

All Cultures Great & Small

A Microbial State of the Union
Presented on behalf of
The Daphne Zepos Teaching Award

Thomas Perry • American Cheese Society Conference, Des Moines, Iowa • July 30, 2016

In the Beginning...



Lots of microbes

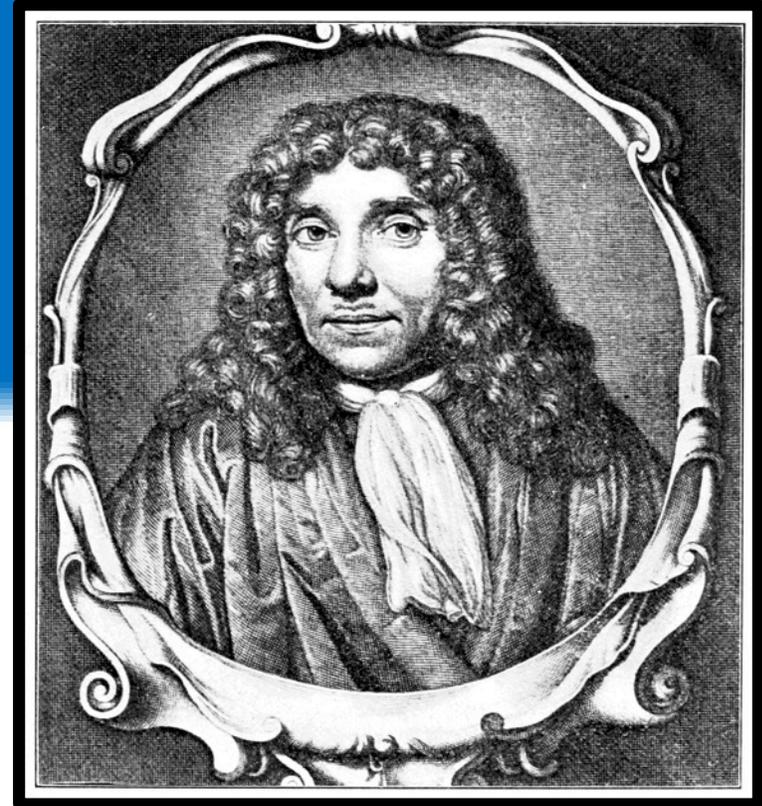


Ancient civilizations had some hard cheeses

A little history...

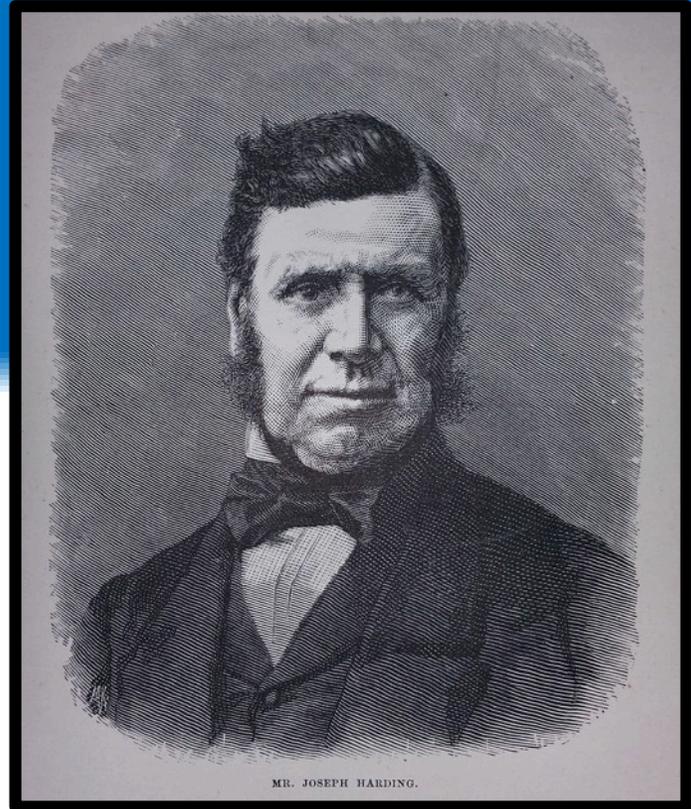


Medieval communities developed
cheeses further

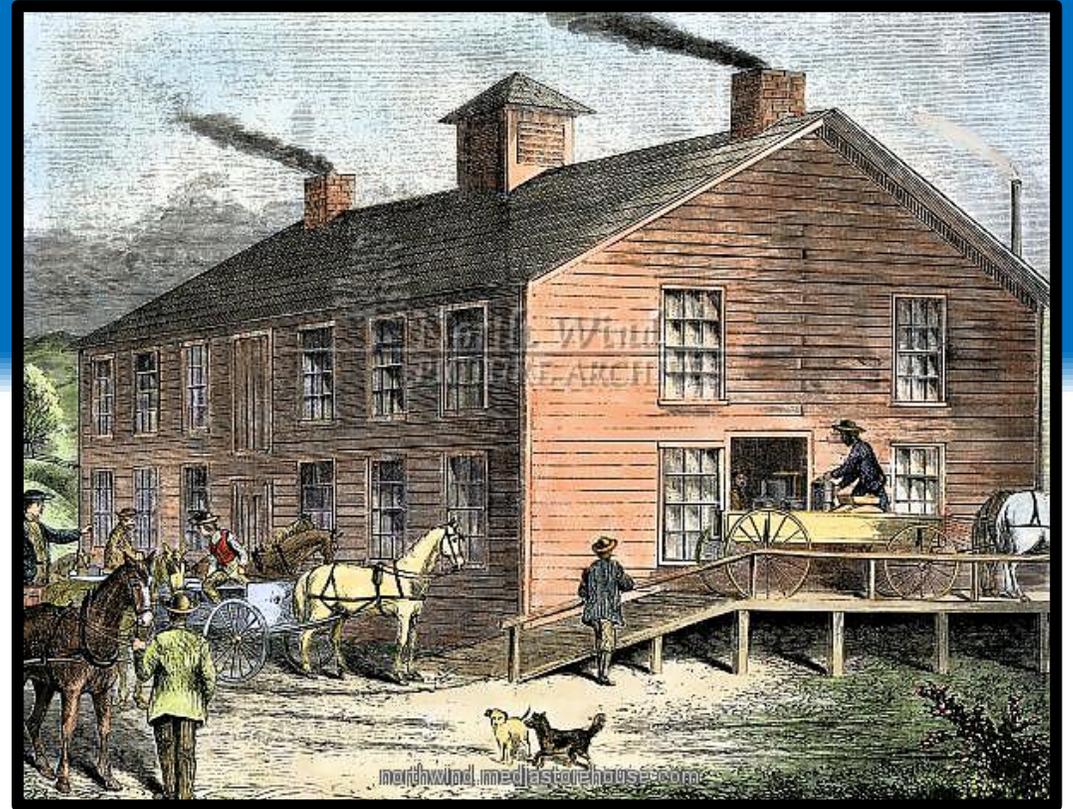


Antoni van Leeuwenhoek
Father of Microbiology

Standardizing the Process...



