

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

Yielding progeny

Heredity

Energy consumption

Cell division



Growing bacteria





Terike Haapoja. "Entropy," 2004





Information carrier





Life stucked to the same standard





Concepts of life

Sustainability, environmental justice

Complexity, intelligence

Evolution

Symbiosis, parasitizing

Disease, death

Sociology, human behaviour

Human relation to ecology

Digitization

Origin of life

Ownership

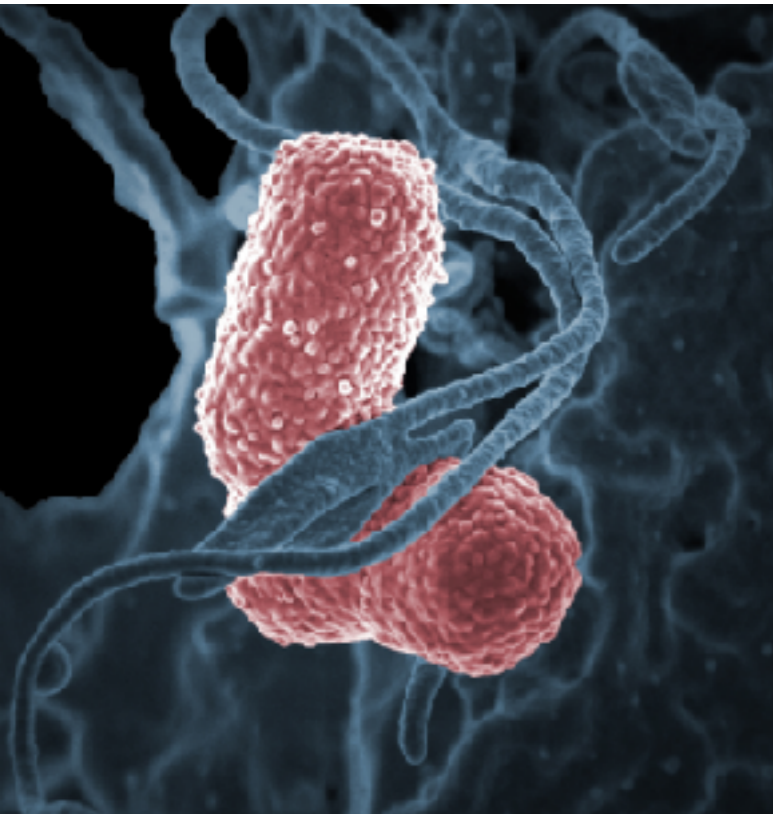


Microbiology



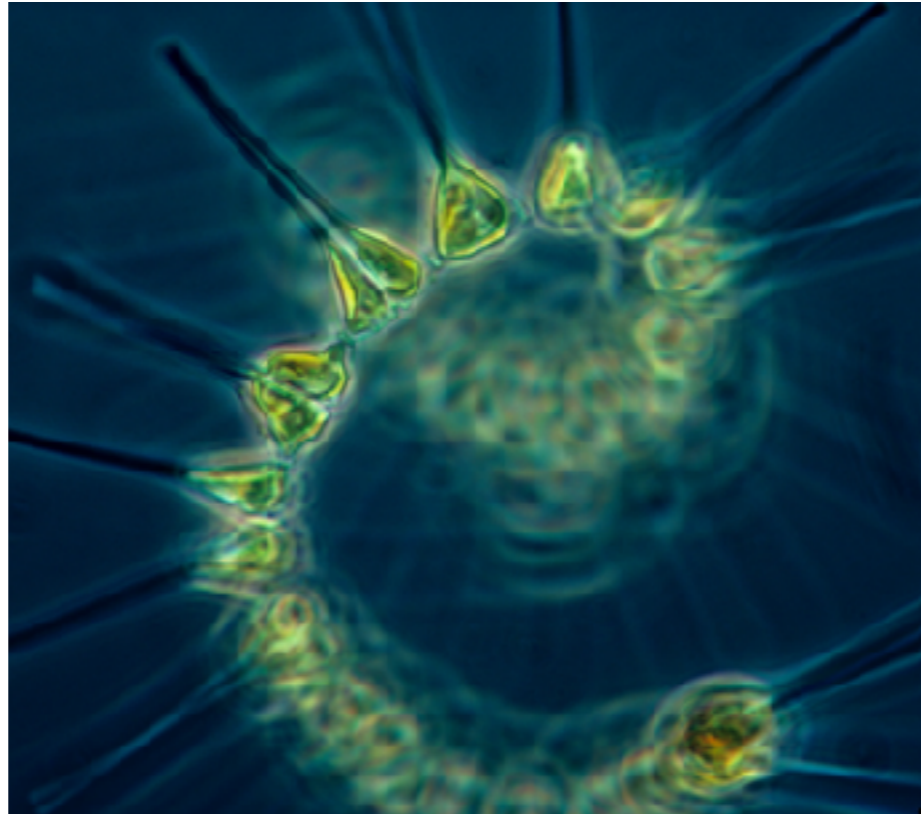
Definition of life

unicellular
(single cell)



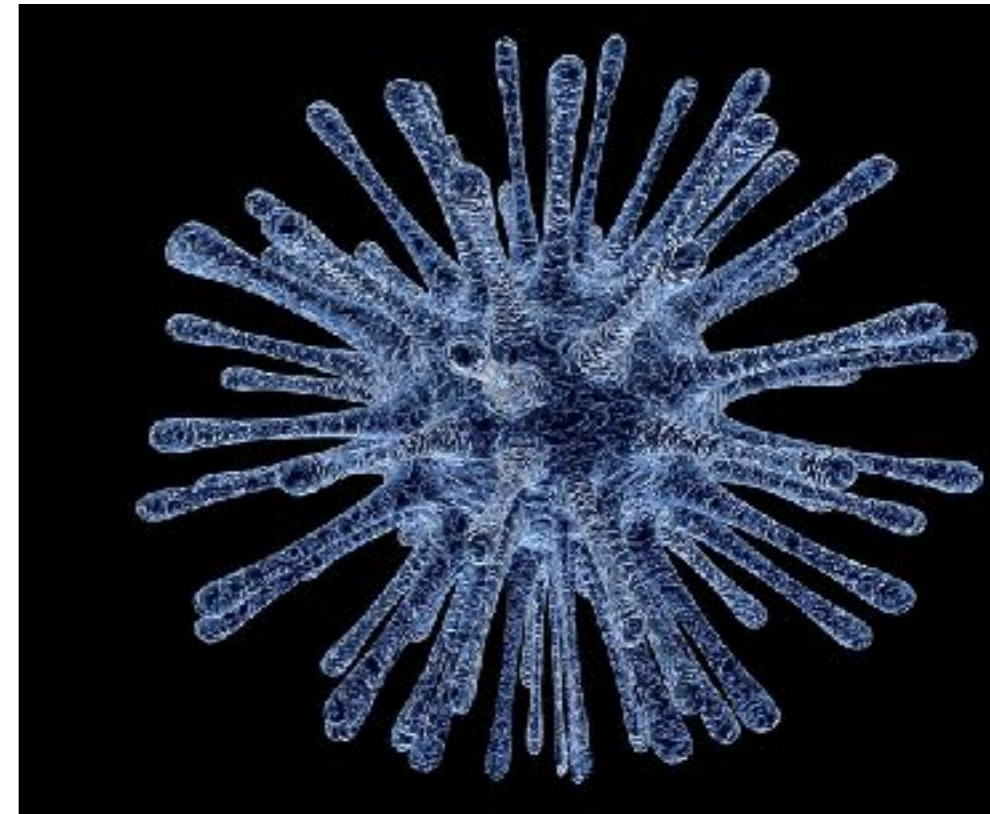
NIAID - CC-BY 2.0

multicellular
(cell colony)



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acellular
(lacking cells)

