

**IWC
PARIS
2008**



5th International Whey Conference

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

The science behind the value

Why Whey?

Bruce German

**University of California, Davis
Nestlé Research Center, Lausanne**

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ The Rationale behind the benefits of milk
- ~ Translational Science
- ~ Beyond milk, whey as an innovator of food values
- ~ Future of Whey Values

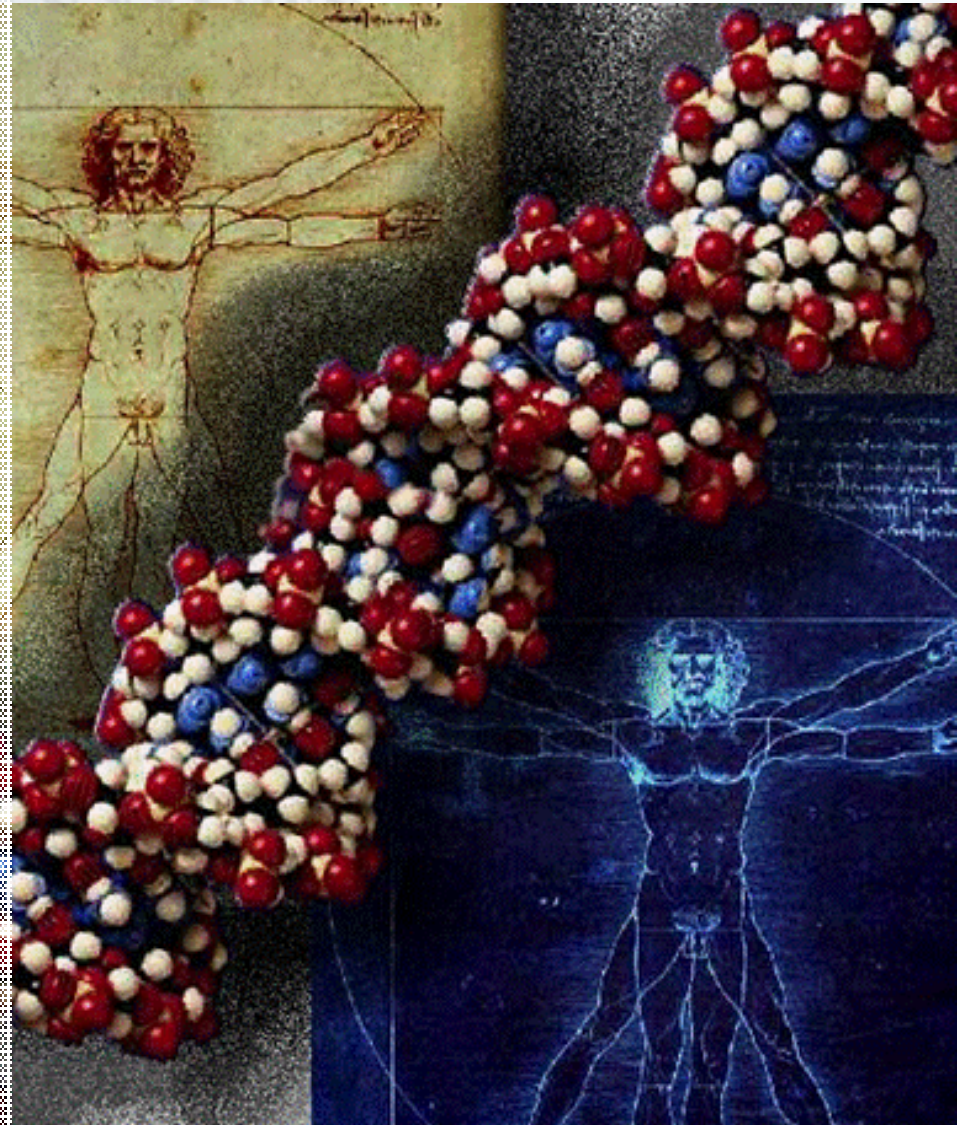
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ The Rationale behind the benefits of milk
- ~ Translational Science
- ~ Beyond milk, whey as an innovator of food values
- ~ Future of Whey Values

Genomics: the Molecular Footsteps of Evolution

- ~ Humans:
- ~ Plants:
- ~ Animals
- ~ Microorganisms:

What can they tell
us about Diet and
Health?



Where do we look for the next generation of Health?

Explore the Plant Kingdom for Bioactive Molecules

Is this the right model for Health?

Plants evolved with the constant Darwinian selective pressure: to avoid being eaten by growing animals

Lactation

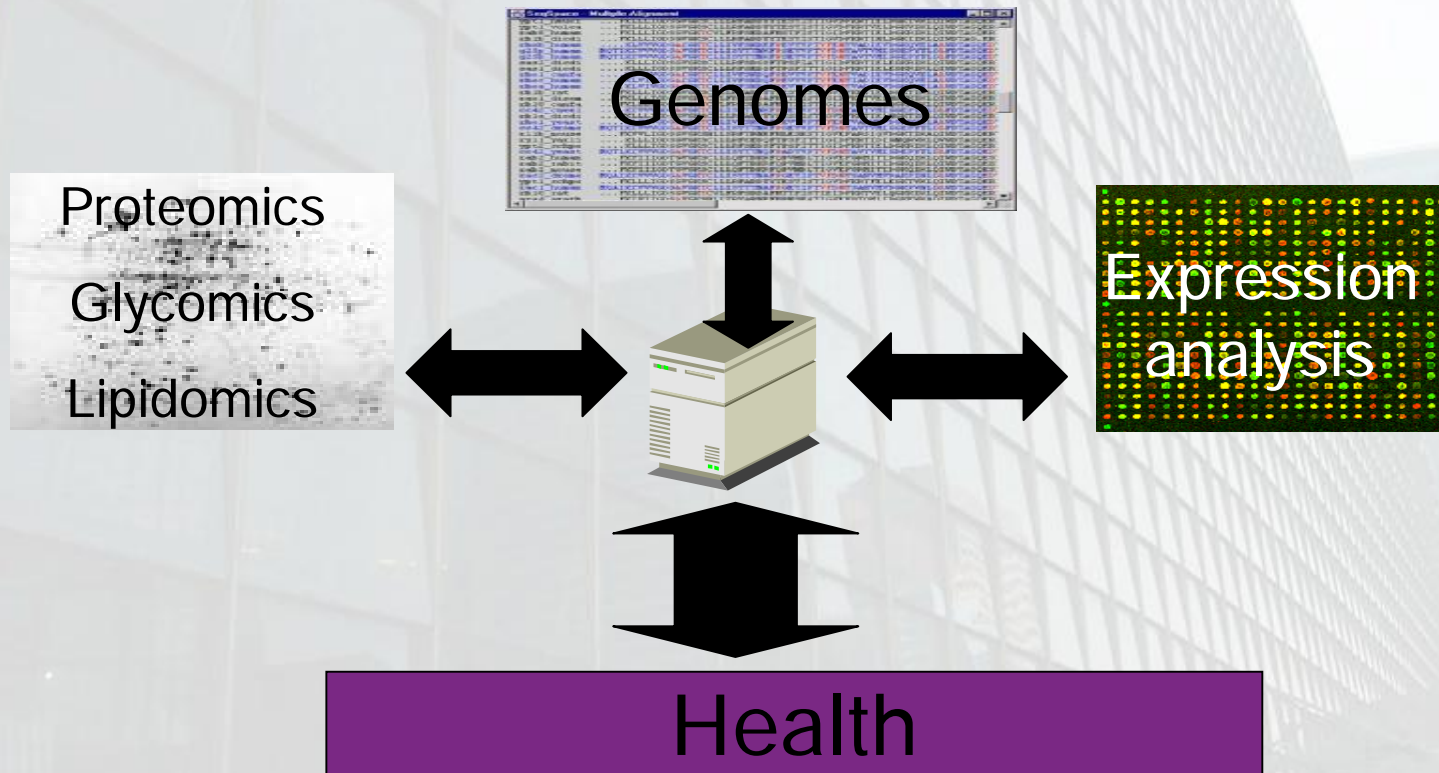
Through **evolutionary experimentation**, mammals have spent the last 120 million years successfully developing “the most **efficient, effective** and **adaptable** means of postnatal **nutrient** provision that has ever arisen among vertebrates-lactation.” *





