

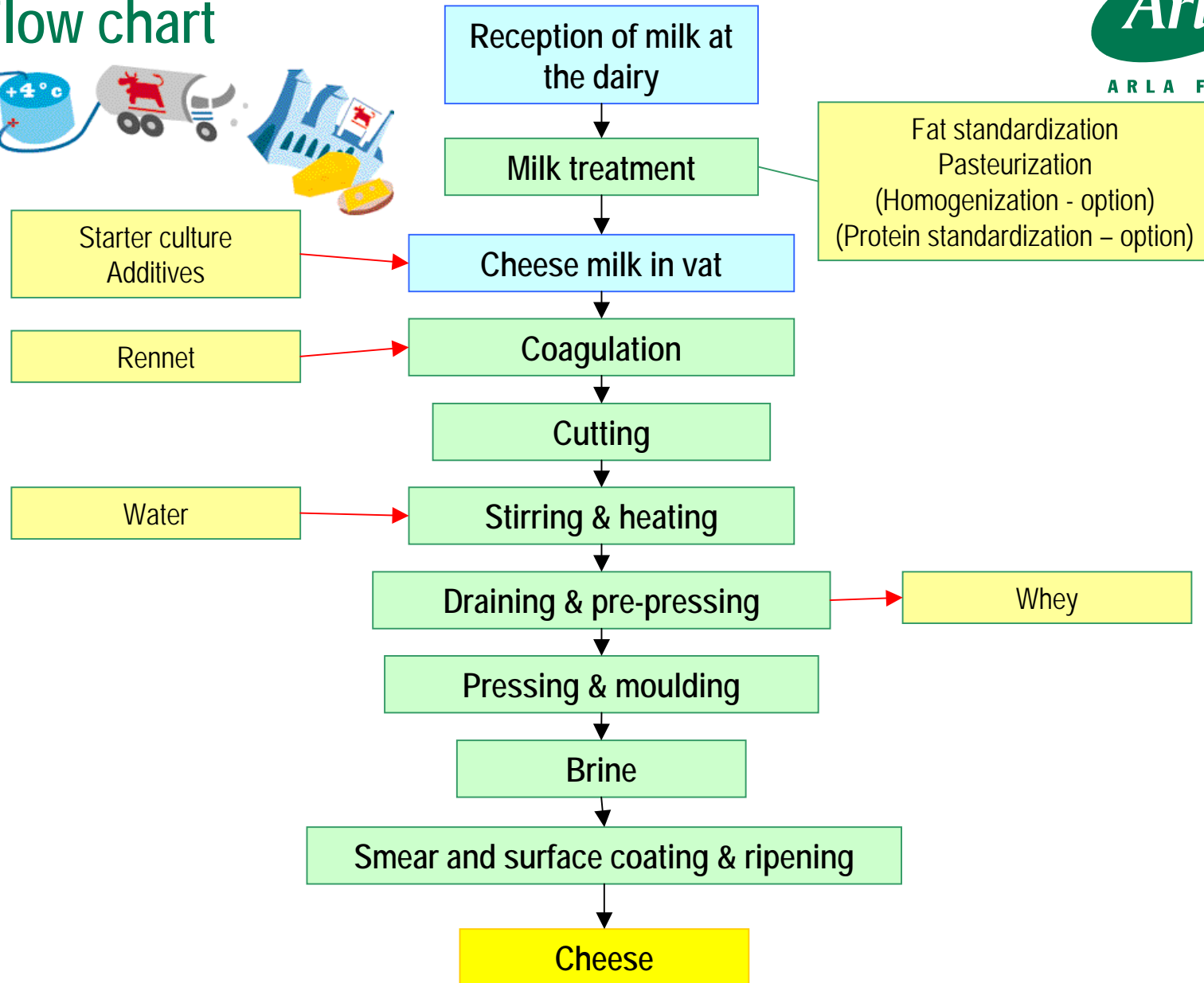


Production and Product Knowledge



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Flow chart



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Reception of milk

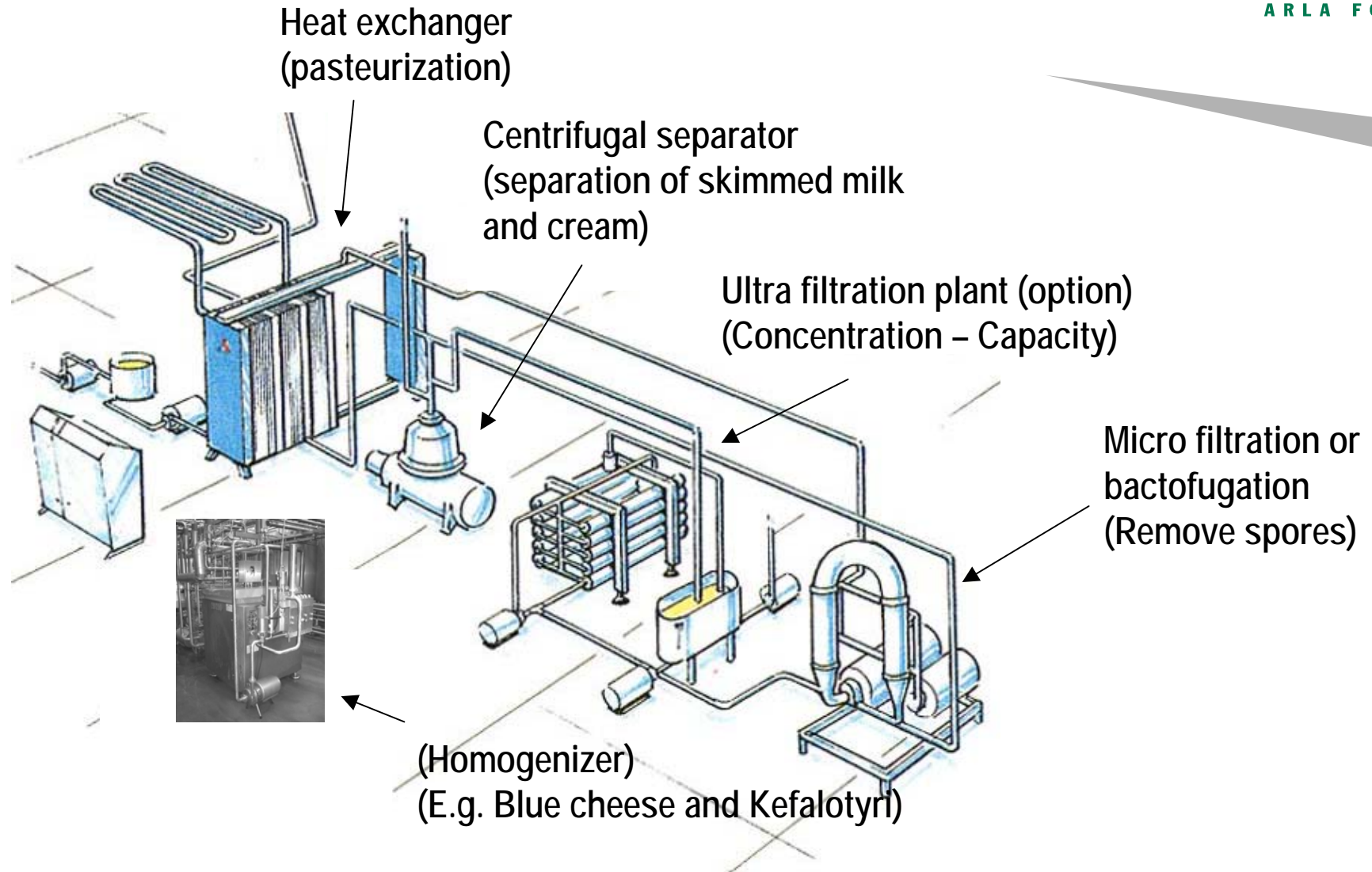


Composition of Danish / Swedish cow milk:

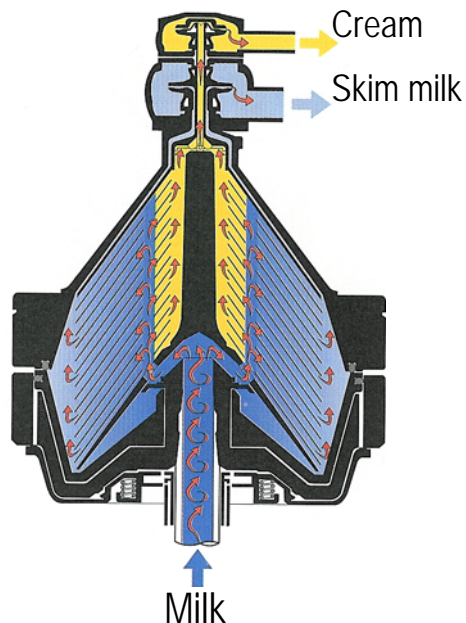
Fat:	4.3%	(3 - 5%)
Protein:	3.4/3.3%	(3.0 – 3.7%) (75% of the protein is casein)
Lactose:	4.6/4.5%	(4.3 – 4.8%)
Total solids:	13.1%	(11 - 17%)
Water:	86.9%	(83 - 89%)



Milk treatment



- ▶ Milk is separated into skim-milk and cream.
- ▶ Skim-milk and cream are mixed again to obtain the right fat content.

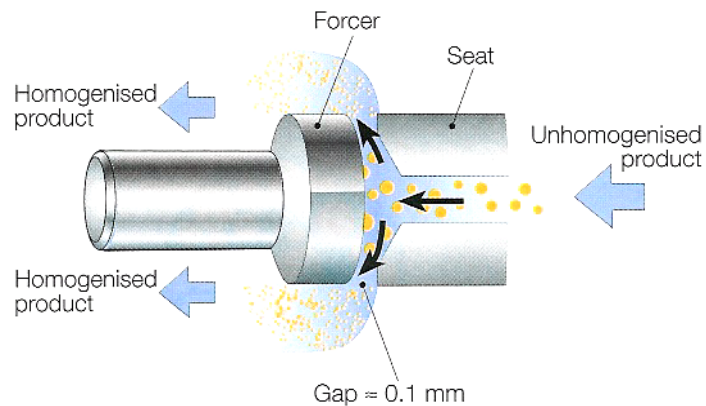


- ▶ The right fat content is dependent upon protein in order to obtain the planned fat content (fat in dry matter) and kilograms of cheese.



Milk treatment – Homogenization (option)

- ▶ Applies white colour and special taste
- ▶ Mixes vegetable oil into milk
- ▶ For most cheese types (e.g. Danbo, Havarti, Edam, Herrgård, Grevé, Wästgöta Kloster, Hushåll etc.) the cream and milk are NOT homogenized.

