Dairy Science Basics for Product Developers

Dr. Carmen Licon-Cano and Dr. Rohit Kapoor

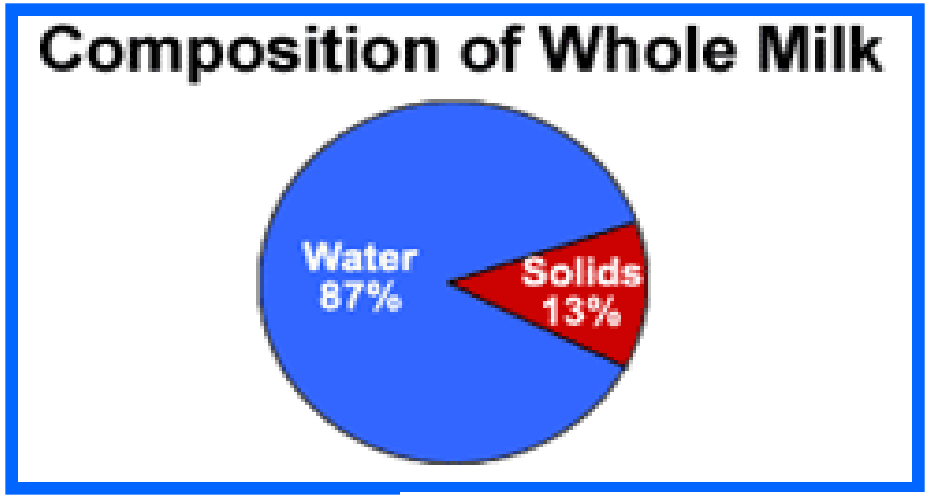
Agenda

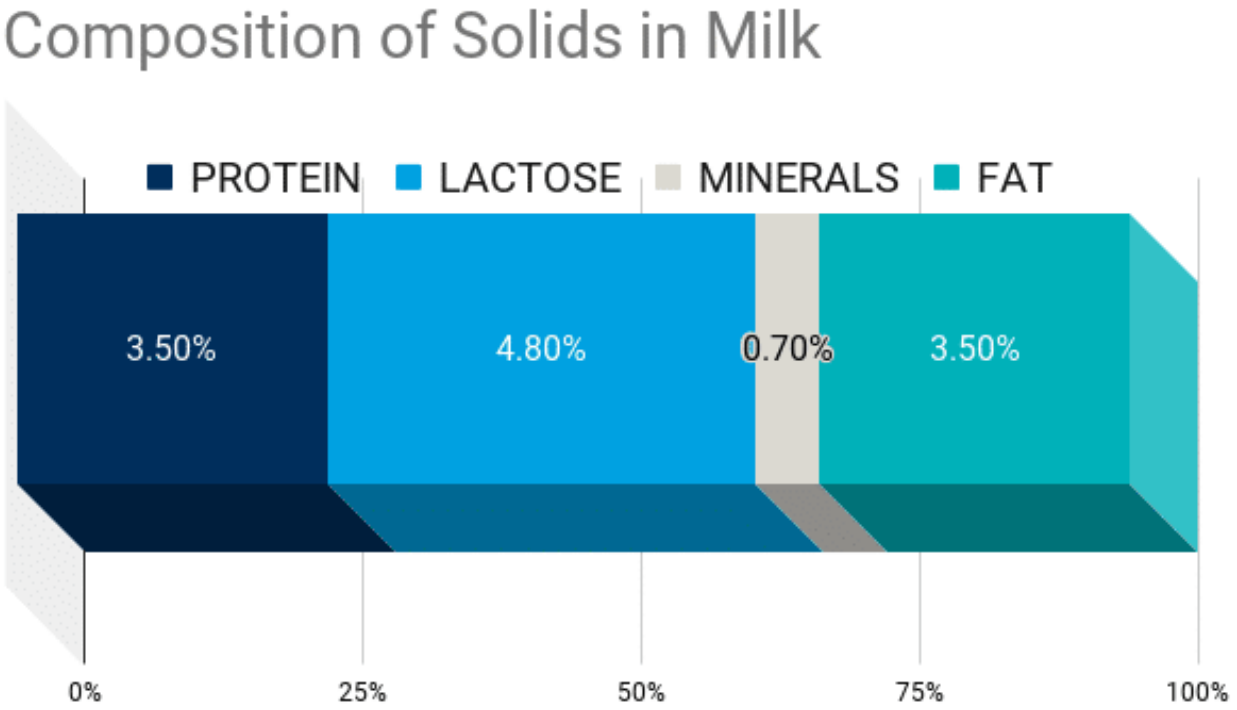
1. **Major milk components and their properties**
2. **Dairy unit operations**
3. **Dairy Ingredients for food product development**
    1. Perspectives on ingredients in food product development
    2. Dry Dairy Ingredients
        1. Dairy protein ingredients
        2. Lactose rich dairy ingredients
    3. Fat Rich Dairy Ingredients
    4. Cheese as an Ingredient
4. **Useful resources (websites, guides, dairy centers)**

1. Major Milk Components And Their Properties

Milk Gross Composition

- Water
- Solids:
  - Lactose
  - Fat
  - Proteins
  - Minerals
  - Others





https://adpi.org/make-it-with-dairy/composition/

Milk Gross Composition

Table 3. Composition of Milk from Different Mammalian Species (per 100 g fresh milk).
Source: Webb, B.H., A.H. Johnson and J.A. Alford. 1974. Fundamentals of Dairy Chemistry. Second Ed. AVI Publishing Co., Westport, CT., Chap. 1.

	Protein (g)	Fat (g)	Carbohydrate (g)	Energy (kcal)
Cow	3.2	3.7	4.6	66
Human	1.1	4.2	7.0	72
Water Buffalo	4.1	9.0	4.8	118
Goat	2.9	3.8	4.7	67
Donkey	1.9	0.6	6.1	38
Elephant	4.0	5.0	5.3	85
Monkey, rhesus	1.6	4.0	7.0	73
Mouse	9.0	13.1	3.0	171
Whale	10.9	42.3	1.3	443
Seal	10.2	49.4	0.1	502

The constituents of milk can vary considerably between **breeds** and between **individual** animals

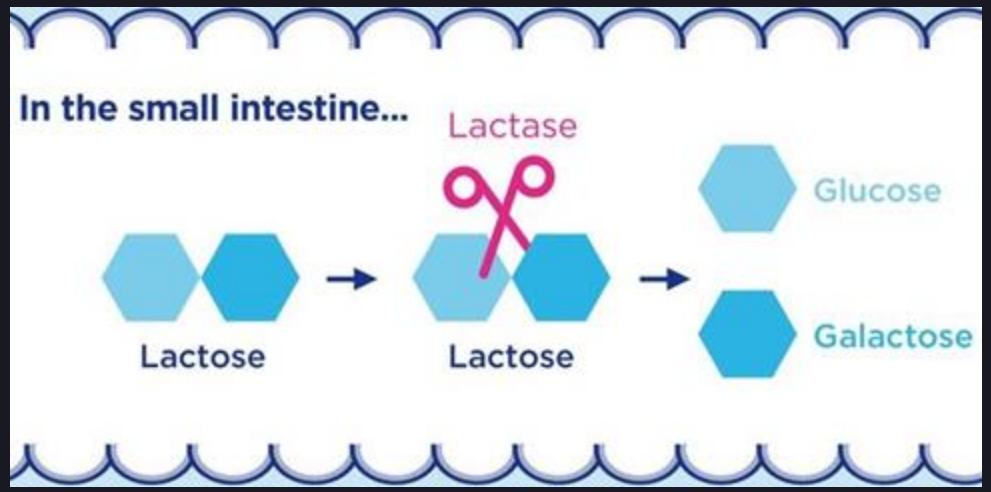
https://www.uoguelph.ca/foodscience/table-3-0

Some key concepts:

The residue left when water and gases are removed is called the **dry matter (DM)** or **total solids** content of the milk

The residue left when water, gases and fat are removed is called the **solids-not-fat** content of the milk

LACTOSE



Unique to milk

Found in nearly all mammmals

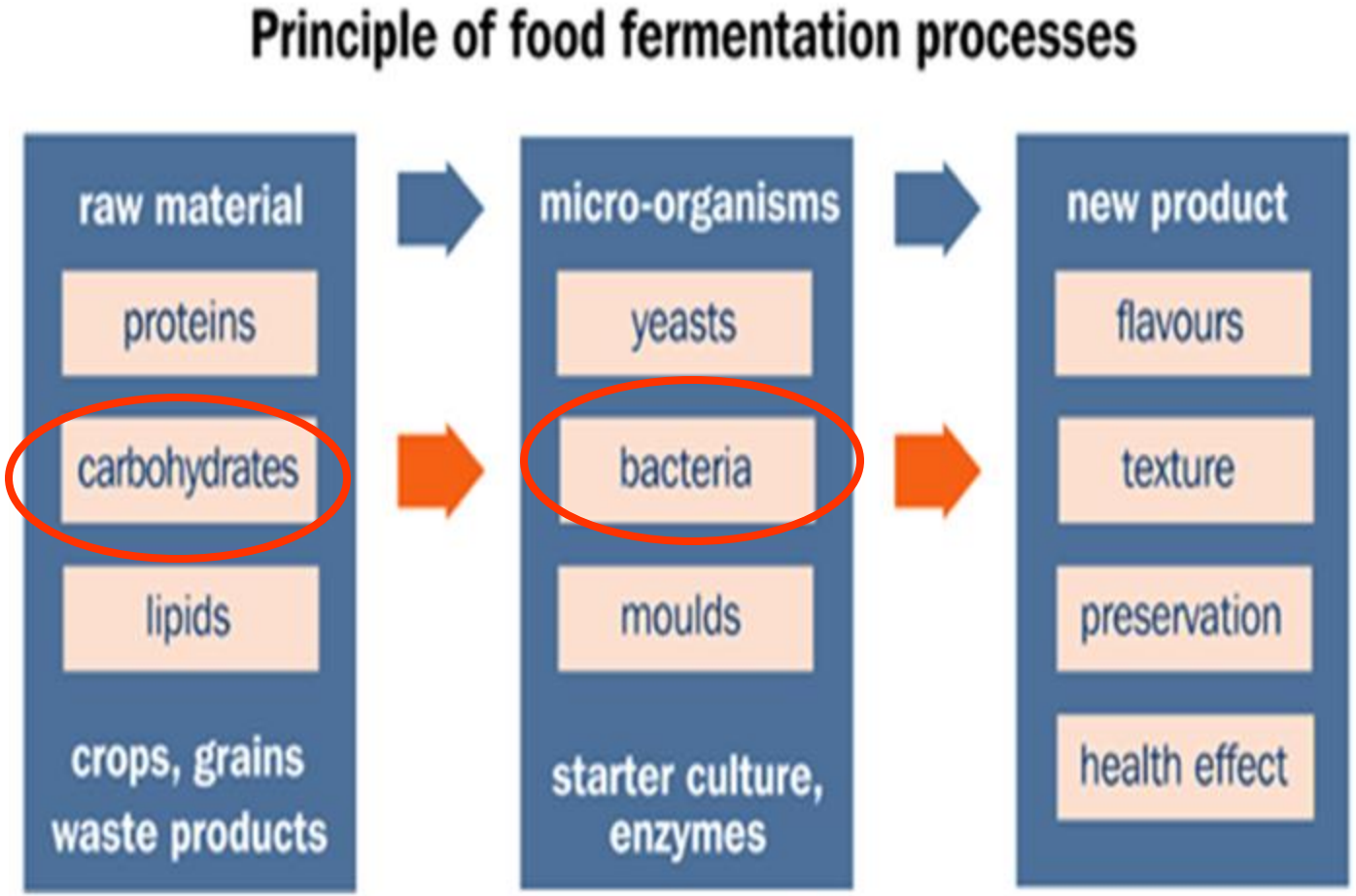
0.3 times sweeter than sucrose

Sweetness is masked by protein and enhanced by hydrolization

Raw material for derivates

Lactulose, lactitol, oligosaccharides

Lactose fermentation

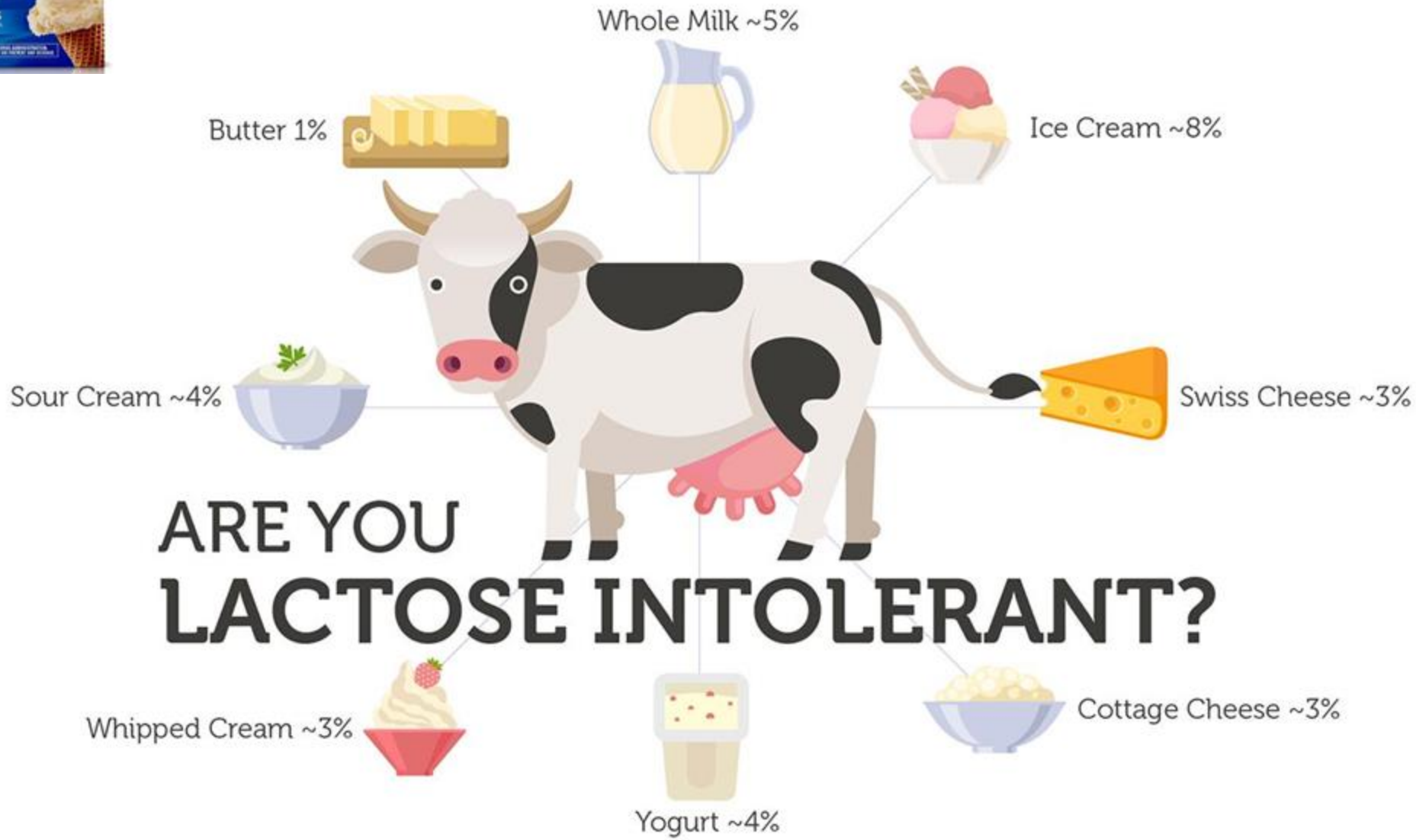


YOGURT

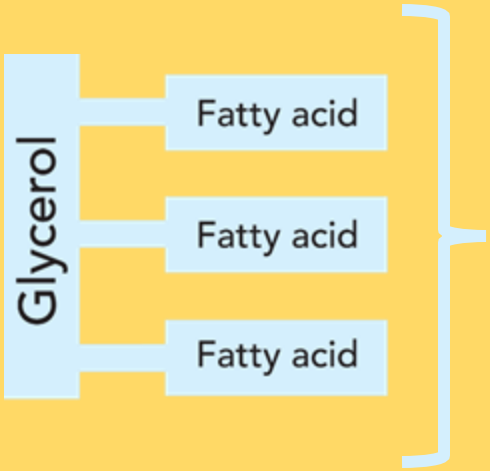
CHEESE

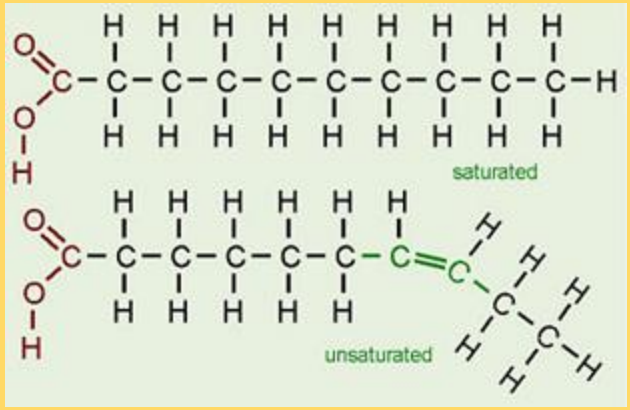
Lactic acid

ENJOY DAIRY AGAIN!
Lactaid
Fast Act
LACTASE ENZYME SUPPLEMENT
For the Prevention of
GAS • BLOATING • DIARRHEA
32 CAPLETS


