



***LA SICUREZZA MICROBIOLOGICA IN IMPIANTI PRODUTTORI  
DI PROSCIUTTO DI PARMA CHE ESPORTANO VERSO PAESI  
TERZI A «TOLLERANZA ZERO»: IL BIOFILM***

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# Superfici & Biofilm

- La formazione di biofilm può realizzarsi virtualmente su qualsiasi tipo di superficie inclusi i tessuti viventi



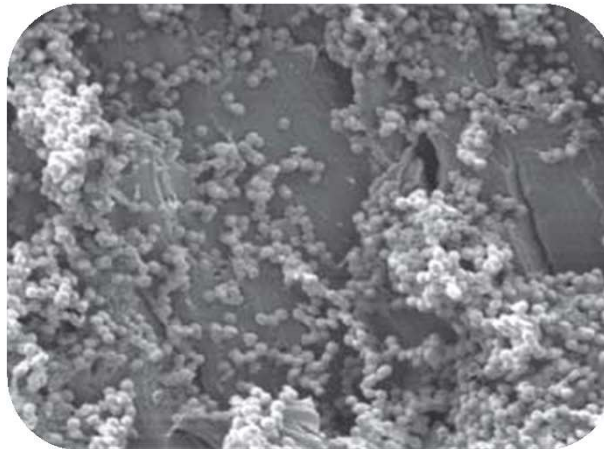
<b>Biofilm in campo medico</b>	
<b>Biofilm</b>	<b>Microrganismi</b>
Lenti a contatto	<i>Cocchi Gram-positivi e P. aeruginosa</i>
Dispositivi per dialisi peritoneale	<i>Flora batterica e fungina mista</i>
Cateteri urinari	<i>E. coli e altri bacilli Gram-negativi</i>
Carie dentali	<i>Cocchi Gram positivi acidofili (streptococchi</i>
Dispositivi endotracheali	<i>Flora batterica e fungina mista</i>
Cateteri venosi	<i>S. epidermidis</i>
Valvole cardiache meccaniche	<i>S. aureus e S. epidermidis</i>
Inneschi vascolari	<i>Cochi Gram-positivi</i>
Dispositivi ortopedici	<i>S. aureus e S. epidermidis</i>
Protesi di vari organi	<i>S. aureus e S. epidermidis</i>

# FORMAZIONE DI BIOFILM SULLE LENTI A CONTATTO



## Natural eye protection:

- Lactoferrine
- Lysozyme



Microcolonies with early biofilm formation of *Staphylococcus aureus*



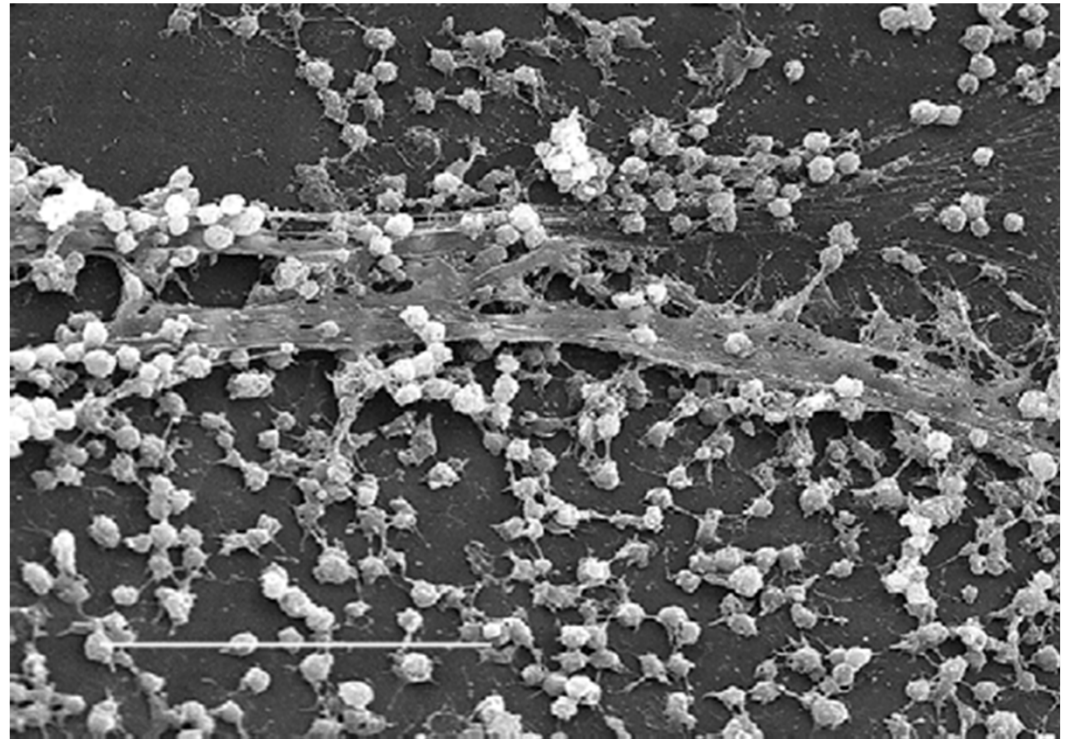
## Most frequent colonisers:

- *Pseudomonas* sp.
- *Staphylococcus* sp.



# Superfici

- Acciaio
- Alluminio
- Vetro
- Teflon, fibre plastiche
- Gomma
- Legno
- Ecc.