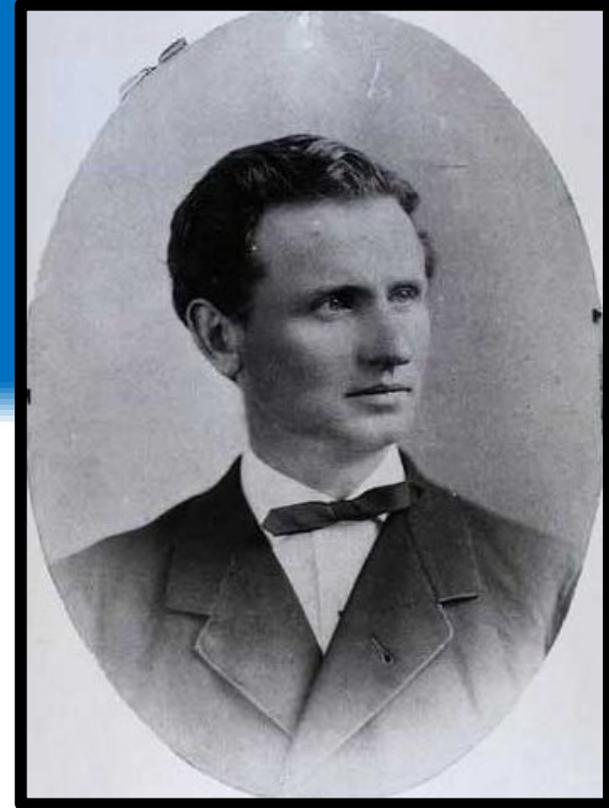
Joseph Harding



Vermont Cheese Factory c. 1860

The Rise of Chr. Hansen...

- First commercial producer of rennet
- 1874: Opens first factory in Denmark
- 1878: Opens first US factory in Little Falls, NY



Christian D. A. Hansen

The Beginning of Cultures...

Hansen Island



- 1893: Lactic Ferment placed on market
- Pasteurization gains more acceptance
- 1916 Flora Danica introduced

The Modern Era...

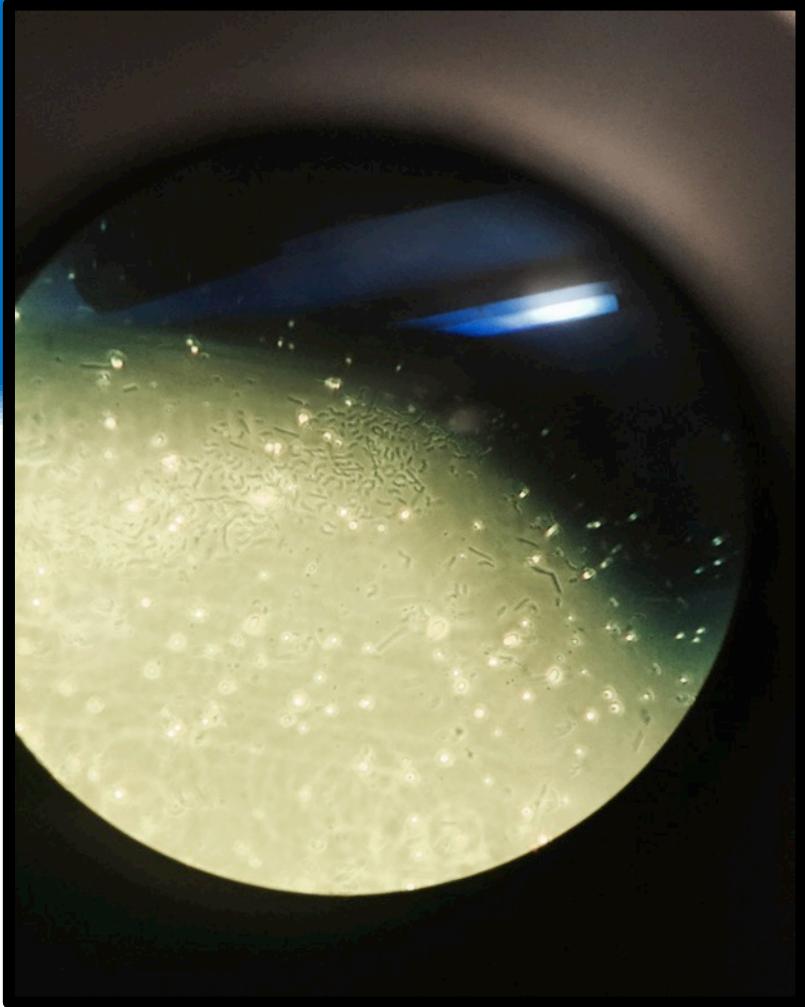


A packet of DVI starter



A modernized cheese factory

The Major Lactic Acid Bacteria...

