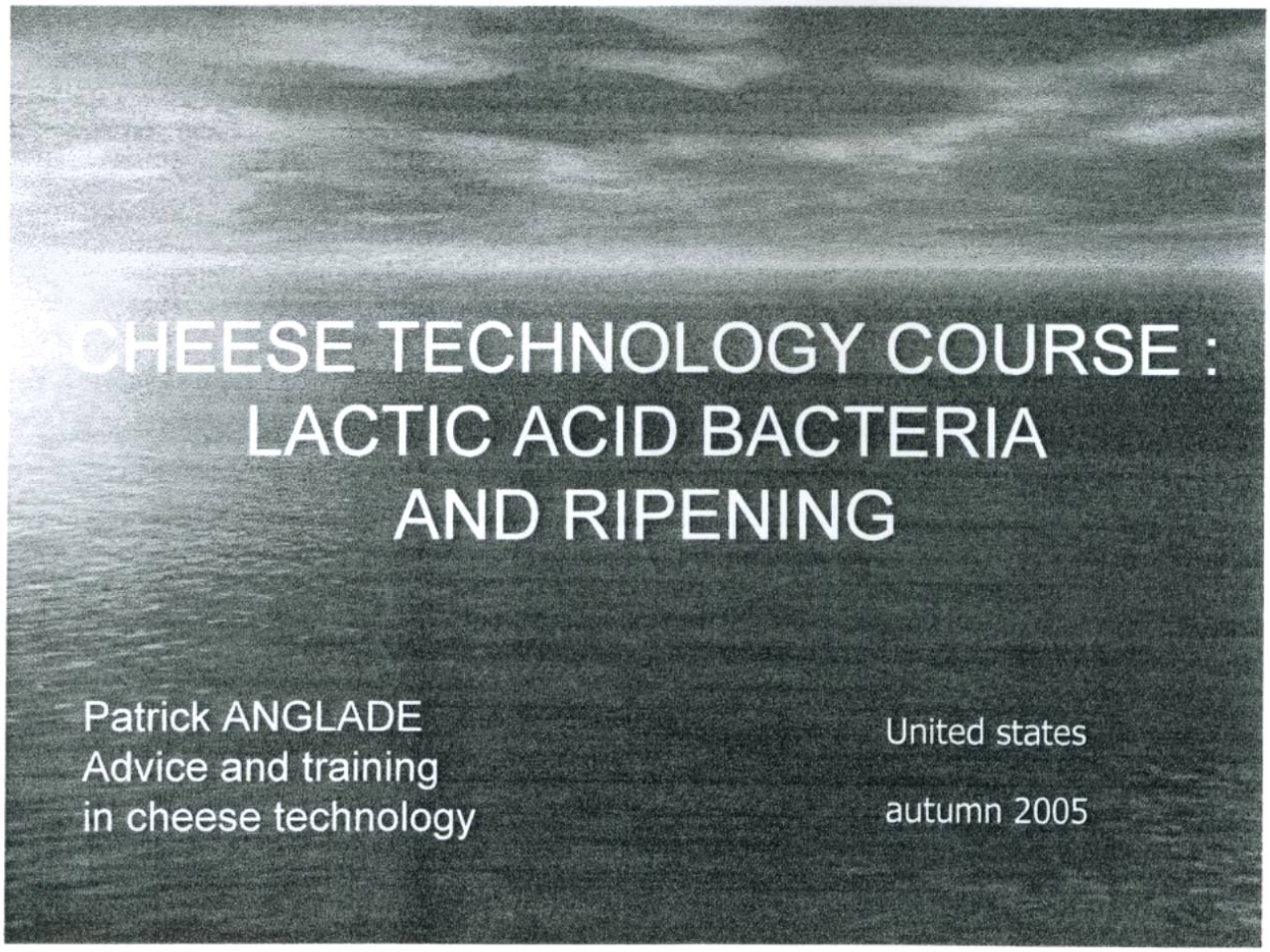
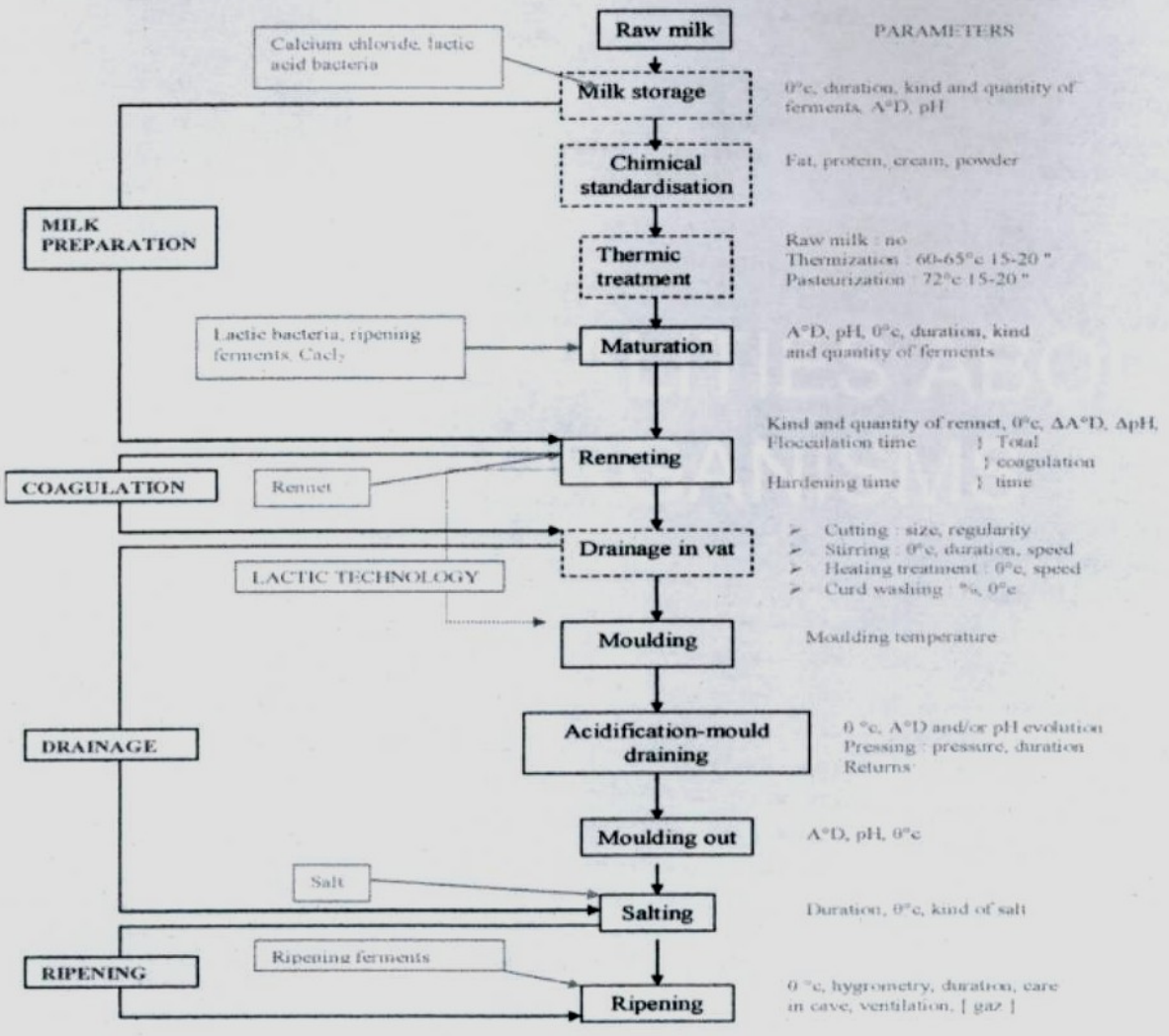
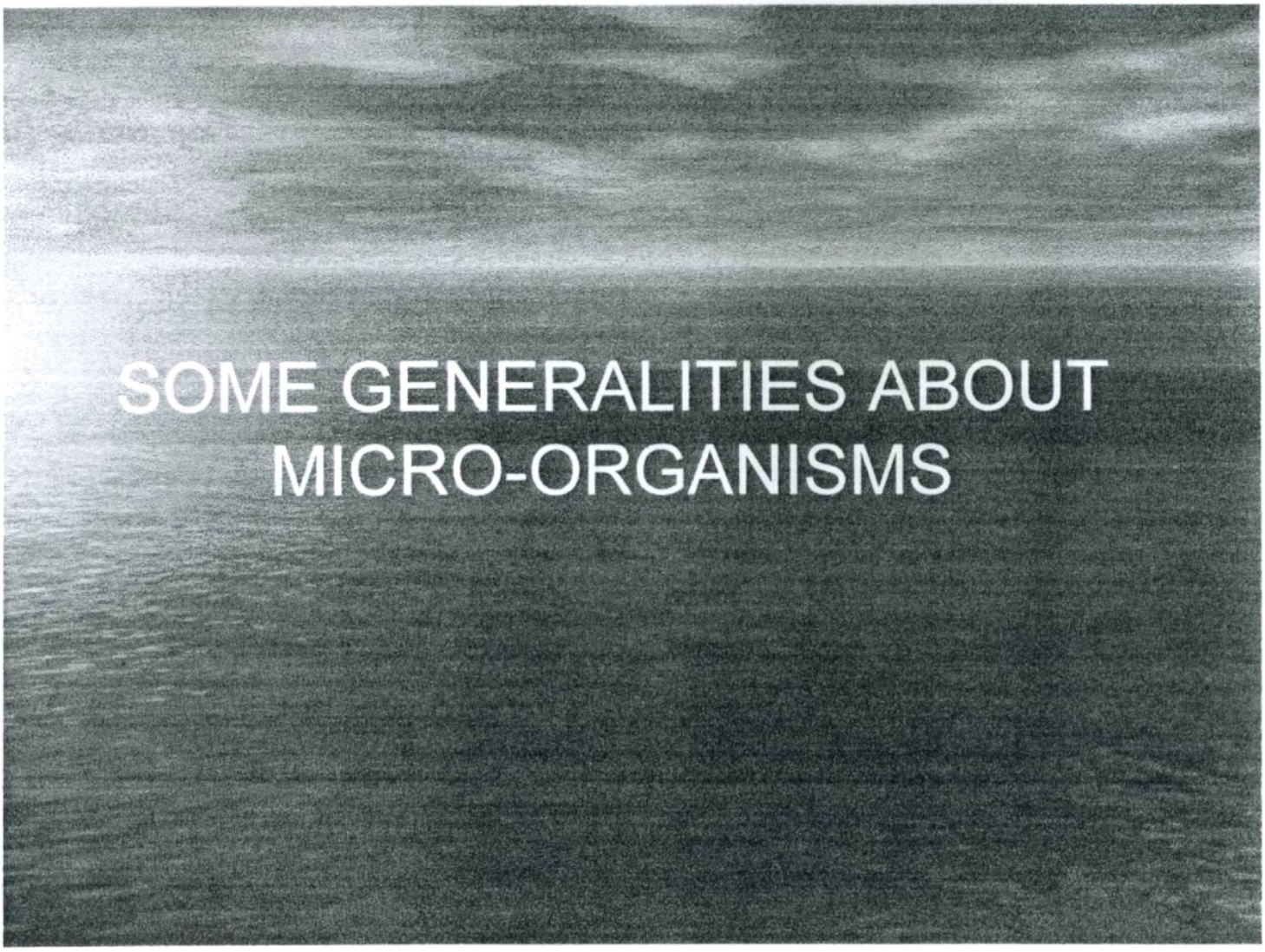

CHEESE TECHNOLOGY COURSE :
LACTIC ACID BACTERIA
AND RIPENING
Patrick ANGLADE
Advice and training
in cheese technology
United states
autumn 2005

