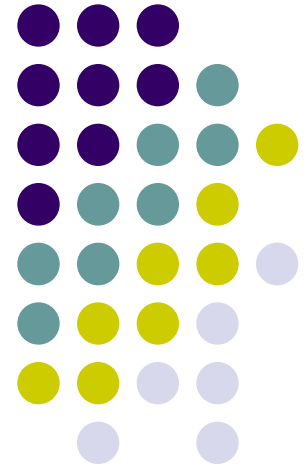


Listeria monocytogenes: an emergent pathogen



Dr. Madeline Velázquez
Assistant Professor

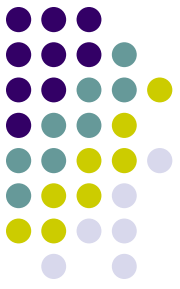
University of Puerto Rico
Mayagüez Campus
Food Science and Technology Program





-
- *Introduction*
 - *Pathogen classification*
 - *Pathogen characteristics*
 - *Significance of Listeria*
 - *Implicated foods*
 - *Importance of control methods*
 - ❖ **Biofilm formation**

Introduction: *Microbiology*

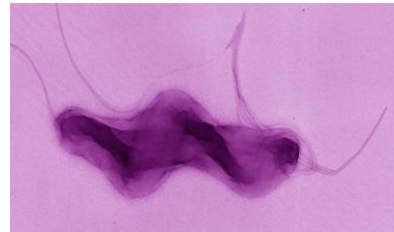


❖ Microorganisms

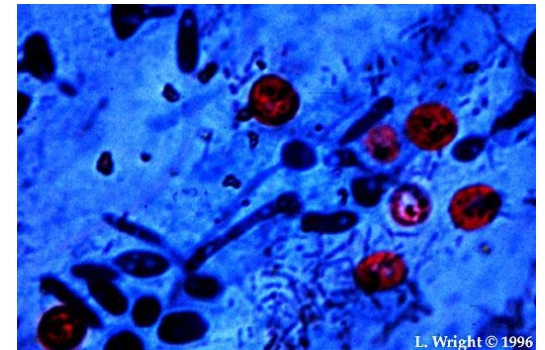
- Viable cells not visible to the naked eye

❖ Those that affect our food supply are:

- Bacteria
- Fungi (yeasts and molds)
- Viruses
- Protozoan parasites



Campylobacter



L. Wright © 1996

Cryptosporidium

Introduction: *Microbiology*



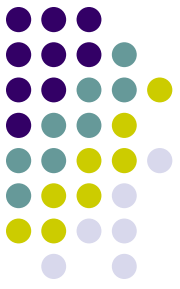
❖ Bacteria:

- Spoilage
 - *Bacillus* spp.
- Fermentative
 - *Lactobacillus casei*
- Probiotics
 - *Bifidobacterium longum*
- Pathogens
 - *Listeria monocytogenes*
 - ***Emerging pathogen***



L. monocytogenes

Introduction: *Microbiology*



❖ *Vibrio cholera* (1884)

Established Pathogens



❖ *Salmonella enteritidis* (1888)



Introduction: *Microbiology*



Established Pathogens

- ❖ *Bacillus botulum* "*Clostridium botulinum*" (1895)



- ❖ Connection between *Staphylococci:enterotoxin* (1914)

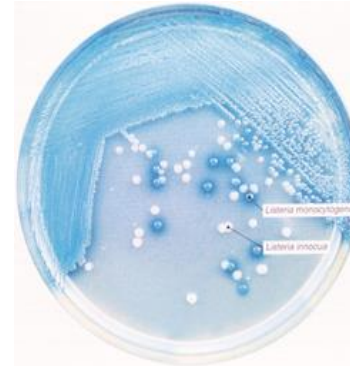


Introduction: *Microbiology*



Emergent Pathogens

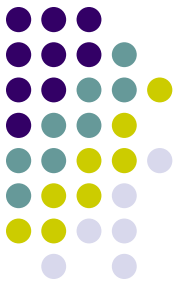
- ❖ *Listeria monocytogenes* (1981, 1985)



- ❖ *Escherichia coli* serotype O157:H7 (1993)



Introduction: *Microbiology*



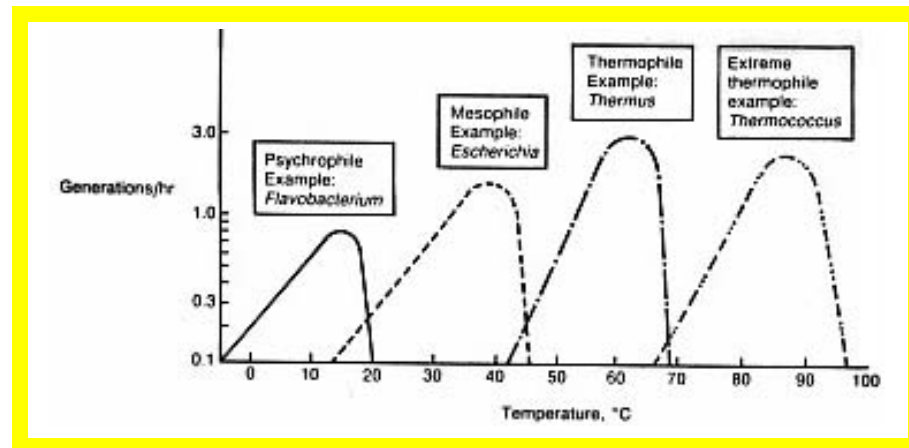
- ❖ Water content
- ❖ pH and acidity
- ❖ Nutritional content
- ❖ Biological structures
- ❖ Reduction and oxidation potential
- ❖ Antimicrobial (added or natural) substances
- ❖ Competitive microflora