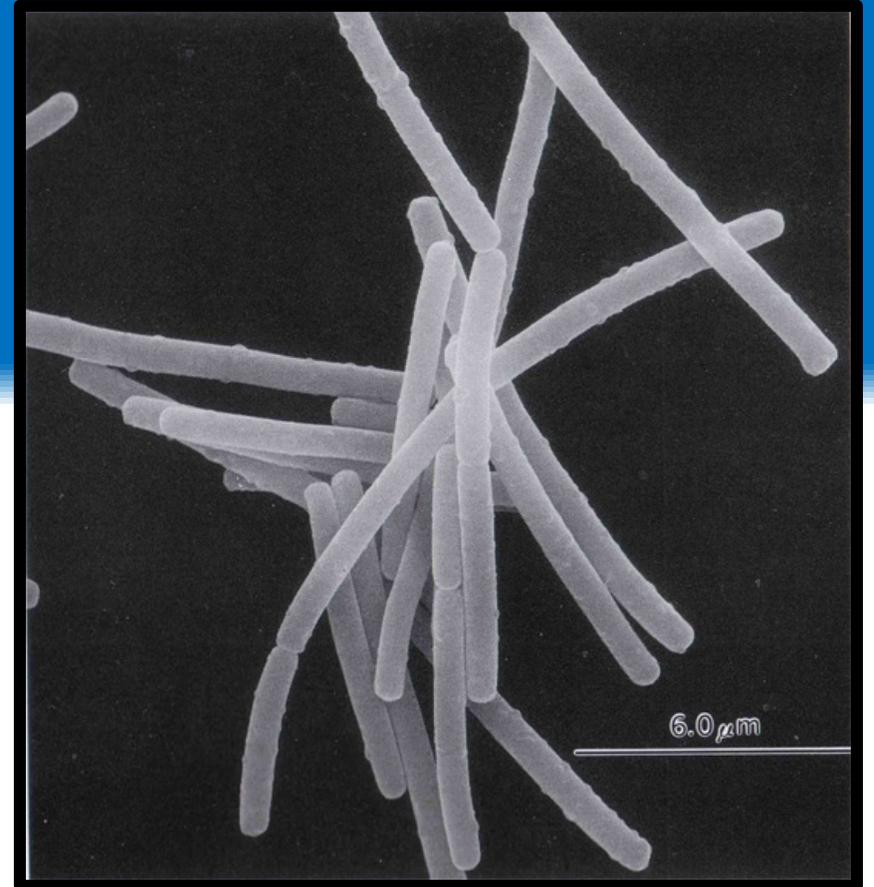


Lactococcus lactis ssp lactis,
Lactococcus lactis ssp cremoris,
Streptococcus Thermophilus,
Lactobacillus helveticus
Lactobacillus delbrueki ssp bulgaricus

- Drive acidification and contribute to future flavor and texture development
- Primarily aged out after 72 hours almost undetectable after 1 week

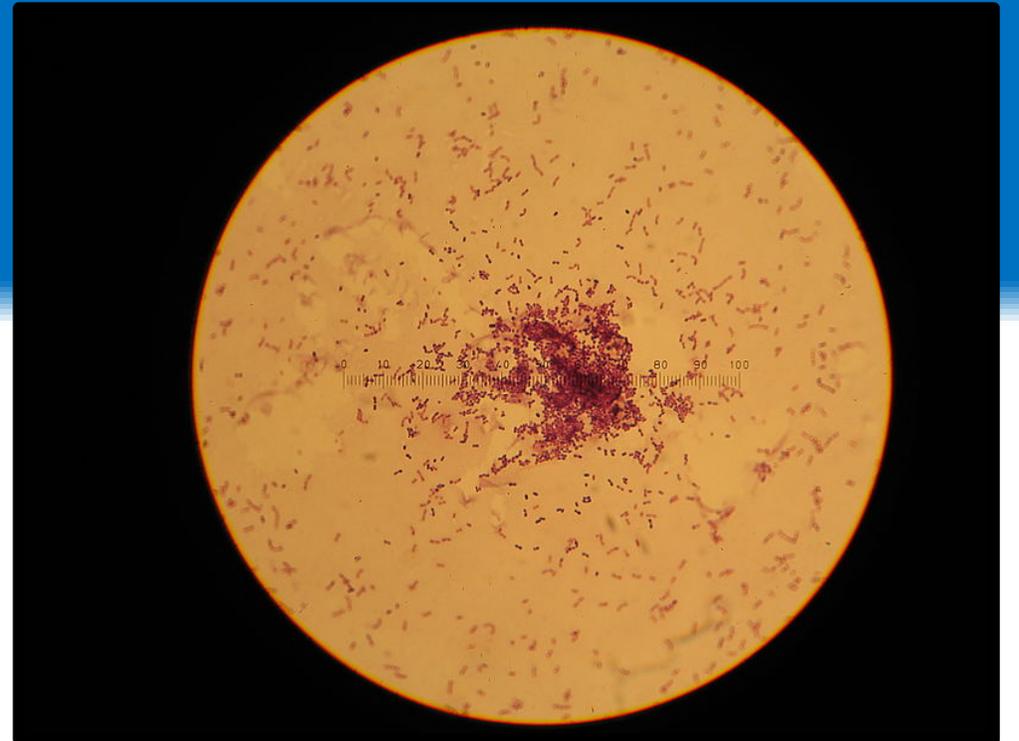
Thermophilic...

- Streptococcus Thermophilus
 - Lactobacillus Helveticus
 - Lactobacillus bulgaricus
- Thrive from 40 - 60 C.
- Activated during cook phase



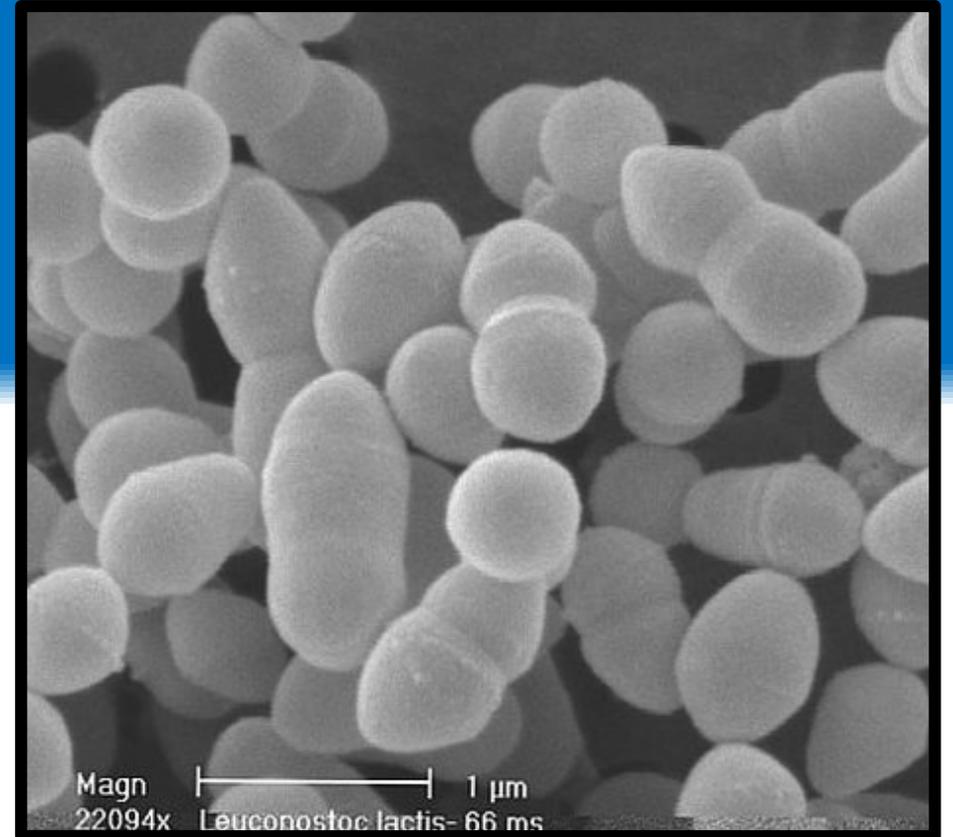
Mesophillic...