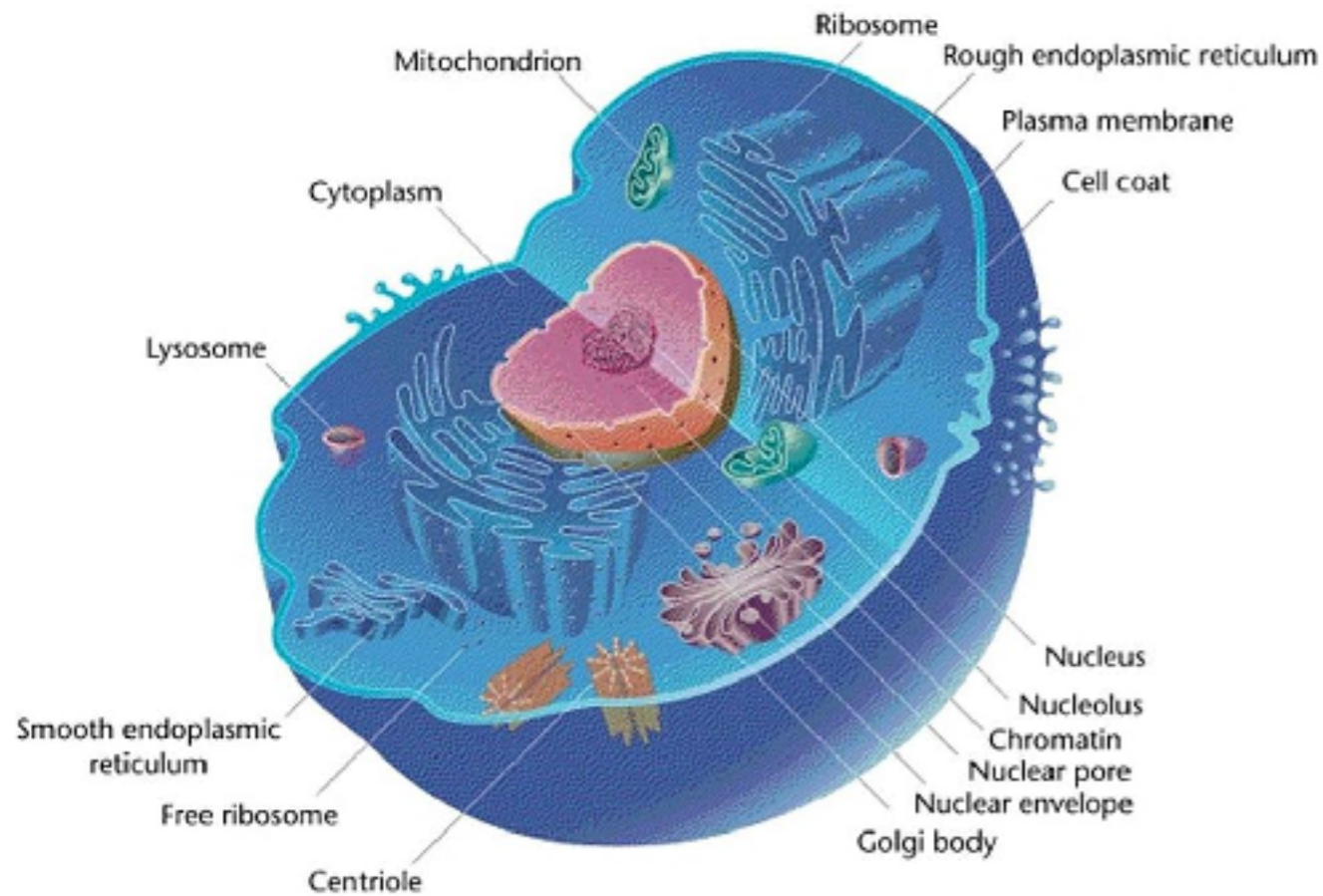


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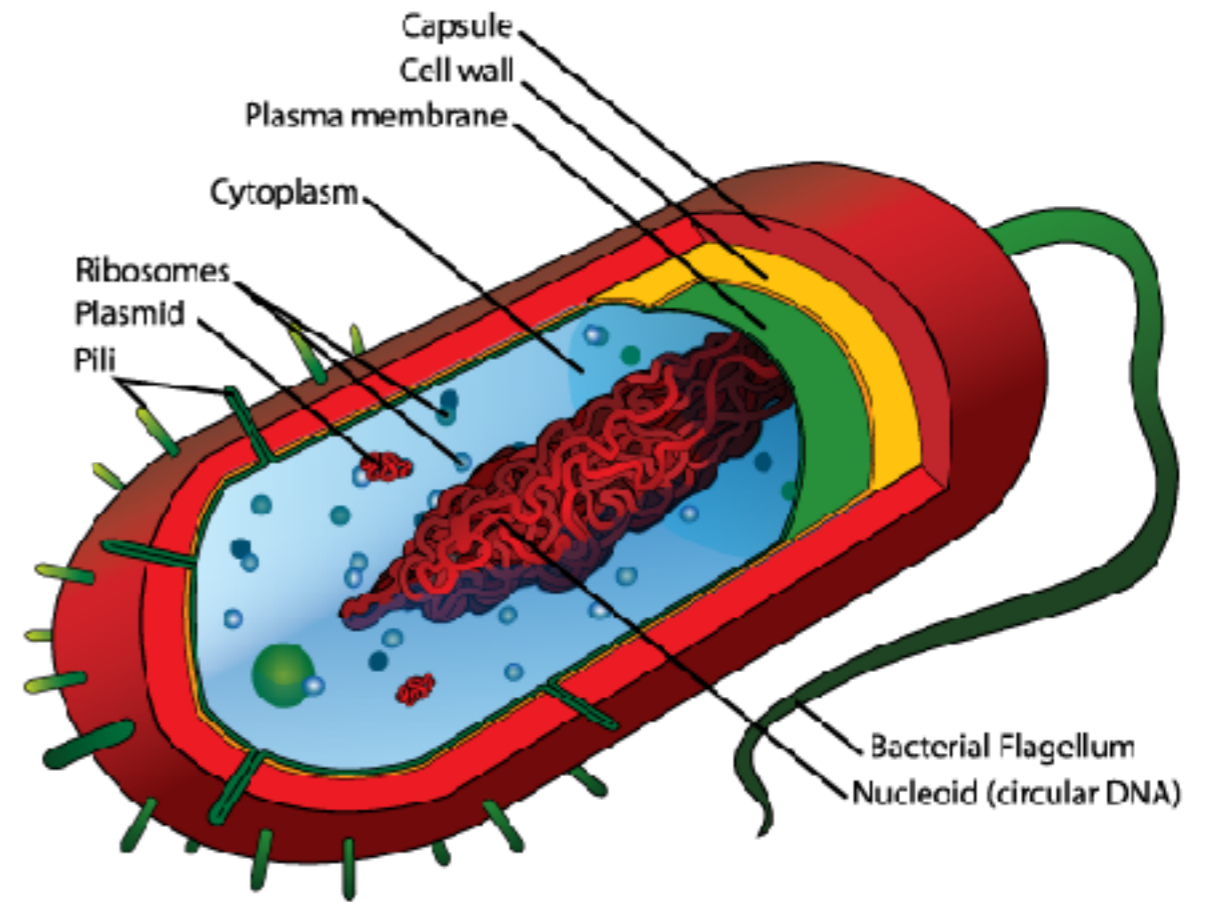


Two main categories

Eukaryotic cell



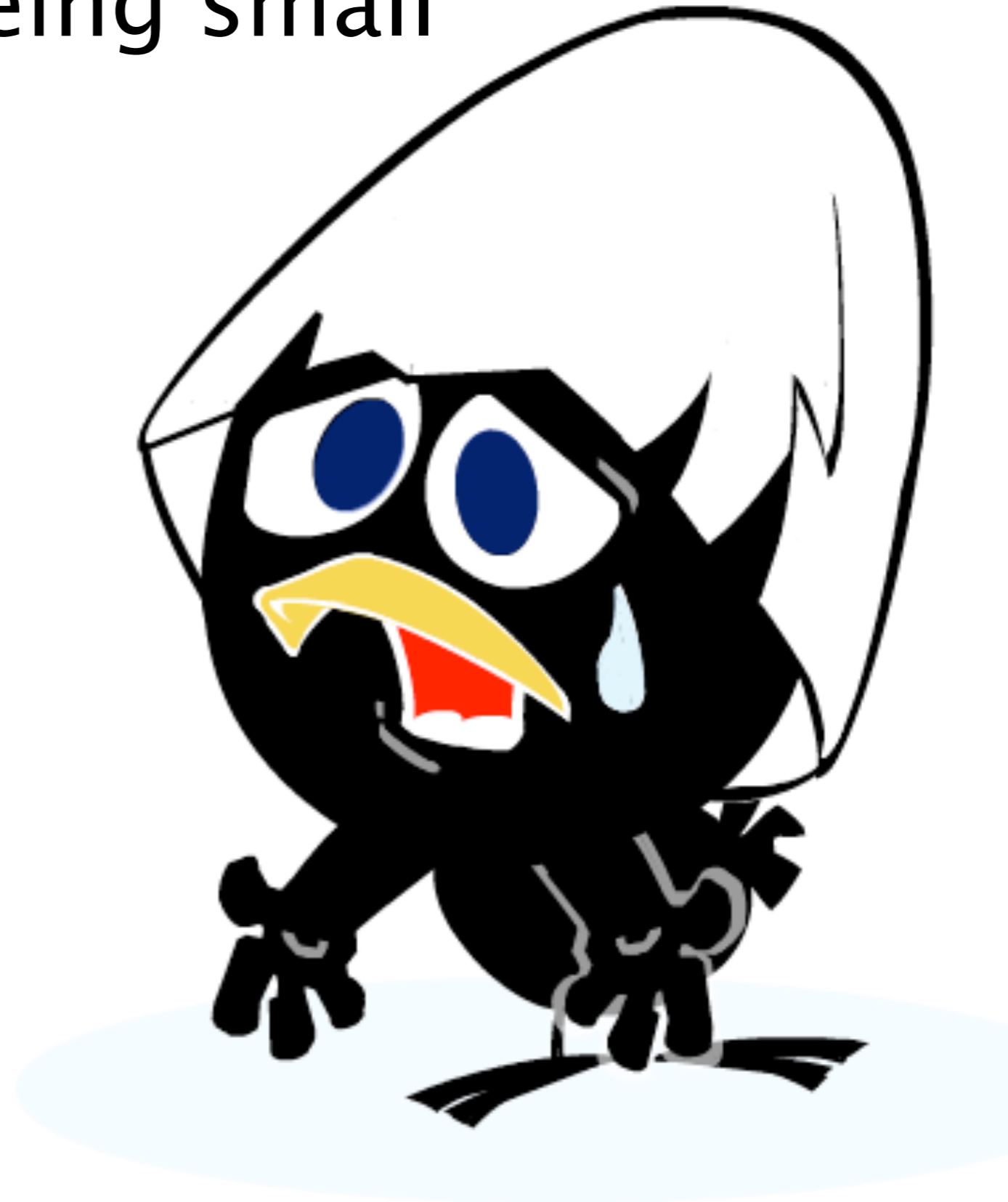
Prokaryotic cell





Advantage of being small

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





Exercise

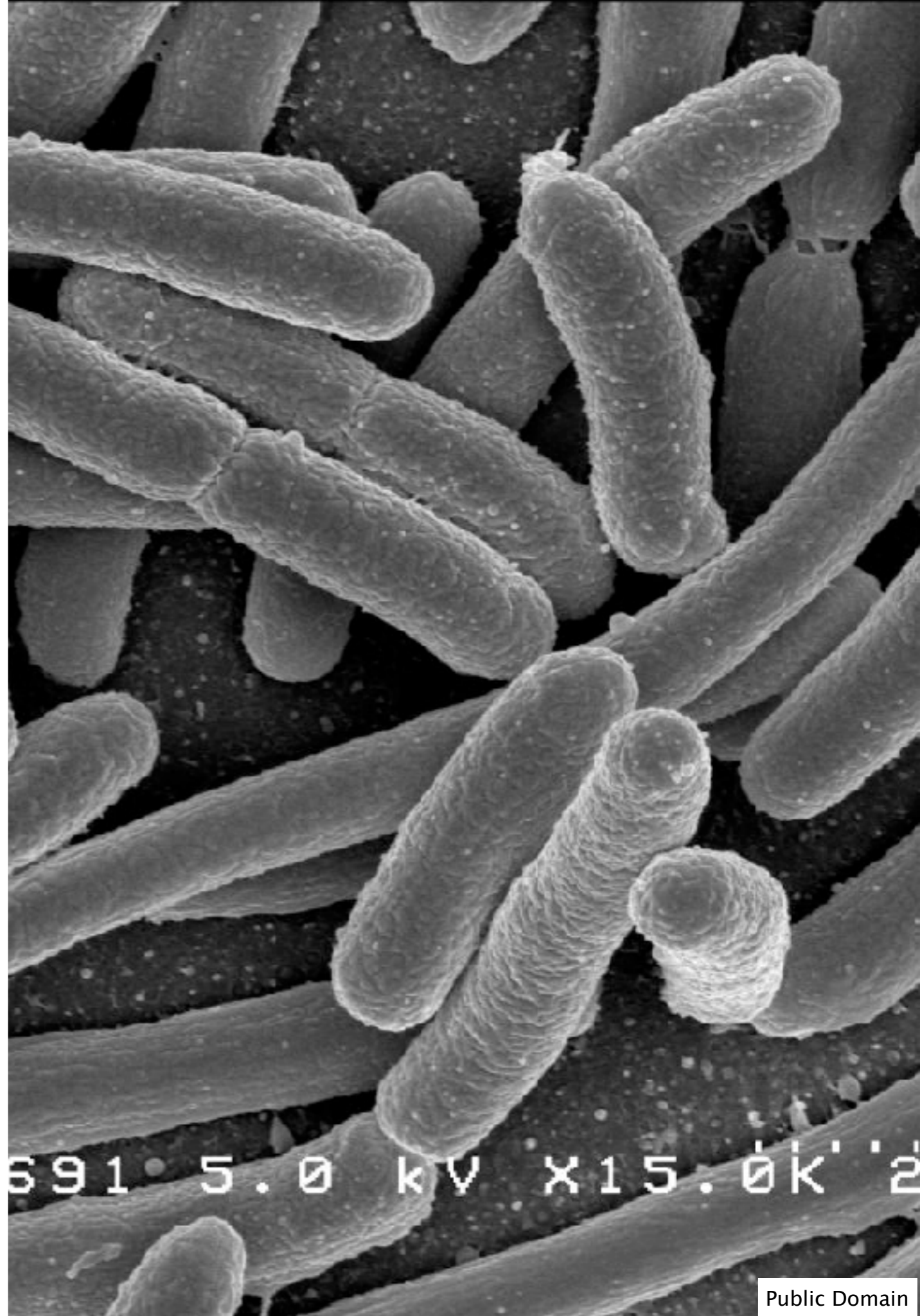
E. coli weighs $3.0 \times 10^{-13} \text{ gr.}$

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 of 1 gram of E. coli cells?





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)

Pollution?



