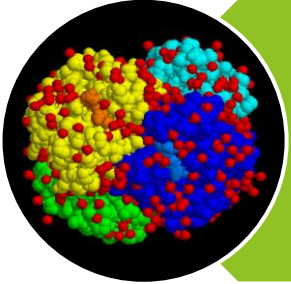


Application of Milk Proteins in Food Product/Nutritional Supplement Powders

PFNDAI Webinar,
May 07, 2021

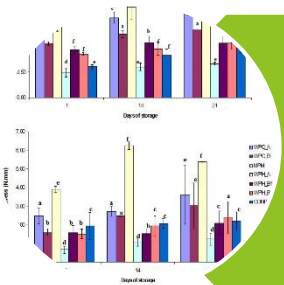
Agenda



Proteins: why, how much, quality & quantity



Milk Tree and Milk Cracking



Milk Proteins & Uses



Asked "What are proteins?" the public are ... perplexed!

Proteins are high molecular weight molecules built up of amino acids

Amino Acid Structure

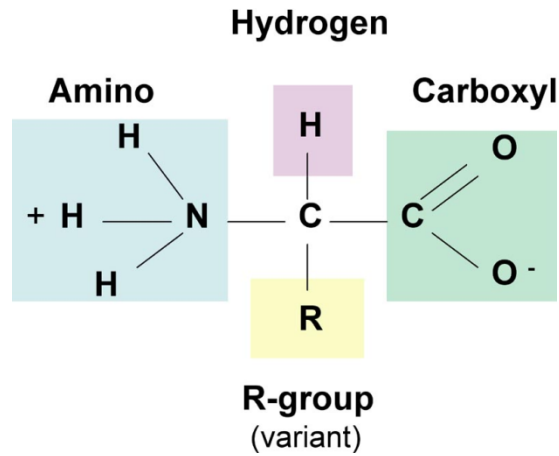
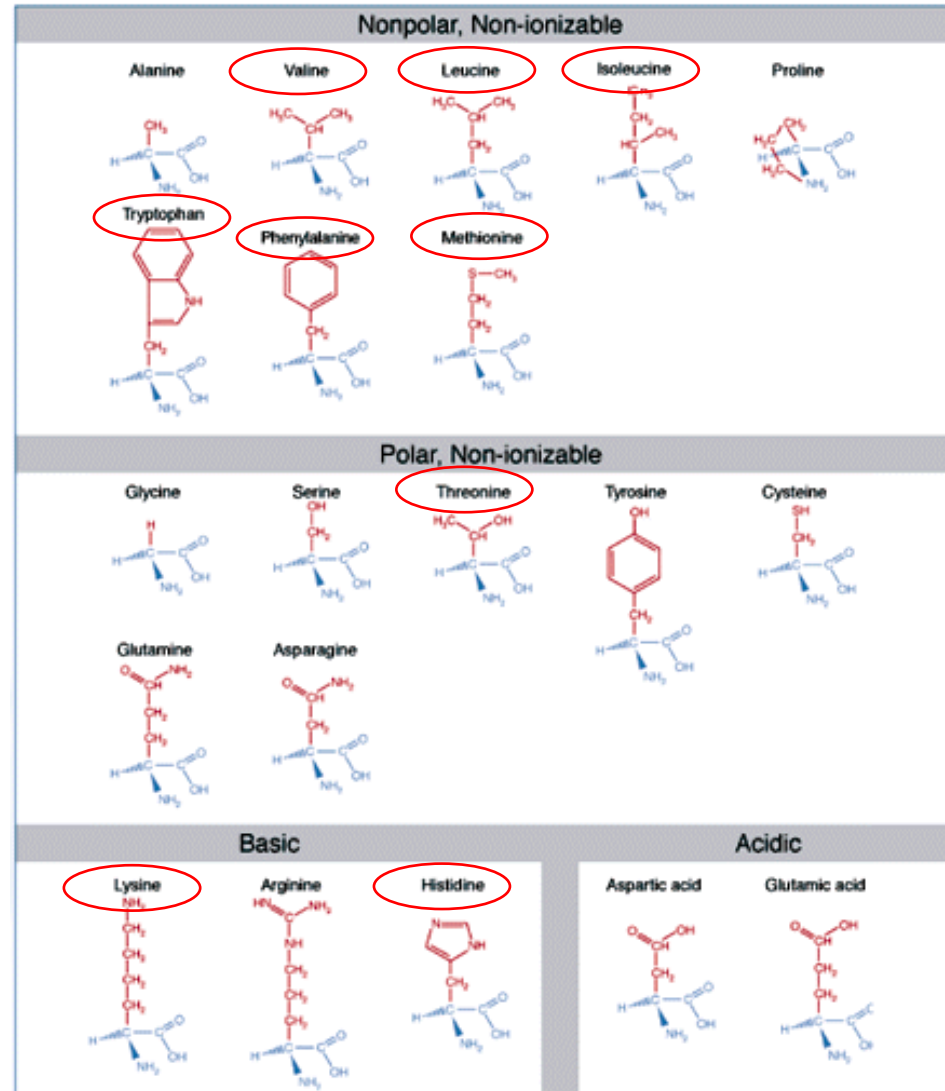


Table 1. Dietary Requirements for Amino Acids in Humans

Essential	Nonessential
Histidine	Alanine
Isoleucine	Arginine
Leucine	Asparagine
Lysine	Aspartate
Methionine	Cysteine
Phenylalanine	Glutamate
Threonine	Glutamine
Tryptophan	Glycine
Valine	Proline
	Serine
	Tyrosine



Why Proteins

Greek Word Proteios - “primary” or “holding the first place”