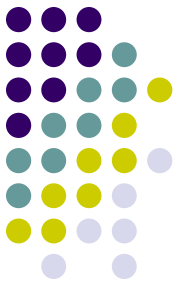
Introduction: *Microbiology*



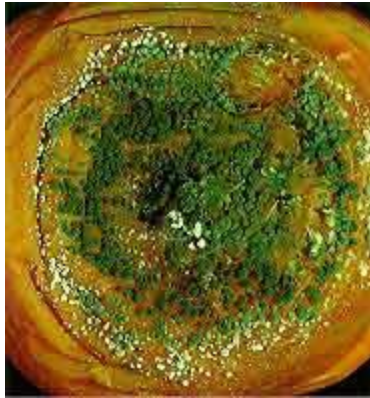
- ❖ Type of packaging/atmosphere (gas)
- ❖ Time/temperature
- ❖ Storage conditions



Introduction: *Microbiology*



Evident Contamination



Blue Rot
Penicillium digitatum



Mold Parasite
Claviceps purpurea



Fungus Rot
Penicillium sp.

Introduction: *Microbiology*



NON-EVIDENT CONTAMINATION *Listeria* outbreaks



**Pasteurized Milk
1983 (MA)**



**Butter
1987 (CA)**



**Vegetables, Turkey
1979, 2002 (MA, NE)**



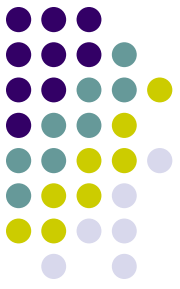
Introduction: *Listeriosis*



- Listeriosis in early 1980's
- Encephalitis and abortions in animals



Introduction: *Outbreaks*



- First reported outbreak in humans (*Nova Scotia, Canada in **1981***)
- Involved **coleslaw**
- 34 pregnant women and 7 adults were affected
- Pathogen was detected in unopened packages
- It was not detected in packaging plant
- Sheep manure was used as fertilizer



Introduction: *Outbreaks*



- First reported outbreak in the U.S. (*California in 1985*)
- Involved Mexican-style soft cheese
- **Most lethal outbreak**
 - 142 people were affected
 - 33.8% fatality (48 deaths)



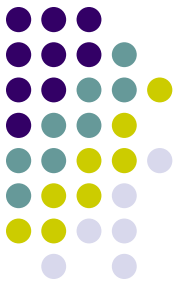
Introduction: *Outbreaks*



- Shrimp (*Connecticut in 1989*)
 - 10 cases
- Chocolate milk (*Illinois in 1994*)
 - 45 cases



Introduction: *Outbreaks*

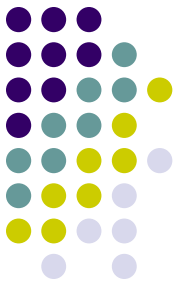


- Second most lethal outbreak 1998-1999
- 101 cases
 - 21 deaths (20.8% fatality)
- Processing plant in Michigan with condensation problems



December 22, 1998

Pathogen classification



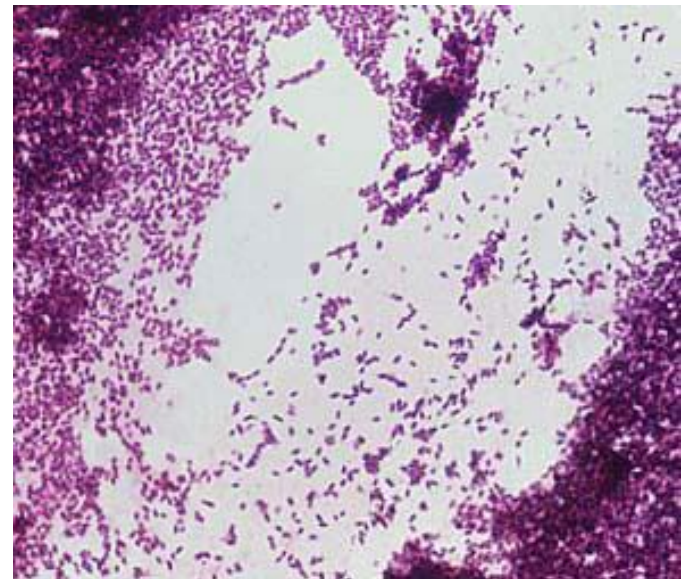
- *L. monocytogenes* (serotype 1/2a, 1/2b and **4b**)
- *L. innocua*
- *L. seeligeri*
- *L. ivanovii* (two subsp.)
- *L. welshimeri*
- *L. grayi*



