How to rank food systems (in order to study them rationally)

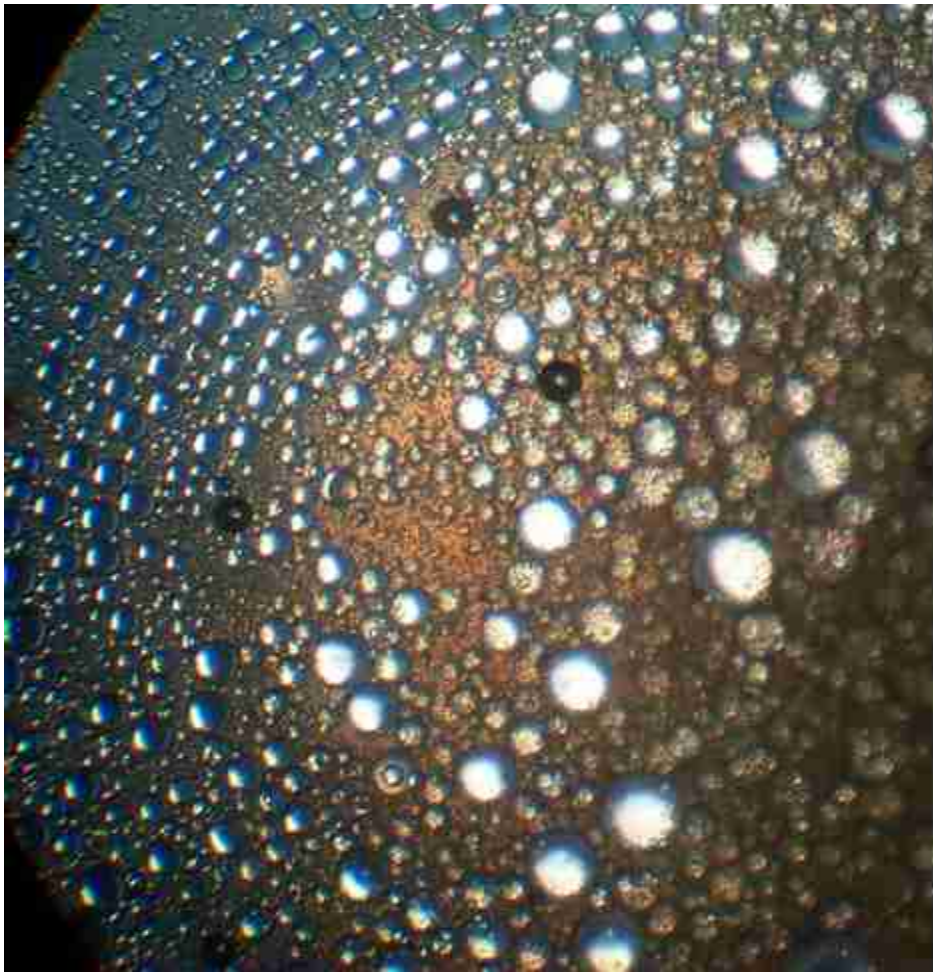
Various systems, which order ?

1.
DSF

The exploration needs a reference scale

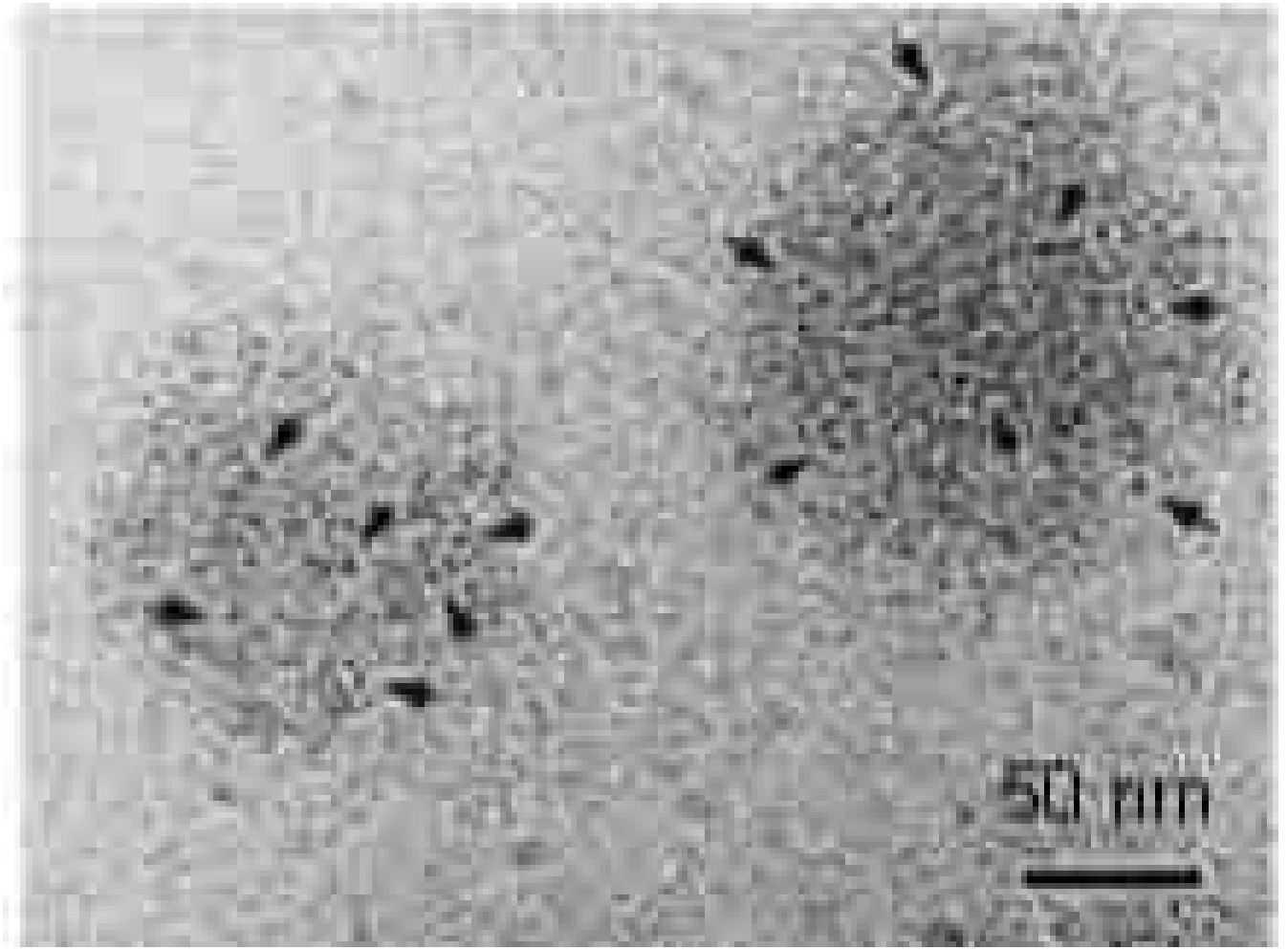
Such as macroscopic organization

Or microscopic organization of the macroscopic parts



1e-5<d<1e-4

Or nanoscopic



Or even supramolecular

Which system is this one?

The old possibilities

Line dispersed in column	**Gas**	**Liquid**	**Solid**
Gas	Gas (not a disperse system)	Liquid aerosol	Solid aerosol
Liquid	Foam	Emulsion	Suspension
Solid	Solid foam	Gel	Solid suspension

Is it an emulsion?
No

emulsion

Online use...

https://doi.org/10.1351/goldbook.E02065

A fluid colloidal system in which liquid droplets and/or liquid crystals are dispersed in a liquid. The droplets often exceed the usual limits for colloids in size. An emulsion is denoted by the symbol O/W if the continuous phase is an aqueous solution and by W/O if the continuous phase is an organic liquid (an 'oil'). More complicated emulsions such as O/W/O (i.e. oil droplets contained within aqueous droplets dispersed in a continuous oil phase) are also possible. Photographic emulsions, although colloidal systems, are not emulsions in the sense of this nomenclature

Cite as: *IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. https://doi.org/10.1351/goldbook.*

Div. I PDF Text JSON History Feedback

Last revised: February 24, 2014

Is it a gel ?
Perhaps (depending on temperature)

gel

Online use...

https://doi.org/10.1351/goldbook.G02600

Non-fluid colloidal network or polymer network that is expanded throughout its whole volume by a fluid.

Notes:

1. A gel has a finite, usually rather small, yield stress.

2. A gel can contain:

Cite as: *IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. https://doi.org/10.1351/goldbook.*

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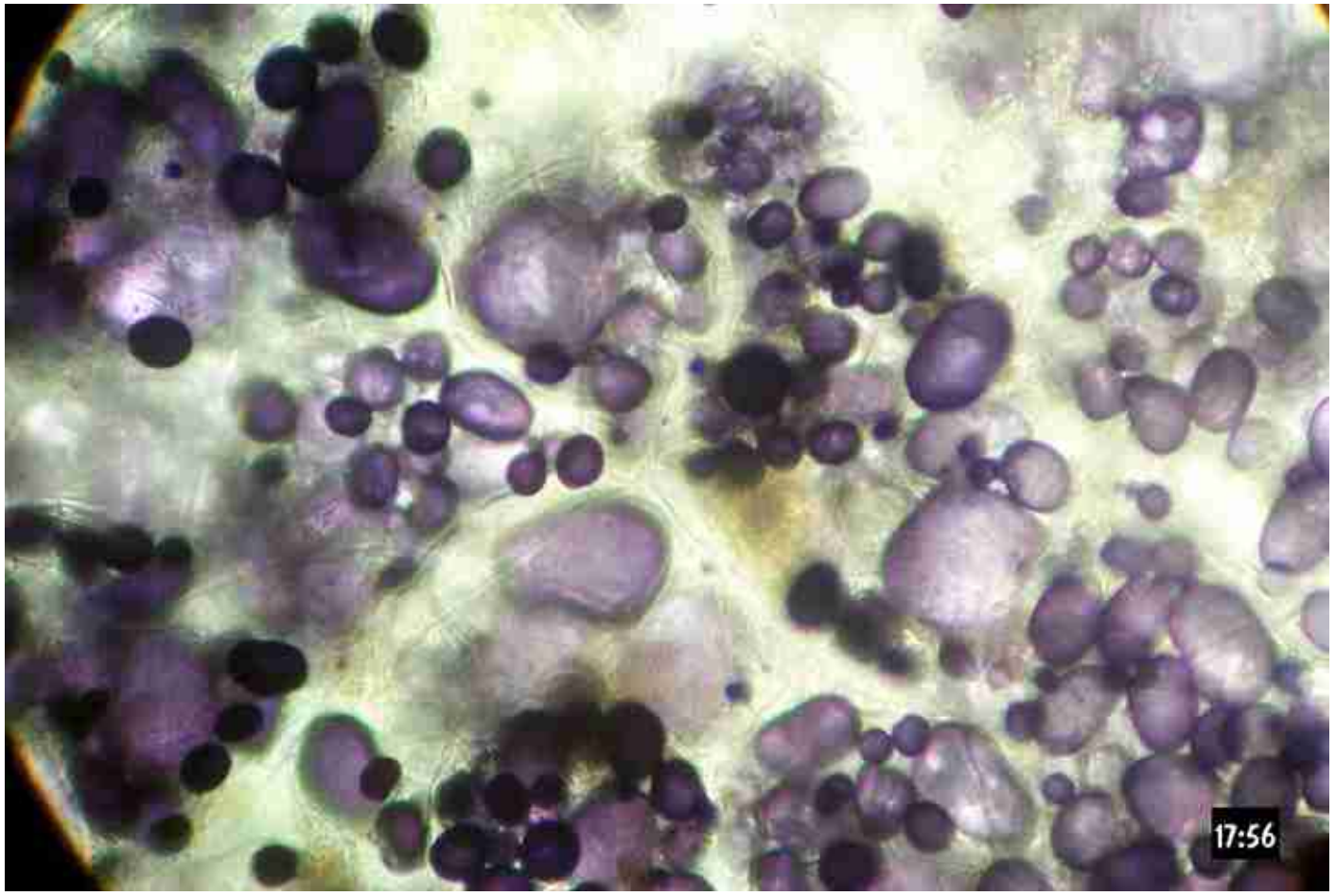
How can we describe this one?