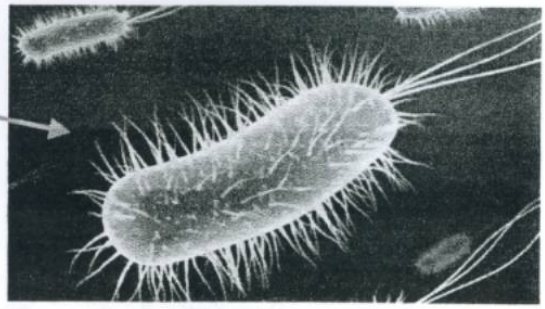
GENERAL CHEESE MAKING PROCESS



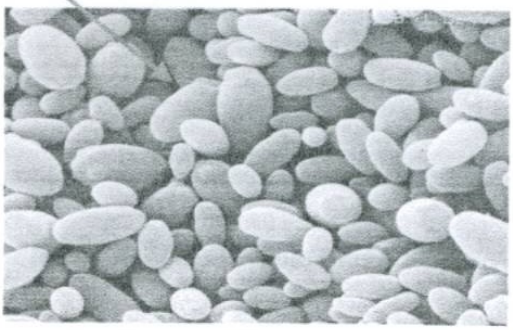

SOME GENERALITIES ABOUT
MICRO-ORGANISMS

MILK'S MICROBIAL FLORA

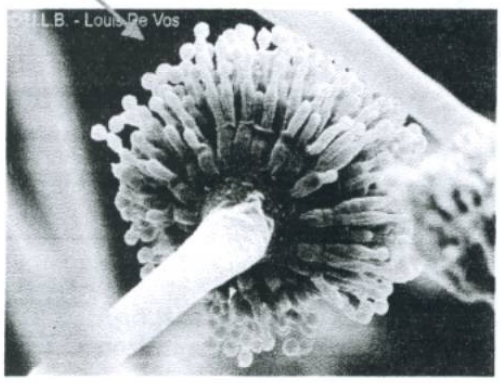
BACTERIA



YEASTS



MOULDS



FLORA'S FAMILIES:

Positive flora

- LAB, ripening B
- Yeasts
- moulds

Alteration flora

- Psychrotrophe flora
- Thermoresistant
- Coliforms flora

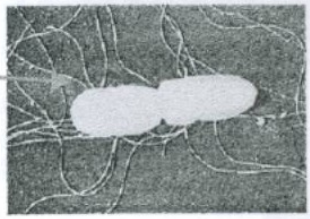
Pathogen flora

- *Salmonella spp*
- *Listeria monocytogenes*
- *Staphylococcus aureus*
- *Escherichia coli*
- *Brucella*

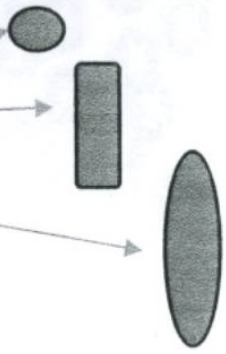
And also: *Yersinia enterocolitica*, *Campylobacter jejuni*, *Bacillus cereus*, *Clostridium perfringens*, some streptococcus

MAIN CARACTERISTICS :

- **Mobility : flagella**



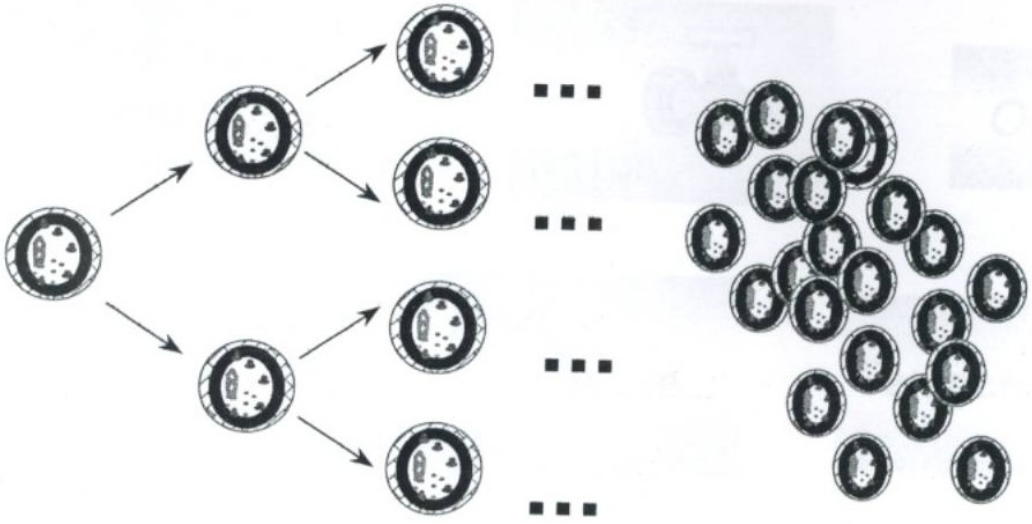
- **Shape**
  - **coccus (lactococcus, streptococcus)**
  - **bacillus or rod (*Listeria monocytogenes*)**
  - ***coccobacillus* (coliforms)**



- **Size : 1 to 10 micrometer**
  so invisible with eyes

- **Sporulation ability : resistance form**

GROWTH OF BACTERIAL POPULATION :



1 bact. E.coli at 37°C ⇨ 2 bact. 17 min. ⇨ 4 bact. 34 min. ⇨ ⇨ ... 2.4 millions bacteria. in 6 h

BACTERIA'S NEEDS :

Nutritional substances

water 

Oxygen

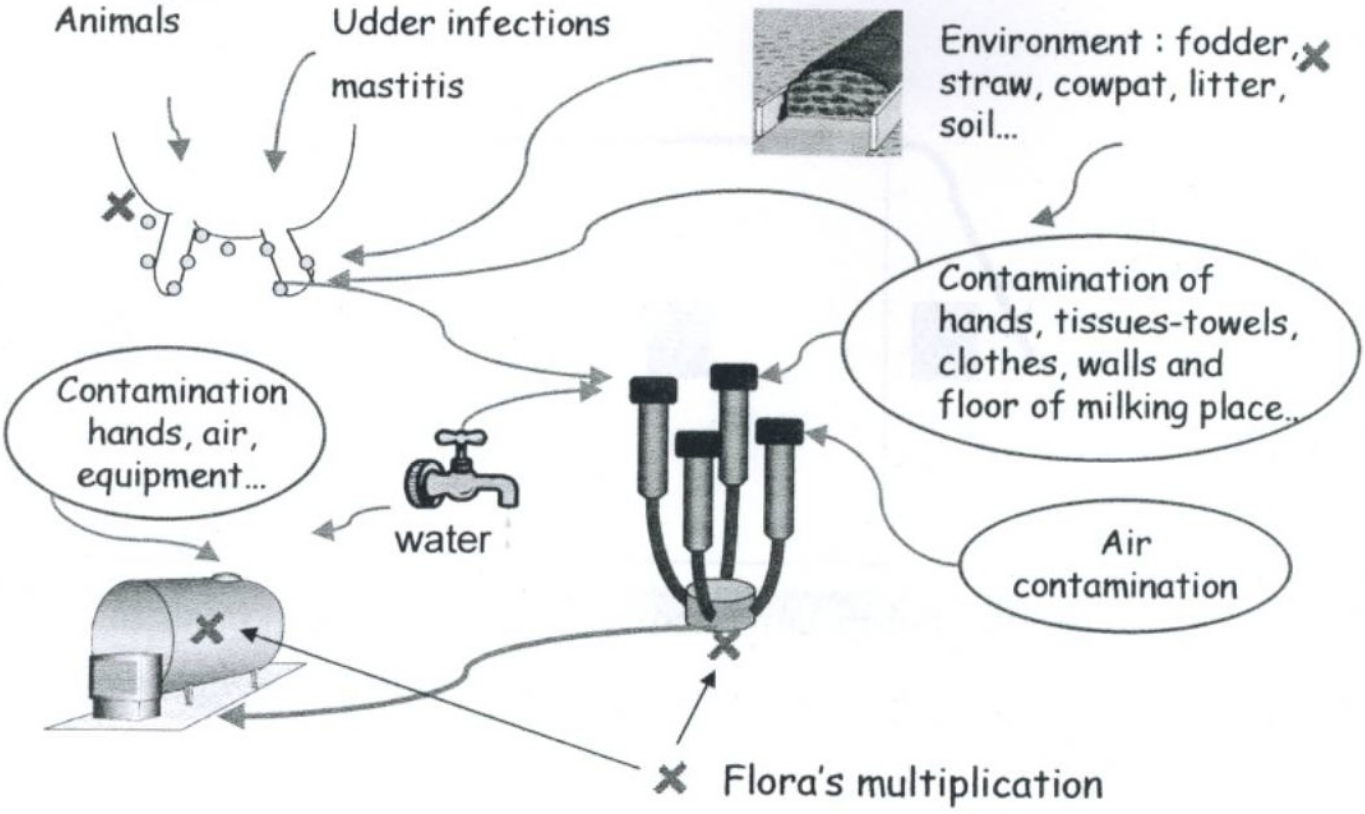
pH

Iron, manganese... etc

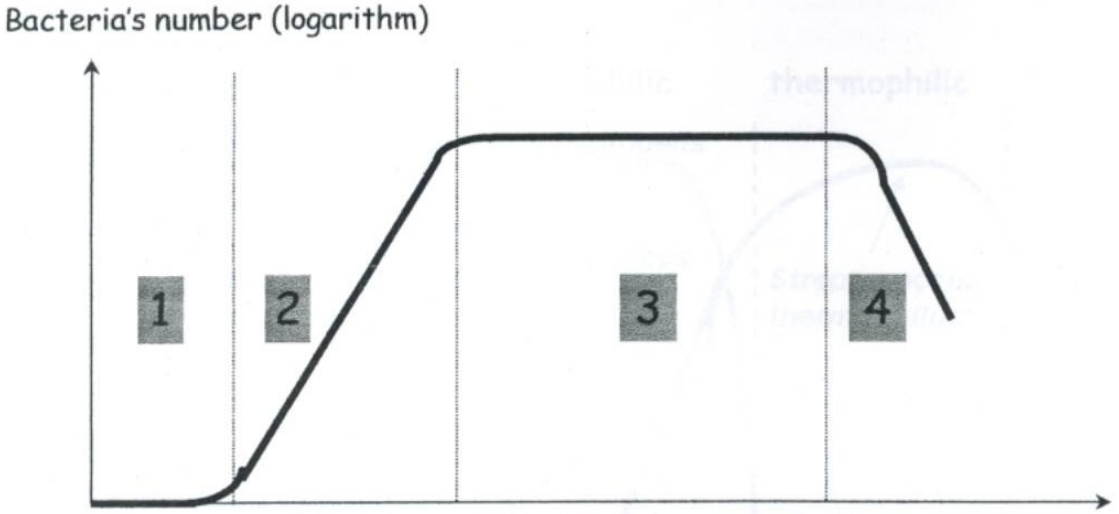
Temperature 

Interactions between factors

ORIGIN OF MILK'S FLORA :

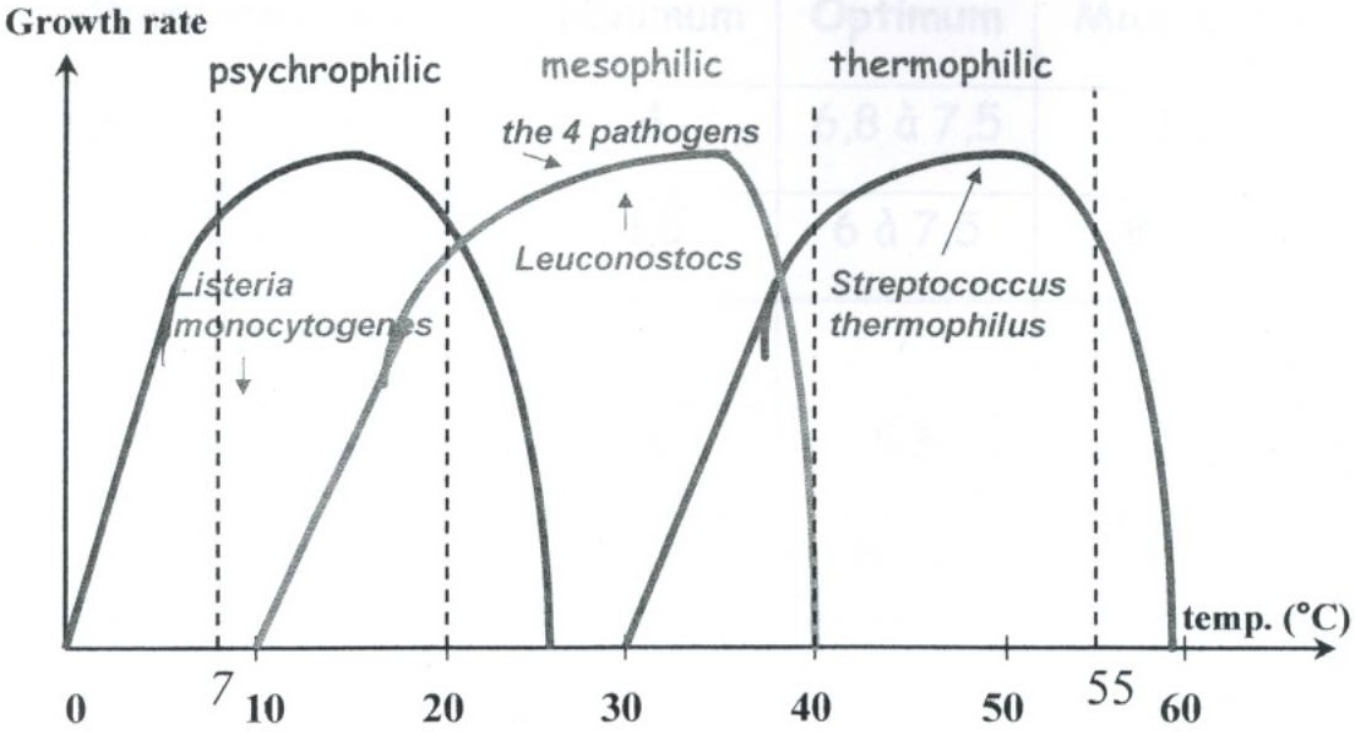


BACTERIA'S POPULATION EVOLUTION :



1 : latent phase
2 : exponential growth phase
3 : stationary phase
4 : decline phase

TEMPERATURE CLASSIFICATION :



pH AND BACTERIAN GROWTH:

Microorganisms	Minimum	Optimum	Maximum
Staphylococcus	4	6,8 à 7,5	9,8
Salmonella	4,5	6 à 7,5	8 à 9
Listeria	5	7	9 à 11
Lactics acid bacteria	3	5,5	8
E. coli	4,3	6 à 8	9 à 10

ANYWAY, DON'T BE AFRAID WITH THE MICROBIOLOGY !!!

