

biohack academy
waag society

Microbiology



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institute for art, science and technology

What is life?



Is this alive?





Is this alive?



Is this alive?



.



Some characteristics of life

Reproduction

Heredity

Adaptation

Energy consumption

Internal self-regulation

genetic information

Cell devision



Growing bacteria



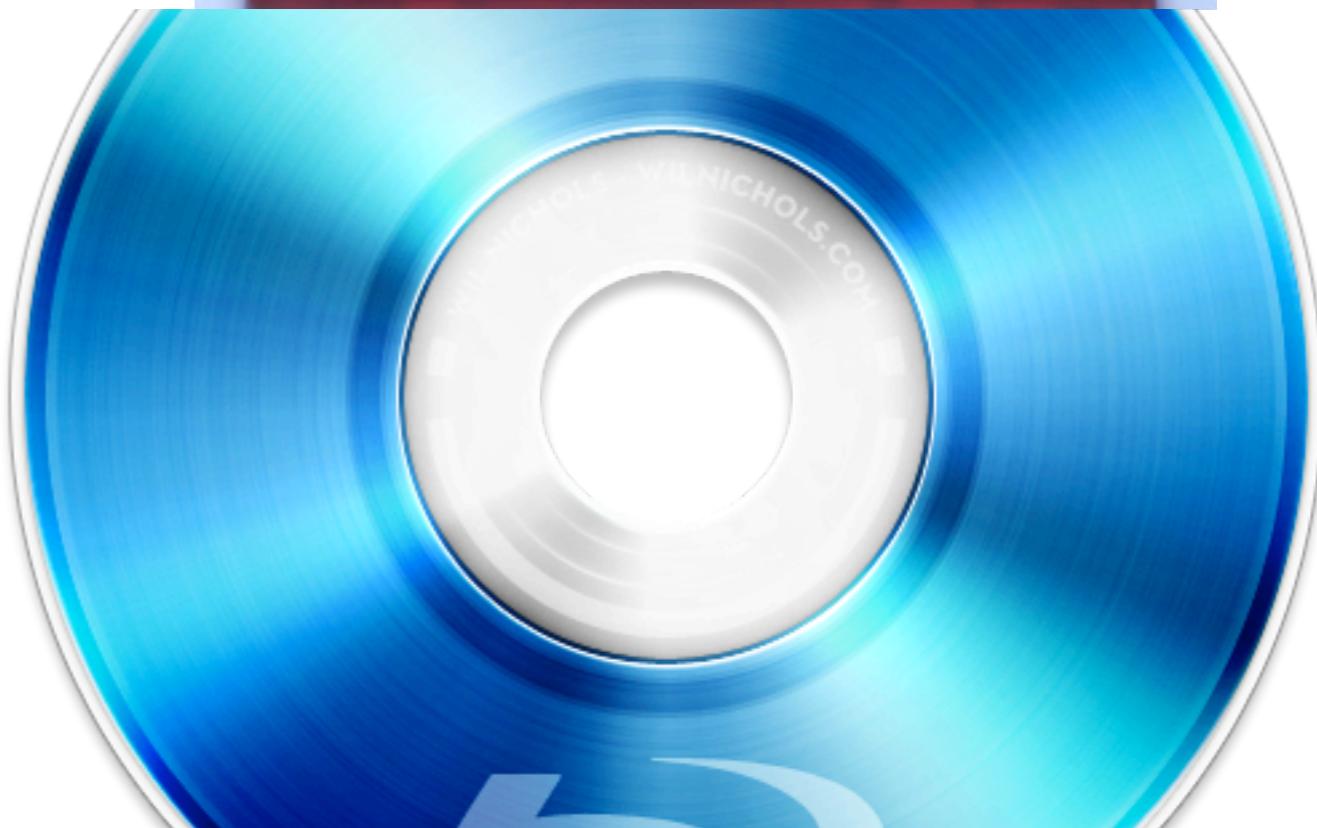
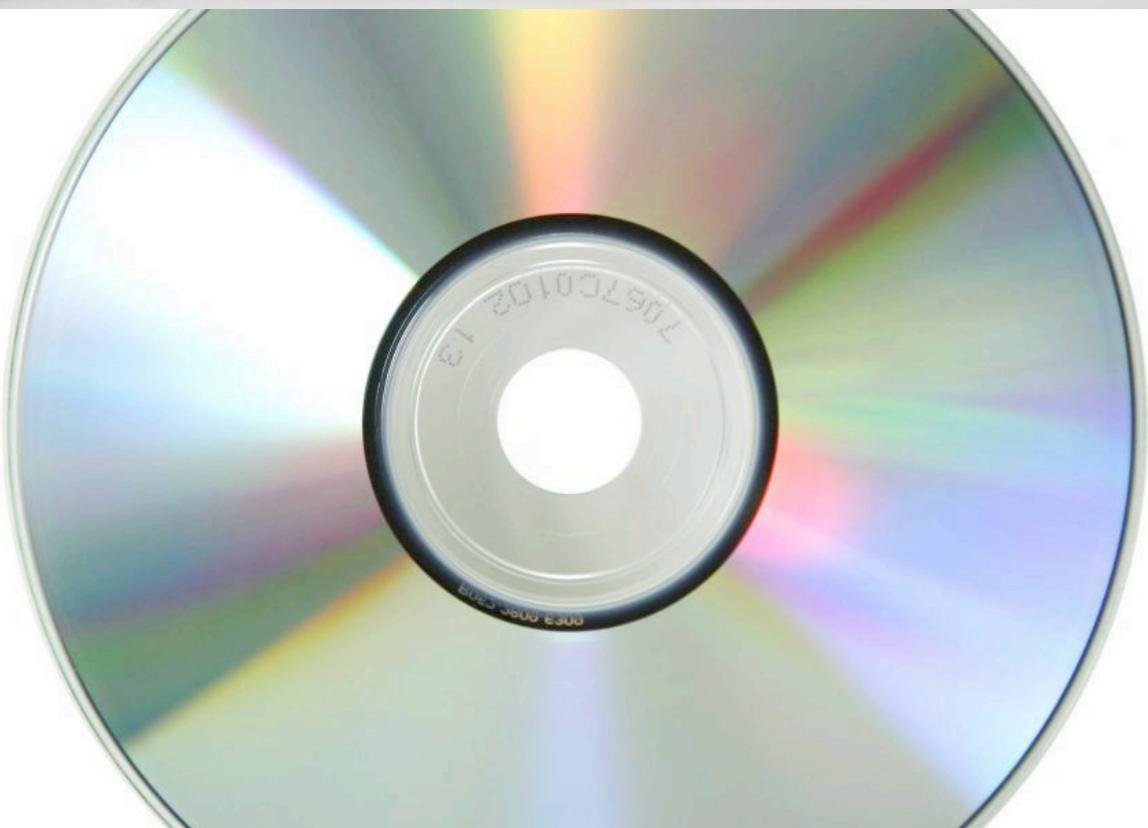


Terike Haapoja. "Entropy," 2004





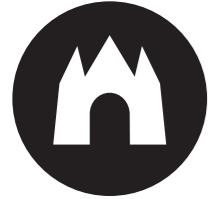
Information carrier





Life sticked to the same standard





Concepts related to life

Sustainability, environmental justice

Complexity, intelligence

Evolution

Symbiosis, parasitizing

Disease, death

Sociology, human behaviour

Human relation to ecology

Digitization

Origin of life

Ownership

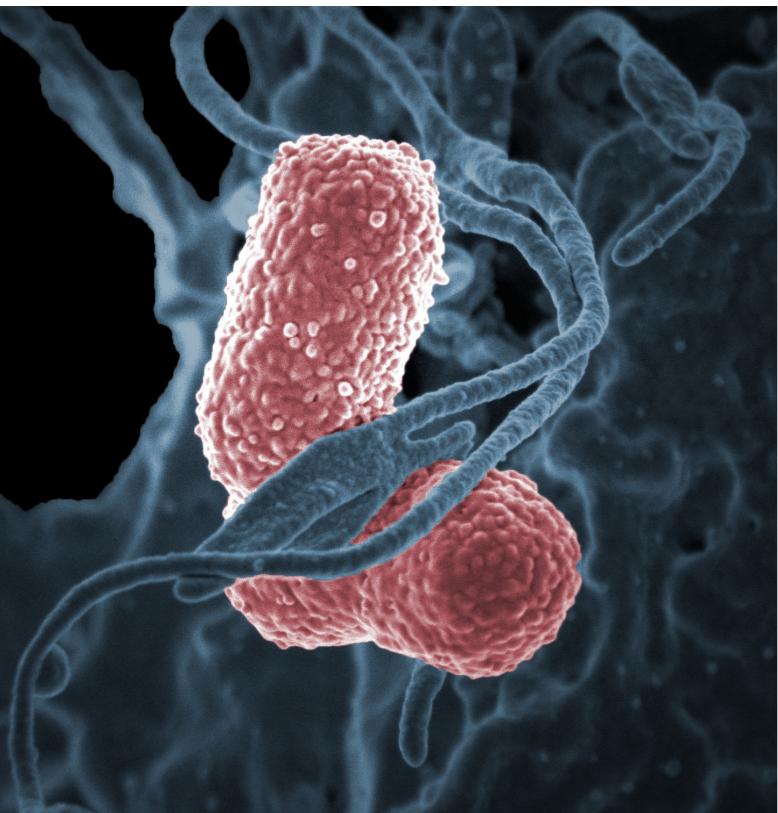


Microbiology



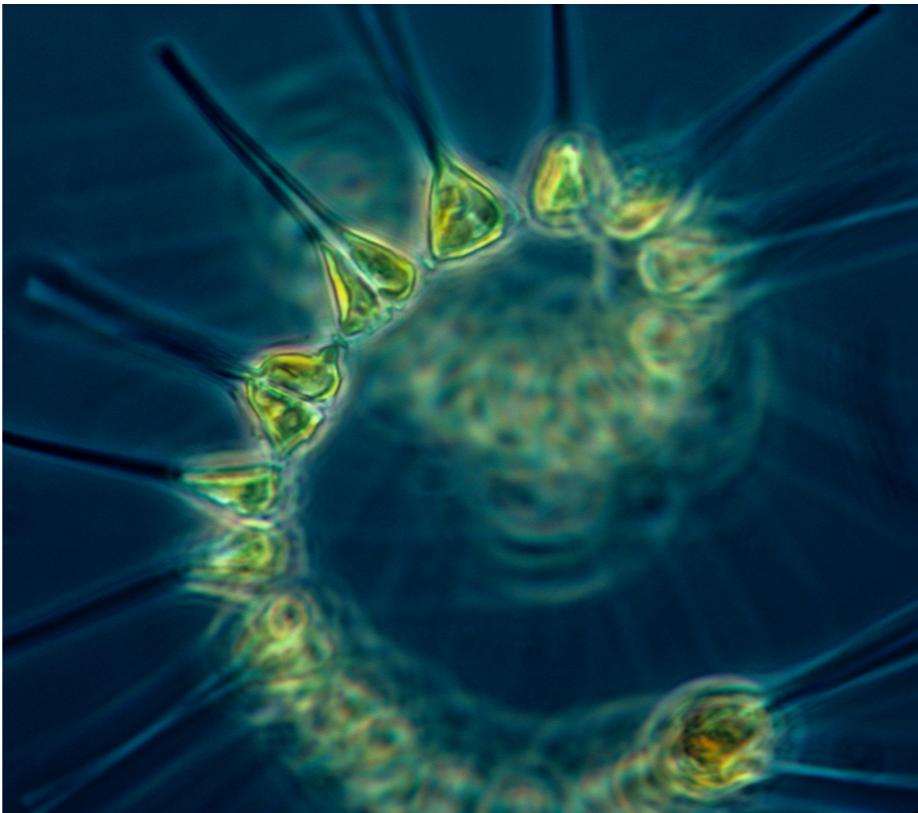
Definition of life

unicellular
(single cell)



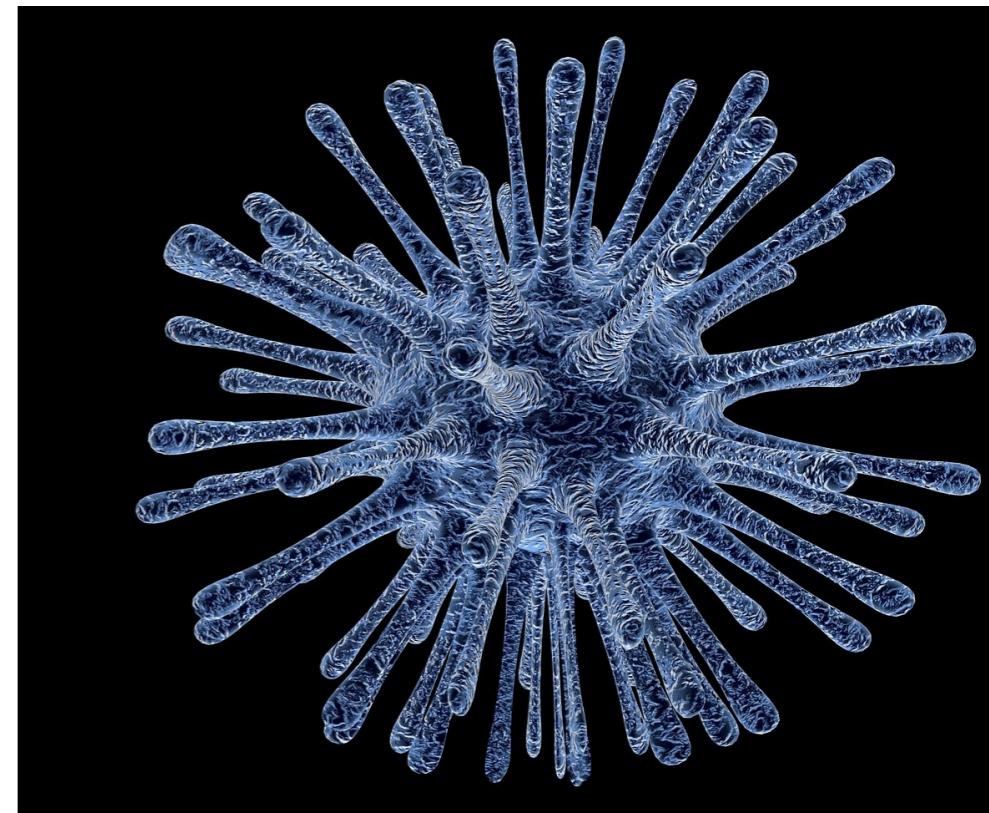
NIAID – CC-BY 2.0

multicellular
(cell colony)



CC0 – Public Domain

acellular
(lacking cells)