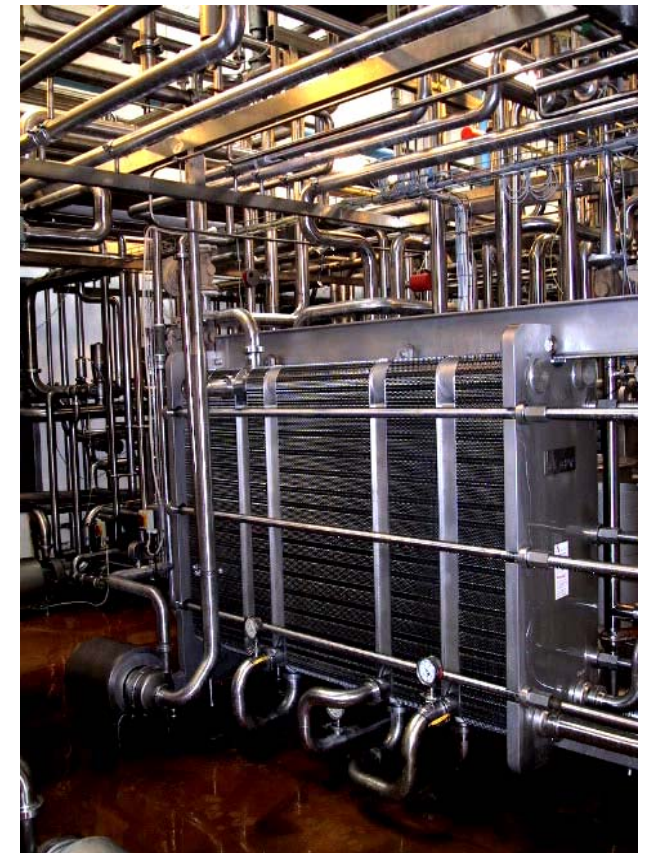
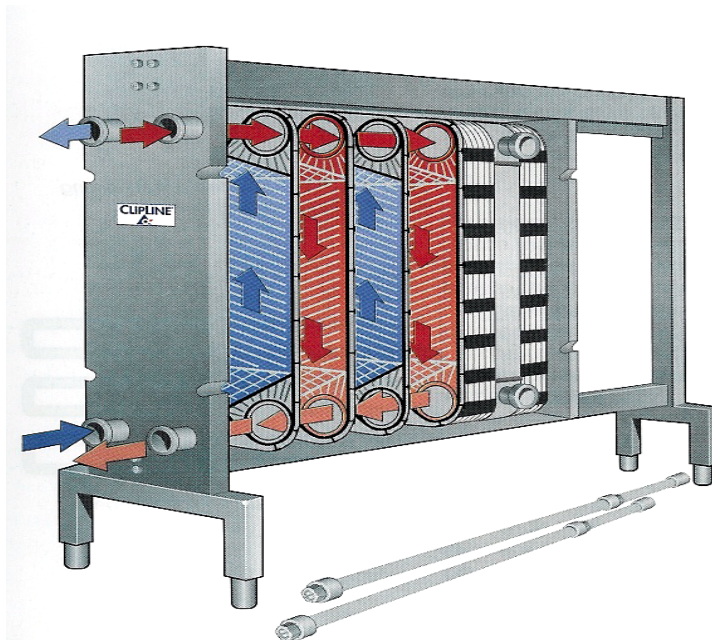


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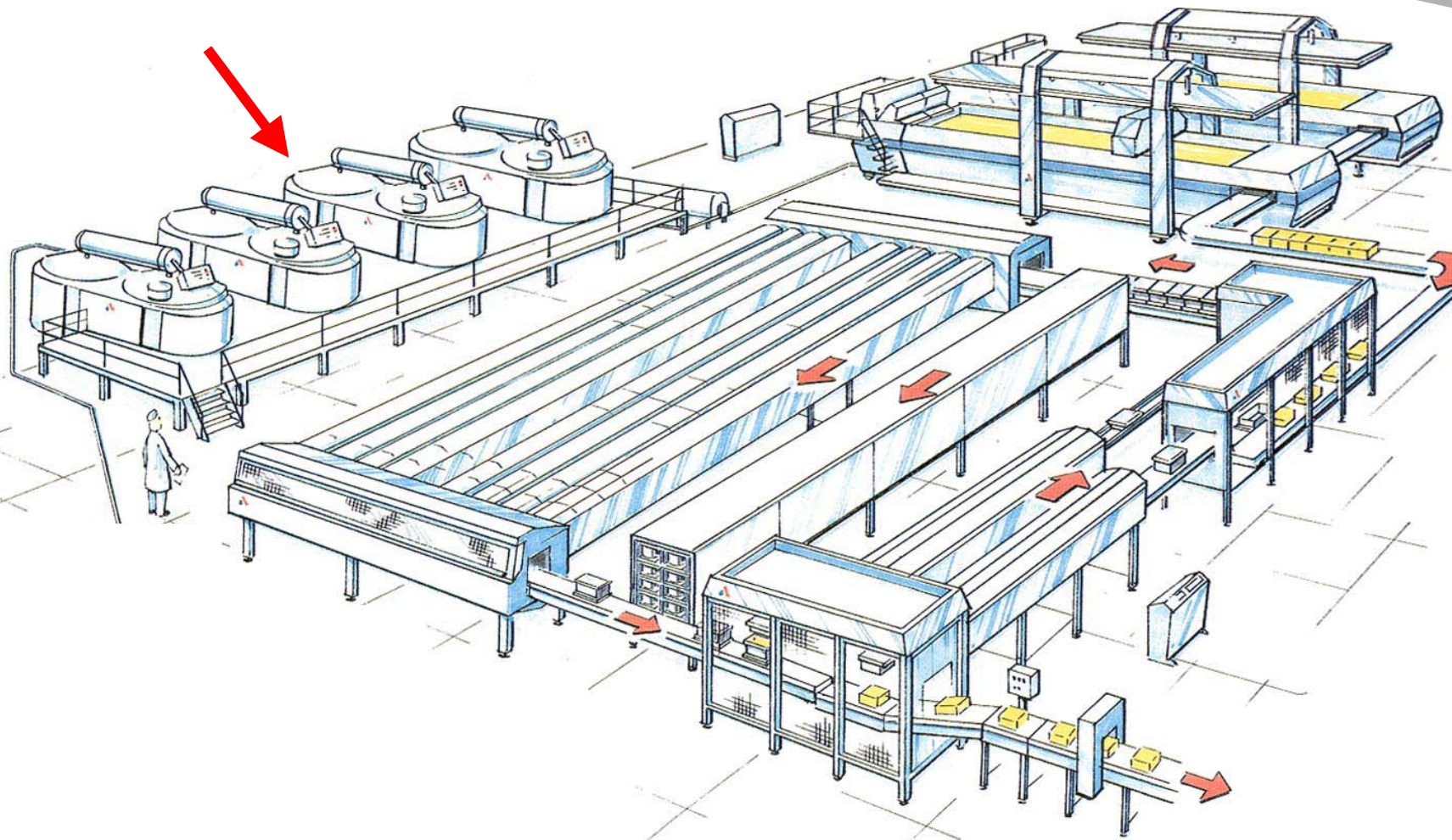
Milk treatment – Pasteurization



- ▶ Milk is always pasteurized before cheese making
- ▶ Pasteurization eliminates all pathogenic bacteria.
- ▶ Pasteurization is a heat treatment at 72°C for 15 seconds.



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Cheese production – Cheese vat

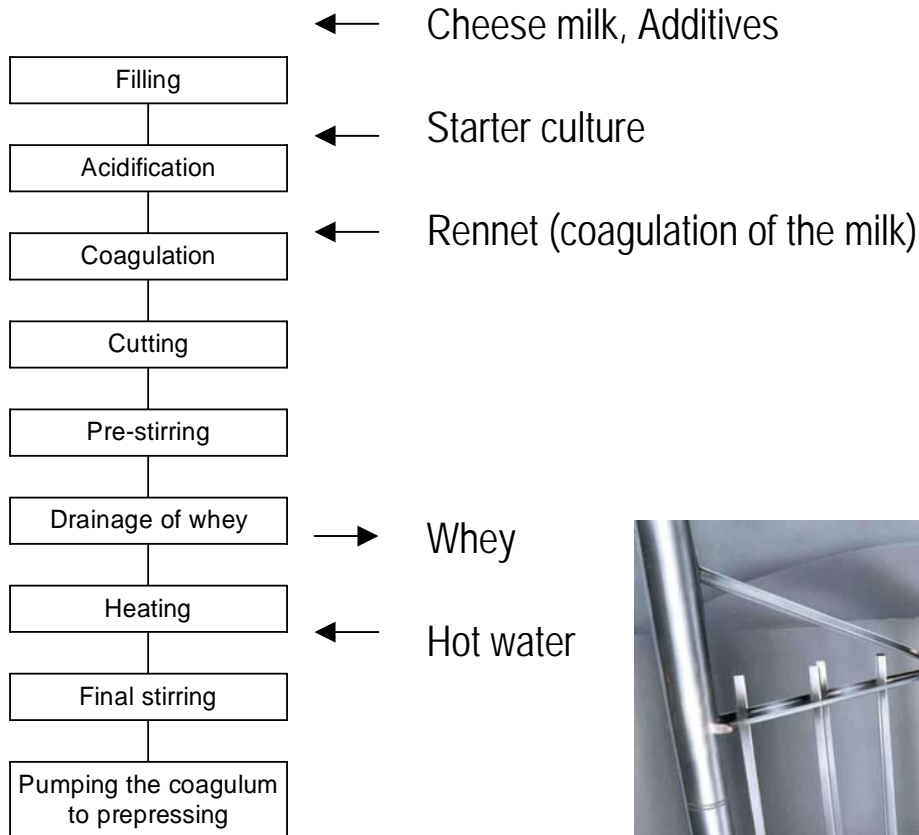


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Cheese production – Cheese vat



Cheesevat



Additives:

Calcium chloride:	Standardize coagulation properties of the milk
Sodium nitrate:	Prevents growth of butyric acid bacteria
Colour:	Adds colour to the cheese, e.g. orange
Lipase:	Splits fat and offers taste



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Cheese production – Cultures



