Why Some Cheeses are Sensitive to Food Safety Problems

WAFP Spring Food Safety Workshop
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Wisconsin Center for Dairy Research

Center for Dairy Research *"Solution Based Research Backed by Experience, Passion and Tradition"*

Factors Influencing Enzyme or Microbiological Activity

- Temperature/time
- pH
- Acidity (And type: acetic, latic, propionic)
- Ionic Strength (salt and mineral content)
- a_w (water activity) and humidity
- Ability to compete in cheese environment
  - Oxygen, nutrient availability, competitiveness
- Initial numbers

Factors Influencing Enzyme and Microbiological Activity

Temperature

- More growth at higher temperature

pH

- Danger if high pH

Salt

- If high, slows ripening

Humidity

- If low, slows ripening

Factors Influencing Enzyme and Microbiological Activity: the BIG 3

Temperature and Time

- 38°F, 45°F, 50°F, 70°F

pH

- 4.4, 5.0, 5.4, 6.4, 6.7

Water Activity (a_w)

- Mostly combination of salt, moisture, and acid content

Water Activity of Various Cheeses

Cheese	a_w
Brie	0.980
Camembert	0.982
Cheddar	0.950
Cottage Cheese	0.988
Gouda	0.950
Gorgonzola	0.970
Parmesan	0.917

Ruegg, M. and Blanc, B., 1981. In “Water Activity: Influences on Food Quality”, ed. Rockland and Stewart, Academic Press, 799.

