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Scientific Report (*Final version*)

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Location:	Conference Centre Hof van Wageningen, Wageningen, NL
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Convener Name:	Professor Lubbert Dijkhuizen, Groningen, NL

Course Organizers:	Chantal Doeswijk, Graduate School VLAG Dr. Mirjam Kabel and Prof. Dr. Henk Schols, Wageningen University, The Netherlands Prof. Dr. Marc. van der Maarel and Prof. Dr. Lubbert Dijkhuizen, University of Groningen, The Netherlands Prof. Dr. Serge Perez, CNRS-Université Joseph Fourier, Grenoble, France
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1. Summary

The Summer Course Glycosciences is a bi-annual event that was organized for the 13th time this year in close collaboration between Wageningen University, University of Groningen and CNRS-Université Joseph Fourier, Grenoble, France.
Distinctive for the Summer Course Glycosciences is that general introductions in the field of polysaccharides and glycoproteins are combined with in depth parallel sessions. This gives participants the possibility to focus on specific interests without loosing a broad education.
Another feature of the Summer Course is that most lecturers will remain present during the course for further communication with participants. In addition, within the program 20-25% of time was scheduled for discussions.
During this edition the participants were exposed to 19 plenary sessions and six parallel sessions, altogether 31 lectures given by 22 senior scientists from seven European countries.
On average this Summer Course attracts about 100 participants. This year we welcomed 87 participants from 14 different European countries (Figure 1), 1 from Israel, and 4 participants from other continents, namely North America (Canada, USA), South America (Brazil)! When looking at the nationalities of the participants we even have a more multifarious audience e.g. 30 different nationalities were represented at the course (Figure 2)!
To encourage participation by researchers from Eastern Europe and from developing countries, a number of grants were made available. However, this year we observed a decrease in participants from Eastern Europe and from developing countries, 4.6% of total count compared to 11 % in 2012. Also the number of participants from Eastern Europe itself decreased rather strongly, from 5.5% to 1%. From the number of participants per country and from the nationality overview, it can be hypothesised that an increasing number of Eastern European PhD students is going to Western European countries to do their PhD and therefore the actual number of participants from Eastern European countries is not decreasing but rather the number of participants in need of a grant.

