The University of Nottingham

Oil Body Emulsions

June 21st 2012

SCI London

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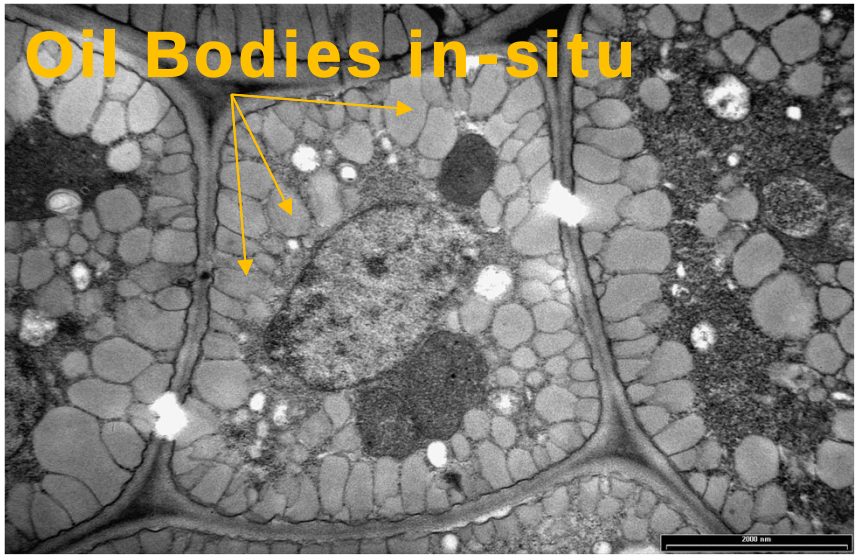
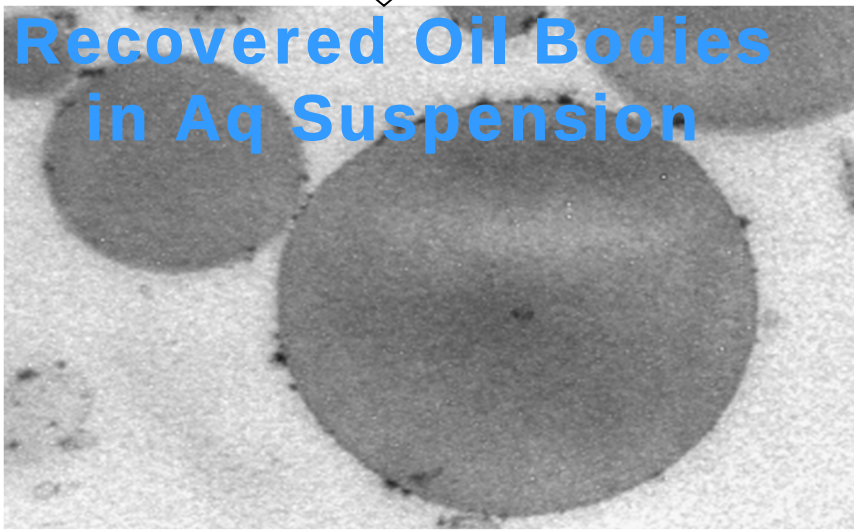
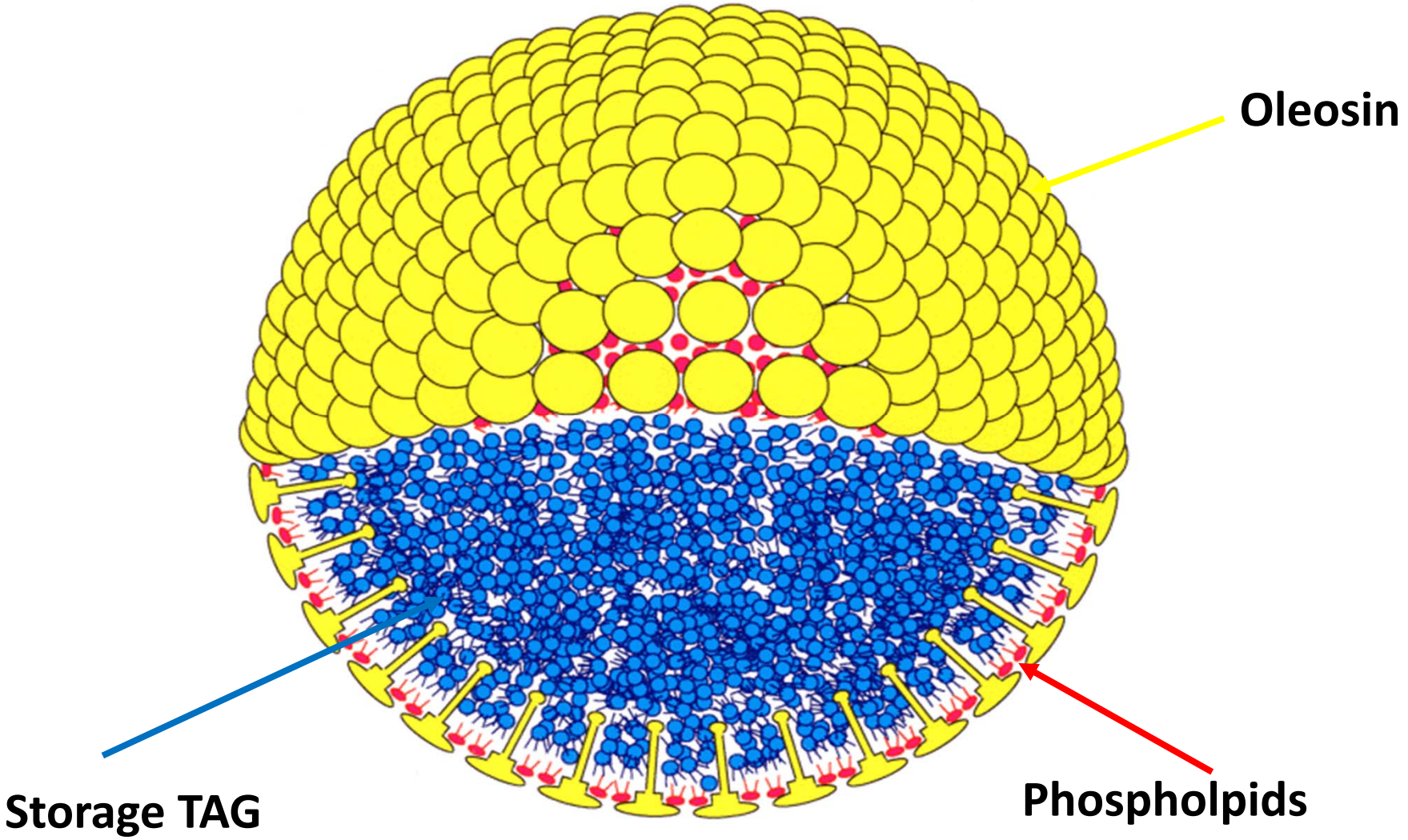
Oil Bodies