Key components of human body

Essential for cell and tissue growth

Enzyme hormones and immune cells our body needs

Different combinations of amino acids

20 amino acids as building blocks >> 9 are essential

How Much Protein

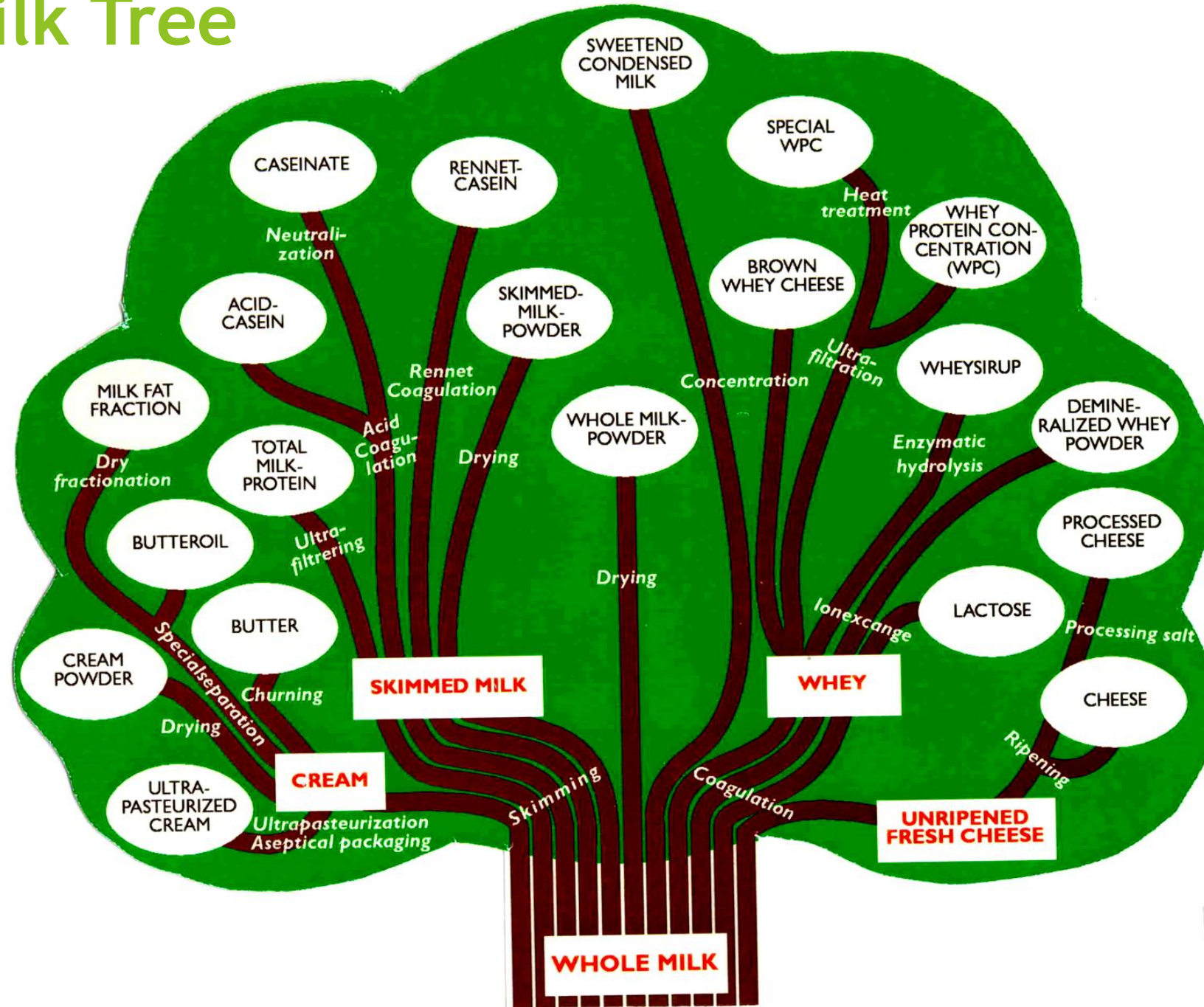
Adults - 0.80 to 0.83 g per kg of body weight

Max Limit?

