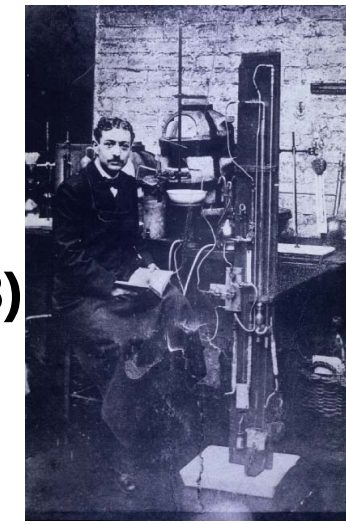
L'OREAL'S commitment to Green and Sustainable Chemistry

Content :

- **L'OREAL : GROUP PROFILE, FACTS AND FIGURES**
- **OUR COMMITMENT TO GREEN AND SUSTAINABLE CHEMISTRY:**
  - **Our Objectives,**
  - **Our methodology,**
  - **Examples of L'Oreal ingredients and process with low environmental impact.**

L'OREAL : GROUP PROFILE

- A "genetically" innovative company
  - → in 1907, Eugène Schueller developed the first synthetic "safe hair colourants"(patented in 1908)
- A century of expertise in cosmetics
- A worldwide leader in cosmetics
- Distributed in 130 countries with offices in 58 countries
- € 17,063 million consolidated sales in 2007
- 3.3 % of the group's annual sales devoted to R&D



L'OREAL : RESEARCH & DEVELOPMENT

- 3095 employees of 61 different nationalities working in 30 different disciplines
- € 560 million dedicated to cosmetic and dermatological research in 2007
- 16 research centers across the world and 13 evaluation centers
- 1/4 of the R&D budget devoted to Advanced Research
- 132 molecules developed over the last 40 years
- 576 patents filed in 2007
- 100 active cooperation agreements with leading academic research

COSMETICS, UNIQUE EXPERTISE

A brand portfolio that is unique in the world

L'ORÉAL PROFESSIONNEL

REDKEN 5TH AVENUE NYC

MATRIX

KÉRASTASE SOLEIL GELÉE FRAÎCHE

L'ORÉAL PARIS

MAYBELLINE NEW YORK

GARNIER

SOFTSHEEN-CARSON

DIESEL FOR SUCCESSFUL LIVING

VIKTOR&ROLF

LANCÔME PARIS

BIOTHERM

HELENA RUBINSTEIN

GIORGIO ARMANI

RALPH LAUREN

cacharel

Kiehl's SINCE 1851

shu uemura

VICHY LABORATOIRES

LA ROCHE-POSAY LABORATOIRE PHARMACEUTIQUE

SKINCEUTICALS

THE BODY SHOP

SANOFLORE

innéov NUTRICOSMETICS

GREEN CHEMISTRY IS INTEGRATED INTO SUSTAINABLE DEVELOPMENT

WHY L'OREAL'S COMMITMENT TO SUSTAINABLE DEVELOPMENT ?

→ **To reduce the impact of our activities on our common heritage by taking into account :**

- **Health of present and future generations,**
- **Protection of the environment and biodiversity,**
- **The concern for fair and responsible trade.**

→ **To develop the acceptability of our activity**

❖ *For more detailed information, consult our Sustainable Development report (Website www.loreal.com)*

WHY L'OREAL'S COMMITMENT TO GREEN AND SUSTAINABLE CHEMISTRY ?

→ To ensure maximum human and environmental health and safety,

→ To develop sourcing innovation from L'OREAL'S R&D and from the Chemical Industry.

↳ **Following the basic principles published by P. T. Anastas and J.C.Warner, greater emphasis is placed on :**

- **The use of renewable raw materials from plant,**
- **The development of environmentally friendly processes,**
- **The manufacture of low ecotoxicity and biodegradable ingredients.**

↳ **Source of innovative products.**

OUR METHODOLOGY TO DEVELOP GREEN AND SUSTAINABLE CHEMISTRY

BASIC IMPORTANCE OF ECO-DESIGN AND MEASUREMENT

BASIC IMPORTANCE OF ECO-DESIGN TO DEVELOP GREEN CHEMISTRY

- **Eco-design is based on upstream selection and measurement :**
  - **Selection of renewable and eco-friendly starting materials (for instance, valorization of the different parts of a plant to avoid use of raw materials dedicated to food and feed),**
  - **Measurement of the « greenness » of the chosen processes**
  - **Assessment of the environmental impact of the new ingredients**