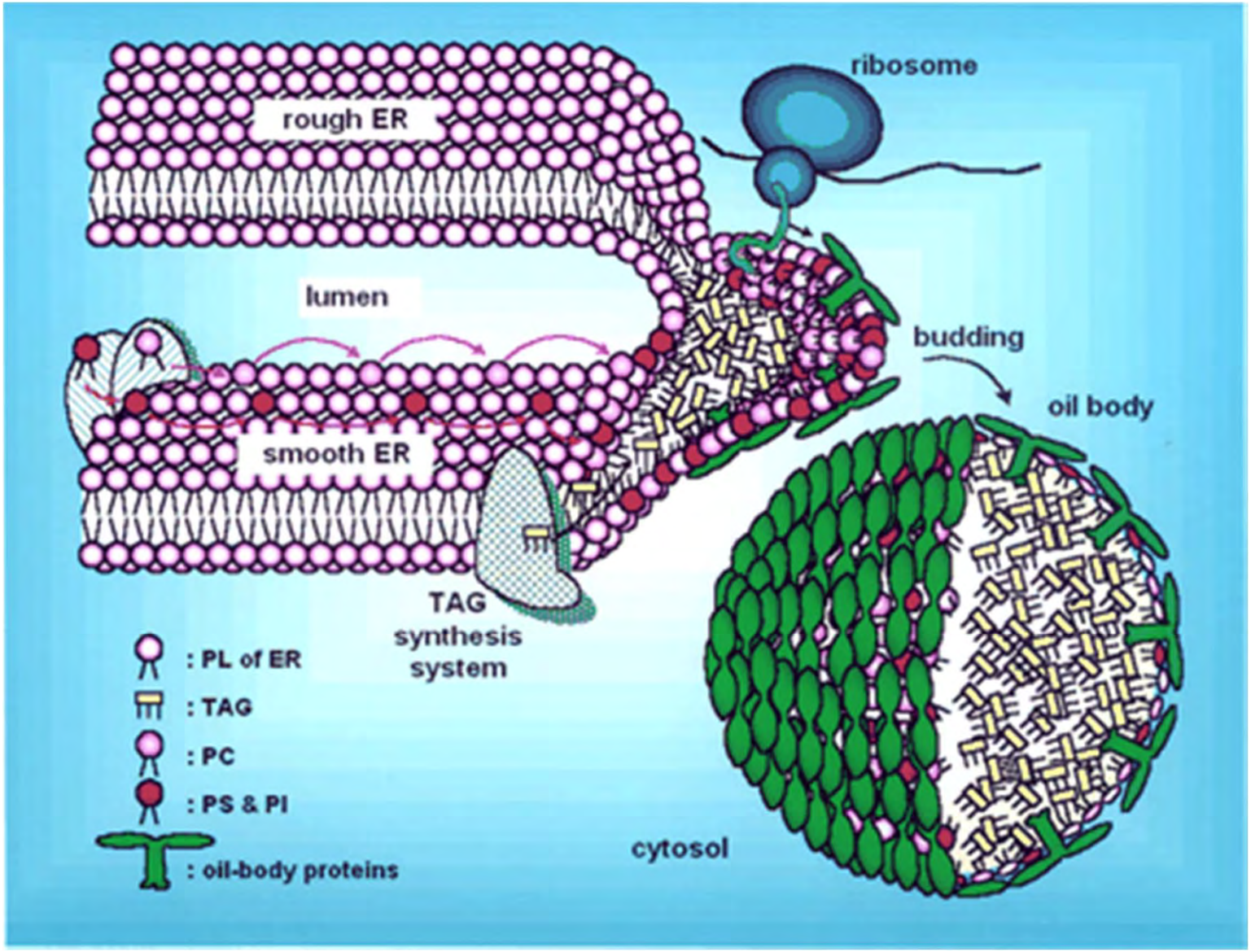




Schematic of the Structure of Oil Bodies



Intracellular Biosynthesis of Oil Bodies in a Developing Oilseed

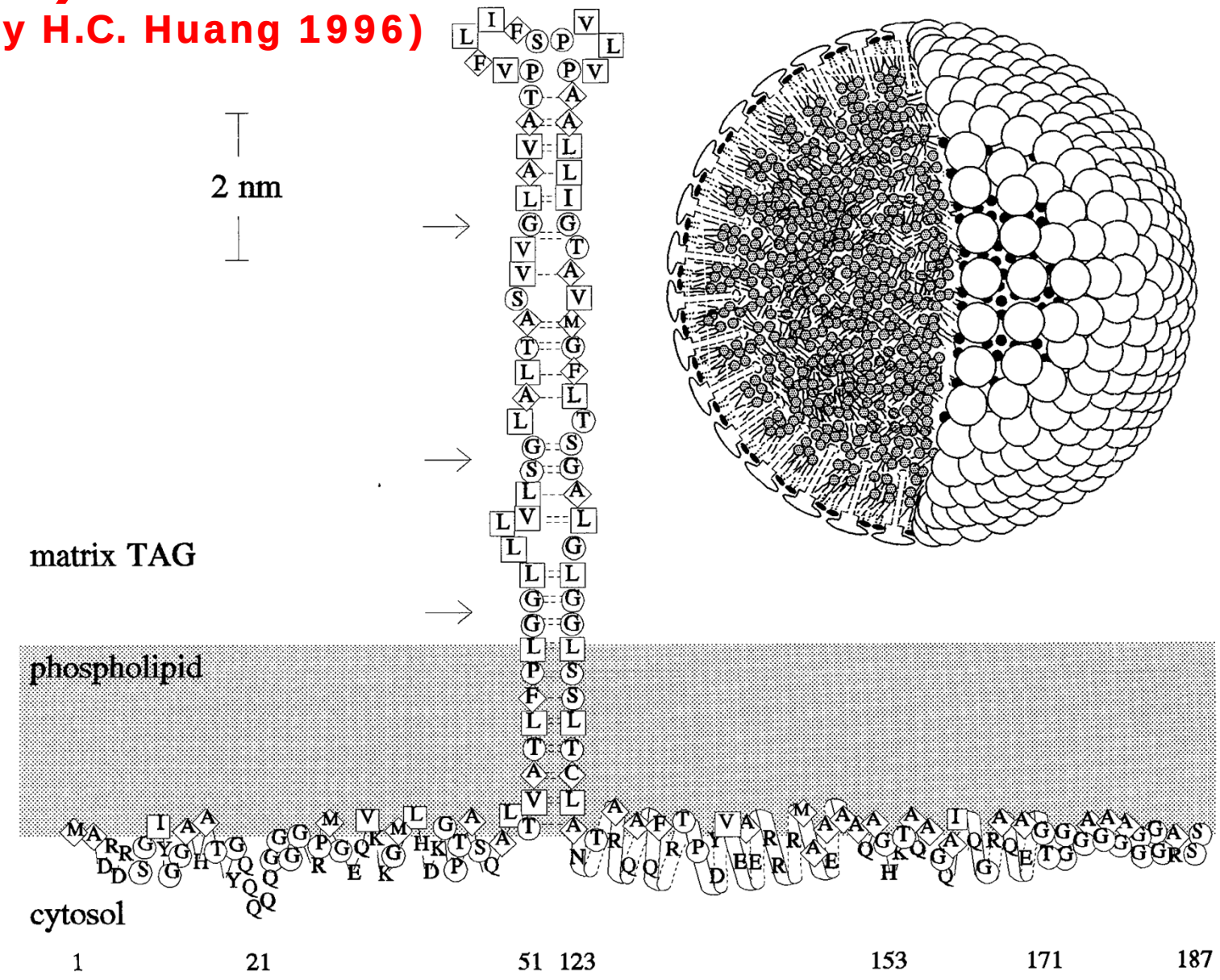


Oleosin

- An amphiphilic protein, of a range of isoforms between 16kDa and 22kDa.
- Oleosin has three functional zones.
  - Two hydrophilic tails
    - Cover the surface of the oil body
  - Hydrophobic core
    - Embedded within the oil bodies neutral lipid core
    - Anchors the protein to the oil body
- Protects the oil body from coalescence during desiccation

Amino Acid Sequence of Oleosin (Maize)

(Anthony H.C. Huang 1996)



Preparing Oil-Bodies

GRIND SEED AND SOAK IN AQ.

CENTRIFUGE