- *Lactococcus. lactis* subsp. *Cremoris*
 - *Lactococcus* subsp. *Lactis*
 - Thrive from 25 to 37 C.
 - Drivers of all acidification
- Official state microbes of Wisconsin

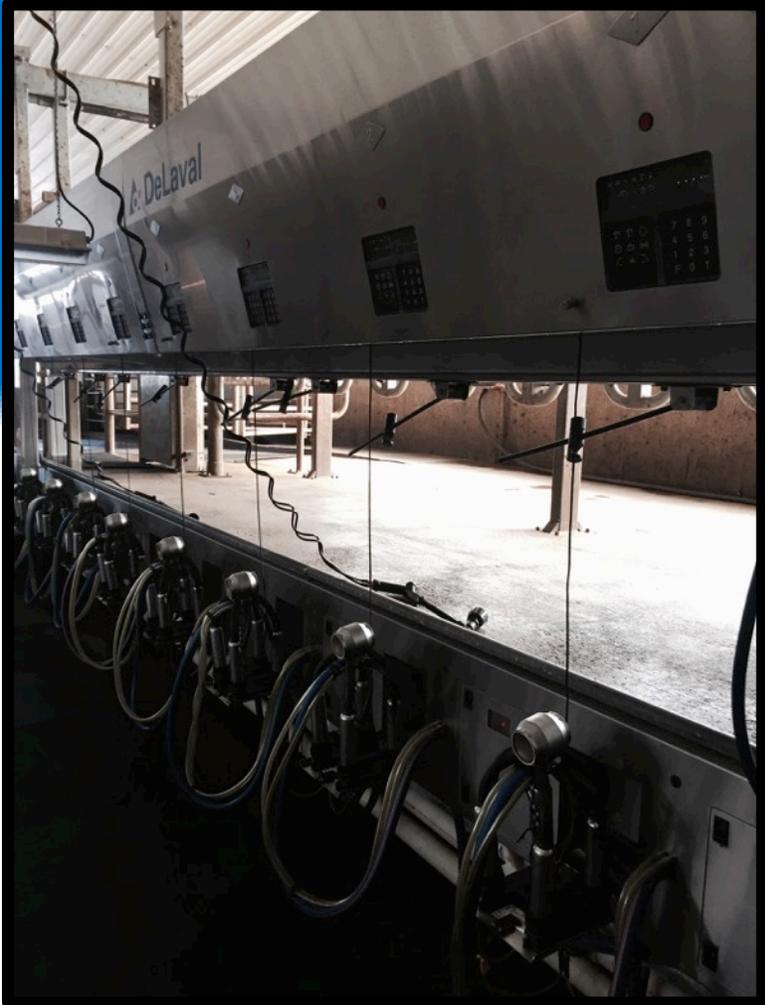


Psychrotrophic...

- Leuconostocs
- *Pseudomonas lundensis*
- Thrive in temperatures of 4 C and below
- Can ferment lactose but not very much
- Primary group of LAB in milk today



Lactic Acid Bacteria & Milk...



- In modern dairy, traditional LAB account for $< 1\%$ of microbial activity in milk
- Increase in sanitation = decrease in microbes
- In most cheeses, commercial cultures are dominant

Finding New Microbes...

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CCTACGTACCGTTCGGTACTGGTAACGTC  
CGGATAATTAACAGATACACACCCTTAG  
TCTTTCCAGGCACTGACAGATAGACAGA  
AATCTTGGCAGTCGTAACGTACGTACGC  
GTGACTGATTACCAGGATCCTAGCGGAT  
TGTTCAACTCGATGACTAGAATATATCCA  
GTAACGTACGTACGGTACTGGTAACGTG  
CGTGACTGATTACCAGGATCCTAGCGGA  
TTGTTCAACTCGATGACTAGAATATATCC  
GCAAATTCAGTCGGTACGTTTCCAGGCT  
RLYHAIRGCCCTTGAATCTTGGCAGTCG  
GAGGAATGGGCCCTACGTACCGTAACGT  
CACTGACAGATAGACAGATTGTCGTGT
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Genomic Sequence



DNA sample sequencing robot

France: Some Background...



Comte, first modern AOC cheese



INRA Poligny

At The Comte Dairy...

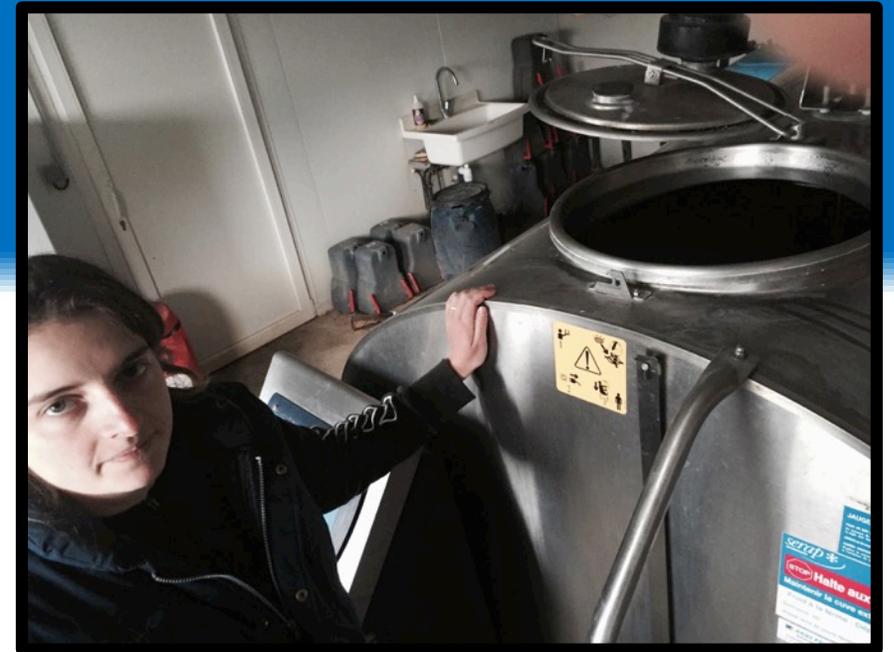


- Only grass, hay and a bit of grain make up the Montbaillard cows diet
- Herd size is determined by the amount of land available per cow
- Comte must be made by milk from several dairies

Milk Quality & French Cheese...



