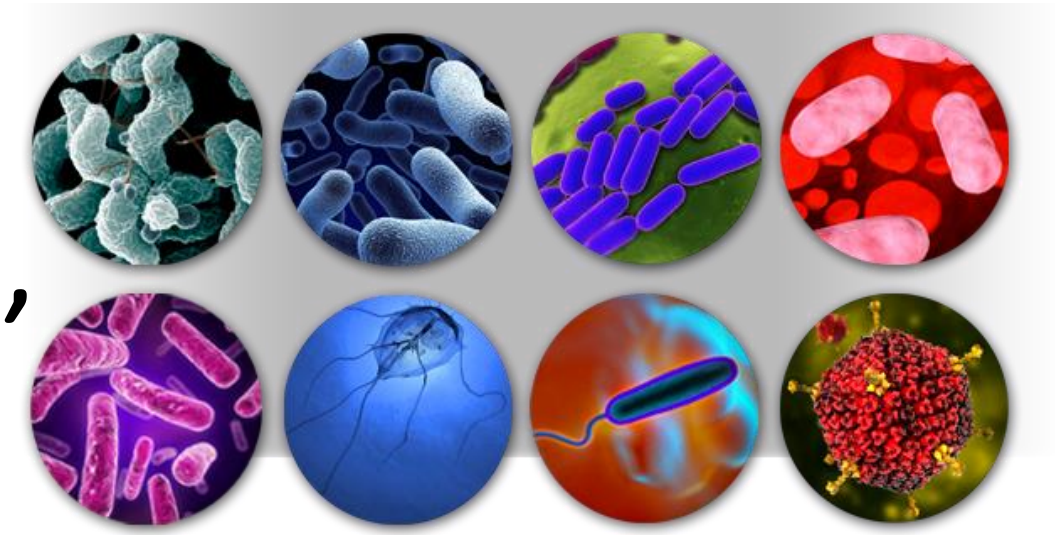
Milk microbiology, cleaning and sanitation, and shelf life



Learning Objectives

- Microorganisms of significance in milk and dairy foods
- Sources and control of undesirable microorganisms
- Effective cleaning and sanitation principles and practices
- Ensuring product shelf life

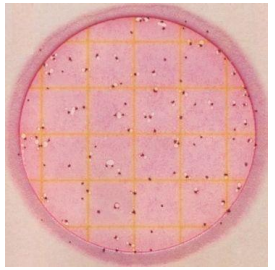
Raw Milk Microbiology

Types of microorganisms (beneficial, spoilage, pathogenic)

- Bacteria
- Yeast & Molds (Fungi)
- Viruses

- **Standard Plate Count (SPC**) of raw milk can range from <1,000 colony-forming units (cfu) per ml to >1 million (10^6) cfu/ml.
- SPC values less than 20,000 cfu/ml reflect good sanitary practices on the farm.
- **Lab Pasteurized Count (LPC)** gives indication of thermoduric microorganisms present

Bacteria of significance in milk



Coliform bacteria

- Gram-negative bacteria; also psychrotrophic. Presence of large numbers can induce swelling of cheese, pin holes and off flavors. Some strains of *E. coli* can be pathogenic.

Spore formers (found when cows are fed silage, biofilms)

Mostly thermoduric bacteria (i.e., organisms that survive pasteurization but do not grow at pasteurization temperatures.

- *Clostridium tyrobutyricum.* Responsible for late gas blowing in Swiss and Dutch-style cheeses.
- Spore levels as low as 500 spores per liter can cause serious defects in cheese and dairy powders
- Bacillus spp. (e.g., *B. cereus*, *B. licheniformis*) particularly in ESL products which allow sufficient time for spore germination and growth.

Predominant microorganisms in milk

- Include various species of :
  - Lactococcus
  - Lactobacillus
  - Pseudomonas
  - Micrococcus
  - Staphylococcus
  - Leuconostoc
  - yeast
  - Enterococcus
  - Streptococcus
  - Bacillus
  - Clostridium
  - Listeria
  - Enterobacteriaceae

Potential pathogens in milk

1. Salmonella sp Bacillus cereus
2. Listeria monocytogenes
3. Yersinia enterocolitica
4. Salmonella spp.
5. Escherichia coli O157:H7
6. Campylobacter jejuni

Why is this person regularly mentioned in discussions of potential pathogens in milk?

