



**waag society**

institute for art, science and technology



# BioHack Academy Microbiology

Picture by Bas Uterwijk



# Growing bacteria







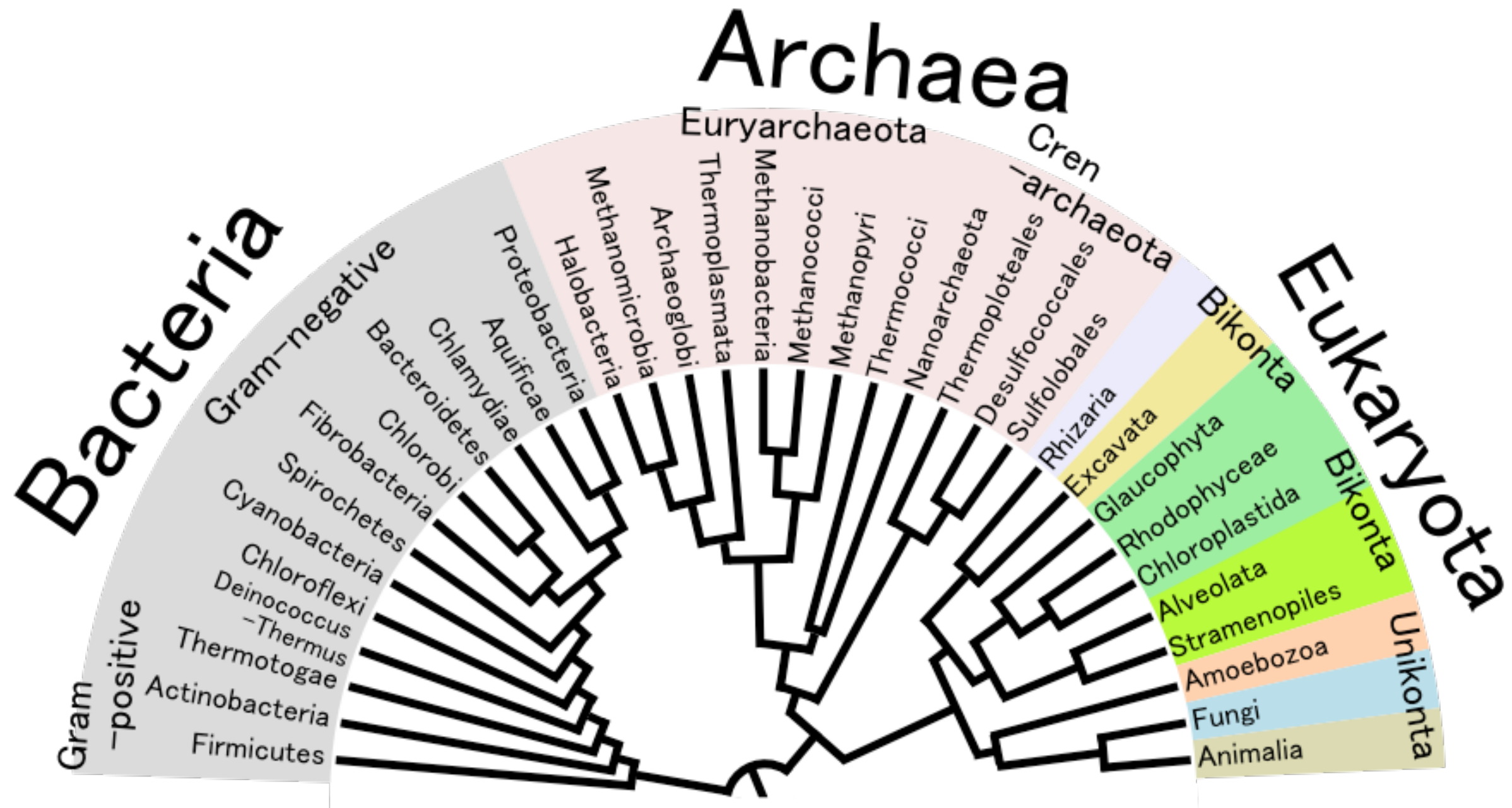
Sonja Baumel







# Phylogeny of the living world







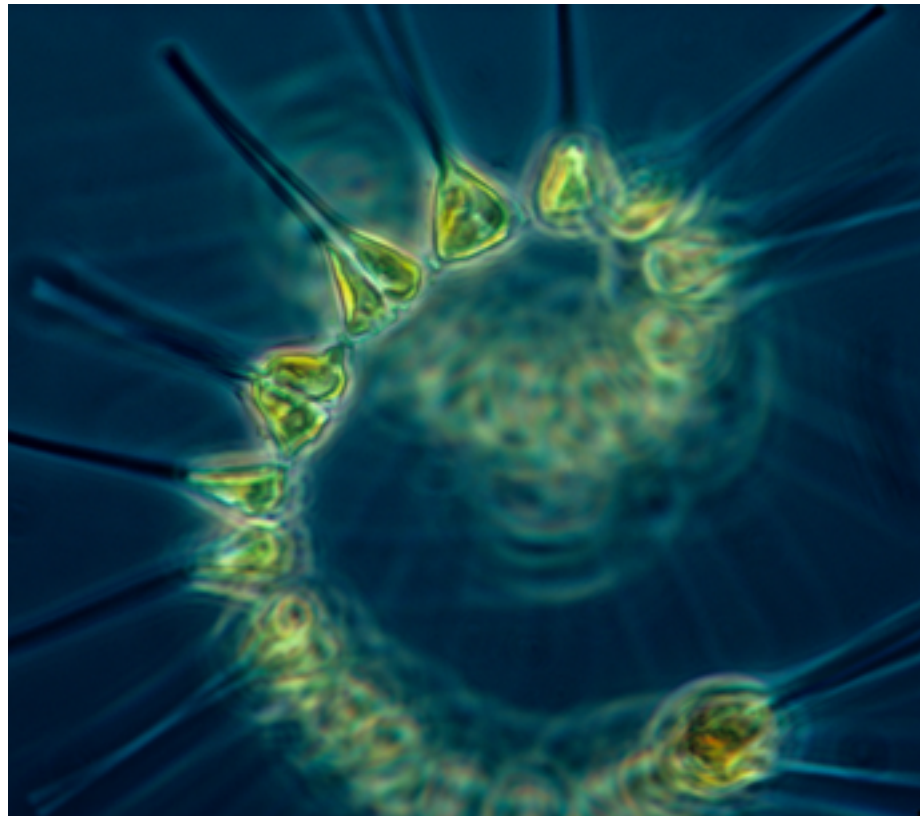
# Definition of life

**unicellular**  
(single cell)



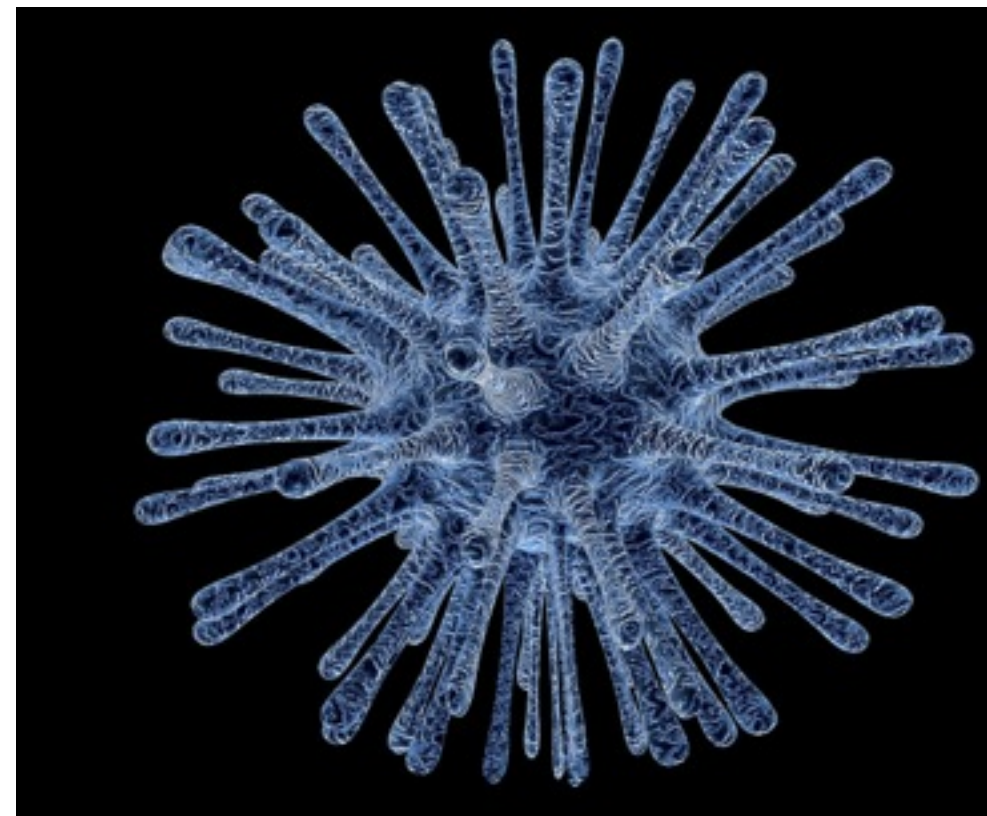