Milk Genomics Consortium

Coordinating world wide resources to assemble, annotate and validate the subset of mammalian genomes responsible for milk: The Milk Genome



~ Black Bear

è 4 month lactation
during fasting,
sleep in cave

~ Hooded Seal

è 4 day lactation
è 7 kg of fat/day from
mom to pup

Lactation Strategies



Olaf Oftadal Smithsonian

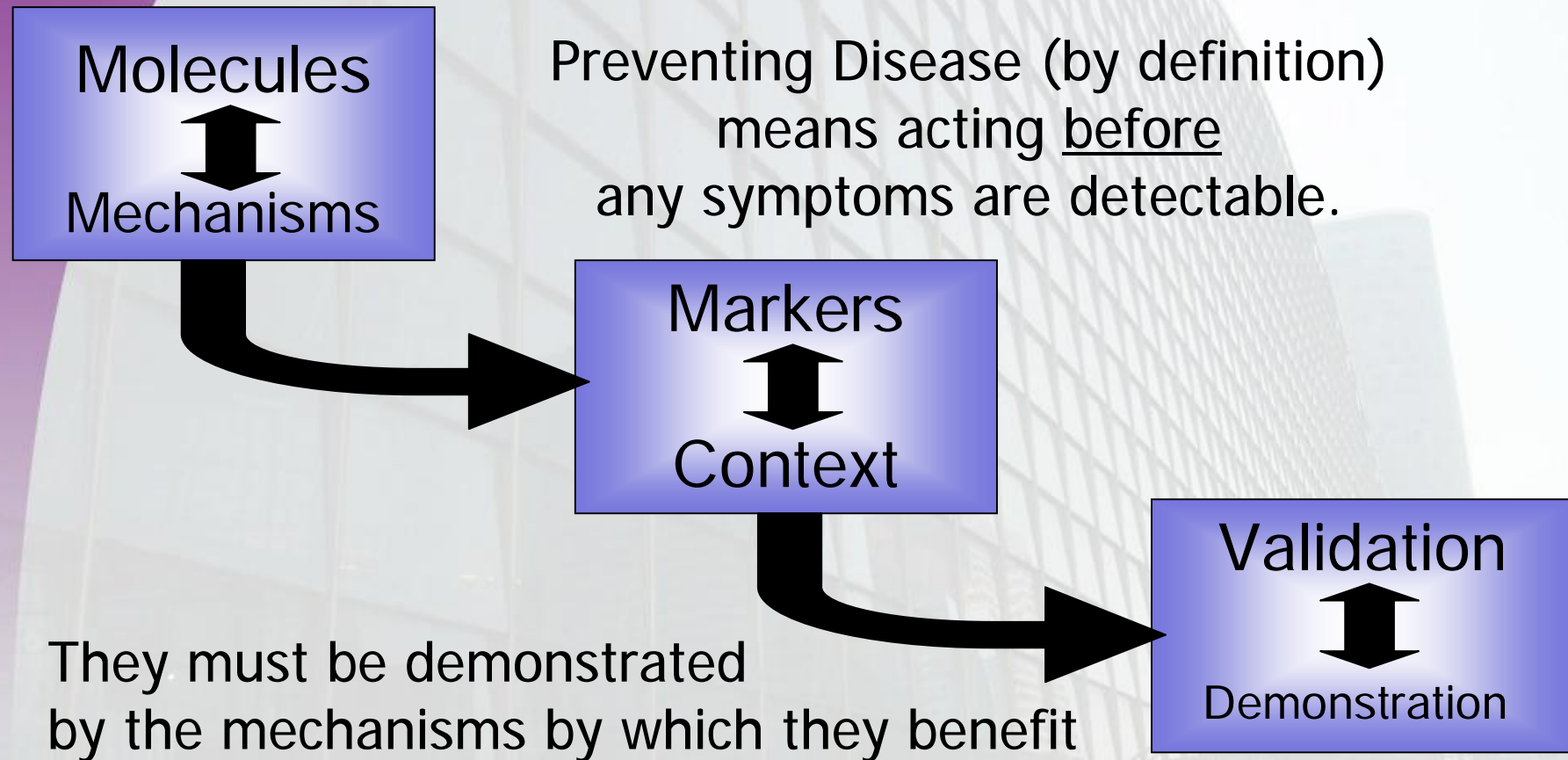


WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ The Rationale behind the benefits of milk
- ~ **Translational Science**
- ~ Beyond milk, whey as an innovator of food values
- ~ Future of Whey Values

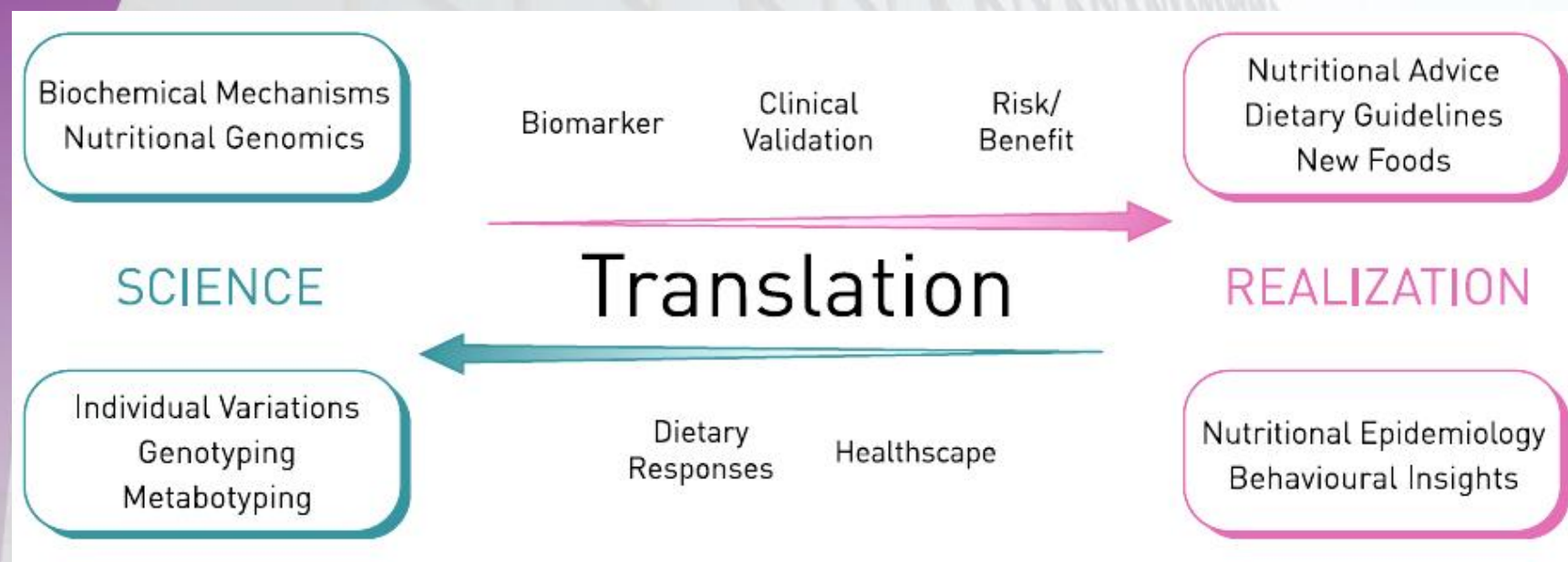
Why is milk undervalued

The Path to products that improve health and prevent disease is not nearly as simple as curing disease.