Indeed we can't



Let us keep the idea of phases

Line dispersed in column	**G**	**L (W or O)**	**S**
G	Gas (not a disperse system)	Liquid aerosol	Solid aerosol
L (W or O)	Foam	Emulsion	Suspension
S	Solid foam	Gel	Solid suspension

A second aspect : dimensions

- **D_0 :**
- **object of dimension 0,**
- **Dots:**

- **D_1 :**
- **Objects of dimension 1,**
- **lines :**

- **D_2 :**
- **Objects of dimension 2,**
- **Plane, sheets :**

- **D_3 :**
- **Objects of dimension 3,**
- **cubes :**

This is why DSF was introduced

Operators:

/ : dispersed into

+ : coexistence of phases, mixture

@ : inclusion

σ : superposition (according to x,y,z)

X : intermixing of two phases

Dimensions

D_0 : dots

- D_1: lines

D_2: sheets

D_3: blocks

Phases :

G : gas

W : aqueous solutions

O : oil

S1, S2, … : solids

Considering phases only

Mayonnaise = O/W
(or better $D_3(O)/D_3(W)$)

But this has drawbacks

1. The most important (W) comes late
2. The two phases appear at the same level

A new proposal, instead :

$$W \backslash o$$

or

$$D_3(W) \backslash d_0(o)$$

Instead, a new proposal

$$W \backslash o$$

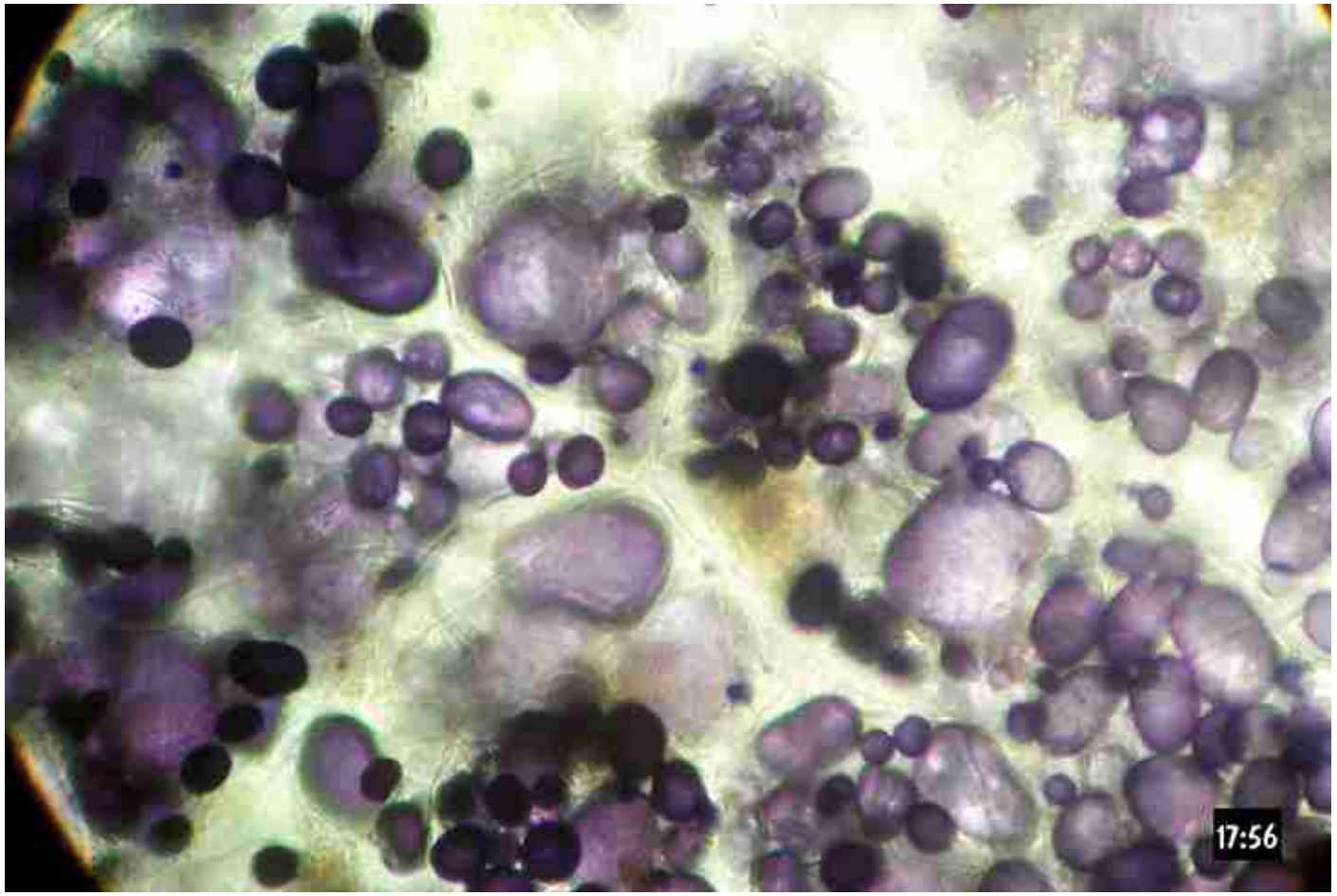
or

$$D_3(W) \backslash d_0(o)$$

In the same way

Potato = (S1/W)/S2 [$R < 10^{-6}$]

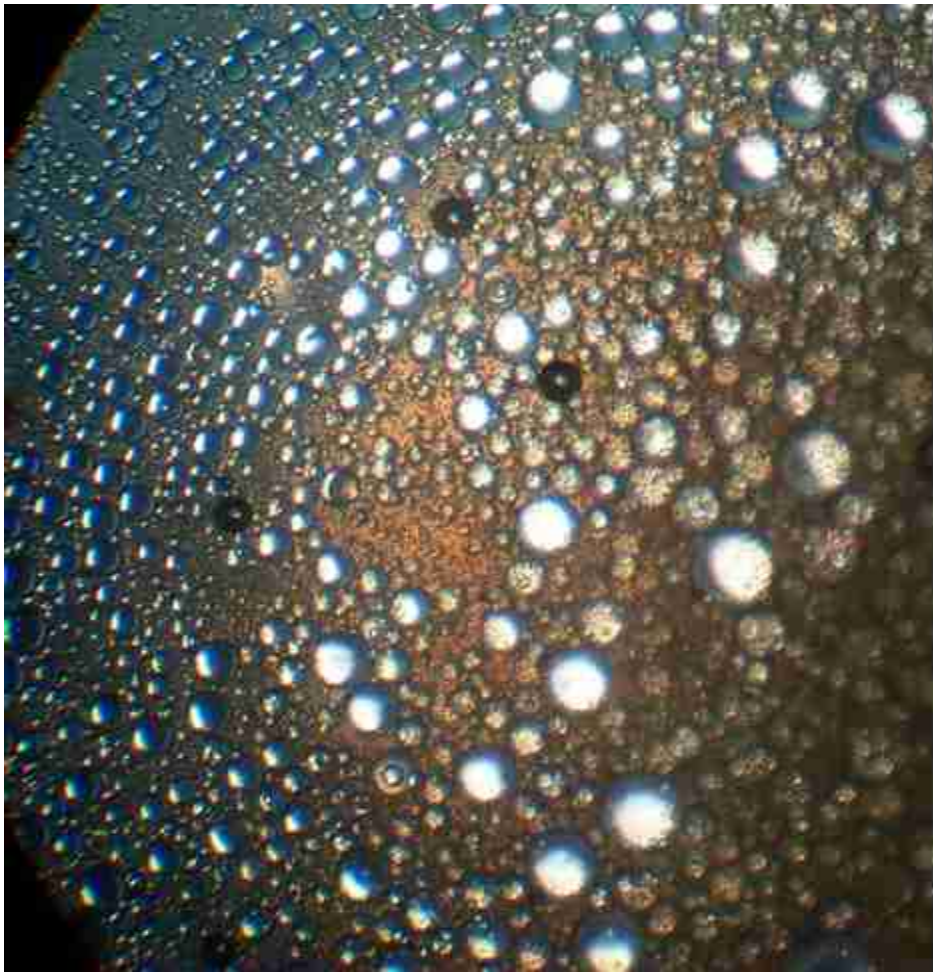
New proposal S1 \ (s_2 \ w)



From top to bottom

$D_2(L_1)\ \sigma\ D_3(S_1)\ \sigma\ D_3(S_2)\ \sigma\ D_2(L_2)\ \sigma\ D_2(L_3)$