NIAID – CC-BY 2.0

**multicellular**  
(cell colony)



CC0 – Public Domain

**acellular**  
(lacking cells)

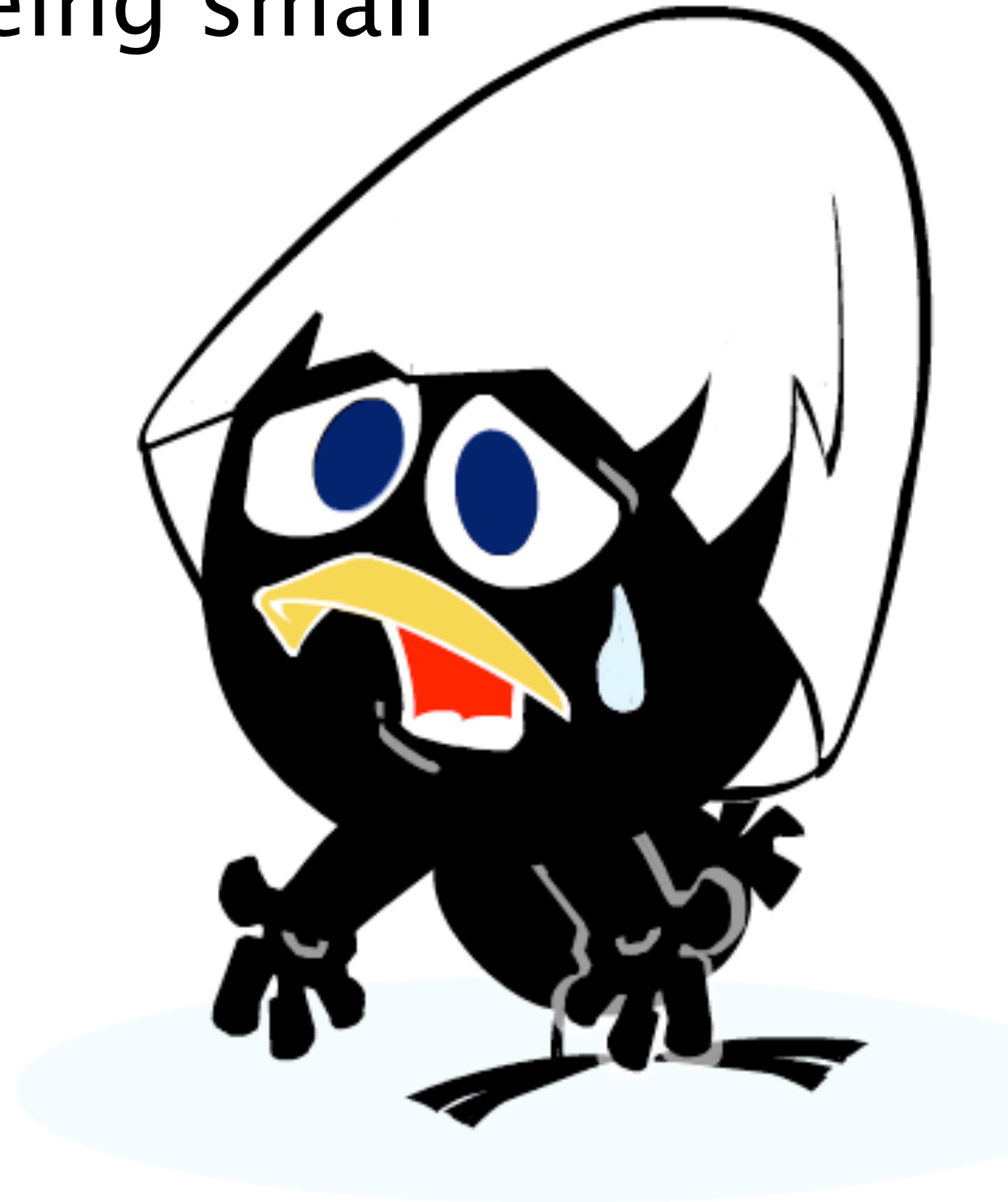


Pixabay – CC0 – Public Domain



# Advantage of being small

- Large surface to volume ratio
- Simple structure
- Quick distribution
- Short generation time
- Huge metabolic diversity
- Ability to swab genes