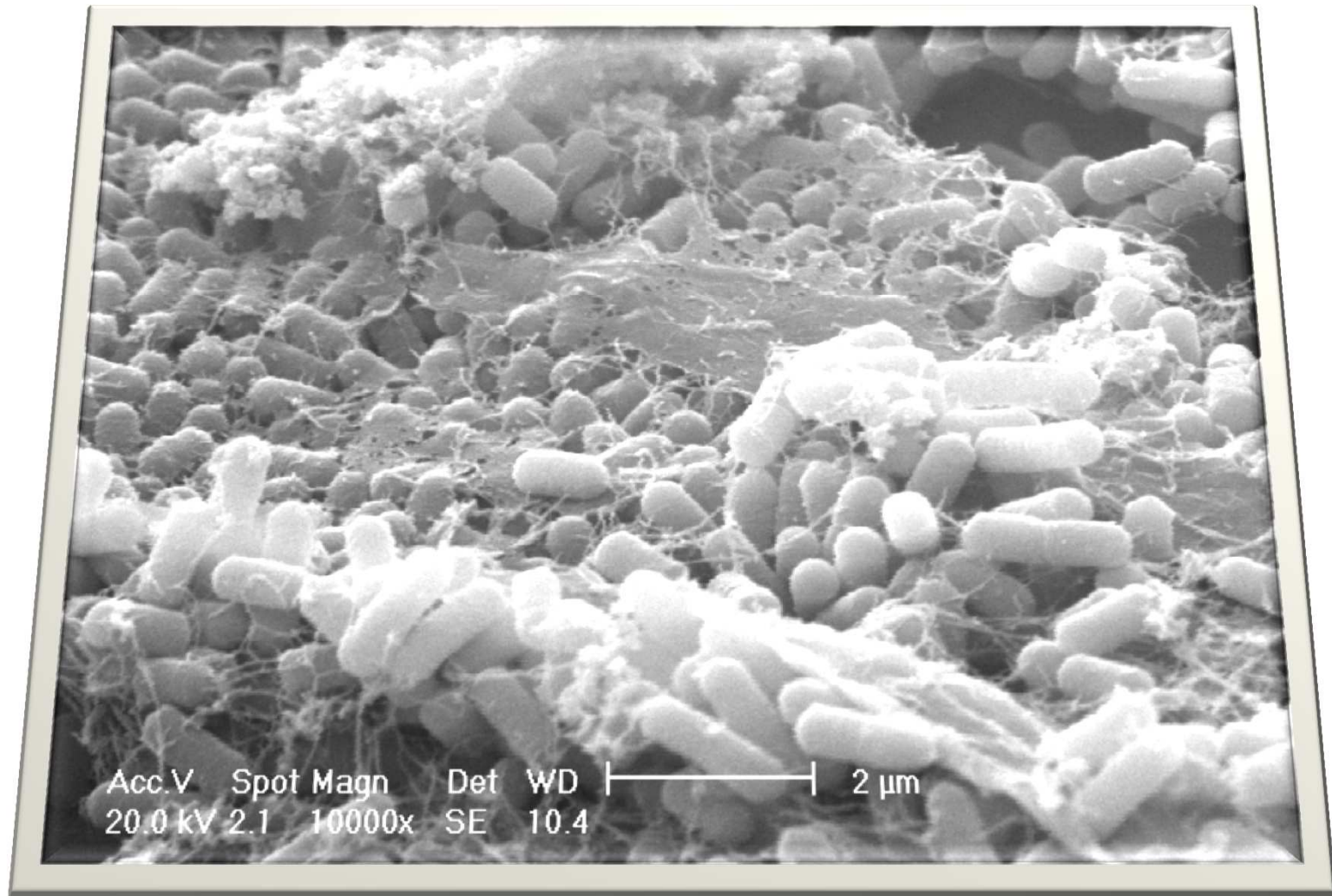


Staphylococcus aureus  
su materiale plastico



# Superfici & Biofilm

## *Le Variabili*



## Principali variabili responsabili dell'adesione cellulare e della formazione del biofilm

<b><u>Substrato</u></b>	<b><u>Cellule</u></b>
Struttura e Microtopografia	Idrofobicità della sup. cellulare
Idrofobicità	Fimbrie, pili
pH, temperatura	Flagelli
Presenza di agenti antimicrobici	Sostanze polimeriche extracellulari

# Struttura della Superficie

- la colonizzazione aumenta con **la rugosità** delle superfici in quanto diminuiscono le forze di superficie e la superficie d'area è maggiore

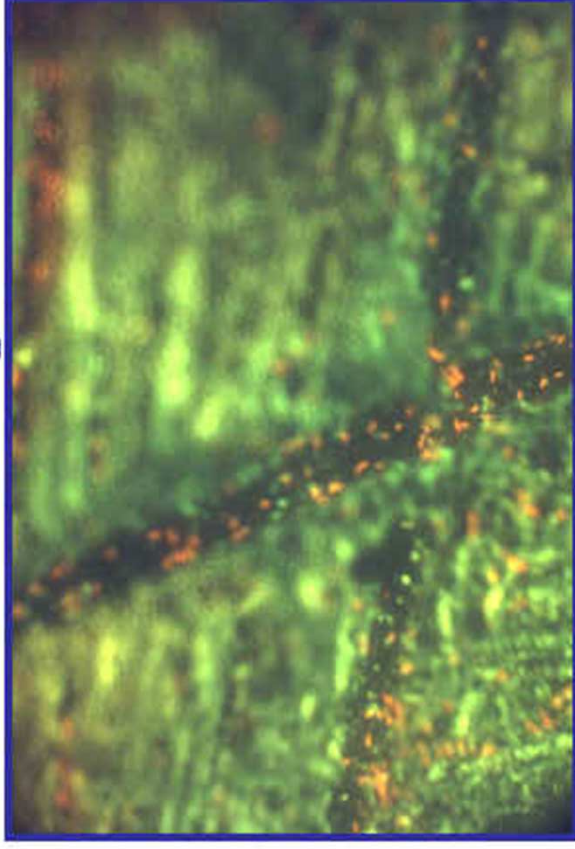


**La rugosità** (o **scabrosità** o **scabrezza**) è una proprietà della superficie di un corpo, costituita da microimperfezioni geometriche normalmente presenti sulla superficie o anche risultanti da lavorazioni meccaniche; tali imperfezioni si presentano generalmente in forma di solchi o scalfitture, di forma, profondità e direzione variabile.

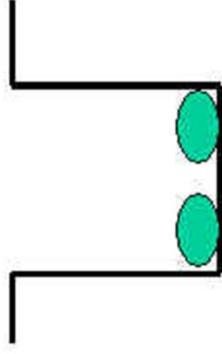
Fotomicrografia al SEM di una superficie di acciaio inox.  
Rugosità > 1  $\mu\text{m}$  (rugosità di punta fino a 5  $\mu\text{m}$ ).

Fotomicrografia al SEM di una superficie nichelata. Rugosità < 0,1  $\mu\text{m}$ .