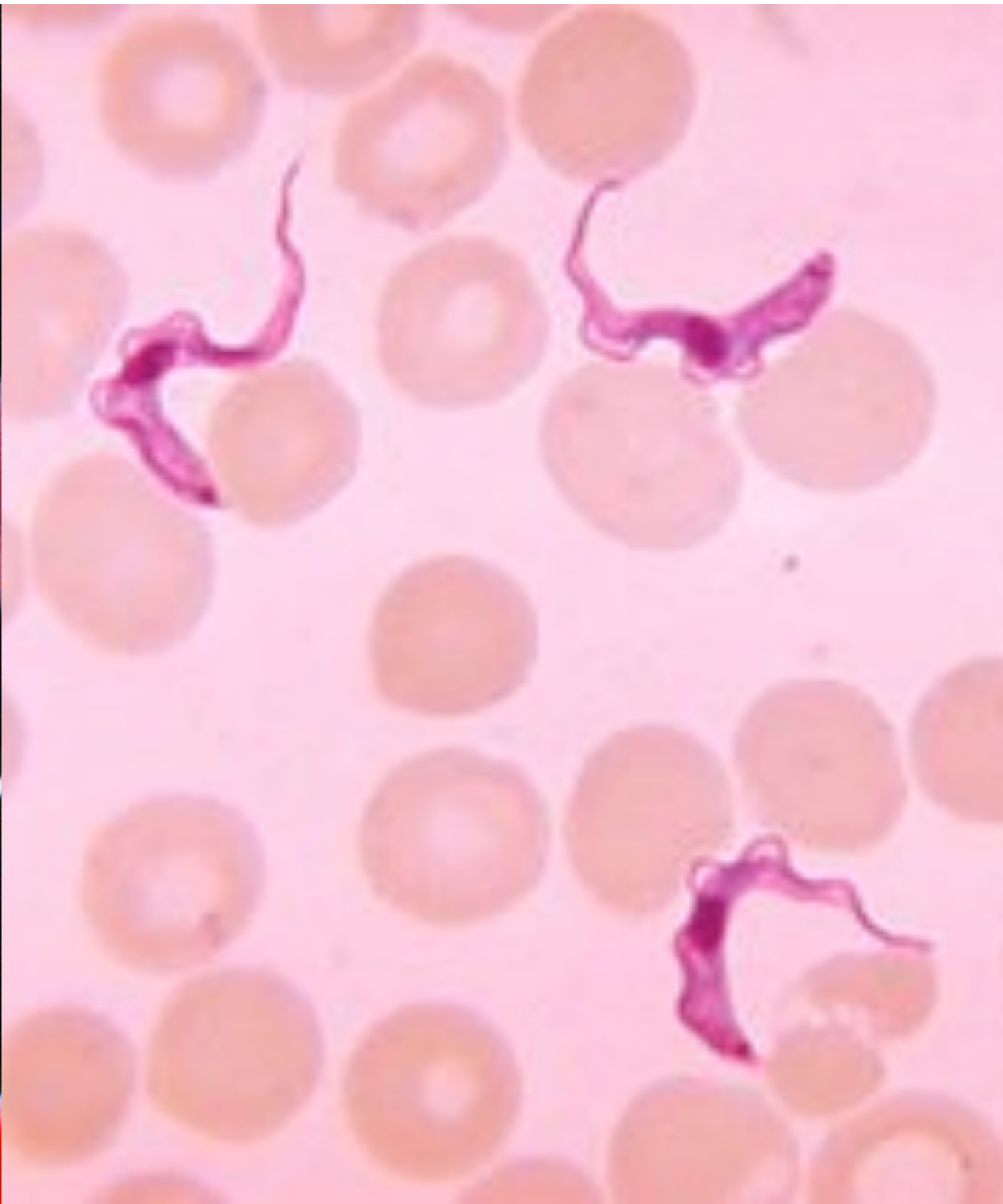
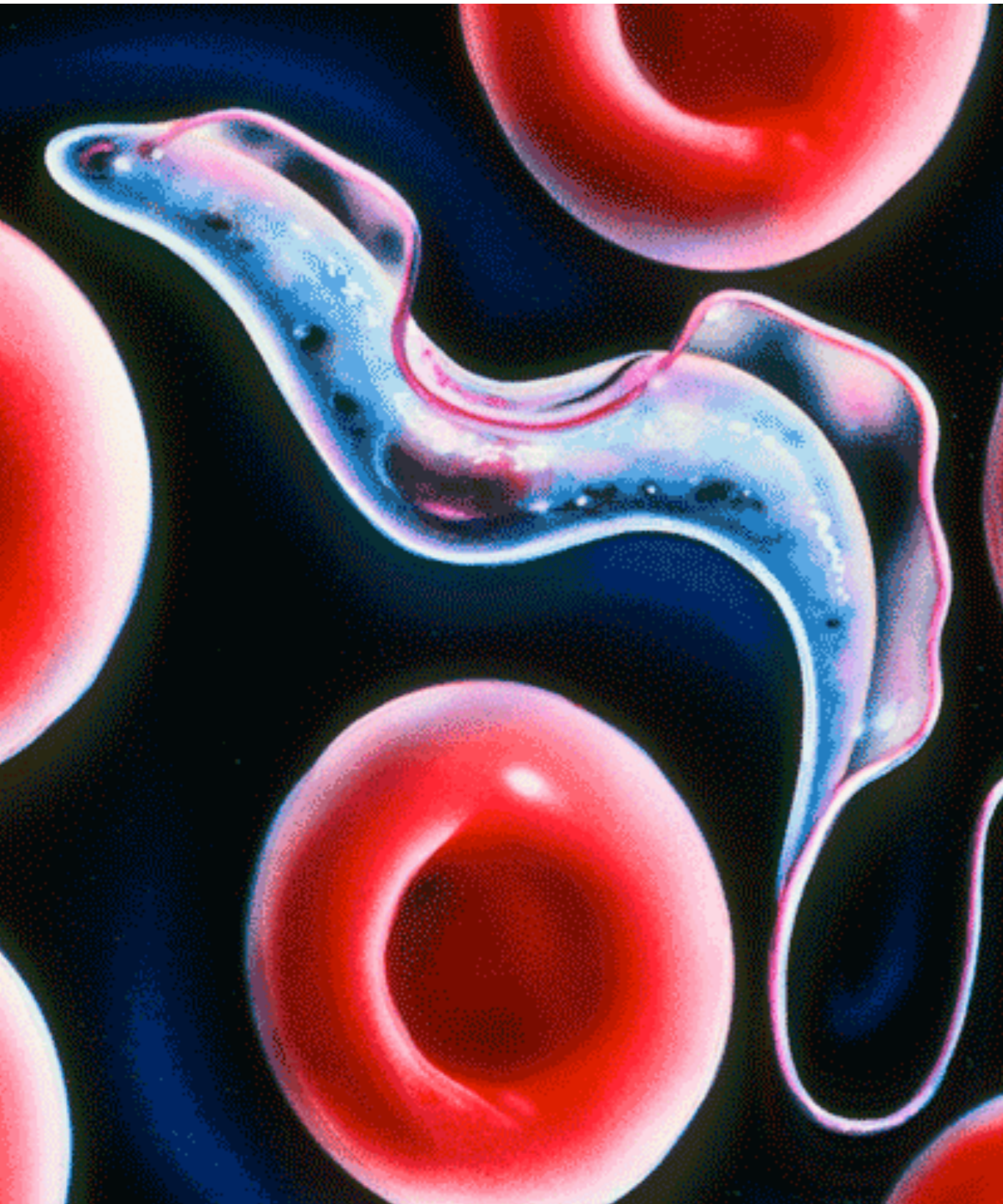


Fixate nitrogen





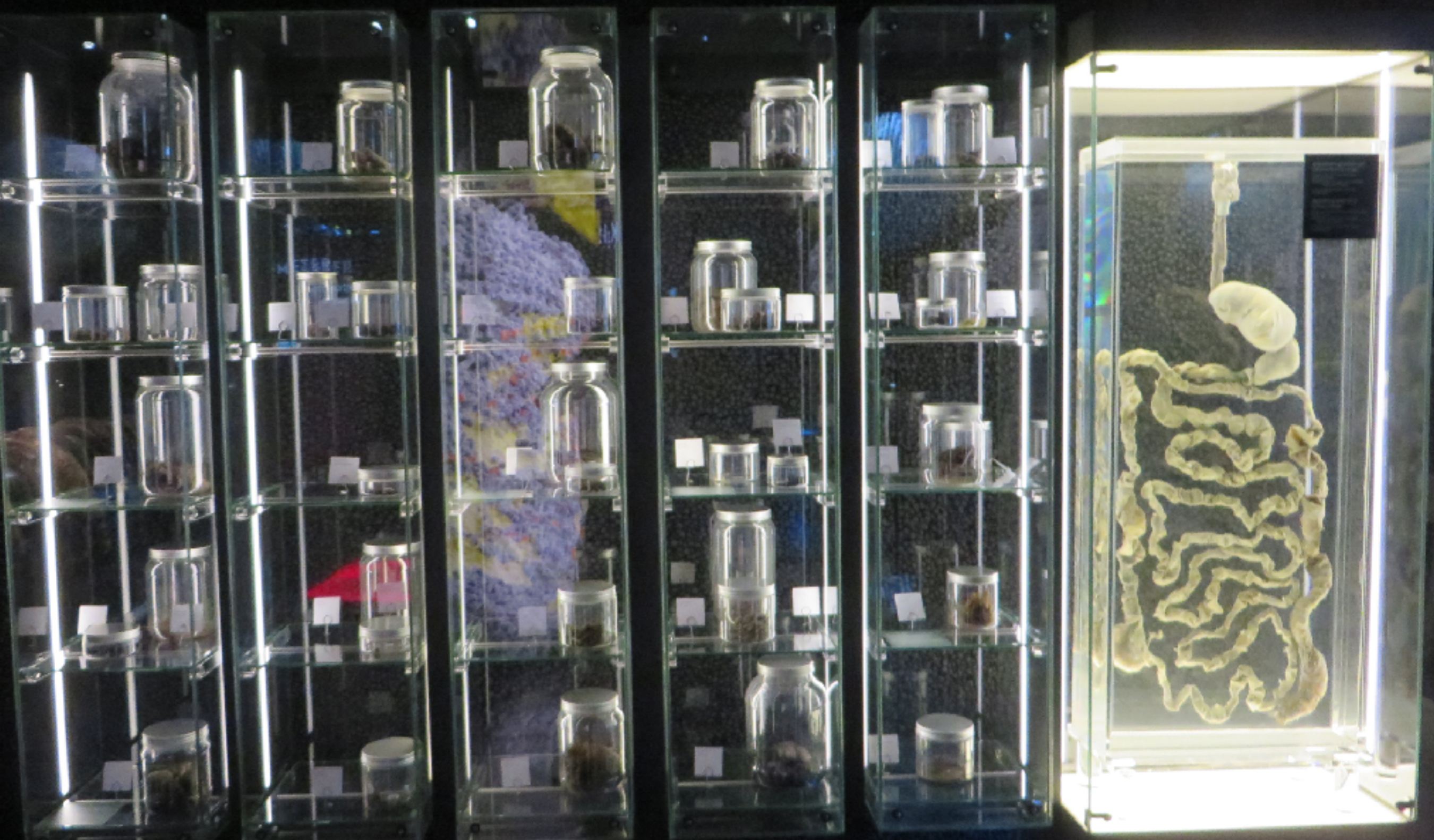
Cause disease – *Trypanosoma brucei*





Second brain?