RE-SUSPEND BUOYANT FRACTION

Current Landscape of OB Research

ENZYMIC BREAKDOWN OF OBs

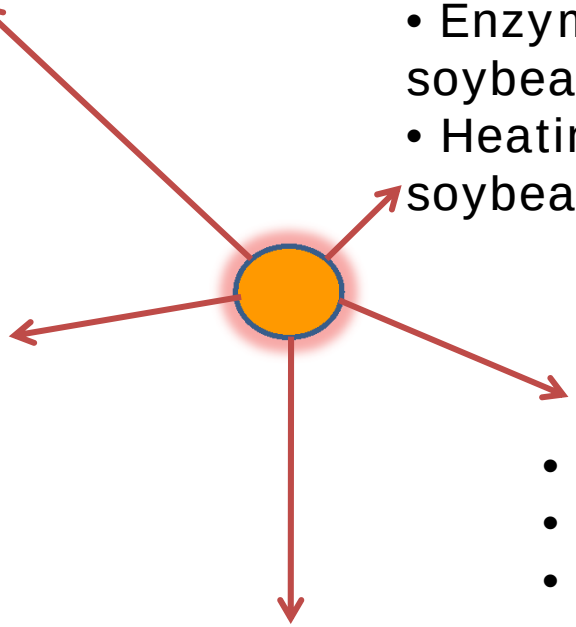
Germination

Digestion

- In-vitro model
- fMRI

PROCESSING

- Life Cycle Analysis
- Recovery of OBs from food-waste
- Enzymic recovery of maize and soybean OBs
- Heating to remove allergens in soybean OBs



ARCHITECTURE

- Interfacial properties of PLs and oleosins
- OB synthesis (impact of oleosins)
- Artificial OBs

APPLICATIONS

- Food/Nutrition
- Cosmetics
- Pharmacy
- Absorbants of HOCs

OB MODIFICATION

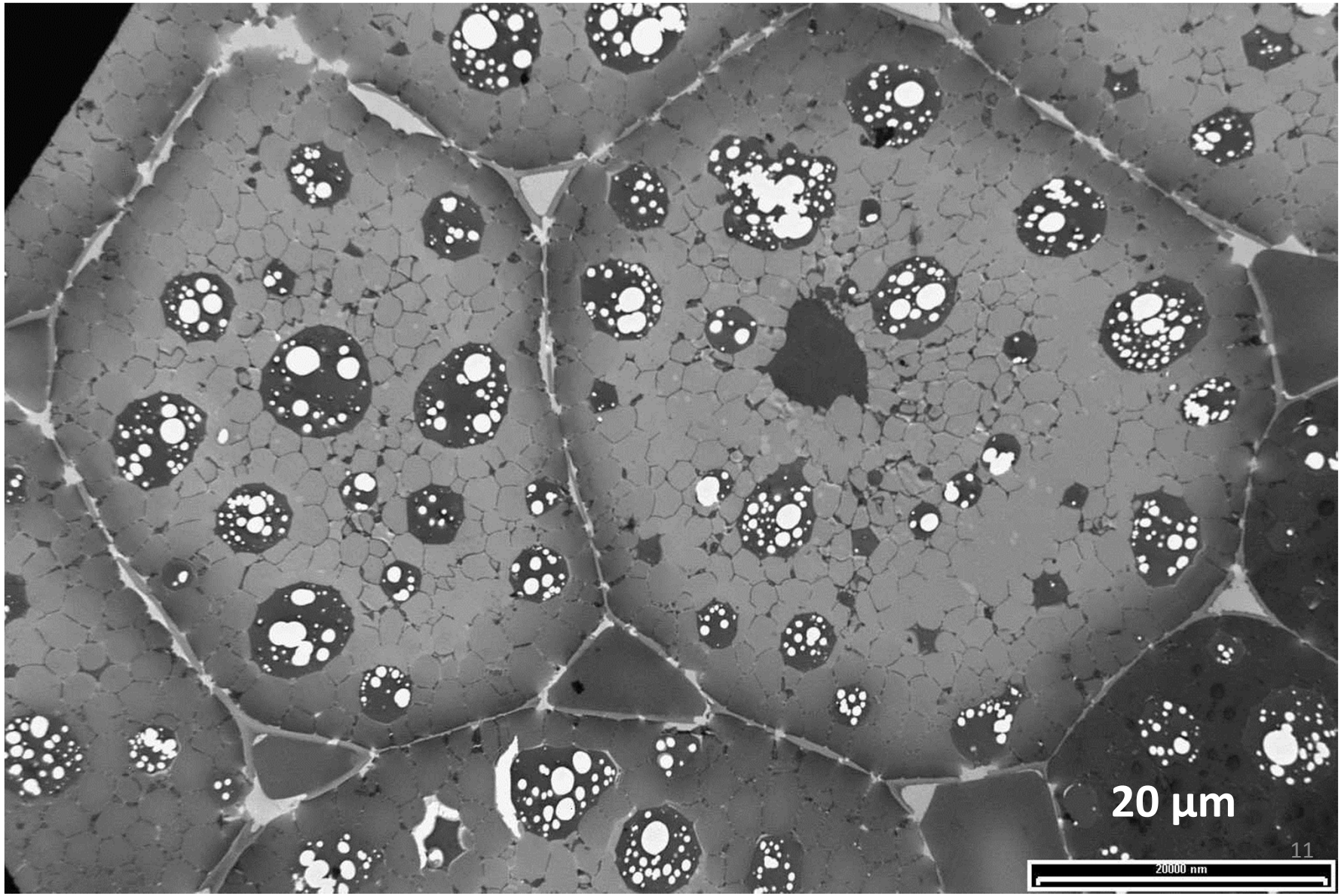
- Multilayer technology
- Unilever patent on satiety
- Surface protein displacement
- Oleosin fusion proteins