OUR GREEN METHODOLOGY IS BASED ON ECO-DESIGN

With the :

- **Creation of an internal database of raw materials from plants based on the following features of these starting materials :**
  - **Available in accordance with Sustainable Development**
  - **Renewable**
  - **Non - (eco)toxic,**
  - **Non - bioaccumulative, non - persistent in the environment**
  - **Functional**

OUR GREEN METHODOLOGY IS BASED ON ECO-DESIGN

- **With the:**
  - **Upstream use of Green indicators such as atom efficiency, E-Factor (waste generated per kg of product, proposed by R.A. Sheldon) to select and develop new green processes (chemical and biocatalytic)**
  - **Assessment of persistence in the environment, bioaccumulation and ecotoxicity (QSAR : Biowin, Kowwin and Ecosar) of our ingredients**
  - **Upstream Assessment of ecotoxicity on daphnia and algae**
  - **Use of cell cultures and reconstructed epidermis models to assess the efficacy and safety of our ingredients**
  - **Development of life cycle analyses**

GREEN METRICS : E-FACTOR



- To lower it, we measure the E-Factor of our processes from the laboratory scale to the industrial scale :

  ► For instance, E- factors of the highest-volume industrial processes (from 0.36 to 3.3) are low, indicating a low amount of waste.

- Solvents are included in the calculation of E-Factor, but we also evaluate an E-Factor without solvent to compare the weight of reactants *versus* solvents.

USE OF RENEWABLE RAW MATERIALS FROM PLANTS : OUR COMMITMENT

- The portfolio of L'OREAL's raw materials originating from L'OREAL'S R&D and Suppliers, includes a high proportion of plant origin :

  ⇒ in 2007, 40 % of raw materials were sourced from plants.

- In 2005, L'OREAL joined the AGRICE Consortium, French research programme on bioproducts managed by ADEME, French agency for the environment and energy.
- In 2007 L'OREAL is also participating in the « Synthons » Project within "The Industry and Agro-Resources Hub" (Region of Champagne-Ardenne Picardie). The aim of this project is to develop new green chemical processes from plants (co-valorization).

IMPORTANCE OF RENEWABLE INGREDIENTS IN OUR DIFFERENT LINES IN COSMETICS

OUR MAIN LINES IN COSMETICS

Hair

- Hair color
- Hair care
- Styling
- Hair dressing

Make-Up

- Skin
- Nails
- Eye-lashes

Skin care

- Moisturizing
- Nutrition
- Protection
- Anti-Ageing
- Whitening

These materials can be used in all lines of products.

WHICH LIPIDS AS RENEWABLE RAW MATERIALS ?

- Oils
- Waxes

→ Hydrolysis →

- Fatty acids
- Fatty alcohols

↳ **For instance** :

- Triglycerides

- Palmitic acid
- Alcohols C-12 → C-18
- And derivatives (esters)

❑ **Advantages**

→ Fatty phase of cream-formulas (texture)
→ Hair and skin protection
→ Pigment, powder dispersion

❑ **Lines**

→ Application in all lines of Cosmetics.

EXAMPLES OF POLYSACCHARIDES UTILIZED AND THEIR APPLICATIONS

❑ Renewable raw materials

Polysaccharides → **Polysaccharide derivatives**

- Cellulose
- Guar
- Xanthan

→

- Hydroxypropyl cellulose
- Carboxymethyl cellulose
- Hydroxypropyl guar

❑ Interest

→ Thickening of aqueous phases.

❑ Lines

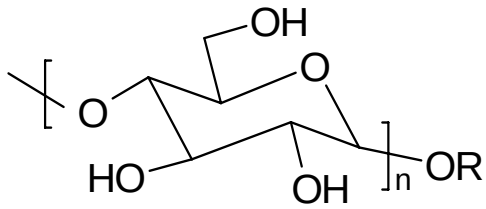
→ Formulation for skin and hair care.