Pathogen characteristics



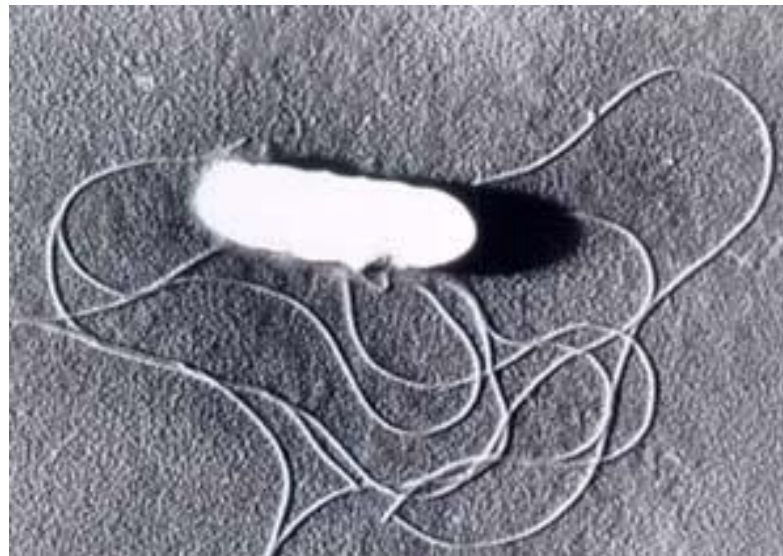
- Gram positive rod
- Facultative anaerobe
- Difficulty in its isolation from foods due to:
 - *Interspecific competition*
 - *Cell damage*
 - *Processing*



Pathogen characteristics



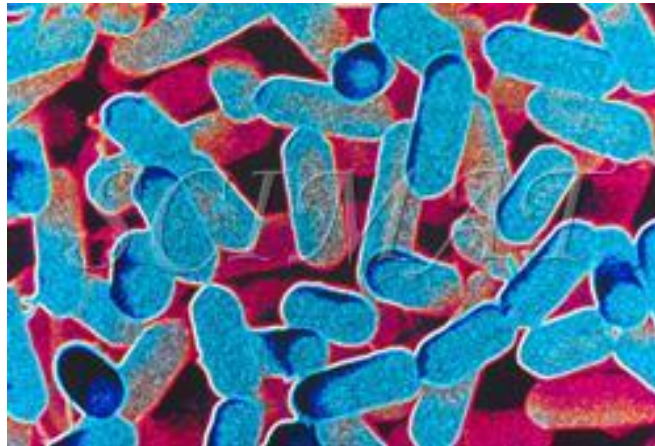
- Mobile (multi-flagellar)
- Psycrotrophic organism
- Can grow at 32-113° F (0-45° C)
- Optimum growth temperature 86-98° F (30-37° C)



Pathogen characteristics



- Tolerates high salt concentration (10-12% NaCl)
- It can survive at a pH range of 4.4 – 9.6



Significance of *Listeria*



- **Non-Invasive Gastroenteritis**

- 9-48 hours “food contaminated with high levels”
- Symptoms similar to influenza
- Diarrhea
- Chills
- Vomiting
- Fever

- **Invasive**

- 5 days to 3 weeks
- Septicemia
- Meningitis
- Endocarditis
- Abortions
- Abscess



BRAIN ABSCESS

Significance of *Listeria*



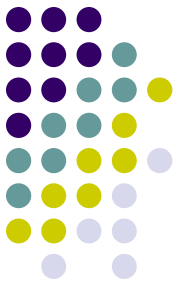
❖ **Most susceptible population:**

- Elderly (>60 years)
- **Pregnant women**
- Inmuno-compromised individuals
- Neonates (newborns; <1 year)

❖ **Listeriosis during pregnancy:**

- CDC estimates 20% more vulnerable
- 1 out of 3 listeriosis cases are pregnant women
- Bacteria enters placenta
- Bacteria has not been found in maternal milk

Significance of *Listeria*



Documented by FoodNet (CDC, USDA-FSIS, FDA)

- *Foodborne Diseases Active Surveillance Network*
- *9 pathogens are included*
- *2004 Report (15,806 confirmed cases)*

<i>Salmonella</i>	6,464
<i>Campylobacter</i>	5,665
<i>Shigella</i>	2,231
<i>Cryptosporidium</i>	613
<i>E. coli O157:H7</i>	401
<i>Yersinia</i>	173
<i>Vibrio</i>	124
<i>Listeria</i>	120
<i>Cyclospora</i>	15

Significance of *Listeria*



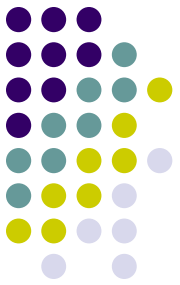
- ❖ **Related mortality and Listeria (CDC, 2014):**
 - **1,600** annual cases
 - 260 die annually
 - 90% of infected individuals are high risk population



Department of Health and Human Services

Centers for Disease Control and Prevention

Recent outbreaks caused by Lm



- **2014**
- [Multistate Outbreak of Listeriosis Linked to Roos Foods Dairy Products](#)
- **2013**
- [Listeriosis Linked to Crave Brothers Farmstead Cheeses](#)
- **2012**
- [Listeriosis Linked to Imported Frescolina Marte Brand Ricotta Salata Cheese](#)
- **2011**
- [Listeriosis Linked to Whole Cantaloupes from Jensen Farms, Colorado](#)

Habitat & Association with Foods



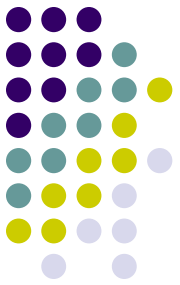
- ❖ *Listeria* species (spp.) are found in the environment.
- ❖ They have been isolated from the soil, decomposing organic matter, residual waters, animal feed, fresh and frozen chicken, produce and processed foods, cheese, raw milk, waste, and the gastrointestinal tract of asymptomatic humans and animals.