Examples of our Research on Oil Bodies

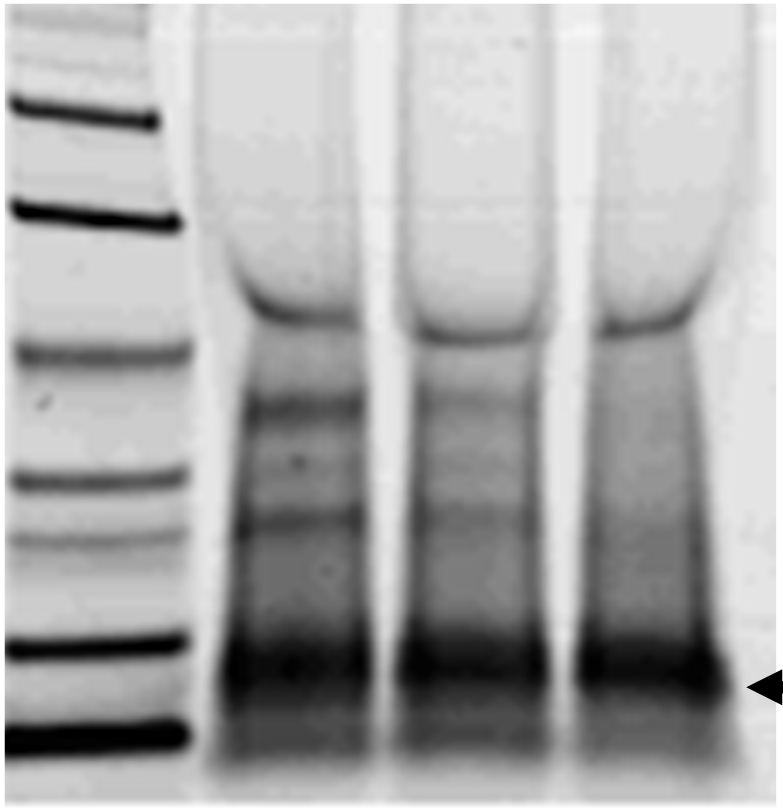
1. Effect of washing oil-body cream on surface-charge and colloidal stability
2. Rheological properties of oil-body preparations
3. Oxidative stability of omega-3 oils naturally present in plant seed oil-bodies
4. Test for a physical link between oil-bodies and vitamin E (tocopherol)
5. Analyse the complex lipids that make up the monolayer on the surface of oil bodies
6. Digestibility of oil-bodies
7. Sustainable processing of oilseeds

Oxidative Stability of Oil Bodies from *Echium plantagineum*

Section of Echium Seed Viewed by Transmission Electron Microscopy



Effect of Washing-Agents on the Profile of Proteins in Echium Oil-Body Preparations