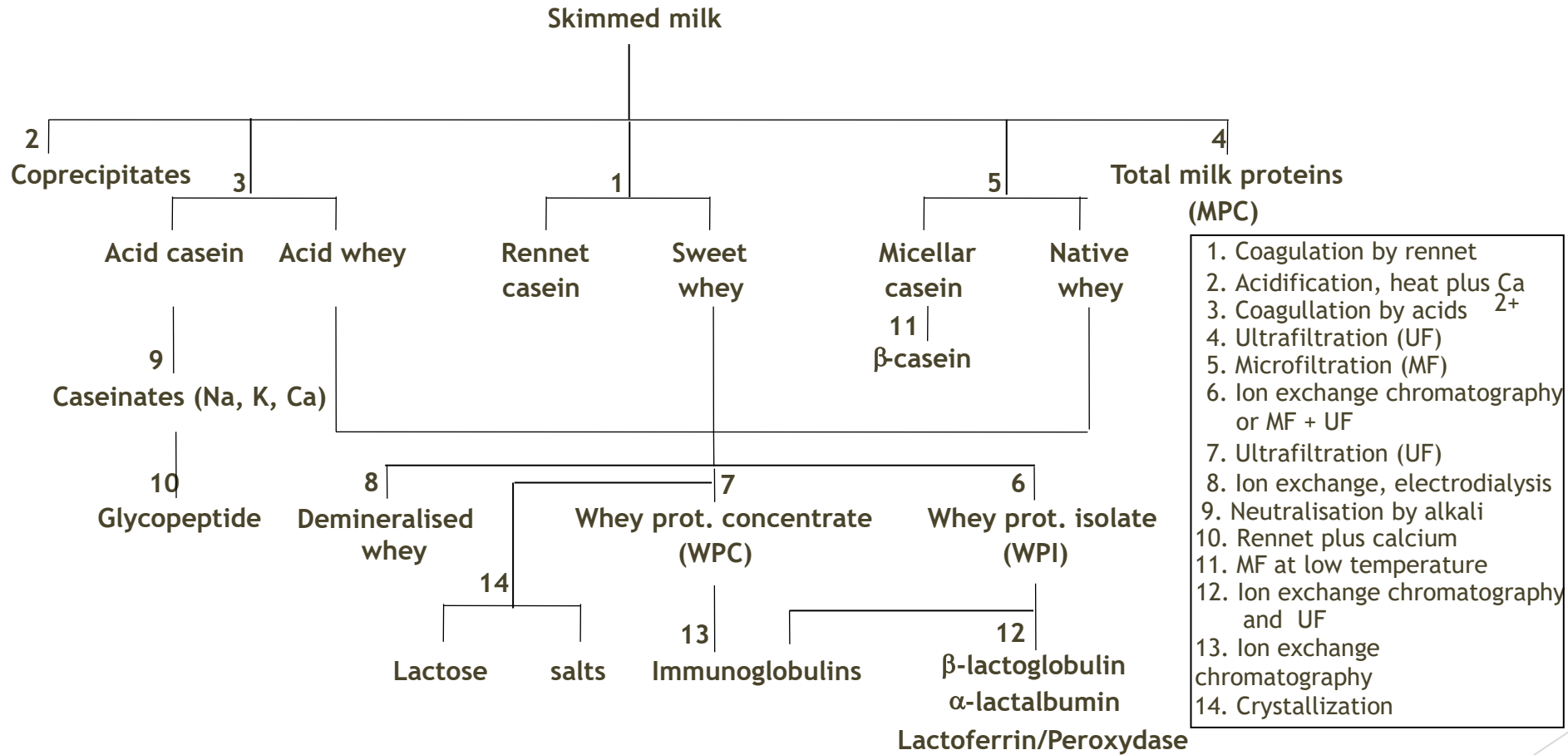
Important elements to consider

- Protein Sources
- Protein Quantity
- Protein Quality

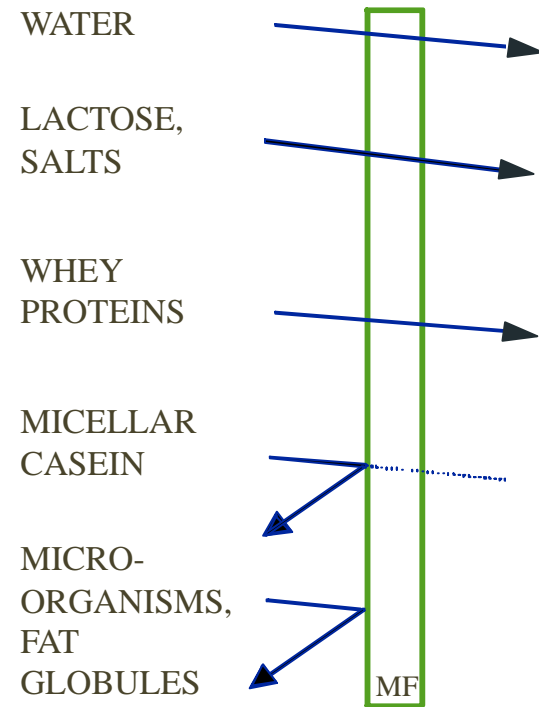
Milk Tree



