

# Molecular Gastronomy and the Note by Note Project

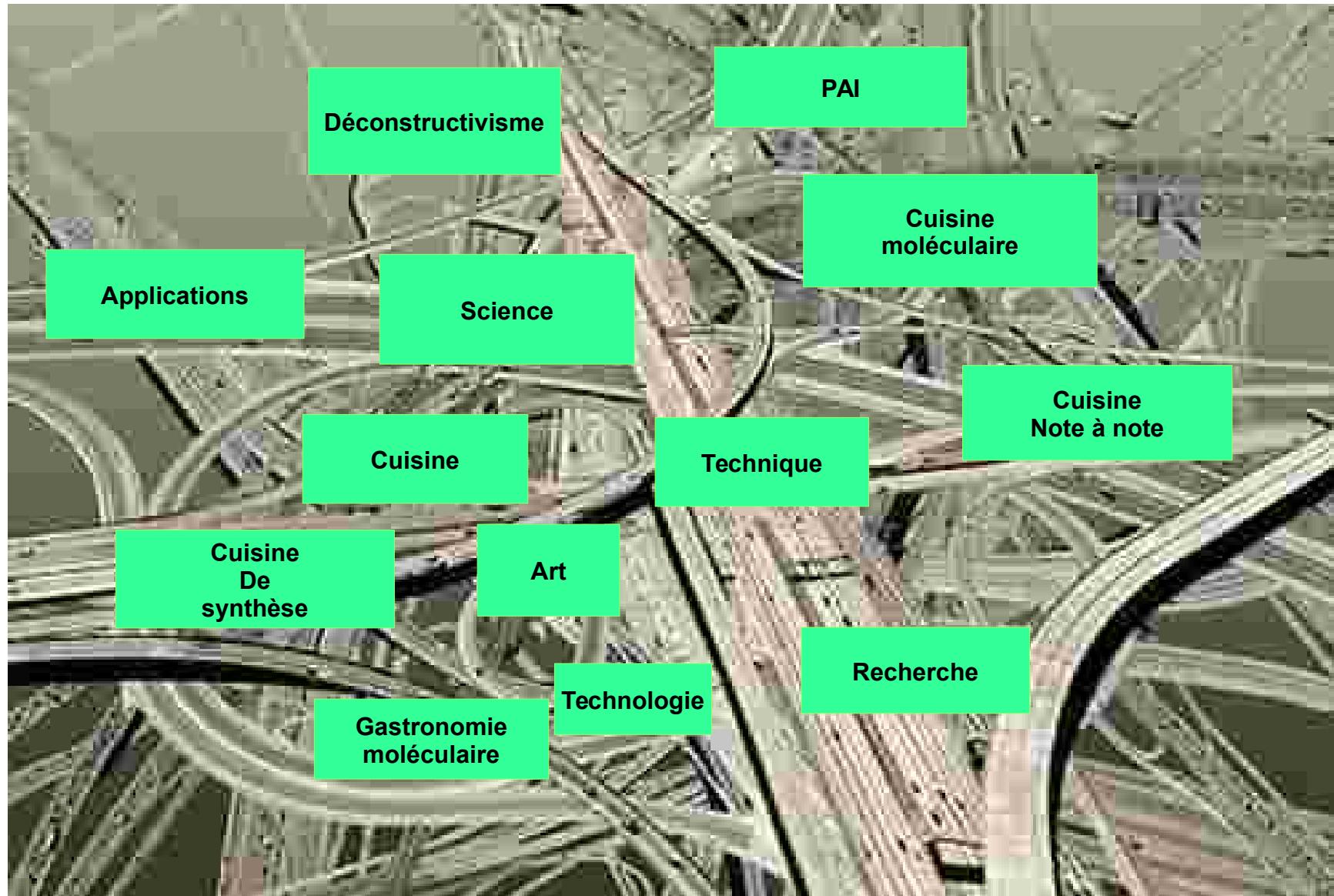




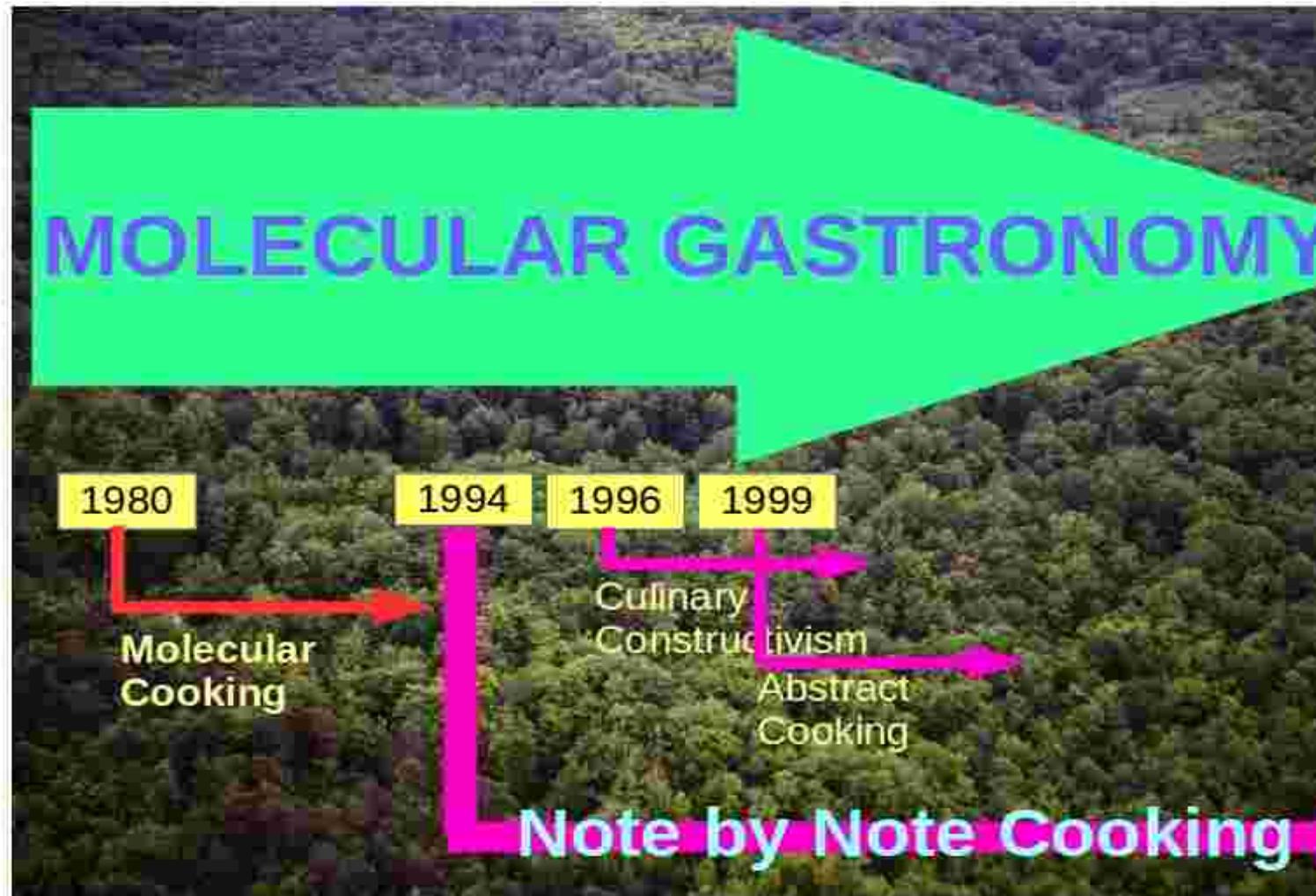
## 1. Molecular Gastronomy

## 2. Note by Note Cooking : new questions

# Confusion !



# Perhaps because I made many proposals



# 1. Science is looking for the mechanisms of phenomena



# The first "leg": experiments !

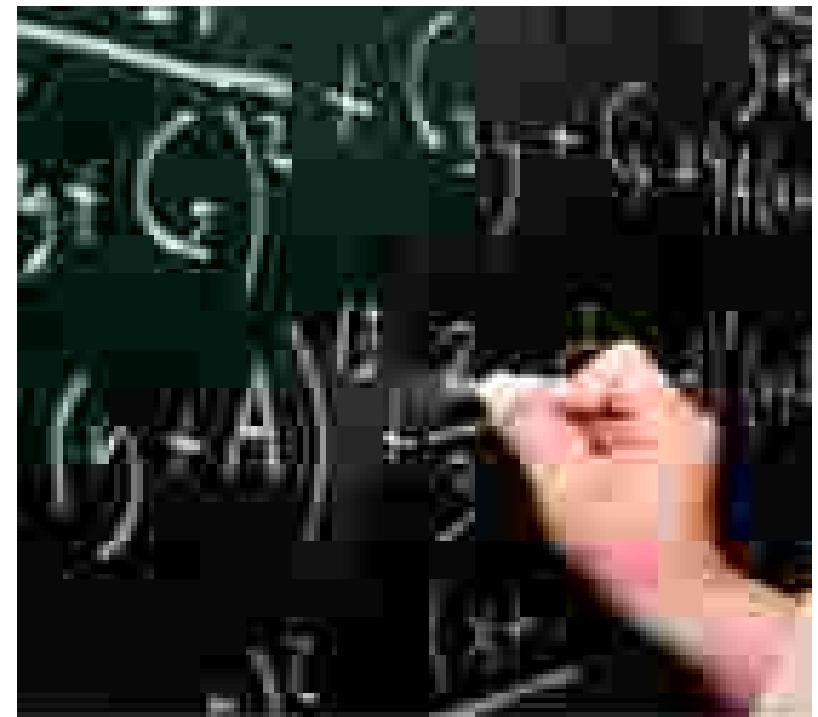
- "Un bon moyen pour atteindre la vérité, c'est de **préférer l'expérience à n'importe quel raisonnement**, puisque nous sommes sûrs que lorsqu'un raisonnement est en désaccord avec l'expérience il contient une erreur, au moins sous une forme dissimulée. Il n'est pas possible, en effet, qu'une expérience sensible soit contraire à la vérité. Et c'est vraiment là un précepte qu'Aristote plaçait très haut et dont la force et la valeur dépassent de beaucoup celles qu'il faut accorder à l'autorité de n'importe quel homme au monde"
- Galilée (1564-1642)



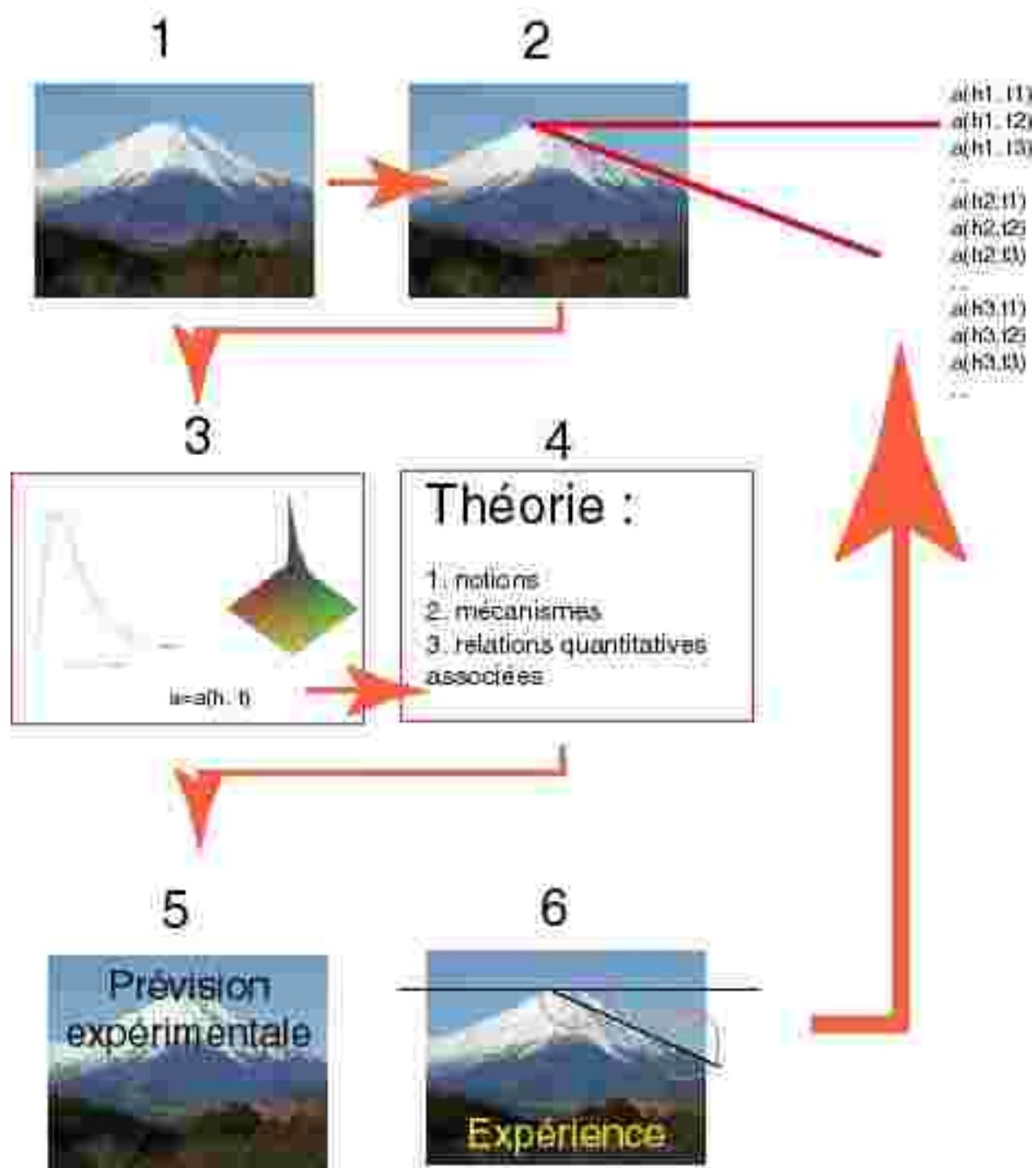
# The second one: calculation

- "La philosophie est écrite dans ce livre immense perpétuellement ouvert devant nos yeux (je veux dire l'univers), mais on ne peut le comprendre si l'on n'apprend pas d'abord à connaître la langue et les caractères dans lesquels il est écrit.

**Il est écrit en langue mathématique** et ses caractères sont des triangles, des cercles, et d'autres figures géométriques, sans l'intermédiaire desquels il est humainement impossible d'en comprendre un seul mot".



# Using this method



# 2. Technology a link between science and technique



Products



Knowledge

# 3. Technique doing things, producing goods and services

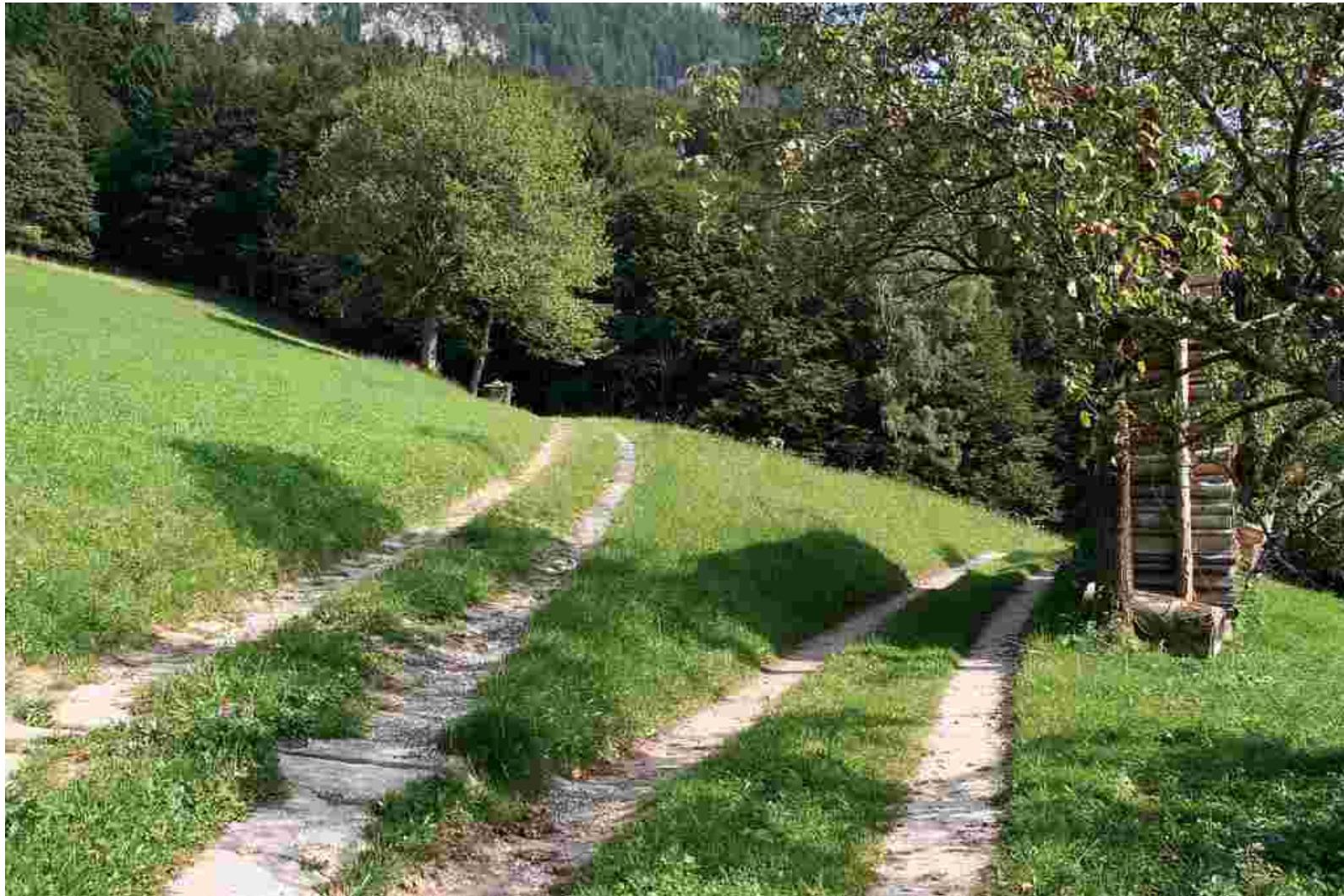


# 4. Art

## "Good" means "beautiful to eat"



# Differents methods, different goals





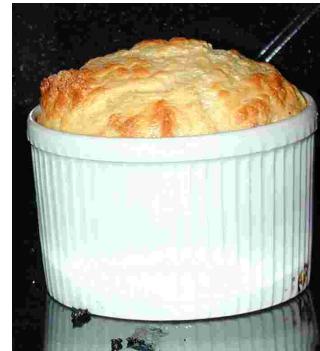
1.



# Molecular Gastronomy

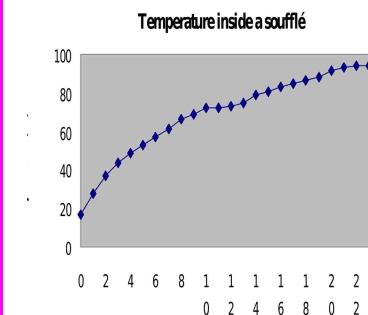
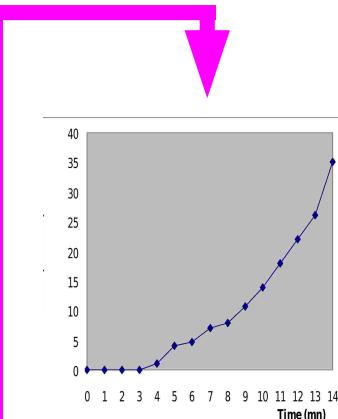
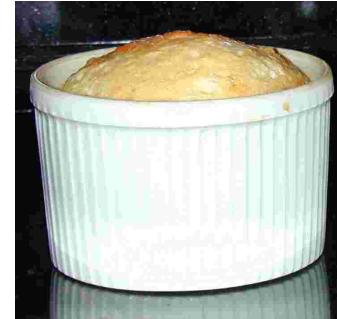
# For example with soufflés

(1980!)



Les bulles  
d'air se  
dilatent

$$P V = n R T$$

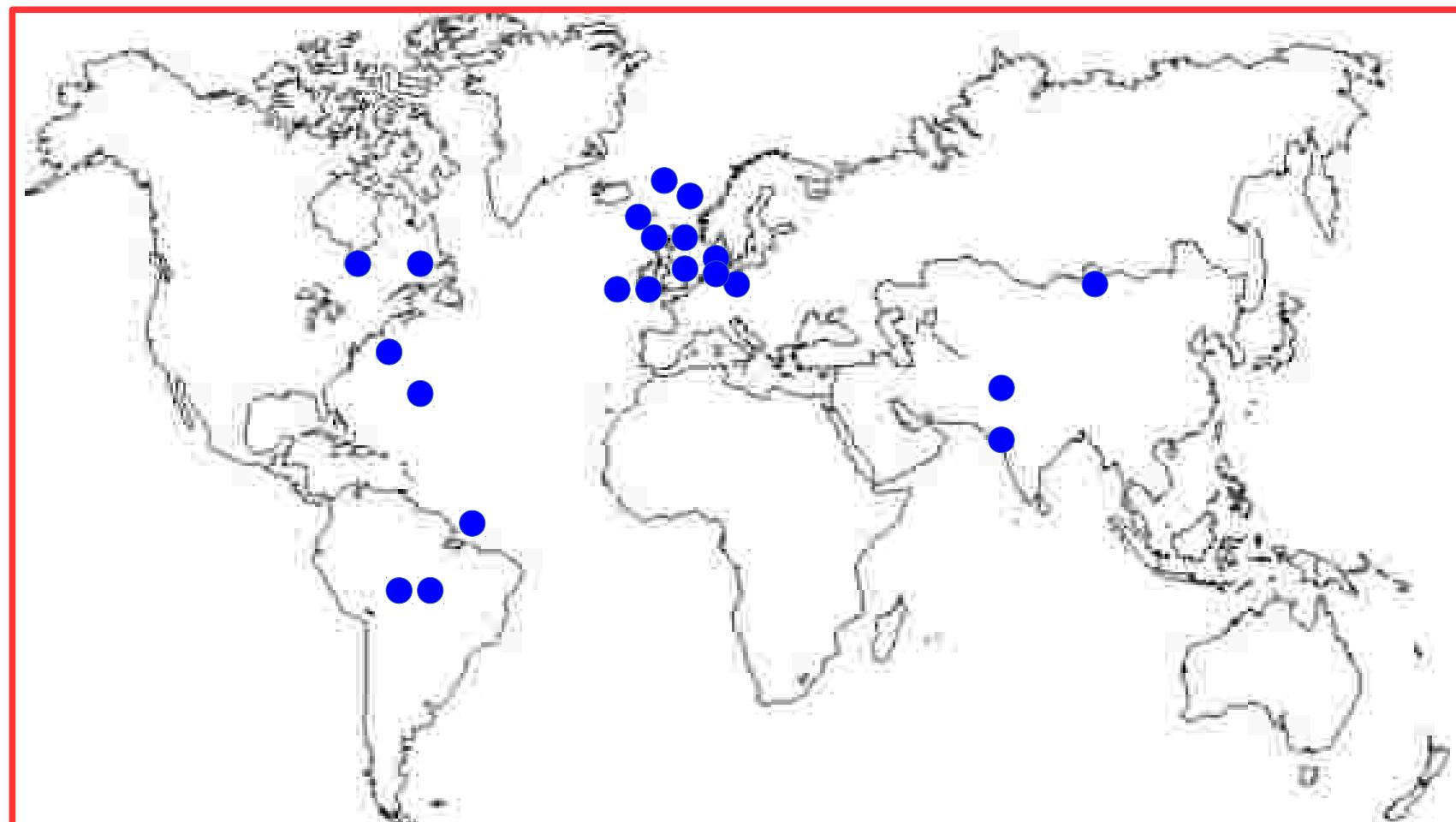


L'eau  
s'évapore

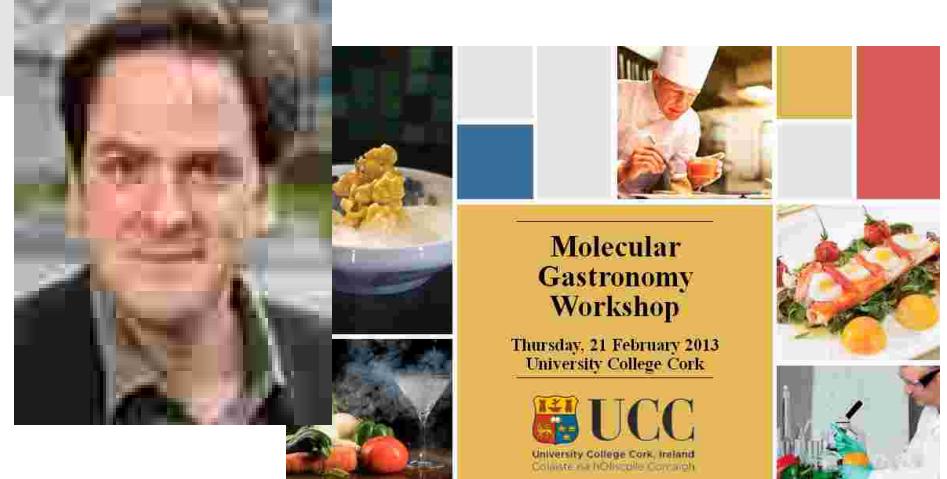


Etc.  
Ad  
infinitum

# It is now in many countries



# Ireland



# Korea



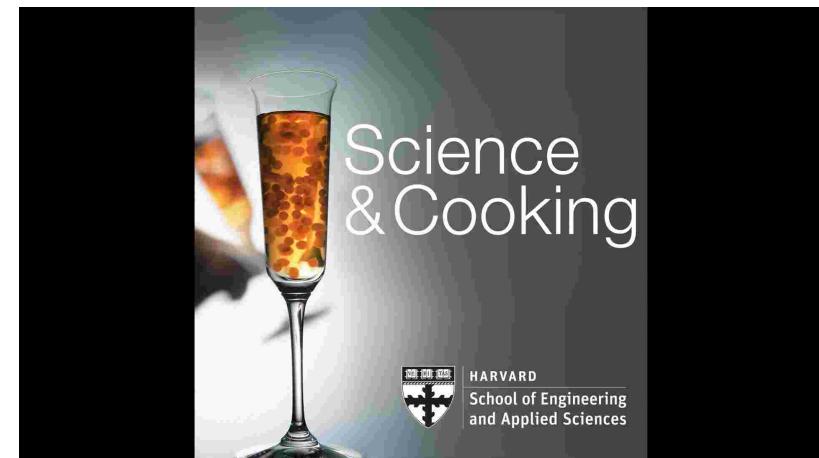
YOU WANT TO CONTRIBUTE TO THE DEVELOPMENT OF  
INNOVATIVE, SUSTAINABLE AND HEALTHY FOOD PRODUCTS



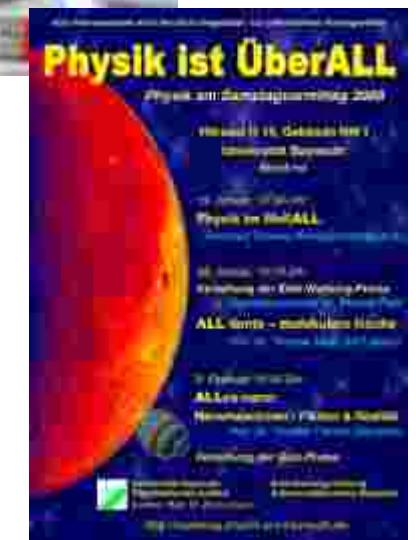
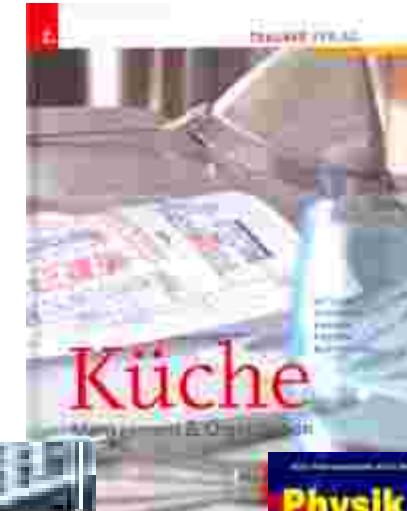
# Italy



# USA

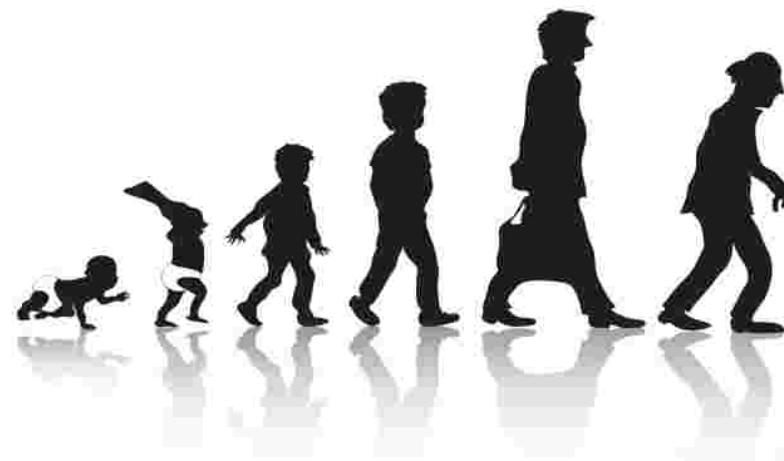


# Germany



# Etc.

# It is now in many contexts



# Education (1. primary schools)



Comment mettre en oeuvre les ateliers expérimentaux du goût ? [http://www.agroparistech.fr/podcast/Comment-mettre-en-oeuvre-les-ateliers-exp%C3%A9rimentaux-du-gout.html?var\\_mode=calcul](http://www.agroparistech.fr/podcast/Comment-mettre-en-oeuvre-les-ateliers-exp%C3%A9rimentaux-du-gout.html?var_mode=calcul)

je (Comment-mettre-en-oeuvre-les-ateliers-exp%C3%A9rimentaux-du-gout.html?var\_mode=calcul)



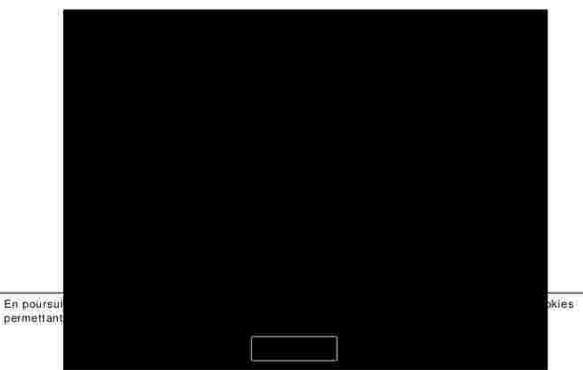
Les podcasts d'AgroParisTech

Accueil (<http://www.agroparistech.fr/podcast/>) / Gastronomie Moléculaire (-Gastronomie-Moleculaire-.html)  
/ Collèges & Lycées (-Collèges-Lycees-.html)  
/ Comment mettre en oeuvre les ateliers expérimentaux du goût ?

Comment mettre en oeuvre les ateliers expérimentaux du goût ?

Publié le 12 octobre 2011 (2011-10-12T20:36:01Z) / AgroParisTech (+AgroParisTech+.html) - Sciences (+Sciences+.html) - Vie de l'école (+Vie-de-l'école+.html) /

Dans le cadre de la fête de la science



En poursuiv...  
permettant

06/04/2016 10:04

1 sur 4

# Education (2. high schools)

The screenshot shows a web page from the Académie de Paris website. The header includes links for 'Accès', 'Contenu', 'Recherche', 'S'identifier', and 'accéder'. The main navigation bar has tabs for 'Académie', 'Parents / Elèves', 'Orientation', 'Enseignement supérieur', 'Pédagogie', and 'Emplois, carrières, formation'. Below this, a breadcrumb trail reads 'Accueil > Pédagogie > Arts et culture >'. A sidebar on the left lists categories like 'Arts et culture', 'Partenariats', 'Histoire des arts', etc., and features a 'VidéoLib' section with a video thumbnail. The main content area is titled 'Ateliers Science & Cuisine' and includes a social sharing bar with Twitter, Facebook, and Google+ buttons. It features a small image of a person in a kitchen and a quote from Hervé This: "'Une nouvelle approche de l'enseignement des sciences, de la cuisine... et un nouvel outil de transmission de la culture.' Hervé This". Below this, a text block states: "Depuis 2004, un groupe de professeurs de l'Education nationale et Hervé This préparent des Ateliers expérimentaux du goût et des Ateliers Science & Cuisine. Dans ce cadre, orchestré par quelques inspecteurs de l'Education nationale, des fiches préparées par Marie-Claude Feora et Laure Fort viennent d'être mises en ligne : <http://www.agroparistech.fr/Les-Ateliers-science-Cuisine-.html>". There are also sections for 'Présentation des Ateliers Science et Cuisine par M. Marcaillou, IA-IPR de sciences physiques et chimiques' and 'Présentation des Ateliers Science & Cuisine par Hervé This, Équipe INRA de Gastronomie moléculaire,'. On the right side, there's a search bar, a checkbox for 'Inclure les sites pédagogiques', and sections for 'Informations pratiques' (Classes à projets culturels et ateliers, Circulaires réglementaires, PREAC, Concours destinés aux élèves, Enseignements artistiques optionnels) and 'Téléchargements' (Stage DAAC 2015-2016, Équipe DAAC, Structures, partenaires et intervenants, Référents culture en lycée 2015-2016, Référents culture en collège 2015-2016). A 'Liens utiles' section is also present.



# Education (3. University)

**FIPDes**  
Food Innovation & Product Design

ERASMUS MUNDUS MASTER

Erasmus Mundus  
Erasmus+

Search go

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Practical Information  
Contact

WITH AN HOLISTIC VIEW - FROM CONCEPTION TO PROTOTYPE AND FINAL PRODUCT

Welcome to the website of the Erasmus Mundus Master in Food Innovation and Product design  
In collaboration with:

Dublin Institute of Technology  
Lund University  
AgroParisTech  
Università Federico II di Napoli (UNINA)

NOW IN FIPDES  
Testimonials

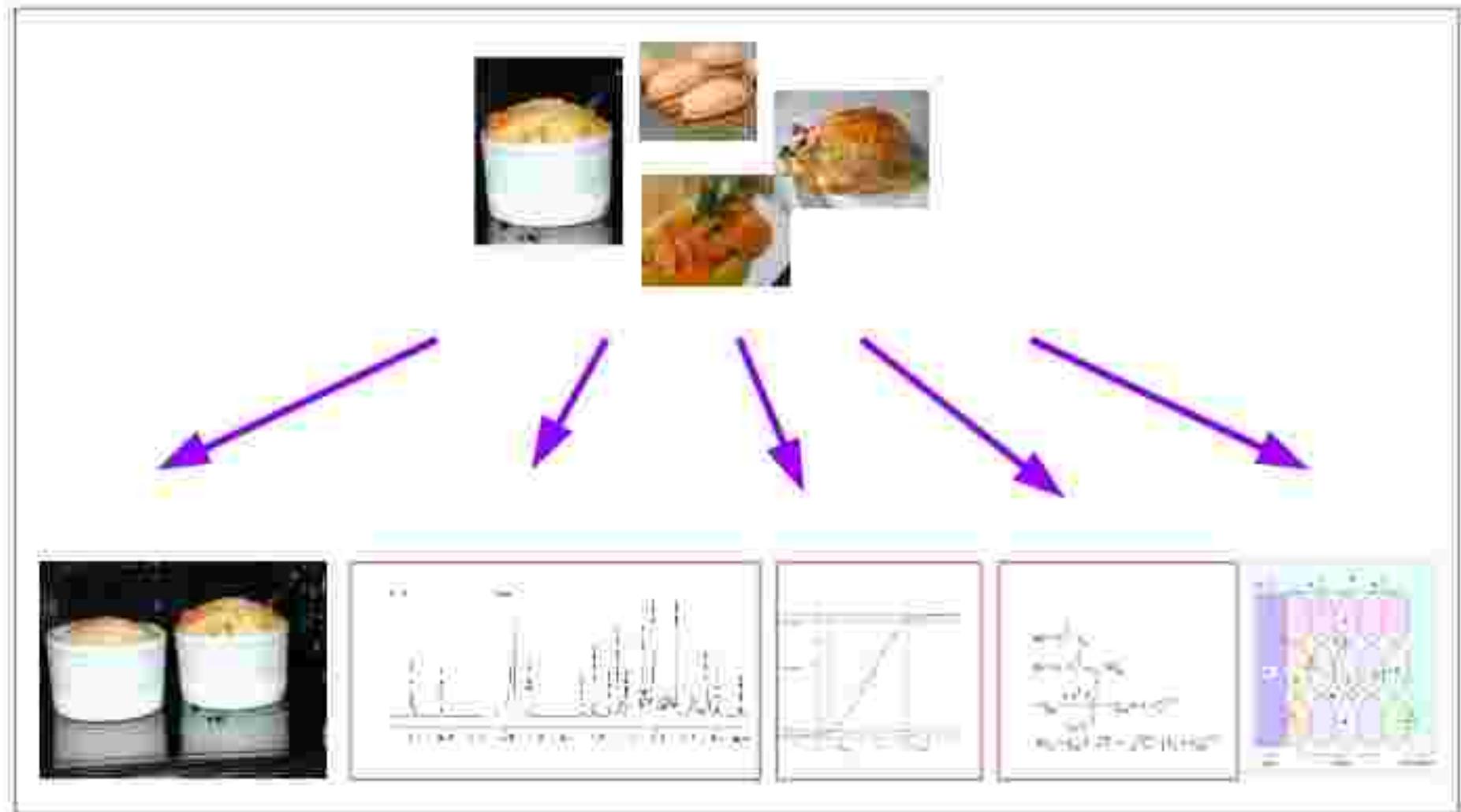
LINKS  
Erasmus students and alumni association  
Erasmus Mundus  
Erasmus +

# Education (4. continuous education)



# Etc.

# Molecular Gastronomy as a research



# In our Group



Le Centre Claude Bernard d'AgroParisTech, à Paris (5e)



# Too many interesting questions !

## Which one should we choose ?

- Photosynthetic pigments as being transformed during the thermal treatment of plant tissues
- Release of proteins during animal tissue thermal heating in aqueous solutions
- Green chemistry : thermal treatment at 100°C in aqueous solution of organic compounds from « food »
- Modification of the color of saffron processed in aqueous solution, with or without light
- Distribution of estragole in the various compartments (water, oil, gas, animal tissues) during a culinary recipe
- Extraction nutriments from plant tissues
- Why apricots appear sourer after thermal treatment (31P NMR spectroscopy)
- Differences between wines thermally processed at low or high heating power
- « Freshness » of yogurts : an influence of the microstructure ?
- Exchange between plant tissue and aqueous solution during thermal treatment
- ...