Whole Milk ~5%
Butter 1%
Ice Cream ~8%
Sour Cream ~4%
Swiss Cheese ~3%
ARE YOU
LACTOSE INTOLERANT?
Whipped Cream ~3%
Cottage Cheese ~3%
Yogurt ~4%

Milk Fat





4 and 18 carbons
Mainly pair number of carbons

98%

Triglycerides
Diglycerides
Fatty Acids
Sterols
Carotenoids
Vitamins: A, D, E, K

Milk flavor is characterized by the presence of relatively large amounts of **butyric** and **hexanoic (caproic)** acids

Phospholipids
Lipoproteins
Glycerides
Cerebrosides
Proteins
Nucleic acids
Enzymes
Metals
Water

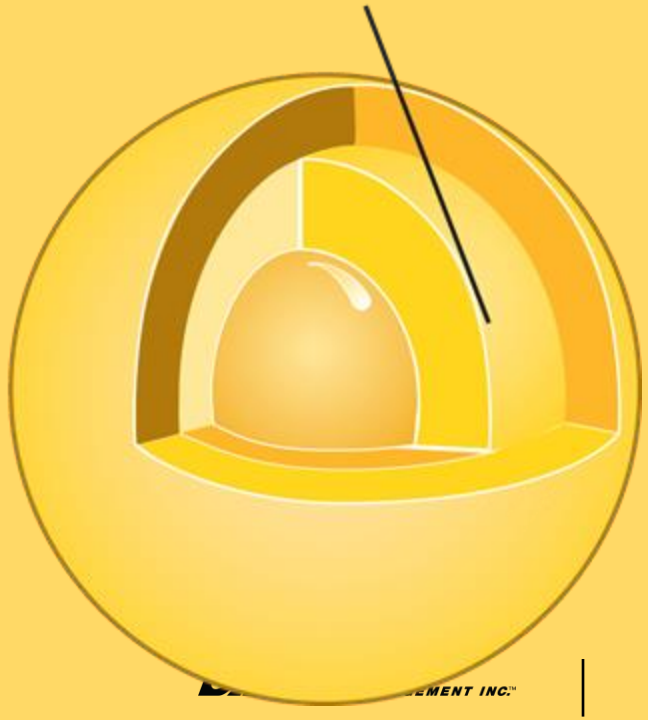


Table 3. Composition of the major fatty acids in milk fat.[1]

Fatty acid carbon number	Fatty acid common name	Average range (wt%)
4:0	Butyric	2–5
6:0	Caproic	1–5
8:0	Caprylic	1–3
10:0	Capric	2–4
12:0	Lauric	2–5
14:0	Myristic	8–14
15:0	Pentadecanoic	1–2
16:0	Palmitic	22–35
16:1	Palmitoleic	1–3
17:0	Margaric	0.5–1.5
18:0	Stearic	9–14
18:1[2]	Oleic	20–30
18:2	Linoleic	1–3
18:3	Linolenic	0.5–2

[1]Adapted from Kaylegian and Lindsay (1995).

[2]Also contains about 3% of total as *trans* isomers (Jensen and Newberg, 1995).

Milk Fat

Table 15. Phospholipid and sphingolipid composition of bovine milk.[1]

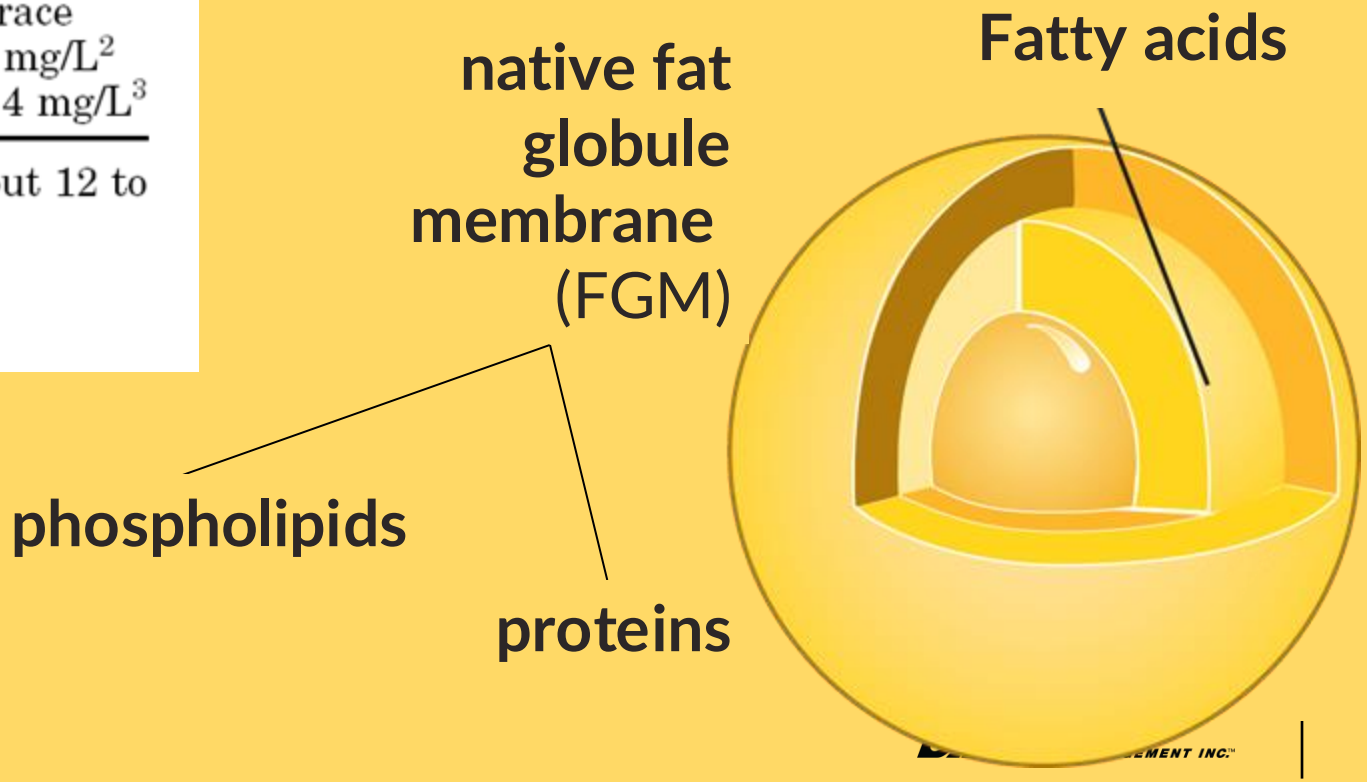
Phospholipid	Mol%
Phosphatidylcholine	34.5
Phosphatidylethanolamine	31.8
Phosphatidylserine	3.1
Phosphatidylinositol	4.7
Sphingomyelin	25.2
Lysophosphatidylcholine	Trace
Lysophosphatidylethanolamine	Trace
Total choline phospholipids	59.7
Plasmalogens	3
Diphosphatidylglycerol	Trace
Ceramides	Trace
Cerebrosides (neutral glycolipids)	3 mg/L[2]
Gangliosides	1.4 mg/L[3]

[1]Adapted from Jensen and Newberg (1995). Contains about 12 to 35 mg/dL.

[2]Christie et al. (1987).

[3]Rueda et al. (1998).

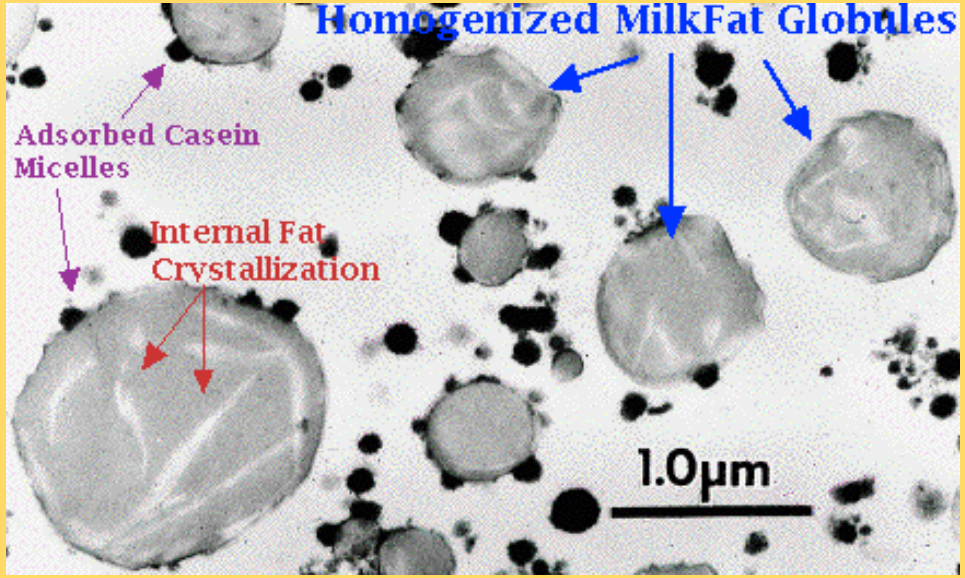
forms the insulation that protects your nerves and facilitates the conduction of nerve impulses



Jensen, 2002

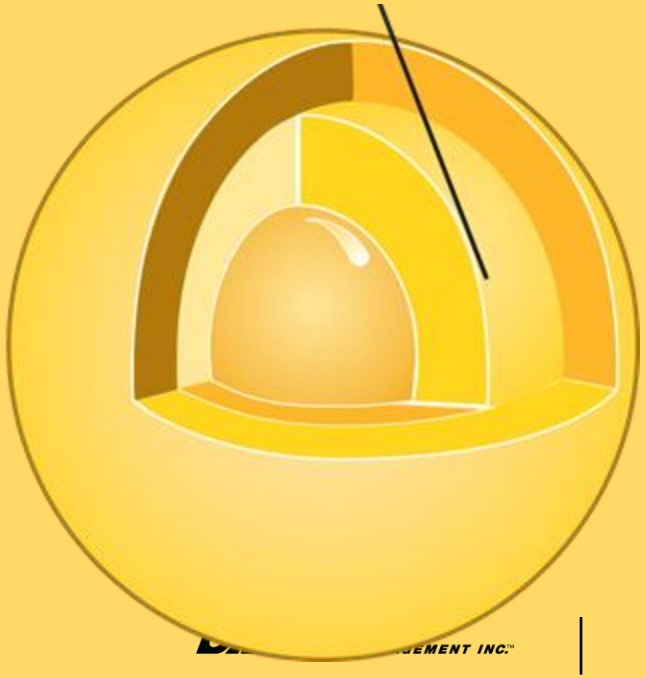
Milk Fat

Their diameters range from 0.1 to 20 **µm (1 µm = 0.001 mm)**; the average size is 3 – 4 µm



Milk fat is liquid when milk leaves the udder at 37°C

Fatty acids



- **Emulsion** is a suspension of droplets of one liquid in another
- Milk is an emulsion of **oil (fat) in water**