$D_3(W) \setminus d_0(o)$

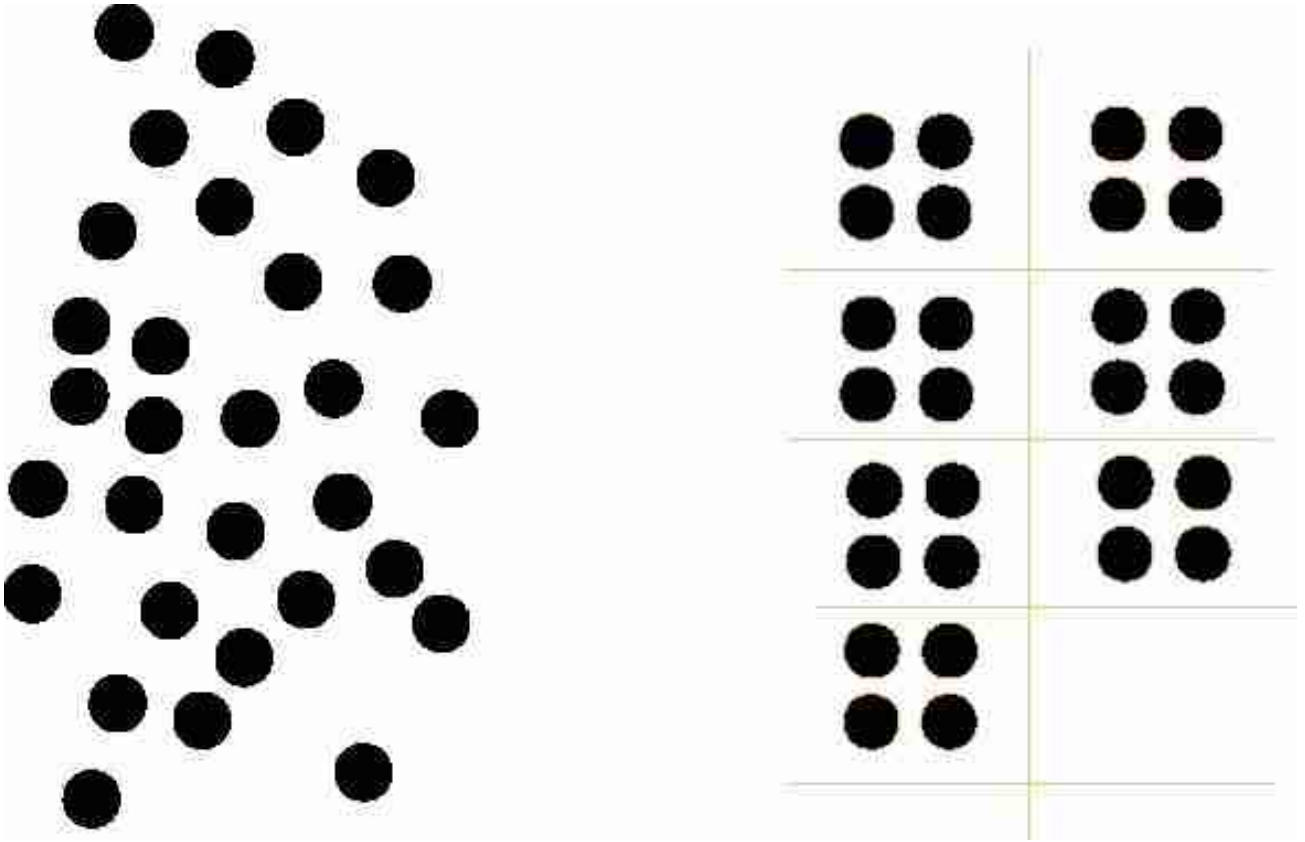


2.
How to rank systems ?

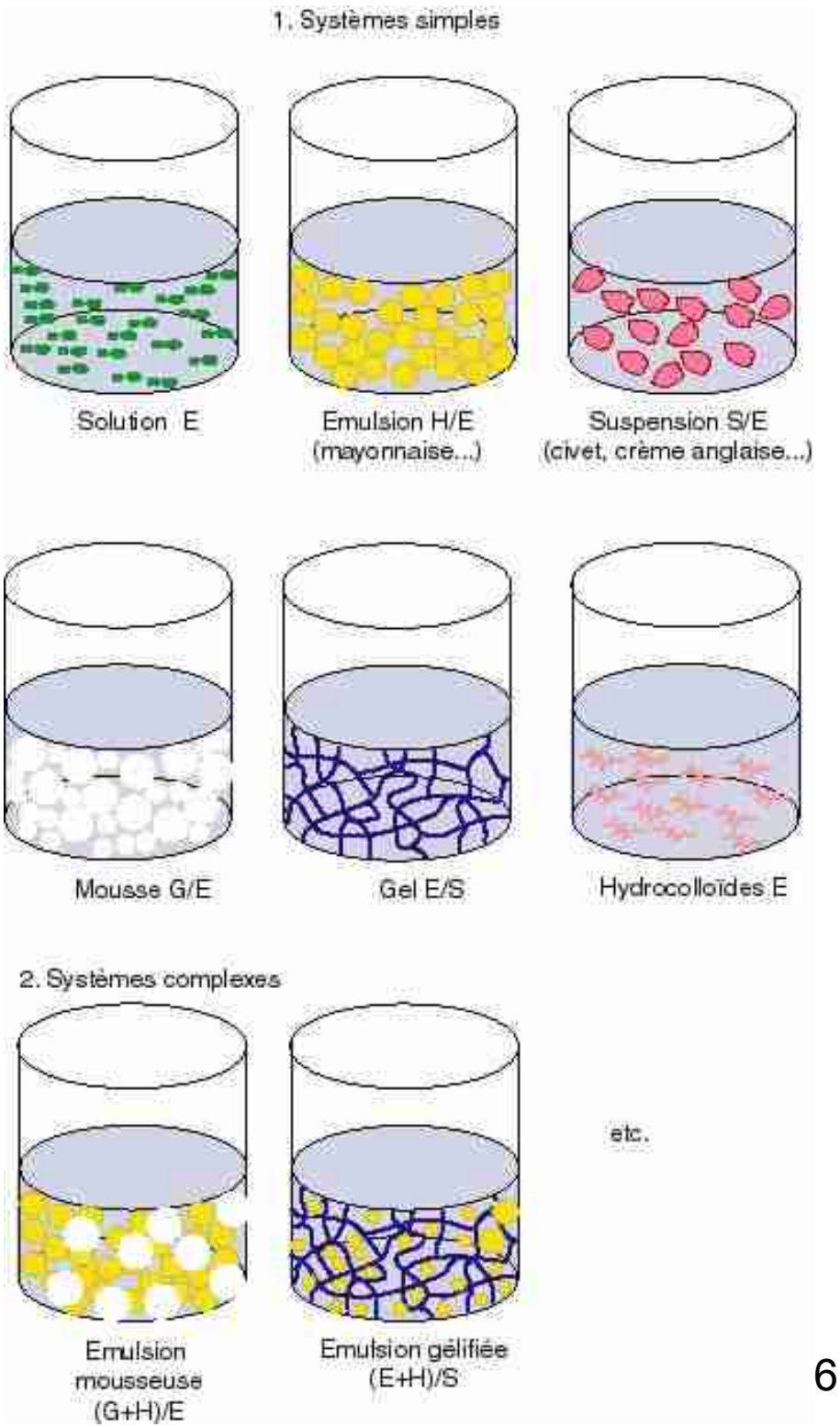
On the example of sauces: how avoiding being lost?

- Fonds brun, Fonds blanc, Fonds de volaille, Fonds de gibier, Fonds, ou fumet de poisson, Fonds de poisson au vin rouge, Essence de poisson, Essences diverses, Glaces diverses, Glace de viande, Glace de volaille, Glace de gibier, Glace de poisson, Roux brun, Roux blond, Roux blanc, Sauce espagnole, Sauce espagnole maigre, Sauce demi-glace, Jus de veau lié, Velouté, ou sauce blanche grasse, Velouté de volaille, Velouté de poisson, Sauce parisienne, Sauce suprème, Sauce béchamel, Petites sauces brunes composées, Sauce bigarade, Sauce bordelaise, Sauce bourguignonne, Sauce bretonne, Sauce aux cerises, Sauce aux champignons, Sauce charcutière, Sauce chasseur, Sauce chaud-froid brune, Sauce chaud-froid pour canards, Sauce chaud-froid pour gibier, Sauche chaud-froid tomatée, Sauce chevreuil, Sauce Colbert, Sauce diable, Sauce Diane, Sauce duxelles, Sauce estragon, Sauce financière, Sauce aux fines herbes, Sauce genevoise, Sauce Godart,Sauce grand-veneur, Sauce gratin, Sauce hachée, Sauce hachée maigre, Sauce hussarde, Sauce italienne, Jus lié à l'estragon, Jus lié tomaté, Sauce lyonnaise, Sauce Madère, Sauce matelote, Sauce moelle, Sauce moscovite, Sauce Périgueux, Sauce périgourdine, Sauce piquante, Sauce poivrade ordinaire, Sauce poivrade pour gibier, Sauce au Porto, Sauce portugaise, Sauce provençale, Sauce régence, Sauce Robert, Sauce romaine, Sauce rouennaise, Sauce salmis, Sauce tortue, Sauce venaison, Sauce au vin rouge, Sauce zingara, Petites sauces blanches, composées et de réductions, Sauce Albuféra, Sauce américaine, Sauce anchois, Sauce Aurore, Sauce Aurore maigre, Sauce bavaroise, Sauce béarnaise, Sauce béarnaise tomatée, dite sauche Choron, Sauce béarnaise à la glace de viande, dite Sauce Foyot ou Sauce Valois, Sauce Bercy, Sauce au beurre, dite Sauce bâtarde, Sauce Bonnefoy, ou Sauce bordelaise au vin blanc, Sauce bretnne,Sauce canotière, Sauce aux câpres, Sauce cardinal, Sauce aux champignons, Sauce Chantilly, Sauce Chateaubriand, Sauce chaud-froid blanche ordinaire, Sauce chaud-froid blonde, Sauce chaud-froid Aurore, Sauce chaud-froid au vert-pré, Sauce chaud-froid maigre, Sauce Chivry, Sauce à la crème, Sauce aux crevettes, Sauce currie, Sauce currie à l'Indienne, Sauce diplomate,Sauce écossaise, Sauce estragon, Sauce aux fines herbes, Sauce groseilles,Sauce hollandaise, Sauce homard, Sauce hongroise,Sauce aux huîtres, Sauce indienne, Sauce ivoire, Sauce Joinville, Sauce Laguipierre, Sauce livonienne, Sauce maltaise, Sause marinière,Sauce matelote blanche, Sauce Mornay, Sauce mousseline, dite Sauce Chantilly, Sauce mousseuse, Sauce moutarde, Sauce Nantua, Sauce New-burg avec le homard cru, Sauce New-burg avec le homard cuit, Sauce noisette, Sauce normande, Sauce orientale, Sauce paloise, Sauce poulette, Sauce ravigote, Sauce régence pour poissons et garnitures de poissons, Sauce régence pour garnitures de volailles, Sauce riche, Sauce Rubens, Sauce Saint-Malo, Sauce smitane, Sauce Solférino, Sauce Soubise, ou Coulis d'oignon Soubie, Sauce Soubise tomaté, Sauce Souchet, Sauce tyrolienne, Sauce tyrolienne à l'ancienne, Sauce Valois, Sauce vénitienne, Sauce Véron, Sauce villageoise, Sauce Villeroy, Sauce Villeroy soubisée, Sauce Villeroy tomatée, Sauce vin blanc, Sauces anglaises chaudes, Sauce aux airelles, Sauce Albert, Sauce aux aromates, Sauces au beurre à l'anglaise, Sauce aux câpres, Sauce au céleri, Sauce au chevreuil, Sauce crème à l'anglaiise, , Sauce crevettes à l'anglaise, Sauce diable, Sauce écossaise, Sauce au fenouil, Sauce aux groseilles, Sauce homard à l'anglaise, Sauce aux huîtres, Sauce brune aux huîtres, Sauce aux oeufs à l'anglaise, Sauce aux oeufs au beurre fondu, Sauce aux oignons, Sauce au pain, Sauce au pain frit, Sauce persil, Sauce persil pour poissons, Sauce aux pommes, Sauce au Porto, Sauce au raifort chaude, Sauce Réforme, Sauce sauge et oignons, Sauce Yorkshire, Sauces froides, Sauce aïoli, ou Beurre de Provence, Sauce andalouse, Sauce bohémienne, Sauce Chantilly, Sauce génoise, Sauce gribiche;, Sauc groseille au raifort, Sauce italienne, Sauce mayonnaiqe, Sauce mayonnaise collée, Sauce mayonnaise fouettée, à la Russe, Sauces mayonnaises diverses, Sauce mousquetaire, Sauce moutarde à la crème, Sauce raifort aux noix, Sauce ravigote, ou Vinaigrette, Sauce rémoulade, Sauce russe, Sauce tartare, Sauce verte, Sauce Vincent, Sauce suédoise, Sauces froides anglaises, Sauce Cambridge, Sauce Cumberland, Sauce Gloucester, Sauce menthe, Sauce Oxford, Sauce raifort

