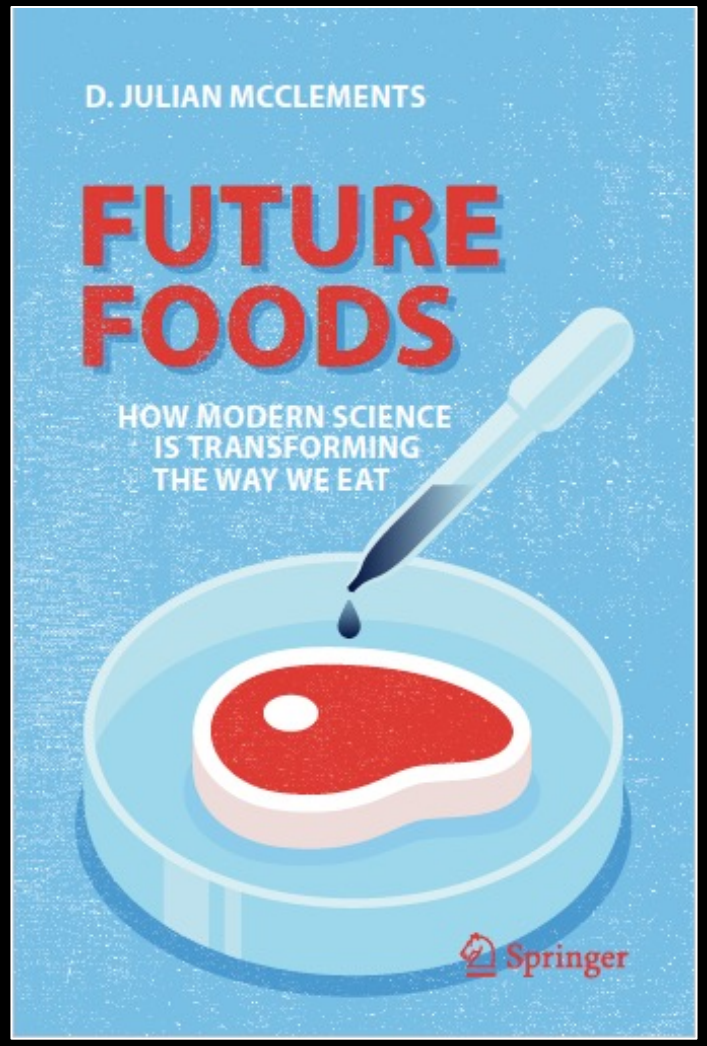
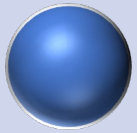
Adventures in Food Science:
A Sci-Fi Journey Through Food

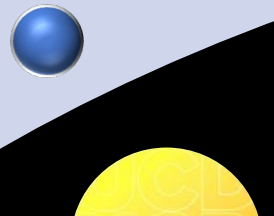


David Julian McClements

UMass Amherst

My Career in Food Science



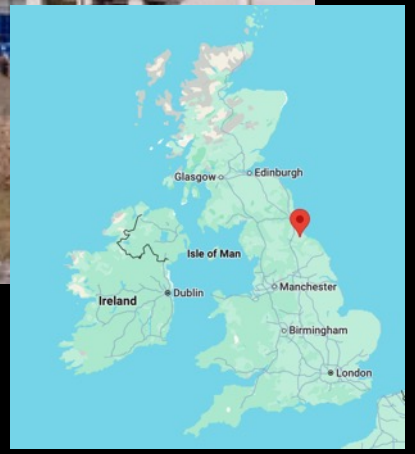


My Academic Inspiration

1969
Moon Landing

Uncle Don

My First Food Job



Billingham, Teesside, UK

Nights in the Crisp Factory

Graduate Studies:
Ultrasonic Characterization of Foods

The Use of Ultrasonics for Characterising Fats and Emulsions

by

David Julian McClements

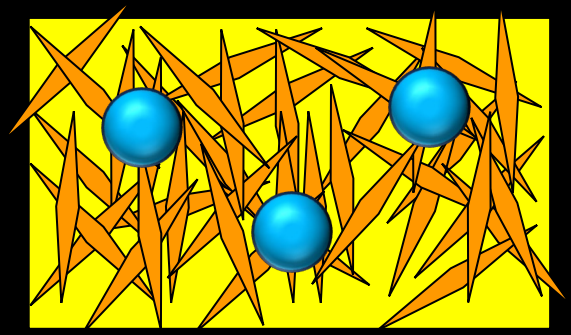
Submitted in accordance with the requirements for the degree of
Doctor of Philosophy

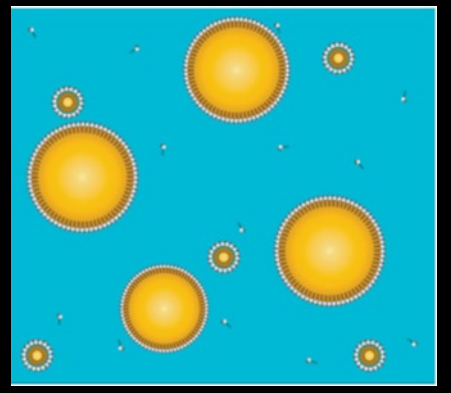
Procter Department of Food Science
University of Leeds
LS2 9JT

November 1988

Graduate Studies:
Ultrasonic Characterization of Foods

Goal: Measure the size and concentration of particles in margarines and dressings



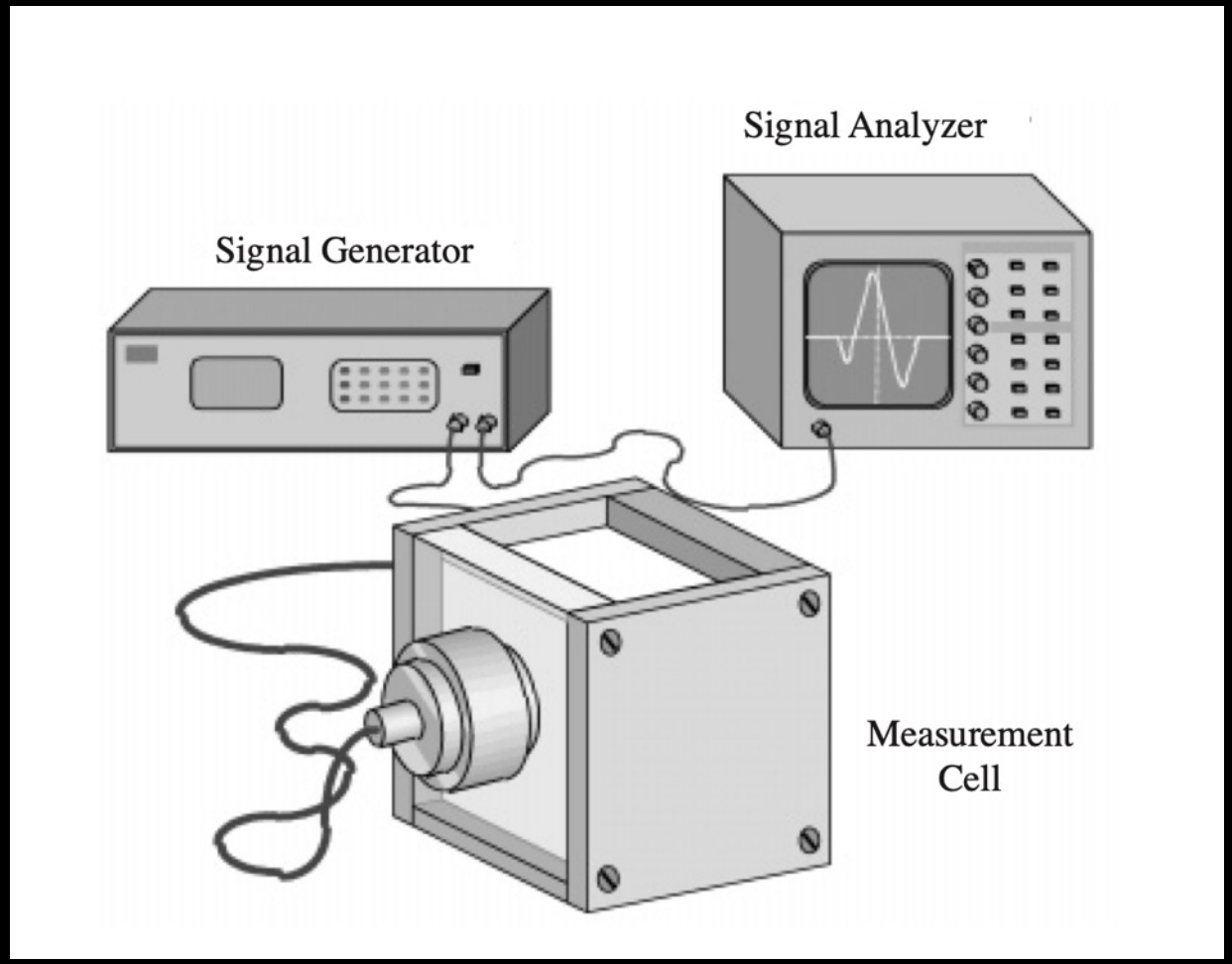


Graduate Studies:
Ultrasonic Characterization of Foods

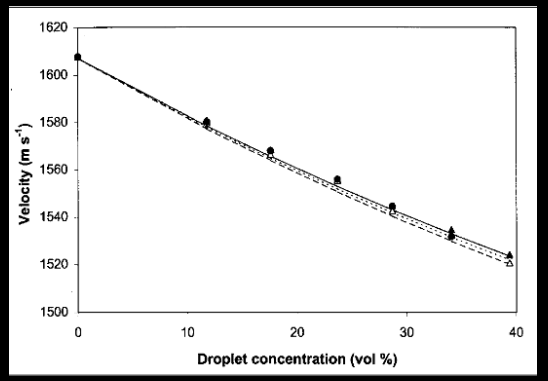
Inspired by Nature

Ultrasonic Characterization of Foods:

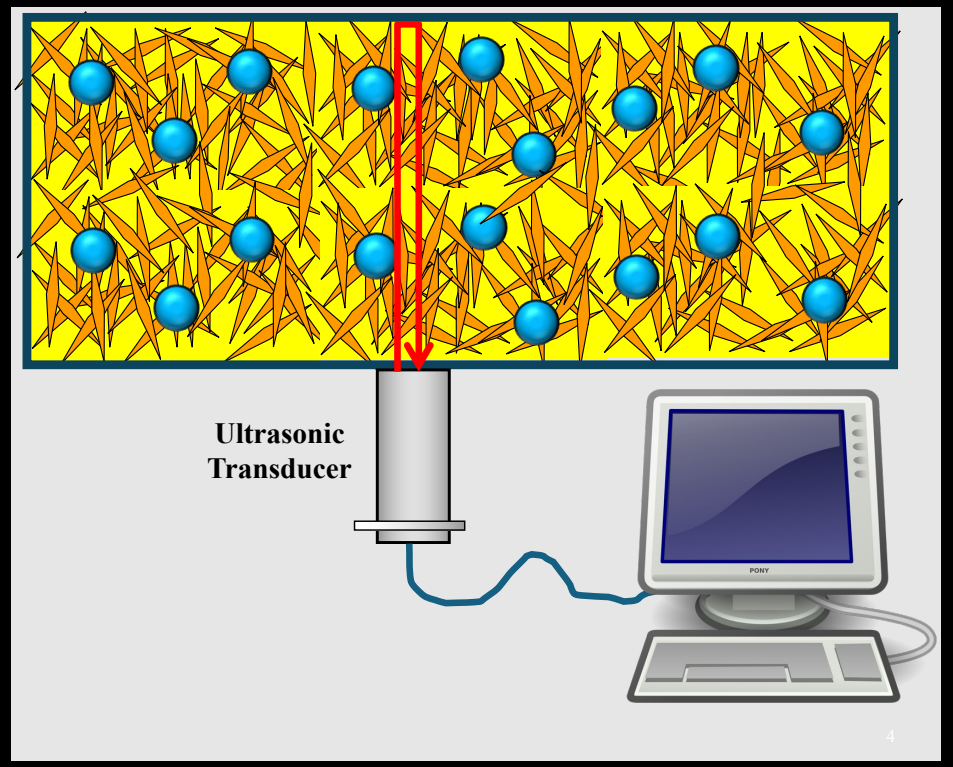
Building an Ultrasonic Sensing Device



Custom-built Ultrasonic Spectrometer

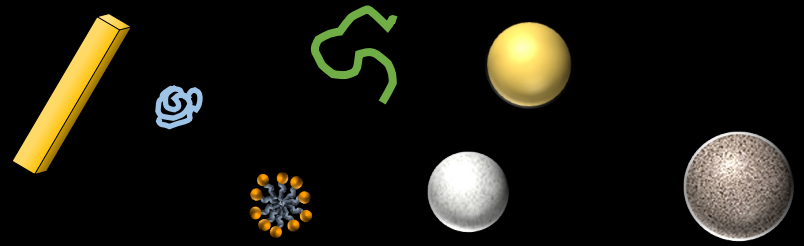


Ultrasonic Characterization of Foods: Applying the Technology

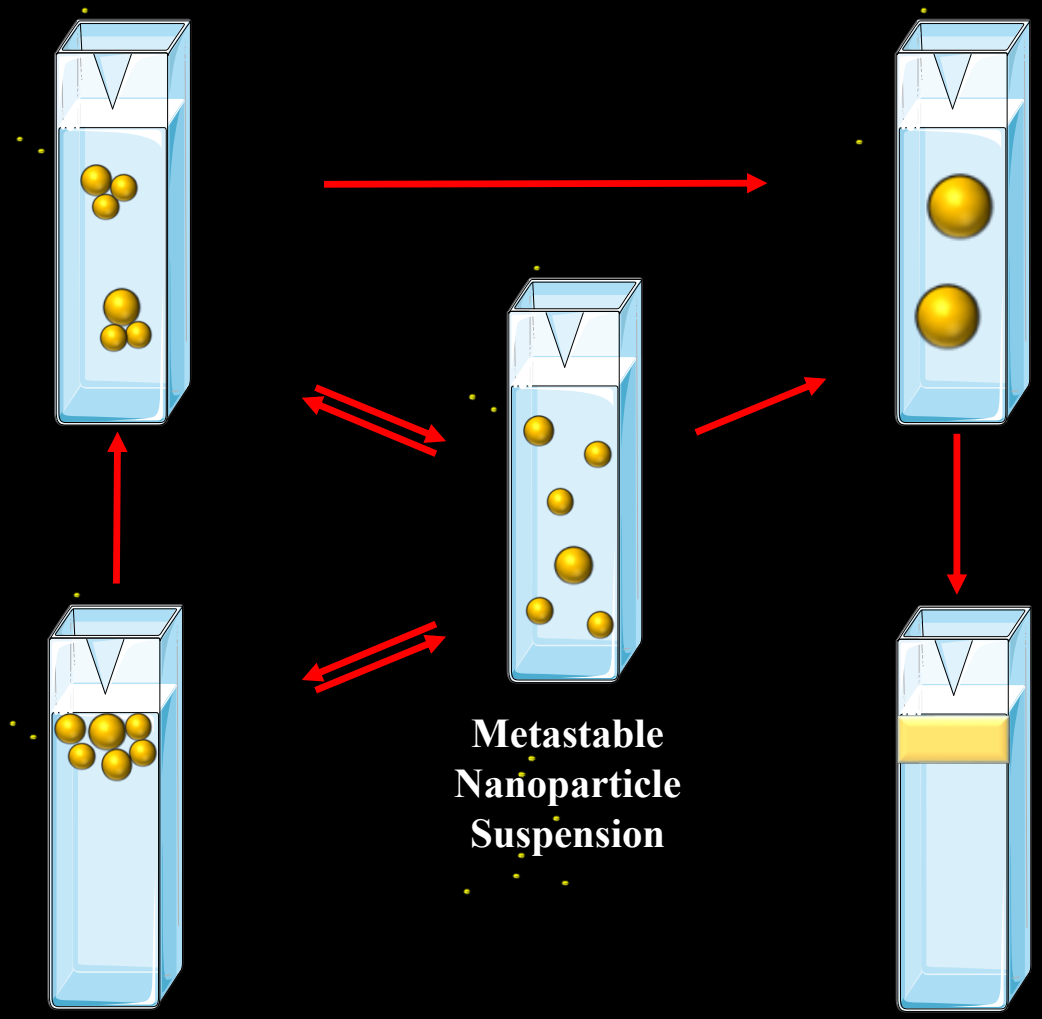


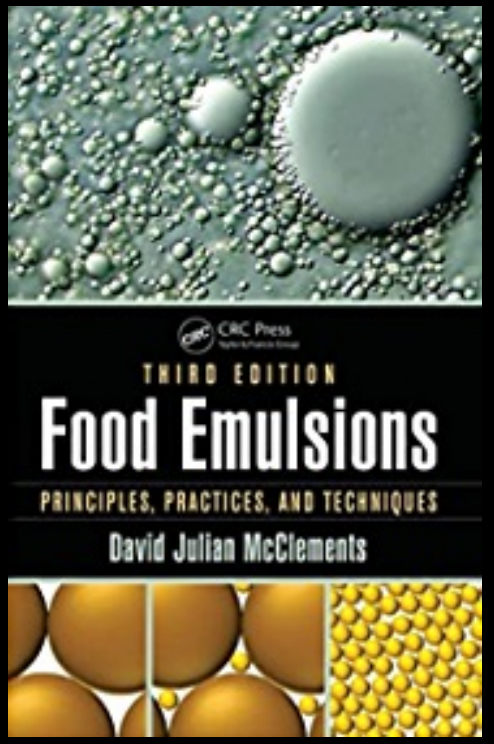
The Importance of Practical Applications