Milk Cracking

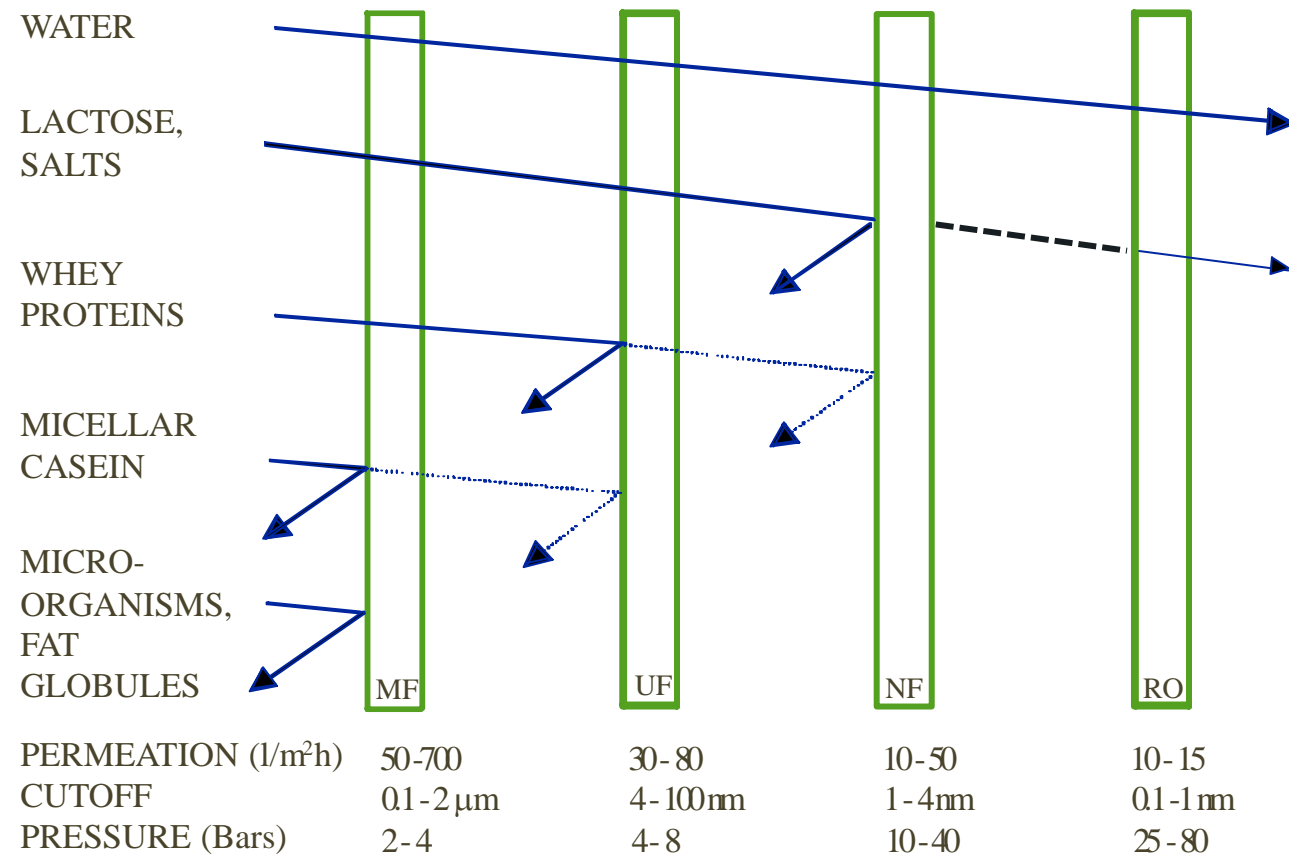


Membrane Processes



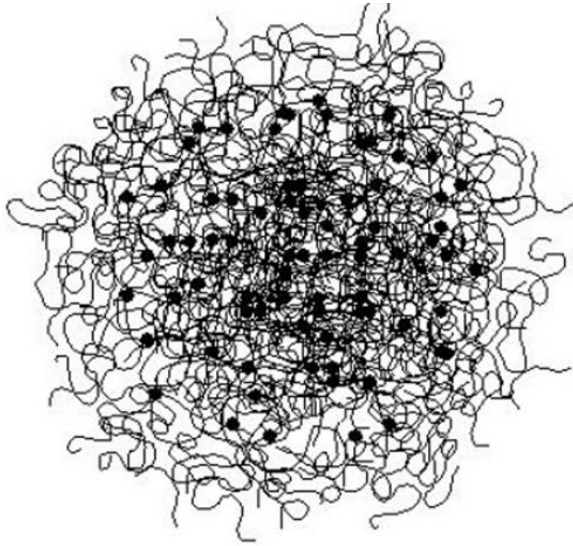
PERMEATION (l/m ² h)	50-700
CUTOFF	0.1-2 μm
PRESSURE (Bars)	2-4