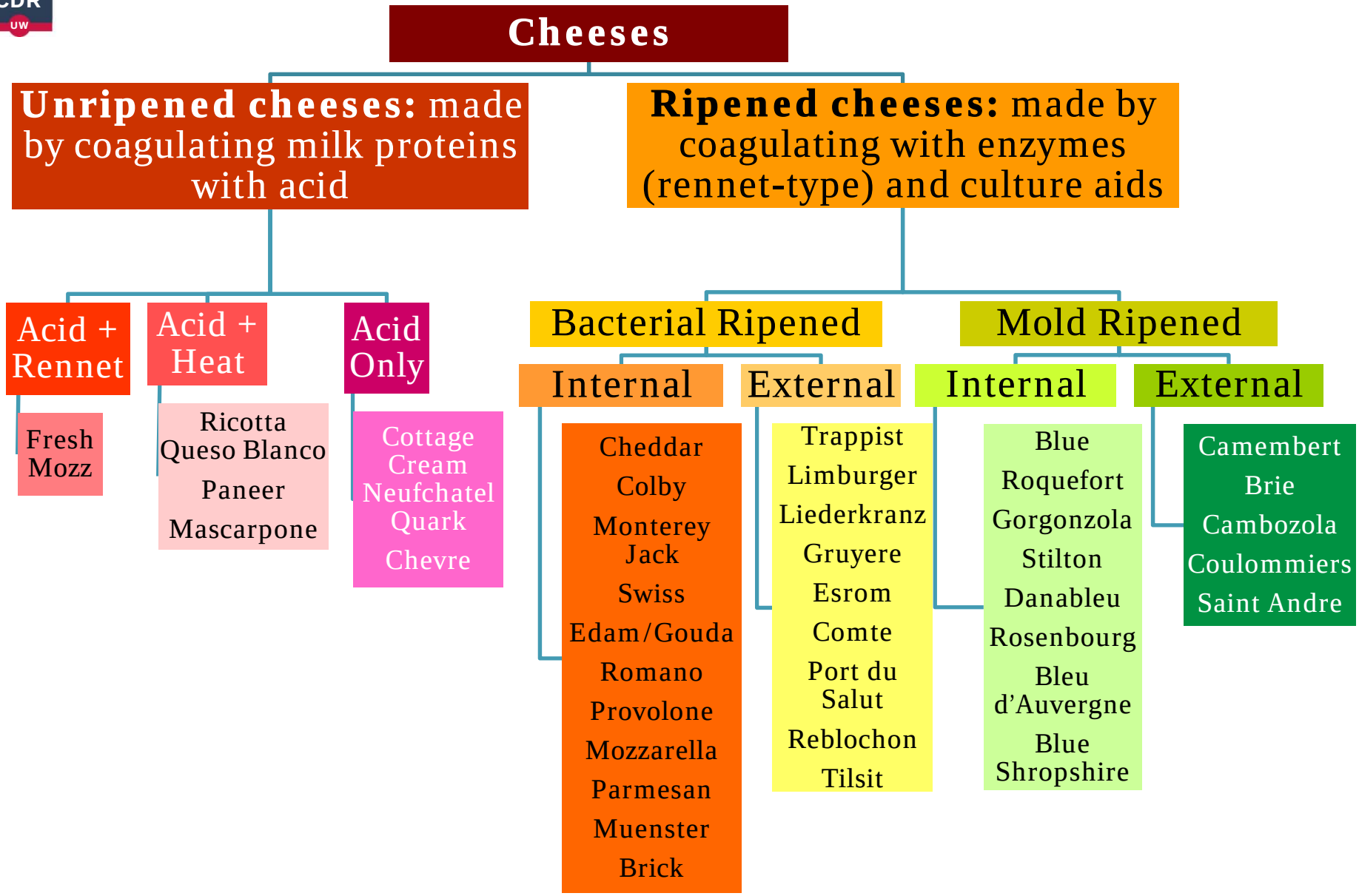
a_w Bacteria Growth Limits

Bacteria	Growth Limit
E. coli	0.96
C. botulinum	0.93*
L. monocytogenes	0.91
S. aureus	0.86
Yeast and Molds	0.65-0.70

*If other conditions are met, such as pH

Source: Food Research Institute, UW Madison

Classification of Cheeses by Type of Ripening



Cheeses Beginning Life at a Very High pH

- Typically no starter culture added
- Cheese coagulated with rennet only

Fresh Latin American Cheeses

- Composition
  - High moisture (46%–58%) – tend to water-off
  - High pH (5.4–6.4)
  - Low or high salt (1.0%–3.0%)
  - Relatively low in fat (18%–25%)
- Commonly (but not strictly) non-melting
- No rind
- Micro issues due to high moisture and pH

Fresh Latin American Cheeses

- Para Frier
- Blanco
- Panela
- Fresco
- Ranchero

Fresh Mozzarella

- Composition
  - High moisture (65-68%) – packaged in slight brine solution
  - High pH (5.40-5.80)
  - Low salt (0.10-1.00%)
  - Relatively low in fat (17-19%)

- No rind
- Micro issues due to high moisture and pH

Ricotta

- Composition
  - High moisture (~77%)
  - High pH (~5.86)
  - Low salt (~0.50%)
  - Low fat (~8.5%)