Montbaillard cows out on pasture

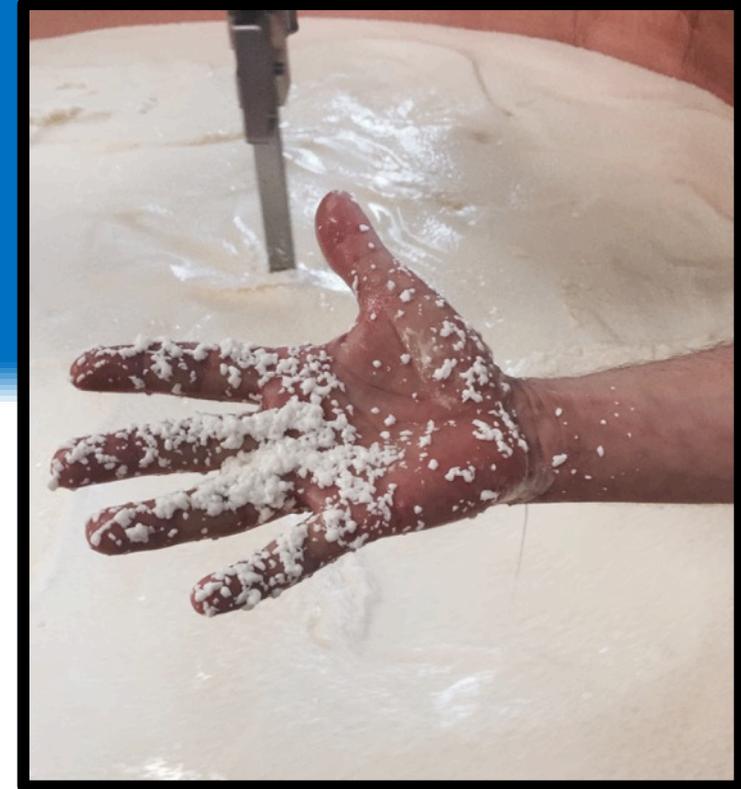


The holding tank for milk

At The Fruitiere...



Adding the cultures



Evaluating the curd

Aging the Comte...

- Affinage methods have changed
- Unique microflora of aging facilities are part of the success
- Comte is different now from 100 years ago



Fort St. Antoine

Switzerland: A Little History...



On a Swiss mountain



Different Association cheeses

The Role of Agroscope...



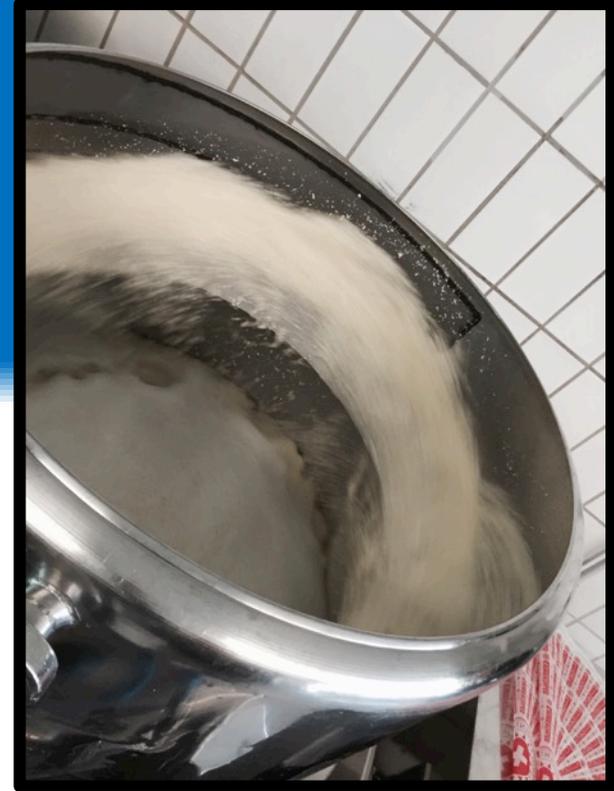
The Liebfeld Campus

- 1901: Experimental Dairy established
- WWI forces Swiss to become more self-reliant
- Funded by state and Associations
- Supply all cultures used by Association cheesemakers

The Swiss Dairy...



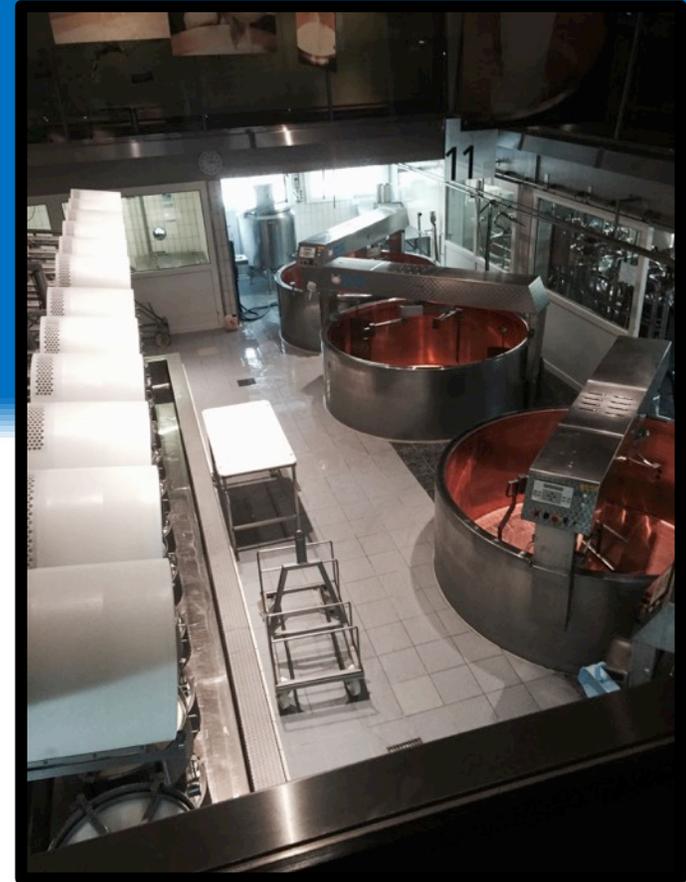
Receiving milk from neighbor farms



Modern efficient cheese technology

Gruyere Production...

