideas into products in the field of nutrition for the elderly. CCC's investment has facilitated a faculty position in carbohydrate competence within the Food Circle Programme.

## **BioBRUG for bio-based economy**

BioBRUG brings together regional industry and science in the areas of life science, chemistry and materials. It focuses on durability, with an emphasis on biomass in a bio-based economy. CCC invests in BioBRUG by facilitating a faculty position in carbohydrate competence within the BioBRUG Programme.

At a national level, the CCC works closely with renowned institutions such as the Top Institute Food & Nutrition (TIFN) and Food & Nutrition Delta (FND). These two institutes aim to transform the Netherlands into a leading European food innovation region.

## **Crossing borders**

CCC aims to gain international recognition in the field of carbohydrates. To this end it stands itself up for organizing an international conference of the European Polysaccharide Network of Excellence (EPNOE). In 2012 CCC will organize the biennial summer school, in Groningen, for agro-food researchers. Young researchers from the Netherlands and around the world will be invited to attend.

#### **European programmes**

Further, new international partners and researchers will be invited to cooperate with CCC in various EU programmes including, possibly, a larger cross-border carbohydrates programme.

#### Towards a healthier and sustainable society

'Countries like Japan, France, the United States and the Netherlands play a major role in innovative carbohydrate research,' concludes Geert Jan Arends, business manager of CCC. 'We cordially invite the agro-food industry and researchers from all over the world to participate in our mission for a healthier and sustainable society.'



Towards a healthier and sustainable society;

# CCC Showcases,

highlights of demand-driven carbohydrate research, is published by the Carbohydrate Competence Center, Groningen, the Netherlands.

March, 2011

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Carbohydrate Competence Center is a public-private partnership in the agro-food industry

Coordinating 22 agro-business challenges Cooperating with 13 research teams Comprising over 100 excellent researchers

CCC consortium activities are co-financed by the European regional development fund (ERDF), the Dutch Ministry of Economics, Agriculture and Innovation, the Northern Netherlands Assembly (SNN), the Provinces of Groningen, Friesland and Drenthe, the City of Groningen.





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