EXAMPLES OF OLIGOSACCHARIDES USED AND THE MAIN LINES OF APPLICATIONS

❑ **Renewable raw materials**

Oligosaccharides and derivatives

◆ Oligoglucosides



Alkyloligosaccharides

❑ **Interest** Non-irritant surfactant → Emulsifiers, rinsers

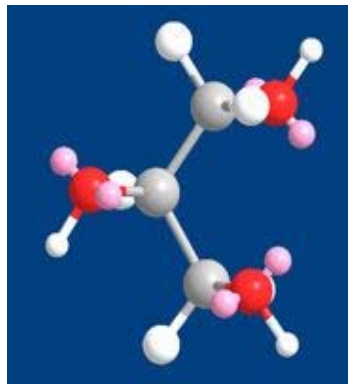
❑ **Lines** Shampoo

EXAMPLES OF POLYOLS USED AND THE MAIN LINES OF APPLICATIONS

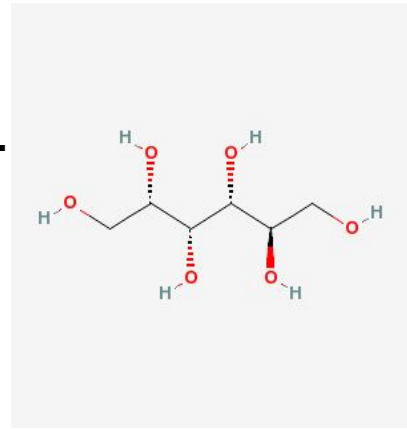
WHICH POLYOLS AS RENEWABLE RAW MATERIALS ?

❑ **Examples of**

GLYCEROL



SORBITOL



❑ **Interest**

→ Key-molecule for skin moisturizing
- o prevention of skin dehydration
- o revitalizing dry skin.

→ Raw material for the synthesis of Ascorbic acid

⇓

→ Ascorbic acid is used in antiageing and in whitening formula.

❑ **Lines**

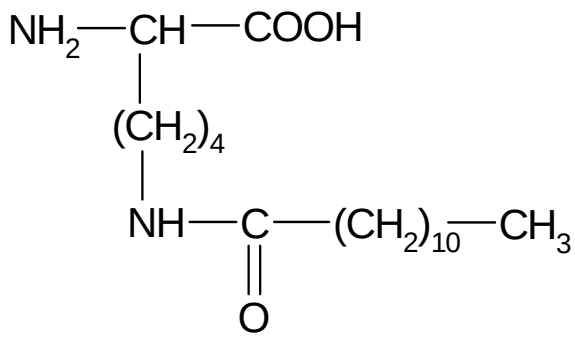
Skin care.

EXAMPLES OF AMINO-ACID DERIVATIVES USED IN COSMETICS

❑ **Renewable raw materials**

L- Lysine

Fatty-L-lysine



❑ **Interest** → White adhesive pigment for skin (lamellar structure)

❑ **Lines** Make-Up.