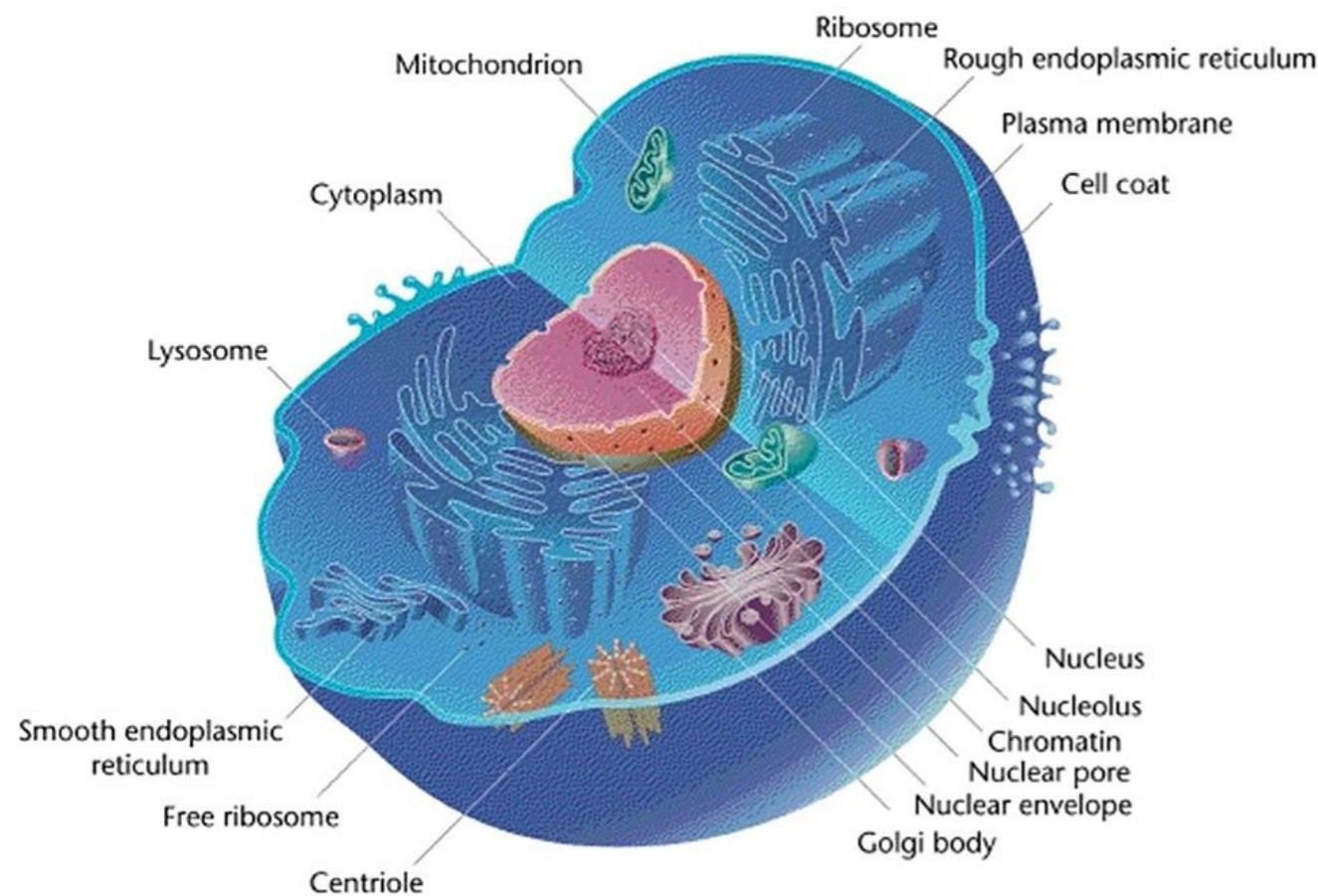


Pixabay – CC0 – Public Domain

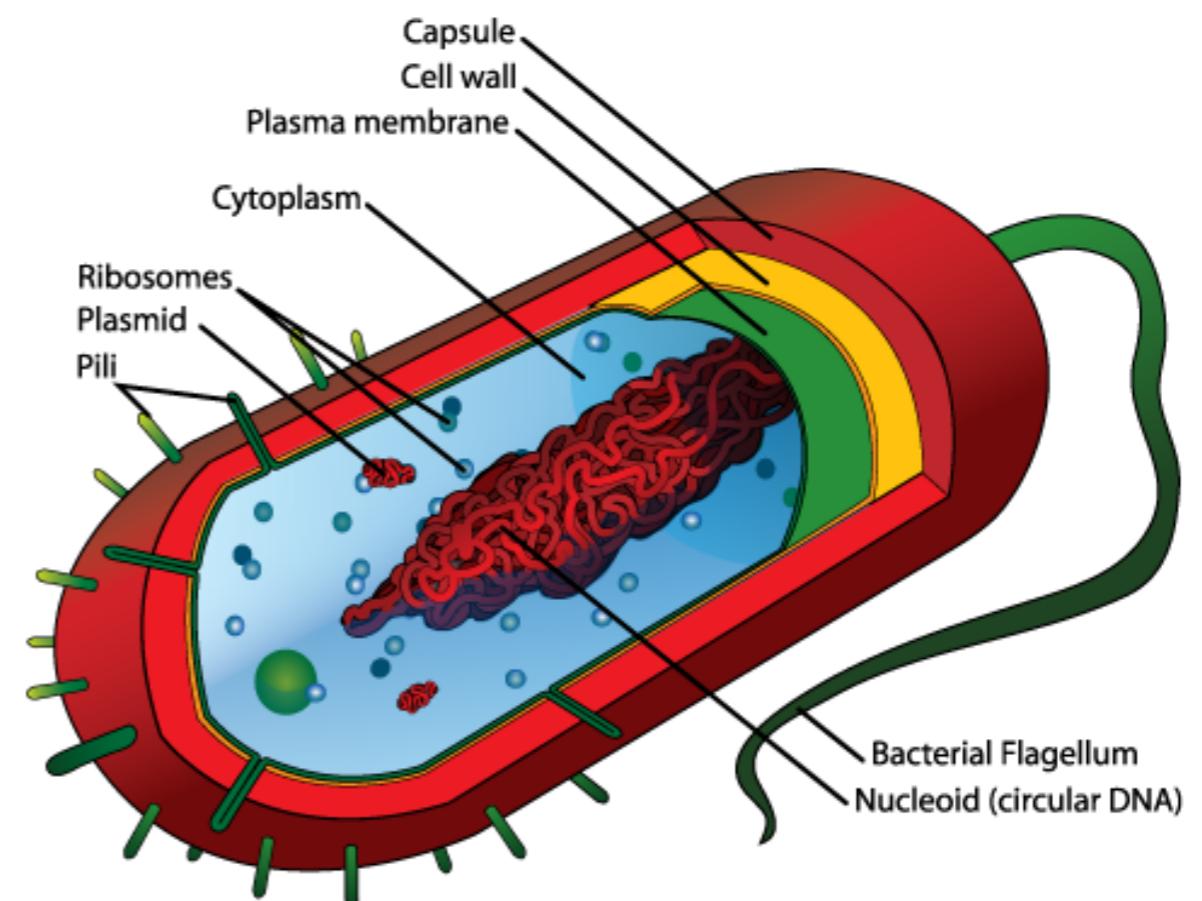


Two main categories

Eukaryotic cell



Prokaryotic cell





Advantage of being small

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





Exercise

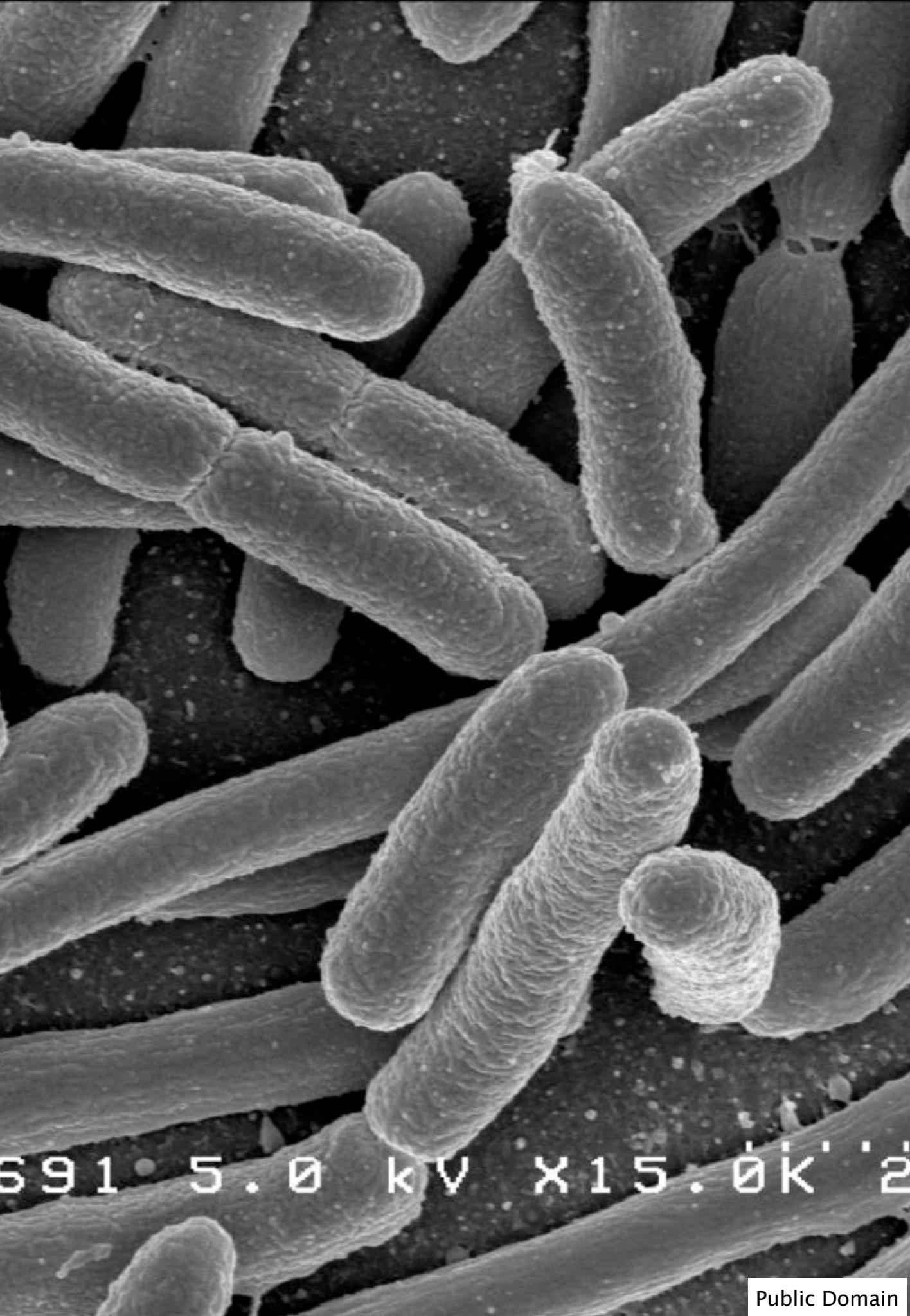
E. coli weighs $3.0 \times 10^{-13} gr.$

Dimension:

- Height $2.0 \mu m$
- Diameter $0.8 \mu m$

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

What is the surface area of 1 gram of E. coli cells?





Cylinder formulas

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

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

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

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

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



Solution exercise 1

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

Surface:

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

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

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

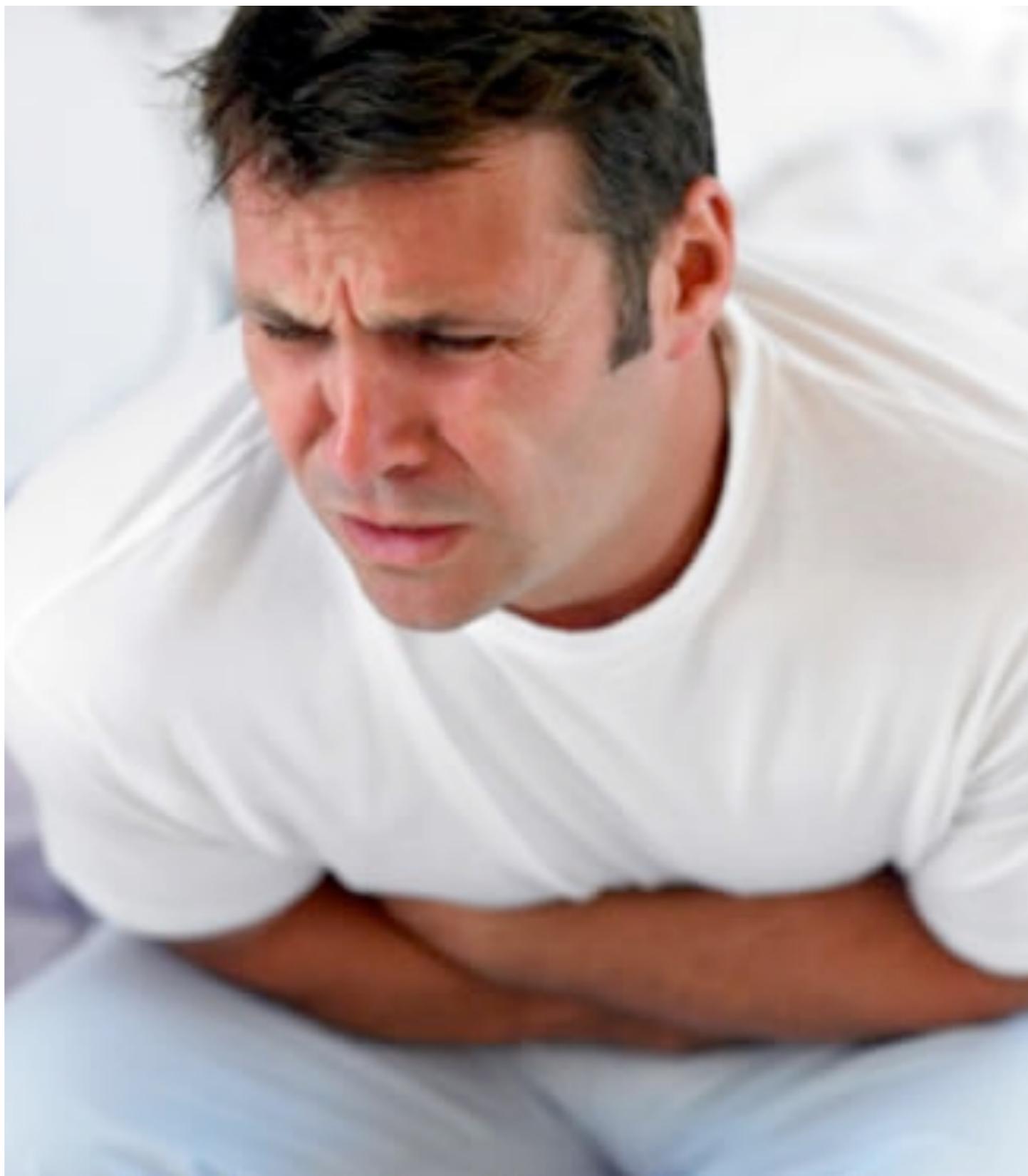


Microorganisms: Role in our daily live





Microorganisms: Role in our daily live





Sulfur (purple) bacteria bloom



Buse Lake 3 – Cal Kimona Brown



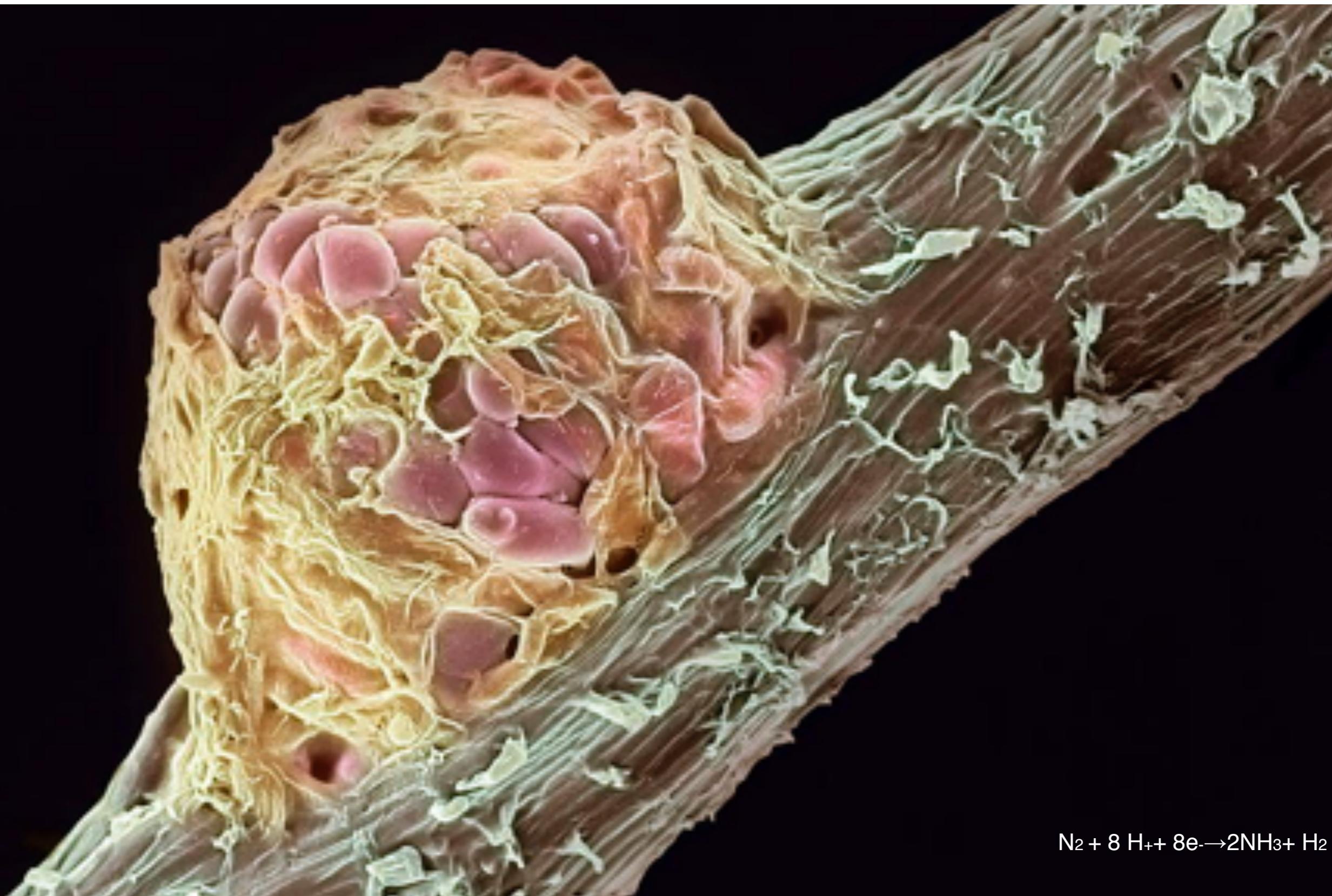
Cyanobacteria (algae)

Pollution?



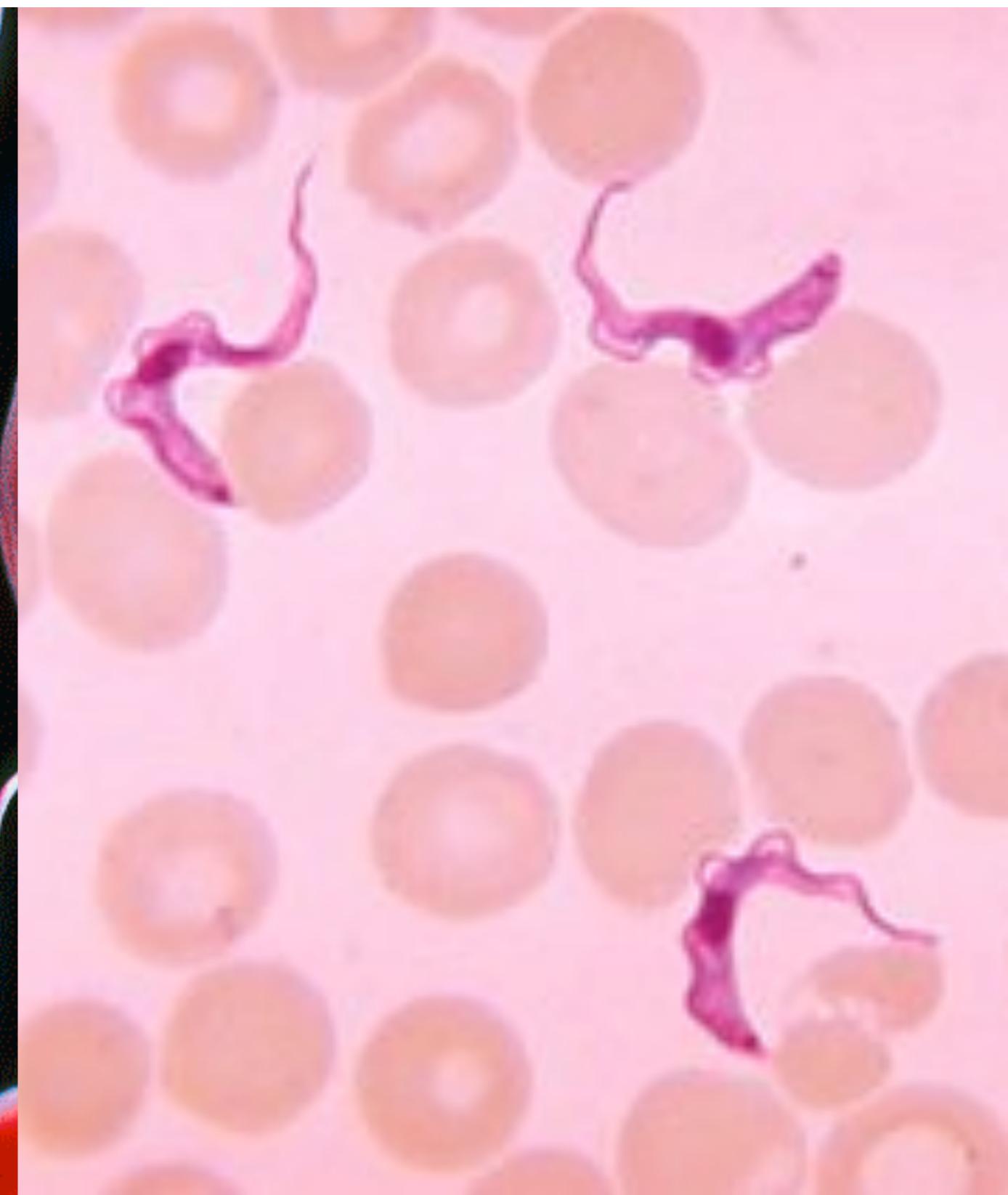
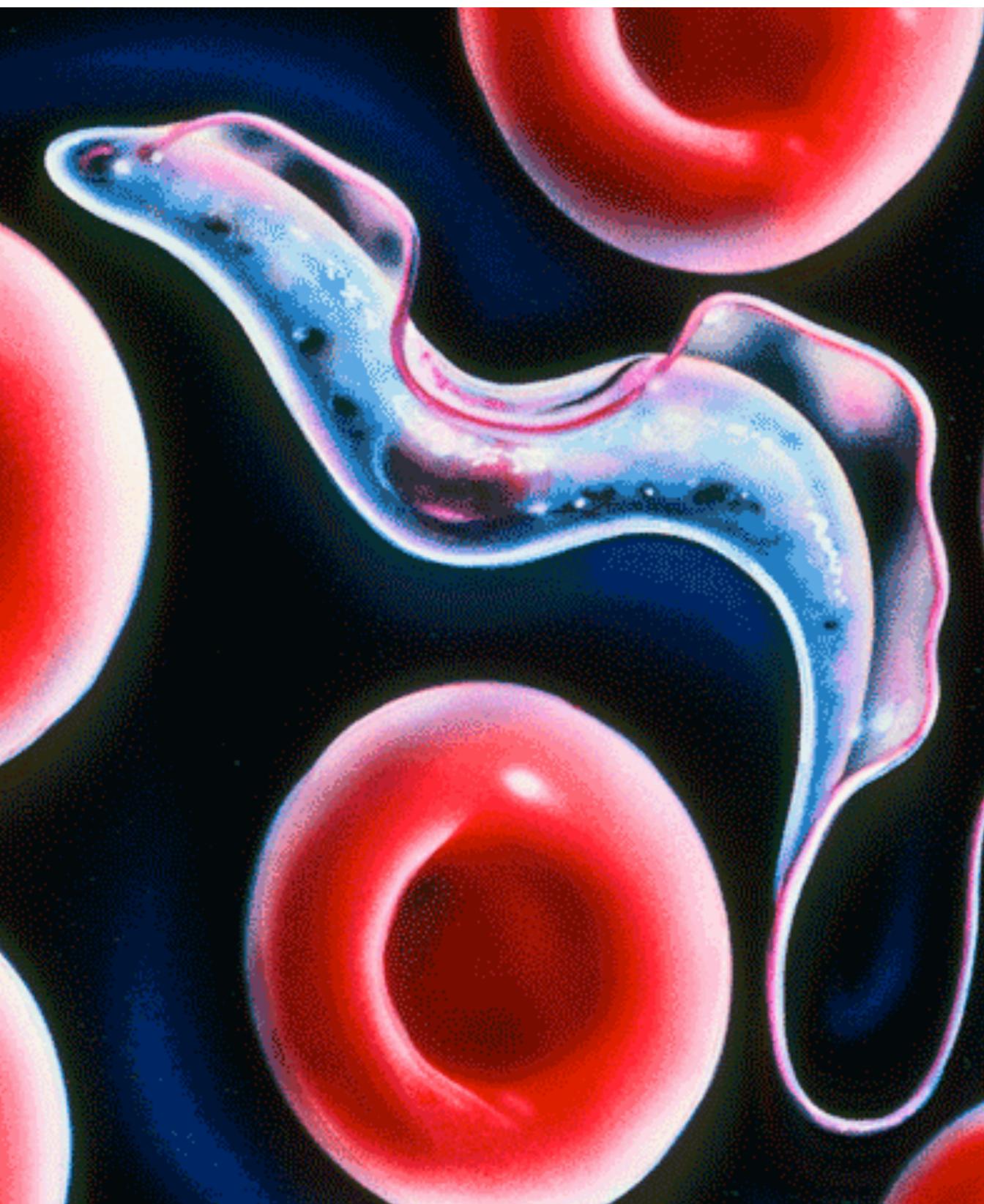


Fixate nitrogen





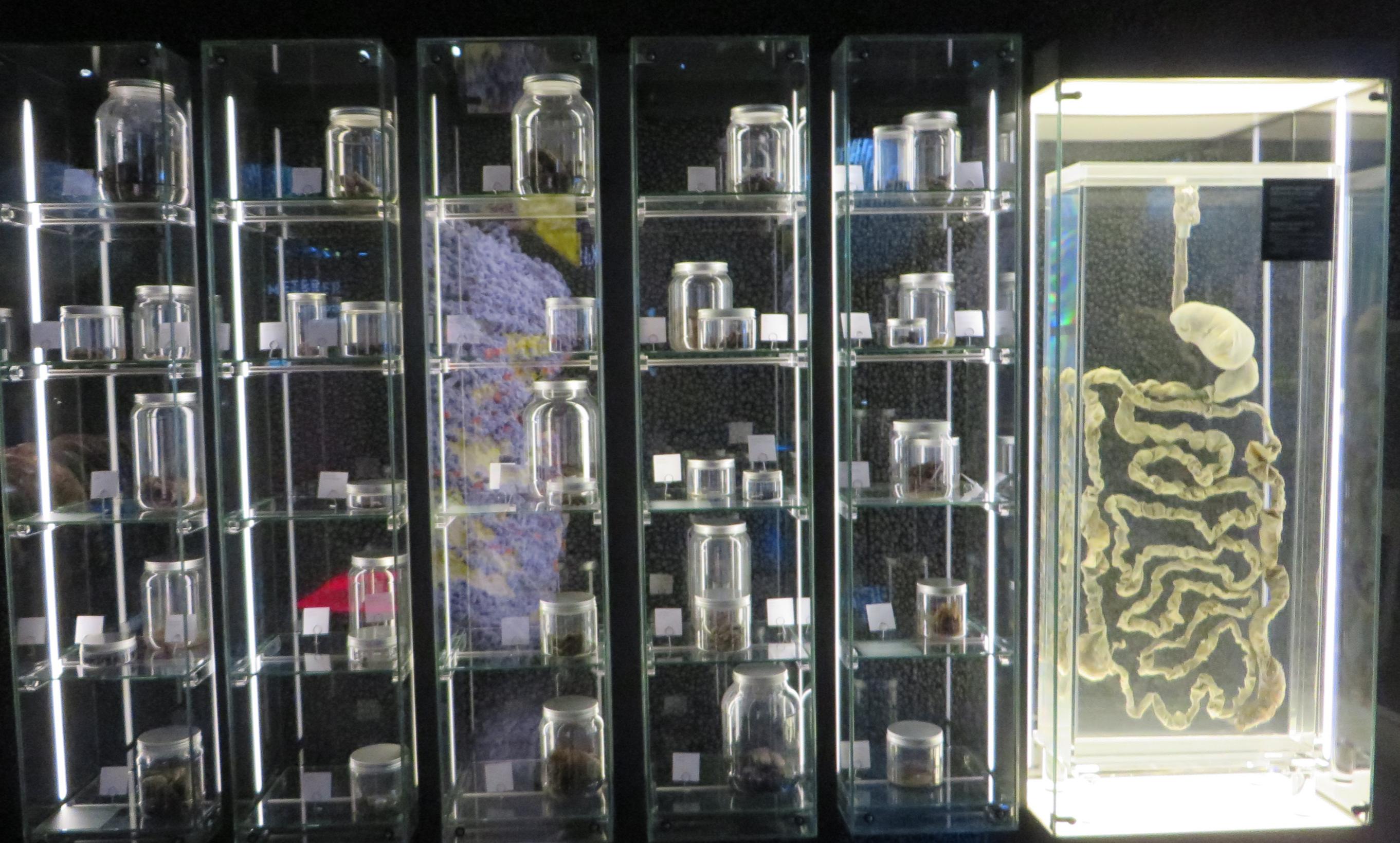
Cause disease – *Trypanosoma brucei*





Second brain?