Looking for structures



The simplest sauces



The corpus studied at macro + microscopic levels (old formalism)

Name	Minimum culinary recipe	Derived from	Formula	Reduced formula	Compulsory indredients	Possibilities	Excluded ingredients
africaine	(3) oignons, tomates, poivron, ail, bouquet garni, basilic, paprika, cuire qques min, vin blanc, réduction fond de veau lié, cuire 15 min, brunoise de zestes de citronfond de veau lié	fond de veau lié	(S1 + S2 + S3 + S4 + S5+ (E/S)) / E	(S + (E / S)) / E			
aïoli	(1) ail broyé avec huile, pomme de terre, lait, jaunes d'œufs (2) (3) ail, jaune d'œuf, huile d'olive, jus de citron, sel, poivre	Aïoli aïoli	H / E H/ E	H / E H / E	Ail, huile, sel, poivre	jaunes d'œuf (1, 3), pomme de terre (1), lait (1), jus de citron (3)	
Etc.							

23 categories (why?) more or less arbitrarily ranked (old formalism)

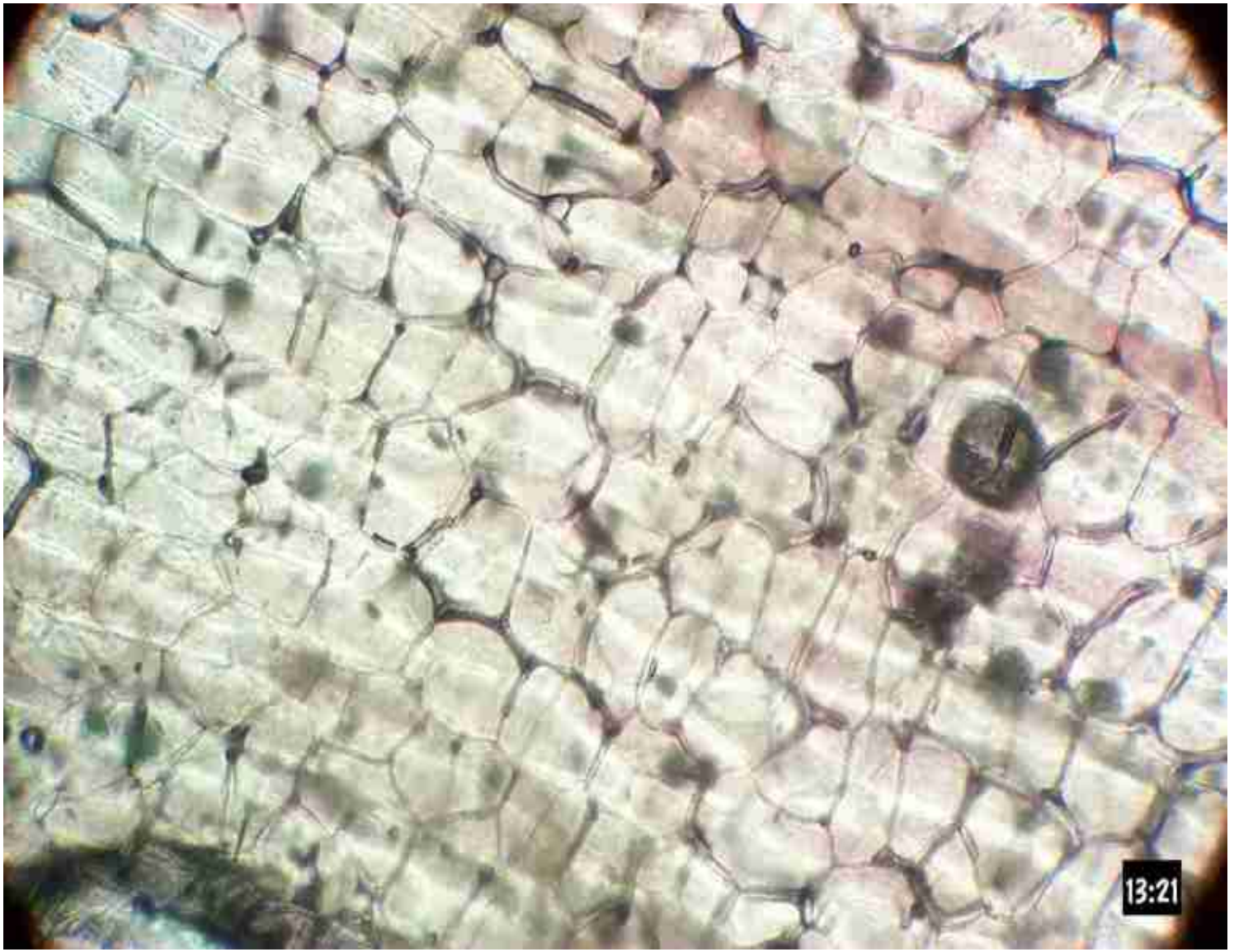
- **Possible Categories :**
- W
- O
- O/W
- W/O
- S/W
- (W/S) /W
- (G + O) / W
- (O + S) / W
- (O + (W/S)) / W
- (S + (W/S)) / W
- (O + ((G+O)/W)) / W
- (G + O + S) / W
- (O + S + (W/S)) / W
- (O + S + (G/W)) / W
- (O + S + ((G + O) / W)) /W
- …

- **I do not see in the list :**
- (G + (W/S))/W…

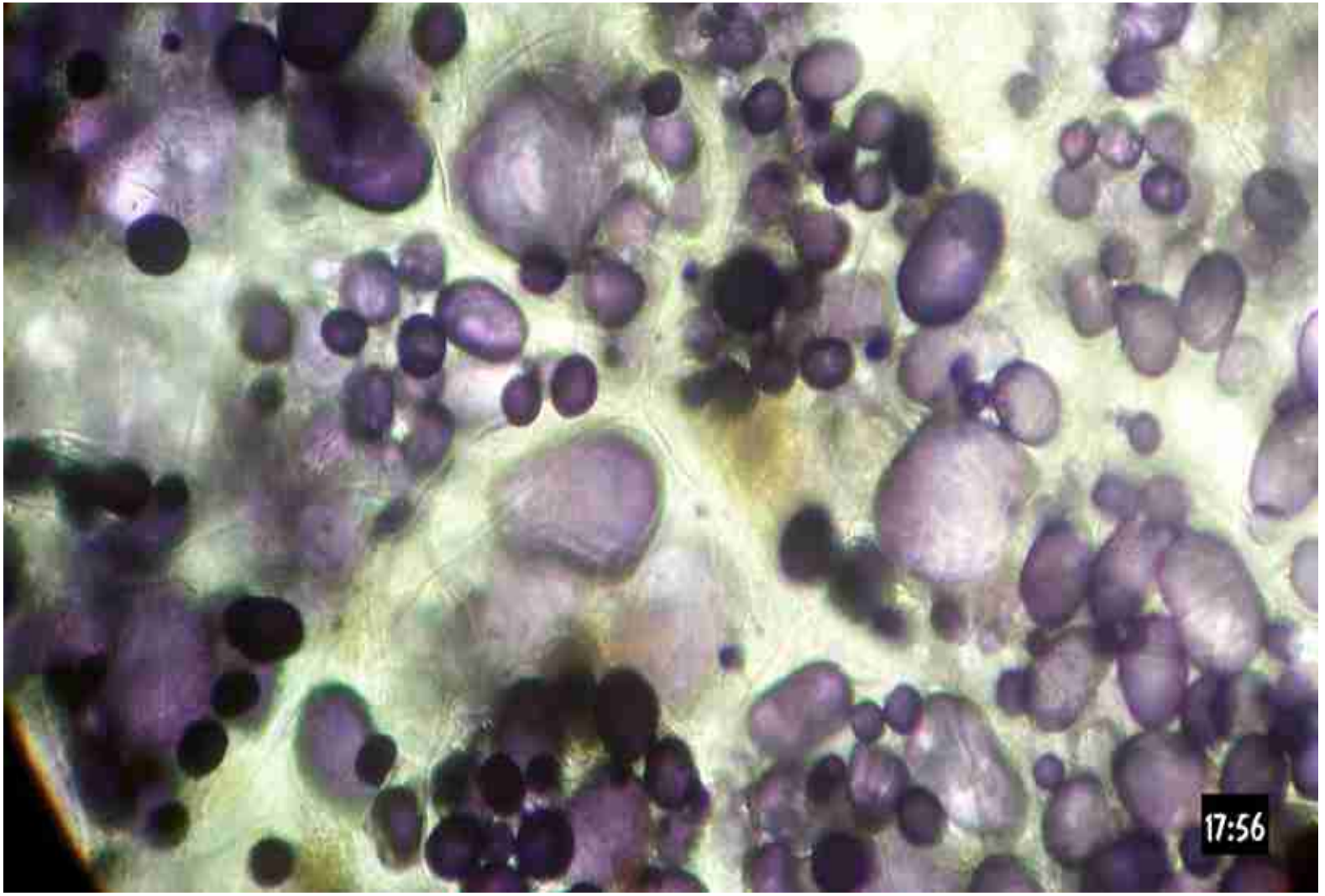
H. This, 14 types de sauces, Pour la Science, Fev. 2004, 6.