L'OREAL GREEN PROCESSES

❖ **SYNTHESIS OF NEW C-GLYCOSIDES**

THROUGH A GREEN PROCESS

❖ **LAUNCHING OF A NEW GREEN INGREDIENT**

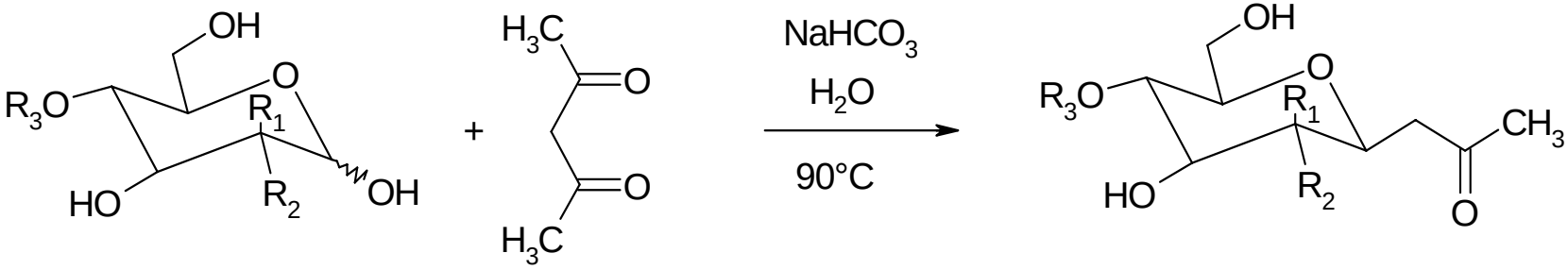
PRO-XYLANE™

USE OF A NEW GREEN PROCESS





Lubineau A. et Coll., Chem. Commun. 2000, 2049-2050



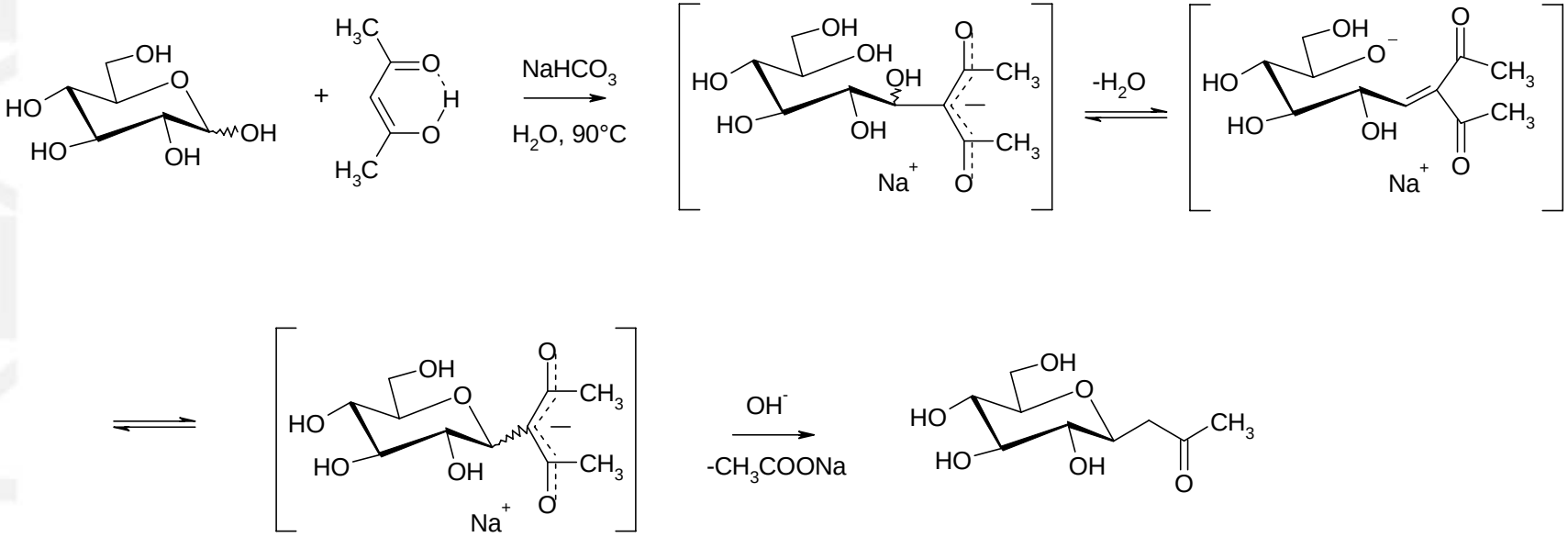
(glucose, mannose, cellobiose)

- → **Use of renewable raw materials such as monosaccharides and disaccharides.**
- → **In-water reaction (knoevenagel condensation) with quantitative yield.**
- → **Single-step synthesis.**
- → **Opening to new β-C-glycosides.**

LUBINEAU'S REACTION



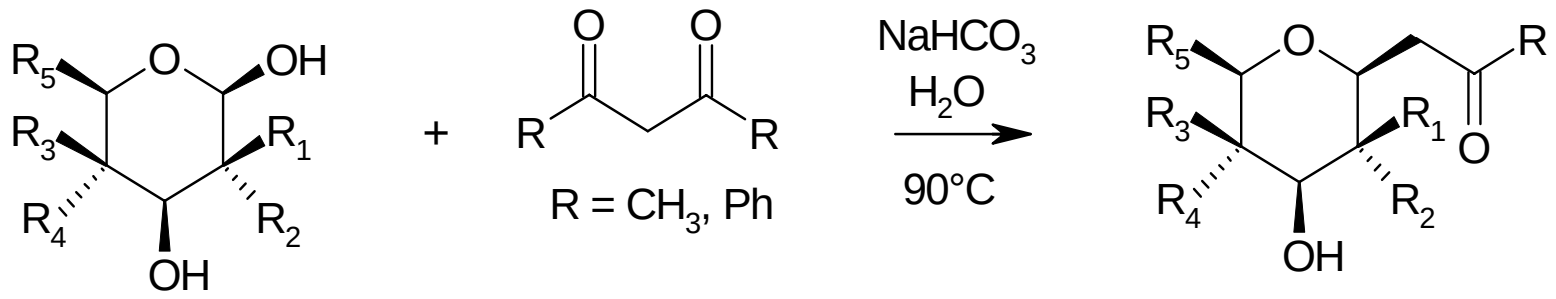




Carbohydrate Research 339 (2004) 741-745

A NEW VERSATILE PROCESS DEVELOPED BY L'OREAL R&D





(xylose, lyxose, glucose, galactose)