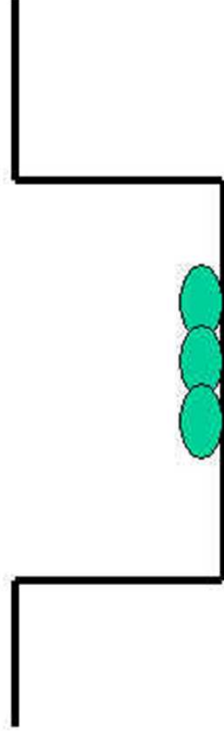
## Effect of topography on biofilm development



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.

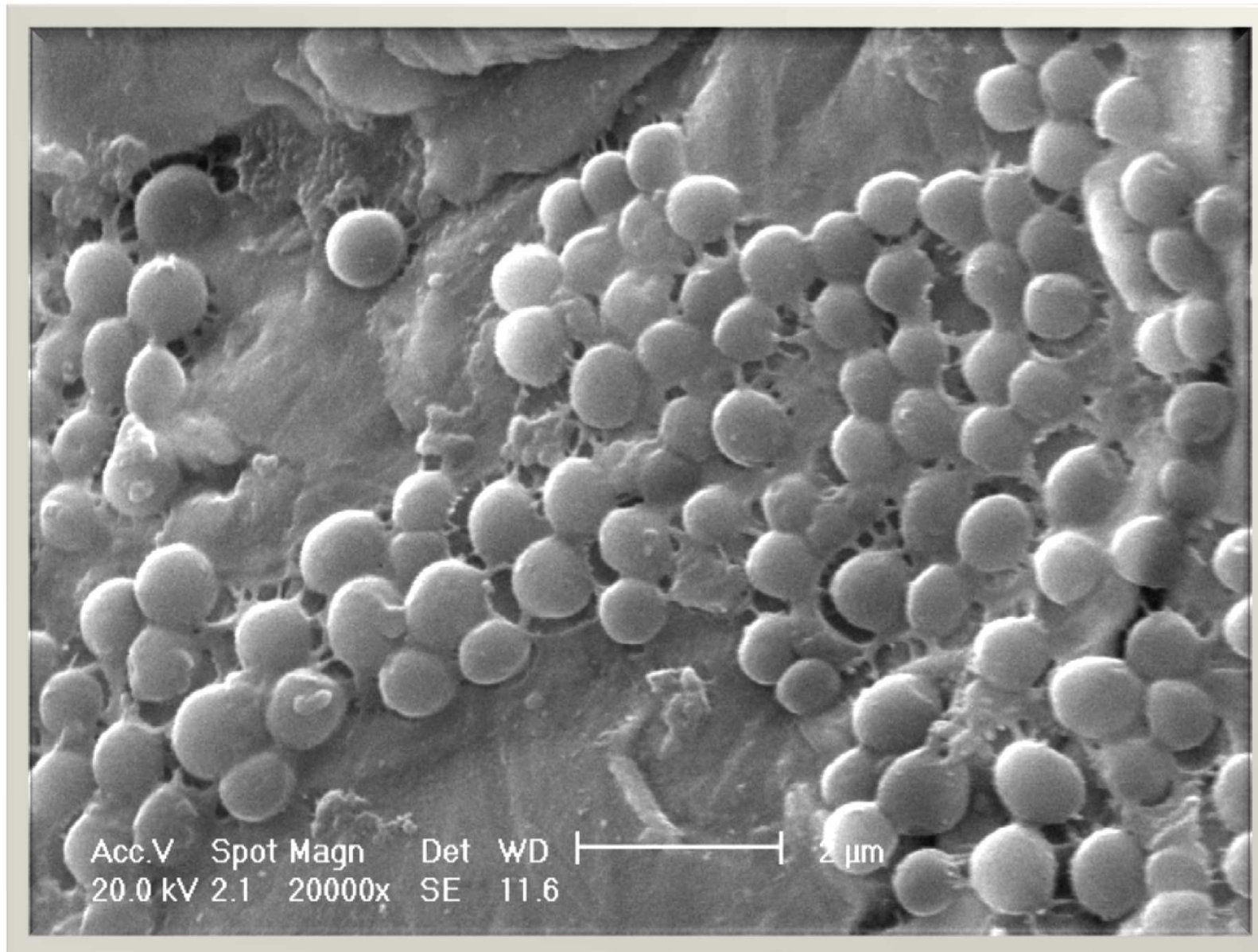


# *Temperatura del substrato*

- Influenza il grado di adesione microbica

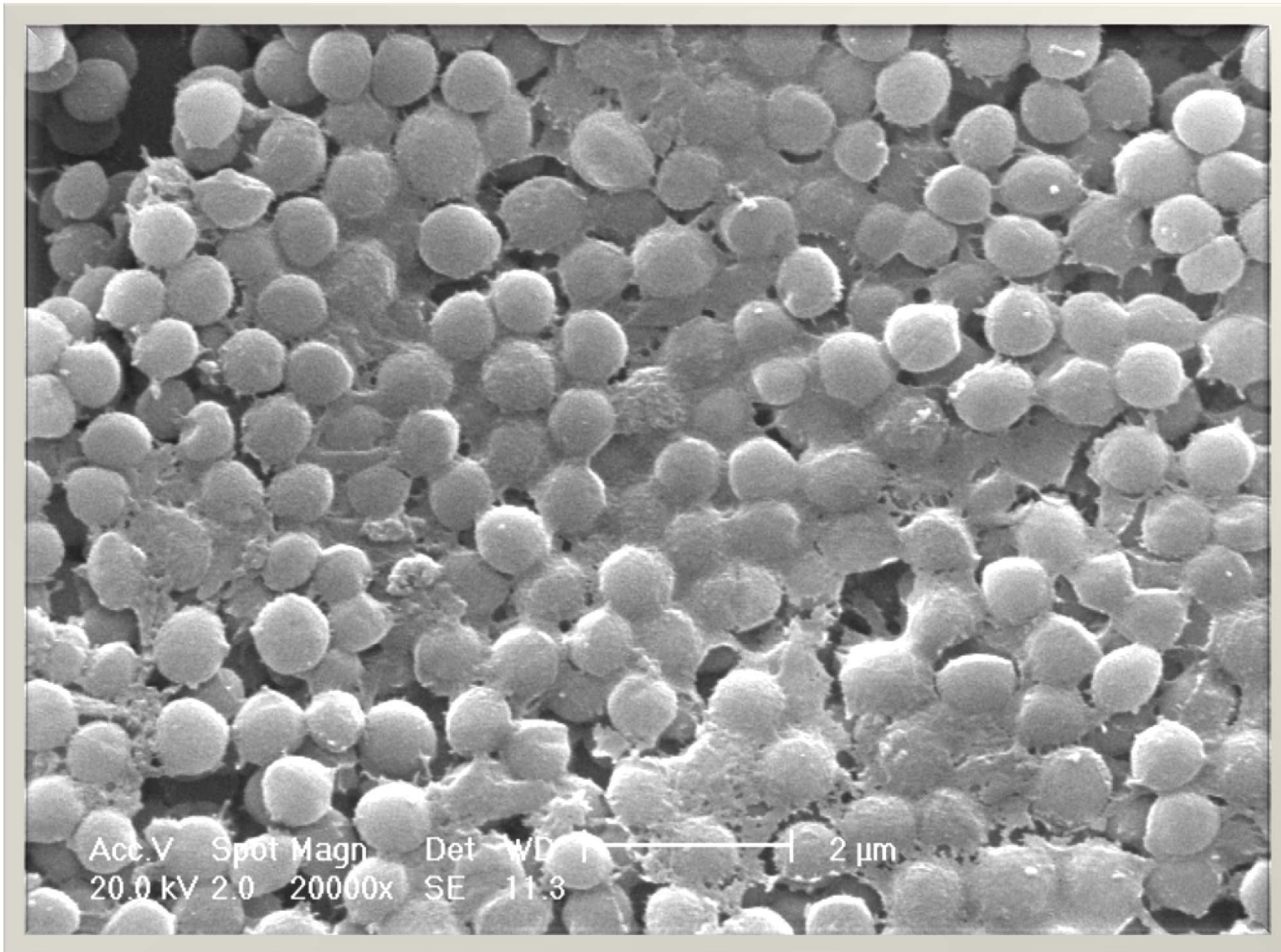






**S. aureus a 37°C su acciaio**

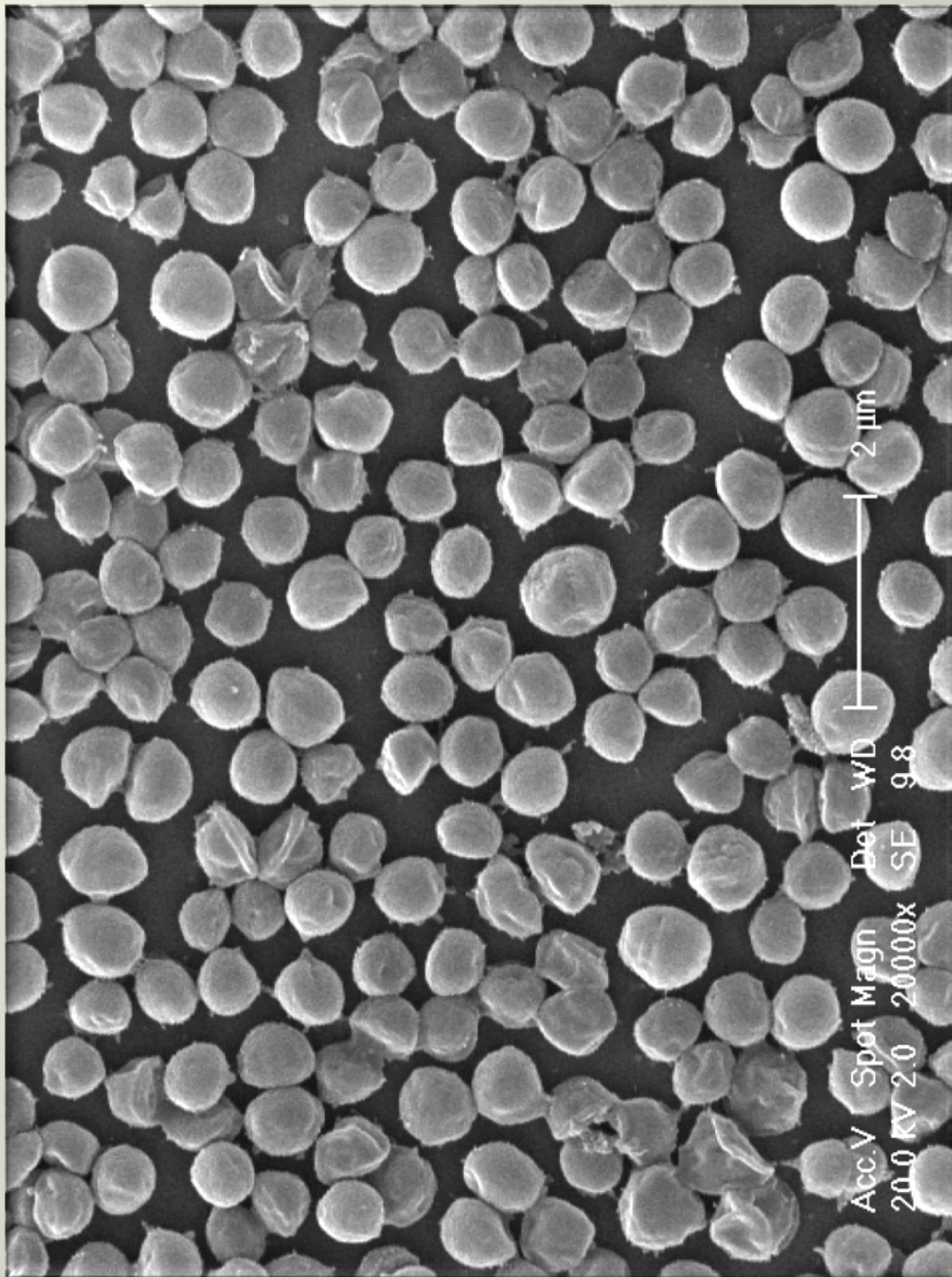
Di Ciccio et al. 2015



***S. aureus* polistirene a 37°C - maggiore**

DiCiccio et al. 2015





Acc.V 20.0 kV 2.0 20000x SE 9.8  
Det WD

2 μm

# Influence of temperature on biofilm formation by *Listeria monocytogenes* on various food-contact surfaces: relationship with motility and cell surface hydrophobicity