- No rind
- Micro issues due to high moisture and pH if contaminated in package

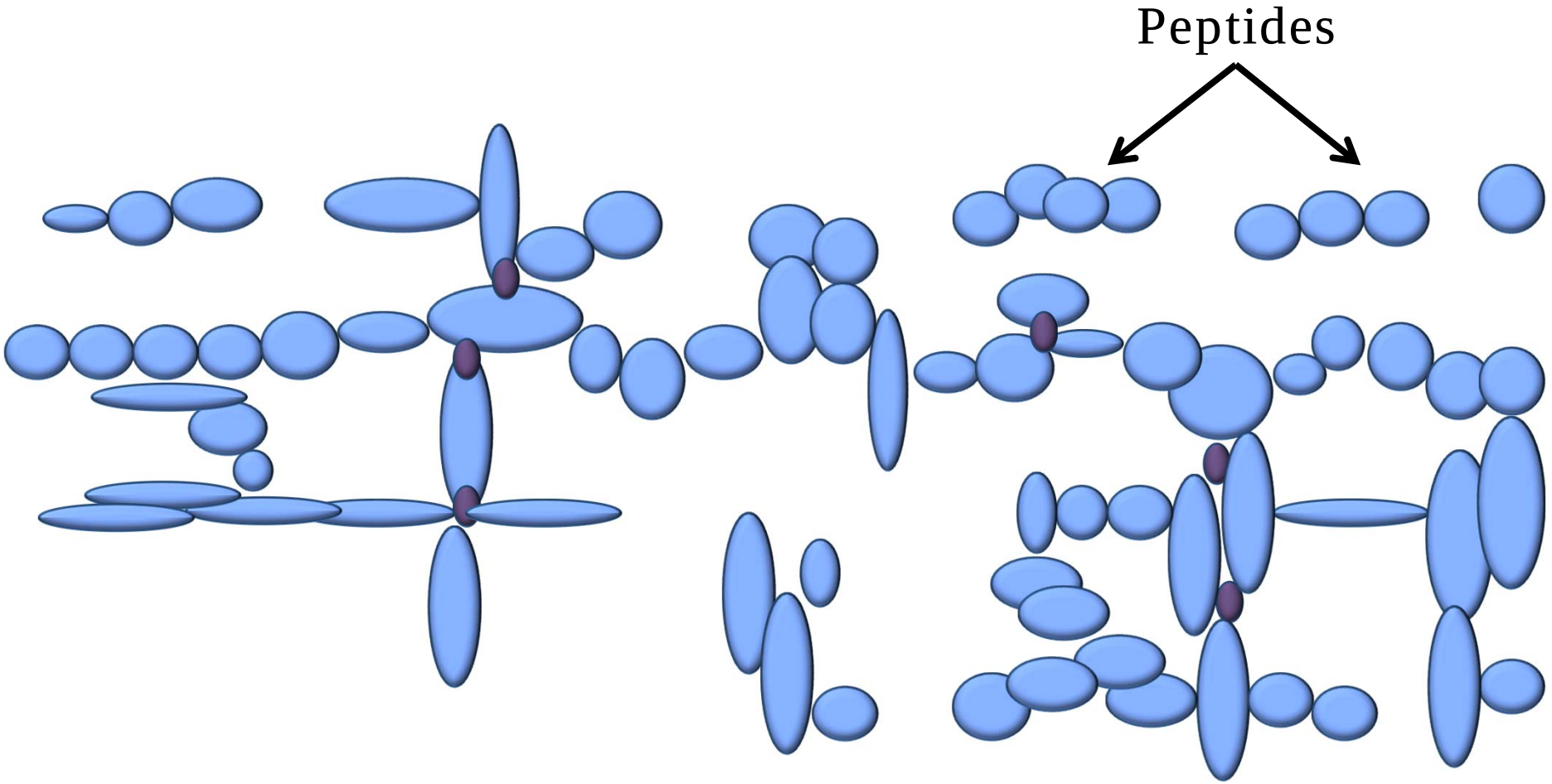
Cheeses Beginning Life at a Low pH, but pH Rises Significantly During Ripening