- Richer place in bacteria : human digestive tractus

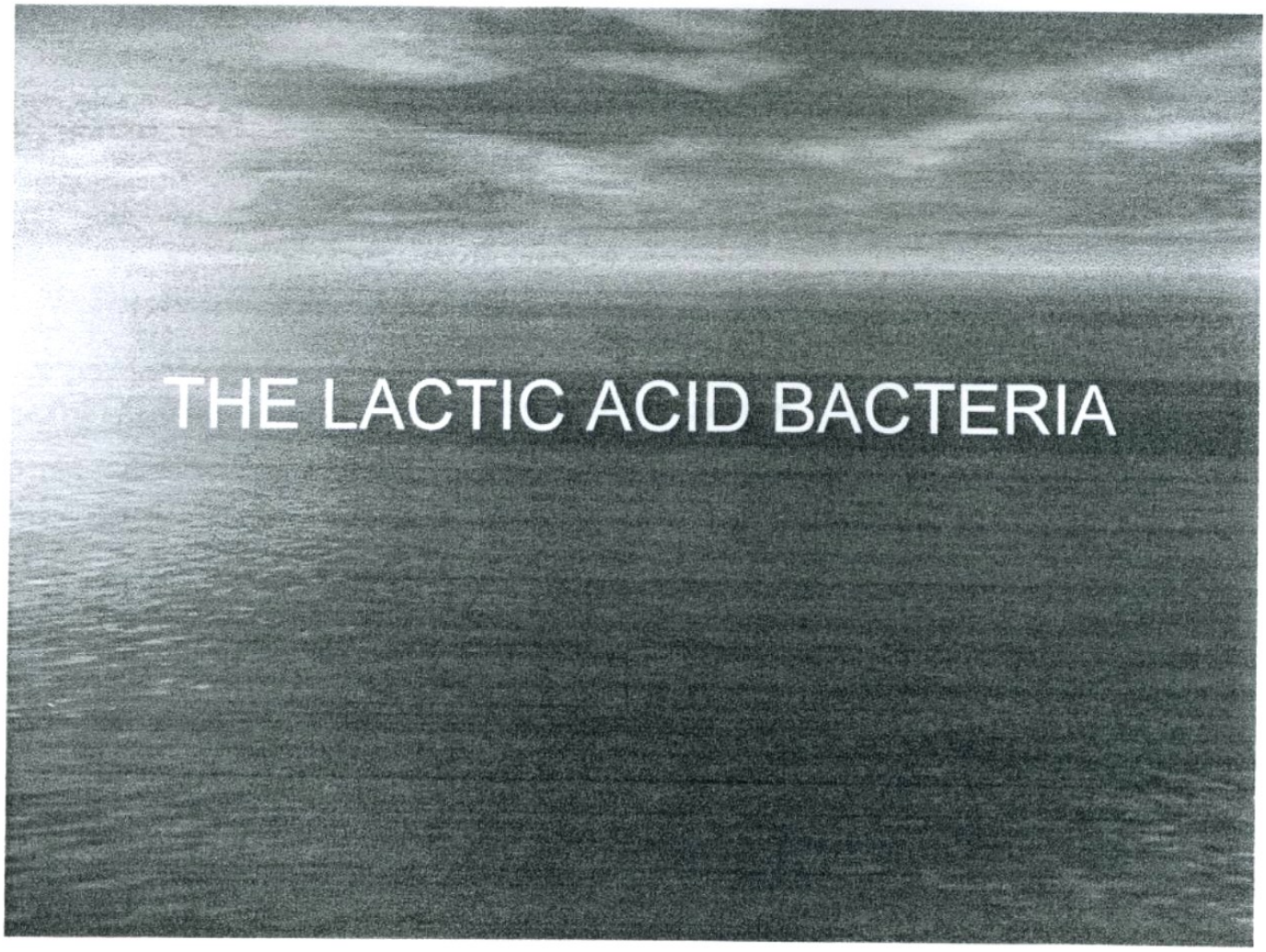
- 99 % of bacteria are useful or neutral (positive "pressure")

- knowledge, hygiene and technology permit to master the last 1%

- without flora, no fermented products : bread, cheeses, delicatessen, beer, wine, sour milk, cream and also fodders and silage !!

- from the flora's diversity comes richness of final products

THEN FINALLY USE IT AS PARTNER
IN FOOD MAKING


THE LACTIC ACID BACTERIA

CARACTERISTICS :

- *Lactobacillus, leuconostocs, lactococcus, enterococcus streptococcus, pediococcus*
- Production of lactic acid from lactose
- No growth below 10°C
- Majority destroyed by pasteurization
- Bacteria gram+

⬇

- Naturals flora in raw milk
- Protection against undesirable flora

- Origin :
  - Vegetables (ensilage, seeds, plants...), animals (skin, hairs...)

LACTICS ACID BACTERIA FUNCTIONS :

1 Acidification

> **pH decreasing**

> **Increasing in the level of soluble Calcium ions leaving from micelles**

> **Decreasing of the micelles electric negatives strengths**

== > BEST COAGULATION

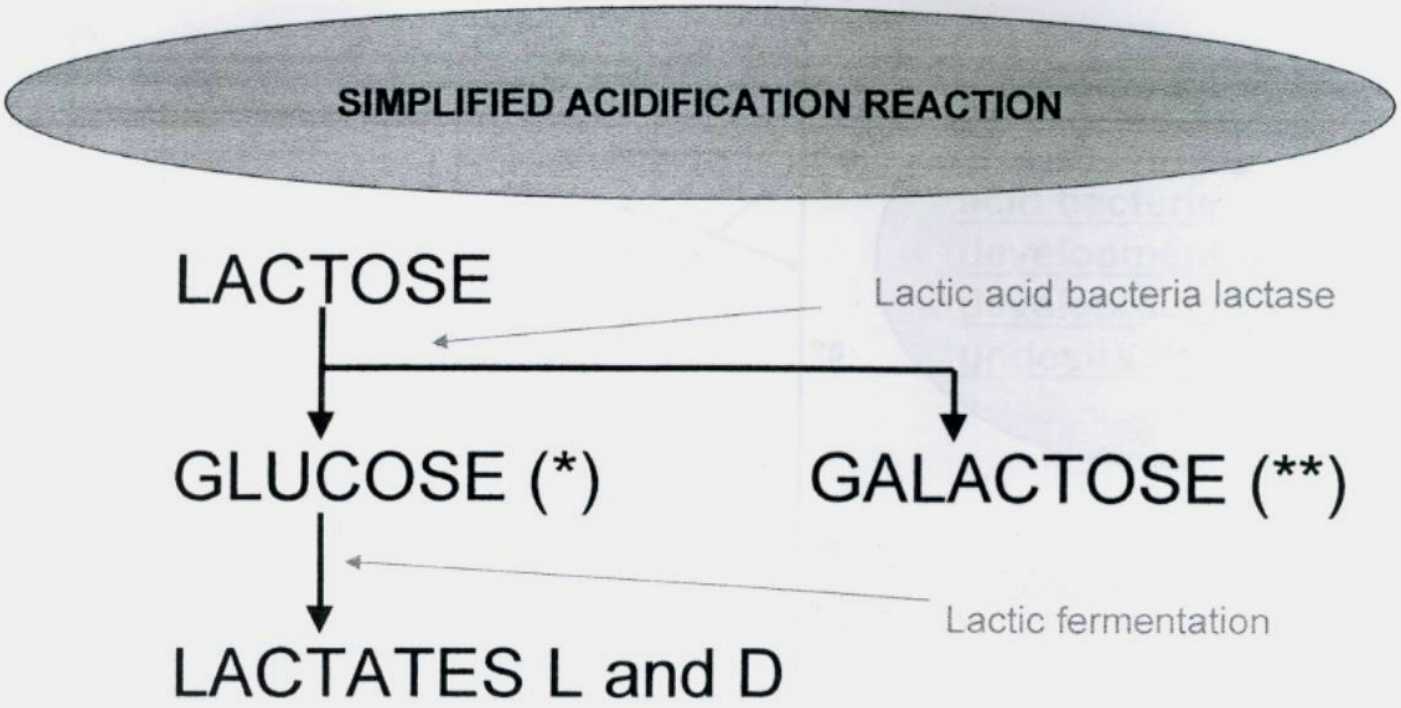
2 Protection and inhibition undesirable flora

3 Ripening

> **Aroma production**

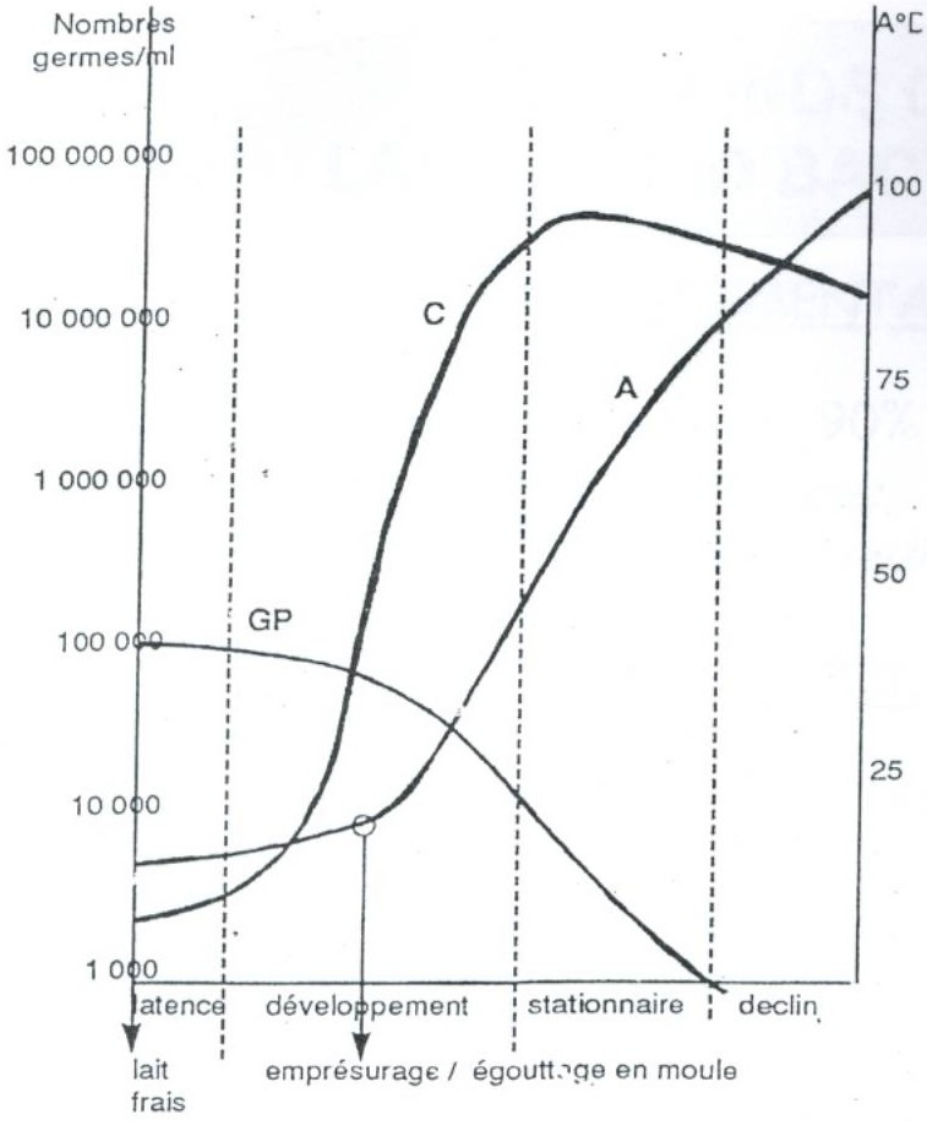
> **Gaz production**

4 Therapeutic action



(*) : Directly fermented

(**) : Accumulating possibility if lactic acid bacteria galactose -



The effect of lactics acid bacteria development on the development of undesirable flora