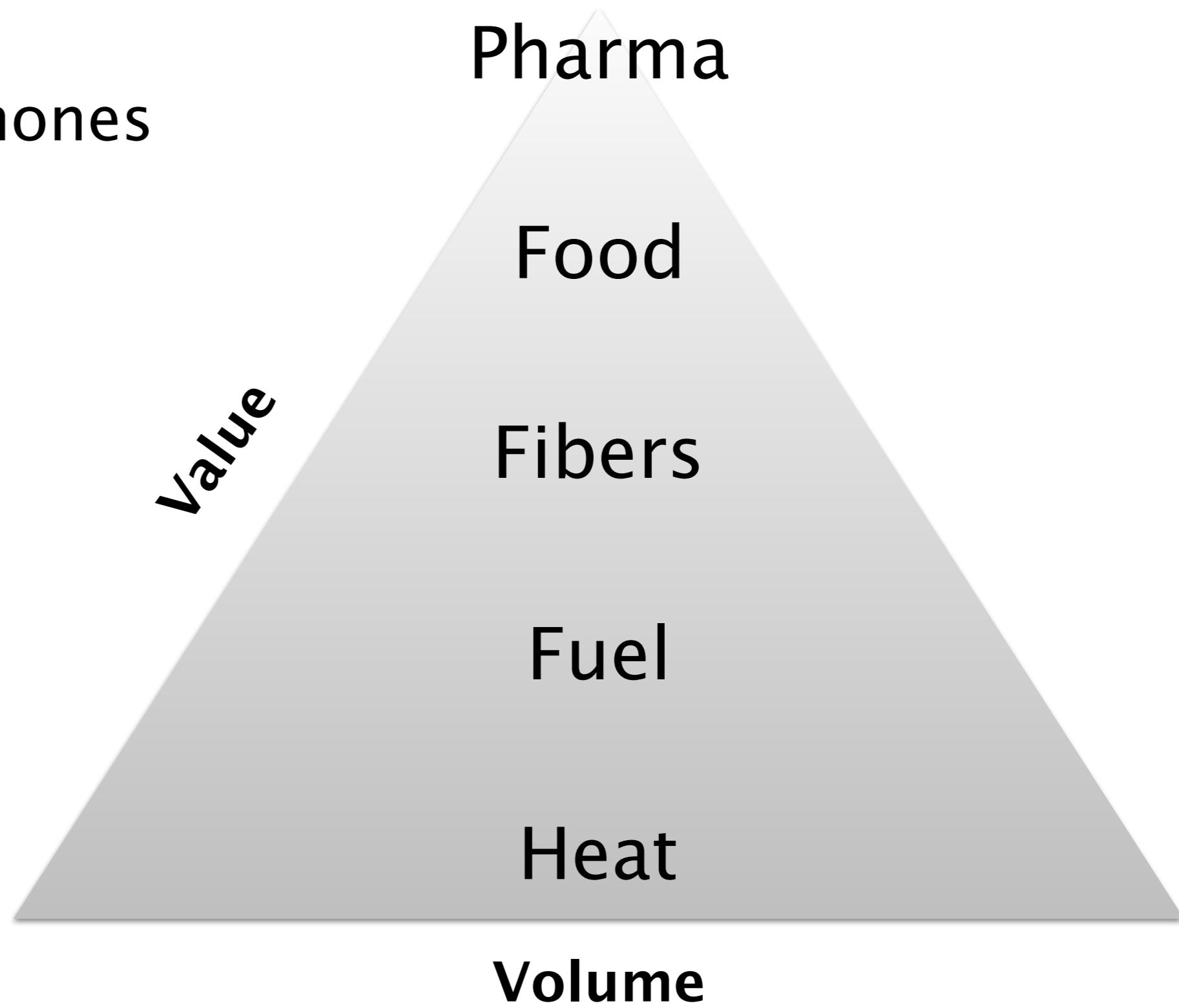
Shaun Moshasha





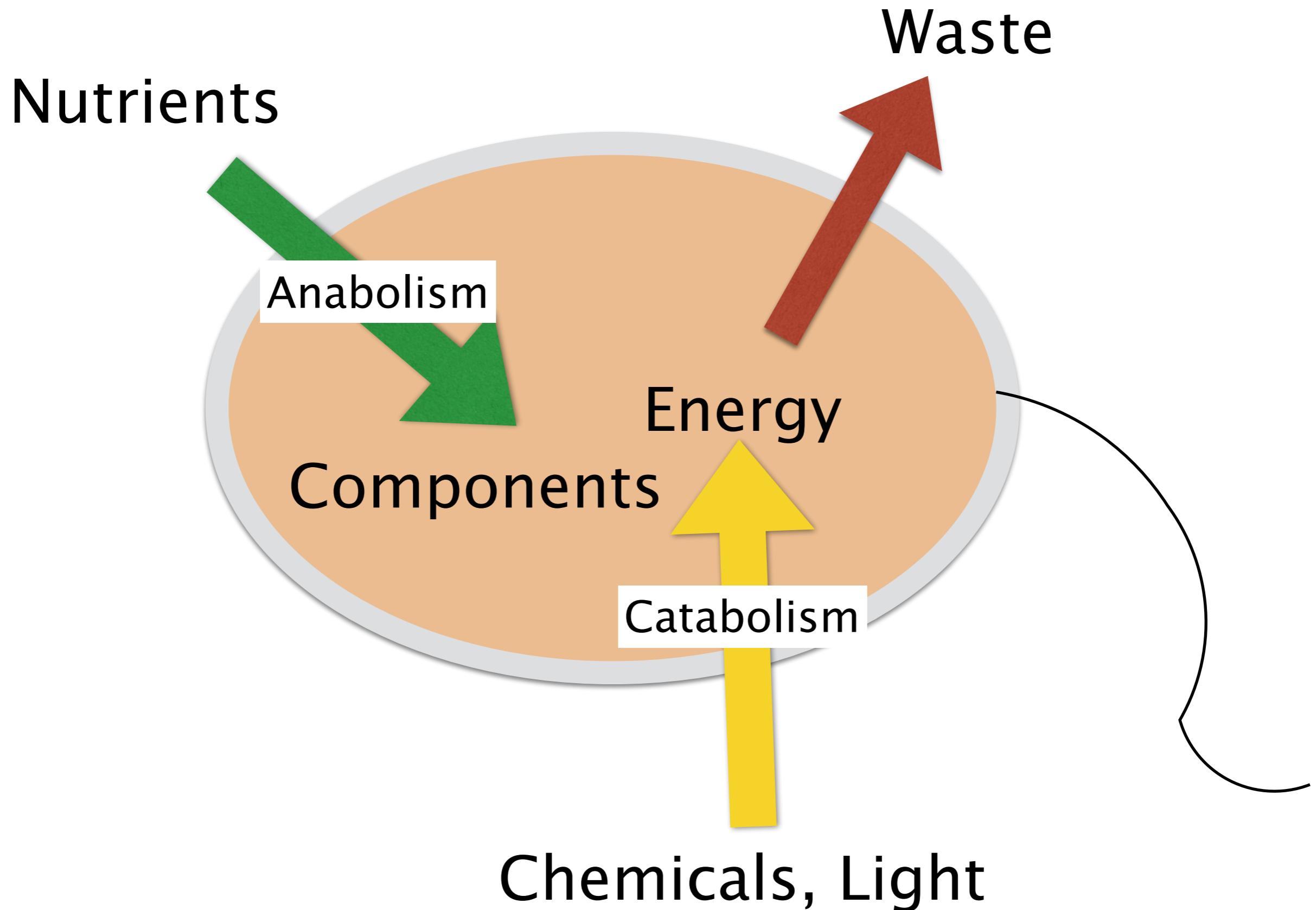
Bioreactor value pyramid

- Antibiotics
- Steroids / hormones
- Vitamins
- Proteins
- Sugars
- Acids





Cellular Metabolism





Biomaterials

“All materials that contain or might contain bio agents, or potentially dangerous material from biological origin”

[blood, serum, body fluids, tissues, organs, environmental samples, biological waste, [non- purified] proteins, allergens, [purified] toxins,
]

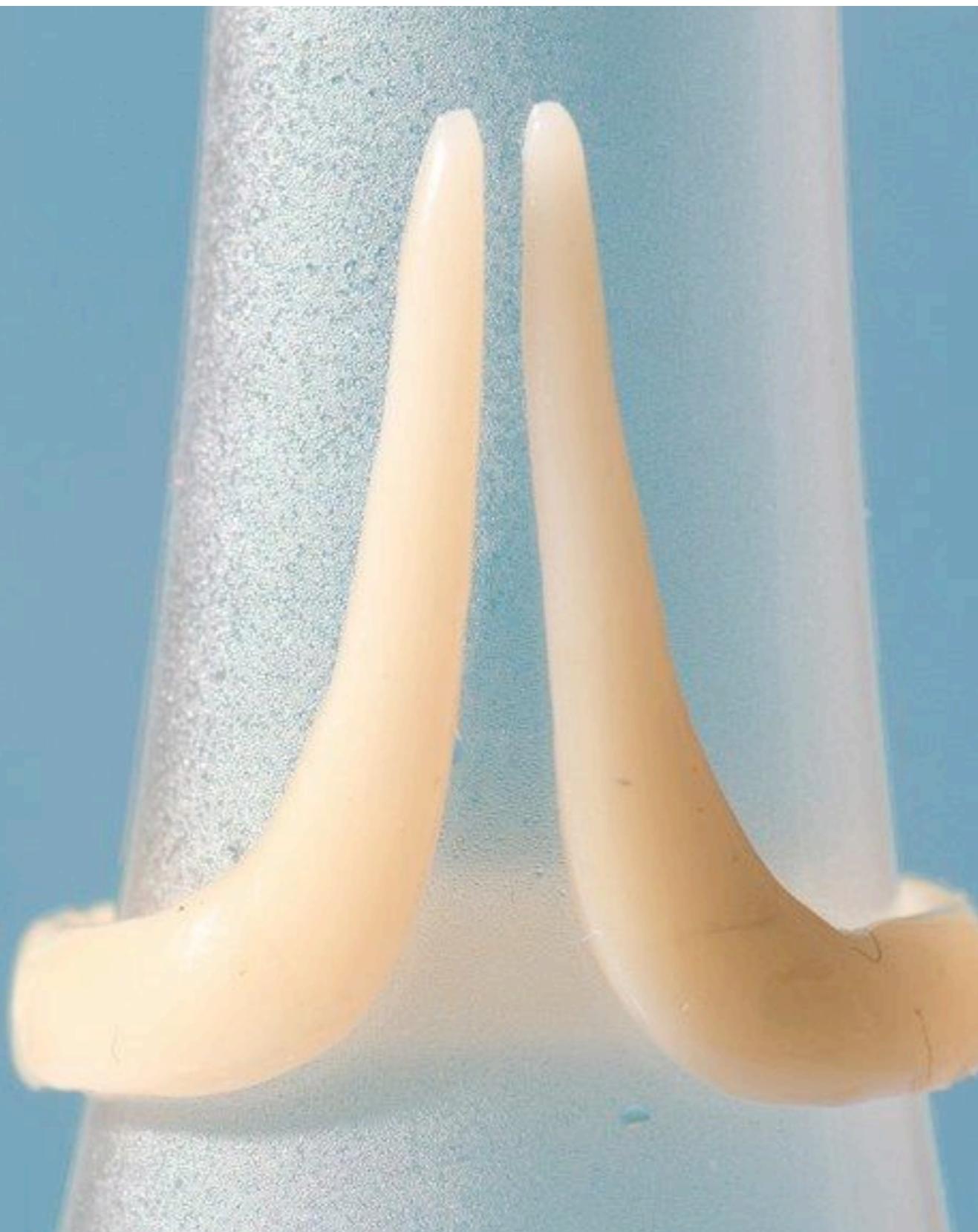


What's easy to produce?