# Exercise

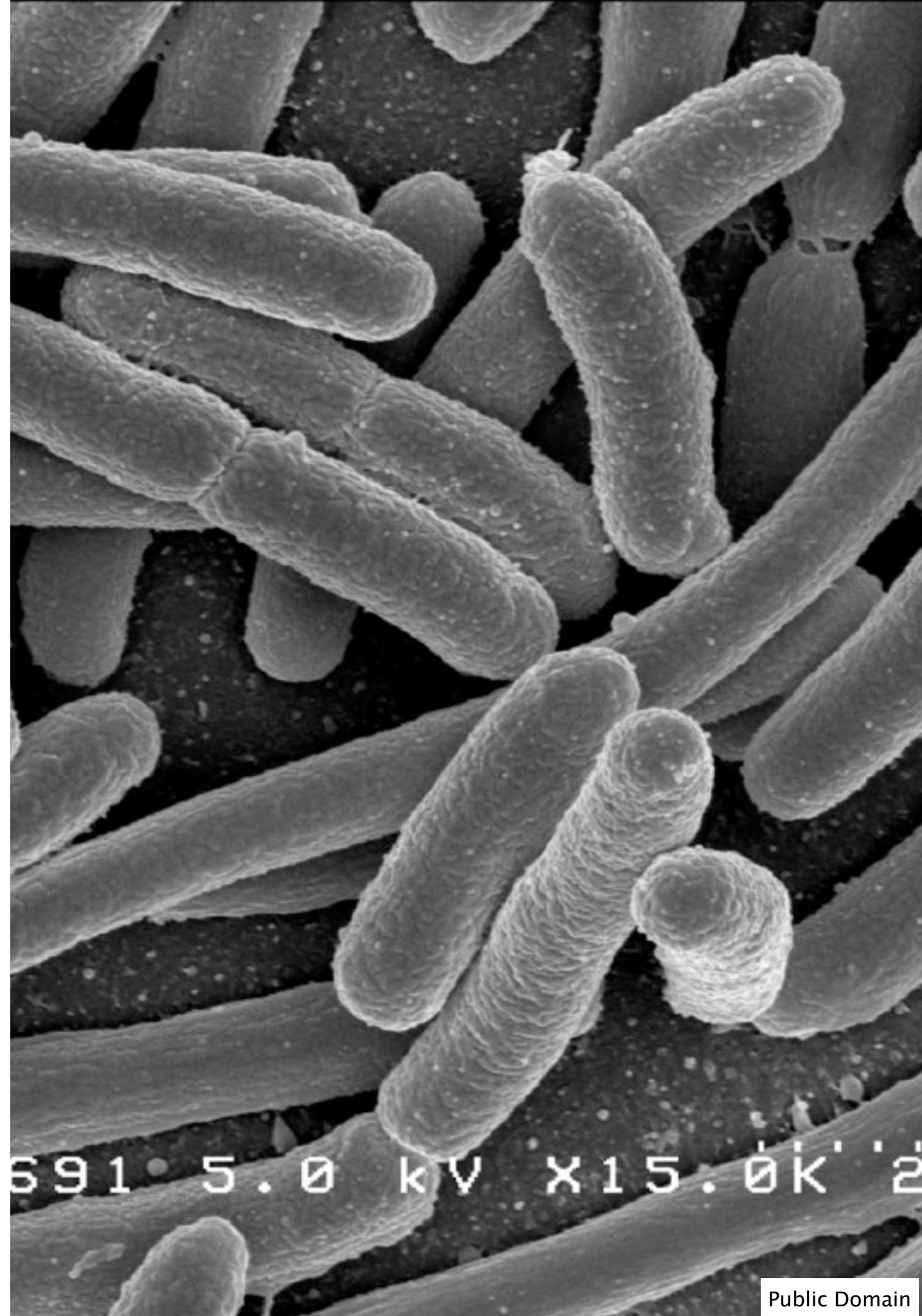
E. coli weighs  
 $3.0 \times 10^{-13} \text{ gr.}$

Dimension:

- Height  $2.0 \mu\text{m}$
- Diameter  $0.8 \mu\text{m}$

Let's assume E. coli is  
shaped like a cylinder

What is the surface area?





# Cylinder formulas

$$\textit{Top area} = \pi \times r^2$$

$$\textit{Bottom area} = \pi \times r^2$$

$$\textit{Side area} = 2 \times \pi \times r \times h$$

$$\textit{Total surface area } A = 2\pi r^2 + 2\pi h$$

$$\textit{Volume } V = \pi \times r^2 \times h$$





# Solution exercise 1

$$1 \text{ gr. of } E. coli \doteq \frac{1}{3 \times 10^{-13}} = 3.33 \times 10^{12} \text{ cells}$$

*Surface:*

$$\text{Length } L = 2 \times 10^{-6}$$

$$\text{Radius } r = 0.4 \times 10^{-6}$$

$$2 \times \pi \times r \times L + 2 \times \pi \times r^2 = 20 \text{ m}^2$$



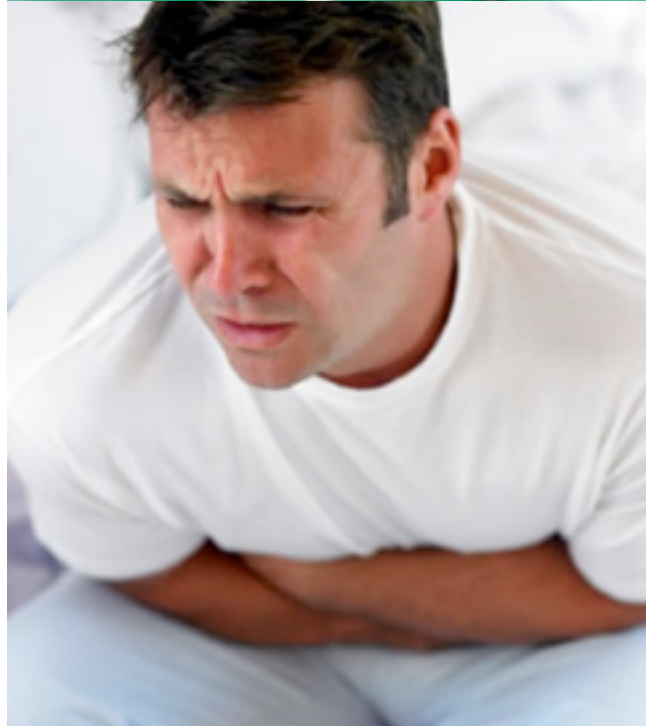
# Microorganisms: Role in our daily live