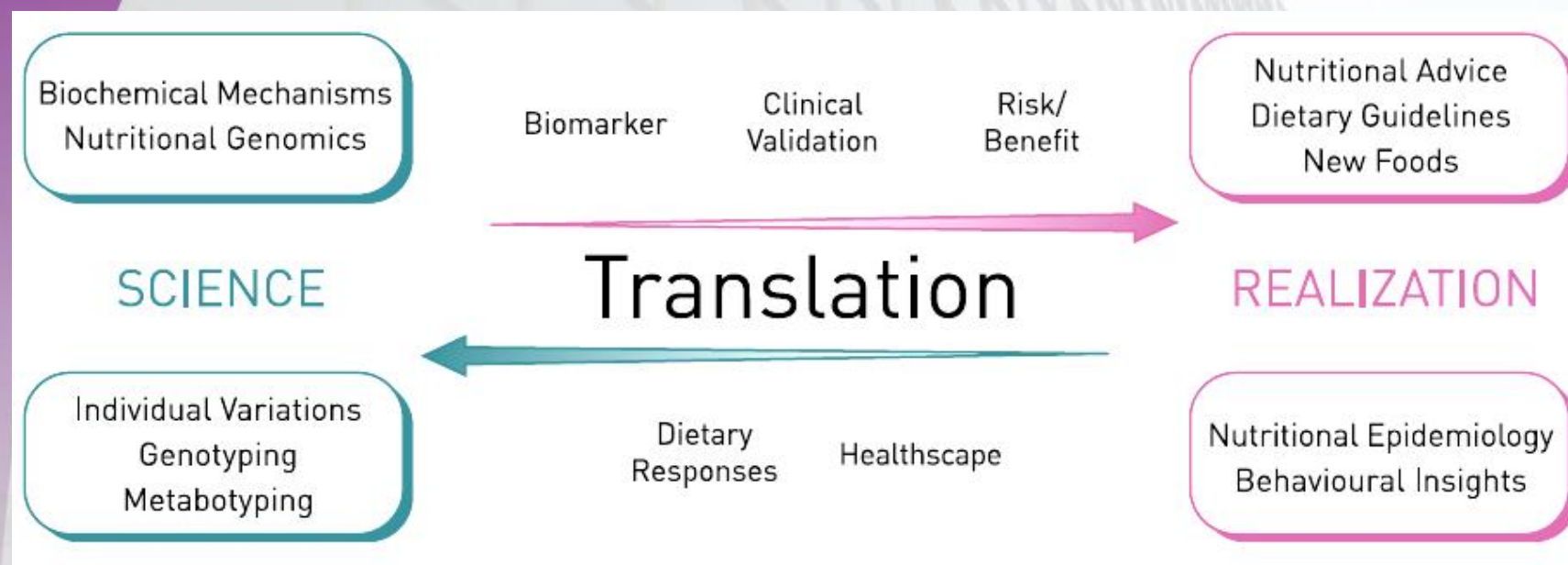
Translation as we see it



Translational Nutrition is bidirectional:
Translating as rapidly from bench to product as
Translating from variations in health to research strategy

Translation in Action

Leucine in protein synthesis to whey enriched products for the elderly



Whole Grain epidemiology to Food Structure and Metabolic Regulation

Postprandial protein synthesis and balance higher with whey than casein in elderly

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

Subjects:

è 9 elderly (72 ± 1 y)

Design:

è Crossover, randomized

Treatments:

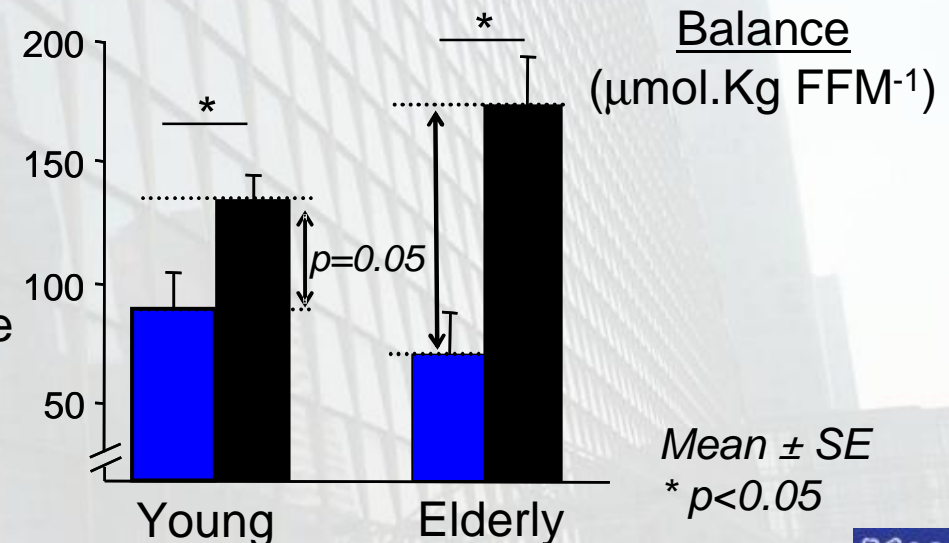
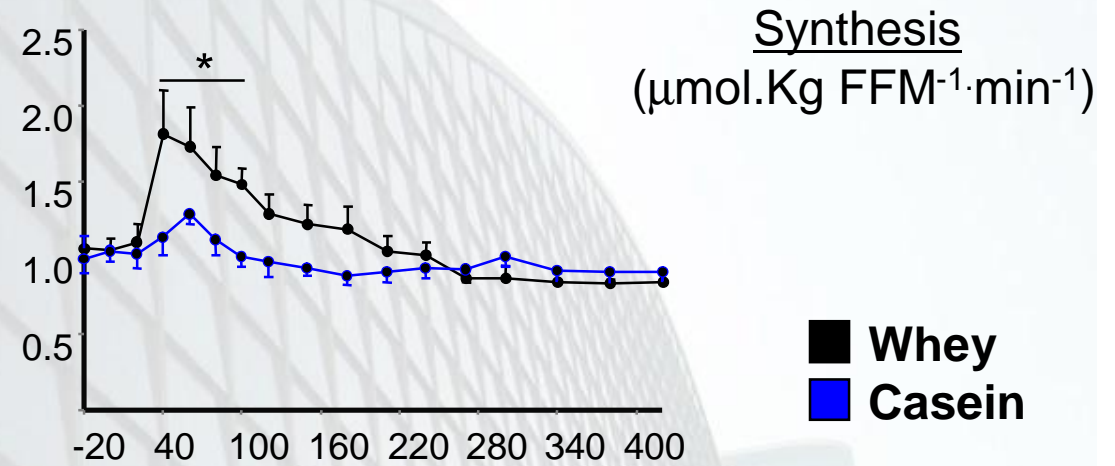
è Casein drink (34 g)

è Whey protein drink (34g)

Outcomes:

è Postprandial protein synthesis (whole body)

è Postprandial protein balance (whole body)





WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ It is now possible to produce accurate quantitative images of individuals prior to, during and after dietary intervention
- ~ Nestle and GE are partnering in this new approach to proof of health