Starter culture

pH

ripening

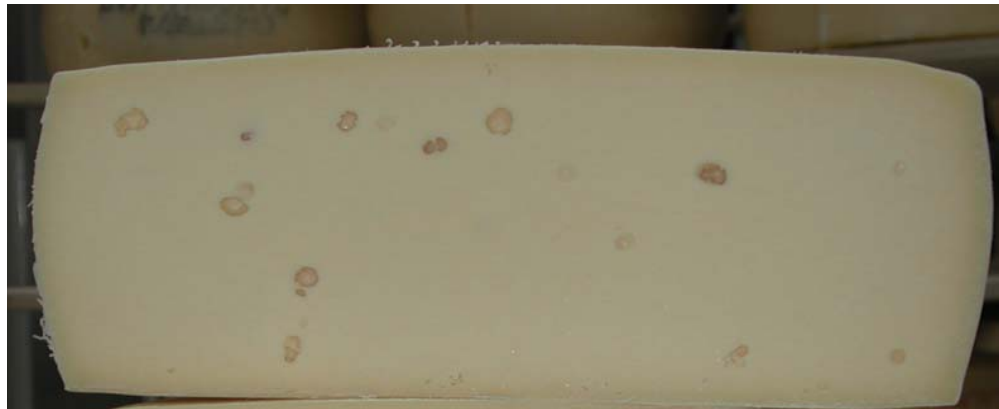
gas production (eye formation)

Additional cultures

Propionic acid bacteria

flavour & big eyes (Emmentaler, Grevé, Magré)

Without propionic acid bacteria



With propionic acid bacteria



Lactose – the sugar in milk



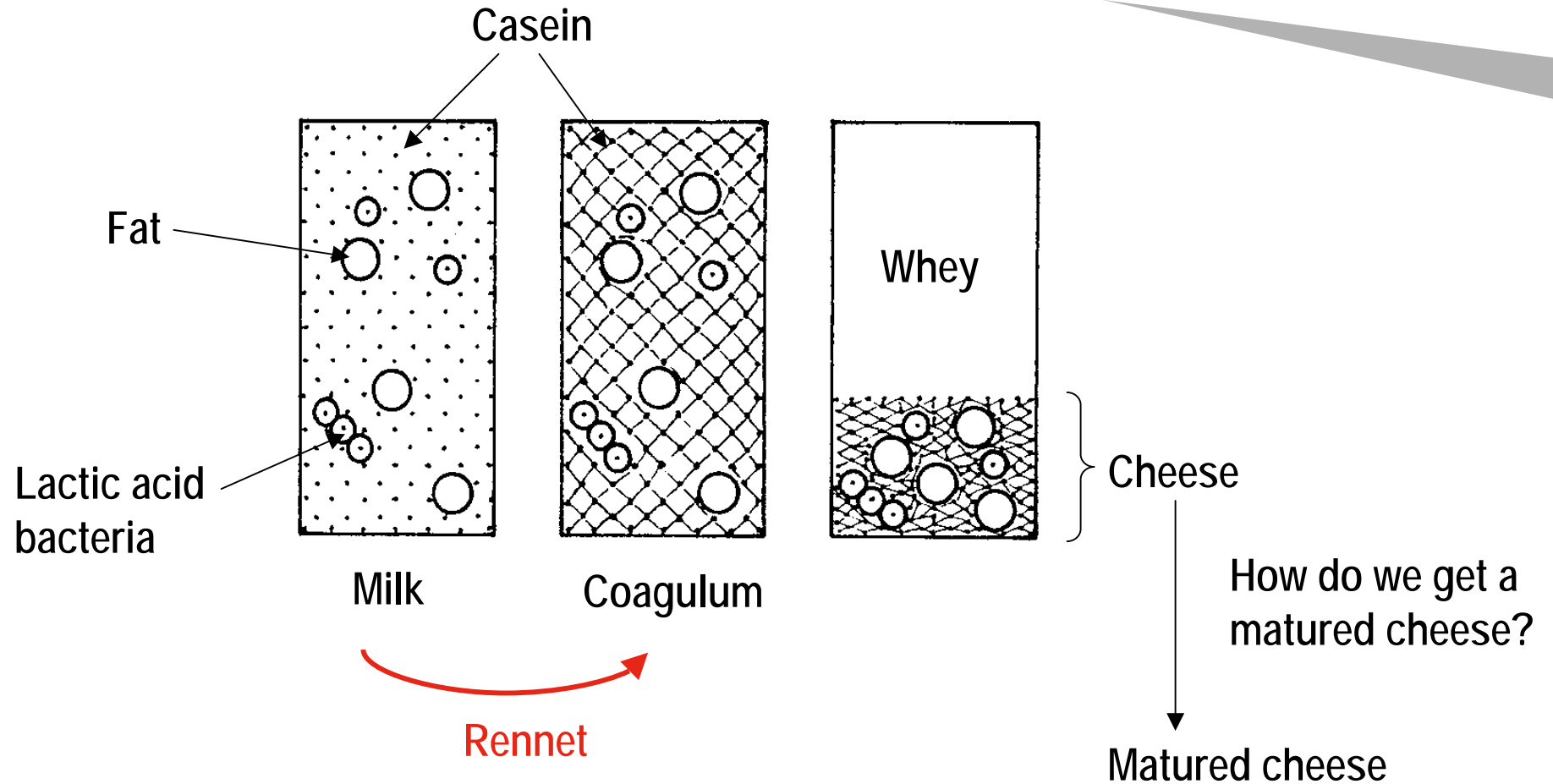
- ▶ The bacteria consume lactose, grow and make lactic acid (decrease pH)
- ▶ All lactose is normally degraded within 24 hours in cheese
- ▶ No more lactose \Rightarrow The bacteria starve and die.
 - ▶ The cells autolyse and enzymes is released

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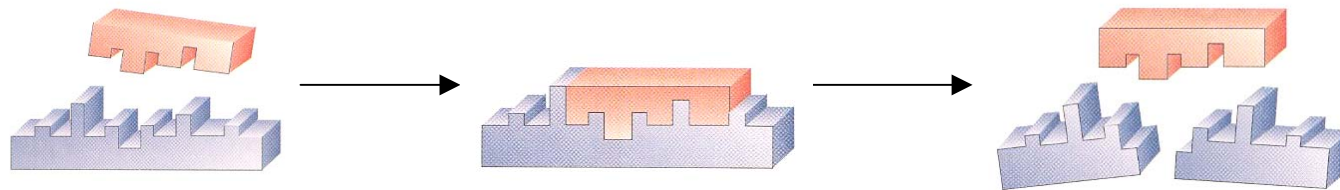
The cheese



How to make a cheese:



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What is an enzyme?



Enzymes is / is in:

- ▶ Milk (protein)
- ▶ Starter culture
- ▶ Rennet
- ▶ Smear

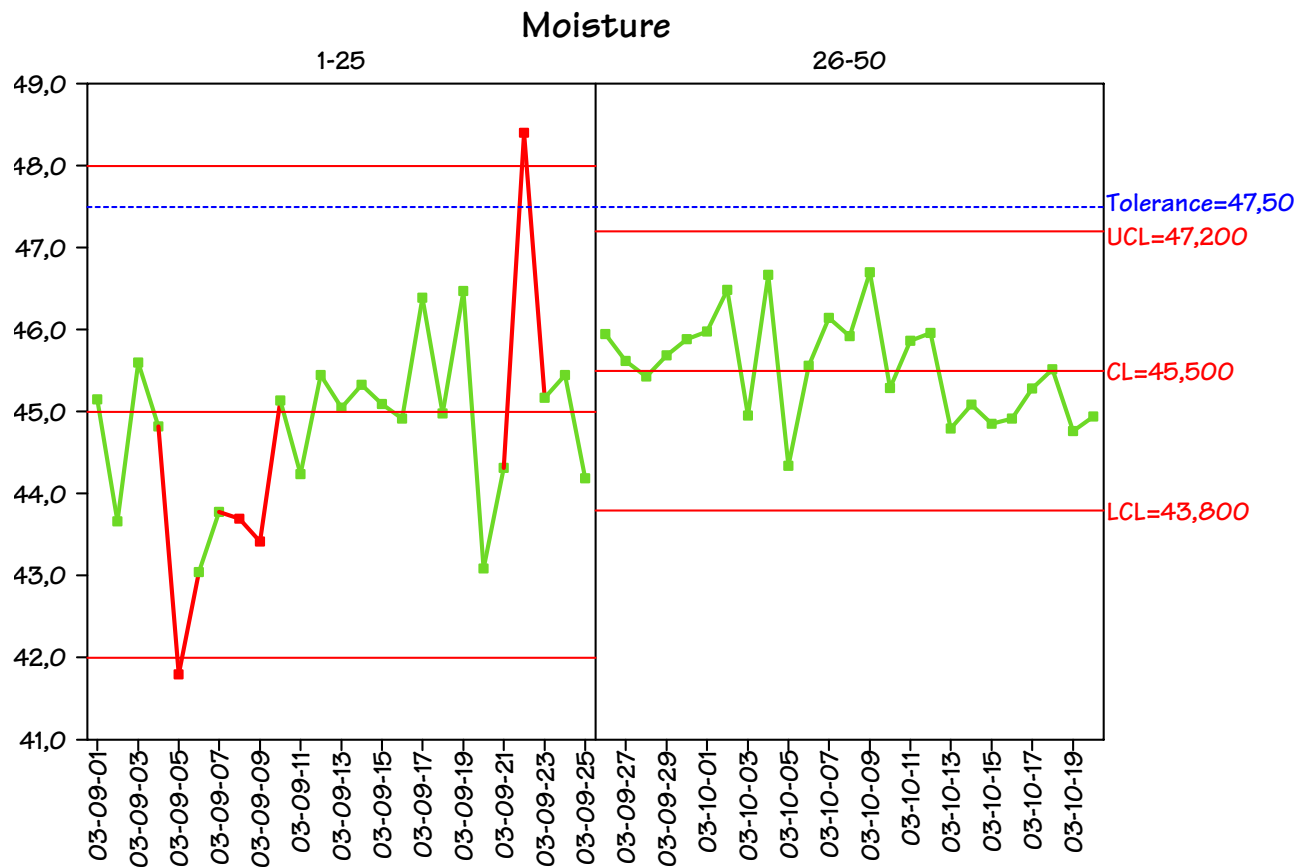
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Cheese production – Control