- Cells -> Biomass -> Food
- Metabolites -> Ethanol -> Food
- Pigments -> Paint
- Light
- Cell structures -> Cellulose / Filaments -> Material



Ivorish - Nina van den Broek





Bacterial Radio - Joe Davis





Fungi products





Maurizio Montalti - Growing Lab





BioSteel fiber





Fragrant Moss

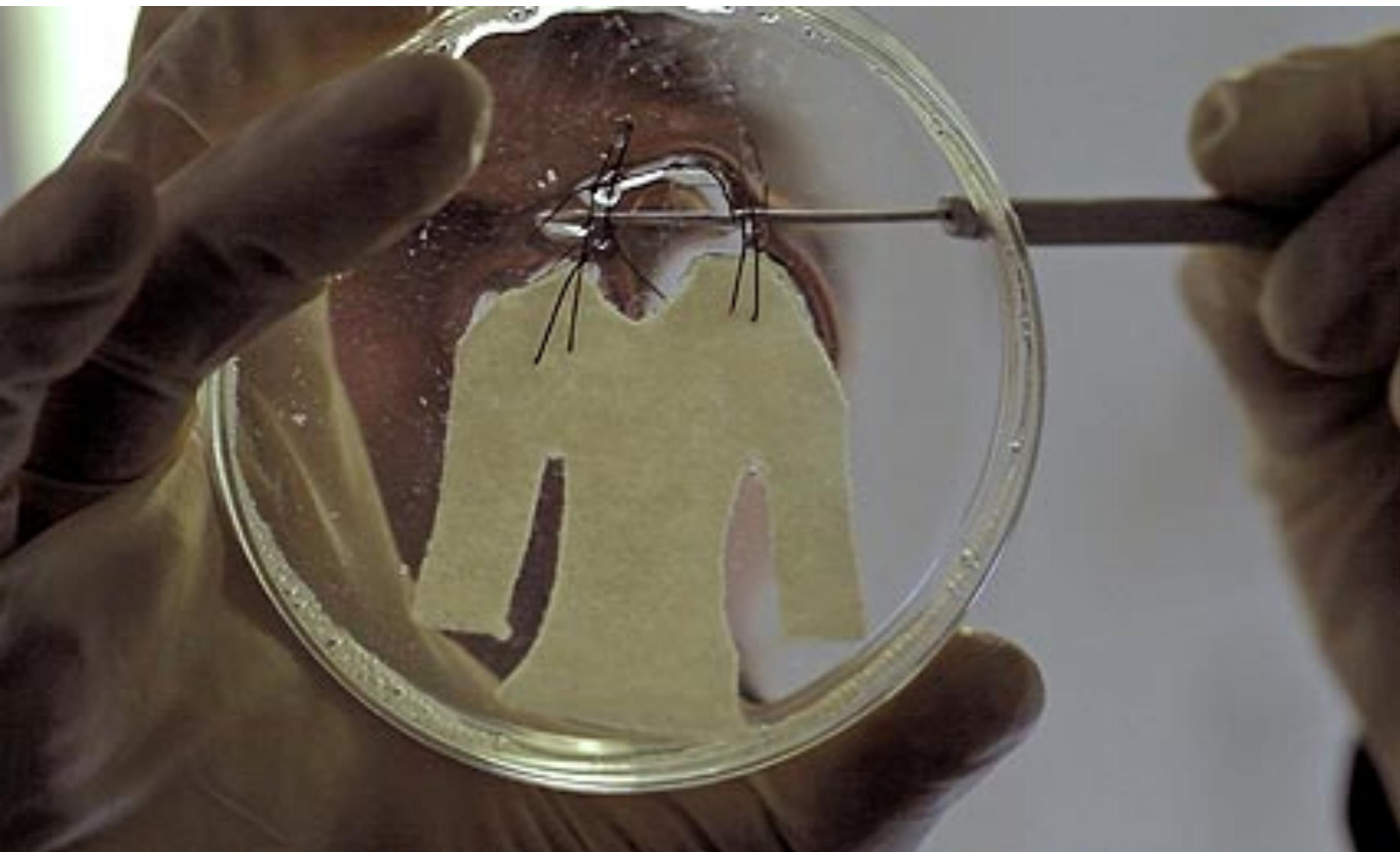
orbella
fragrant moss



Grow Your Own
Aromatic Terrarium



Victimless Leather





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The Cell



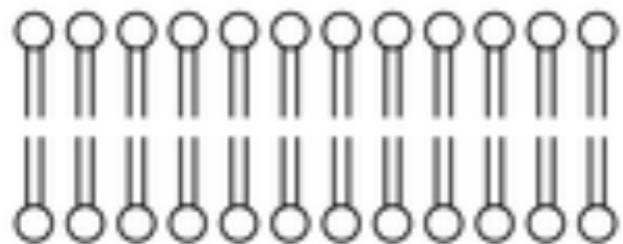
Lipid bilayer cell



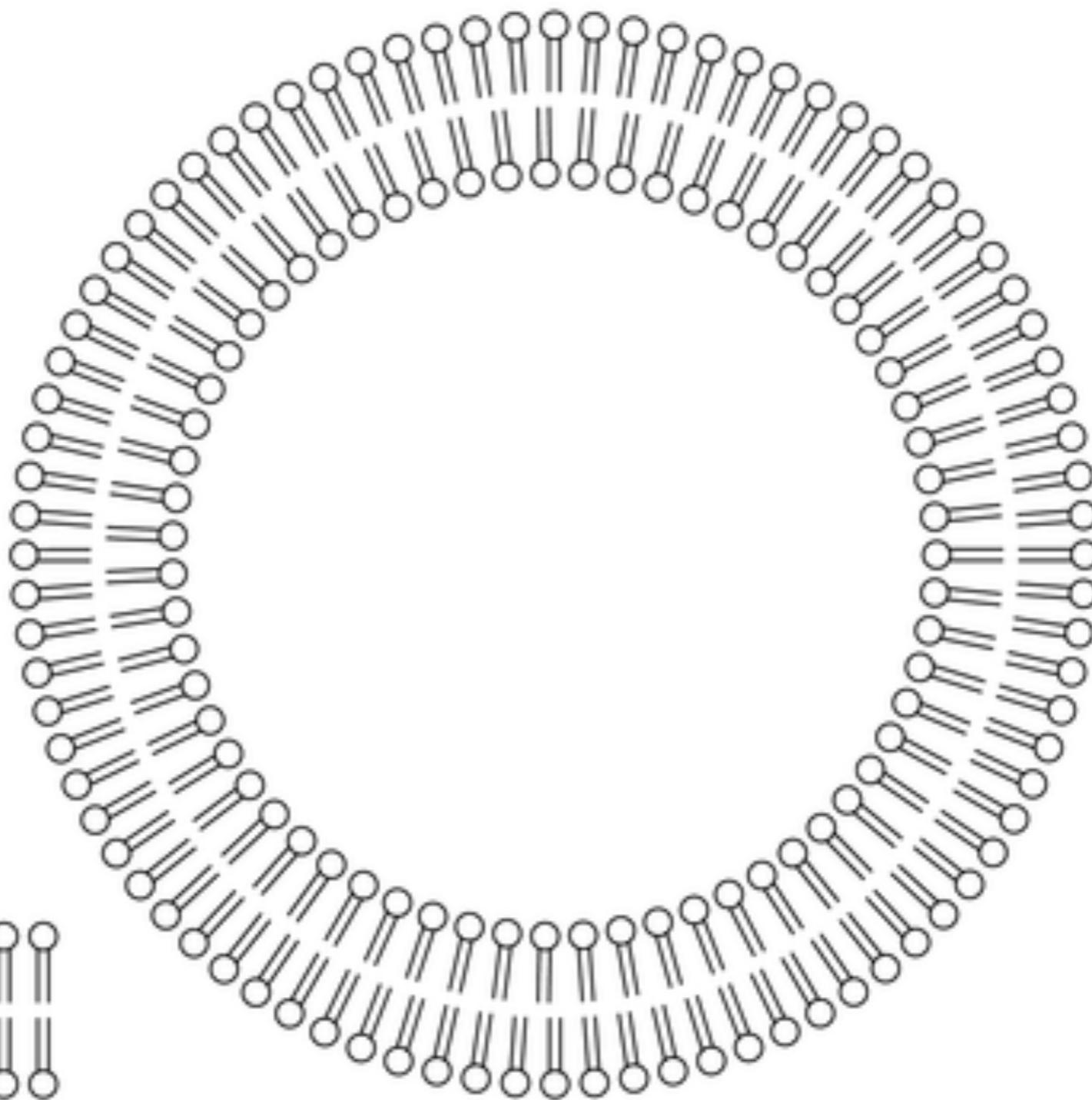
Micelle



Inverted micelle



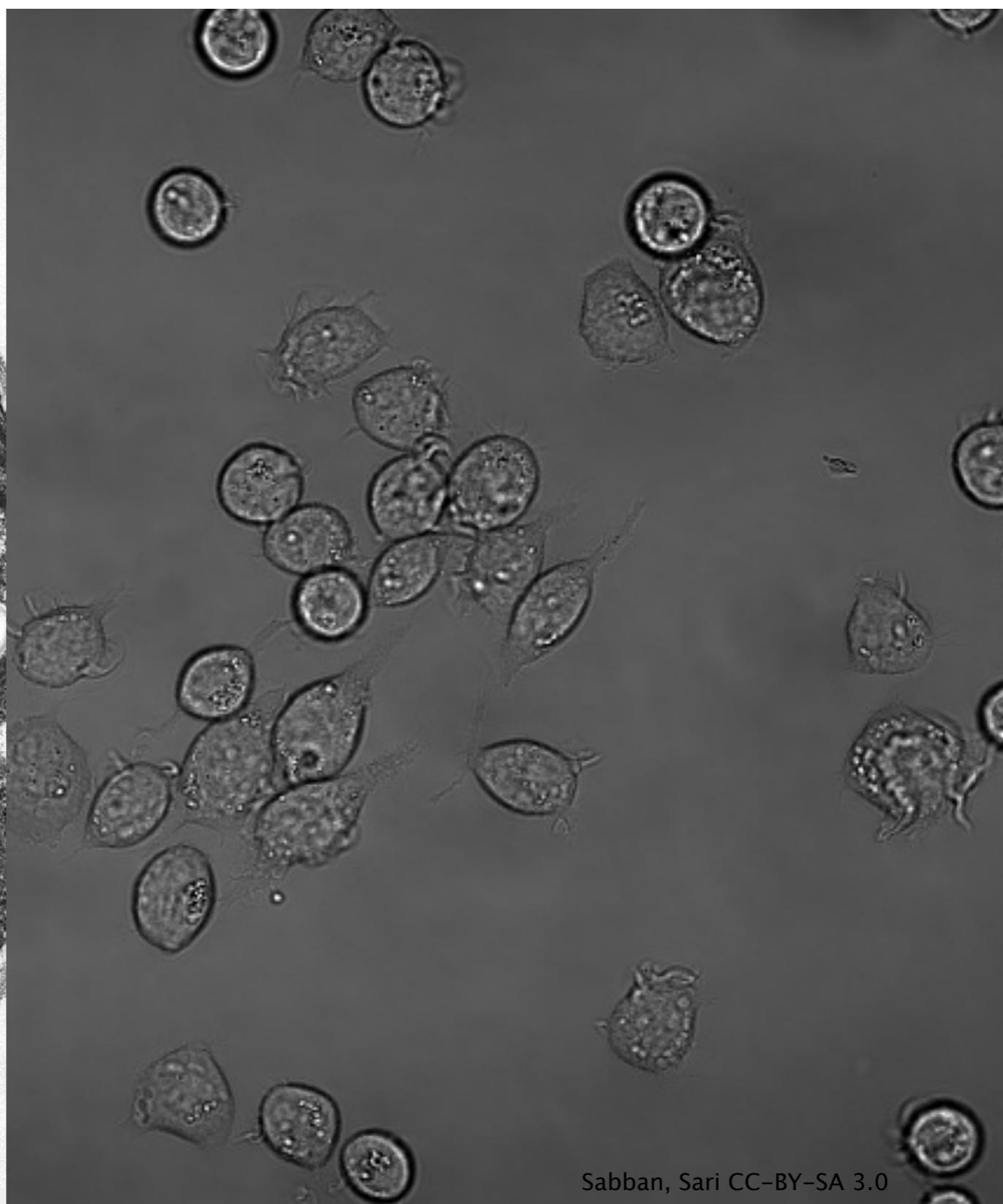
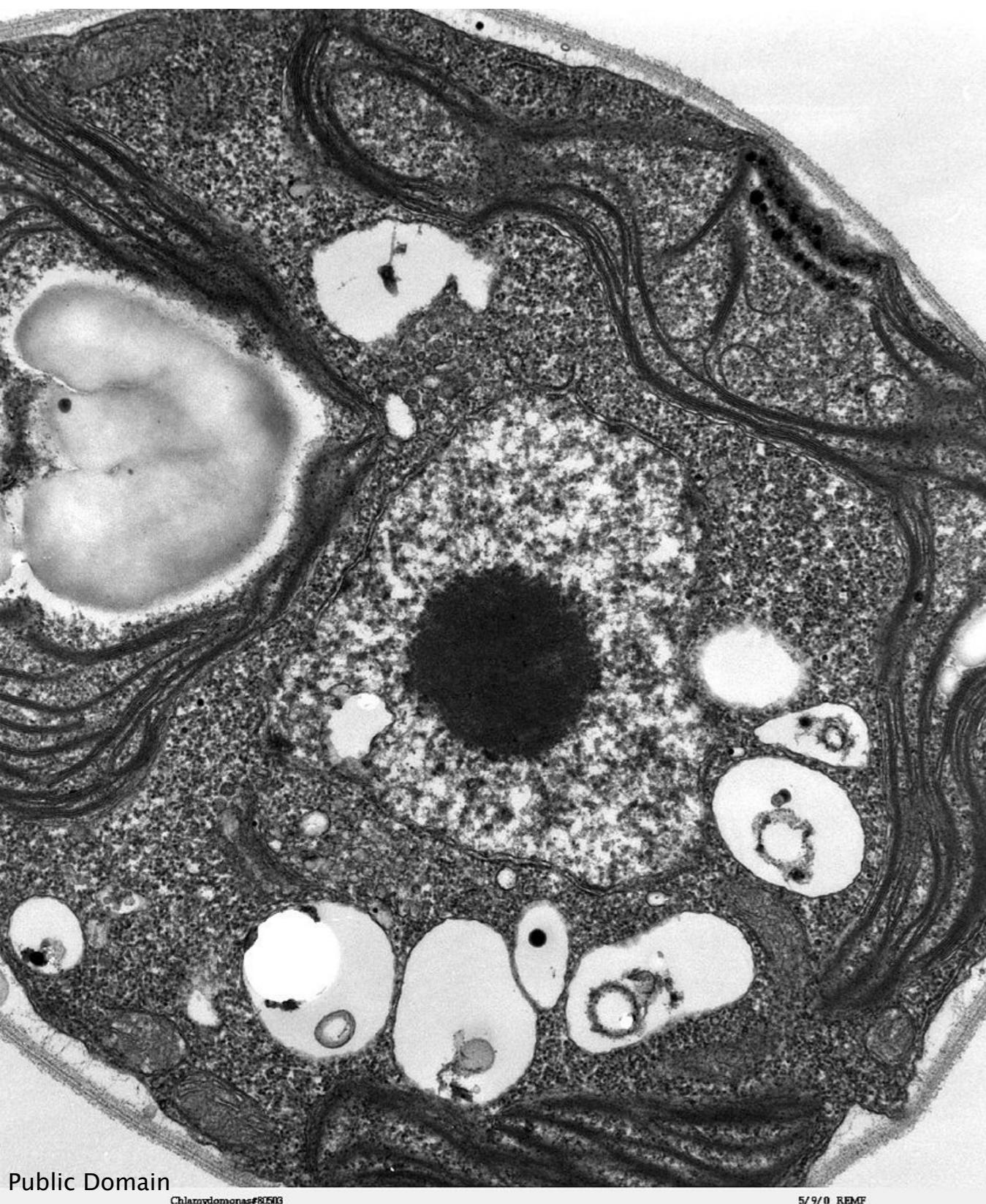
Lipid bilayer