- Smear Ripened Cheeses
- Blue Mold Cheeses
- White Mold Cheeses

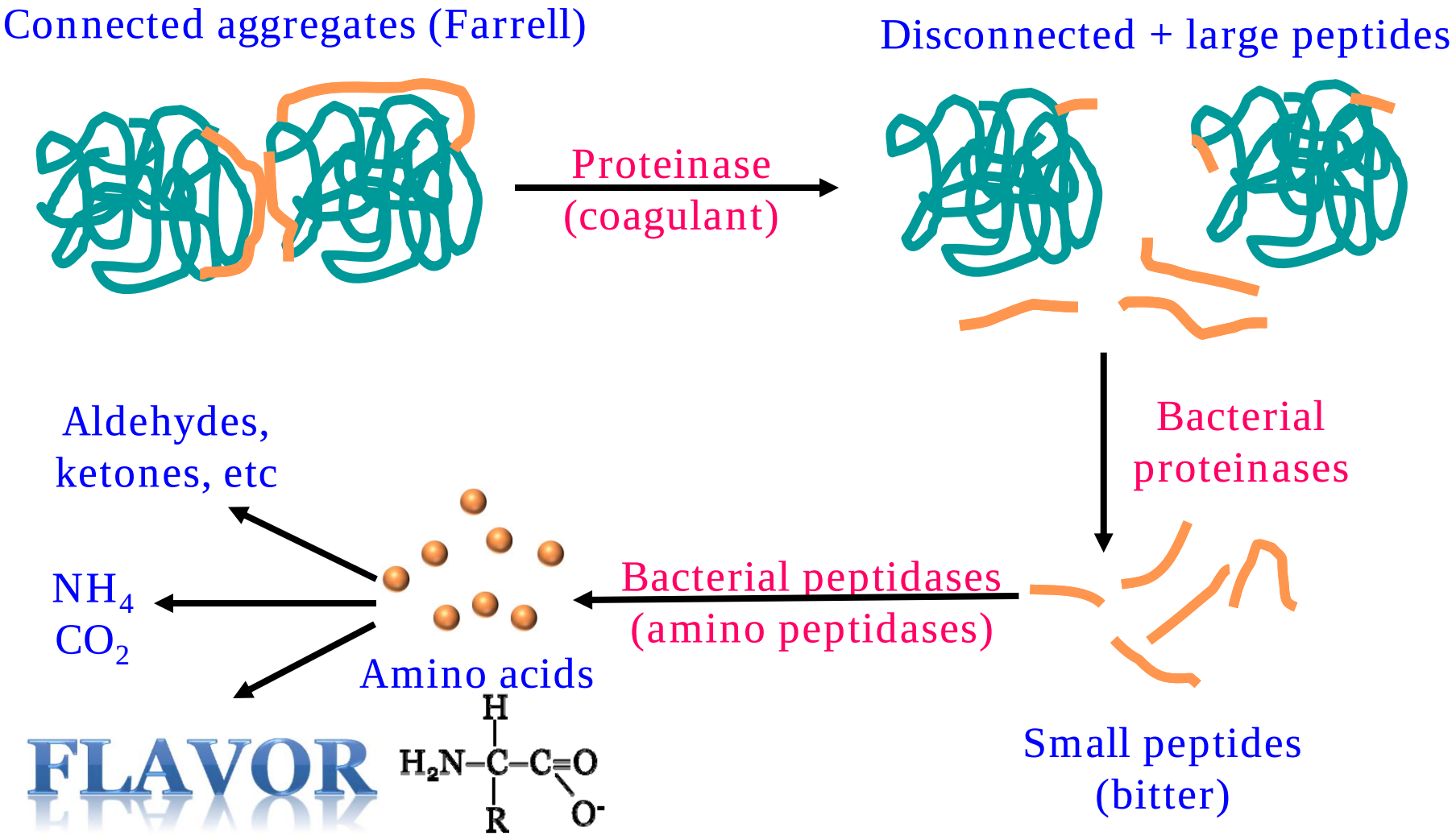
Cheeses Beginning Life at a Low pH, but pH Rises Significantly During Ripening

Degradation of proteins (proteolysis) during ripening, which generates ammonia, neutralizes acid and raises the pH