Jensen, 2002

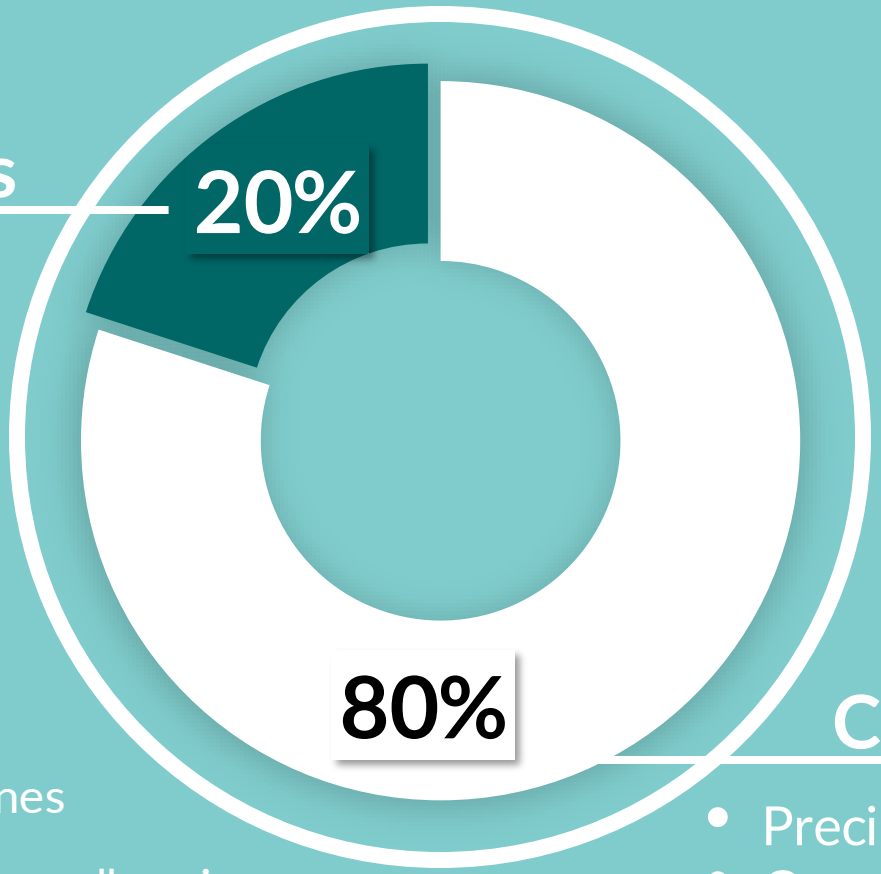
Milk Fat

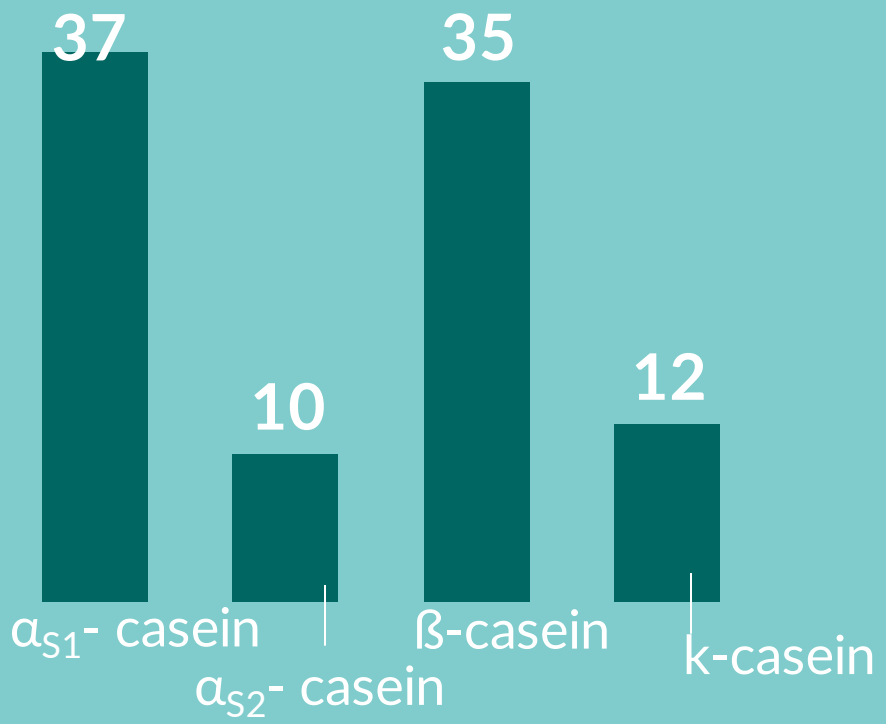
For what dairy products is important?

Milk Proteins

Serum proteins

- Heat labile, completely denature at 194 F for 10 min
- No P content
- Rich in S
- Remain in solution at pH 4.6





α-Lactalbumin

Proteose peptone

Immunoglobulines

Serum albumin

ß-Lactoglobulin

Others

Lactoferrin
Transferrin
Membrane proteins
Enzymes

11 fractions in total!

Caseins

- Precipitate at pH 4.6
- Coagulate in the presence of rennet
- Stable to high temperatures
- Contain P group (Ca binding properties)
- Micelles

Milk Proteins-micelles

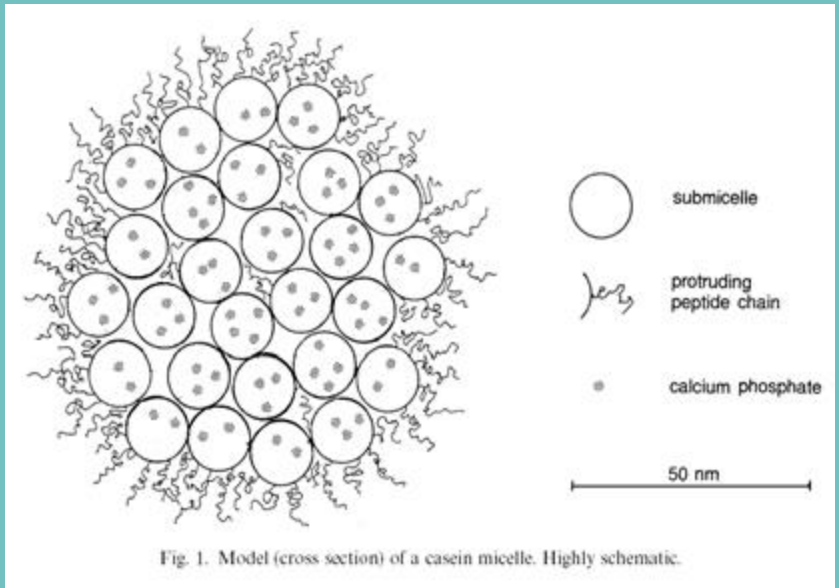
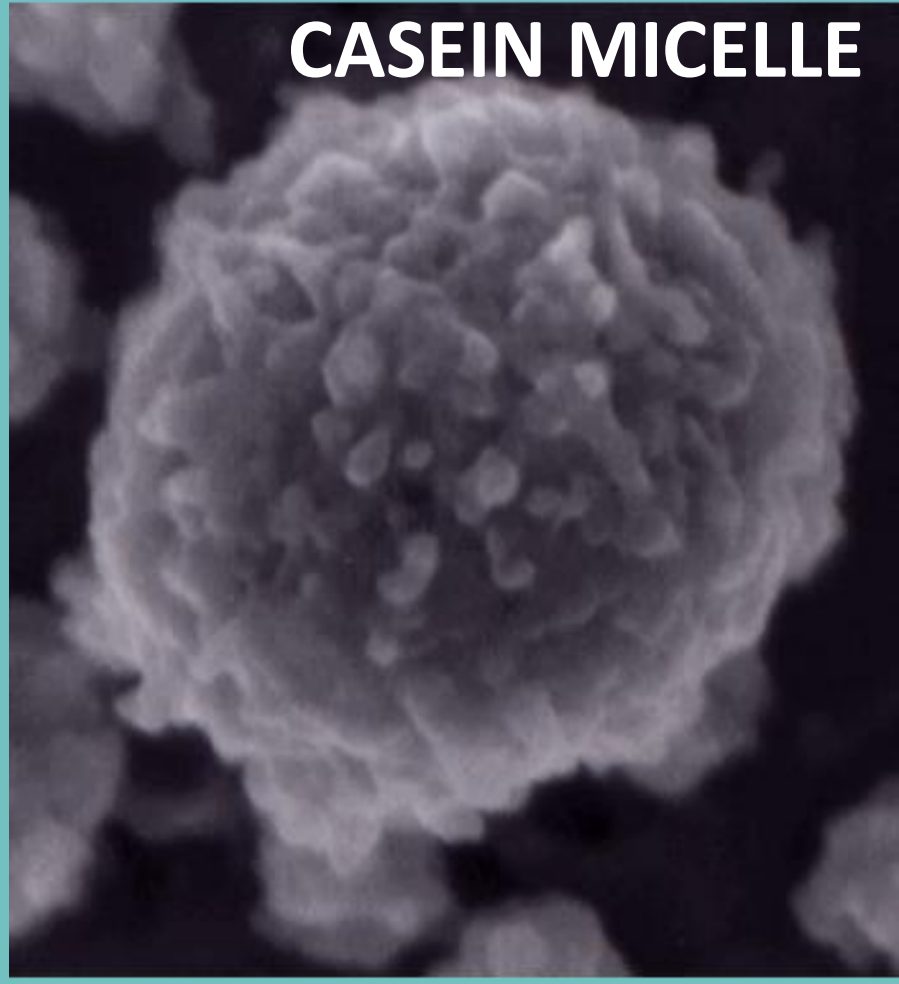


Fig. 1. Model (cross section) of a casein micelle. Highly schematic.

Modifications/alterations

1.Chymosin - rennet or other proteolytic enzymes
2.Acid
3.Heat
4. Age gelation



https://www.uoguelph.ca/foodscience/book-page/structure-casein-micelle

Whey proteins

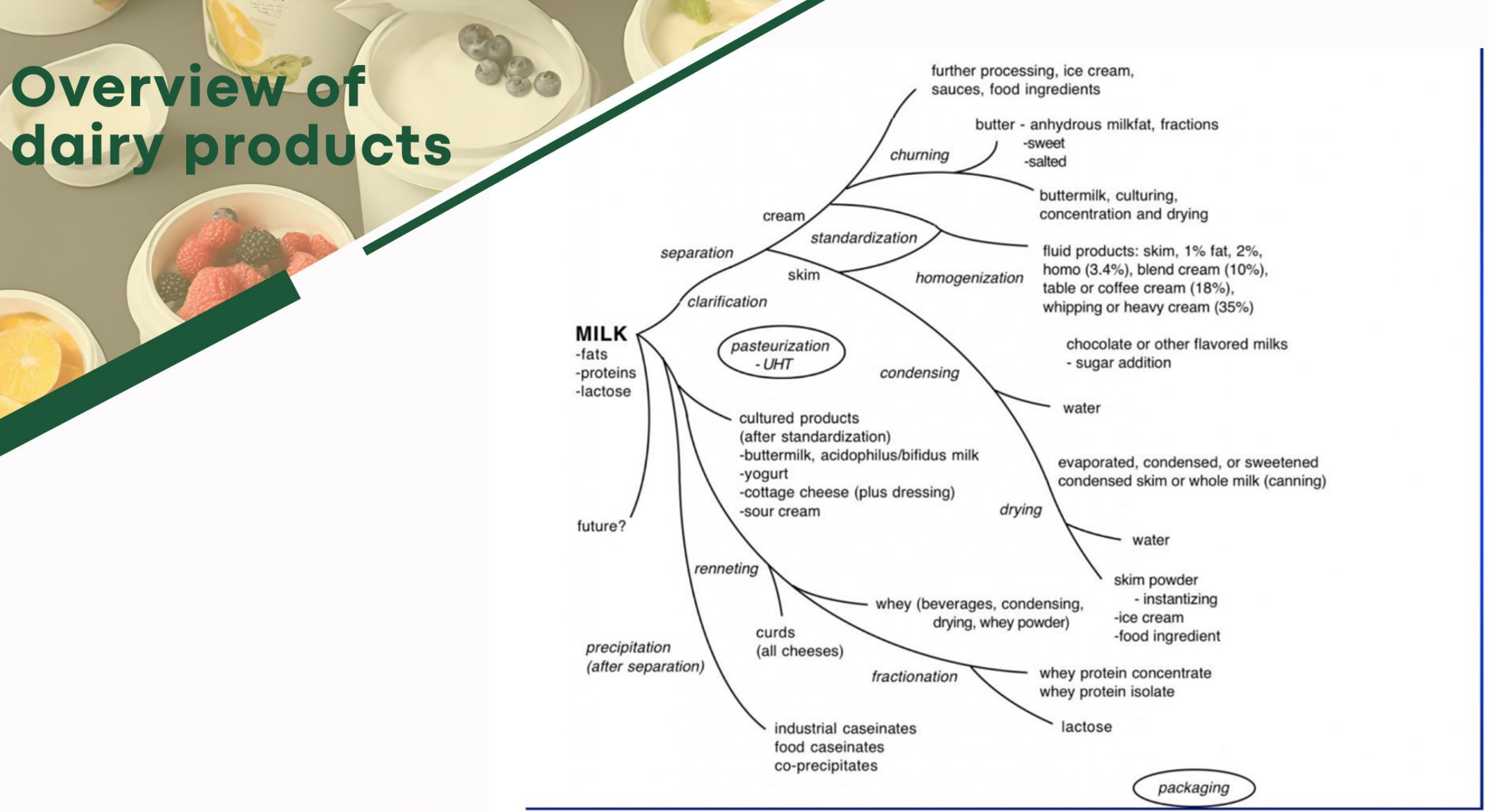
- When casein is removed from milk by precipitation, the proteins remaining in solution are whey proteins.

- This protein is typically a mixture of β-lactoglobulin (~65%), α-lactalbumin (~25%), bovine serum albumin (~8%), and immunoglobulins.