# Microorganisms: Role in our daily live





# Sulfur (purple) bacteria bloom







# Cyanobacteria (algae)







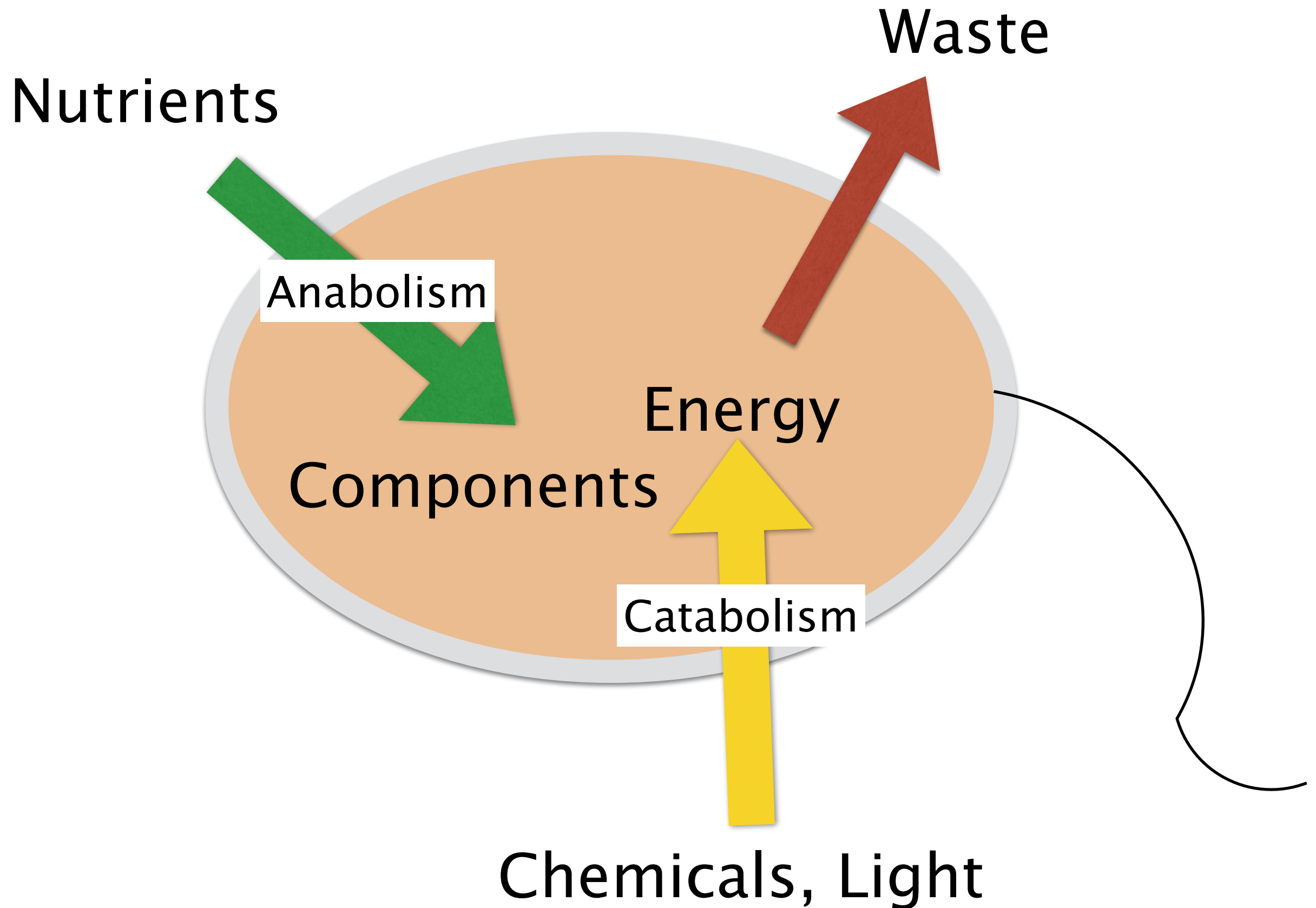
# Fixate nitrogen







# Cellular Metabolism





# What to produce in a biofactory?

- Cells → Biomass → Food
- Metabolites → Ethanol → Food
- Antibiotics → Pigments → Paint
- Light
- Cell structures → Cellulose → Material