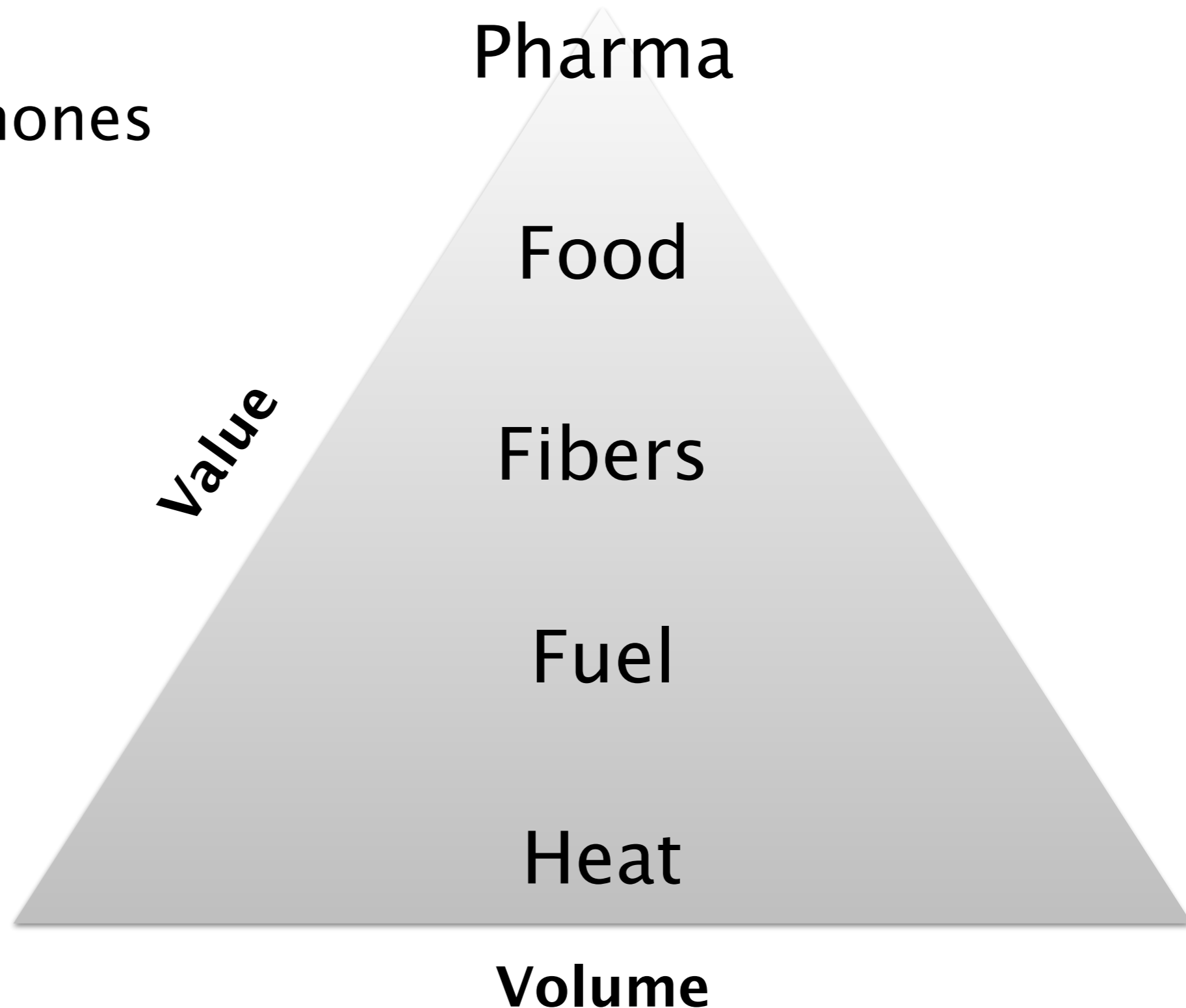
Shaun Moshasha





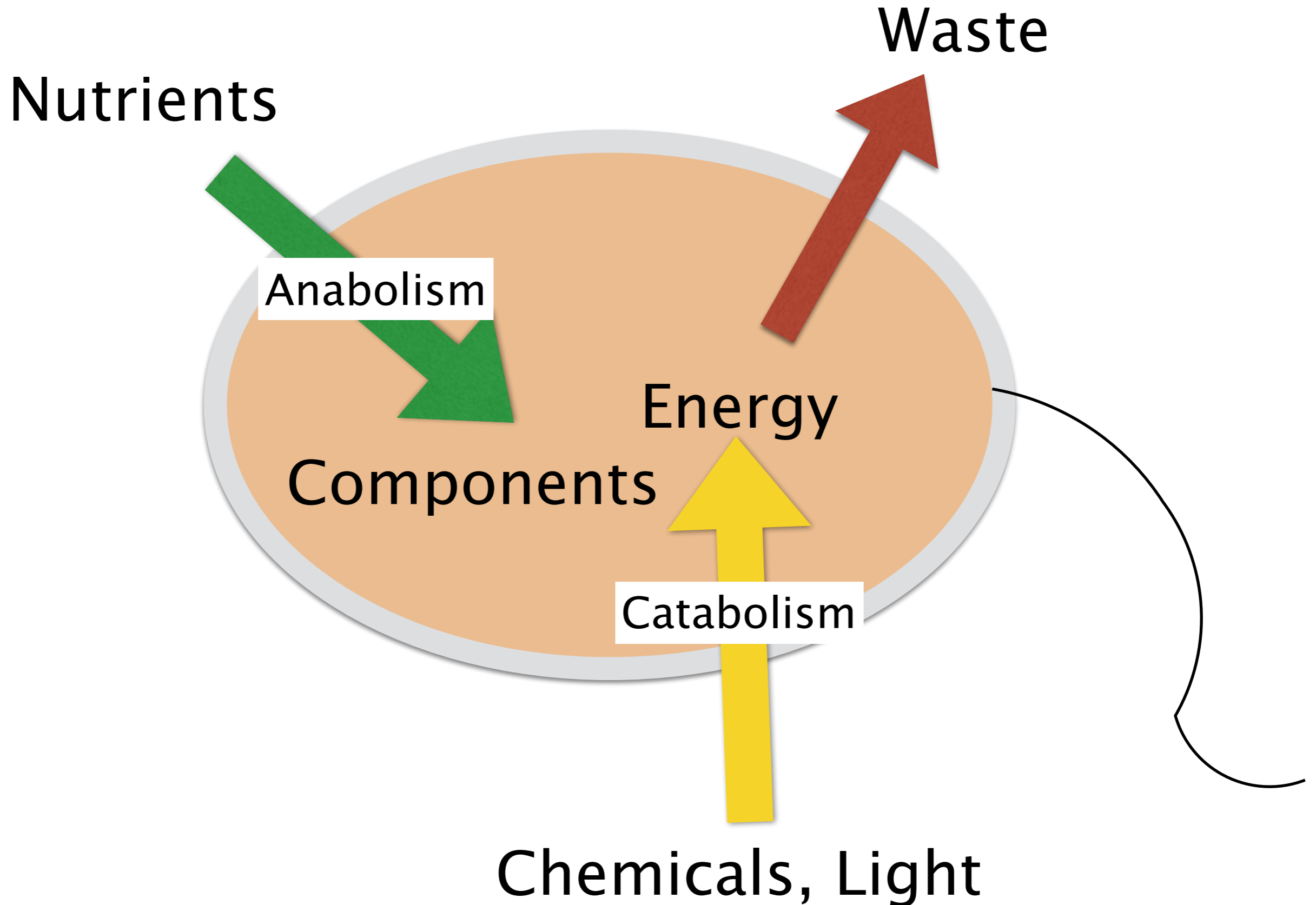
Bioreactor value pyramid

- 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
- Antibiotics -> Pigments -> Paint
- Light
- Cell structures -> Cellulose / Filaments -> Material