Y MANAGEMENT INC.™

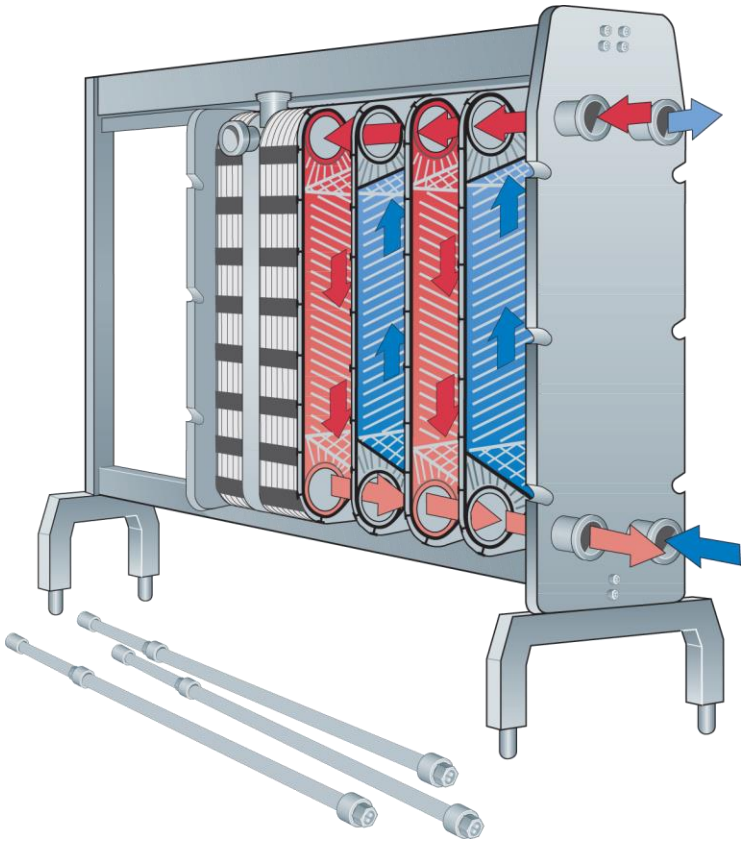
2. Dairy Unit Operations

Overview of dairy products



https://www.uoguelph.ca/foodscience/book-page/overview-and-fluid-milk-products

Heat Treatment-Pasteurization

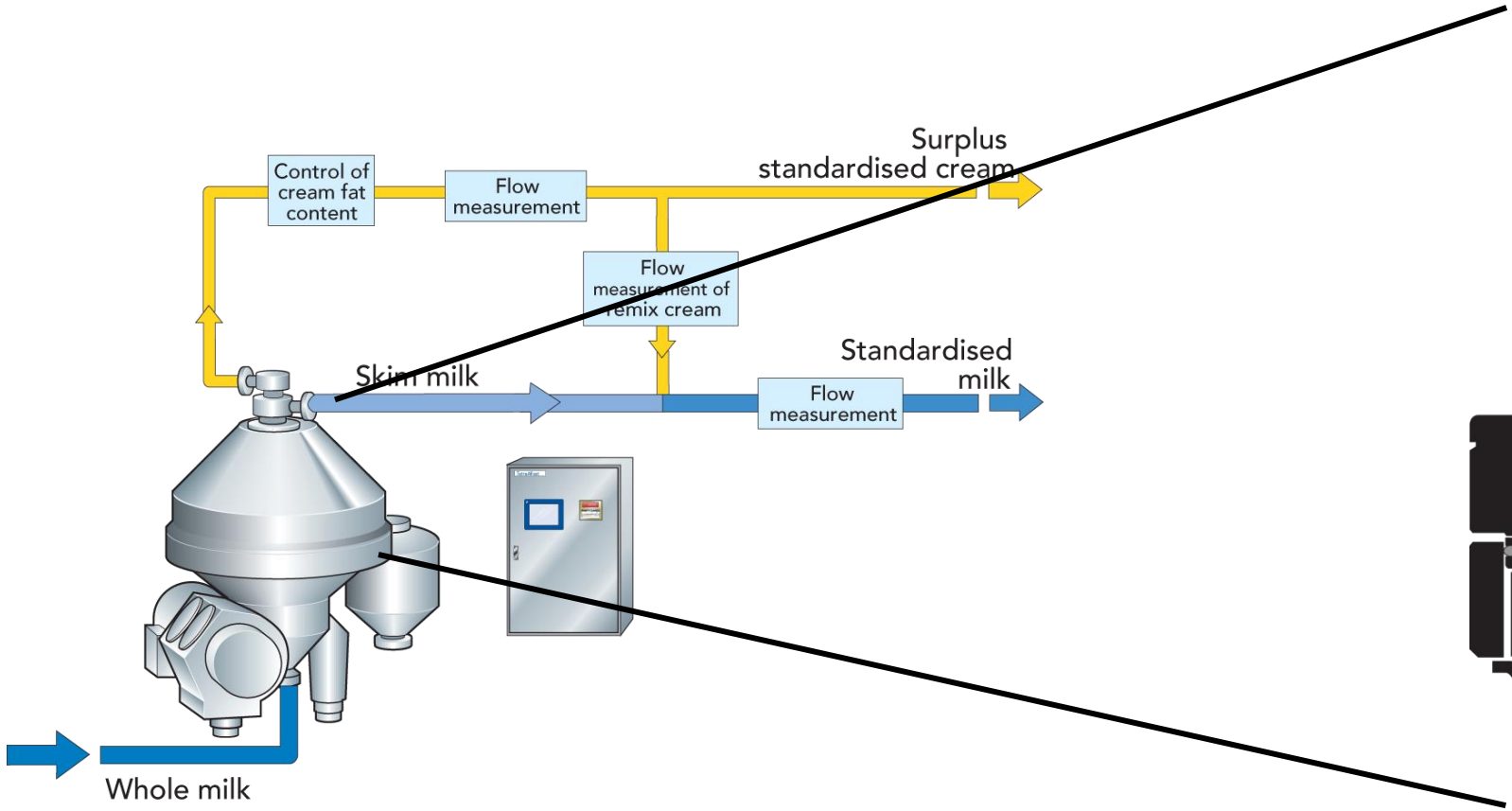


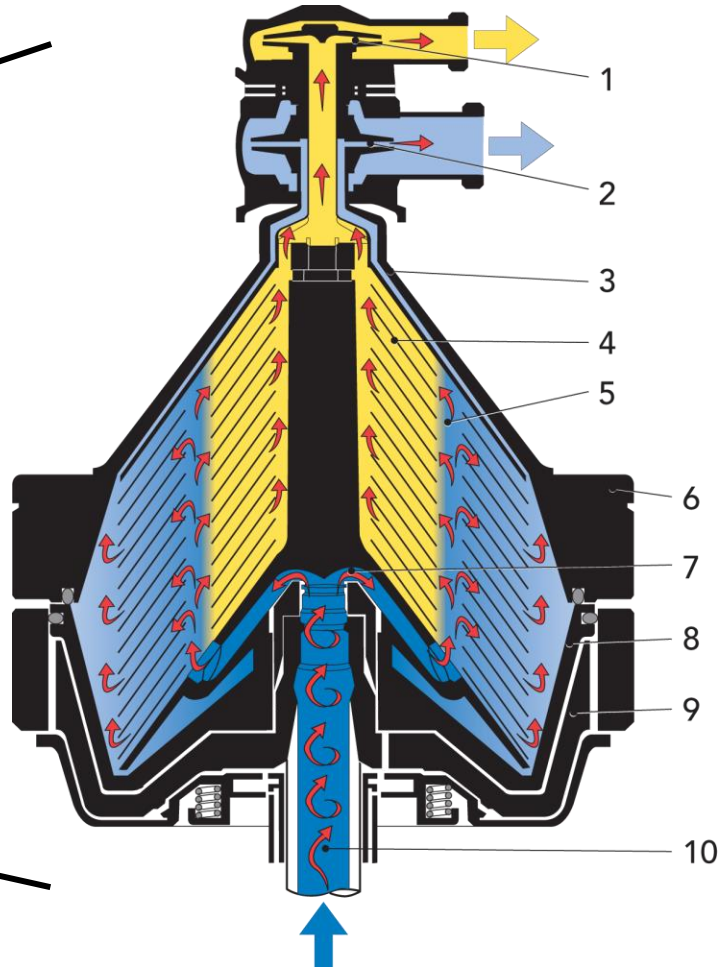
The main categories of heat treatment in the dairy industry

Process	Temperature, °C	Time
Thermization		
LTLT pasteurization of milk	63	30 min
HTST pasteurization of milk	72 – 75	15 – 20 s
HTST pasteurization of cream, etc.	> 80	1 – 5 s
Ultra pasteurization	125 – 138	2 – 4 s
UHT (flow sterilization) normally	135 – 140	a few seconds
Sterilization in container	115 – 120	20 – 30 min

Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

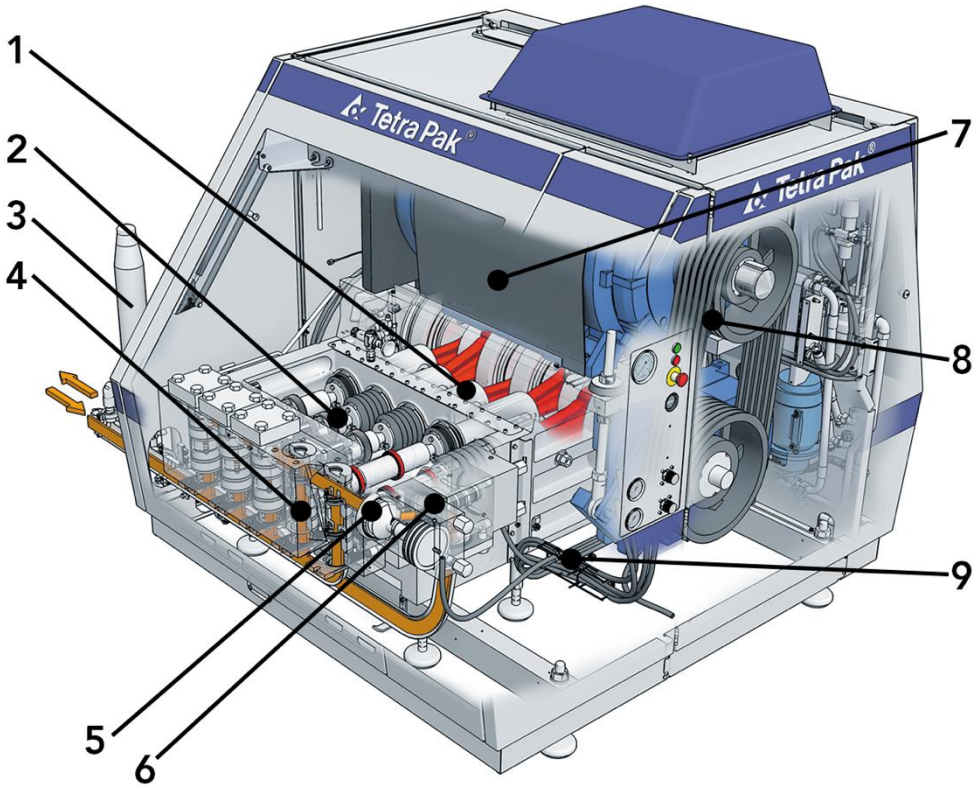
Cream Separation

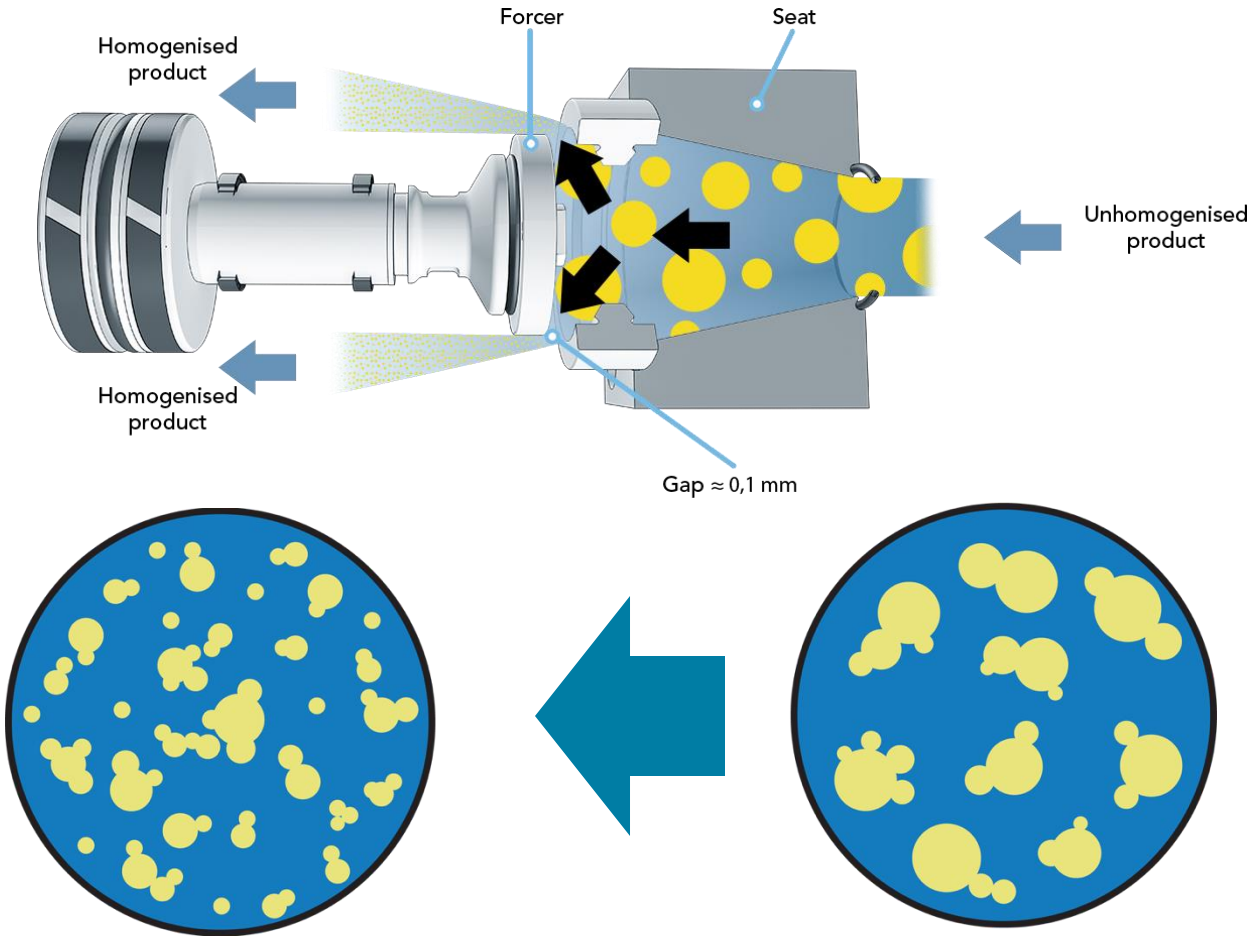




Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

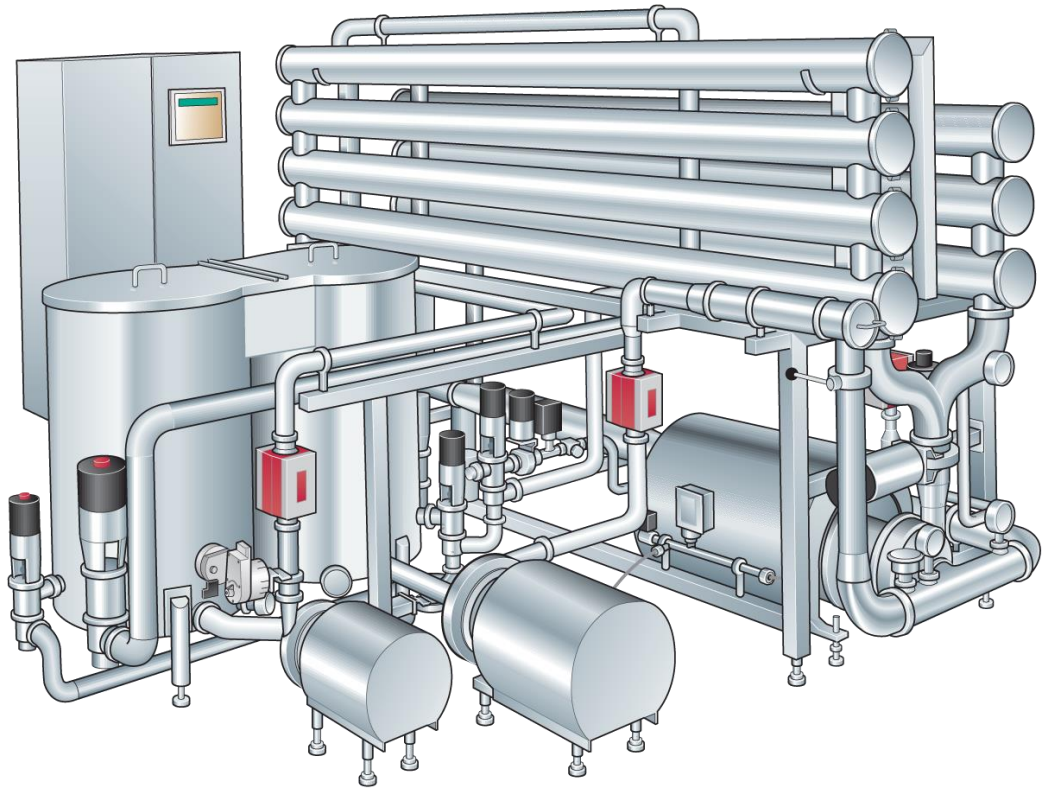
Homogenization

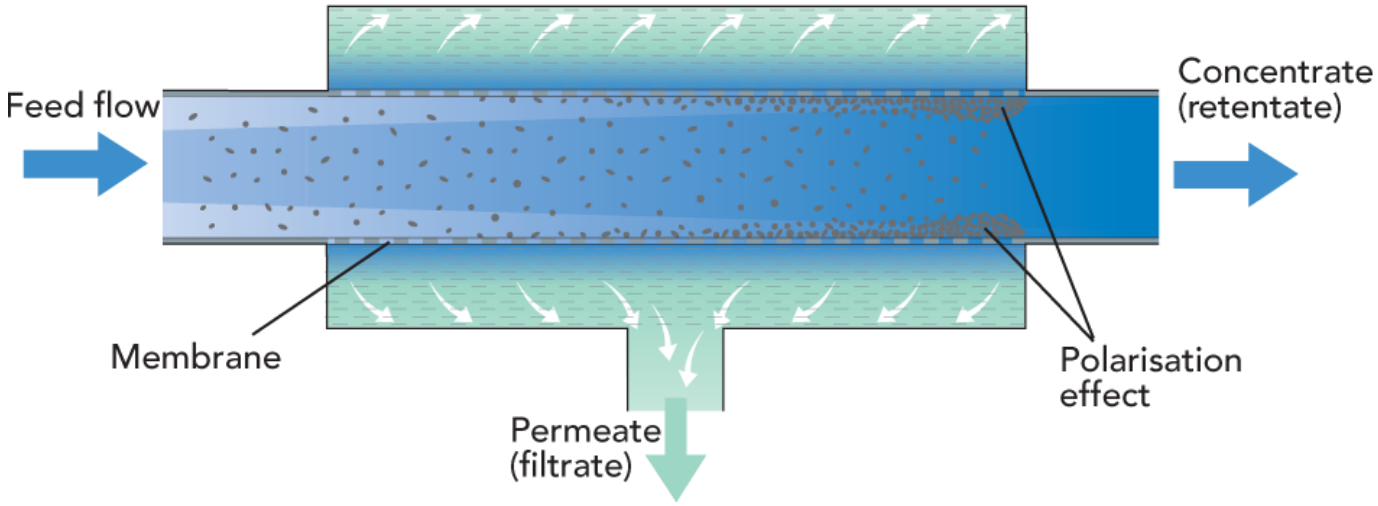




Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

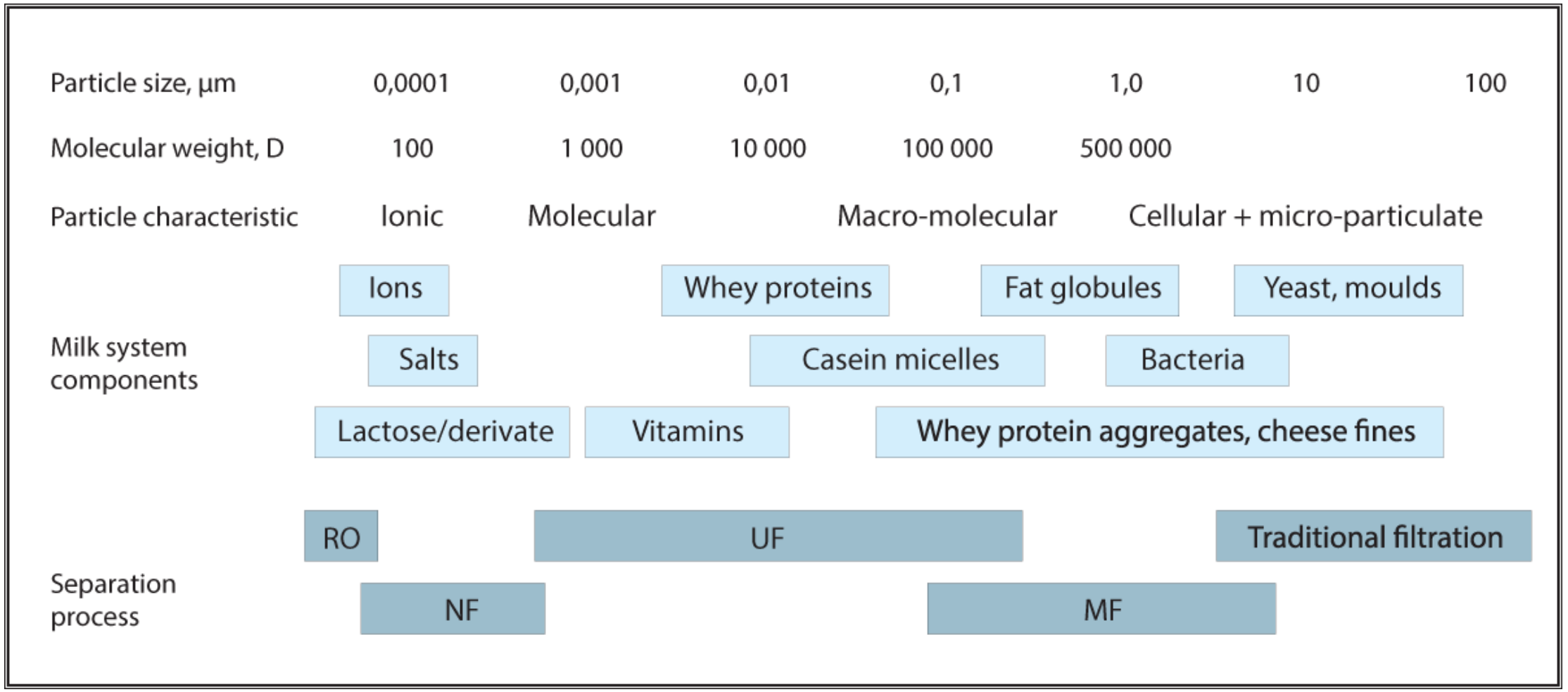
Membrane Filtration





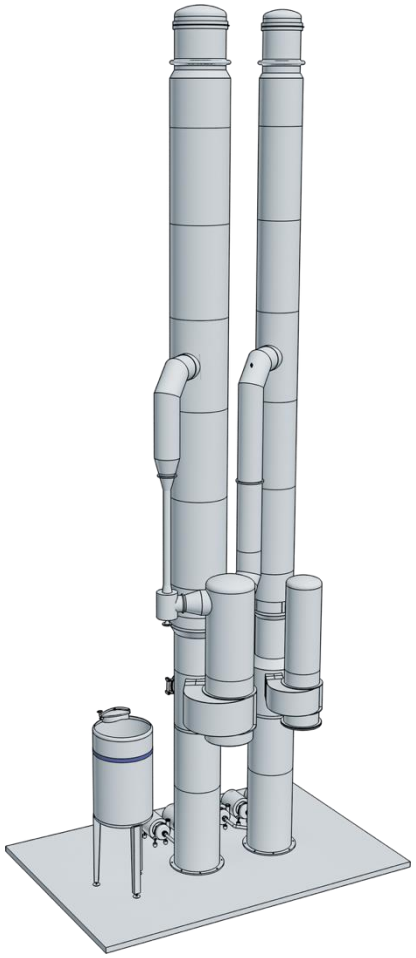
Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

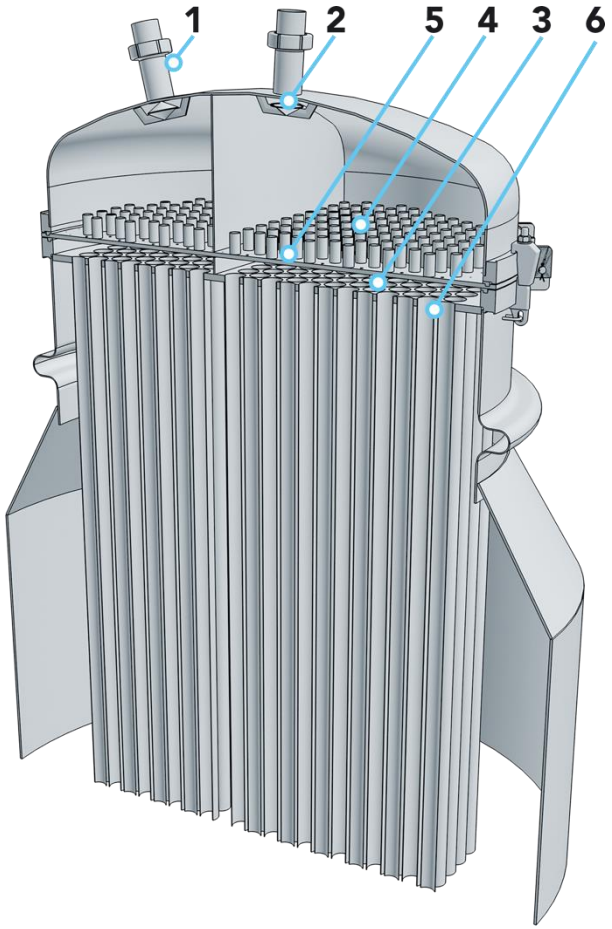
Membrane Filtration



Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

Evaporation





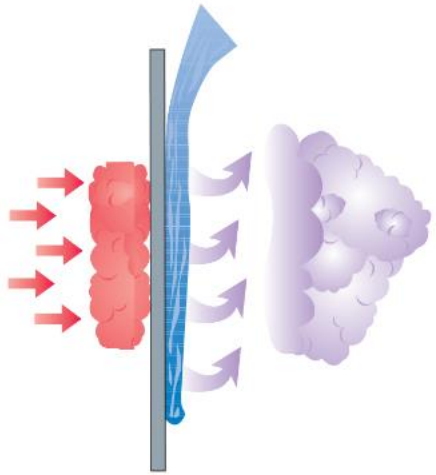
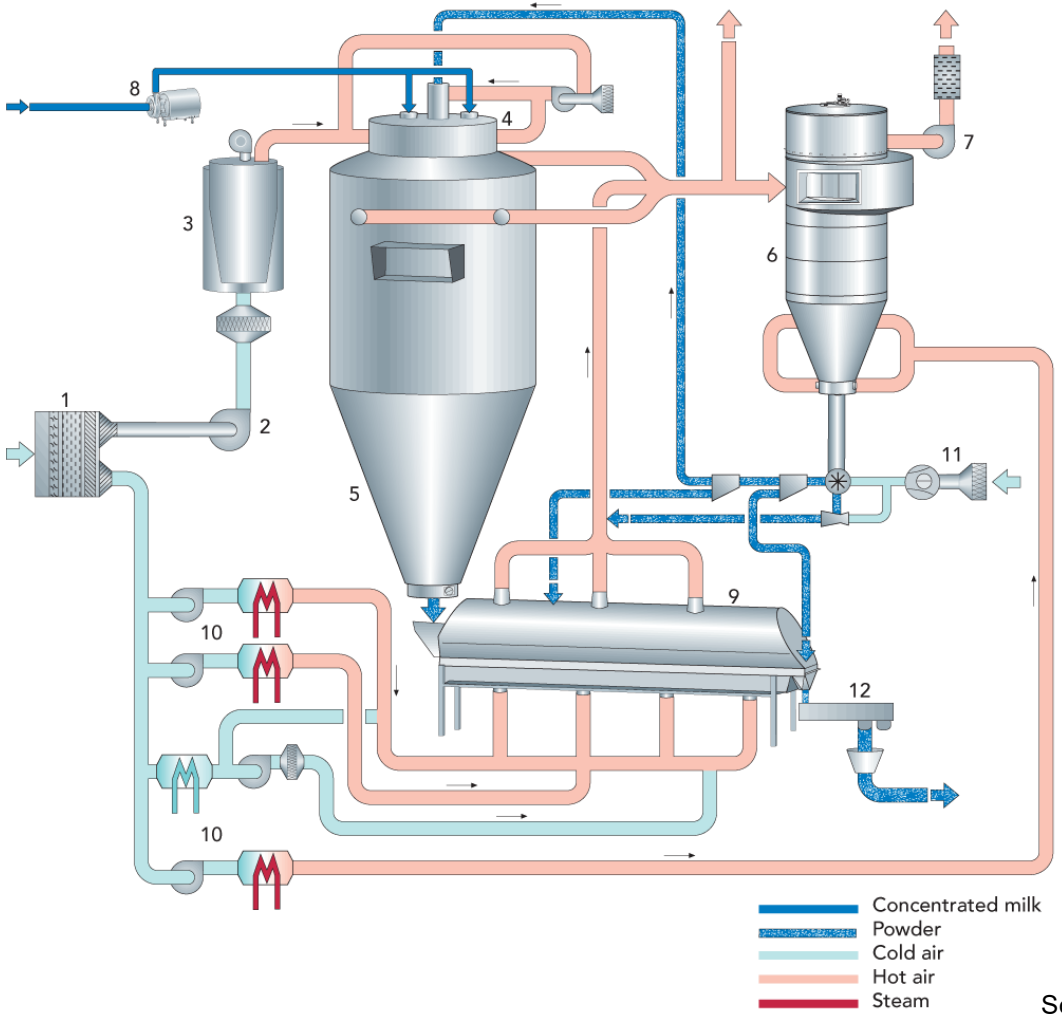


Fig. 6.5.1

General principle of evaporation. A partition is heated by hot steam and vapour evaporates from the liquid on the other side

Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

Drying



Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

To Sum Up…

PASTEURIZATION

CREAM SEPARATION

Fluid Milk and Cream

Fermentation

Whey

Evaporation

Membrane Filtration

Drying

Fluid Milk
Cream
Butter
Butter Oil/AMF

Cheese
Yogurt

Evaporated Milk
Condensed Milk

Milk Powders
(WMP/SMP/NDM)

Whey Powders

Milk Protein Ingredients
(MPC, MPI, MCC, Specialty Milk Proteins)

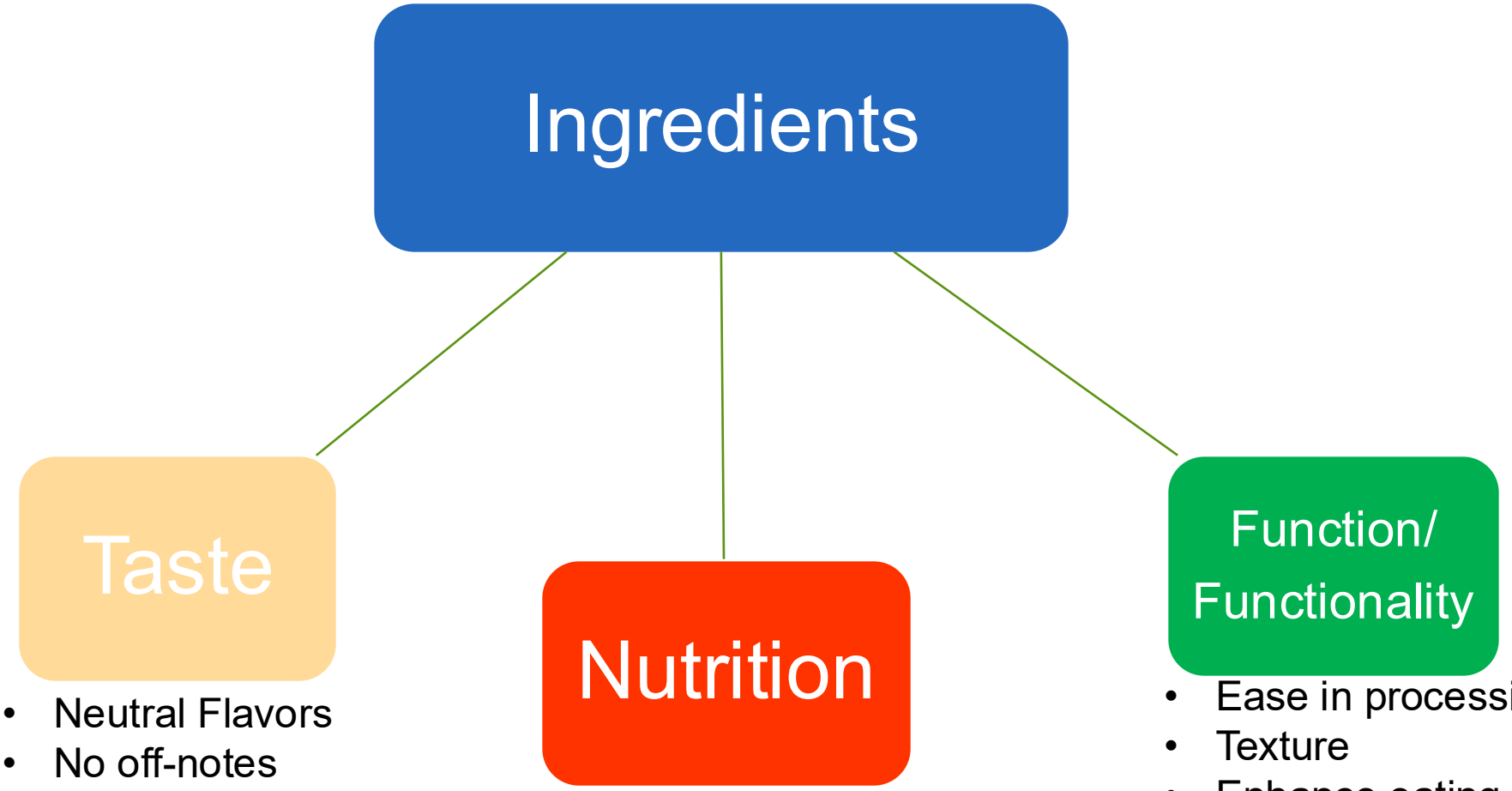
Whey Protein Ingredients
(WPC, WPI, Specialty Whey Proteins)