Membrane Processes

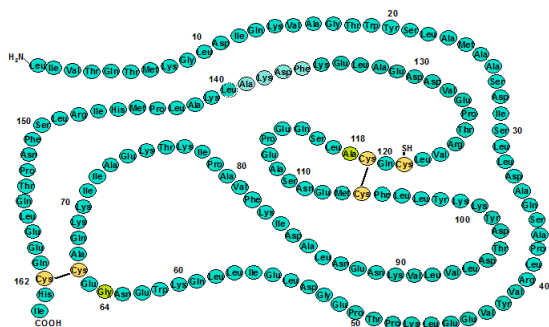


Milk Proteins

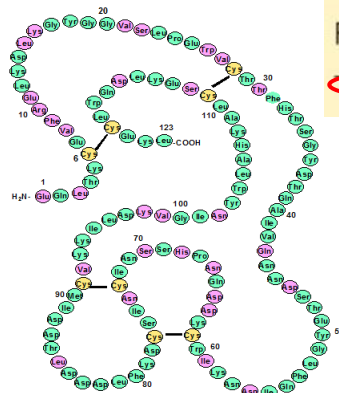
CASEINES



WHEY PROTEINS



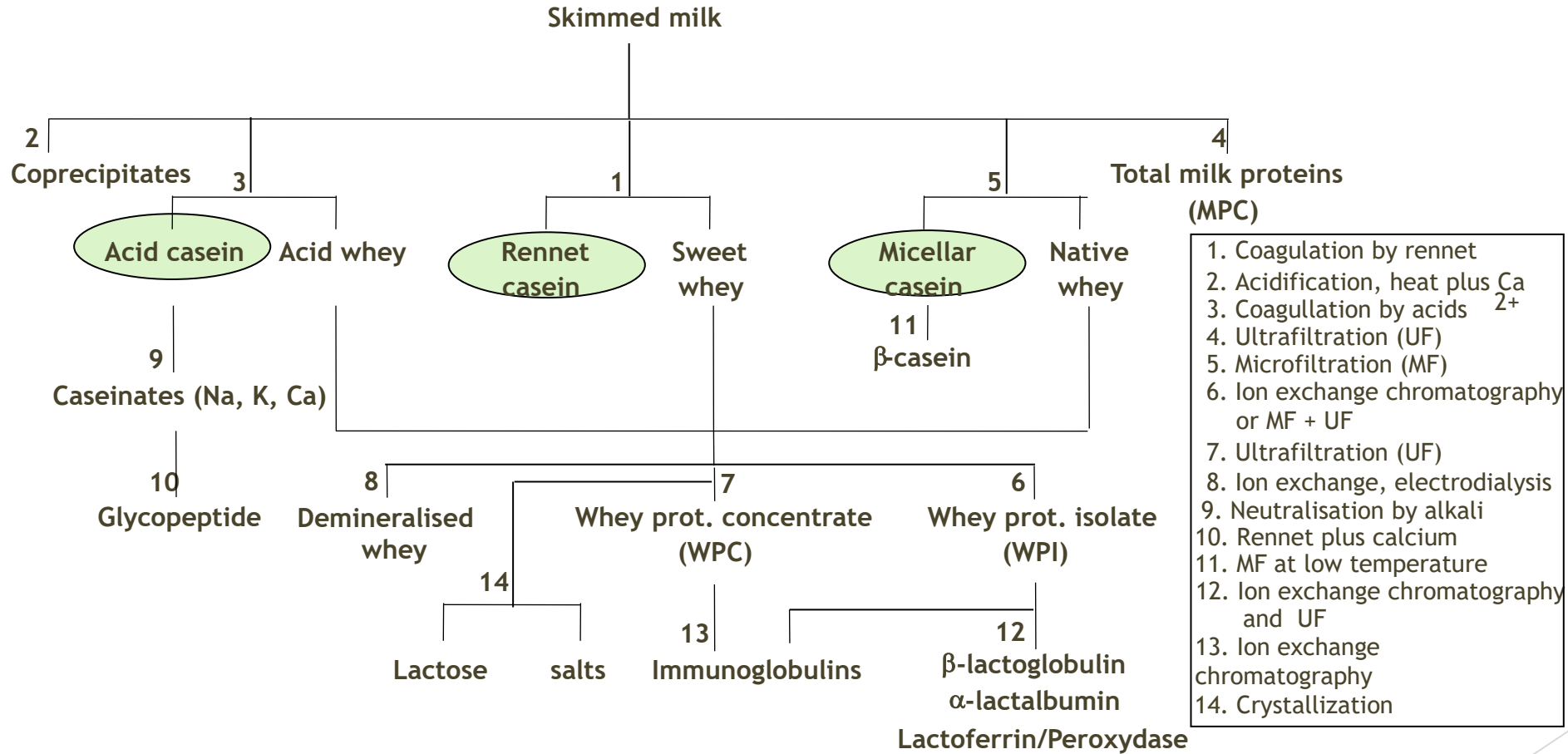
β -Lactoglobuline B



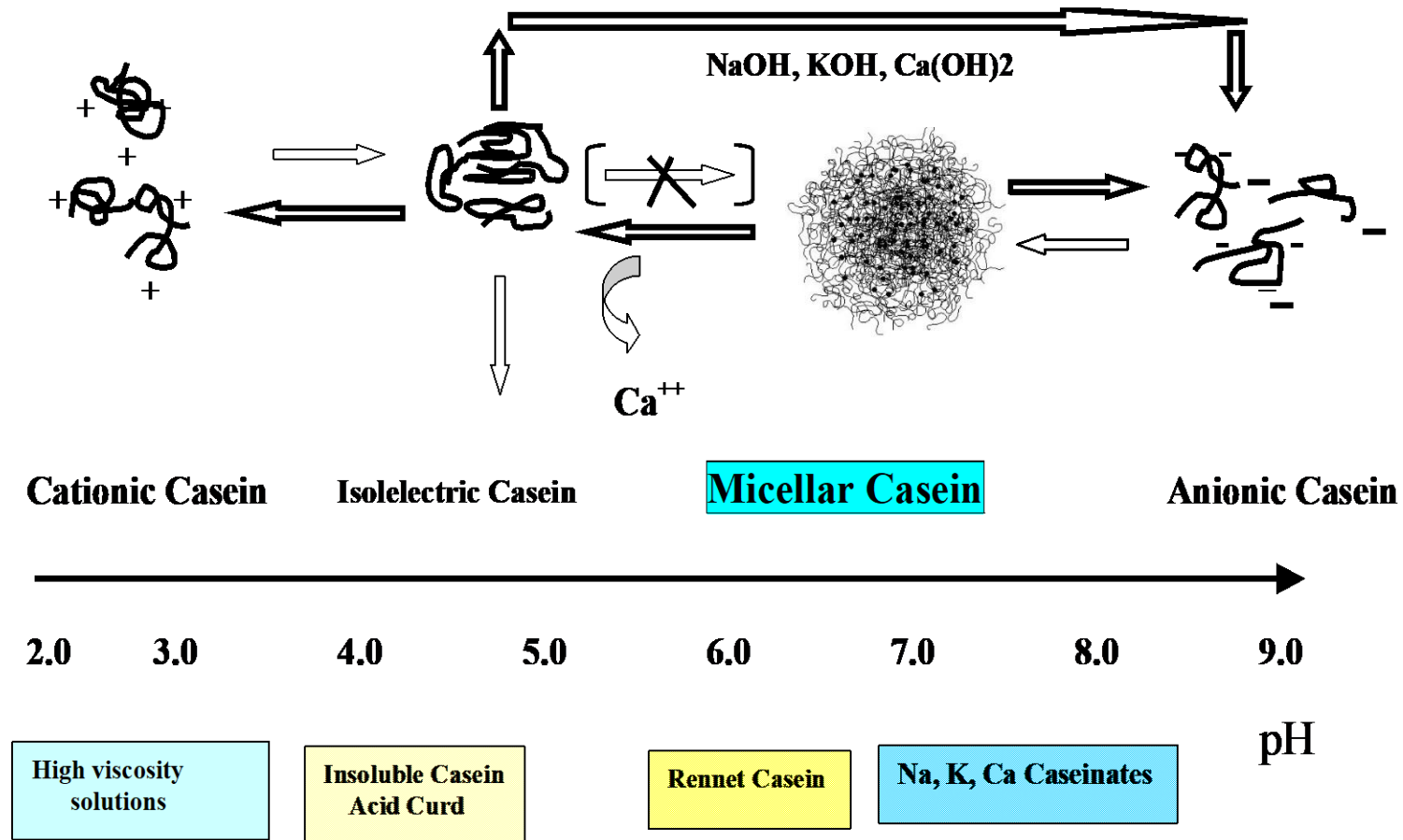
α -Lactalbumin

	Conc. in milk g/kg	% of total protein w/w
Casein		
α_{s1} -casein*)		
α_{s2} -casein*)		
β -casein**)		
κ -casein		
Total Casein	26.0	79.5
Whey Proteins		
α -lactalbumin		
β -lactoglobulin		
Blood Serum Albumin		
Immunoglobulins		
Miscellaneous (including Proteose-Peptide)		
Total Whey Proteins	6.3	19.3
Fat Globule Membrane Proteins		
Total Protein	32.7	100