→ **Confirmation of the highly valuable reaction on C-5 monosaccharides**

→ **Generally applicable to various stereochemistries of the cycle.**

→ **Great potential for fast scaling-up.**

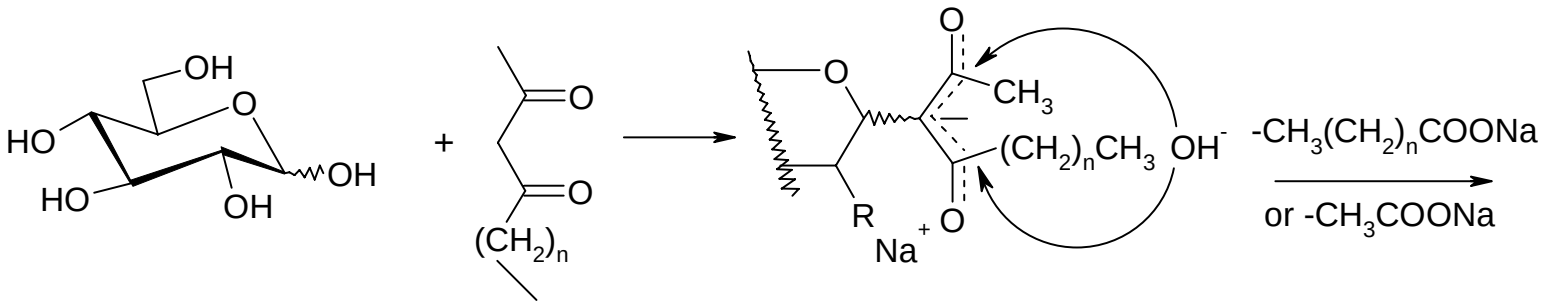
→ **Direct access to new amphiphilic compounds (long chain R)**

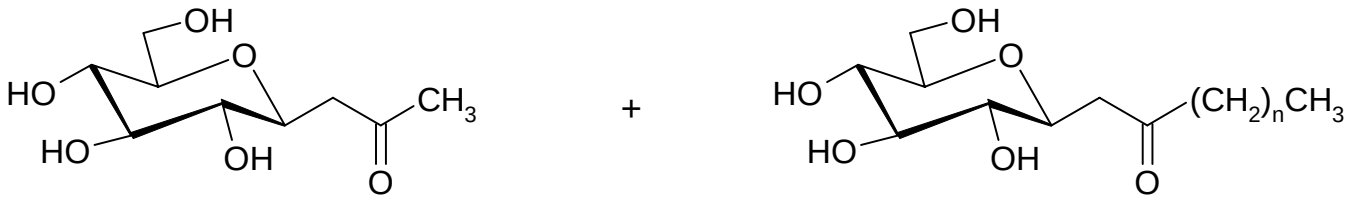
SYNTHESIS OF AMPHIPHILIC COMPOUNDS

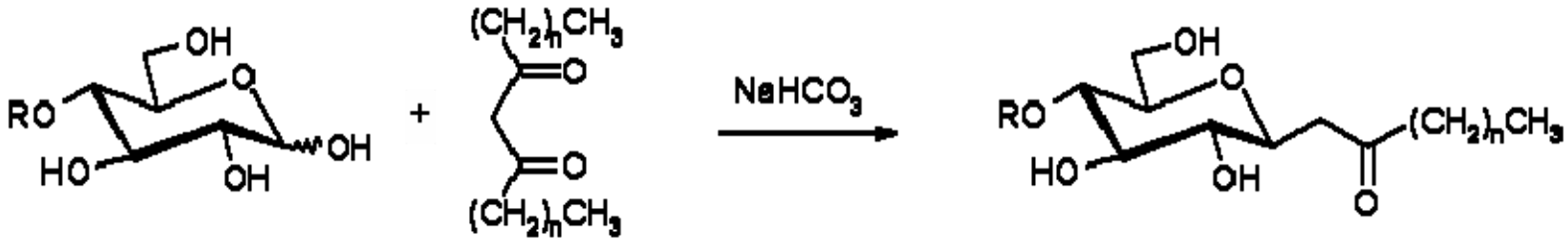
(Carbohydrate Research 339, 2004, 741-745, coll. U. Paris XI)