Post-Doctoral Work:
Biopolymers and Colloids

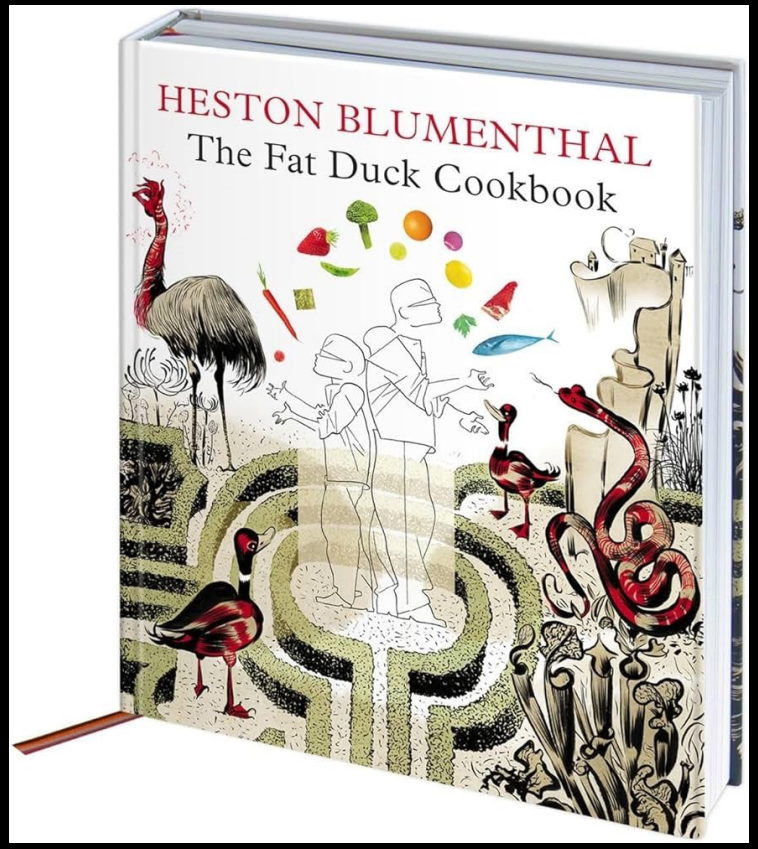


Food Biopolymers & Colloids Lab:
Emulsified Foods



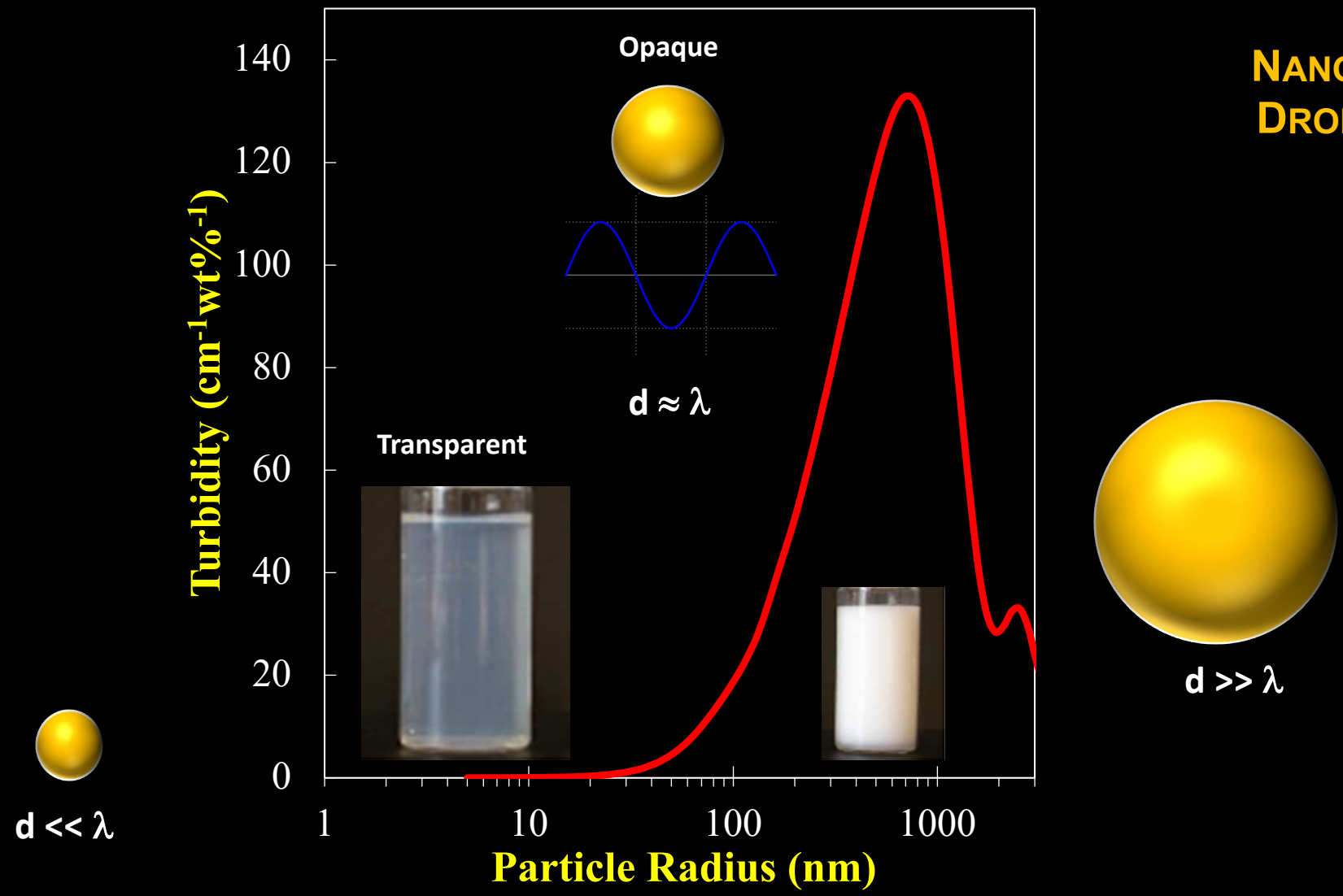


Molecular Gastronomy: Transparent Mayo?



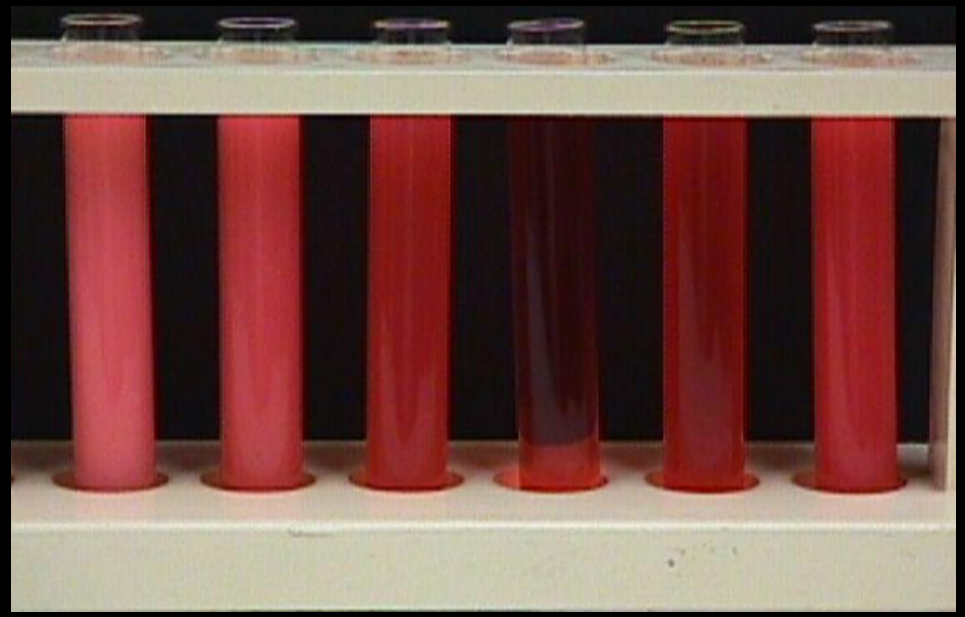
Heston Blumenthal

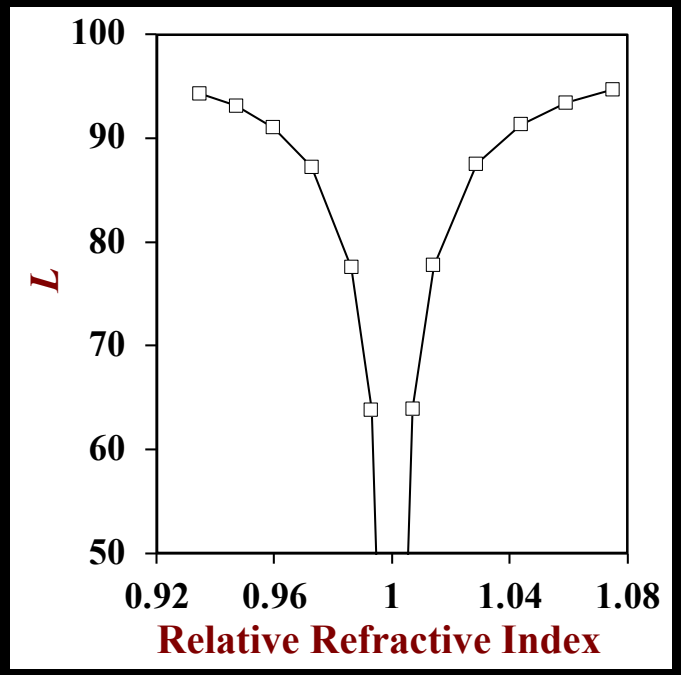
Molecular Gastronomy:
Transparent Mayo

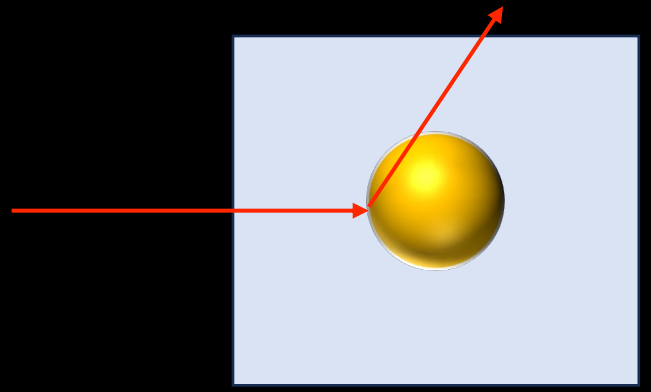


Nano-Size Droplets

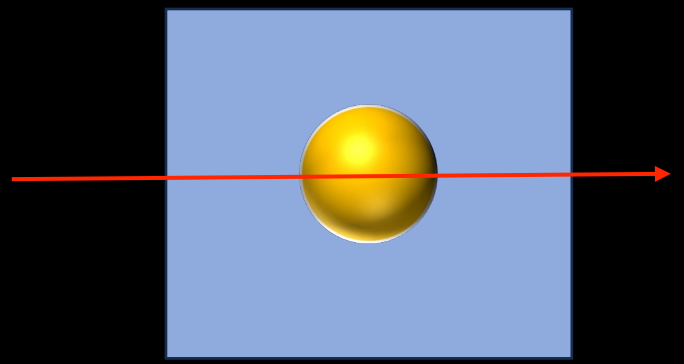
Molecular Gastronomy: Transparent Mayo







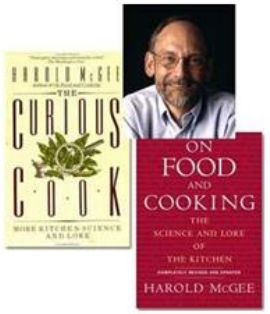
$RI_{Oil} < RI_{Water}$



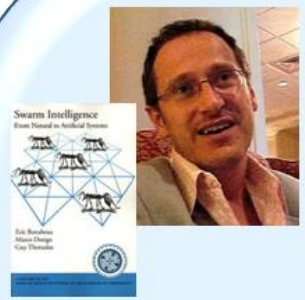
$RI_{Oil} = RI_{Water}$

Changing Directions:
Star Trek and Beyond

Homaru Canto
Chef & TV personality
(Moto Restaurant)