Ivorish – Nina van den Broek





Bacterial Radio – Joe Davis





Fungi products





Maurizio Montalti – Growing Lab





BioSteel

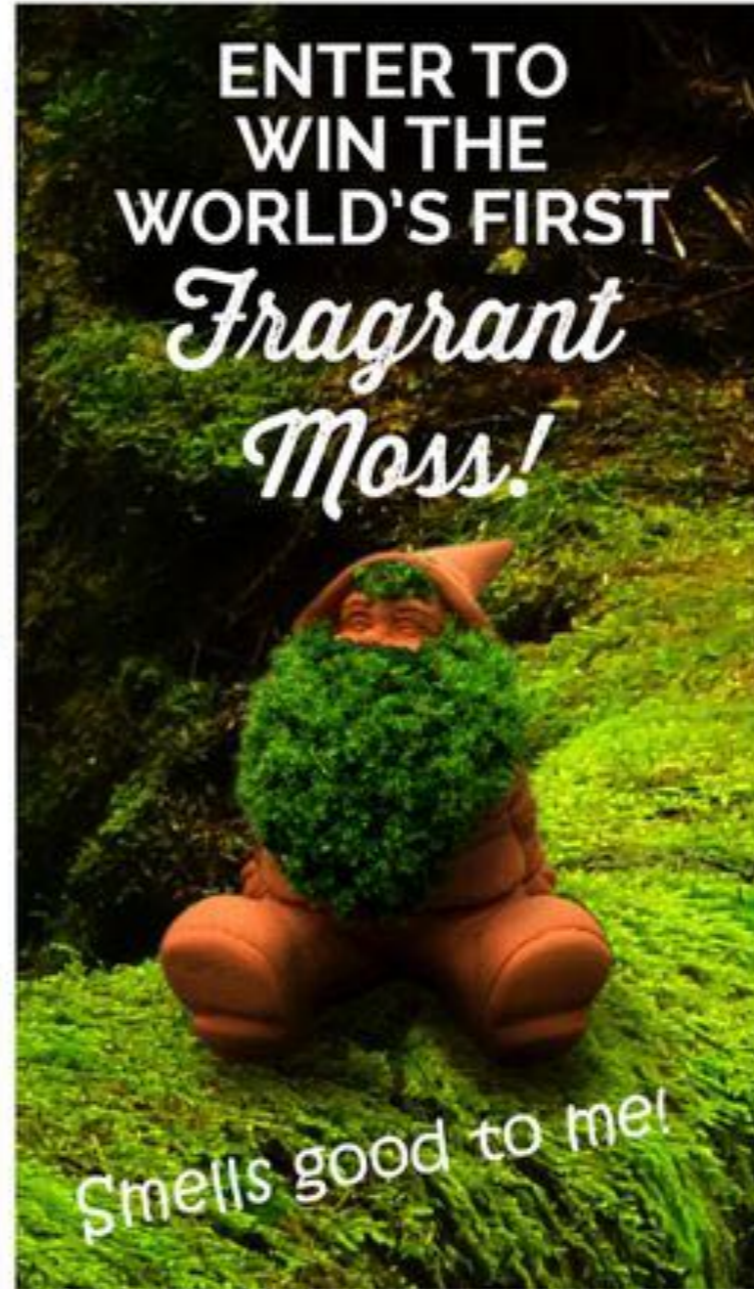




Fragrant Moss



TAXA





Victimless Leather





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The Cell



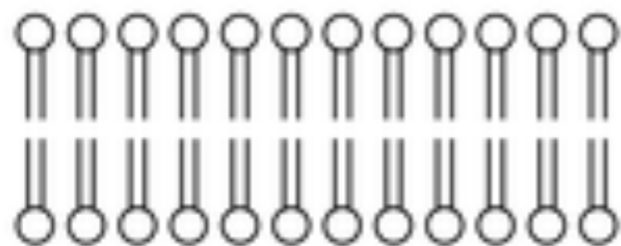
Lipid bilayer cell



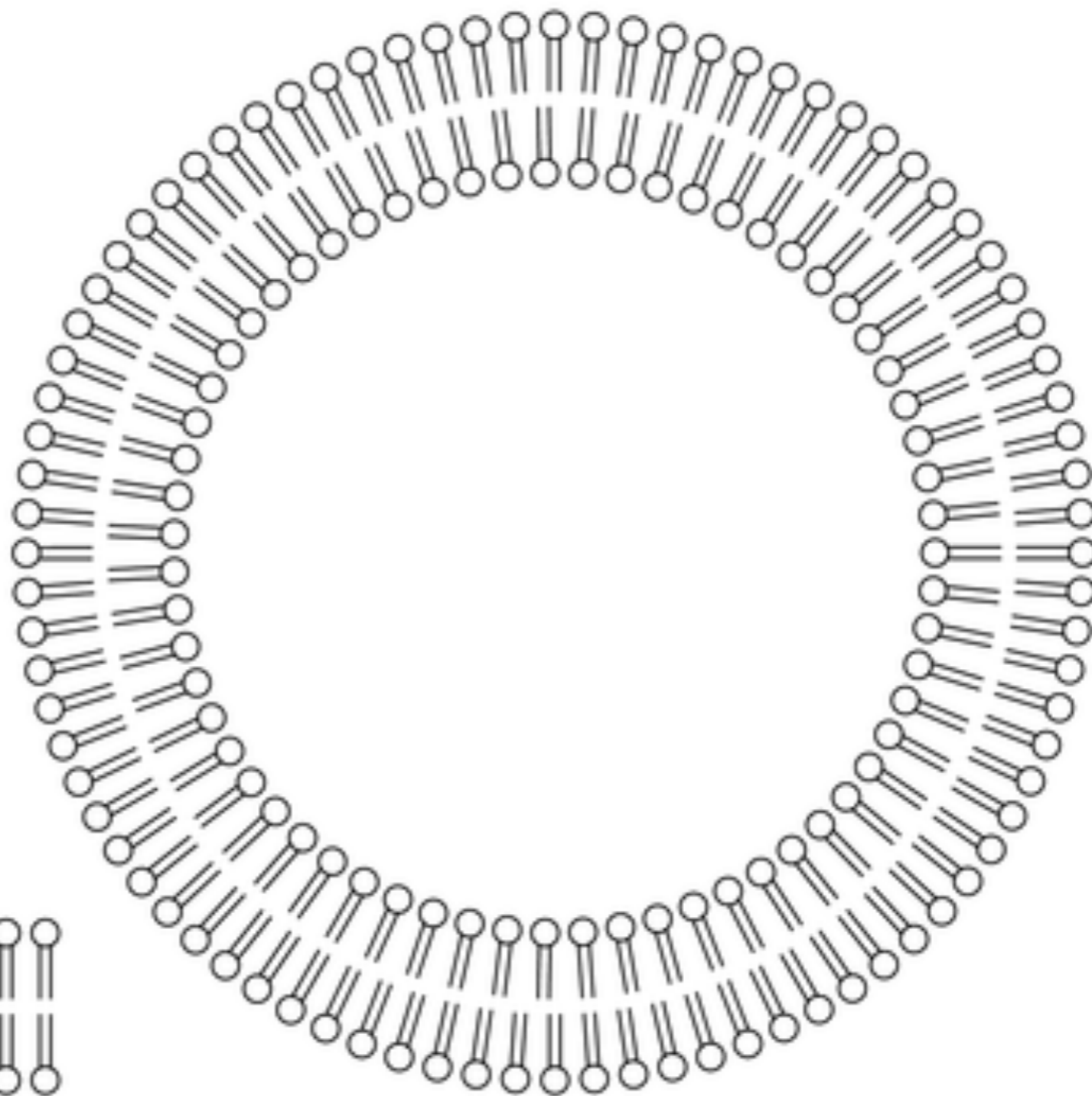
Micelle



Inverted micelle



Lipid bilayer



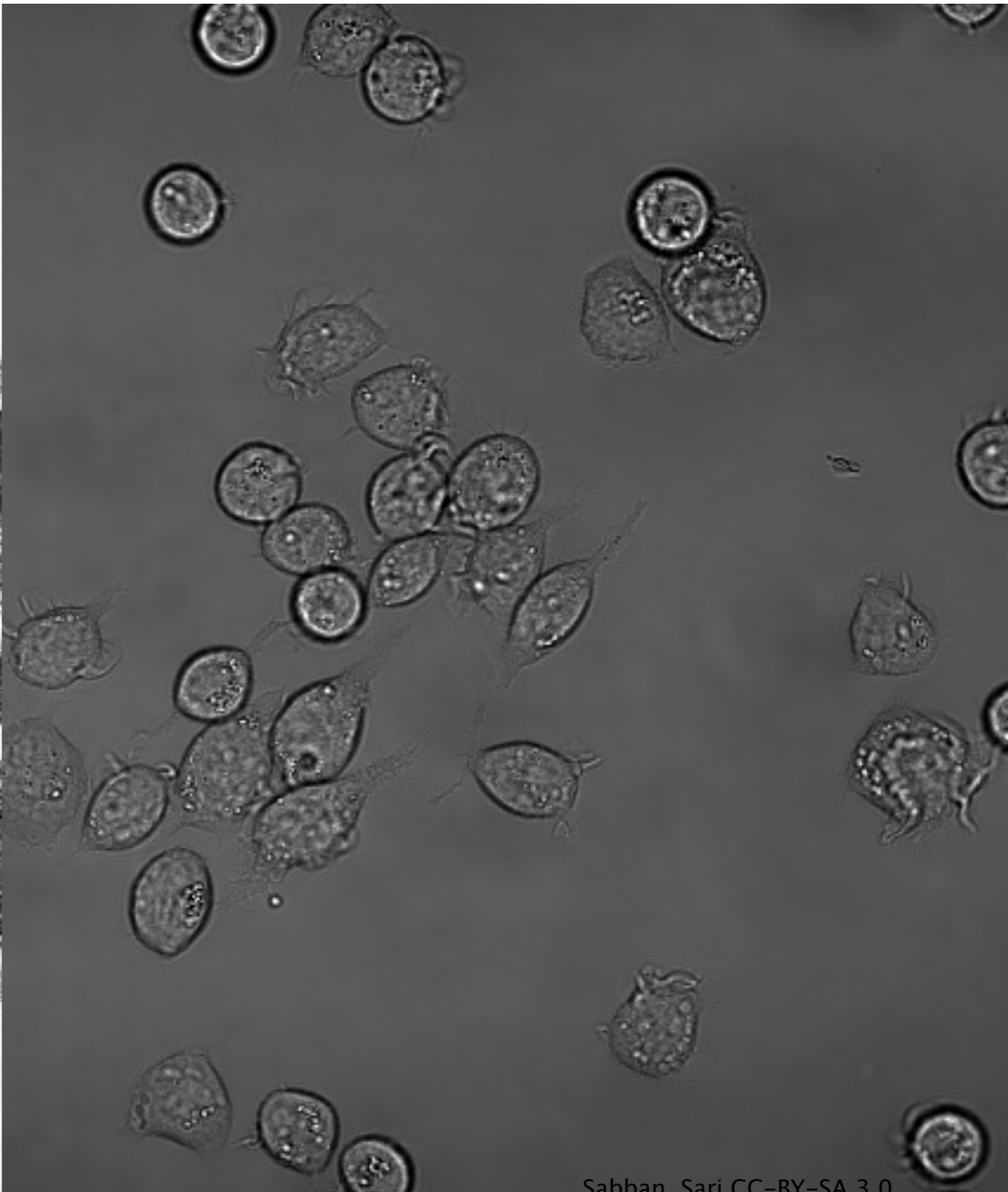
Vesicle



Life is made out of cells



Public Domain

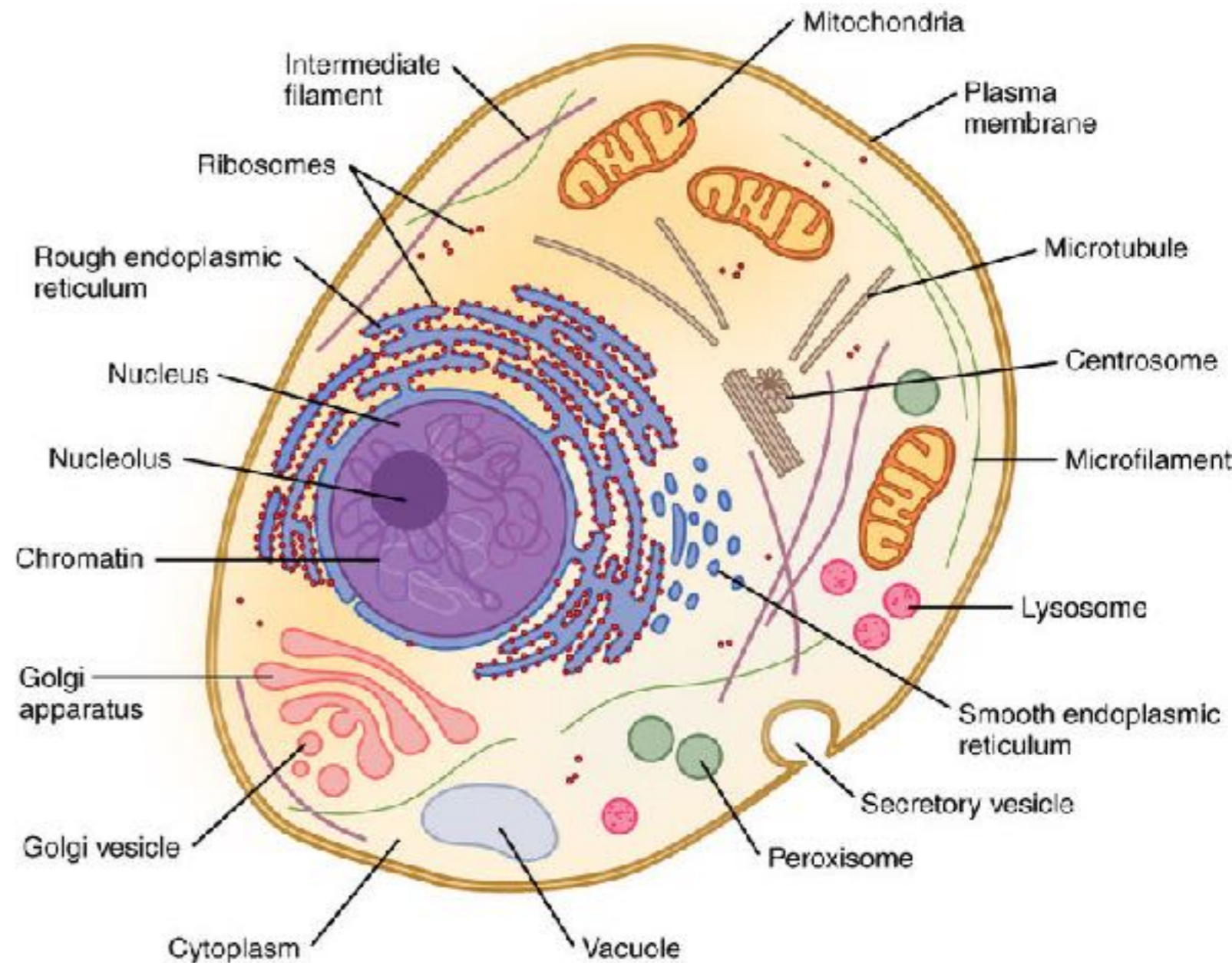


Sabban, Sari CC-BY-SA 3.0



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)

Redudant backups (double helix, copy number)

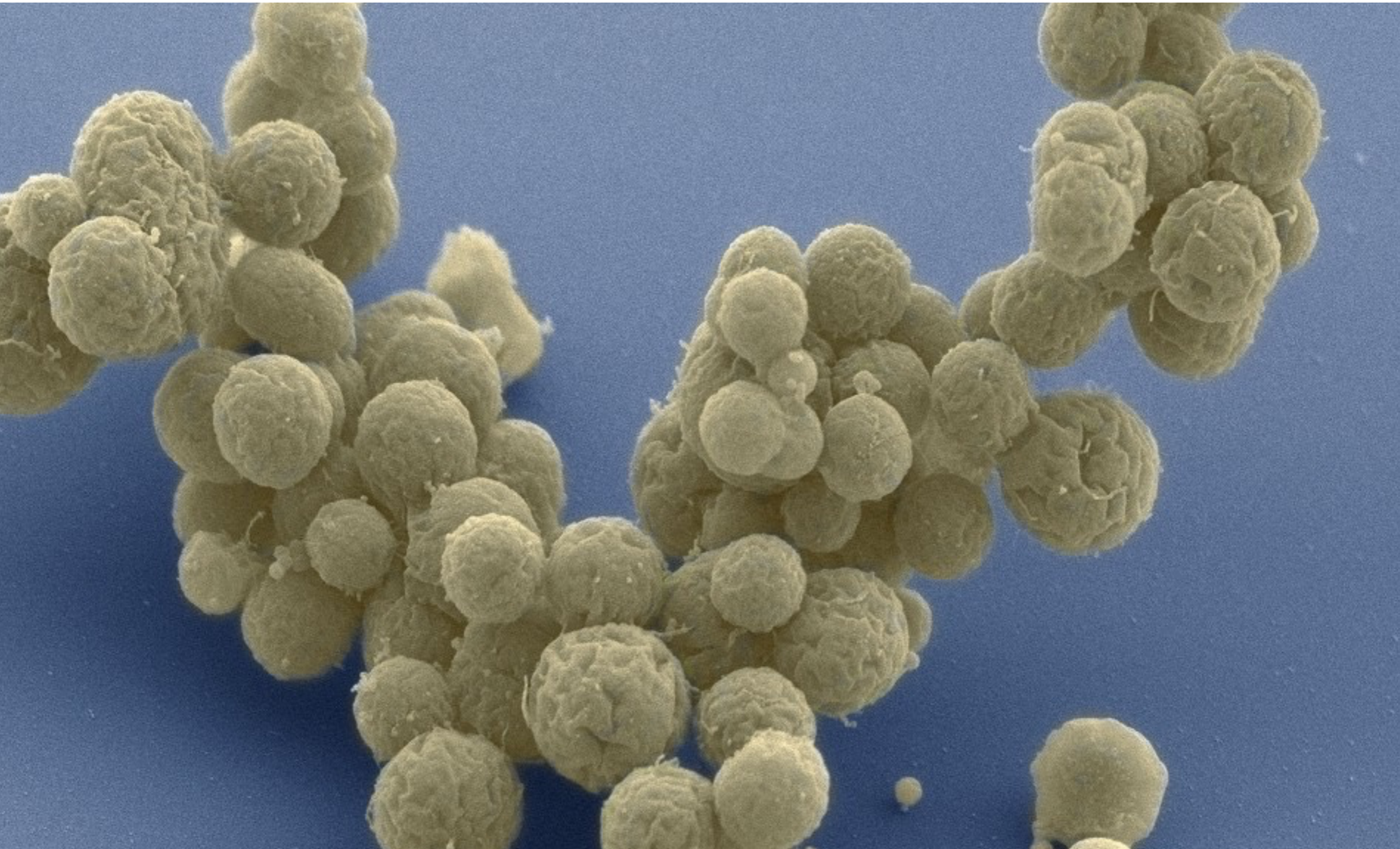
Self-diagnostics (apoptosis)

Firewalls (species)

Operating system (ribosomes)