**waag society**

institute for art, science and technology

# Biohack Academy Strains

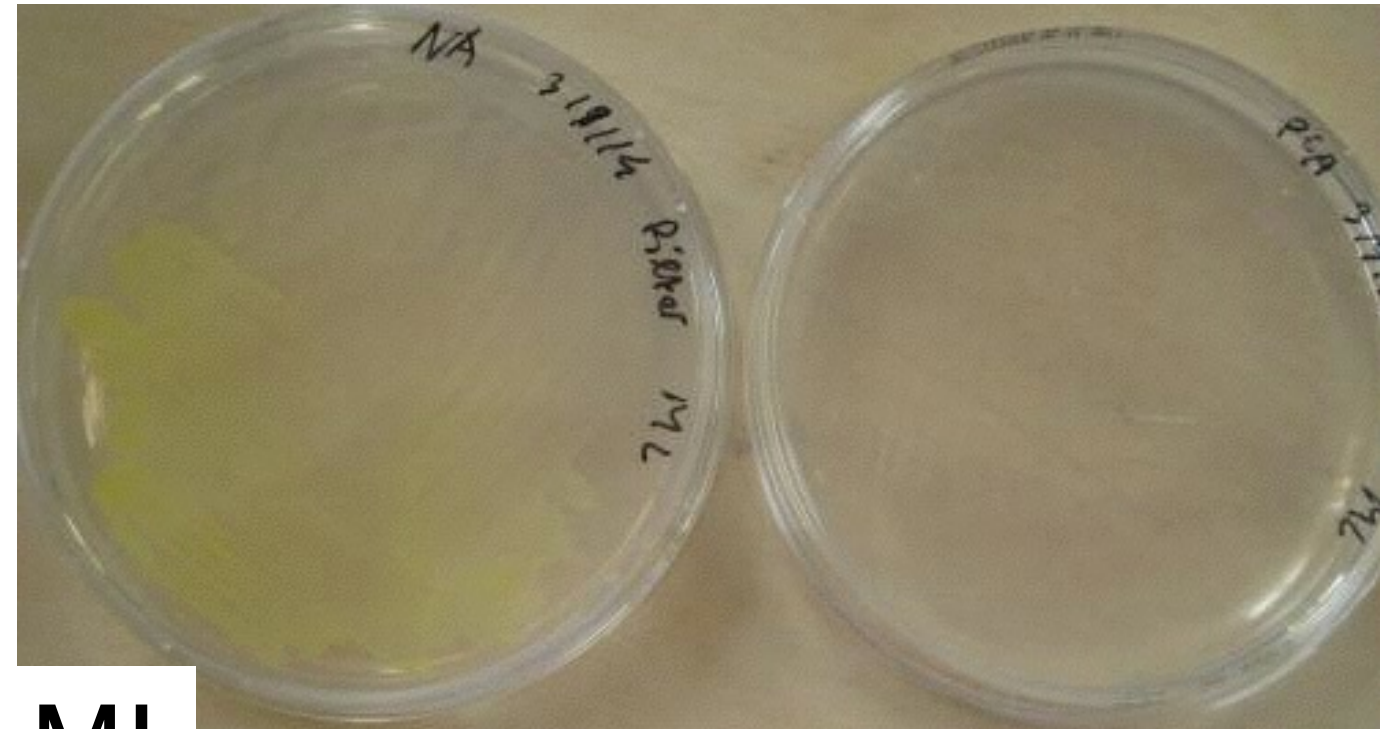
Meet the Microbes



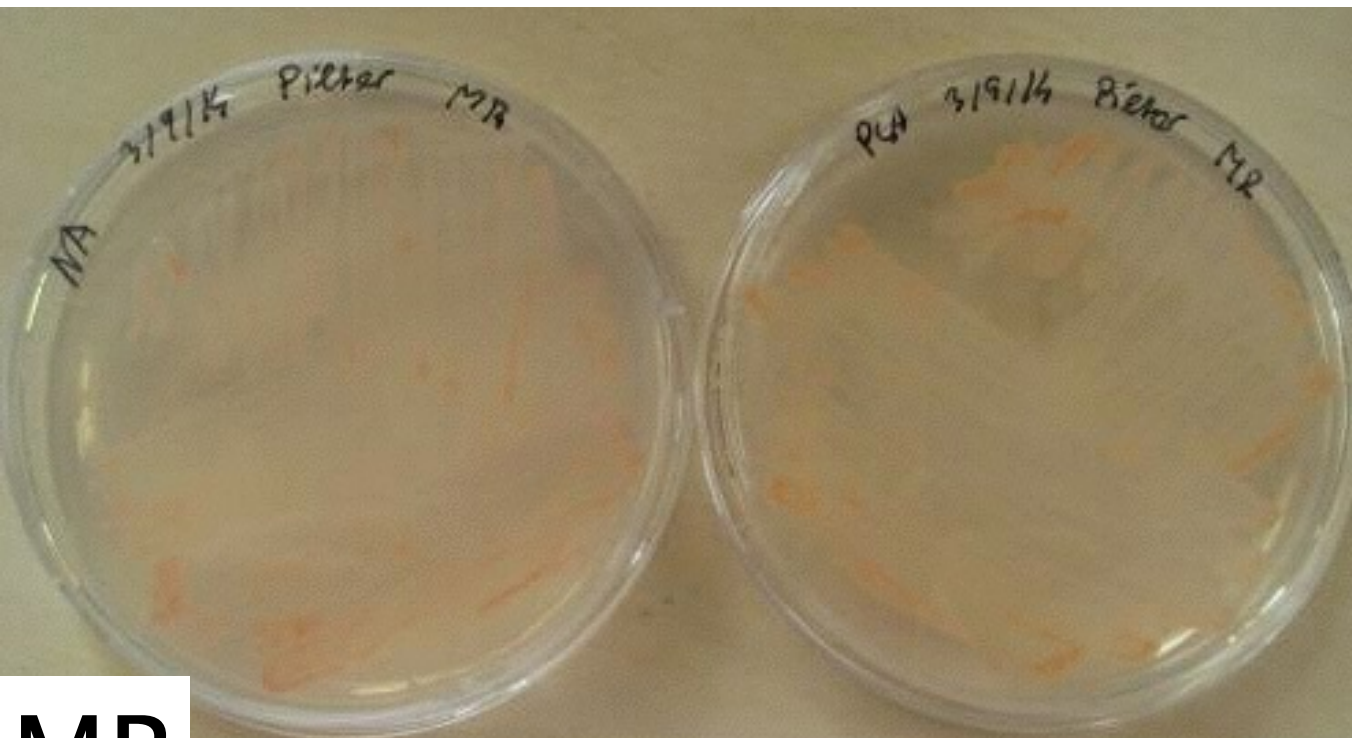
# Pigmented bacteria

Pigments  
Antibiotics

Micrococcus luteus (ML)  
Janthinobacterium lividum (JL)  
Micrococcus roseus (MR)