Caseins



Caseins are very sensitive to pH



Whey Proteins

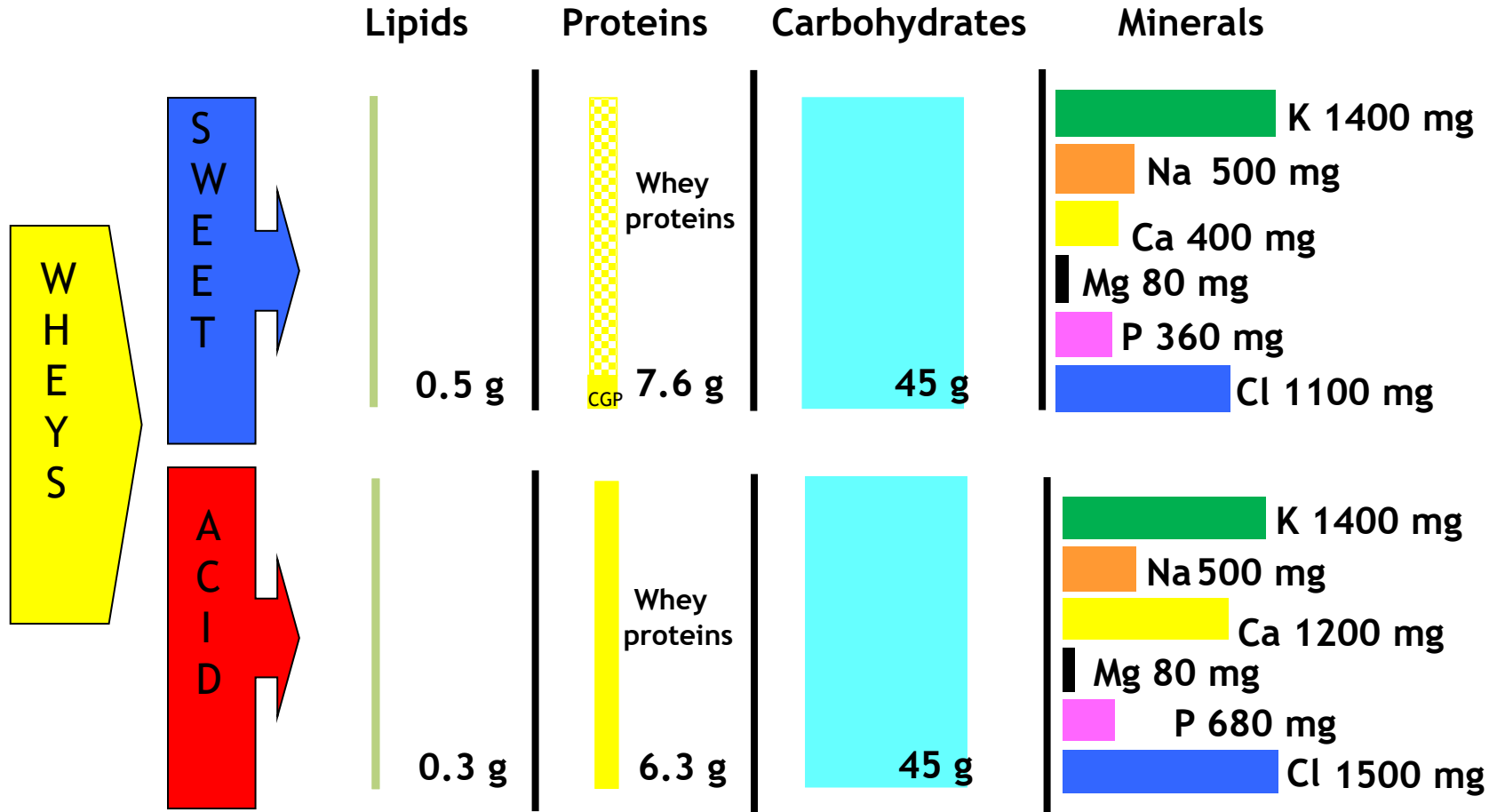
Raw whey composition

Water	94.4 %	
Lactose	4.2 %	
Minerals	0.5 %	
Fat	0.1 %	
PROTEIN		
		<u>Whey proteins 0.7 %</u>
		β-Lactoglobulin 0.36 %
		α-Lactalbumin 0.15 %
		Serum albumin 0.04 %
		Immunoglobulins 0.07 %
		Etc. 0.08 %
		<u>Casein fraction 0.05 %</u>

Whey is the main by-product of the industrial manufacture of cheese or casein production

The protein of whey is of an exceptionally high nutritional value

Whey Composition



Functional Properties of Whey

DUE TO LACTOSE

The high lactose rate of whey makes it a very active agent for maillard-reaction and enzymatic browning

UTILISATION

Biscuits
Bread-making
Special pastry

DUE TO WHEY PROTEINS

Better water linking

UTILISATION

Meat products

Nutritional properties

Proteins included in sweet whey are soluble and rich in essential amino-acids

High nutritional value

Diet foods
Infant formulae

Solubility on all pH range

Soft drinks

Jellying and structuring power

Meat foods

Emulsifying power

Liver mousses

Foaming power

Confectionery

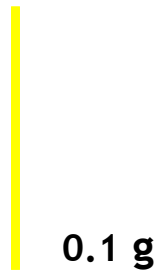
Whey Processing Technologies

- ▶ The crucial step in the fractionation of whey is the separation of the protein
- ▶ Large-scale fractionation is economical only if all components are utilized
- ▶ Several industrial procedures have been developed for whey fractionation and recovery of proteins:
 - ▶ Heat-acid precipitation
 - ▶ Electrodialysis
 - ▶ Ion-exchange
 - ▶ Membrane technologies

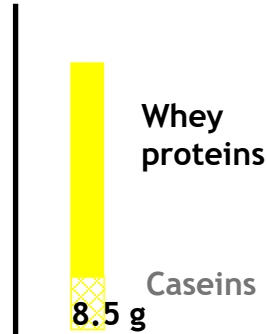
Whey >> to increase the whey protein content of milk

Sweet whey

Lipids



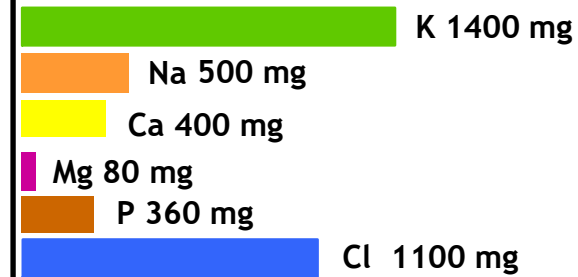
Proteins



Carbohydrates

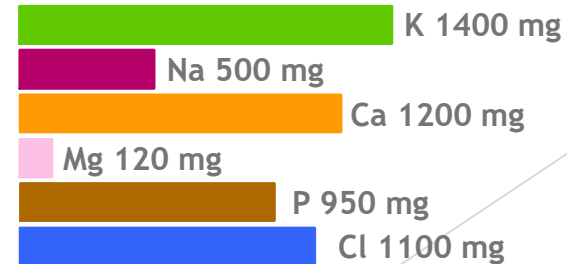
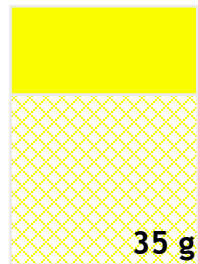
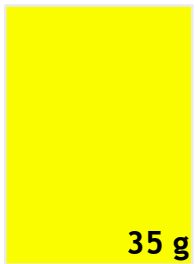