# The issue of scientific strategy (Where is there a mountain?)

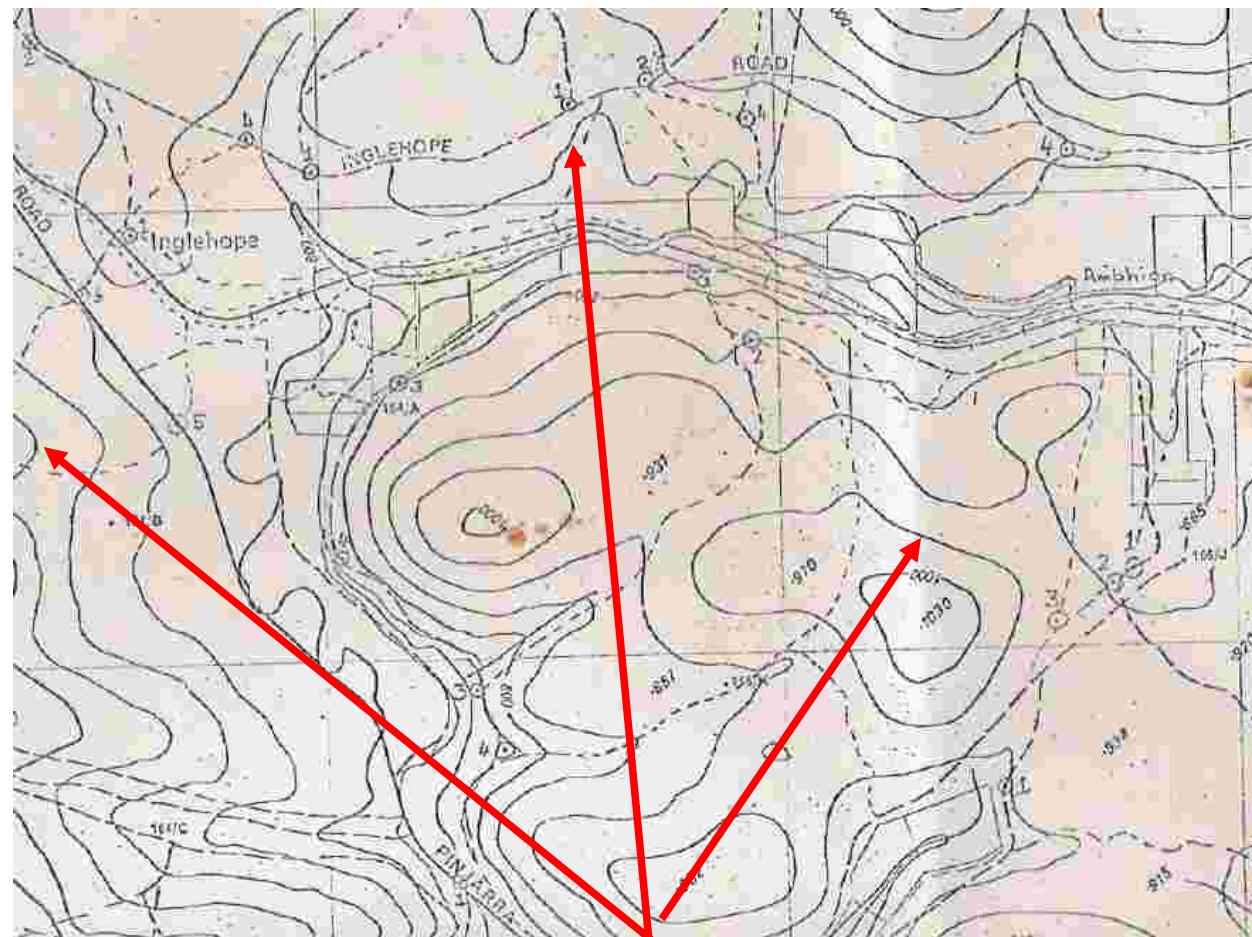
Behind us



In front of us



# Which direction should we use ?



# Methods, instead of directions ?



[www.vobisdesign.net](http://www.vobisdesign.net)

# Where is there a mountain ?

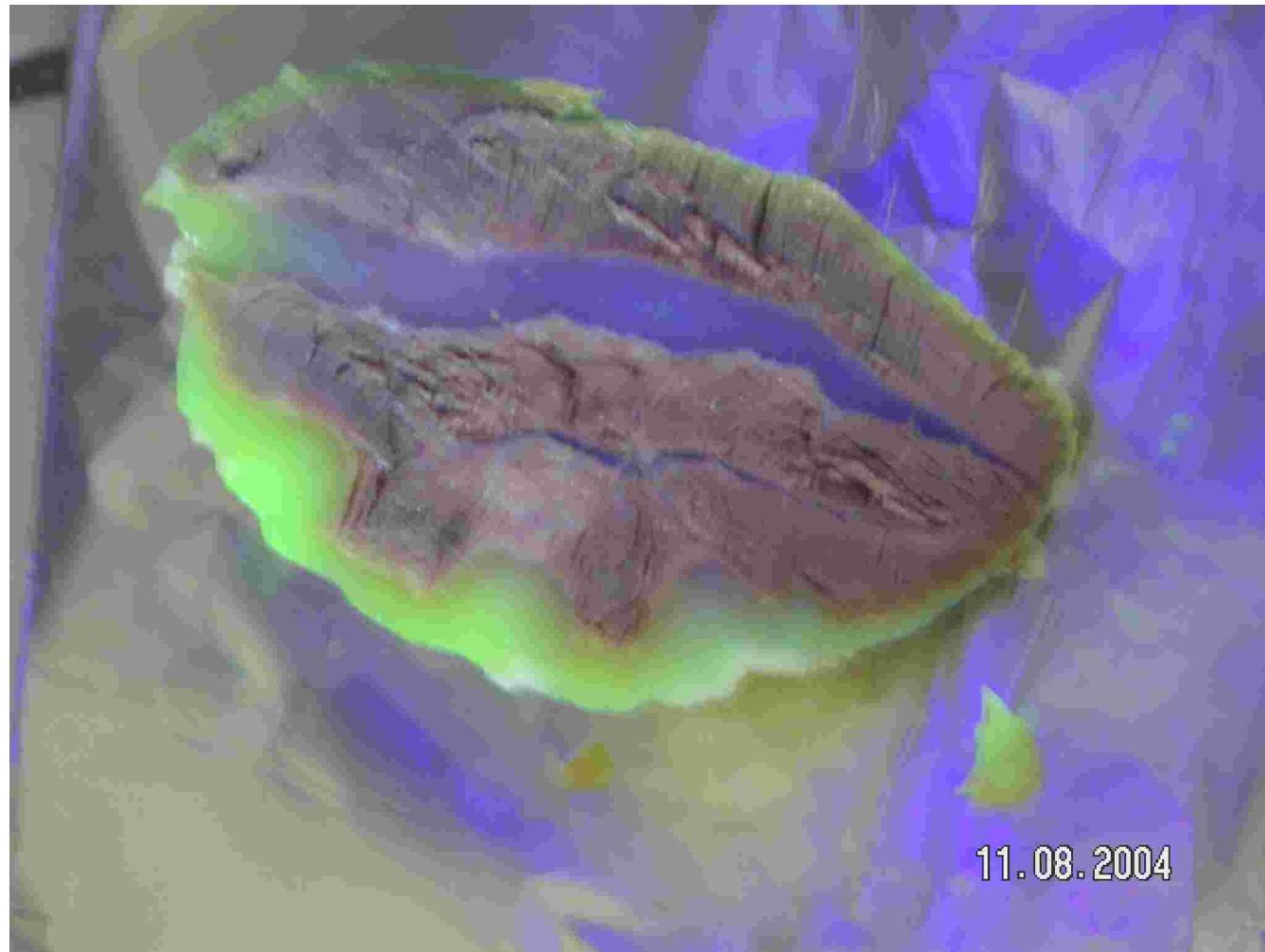
1.

**Looking for mechanisms**  
**(with deception when nothing is new)**

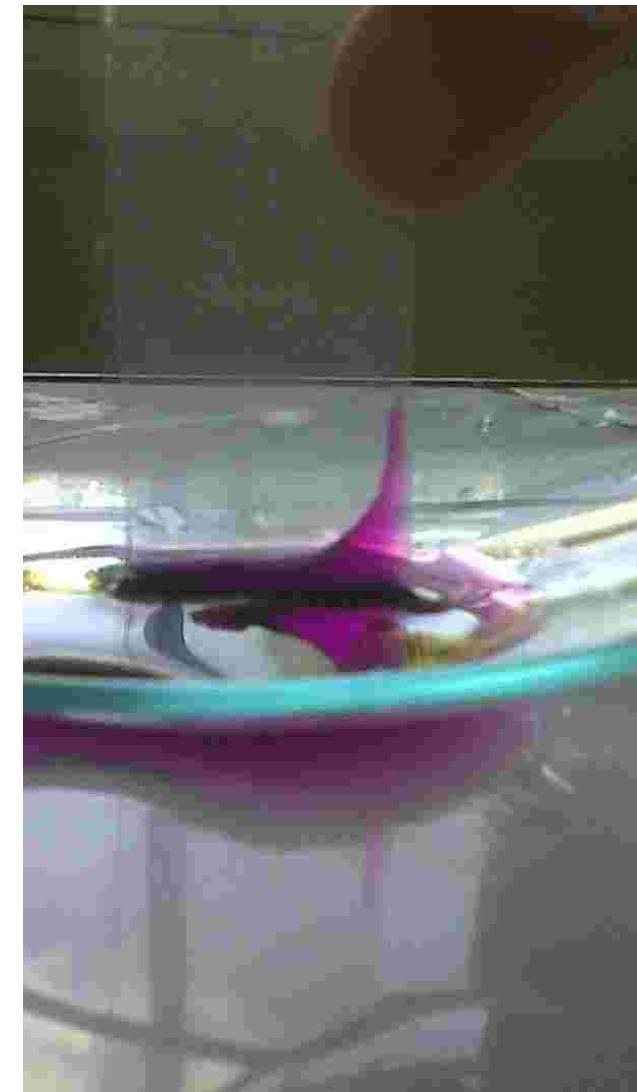
# What's going on during marinating ?



# Almost nothing ?



# But sometimes...

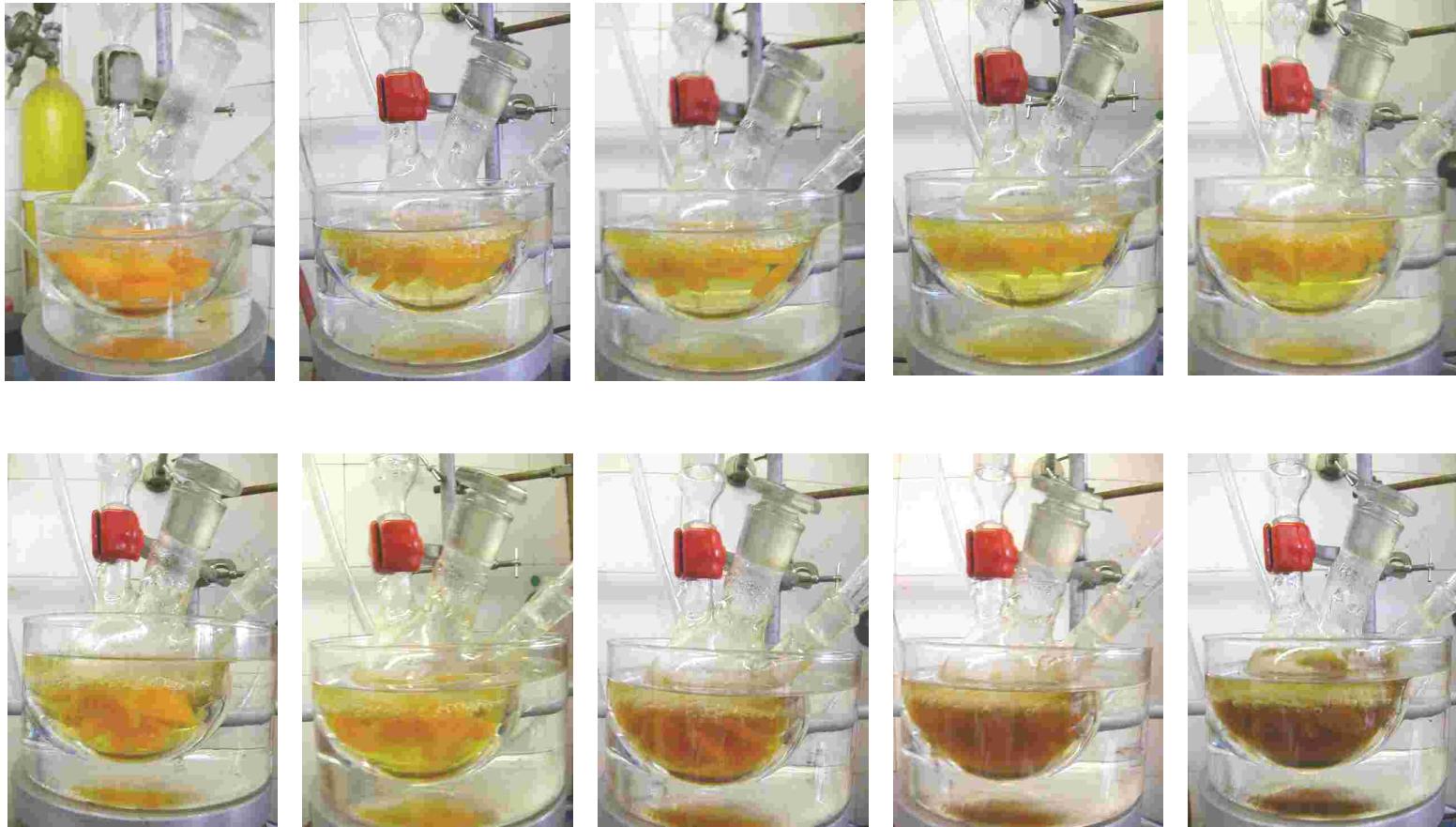


# Where is there a montain ?

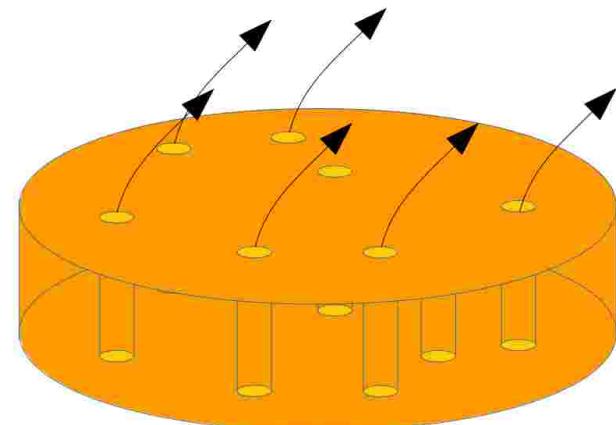
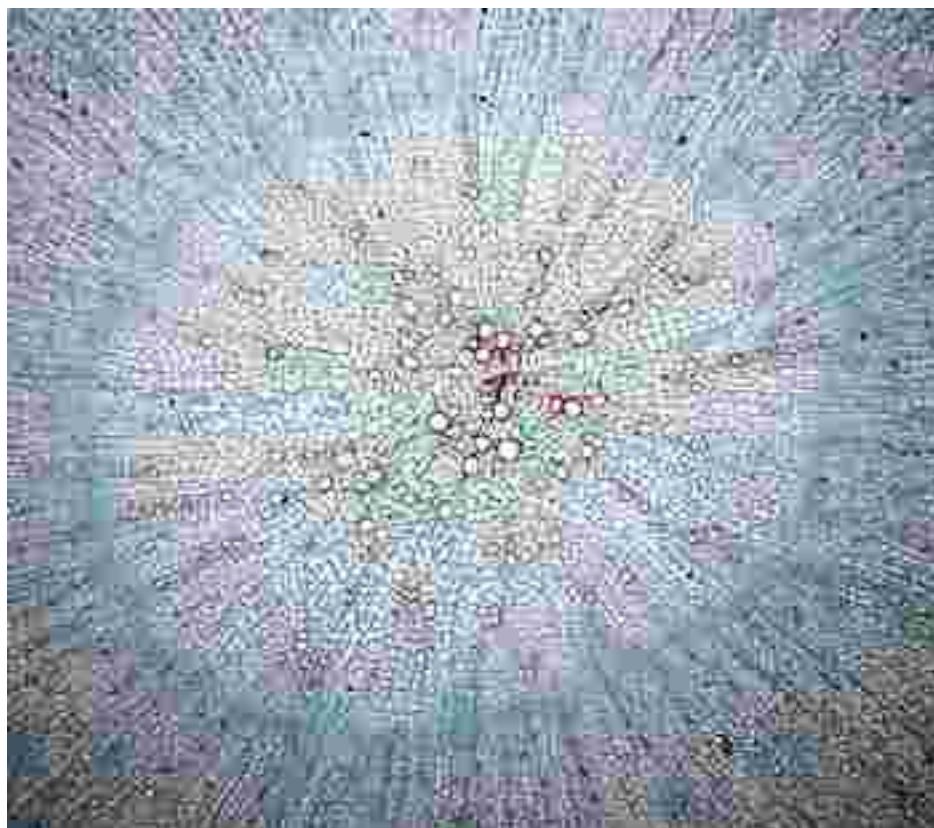
2.

## Refuting a theory

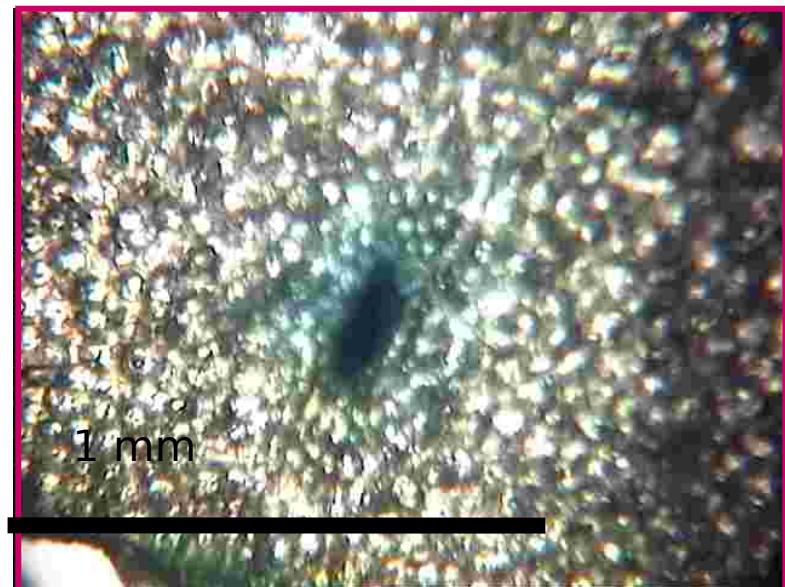
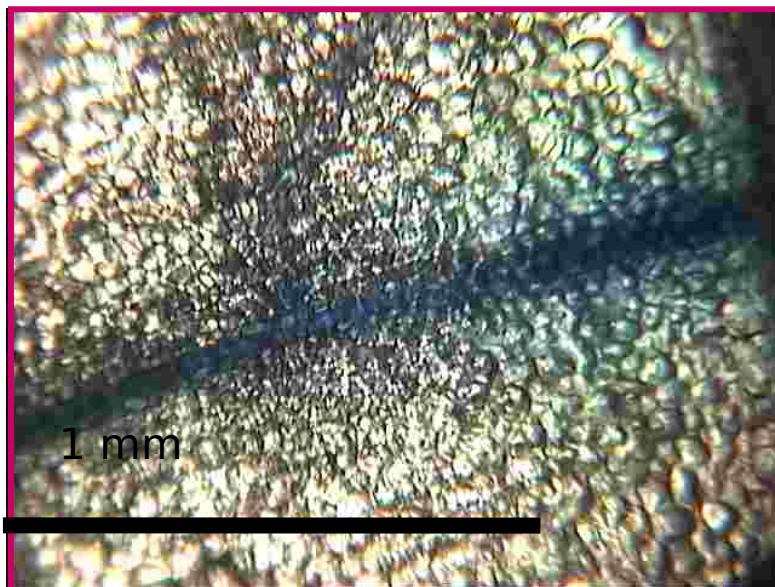
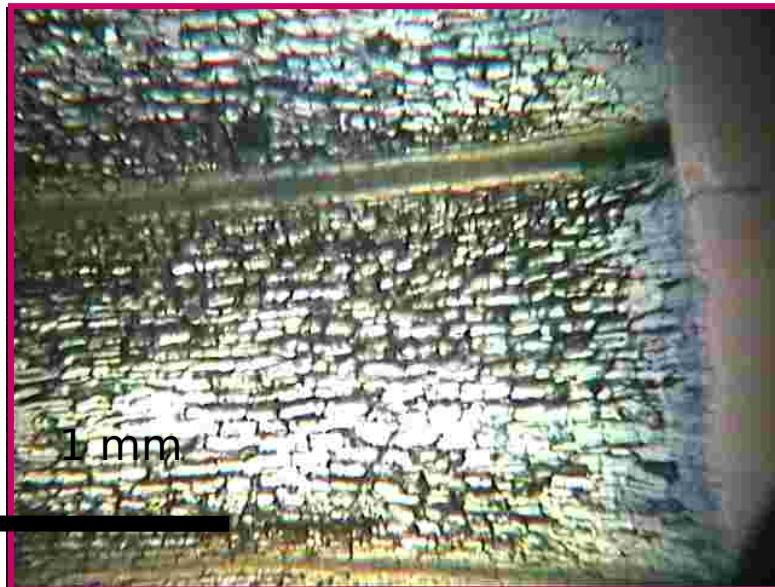
# What goes out from a plant tissue and how ?



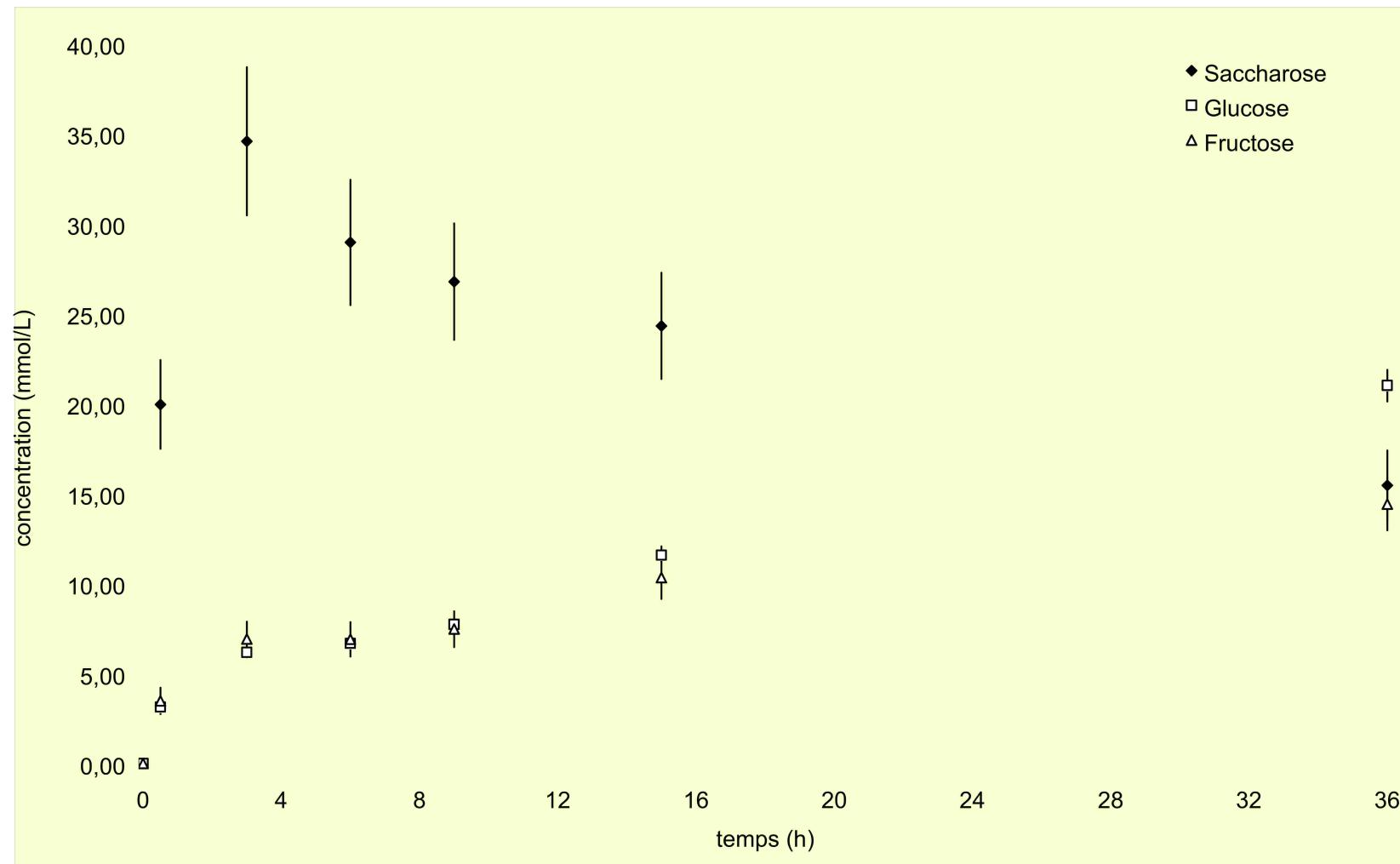
# The old theory



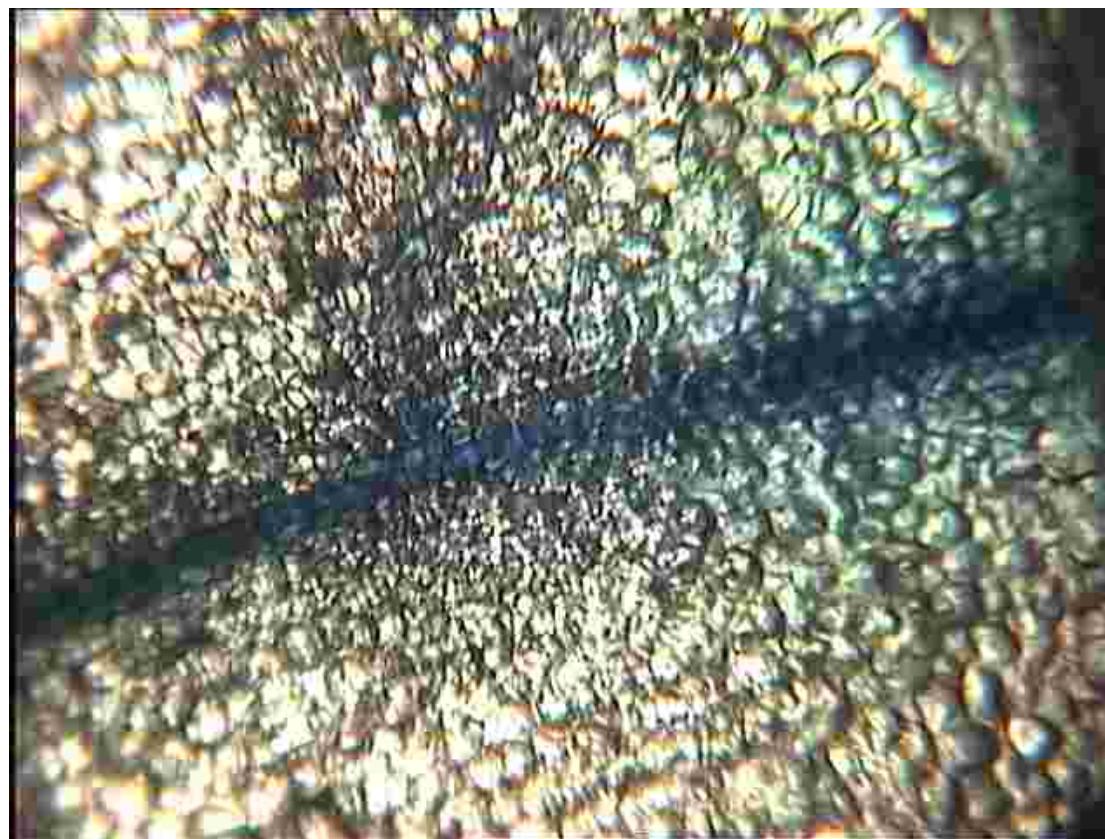
# Diffusion ?



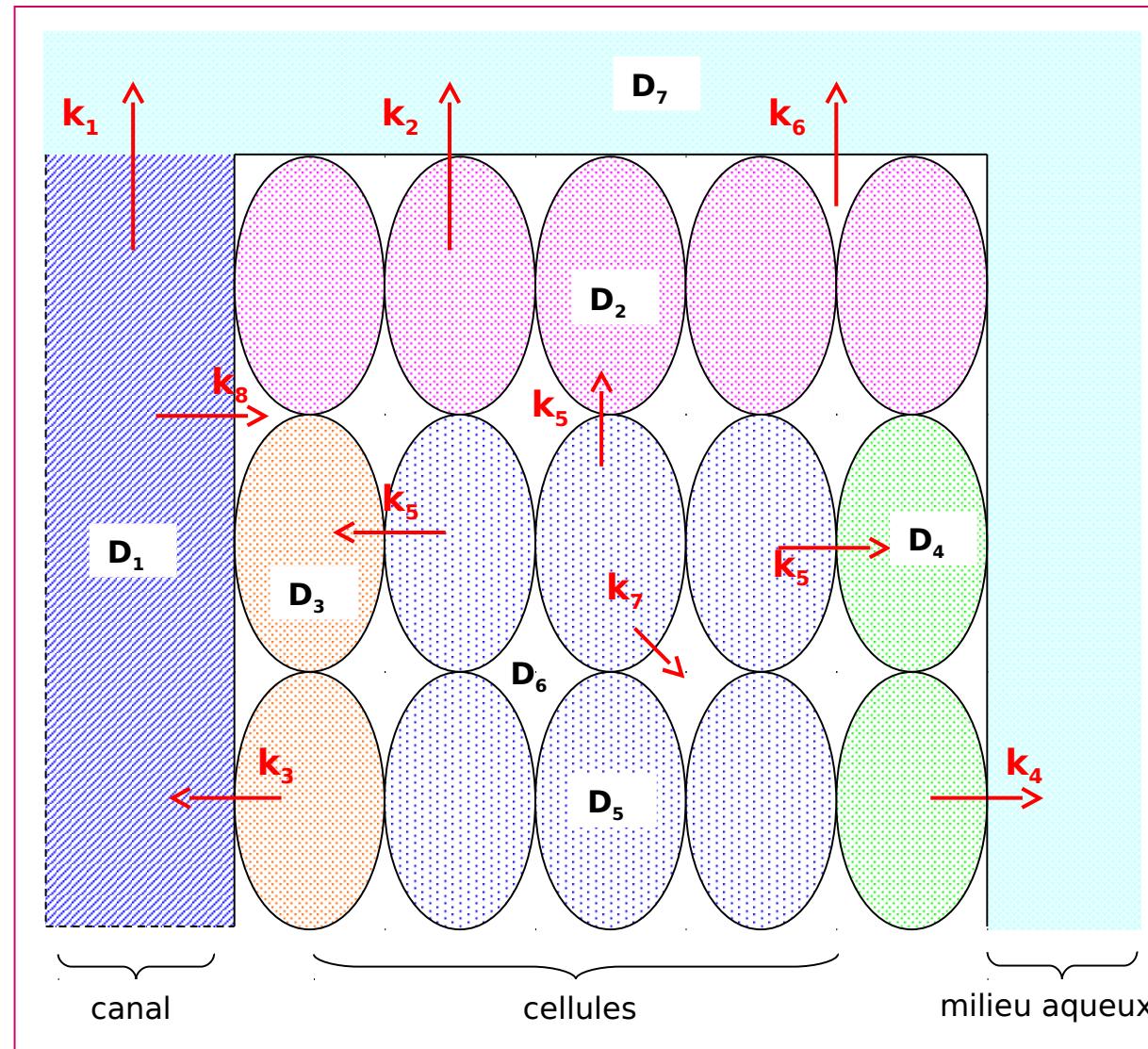
# But there are molecular modifications



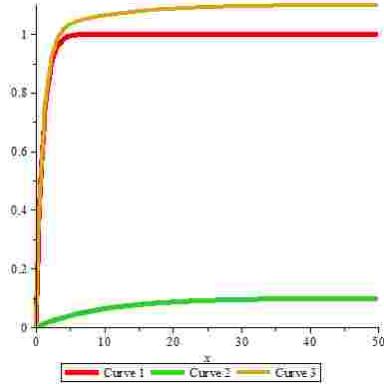
# But the model is clearly wrong



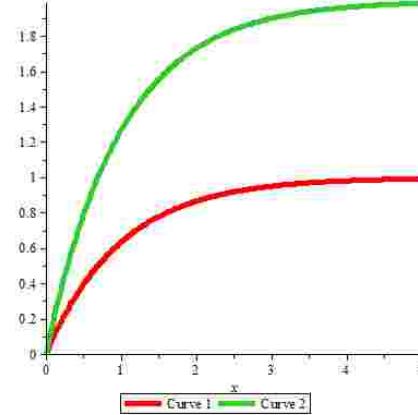
# A model to improve (quantitatively)



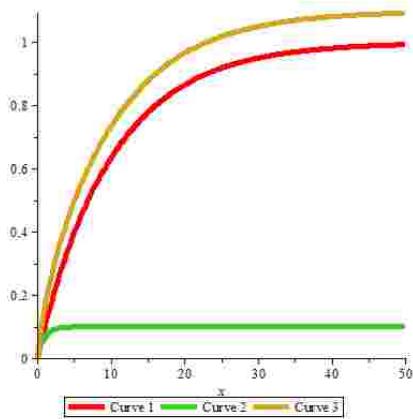
More metabolites in cells,  
fast release from cells



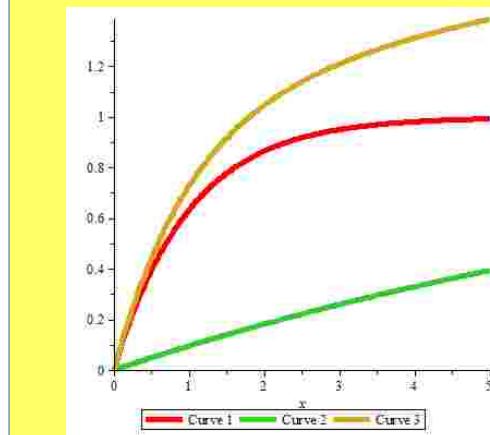
Same quantity, same speed  
More metabolites in channels,  
Slow release from channels



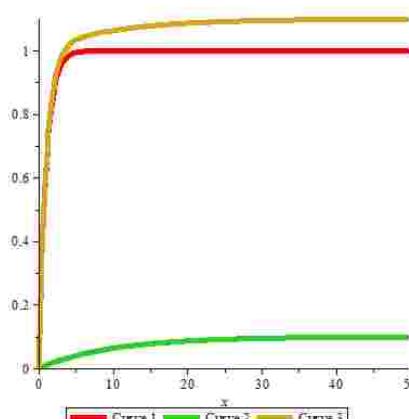
Moere metabolites in cells,  
slow release from cells



Same quantity, different speed



More metabolites in channels,  
fast release from channels



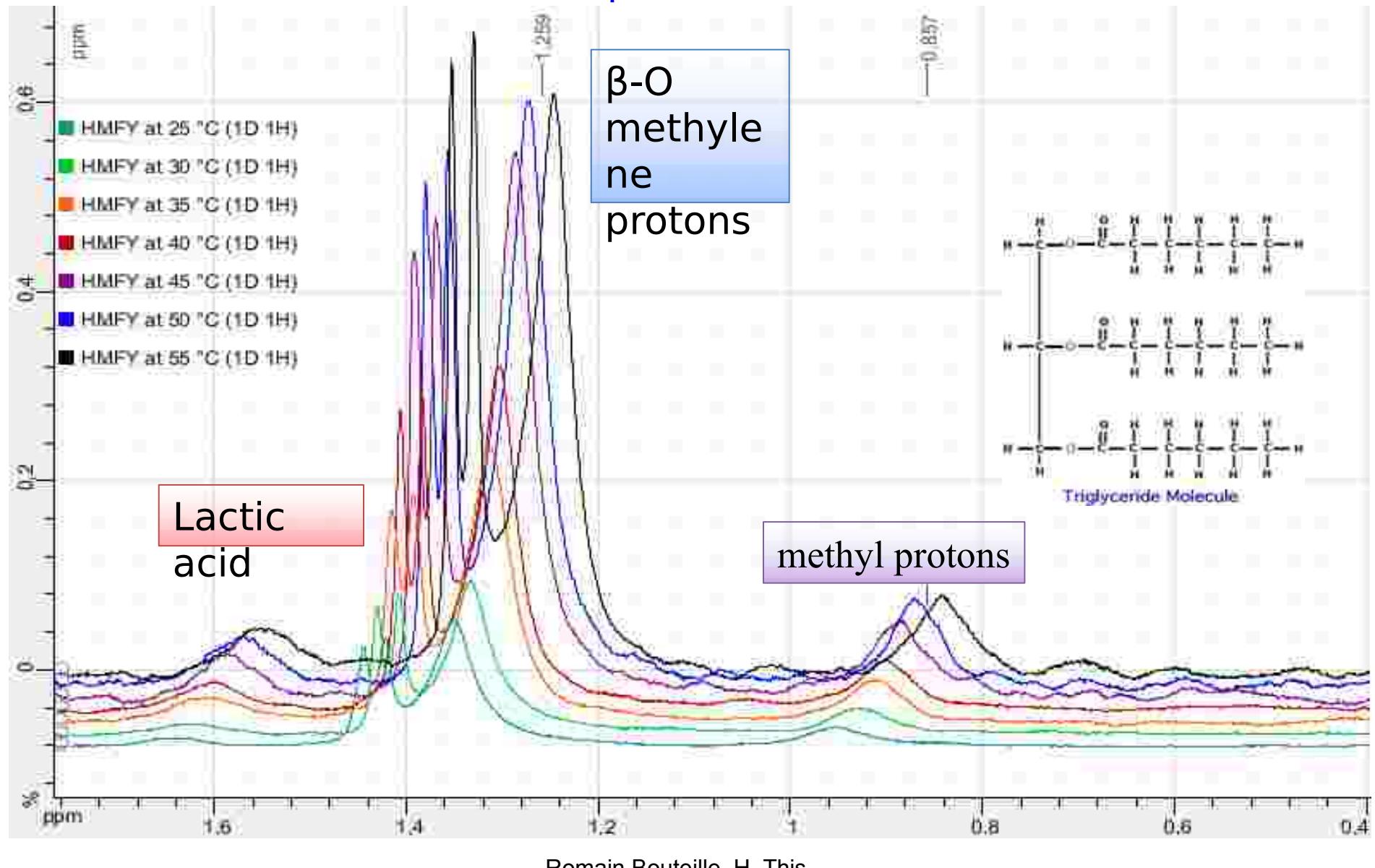
... but validation is needed !