Vesicle



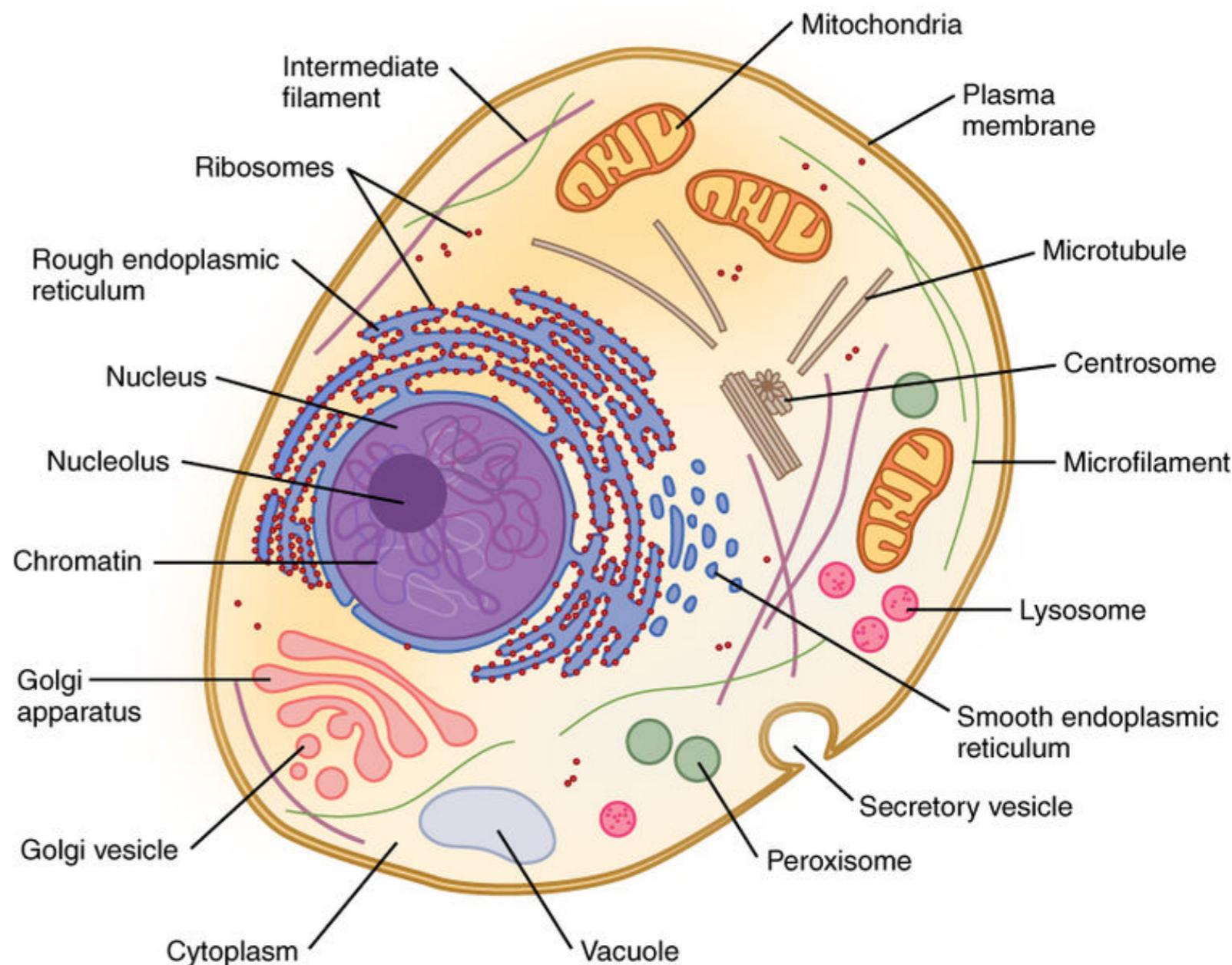
Life is made out of cells





What cells are made of

- Lipids
- Proteins
- DNA
- RNA
- Carbohydrates
- Metabolites
- Ions





IT vs Bio

Digital code (atgc)

Open standards (codons)

Modular code (genes)

Error protection (DNA repair)

Data compression (overlapping ORFs)

Redundant backups (double helix, copy number)

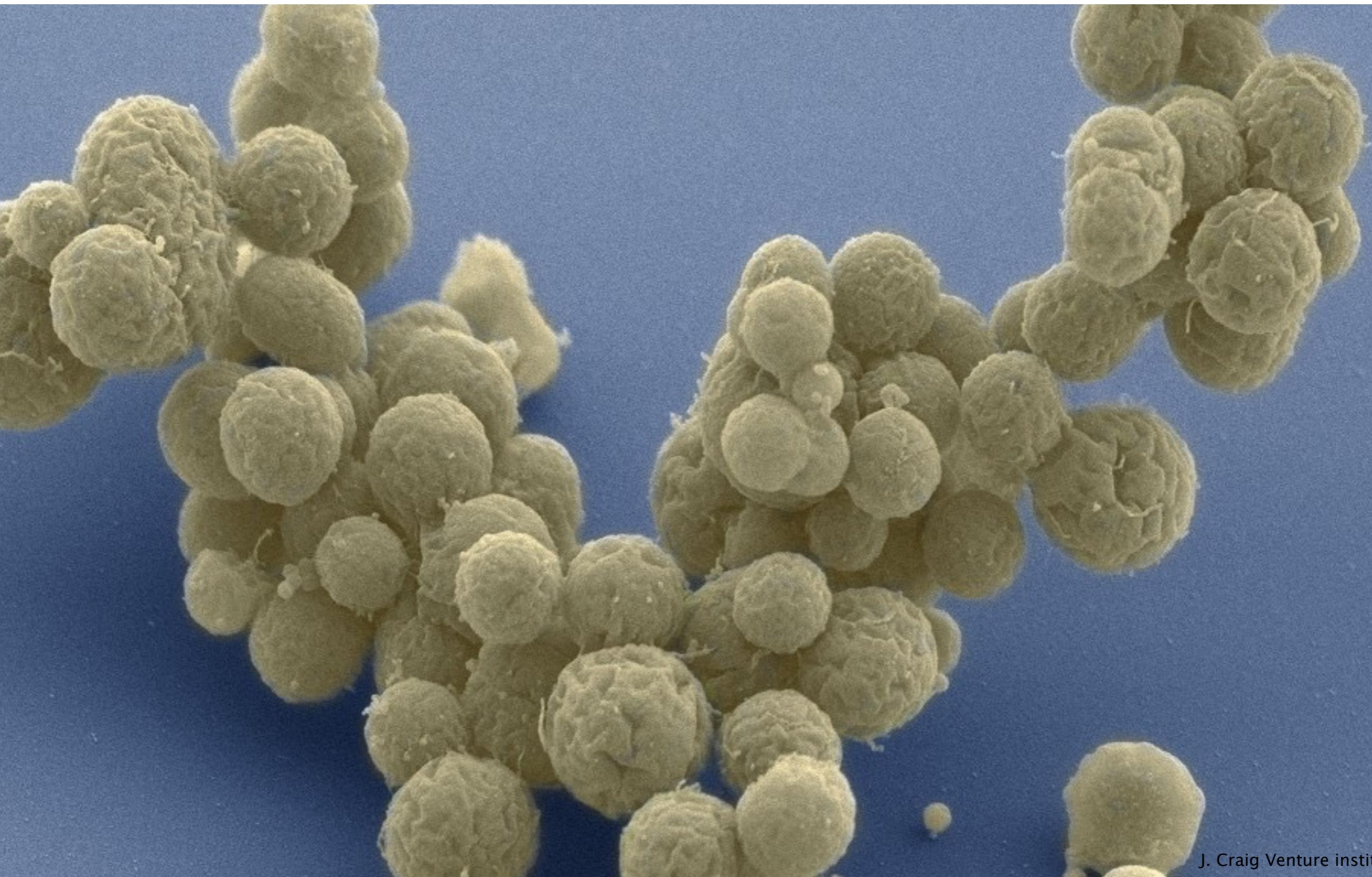
Self-diagnostics (apoptosis)

Firewalls (species)

Operating system (ribosomes)



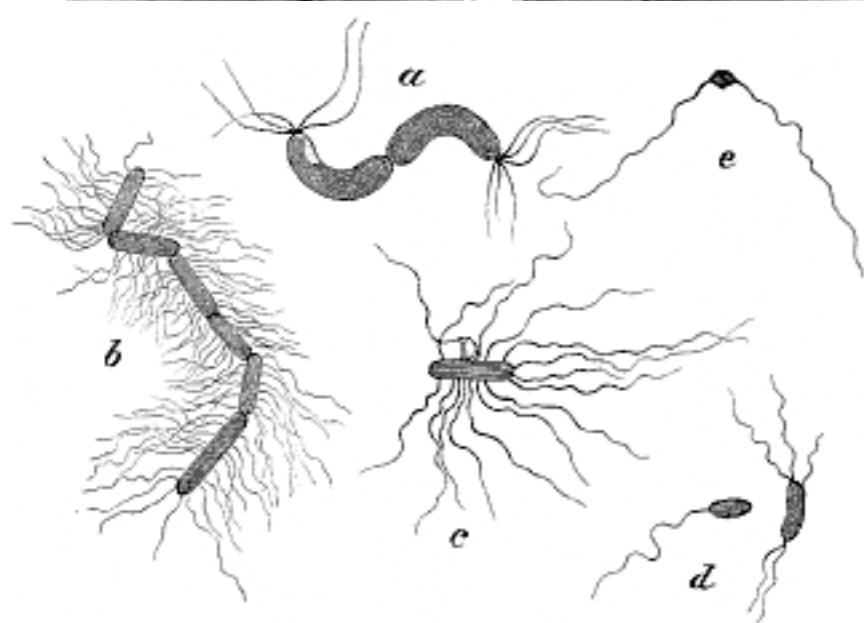
Minimal genome 473 genes





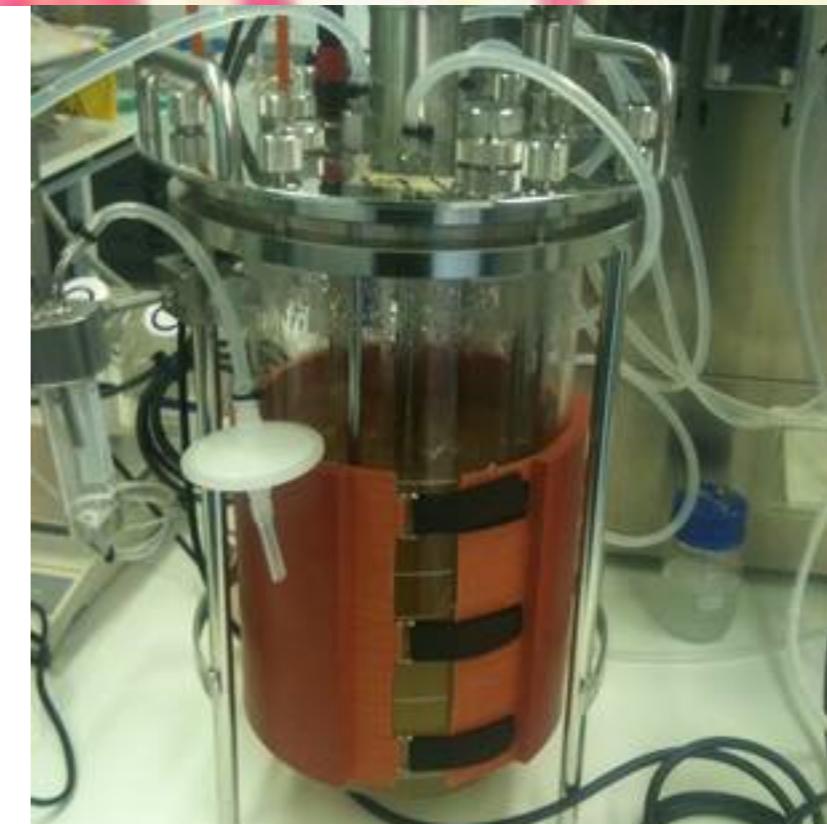
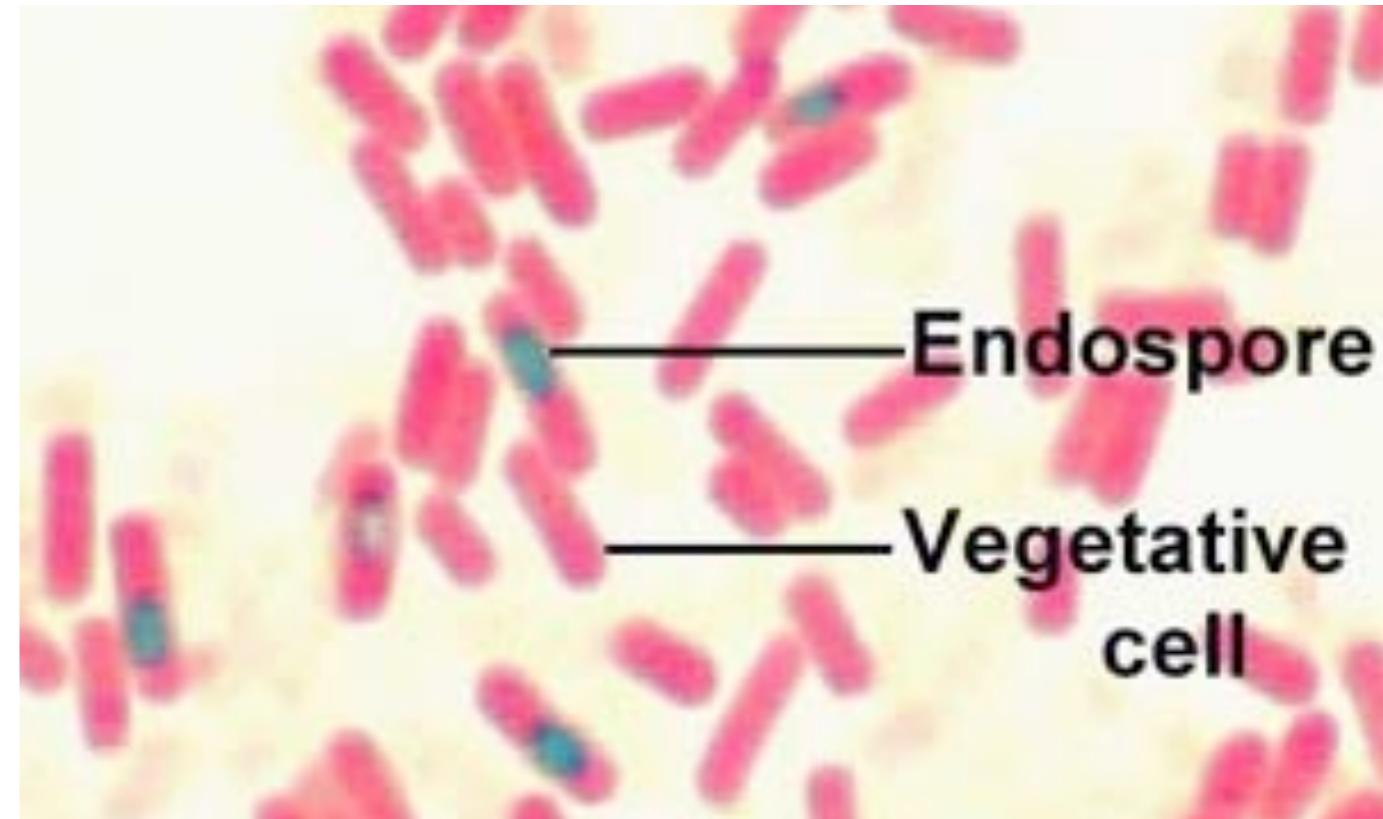
Ferdinand Cohn