- Cheesemaker decides upon farmers
- Evening milk held overnight in copper vats at 15 to 18C
- LAB derived from incubated whey
- Have proprietary cultures

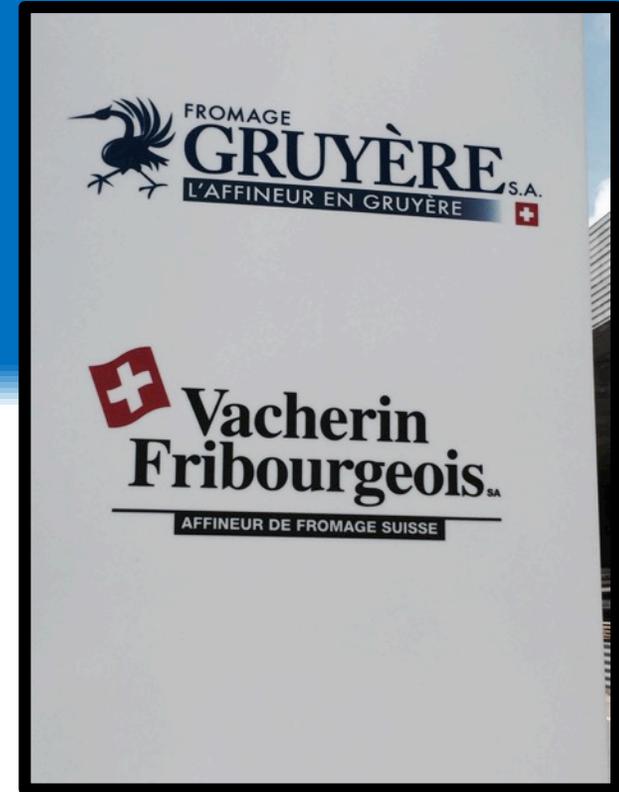


Gruyere Show Dairy, Pringy

Aging Gruyere...



Aging Gruyere at Production Facility



An Affineur in Bulle, Switzerland

Emmental Production...



Kaserei Hupfenboden

- Made from fresh raw, skimmed milk
- Cultures supplied by Agroscope
- Skim milk is inoculated the night before with cultures
- Slow Food Emmental also uses cultured whey as was done in the past

Aging Emmental...

- Two stage aging process
- Dry cellar at 75% humidity & 30 C
- Held in dry cellar for 2 months to encourage propionics
- Transferred to a more humid cellar at 15 C for rest of aging process



Fort St. Antoine

Current State of Emmental...



Cultures from Agroscope

- Naturally occurring propionics in decline
- Cleaner milking practices and introduction of state cultures responsible
- Takes 2 to 4 weeks longer to achieve same amount of eyes
- Cheesemakers reticent to add more propionics

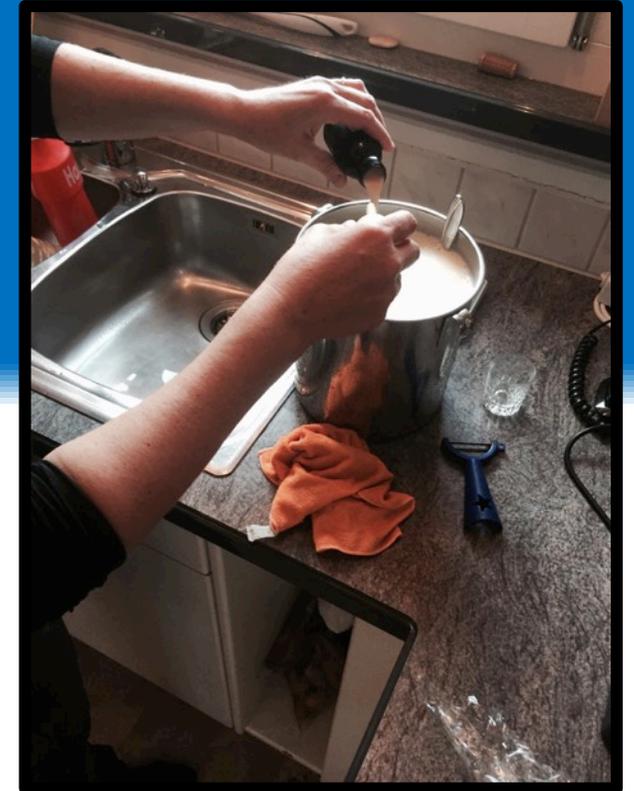
Challerhocker...



Removing cheese from
the press



The different
cheeses from
Kaserei Turfischwil



Making the yogurt
culture

England: A Look Back...



English sensibility



London during the Blitz

Milk Marketing Board & Decline...



Reading Milk Marketing Board
c. 1940's

- 1930's: Milk Marketing Board established
- Traditional cheesemakers switched to fluid milk production.
- Early 1980's: MMB dismantled by Thatcher Government

Neal's Yard Dairy & Renaissance...



Randolph Hodgeson of Neal's
Yard Dairy

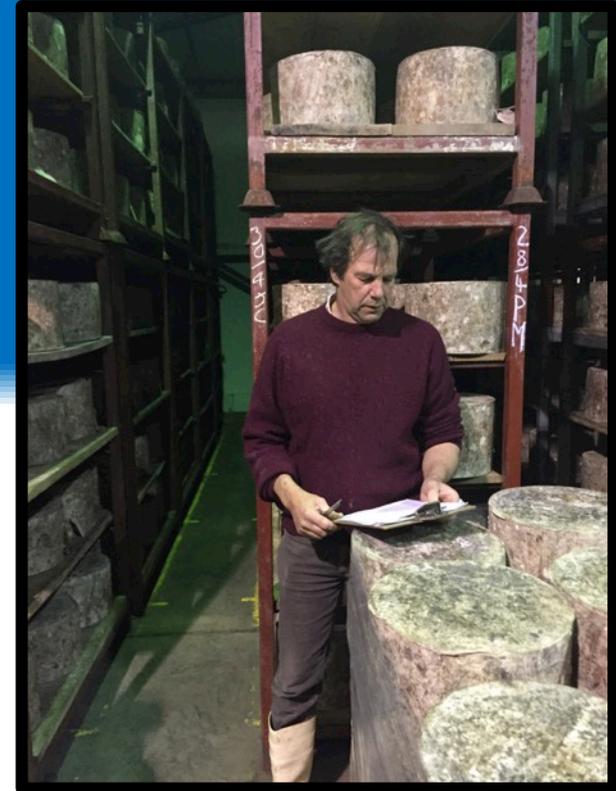


Base 1 Samples at Barber's

The English Make & Cheddar...