# Where is there a montain ?

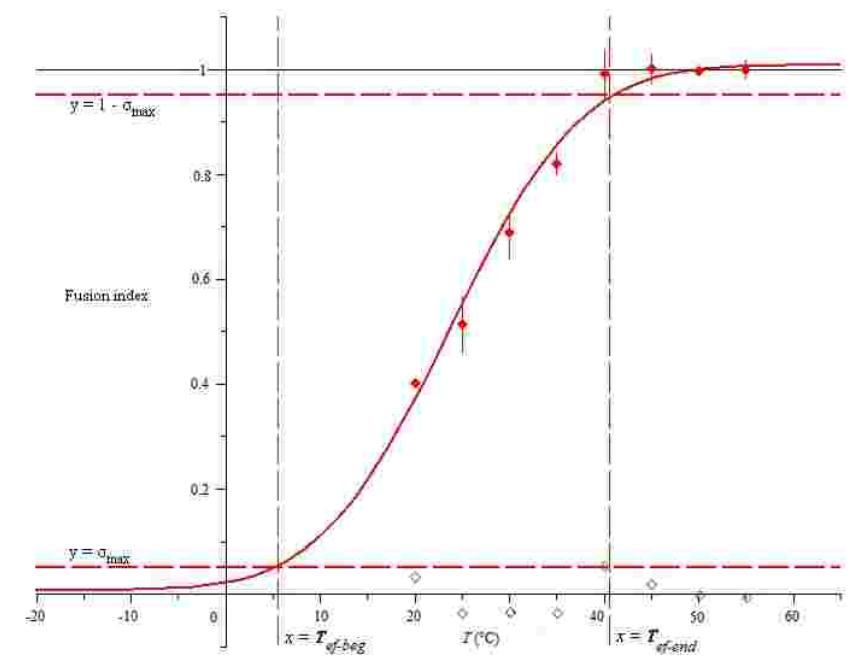
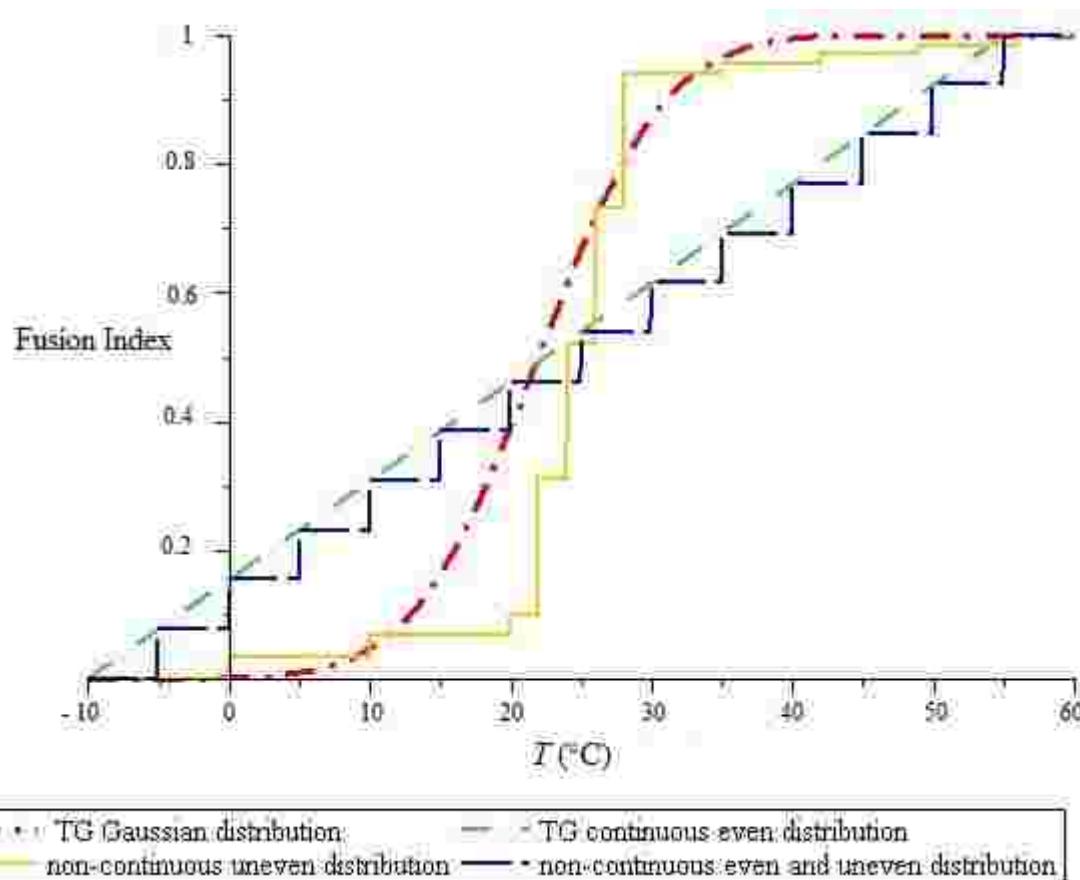
## 3. Solving a problem

# Does fat crystallize differently in emulsions ?

Example of HMFY



# Not, from our experiment



# Where is there a montain ?

4.

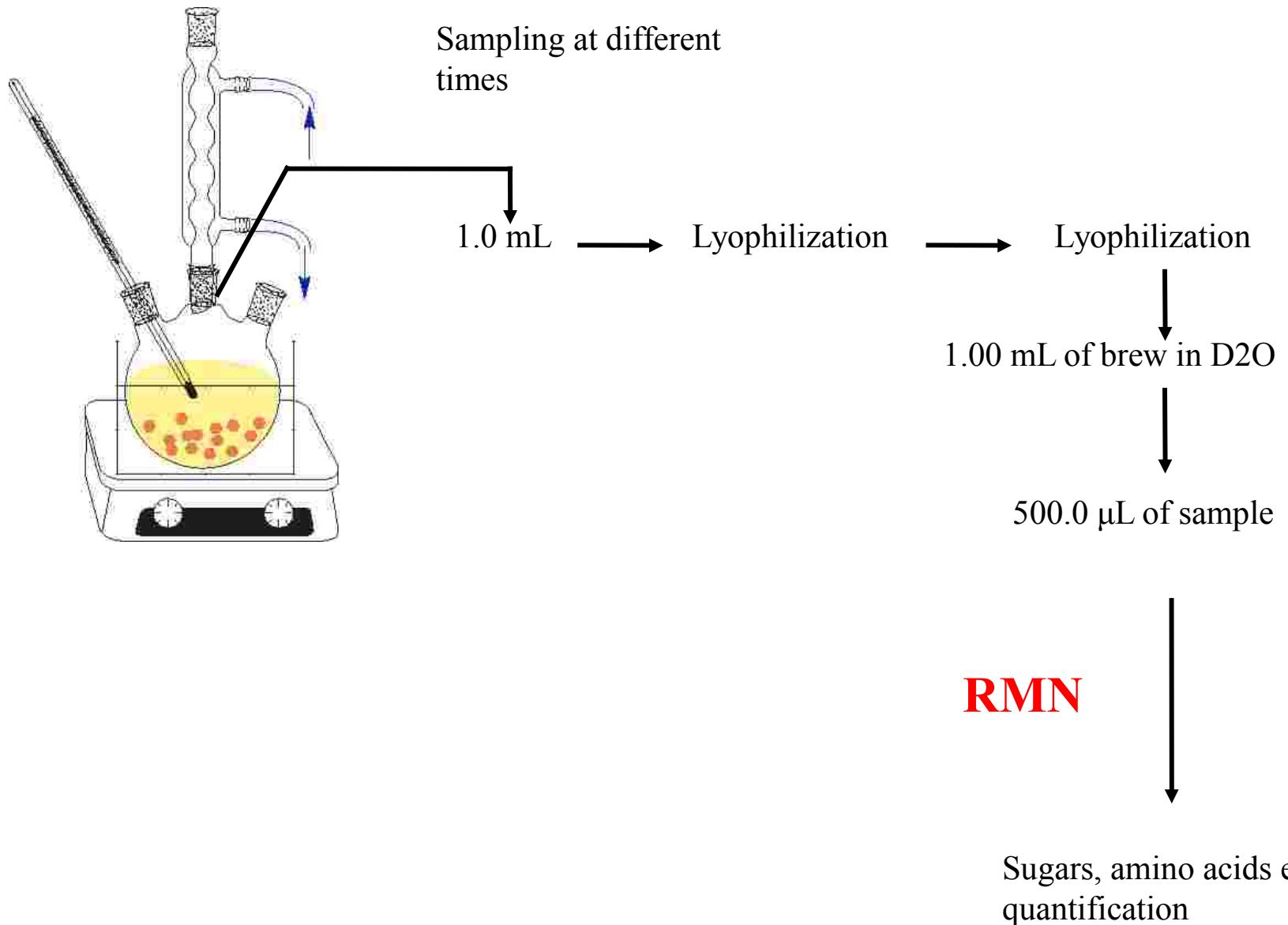
A new "microscope"

# From q NMR to *is* q NMR

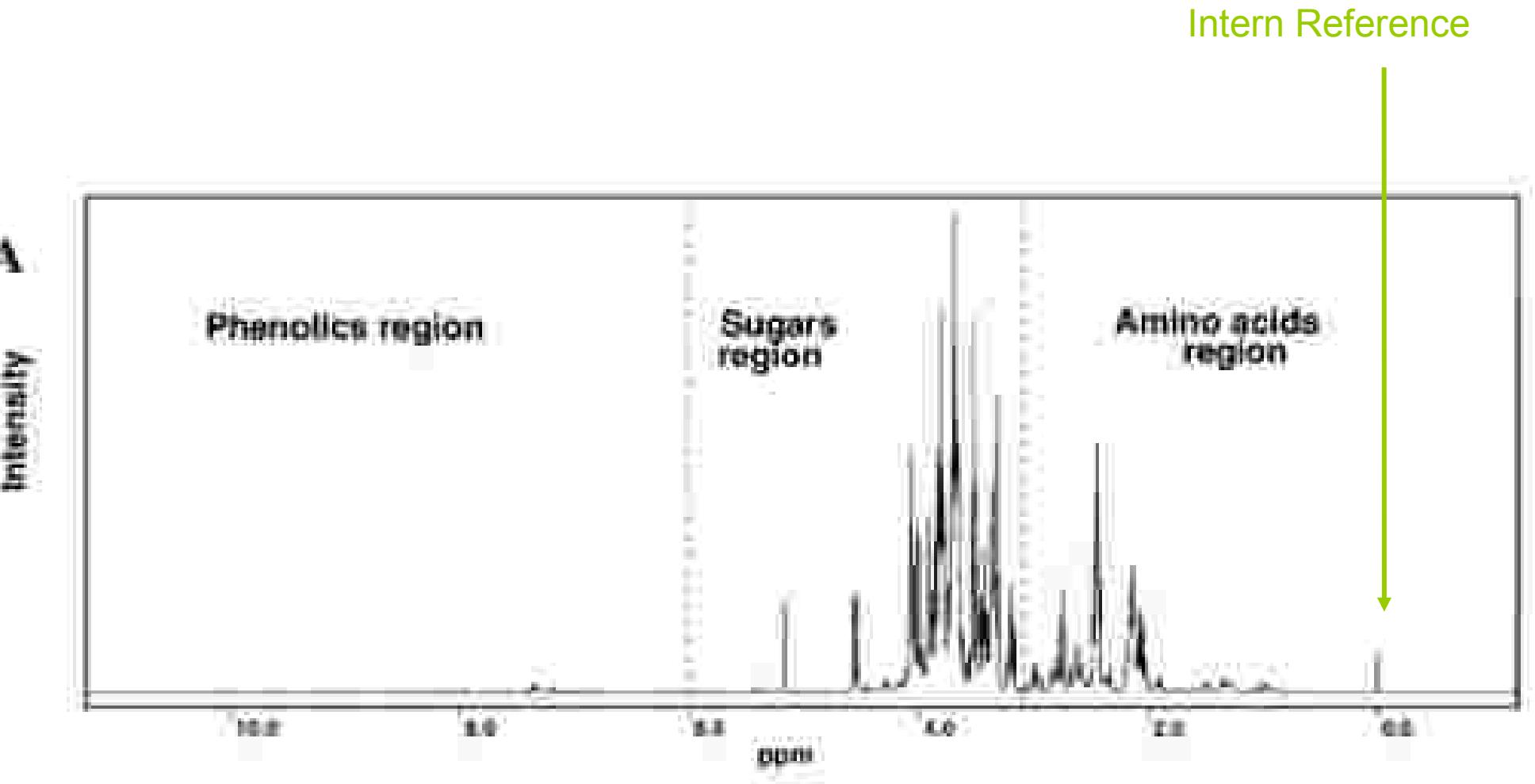




# Preparing samples: 5 days!

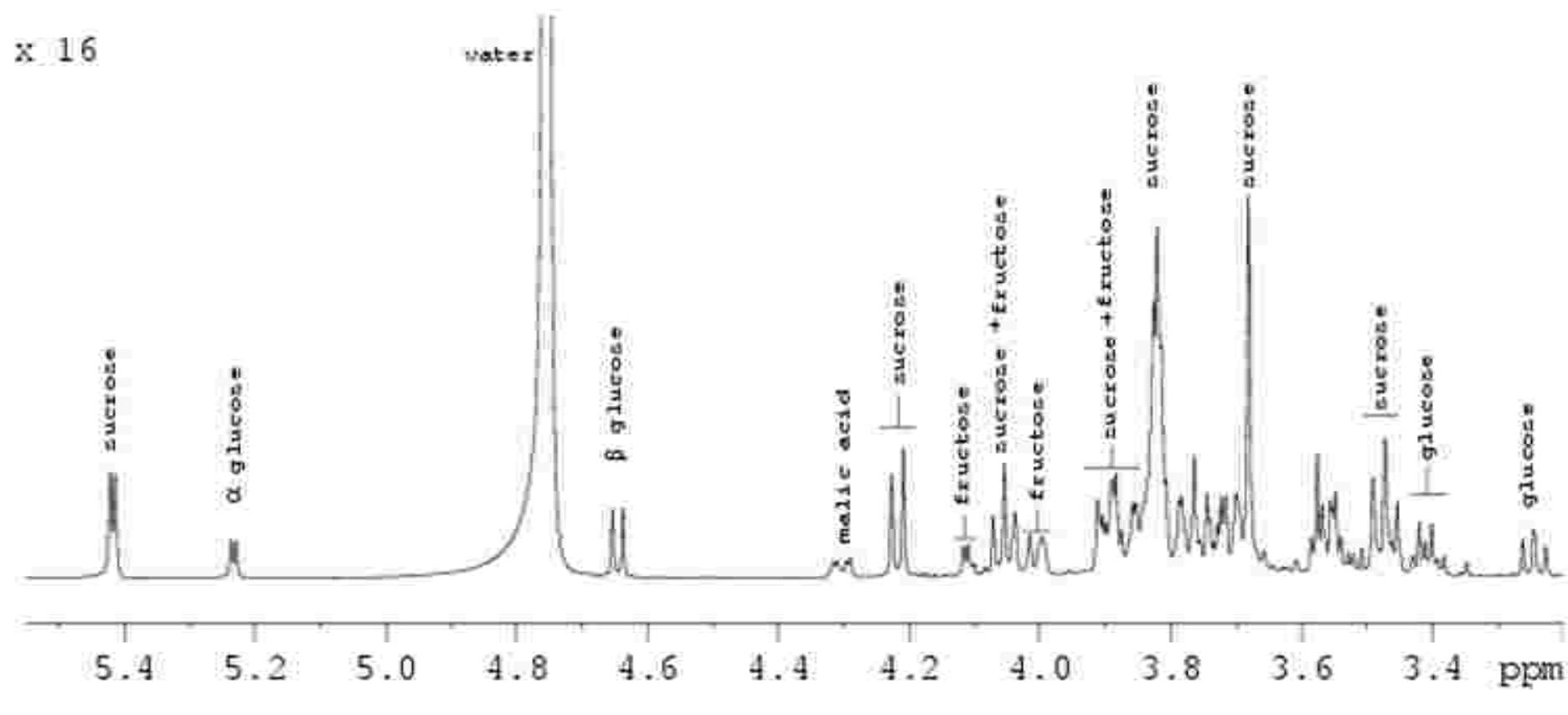


# Here is a carrot stock



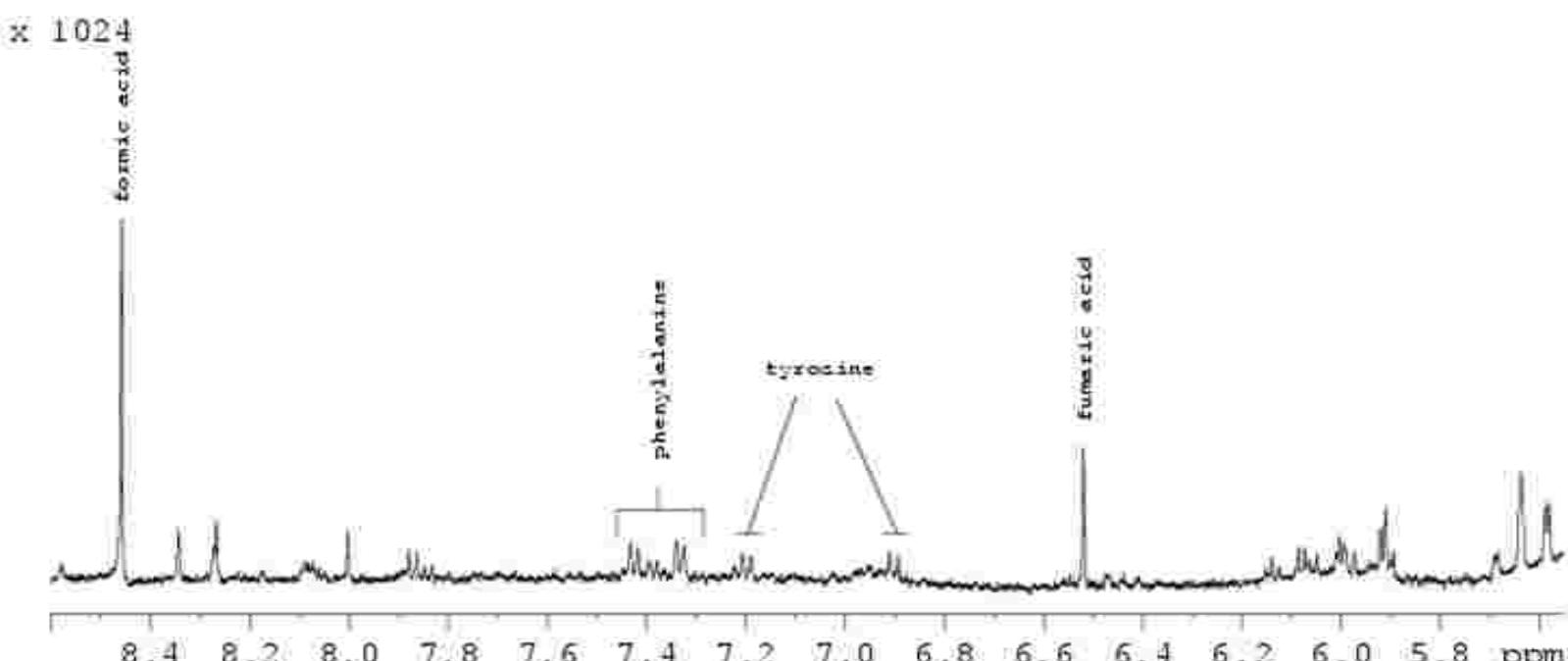
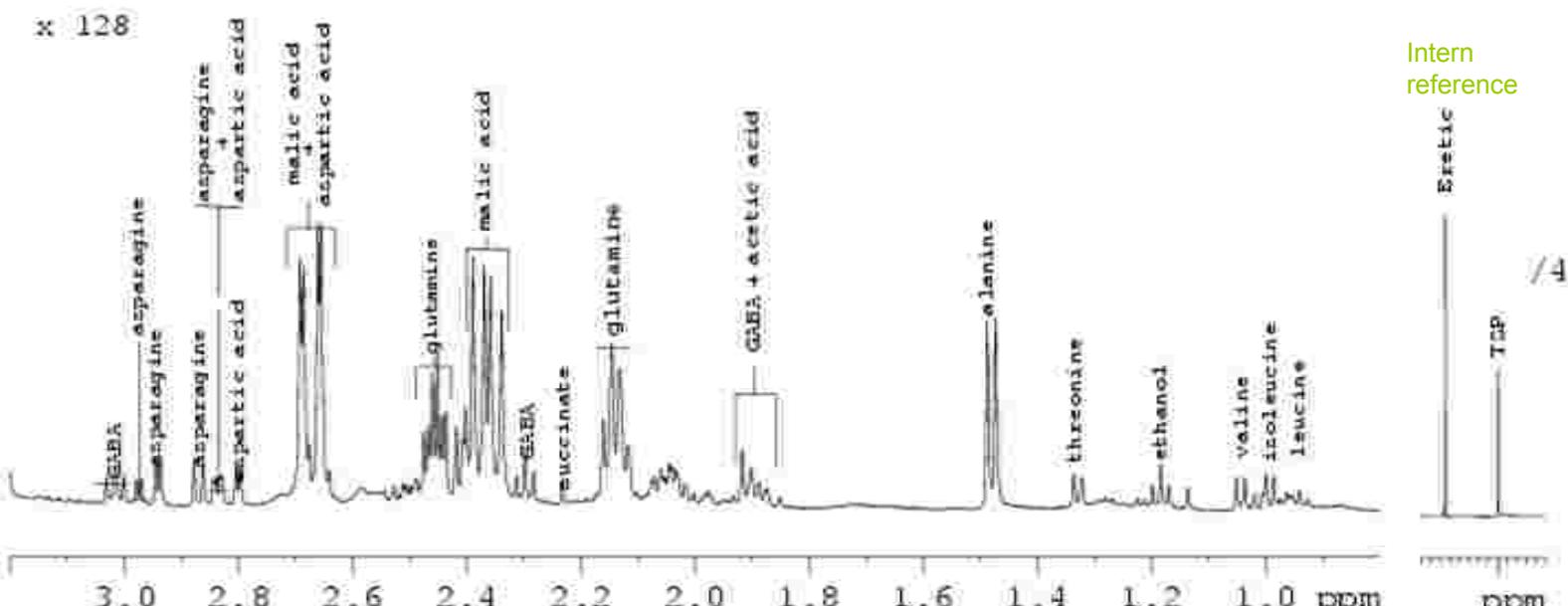
Anne Cazor, H This

# Mainly saccharides

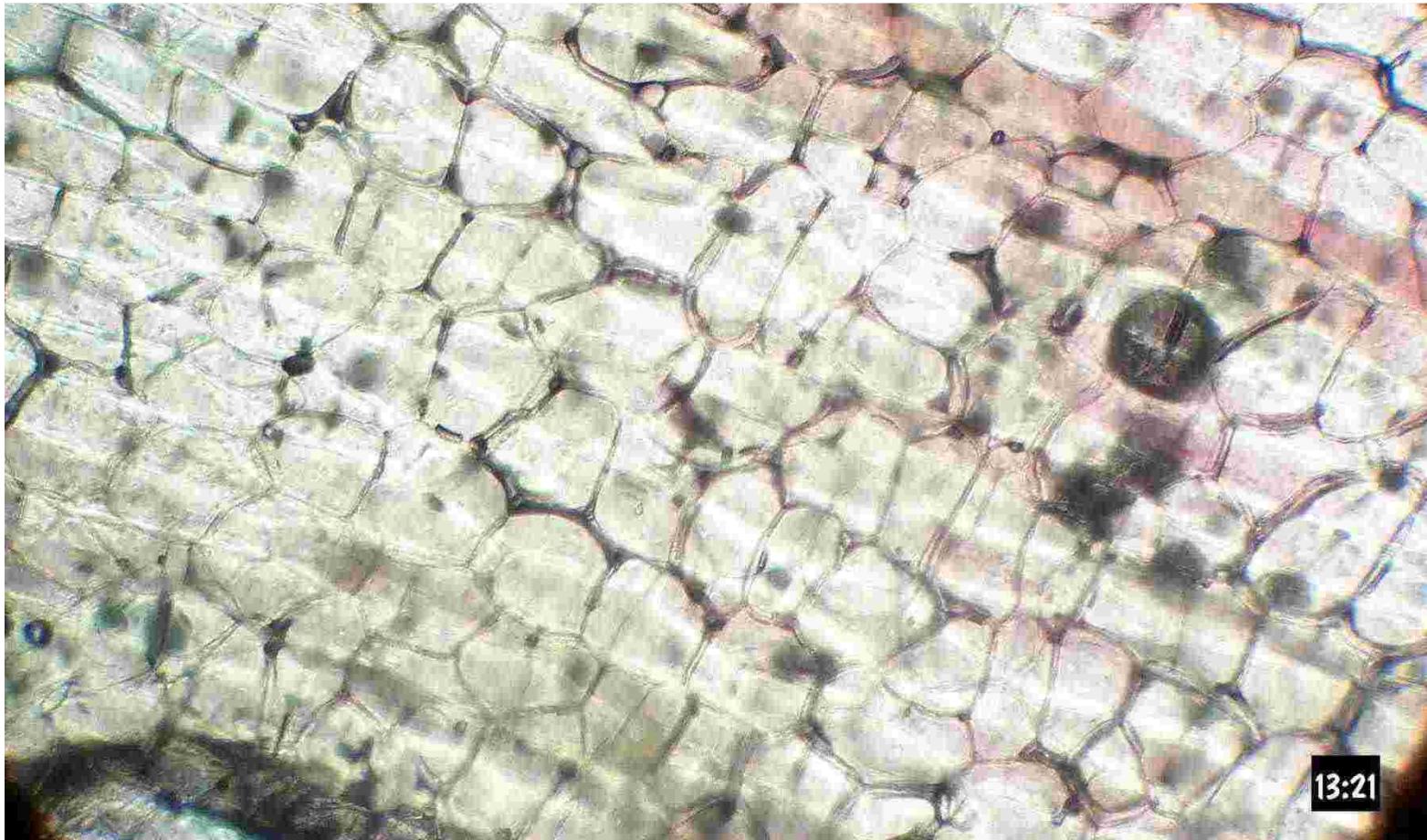


Anne Cazor, H This

# And amino acids, organic acids



# But plant tissues are gels $D_0(W)/D_3(S)$ ...



# Hence quantitative in situ quantitative NMR

of 14

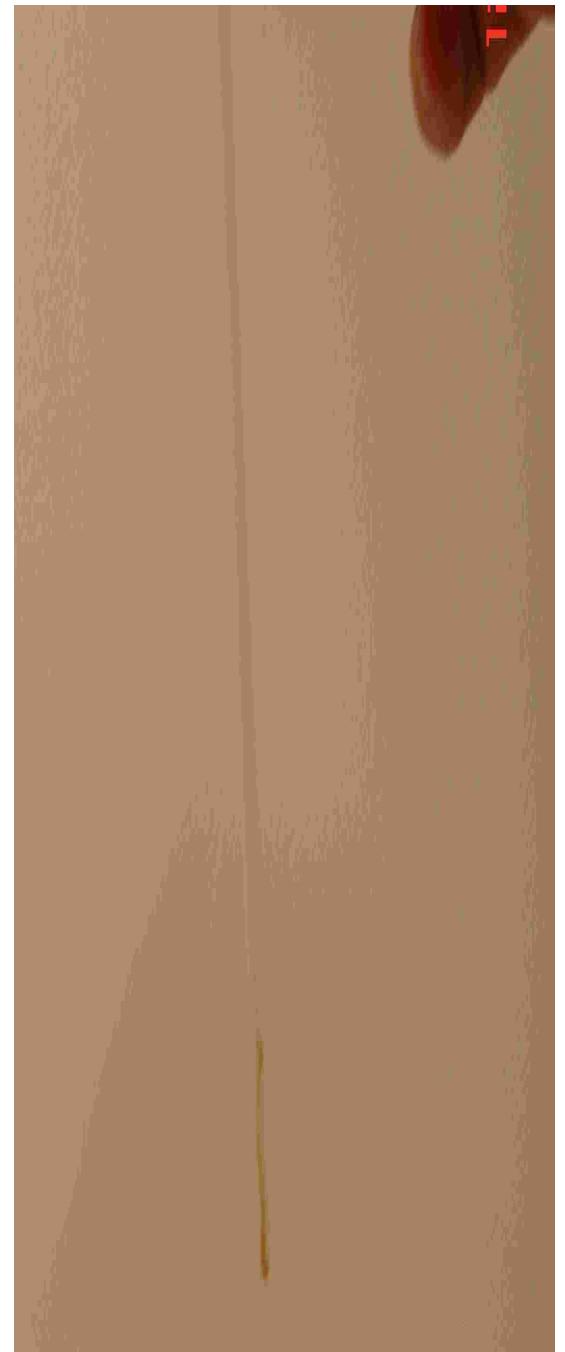
Analytical & Bioanalytical Chemistry

Comparison of two methods for the determination of saccharides in carrot (*Daucus carota L.*) roots: extraction using the standard “modified O'Donoghue” method followed by quantitative proton NMR ( $\text{q } ^1\text{H}$  NMR) spectroscopy, and direct, whole tissue  $\text{q } ^1\text{H}$  NMR spectroscopy.

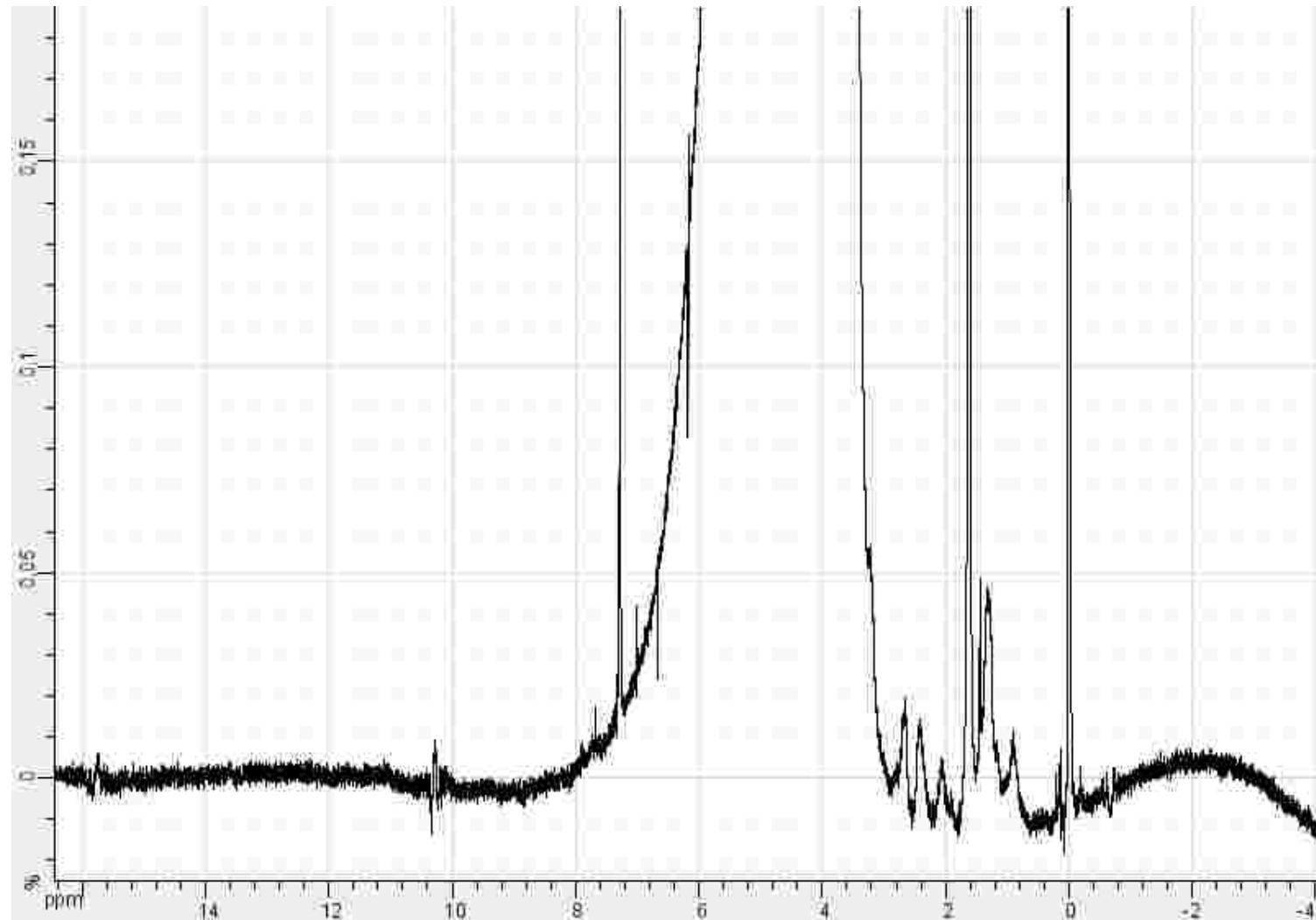
LINDA WEBERSKIRCH, ALAN LUNA, SARA SKOGLUND,

HERVÉ THIS<sup>1,2</sup>

Fast (10 min), no solvant, no preparation, small samples, precision %, etc.