Minerals



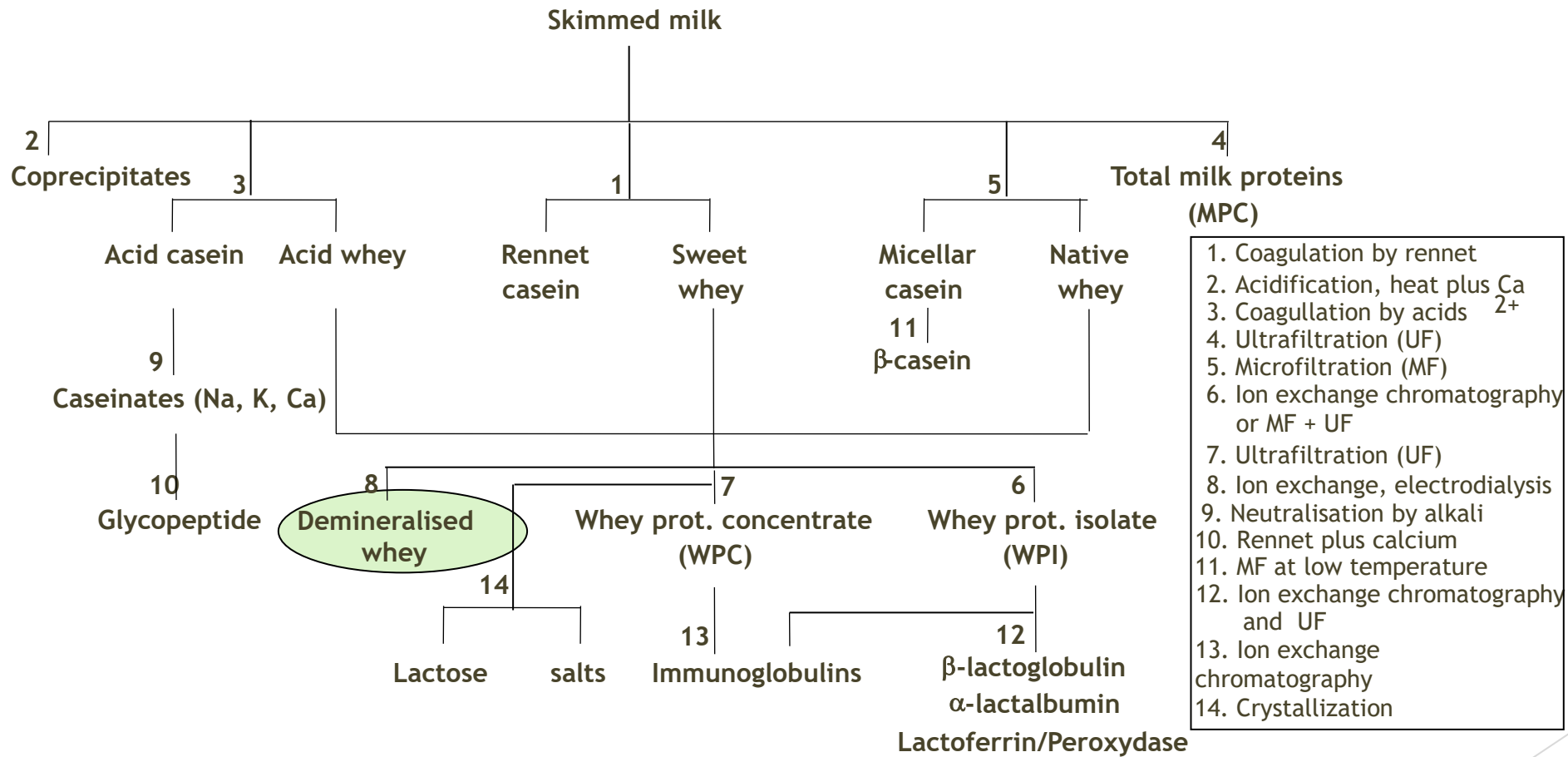
cas/whey protein = 18/82

Cow's milk



cas/whey protein = 80/20

Milk Cracking



1. Coagulation by rennet
2. Acidification, heat plus Ca
3. Coagulation by acids ²⁺
4. Ultrafiltration (UF)
5. Microfiltration (MF)
6. Ion exchange chromatography or MF + UF
7. Ultrafiltration (UF)
8. Ion exchange, electro dialysis
9. Neutralisation by alkali
10. Rennet plus calcium
11. MF at low temperature
12. Ion exchange chromatography and UF
13. Ion exchange chromatography
14. Crystallization

Whey Demineralization

- ▶ Demineralized whey is a product in which the natural mineral content has been reduced to different levels with appropriate processes.
- ▶ Demineralization of whey was developed because the high mineral content of normal whey limits its use: electrolyte imbalance in dietetic products and salty taste
- ▶ DWP contains 10-12 % proteins, 75-80 % lactose, residual fat and minerals
- ▶ After demineralization, the new mineral composition must be adjusted for special nutrition requirements and for pH regulation

Whey Demineralization

Manufacturing Process

Reception, clarification and skimming of the raw whey.

➔ Concentration (reverse osmosis, nanofiltration or evaporation)

➔ Demineralization:

- Ion Exchange (IE) or combining
- Electrodialysis (ED) + Ion Exchange

➔ Standardization of proteins

➔ Standardization of minerals and pH

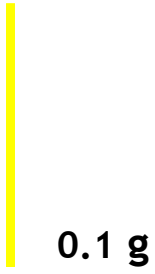
➔ Pasteurization

➔ Concentration and Spray drying

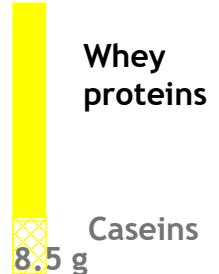
Mineral Content is Reduced up to 90% without Protein Degradation

Sweet whey

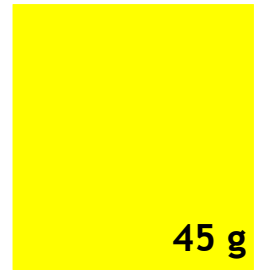
Lipids



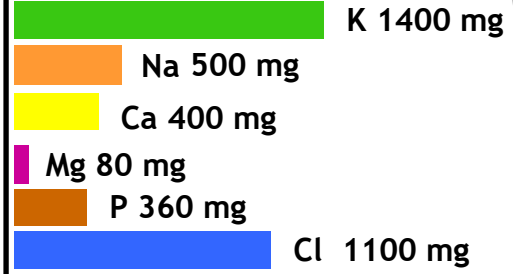
Proteins



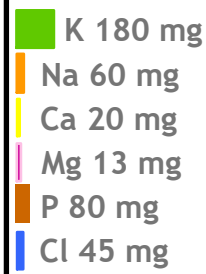
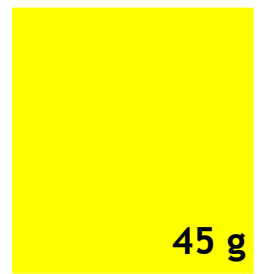
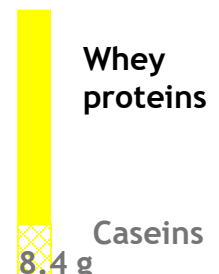
Carbohydrates