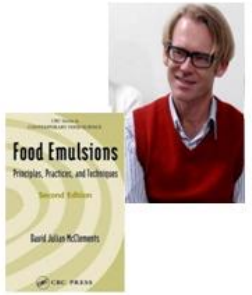


Harold McGee
Food Expert
(Journalist and Author)



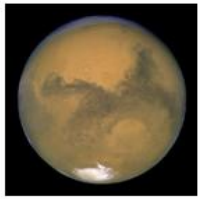
Eric Bonabeau
Complexity Theorist
Icosystem, Boston, MA

Leroy Chiao
(International Space
Station Commander)



David Julian McClements
Emulsion Scientist
(Food Science Professor)

NASA



Mars

Icosystem, Boston, MA

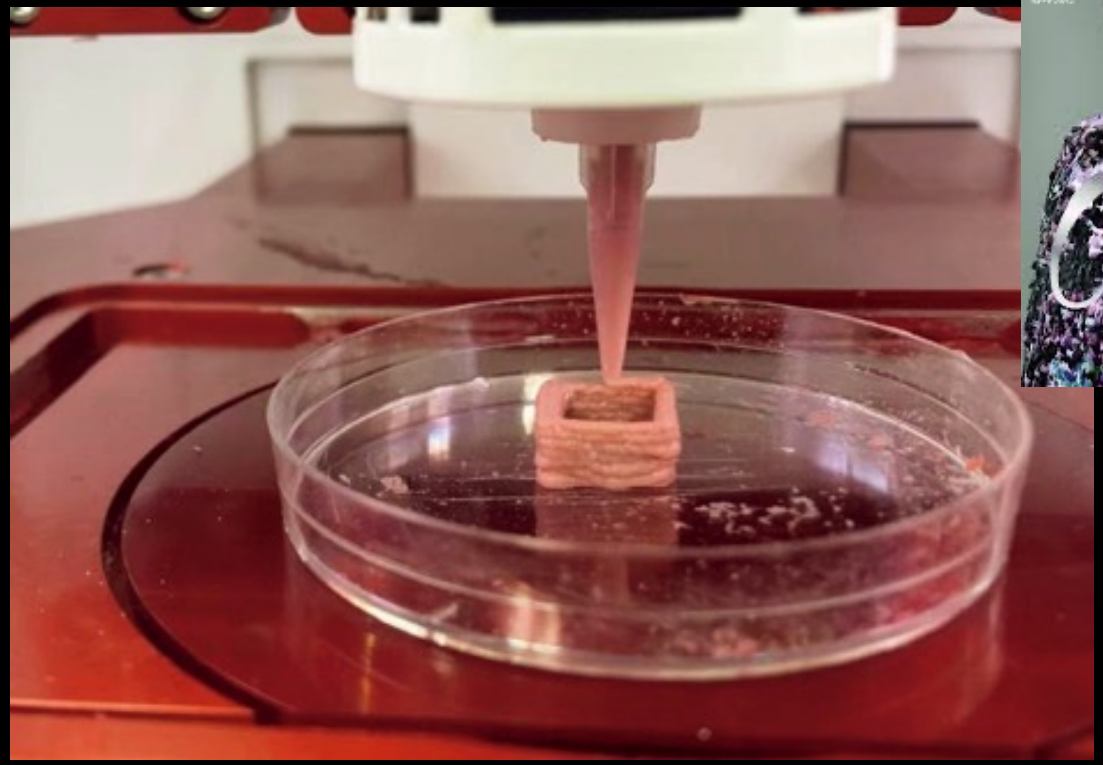
Food Replicator

3-D Food Printing

Food Ink (London)

- 3-D printed food & restaurant: cutlery, tables, chairs, lights *etc.*

3-D Printing of Plant-Based Meat



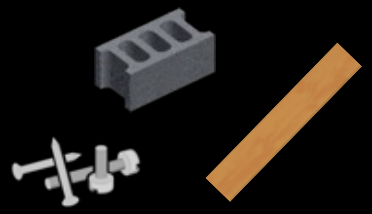
Featured in Japanese ***Vogue*** magazine (2022)

3-D Printed Wagyu Beef (Japan)

Food Architecture:

Designing Foods From the Bottom Up

Design Plan

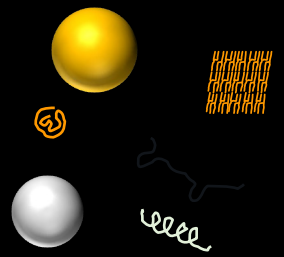


Building Materials

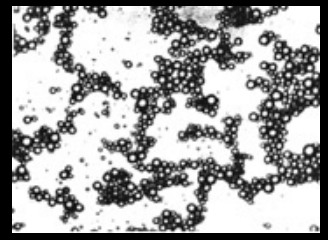
Structural Engineering Principles

Fabricated Structure

Design Plan



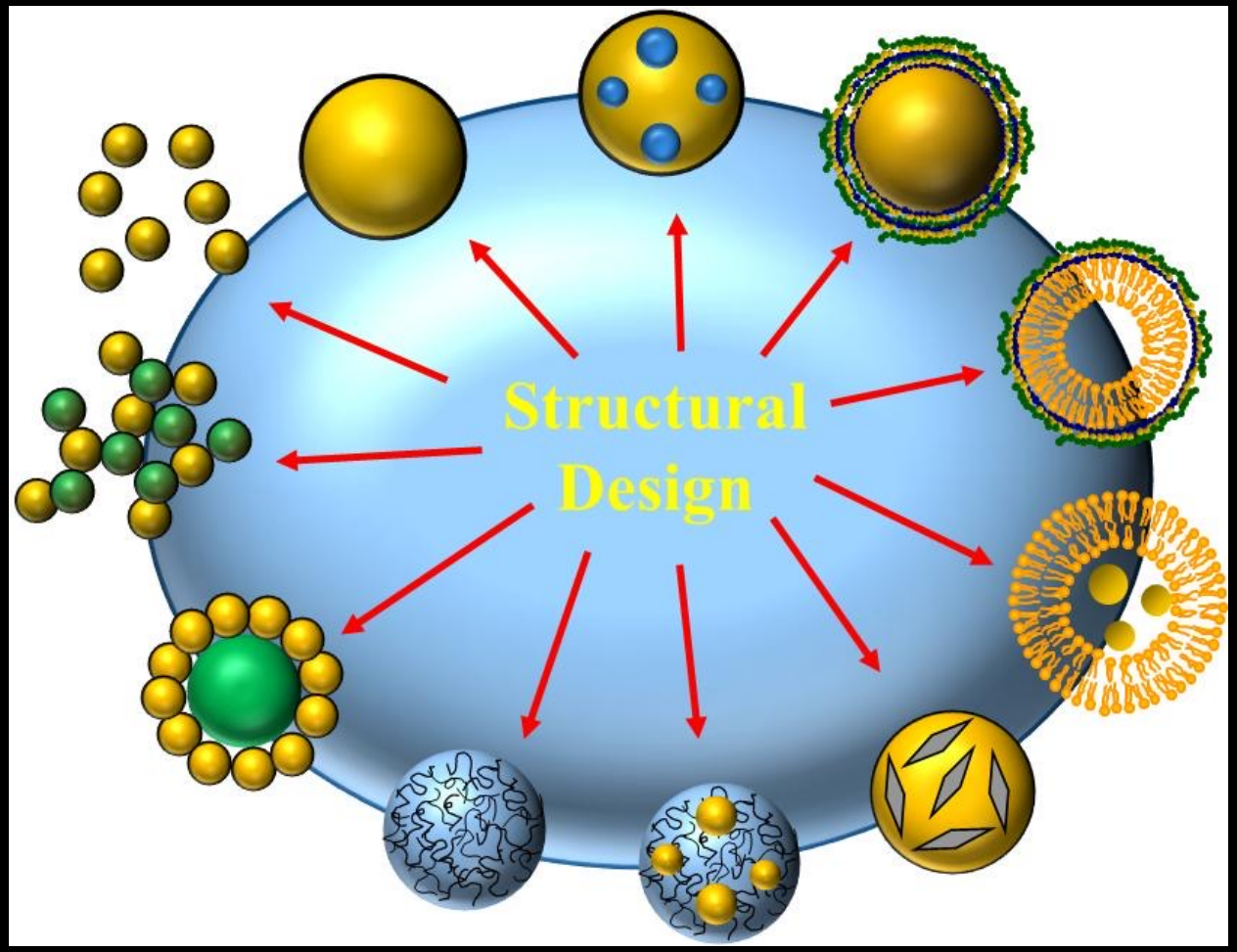
Building Materials



Structural Engineering Principles

Fabricated Structure

Food Architecture:
Building Foods from the Bottom Up



TARGETED DELIVERY: ENHANCING STABILITY OF GASTRIC LABILE BIOACTIVES

Gastric Labile Substances

- **Probiotics**
- **Enzymes**
- **Nutraceuticals**

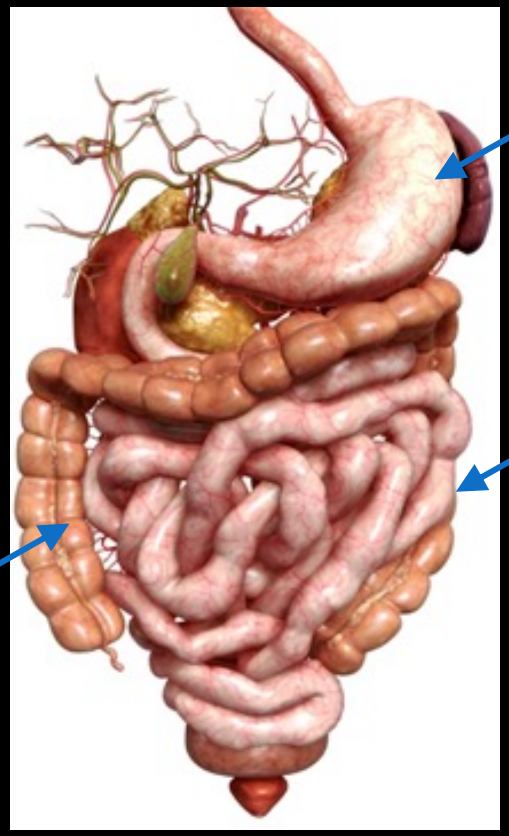
Gastrointestinal Stability: Some bioactive agents are degraded due to harsh conditions in the GIT:

- *Enzyme activity*
- *pH changes*
- *Bile salts*

PROBIOTICS:

DELIVERING THEM TO THE COLON

Probiotics

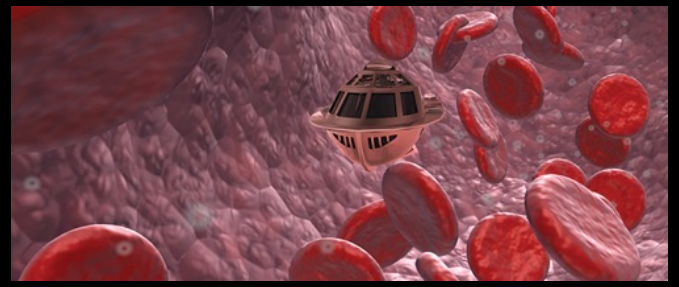


Stomach
(Highly Acidic, Enzymes)

Small Intestine
(Bile Salts, Enzymes)

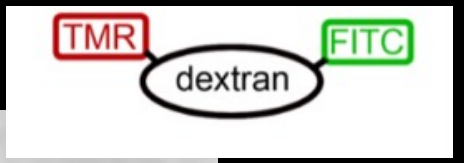
Colon
(Microbiome)

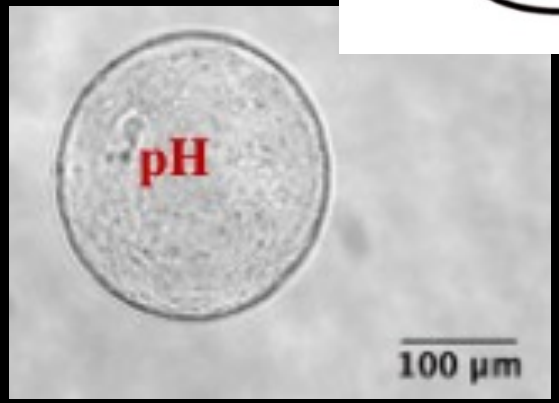
Probiotic bacteria should survive journey from mouth to colon



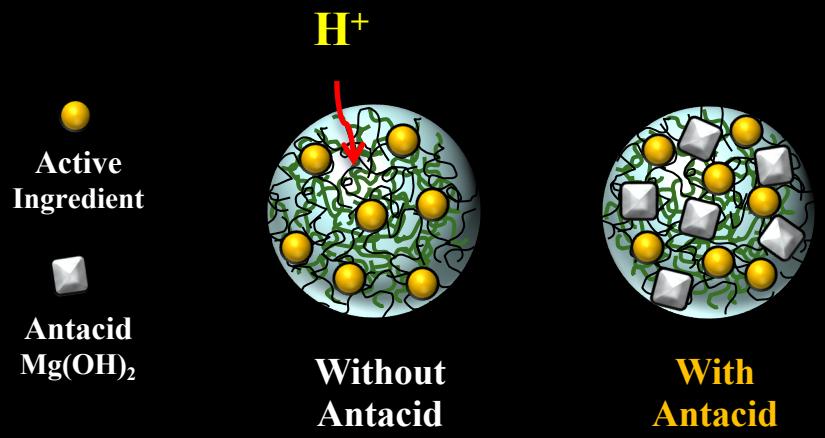
Protecting Gastric-sensitive Bioactives in the GIT: Microgel Technology

Micro-pH Probe

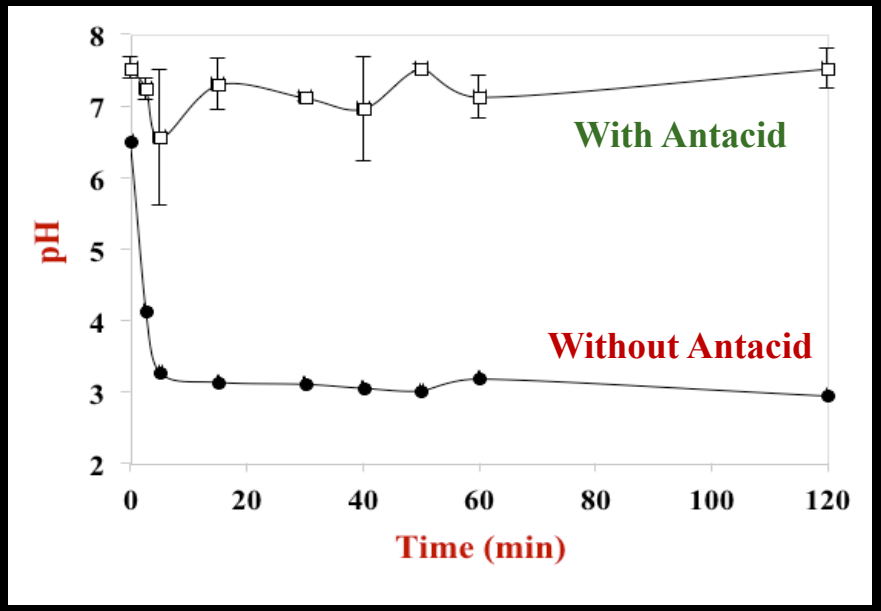




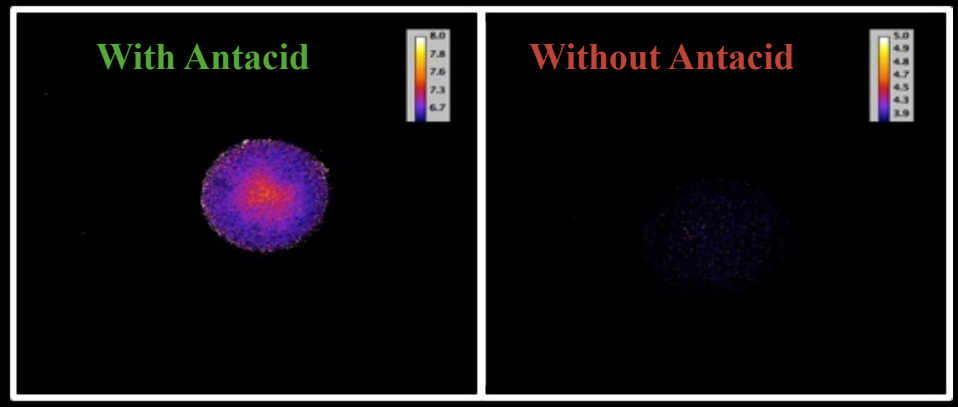
Bioactive components can be encapsulated inside specially designed tiny beads



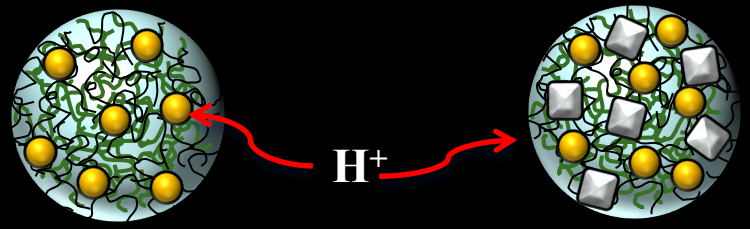
Gastric Protective Microgels:
Antiacid-loaded Microgels



pH inside beads under gastric conditions



Fluorescent after 2-hour gastric incubation

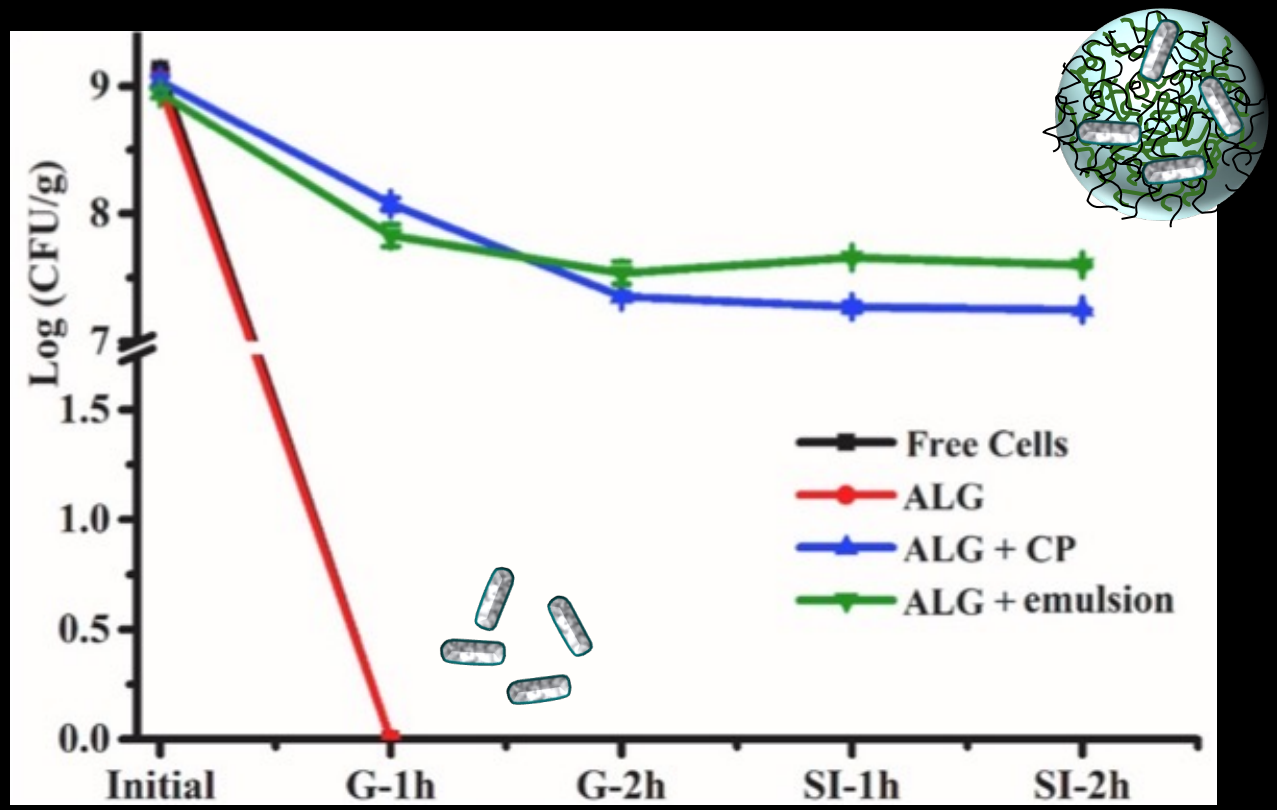


$$Mg(OH)_2 + 2H^+ \rightarrow Mg^{2+} + 2H_2O$$

Gastric Protective Microgels:

Encapsulation and Delivery of Probiotics

Improved Gastric Resistance



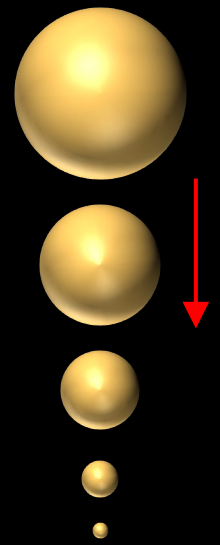
More Effective Probiotics

Dolphins Again!