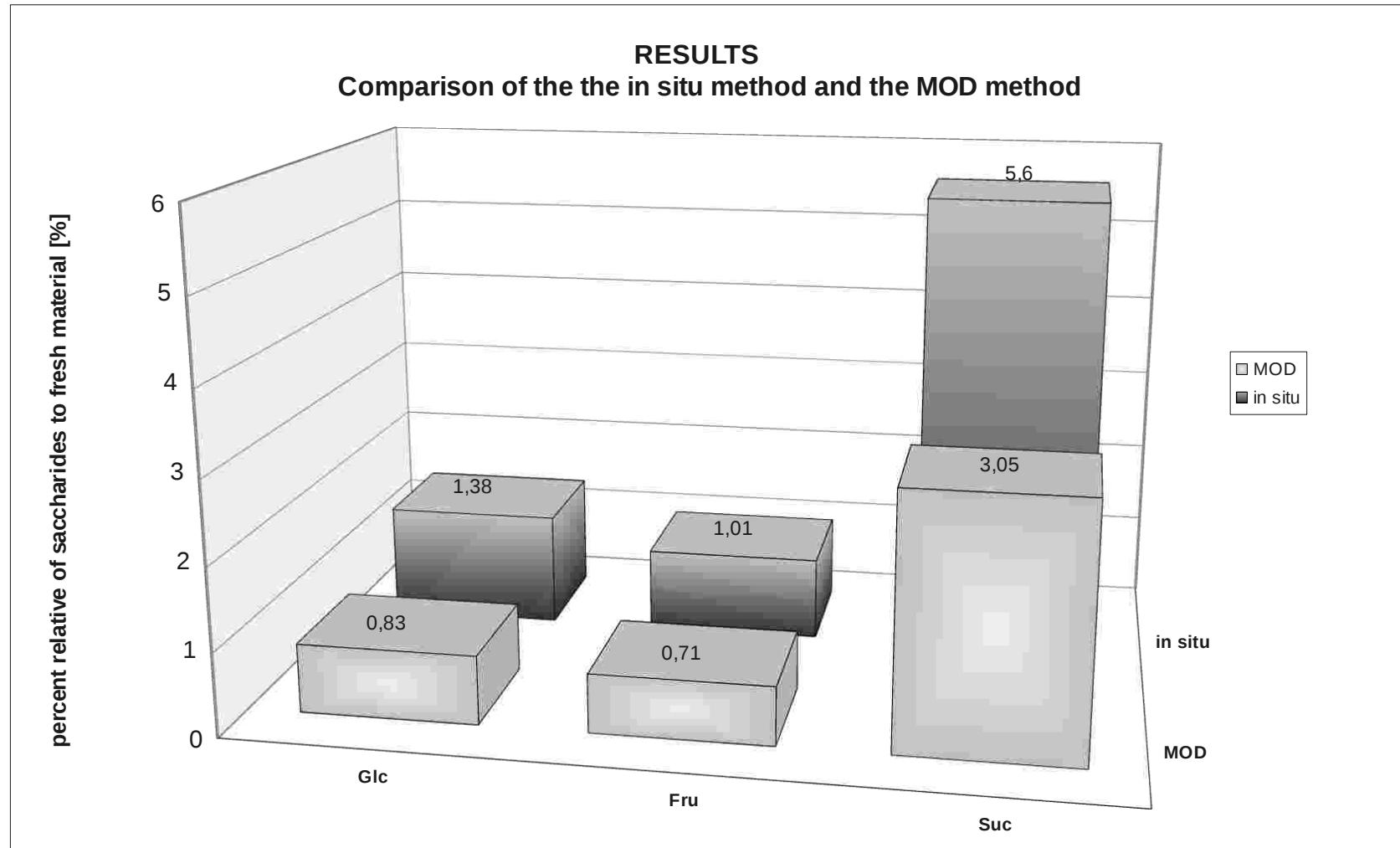


# Why does drying improve spectra?



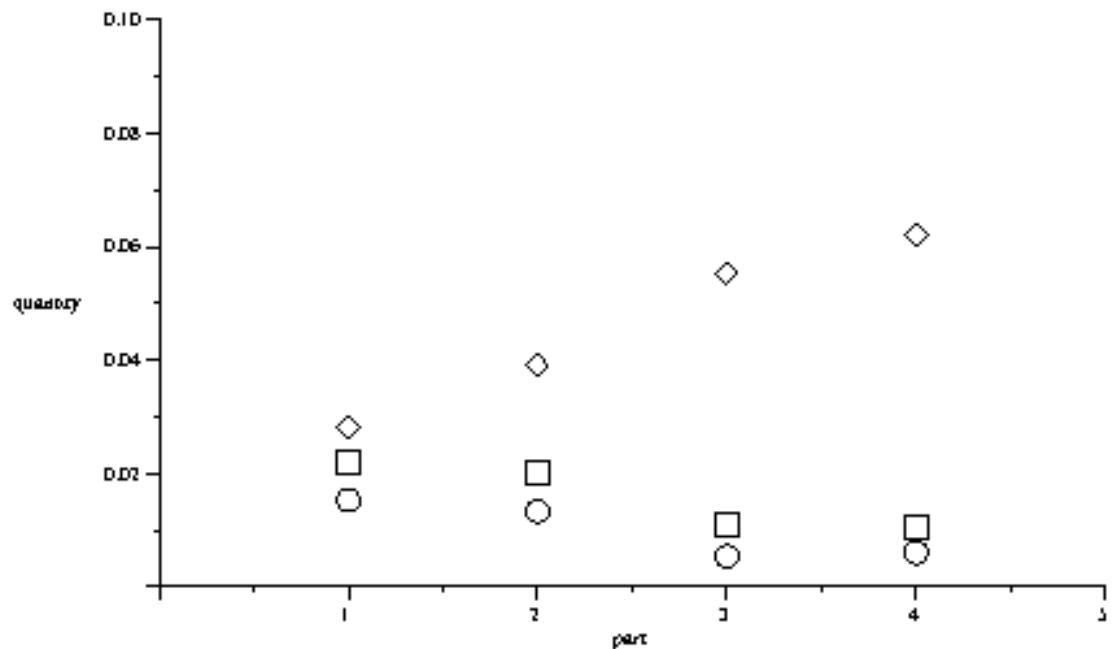
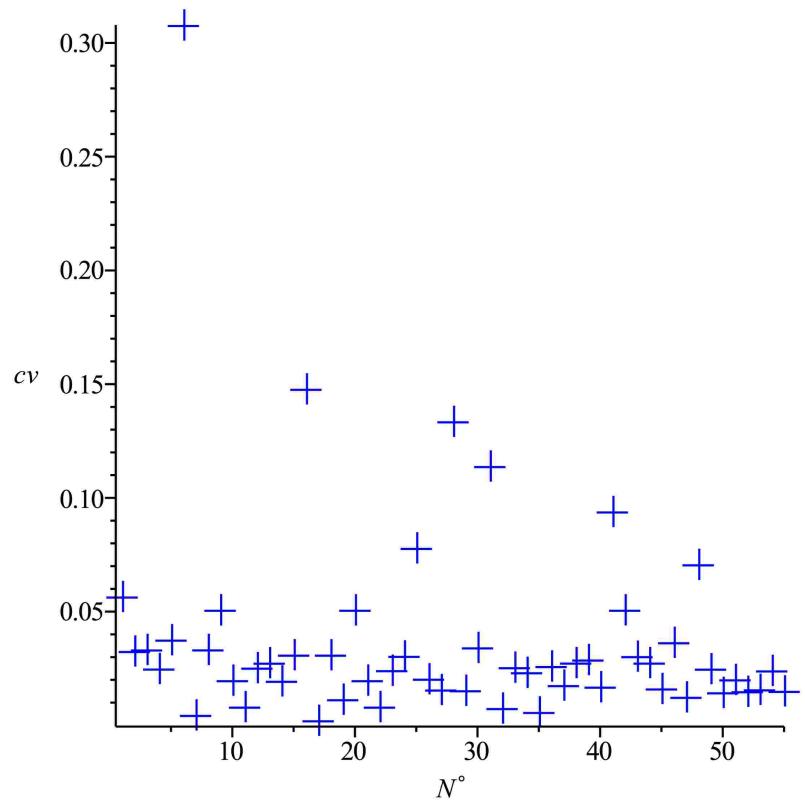
Linda Weberskirch, H. This

# Extraction : beware !



Linda Weberskirch, H. This

# Wonderful performances... and new applications



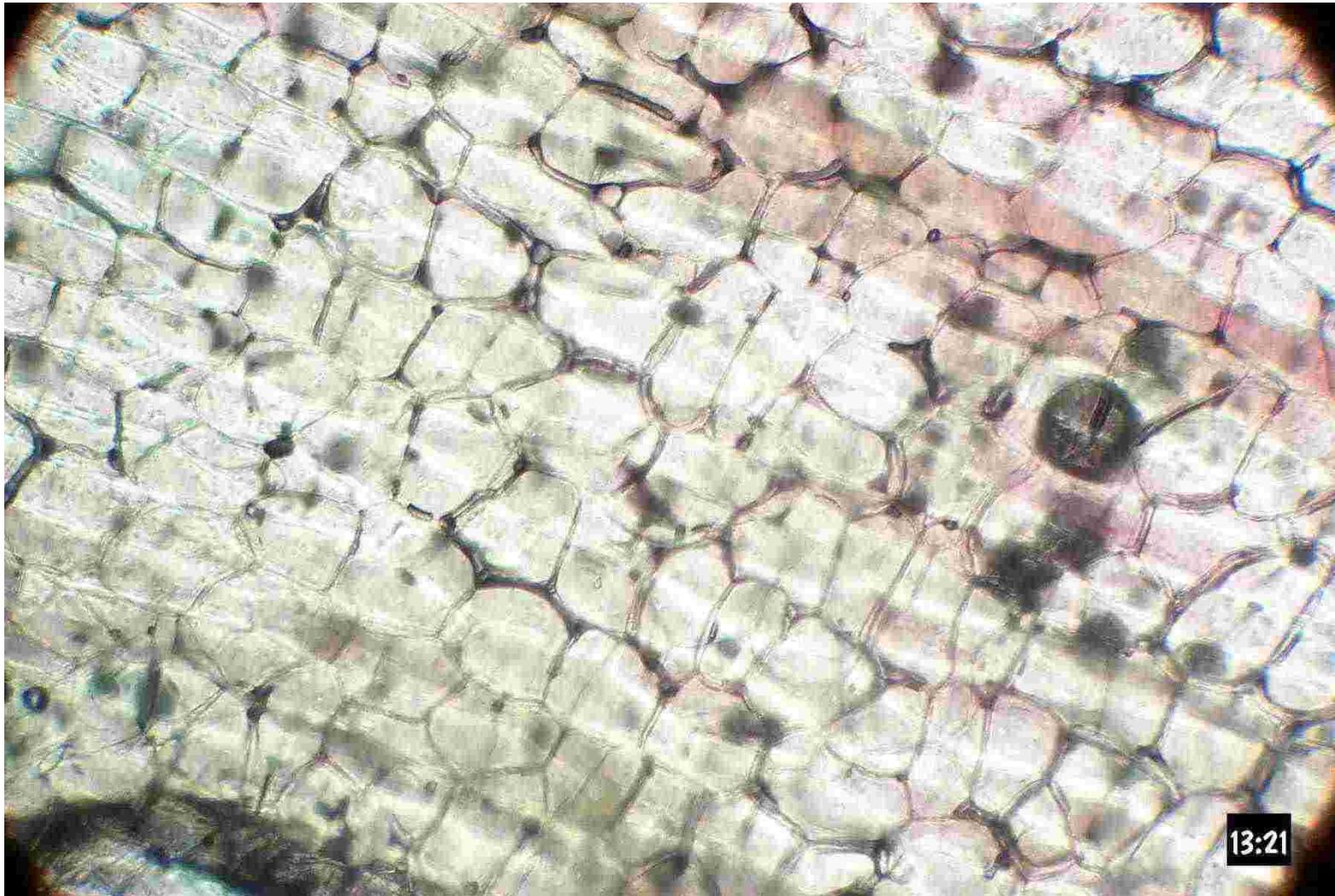
Elsa Bauchard, H. This

# Where is there a montain ?

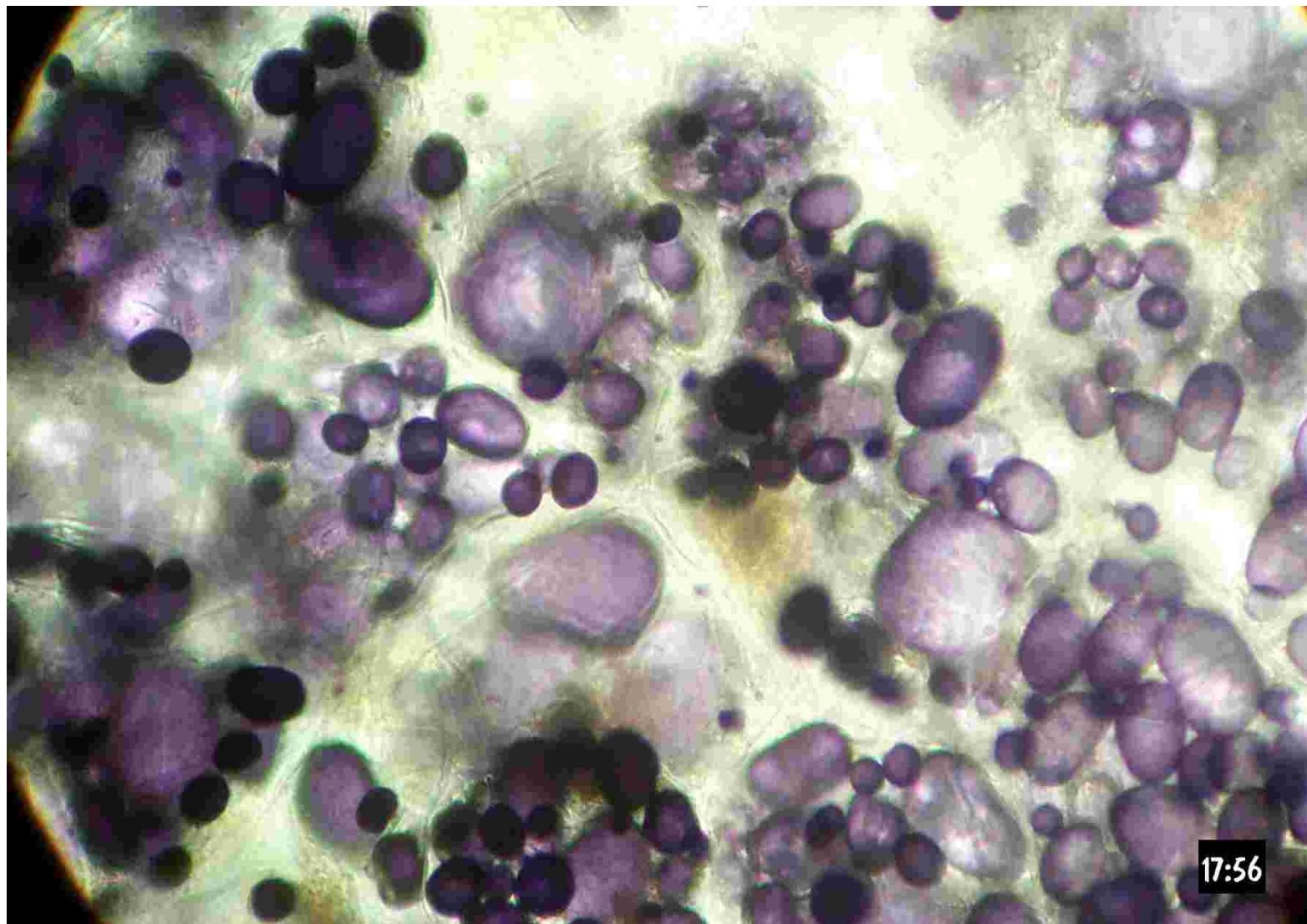
5.

Any fact, result... should be considered as a projection of general cases that we have to invent

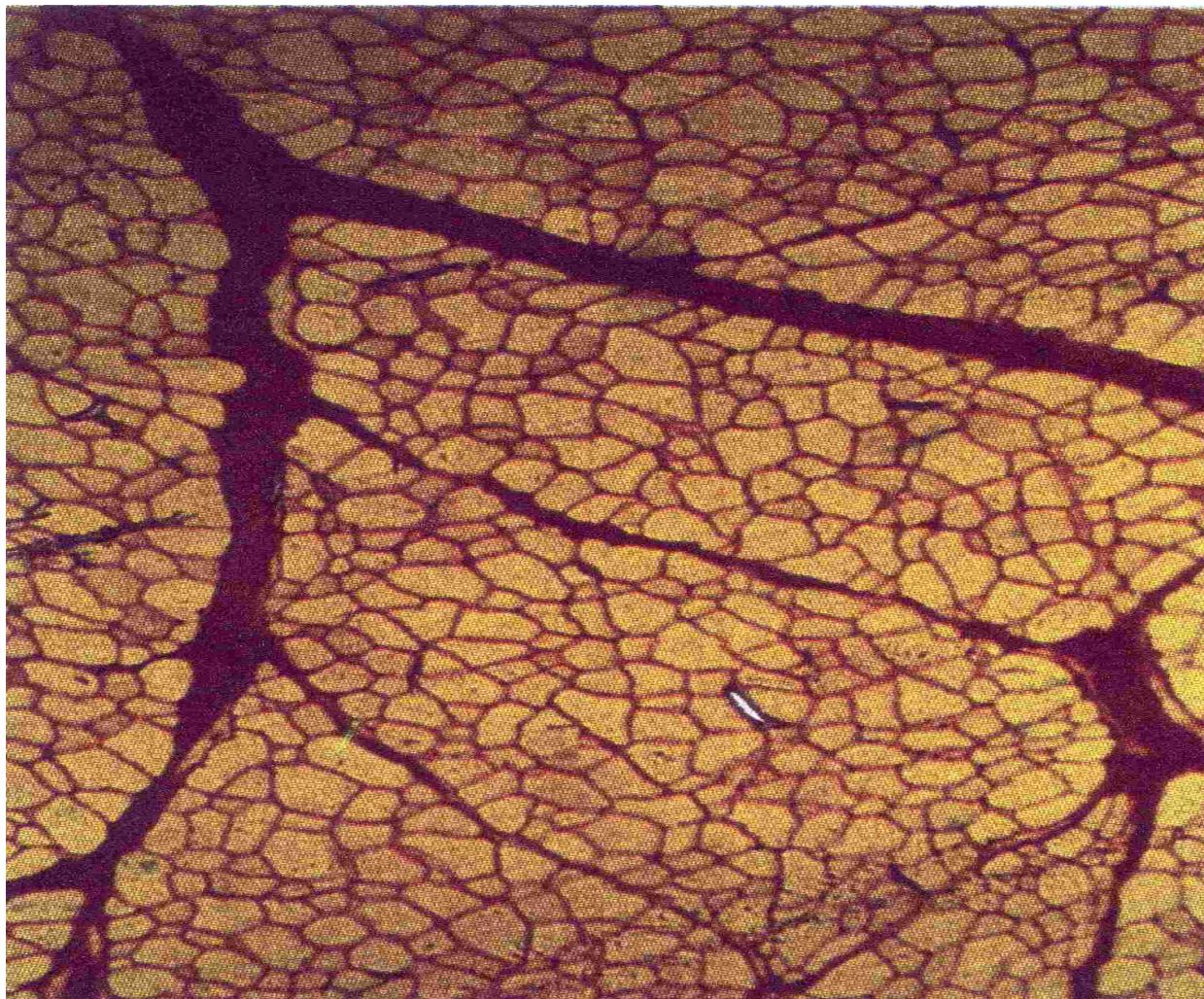
# Most food is a « gel »



# But gels can be complex

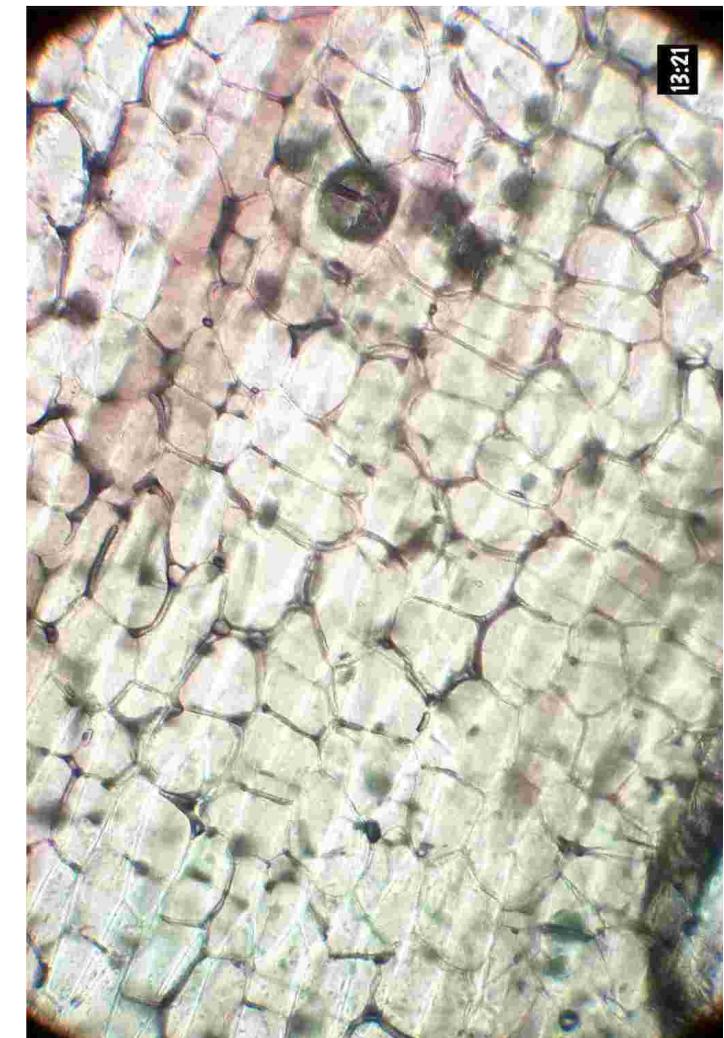
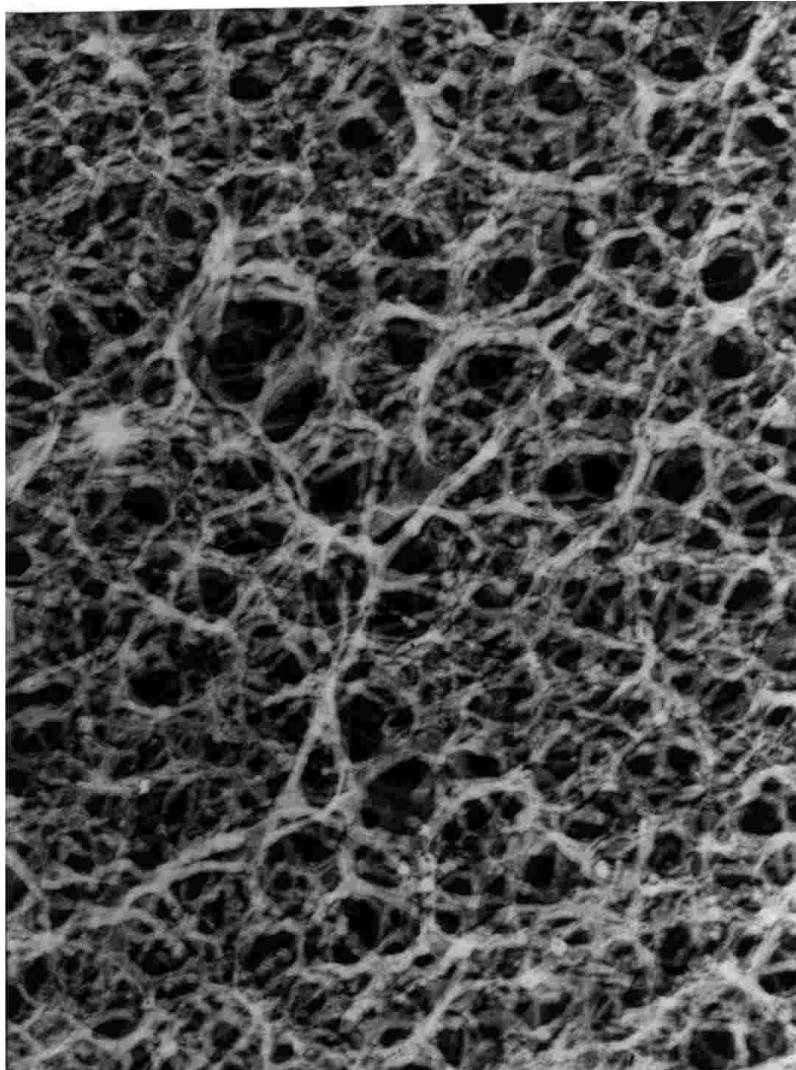


# « Dimensionality », an important characteristic



Cliché J. Lacour, INRA Theix

# How to distinguish gels ?



# Disperse Systems Formalisms (DSF)

## Four symbols :

/ : dispersed into

+ : coexistence of phases, mixture

@ : inclusion

$\sigma$  : superposition (according to x,y,z)

x : interdispersion

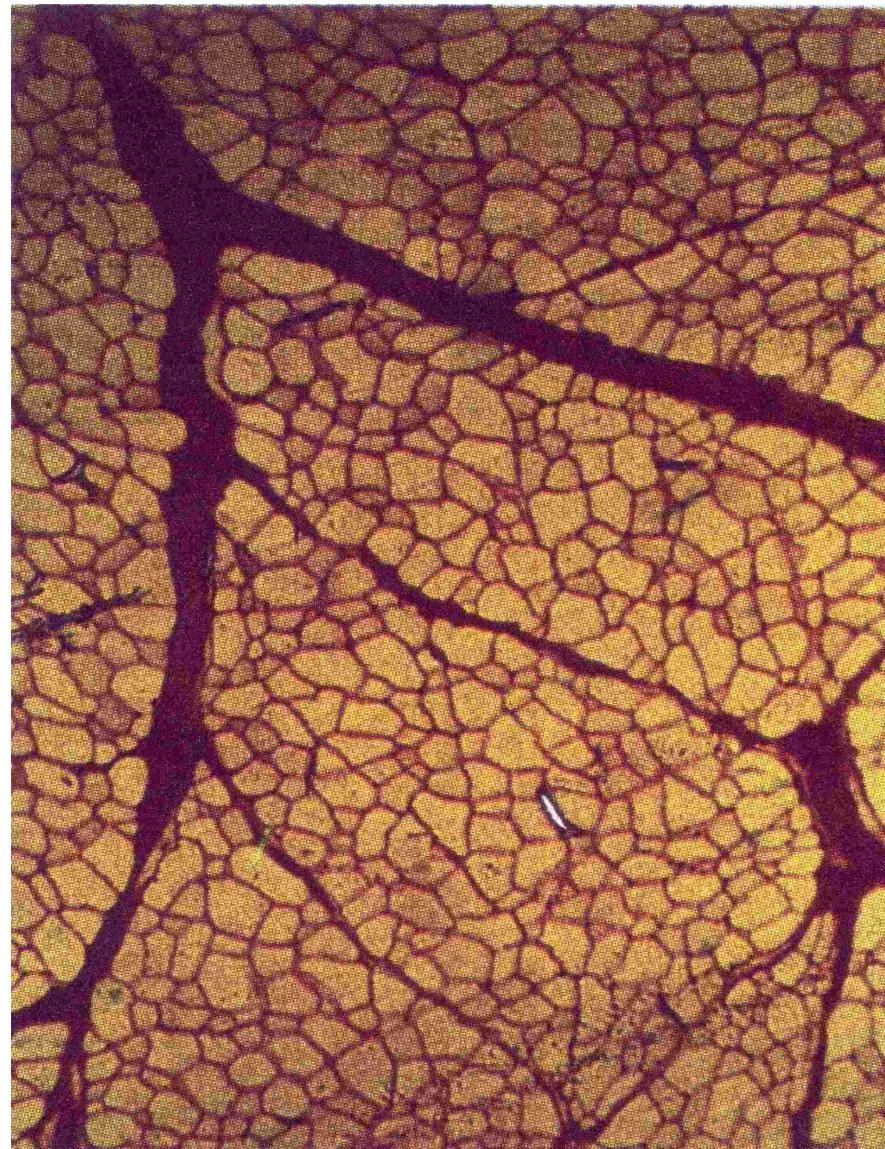
## Four kind of phases :

G : gas; O: oil; S: solids; W: aqueous solutions

## Four kind of object:

D0 : dimension 0 ; D1: dimension 1 ; D2 : dimension 2 ; D3 :  
dimension 3

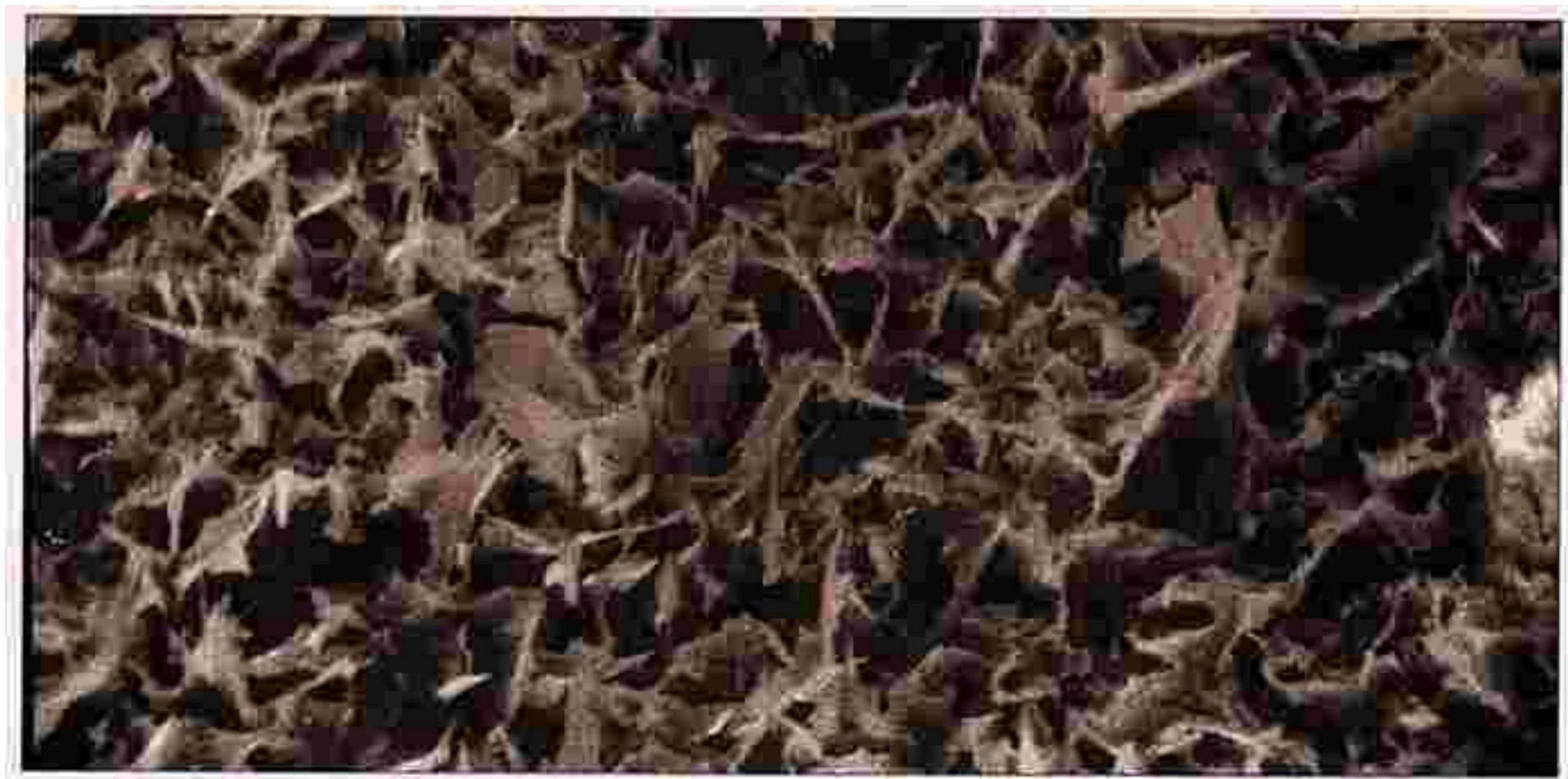
# Meat : D<sub>1</sub>(W)/D<sub>3</sub>(S)



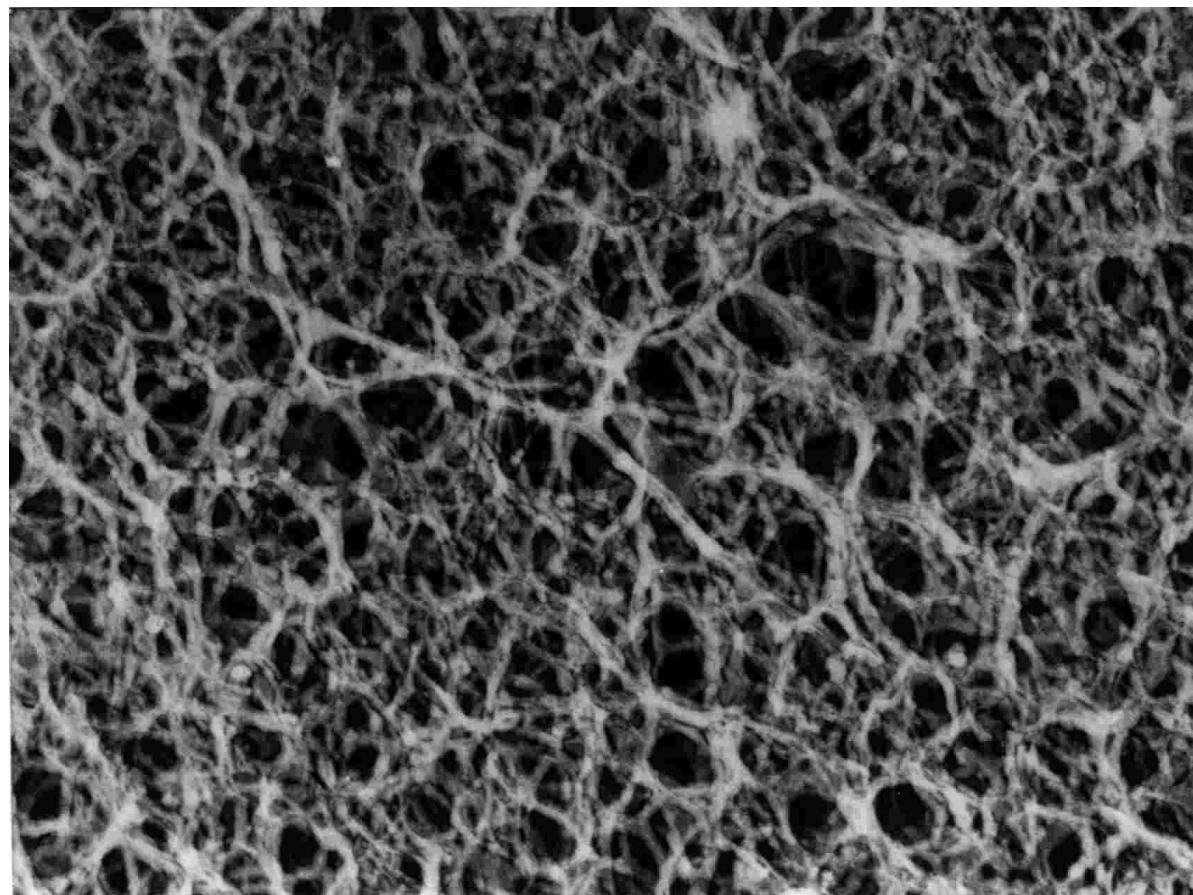
Cliché J. Lacour, INRA Theix

International Centre for Molecular Gastronomy

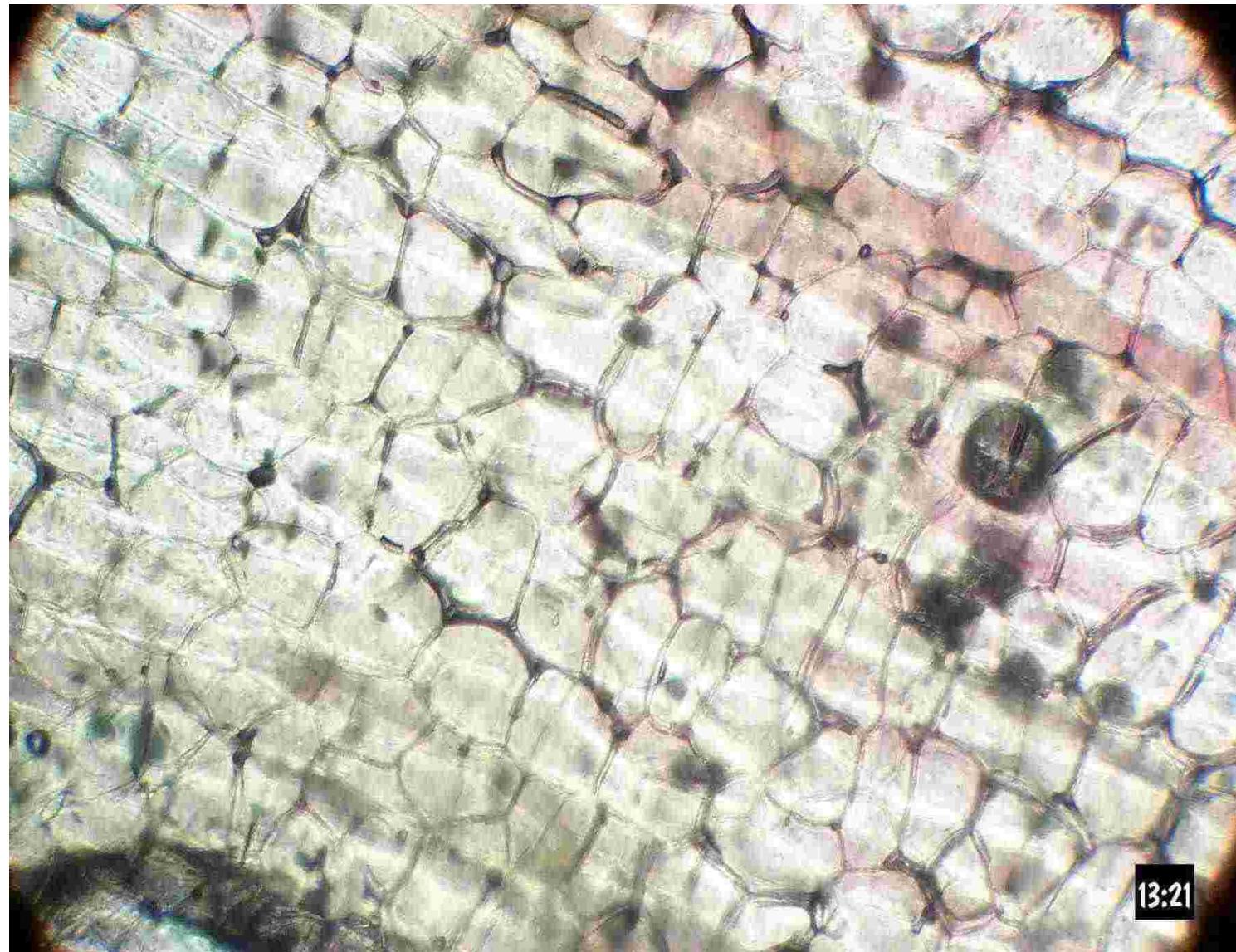
# Chocolate : D<sub>3</sub>(O)xD<sub>3</sub>(S)