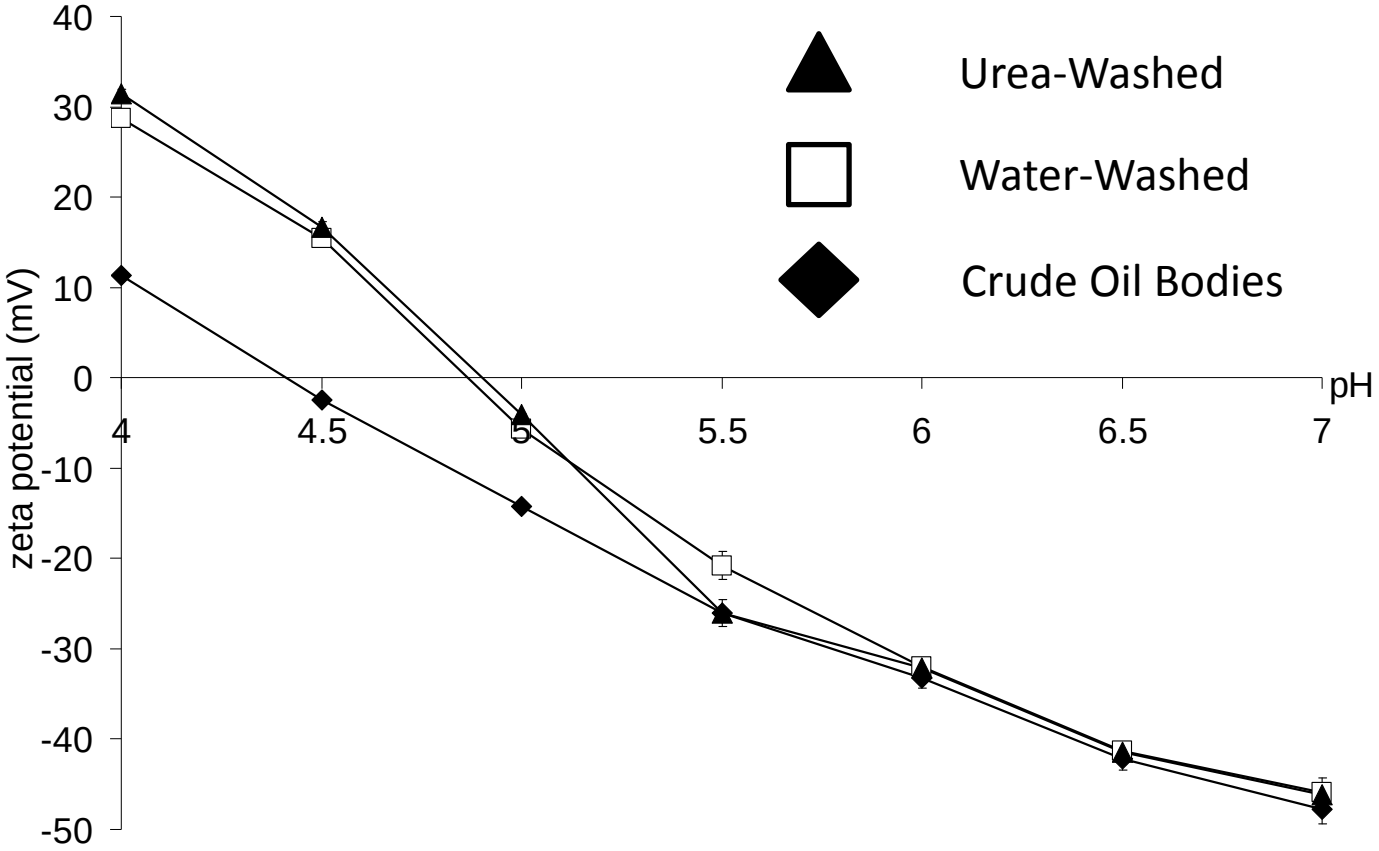
OLEOSIN

Crude/Unwashed OB

Water-Washed OB

Urea-Washed OB

Zeta Potential of Variably Washed Echium Oil Bodies



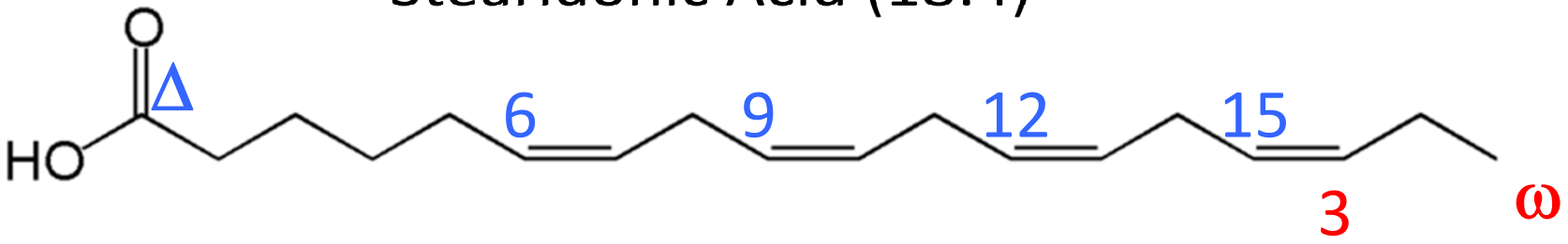
Fatty Acid Composition of Echium Seed and of Recovered Oil Bodies

Sample	Palmitic Acid	Stearic Acid	Oleic Acid	Linoleic Acid	γ-Linolenic acid	α-Linolenic acid	Stearidonic acid
			[% of total fatty acids]				
Seed	7.27±0.25	3.86±0.15	17.36±0.44	14.17±0.55	10.26±0.30	33.77±0.71	13.31±0.67
COB	7.53±0.09	3.87±0.04	17.60±0.70	13.45±0.28	9.34±0.54	33.65±1.29	13.66±0.97
WWOB	7.41±0.56	3.74±0.04	15.63±2.27	13.29±0.16	8.54±0.33	33.24±1.64	14.60±0.47