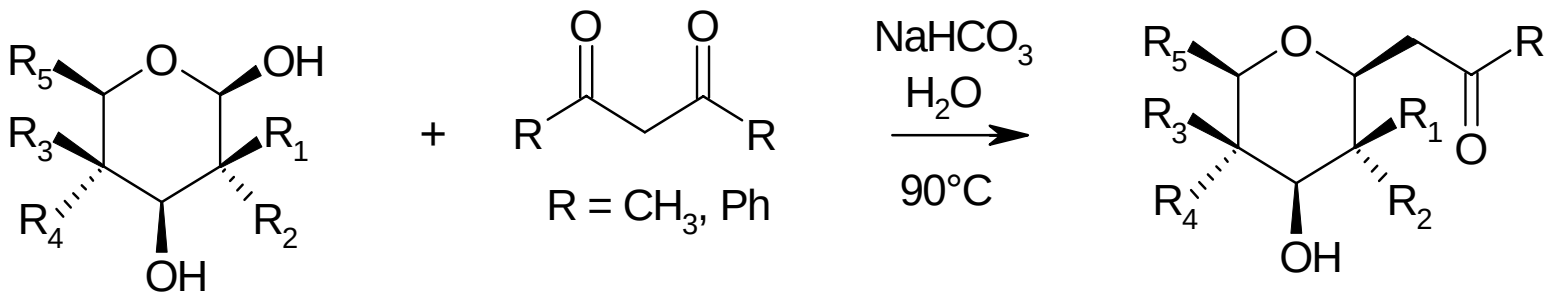




R = H n = 0 à 8

R = α-D-Glc

A NEW VERSATILE PROCESS DEVELOPED BY L'OREAL R&D



(xylose, lyxose, glucose, galactose)

→ **Numerous advantages compared to known processes using :**

- **eletrophilic sugar derivatives such as glycosyl halides or glycals,**
- **nucleophilic carbons such as cyanides, enamines or organometallics,**
- **several steps to prepare the C – Glycosides**

IMPORTANCE OF C-GLYCOSIDES AS ACTIVATORS OF GLYCOSAMINOGLYCANS BIOSYNTHESIS

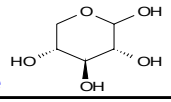
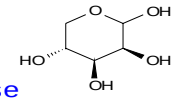
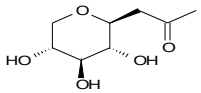
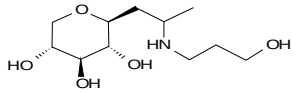
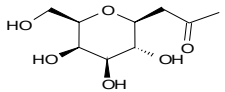
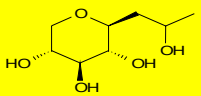
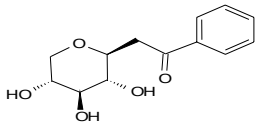
GAGs and skin ageing :

- Proteoglycans and Glycosaminoglycans (GAGs) of skin play an important role in structural organization of water at a molecular level in dermis, which means a significant contribution :
  - => to the structure of the extra-cellular matrix
  - => to skin moisturizing and elasticity
- The amount of GAGs decreases with ageing thus altering the biomechanical properties of skin.

L'Oréal discovery :

- Several C-glycosides are able to stimulate the biosynthesis of GAGs.

POTENTIAL OF C-GLYCOSIDES AS ACTIVATORS OF GAGS BIOSYNTHESIS

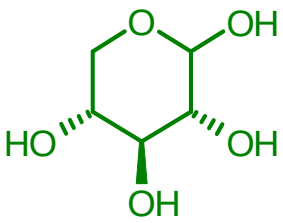
COMPOUND	[C]	%	p
none	-	100	-
TGFβ (positive control)	10 ng/mL	348	<0.01
 Xylose	0.5 mM 0.1 mM 0.02 mM	52 85 106	<0.01 >0.05 >0.05
 Lyxose	2.0 mM 0.4 mM 0.08 mM	86 102 90	>0.05 >0.05 >0.05
 compound 1	10 mM 2.0 mM 0.4 mM	161 141 110	<0.01 <0.01 >0.05
 compound 2	1.0 mM 0.3 mM 0.1 mM	140 109 110	<0.01 >0.05 >0.05
 compound 3	10.0 mM** 3.0 mM 1.0 mM	99 119 136	>0.05 >0.05 <0.01
 compound 4	3.0 mM 1.0 mM 0.3 mM	218 169 139	<0.01 <0.01 <0.05
 compound 5	1.0 mM** 0.3 mM 0.1 mM	95 102 120	>0.05 >0.05 >0.05