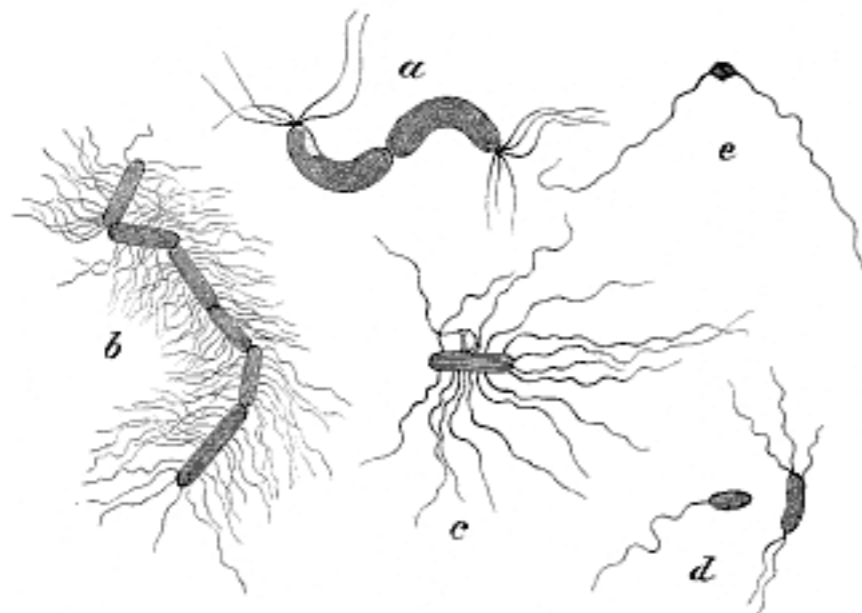
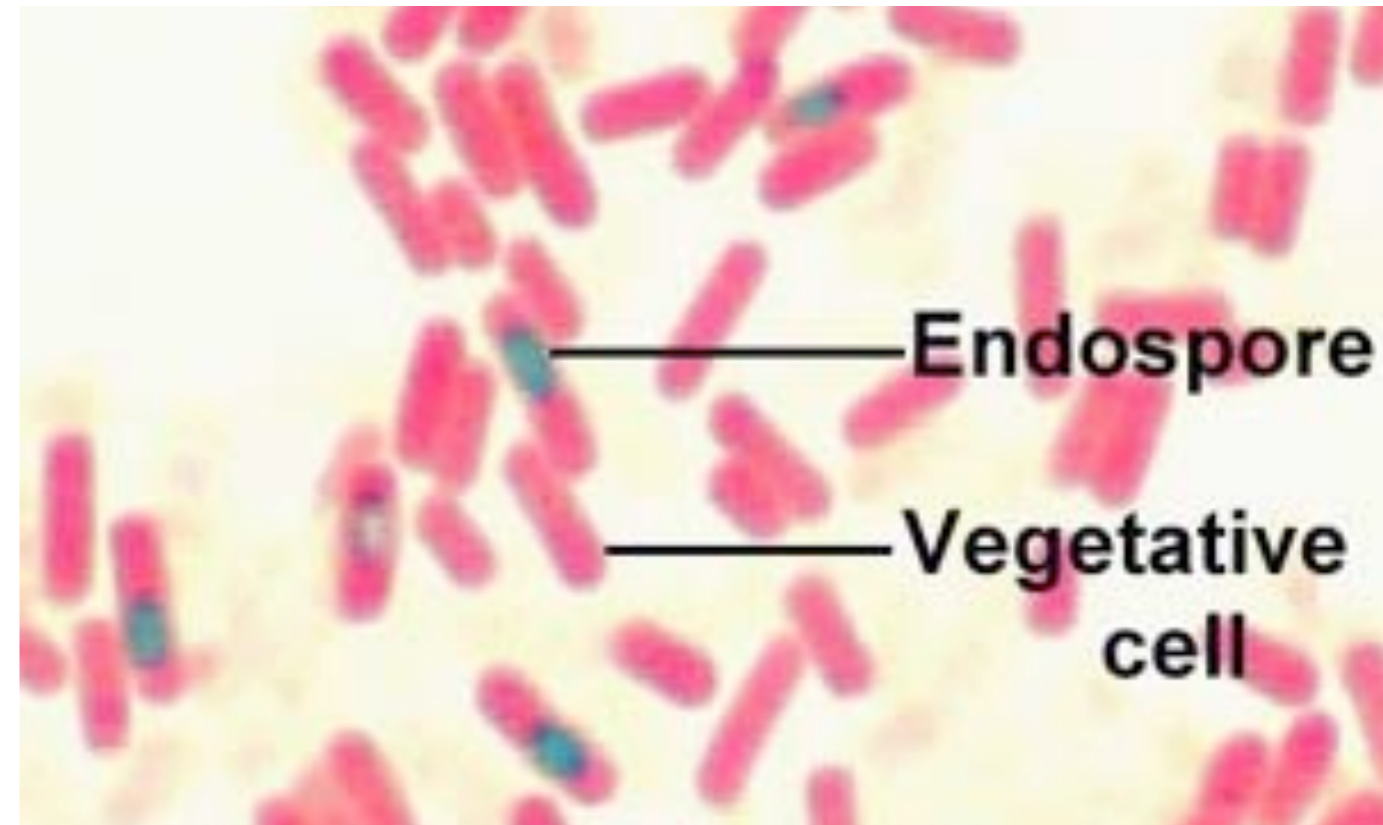
Minimal genome 473 genes





Ferdinand Cohn

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



Geißeln der Bakterien

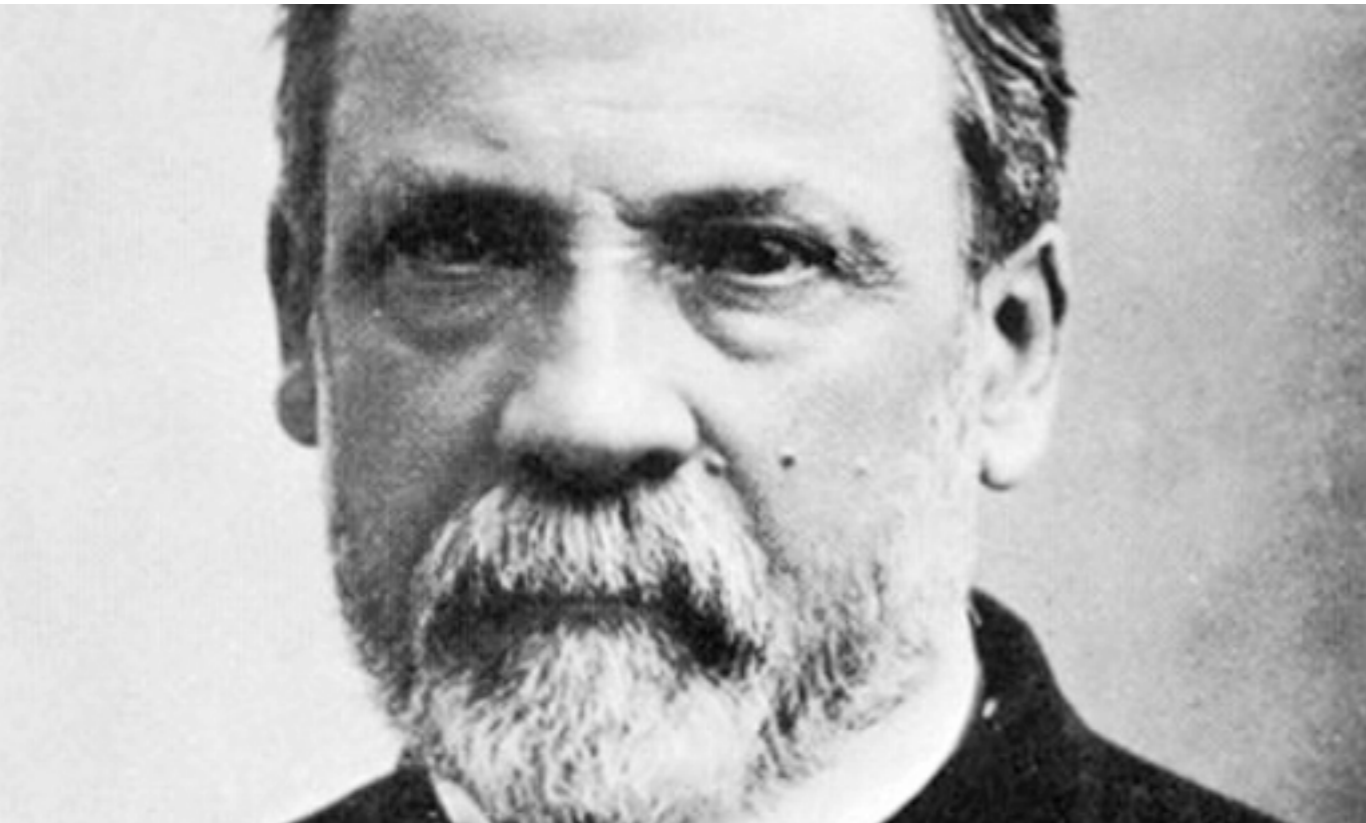
a von *Spirillum Undula* in der Theilung; b vom Heubacillus (*Bacillus subtilis*), Faden bildend; c einzelnes Stäbchen des Heubacillus; d von Käufnickbakterien (*Ba-*



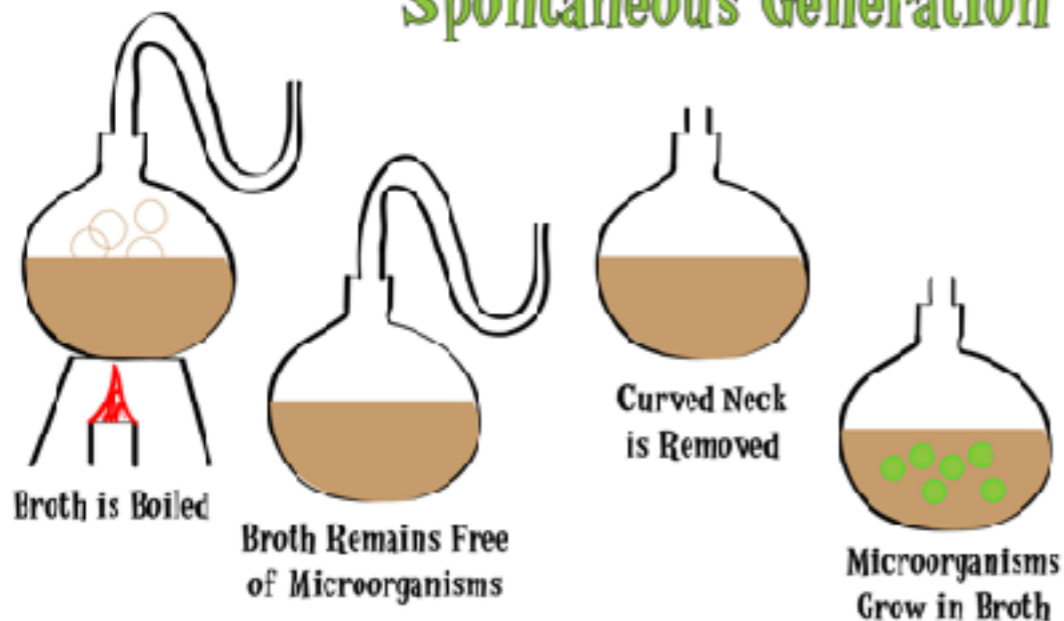


Louis Pasteur (19th century)

Proof that microbes do not “spontaneously appear”