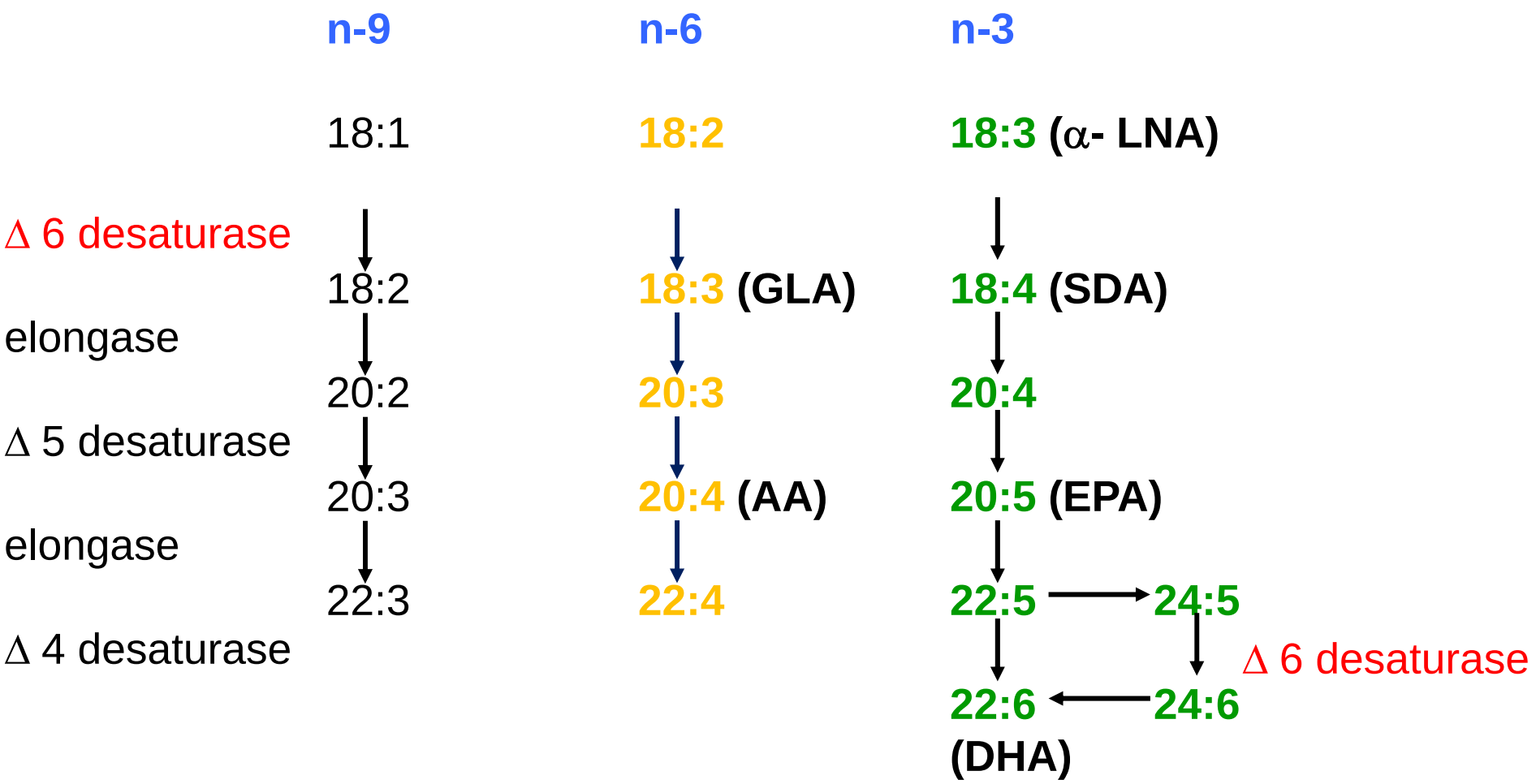
COB = Crude Oil Bodies

WWOB = Water-Washed Oil Bodies

Stearidonic Acid (18:4)



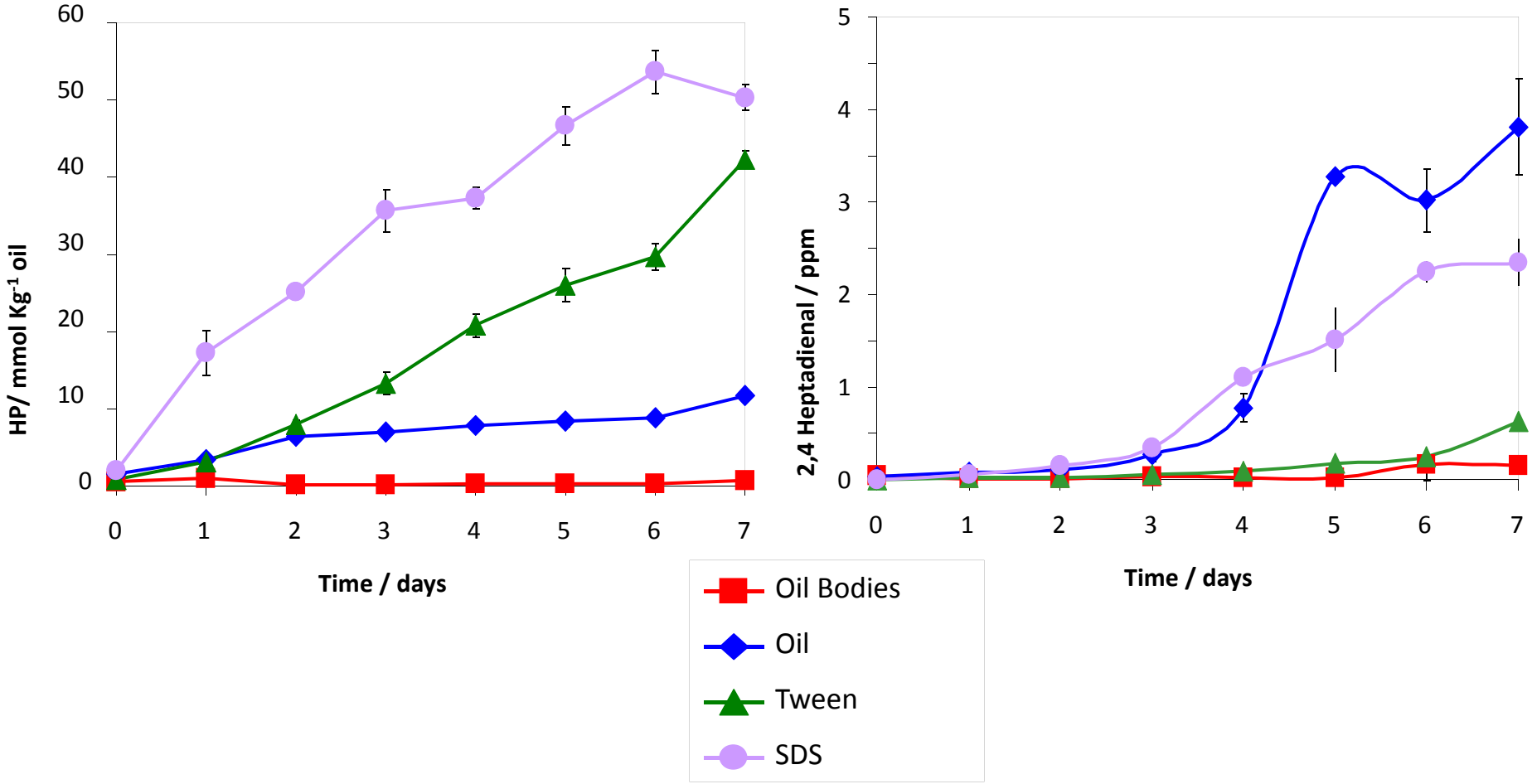
Desaturation-Elongation Pathways for Synthesis of PUFAs in Humans



