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5th International Whey Conference

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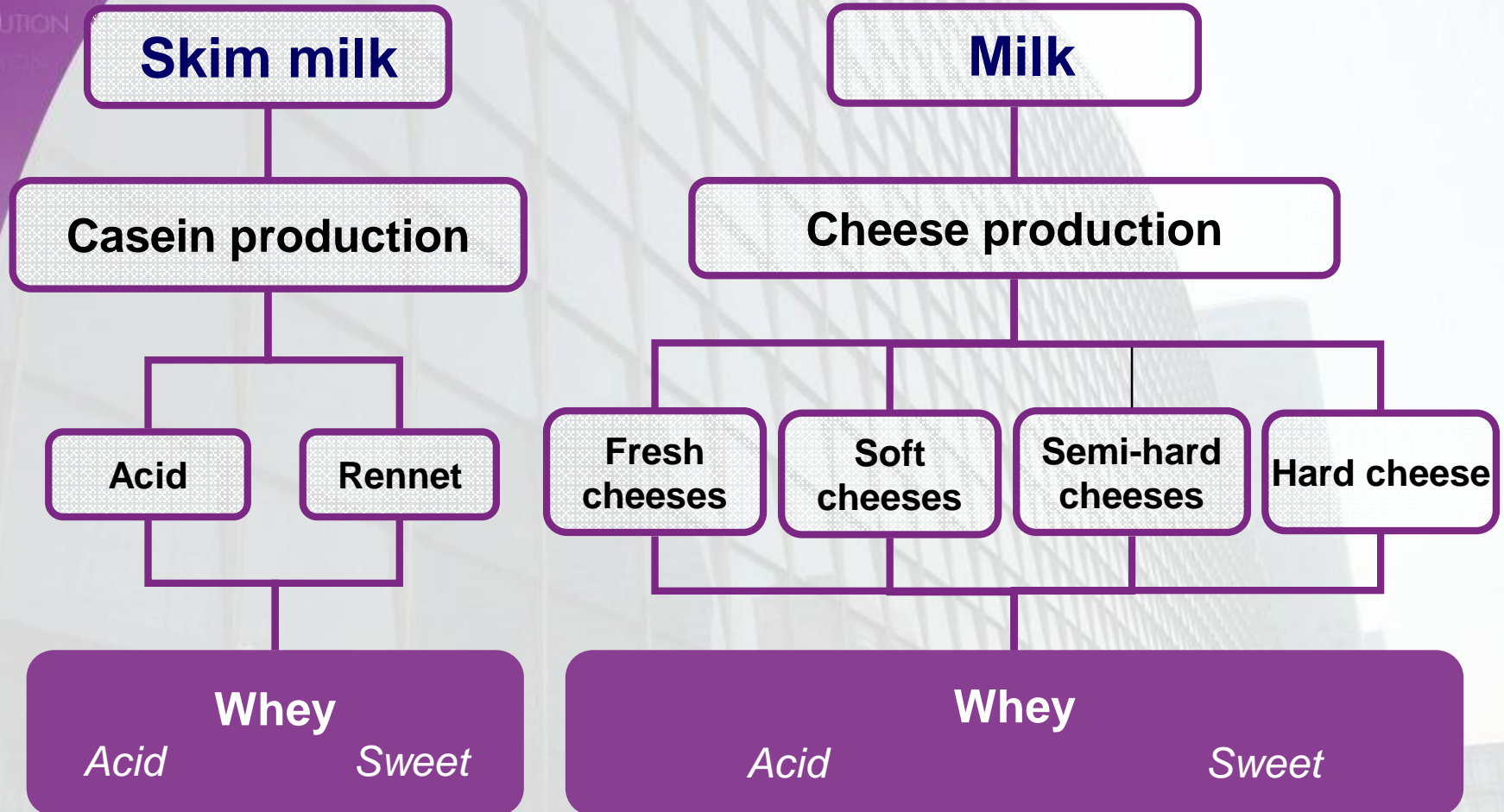
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Whey, the natural source for a broad range of food ingredients

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LACTALIS R&D



Whey





What can you obtain from whey ?