3.
Formerly, for gels

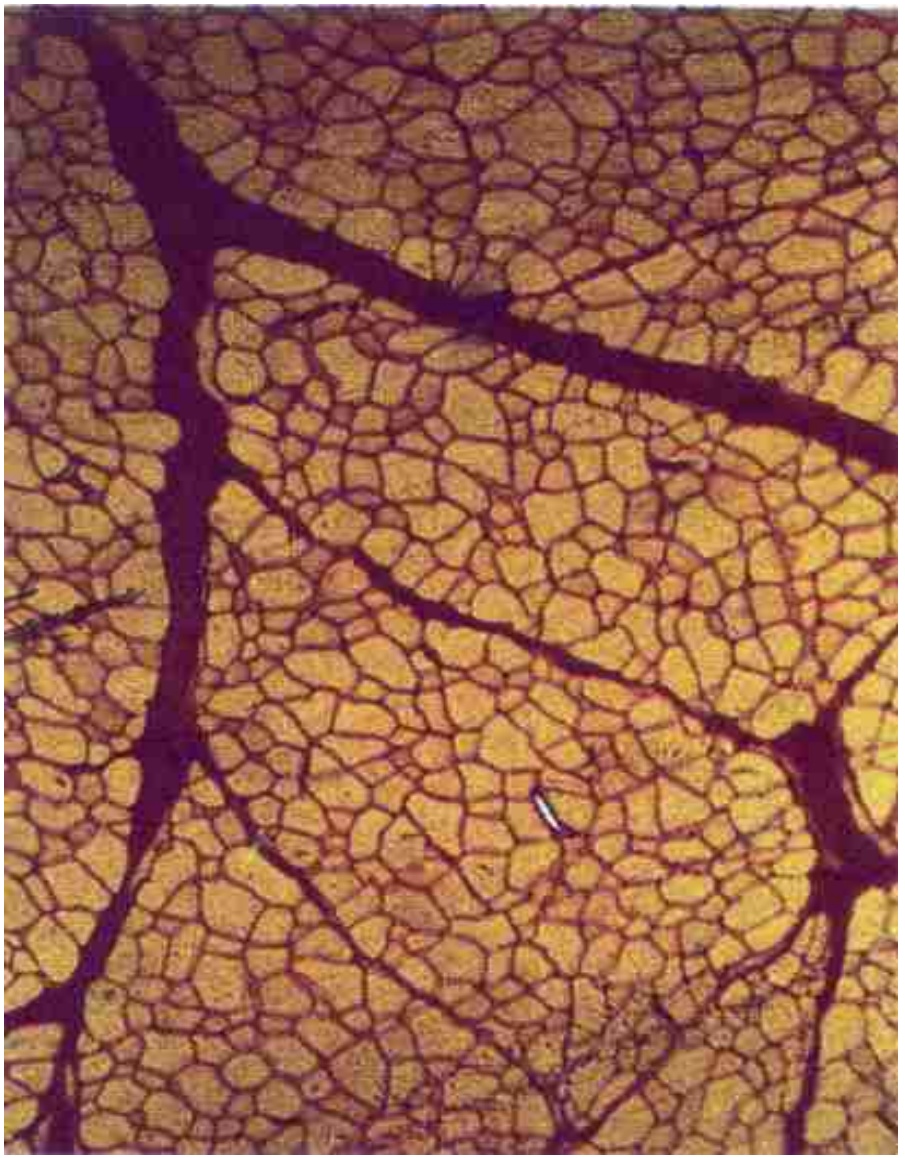
Plant tissues are formally gels



Even when cells contain starch granules

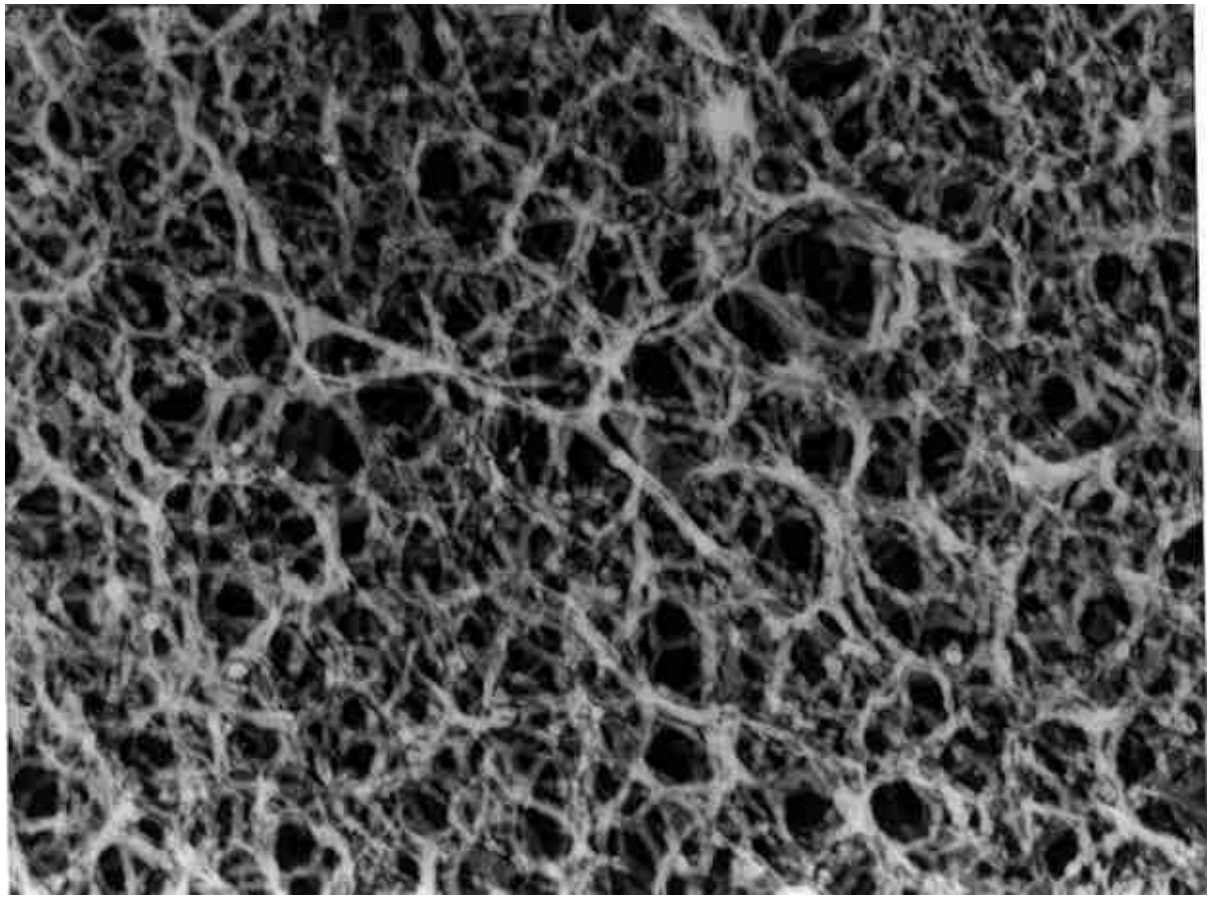


Gels with fibres



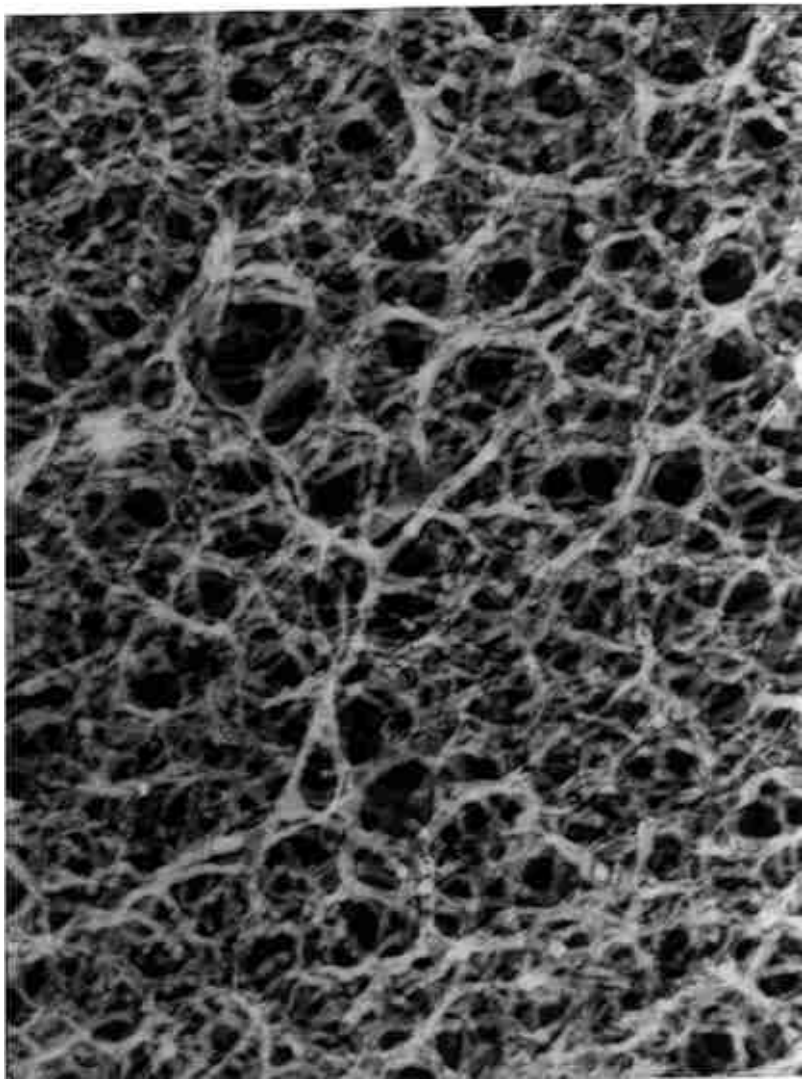
Cliché J. Lacour, INRA Theix

Connected gels