Proteolysis

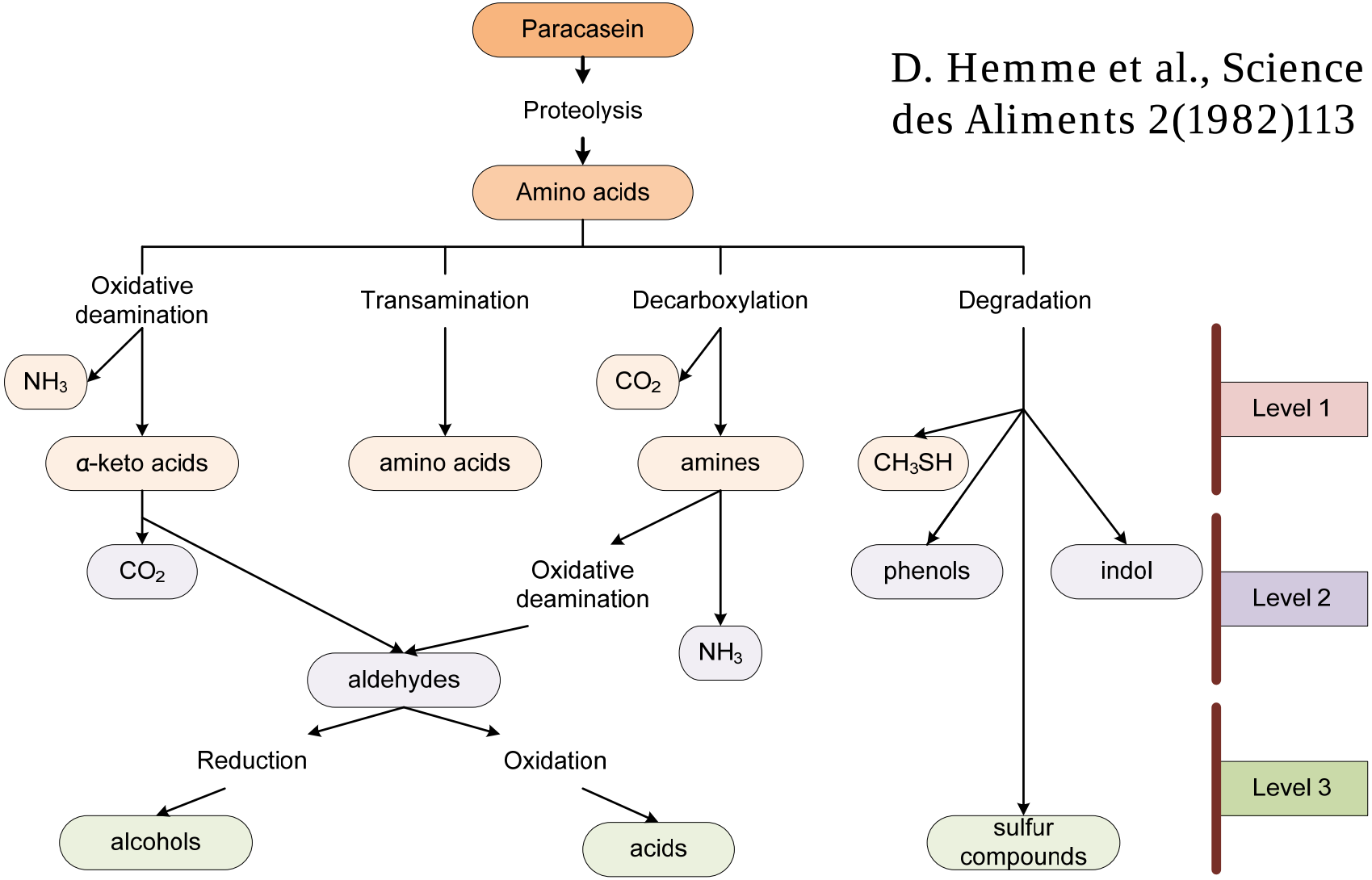


Proteolysis: Breakdown of Casein



Decomposition Steps of Amino Acids During Ripening of Cheese

D. Hemme et al., Science des Aliments 2(1982)113



Consequences of Proteolysis

- Flavor
- Loss of stretch
- Increased melt and oiling-off (fat release during heating)
- Soft, pasty, smoother; shorter body in drier cheeses
- Increase in pH (release of ammonia)

Smeared Brick, Raclette, Gruyere, Limburger, and Havarti

- Cheese comes out of the brine, and is put into the smear room for 4-10 days at 60°F and 95% RH
- Progression of Growth – surface smear
  - 1st Yeast
  - 2nd Micrococci
  - 3rd *Brevibacterium linens*, *Arthrobacter sp.*

Ripening Protocol for Soft Smear-Ripened Cheeses

- Put in cool room (~54°F) overnight
  - pH ~4.9-5.4
- Brine (>18% salt) or dry salt
- Into smear room 7-10 days
  - 96-98% RH, 54-57°F
  - Lower RH favors yeasts
    - Debaryomyces hansenii
  - Higher RH favors bacteria
    - Staphylococci, Micrococcus, Corynebacterium, Brevibacterium linens, Arthrobacter nicotianae
  - Finish with 85% RH to dry surface
  - Optional: wash off smear, then dry
- Package cheese in foil/storage 40-43°F
- 45-55% moisture, pH surface >6.0

Smeared Brick, Raclette, Gruyere, Limburger, and Havarti

First—Yeast:

- Tolerates low pH and high salt concentration at cheese surface. Lactic acid is metabolized to H_2O and CO_2
- Cheese pH starts at 4.8-5.2, then increases to 5.5 and even higher (6.5)
- Vitamins (panothenic acid, niacin, riboflavin, biotin) are synthesized, which are essential for the growth of *Brevibacterium linens*. Yeasts are also proteolytic and stimulate micrococci>

Smeared Brick, Raclette, Gruyere, Limburger, and Havarti

Second—Micrococci Growth:

- *M. freundenreichi*
- *M. caseolyticus*
- *M. varians*
- Very proteolytic, also forms alcohols, volatile fatty acids

Smeared Brick, Raclette, Gruyere, Limburger, and Havarti

Third—*Brevibacterium linens*, *B. casei*, *Arthrobacter sp.*:

- Reddish orange color to smear
- Very proteolytic, but can not grow below pH 5.5
- Produces H_2S (hydrogen sulfide), methyl mercaptan and ammonia (NH_3)
- Limburger is thin and this allows for ripening to occur throughout the cheese, resulting in a cheese with a creamy or almost liquid body
- Brick – flavor compounds diffuse into the cheese from the surface, enzymes do not

Limburger Ripening Room (Chalet)

Comte Ripening Cave (France)

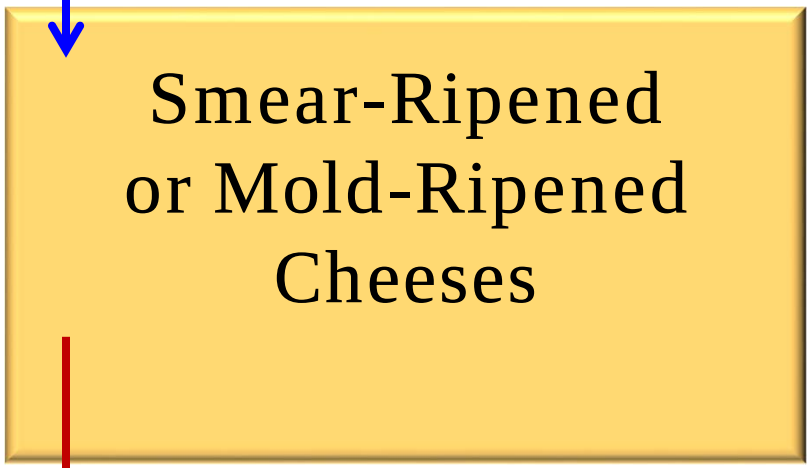
Limburger Cheese

1 Day 5 Days 7-10 Days

Ripening or Curing Process