The radioactivity of D-[6-H^3]-glucosamine incorporated into the GAGs was quantified.

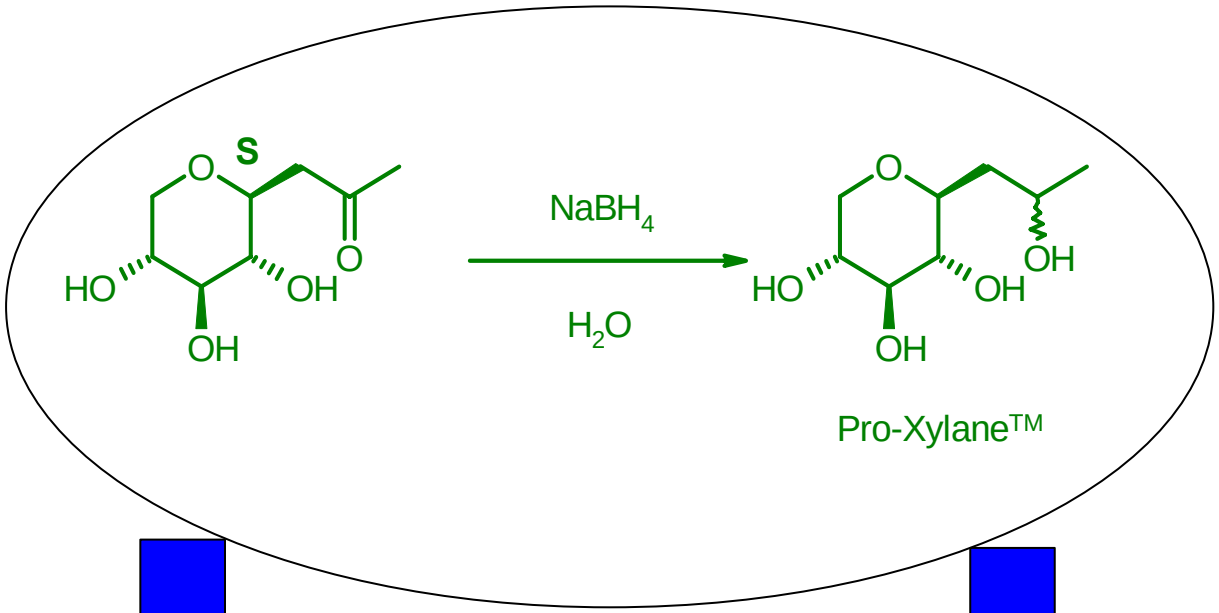
L'Oréal Discovery:

* β-C-xyloside derivatives are able to stimulate efficiently GAG synthesis.
* Pro-Xylane™ (Compound 4) has been developed as a new breakthrough in anti-ageing active ingredient

PRO-XYLANE™ SYNTHESIS :



D-Xylose



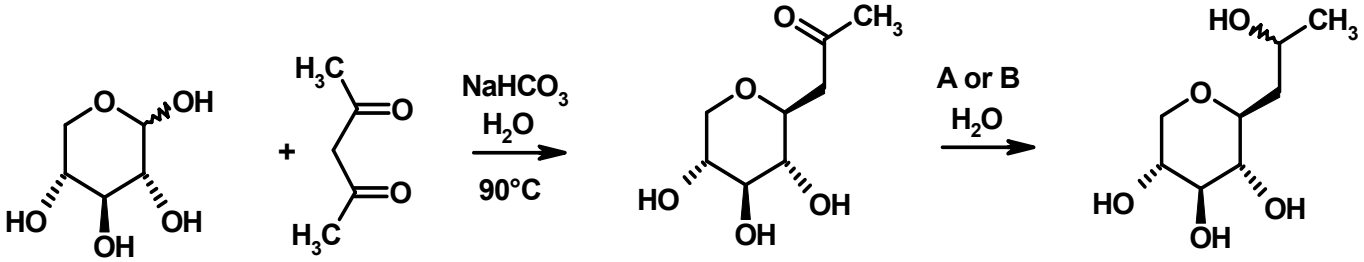
Pro-Xylane™

Only β-C-glycoside (thermodynamic product)