Figure 1: Number of participants per country

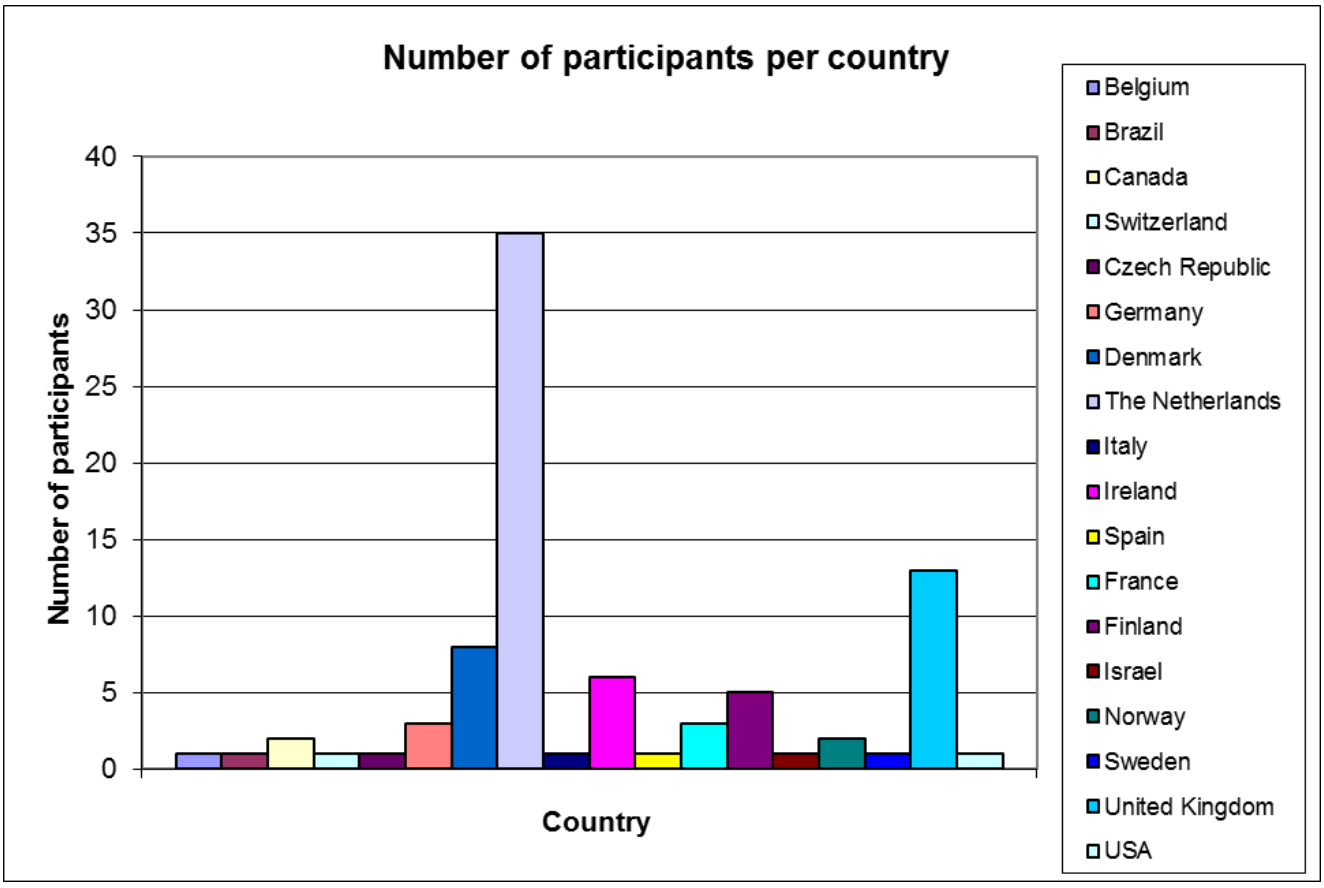
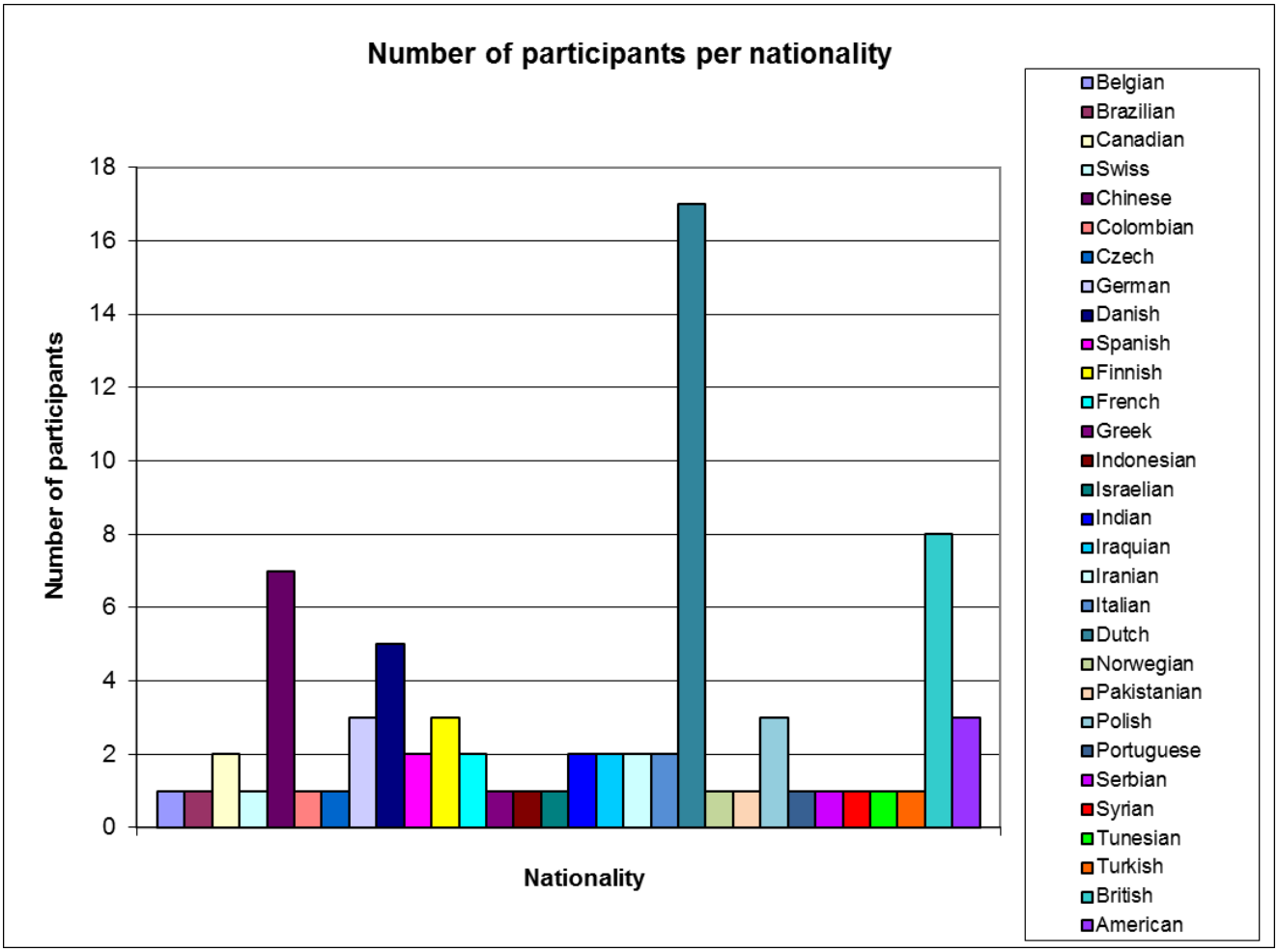