Keeping Military Dolphins Healthy

Food Nanotechnology:

Honey, I Shrank the Food



Imaged by Heritage Auctions, HA.com

How Small are Nanoparticles?

The Earth

(10,000 km or 10^7 m)

x 10 million

A Pumpkin

(1 m)

x 10 million

A Nanoparticle

(100 nm or 10^{-7} m)

Food Nanotechnology:
The Good Side

More Effective Antimicrobials

Enhanced Biodegradable Packaging

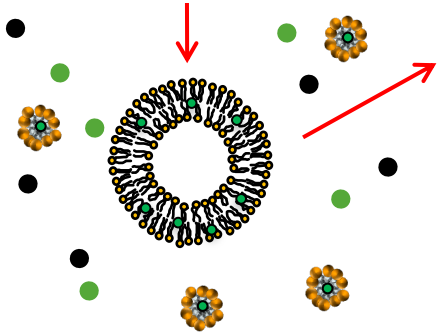
Food Fortification

The Potentially Beneficial Effects of Nanosizing Food Ingredients

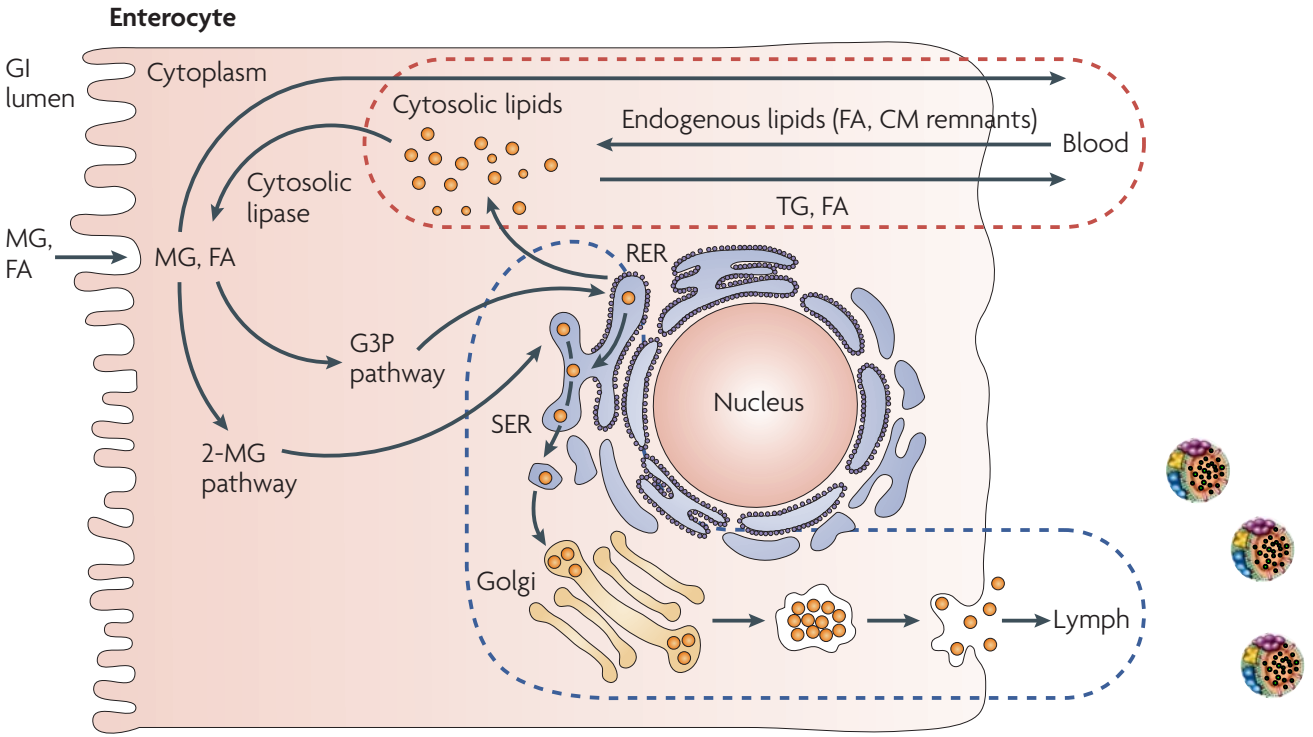
Controlling Food Bioactivity Using Nanotech
From Nano to Nano to Nano

Nanoparticles in Food

Digestion



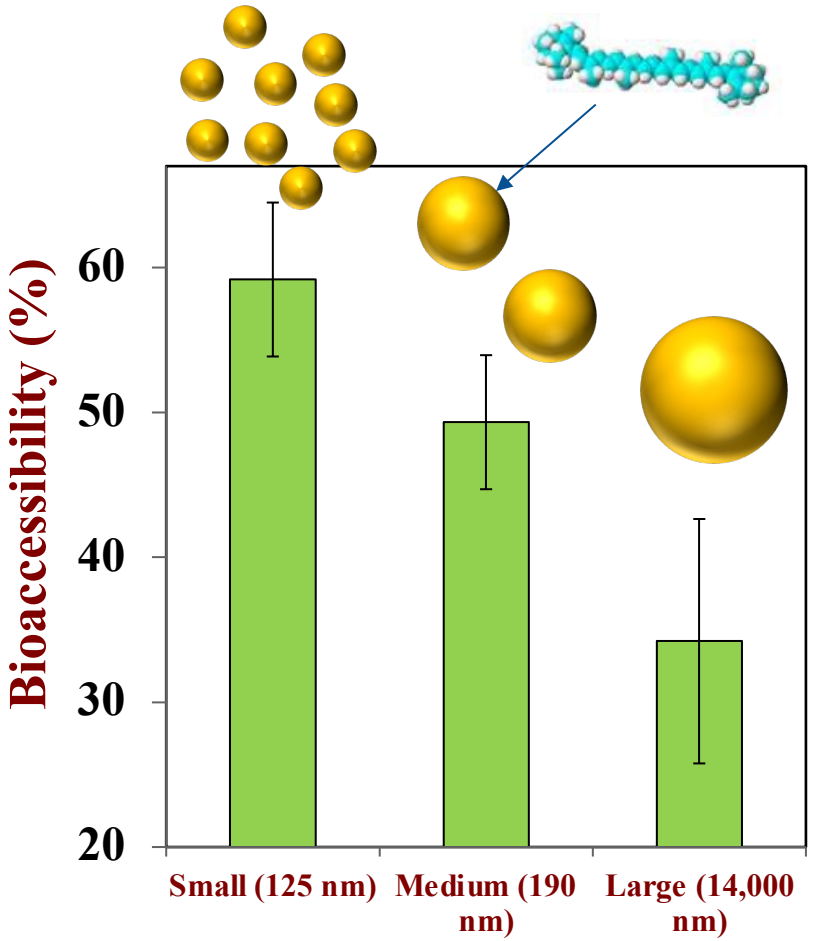
Digestion Products (Nanostructured)



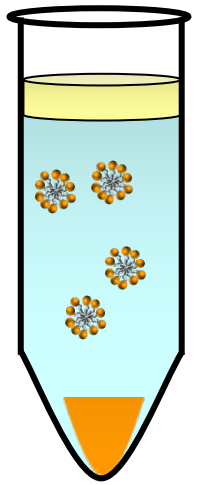
Porter CJ, et al Lipids and lipid-based formulations: optimizing the oral delivery of lipophilic drugs, Nature Reviews Drug Discovery 6, 231-248 (2007). - Image of cell.