Habitat & Association with Foods



- ❖ *L. monocytogenes* has been isolated from several mammal, bird, fish and insect species.
- ❖ Nevertheless its principal habitat is the soil and decomposing organic matter.

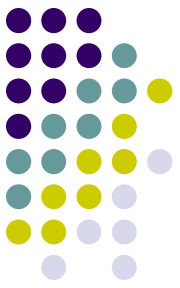
Association with Foods



- ❖ Due to its wide distribution, this microorganism can contaminate foods during different steps along the food chain. Foods are the **most frequent** source of infection in humans.



Association with Foods



- *Cottage* and *Cheddar* cheese with a pH of 5.0
- Probability in raw milk of 4.1%
- Probability in pasteurized milk of 0.4%
- ***Ready-to-eat***
- Those of **highest risk** are **deli-meats**



Importance of control measures



- FDA and the USDA-FSIS have a zero tolerance (December 2004)
- Ready to eat foods
- Sanitation is critical during:
 - Processing
 - Packaging
 - Storage



U.S. Food and Drug Administration



United States Department of Agriculture
Food Safety and Inspection Service



Importance of control measures



- **USDA-FSIS and the FDA**

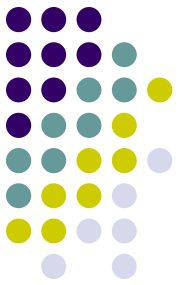
- Do not eat **un-heated** hot dogs or deli meats
- Avoid **soft** cheese including:
 - *Feta*
 - *Brie*
 - *Camembert*
 - *Mexican-style*
- Do not eat **refrigerated** meat *paté*
- Do not eat **un-heated** *smoked* sea foods
- Do not drink **raw** milk