NH4 Moves In

Proteolysis by smear and molds produces ammonia



Ca and Lactic acid move out

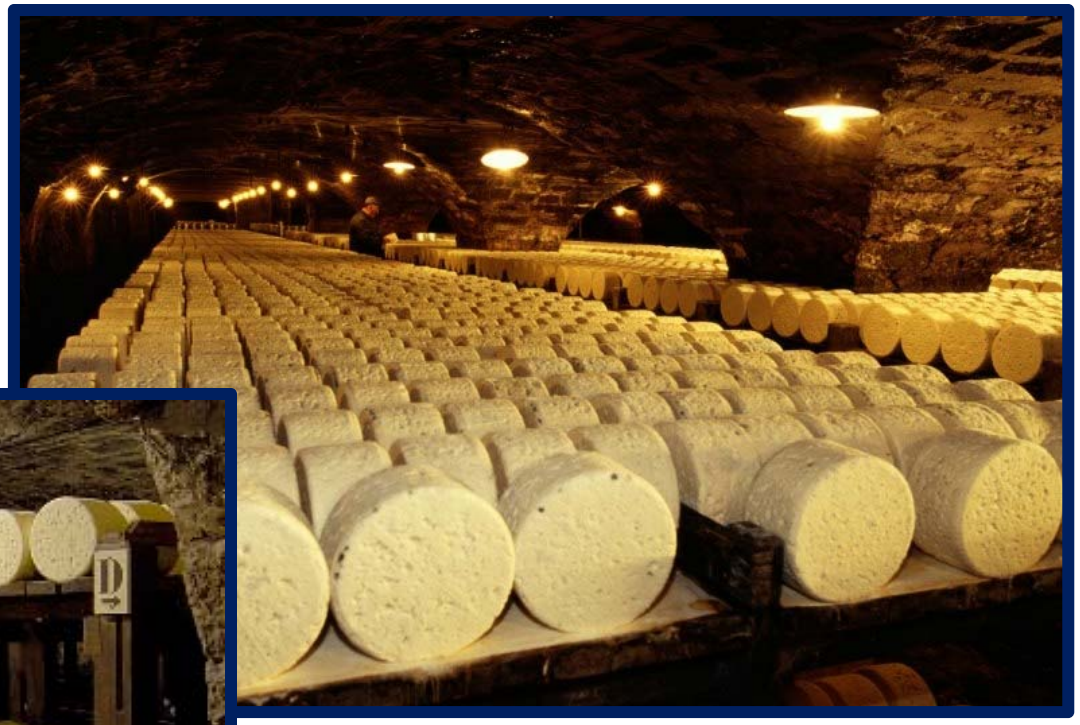
Lactic Acid → CO_2 and Water

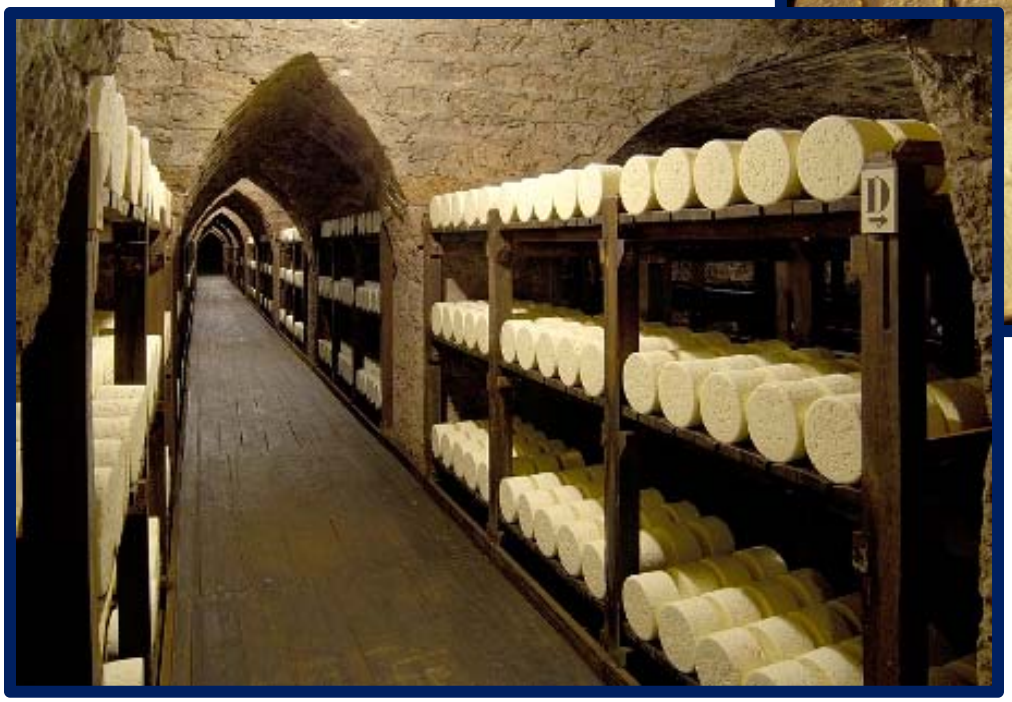
Cheese pH increases from the outside to the inside (4.8 increases to >6.5)

Mold Ripened Cheeses

- In order to ripen all the way through, mold needs oxygen to grow
- Mold spores are added to milk in blue-veined cheeses so cheeses are spiked (punctured)
- Brie and Camembert are sprayed with mold and ripen from the outside to the inside