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- ~ Whey powder
- ~ Demineralised whey
- ~ WPC 35
- ~ WPC80 and WPI
- ~ Whey permeate
- ~ Lactose and derivatives
- ~ Calcium
- ~ Native and denatured whey proteins
- ~ Fractions with enriched proteins
- ~ Hydrolysates
- ~ Bioactive peptides
- ~ Growth factors
- ~ Oligosaccharides



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Transform liquid into powder

- ~ Before the 60's, whey was either rejected or used for feed
- ~ 60-70's: development of spray-drying technology
è **WHEY POWDER**, feed and food grade



- ~ Before drying the whey, lactose should be crystallised



Demineralised whey (60's)

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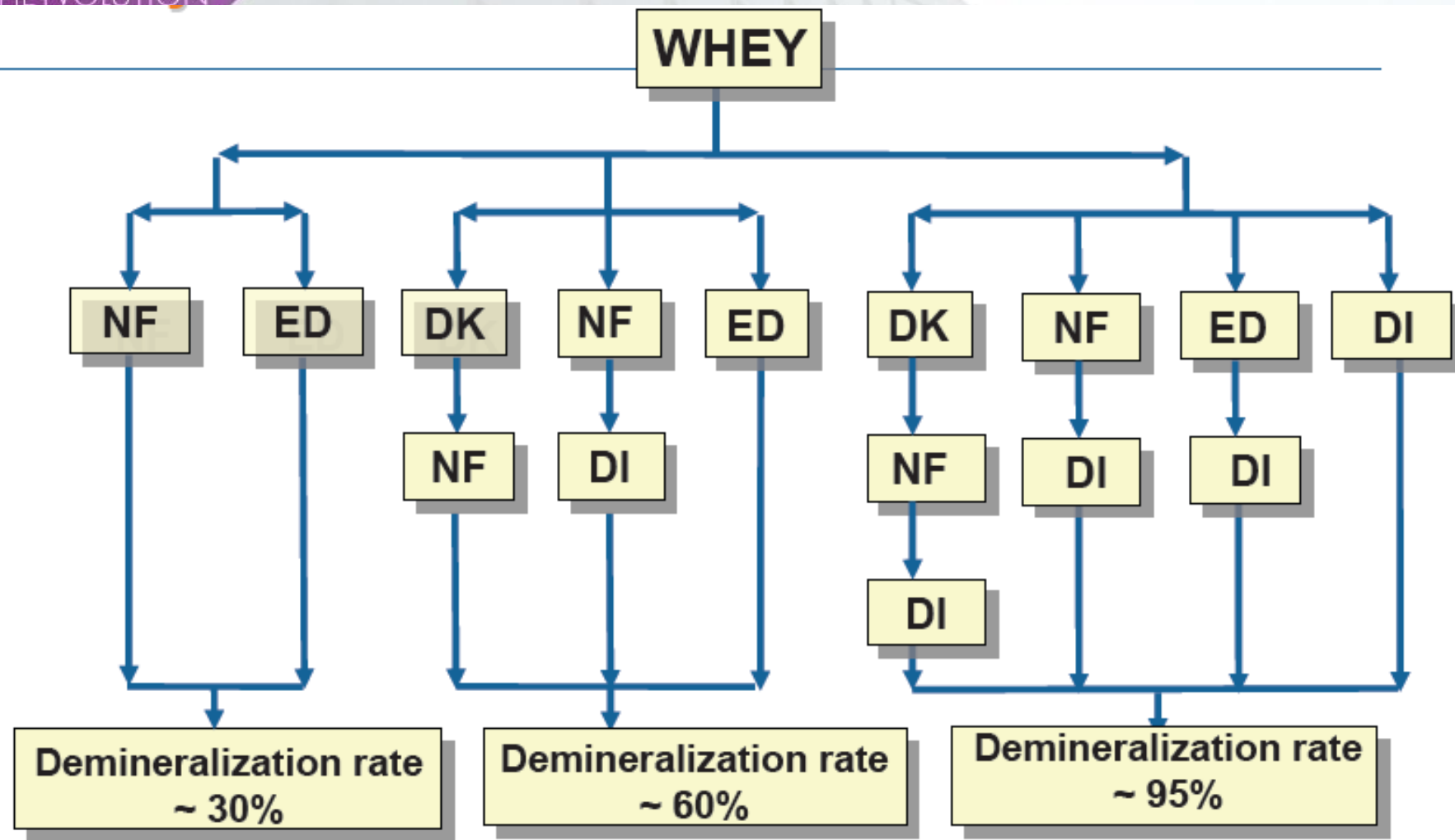
- ~ Demineralised whey = the first component of an infant formula (40 to 50 % of the final product weight)
- ~ Minerals in infant formulas should be low in order to comply to nutritional and regulatory needs
- ~ Technologies for demineralization:
 - 4 Ion exchange
 - 4 Nanofiltration
 - 4 Electrodialysis
- è More often a combination of 2 or 3 of these technologies