Culture of lactics starter at 30°C

Curve A : Acidification
Curve C : Growth
Curve GP : decline undesirable flora

TWO KINDS OF LACTIC ACID BACTERIA :

HOMOFERMENTATIVE

Lactose ⟶ 90% lactic acid

Streptococcus, enterococcus, lactococcus, some *lactobacillus, pediococcus*

HETEROFERMENTATIVE

Lactose ⟶ 50% lactic acid,
20-25% ethanol, other acids
20-25% CO_2

leuconostocs and some *lactobacillus*

NECESSITY TO KNOW THE NAME OF LACTIC ACID BACTERIA : THE TAXONOMY

Form	TAXONOMY			TEMPERATURE (°c)			Thermo-résistance 63°c 30'	max A°D développed	Acidification speed	Protéolytic activity
	Genus	species	subspecies	min.	opt.	max.				
BACILLUS	*Lactobacillus* (Lb)	*delbrueckii*	*bulgaricus*	35	45-47	60	limit	180	slow to rapid	importante
		"	*lactis*		45-47		yes	180	slow	importante
		helveticus	*helveticus*		45-47		yes	300	slow	importante
		acidophilus	*acidophilus*		45-47		no	150	slow	importante
		gasseri			45-47					
		casei		10	25-30	45	no	150	slow	importante
		plantarum		10	25-30	40	no	50	slow	importante
		fermentum			40-45		no	50		
		brevis		10	25-30	40	no	50		
COCCUS	*Lactococcus* (Lc)	*lactis*	*lactis*	10	25-30	45	no	100	slow	feeble
			diacetylactis	10	25-30	45	no	100	very slow	feeble
			cremoris	10	25-30	45	no	100	slow	feeble
	Streptococcus (Sc)	*salivarius*	*thermophilus*	18	40°c	60	yes	80-90	rapid	medium
	Leuconostocs (Ln)	*mesenteroides*	*mesenteroides*	10	25-30	40	no	30-50	slow	feeble
			dextranicum	10	25-30	40	no	30-50	slow	feeble
			cremoris	10	25-30	40	no	30-50	slow	feeble
		lactis		10	25-30	40	no	30-50	slow	feeble

HOW TO READ CLASSIC LACTOFERMENTATION TEST (COW MILK)?

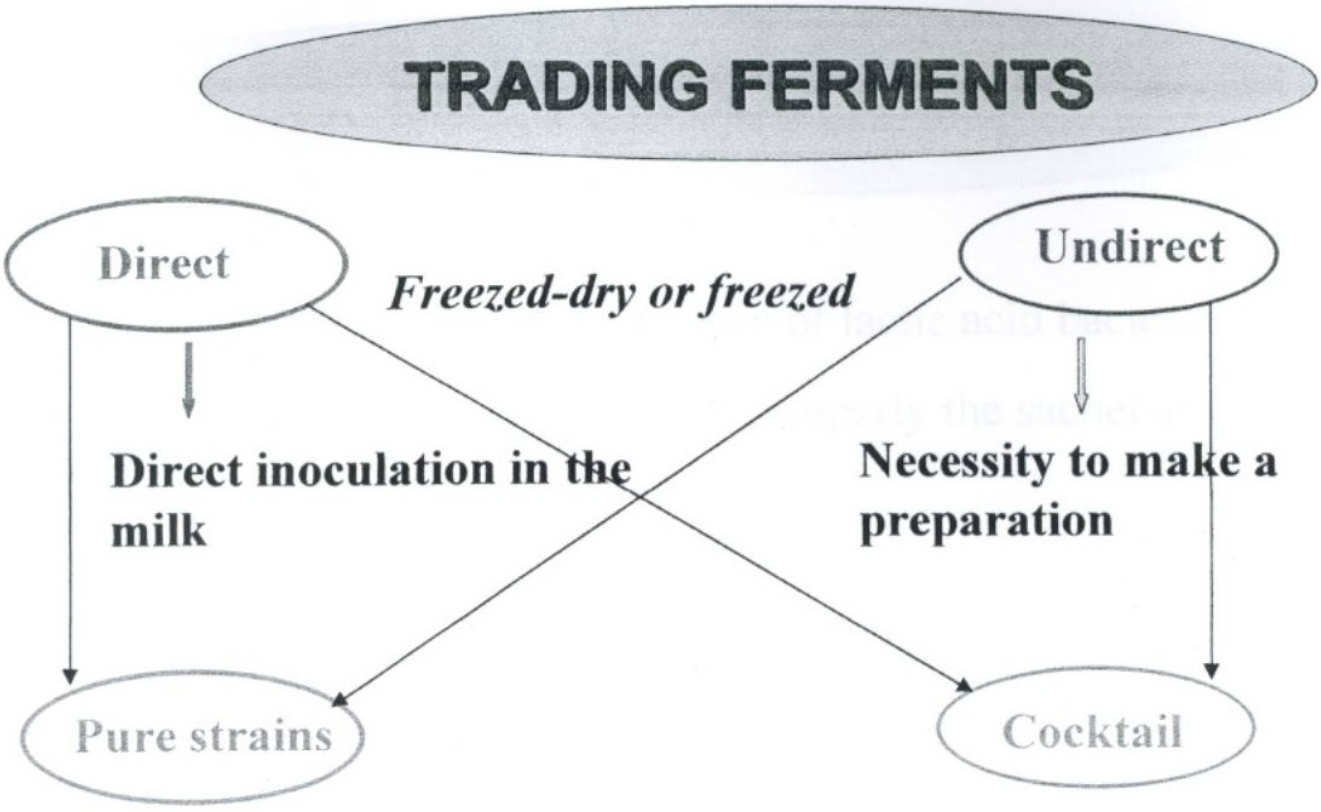
(Origin : *Comité Technique du Comté 1999-2000)*

Kind of lactofermentation results	Aspects
Gelatinous	The coagulum is firm, white, mast. Possibility to have some bubbles but without gaz pocket, streak or small crack fissure. Few whey on surface.
Liquid	The milk stays completely liquid or is just at the beginning of coagulation.
Fleecy	Appearance of casein fine flakes (like grains) of caséine with white or yellow whey expulsion (result of proteolysis)
Digested	The curd is proteolyzed with gaz pockets. This curd looks like a sponge (alveolate).
Inflated	Many bubbles. The curd is spongy with a bad smell.

LACTIC ACID BACTERIA USE

- Naturals : lactofermentation

- Selected blends : direct and undirect inoculation


TRADING FERMENTS
Direct
Undirect
Freezed-dry or freezed
Direct inoculation in the milk
Necessity to make a preparation
Pure strains
Cocktail
Strains known, but phages (viruses) sensibility
Mix of many strains unknowed, but best phages resistance

DIRECT INOCULATION

- 10^{11}à 10^{12} ufc/g. It's a concentrate of lactic acid bacteria

- Very simple to use (only to open properly the sachet and empty it in the vat)

BUT :

- Difficult to mesure exactly the quantity in proportion of milk

- Latent phase longer

- Costly

=====→Technological adjustments

UNDIRECT INOCULATION

- 10^8 à 10^9 ufc/g. Less bacteria than direct but active quicker!

- Latent phase shorter

- Cheaper

- More enzymatic stock

- Easier to mesure exactly the quantity in proportion of milk

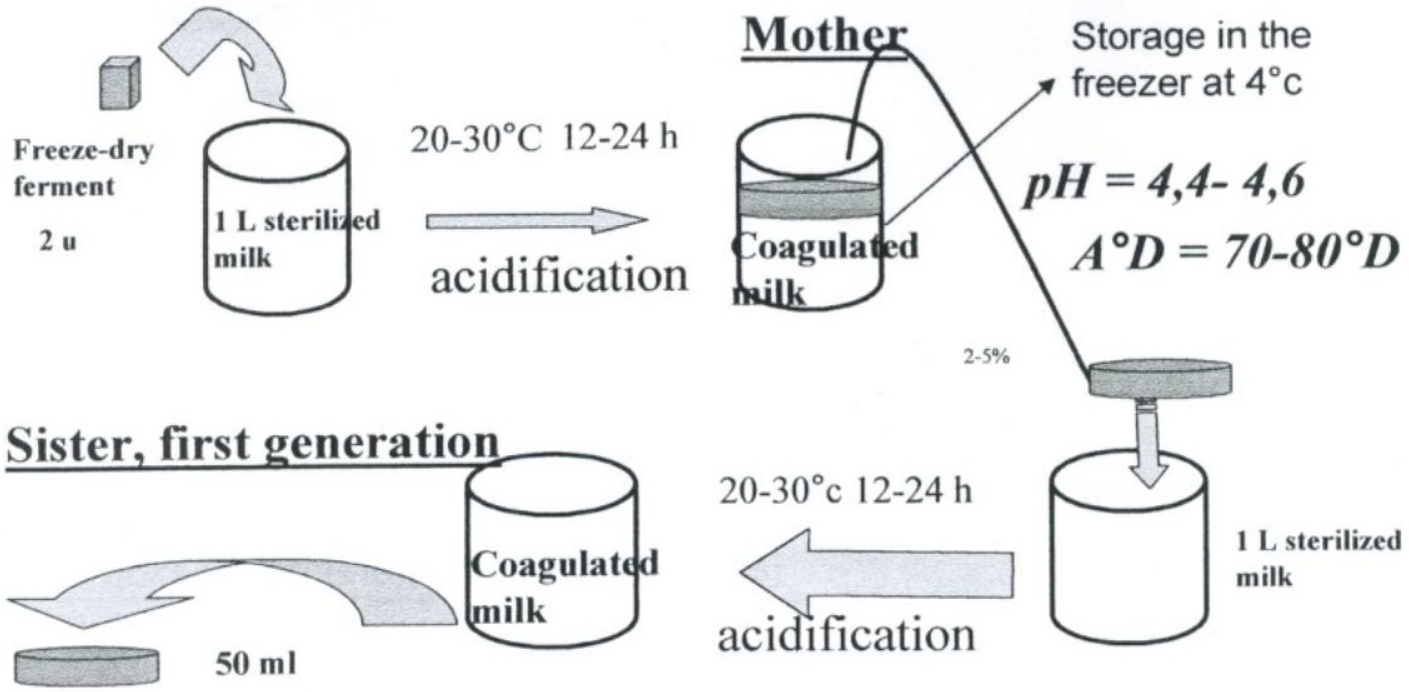
BUT :

- Difficulty to prepare properly and to check exactly the temperature in the farm