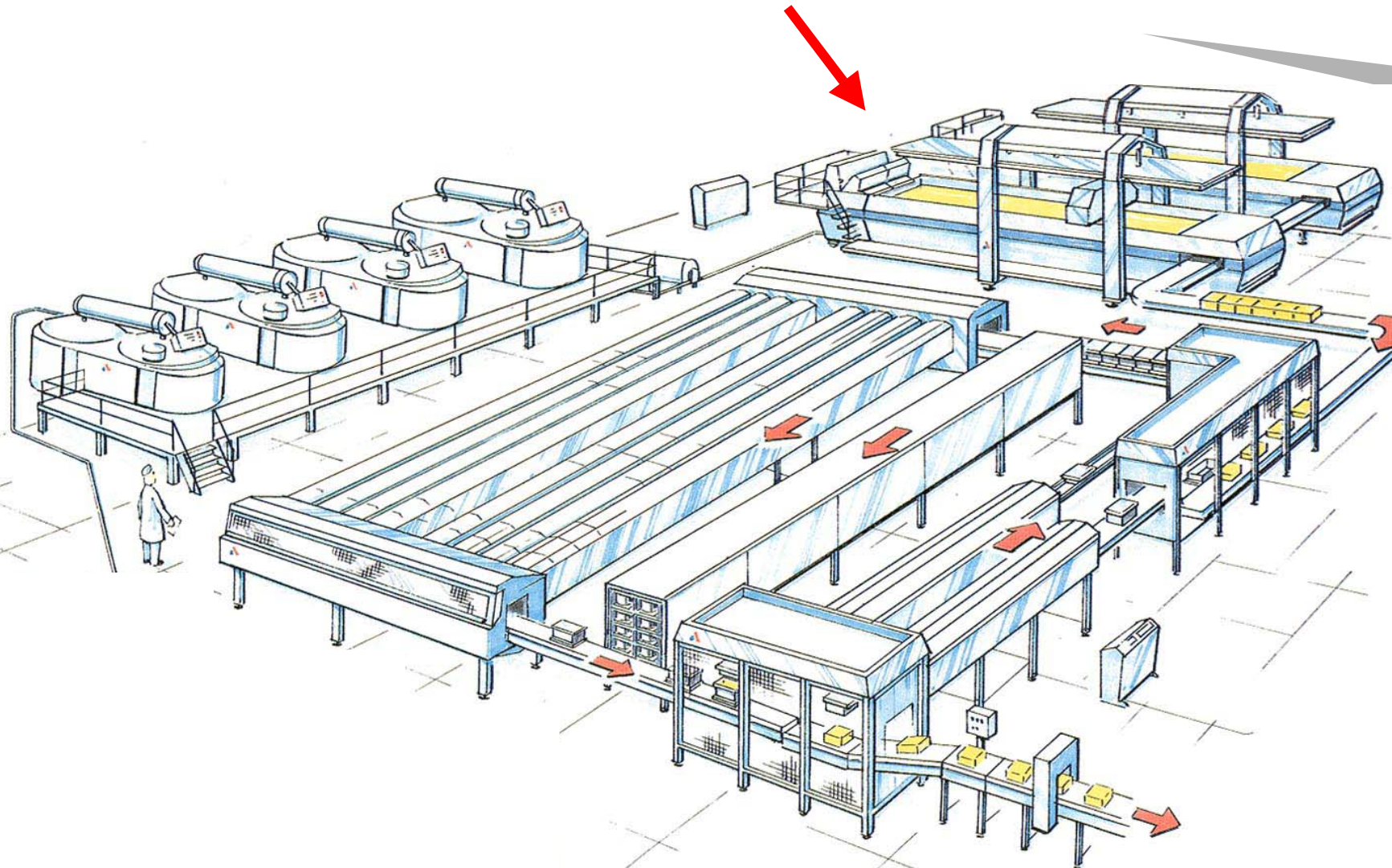
Controlling of the cheese production by **SPC, Statistical Process Control** (in Denmark and Sweden called SPS (statistisk proces styring)). SPC is a tool for all kinds of processes, even the sales processes!

Decrease variation! Study process behavior. Identify natural variation and special causes.



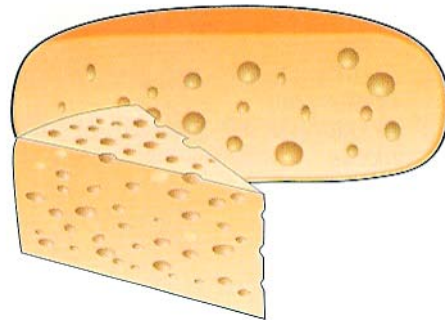
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Cheese production – Pre-pressing

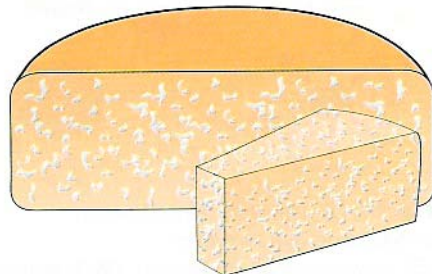


Cheese production – Pre-pressing

- ▶ From the cheese vat the mix of curd and whey is led to the pre-pressing vat.
- ▶ **Round eye** – e.g. Edam, Gouda, Herrgård, Grevé (closed structure with a few eyes)

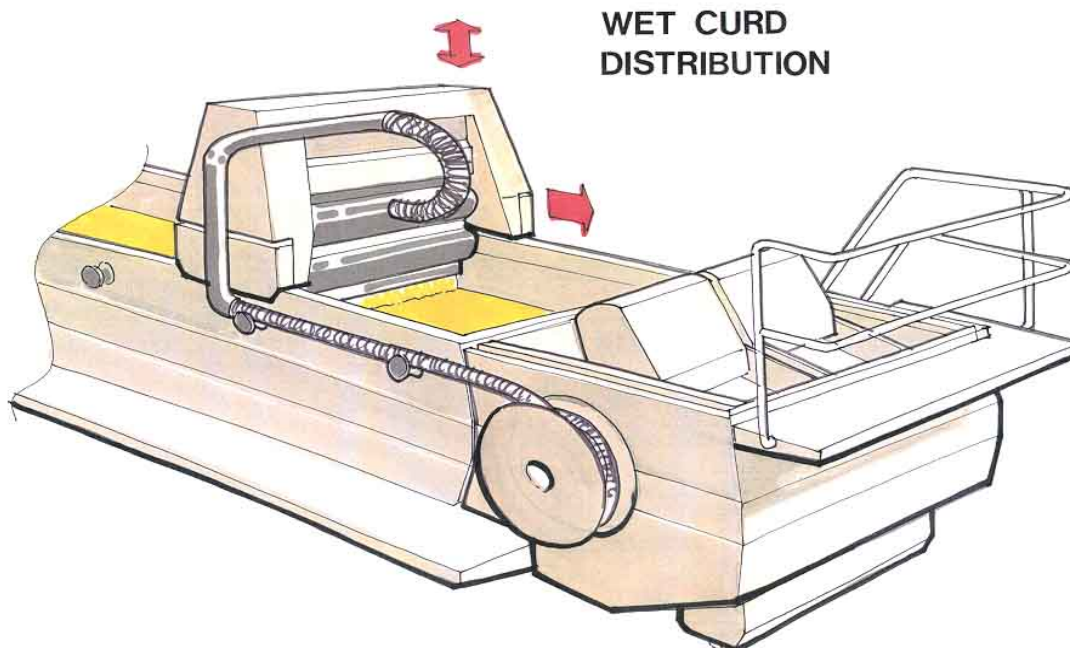


- ▶ **Granular** – e.g. Havarti, Tilsiter, Präst, Hushållsost (open structure with many irregular eyes)



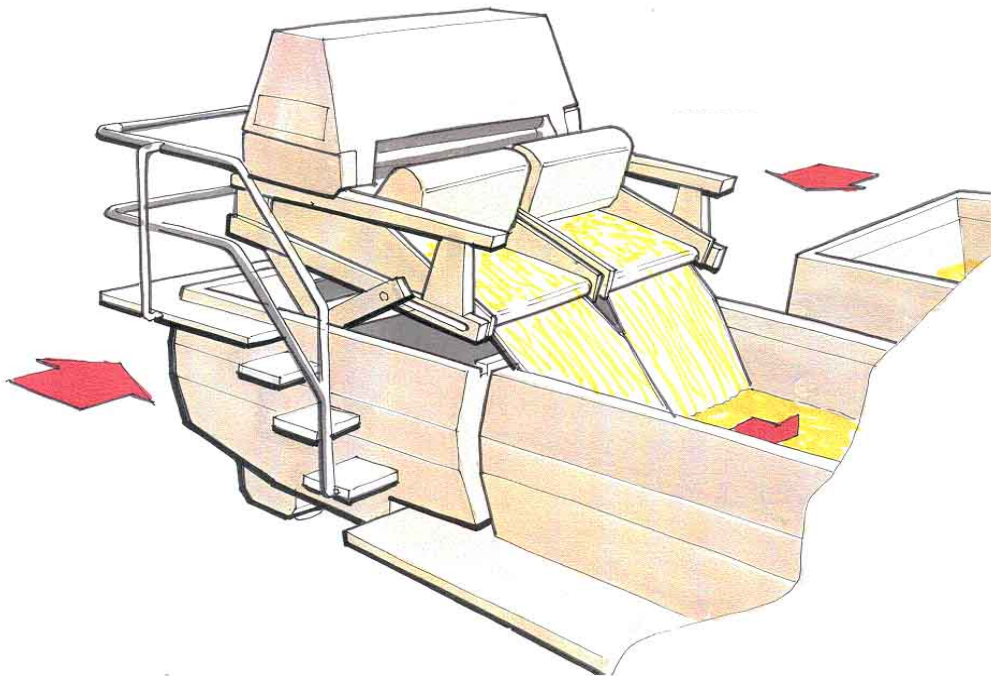
Cheese production – Pre-pressing - round-eye

- ▶ Curd is transferred to the pre-pressing vat below whey in order to avoid inclusion of air.
- ▶ The process causes the closed structure of the cheese.



Cheese production – Pre-pressing – granular

- ▶ Curd transferred to the pre-pressing vat over a vibrating screen to obtain air inclusion and to drain out the whey.
- ▶ This contributes to the open structure of the cheese.

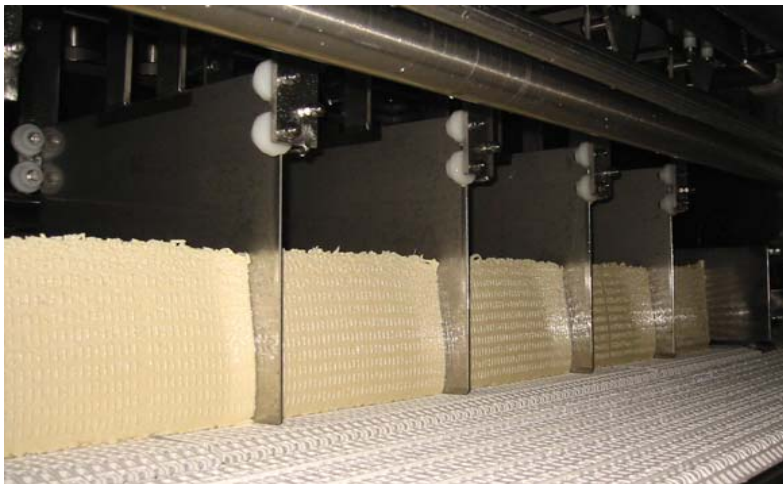


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Cheese production – Pre-pressing – cutting



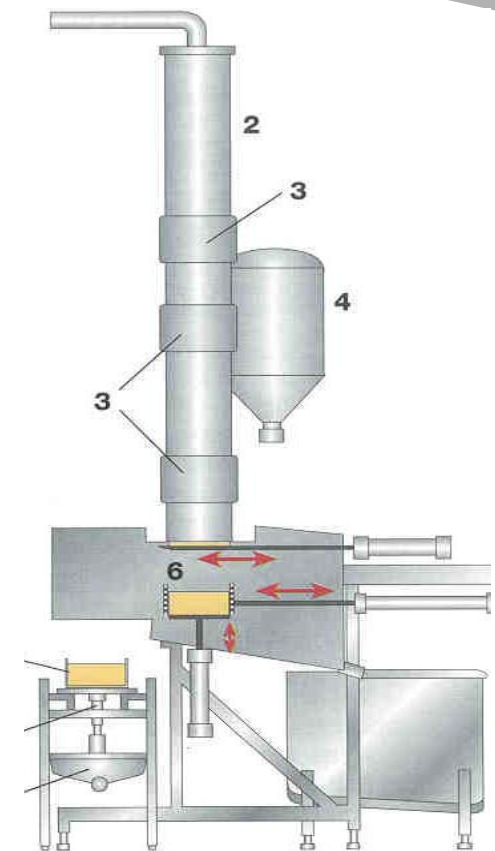
- ▶ After transferring curd to pre pressing vat the cheese is pressed to one big block.
- ▶ Pressure and time vary due to the type of cheese.
- ▶ The pre-pressed cheese block is cut into the right shapes.
- ▶ The cut cheeses are placed into moulds.