Lipoproteins

Enhancing Bioaccessibility:
Impact of Nanosizing

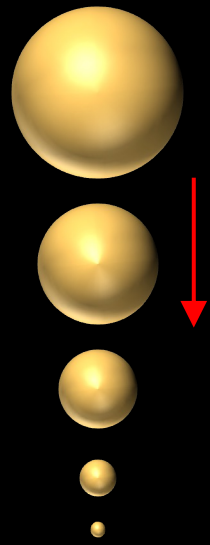


Mouth
Stomach
Intestine



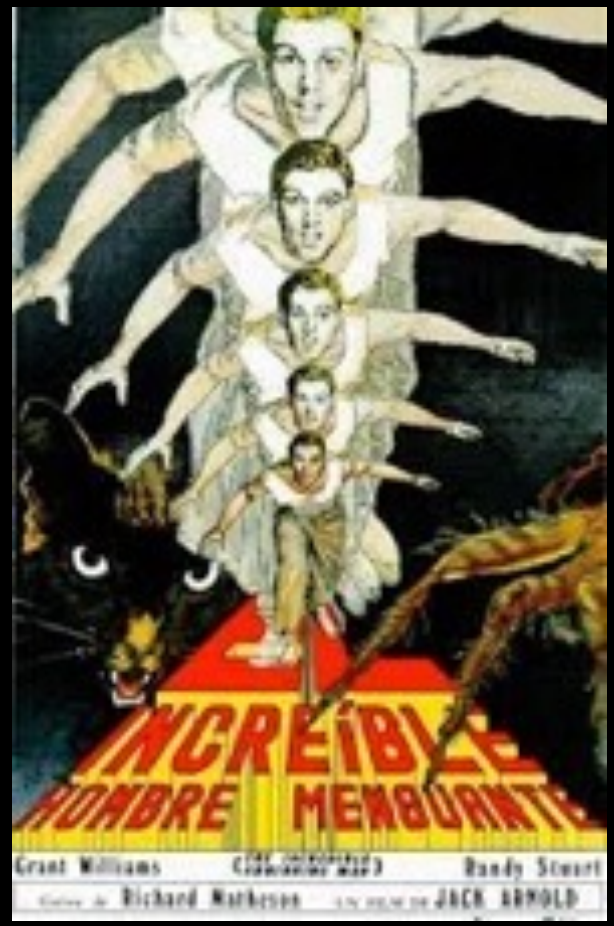
Mixed
Micelle
Phase

Nanosizing food ingredients



BETA-CAROTENE BIOACCESSIBILITY

Food Nanotechnology:
The Dark Side



The Potentially Adverse Effects of Nanosizing Food Ingredients

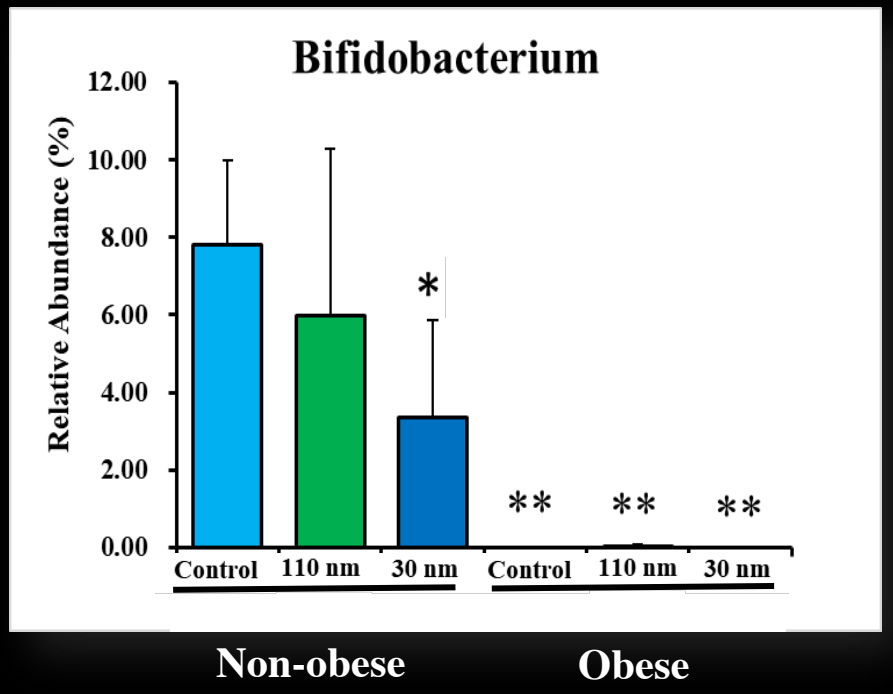
TiO_2 Nanoparticles:
Lightening Agents in Foods

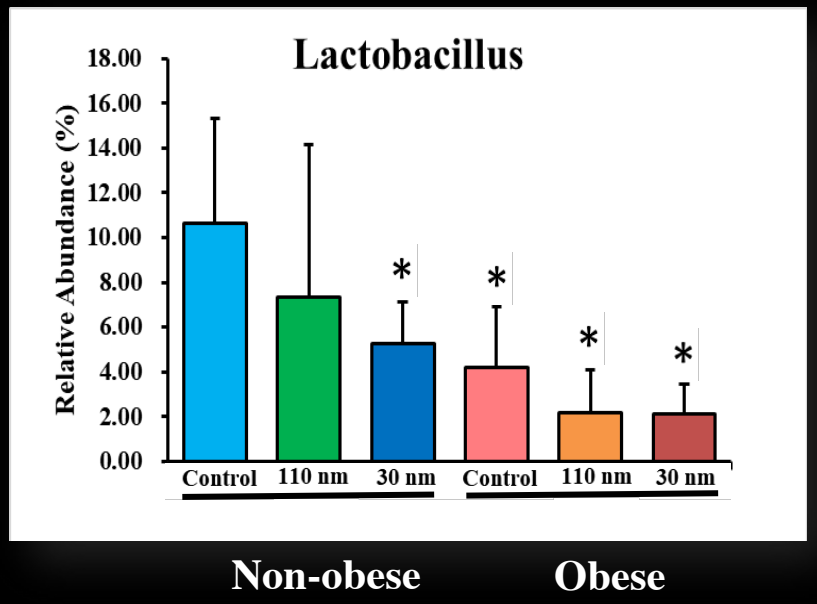
Some foods contain high levels of TiO_2 (E171), including cakes, candies, sweets, and chewing gums.

Most commonly consumed by childern

Hang Xiao

TiO_2 Nanoparticles Alter Gut Microbiota





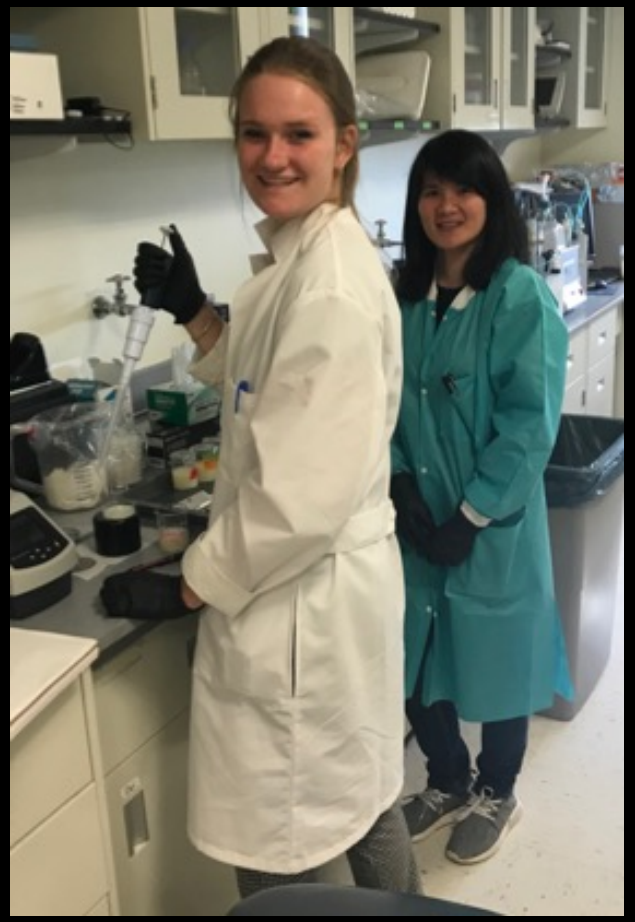
Nanoparticles effects depend on fat content of diet

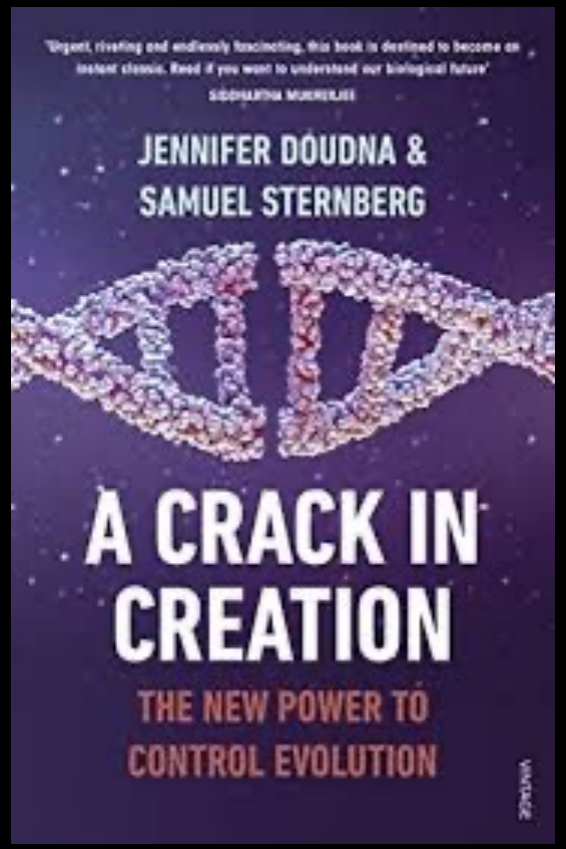
Nanoparticles Alter Gut Microbiota

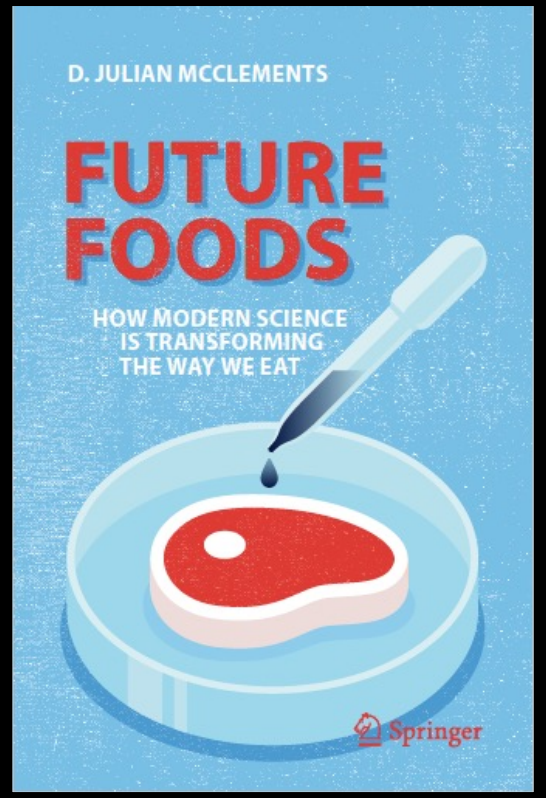
Back to My Roots!