Icons: The noun project

3. Dairy Ingredients for Food Product Development

Perspectives on ingredients in food product development

Role of Food (Dairy) Ingredients in Food Products



- Neutral Flavors
- No off-notes
- Complement
- Enhance eating experience

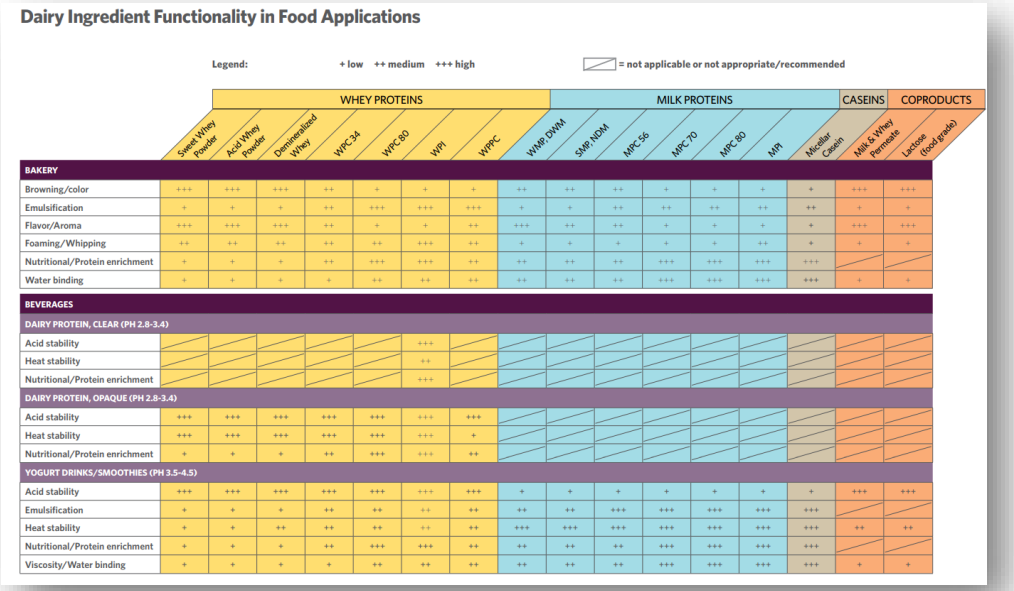
- Macro and Micro-Nutrients
- Protein and Nutrition/Claims

- Ease in processing
- Texture
- Enhance eating experience
- Product Stability
- Shelf Life (Enhancement)

Quick Refresher: Functional Properties

"Functional properties describes how ingredients behave during preparation and cooking, how they affect the finished food product in terms of how it looks, tastes, and feels."

https://www.ifst.org/lovefoodlovescience/resources/functional-properties-food

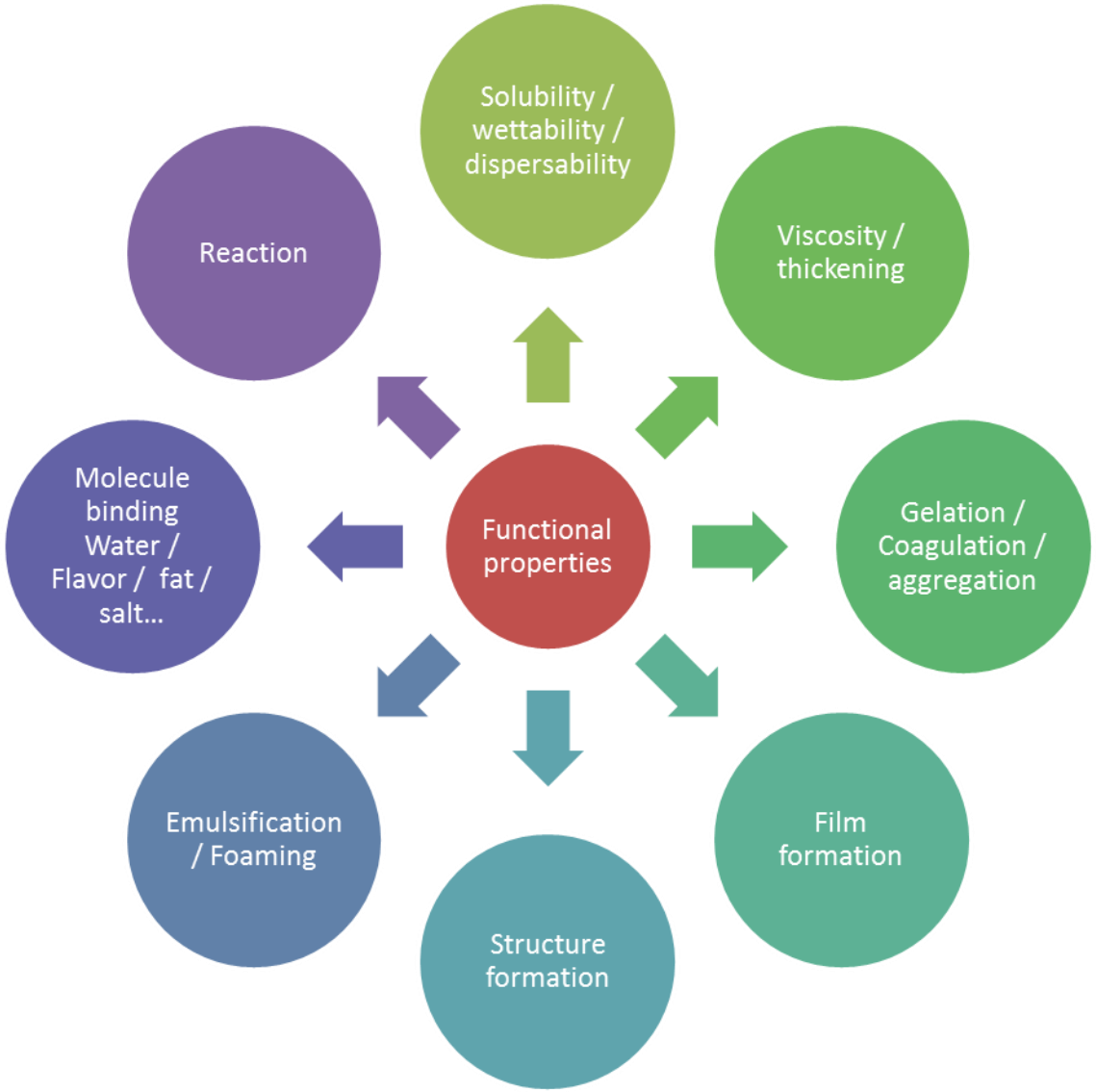


Dairy Ingredient Functionality in Food Applications

Legend: + low ++ medium +++ high = not applicable or not appropriate/recommended

	WHEY PROTEINS							MILK PROTEINS						CASEINS	COPRODUCTS	
	Sweet Whey Powder	Acid Whey Powder	Demineralized Whey	WPC 34	WPC 80	WPI	WPPC	WMP DMM	SMP NDM	MPC 56	MPC 70	MPC 80	MPI	Micellar Casein	Milk & Whey Permeate	Lactose (food grade)
BAKERY																
Browning/color	+++	+++	+++	++	+	+	+	++	++	++	+	+	+	+	+++	+++
Emulsification	+	+	+	++	+++	+++	+++	+	+	++	++	++	++	++	+	+
Flavor/Aroma	+++	+++	+++	++	+	+	++	+++	++	++	+	+	+	+	+++	+++
Foaming/Whipping	++	++	++	++	++	+++	++	+	+	+	+	+	++	+	+	+
Nutritional/Protein enrichment	+	+	+	++	+++	+++	++	++	++	++	+++	+++	+++	+++		
Water binding	+	+	+	+	++	++	++	++	++	++	+++	+++	+++	+++	+	+
BEVERAGES																
DAIRY PROTEIN, CLEAR (PH 2.8-3.4)																
Acid stability						+++										
Heat stability						++										
Nutritional/Protein enrichment						+++										
DAIRY PROTEIN, OPAQUE (PH 2.8-3.4)																
Acid stability	+++	+++	+++	+++	+++	+++	+++									
Heat stability	+++	+++	+++	+++	+++	+++	+									
Nutritional/Protein enrichment	+	+	+	++	+++	+++	++									
YOGURT DRINKS/SMOOTHIES (PH 3.5-4.5)																
Acid stability	+++	+++	+++	+++	+++	+++	+++	+	+	+	+	+	+	+	+++	+++
Emulsification	+	+	+	++	++	++	++	++	++	+++	+++	+++	+++	+++		
Heat stability	+	+	++	++	++	++	++	+++	+++	+++	+++	+++	+++	+++	++	++
Nutritional/Protein enrichment	+	+	+	++	+++	+++	++	++	++	++	+++	+++	+++	+++		
Viscosity/Water binding	+	+	+	+	++	++	++	++	++	++	+++	+++	+++	+++	+	+

Source: https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/dairy-ingredients-functionality-and-composition-reference-guide



(Damodaran and Paraf, 1997)

3. Dairy Ingredients for Food Product Development

Dry Dairy Ingredients

Major Dry Dairy Ingredient Classes

Milk Powders

- Nonfat Dried Milk (NDM)
- Skim Milk Powder (SMP)
- Whole Milk Powder (WMP)

Milk Protein and Casein Ingredients

- Milk Protein Concentrate (MPC)
- Milk Protein Isolate (MPI)
- Micellar Casein (MCC)

Whey Protein Ingredients

- Whey Protein Concentrate (WPC)
- Whey Protein Isolate (WPI)

Lactose Rich Ingredients

- Whey Powder
- Milk and Whey Permeates
- Lactose

Milk Powders

	NDM/SMP	WMP
Protein, %	34.0 – 37.0	24.5 – 27.0
Lactose, %	49.5 – 55.0	36.0 – 38.5
Fat, %	0.6 – 1.25	26.6 – 40.0
Minerals, %	8.2 – 8.6	5.5 – 6.5
Moisture, %	3.0 – 5.0	2.0 -4.5

- **Skim Milk Powder (SMP)**
  - CODEX (Stan 207)
  - Min 34% protein in MSNF
- **Nonfat Dry Milk (NDM)**
  - FDA/USDA
  - Removal of fat and water only (no protein adjustment)
  - Extra Grade (highest quality) or Standard Grade
- **Classified according to heat treatment (WPNI)**
  - High-heat, medium-heat, or low-heat

Classification (NDM/SMP)	WPNI (mg/g)	Recommended Applications
Low heat	Over 6.00	Fluid milk fortification, cheese milk standardization, cultured skim milk, starter culture, dairy drinks and recombined products, ice cream, yogurts
Medium heat	1.51 – 5.99	Prepared mixes, ice cream, yogurts, confectionery, meat products, recombined milk products
High heat	Under 1.50	Bakery, meat products, prepared mixes, ice cream

- http://www.thinkusadairy.org/products
- USDEC. 2019. Reference Manual for U.S. Milk Powders and Microfiltered Ingredients. https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/product-resources/reference-manual-for-us-milk-powders-and-microfiltered-ingredients

SMP/NDM: Where is it Used?

Top Product Categories

- Dairy
- Confectionary
- Bakery
- Prepared Dry Mixes & Dry Blends
- Infant Formula

Benefits

- Superior Flavor
- Clean Label
- Emulsification, gelling, water binding, whipping and foaming

Milk Protein Ingredients

	MPC-70	MPC-80	MPI
Protein, %	**Casein : Whey Protein = 80 : 20**		
Lactose, %	20.0 (max)	9.0 (max)	5.0 (max)
Fat, %	2.5 (max)	2.5 (max)	2.5 (max)
Minerals, %	10.0 (max)	8.0 (max)	8.0 (max)
Moisture, %	6.0 (max)	6.0 (max)	6.0 (max)

Sources:

1. http://www.thinkusadairy.org/products
2. USDEC. 2017. Dairy Ingredients Functionality and Composition Reference Guide. http://www.thinkusadairy.org

MPC and MPI characteristics

Highly functional low lactose ingredient

Complete dairy protein (whey and casein)	**Mild,** dairy flavor **Smooth** mouth-feel	Unique combination of fast and slow proteins
Excellent **solubility and hydration** properties	Sold in various protein levels: 70, 80 and 90 (isolate)	Adds **viscosity** through water binding capabilities

Ideal for low carbohydrate or high protein products

Milk Protein Ingredients: Where are they Used?

Top Product Categories

- Diet/higher protein versions of dairy products
  - Ice Cream
  - Yogurt
  - Cheese
- High protein/nutritional/Meal replacement beverages (RTM and RTD)
- Nutrition Bars

Benefits

- Increase protein content
- Enhanced functionality
- Heat stability
- Product diet versions of traditional dairy products

MPC or MPI – What Should I Choose?

MPC

- Lower Protein (vs MPI)
- High Lactose (vs MPI)
- Lower Cost (vs MPI)
- Applications:
  - Diet/higher protein versions of traditional dairy products
  - Higher protein versions of traditional food products

MPI

- High Protein
- Lower Lactose
- Higher Cost
- Higher value applications where protein is desired (nutrition/functionality)
  - RTM and RTD nutritional/high protein beverages
  - Bars

Casein Ingredients

	Micellar Casein
Protein, %	83.0
Lactose, %	1.0
Fat, %	1.0
Minerals, %	7.8
Moisture, %	5.0

Sources:
1. http://www.thinkusadairy.org/products
2. USDEC. 2017. Dairy Ingredients Functionality and Composition Reference Guide. http://www.thinkusadairy.org

Micellar Caseins: Where are they Used?

Top Product Categories

- Nutritional Products
  - Powders
  - Bars
  - Snacks
- Coffee Creamers
- Whipped toppings

Benefits

- Emulsification
- Fat & water binding
- Suspension stability
- Whipping ability
- Clean Label

Whey Protein Ingredients

	WPC 34	WPC 80	WPI
Protein, %	34.0 – 36.0	80.0 - 82.0 (db)	90.0 – 92.0 (db)
Lactose, %	48.0 – 52.0	4.0 – 8.0	0.5 – 1.0
Fat, %	3.0 – 4.5	4.0 – 8.0	0.5 – 1.0
Minerals, %	6.5 – 8.0	3.0 – 4.0	2.0 – 3.0
Moisture, %	3.0 – 4.5	3.5 – 4.5	4.0 – 6.0

Sources:
1. http://www.thinkusadairy.org/products
2. USDEC. 2017. Dairy Ingredients Functionality and Composition Reference Guide. http://www.thinkusadairy.org

Whey protein ingredient characteristics

Highly functional

High solubility over a wide pH range	**Mild**, dairy flavor	**Smooth** mouth-feel
Good **dispersibility**	**High clarity** at low pH	Adds **viscosity** through water binding capabilities

Superior protein
(rich in all essential amino acids)

Whey Protein Ingredients: Where are they used?