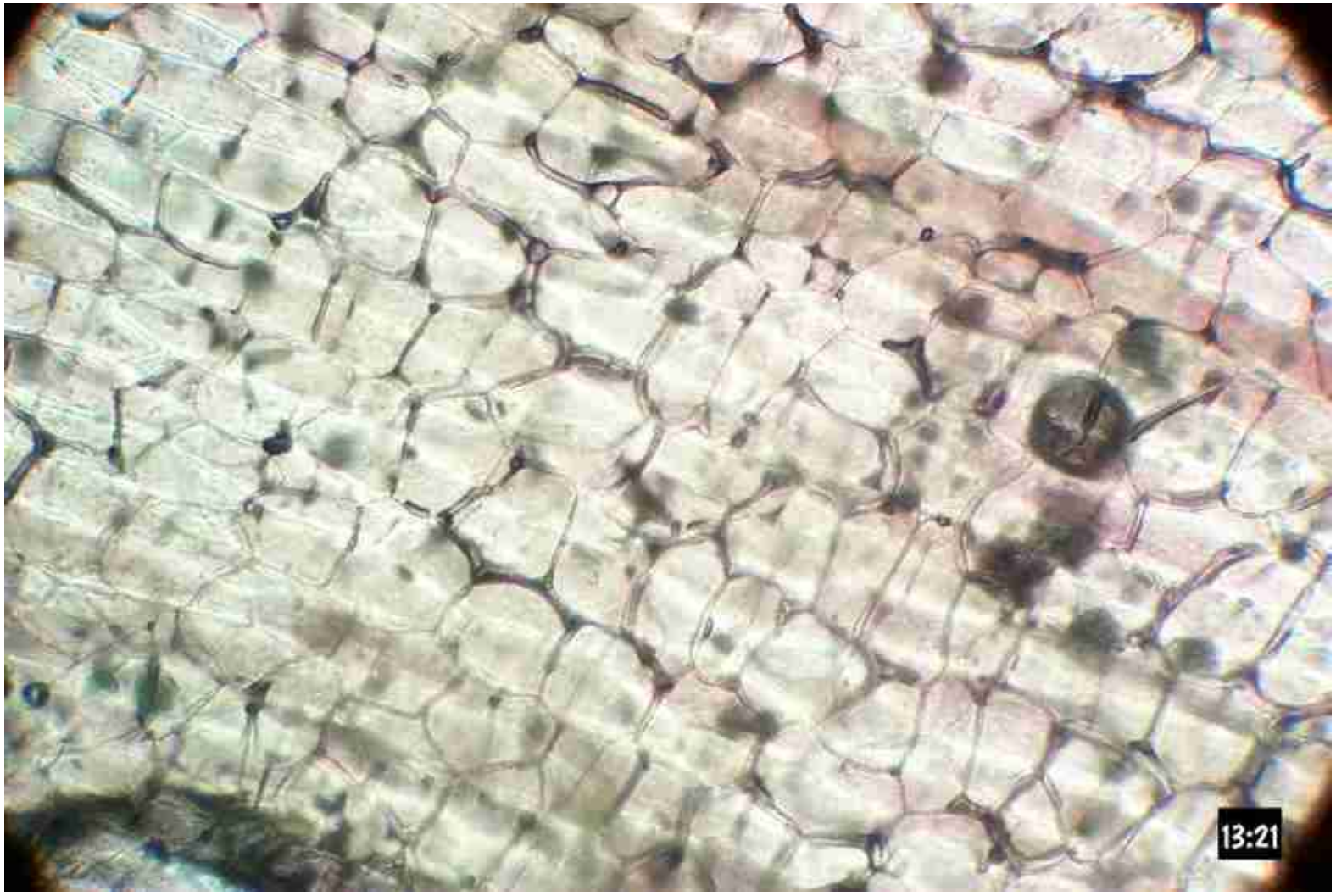


In ‘’connected gels’’, diffusion is possible

How to distinguish gels ?

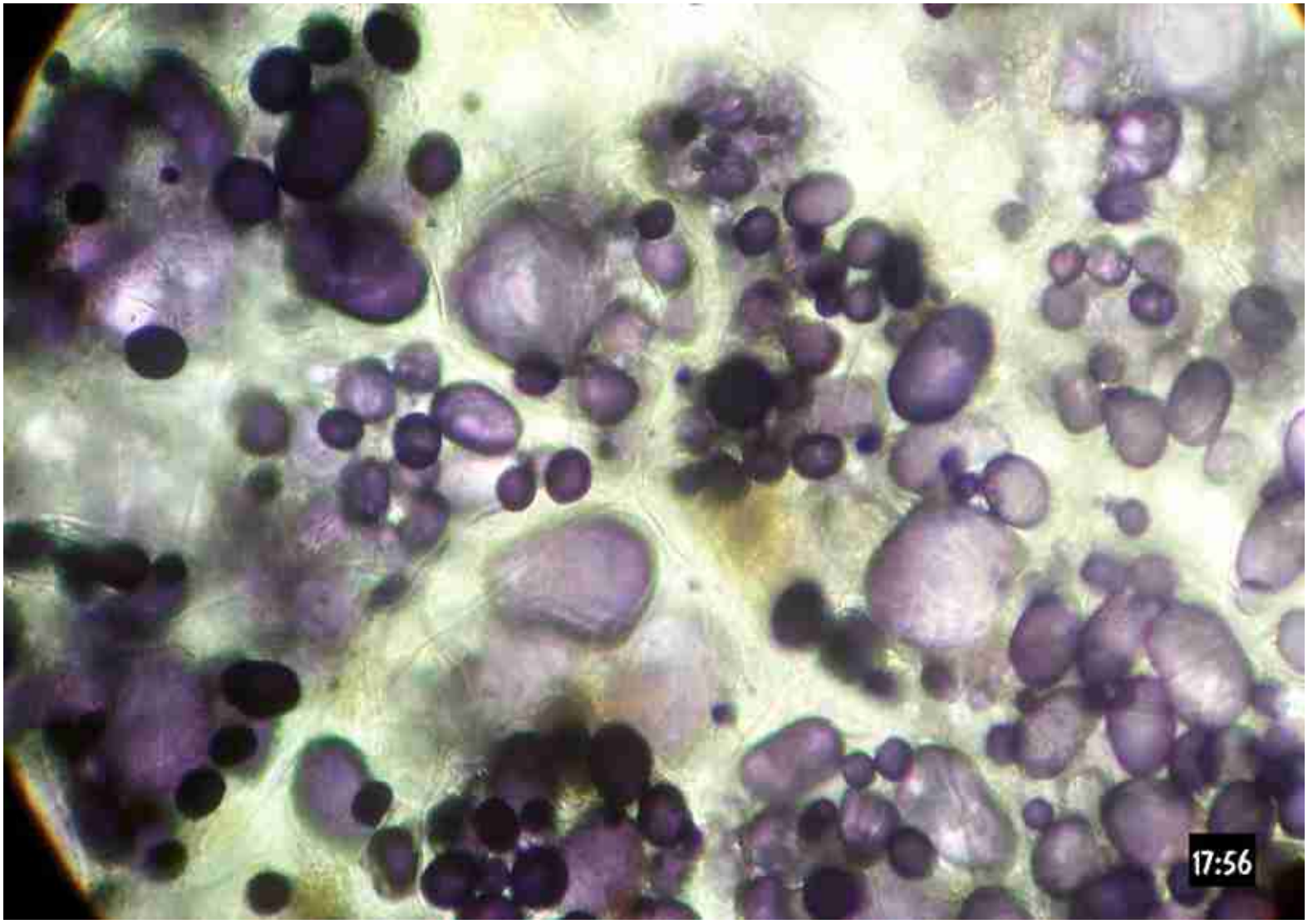


For this one :
$D_3(S) \setminus d_0(w)$



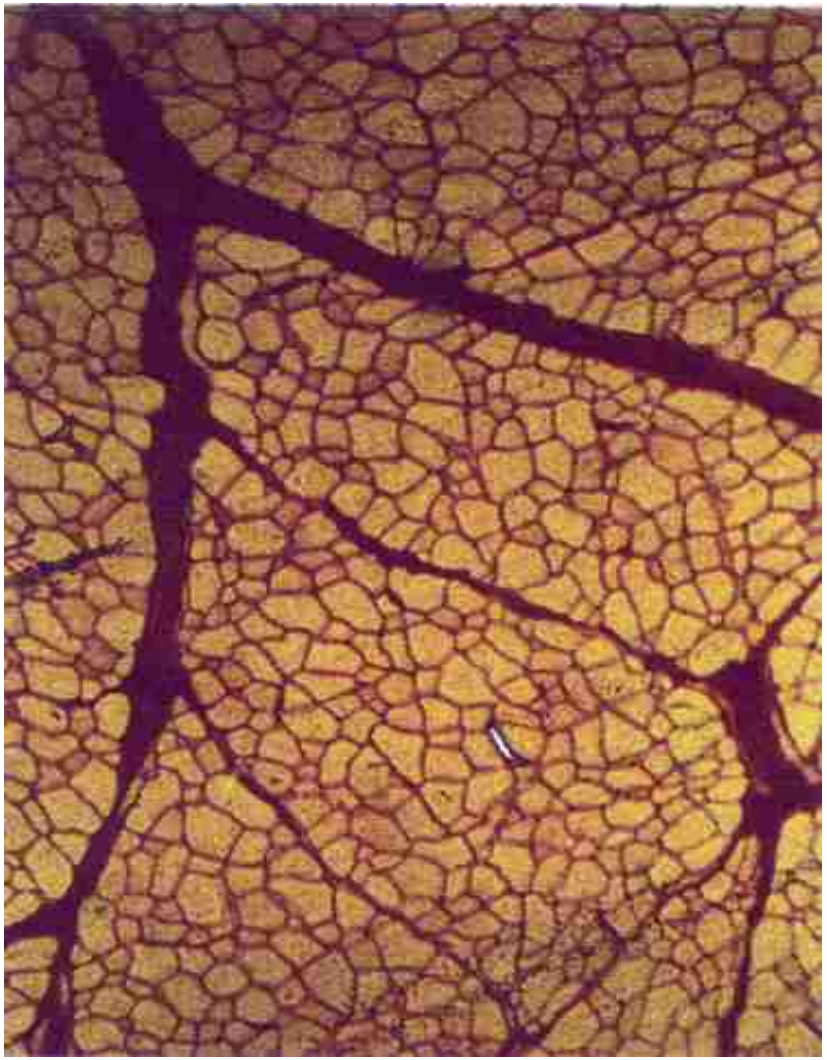
For this one also
$D_3(S) \setminus d_0(w)$