Demineralised whey

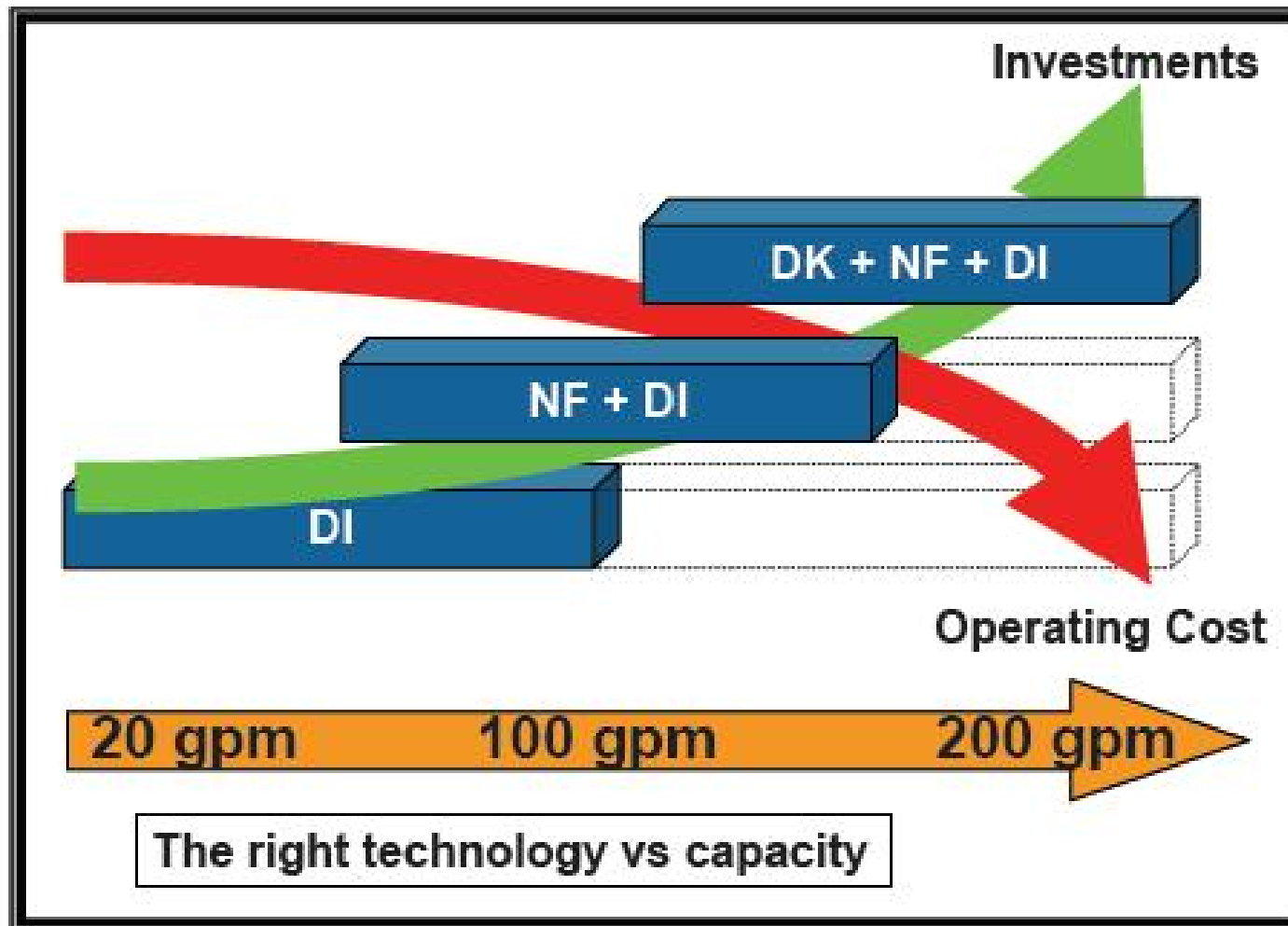
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Demineralised whey