Innovative Demonstration

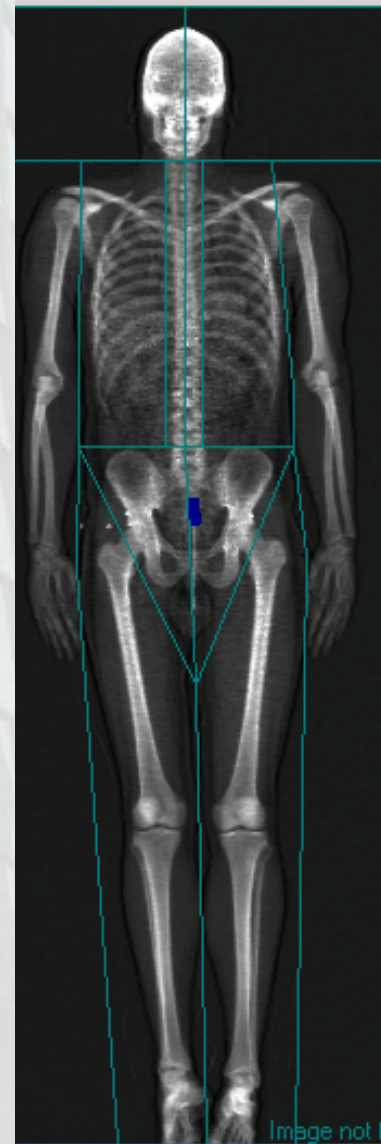


Image not for diagnosis

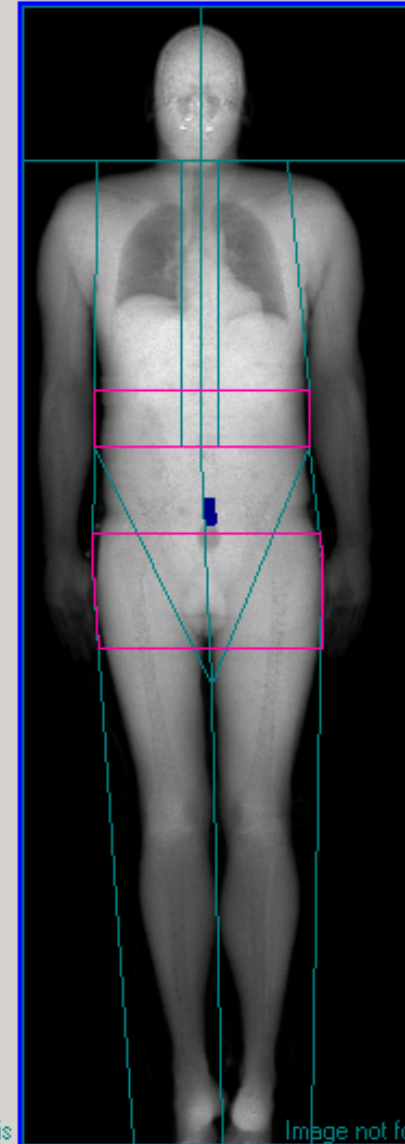


Image not for diagnosis



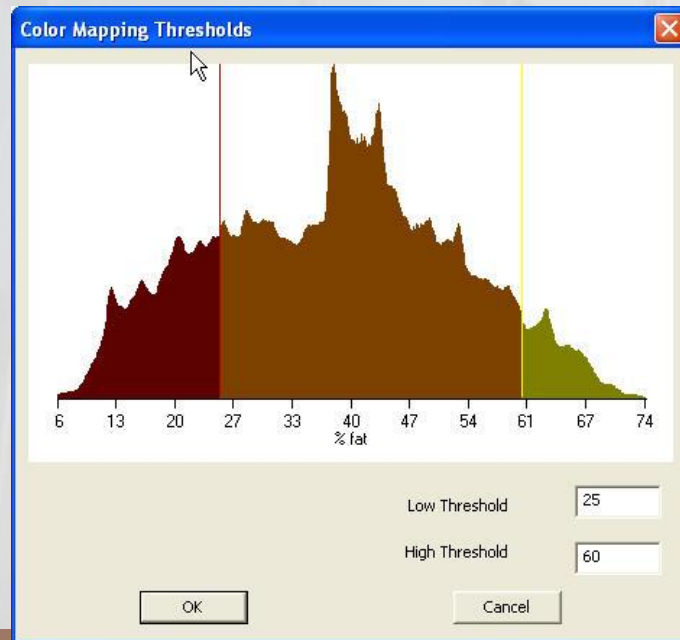
Good Food, Good Life



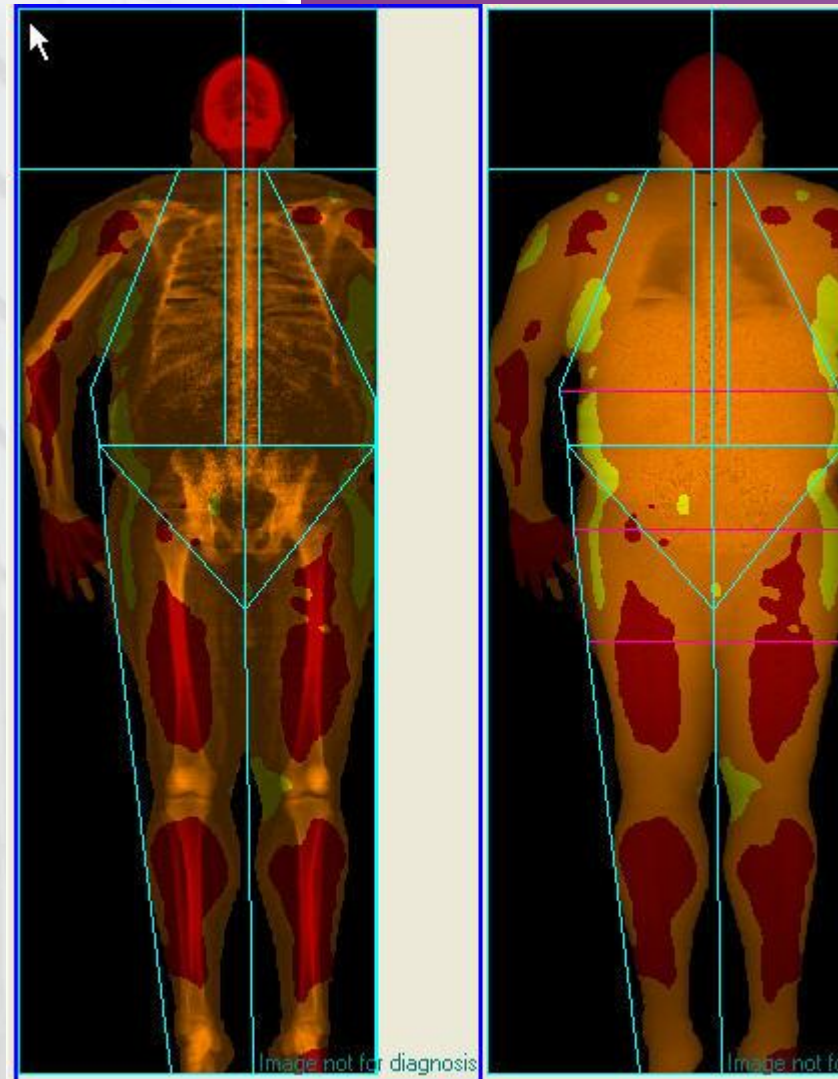


WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

Quantitative Imaging of body composition: Bone, Muscle Adipose



Imaging Health Benefits





WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ The Rationale behind the benefits of milk
- ~ Translational Science
- ~ Beyond milk, whey as an innovator of food values
- ~ Future of Whey Values

Whey Proteins for Structure

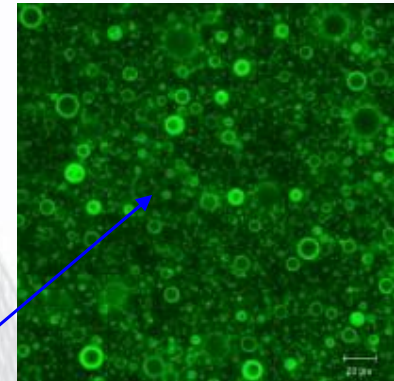
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

**Whey – most
nutritional protein
source**

Fat droplet (~ 2000nm)



**Coacervates with
polysaccharides
(acacia gum)**



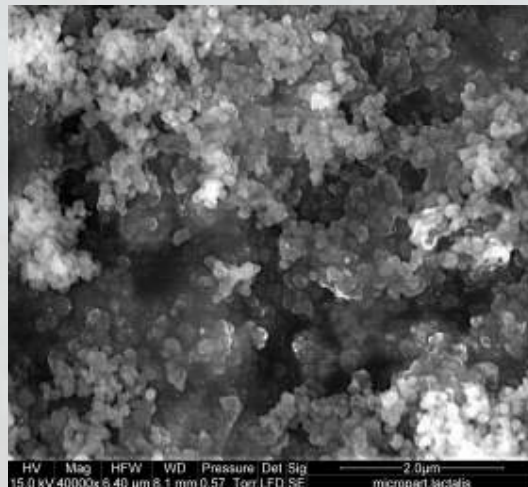
Casein micelle (~ 200nm)