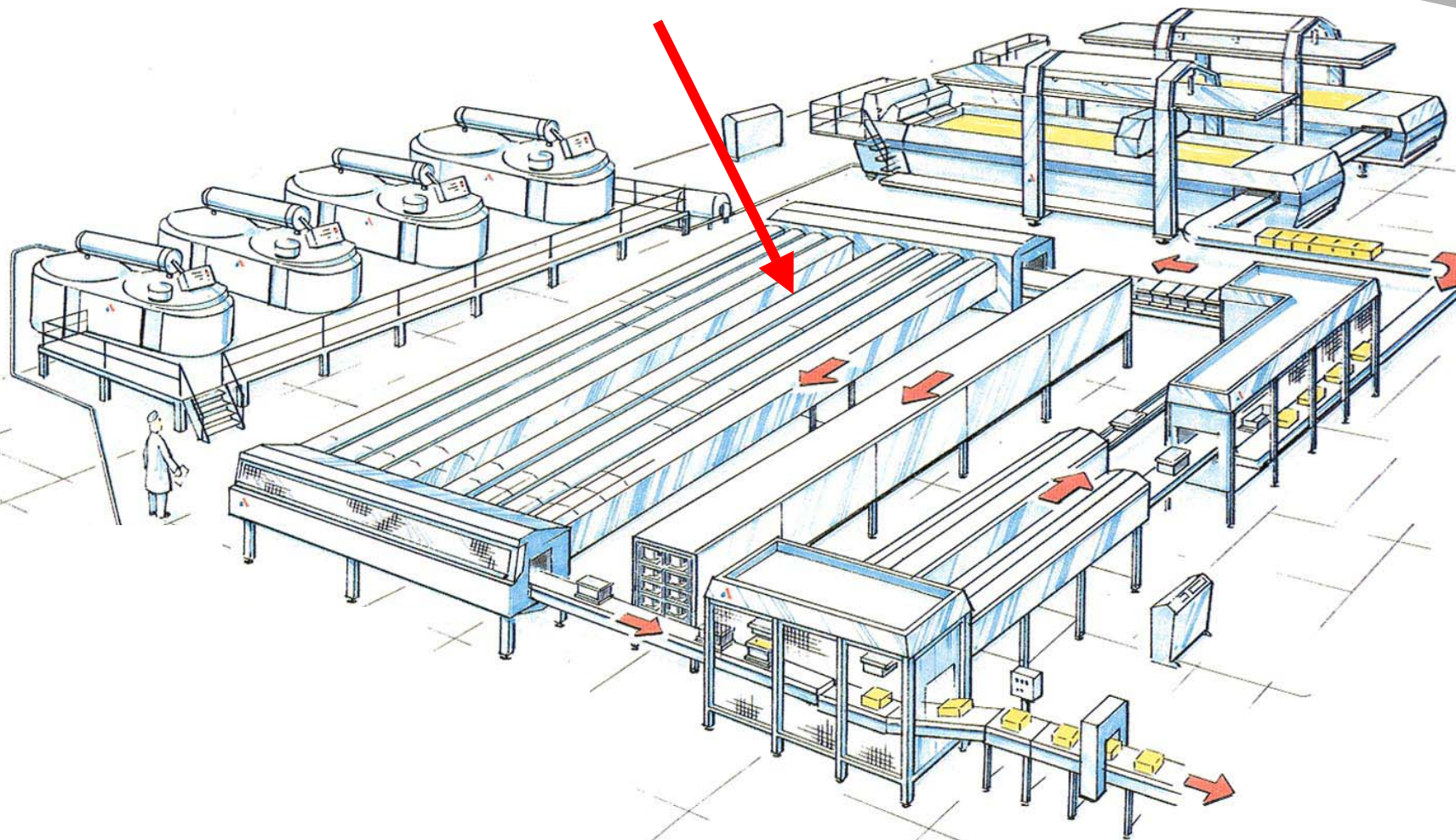
Cheese production – Casomatic



- ▶ Alternative for using pre pressing vat.
- ▶ Casomatic is a continuous pre-pressing in a high column.
- ▶ The cheese blocks are cut directly into pieces that fit into the moulds.
- ▶ Less flexible than pre-pressing vats.
- ▶ Casomatic can be used for both round-eyed and granular cheeses.
- ▶ Casomatic gives good conditions for weight control of the cheeses.



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Cheese production – Pressing



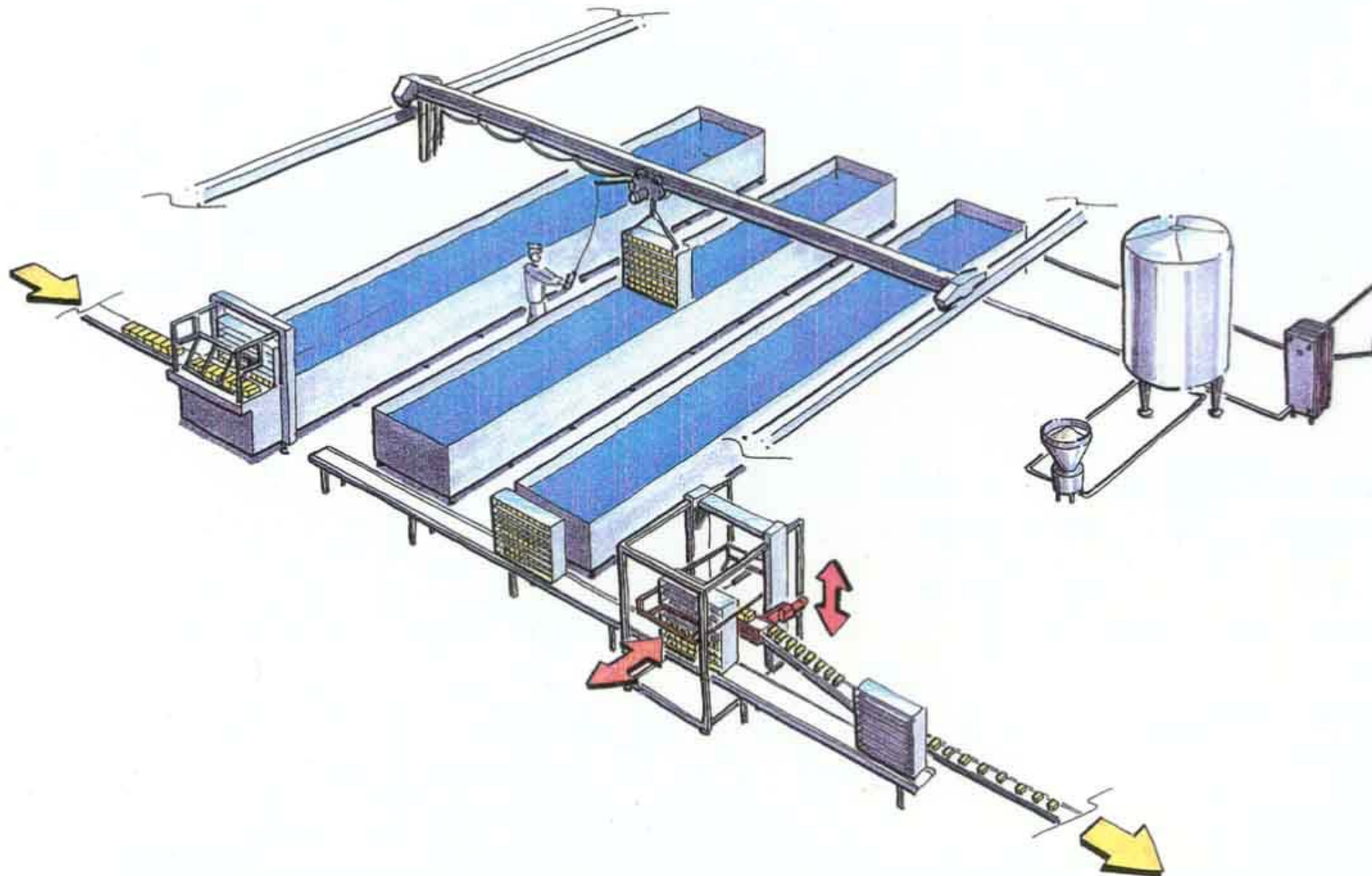
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Cheese production – Pressing



- ▶ Moulds with cheese are placed in the press.
- ▶ Close the rind and create the final shape of the cheese.
- ▶ Further acidification and draining.



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Cheese production – Cooling and salting



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Cheese Production – Cooling and salting



- ▶ Immediately after pressing the cheese is cooled in order to keep shape and stop the ongoing acidification.
- ▶ Subsequently, the cheese is salted in brine.
- ▶ Time and temperature depend on the type of cheese produced. Normally a 10-14 kg cheese is cooled down to 10-15° C and salted for 24-48 hours.