ML



MR



JL

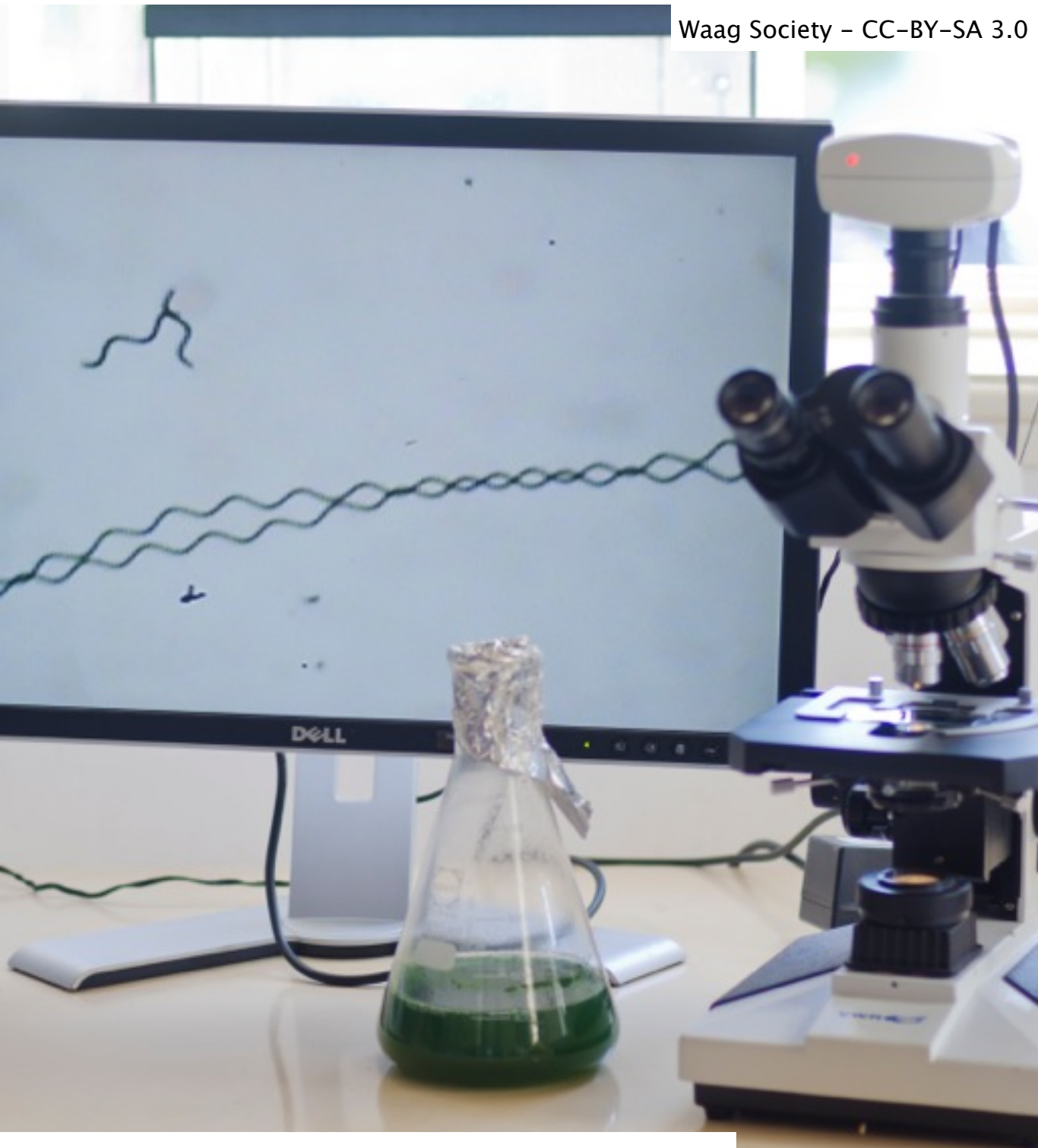




# Algae

Pigments  
Food

Waag Society – CC-BY-SA 3.0



*Spirulina maxima*

Society for General Microbiology



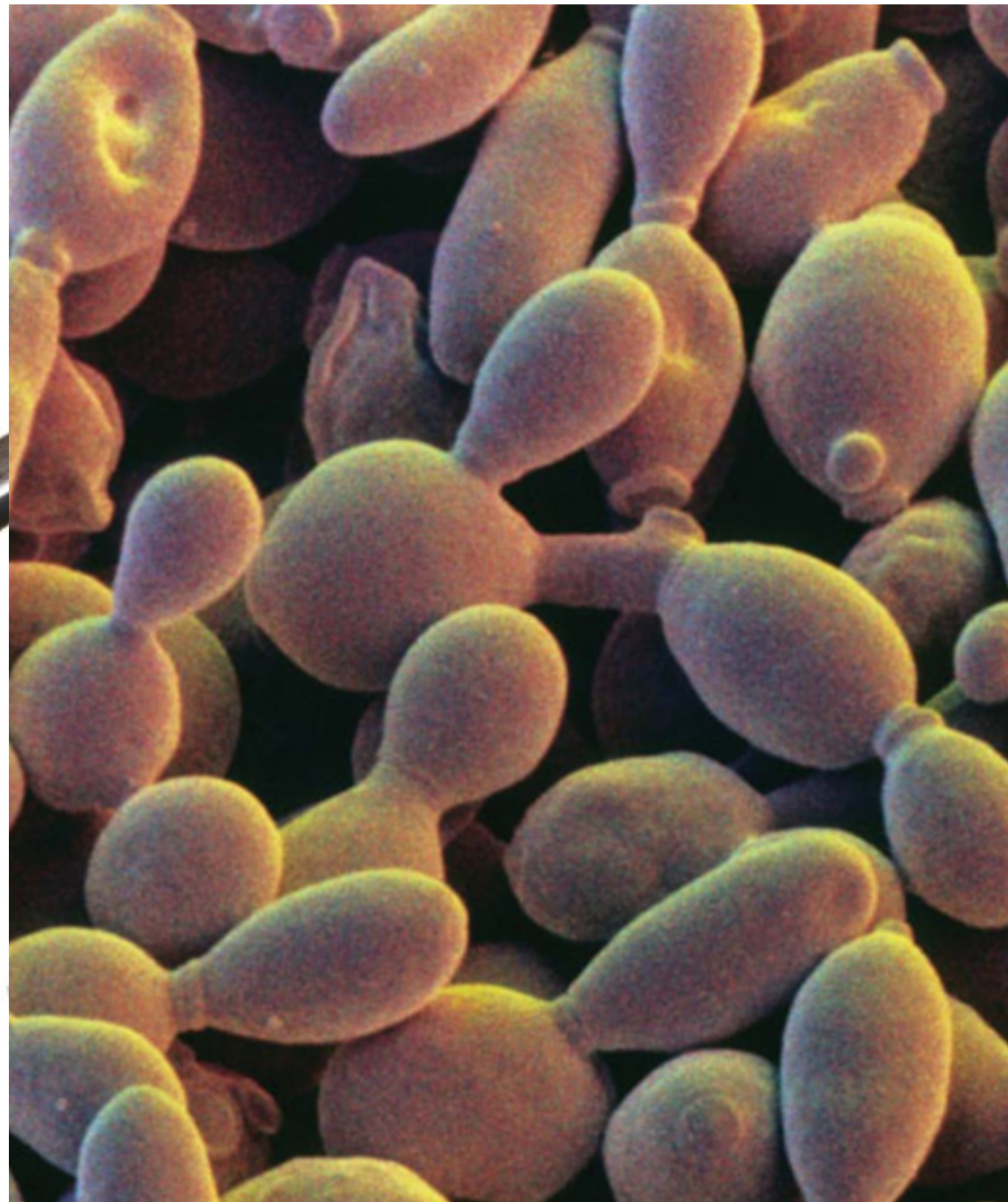
*D. salina*





# Yeast

Alcohol  
CO<sub>2</sub>



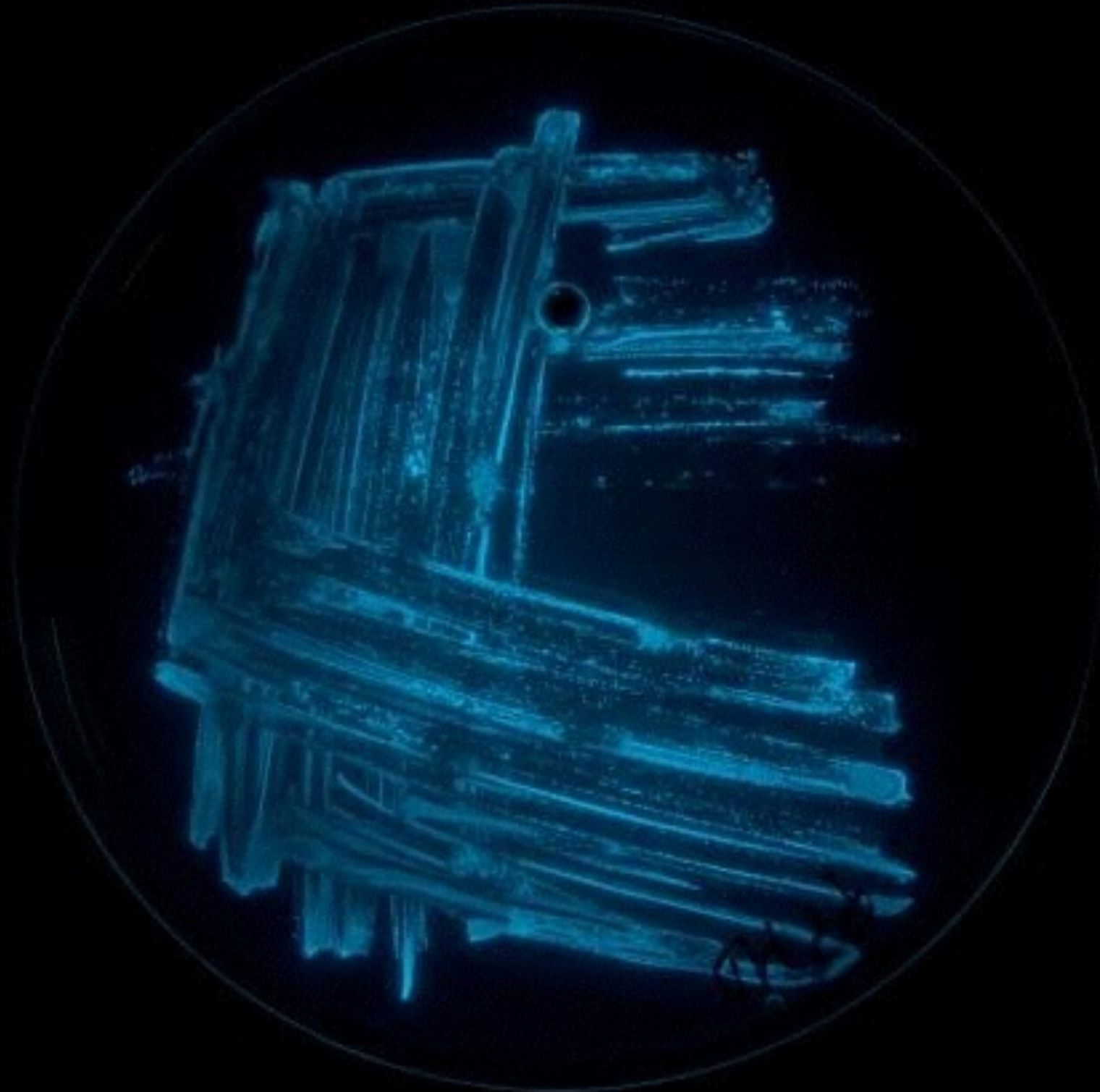




# Photobacterium phosphoreum

Light

Waag Society – CC-BY-SA 3.0