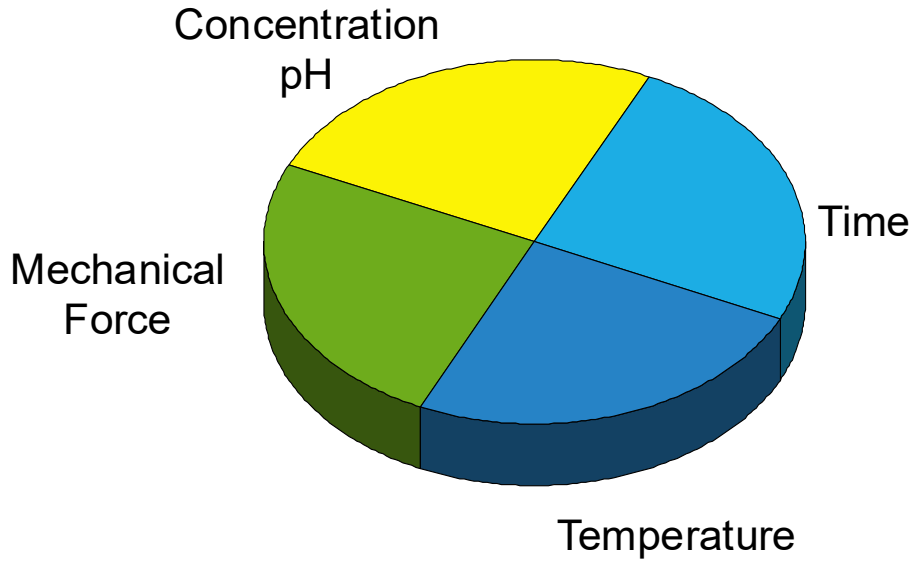
Sources of contamination in raw milk

Source of contamination	Estimate of contribution to counts per ml milk
Udder of healthy cow	Up to several thousand
Udder of mastitic cow	Up to several million
Skin of cow	A hundred up to several thousand
Milking parlor (soil, manure, dust, air)	Up to a thousand
Feed	Up to a thousand
Milking machine	A thousand to several million
Water for cleaning, rinsing	Up to several thousand
Good milker	Little

Sanitation- Key Concepts

- Cleaning alone, may remove some bacteria. However, it is NOT adequate to reduce the bacterial populations to an acceptable low level.
- Sanitizers are not as effective on unclean surfaces