# Gelatine gel : D<sub>3</sub>(W)xD<sub>3</sub>(S)



# Plant tissues : D0(W)/D3(S)

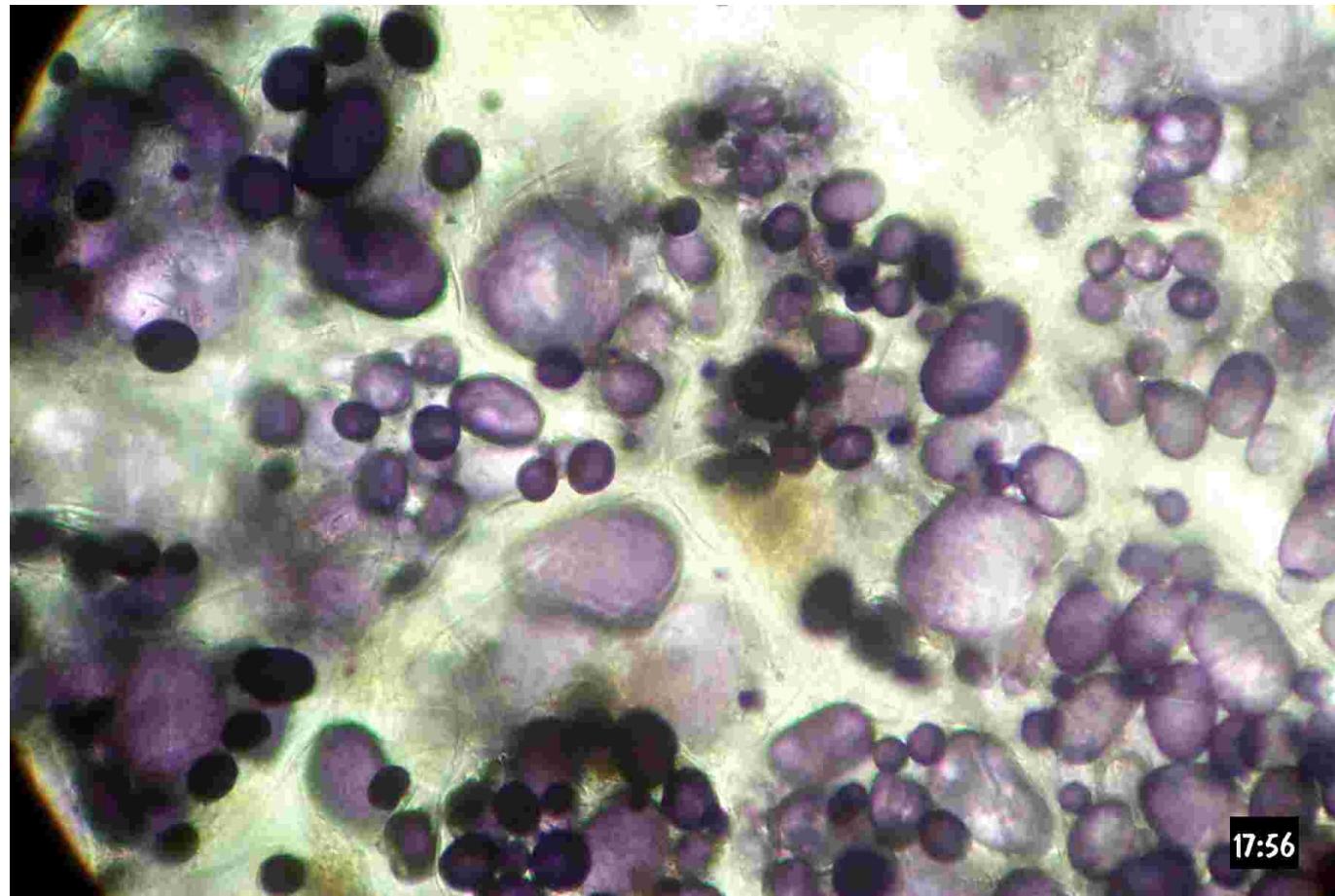


# Conglomeles: artificial plant tissues

## D<sub>0</sub>(W)/D<sub>3</sub>(S)



# Potato : [D<sub>0</sub>(S)/D<sub>0</sub>(W)]/D<sub>3</sub>(S)



# Food ?



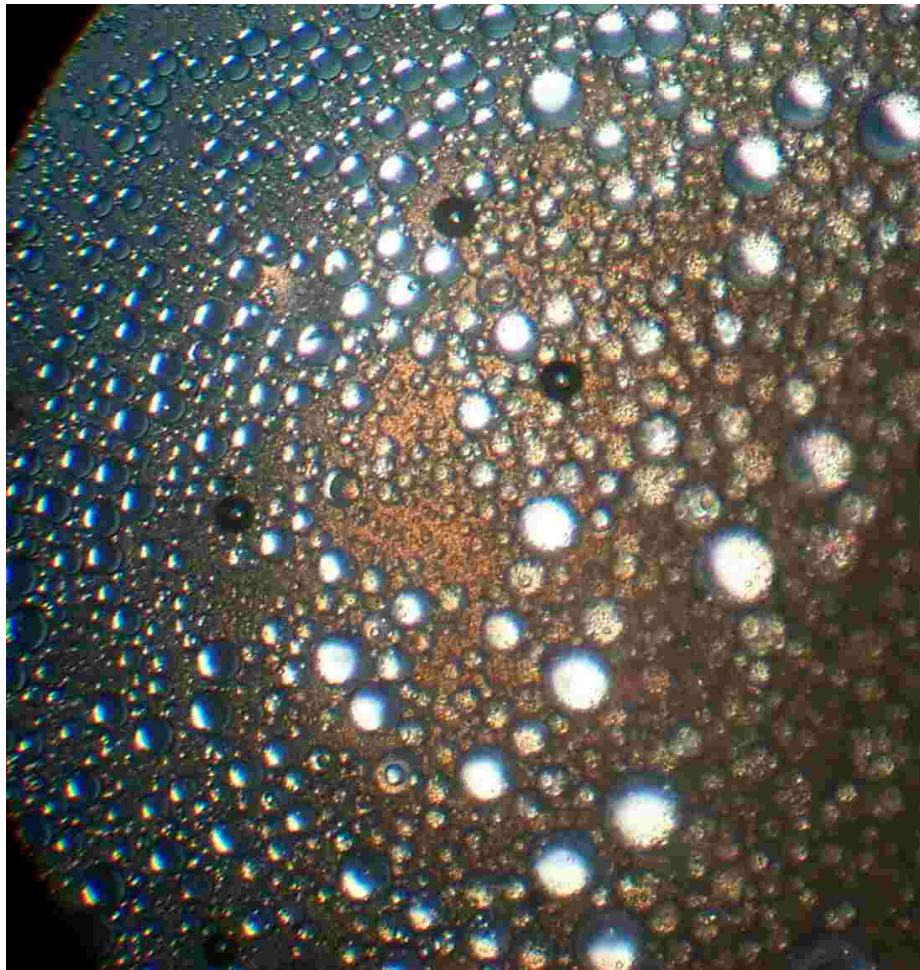
20 17:12

# A macroscopic organization

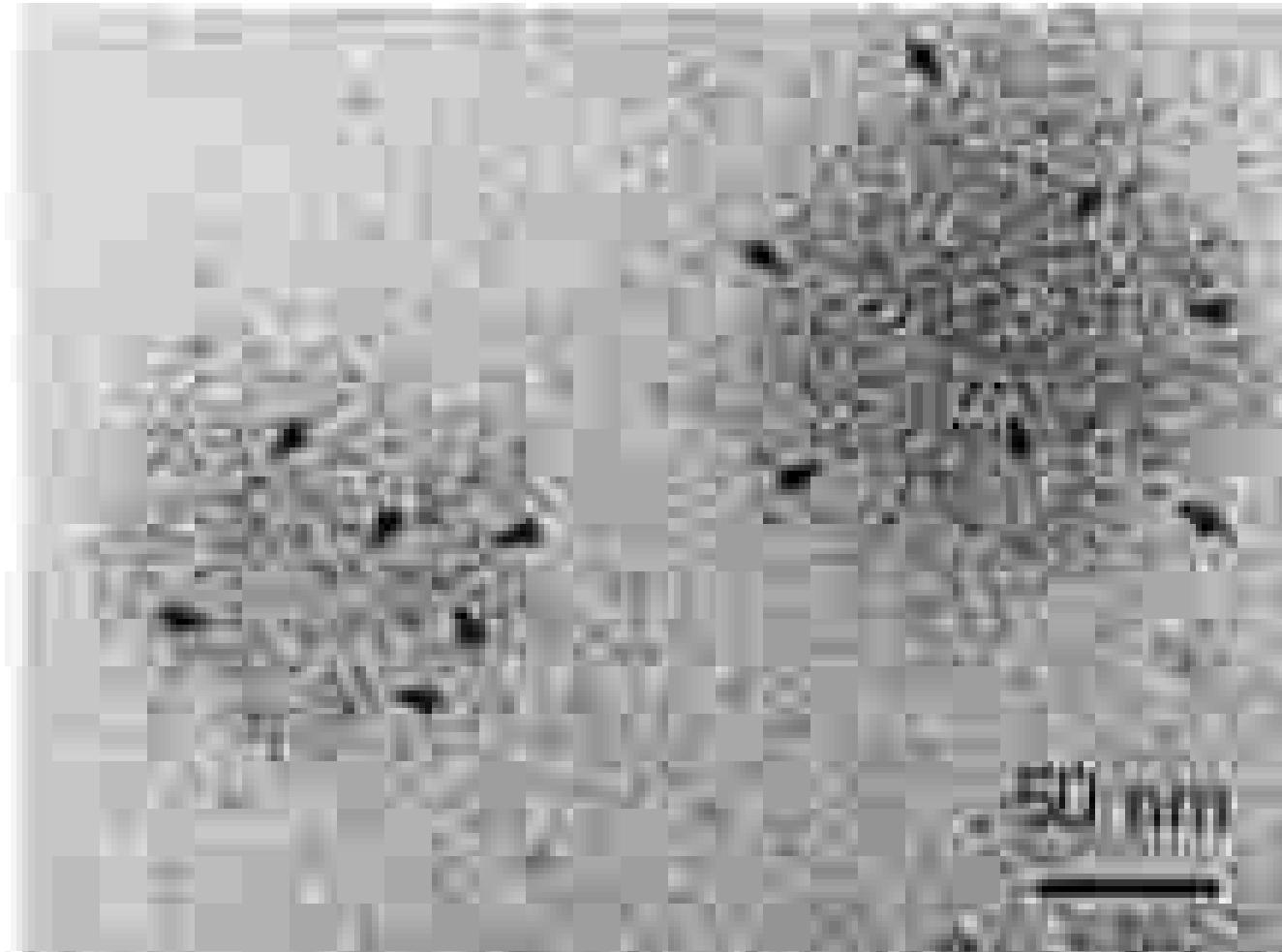


20 17:12

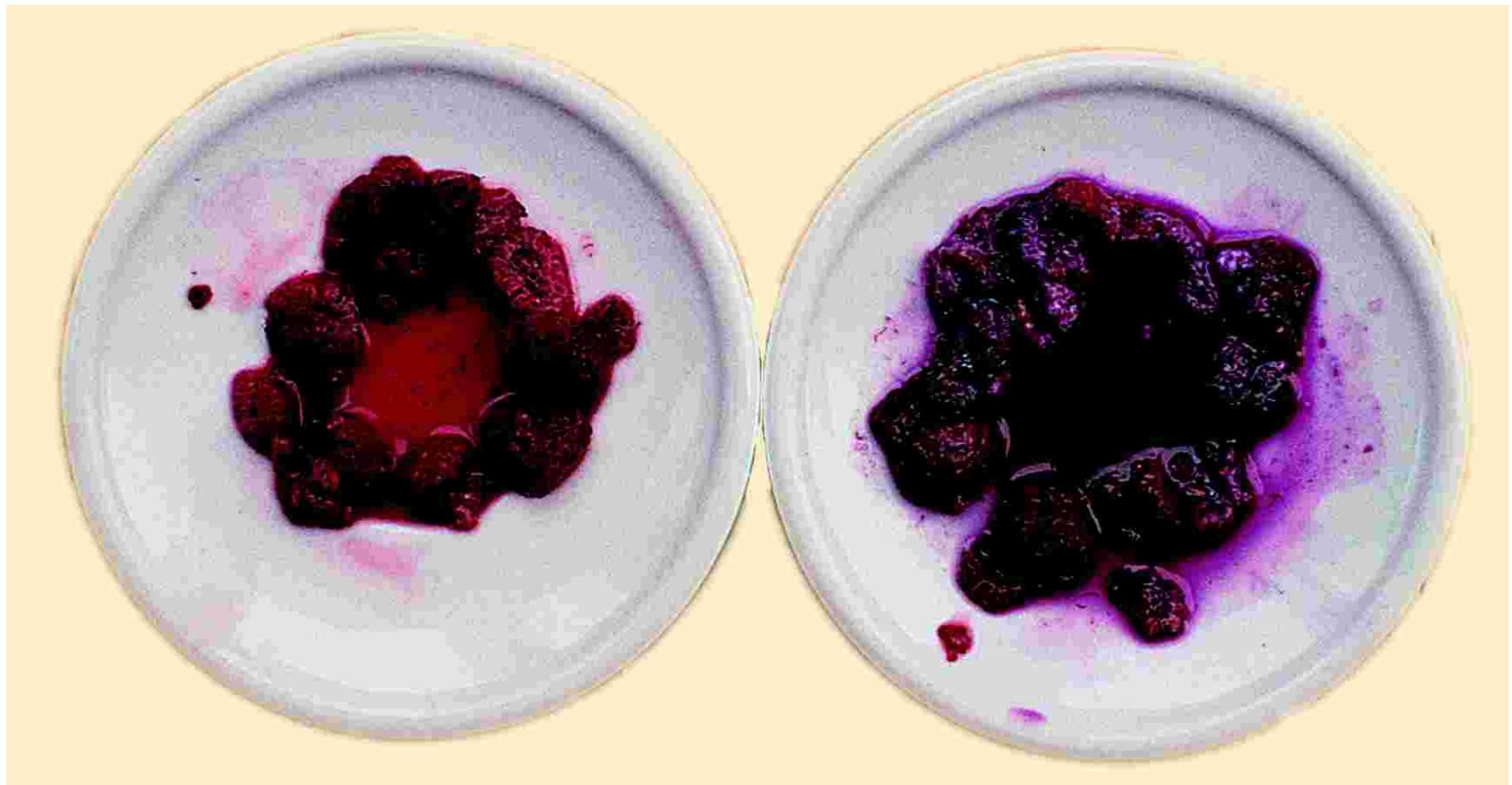
# For each part, A microscopic organization



# For each part, a nanoscopic organization



# For each part, a molecular organization



# And DSF applies to any level

## Four symbols :

- / : dispersed into
- + : coexistence of phases, mixture
- @ : inclusion
- $\sigma$  : superposition (according to x,y,z)
- x : interdispersion

## Four kind of phases :    Four kind of object:

- G : gas       D0
- W : solution      D1
- O : oil       D2
- S1, S2, ... : solids      D3

# Until today, all food systems could be described... But is the system "complete" ?



$$(D_{1,1}(W_1/S_1)@D_{1,2}(W_2/S_2))/D_3$$

$$D_0(W_1)@D_0(W_2/S_1)/\\ D_2(W_3/S_2)$$

$$D_1(S)/D_3$$

Hervé This, *Formal description for formulation*, in *International Journal for Pharmaceutics*, 2007, 344 (1-2), 4-8.  
*doi:10.1016/j.ijpharm.2007.07.046.*

# From some gels to all gels

```
phase := [W, O, S];
dimension := [D0, D1, D2, D3];
operateur := ["X", "/", "@", "&sigma;"];
formule := ""; graine := "";
for dim1 to 4 do
  for phas1 to 3 do
    for ope to 4 do
      for dim2 to 4 do
        for phas2 to 3 do
          if phas1 <> phas2 then formule := cat(graine, dimension[dim1], "(", phase[phas1], ")",
            operateur[ope], dimension[dim2], "(", phase[phas2], ")")
        end if
      end do
    end do
  end do
end do;
end do;
```

# About 1500 new systems!

[D0(W)XD0(W)]XD3(S)	[D0(W)/D2(W)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S)	[D0(W)/D2(W)]/D3(S)	[D0(W)σD0(O)]XD3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(S)]/D3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]XD3(S)	[D0(W)/D2(O)]XD3(S)	[D0(W)σD0(O)]/D3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S)	[D0(W)/D2(O)]/D3(S)	[D0(W)σD0(S)]XD3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)XD0(S)]XD3(S)	[D0(W)/D2(S)]XD3(S)	[D0(W)σD0(S)]/D3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD0(S)]/D3(S)	[D0(W)/D2(S)]/D3(S)	[D0(W)σD1(W)]XD3(S)	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]XD3(S)	[D0(W)/D3(W)]XD3(S)	[D0(W)σD1(W)]/D3(S)	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(S)]XD3(S)
[D0(W)XD1(W)]/D3(S)	[D0(W)/D3(W)]/D3(S)	[D0(W)σD1(O)]XD3(S)	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]XD3(S)	[D0(W)/D3(O)]XD3(S)	[D0(W)σD1(O)]/D3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(O)]/D3(S)	[D0(W)/D3(O)]/D3(S)	[D0(W)σD1(S)]XD3(S)	[D0(W)+D3(O)]XD3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]/D3(S)
[D0(W)XD1(S)]XD3(S)	[D0(W)/D3(S)]XD3(S)	[D0(W)σD1(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)σD2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(S)]XD3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)σD2(W)]/D3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)σD2(O)]XD3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)/D2(S)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)σD2(O)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)/D3(W)]XD3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)σD2(S)]XD3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)/D3(W)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]XD3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)σD2(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(W)]/D3(S)	[D0(W)@D1(W)]/D3(S)	[D0(W)σD3(W)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)σD3(W)]/D3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD1(S)]XD3(S)
[D0(W)XD3(S)]XD3(S)	[D0(W)@D1(S)]XD3(S)	[D0(W)σD3(O)]/D3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)σD3(O)]XD3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)/D3(O)]XD3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)D0(W)]XD3(S)	[D0(W)@D2(W)]XD3(S)	[D0(W)σD3(S)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)/D3(O)]/D3(S)	[D0(O)σD2(W)]/D3(S)
[D0(W)D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)σD3(S)]/D3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)σD0(W)]XD3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)σD0(W)]/D3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(W)σD0(O)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)D1(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(W)σD0(S)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD3(W)]XD3(S)
[D0(W)D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)σD0(S)]/D3(S)	[D0(O)XD3(W)]XD3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD3(W)]/D3(S)
[D0(W)D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)σD1(W)]XD3(S)	[D0(O)XD3(W)]/D3(S)	[D0(O)/D3(S)]XD3(S)	[D0(O)σD3(O)]XD3(S)
[D0(W)D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)σD1(W)]/D3(S)	[D0(O)XD3(O)]XD3(S)	[D0(O)/D3(S)]/D3(S)	[D0(O)σD3(O)]/D3(S)
[D0(W)D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)σD1(O)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD3(O)]/D3(S)
[D0(W)D1(S)]/D3(S)	[D0(W)@D3(S)]/D3(S)	[D0(W)σD1(O)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD3(S)]XD3(S)
[D0(W)σD0(W)]XD3(S)	[D0(W)@D1(S)]XD3(S)	[D0(W)σD1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD3(S)]/D3(S)

# And here

[D0(W)XD0(W)]XD3(S)	[D0(W)/D2(W)]XD3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S)	[D0(W)/D2(W)]/D3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]XD3(S)	[D0(W)/D2(O)]XD3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(O)]/D3(S)	[D0(W)/D2(O)]/D3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)XD0(S)]XD3(S)	[D0(W)/D2(S)]XD3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD0(S)]/D3(S)	[D0(W)/D2(S)]/D3(S)	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]XD3(S)	[D0(W)/D3(W)]XD3(S)	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(S)]XD3(S)
[D0(W)XD1(W)]/D3(S)	[D0(W)/D3(W)]/D3(S)	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]XD3(S)	[D0(W)/D3(O)]XD3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD1(O)]/D3(S)	[D0(W)/D3(O)]/D3(S)	[D0(W)+D3(O)]XD3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)@D0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S)	[D0(W)/D3(S)]XD3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)@D0(W)]/D3(S)
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)@D0(O)]/D3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)@D0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)@D1(W)]XD3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)@D1(W)]/D3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)@D1(S)]XD3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)@D1(S)]/D3(S)
[D0(W)XD3(W)]/D3(S)	[D0(W)@D1(W)]/D3(S)	[D0(W)+D3(W)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S)	[D0(W)@D1(S)]XD3(S)	[D0(W)+D3(O)]XD3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)@D1(S)]/D3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D1(O)]XD3(S)
[D0(W)D0(W)]XD3(S)	[D0(W)@D2(W)]XD3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D2(W)]/D3(S)
[D0(W)D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D0(O)]XD3(S)	[D0(W)@D2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D2(O)]XD3(S)
[D0(W)D0(O)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D0(S)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D2(O)]XD3(S)
[D0(W)D0(S)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D1(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(O)]XD3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)D1(S)]/D3(S)	[D0(W)@D3(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D3(S)]XD3(S)
	[D0(W)σD0(W)]XD3(S)	[D0(W)+D1(S)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D3(S)]/D3(S)

# And here

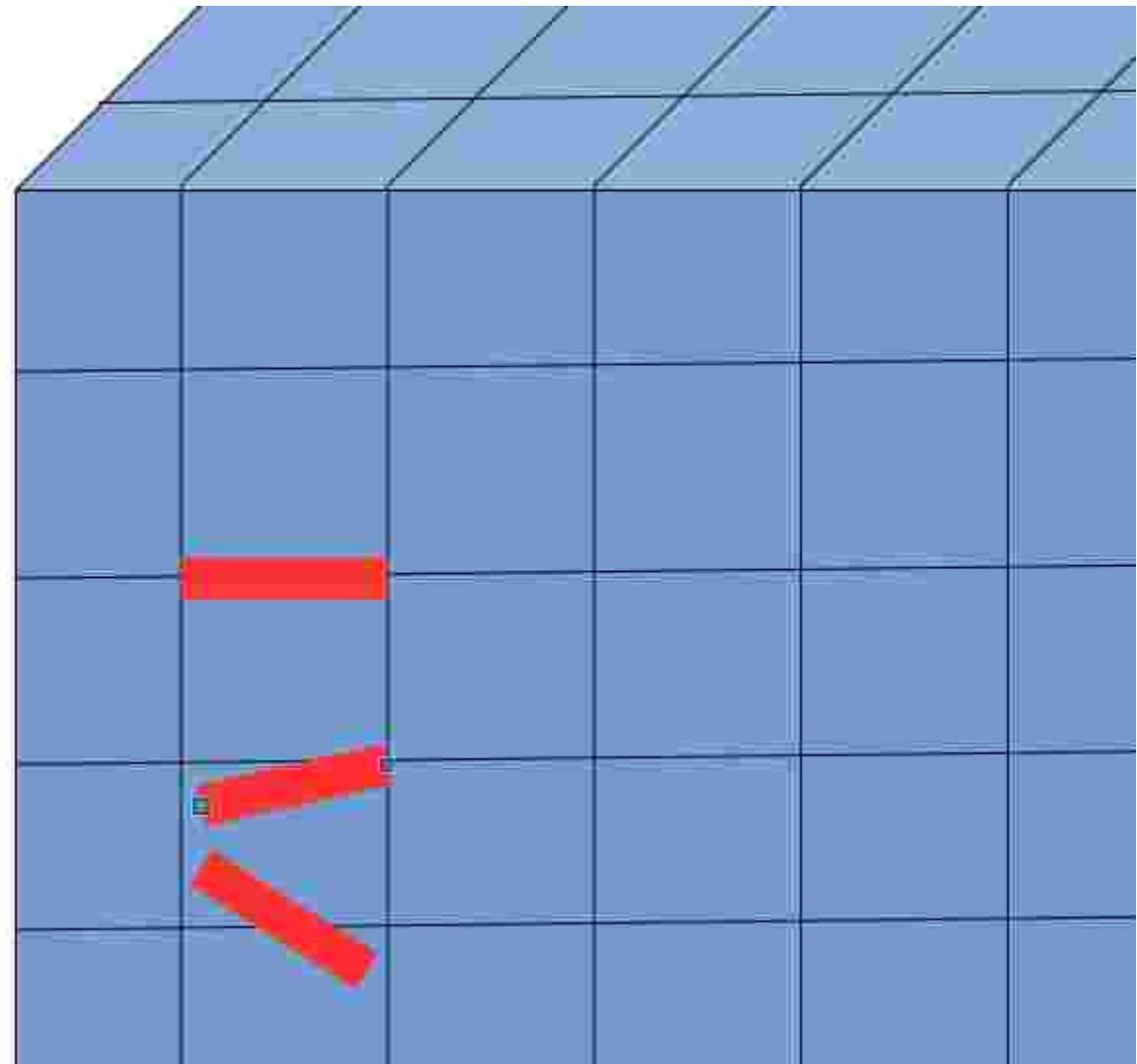
[D0(W)XD0(W)]XD3(S)	[D0(W)/D2(W)]XD3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S)	[D0(W)/D2(W)]/D3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]XD3(S)
[D0(W)XD0(O)]XD3(S)	[D0(W)/D2(O)]XD3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D0(S)]XD3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]/D3(S)	[D0(W)/D2(O)]/D3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D0(S)]/D3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(S)]XD3(S)	[D0(W)/D2(S)]XD3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)XD0(S)]/D3(S)	[D0(W)/D2(S)]/D3(S)	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD1(W)]XD3(S)	[D0(W)/D3(W)]XD3(S)	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]/D3(S)	[D0(W)/D3(W)]/D3(S)	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]XD3(S)	[D0(W)/D3(O)]XD3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]/D3(S)	[D0(W)/D3(O)]/D3(S)	[D0(W)+D3(O)]XD3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)σD0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S)	[D0(W)/D3(S)]XD3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)σD0(W)]/D3(S)
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)σD0(O)]XD3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)σD0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)σD0(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)σD0(S)]/D3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)σD1(W)]XD3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)σD1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)σD1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S)	[D0(W)@D1(W)]/D3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)σD1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)σD1(S)]XD3(S)
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S)	[D0(W)@D1(S)]XD3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)@D0(W)]XD3(S)	[D0(O)σD1(S)]/D3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D0(W)]/D3(S)	[D0(O)σD2(W)]XD3(S)
[D0(W)D0(W)]XD3(S)	[D0(W)@D2(W)]XD3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D0(O)]XD3(S)	[D0(O)σD2(W)]/D3(S)
[D0(W)D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D0(O)]/D3(S)	[D0(O)σD2(W)]/D3(S)
[D0(W)D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)	[D0(O)σD2(O)]XD3(S)
[D0(W)D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(O)]/D3(S)
[D0(W)D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D0(S)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D1(W)]/D3(S)	[D0(O)σD2(S)]/D3(S)
[D0(W)D1(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D1(W)]XD3(S)	[D0(O)σD3(W)]XD3(S)
[D0(W)D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(O)XD3(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)	[D0(O)σD3(W)]/D3(S)
[D0(W)D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(O)XD3(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)	[D0(O)σD3(O)]XD3(S)
[D0(W)D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(O)XD3(O)]XD3(S)	[D0(O)@D2(W)]XD3(S)	[D0(O)σD3(O)]/D3(S)
[D0(W)D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D2(W)]/D3(S)	[D0(O)σD3(S)]XD3(S)
[D0(W)D1(S)]/D3(S)	[D0(W)@D3(S)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D2(O)]XD3(S)	[D0(O)σD3(S)]/D3(S)
	[D0(W)σD0(W)]XD3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D2(O)]/D3(S)	[D0(O)σD3(S)]/D3(S)

# And finally here

[D0(W)XD0(W)]XD3(S)	[D0(W)/D2(W)]XD3(S)	[D0(W)+D1(S)]/D3(S)	[D0(O)/D0(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)XD0(W)]/D3(S)	[D0(W)/D2(W)]/D3(S)	[D0(W)+D2(W)]XD3(S)	[D0(O)/D0(O)]/D3(S)	[D0(O)@D2(S)]/D3(S)
[D0(W)XD0(O)]XD3(S)	[D0(W)/D2(O)]XD3(S)	[D0(W)+D2(W)]/D3(S)	[D0(O)/D0(S)]XD3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)XD0(O)]/D3(S)	[D0(W)/D2(O)]/D3(S)	[D0(W)+D2(O)]XD3(S)	[D0(O)/D1(W)]XD3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)XD0(S)]XD3(S)	[D0(W)/D2(S)]XD3(S)	[D0(W)+D2(O)]/D3(S)	[D0(O)/D1(W)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD0(S)]/D3(S)	[D0(W)/D2(S)]/D3(S)	[D0(W)+D2(S)]XD3(S)	[D0(O)/D1(O)]XD3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)XD1(W)]XD3(S)	[D0(W)/D3(W)]XD3(S)	[D0(W)+D2(S)]/D3(S)	[D0(O)/D1(O)]/D3(S)	[D0(O)@D3(S)]XD3(S)
[D0(W)XD1(W)]/D3(S)	[D0(W)/D3(W)]/D3(S)	[D0(W)+D3(W)]XD3(S)	[D0(O)/D1(S)]XD3(S)	[D0(O)@D3(S)]/D3(S)
[D0(W)XD1(O)]XD3(S)	[D0(W)/D3(O)]XD3(S)	[D0(W)+D3(W)]/D3(S)	[D0(O)/D1(S)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)XD1(O)]/D3(S)	[D0(W)/D3(O)]/D3(S)	[D0(W)+D3(O)]XD3(S)	[D0(O)/D2(W)]XD3(S)	[D0(O)@D0(W)]XD3(S)
[D0(W)XD1(S)]XD3(S)	[D0(W)/D3(S)]XD3(S)	[D0(W)+D3(O)]/D3(S)	[D0(O)/D2(W)]/D3(S)	[D0(O)@D0(W)]/D3(S)
[D0(W)XD1(S)]/D3(S)	[D0(W)/D3(S)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)/D2(O)]XD3(S)	[D0(O)@D0(O)]/D3(S)
[D0(W)XD2(W)]XD3(S)	[D0(W)@D0(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)/D2(O)]/D3(S)	[D0(O)@D0(O)]/D3(S)
[D0(W)XD2(W)]/D3(S)	[D0(W)@D0(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(W)]XD3(S)	[D0(O)/D2(S)]XD3(S)
[D0(W)XD2(O)]XD3(S)	[D0(W)@D0(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(W)]/D3(S)	[D0(O)@D0(S)]XD3(S)
[D0(W)XD2(O)]/D3(S)	[D0(W)@D0(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(O)]XD3(S)	[D0(O)@D0(O)]/D3(S)
[D0(W)XD2(S)]XD3(S)	[D0(W)@D0(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(O)]/D3(S)	[D0(O)@D1(W)]XD3(S)
[D0(W)XD2(S)]/D3(S)	[D0(W)@D0(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(S)]XD3(S)	[D0(O)@D1(W)]/D3(S)
[D0(W)XD3(W)]XD3(S)	[D0(W)@D1(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD0(S)]/D3(S)	[D0(O)@D1(O)]XD3(S)
[D0(W)XD3(W)]/D3(S)	[D0(W)@D1(W)]/D3(S)	[D0(W)+D3(S)]XD3(S)	[D0(O)XD1(W)]XD3(S)	[D0(O)@D1(O)]/D3(S)
[D0(W)XD3(O)]XD3(S)	[D0(W)@D1(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(W)]/D3(S)	[D0(O)@D1(S)]XD3(S)
[D0(W)XD3(O)]/D3(S)	[D0(W)@D1(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(O)]XD3(S)	[D0(O)@D1(S)]/D3(S)
[D0(W)XD3(S)]XD3(S)	[D0(W)@D1(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(O)]/D3(S)	[D0(O)@D1(S)]/D3(S)
[D0(W)XD3(S)]/D3(S)	[D0(W)@D1(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(S)]XD3(S)	[D0(O)@D2(W)]XD3(S)
[D0(W)D0(W)]XD3(S)	[D0(W)@D2(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD1(S)]/D3(S)	[D0(O)@D2(W)]/D3(S)
[D0(W)D0(W)]/D3(S)	[D0(W)@D2(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(W)]XD3(S)	[D0(O)@D2(O)]XD3(S)
[D0(W)D0(O)]XD3(S)	[D0(W)@D2(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(W)]/D3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D0(O)]/D3(S)	[D0(W)@D2(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(O)]XD3(S)	[D0(O)@D2(O)]/D3(S)
[D0(W)D0(S)]XD3(S)	[D0(W)@D2(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(O)]/D3(S)	[D0(O)@D2(W)]/D3(S)
[D0(W)D0(S)]/D3(S)	[D0(W)@D2(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(S)]XD3(S)	[D0(O)@D2(W)]/D3(S)
[D0(W)D1(W)]XD3(S)	[D0(W)@D3(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD2(S)]/D3(S)	[D0(O)@D3(W)]XD3(S)
[D0(W)D1(W)]/D3(S)	[D0(W)@D3(W)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(W)]XD3(S)	[D0(O)@D3(W)]/D3(S)
[D0(W)D1(O)]XD3(S)	[D0(W)@D3(O)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(W)]/D3(S)	[D0(O)@D3(O)]XD3(S)
[D0(W)D1(O)]/D3(S)	[D0(W)@D3(O)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(O)]XD3(S)	[D0(O)@D3(O)]/D3(S)
[D0(W)D1(S)]XD3(S)	[D0(W)@D3(S)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(O)]/D3(S)	[D0(O)@D3(S)]XD3(S)
[D0(W)D1(S)]/D3(S)	[D0(W)@D3(S)]/D3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(S)]XD3(S)	[D0(O)@D3(S)]/D3(S)
	[D0(W)σD0(W)]XD3(S)	[D0(W)+D3(S)]/D3(S)	[D0(O)XD3(S)]/D3(S)	[D0(O)@D3(S)]/D3(S)