SCOBY

Cellulose  
Vinegar

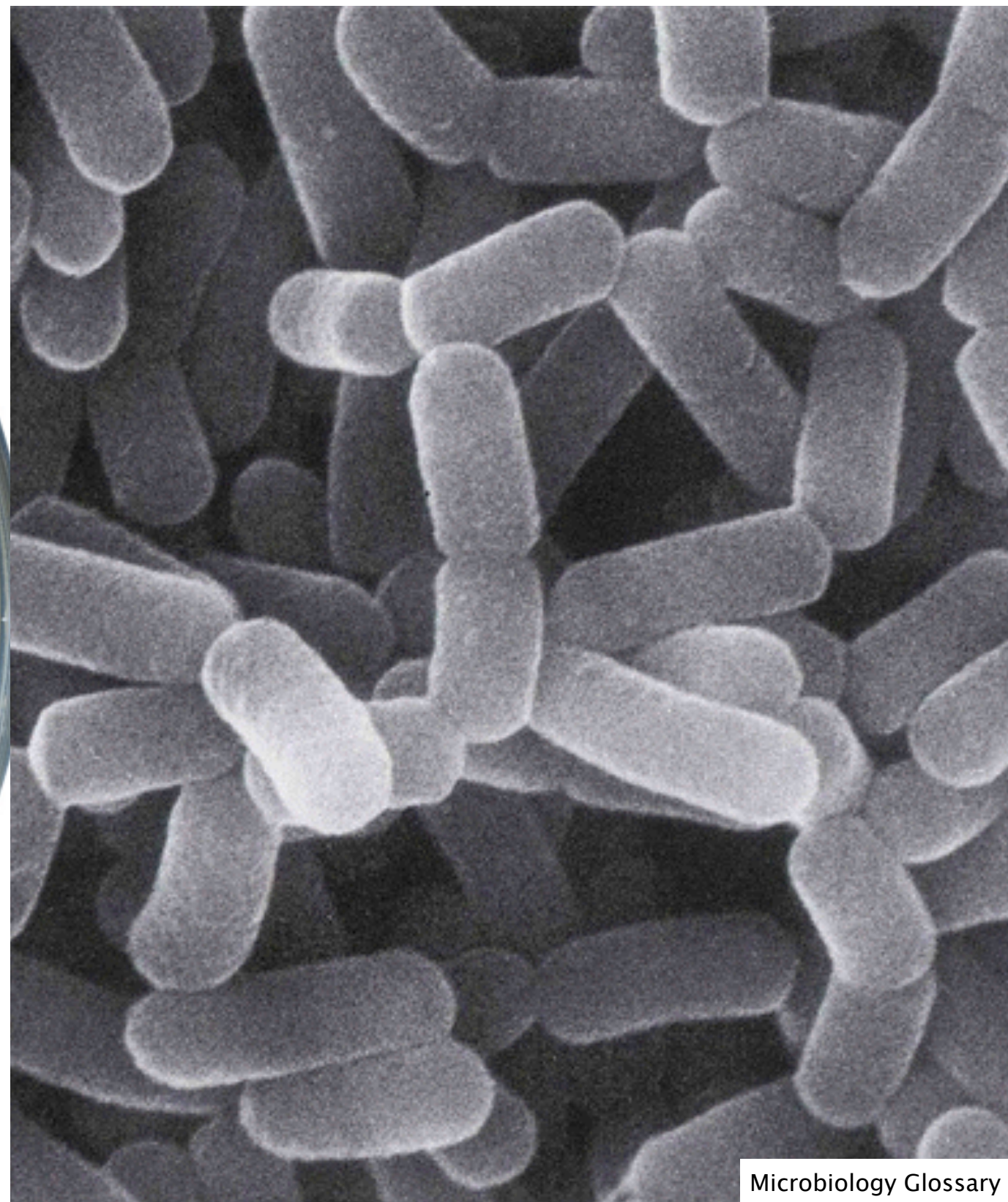
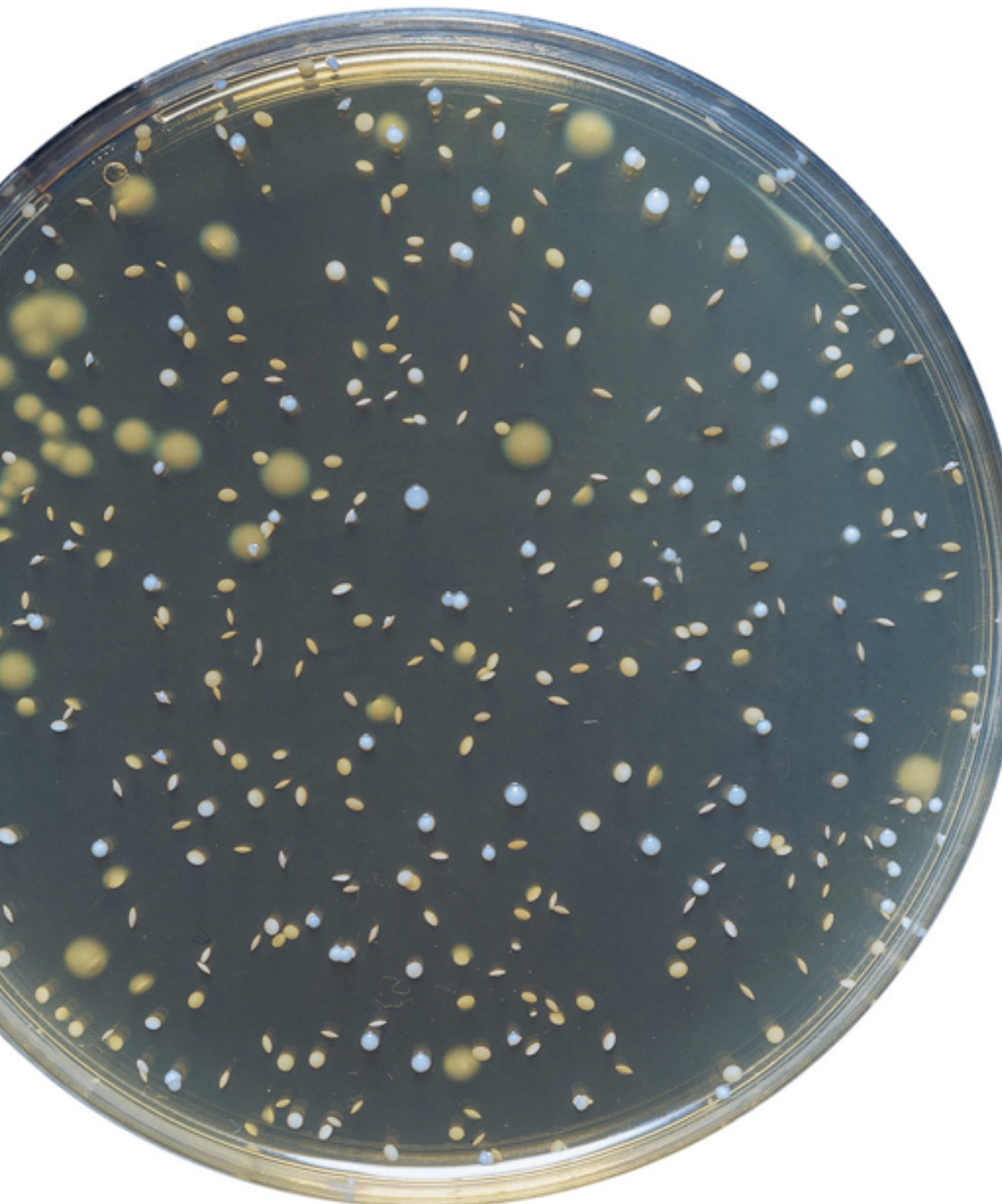
Symbiotic Culture of Bacteria and Yeast





# Lactobacillus

Yoghurt  
Lactic acid







# Classification

- Bio safety level number indicates the level of regulations that need to be in place to prevent contamination.
- Types of organisms allowed per level:
  - 1) Well characterized non pathogenic organisms to humans
  - 2) Micro organisms with high infection doses, and known cures
  - 3) Micro organisms with low infection doses, and known cures
  - 4) Micro organisms with extremely low infection doses, severe disease and no cure







**some  
rights  
reserved**

These slides are published by Waag  
Society under CC-BY-SA 4.0 license