Pure *Bacillus subtilis* cultures, thanks to heat-resistant endospores



Geißeln der Bakterien

a von *Spirillum Undula* in der Theilung; b vom *Heubacillus* (*Bacillus subtilis*), Fäden bildend; c einzelnes Stäbchen des *Heubacillus*; d von *Räuberknabberien* (*Ba-*



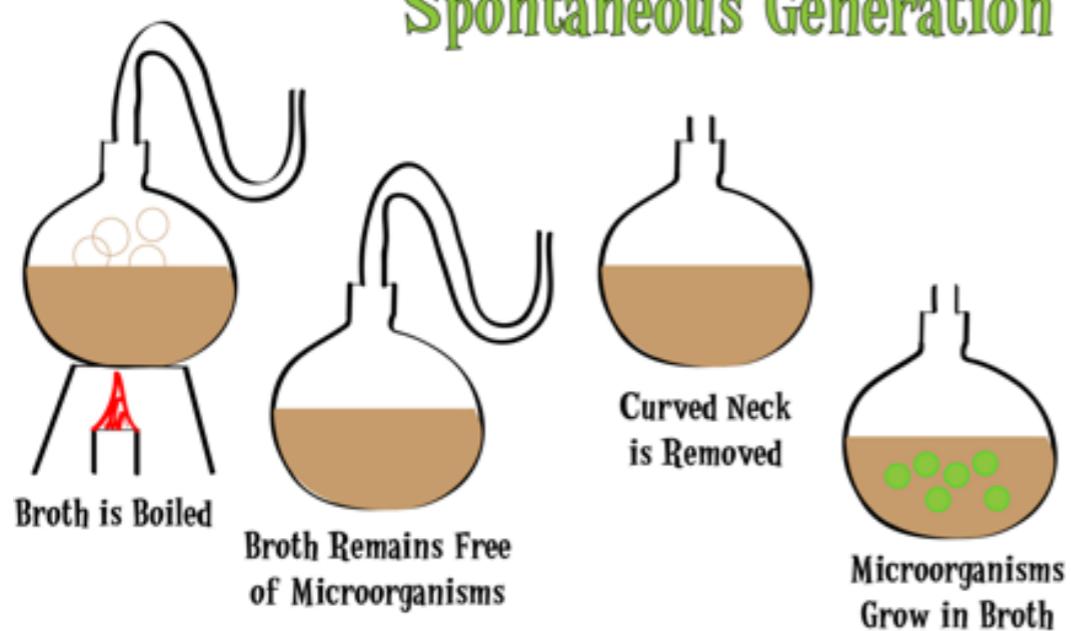


Louis Pasteur (19th century)

Proof that microbes do not “spontaneously appear”