Figure 2: Number of participants per nationality



Prior to the start of the course, all participants and lecturers got access to our special Glycosciences website with course information and biographical sketches of the lecturers, and downloadable background literature. In addition, after the course all presentations and posters have been made available as PDF-files. The website will remain open to all participants for at least one year. A course binder containing hardcopies of all presentations and a Book of Abstracts were handed out to all participants and lecturers during registration.

2. Scientific contents and discussion

Introduction

The 2014 Summer Course Glycosciences (13th European Training Course on Carbohydrates), held from April 13 to April 17, 2014, in Wageningen, The Netherlands, comprised a well-balanced educational programme for the 107 participants (PhD students, post-docs, lecturers, industrial scientists), mostly from all over Europe. The topics were grouped in 6 topical research areas:

- **Medical and Health Aspects of Carbohydrates**
- **Polysaccharides and Functional Properties**
- **Carbohydrate Degrading Enzymes**
- **Carbohydrate Analysis**
- **Chemical and Enzymatic Synthesis of Carbohydrates**
- **Valorization of Carbohydrate-rich Biomass**

Opening session

The 13th edition of the Glycosciences Summer Course was opened by **Prof. A.G.J. Voragen**, involved in the organization of the previous 12 editions of the course over the period of 1989-2012. He presented a historic overview, explained the origins of the course, its early locations, and main topics dealt with. He estimated that over these years approximately 1200 young European scientists have participated in the course.

Polysaccharides and Functional Properties

On the opening evening **Prof. Dr. J. Delcour (University of Leuven, Belgium)** outlined the multidisciplinary approach followed to study the properties of arabinoxylan oligosaccharide (AXOS) as a novel prebiotic. He described a pilot scale process for extracting AXOS from wheat bran, and studies of their prebiotic effects in chickens and rats as well as in humans. A major feature of AXOS is that, in the colon, it is selectively fermented to short chain fatty acids in general and butyric acid (a fuel for colon mucosa cells) in particular. AXOS induces specific changes, both in the composition and/or activity of the gastrointestinal microflora, that confer benefits upon host well-being and health. It thus meets the criteria needed for classification as prebiotics.

Further lectures dealt with plant cell wall polysaccharides, bacterial polysaccharides, the storage polysaccharide starch, and cellulose. **Prof. Dr. H.A. Schols (Wageningen University)** gave a description of the most dominant polysaccharides as present in different plants (monocotylic versus dicotylic plants; primary versus secondary cell walls), the cross-links within the cell wall between different (classes of) polysaccharides, their isolation and characterization and detailed information on the structural elements of pectin and the wide variety of variations possible within these structural elements depending on origin and localization within the plant. Examples were given of how to approach the elucidation of the chemical structure of such highly complex and highly variable plant polysaccharides by making use of chromatography and pure and well-defined carbohydrases in combination with identification of oligosaccharides released using state-of-the-art analytical techniques like e.g. mass spectrometry. The polysaccharide composition and chemical structure and architecture of cell wall polysaccharides were related to the functional properties of (isolated) cell wall polysaccharides and the quality of foods derived from plant produce.