Cheddar Make at Quicke's
Devon, England



Jamie Montgomery & stores of West
Country Farmhouse Cheddar

Lancashire & Stichelton...



“Microcheddaring” of
Lancashire

- Both rely exclusively on MT36 culture
- Both very slow and drawn out makes
- Both use minimal amounts of starters
- Both minimally agitated

Aging English Cheese...

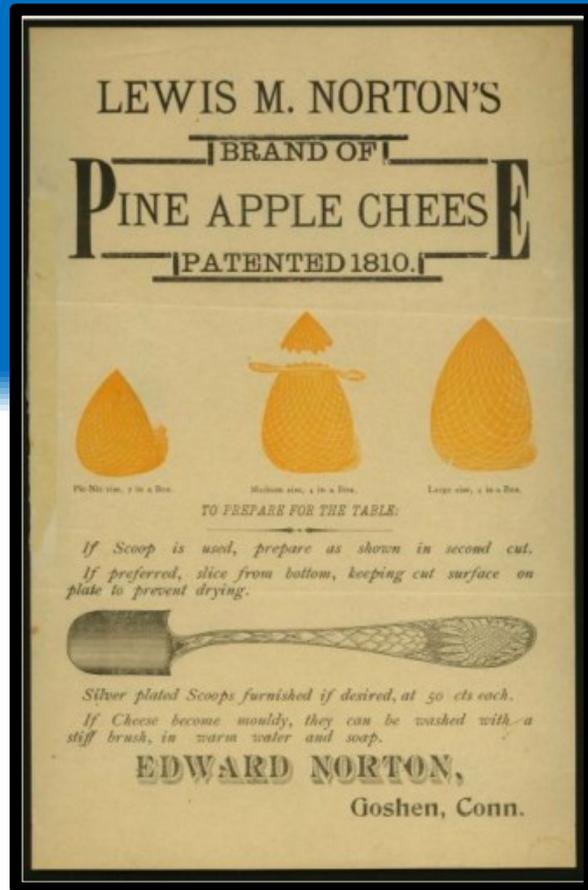


Neal's Yard Dairy
Borough Market



Hard Cheese Aging at
Arches Facility

The United States: US History 101...



The Pineapple Cheese Guide

- Traditions based off of successive waves of immigration
- Cheshire was most common style made in Colonial era
- Pineapple cheese was most popular until the rise of cheddar in the 1850's
- WWI leads to birth of Kraft processed cheese

Artisan Rebirth...



Ig Vella



Vermont
Creamery



Cato Corner
Farm

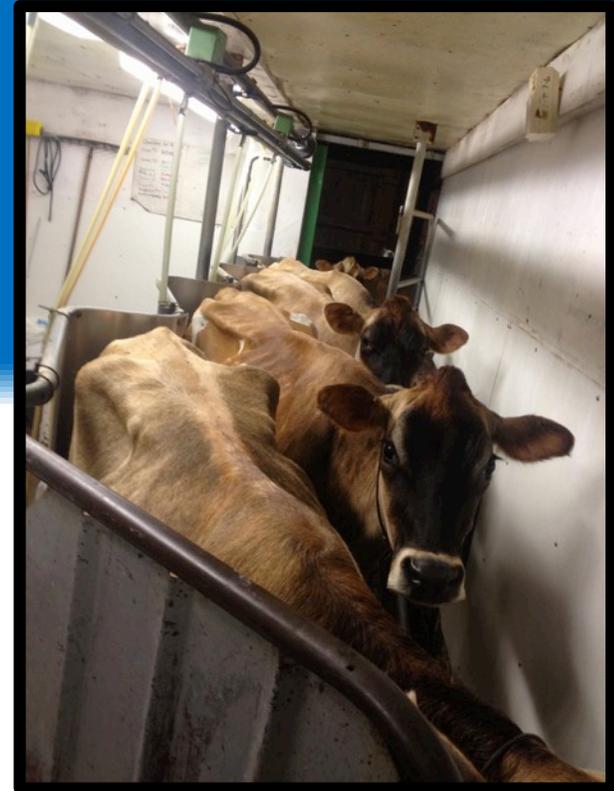


Jasper Hill
Farm

Microbial America...



Chr. Hansen Culture Plant
Milwaukee, Wisconsin



Milking parlor at
Cato Corner Farm

Wisconsin...



Andy Hatch, Uplands Cheese



Bandage-wrapped cheddar
at Bleumont Dairy

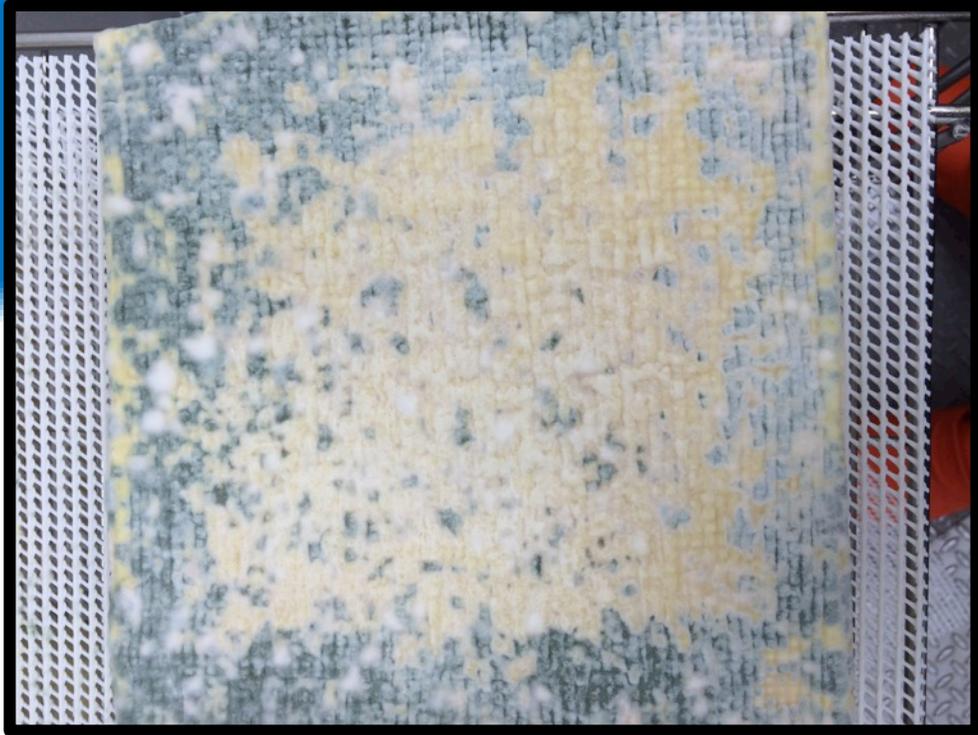
Abbey of Regina Laudis...