⟹→Contaminations and technical drift risk

Mesophilic starter preparation

ex : for an inoculation at less than 2u per 100 liters of milk



Generations 2, 3, 4, 5 …

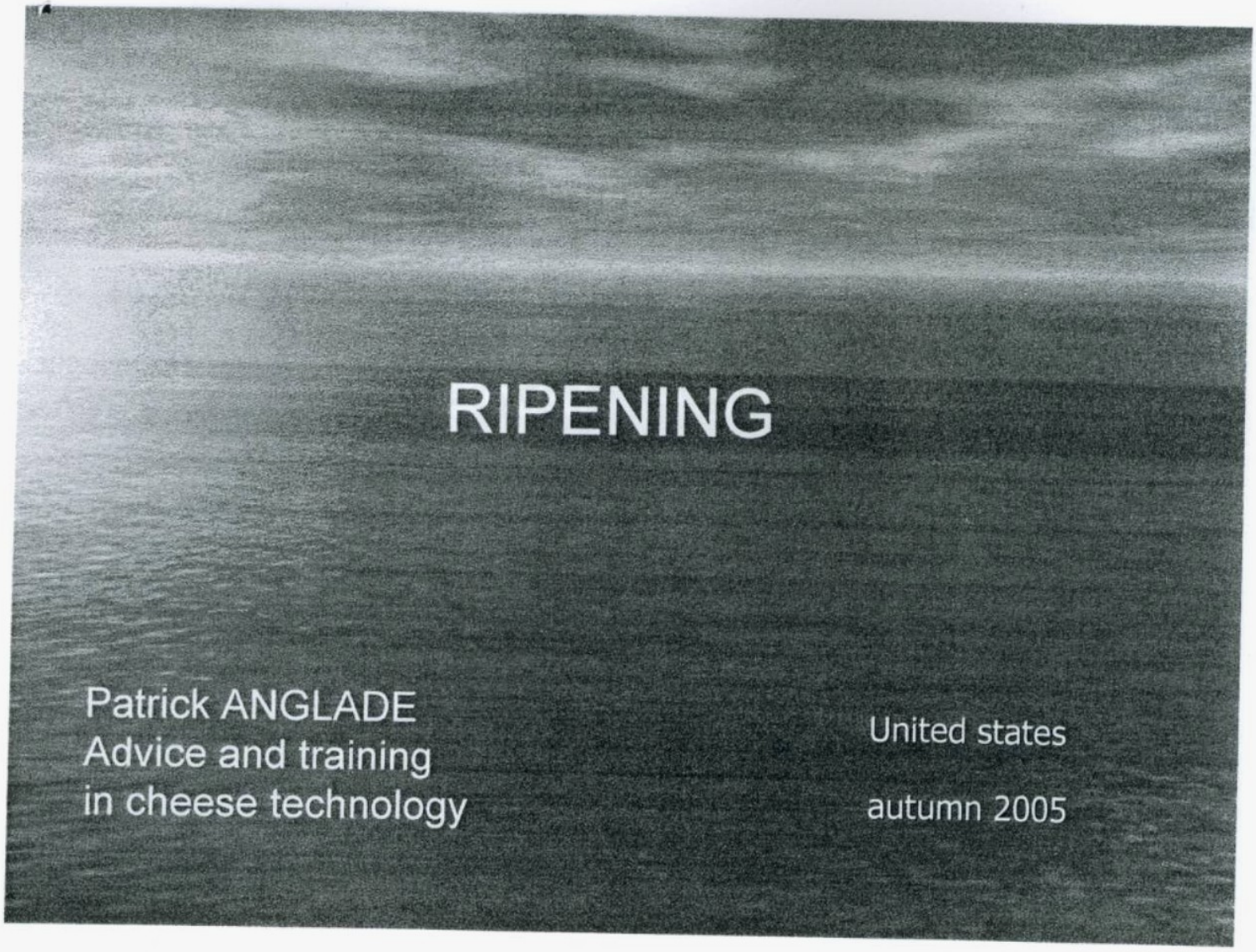
LACTIC ACID BACTERIA CHOICE CRITERION

- Cheese type
  - Temperature
  - Fermentative profil
  - Association (Yogurt)
  - Acidification activity (speed, texture)
  - Ripening and aromatic activity
- Use (direct or undirect, freezed dry or freezed, cocktails or pure strain)
- Packaging (conditionning per x liters)

===> COMPROMISE

LACTIC ACID BACTERIA CAUTIONS USING

- Keep at 4°c for Freezed-dry sachets and below - 40°c for freezed sachets
- Don't mix with water or salted water. Only with milk.
- For starter preparation, be extremly severe on cleanliness and respect a continuous temperature during fermentation
- Open the direct sachets cleanly
- To prevent phages keep always two or three differents strains of same ferment (different companies per exemple)
- Ask and discuss with the company technician
- Make trials


RIPENING
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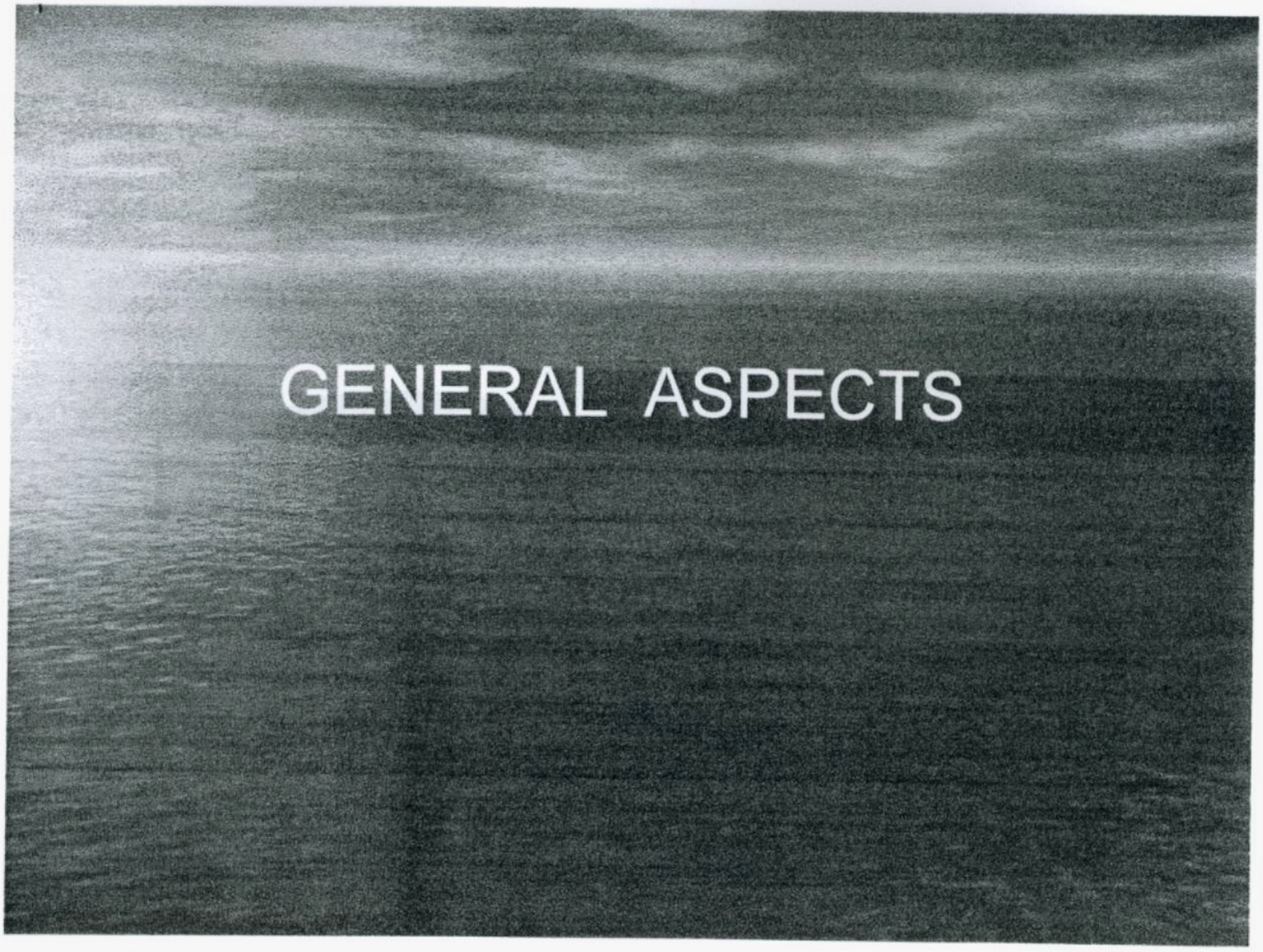

GENERAL ASPECTS

Ripening = enzymatic degradation of the curd's components :

SUBSTRATE

-Water, dry extract
-fat matter
-nitrogenous matter
-Minerals (Ca)
-pH
-Nacl
-Residuals sugars
-Colour
-Aspect
-Form
-Texture
-Tast and flavour

CHEESE MAKER

AIR CONDITIONNING EQUIPMENT

MATURATION FACTORS

-temperature
-humidity
-air composition
-air renewal
-ripening time
-ventilation

TRANSFORMATION

-glycolysis
-proteolysis
-Lipolysis

-cares in cave

SUBSTRATE

-Water, dry extract
-fat matter
-nitrogenous matter
-Minerals (Ca)
-pH
-Nacl
-Residuals sugars
-Colour
-Aspect, form
-Holes,
-Texture
-Taste and flavour

RIPENING AGENTS

-natural milk enzymes (lipases, plasmin)
-coagulating enzymes
-micro-organisms enzymes : fungal bacterial
-milk natural flora

Cheese qualities : sanitary, nutritious and sensorial

INTERNAL MODIFICATIONS

- Color : white (goat cheeses) ivory to yellow (proteolysis, fermentations) homogeneous or heterogeneous
- Texture : firmness, suppleness, deformation and crushing resistance, melting, sticky, dry, granulous paste…
- Holes :
  - wanted : propionic fermentation, mechanical holes, heterofermentative ….
  - declined : butyric fermentation, coliforms, yeasts heterofermentatives …
- pH climb : conséquence of yeasts development, necessity for an optimal ripening flora development (surface bacteria, moulds …)

ORGANOLEPTICS MODIFICATIONS

-Sapidity and smell : flavors
Origin : proteolysis and lipolysis (small molecules)

This step is an enzymatic digestion of the components of the curds.
Curd (nitrogenous matter, fat matter, lactose, lactic acid….).

-Amin acids, volatils fatty acids, CO_2, H_2O, NH_3…

THREE STEPS

- Pre-drying or yeast stage
- Drying
- Ripening

PRE-DRYING OR YEAST STAGE

- Beginning of the yeasts and *geotrichum* development
- Color modification
- Indispensable step in Lactic and soft cheese technology
- General conditions :
  - **Temperature : 20 – 22°c**
  - **Hygrometry : > 85 %**
  - **Duration : 12 à 48 H, according to flora development**

===> In the cheese making room

DRYING

- Concluded yeasts and *geotrichum* development.
- Drainage complement by water evaporation
- General conditions :
  - **temperature : 14 – 18°c**
  - **Hygrometry : 65 to 80 %**
  - **Duration : 12 to 72 H**
  - **Aerage, ventilation**

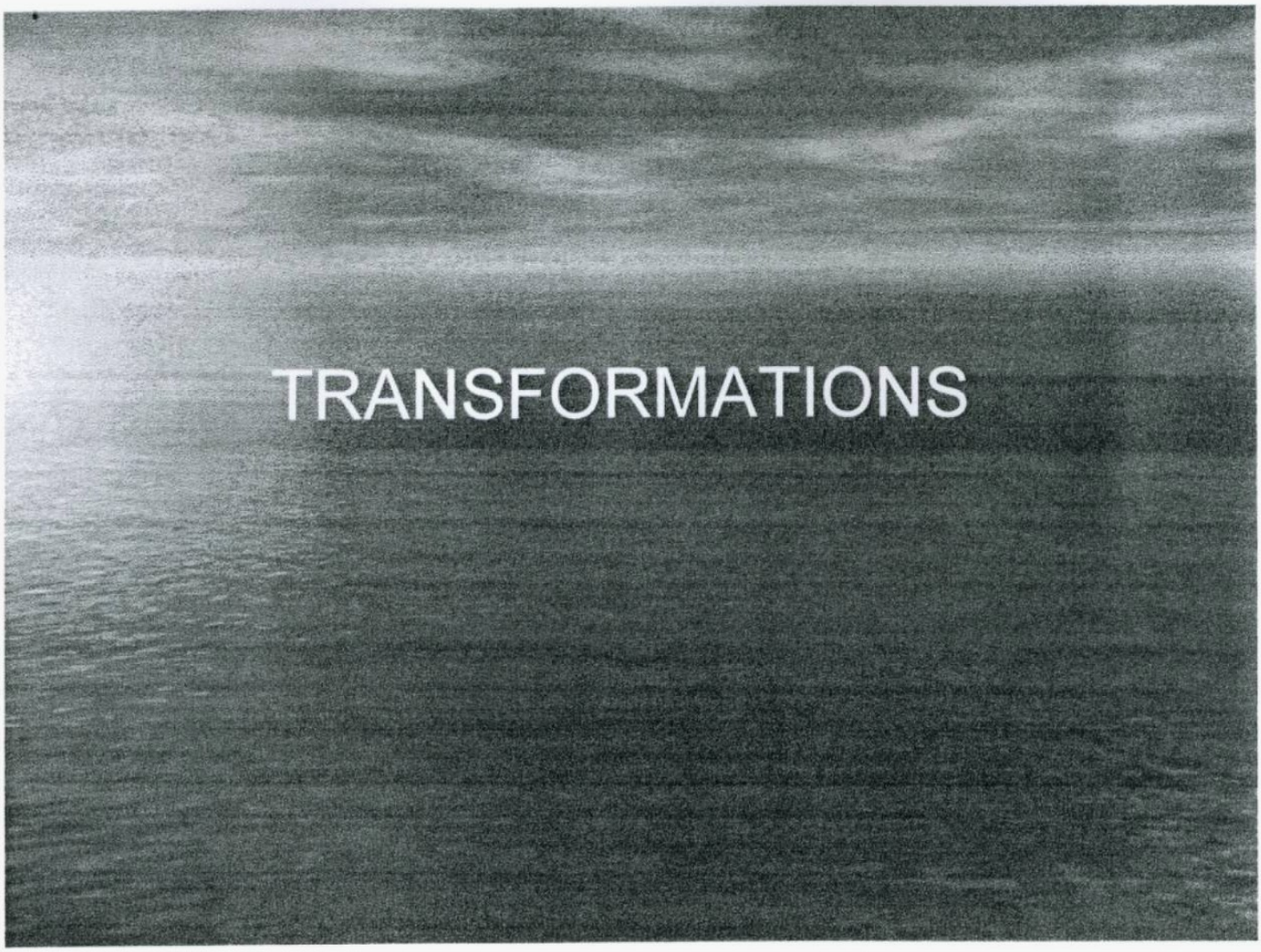
===> In the drying room

RIPENING

- Moulds or bacteria development.
- Loss of weight limited
- Arriving of the ripening flora as quickly as possible
- General conditions :

  – **Temperature : 9 – 15°c**
  – **Hygrometry : 80 – 98 %**
  – **Duration : 1 week to several months**
  – **Aérage, ventilation according to the kind of cheese**

  ===> In the adapted ripening room (depends of the kind of cheese)


TRANSFORMATIONS

Cheese ripening enzym

- Protein products by micro-organisms (bacteria, yeasts, moulds)
- Specific activity according to substract
- Naturally, in raw milk : Lipase, lysozyme, peroxydase, catalase, alcalin and acid phosphatase, plasmin (casein β, αs_1, αs_2 hydrolysis), esterases, lactoperoxydase…
- Don't forget….rennet!