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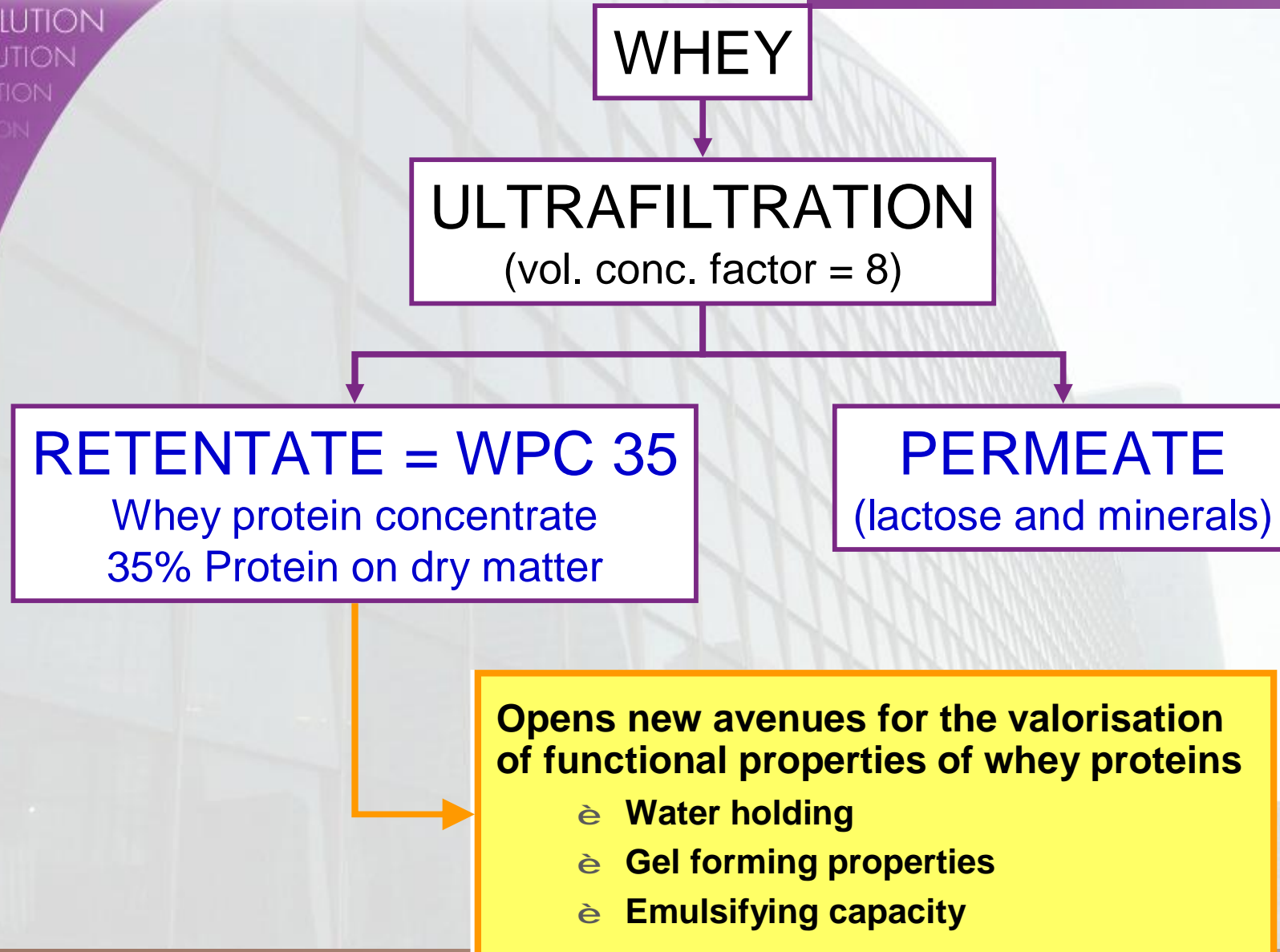
Ultrafiltration (60's and 70's)

A real breakthrough was achieved at the end of the 60's with the development of membrane filtration, thanks to Jean Louis Maubois and others.