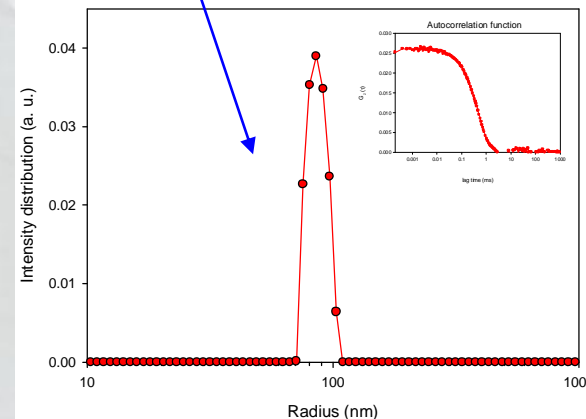
Whey proteins (~15nm)

Lactose (~1nm)

**Micellization
through
thermal
treatment**



Size distribution of Blg particles in the presence
of lyso-lecithin at a molar ratio of 2



**Micellization
through
Protein-
Emulsifier
Interactions**

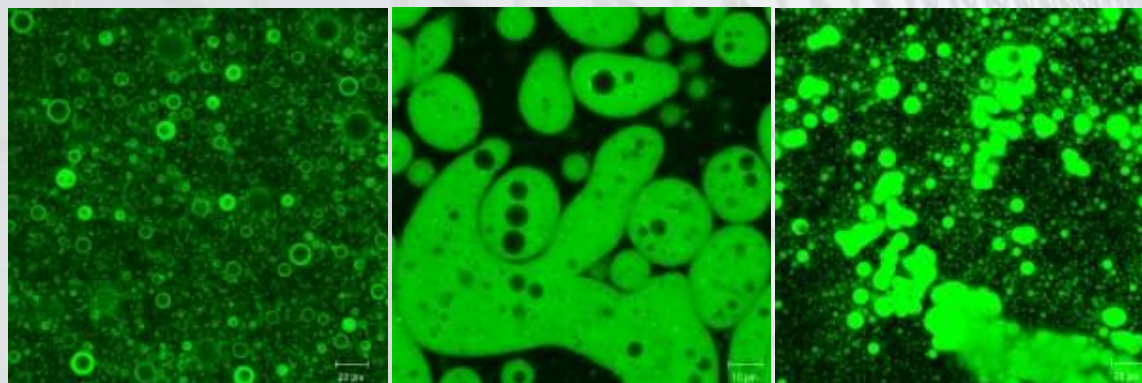
Biopolymer Interactions

b-lactoglobulin



Acacia gum

**Bulk
coacervation of
a mixture of b-
lactoglobulin 2.5
wt% and acacia
gum 1.25 wt% at
pH 4.2.**

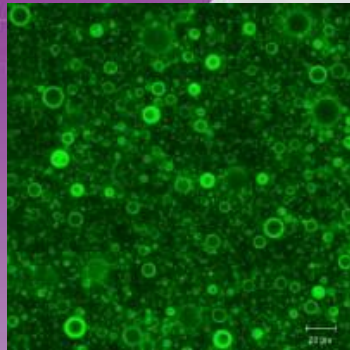


time

Coacervation = concentration of biopolymers to form a liquid viscoelastic phase

Whey protein isolate/acacia gum electrostatic complexes and coacervates

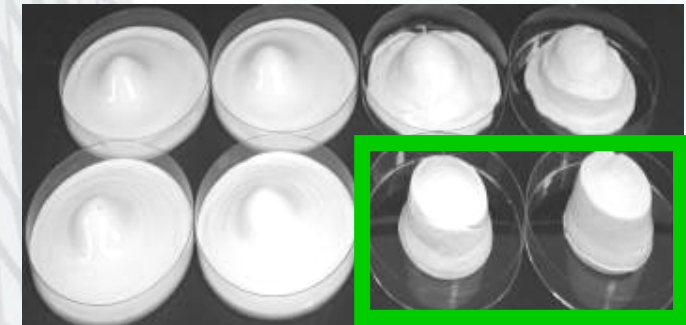
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION



At acidic pH (< 5.2), WPI/acacia gum form spontaneously electrostatic complexes. Aggregation of complexes = liquid coacervates.

Benefits in ice cream:

- shape retention,
- clean label (no emulsifiers needed),
- heat shock stability,
- creaminess in low-fat products,
- improved nutritional benefits by addition of whey proteins and a fiber (acacia gum).

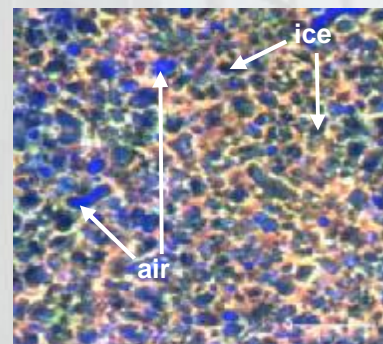
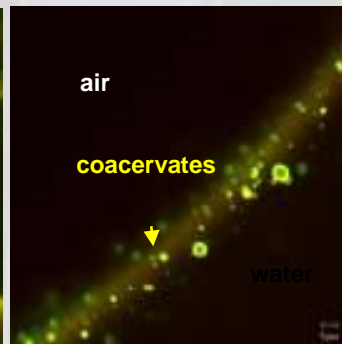
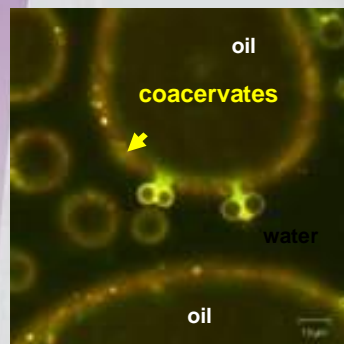


90 min, 37 °C

Complex

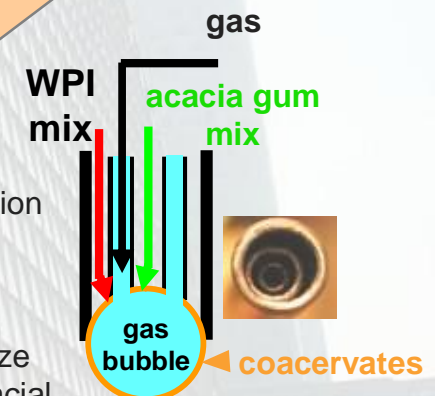
Interfacial activity

Product design



Re-organization of complexes at air/water or oil/water interface to form a stable coacervate viscoelastic film.

Design of an injection needle to control complex formation during interface creation to maximize formation of interfacial film at the right place.



Whey as Delivery Vehicle

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

Milk proteins extract, stabilize and deliver the nutritional components of other raw materials

Fat droplet (~ 2000nm)



Casein micelle (~ 200nm)

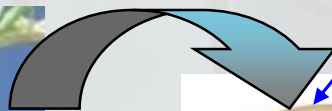


Whey proteins (~15nm)

Lactose (~1nm)



Lacto-Wolfberry

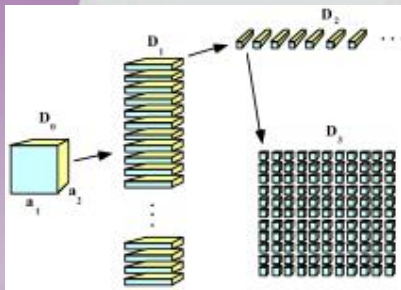


Lacto-Lycopene

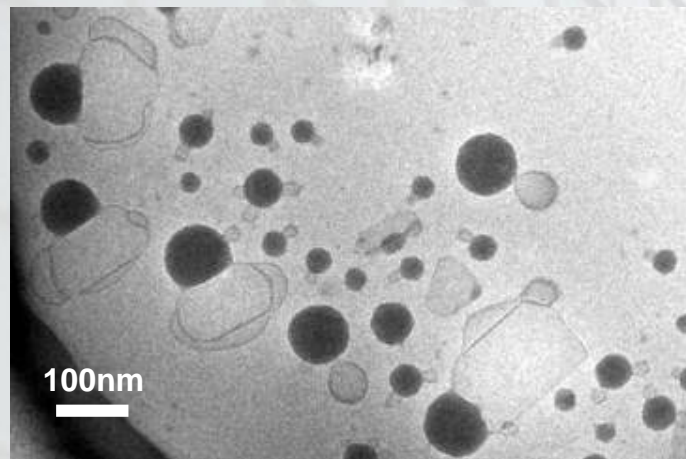


Lacto-lycopene™ Delivery

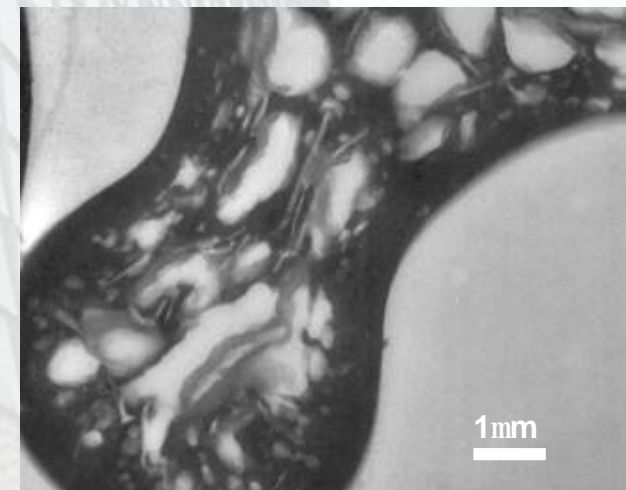
- ~ Colloidal approach to suppress crystallization:
 - è high binding capacity to milk proteins
 - è micro-crystals are more absorbable than larger crystals
 - è stabilization and delivery through digestible carrier