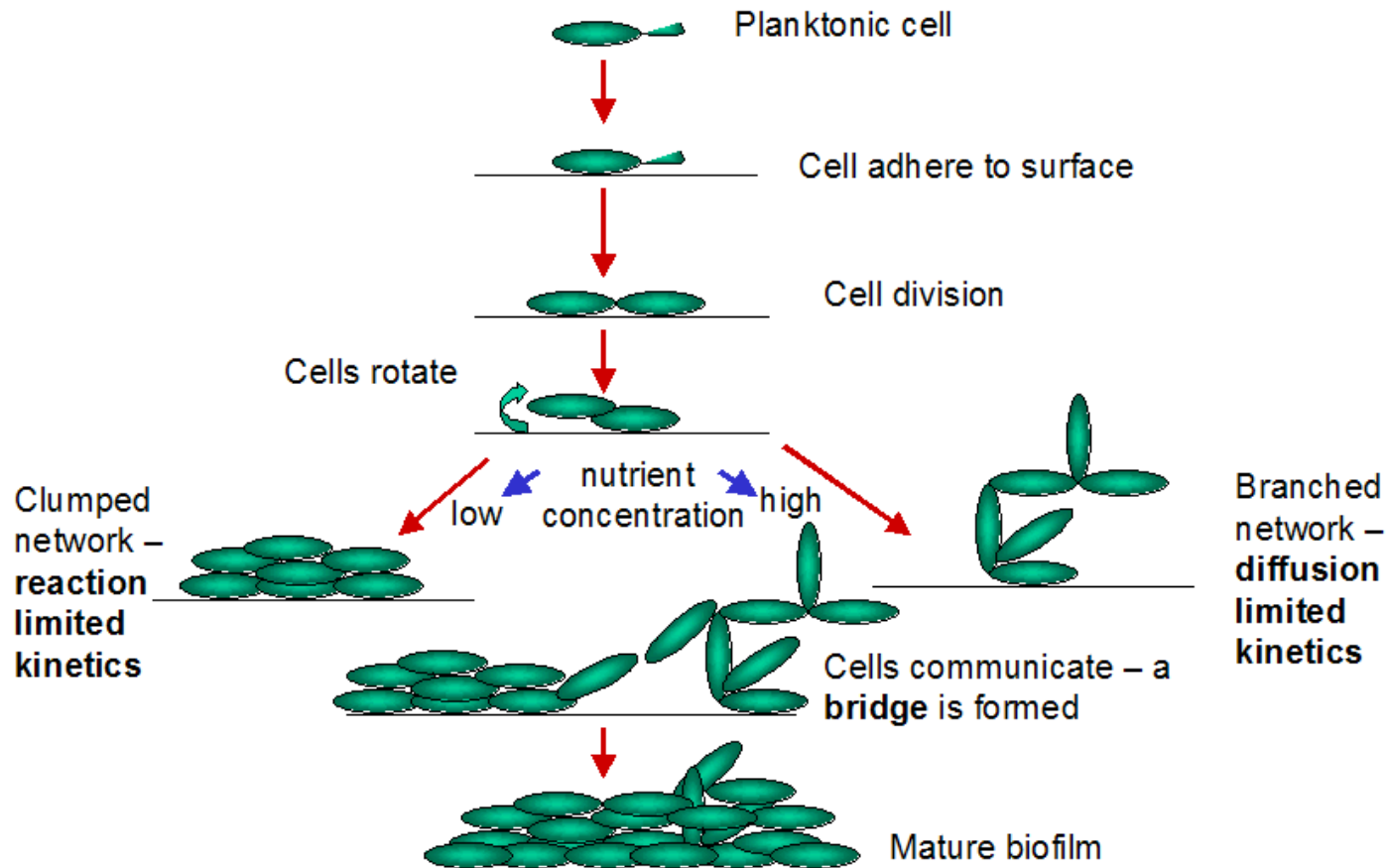
U.S. Food and Drug Administration



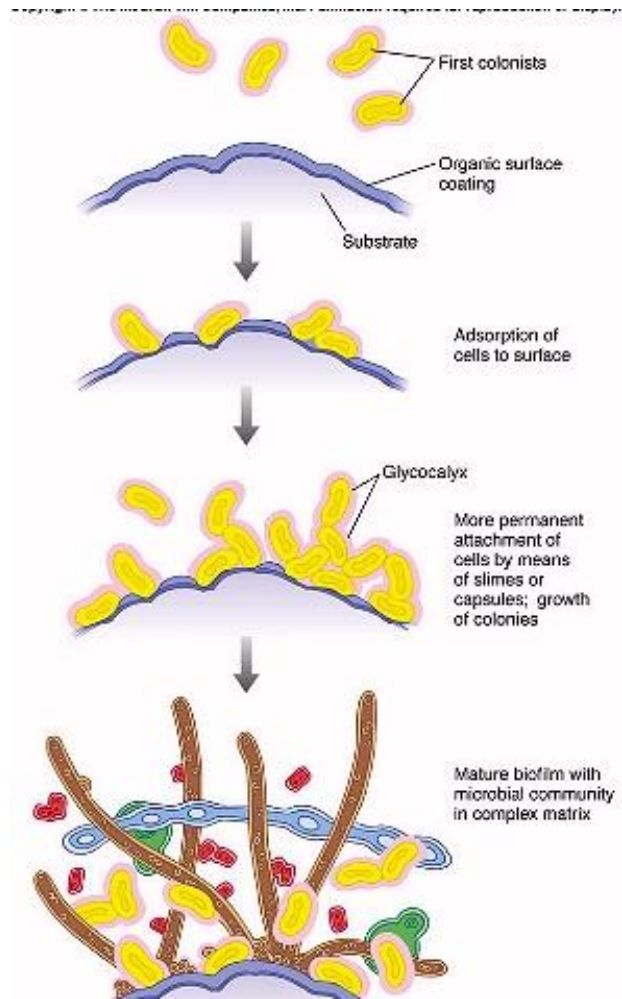
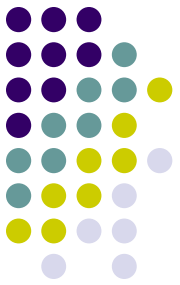
Biofilms



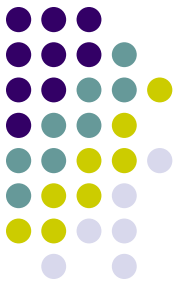
Morphological map of the biofilm initiation and development