Salt



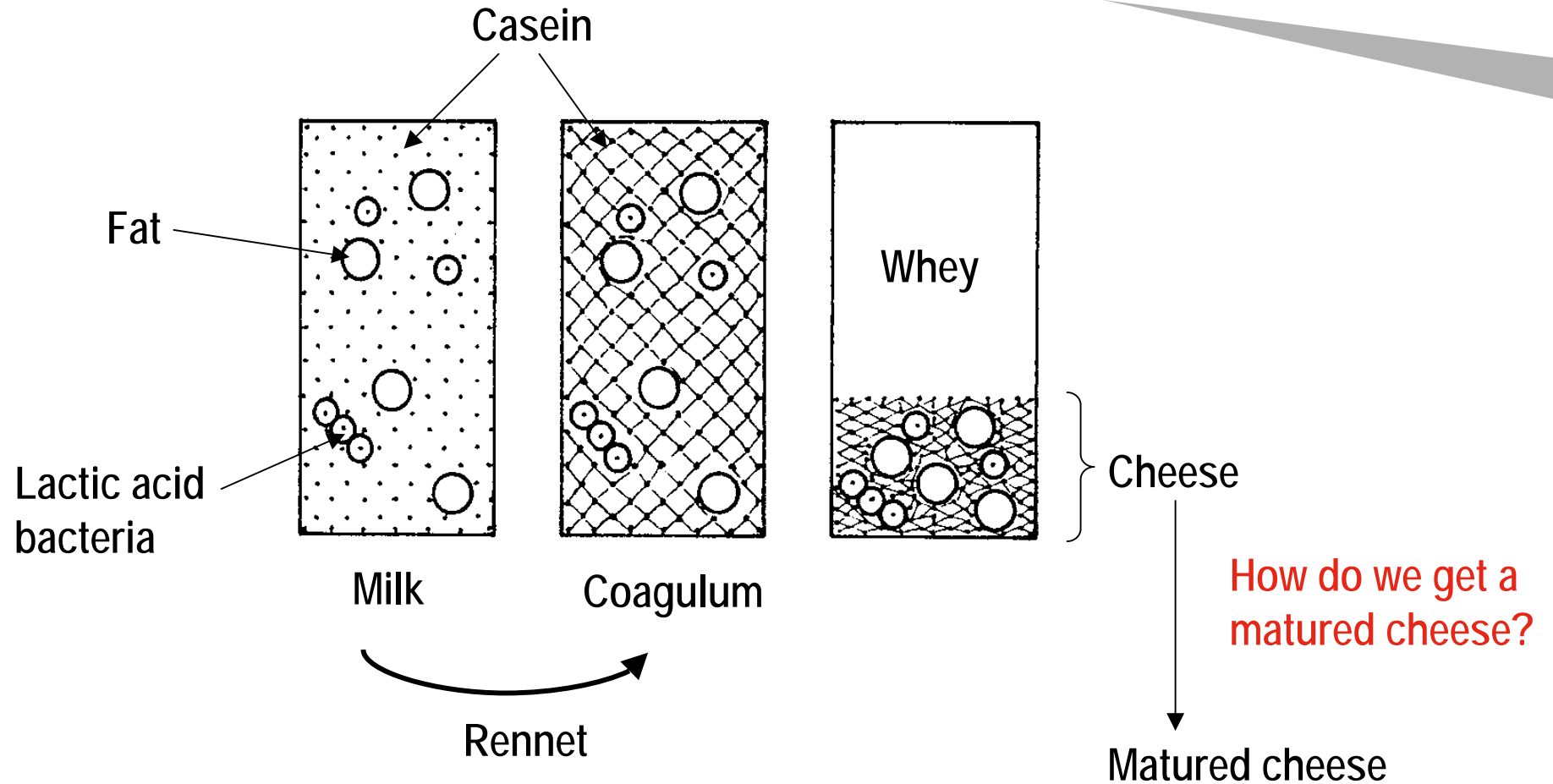
- ▶ Normally added to the cheese from dry salting or brine

- ▶ Purpose:
 - ▶ Helps keeping the shape of cheese
 - ▶ Regulating growth of micro organisms
 - ▶ Taste

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The cheese



How to make a cheese:



What makes a matured cheese?



- ▶ Sensory properties of a matured cheese are defined by:
 - ▶ Consistency / texture
 - ▶ Taste and smell
 - ▶ Colour
 - ▶ Overall appearance

- ▶ To achieve these sensory properties, complex processes within the cheese take place.

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Consistency / texture



Depends upon:

- ▶ Water content
- ▶ Fat content
- ▶ Salt
- ▶ Breakdown of protein network

What are proteins in milk and cheese?



- ▶ **Milk:**
 - ▶ Whey protein ~ 20% of total protein.
 - ▶ Casein ~ 80% of total protein.

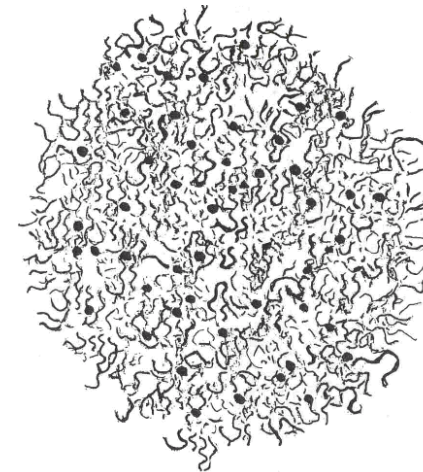
- ▶ **Cheese:**
 - ▶ Casein ~ 100% of total protein



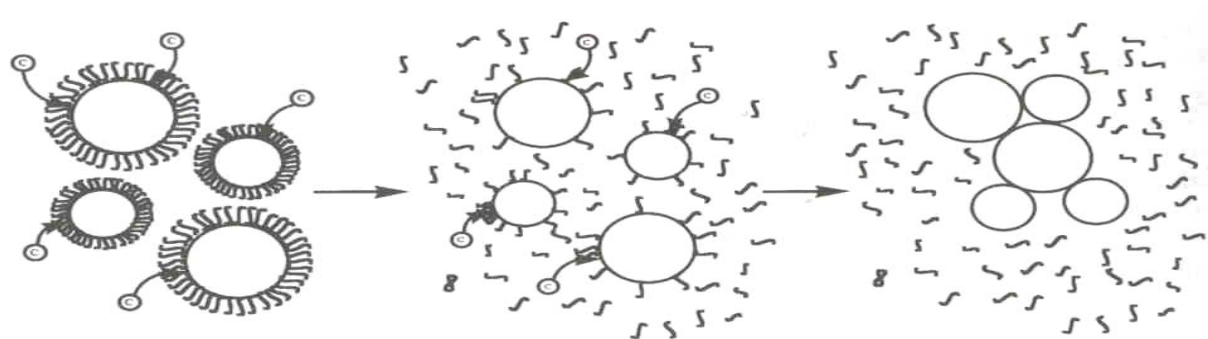
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The important casein



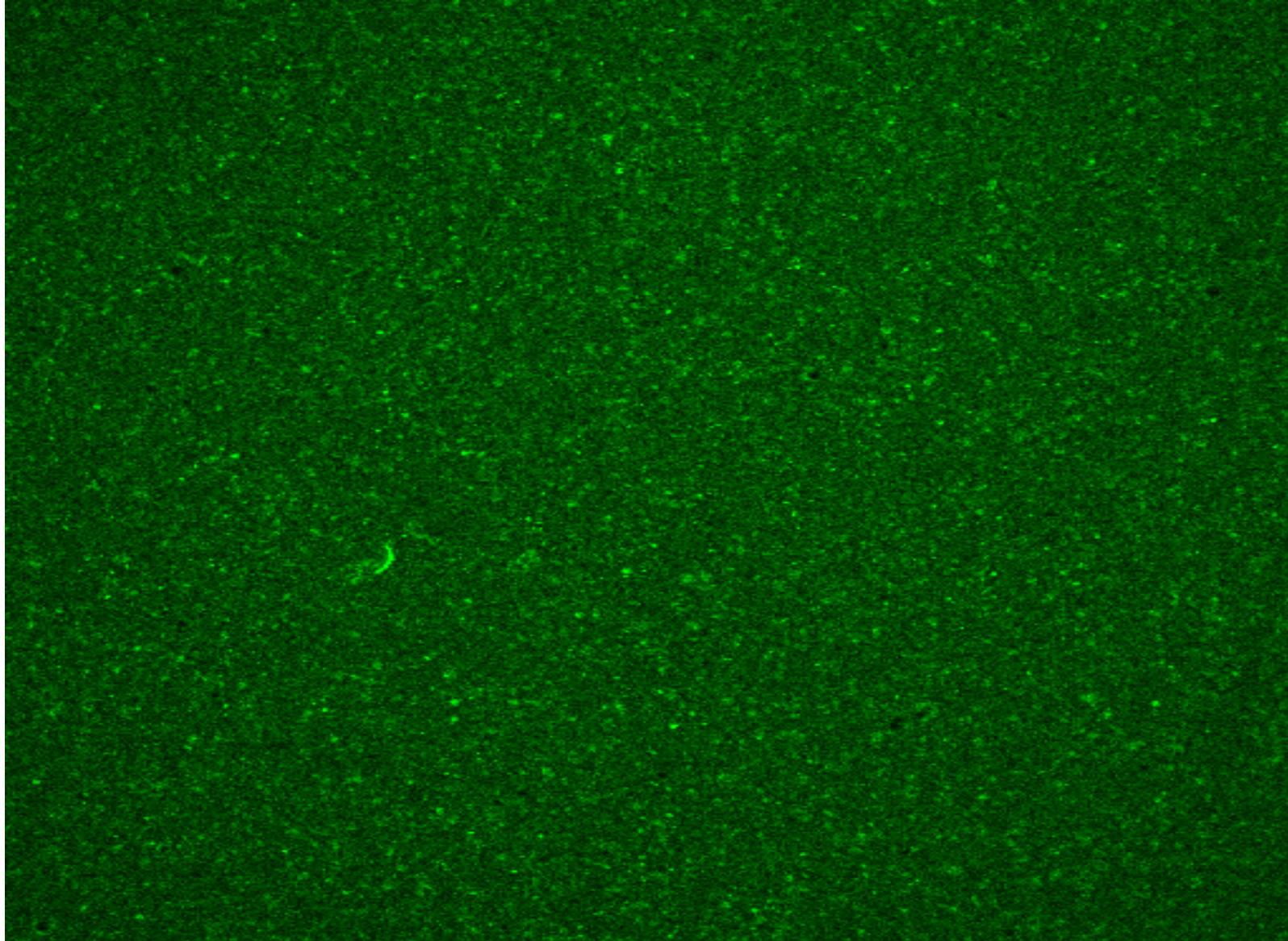
- ▶ Caseins
 - ▶ α_{s1} -casein ~ 40.8% of casein
 - ▶ α_{s2} -casein ~ 11.0% of casein
 - ▶ β -casein ~ 36.3% of casein
 - ▶ κ -casein ~ 11.9% of casein