Prof. Dr. B.E. Christensen (NTNU, Trondheim, Norway) presented an overview of the use of size exclusion chromatography for the characterization of physico-chemical properties of polysaccharides. This was illustrated with examples of various polysaccharides (e.g. dextrans, xanthans, alginates).

In a second lecture **Prof. Christensen** described the discovery, production and characterization of alginates, their bacterial biosynthesis and processive epimerization. Alginates are structurally diverse and examples of structure elucidation by H-NMR analysis were presented. Alginates find applications in food, as well as in pharmacy and biomedicine.

Prof. Dr. O Holst (Research Center Borstel, Germany) gave an overview of the broad variety of polysaccharides found in bacteria, in particular with a focus on structures, functions, and biosynthesis of polysaccharides from Gram-negative and -positive bacteria, and from mycobacteria, e.g. lipopolysaccharides, capsular polysaccharides, lipoteichoic acids, arabinogalactan, and others. Also the general architectures of the Gram-negative, -positive and mycobacterial cell walls were discussed.

Dr. P. Buwalda (AVEBE) discussed the structures of starches from different botanical sources and explained how the complex architecture of starch granules correlated with starch functionality. The crystallinity of the amylopectin part of starch is influenced not only by natural variations like phosphate and lipid levels, but can be changed upon chemical modification of the starches. Also crosslinking and gelling of starches to improve their functionality in food and non-food applications were discussed.

Medical and Health Aspects of Carbohydrates

Professor Dr. J.M.F.G. Aerts (AMC, University of Amsterdam) reported studies on Gaucher disease, the most common lysosomal storage disorder due to a deficiency in an enzyme, lysosomal acid beta-glucosidase (Glucocerebrosidase; GBA1), currently treated by enzyme supplementation therapy. He described the synthesis of activity-based probes allowing specific and sensitive visualization of GBA1, i.e. in cultured

cells, and in different tissues of mice. It is also feasible to follow the fate of labeled therapeutic enzymes in cultured macrophages and mice.

Dr. E. van Leusen (FrieslandCampina) reviewed the synthesis of galacto-oligosaccharides (GOS) from lactose with the enzyme beta-galactosidase, detailing the scaling up process from small scale laboratory experiments to commercial scale bulk production. Since their market introduction about 10 years ago, GOS are nowadays broadly applied in nutritional formulations. Various recent developments were highlighted, i.e. the detailed structural characterization of GOS molecules, enzymatic synthesis of sialylated-lactose and –GOS, and beta-galactosidase enzyme immobilization.

Prof. Dr. O. Holst (Research Center Borstel, Germany) discussed biomedical aspects of (poly-)saccharides, with focus on the endotoxic properties of Gram-negative bacterial lipopolysaccharides (LPS), phase variation of LPS/oligosaccharides and the role of LPS in host cell invasion. Capsular polysaccharides present good vaccine candidates, exemplified by the *Haemophilus influenza* type b polysaccharide vaccine.

Dr. K. Venema (Beneficial Microbes Consultancy) outlined current insights in polysaccharide conversion by bacteria resident in the human gut. His contribution focused on recent technical advances to study fermentation of prebiotics in the colon. Novel molecular tools to identify members of the microbiota that ferment these substrates were highlighted, as well as the use of stable-isotope (^{13}C) labeled substrates to trace exactly what happens with the prebiotics. These novel technologies allow detailed analysis of such fermentations, including monitoring of changes in microbial populations, and in metabolites produced.

Carbohydrate degrading enzymes

Prof. Dr. M.O. Coutinho (CNRS, Marseille, France) reviewed the current status the systematic of classification and annotation of carbohydrate degrading enzymes. He outlined the Carbohydrate Active enZYmes database (CAZy; www.cazy.org) describing the families of structurally-related catalytic and carbohydrate-binding modules of enzymes that breakdown or build glycosidic bonds in glycoconjugates, oligo- and polysaccharides, presently covering over 320,000 non-redundant enzyme modules. On line since 1998, this sequence-based classification (i) reflects the structural features of these enzymes better than solely their substrate specificity, (ii) reveals evolutionary relationships between enzymes and enzyme families, (iii) provides a convenient framework to understand mechanistic properties, and (iv) highlights the complex relationships between family membership and enzyme specificity.