Pasteur's Test of Spontaneous Generation





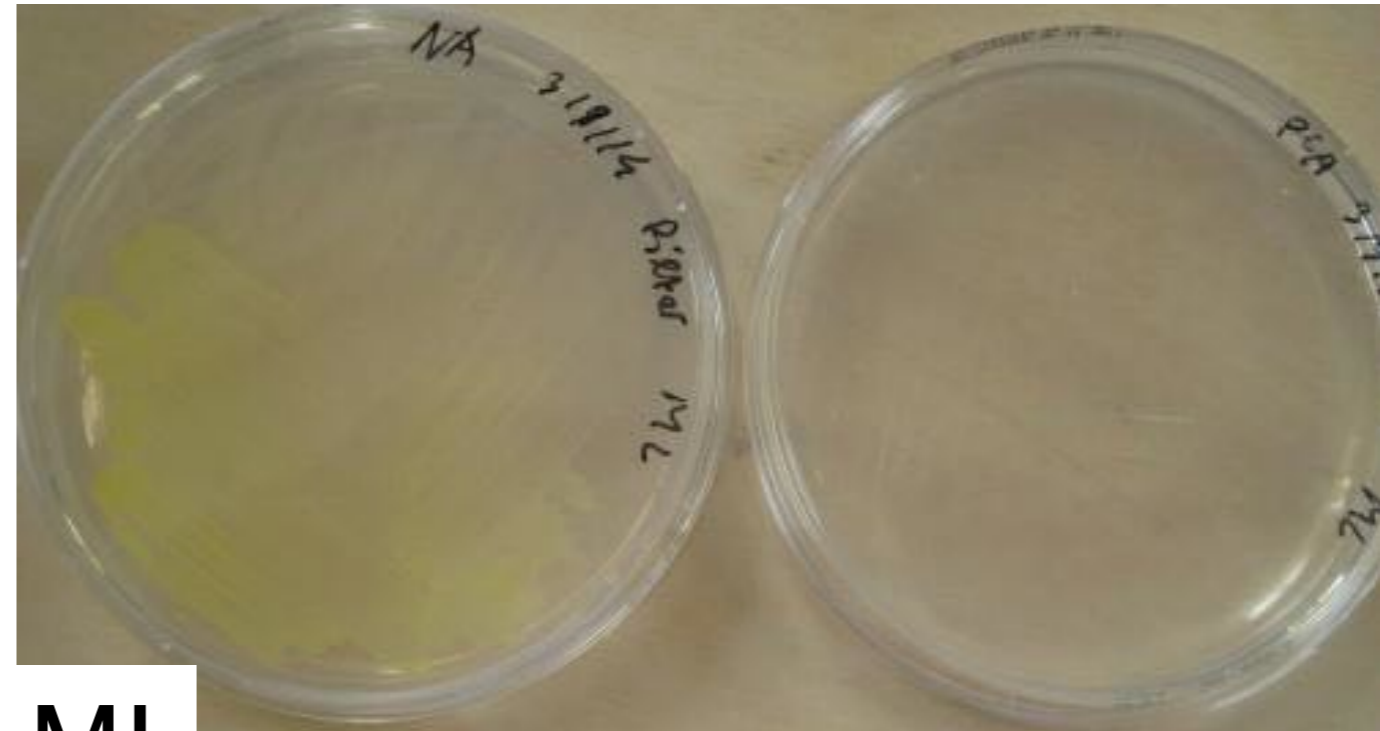
Culture Collection



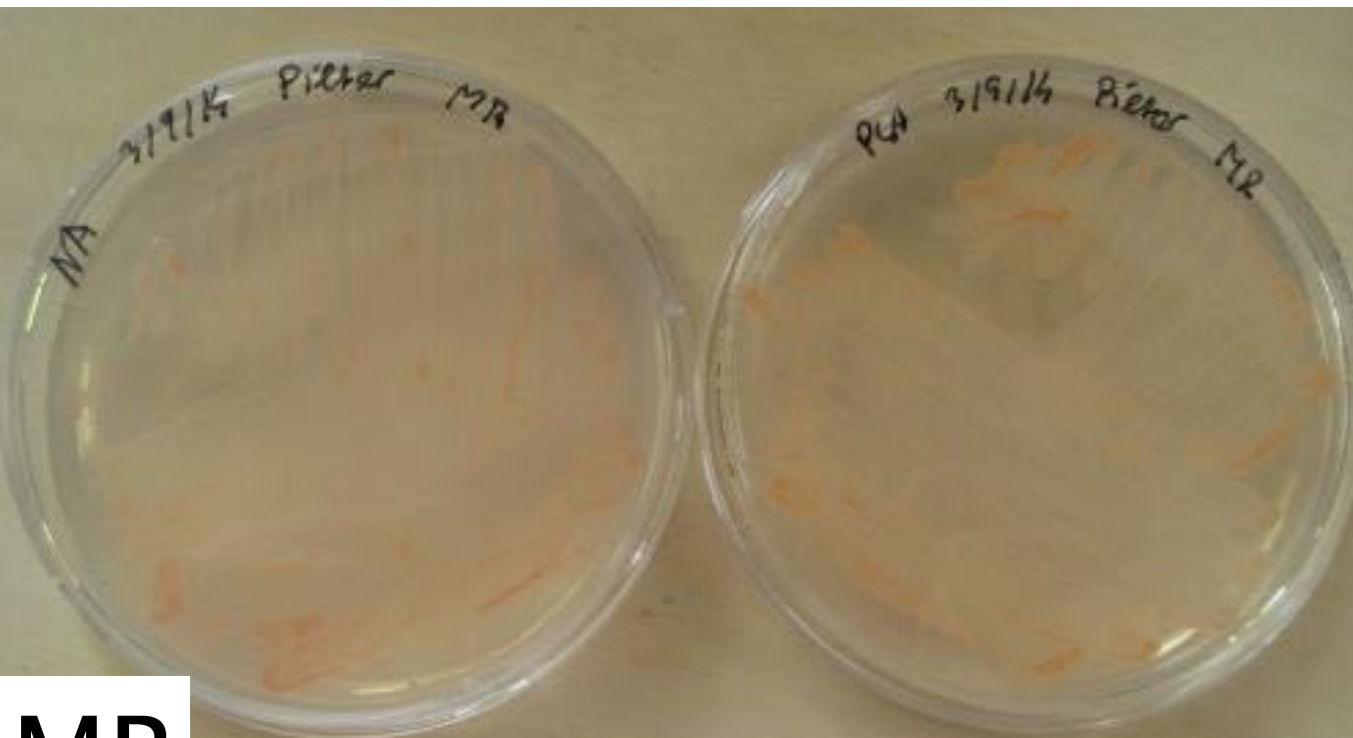
Pigmented bacteria

Pigments
Antibiotics

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



ML



MR



JL



Algae

Pigments
Food

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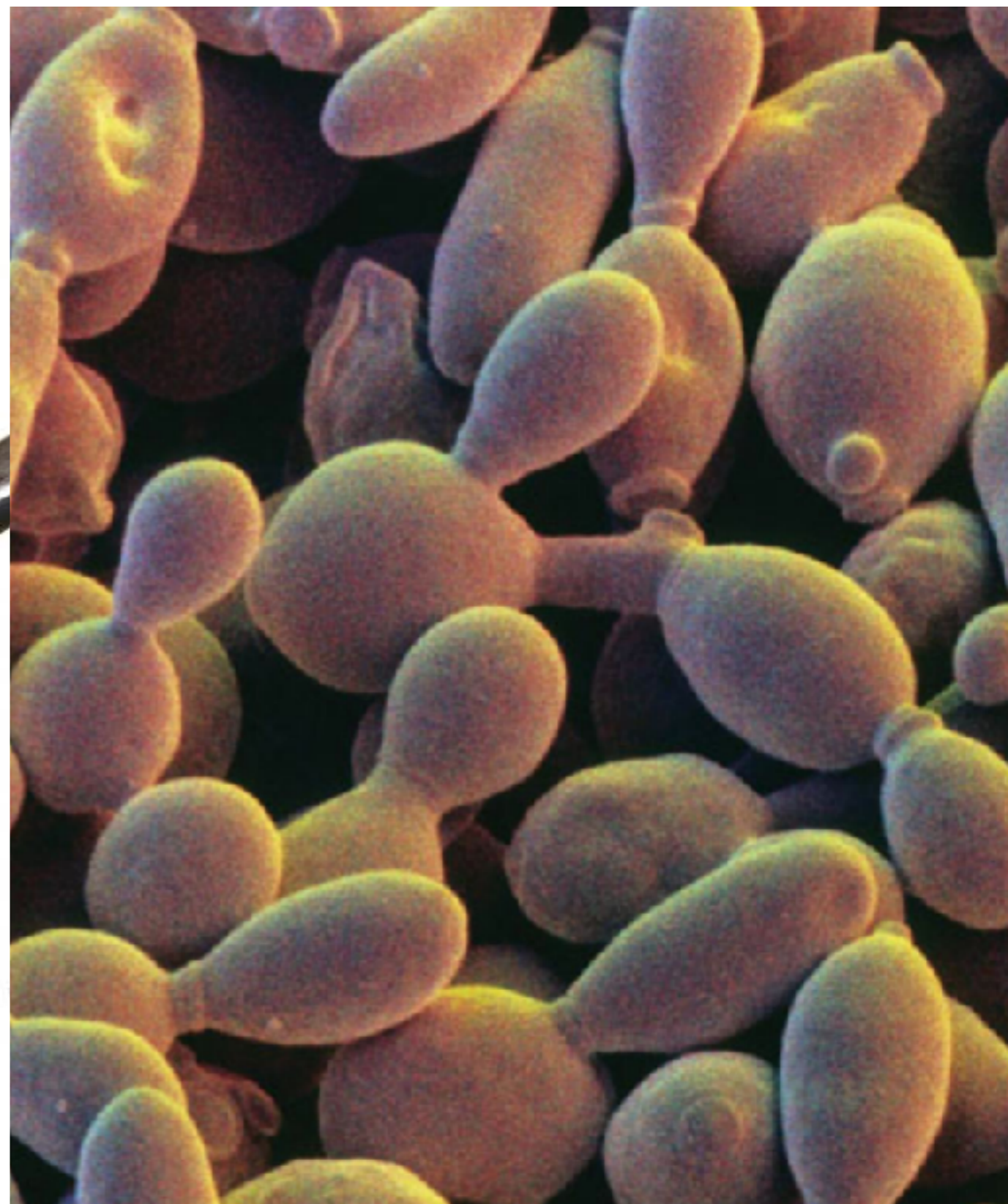