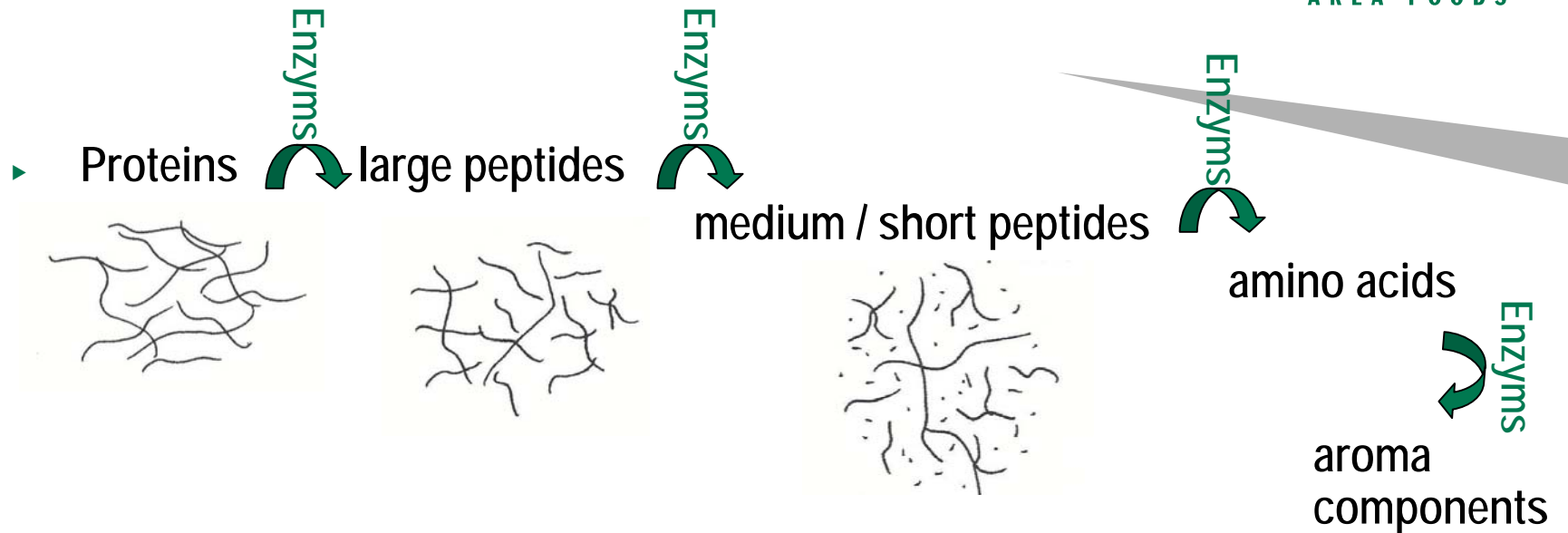
- ▶ The caseins create casein micelles
- ▶ The micelles create a network which look like a "gel" when adding rennet \Rightarrow cutting \Rightarrow cheese curd + whey



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Coagulation



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Breakdown of proteins



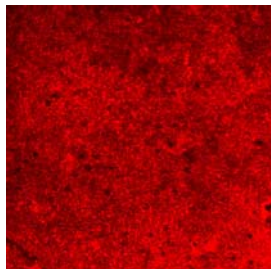
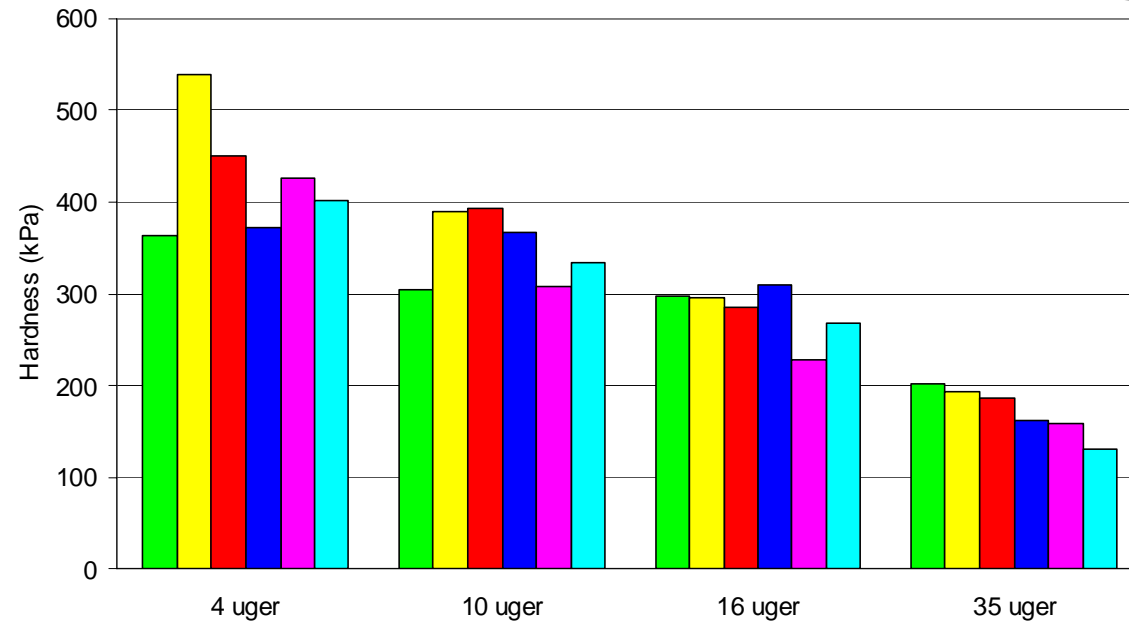
- ▶ The taste appears during the last ripening steps, when the small soluble components are produced.
- ▶ Due to protein degradation the consistency develops as the cheese goes through the ripening steps.

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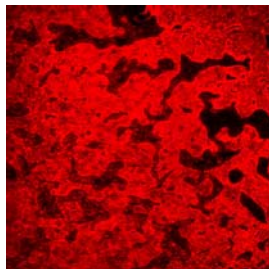
Consistency of the cheese



The consistency becomes less hard (softer) during ripening.



Cheese 1



Cheese 2

The consistency becomes less stretchable during ripening

Parameters for differentiation in the ripening process



- ▶ The depth of the ripening depends on:
 - ▶ Quantity and activity level of bacteria (enzymes)
 - ▶ Available substrates (lactose, fat, protein, citric acid)
 - ▶ Temperature
 - ▶ Time
 - ▶ Surface (smear) ripening

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Maturation



- ▶ Purpose of storage is to control the ripening of the cheese.
- ▶ Climatic conditions are of great importance in relation to the rate of ripening, loss of weight, rind formation and development of the surface flora.

Rindless cheese:	Vacuum packaged (Edam)
Waxed Cheese	Round cheese, dried and then waxed (Herrgård)
Dry salted cheese:	High content of salt (Kefalotyri)
Plastic coated cheese:	(Gouda, Fontal)
Smearred cheese:	Smear treated on the surface (Danbo)



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Storage – Rindless cheese



- ▶ Immediately after salting the cheese is vacuum packed and stored in boxes until retail packing.

E.g. Edam, Magré, Kadett, Hushåll

Important factors:

Time: 1-32 weeks

Temperature: E.g. 18-15-10-5°C



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Storage – Waxed cheese



- ▶ After brining, the cheese is dried for 5-14 days. It is then coated with wax. The waxing is repeated every 6-8 weeks during ripening

E.g. Herrgård, Grevé

Important factors:

Time:	10-52 weeks
Temperature:	E.g. 18-15-10-5°C
Humidity:	65-80% RH



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Storage – Dry salted cheese



- ▶ Instead of brine, the cheese is treated with dry salt on the surface at relatively high humidity in order to optimize the take-in of salt through the rind.

E.g. Kefalotyri

Important factors:

Time: 1-4 weeks
Temperature: E.g. 12°C
Humidity: E.g. 90% RH



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Storage – Plastic coated cheese



- ▶ After the salt brine, the cheese is treated several times with plastic coat on the surface.

E.g. Fontal

Important factors:

Time: 1-5 weeks
Temperature: E.g. 11°C
Humidity: E.g. 90%
Air circulation: High



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Storage – Smear cheese



- ▶ After the salt brine, the cheese is treated with smear culture, which causes a ripening of the surface.

E.g. Danbo

Important factors:

Time: 1-60 weeks
Temperature: E.g. 18-15-10-5°C
Humidity: E.g. 97-95-90%



What is smear?



- ▶ After the brine, the cheese is treated with smear culture
 - ▶ Smear contains yeast and bacteria. They grow on the surface of the cheese. They will prevent mould and unwanted bacteria's e.g. *Listeria*
- ▶ A low level of pH in the beginning of the ripening will favour yeast
 - ▶ Decomposition of lactic acid \Rightarrow $\text{CO}_2 + \text{H}_2\text{O} + \text{amino acid} \Rightarrow$ e.g. ammonia \Rightarrow pH \uparrow
- ▶ pH $\uparrow \Rightarrow$ will favour development of smear-bacteria \Rightarrow degradation of protein, amino acid and fat begins
- ▶ The enzymes are not able to diffuse into the cheese, but the low-molecular breakdown products are \Rightarrow will affect the taste of the cheese



Factors affecting growth of smear



- ▶ Temperature in storage
- ▶ Moisture in storage
- ▶ Ventilation rate
- ▶ Circulation of air around cheeses
- ▶ Smear on cheese at packaging

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- ▶ After ripening the cheese is packed in retail packaging.