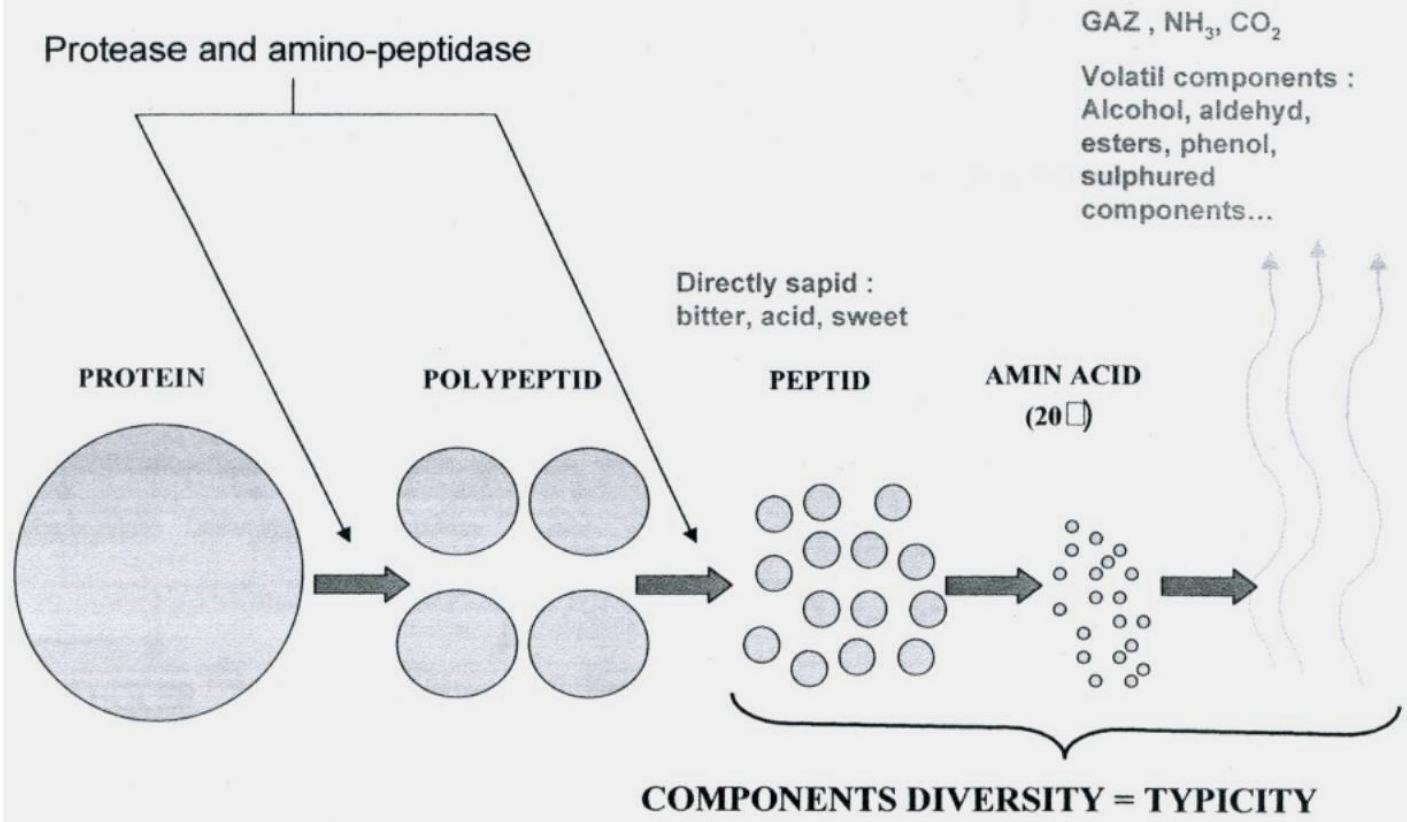
GLYCOLYSIS

• Acidification : first responsability in aroma production, because lactic acid reduce the volatils fatty acids pH (C_4, C_6, C_8, C_{10} and C_{12} (butyric, caproïc, caprylic, capric and lauric acid))
===> directly sapid

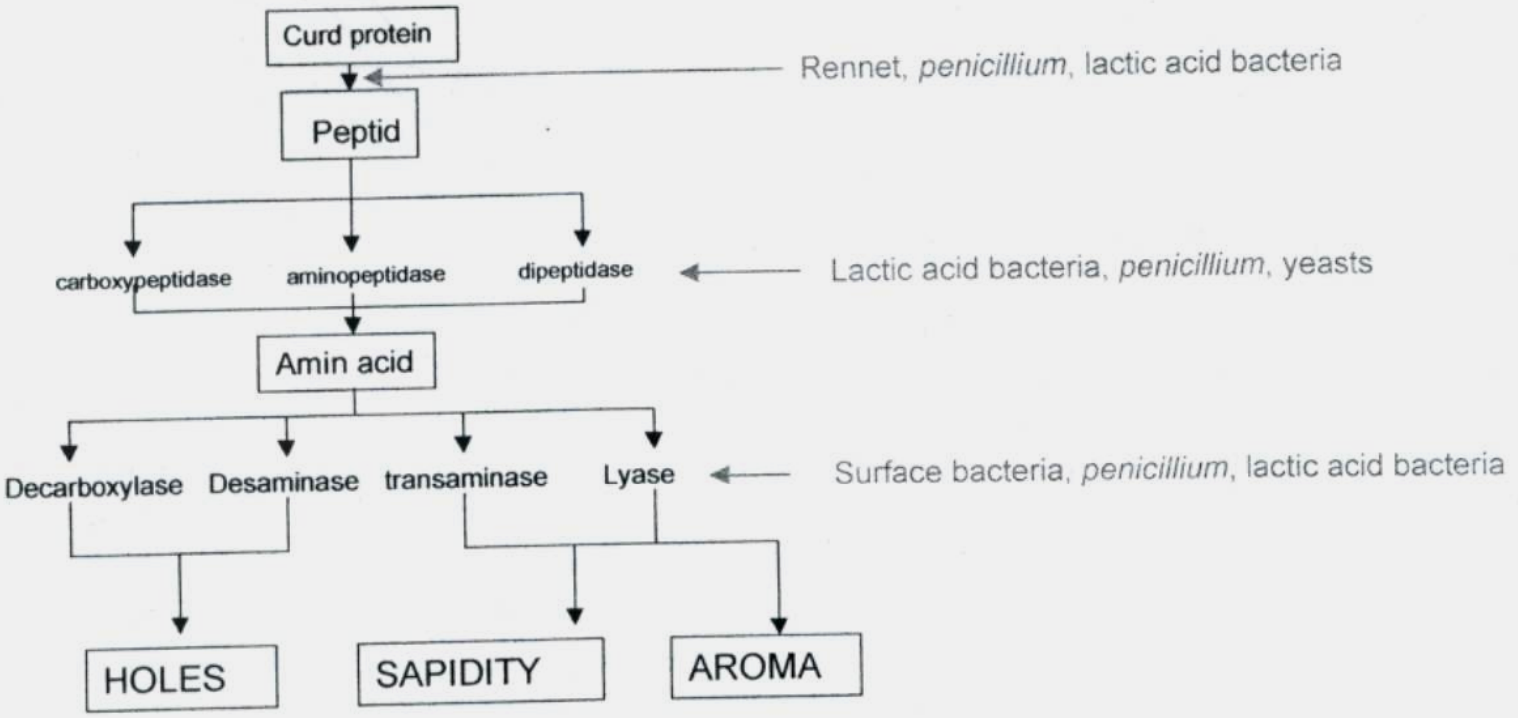
• Citrate fermentation → diacétyl (2-3 butandiol), product by *Lactococcus lactis var diacetylactis* (butter and cream aroma, nuts taste)

Enzyme or Métabolic way	Enzym origin	Principal substract	Molecule produced	Sensorial descriptor
B-galactosidase	Lactic acid bacteria	Lactose	Clucose Lactose Lactic acid (post-acidification)	Acid Hard heart White Dry texture
Homofermentative way	Lactic acid bacteria	Clucose Lactose	Lactates Lactic acid (post-acidification)	Acid Hard heart White Dry texture
Heterofermentative way	*Leuconostoc*	Clucose Lactose	Lactates Ethanol Acetate Lactic acid CO_2	Fermented Alcoholic Acid
Citrate way	*Lactococcus lactis ssp lactis biovar diacetylactis* *Leuconostoc*	Citrate	Acetate Diacetyl Acetoïn CO_2	Fermented Alcoholic Acid Nuts
Propionate way	Propionibacterium	Lactate	Propionate Acetate	Acid