Colloidal
Strategy



Crystals of
Lycopene on oil droplets



Embedded in milk
Protein matrix



WHEYVOLUTION

WHEYVOLUTION

WHEYVOLUTION

WHEYVOLUTION

WHEYVOLUTION

Using milk as both
extracting agent and
carrier for the integral
retention of water- & oil-
soluble bioactives of the
'whole' fruit.



Bioguided Processing



Patented process

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ The Rationale behind the benefits of milk
- ~ Translational Science
- ~ Beyond milk, whey as an innovator of food values
- ~ Future of Whey Values



WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

- ~ 20th Century Science
 - è What Food Is
- ~ 21st Century Science
 - è What Food Does



WHEYVOLUTION

WHEYVOLUTION

WHEYVOLUTION

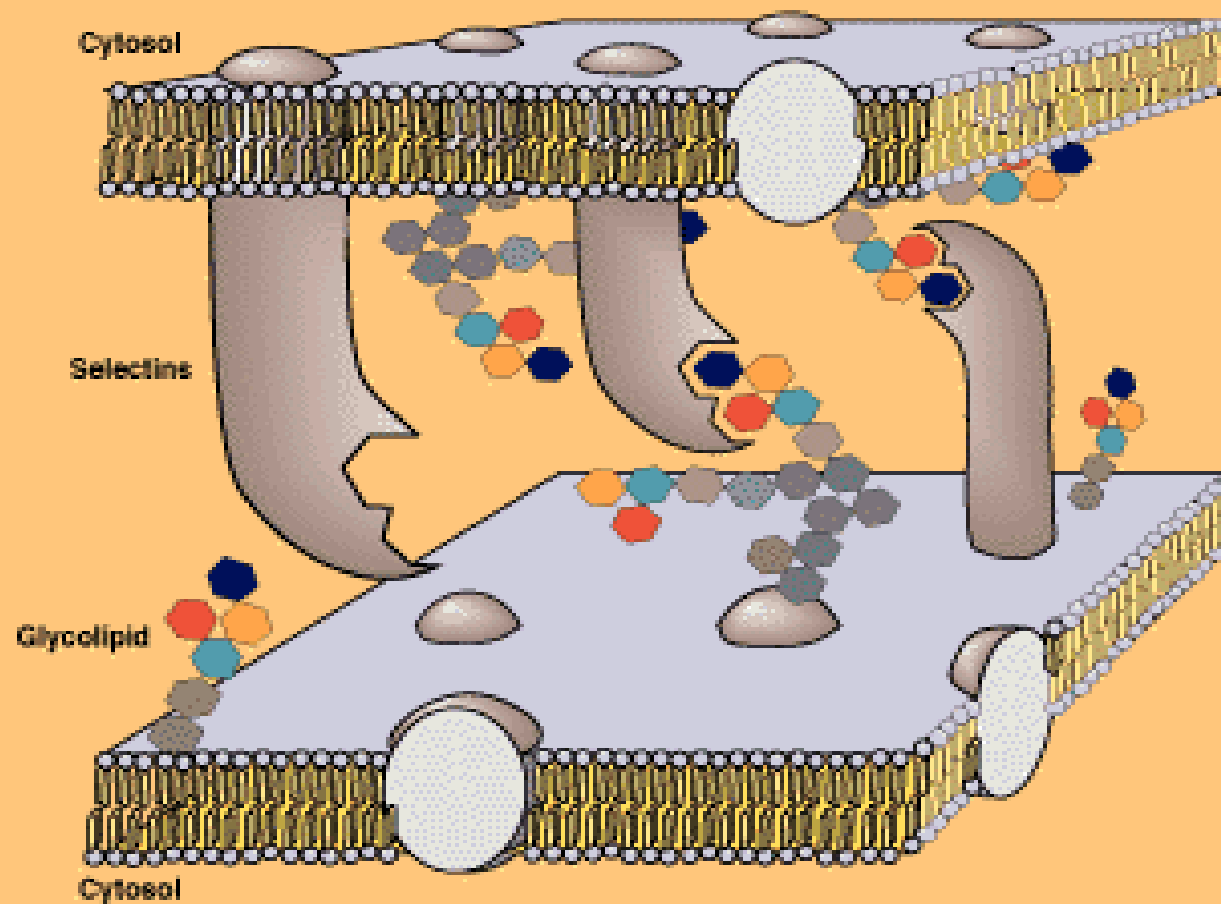
WHEYVOLUTION

WHEYVOLUTION

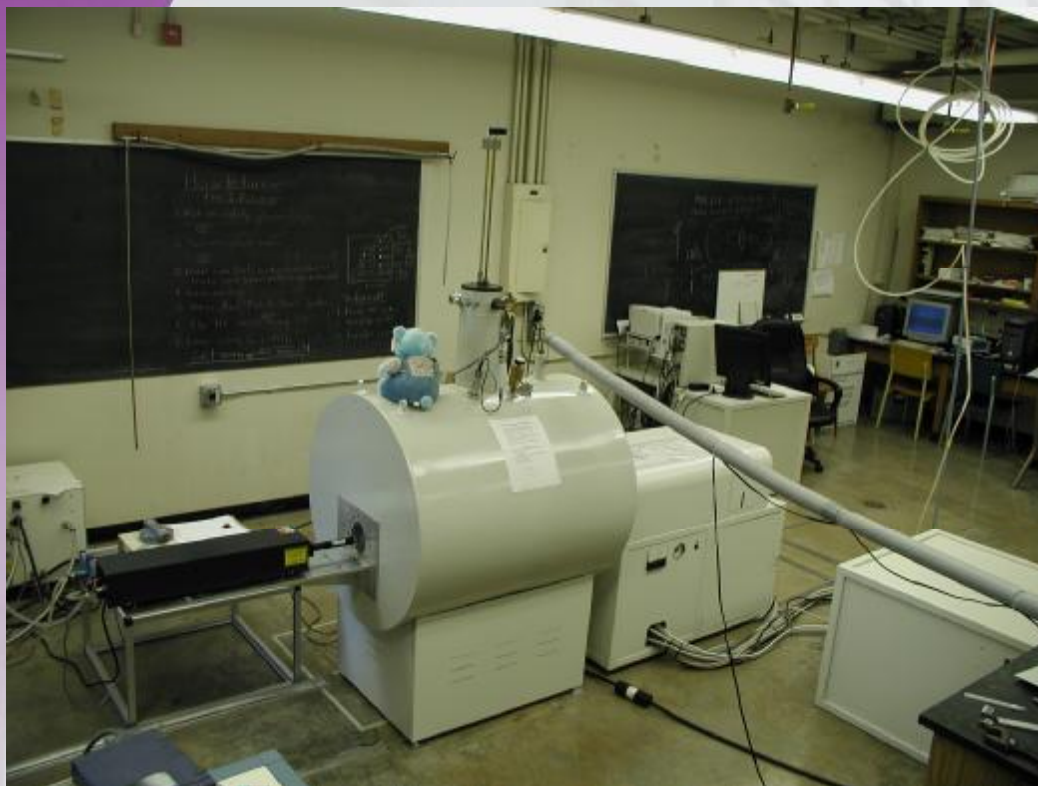
Glycobiology

Interaction of cell surfaces through carbohydrate recognition

1



Fourier transform Ion cyclotron resonance MS



MALDI and ESI sources compatible.