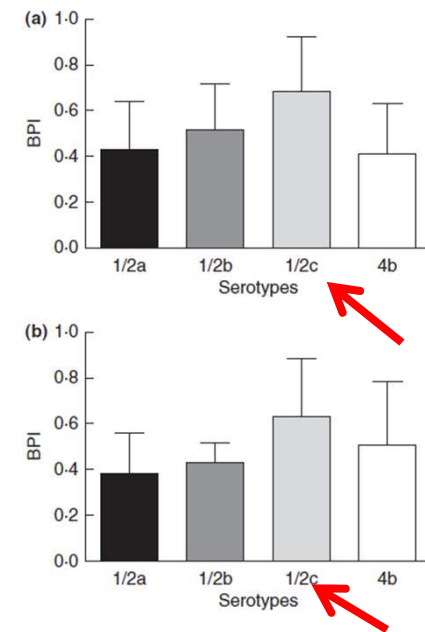
G. Di Bonaventura<sup>1,2</sup>, R. Piccolomini<sup>1,2</sup>, D. Paludi<sup>3</sup>, V. D'Orio<sup>3</sup>, A. Vergara<sup>3</sup>, M. Conter<sup>4</sup> and A. Ianieri<sup>4</sup>

Journal of Applied Microbiology **104** (2008) 1552–1561

**Aims:** To assess the ability of *Listeria monocytogenes* to form biofilm on different food-contact surfaces with regard to different temperatures, cellular hydrophobicity and motility.

**Methods and Results:** Forty-four *L. monocytogenes* strains from food and food environment were tested for biofilm formation by crystal violet staining. Biofilm levels were significantly higher on glass at 4, 12 and 22°C, as compared with polystyrene and stainless steel. At 37°C, *L. monocytogenes* produced biofilm at significantly higher levels on glass and stainless steel, as compared with polystyrene.

Modulation of *L. monocytogenes* biofilm formation

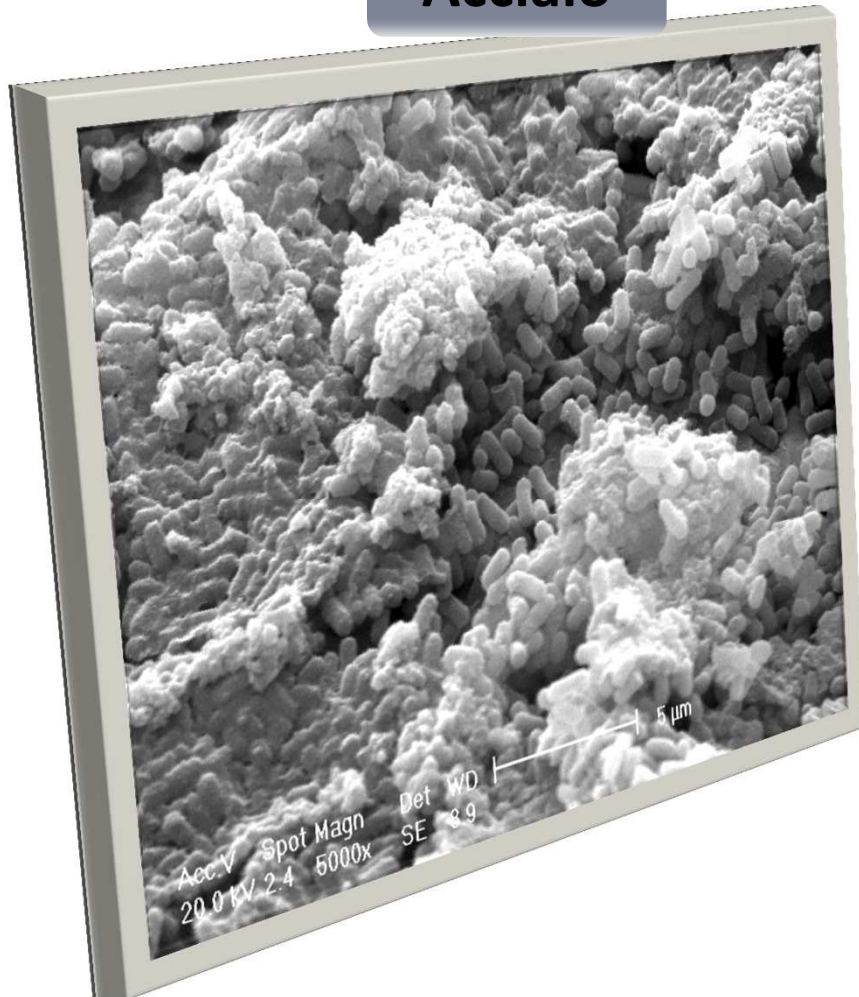


**Figure 2** Biofilm formation by 44 *Listeria monocytogenes* at 37°C on (a) glass and (b) stainless steel: stratification for serotypes. Biofilm intensity is expressed as biofilm production index (BPI). Values are expressed as mean + SD. All experiments were carried out in triplicate and repeated in two independent sets of experiments. Analysis using one-way ANOVA followed by Newman-Keuls multiple comparison test (set at 5%) indicates that serotype 1/2c formed an average amount of biofilm significantly higher than serotype 1/2a on stainless steel, and serotypes 1/2a and 4b on glass.