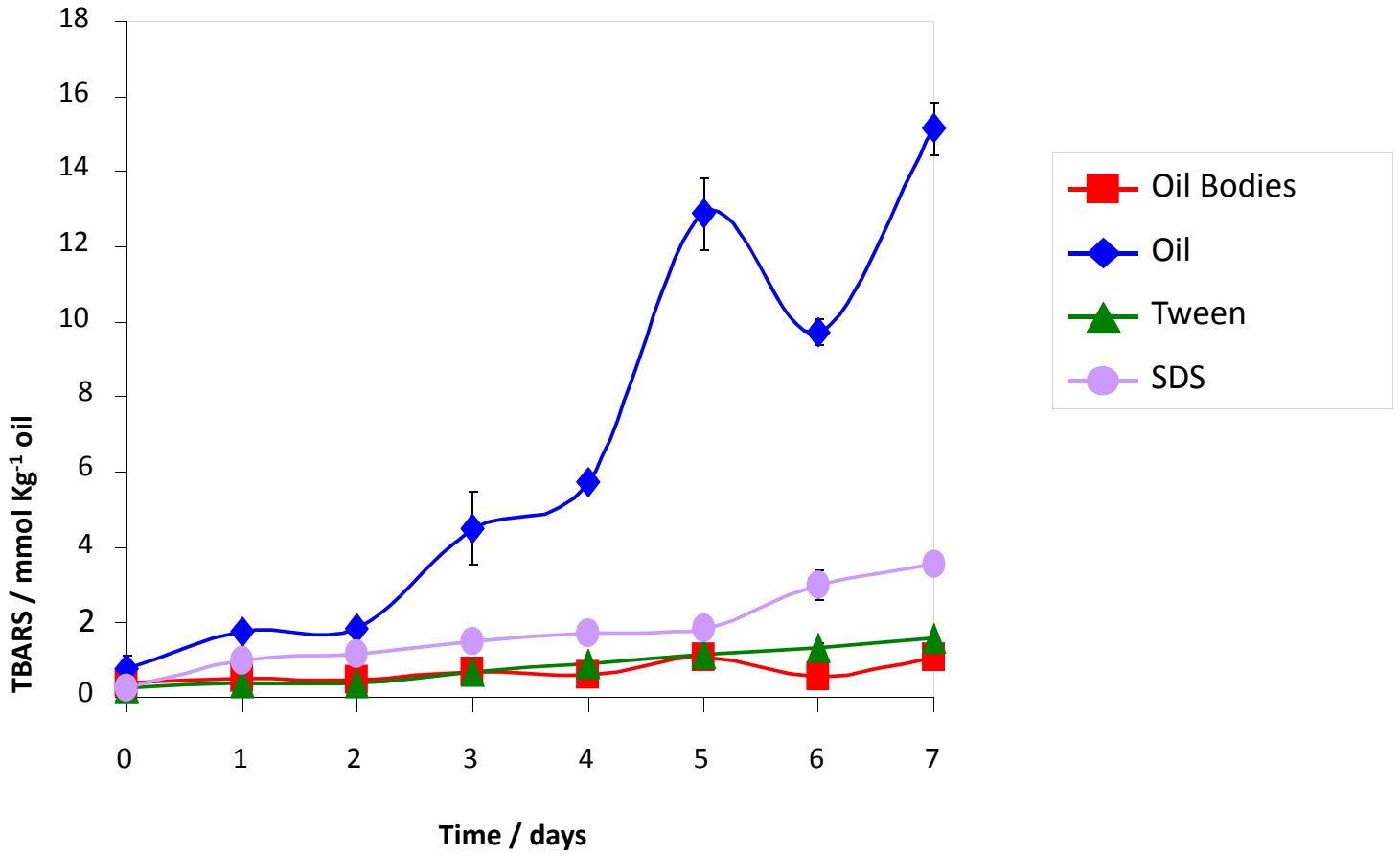
Incubation of Emulsions for Oxidation Study

SPME – GCMS to Analyse Volatile Secondary Products of Oxidation

Comparing Oxidative Stability of Echium WWOBs with Equivalent Processed Emulsions at 40°C – Slide A



Comparing Oxidative Stability of Echium WWOBs with Equivalent Processed Emulsions at 40°C – Slide B



Conclusions

- Oil bodies ex-vivo provide protection against oxidation of the entrapped oil
- This level of protection is significantly greater than that afforded by SDS or Tween 20 stabilised emulsions
- The precise cause of this protection is unclear, but some hypotheses can be proposed

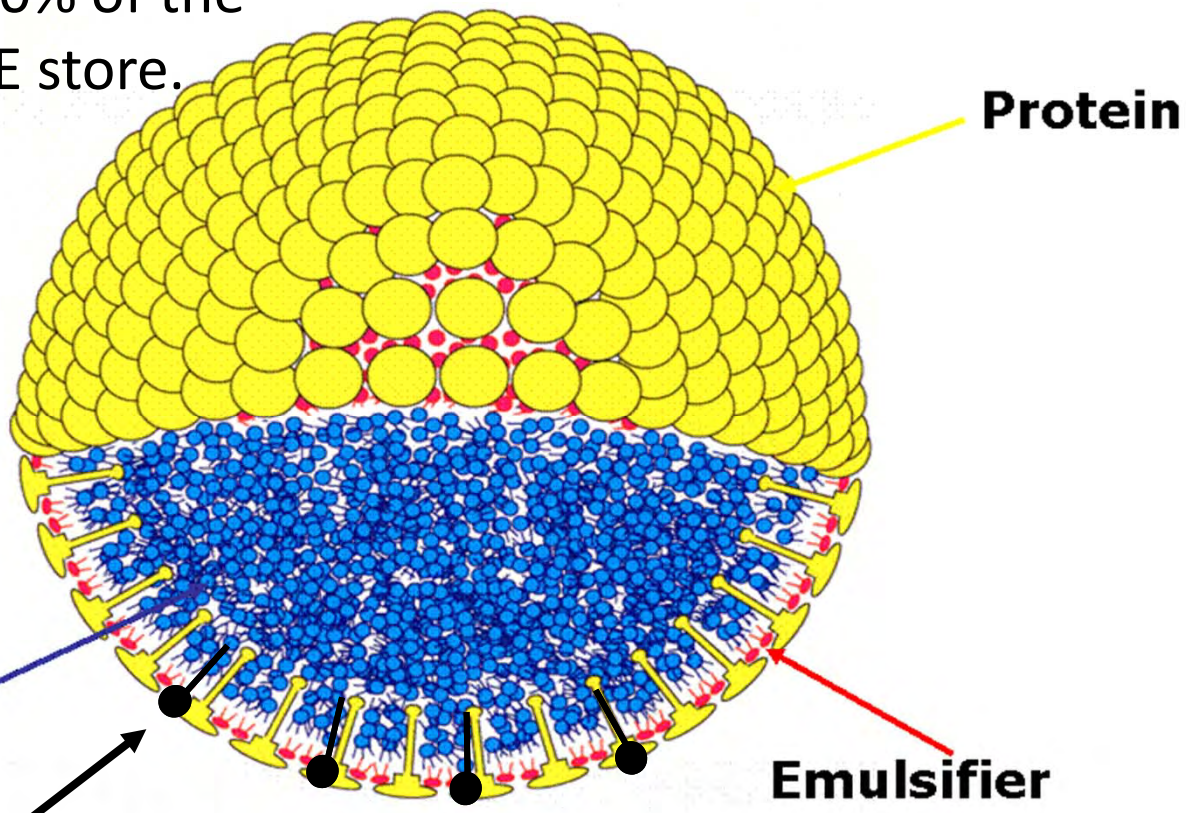
Questions emerging from the oil body oxidation study