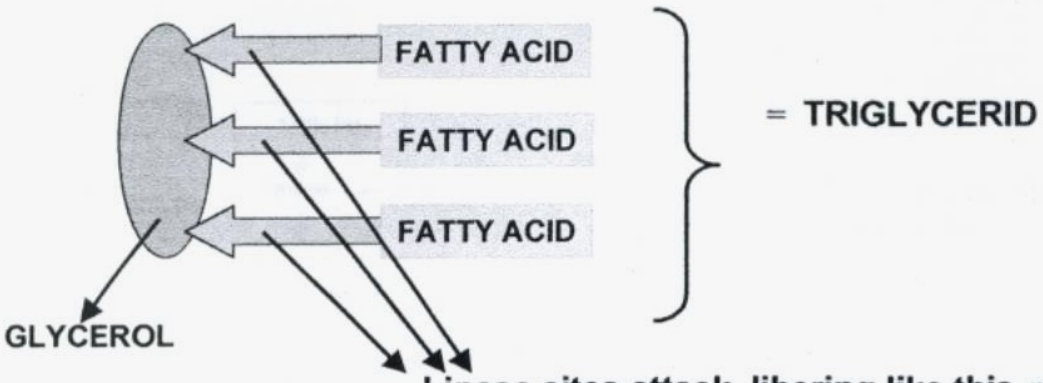
PROTEOLYSIS



PROTEOLYTIC ACTIVITY



LIPOLYSIS

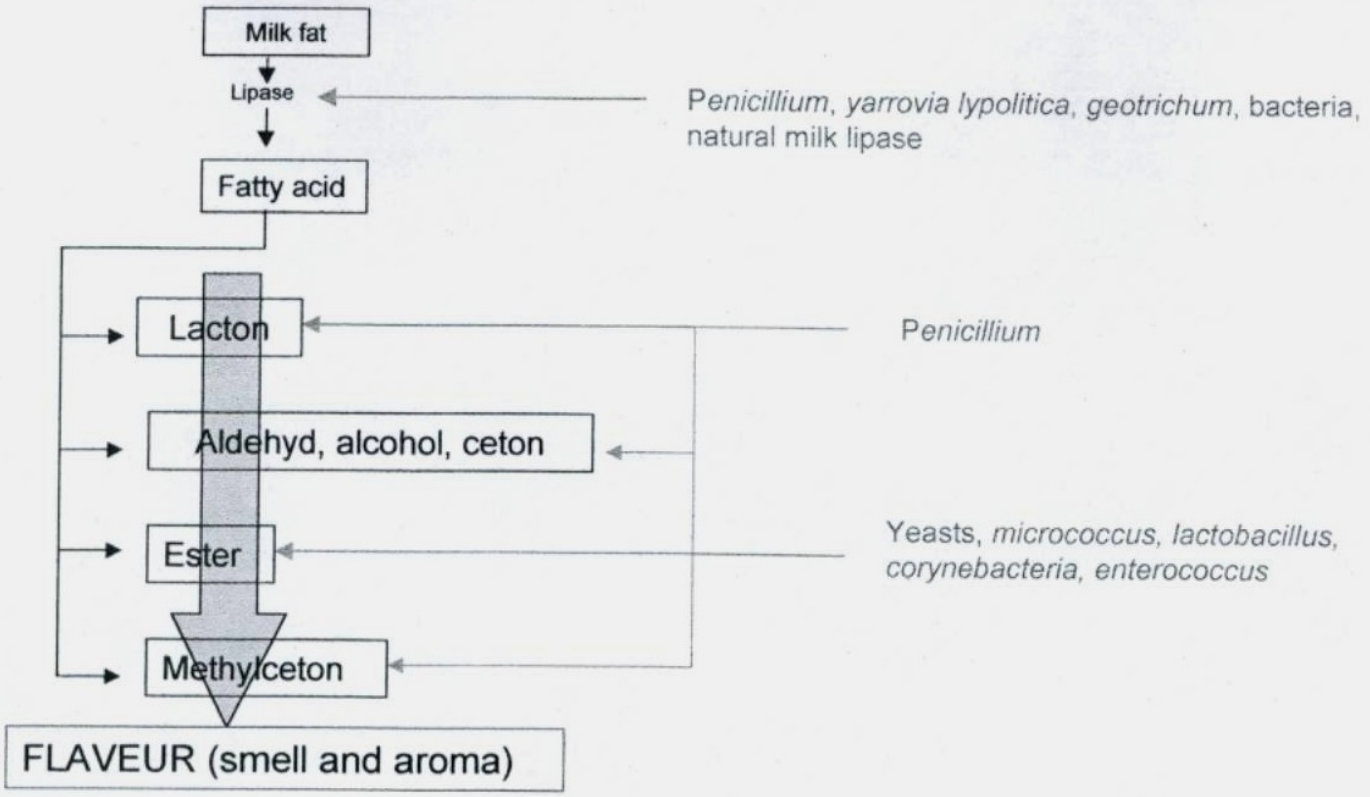


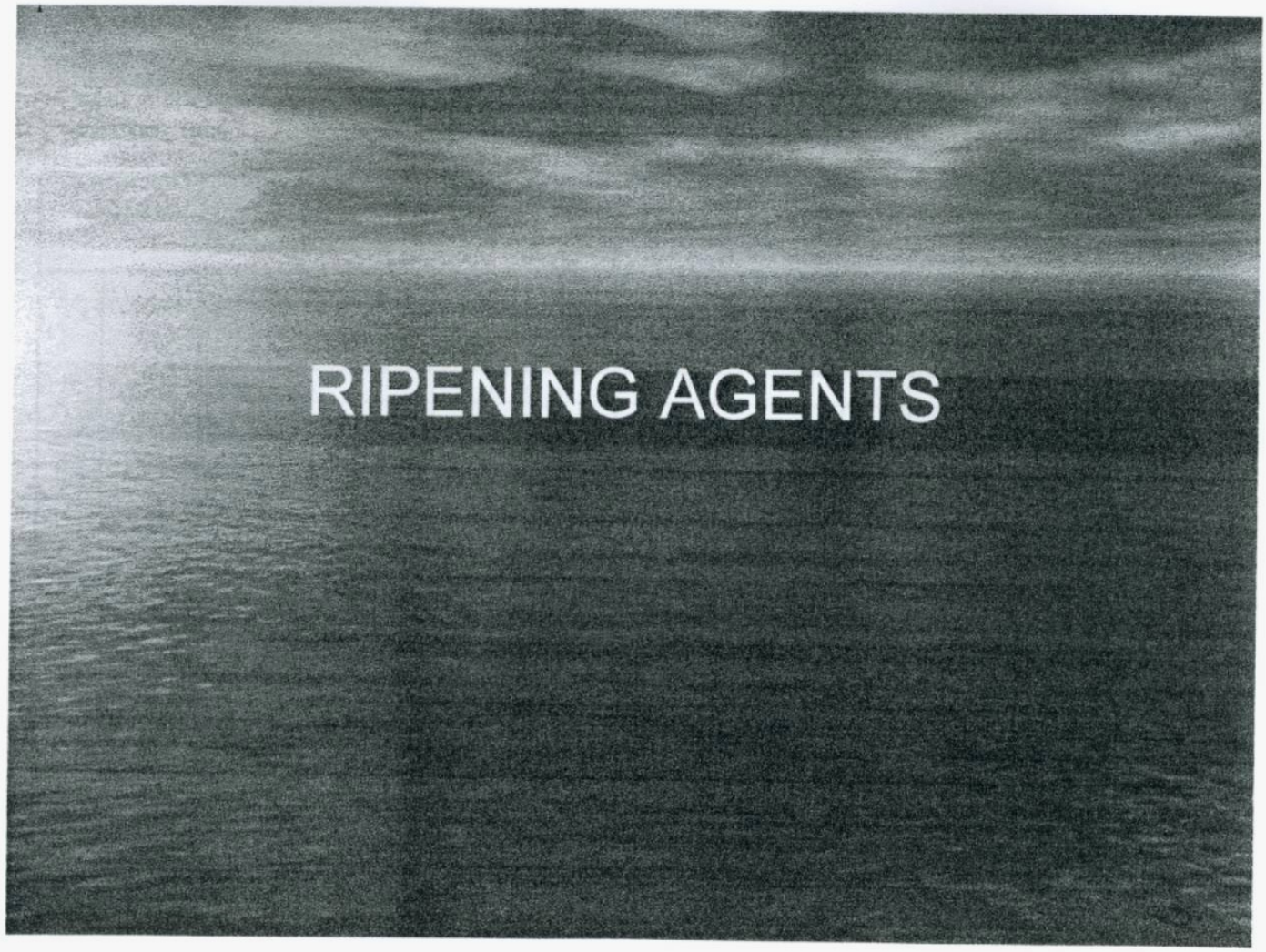
Lipase sites attack, libering like this « free » fatty acid

- Fat in the cheese : - texture (fat and soft sensation)
  - generate and fixing aroma (hydrophob)

- Most important components are fatty acids directly sapid (C_4 to C_{12}) or like precursor C_{14} to C_{18}
- Fatty acids are responsable in the soap and rancid taste.
- Fatty acids are acid! Like this, goat aroma is more perceptible in the goat lactic cheeses than in the goat hard cheeses.
- Origin of typical goat aroma is an fatty acid C_8 : the 4 ethyl-octanoïc. Naturally in the milk or result of lipolysis.

LIPOLYTIC ACTIVITY




RIPENING AGENTS

Lactic acid bacteria and yeasts metabolism in cheese technology

				FERMENTATIVE METABOLISM										OXYDATIVE METABOLISM		
				Substracts				Productions						Substracts		Productions
				Lact.	Gluc.	Galac.	Citra.	Lact. L	Lact. D	Diacetyl	Alcool	CO_2		Lact.	Lactates	CO_2
L.A.B.	MESO.	*Lc.*	*cremoris*	+	+	+	-	+	-	-	-	-		-	-	-
			lactis	+	+	+	-	+	-	-	-	-		-	-	-
			diacetylactis	+	+	+	+	+	-	+	+	+		-	-	-
		Ln.	*cremoris*	+	+	+	±	-	+	+	+	+		-	-	-
			lactis	+	+	+	±	-	+	+	+	+		-	-	-
		Lb.	*casei*	+	+	+	-	+	-	-	-	-		-	-	-
			plantarum	+	+	+	-	+	+	-	-	-		-	-	-
			brevis	+	+	+	-	+	+	-	-			-	-	-
	THERMO.	*Sc.*	*thermophilus*	+	+	-	-	+	-	-	-	-		-	-	-
		Lb.	*helveticus*	+	+	+	-	+	+	-	-	-		-	-	-
			bulgaricus	+	+	-	-	-	+	-	-	-		-	-	-
			lactis	+	+	+	-	-	+	-	-	-		-	-	-
			acidophilus	+	+	+	-	+	+	-	-	-		-	-	-
			fermentum	+	+	+	-"?"	+	+	-	-	+		-	-	-
YEASTS		*C.*	*utilis*	-	+	?	-	-	-	-	+	+		-	+	+
		K.	*lactis*	+	+	?	-	-	-	-	+	+		+	+	+
		D.	*hansenii*	-	-	-	-	-	-	-	-	-		+	+	+

Origin : Bernard MIETTON, ENILBIO POLIGNY cheese technology course (2000/05)

Principal cheese technology flora requirements for their development during ripening

	TEMPERATURE	AW and $NaCl/H_2O$	O_2	pH
Lactic and pseudolactic bacteria	méso. : >10°c opt 30-35°c thermo. : > 20°c opt 40-45°c	aw>0,95 → 0,985* $NaCl/H_2O$ <1→ 5%*	aérobies	pH opt. : 5,5 →6,5* pH max. : 3,4 →5,1*
Yeasts	min. : 4-8°c* opt. : 20-30°c* 14 → 22°c **	> 0,85, few restrictive	+ θ°c high, + importants needs If restrictive, Cu. et Kl. → fermentative métabolism with alcohol production...	No limitative in général, but they like acidity
Geotrichum candidum	min. : 4-8°c* opt. : 25-30°c* 14 → 22°c **	$NaCl/H_2O$ <2,8%	Few confinement sensibility	min. : 4,6 →5,3* opt. : 6-7
P. camemberti	min. : 6°c opt. : 20-22°c 10 → 14°c**	min : 0,93 opt. : 0,98 no restrictive	Very exigent for rapidly dévelopment. Necessity to limit after to avoid a to much rapidly maturing	No limitative in general
P. roqueforti	min. : 2°c opt. : 20-25°c	$NaCl/H_2O \leq 10$ %	Development until 10% de CO_2	opt. : 6-7. Significative development from 5-5,05
B. linens	min. : 4 15°c* opt. : 20-25°c 10 → 15°c**	opt. : 4-5% $NaCl/H_2O$	Very exigent (more than *P. camemberti*)	min. : 5,2 → 6,1* opt. : 6 → 6,5 Significative development > 5,8-6

* variable with specie and et strain

*** Températures usuals temperature in farms cheeses*

First limitative parameter Second limitative parameter

Origin : Bernard MIETTON, ENILBIO POLIGNY Cheese technology course (2001/02)

HOW TO USE YEASTS ?

	Candida utilis	*Kluyveromyces lactis*	*Debaryomyces hansenii*
Ph neutralizing	+++	+	++
Growth surface profoundness	+++ +++	+++ +++	+++ +
Aromatization power	++	++	+
Applications	To desacidify paste quickly. For lactic cheeses (moulding out pH <4,6). Inoculation in the milk	Anti-post-acidification for soft cheeses. Inoculation in the milk.	In surface. Use it to help Brevi bacterium linens installation. Inoculation in surface (washing or spray)

EXEMPLES OF DIFFERENTS BETWEEN *GEOTRICHUM* STRAINS (origin : RHODIA FOOD)

STRAINS NAME	GEO 13	GEO 15	GEO 17
FORME	Intermediate	Yeast	Mould
GROWTH SPEED	+++	++	+++
Ph NEUTRALIZING	Rapid		
PROTEOLYTIC ACTIVITY	Medium	Very feeble	Feeble
LIPOLITYC ACTIVITY	Medium	Feeble	Feeble
OPTIMUM TEMPERATURE	25-30°c		
GROWTH AT 3°c	No		
OPTIMUM pH	5,3-8		
ACTIVITY AT pH 3	Very feeble		
Geotrichum begins to growth at pH 4,6			
RELATIVE HUMIDITY	90 %		
Aw	>0,95		
Very exigent in Oxygen. Few *geotrichum* are able to growth in an oxygen impoverished atmosphere.			