In a second lecture **Prof. Coutinho** detailed that carbohydrate-active enzymes frequently bear ancillary carbohydrate-binding modules (CBMs) that complement enzyme action (i) by facilitating the transfer of enzymes or associated proteins from solution to the substrate surface, (ii) by perturbing the interactions established in crystalline, amorphous or oligomeric state of substrates, and (iii) by extending enzyme active sites to facilitate substrate breakdown.

Dr. A. Lammerts van Bueren (University of Groningen) reviewed carbohydrate-binding modules, non-catalytic protein modules attached to Carbohydrate-active enzymes (CAZymes) which have beneficial effects on the activity of the enzymes. She gave an overview of how CBMs were discovered, what our current knowledge is on their importance in CAZ"omics" and finally where future research is headed in CBMs including technological and industrial applications.

The structural and functional analysis of carbohydrate acting enzymes was discussed by **Dr. T. Pijning (University of Groningen),** with emphasis on glucansucrase en fructansucrase enzymes of Lactobacilli. Only in the last decade, the first high-resolution 3D structures of glucansucrases and fructansucrases have become available from X-ray crystallography, using truncated forms of these enzymes. In addition, SAXS studies very recently revealed the low-resolution structure of an entire glucansucrase. This has resulted in detailed knowledge about their mechanism; in addition their complexes with substrate and some acceptor sugars have given insight in the differences in substrate- and product specificity. Yet, intriguing issues remain to be solved, such as the details of product specificity, the processivity of the polymerization reaction, and the function of the non-catalytic domains.

Properties and applications of starch converting enzymes were discussed by **Prof. Dr. M.J.E.C. van der Maarel (University of Groningen)**. Starch accounts for a large part of the dietary energy of man and animals. In plants starch is stored in a crystalline form in compact spherical granules. The chemical and physical properties of starches, and changes therein upon heating in aqueous media, were reviewed. Also the industrial processing of starch to maltodextrins, maltose and glucose syrups using starch degrading enzymes

was discussed. Because solubilization of starch is desired for such enzymatic treatment, the enzymes used need to be stable and active at higher temperatures. A relatively little explored group of enzymes for the processing of starch are those that modify starch by using a transglycosylation reaction. The reactions catalyzed by various of these enzymes, cyclodextrin glucanotransferase, amylomaltase and branching enzyme, were evaluated.
The lecture by **Dr. M. Kabel (Wageningen University)** covered the plant cell wall polysaccharides (i.e. cellulose, pectin and hemicelluloses) degrading enzymes. Plant polysaccharides determine to a large extent the properties of a food from plant origin. A few examples are the texture of fruits, the consistency of tomato pastes, the cloud stability of fruit juices and the baking quality of wheat flour. For the production of foods, polysaccharide-degrading enzymes that breakdown or modify the cell wall polysaccharides can be applied. This can lead to new products, improved product quality or novel processing. Several aspects of plant polysaccharide degrading enzymes were presented, in particular their mode of action towards the complex cell wall polysaccharides in relation to their application in food and bio-based technologies.

Chemical and Enzymatic Synthesis of Carbohydrates
Prof. Dr. S. Oscarson (UCD Dublin, Ireland) presented an Introduction to (and pitfalls in) Carbohydrate Synthesis and a second (advanced) lecture on Chemical Synthesis of Oligosaccharides. He gave a general background and focused on three areas of major importance: protecting group manipulations, stereoselective glycosylation reactions and synthetic strategies, including examples of possible and often frequent pittfalls.
Prof. Dr. H. Höfte (INRA Versailles, France) presented an overview of our current understanding of the Synthesis of cell wall polysaccharides using genomics of the model species *Arabidopsis thaliana* for the identification of key players in cell wall synthesis. Items discussed involved cell wall composition, glycosyl transferase enzymes, synthesis of (hemi)cellulose and pectins, the role of the endomembrane system in polysaccharide synthesis, C-allocation and nucleotide sugar synthesis, cell wall cross-linking, wall remodeling and growth control.
Prof. Dr. L. Dijkhuizen (University of Groningen) reported the diversity of glucansucrase enzymes of family GH70 in lactic acid bacteria converting sucrose into alpha-glucans with various glucosidic linkages. Several lactobacilli also encode glucansucrase-like enzymes that are inactive with sucrose, but catalyze disproportionation type and polymerization reactions with malto-oligosaccharides containing more than five glucose units, including starches. Detailed analysis of the products synthesized from starch showed that these enzymes (e.g. GTFB) act as 4,6-alpha-glucanotransferases, cleaving alpha-(1→4) linkages and introducing alpha-(1→6) linkages. Although the primary structure of GTFB is similar to GH70 enzymes, its activity resembles more the GH13 alpha-amylase type of enzymes using malto-oligosaccharides as preferred substrate. GTFB thus provides the first time evidence of a GH13-GH70 enzyme evolutionary intermediate.