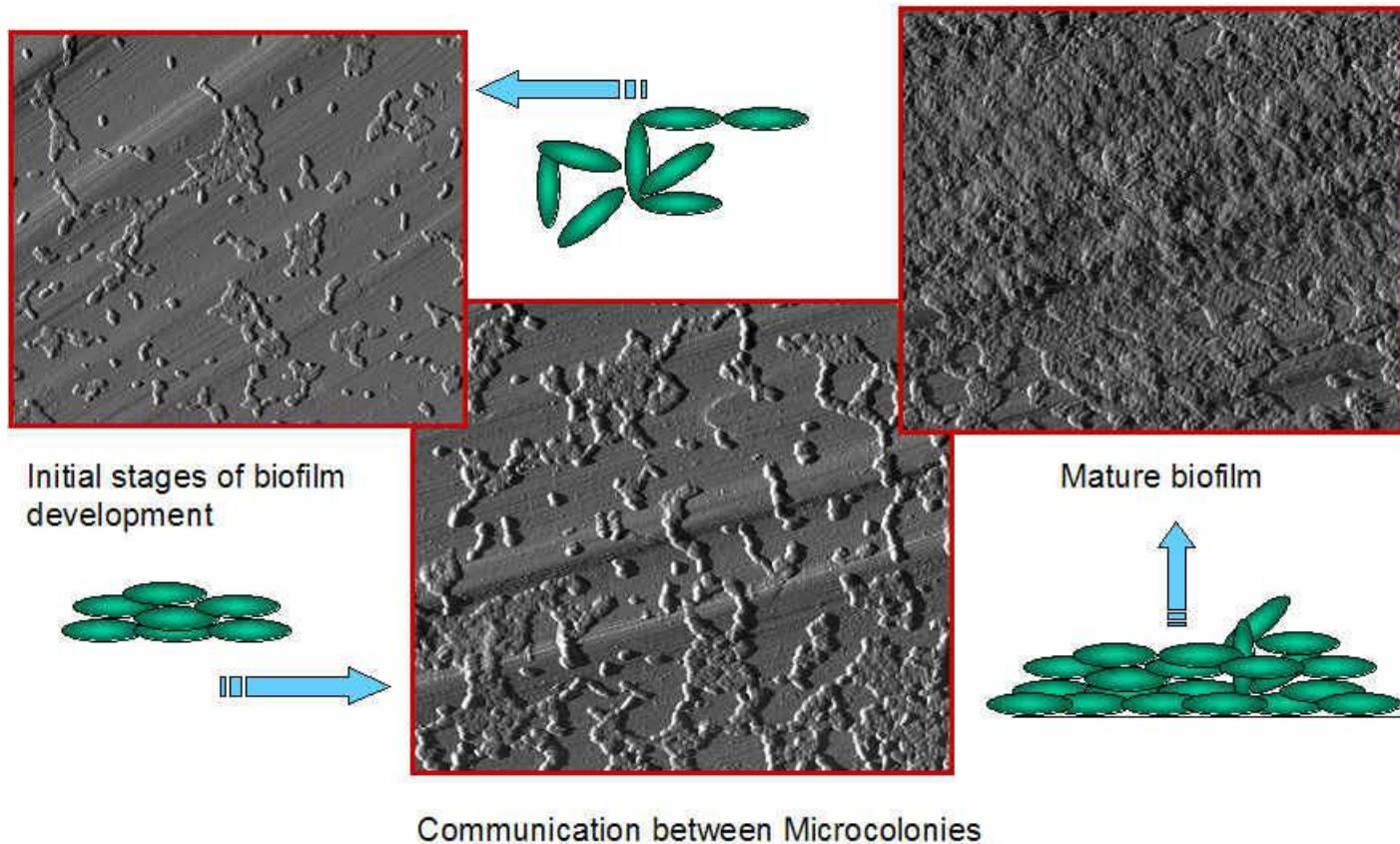
Biofilms



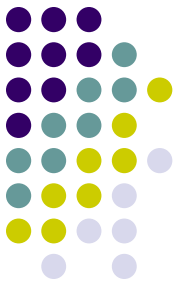
Biofilms



Microcolonies spreading and maturation of biofilm

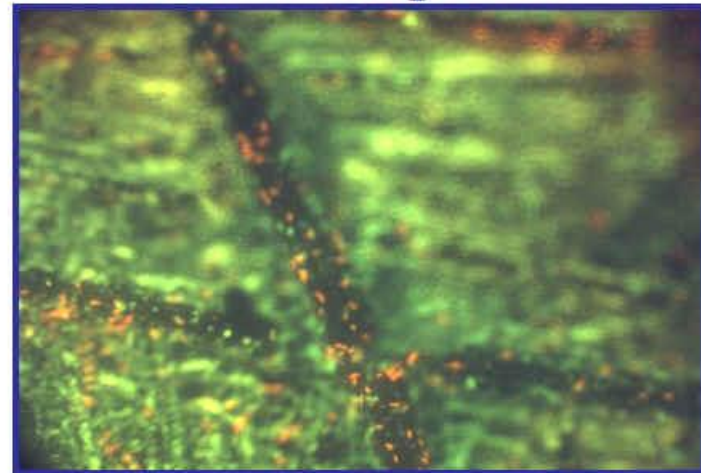
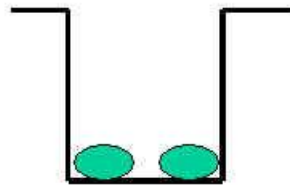


Biofilms

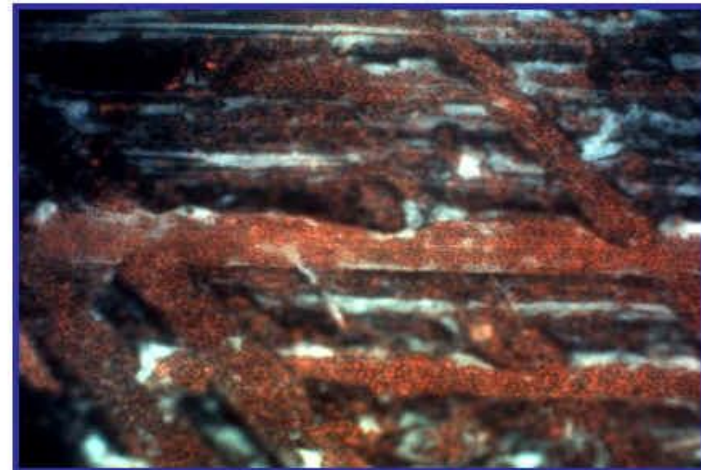
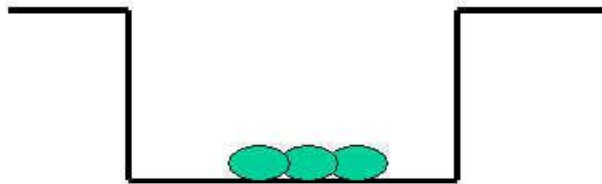