SOME EXEMPLES OF DIFFERENTS ENZYMATIC ACTIVITIES DURING CHEESE PROTEOLYSIS

Cheese type	Contribution to proteolysis by						
	Rennet	Plasmin	Lactic acid bacteria		Surface flora		Internal mould
			Mesophilic	Thermophilic	Coryneform	Mould	
Butterkäse	+++	Very feeble	++	-	-	-	-
Camembert	+++	±	++	-	-	+++	-
Munster	+++	±	++	-	+++	-	-
Gouda	+++	Very feeble	+++	-	-	-	-
Cheddar	+++	Very feeble	+++	-	-	-	-
Emmental	±	+/++	±	++	-	-	-
Gruyère	±	+/++	±	++	+	-	-
Provolone	+	+	-	++	-	-	-
Roquefort	++	±	++	-	-	-	+++
Gorgonzola	++	±	++	- or ++	+	-	+++

\+ Significativ
++ Importante
+++ Very importante
± Feeble
Origin : NOOMEN et Al., 1992

PROTEIN HYDROLYSIS AND AROMATIC COMPONENTS

Enzyme or metabolic way	Enzyme origin	Major substract destroyed	Produced molecule
Chymosin	Rennet	Casein β, αs_1	Polypeptid
Pepsin	Rennet	Casein β, αs_1	Peptid
Plasmin	Milk	Casein β, αs_2	Casein γ, proteose pepton, polypeptid
Extracellular and intracellular (*) protease	Lactic acid bacteria		Polypeptid, peptid
Peptidase, Aminopeptidase, Dipeptidase, Carboxypeptidase (**)	Lactic acid bacteria	Polypeptid, peptid	Amin acid
Decarboxylase	*Micrococcus, enterococcus, brevibacterium*	Amin acid	Amin
Desaminase	*Lactobacillus, Geotrichum candidum*	Amin acid	Aldehyd, organic acid, NH_3
Transaminase	Lactic acid bacteria *Micrococcus, enterococcus*	Amin acid	Others amin acid
Lyase	*Brevibacterium Pseudomonas Penicillium candidum*	Amin acid	Phenol, Indol, sulphurud components

* activ after death bacteria
** excepted *lactococcus*

FAT HYDROLYSIS AND AROMATIC COMPONENTS

Principal enzyme or metabolic ways	Principal origin of enzyme	Major substract attacked	Produced molecule
Lipase	Milk Moulds *Pseudomonas* *Geotrichum*	Triglycerid	Fatty acid Partial triglycerid
Esterase	*Pseudomonas* Yeasts *Micrococcus*	Fatty acid	Fruited components Ester, ethyl acetat
Enzyme by beta-oxydation	*Penicillium camemberti* *Penicillium roqueforti*	Fatty acid	Methylceton Secondary alcohol

RIPENING FLORA CHOICE CRITERION

- Cheese type (lactics, soft, hard, pH....)
- Crust type
- Proteolysis activity (different strains)
- Lipolysis activity (different strains)
- Association (*geotrichum-penicillium*)

===> Ask to the company technician


AIR CONDITIONING EQUIPMENTS

DEFINITION AND PARAMETERS

- EVERY AIR TREATMENT OPERATIONS TO MAINTAIN CONSTANT PHYSICAL AND SOMETIMES CHIMICAL THEIR CARACTERISTICS

- Temperature
- Relative humidity
- Ventilation
- Aerage
- Chimical and microbiological compositions

- Indispensable to :
  - Bacterian ripening control
  - Moulds (and yeasts) development control
  - Cave atmosphere conditions control
  - Avoid ripening troubles
  - Limit weight losses

TEMPERATURE

- DRY
- HUMID
- CONDENSATION

VENTILATION

- Objective : To homogenize atmosphere in the room and to renew the air who is in cheese contact

- Speed : meter/second (m/s)

- Stirring rate : cubic meter/hour (m^3/h)

  ⟶ volume/hour (vol/h)

VENTILATION

- Naturally ventilation : static system

- Forced ventilation : dynamic system

AERAGE

- Indispensable for different cheese making process (soft cheeses with moulding skin, lactic cheeses)

- In volume per hour (vol/h)

CHIMICAL AND MICROBIOLOGICAL COMPOSITION

- Aerage and ripening fermentations result (0_2, $C0_2$,H_20 (vapour), NH_3…)
- Quality of incoming air (filtration)
- Best : overpressure

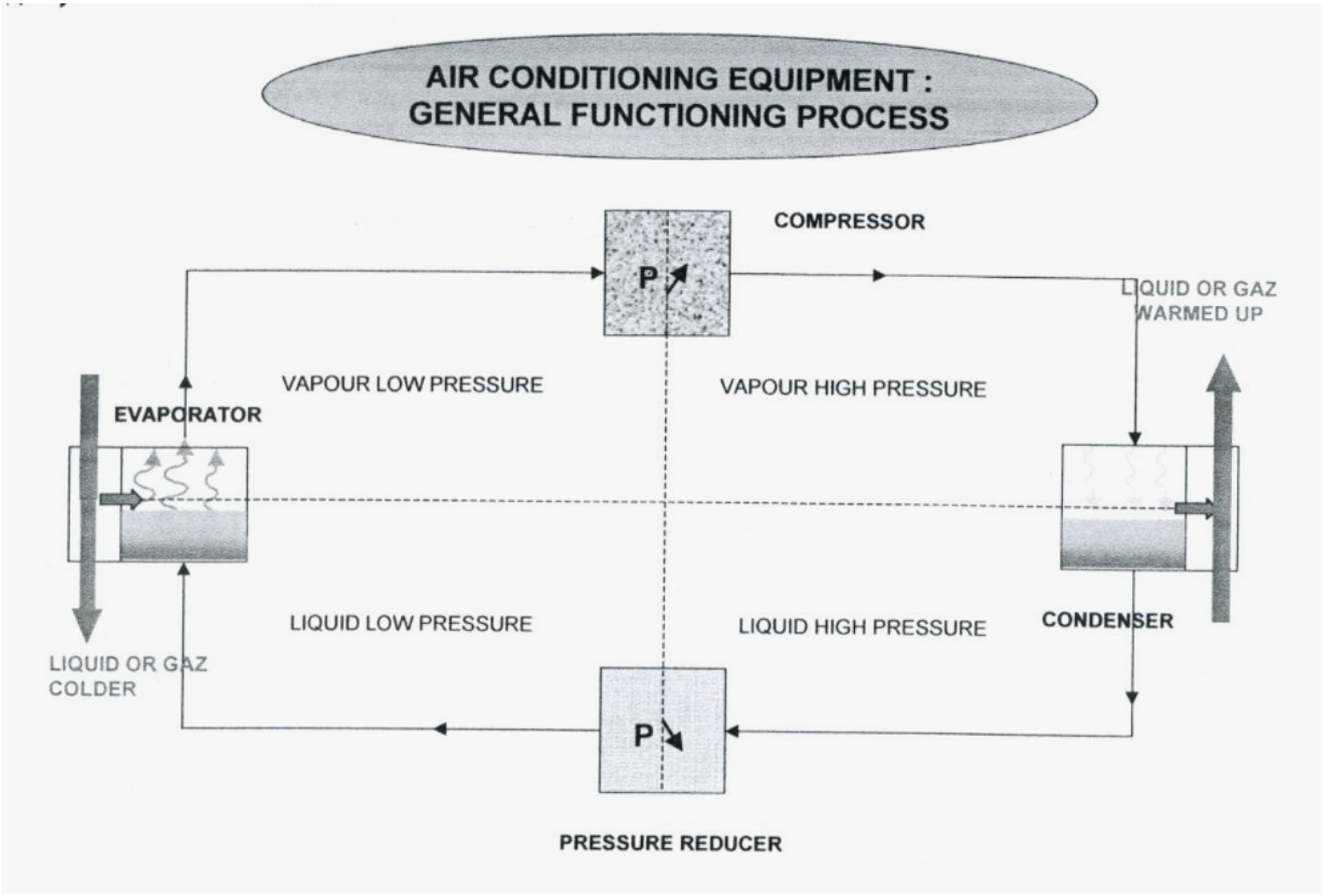
====> Dairy conception

HUMID AIR CARACTERISTICS

- Dry air = 78% Nitrogen
  21% Oxygen
  1% rare gaz (argon, helium…)

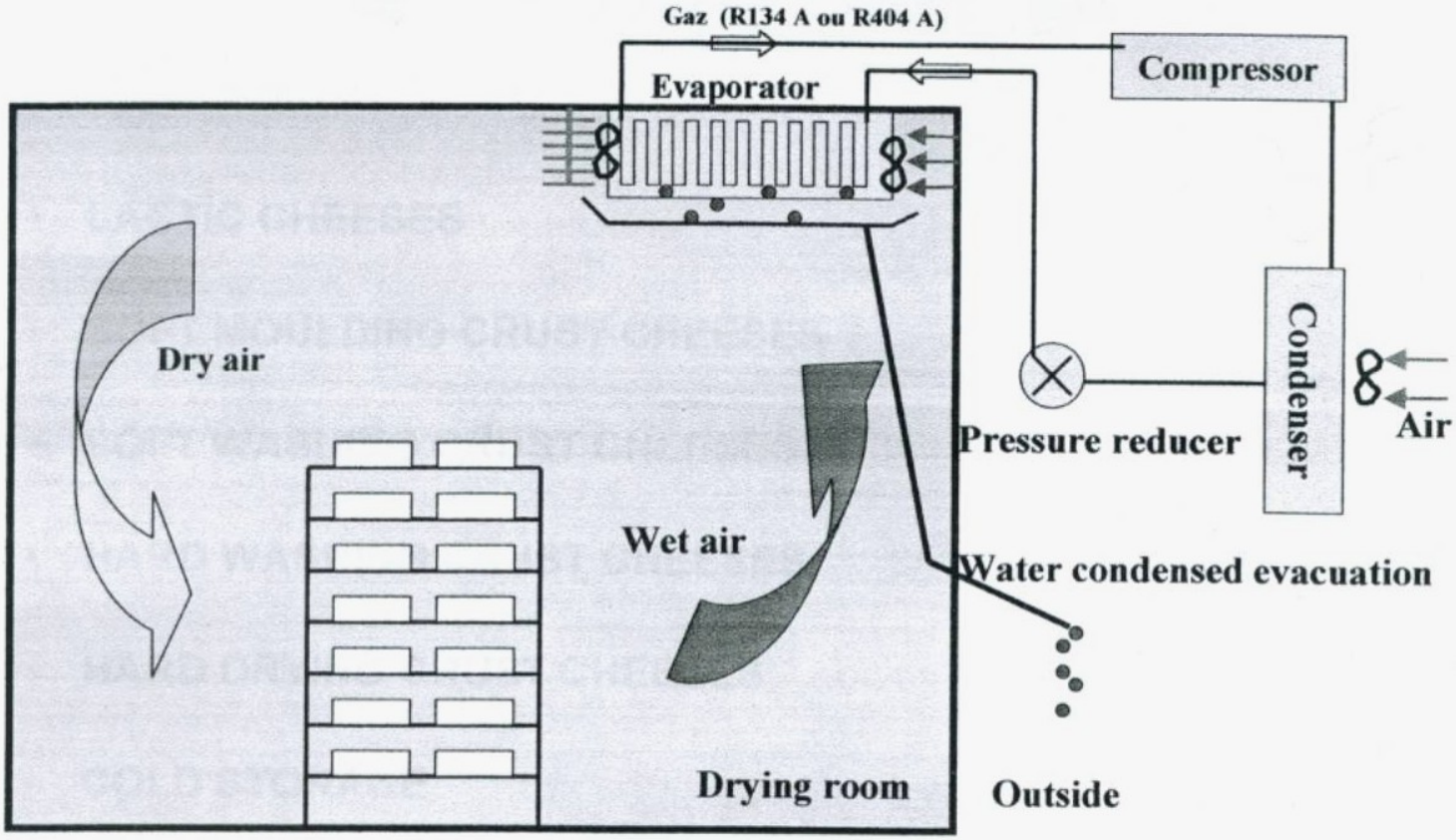
AND VAPOUR WATER according to temperature

- Psychrometric diagram


AIR CONDITIONING EQUIPMENT :
GENERAL FUNCTIONING PROCESS
COMPRESSOR
P
LIQUID OR GAZ
WARMED UP
VAPOUR LOW PRESSURE
VAPOUR HIGH PRESSURE
EVAPORATOR
CONDENSER
LIQUID LOW PRESSURE
LIQUID HIGH PRESSURE
LIQUID OR GAZ
COLDER
P
PRESSURE REDUCER

THE EVAPORATOR

- INSTALLATION MAIN PIECE
- ?t
- STATIQUE EVAPORATOR
- DYNAMIC EVAPORATOR



DRYING ROOM GENERAL PRINCIPLE FUNCTIONING

GENERAL APPLICATIONS

- LACTIC CHEESES
- SOFT MOULDING CRUST CHEESES
- SOFT WASHING CRUST CHEESES
- HARD WASHING CRUST CHEESES
- HARD DRYING CRUST CHEESES
- COLD STORAGE