Minerals



Demineralized sweet whey



The Nestlé Patent

A fractionation process developed

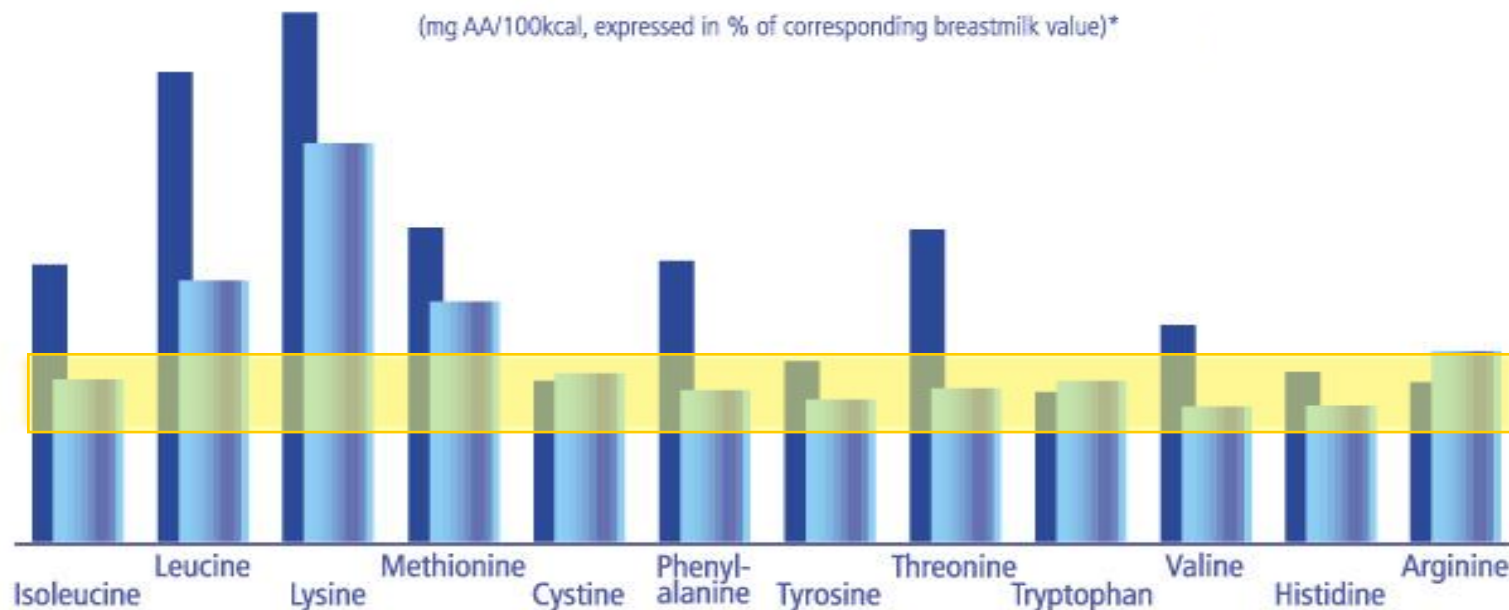
To demineralise sweet whey in an **unique** process step



Improved whey protein quality !!

An Improved Amino-acid Profile

(mg AA/100kcal, expressed in % of corresponding breastmilk value)*



Usual Milk Derivatives

Milk derivative	Process	Protein	Lipids	Lactose	Ash	Moisture	Ca	K	Na	P
Acid casein	Acid precipitation of casein from skimmed milk	86.8	1.5	0.8	1.2	8.2	0.05	0.09	0.06	0.74
K-Caseinate	neutralisation of acidic Cagulum with KOH	87.4	1.2	0.3	5.3	3.9	0.10	2.30	0.07	0.65
Ca-Caseinate	neutralisation of acidic Coagulum with Ca[OH] ₂	89.1	1.5	0.2	3.9	4.0	1.19	0.04	0.21	0.77
Micellar casein	microfiltration of skimmed milk	84.7	1.4	0.7	8.3	3.8	2.50	0.18	0.05	1.60
Rennet casein	coagulation by rennet of casein from skimmed milk	81.0	0.7	0.2	8.7	10.0	2.80	0.42	0.16	1.73
Milk protein Concentrate (MPC)	ultrafiltration of skimmed milk	79.1	1.5	7.5	7.8	3.4	2.80	0.30	0.24	1.20
Whey protein concentrate (WPC)	ultrafiltration of sweet whey	77.0	7.2	5.0	2.7	3.6	0.37	0.61	0.20	0.33
Delipidated WPC	microfiltration and ultrafiltration of sweet whey	83.0	0.3	6.5	3.0	3.8	0.63	0.33	0.42	0.13
Acid WPC	ultrafiltration of acid whey	78.6	4.7	4.7	1.3	3.7	0.10	0.12	0.02	0.50
Whey protein isolate (WPI)	Ion exchange chromatography of whey	88.6	0.6	0.2	2.0	3.5	0.13	0.19	0.48	0.03
Whey protein isolate (WPI)	Ultrafiltration and diafiltration of whey	80.7	0.8	0.3	7.5	4.1	0.26	1.72	1.24	0.40

Casein and Whey Proteins bring Different Functionality to Food Products

	Casein	Whey Proteins
Solubility	Insoluble at pH 4.6	Soluble at any pH if not denatured
Viscosity	High at neutral or alkaline pH	Viscous solution except when denatured
Hydration	High water retention at high concentration	Water retention increases with denaturation
Gelation	No heat gelation except in presence of Ca.	Heat gelation at $T > 70$ deg C affected by pH & salts
Emulsifying power	Excellent particularly at neutral; and alkaline pH	Good except at pH 4-5 if denatured
Foaming Power	Good but low stability of foam	Good and good foam stability

Applications of Some Milk Derivatives

Final Product	Milk fraction	Preferred milk derivative	Non milk alternative
Imitation Cheese	Casein	Rennet Casein	None
Hamburgers, Sausages, Petties	Casein, protein concentrate, co-precipitates	Sodium Caseinate	Soy isolates, egg albumen, wheat gluten
Non-Dairy Whiteners	Caseinates	Sodium Caseinate	Soy isolates
Sauces, salad dressings, light mayonnaise	Caseinates, protein concentrate and protein isolates	protein concentrate and protein isolates	Egg albumen, Gelatin
Biscuits and pastries	Lactose powder, protein concentrate	protein concentrate	Egg albumin
Ice Cream, Smoothies	protein concentrate and protein isolates	protein isolates	Any
Dietetic and Infant Food	Caseinates, protein concentrate and Lactose	K-caseinate, acidic casein & Ca-caseinate	Soy isolates

The background features a series of overlapping, semi-transparent green geometric shapes, primarily triangles and quadrilaterals, that create a dynamic, layered effect. The colors range from a light, pale green to a vibrant, saturated lime green. The shapes are positioned on the right side of the frame, extending towards the center, while the left side remains mostly white.

Thank You