WPC 35 (70's)





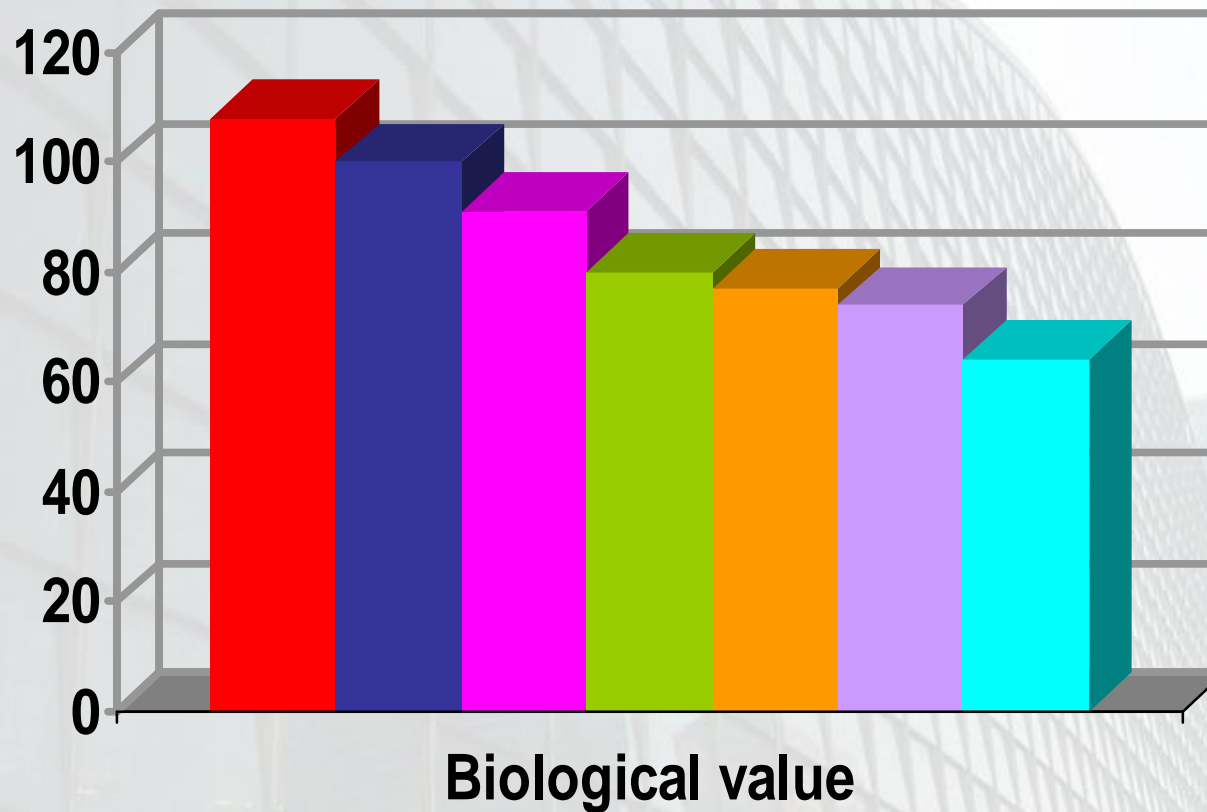
WPC80 an WPI (80's)

- ~ Obtained by Ultrafiltration / Diafiltration / Chromatography
- ~ Higher concentration of protein together with lipid removal => **improvement of technological properties**
 - è Higher gelling properties
 - è Stabilisation of Foams
- ~ High nutritional value => **nutrition and diet market**
 - è Functional beverages (clear beverages; shakes)
 - è Nutritional bars



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Biological value of whey proteins





Native soluble milk proteins (90's)