# Plus "dynagels"

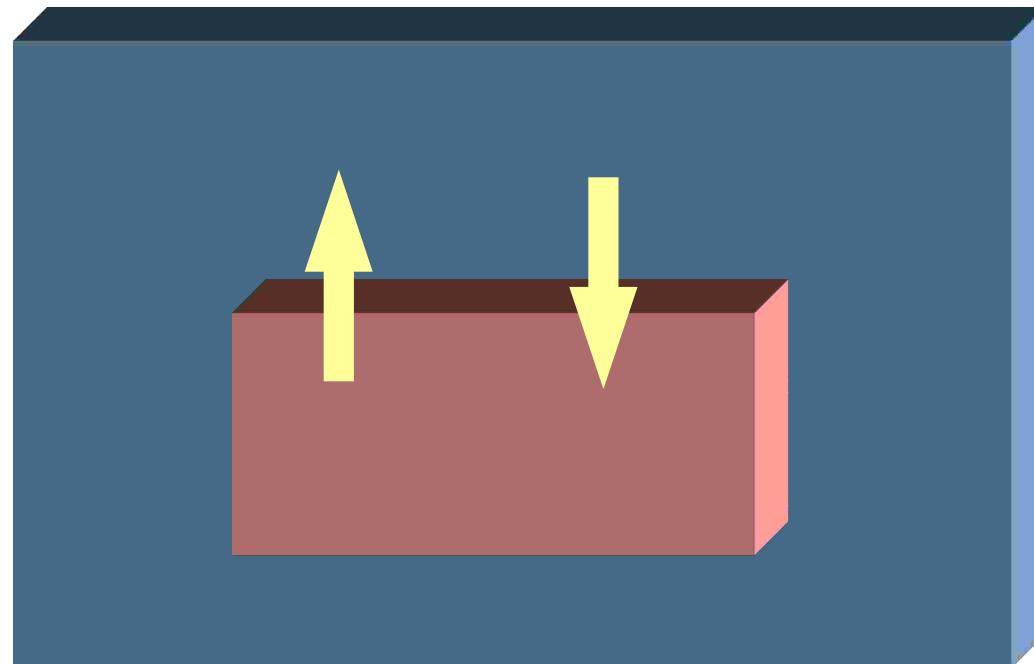
If E is the binding energy,  
The proportion of linked ends at  
one end at a temperature T is :  
 $K \exp(-E/kBT)$



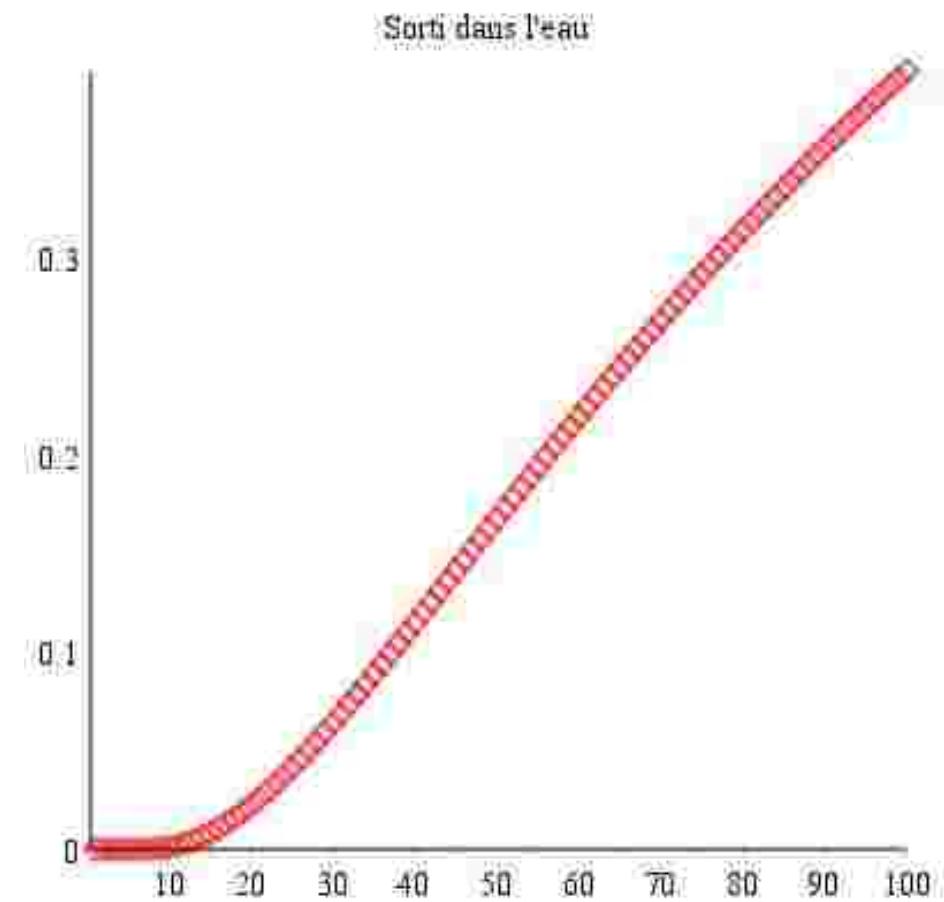
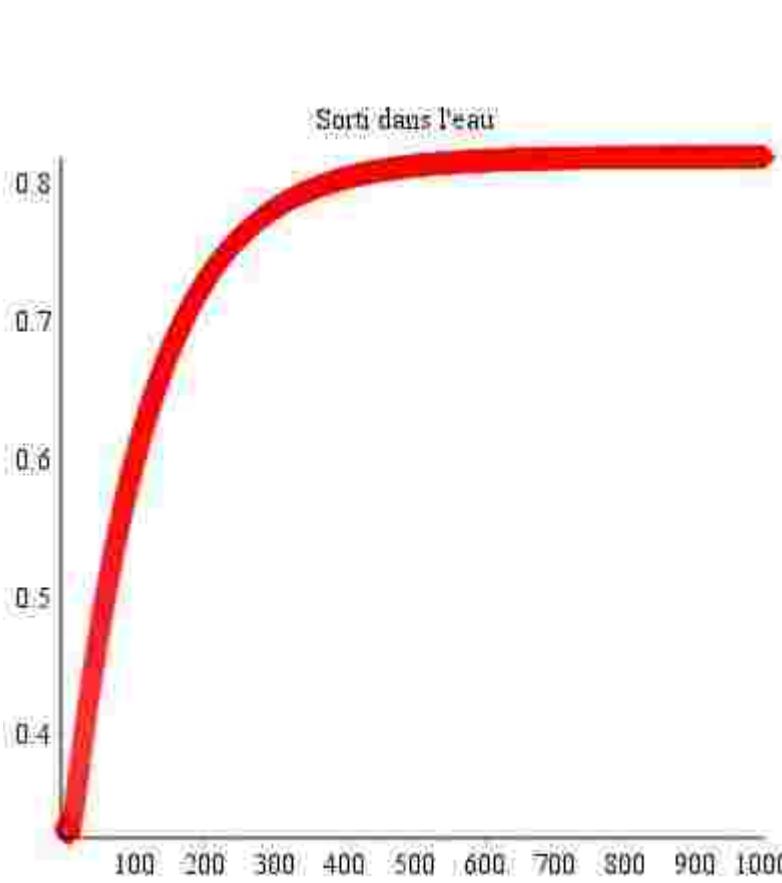
# What shall we do with all this

?

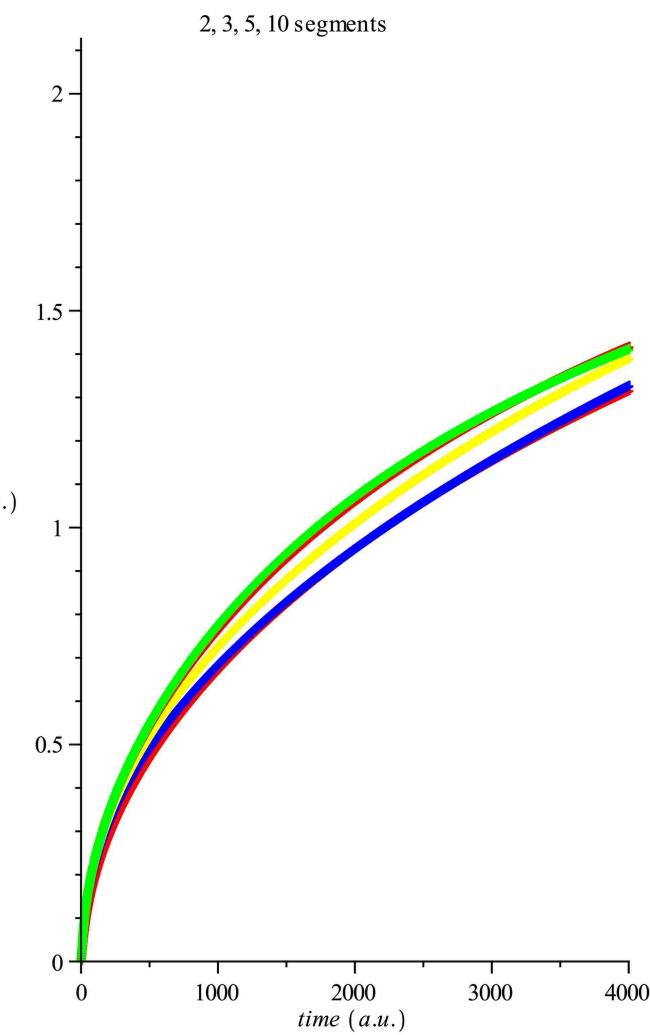
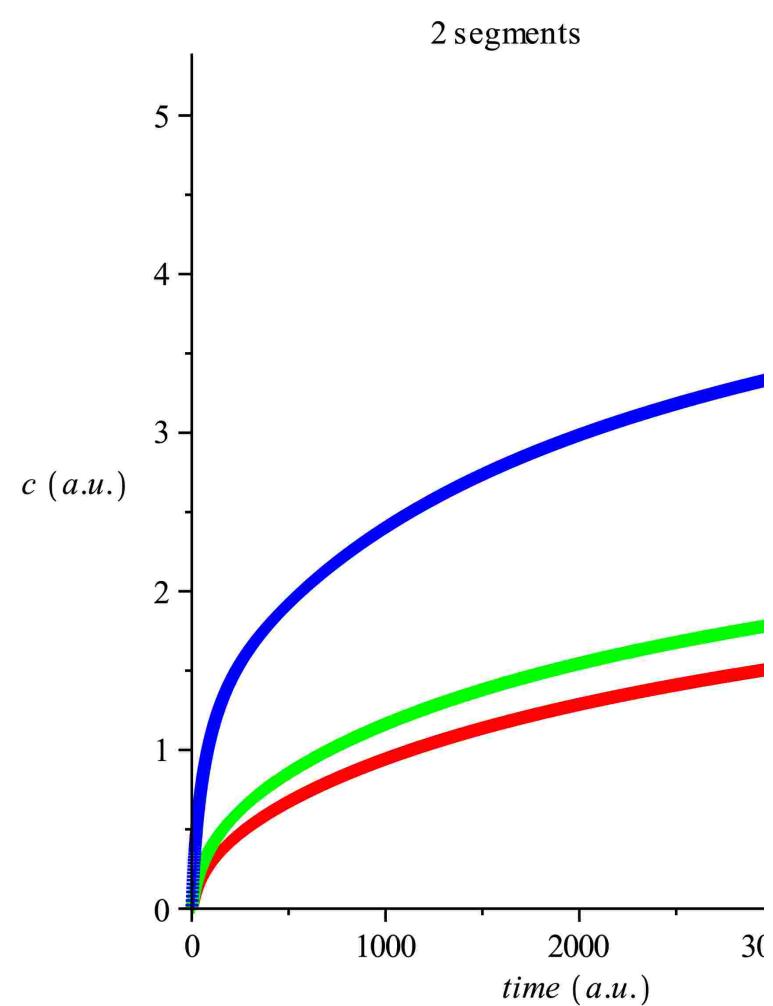
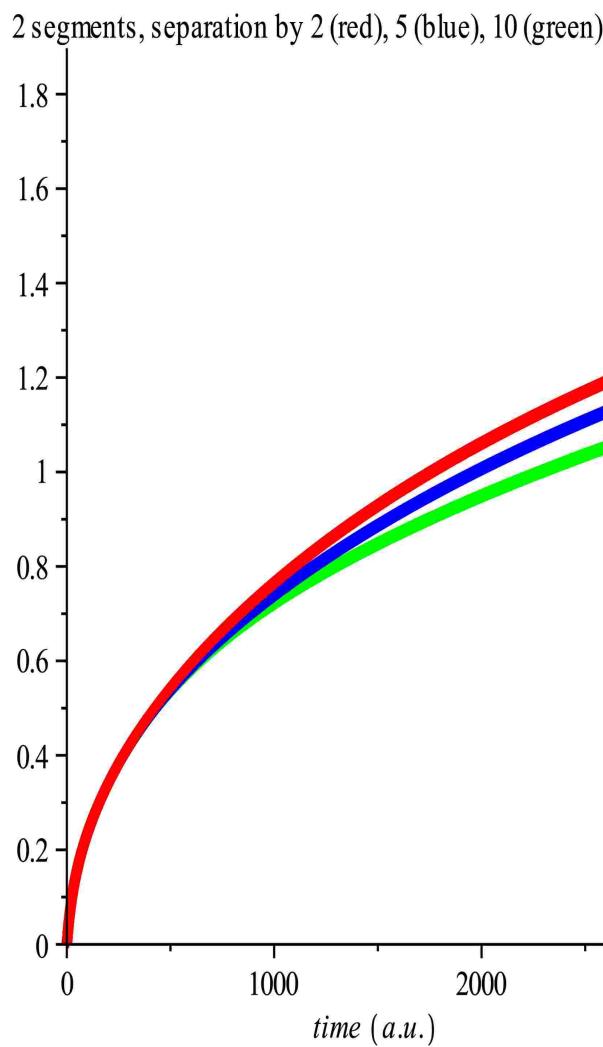
# Food is not simple a physical/chemical system : "bioactivity" is fundamental !



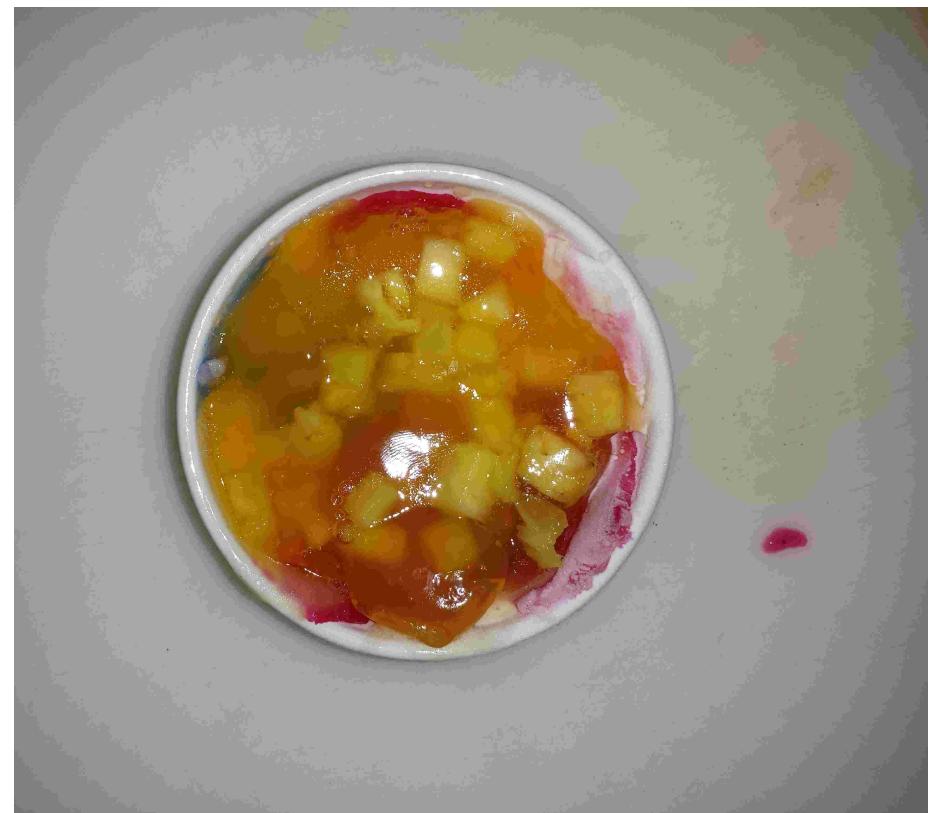
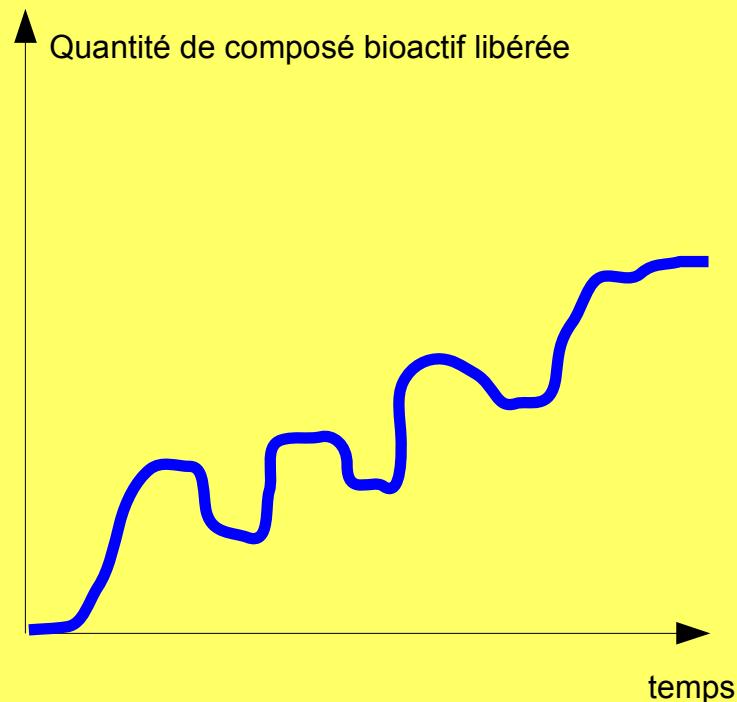
# And other laws... How many kinds ? Which kinds ?



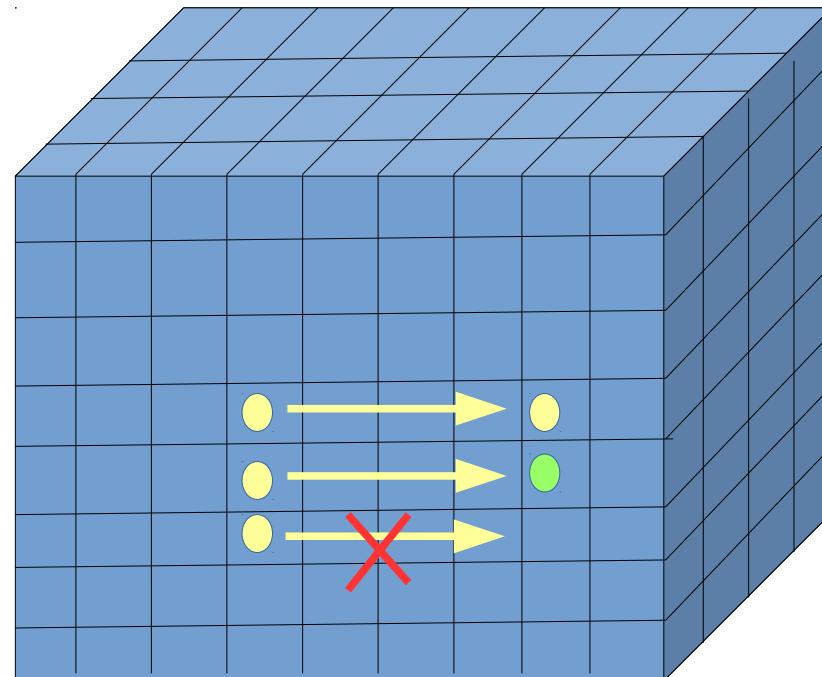
# Looking for "bioactivity"



# Can we do this ? (yes)



# Without forgetting chemistry !



# And the main issue of bioactivity

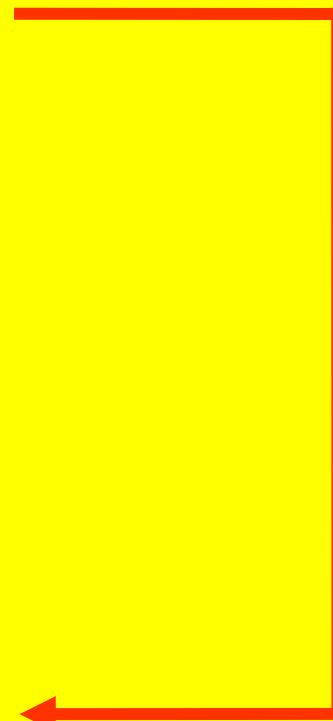
{formula}



{Physical systems}



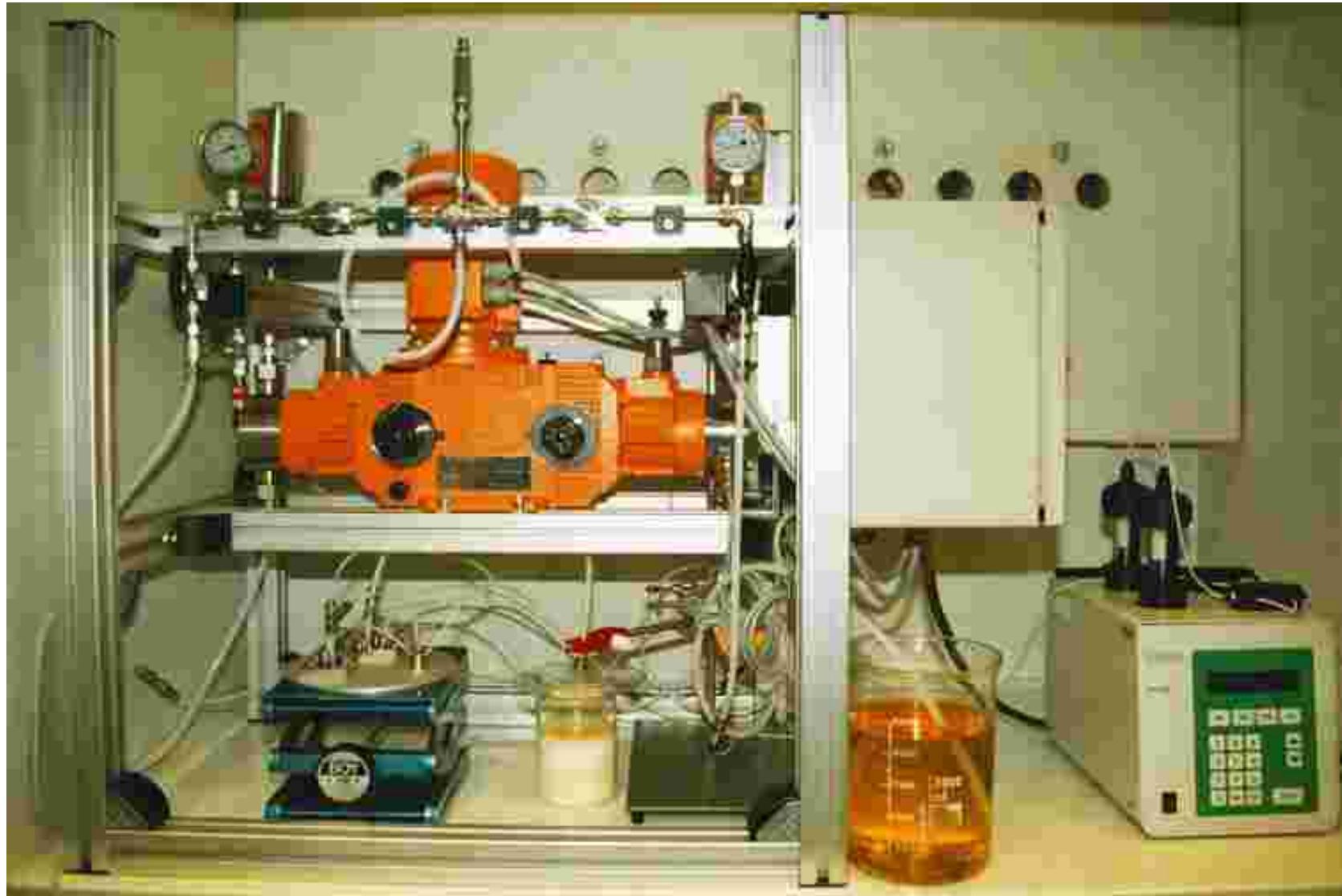
{Chemical and physical  
properties: odorant release, taste  
molecule release, optical  
properties...}



# Many friends contributed

Valérie Michaut, Raphaël Haumont, Sylvie Verrier, Vincent Pajot, Matthieu Maesani, Laurent Vincent, Camille Grémillet, Aurélie Morgen, Violaine Pistre, Rachel Edwards-Stuart, Anne Cazor, Johannie Martin, Anne Matignon, Anne Bouysse, Juan Valverde, Christine Liénard, Cécile Daniel, Fabien Hennion, Antoine Mathurin, Marie Geoffroy, Pierre Coeurdeuil, David Trinh, Lise Le Berre, Audrey Tardieu, Laure-Armandine Gomot, François Boyer, Jérôme Klingenfus, Robert Méric, Michel Dhanens, Coppélia Marincovic, Laure Menville, Gabrielle Petit de Leudeville, Quentin Bellier, Delphine Bayon, Chloé Lesage, Jérôme Klingenfus, Ondine Suavet, Agnès Portejoie, Guillaume Cheviron, Jérôme Bosano, Quentin Dudebout, Emma Lefevre, Clotilde Farah-Moussa, Vianney Delplace, Grégoire Seizilles de Mazancourt, Julie Faucher, Emilie Hsieh, Clémence Wable, Céline Tabary, Grégoire Lebrun-Taugourdeau, Nicolas Laurent, Mireille Bramant, Mélissa Boultadakis-Arapinis, Anne-Laure Bequet, Ioulia Gorokhovik, Eloise Giraud, Marie Jarousse, Agathe Souffrin, Sara Bessin, Sidarin Phana, Elisa Chiquet, Alice Guerez, Elisa Chiquet, Jean-Baptiste Sauvet, Meihing Chhan, Vianney Delplace, Blanca Escudero Lopez, Vérane Chardonnet, Bastien Néel, Thomas Delaunay, Elise Bouthenet, Hélène Duval, Vanessa Robert, Charlotte Poplawskyj, Gaëlle Sicaud, Pauline Dominé, Jill Pardini, Lucie Bedon, Delphine Rossi, Marion Plassais, Loïc Raban, Fanny Jacot-Blais, Alan Luna, Clément Feyt, Meihing Chhan, Linda Weberskirch, Romain Bouteille, Agathe His, Sara Skoglund, Stéphanie Calafat, Célia Daix, Cécile Chauvière, Elise Yang, Arslane Kchkar, Mingmin Fan, Emmanuelle Baron-Louise Alexandrine, Sylvain Loyer, Tiphaine Bourgetteau, Jeanne Perez, Arianna Lugani, Ludivine Ferey, Julius Henne, Lucie Legros-Audenaert, Elsa Bauchard, Marcia France, Joris Autran, Guillaume Pichot, Farid Khifer, Anne Cécile Buis, Manon Dassy, Marion Gaudet, Jérôme Lançon, Claire Fior, Marion Gaudet, Jérôme Lançon, Indira Fabre, Laetitia Bisiaux, Arthur Bricq, Emilie Carpentier, Julie Cheong, Charly Carrière, Marie Antony, Mathilde Sayegh, Guillaume Duc, Mathias Pietance, Romain Brulard, Isabel Barbosa, Ricardo Cardoso, Alberto Gonzalez Jordan, René Enderlein, Heikki Aisala, Alice Meignié, Juliette Deweidt, Valérie Ory, Audrey Delissey, Julie Mathon, Lena Coutrot, Marie Pothier, Hélène Pasco, Patricia Bolle, Aurélie Meunier, Manuela de Buhan, Marine Migné, Marie Prim, Elham Tehrani, Morgane Bussy, Maxime Boutier, Yuqi Wu, Ebe-Tiya Edinguélé, Vincent Faugeras, Laetitia Le Falher, Yann Le Fur, Hélène Bisi, Tsing Wing Lui, Siting Liu, Camille Doyen, Daisy Pitoux, Laetitia Le Falher, Nadia Bastide...

# How to study this question in practice



$$(G + O + S) / W$$





# Mai 2003, Frankfurt, Germany



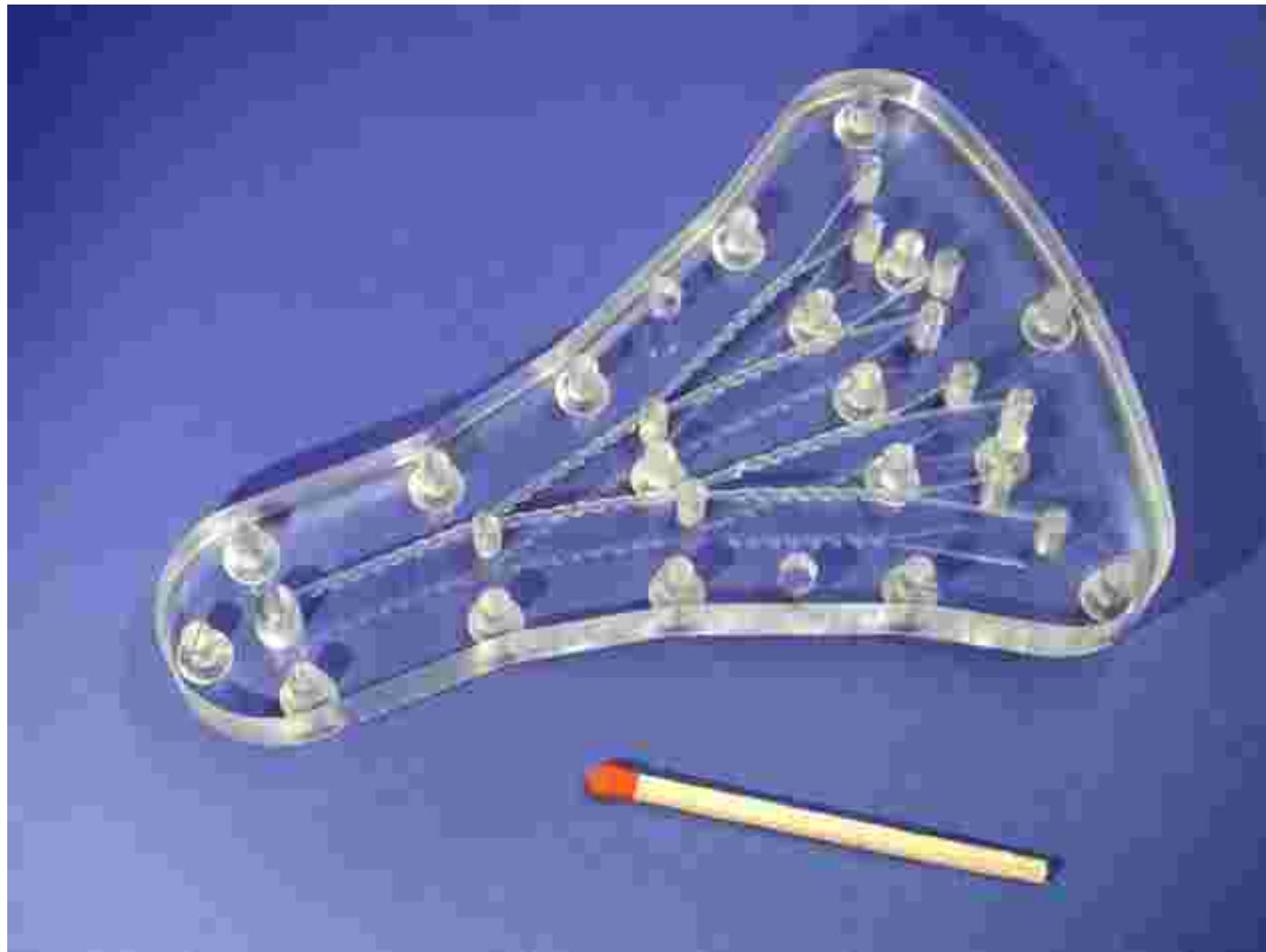
# Cocktails, sauces, dishes



# November 2003 : home "pianocktail"



# 500 billions of possibilities





2.



# Applications

# First, Molecular Cooking since 1980



# The definition : Molecular Cooking means using new tools



isTech

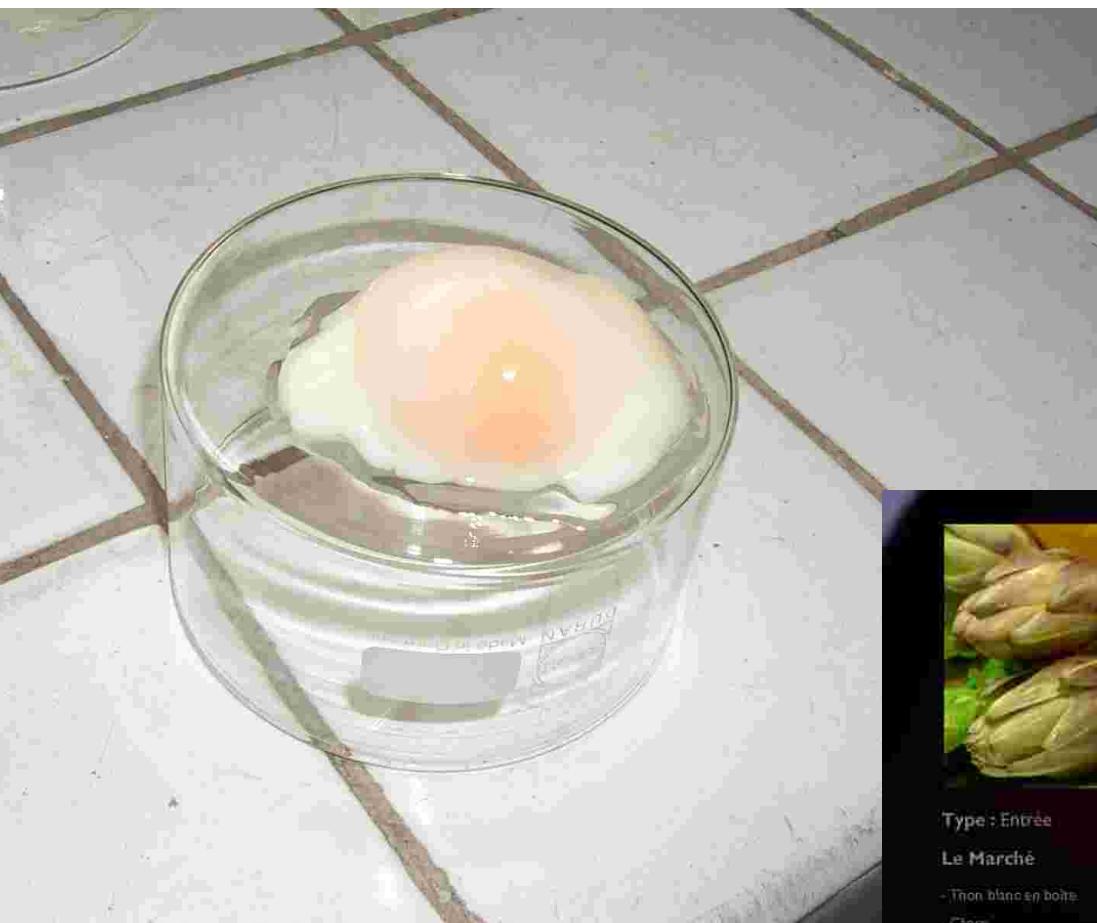
DUSTRIES DU VIVANT ET DE L'ENVIRONNEMENT  
PARIS INSTITUTE OF TECHNOLOGY FOR LIFE, FOOD AND ENVIRONMENTAL SCIENCES

International Centre for Molecular

# One invention per month since 1999

The screenshot shows a website layout for Pierre Gagnaire. At the top, there is a navigation bar with links to "PIERRE GAGNARE", "ACCUEIL", "L'ESPRIT GAGNARE", "OCCIDENT", "ORIENT", "LA LETTRE", "CONTACT", "OFFRIR...", "CULINAIRE VITAE", "PIERRE & HERVÉ", "VOYAGES", "AU JOUR LE JOUR", "CUISINEZ!", and "BIBLIOTHÈQUE". Below the navigation bar, there is a sidebar with sections for "PIERRE & HERVÉ", "TRAVAUX PRÉCEDENTS", and "ACCUEIL DE LA RUBRIQUE". The main content area features a blog post titled "Beurre Feuilleté" dated "Mars 2016". The post begins with "Mon cher Pierre," followed by text about the quality of butter. It includes a photo of Hervé and three recipe cards for different butter variations: "Beurre Feuilleté : jus orange et carotte / ananas, citron vert acide citrique", "Beurre Feuilleté : Pistache / café", and "Beurre Feuilleté : pâte de cresson / genièvre".