Top Product Categories

- Beverages
- Snacks/Bars
- Dairy
- Meal Replacements
- Infant Formula
- Supplements

Benefits

- Water binding
- Emulsification
- Gelling
- Nutrition
- Bland flavor
- Clarity in solution (WPI)

WPC or WPI – What Should I Choose?

WPC

- Lower Protein (vs WPI)
- High Lactose (vs WPI)
- Lower Cost (vs WPI)
- Applications:
  - Higher protein versions of traditional food products

WPI

- High Protein
- Lower Lactose
- Higher Cost
- Higher value applications where protein is desired (nutrition/functionality)
  - Infant Formula
  - RTM and RTD nutritional/high protein beverages
    - Clear Beverages
  - Bars

The protein debate…

Proteins from various sources are available in the marketplace.

Some consumers, influencers and end-users may be confused about the unique value of proteins from milk compared to other protein sources.

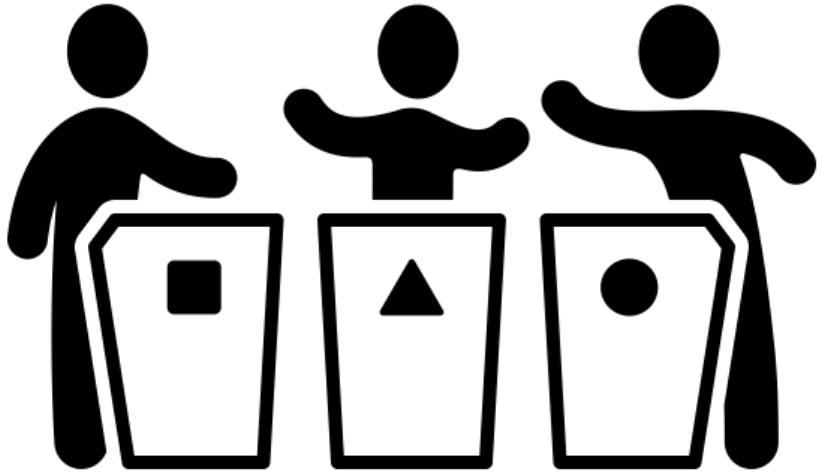


Image Source: The noun project

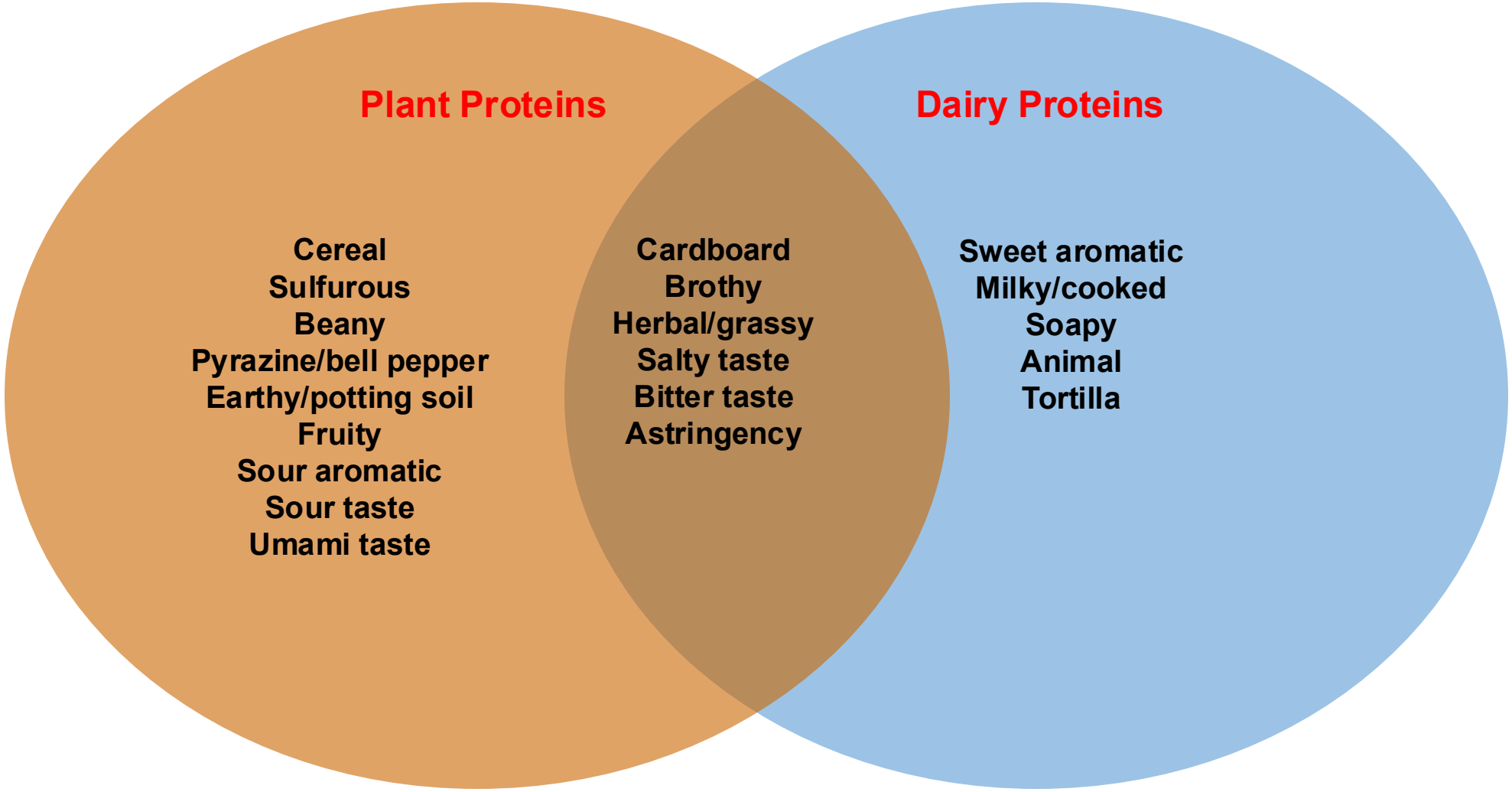
Protein ingredients from various sources
The study on functionality and sensory

Key Takeaway

"No other protein can provide this breadth of functionality while ensuring a simple ingredient list and neutral flavor profile that consumers desire."

USDEC. 2018. A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace

Flavor Differences between Plant and Dairy Proteins



Sources:

1. USDEC. 2018. A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace. www.thinkusadairy.org
2. Kapoor et. al. 2017. Characterization of commercial food protein ingredients. International Whey Conference. Chicago IL

Nutrition implication: All proteins are not created equal

Protein Quality: The ability of a food protein to meet the body's metabolic demand for amino acids and nitrogen

Also, important when making **protein claims**

Food proteins vary in their protein quality based on:

- Amino acid composition
- Digestibility
  - Animal based proteins >90%
  - Plant based proteins 45 – 80%
- Bioavailability

PDCAAS (Protein Digestibility Corrected Amino Acid Score) is the current gold standard for assessing protein quality

PDCAAS for Selected Isolated Proteins and Foods

Food	PDCAAS
Milk Protein Concentrate	1.00
Whey Protein Isolate	1.00
Soy Protein Isolate	0.98
Pea Protein Concentrate	0.89
Rice Protein Concentrate	0.42
Whole milk	1.00
Chicken breast	1.00
Egg (hard boiled)	1.00
Cooked peas	0.60
Cooked rice	0.62
Almonds	0.39
Chickpeas	0.74
Tofu	0.56

Table adapted from Phillips SM, *Front. Nutr.*, 2017

Functionality: How do they compare to other protein sources?

Functional Property	Results
Water Holding Capacity	Milk ~ Soy ~ Pea > Whey ~ Potato ~ Rice
Viscosity	Milk ~ Pea > Whey ~ Soy ~ Potato ~ Rice
Heat Stability (acidic conditions, pH 3)	Whey > Plant > Milk
Heat Stability (neutral conditions, pH 7)	Milk ~Whey > Plant
Emulsion Activity Emulsion Stability	Milk ~Whey ~ Pea ~ Soy > Potato > Rice Milk>Whey~ Pea ~ Soy > Potato > Rice
Foam Ability Foam Stability	Whey > Soy ~Potato > Milk > Pea Whey > Milk > Soy and > Pea > Rice
Gel Strength	Whey > Potato~Pea~Soy

Dairy proteins are versatile and offer a comprehensive solution to end users.

Sources:
1. USDEC. 2018. A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace. www.thinkusadairy.org
2. Kapoor et. al. 2017. Characterization of commercial food protein ingredients. International Whey Conference. Chicago IL

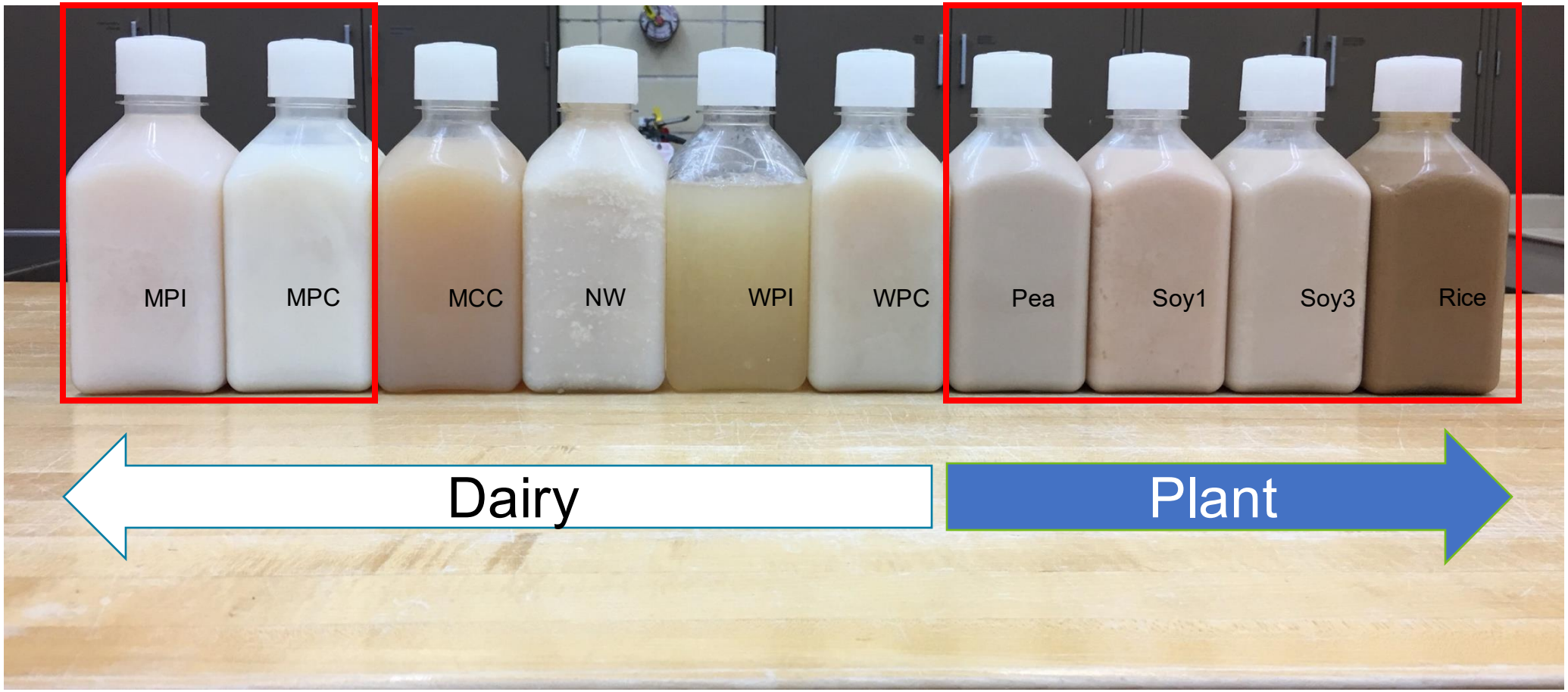
Scenario 1: Choosing My Protein*

Low Acid High Protein UHT beverages

Desired Properties	Milk Protein	Soy Protein	Pea Protein
Clean Taste	●		
Good Solubility	●		
Medium Viscosity	●		●
Good Heat Stability at neutral pH	●		
Low Foaming	●		●
Good fat emulsification	●	●	●

* For Illustrative Purposes Only

Model UHT Beverage Test at WI-CDR (5% total protein, processed at 140 C/6 sec., pH 7)



Source: USDEC. 2018. A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace. www.thinkusadairy.org

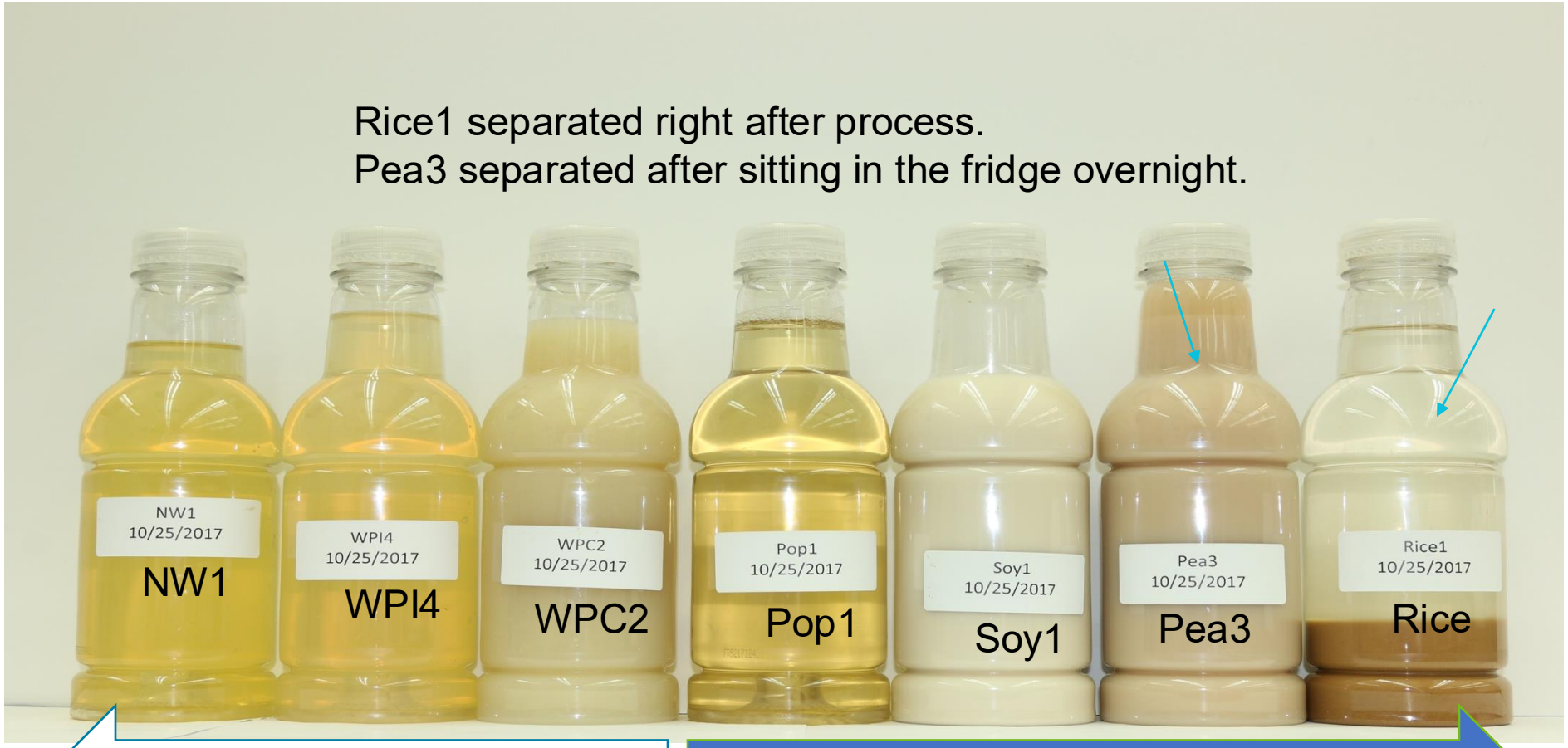
Scenario 2: Choosing My Protein*

High Acid Protein Beverages

Desired Properties	Whey Protein	Soy Protein	Pea Protein
Clean Taste	●		
Good Solubility	●		
Low Viscosity	●	●	
Good Heat Stability at acidic pH	●		
Low Foaming		●	●
Clarity	●		