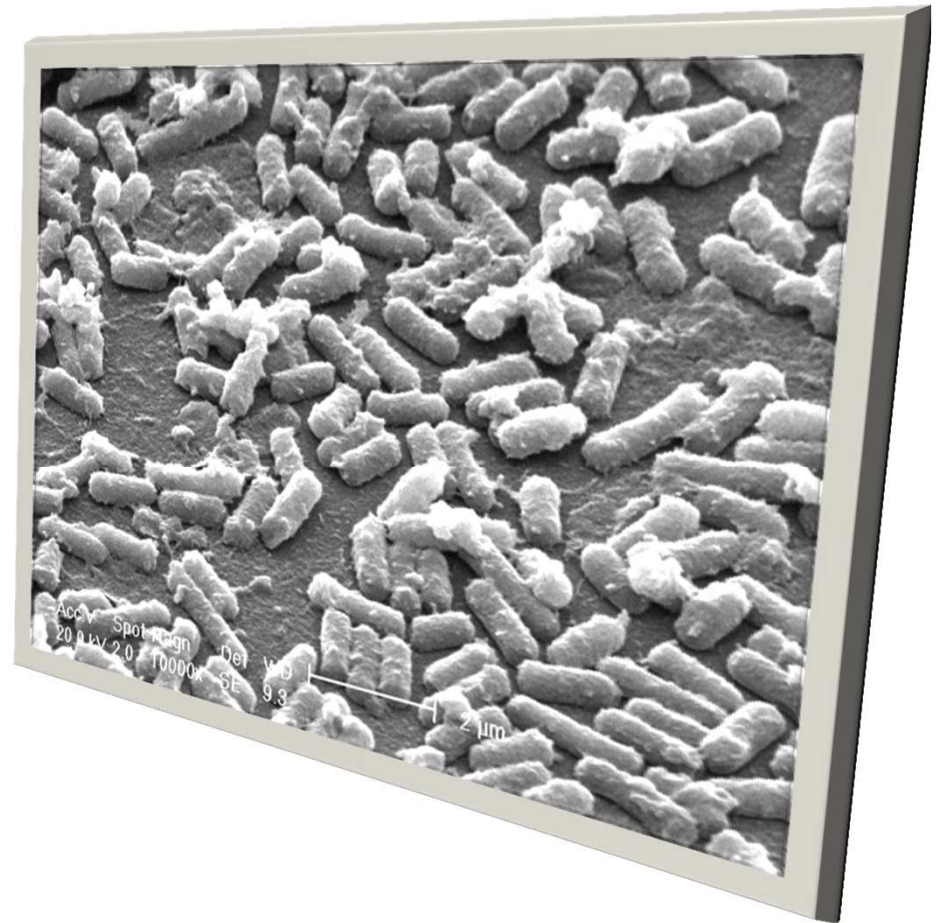


# *L. Monocytogenes* 37°

Acciaio



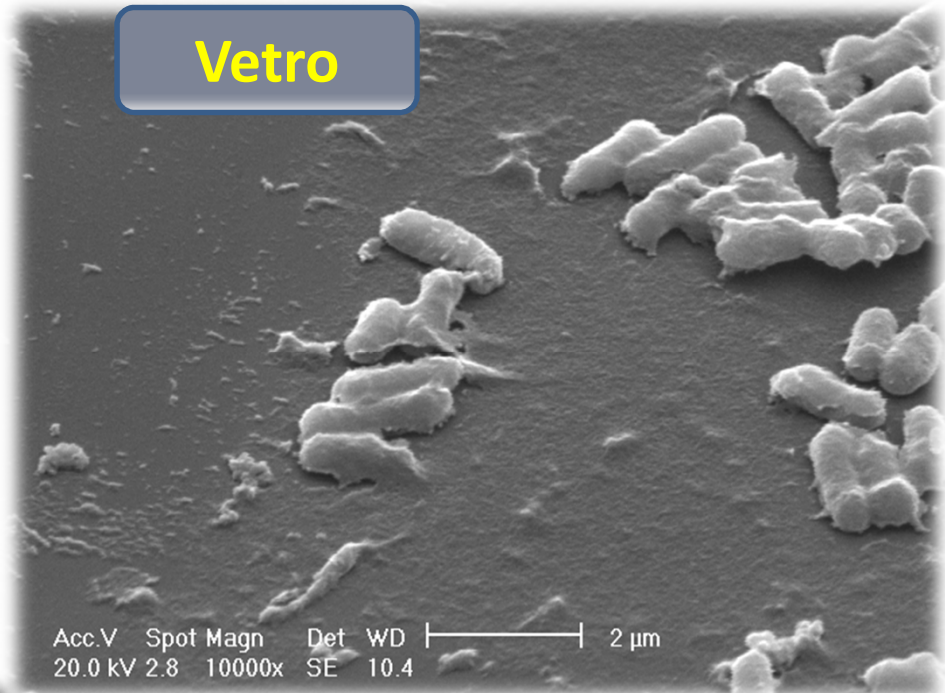
Plastica



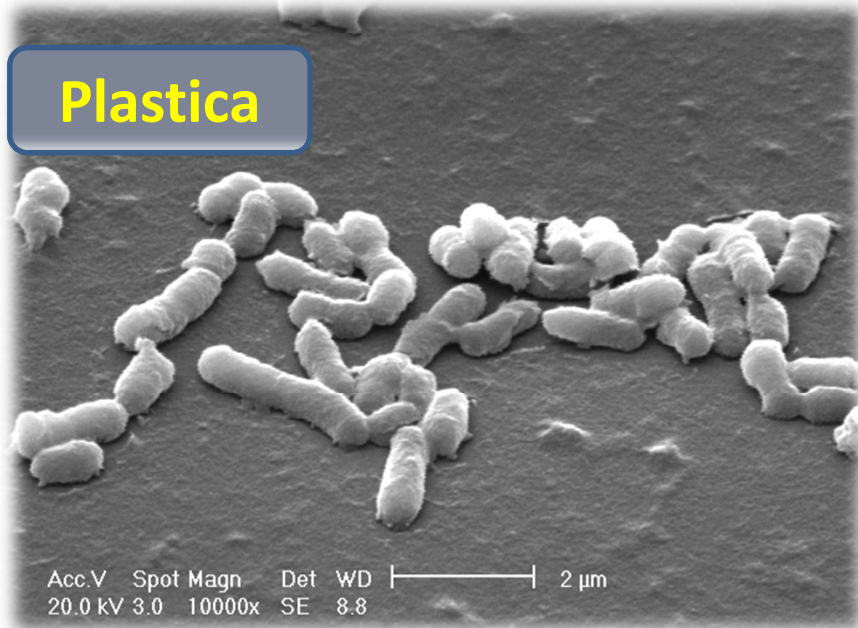
# *L. monocytogenes*

4°C

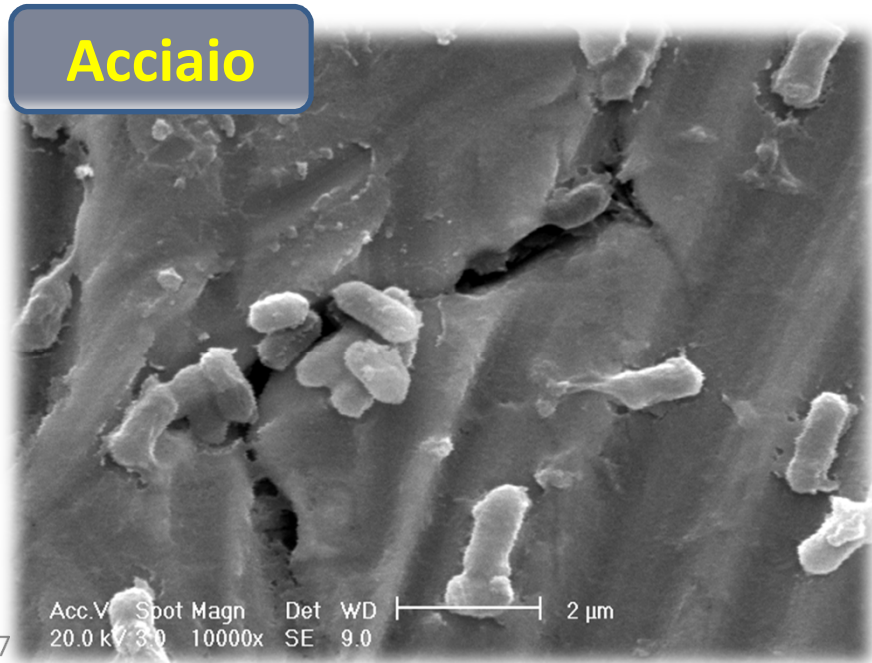
Vetro



Plastica



Acciaio