Spirulina maxima



Yeast

Alcohol
CO₂

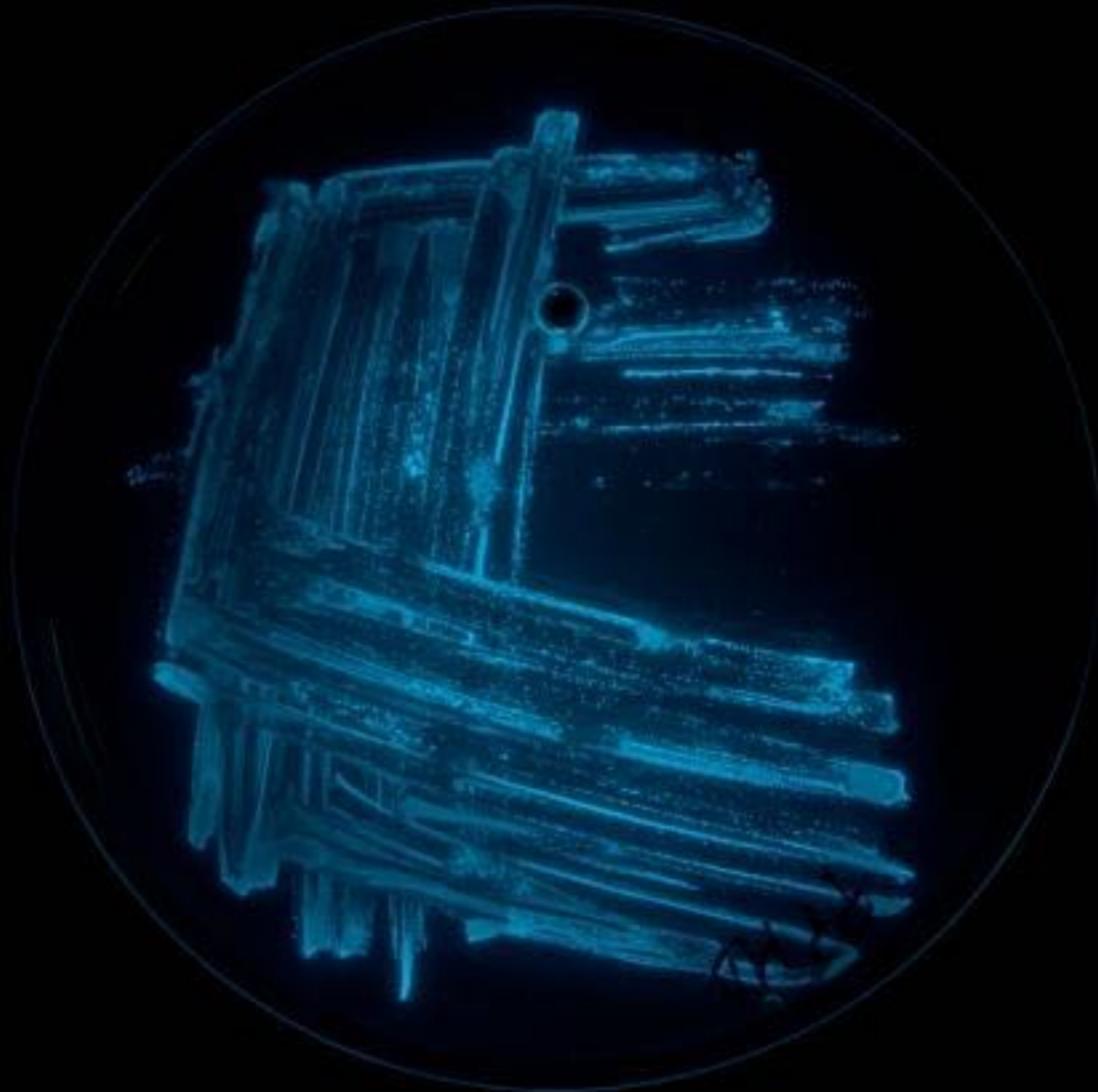




Photobacterium phospherium

Light

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SCOBY

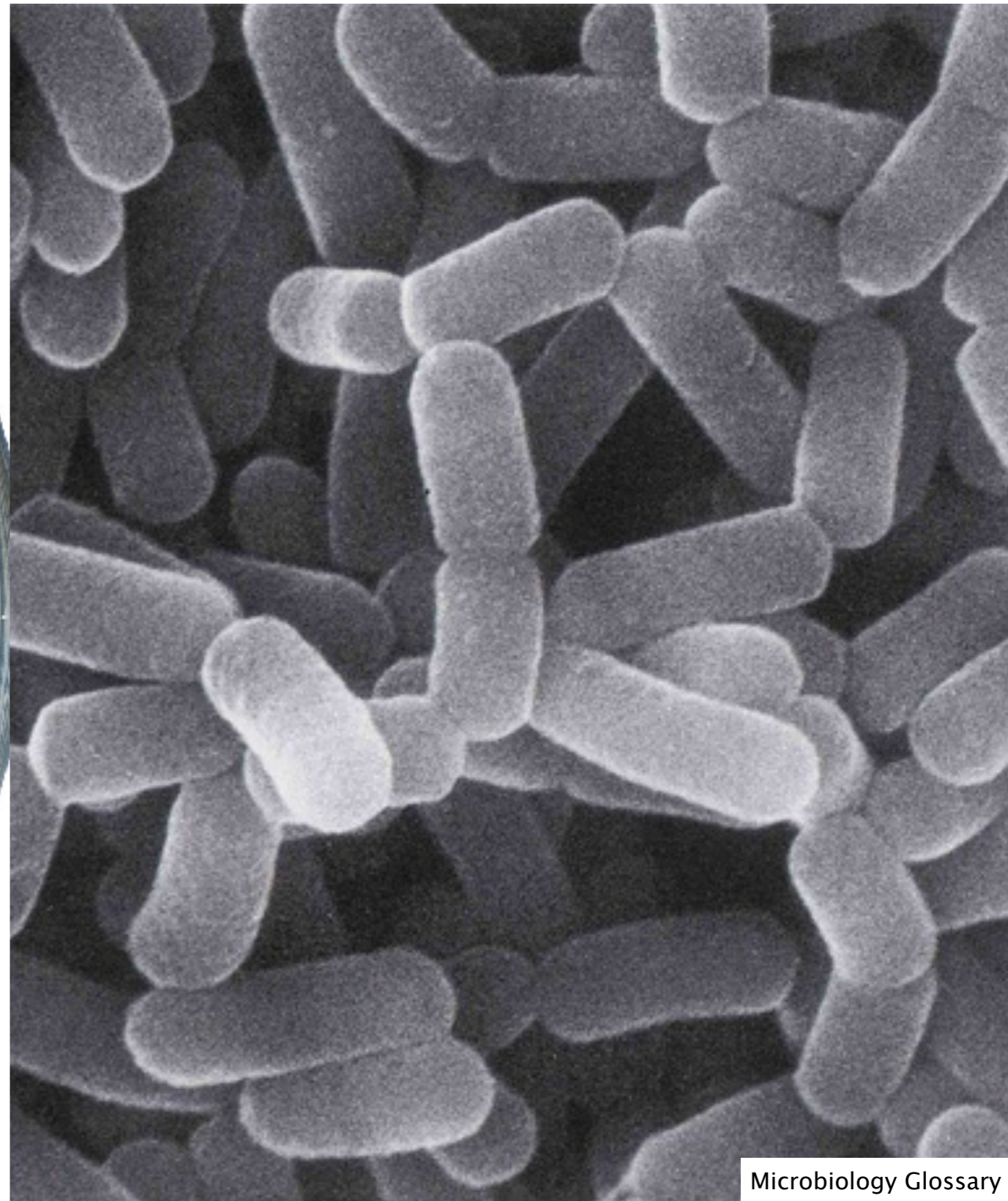
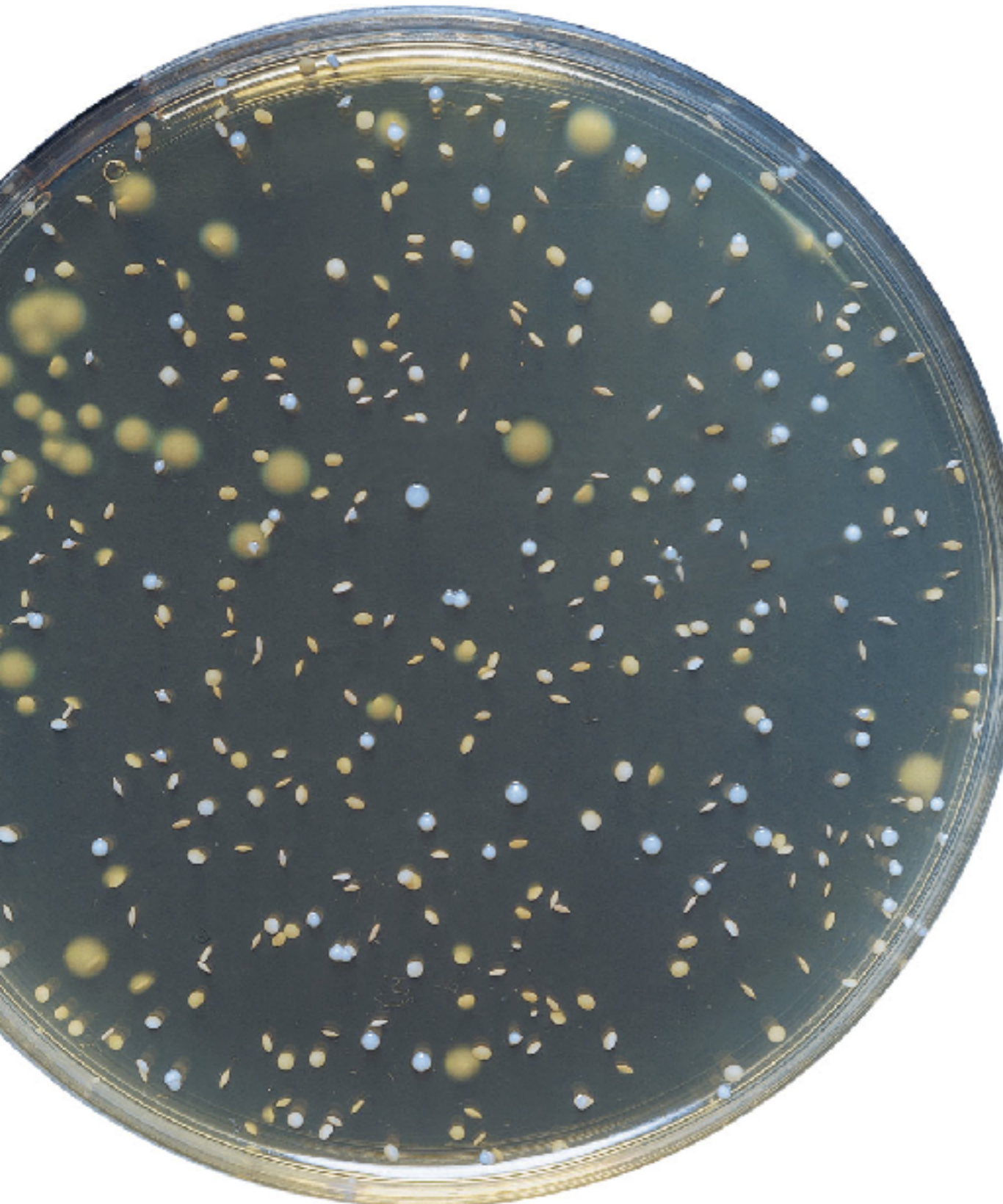
Cellulose
Vinegar

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/>



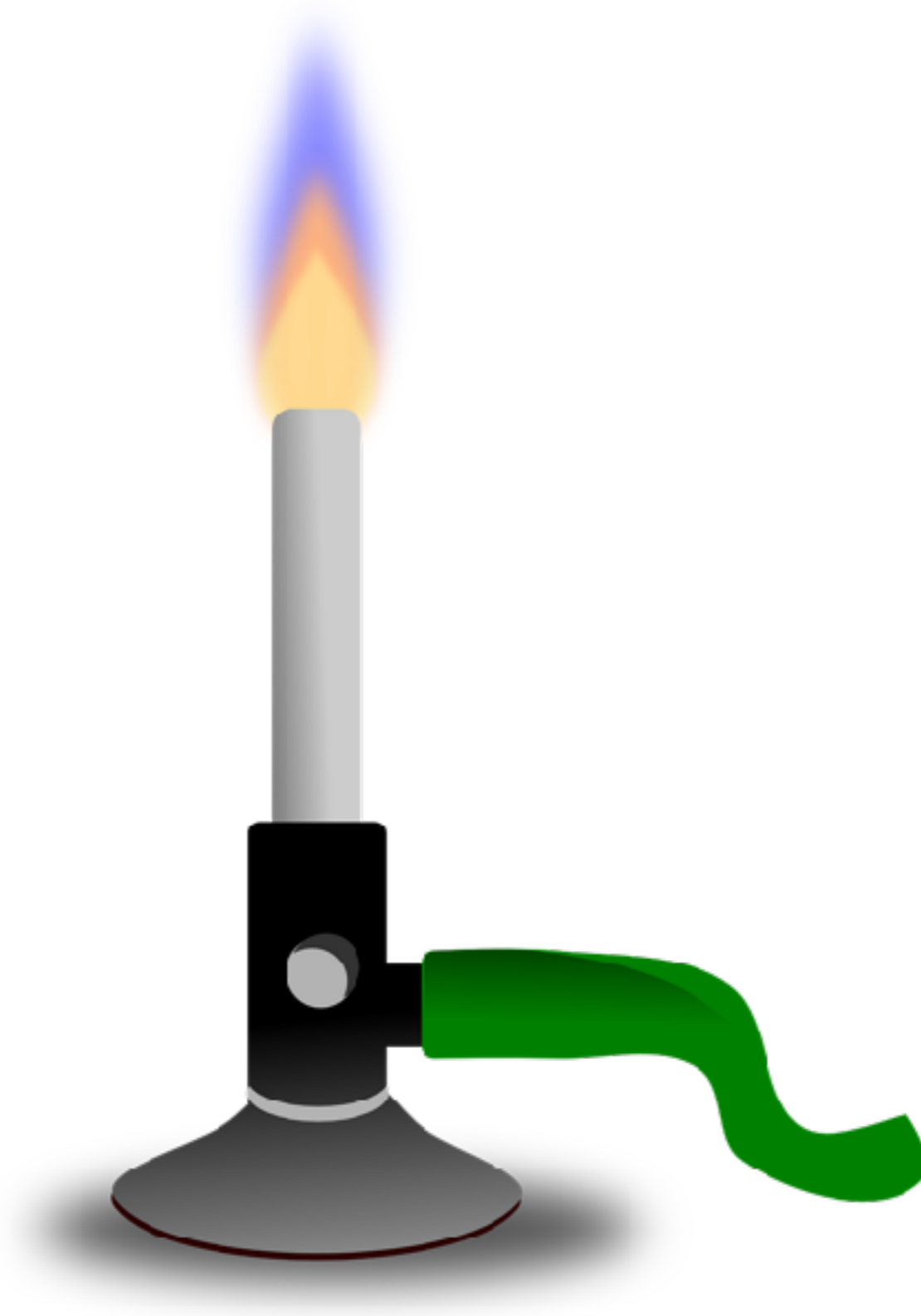
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Working with Microbes



Working sterile with gas burner





Preparing plates

Autoclaving for 20 min



Pouring petri dishes





Inoculation