1. Pre-Rinse	1.Temperature
2. Wash	2. Agitation
3. Rinse	3. Concentration
4. Sanitize	4. Time



Steps to Clean and Sanitize Food Contact Surfaces

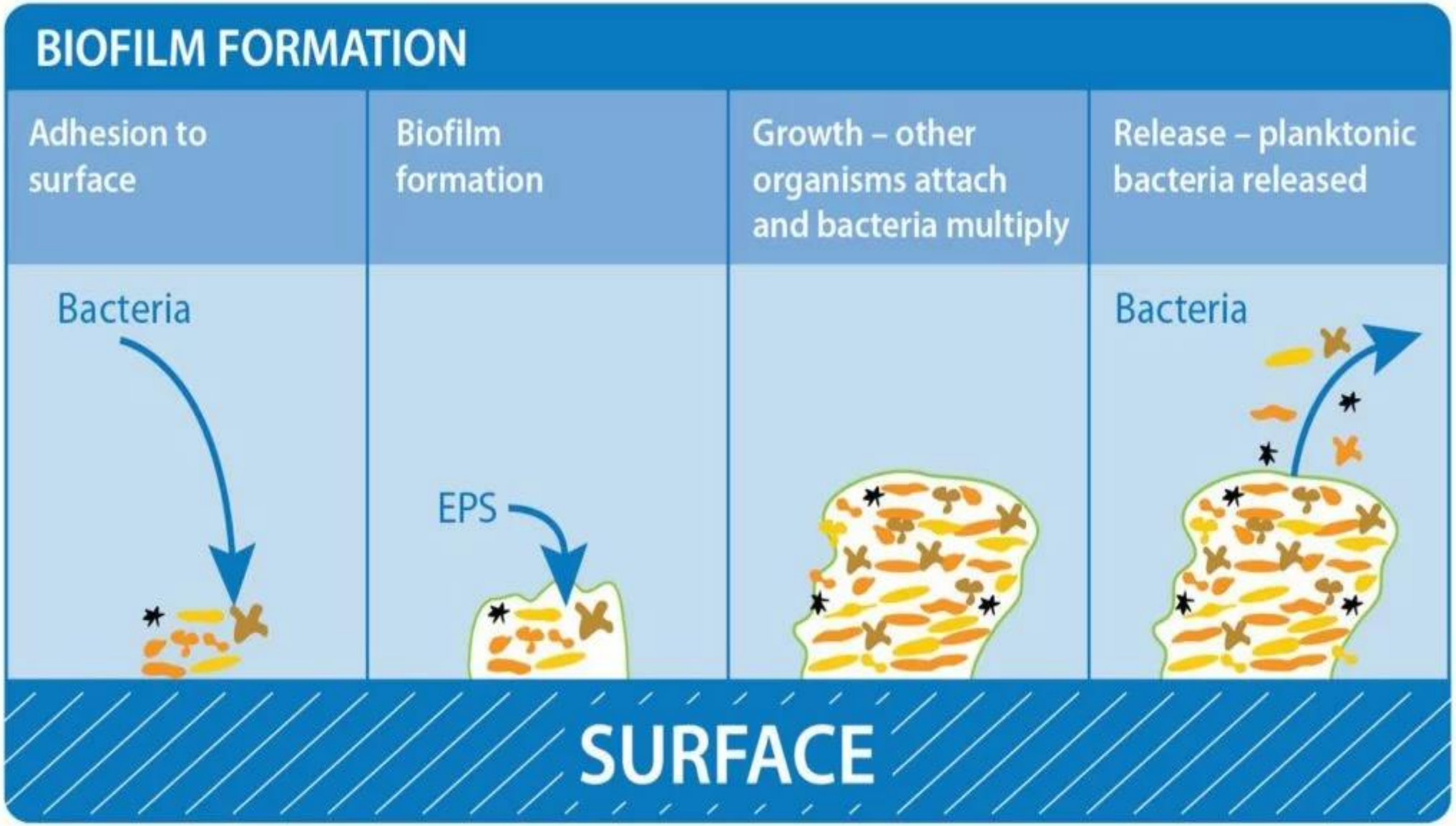
STEP	PURPOSE	CIP TEMPERATURE
Pre-rinse:	Remove visible soil. Melt butterfat. Prevent protein adherence. Prevent thermal shock.	36°C
Wash:	Remove remaining soil. Chemicals lift biofilms that bind to equipment surfaces.	55°C - 66°C
Post-rinse:	Removes suspended soils and chemical residues. Prepares surface for sanitizing.	36°C
Sanitizing:	Kills bacteria that remain on equipment surface. Must contact surfaces for at least one minute.	5°C - 25°C

Five Factors in Cleaning

- Nature of the Soil
- Water Quality
- Surface to be Cleaned
- Method of Application
- Environmental Concerns

Soil Types and Identification

DESCRIPTION	SOIL	CAUSE	REMOVAL
Blue/rainbow hue	protein	1. Using non-chlorinated cleaner 2. Inadequate pre-rinse	1. Chlorinated alkali 2. Strong acid
White or yellow deposits	milkstone	1. Mineral from milk 2. Mineral from water	1. Chlorinated alkali 2. Strong acid
Greasy appearance	fat	1. Low temperature or improper detergent concentration 2. Regular use of acid wash	1. Alkali
White, grey, chalky deposits	mineral	1. Improper rinse 2. Minerals from water 3. No acid rinse 4. Incompatible alkali 5. Failure to use acid detergents	1. Acid
Red to brown/black deposits	iron	1. Water supply	1. Strong acid