Sometimes, complex gels:
$D_3(S_1) \setminus [d_0(W) \setminus d_0(S_2)]$



For meat

$D_3(S) \setminus d_1(w)$



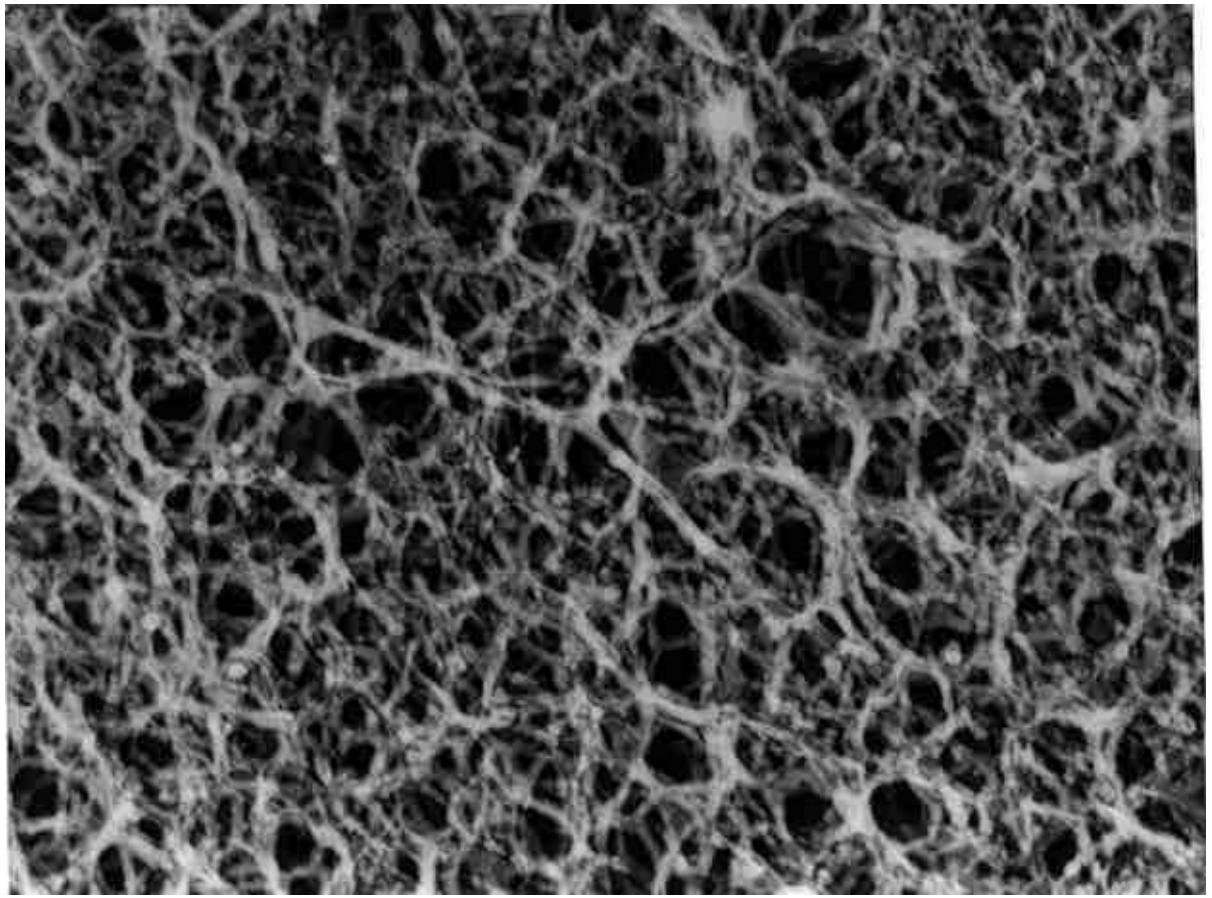
Cliché J. Lacour, INRA Theix

Fibrés, artificial meats :
$D_3(S_1) \setminus [\, d_1(s_2) \,@\, d_1(w) \,]$

Sometimes, the gels were not recognized as such

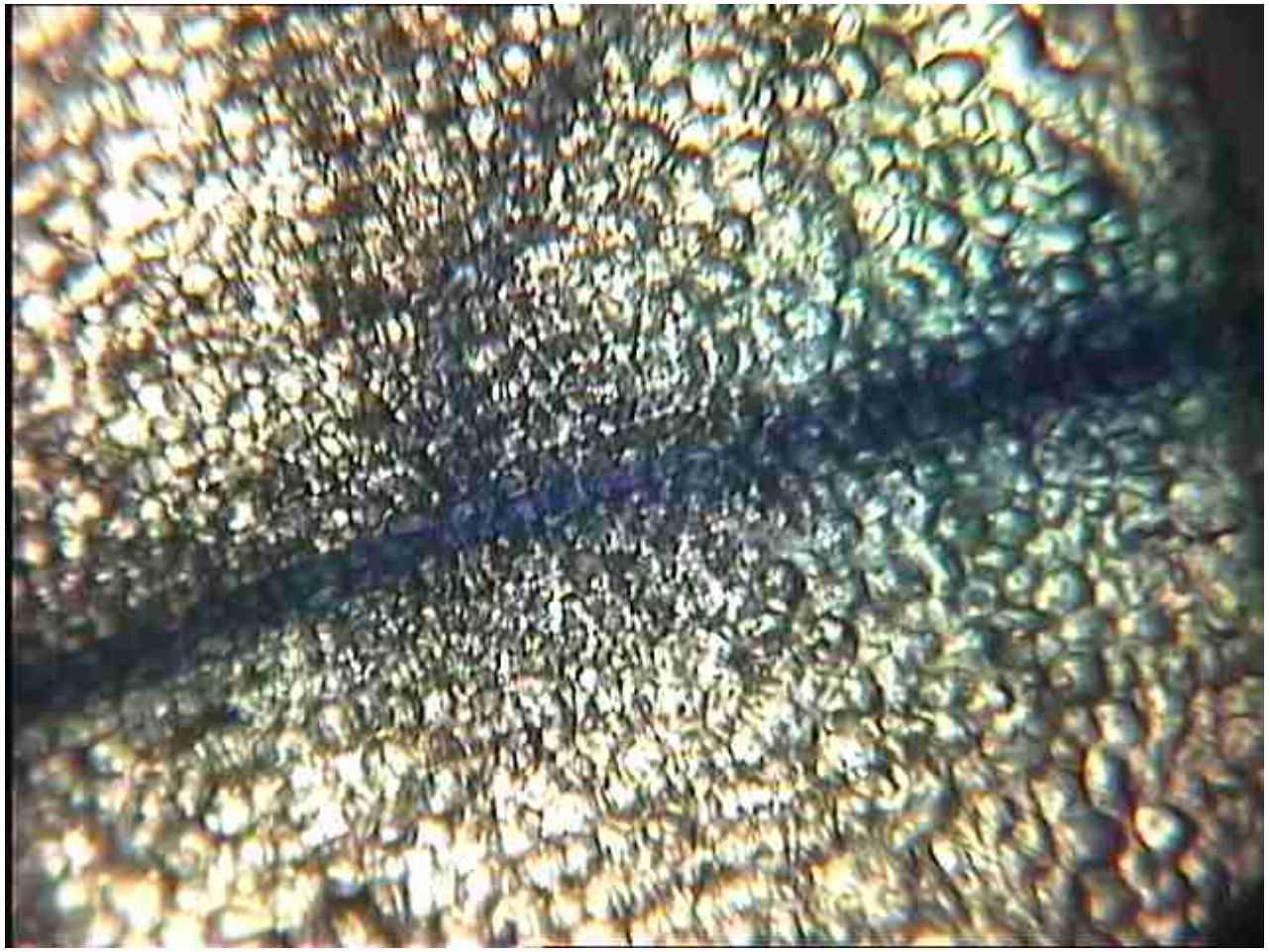
$D_3(O) \times D_3(S)$

For gelatine gels
$D_3(S) \times D_3(W)$



Complex gels are an invitation to do more:

$D_3(S) \setminus [d_0(w)+d_1(w)]$



How many gels ?
For ‘’class 1’’ (old writing)

```
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;
```

16, and 16 exactly (old writing)

D0(O)/D3(S)

D0(W)/D3(S)

D1(O)/D3(S)

D1(W)/D3(S)

D2(O)/D3(S)

D2(W)/D3(S)

D1(O)xD3(S)

D1(W)xD3(S)

D2(O)xD3(S)

D2(W)xD3(S)

D3(O)xD3(S)

D3(W)xD3(S)

D1(O)@D3(S)

D1(W)@D3(S)

D2(O)@D3(S)

D2(W)@D3(S)

For gels of class 2 (two phases), now (old writing)

```
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;
```

Slightly less than 1500 new systems! (old writing)

And here… (old writing)

And again here… (old writing)

And finally here (old writing)

4.
Formerly, for suspensions

What they are

https://doi.org/10.1351/goldbook.C01177

Suspension : A liquid in which solid particles are dispersed.