Effect of topography on biofilm development

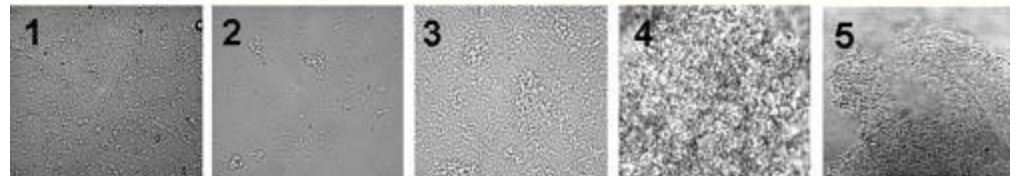
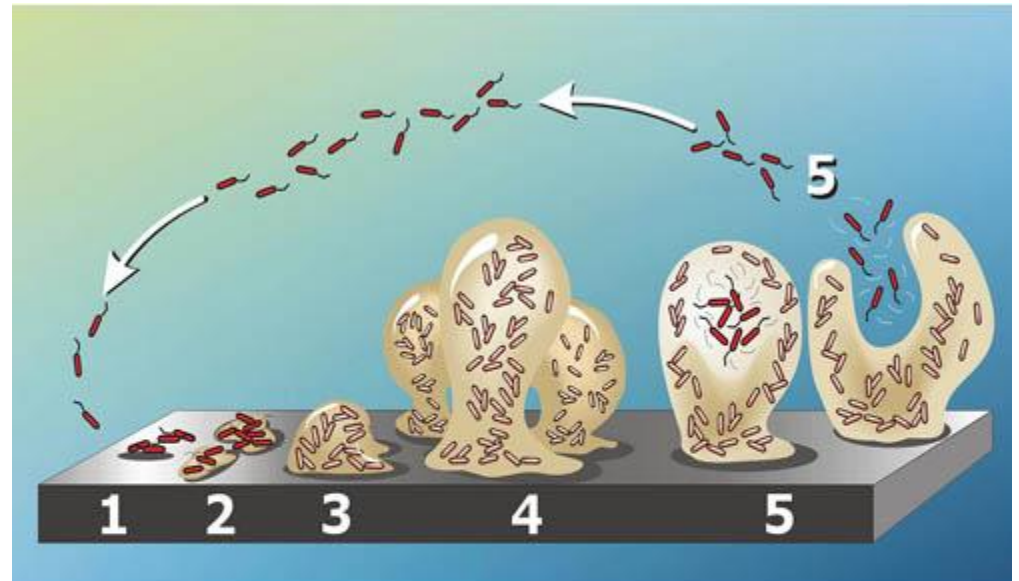
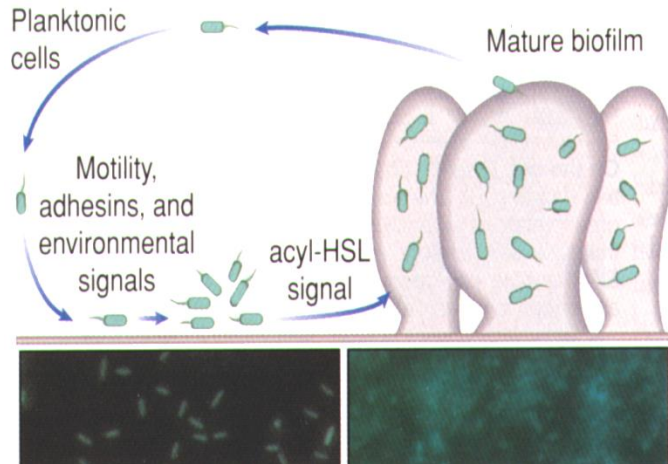
Cells preferentially adhere to the corners of the groove, if it is narrow. They attain greatest security there.



Cells spread out within and on top of the grooves if it is wide. Nutrients availability is the limiting factor, then.



Biofilms

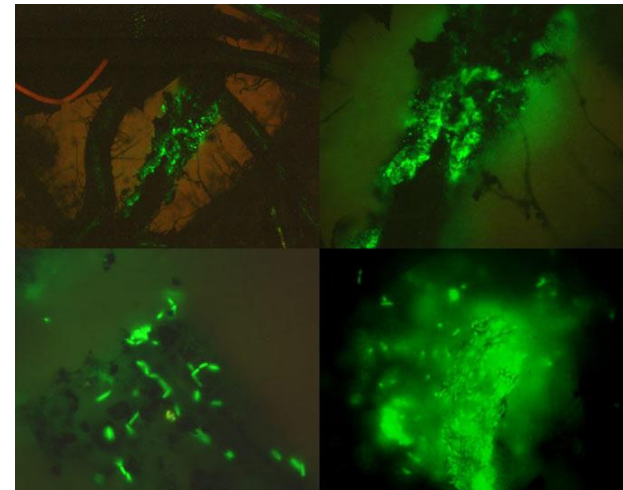


Biofilms: *Significance*



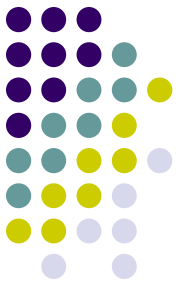
- ***Beneficial:***

- *Pseudomonas fluorescens* on plant roots
- *In situ* bio-remediation:
 - ❖ *P. putida* in toluene degradation



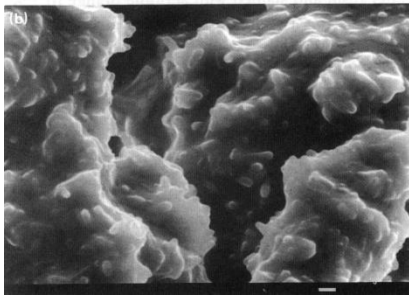
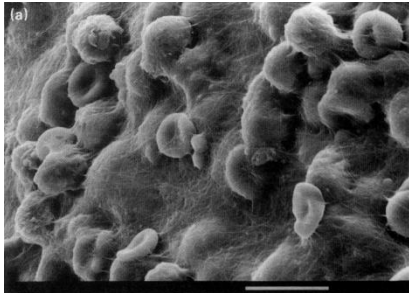
P. fluorescens