BIOFILM FORMATION
Adhesion to surface
Biofilm formation
Growth – other organisms attach and bacteria multiply
Release – planktonic bacteria released
Bacteria
EPS
Bacteria
SURFACE

Sanitation and Hygienic Design

- Cleaning chemistry and well designed process alone cannot EFFECTIVELY clean all equipment and surfaces
- Equipment and surfaces must be cleanable, accessible and designed to be able to cleaned and sanitized (be aware of cracks and crevices, worn gaskets, etc.)
- Food Safety regulations requires the use of hygienic equipment and premises for handling, preparation, processing, packaging of food
- 3-A Sanitary Standards relate to the cleanability of dairy equipment.

Cleaning

Mechanical (high pressure/flow)

- Clean in Place (CIP)
  - No assembly or disassembly

- Clean Out of Place (COP)
  - Partially disassemble, COP tank cleaning

Manual Cleaning

- disassemble, manually clean and inspect

Sanitizing

Thermal – hot water or steam

- Time and temperature

Chemical – approved sanitizers

- Approved chemicals for food contact surfaces
  - Chlorine based
  - Iodine based
  - Quaternary Ammonia
  - Acid Anionic Surfactants

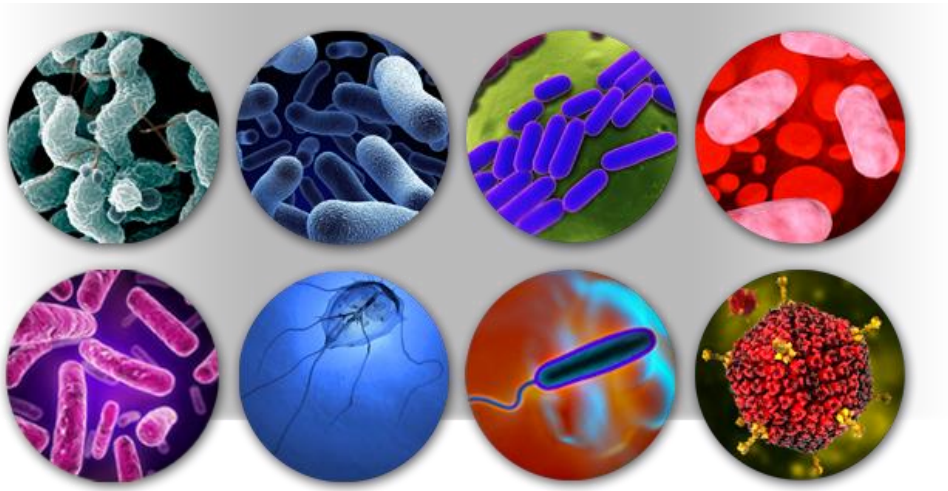
Factors Influencing Dairy Product Shelf-Life

- the quality of the basic raw material
- implementation of good hygiene practices at all stages of dairy processing
- composition of final product (pH, moisture, anti-microbials, other additives, microbial and enzyme activity post processing,)
- Post pasteurization contamination
  - Cracked gaskets, fouled heat exchangers
  - filler and packaging cleanliness, integrity of packaging
  - storage conditions of dairy products from the producer, transport and retailer
  - Temperature, light transmission
  - Transport and storage conditions in the consumer's refrigerator.
- physical and chemical stability of final product

What have we learned?

- Microbial growth can impact quality, safety and shelf-life of dairy foods
- Precise cleaning and sanitizing practices in well designed equipment are effective to control microbial counts(https://video.search.yahoo.com/search/video;_ylt=Awr4_fxqz0xmn8oYqCaJzbkF?p=biofilm+in+dairy+plant&type=E211US885G0&fr=mcafee&fr2=p%3As%2Cv%3Ai%2Cm%3Apivot#action=view&id=9&vid=b06d5b4467d5f0c71a6f63f01319a3ef)
- Factors influencing shelf life of dairy products

Thanks for your attention!

Questions? Comments?

Milk microbiology, cleaning and sanitation, and shelf life