Carbohydrate Analysis
Prof. Dr. J.P. Kamerling (Utrecht University, University of Groningen), involved in the organization of the first 12 editions of the Glycosciences Summer Course, gave an overview of his 45 years of research in glycosciences, with emphasis on structural and functional glycomics. He described the progress his research has made over the years, in structural analysis of polysaccharides and glycoconjugates, chemo-enzymatic synthesis of oligosaccharides and glycoconjugates, and carbohydrate-protein and carbohydrate-carbohydrate interactions.
Prof. Dr. S. Perez (CNRS Grenoble, France) reviewed the use of computational methods in glycosciences to the characterization of the three-dimensional conformation of complex carbohydrates, alone or in their interaction with proteins. He explained the basics of molecular modeling using molecular mechanics and molecular dynamics approaches, and gave a series of applications of molecular modeling, thereby demonstrating the importance of such approaches in understanding interaction phenomena in the glycofield.
In a second lecture **Prof. Perez** outlined the neutron and synchrotron infrastructures in Europe, and their major contributions to the advancement of sciences and technology. The lecture focused on the possible use of these unique facilities in research on structural glycosciences.
Dr. S. Haslam (Imperial College London, UK) explained that mass spectrometry (MS) with its ultra-high sensitivity and ability to analyze complex mixtures of glycans, is the most powerful tool available for glycan structure analysis. His presentation reviewed MS strategies incorporating MALDI-MS/MS and nanoLC-ES-

MS/MS for defining glycomes of cells, tissues and purified glycoconjugates as well as establishing glycoprotein site specific glycosylation.
In a second lecture, **Dr. S. Haslam** discussed the need and potential of accessible, curated and comprehensive data collections and software tools for Glycosciences. Glycobioinformatics is still in an explorative stage, and the sparseness of glycan databases hampers large scale high throughput glycomics studies. This lecture provided an overview of the current status of the field and highlighted possible future developments.
Prof. Dr. T. Peters (University of Luebeck, Germany) provided basic knowledge about carbohydrate NMR methodologies and strategies in glycosciences. This included the fundamental properties of carbohydrate 1H and 13C NMR spectra, and how to derive conclusions about e.g. anomeric configurations or types of glycosidic linkages from such data. Also concepts that aim at sequence and conformational analyses were introduced e.g. the structural reporter group concept. Important novel NMR technological developments and their impact on the analysis of carbohydrates were explained. Such developments are the dramatic improvement in sensitivity and the availability of specialized pulse sequences that deconvolute crowded carbohydrate NMR spectra.
In a second lecture **Prof. Peters** gave an overview of NMR spectroscopy of carbohydrate-protein interactions. Transfer NOE experiments and saturation transfer difference (STD) NMR experiments were explained in detail and applied to selected examples. It was shown that this methodology is very well suited for the application in biological systems since the targets can be e.g. whole cells or viruses.
Prof, Dr. H.A. Schols (Wageningen University) described the fractionation and analysis of polysaccharides from plant origin. The lecture focused on the extraction of different plant cell wall polysaccharides -pectins, (hemi)cellulose-, methods used for analysis of sugar linkage composition, and use of enzymatic fingerprinting techniques to determine the distribution of substituents over the polysaccharide backbone.

Valorization of carbohydrate-rich biomass
The lecture by **Dr. M. J. O'Donohue (INRA-CNRS-INSA Toulouse, France)** dealt with Carbohydrate biorefineries - concepts, technologies and process configurations and Industrial bio-transformation of sugars into value-added fuels and chemicals. In his first lecture the notion of biorefining was explained and some basic facts and figures were supplied to help the audience to get a basic understanding of the issues at stake. Starting with 1st generation biorefining, some basic process concepts were introduced followed by a discussion of 2nd generation biorefining. The hurdles and drawbacks of the different technologies were underlined and a view of some future prospects in this exciting area was presented
The second lecture by **Dr. O'Donohue** described industrial biotransformation of sugars into value-added fuels and chemicals. This provided a general overview of Industrial Biotechnology with some basic figures which gave the audience a grasp of the current status and future potential of this technology. IB is very well developed in de areas of food and drinks, and detergents industry. However, in the chemical and fuels industries the introduction of IB has been slower, despite the fact that it holds much promise. The major reason for this slow uptake is the persistent availability of competitively-priced crude oil and the consequent predominance of the petrochemical industry. However, things are now changing fast and IB is already responsible for the production of >90 MT ethanol worldwide. The lecture was concluded by featuring future frontiers, especially concerning the prospect of harnessing microbial consortia. It is expected that Industrial Biotechnology will be a key driving force in a bio-based economy, which will use carbohydrates as the principal feedstock for fuels and chemicals.