Carlito Lebrilla



Glycoproteomics

- ~ The majority of milk proteins are glycosylated.
- ~ What is the role of glycans in glycoproteins?
- ~ Entire field is limited by the absence of high throughput technologies to analyze glycoproteins.



WHEYVOLUTION

WHEYVOLUTION

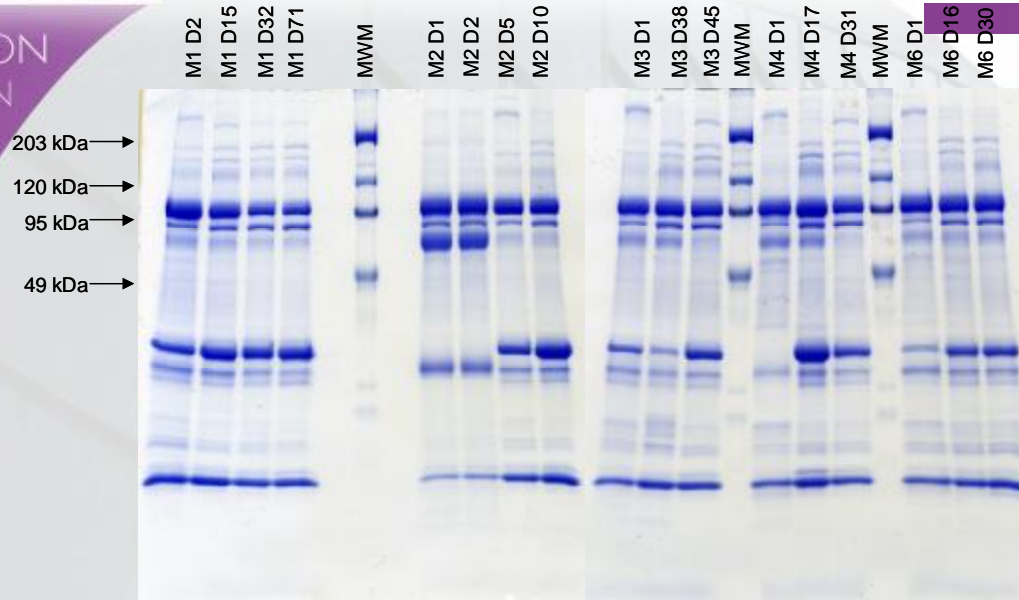
WHEYVOLUTION

WHEYVOLUTION

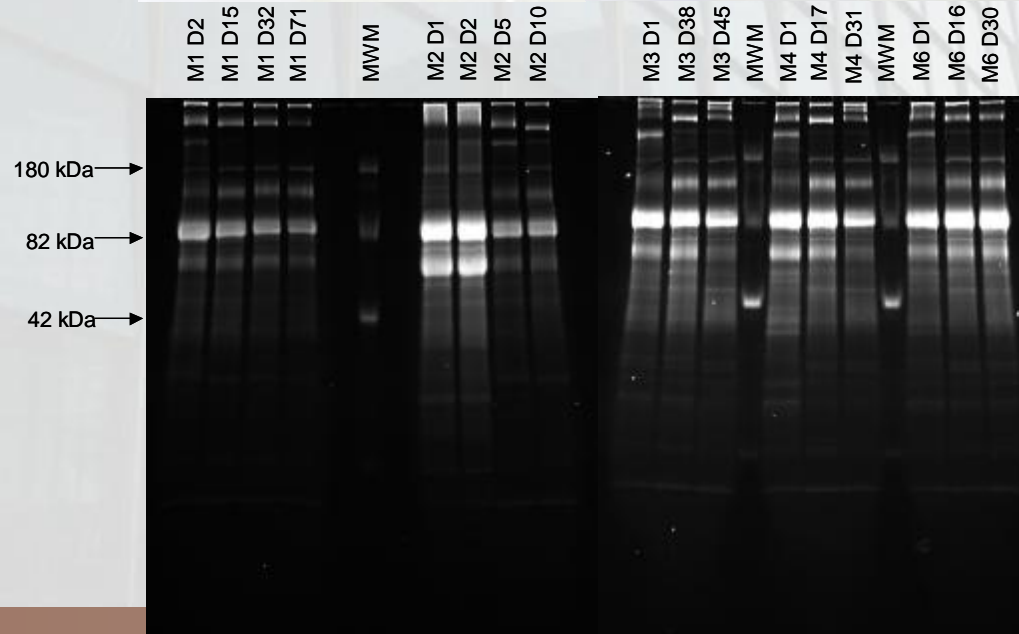
WHEYVOLUTION

WHEYVOLUTION

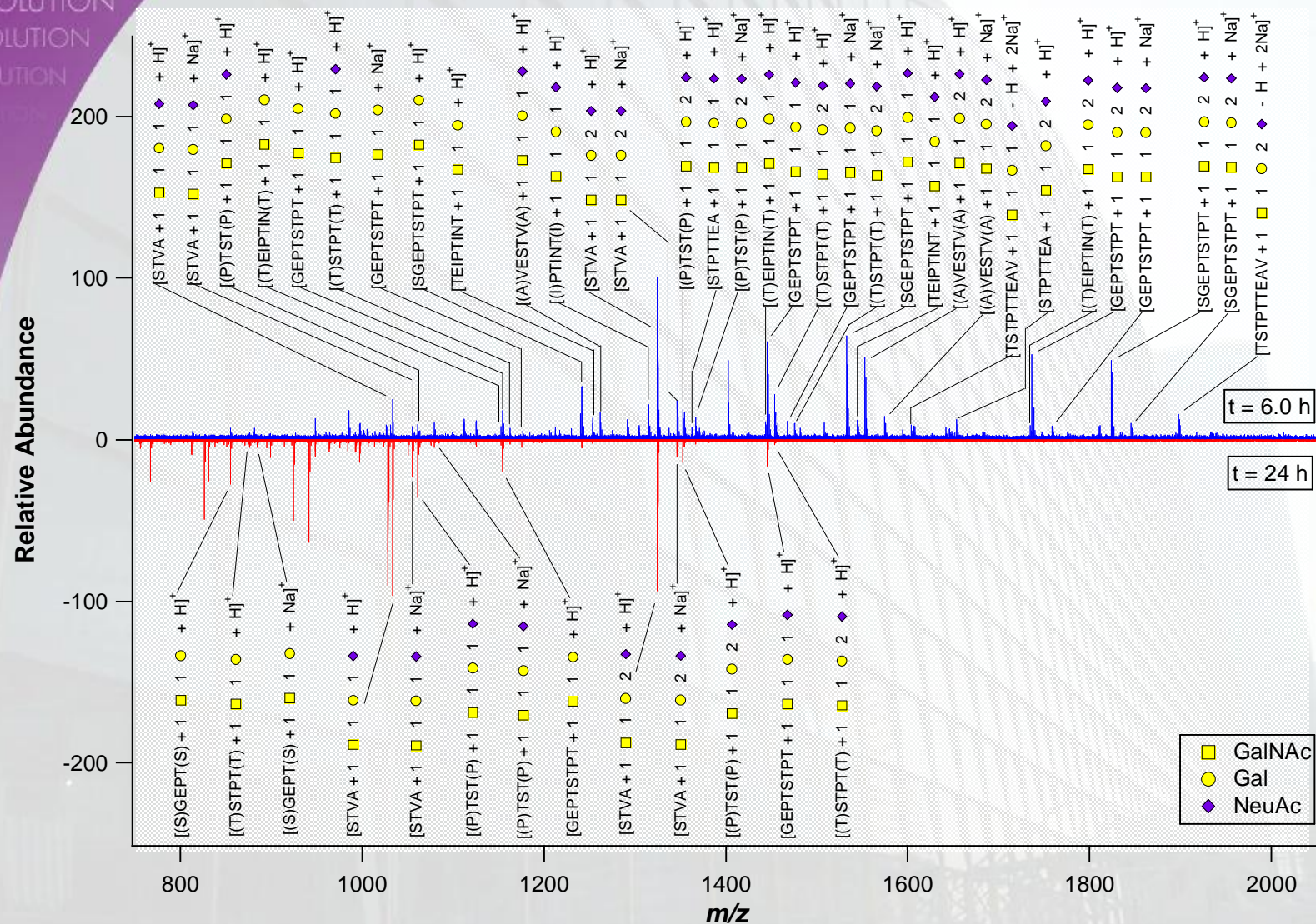
milk proteins: total and glycosylated



Total
Protein

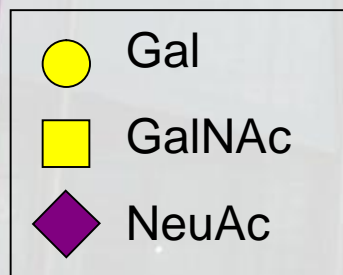
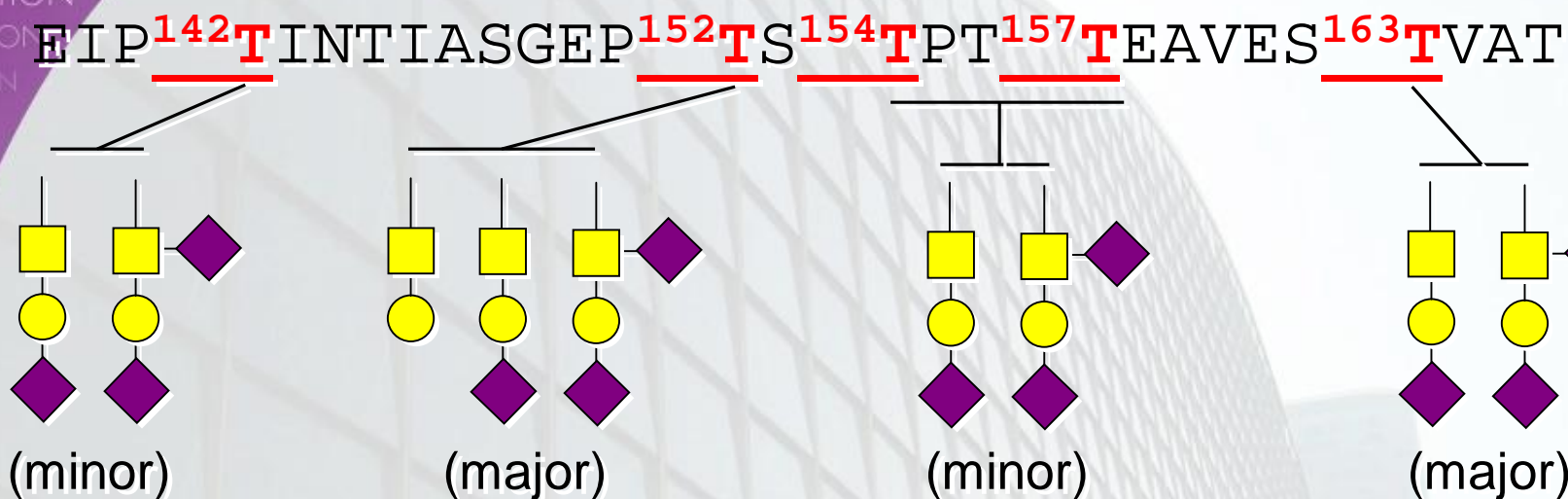


Glycosylated
Protein



Site-specific glycosylation of k-casein

WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION
WHEYVOLUTION

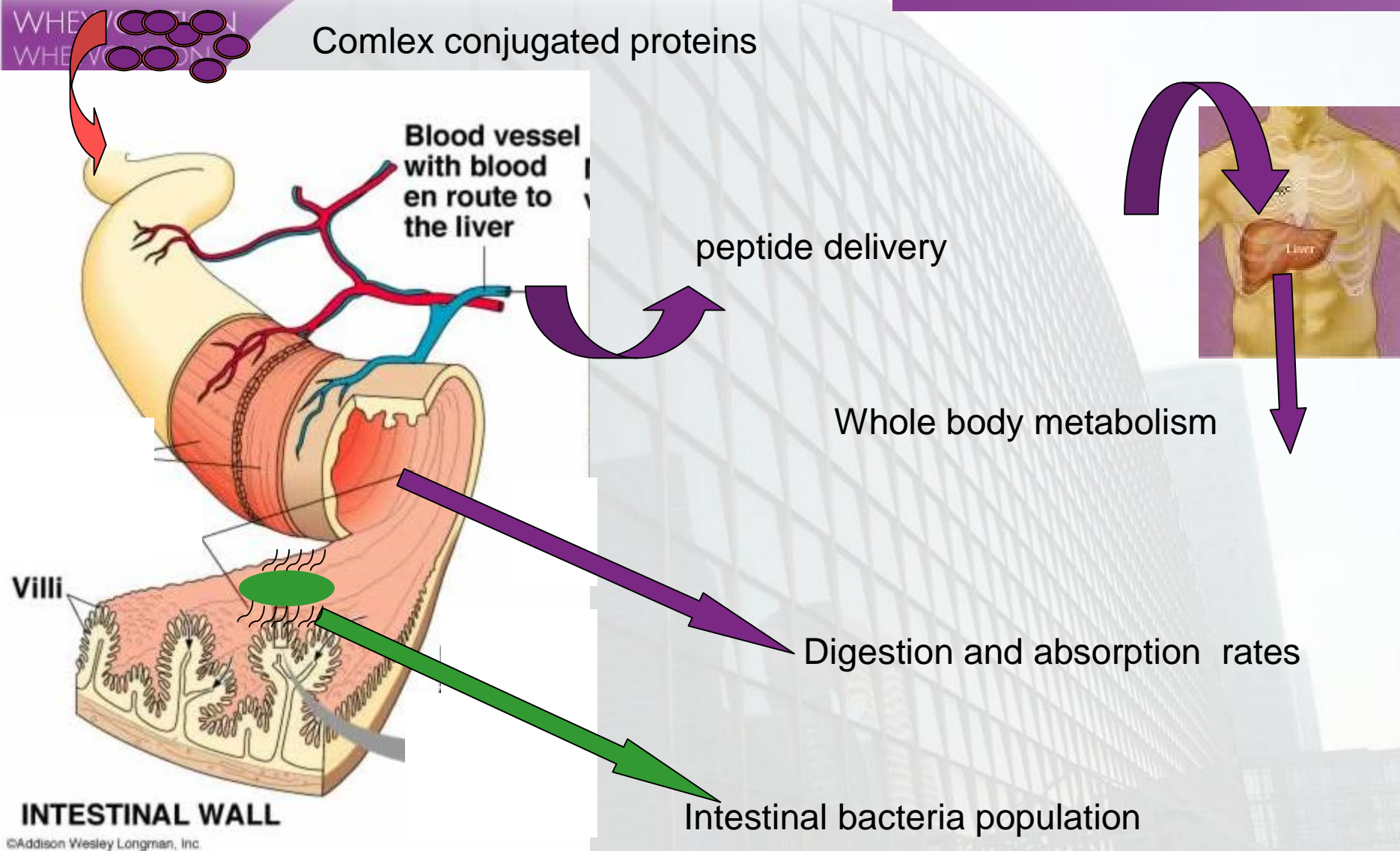


Relative abundance of glycopeptides is in agreement with the previous observation that glycosylation of each site is ordered:

$T\ 152 > T\ 163 > T\ 154 > T\ 157 \ \& \ T\ 142$

J. W. Holland, H. C. Deeth, and P. F. Alewood, *Proteomics* 5: 990-1002 (2005).

The Multiple Targets of Whey





Conclusions

- ~ Milk evolved under the Darwinian pressure to improve the health of healthy mammals
- ~ Science is still discovering the molecules, structures, mechanisms and benefits that milk provides
- ~ As Life sciences become dominated by biological properties of foods, whey will be increasingly recognized for these values