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- ~ Soluble milk proteins can be separated from milk by microfiltration (technology started in the 90's)
- ~ The soluble phase of milk contains all the native whey proteins, without GlycoMacroPeptide (only present in cheese whey)
- ~ Benefits of soluble whey proteins
 - è Increased nutritional value for infant nutrition
 - è Better control on composition and functional properties thereof



Denatured whey proteins

- ~ Denaturation of whey proteins is caused by heat

In order to control the structural state of denatured whey proteins, pH and calcium are the 2 main parameters

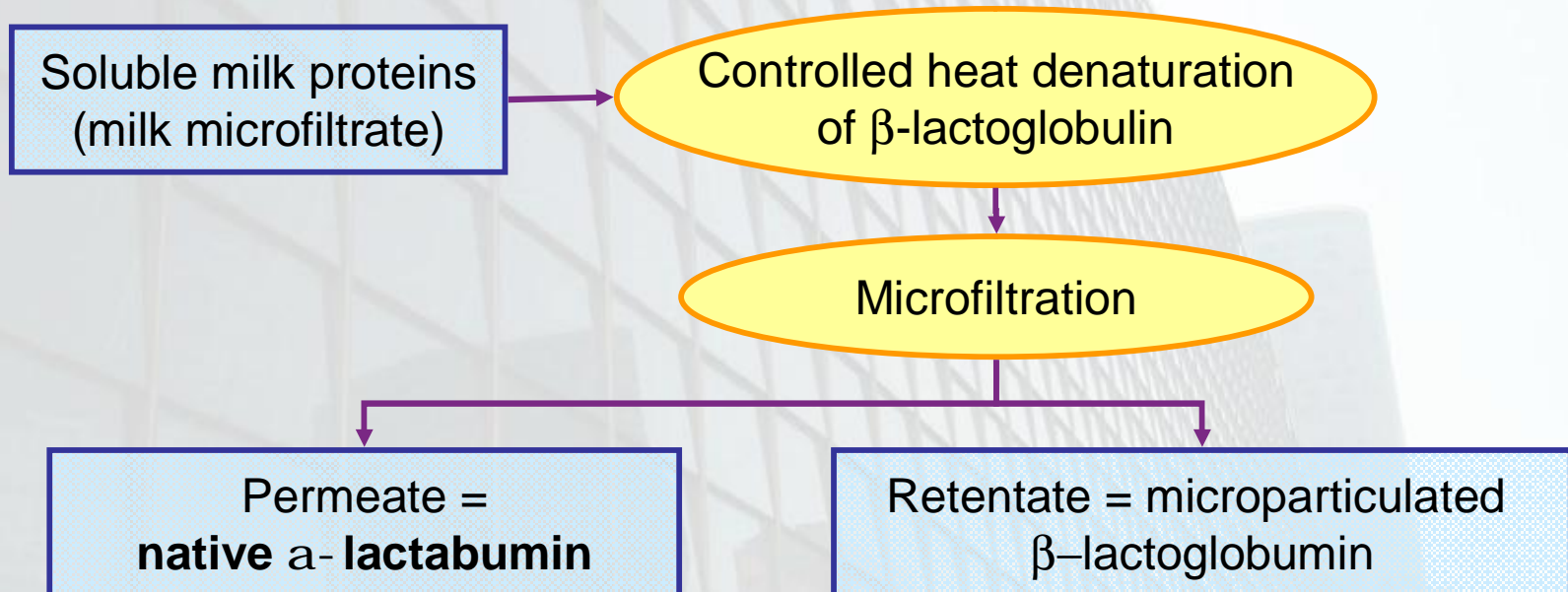
è **Structural Design is possible**

- ~ Denatured whey proteins have remarkable functional properties
 - è Increased water retention (i.e. for fresh dairy products) for **soluble whey protein aggregates**
 - è Heat stability for **micellar whey protein**
 - è Creamy texture for reduced fat products is obtained through **microparticulated whey proteins**



Fractions with enriched proteins

- ~ Alpha-Lactalbumin: the protein of human milk
- ~ Production of bovine α -Lactalbumin rich fraction



- ~ Other proteins: lactoferrin, lactoperoxydase
 - è Production by membrane processing and/or ion-exchange chromatography
 - è Bioactivity = anti-microbial properties, iron-binding (Lf)