Oily mixture of ~1:1 diasteroisomers

ECOFRIENDLY SYNTHESIS OF PRO-XYLANE™





(xylose)

A = NaBH4
B = catalytic reduction (industrial process)


↳ Following our commitment to Green and Sustainable Chemistry :

☒ **Sustainable Raw Material:** Xylose from Beech Wood

☒ **Green Process:**

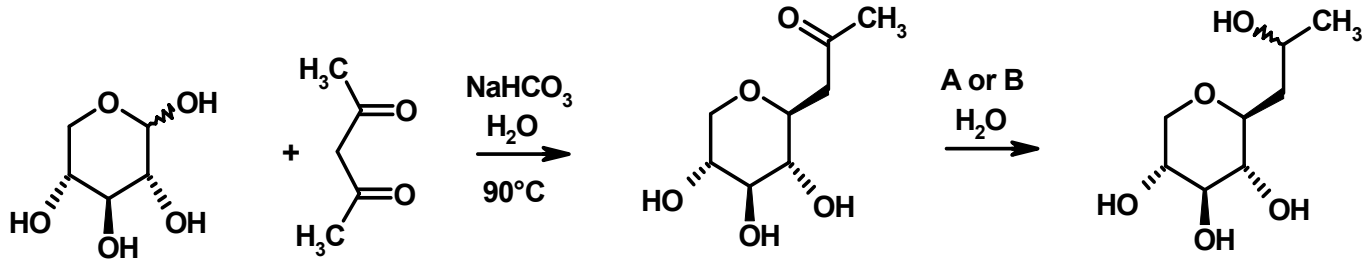
=> efficient synthesis (2 steps), use of water as solvent, use of catalysis

☒ **Ecofriendly Compound:** neither suspected to be persistent (software BIOWIN), nor bioaccumulative (software KIOWIN) and nor ecotoxic (software ECOSAR)

ECOFRIENDLY SYNTHESIS OF PRO-XYLANE™







(xylose)

A = NaBH4
B = catalytic reduction (industrial process)

↳ Moreover, catalytic reduction B was selected :

⇨ **Use of catalytic reduction B (E-Factor = 13 in solution with a tonnage/y less than 100t) enabled us to reduce 60% of waste in 2007 in comparison with reduction A with $NaBH_4$.**

L'OREAL COMMUNICATION ON C-GLYCOSIDES

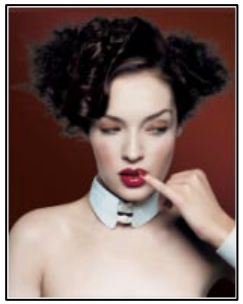




- **<u>Activation of glycosylaminoglycans and synthesis of Pro-Xylane™</u> :**
  - WO 2002051828 : M. DALKO, L. BRETON (L'OREAL)
  - EP 1589010: A. CAVEZZA, S. TROUILLE, P. PICHAUD (L'OREAL)
  - Posters: M. DALKO *et al.*
    - 20th World Congress of Dermatology, Paris, July 2002
    - 12th SCI-RSC Medicinal Chemistry Symposium, UK, September 2003
    - 13th European Symposium on Organic Chemistry, Cavtat-Dubrovnik (Croatia), September 2003
  - Bioorganic & Medicinal Chemistry Letters : M. DALKO *et al.* Online publication complete: 8-JAN-2009 DOI information : 10.1016/j.bmcl.2008.12.037

- **<u>C-glycosides as amphiphiles</u> :**
  - WO 2002051803 : M. PHILIPPE, D. SEMERIA (L'OREAL)
  - Carbohydrate Research 339 (2004) 741-745 : Y. HERSANT, R. ABOU-JNEID, Y. CANAC, A. LUBINEAU, M. PHILIPPE, D. SEMERIA, X. RADISSON and M-C. SCHERRMANN

ACKNOWLEDGEMENTS



- L'OREAL Research and Development
- Pr. LUBINEAU's team at Paris-Sud University

And thank you for your attention