Blue Cheese Ripening Caves

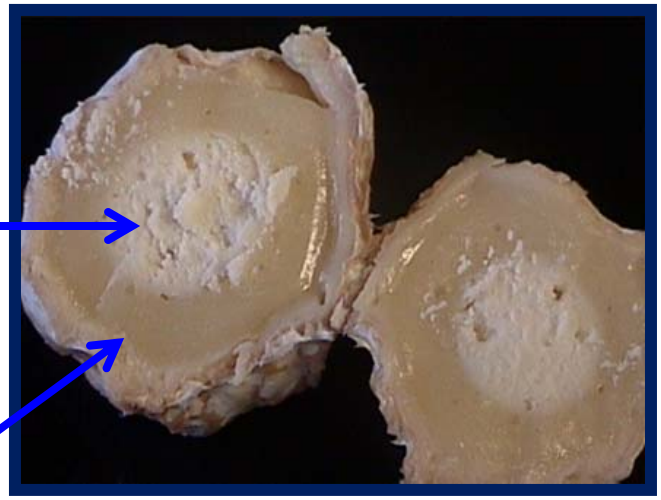




Blue Cheese Puncturing

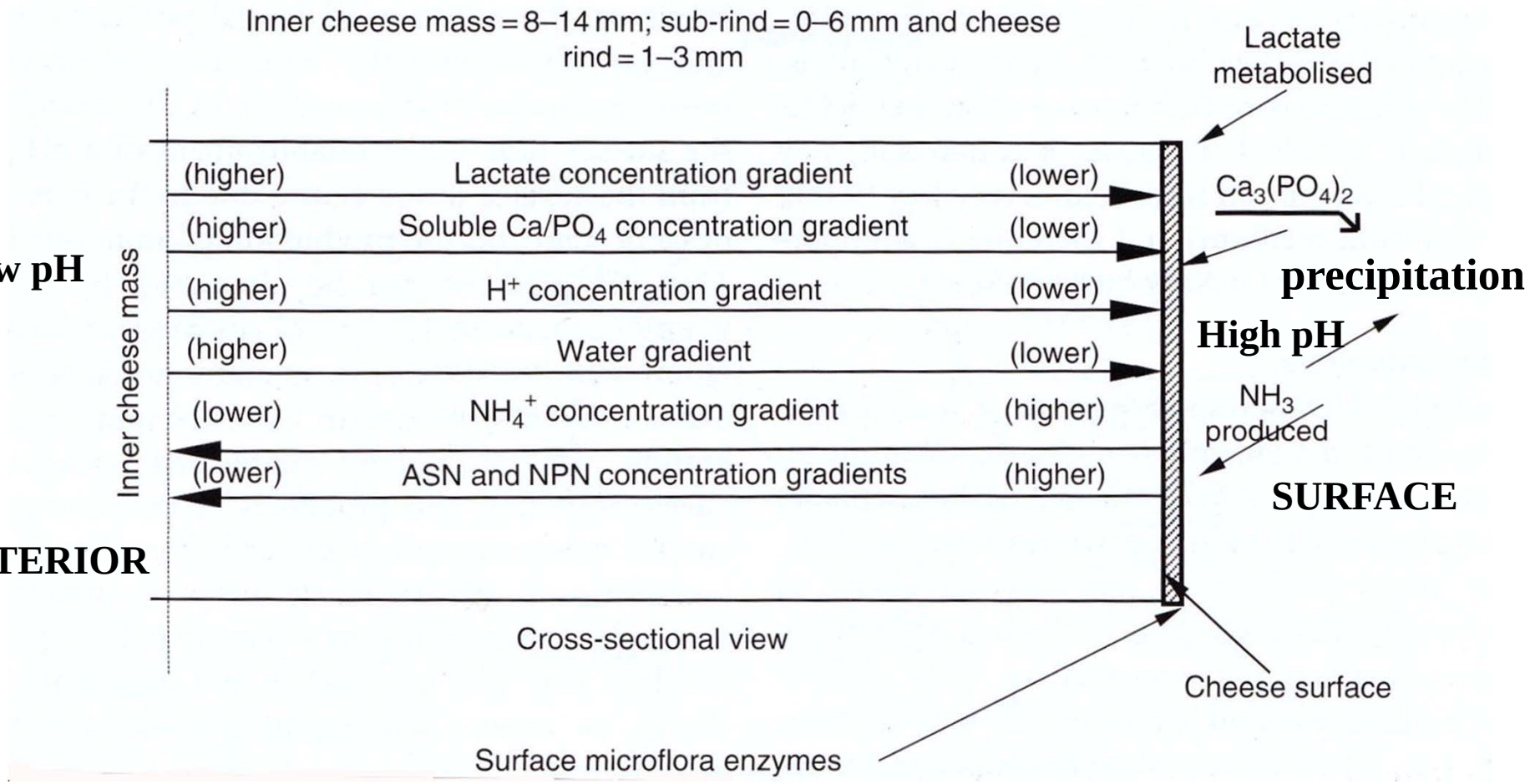
Camembert

Traditional Camembert
(mold ripened)
Penicillium candidum



- Initially he cheese is low pH 4.8
- Body is brittle (now just the center)
- Ammonia leaches into cheese
- Causes pH to rise (6.5) and cheese becomes creamy
- Color changes from bright white to straw (whey)

Gradients in Camembert Cheese



Proteolysis of White Mold Cheese

White Mold Cheese Ripening Rooms

"60-Day Aging Requirement Does Not Ensure Safety of Surface-Mold-Ripened Soft Cheeses Manufactured from Raw or Pasteurized Milk When *Listeria monocytogenes* Is Introduced as a Post-processing Contaminant"

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Thank You

Wisconsin Center for Dairy Research

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