Billingham, Teesside, UK

Back to the Future:
The History of Future Foods







Improving the Health of The Planet:
Environmental Impact of Foods

Food and Agricultural Impact

- Increasing land and water use
- Pollution of land, water, and air
- Global warming
- Biodiversity Loss
- Zoonotic disease risk

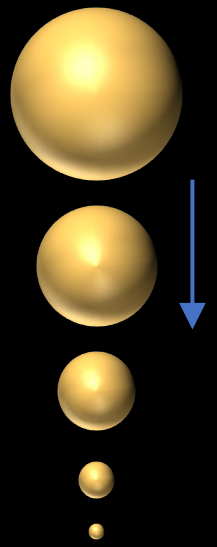
Livestock production is a major problem!

Agriculture responsible for:

- 30% GHG emissions
- 70% water use
- 40% land use

J. Poore and T. Nemecek, "Reducing food's environmental impacts through producers and consumers" Science 360, 987–992 (2018)

Future Foods: From Food Nanotechnology to More Sustainable and Healthy Foods



HEALTH ASPECTS





Traditional Animal-based Diet





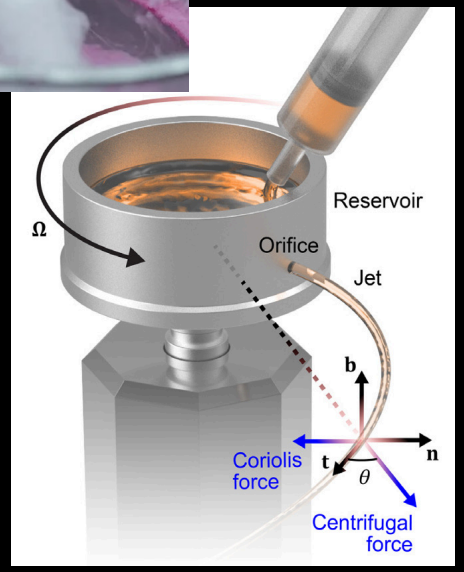
Next-Generation Plant-based Diet

CLIMAX

Tender

Luke McQueen

Inspired by cotton candy…



We make fibers from proteins

Wicked delicious food!!

Liu Q. and Parker K., Extreme Mechanics Letters. 25 (2018).

www.tenderfood.com

Tender Food samples at the Industry Showcase from 1:00PM-3:30PM at the BlueWall, Campus Center

Driando Ahnan-Winarno

(Co-founder Better Nature and Rock Star)

HYBRID PRODUCTS

Insect-derived Ingredients

Hybrid Foods

Plant-derived Ingredients

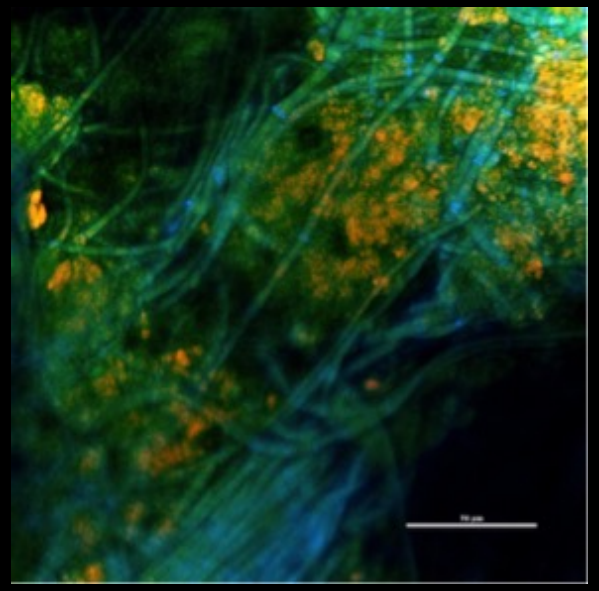
Mycelium-derived Ingredients

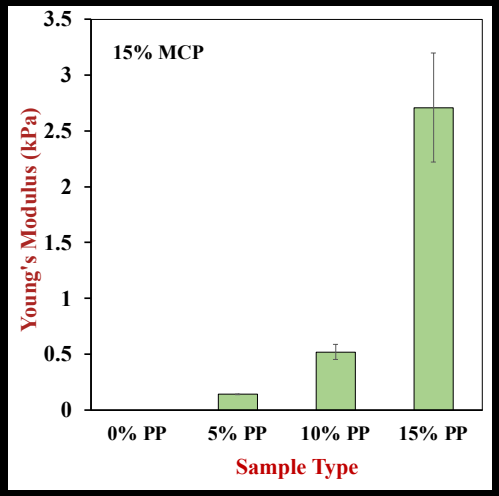
Animal-derived Ingredients

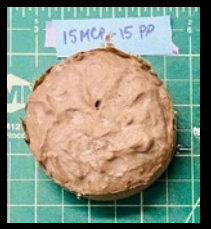
Bioreactor-derived Ingredients

Hybrid Foods

Combining Benefits of Different Alt Proteins







Mycelium-Plant Protein Hybrids

Different sources of alternative proteins have unique advantages and disadvantages:

Mycelium contain vitamins, minerals, and fibers, whereas plant proteins have high protein levels

Back to My Roots Again!

Billingham, Teesside, UK

My Career in Food Science

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

UCDAVIS

UNIVERSITY OF MASSACHUSETTS
1863

UNIVERSITY OF LEEDS

?

My Career in Food Science

Redesigning Ultraprocessed Foods

UCDAVIS

UCC
University College Cork, Ireland
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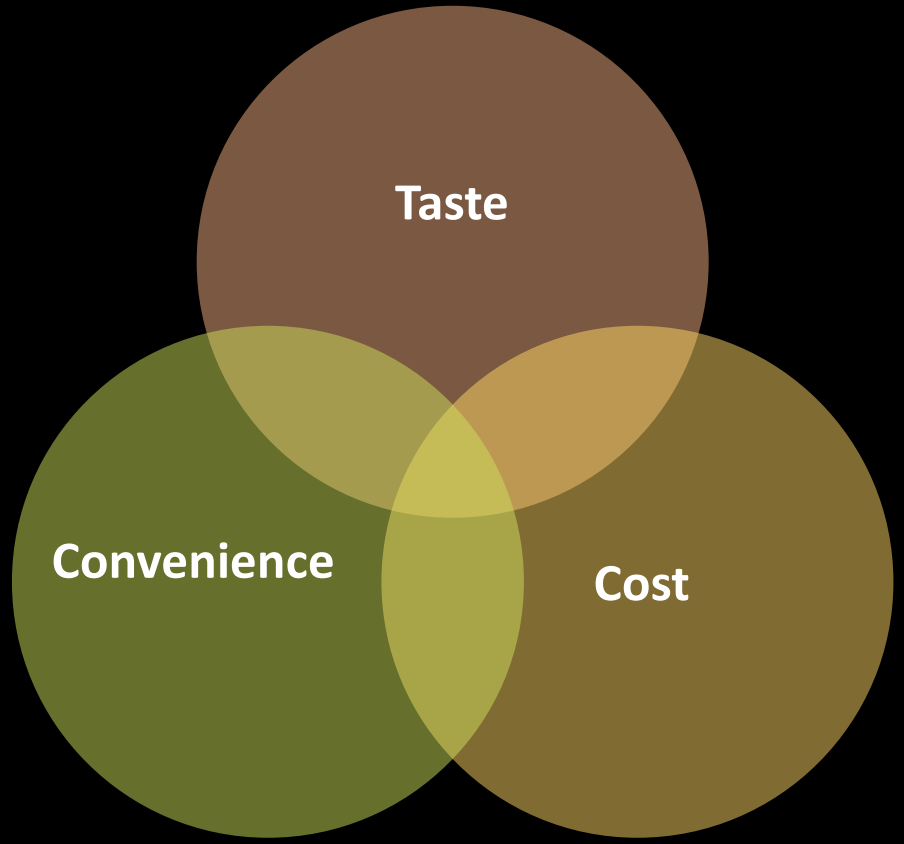
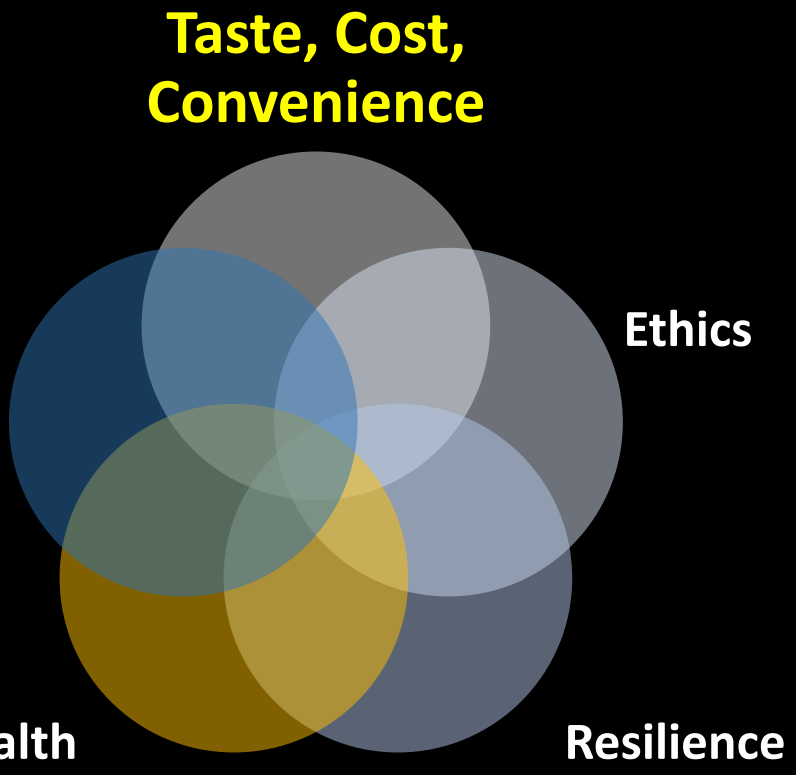
UNIVERSITY OF MASSACHUSETTS
1863

UNIVERSITY OF LEEDS

Food Science & Engineering:
The Old Paradigm



Food Science & Engineering:
The New Paradigm



Acknowledgements

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