Poster Sessions During the meeting 2 sessions of about 3-4 hours each were held where the participants showed posters of their own ongoing research work. These sessions were highly appreciated by all participants, with lively discussions between participants and between participants and lecturers. Participants were challenged to select the best posters which they did with a broad consensus. The award winning posters were named at the final dinner. The winner of the 1st prize (Caroline Biggs, Warwick University, UK) gave a short account of her work before the closing session.

3. Assessment and impact:

All participants were asked to fill in an evaluation form and give an overall rate of the course varying from excellent to poor. The respondents rated the course as excellent (41%), as good (49%), as moderate (7%) and insufficient (3%).
On average the amount of information presented during the course was scored as 4.0 by the respondents (5 equaling very much and 1 nothing).
The participants were quite satisfied about the interactions with the lecturers, which scored an average of 4.0 (5 equaling excellent and 1 sufficient). The possibilities to interact with other participants was highly appreciated as well which resulted in an average score of 4.7 (same scale). These scores show that our attempts to improve overall interaction by organizing a social event and interviews with two of our "regular" lecturers (by all participants) were successful.
The course material provided (course binder, book of abstracts, website with access to presentations and background literature) was highly appreciated. Unfortunately, the quality of part of the course binder was poor due to a technical failure at the printing office resulting in missing slides. To avoid this problem in future we consider providing the participants with a memory stick with all presentations and ask them to bring a laptop / tablet to the course.
Various participants (19 %) indicated that they had expected some more focus on other topics, e.g. synthesis (4.4%), industrial applications (4.4%), glycobiology (4.4%), carbohydrate nomenclature (4.4%) or glycans (3%), but were otherwise satisfied.
The overall course level was rated as good. Junior scientists and participants from industry liked the broad range of topics addressed during the course. Occasionally they found the lectures outside their field too advanced whereas more experienced and senior scientists would have preferred even more in depth information next to the basic information provided. A suggestion for the next edition might be to start the course with a one day master class with all the basics for scientists relatively new to the field.
As on previous occasions, the course was experienced as intense. Based on the experience and recommendations of the 2012 edition, we adjusted the program by shortening the lectures from 1 hour to 45 minutes and including more social activities. However, course intensity and course length per day were still rated as slightly too intense. One of the side effects of shortening the time per lecture was that most lecturers now overran the time scheduled for their presentation. Time management and reducing the information load should certainly be addressed in the next edition.
Finally, 9 % of the respondents commented on the poor gender balance of the lecturers, with only 3 female lecturers out of 23 in total. In future editions we will certainly try to improve this balance.

In conclusion, this course clearly meets the need of young glyco-scientists for a broader background in glycosciences and the need for more specific knowledge in specific areas of glycosciences.
The course also contributes to formation of networks and collaborations at several levels:

- Between young European scholars and the renowned senior scientists teaching the courses.
- Between young, starting European glyco-scientists
- Between European science institutions on glyco-sciences
- Between academic and industrial glyco-scientists

From the evaluation we also conclude that the existing course needs continuous updating. For future editions, the participants expressed a wish for more attention to synthesis, industrial applications, carbohydrate nomenclature and glycobiology.