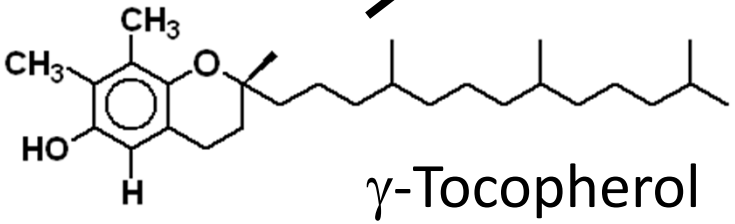
- What is the natural antioxidant profile of oil bodies?

- Does the chemistry of the phospholipids surrounding the oil body confer any stability to oxidation?

Vitamin E (Tocopherol) in Echium Seed Oil Bodies

Oil bodies carry 80% of the seed's vitamin E store.





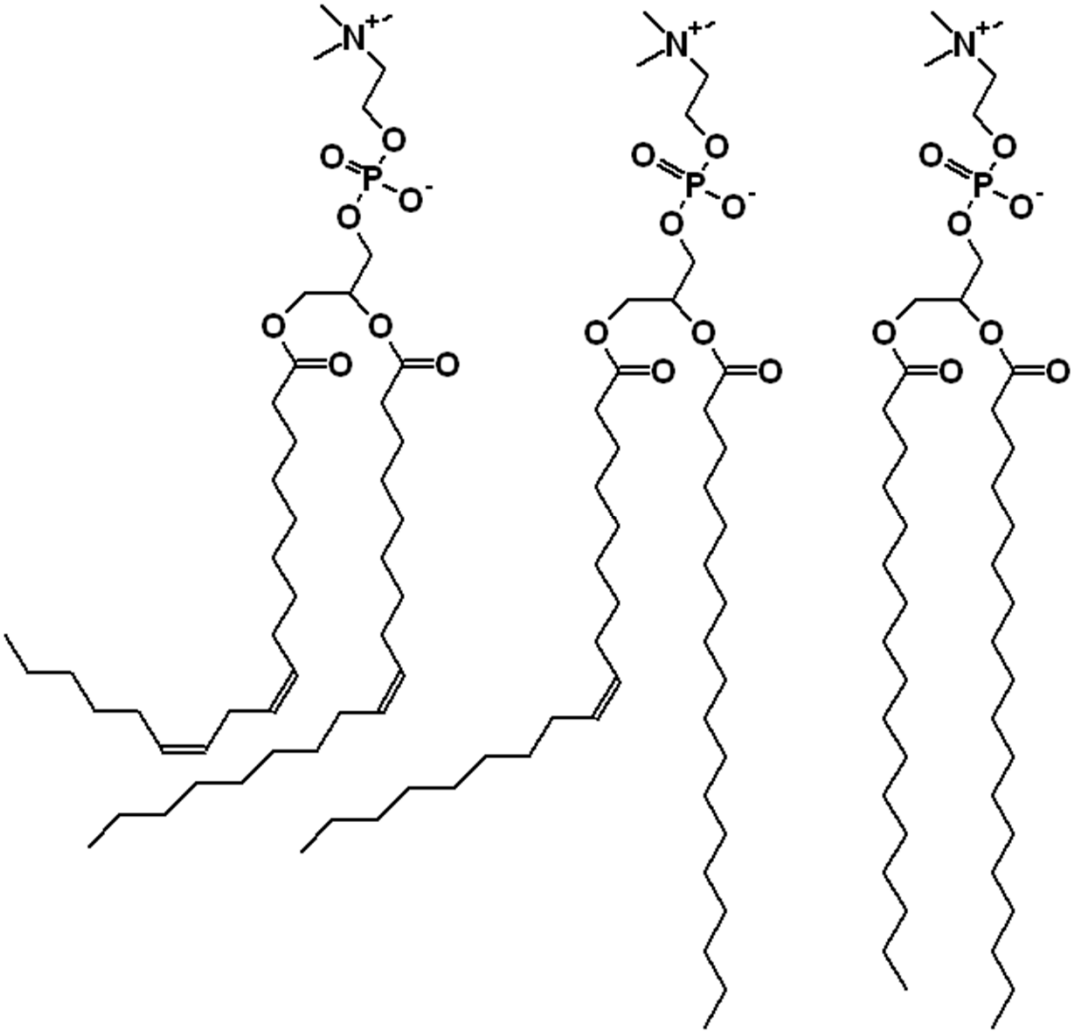
γ-Tocopherol

Data from Gray et al. 2010 EJLS

Phospholipid Composition of Echium Seed Oil Bodies

	Crude oil bodies	Water washed oil bodies	Urea washed oil bodies
PC (%)	52.4 ± 6.6	54.5 ± 5.2	55.1 ± 5.1
PS (%)	32.6 ± 5.2	30.7 ± 4.1	31.2 ± 6.5
PI (%)	4.2 ± 0.9	5.2 ± 0.5	4.0 ± .1.3
PE (%)	12.3 ± 2.6	13.2 ± 3.9	11.7 ± 2.1

Fatty Acyl Composition of Phospholipids at the Surface of Echium Oil Bodies



Soya bean lecithin is 60-65% linoleic acid

PL in Echium OB half unit membrane is 70% saturated

Do Oil Bodies Induce Appetite Suppression?

Sunflower Seeds + Water

Sunflower Oil Bodies

MRI

Some properties of oil bodies that we have established

- Oil bodies ex-vivo provide protection against oxidation of the entrapped oil
- Oil bodies appear to carry a significant proportion of the oilseed vitamin E store
- The fatty acyl composition of the phospholipids surrounding the oil body is unusual
- The rate of digestion of oil bodies appears to vary compared with processed emulsions

Acknowledgements

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