# The egg at 6X °C



Type : Entrée

Le Marché

- Thon blanc en boîte
- Capres
- Persil simple, de coriandre fraîche
- Biscotte écrasée

ACCUEIL DE LA RUBRIQUE

## CUISINEZ !

L'oeuf à 65° : recette de ménage

"l'oeuf |"

### Méthode

1 Prendre du thon blanc en boîte, l'effeuiller avec soin.

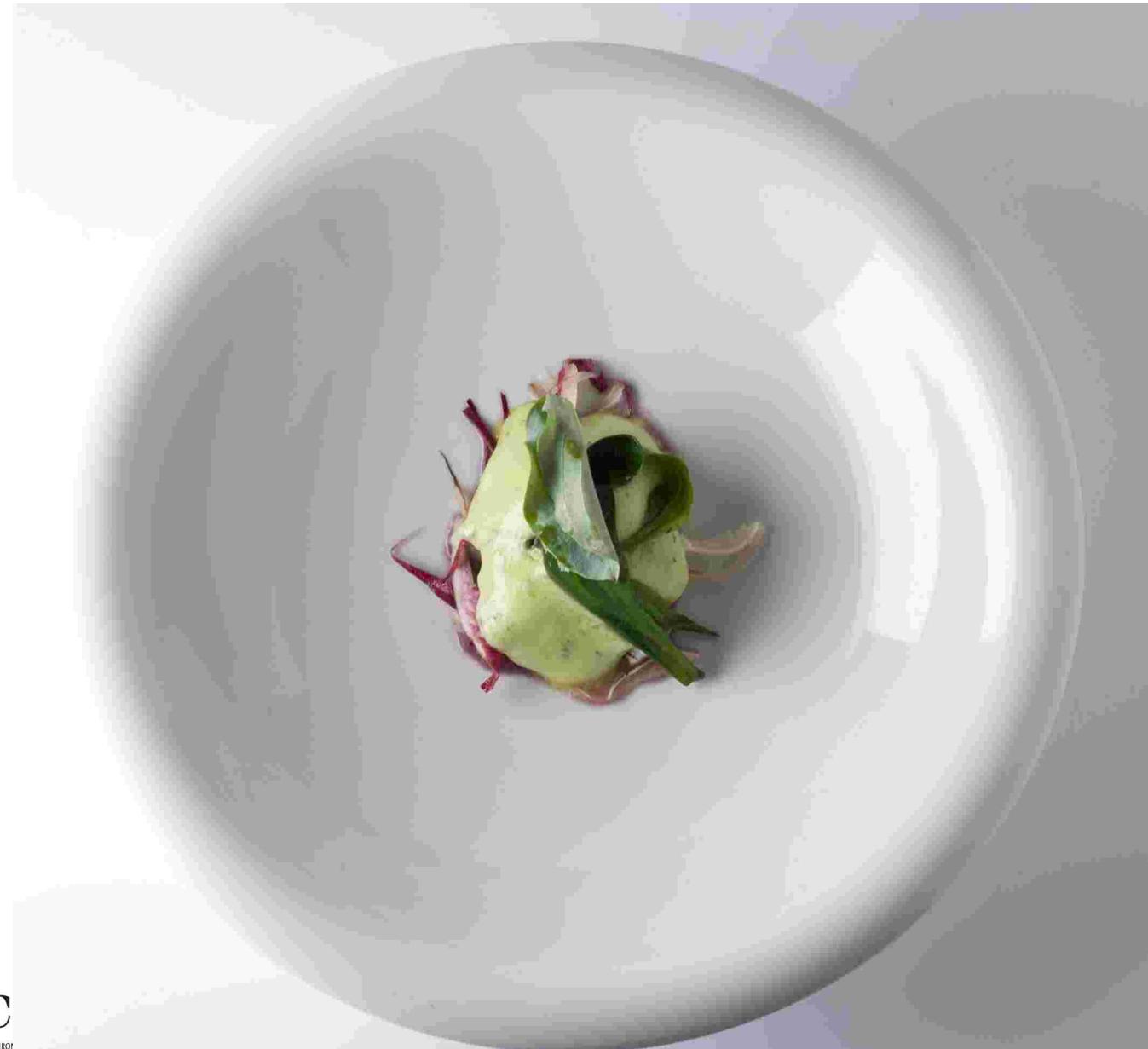
### 2 Assaisonnement :

Récupérer l'huile de la boîte, l'agrémer de capres, de persil simple, de coriandre fraîche, de biscotte écrasée et d'une pointe de moutarde condimentaire type savoré.

3 Étincer des coeurs d'artichaut, assaisonner de citron de fleur de sel au moment de l'envol et, écaser, vos œufs

### Le dressage

# Liebig



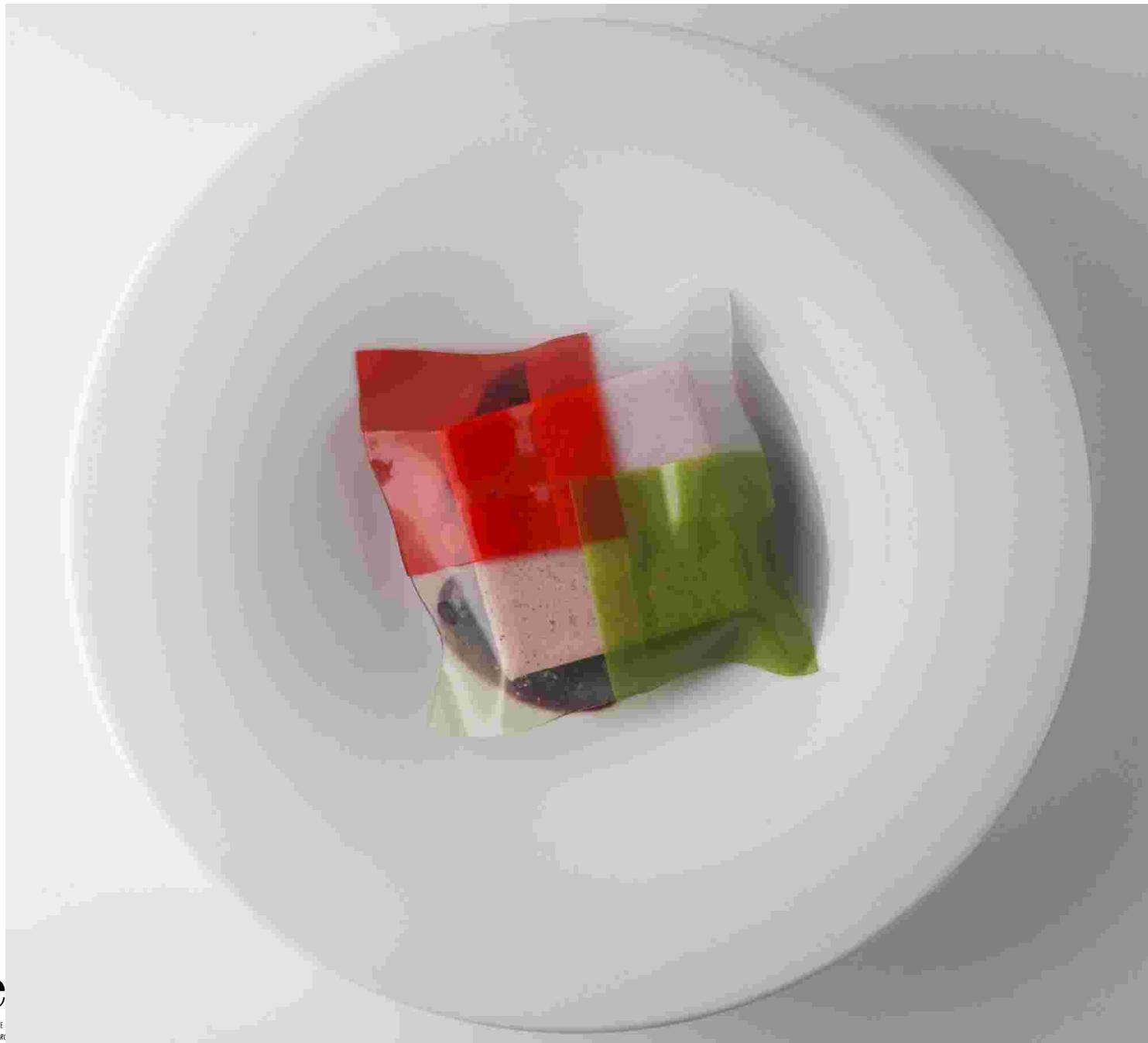
# Priestley



# Wurtz



# Salade à la Nollet



# Gibbs



# Chocolate Chantilly



# And many others...

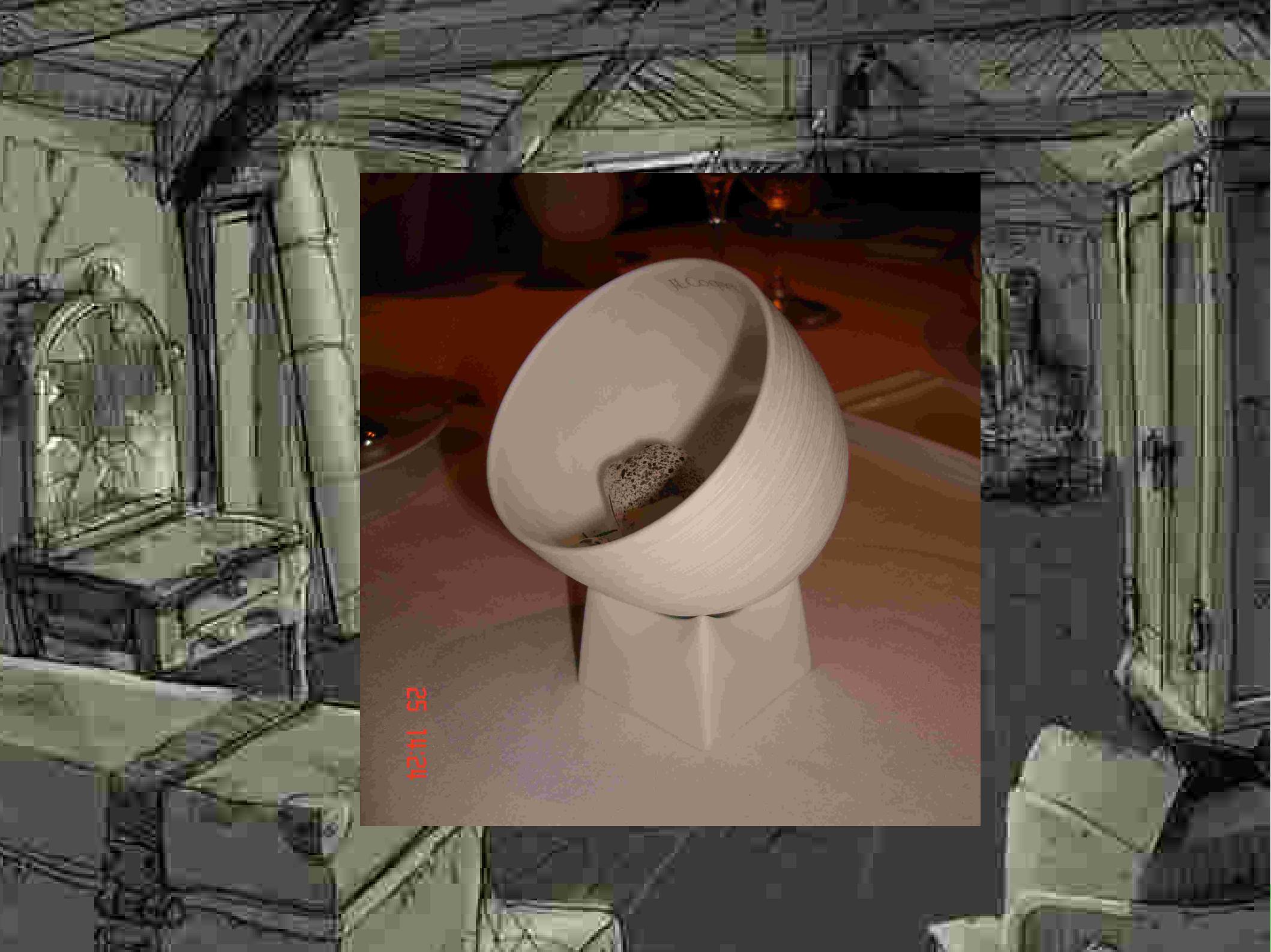
Avogadros, lavoisier, baumé, berzelius, braconnot, cailletets, caventoux, chaptals, chateliers, chevreuls, debyes, descartes, diracs, faradays, ficks, faradays, florys, gay-lussacs, gauss, de gennes, goefroys, gibbs, graham, kesselmeyer, laplaces, liebigs, maillards, mendeleievs, metchnikoffs, nollets, onnes, parés, parmentiers, pasteurs, péliggots, poiseuilles, pravaz, priestleys, quesnays, roux, thenards, vauquelins, wöhler, wurtz, dalton, dumas...

Forget it, even if it's funny

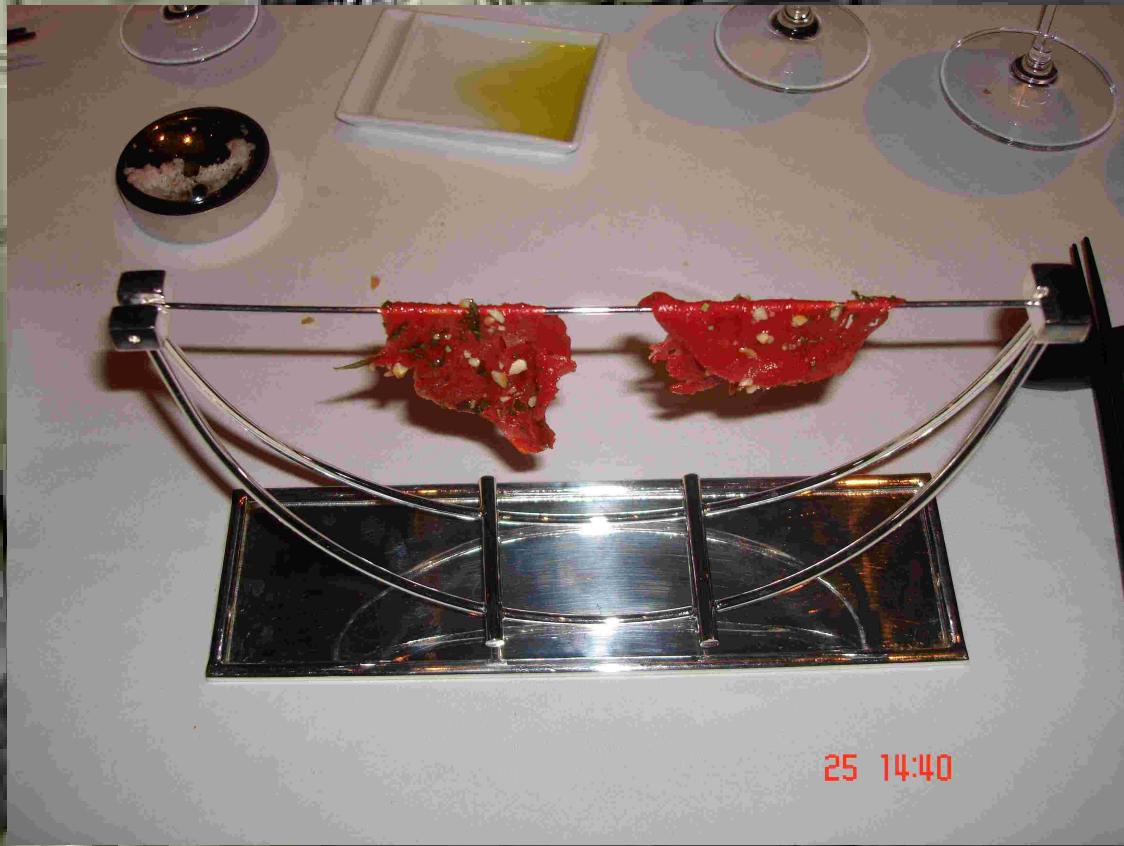




25 14:17











25.11.8





25 15:27



25 15:50











25  
16:33



25.10.10



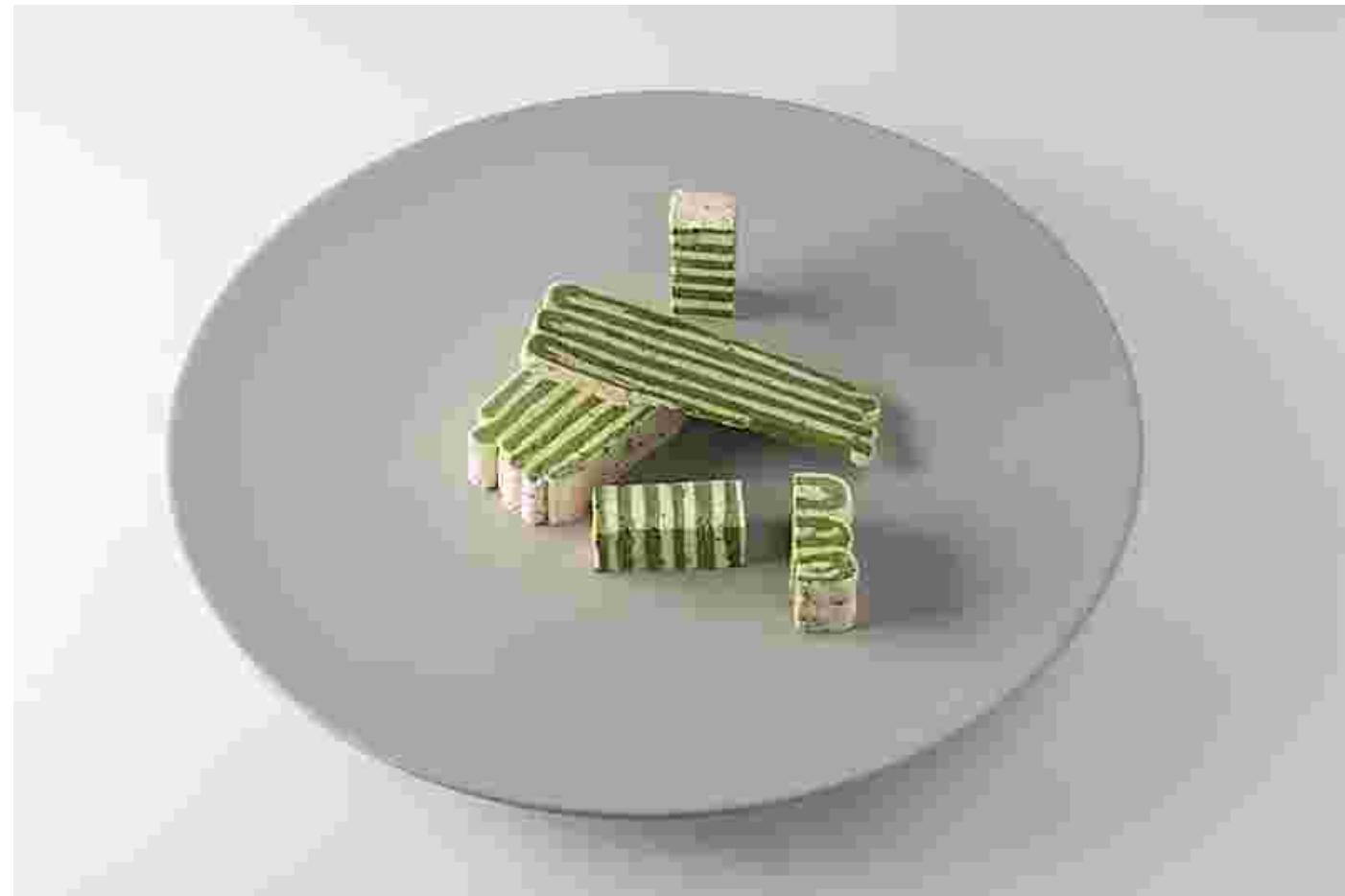
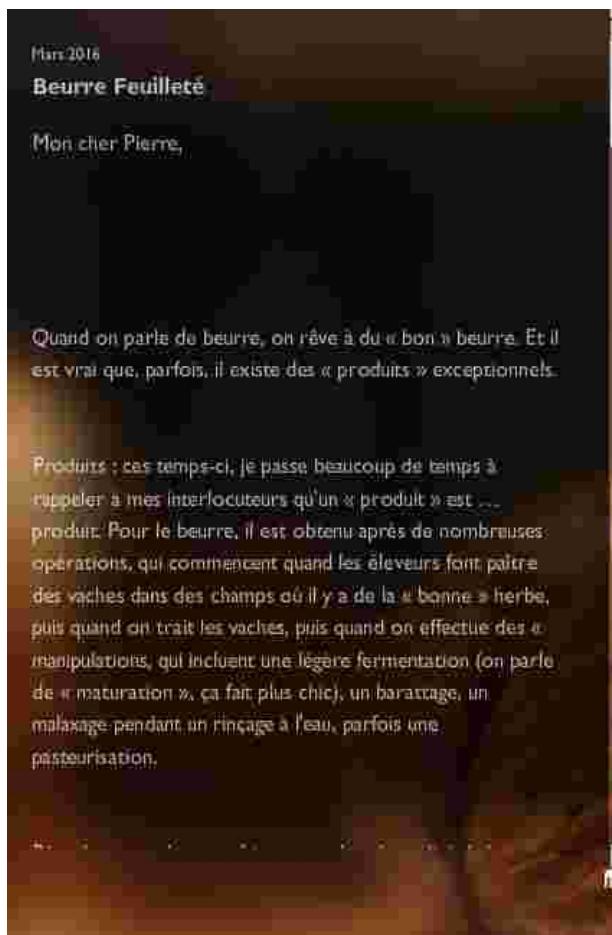
25 16:58



25 17:09



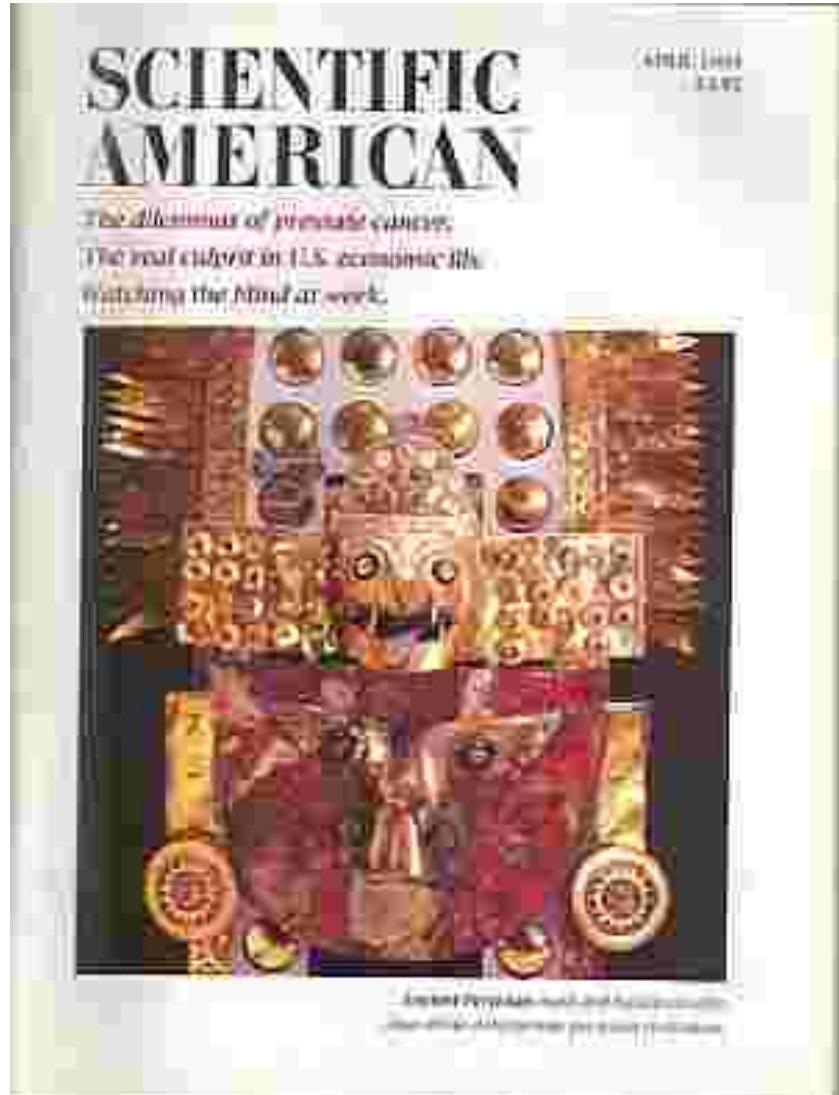
# The latest, with my friend Pierre



# All this is over



# Note by Note Cooking was first proposed in 1994



BRUNONE...

Pour le «gastronomie moléculaire», la découverte la plus intéressante était sans doute que la vanilline (le principal composé aromatique de la vanille) était un produit final de dégradation de la lignine. On perçoit d'ailleurs des notes vanillées dans les vieux cognacs, dans les vieux rhums ou dans les vieux whiskies.

La loi interdit aux fabricants de vins et de spiritueux d'améliorer le goût de leurs produits en ajoutant des composés chimiques, mais le consommateur est libre de s'amuser à utiliser des résultats scientifiques pour transformer les produits qu'il consomme. Il peut, notamment, ajouter de l'extrait de vanille liquide dans des alcools très jeunes (deux ou trois gottes par bouteille suffisent).

Ce type d'expérience pourrait être généralisé à de nombreuses boissons ou plats préparés à domicile. Les livres de cuisine du futur contiendront-ils des instructions telles que : «Ajoutez à votre bouillon deux gouttes d'une solution dans l'absolu de vanilline concentrée à 0,001 pour cent»? La proposition n'est pas insensée : depuis toujours, les épiceries et les cuisinières modifient le goût de leurs plats en ajoutant des épices et des herbes aromatiques, qui ne sont en fait que des conditionnements particuliers de mélanges de molécules aromatiques.

La science exulte et amuse.



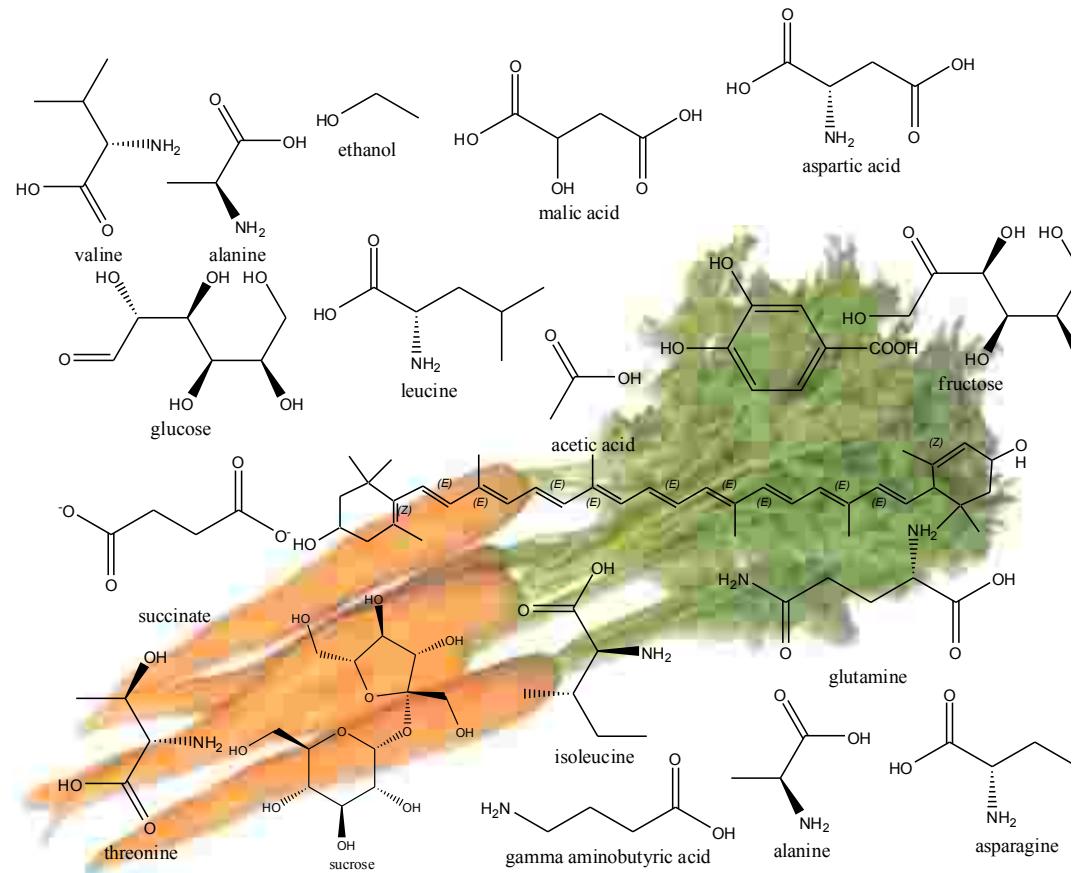
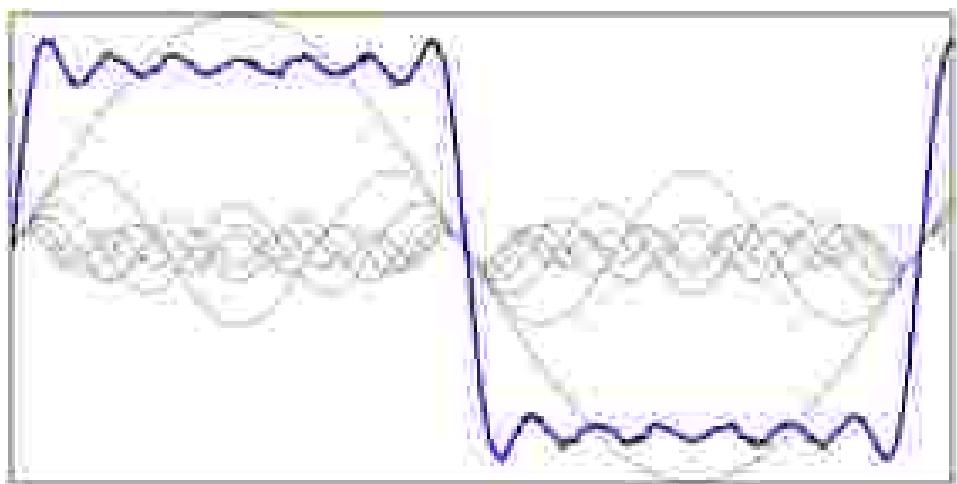
# The idea: instead of meat, fish, vegetables and fruits, use **COMPOUNDS**



# A comparison with music in order to make it more obvious



# Analyzing organizations



# And synthesis



# The future is clear

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Votre spécialiste en Pianos

Inscription Parcage Vendre Aide

Toutes les catégories Rechercher mot clé, code-barres, trempo vendeur... Super Points Mon compte Mon panier

Promos Livres BD Musique CD DVD Blu-Ray Jeux Vidéo Téléphonie Tablettes Informatique Logiciels Image Son Maison Electro Sports Loisirs Mode Beauté Jouets Enfant Art Collection Vins Epicerie Vendre ?

Accès > Jouets & Enfant > Jouets > Musique et multimédia > Piano et claviers > Ref : 63 - Tapis...

**REF : 63 - TAPIS CLAVIER PIANO JOUET SYNTHÉTISEUR MUSICAL INSTRUMENT DE MUSIQUE POUR ENFANT AVEC ENCEINTES**

★★★★★ Soyez le premier à donner un avis.

Jouet - Enfant  
61 touches-35 fonctions-16 instruments de musique-10 rythme différents-8 touches batterie-3 modes d'accord 2 modes de modification-mode enregistrement mode démo-mode leçon-mode pitch bend-mode tempo-mode contrôle volume-mise hors tension automatique-fonctionne avec 4 piles AAA LR6 (non fournies)-dimensions de l'article : 99x46 cm-dimensions du colis : environ 47x33x7,5 cm  
Voir le descriptif

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2 neufs dès 23,00 €  
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Vendez le vôtre

Vous aimez ce produit ?  
Créez une alerte prix (souhait)  
Partagez et gagnez 7 €  
Gagnez jusqu'à 500€ en donnant votre avis

# Why ?

# Because we have to prepare the future



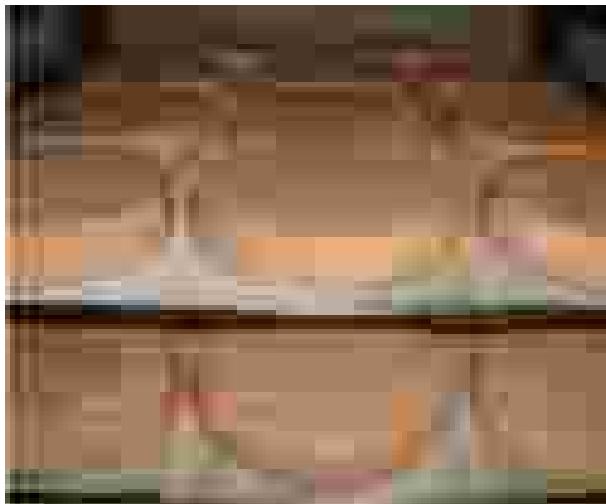
# Some species disappear



# We cannot eat anything



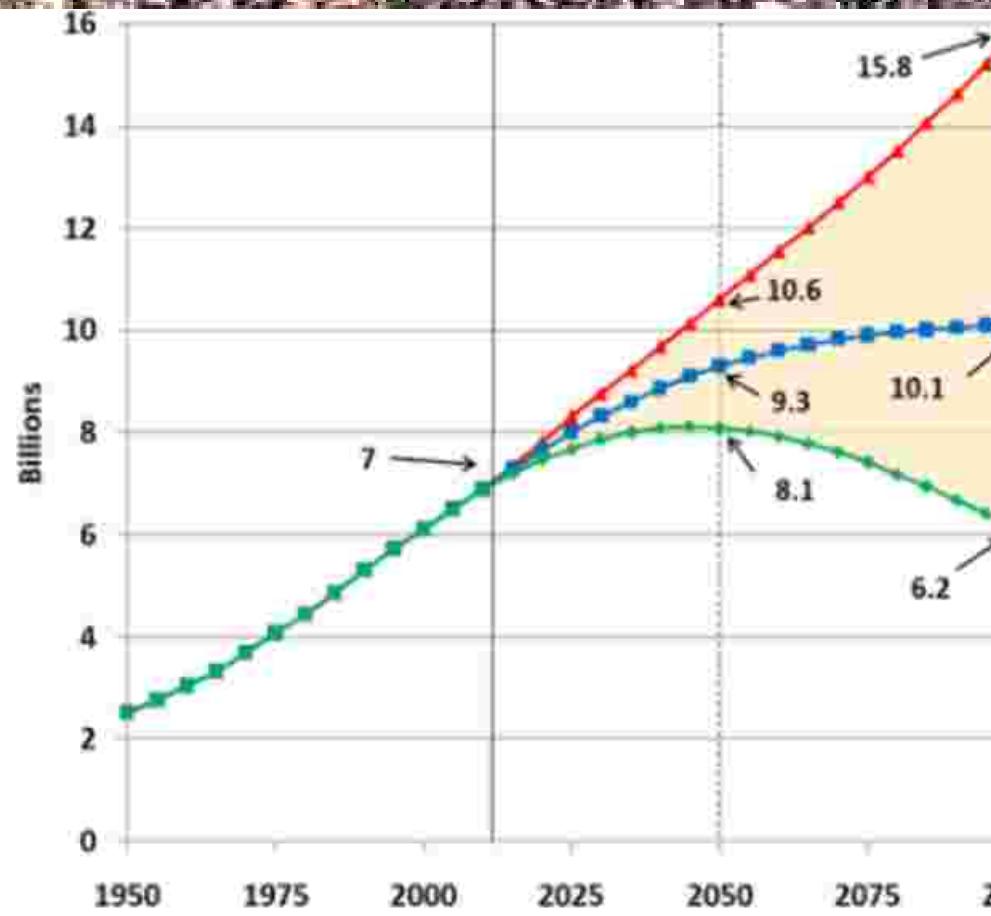
# What can we eat ?