4. Final program:

Sunday April 13, 2014			
15.30-16.15	Registration		
16.15-16.45		Opening Summer Course Glycosciences	Prof. A.G.J. Voragen
16.45-17.45	Plenary session 1:	AXOS	Prof. J. Delcour
17.45-20.30	*Drinks and Buffet Dinner*		

Monday April 14, 2014			
08.45-09.35	Plenary session 2:	Overview 45 years of carbohydrate research	Prof. J.P. Kamerling
09.35-10.25	Plenary session 3:	Architecture and characterization of plant polysaccharides	Prof. H.A. Schols
10.25-10.55	*Coffee/tea break*		
10.55-11.45	Plenary session 4:	Pitfalls in carbohydrate synthesis	Prof. S. Oscarson
11.45-12.35	Plenary session 5:	Carbohydrate-protein interactions – molecular modelling insights	Prof. S. Perez
12.35-12.45	***Group photo!***		
12.45-13.30	*Lunch*		
13.30-14.20	Plenary session 6:	Characterizing physico-chemical properties of polysaccharides	Dr. B.E. Christensen
14.20-15.10	Plenary session 7:	Mass spectrometry approaches in glycoscience	Dr. S. Haslam
15.10-15.40	*Coffee /tea break*		
15.40-16.30	Plenary session 8:	Bacterial polysaccharides	Prof. O. Holst
16.30-17.30	College Tour		
18.00-20.00	*Dinner*		
20.00-21.30	*POSTERS and drinks*		

Tuesday April 15, 2014			
08.45- 09.35	Plenary session 9:	Glycoinformatics - databases and software tools for glycosciences	Dr. S. Haslam
09.35 -10.25	Plenary session 10:	Carbohydrate degrading enzymes: classification and annotation	Prof. P.M. Coutinho
10.25-10.55	*Coffee/tea break*		
10.55-11.45	Plenary session 11:	Studies on Gaucher disease: Ultrasensitive visualization of beta-glucosidases with activity-based probes	Prof. J.M.F.G. Aerts
11.45-12.35	Plenary session 12:	NMR methodologies and strategies in glycoscience	Prof. T. Peters
12.35-13.30	*Lunch*		
13.30-14.20	Plenary session 13:	The stories behind the prebiotic GOS	Dr. E. van Leusen
14.20-15.10	Parallel session I A:	Structure, properties and applications of alginates	Dr. B.E. Christensen
	Parallel session I B:	Biochemical properties of starch	Dr. P. Buwalda
15.10-15.40	*Coffee/ tea break*		
15.40-16.30	Parallel session II A:	Advanced carbohydrate synthesis	Prof. S. Oscarson
	Parallel session II B:	Neutron and synchrotron radiations for glycosciences	Prof. S. Perez
16.30-17.20	Plenary session 14	Carbohydrate binding modules	Dr. A. Lammerts van Bueren
18.30-20.00	*Dinner*		
20.00-21.30	*POSTERS and drinks*		

Wednesday April 16, 2014			
08.45-09.35	Plenary session 15:	Fractionation and characterization of polysaccharides	Prof. H.A. Schols
09.35-10.25	Plenary session 16:	Structural and functional analysis of carbohydrate acting enzymes	Dr. T. Pijning
10.25-10.55	*Coffee / tea break*		
10.55-11.45	Parallel session III A:	NMR spectroscopy of carbohydrate-protein interactions	Prof. T. Peters
	Parallel session III B:	Carbohydrate Binding Modules and enzyme modularity	Prof. P.M. Coutinho
11.45-12.35	Parallel session IV A:	Biomedical aspects of polysaccharides	Prof. O. Holst
	Parallel session IV B:	Properties and applications of starch converting enzymes	Prof. M.J.E.C. van der Maarel
12.35-13.30	*Lunch*		
13.30-14.20	Plenary session 17:	Carbohydrate bio refineries - concepts, technologies and process configurations	Dr. M. J. O'Donohue
14.20-18.00	*Social programme: Guided Tours (Historical Centre and Surroundings of Wageningen)*		
18.30-23.00	*Course Dinner with Poster Prize awarding*		

Thursday April 17, 2014			
08.45-09.35	Plenary session 18:	Introduction to plant cell wall synthesis	Dr. H. Höfte
09.35-10.25	Parallel session V A:	Plant cell wall polysaccharide degrading enzymes in food and non-food applications	Dr. Mirjam Kabel
	Parallel session V B:	Polysaccharide conversion in the gut	Dr. K. Venema
10.25-10.55	*Coffee/tea break*		
10.55-11.45	Parallel session VI A:	Characterization of novel alpha-glucan acting enzymes	Prof. L. Dijkhuizen
	Parallel session VI B:	Industrial biotransformation of sugars into value-added fuels and chemicals.	Dr. M. J. O'Donohue
11.45-12.00	Presentation Poster Prize Winner		
12:00-12.45	Plenary session 19:	Trends in future	Dr. K. de Gooijer
12.45-13.00	Closing session		
13.00-14.00	*Farewell Lunch*		