Purpose of fat in cheese

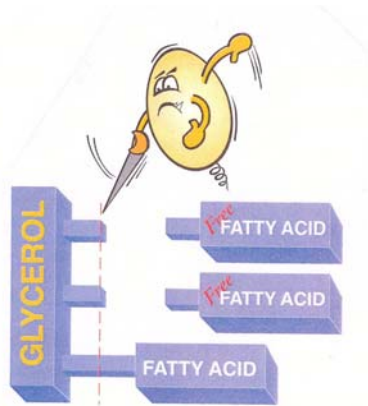


Fat is very important for smell and taste of the cheese

- ▶ Fat dissolve components of flavour
- ▶ Fat covers up bitter taste
- ▶ The fat can also be used to create characteristic flavours by adding lipase.
- ▶ Flavour components from fat degrade (positive and negative)

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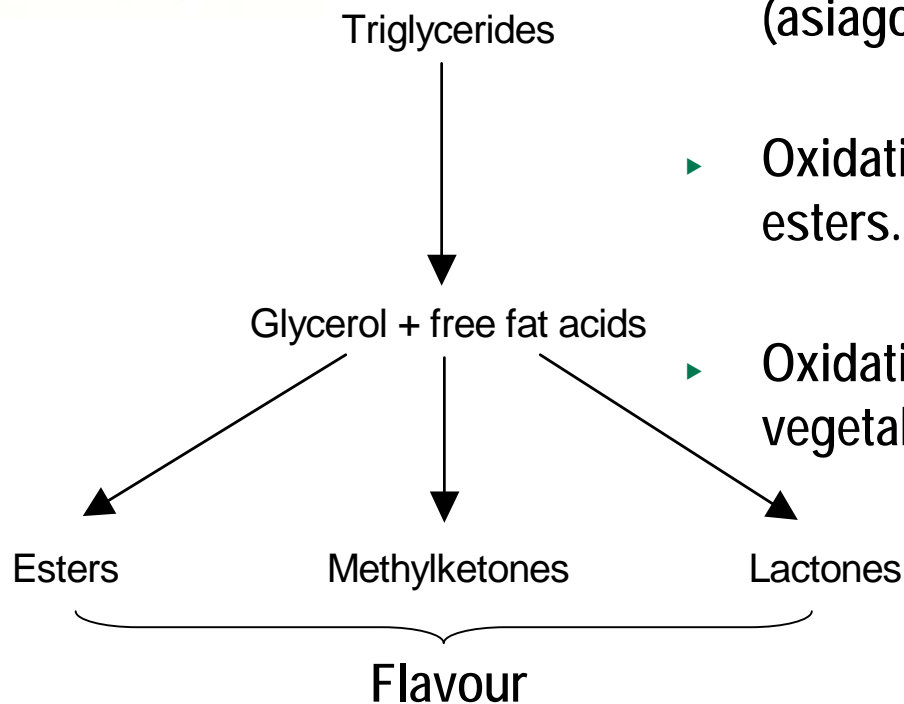
Fat degrade



- ▶ Hydrolysis of triglycerides releases free fatty acids which gives a piercing smell and taste. For most milk and cheese products, this is unwanted, but for some cheeses it is a very important part of the product (asiago, kefalotyri).

- ▶ Oxidation of fatty acid can bring methylketones and esters. Those are very important for mould cheese.

- ▶ Oxidation of fatty acid is very unwanted in cheeses with vegetable oil.



Low fat cheese

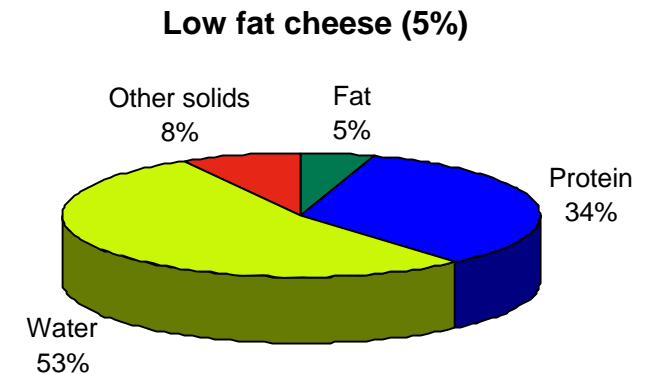
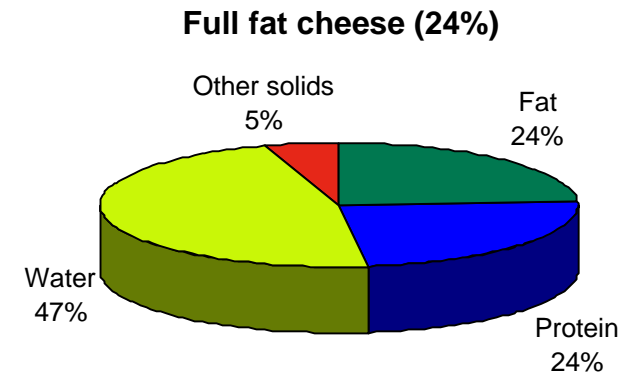


- ▶ It is possible to make a low-fat cheese, but the taste and consistency will normally differ from a full-fat cheese.

- ▶ Low-fat cheeses
 - ▶ Lower fat content
 - ▶ More protein
 - ▶ More water

The total fat percent in cheese depends on all components.
 Fat in dry matter is not dependent upon the water content.

Fat in dry matter (FIT)	Approx. Fat %
45 +	24
30 +	17
20 +	10



Low fat cheese



It is difficult to make a low-fat cheese as a full fat cheese.

- ▶ Typical development of taste in low-fat cheeses
 - No or very little taste
 - Often a bitter taste
 - Bad background-taste (lacking depth)

- ▶ Typical consistency in low fat cheeses
 - ▶ Tough and hard or
 - ▶ Soft and deform

Eyes – how do they get there?

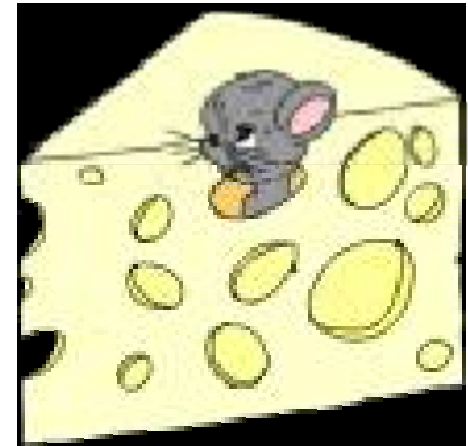


- ▶ Citric acid
 - ▶ By break down of citric acid CO_2 is created which causes eyes in the cheese
 - ▶ Too quick degrade → the cheese will get too many eyes
 - ▶ Too slow degrade → the cheese will be lacking eyes

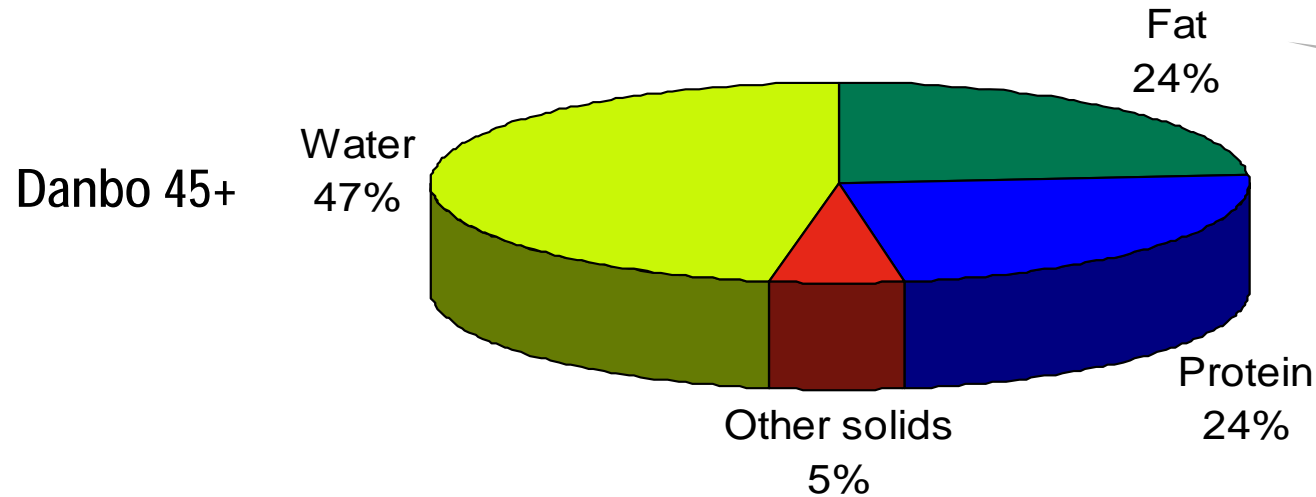
- ▶ Air in the curd
 - ▶ Small irregular eyes like in Havarti and Gräddost.

- ▶ Propionic acid
 - ▶ Created by the starter culture. Big holes Emmentaler, Grevé and a nutty flavour.

- ▶ Spores



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Summing up



- ▶ Cheese matures primarily by breakdown of protein and fat
 - ▶ Breakdown of proteins is conducted of enzymes from milk, starter culture, rennet, smear and other bacteria in the cheese
 - ▶ Breakdown of fat can be wanted or unwanted
- ▶ Getting a perfect cheese is a balance of all ingredients and processes within the cheese

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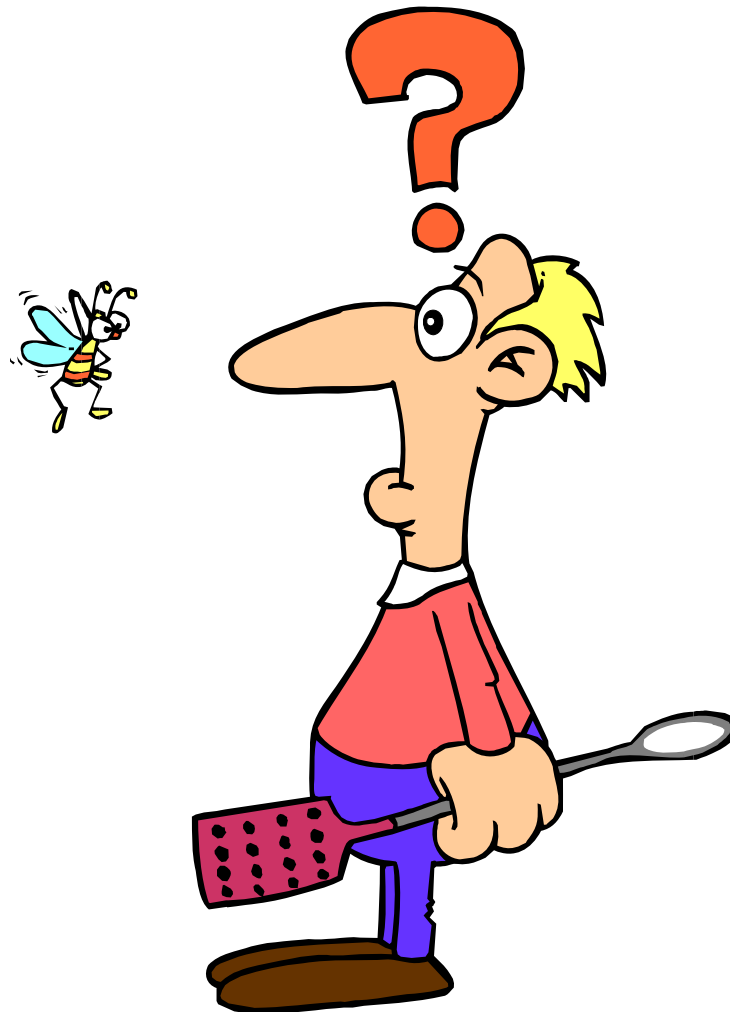
Cheese production – Second product

Whey treatment



- ▶ Whey is concentrated in an **ultra filtration plant**. Under high pressure the whey is pumped through very fine strainers. Through this procedure the dry matter (protein) is concentrated.
- ▶ The concentrated whey – whey concentrate - is shipped to e.g. Denmark Protein in Nr.Vium for further processing.
- ▶ Remember that 90% of the production is whey and only 10% is cheese!







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