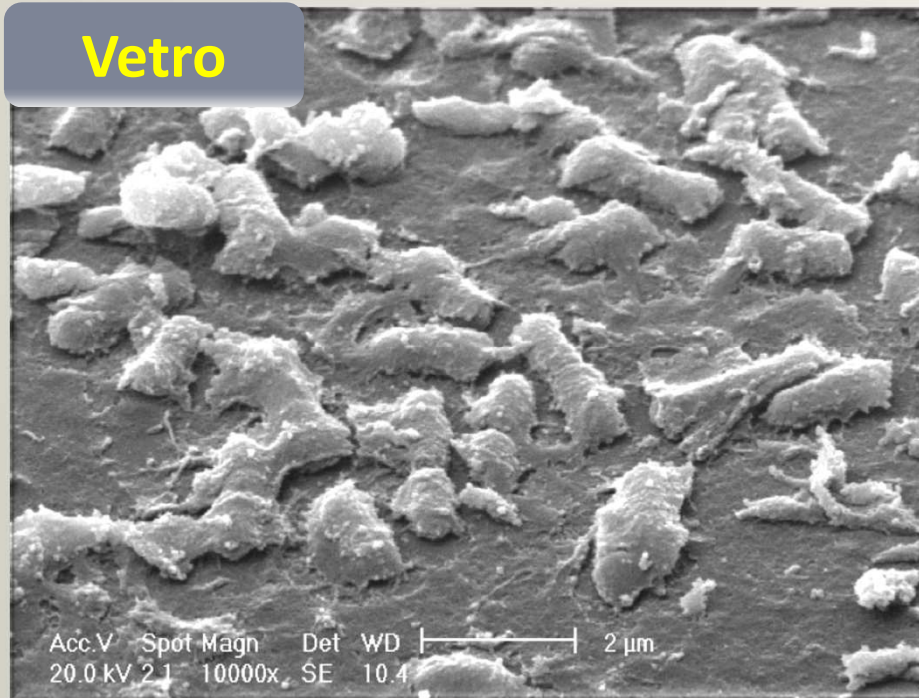




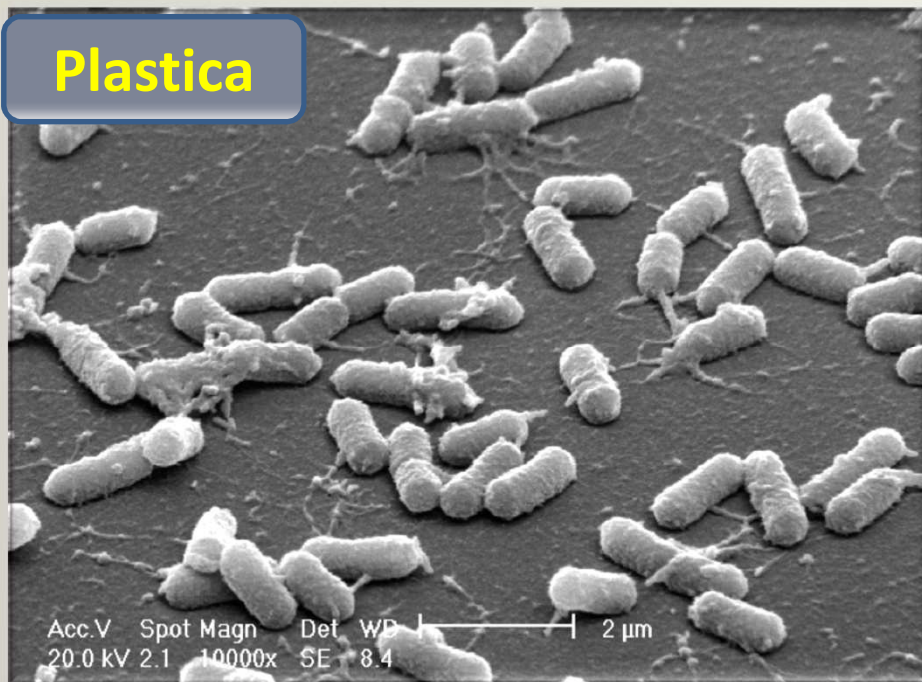
# *L. monocytogenes*

12°C

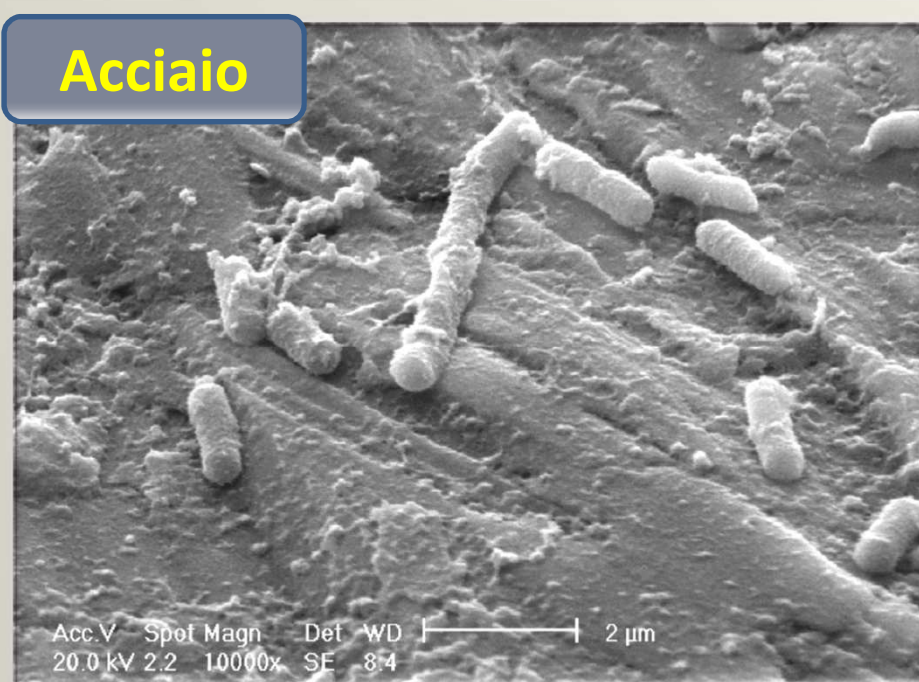
Vetro



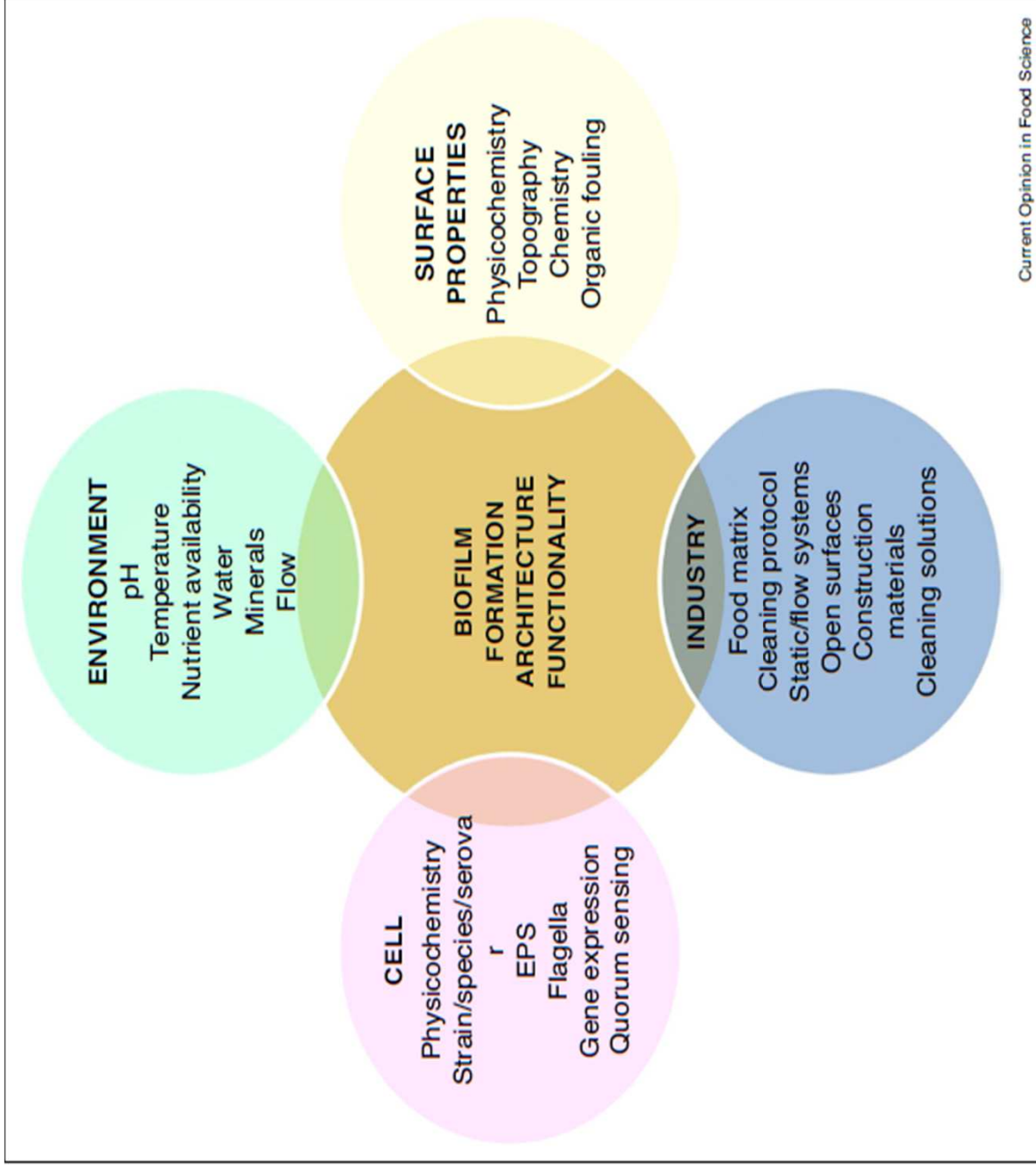
Plastica



Acciaio



*La capacità di formare biofilm di L.m.  
varia notevolmente da ceppo a ceppo  
e nell'ambito di uno stesso ceppo varia  
in funzione della temperatura e del  
substrato*



A complex interplay of factors results in biofilm formation, architecture and hence functionality which are related to the specific industrial food setting in which they are found.