# A possible energy crisis



# Perhaps 10 billion people !



# 1/3 is spoiled!



# Reasons and hope



# Can we avoid transporting water ?



= 95 % eau

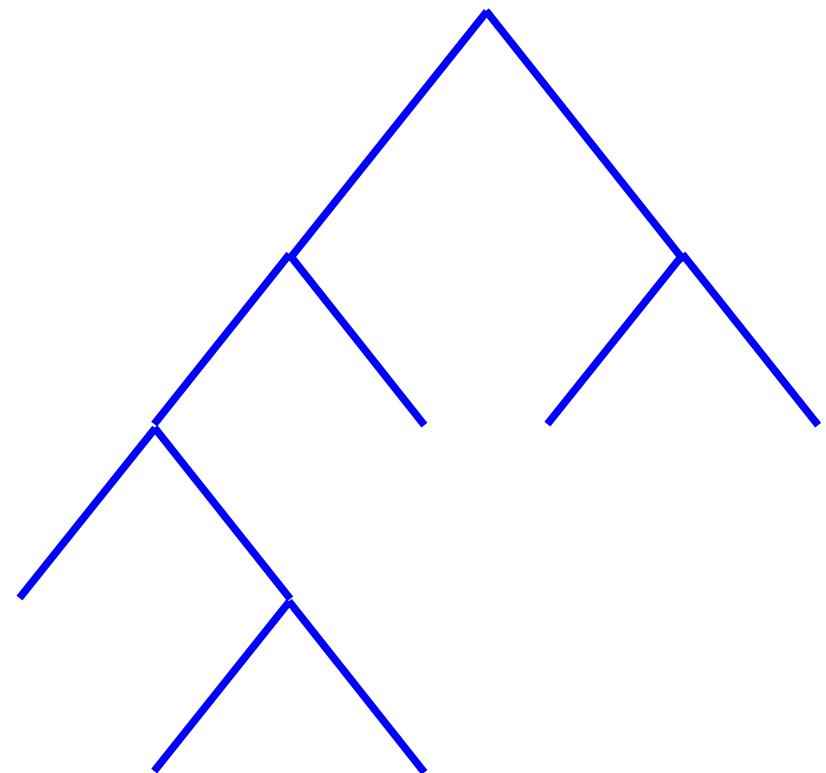


= 85 % eau



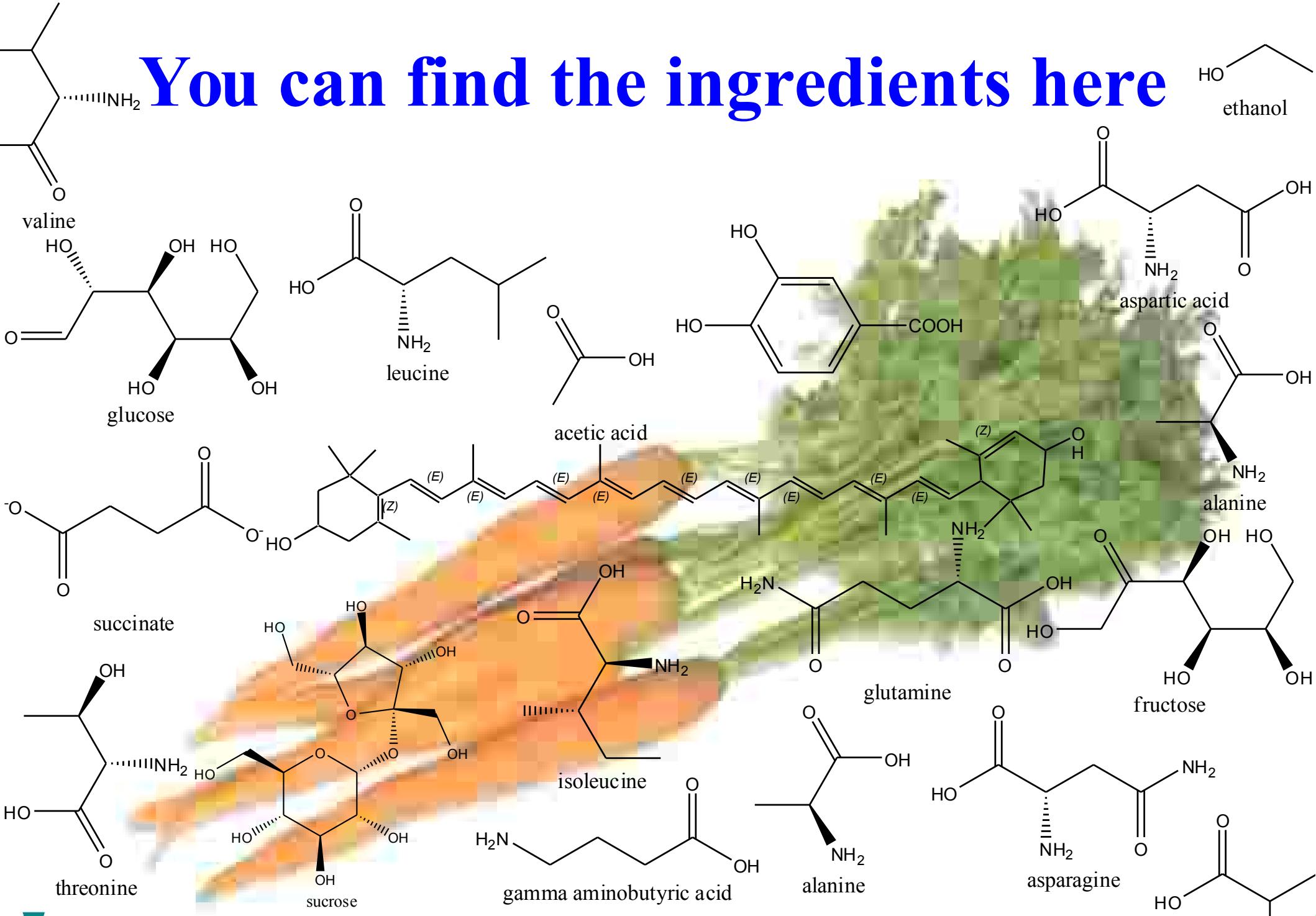
= 80 % eau

# Yes : let's fractionnate

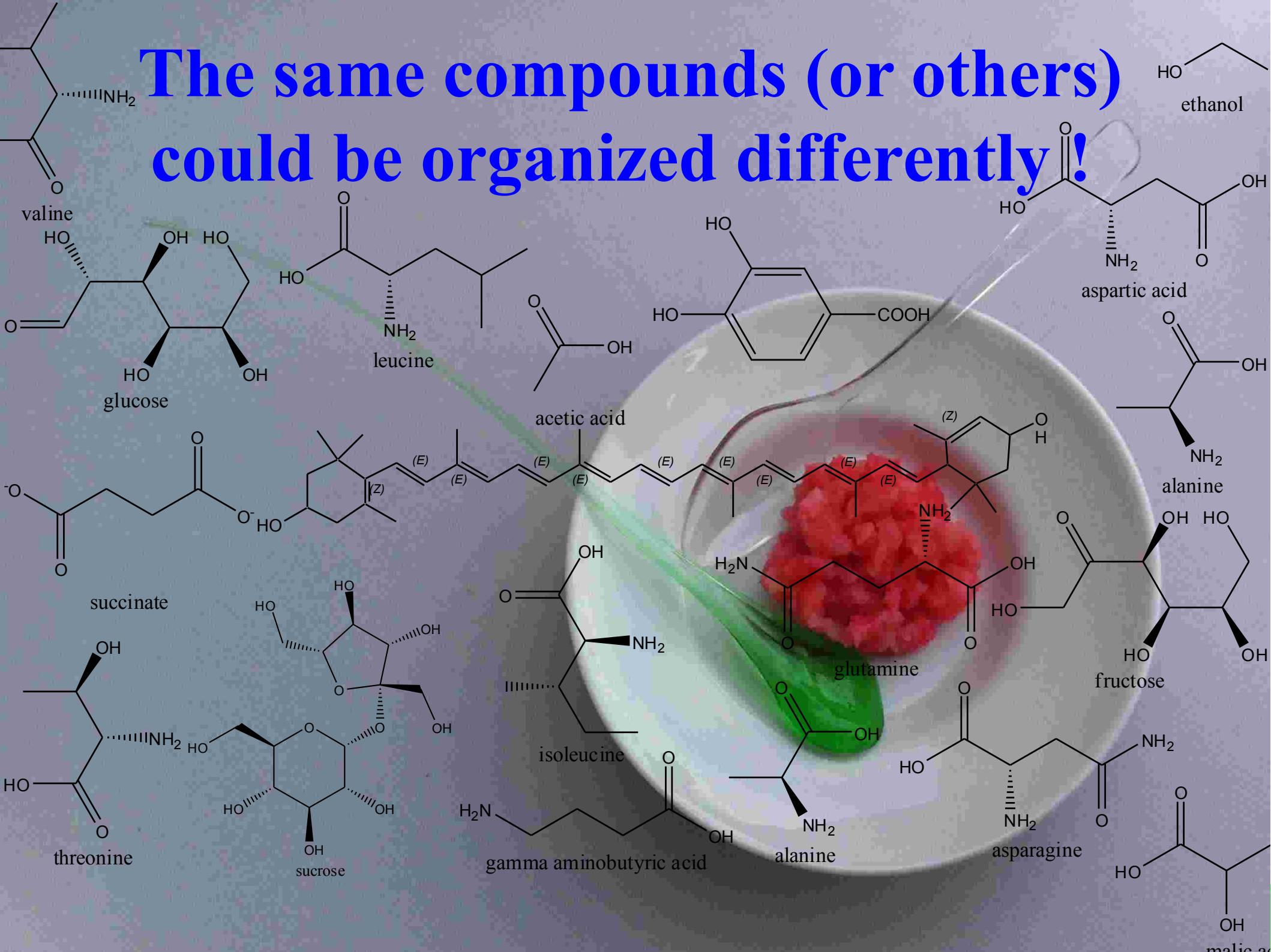


# Using already existing techniques





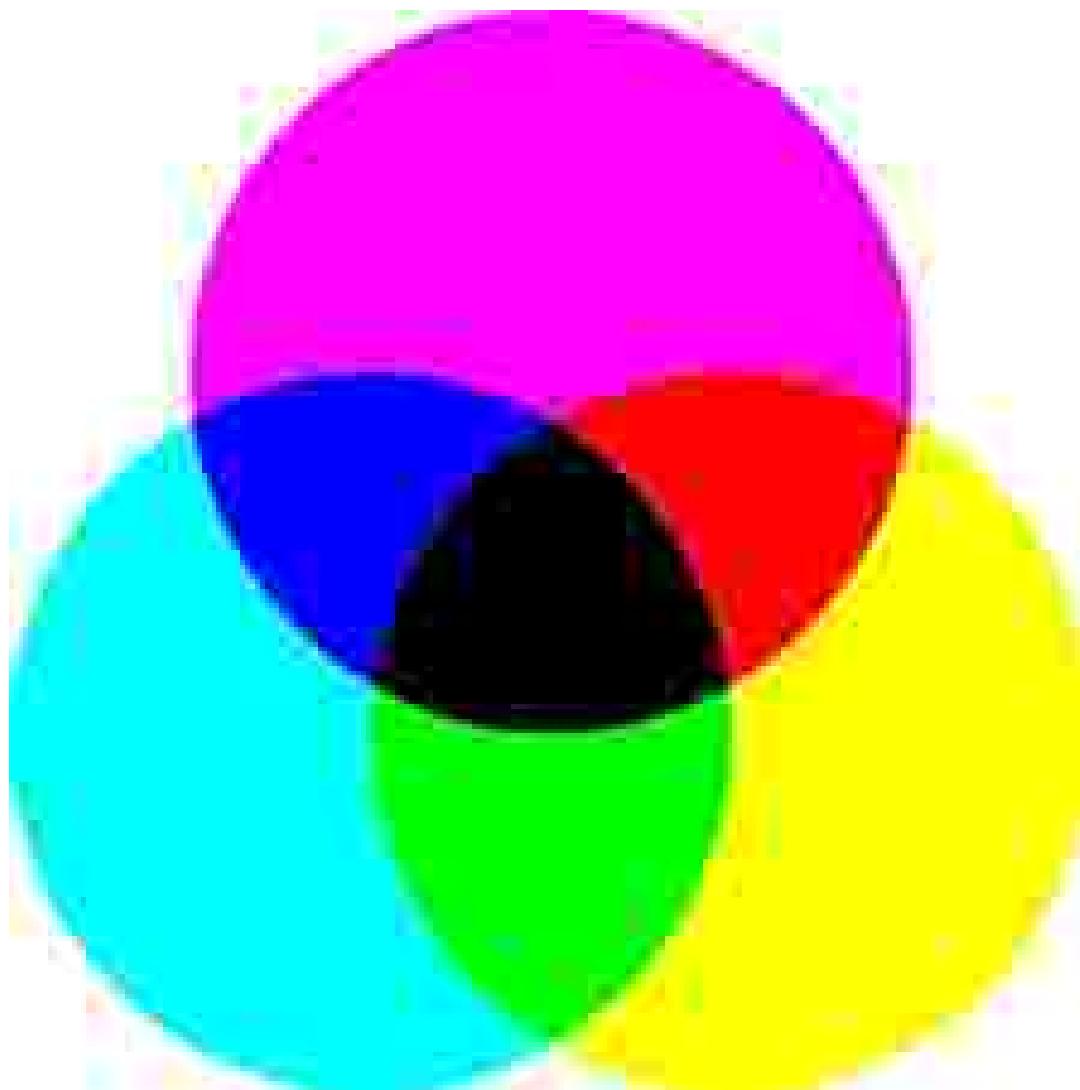
# The same compounds (or others) could be organized differently!



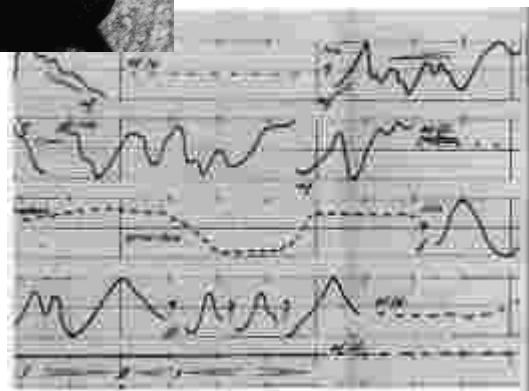
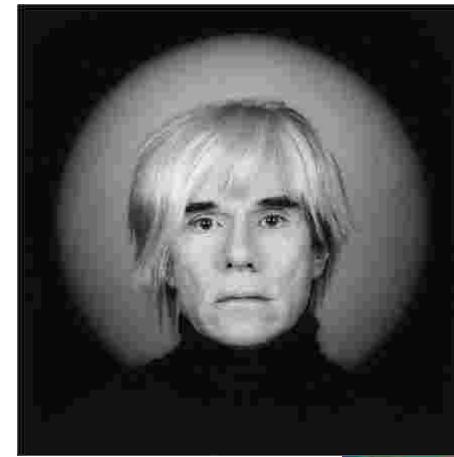
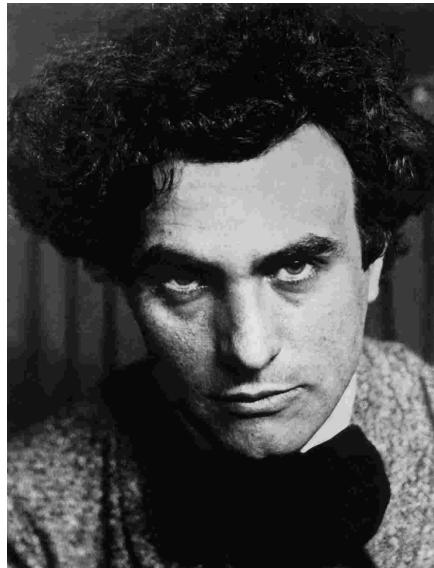
# We can enrich farmers and improve sustainability



# The number of possibilities is INFINITE !



# Note by Note Cooking : a new Art



# We can now learn to build food with new:

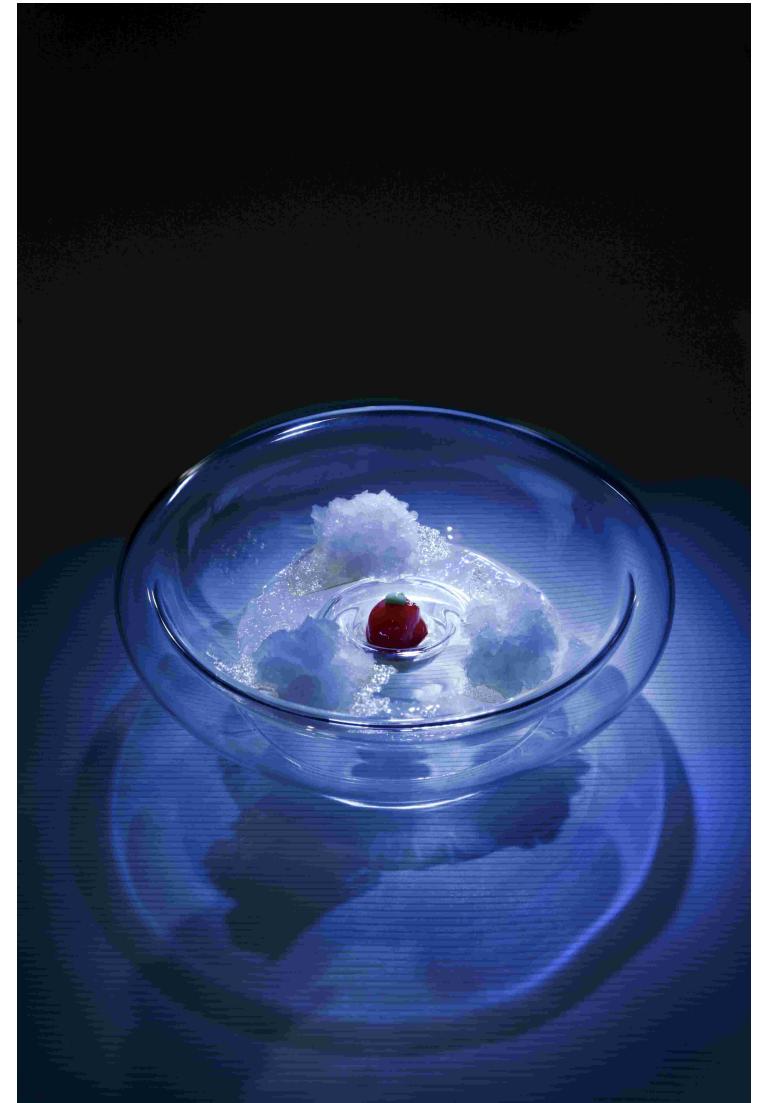
- shapes
- consistencies
- colors
- tastes
- odors
- trigeminal sensations (fresh, pungent...)
- Nutritional properties



# Everything is possible From seasoning to fully note by note



# 2009 : the first note by note dish ever served in a restaurant





# At the Cordon bleu Paris (2010) ...



16 20:17





16 21:52

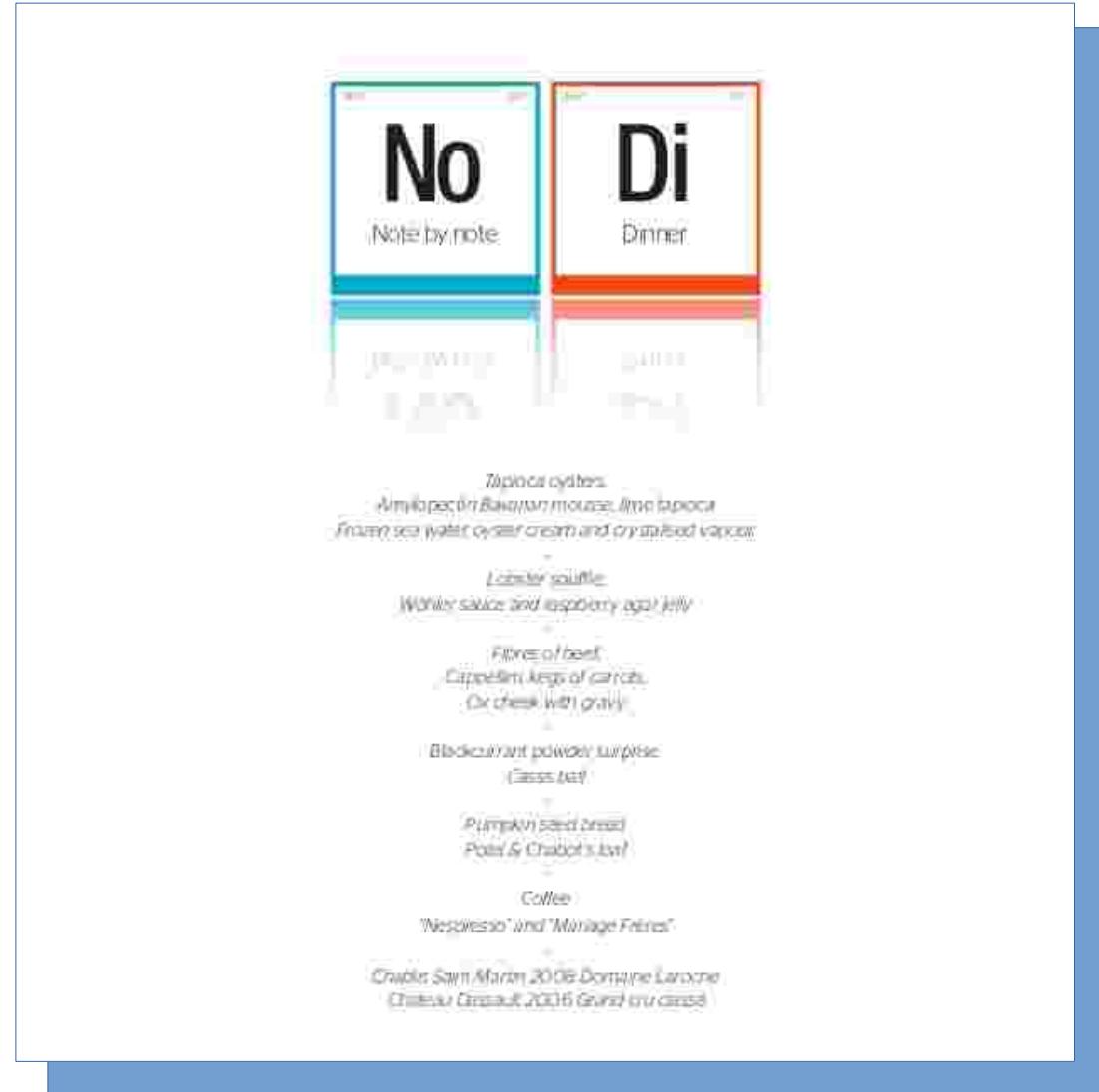


16 22:24

16 22:40



# 2011 : for the opening banquet of the International Year of Chemistry











# Le Corbon Bleu Paris, 11 octobre 2011





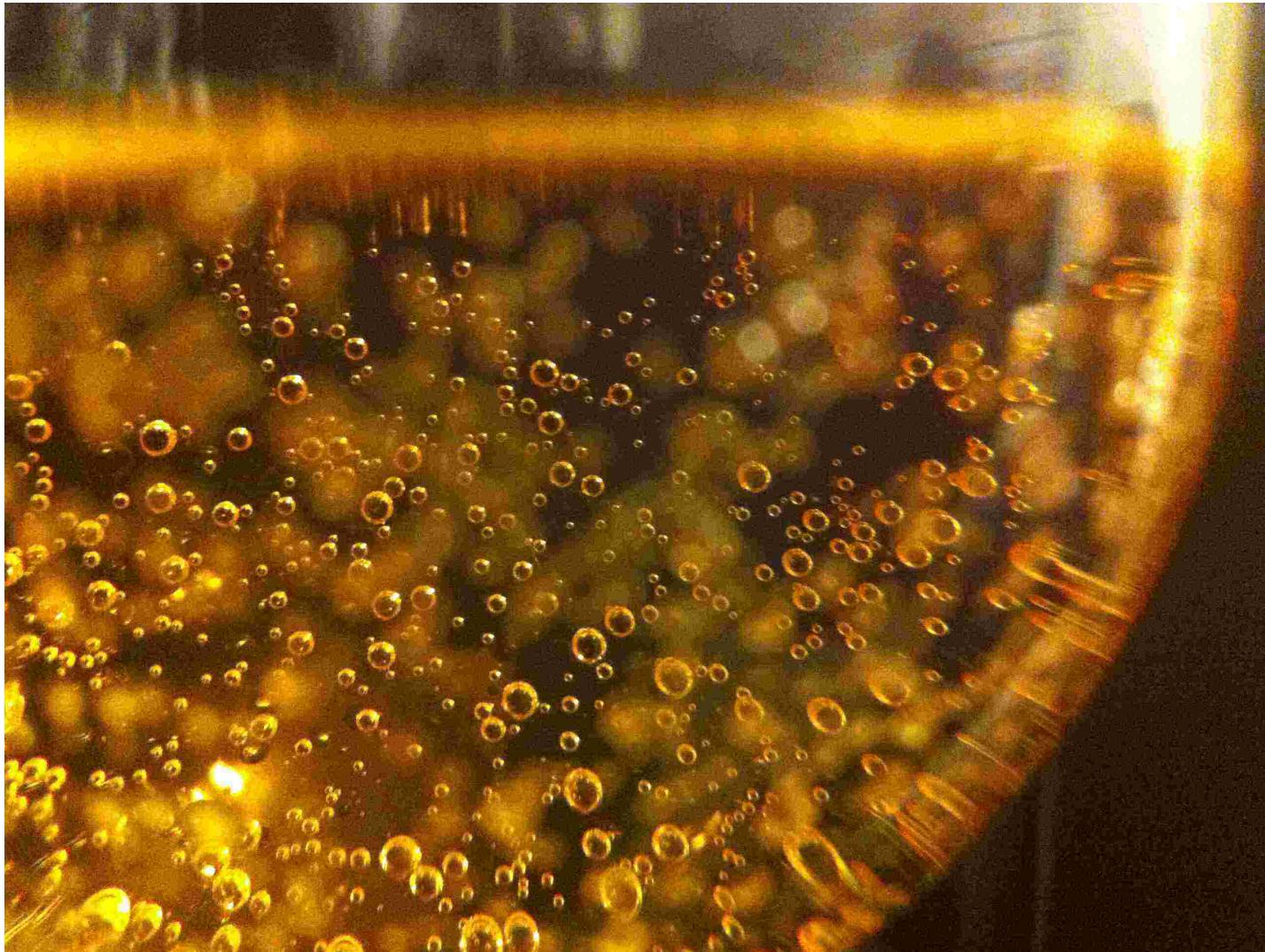
15 19:30



15 22:50

# Montréal, Canada

## April 2012



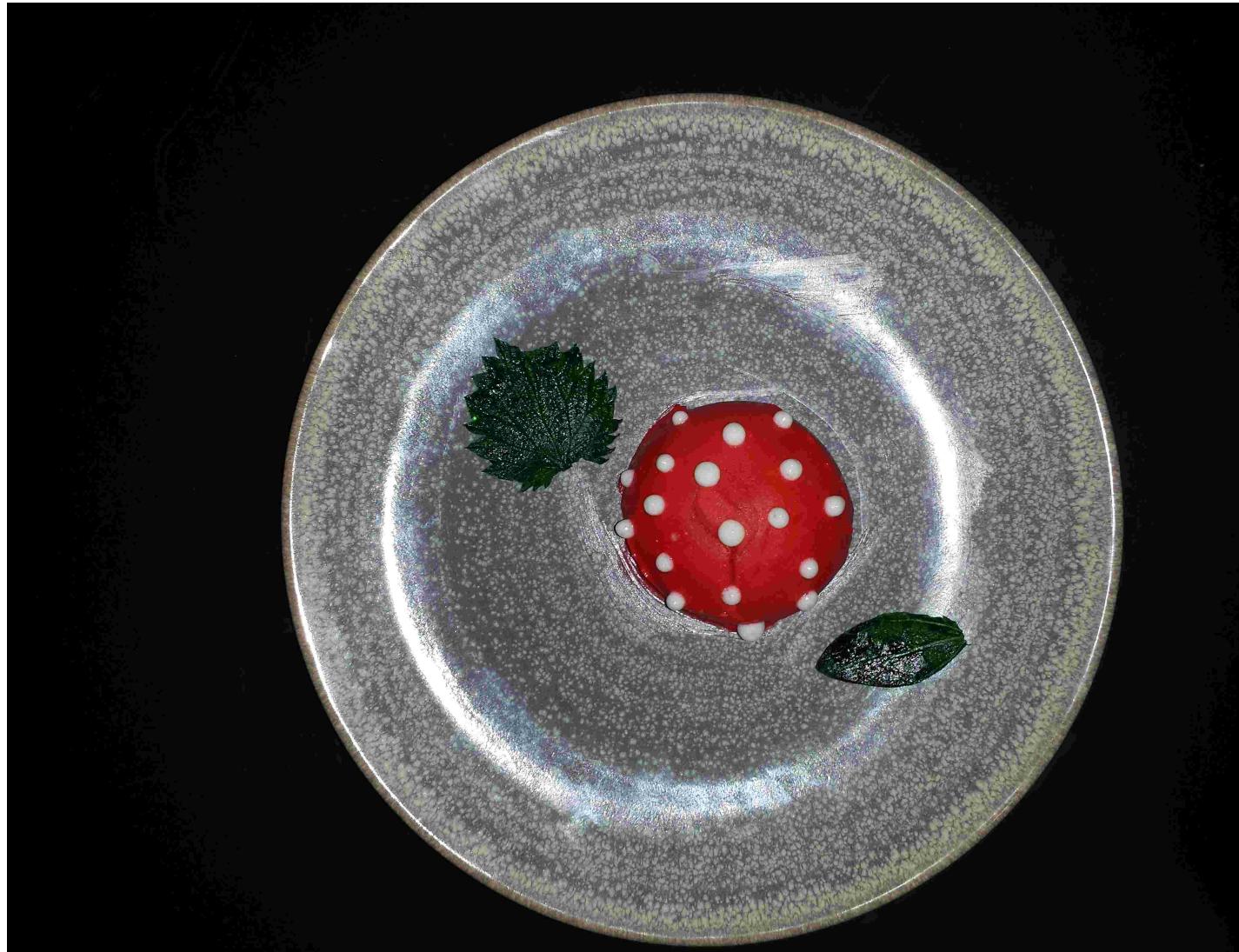


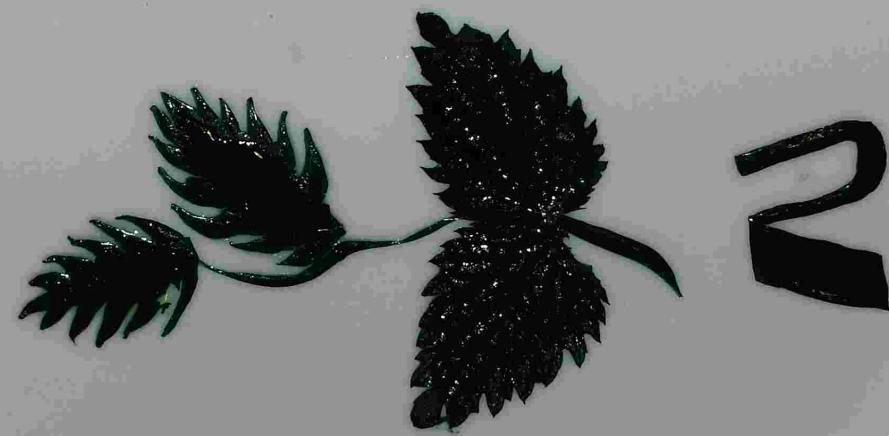


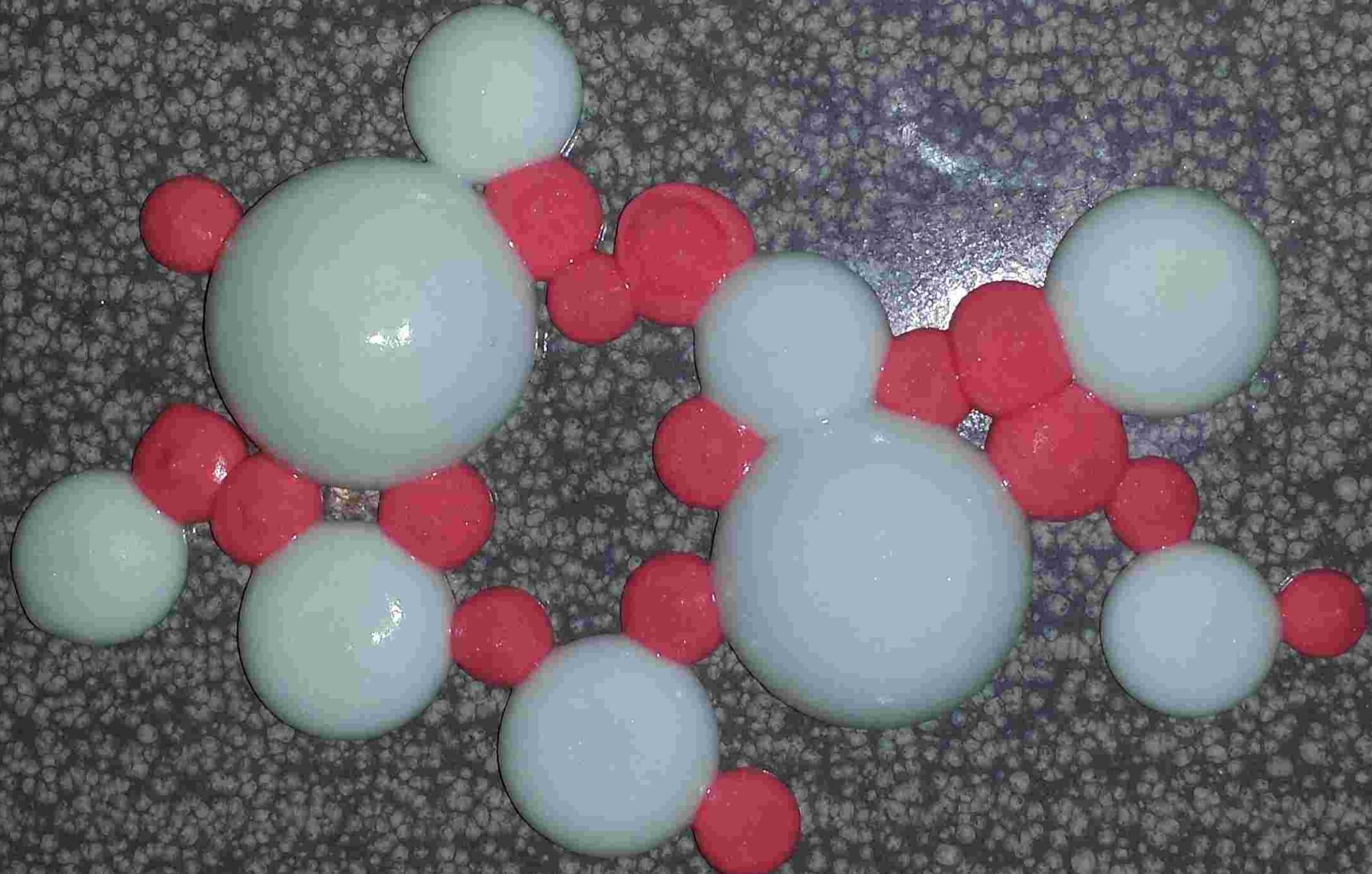




# Copenhagen, Denmark, April 2014







# Winner of the 2015 International Contest for Note by Note Cooking



# Winner 2014



# In Japan, by Guillaume Siegler (chef of the Cordon Bleu)





# A note by note meal at Pierre Gagnaire



# cis-hexen-3-ol



# gaïacol and 2,4,6-triisobutyl-5,-- dihydro-4H-1,3,5- dithiazine



# 2-acetylthiazole



# acetyl methyl carbinol acetyl propionyl



# Piperine



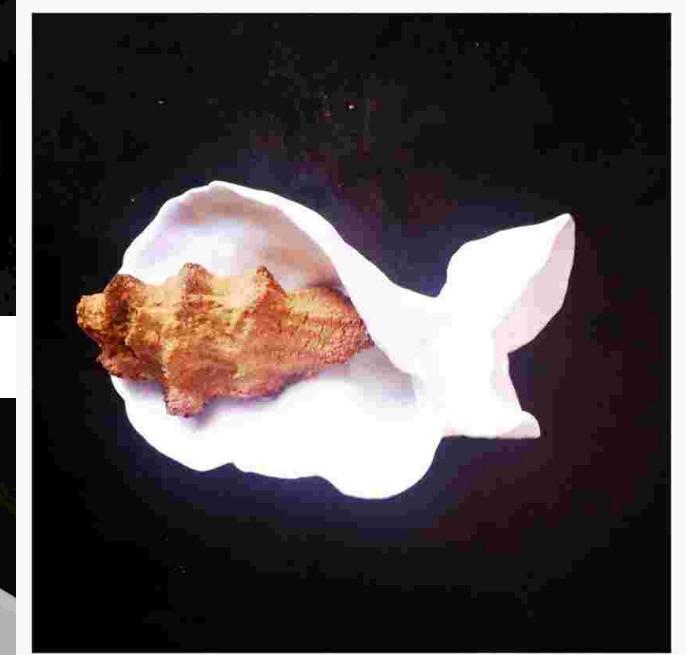
# Chick corea (entirely note by note)



# benzaldehyde



# And the International Contest for Note by Note Cooking



# Celebrate Molecular Gastronomy



forum : <http://scfconfhervethis.forumactif.org>