* For Illustrative Purposes Only

Model High Acid Beverage Test at WI-CDR (5% total protein, processed at 82 C/2 min, pH 3)



Source: USDEC. 2018. A New Era for Protein: Why U.S. Dairy Delivers in the Crowded Protein Marketplace. www.thinkusadairy.org

Lactose Rich Ingredients

	Sweet Whey Powder	Whey Permeate	Lactose (Food Grade)
Protein, %	11.0 – 14.5	2.0 – 7.0	0.1
Lactose, %	63.0 – 75.0	76.0 – 88.0	99.0 (min)
Fat, %	1.0 – 1.5	0.0 – 1.5	---
Minerals, %	8.2 – 8.8	8.0 – 14.0	0.1 – 0.3
Moisture, %	3.5 – 5.0	3.0 – 5.0	4.5 – 5.5

Sources:
1. http://www.thinkusadairy.org/products
2. USDEC. 2017. Dairy Ingredients Functionality and Composition Reference Guide. http://www.thinkusadairy.org

Sweet Whey Powders: Where are They Used?

Top Product Categories

- Dairy
- Bakery
- Confectionery
- Snacks

Benefits

- Economics
- Browning

Permeate & Lactose: Where are They Used?

Top Product Categories

- Pharmaceutical (lactose)
- Confectionery
- Infant Formula
- Bakery
- Dressings and Sauces
- Animal Feed

Benefits

- Tableting (lactose)
- Browning
- Dispersing agent
- Savory flavor/sodium reduction (permeate)

3. Dairy Ingredients for Food Product Development

Fat Rich Dairy Ingredients

Fat Rich Dairy Ingredients

Major Milk Fat Ingredients

- Cream
- Butter
- Anhydrous Milk Fat

Advantages

✓Changing nutritional/health perspectives

✓Clean and unique flavor profile

✓Complex melt profile and crystallization behavior

- Unique mouthfeel
- Flavor release and sensory experience
- Shortening replacements
- Ability to be fractionated for targeted applications

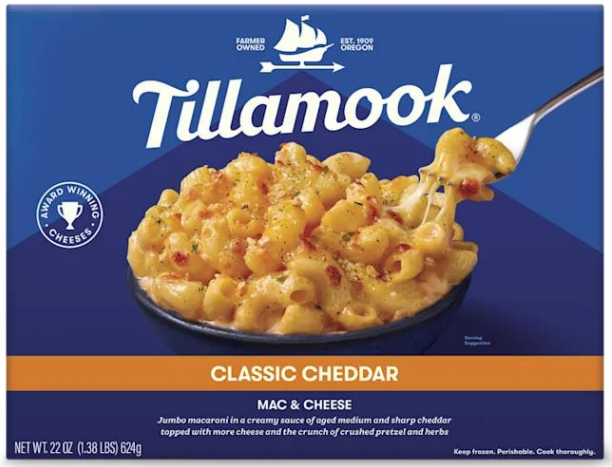
Source: Gnanasambandam et al. 2017. Milkfat and Related Ingredients Serving Today's Marketplace. https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/technical-report-milkfat-and-related-ingredients-serving-todays-marketplace

3. Dairy Ingredients for Food Product Development

Cheese as an Ingredient

Cheese as an Ingredient

- Natural Cheeses (mainstream and artisanal)
- Process Cheese
- Cheese Powders
- Enzyme modified cheese



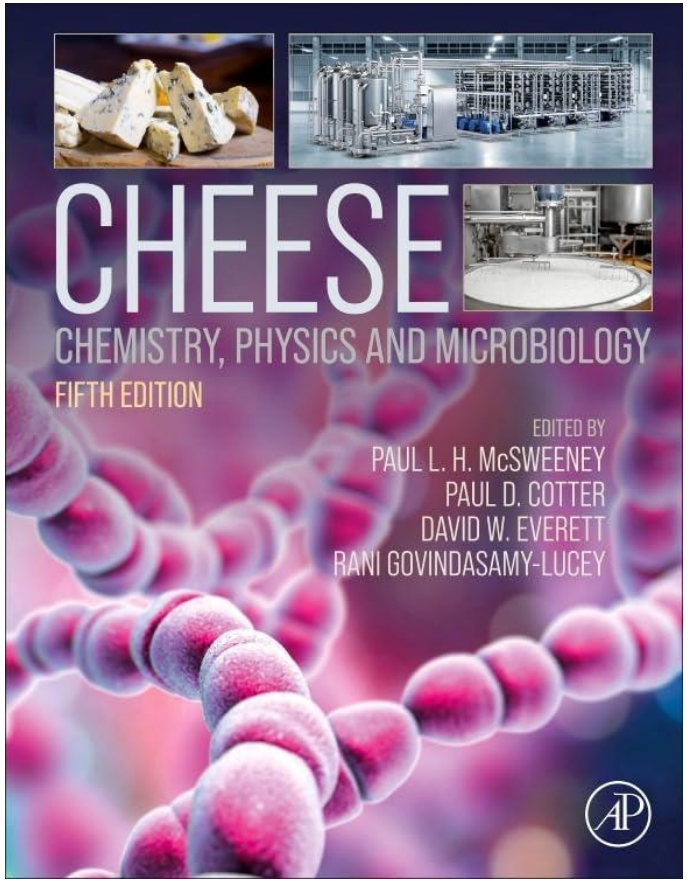
Advantages

✓Positive consumer association with “tasty”, “wholesome”, and “natural”.

✓Offers food marketers various advantages in terms of specific claims related to the place of origin, etc., and even helps upgrade some foods to gourmet status from a marketing standpoint.

✓Ability to achieve a variety of flavor, textural, and functionality profiles in the final food product.

Cheese as an Ingredient



Chapter 28

Cheese as an Ingredient

Ahmed R.A. Hammam[1], Karthik Sajith Babu[2], Rohit Kapoor[3] and Lloyd E. Metzger[4]
[1]Animal Sciences and Industry Department, Kansas State University, Manhattan, KS, United States, [2]Sargento Foods Inc., Elkhart Lake, WI, United States, [3]Dairy Management Inc., Rosemont, IL, United States, [4]Valley Queen Cheese, Milbank, SD, United States

https://shop.elsevier.com/books/cheese/mcsweeney/978-0-443-15956-5

Tables from the chapter shared with you:

- Functional properties of cheese and their implications when the cheese is used as an ingredient
- Typical flavor and texture contribution of different cheeses.

Key References

Dry dairy ingredient composition and functionality: https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/dairy-ingredients-functionality-and-composition-reference-guide

Dairy Proteins and Plant Proteins: https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/a-new-era-for-protein-why-us-dairy-delivers-in-the-crowded-protein-marketplace

High protein beverages: https://www.journalofdairyscience.org/article/S0022-0302(22)00573-2/fulltext

UF Milk as an Ingredient: https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/product-resources/ultrafiltered-milk-spec-sheet

Milkfat based ingredients: https://www.thinkusadairy.org/resources-and-insights/resources-and-insights/application-and-technical-materials/technical-report-milkfat-and-related-ingredients-serving-todays-marketplace

Cheese as an ingredient*: Chapter 28 in the book https://shop.elsevier.com/books/cheese/mcsweeney/978-0-443-15956-5 * Not open access

4. Resources

Websites, Guides, Dairy Center Network

Key “Open Access” Websites

DMI Product R&D Website:

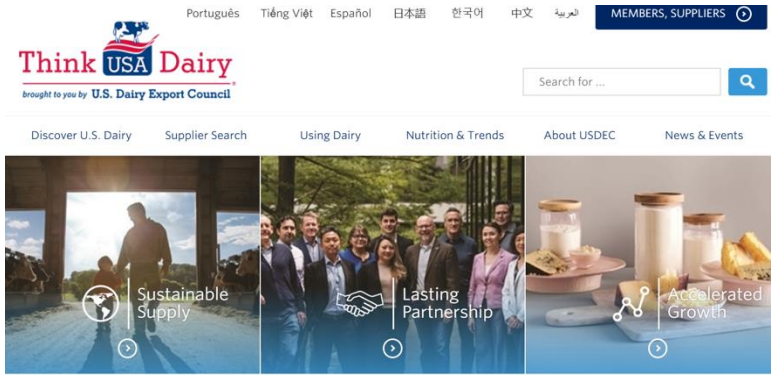
https://www.usdairy.com/about-us/dmi/product-research-team

- Dairy Center Network and Innovation Labs
- Tools to Innovate: Innovate with Dairy
- Claims and Labeling: Nutrient Claims for Dairy Products

Thinkusadairy (US Dairy Export Council)

https://www.thinkusadairy.org/

- Ingredient Guides and Whitepapers
- Supplier Search
- Product Concepts



Definition/U.S. Standards of Identity (SOI) of various milk products and ingredients

FDA- Code of Federal Regulations Standards of Identity

21 CFR PART 131—MILK AND CREAM:

https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-131

21 CFR PART 133—CHEESES AND RELATED CHEESE PRODUCTS:

https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-133

21 CFR PART 184.1979, 1979a, 1979b---WHEY AND WHEY PROTEINS:

https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-184/subpart-B/section-184.1979

Questions?

Lets start from the basics…composition

Cow's Milk

Component	Typical Composition, %
Water	87.5
Proteins	3.4
Lactose	4.8
Fat	3.9
Ash (Minerals)	0.8

Caseins	2.7 %
Whey Proteins	0.7 %

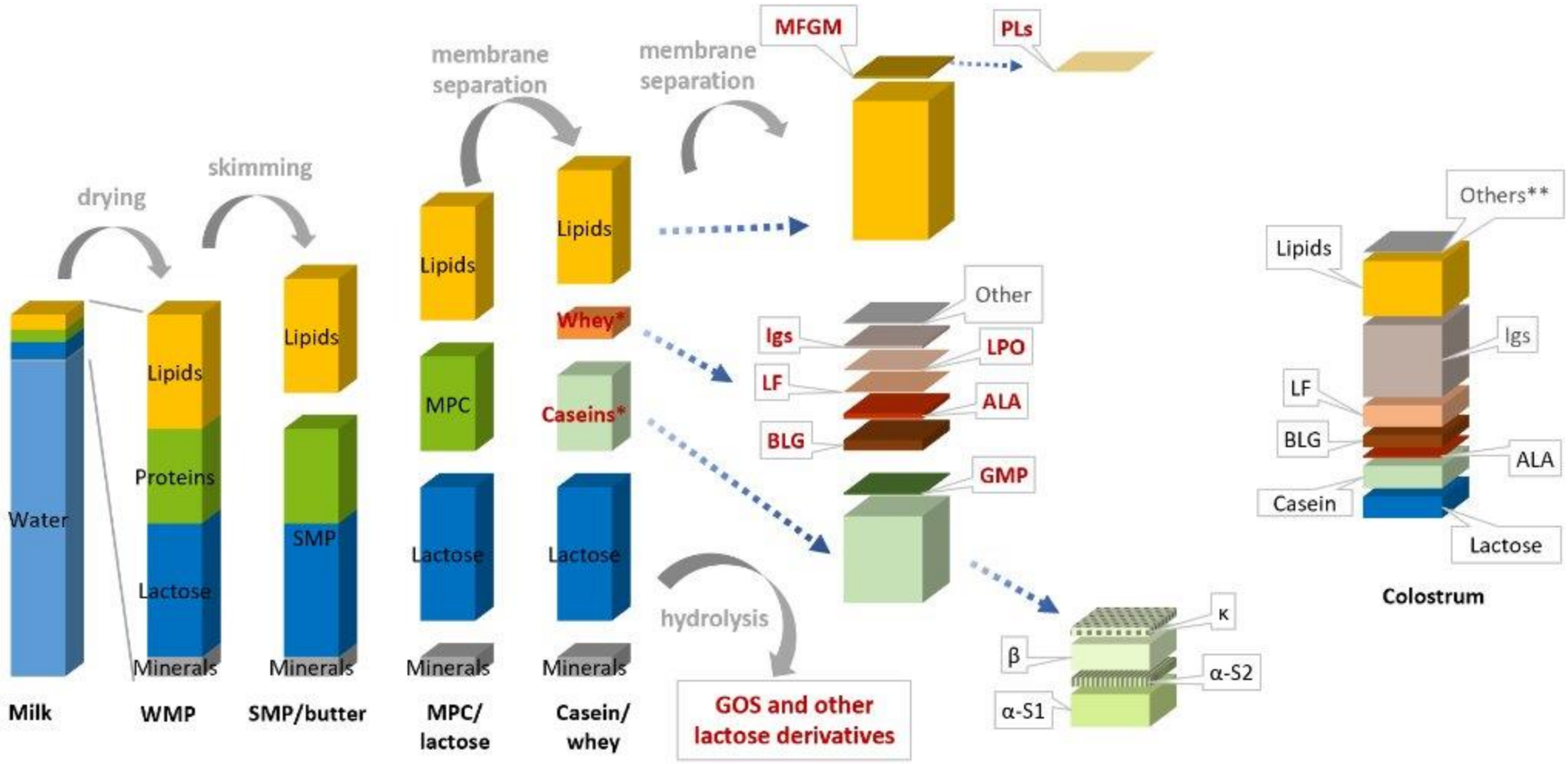
Source: Dairy Processing Handbook 2nd edition, Tetra Pak 2024

Other Minor Components of Interest

Component	Part of…	Typical Composition in Milk, %
Lactoferrin	Whey Proteins	0.01
Immunoglobulins	Whey Proteins	0.08
Glycomacropeptide	Whey Proteins	0.08 – 0.17
Milk Fat Globule Membrane (MFGM)	Milk Fat	0.2 (with 0.08% of it being phospholipids)
MMI	Sky is the limit!!	

Sources:
Dairy Processing Handbook 2nd edition, Tetra Pak 2024;
Lin et al. 2021

How the various milk components breakout into valuable ingredients!



* Native whey and micellar caseins if produced by micro/ultrafiltration

** LPO, Lysozyme, growth factors and other enzymes

Source: GIRA 2023