Pasteur's Test of Spontaneous Generation





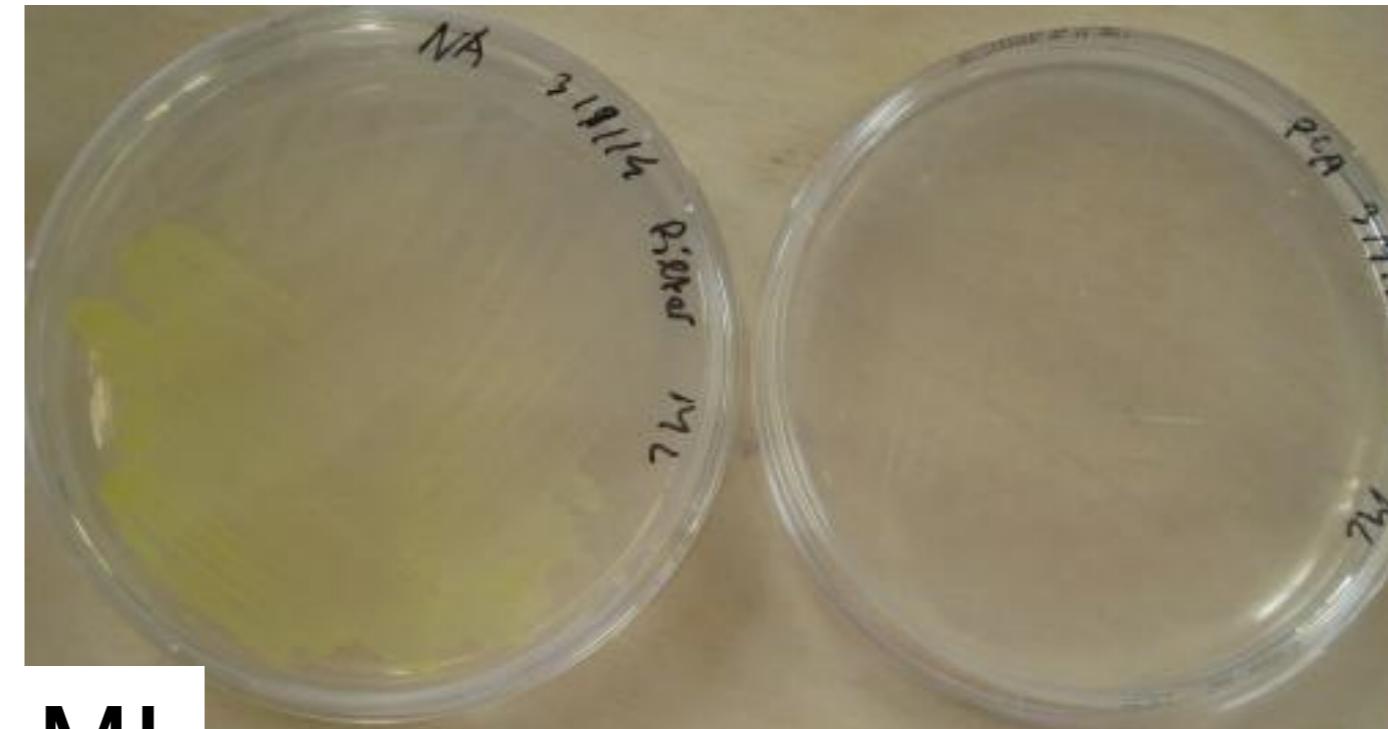
Culture Collection



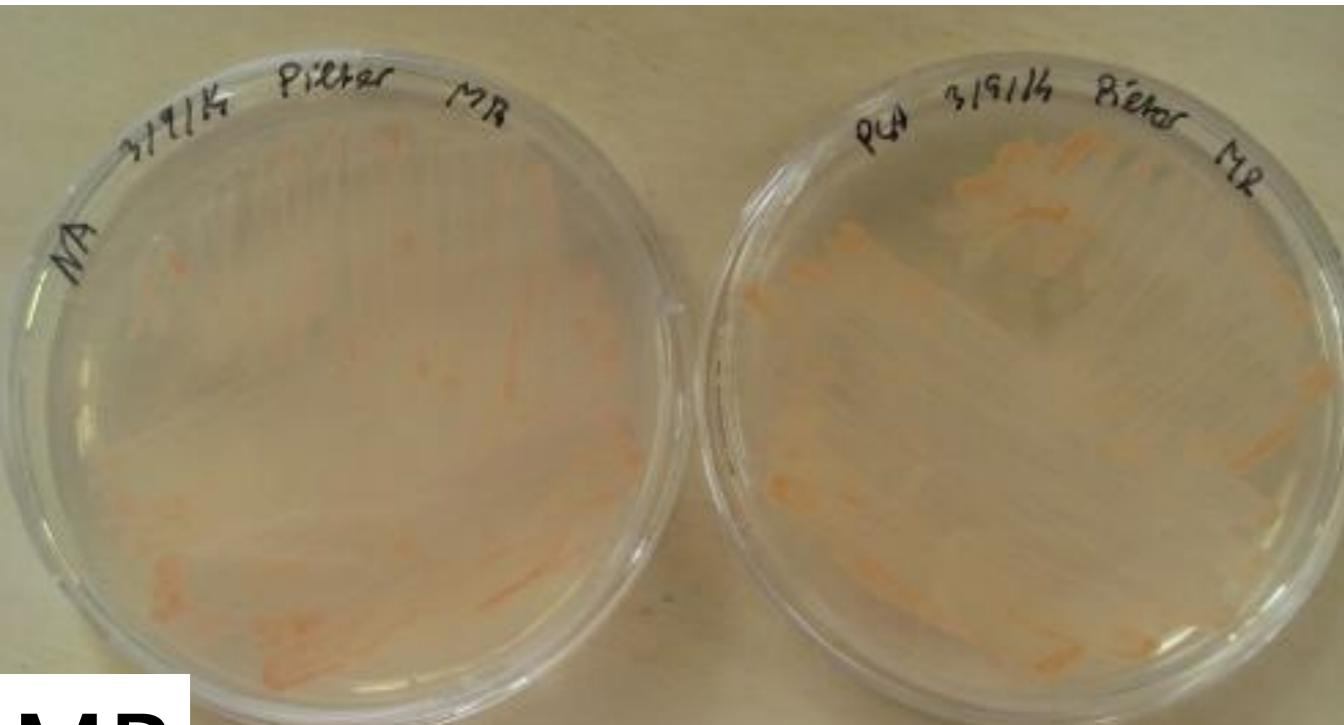
Pigmented bacteria

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

Pigments
Antibiotics



ML



MR



JL



Algae

Pigments
Food



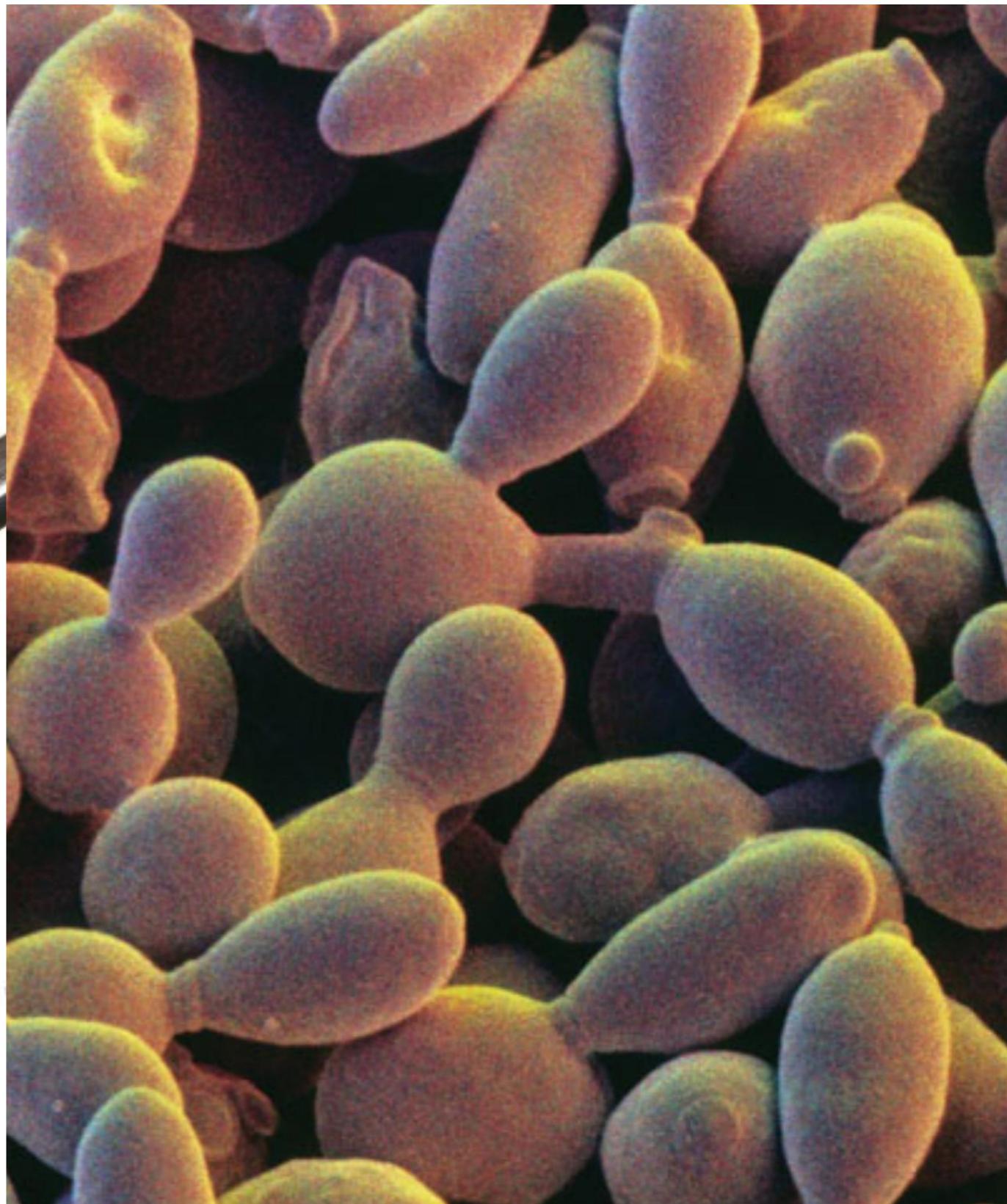
Spirulina maxima



Yeast



Alcohol
CO₂

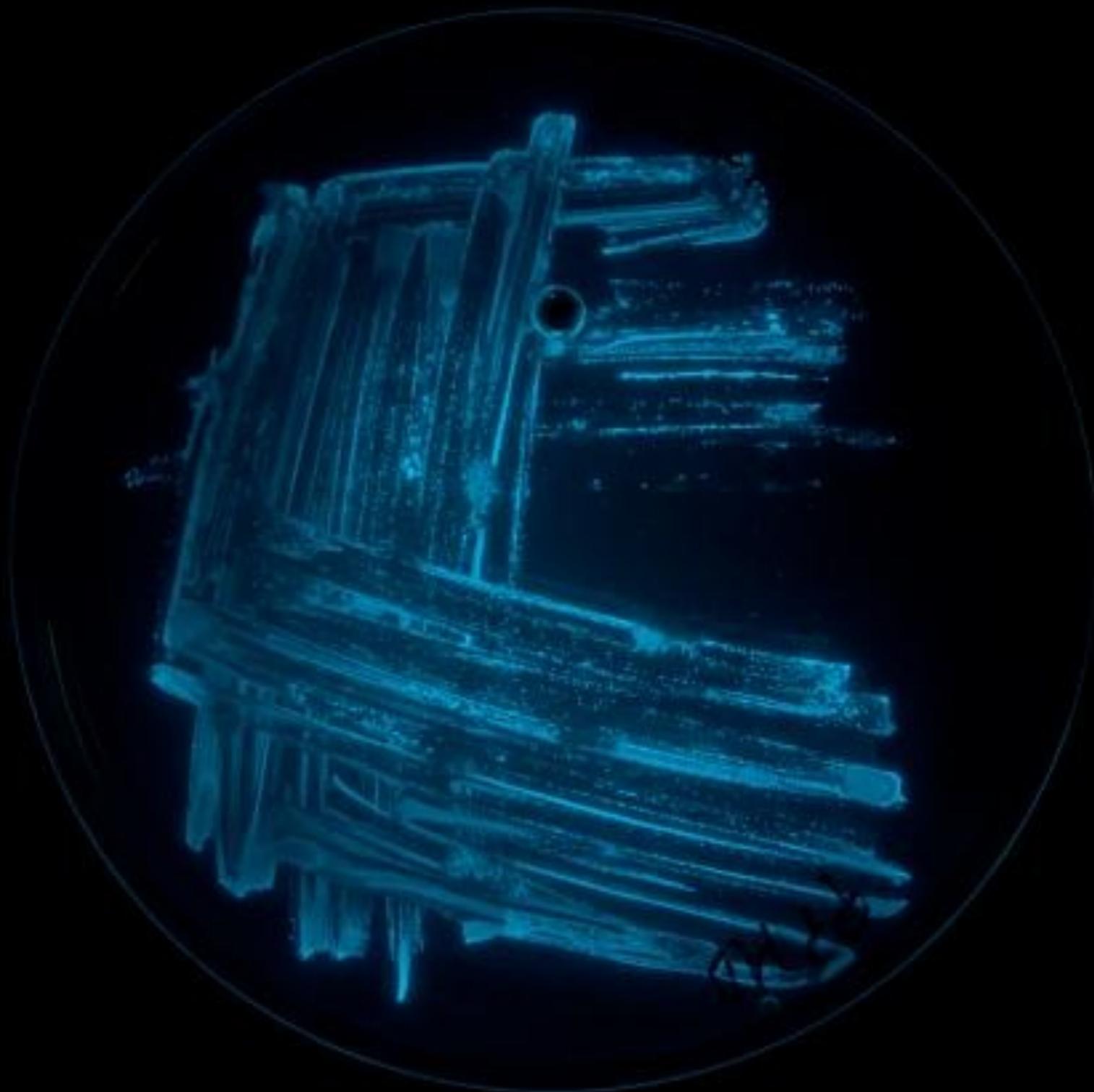


Light



Photobacterium phospherium

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SCOBY

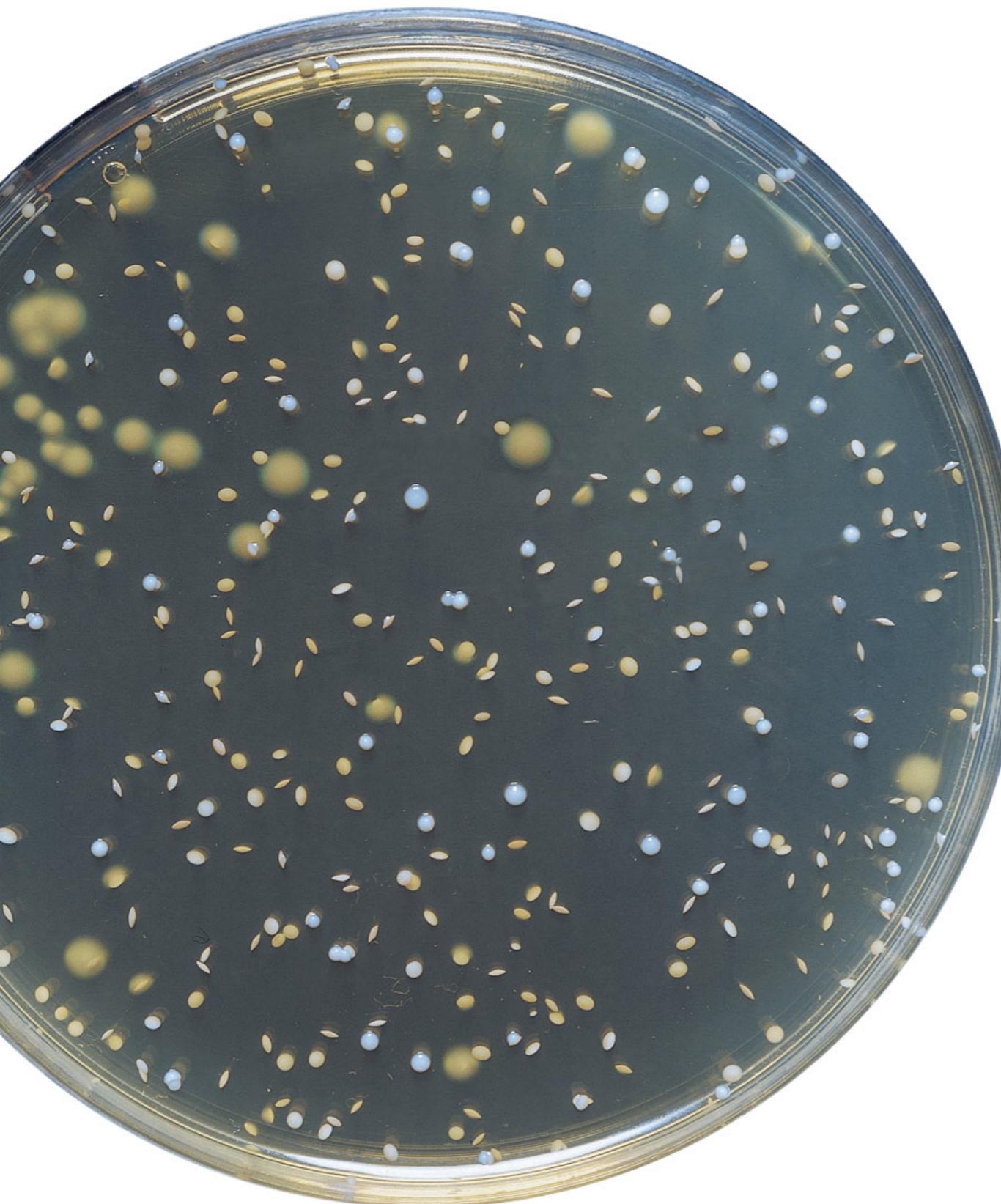
Cellulose
Vinegar



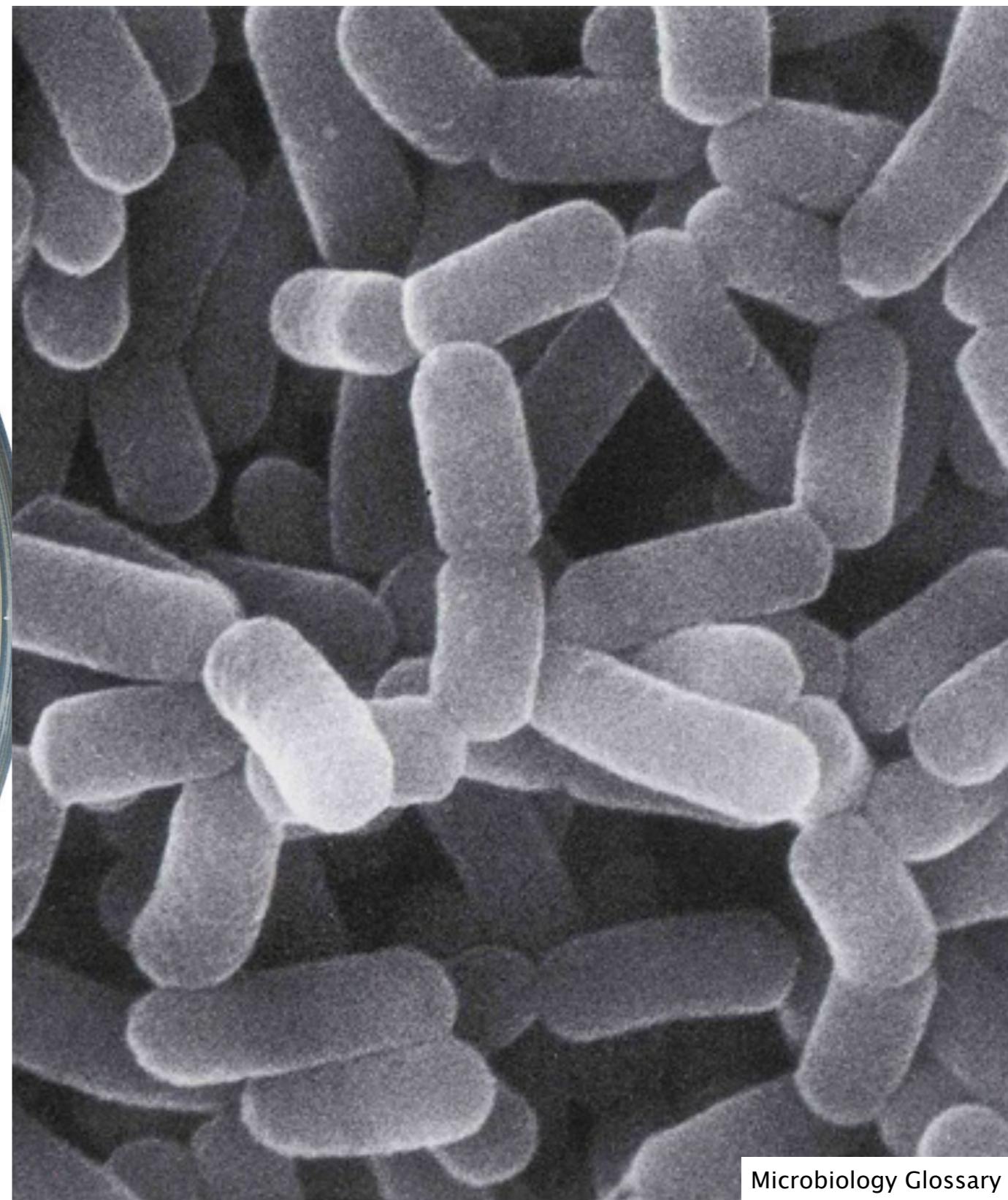
Symbiotic Culture of Bacteria and Yeast



Lactobacillus



Yoghurt
Lactic acid





Mycelium

Filaments

Fomes fomentarius
Piptoporus Betulinus
Lenzites Betulina
Pleurotus Ostreatus
Trameles Vesicolo
Sarrasis crispa





Slime mold

Physarum polycephalum

Intelligence





Isolation

- Contamination test
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/contamination-test/>
 - Be ware of safety!
- Yoghurt
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/yoghurt-bacteria-isolation/>
- Beer yeast
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/beer-yeasts-isolation/>



Advanced isolation

- Bioluminescent
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/bioluminescent-bacteria-isolation/>
- Nitrogen fixating
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/isolation-of-nitrogen-fixating-bacteria/>
- Sulphur-oxidizing
 - <http://biohackacademy.github.io/biofactory/class/1-incubator/isolation-of-sulphur-oxidizing-bacteria/>



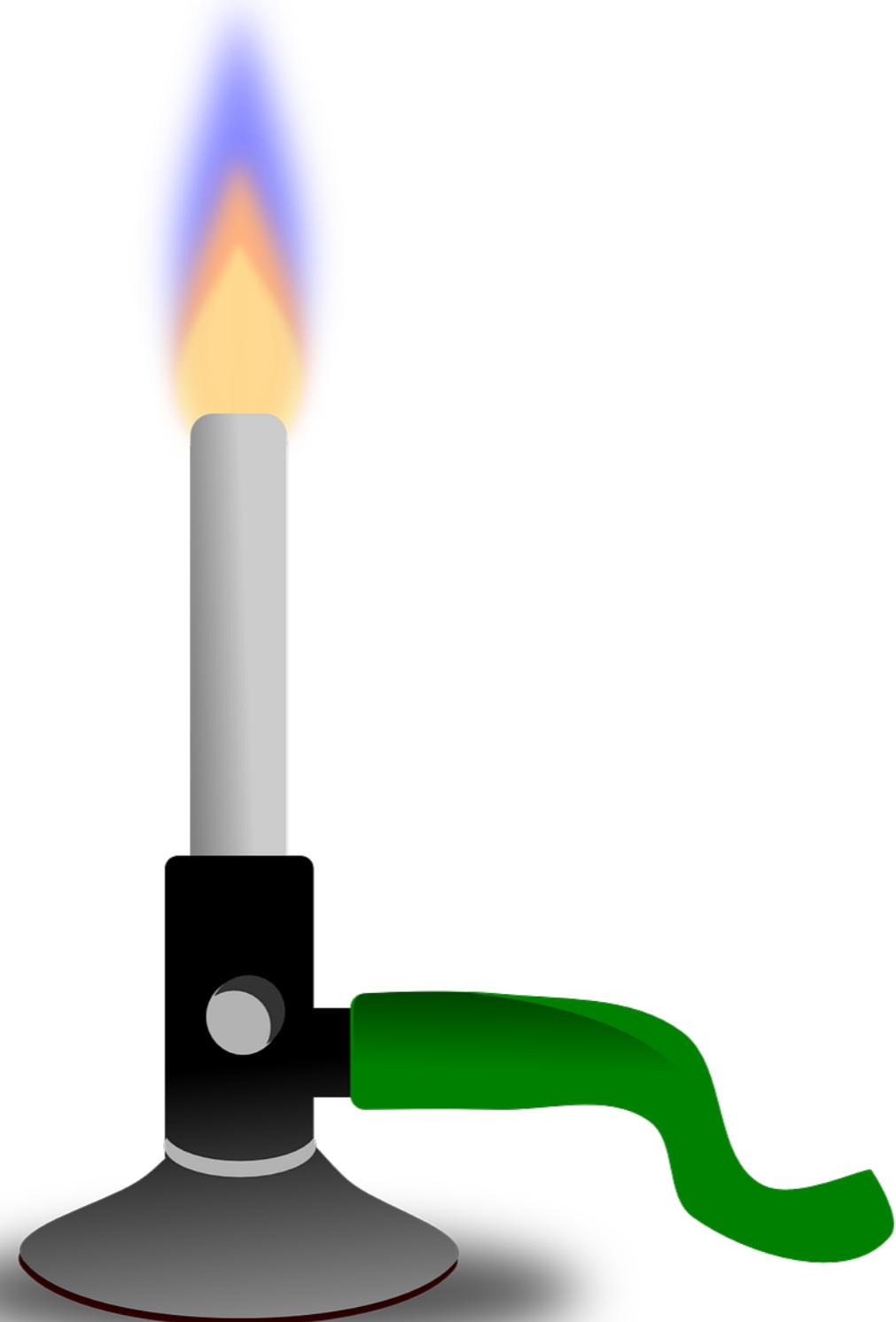
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Working with Microbes



Working sterile with gas burner





Preparing plates

Autoclaving for 20 min



Pouring petri dishes





Inoculation



Marco Tolo - Public Domain