A piece of Bethlehem Cheese

- Uses no commercial starter cultures
- Uses wooden tools and relies on biofilm
- Has had every type of make failure occur
- No commercial strains of Geo allowed
- Biodiversity and encouragement of native flora most important to her

Mystic Cheese Company...



Sea Change rind development

- Makes cheese in custom shipping container
- Doesn't own the cow. Pays for milk.
- Pushes cultures to their limits
- Consistency, high quality & yield most important
- Uses modified strains to prevent spoilage

Parrish Hill Creamery...



The four different housemade cultures of Parrish Hill

- Developed own bulk starters from the herd they obtain milk from
- Believes in making as many components as possible
- Is attuned to the potential of the starters they use
- Take inspiration from tradition but doesn't copy

Jasper Hill Farm & Cellars...



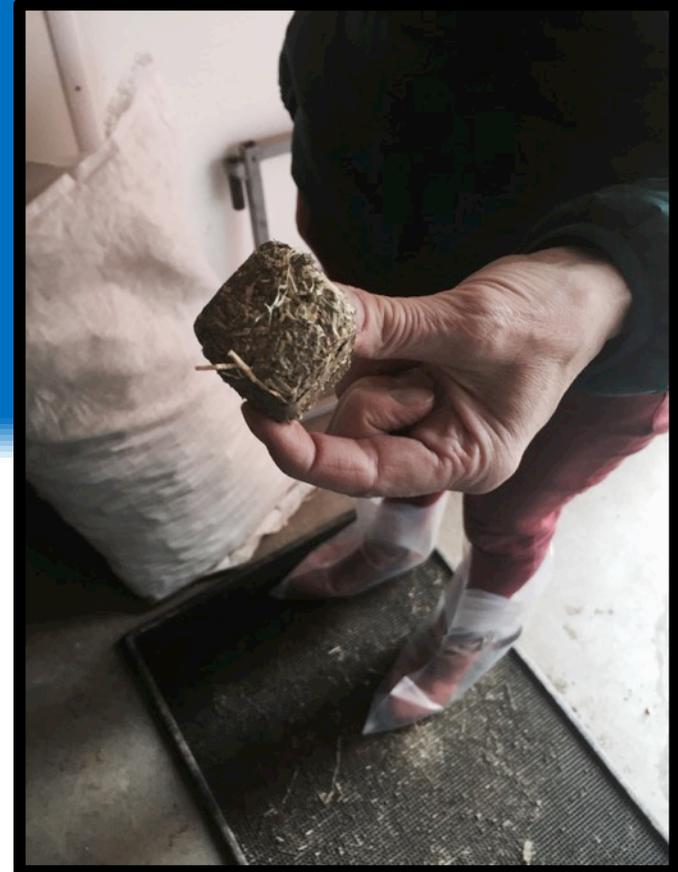
Wheels of Alpha Tolman aging
in the Cellars

- Wide range of cheeses that require specific aging environments
- All milking practices designed to make Winnimere
- Staff microbiologist is helping isolate microbes unique to farms and cellars.
- Milk source is very clean

Vermont Butter & Cheese...



A goat at the Ayers Brook
Farm



The custom feed for Ayers Brook

Survey Results...

- Over 60% make raw milk cheese
- Majority of cheesemakers hold milk at 41 F or below worldwide
- Over 95% of respondents would like to have their milk or aging facility analyzed.
- Over 2/3rds of cheesemakers would eventually share any new or unique microbes found in their milk or environment
- Over 2/3rds of cheesemakers think that their region produces a unique flavor profile

Steps To Consider...

1. Safety is number 1 priority
2. Talk with scientists and academics
3. Reconsider herd size, maintenance and analytics
4. Take another look at the animals diet
5. Change milk priorities
6. More official state certifications
7. Make your own bulk starters
8. Be mindful of aging practices
9. Notice our effect on microbial evolution
10. Be prepared for not having access to newly found strains

Conclusion...

- No one way to make and age cheese
- The majority of LAB discovery has been done.
- Cheesemaking is safer than it has ever been
- Culture houses have everything needed so long as it's economically viable
- More independent research is needed
- Swiss & French know on a cellular level what makes their cheeses their own
- Will take many years to develop our own microbiological heritage

Thank you...

The DZTA Board, Rachel Juhl, Robert Aguilerra, Jess Perrie, Emily Shartin, Dave Potter, Dupont/Danisco, Chr. Hansen, Andy Hatch, Willi Lehner, Yoav Perry, Brie Hurd, Brian Civitello, Sister Noella, Peter Dixon & Rachel Schall, The entire team at the Cellars at Jasper Hill, Mateo Kehler, Allison Hooper, Adeline Druart, Seacrest International, Carlos Yescas, Gourmino, Jonathan Richardson & Adam Moskowitz, Walter and Anelise Raess, Dr. Ernst Jakob, Laure Rousseau, Marcel Petite, The entire team at Neals Yard Dairy, Bronwen Percival, David Lockwood, Chris Griggs, Charlie Barber, Jamie Montgomery, George Keen, Tom Chatfield, Mary Quicke, Patrick Holden, Graham Kirkham, Joe Schneider, most of my airbnb hosts, Potash Markets, The Chicago Cheese Collaborative, and most importantly, my wife Mary Wozniak.