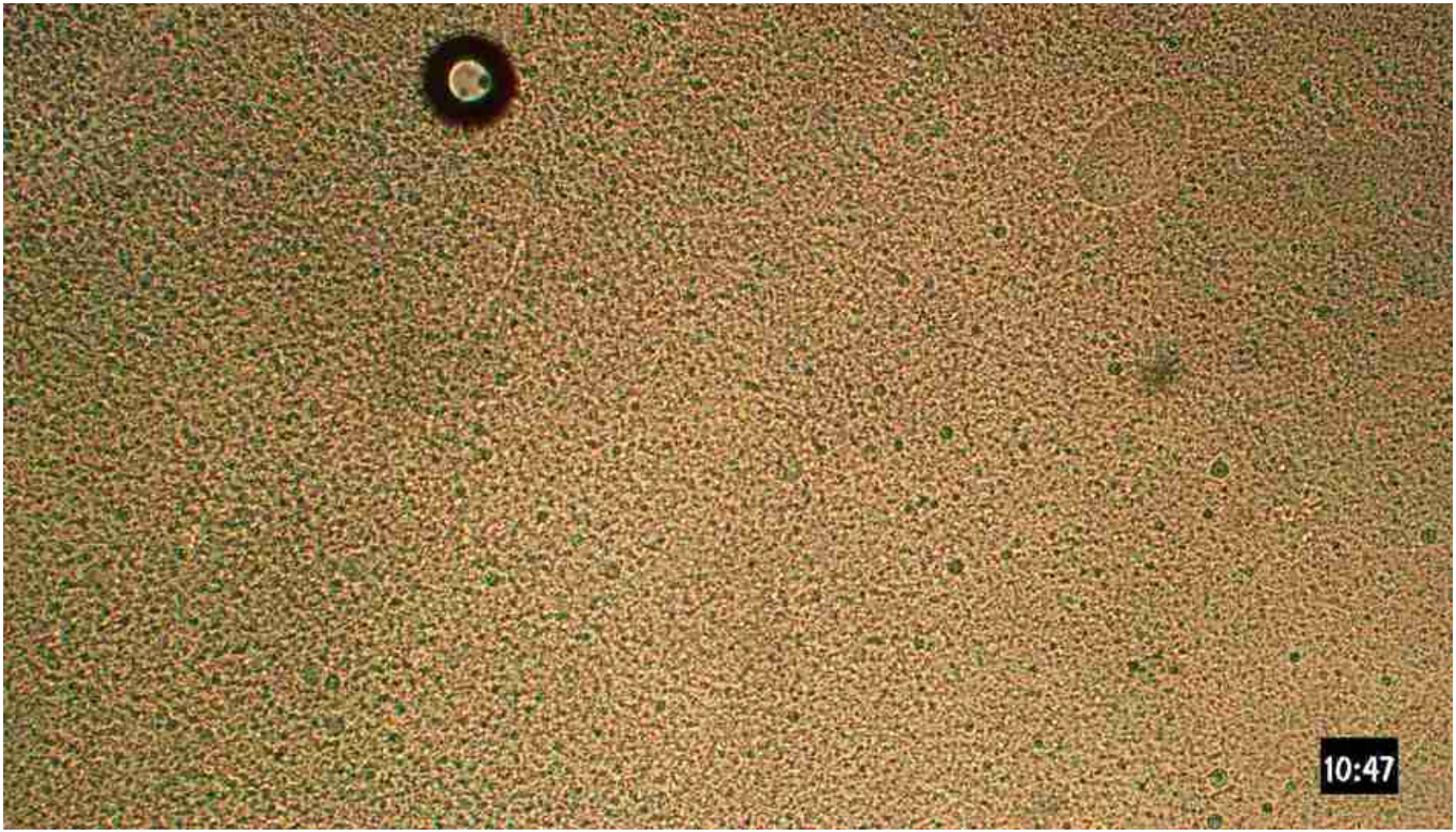
Colloidal suspension: A suspension in which the size of the particles lies in the colloidal range.

Source:

PAC, 1972, 31, 577. (Manual of Symbols and Terminology for Physicochemical Quantities and Units, Appendix II: Definitions, Terminology and Symbols in Colloid and Surface Chemistry) on page 606

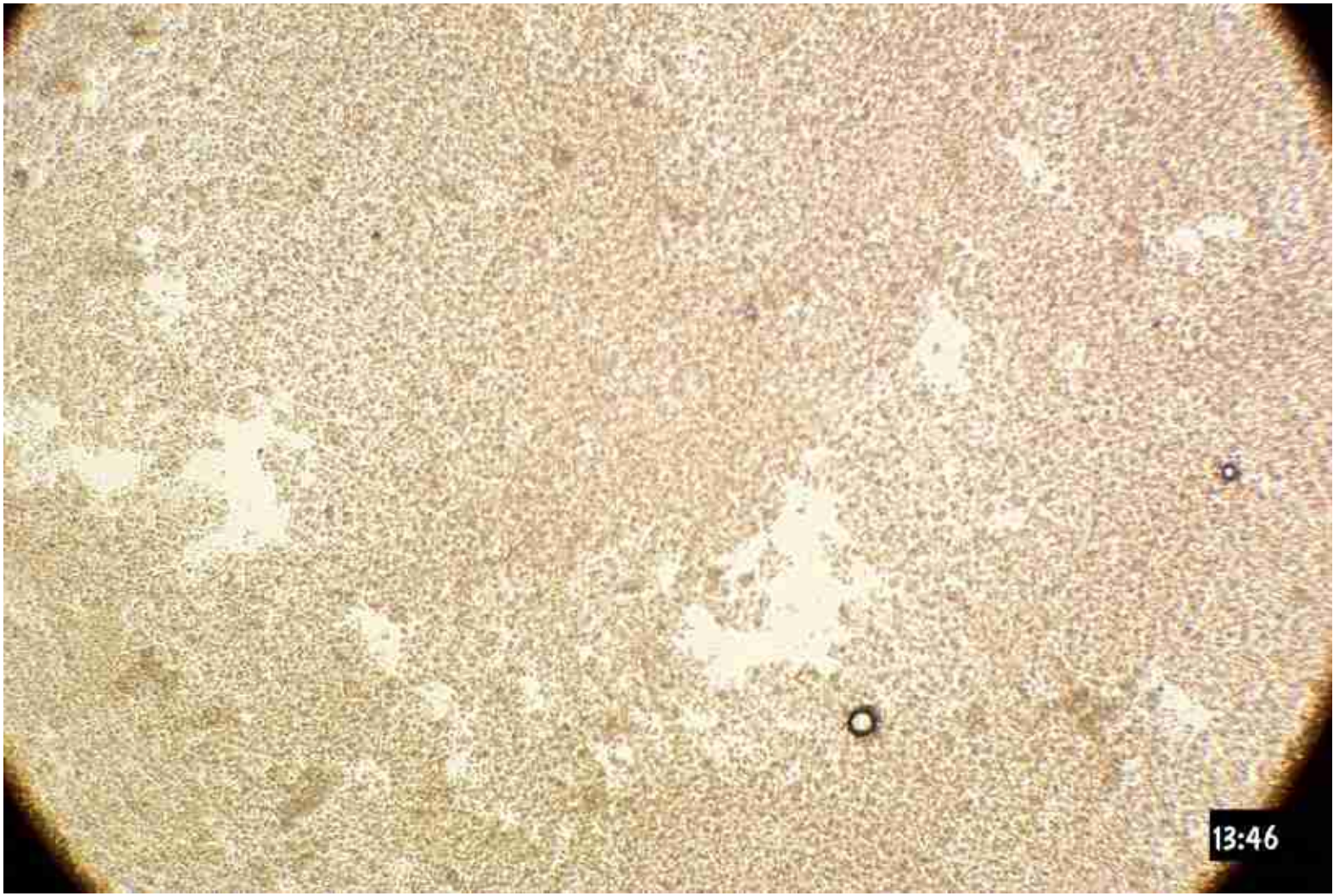
Cite as: IUPAC. Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"). Compiled by A. D. McNaught and A. Wilkinson. Blackwell Scientific Publications, Oxford (1997). Online version (2019-) created by S. J. Chalk. ISBN 0-9678550-9-8. https://doi.org/10.1351/goldbook.

Egg yolks : dispersion of granules in a plasma



Adding sugar (still a suspension)

And when you cook, proteins coagulate



Suspensions Class 1 (old writing)

```
A := [];
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 2 do
formule := cat(graine, dimension[dim1], "(", phase[phas1], ")", operateur[ope], dimension[4], "(", phase[1], ")"); A :=
    [op(A), formule];
end do;
end do;
end do;
formule;
writedata("suspensions_classe_1_ds_W_brut", A, string);
```

Here they are (old writing)

D0(W)XD3(W)	D0(W)/D3(W)
D0(O)XD3(W)	D0(O)/D3(W)
D0(S)XD3(W)	D0(S)/D3(W)
D1(W)XD3(W)	D1(W)/D3(W)
D1(O)XD3(W)	D1(O)/D3(W)
D1(S)XD3(W)	D1(S)/D3(W)
D2(W)XD3(W)	D2(W)/D3(W)
D2(O)XD3(W)	D2(O)/D3(W)
D2(S)XD3(W)	D2(S)/D3(W)
D3(W)XD3(W)	D3(W)/D3(W)
D3(O)XD3(W)	D3(O)/D3(W)
D3(S)XD3(W)	D3(S)/D3(W)

Suspensions Class 2

```
A := [];
dimension := [D0, D1, D2, D3];
phase := [W, O, S];
operateur := ["X", "/", "@", "&sigma;", "+"];
formule := "";
graine := "";
for dim1 to 4 do
for phas1 to 3 do
for ope1 to 5 do
for dim2 to 4 do
for phas2 to 3 do
for ope2 to 2 do
if ope1 <> operateur[2] then formule := cat(graine, "[", dimension[dim1], "(", phase[phas1], ")", operateur[ope1], dimension[dim2], "(", phase[phas2], ")", "]", operateur[ope2], "D3(S)"); A := [op(A), formule];
end if;
end do;
end do;
end do;
end do;
end do;
end do;
end do;
writedata("liste deux phases trois objets", A, string);
```

Class 2 : 158 systems (old writing)

[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)

[D0(G)σD0(S)]/D3(O)
[D0(G)σD0(S)]/D3(O)
[D0(G)σD0(S)]/D3(O)
[D0(G)σD0(S)]/D3(O)
[D0(G)σD1(S)]/D3(O)
[D0(G)σD1(S)]/D3(O)
[D0(G)σD1(S)]/D3(O)
[D0(G)σD1(S)]/D3(O)
[D0(G)σD2(S)]/D3(O)
[D0(G)σD2(S)]/D3(O)
[D0(G)σD2(S)]/D3(O)
[D0(G)σD2(S)]/D3(O)
[D0(G)+D0(S)]/D3(O)
[D0(G)+D0(S)]/D3(O)
[D0(G)+D0(S)]/D3(O)
[D0(G)+D0(S)]/D3(O)

[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D1(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(G)+D2(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD0(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)
[D0(O)XD1(S)]/D3(O)

5.
How to rank

The Kolmogorov complexity ?

Facts
to be taken into account

1. Systems with only 1 phase are simpler than with 2, etc.

2. The systems should be considered by decreasing orders of magnitude (1rst order before 2nd order, etc.).

3. About dimensions, there does not seem to be a particular order of complexity.

4. Quantities, as well, do not seem to be relevant.

5. Free enthalpy can guide the order for operators : σ, @, /, x.

A proposal

1 phase (dcp = 1)	A, with A = G, O, S, W
2 phases (dcp=2)	A op B, with A = G, O, S, W ; op= +, σ, @, /, x ; B = G, O, S, W : 2.1. σ 2.2. @ 2.3. / 2.4. x
3 phases (dcp = 3)	(A op B) op C or A op (B op C) 3.1. σσ, 3.2. σ@, 3.3. σ/, 3.4. σx 3.5. @σ, 3.6. @@, 3.7. @/, 3.8. @x 3.9. /σ, 3.10. /@, 3.11. //, 3.12. /x 3.13. xσ, 3.14. x@, 3.15. x/, 3.16. xx
etc	

Celebrate chemistry!