Biofilms: *Significance*

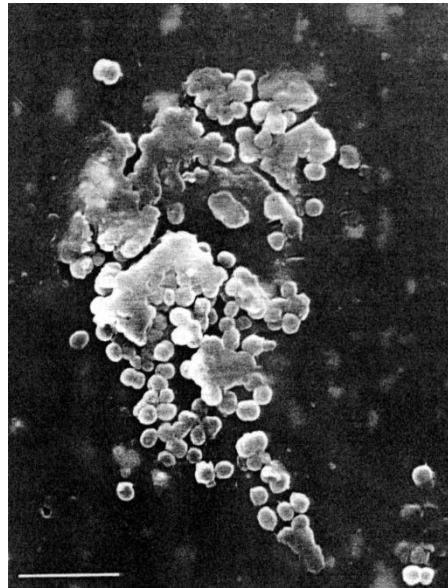


● *Detrimental:*

- *Intravenous catheter and implants*
- *Lungs of patients*



Peritoneal



Vascular catheter



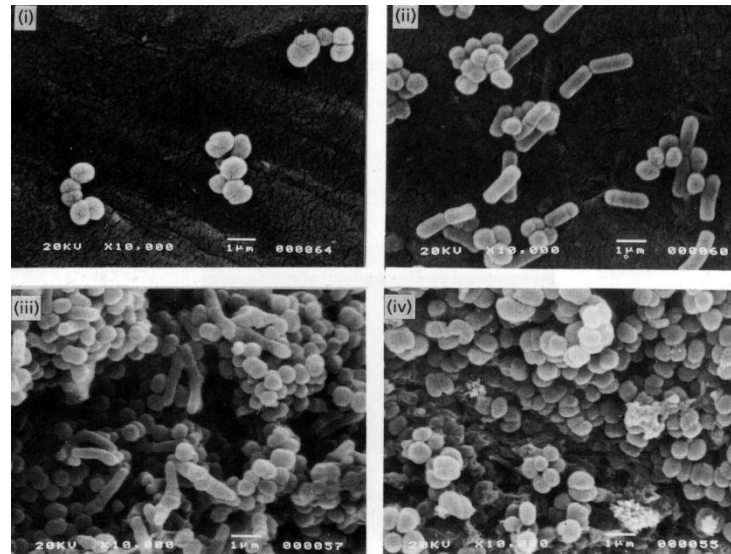
Implant

Biofilms: *Significance*



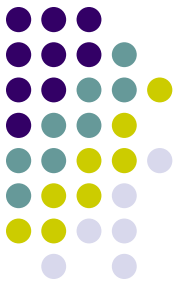
- ***Detrimental:***

- *Dental plaque*
- *Contact lenses*

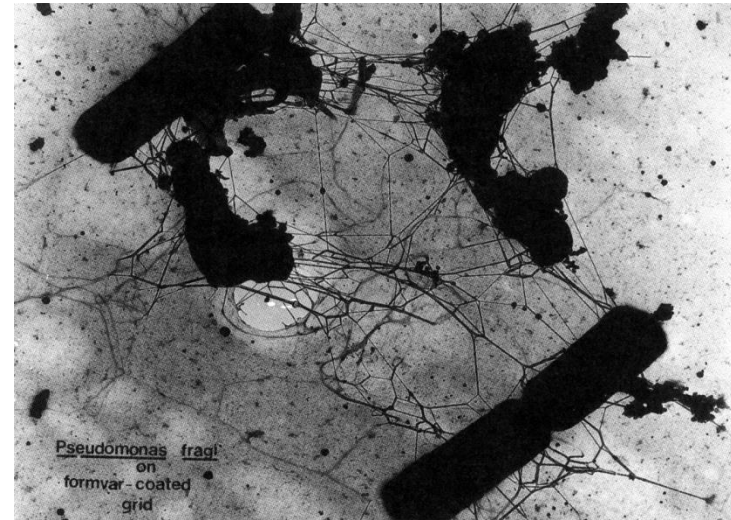
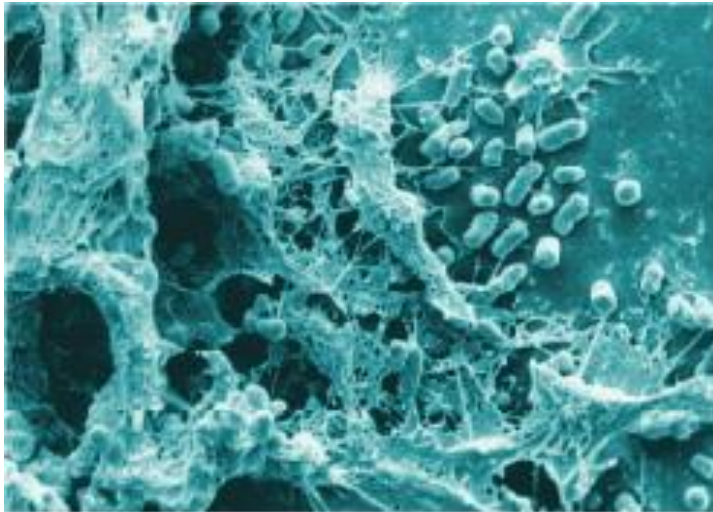


Dental Plaque

Biofilms: *Significance*



- ***Detrimental:***
 - ***Surfaces*** in food processing plants



References



Michael P. Doyle, Larry R. Beuchat and Thomas J. Montville. 2001. Food Microbiology: Fundamentals and Frontier. Second Edition. American Society for Microbiology (ASM Press)

Kornacki, J.L. 2005. Controlling Listeria in the Food Processing Environment. Food Technology. 11(05). 36-42.

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<http://www.cdc.gov/foodnet/>

<http://www.foodsafety.gov>

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