Hydrolysates

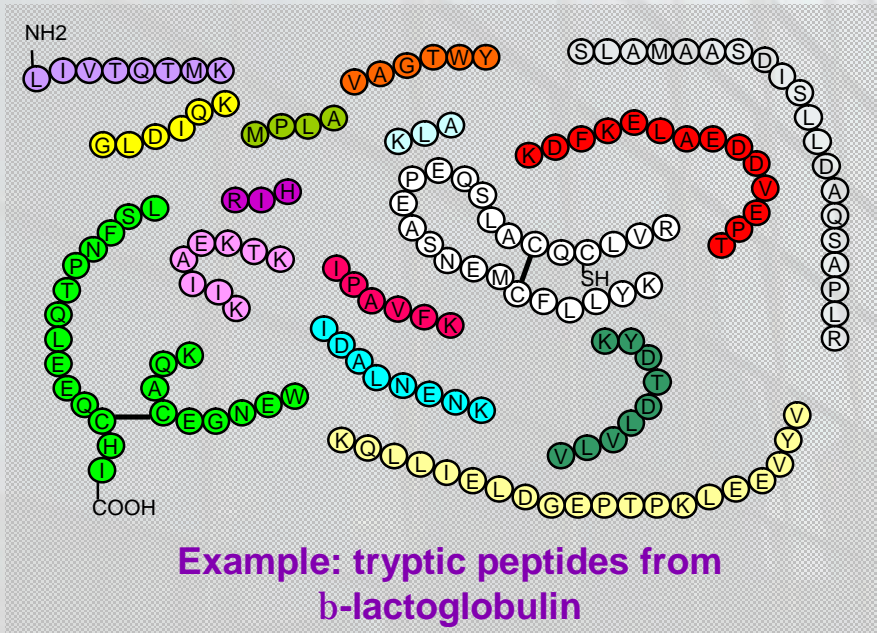
- ~ Hydrolysates are obtained by enzyme technology, sometimes combined with a fractionation technology (UF or chromatography)

- ~ Hydrolysates can be divided in 2 main categories:
 - è Hypo-allergenic and non-allergenic hydrolysates
 - è Specific hydrolysates with bioactivity:
 - 4 With anti-oxidant properties (enriched with Cysteine)
 - 4 With anti-hypertensive effect
 - 4



Non-allergenic hydrolysate

- ~ 2-7 % of infants are allergic to milk proteins
=> Diet = non-allergenic formulas with fully hydrolysed proteins



- ~ A combination of heat denaturation and enzymatic hydrolysis is needed since native whey proteins are resistant to enzymes.

- ~ An ultrafiltration step might be added to remove bigger fragments with residual antigenicity



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Bioactive whey peptides

Peptides	Protein precursor	Bioactivity
Lactorphins	α -Lactalbumin β -Lactoglobulin	Opioid agonist
ACE inhibitory peptides	α -Lactalbumin β -Lactoglobulin	Anti-hypertensive
Lactoferricin	Lactoferrin	Anti-microbial



Growth factors

~ Can be used in therapeutic products for wound healing and treatment of inflammatory gut disorders

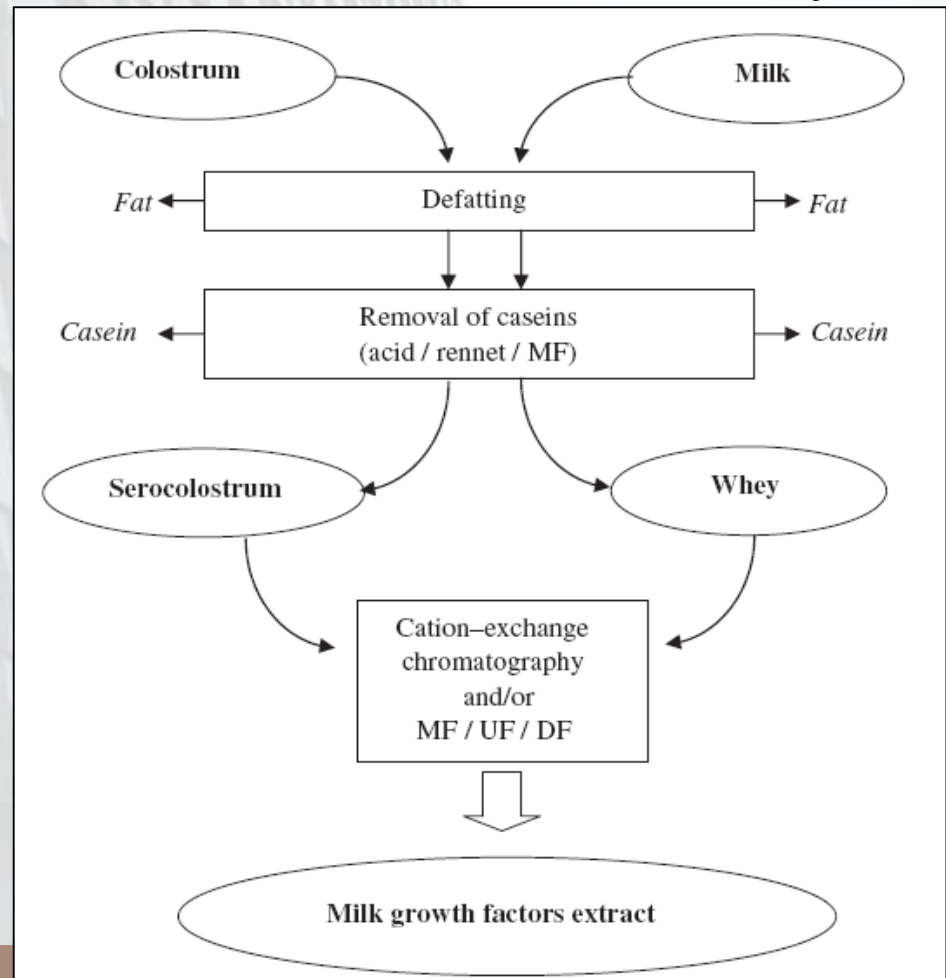
è **IGF**

è **TGF- β**

è **EGF**

Isolation of growth factors from milk and colostrum whey using cation exchange chromatography and / or microfiltration / ultrafiltration

From Pouliot and Gauthier (2006)
Int. Dairy J., 16, 1415-1420





Prebiotics derived from whey

- ~ Obtained by enzymatic or chemical conversion of lactose
- ~ Galacto-oligosaccharides (GOS)
 - è produced by lactose hydrolysis and transfer of the galactose on residual lactose by transgalactosylation
 - è incorporated in infant milk formula as a bifidogenic factor in order to stimulate the growth of bifidobacteria
- ~ Lactulose
 - è produced by chemical or enzymatic isomerization of lactose
 - è mainly used as a medicine for the treatment of chronic constipation and portal systemic encephalopathy
 - è prebiotic effect



Whey oligosaccharides

- ~ Health benefit: **protection**
 - è Naturally-occurring prebiotic in milk
 - è Trick harmful microbes, viruses and toxins (decoy function)

- ~ Main oligosaccharides in bovine whey = Sialylated-oligosaccharides
 - 4 Concentration in cow's milk: 0,1 g/l
 - 4 Concentration in human milk: 1-2 g/l

- ~ Technological challenge: development of enrichment strategies for large scale applications



Conclusion

- ~ During the last 40 years, each technology pushes has led to new ingredients with improved functionalities
- ~ Texture forming properties of whey proteins
 - 4 **Whey is a toolbox for structure and texture design**
- ~ Nutrition and health:
 - è Existing ingredients have a high nutritional value and bioactive properties
 - è Continuous discovery of new health benefits
 - 4 **Whey is a toolbox for Nutrition**



Future trends

- ~ Emerging bioactive whey ingredients: oligosaccharides, bioactive peptides, ...
- ~ Physical processing
 - è Controlled heat induced interactions between whey proteins and other food components: lipid membranes, casein micelles..
 - è Processing with a lower thermal impact : ultra high pressure, cold processing..
- ~ Convergence of structure and nutrition:
Impact of the structural state of whey ingredients on post-prandial metabolism ?
 - è Fast and slow proteins
 - è Satiety induction..