biohack academy
waag society

Microbiology

waag society

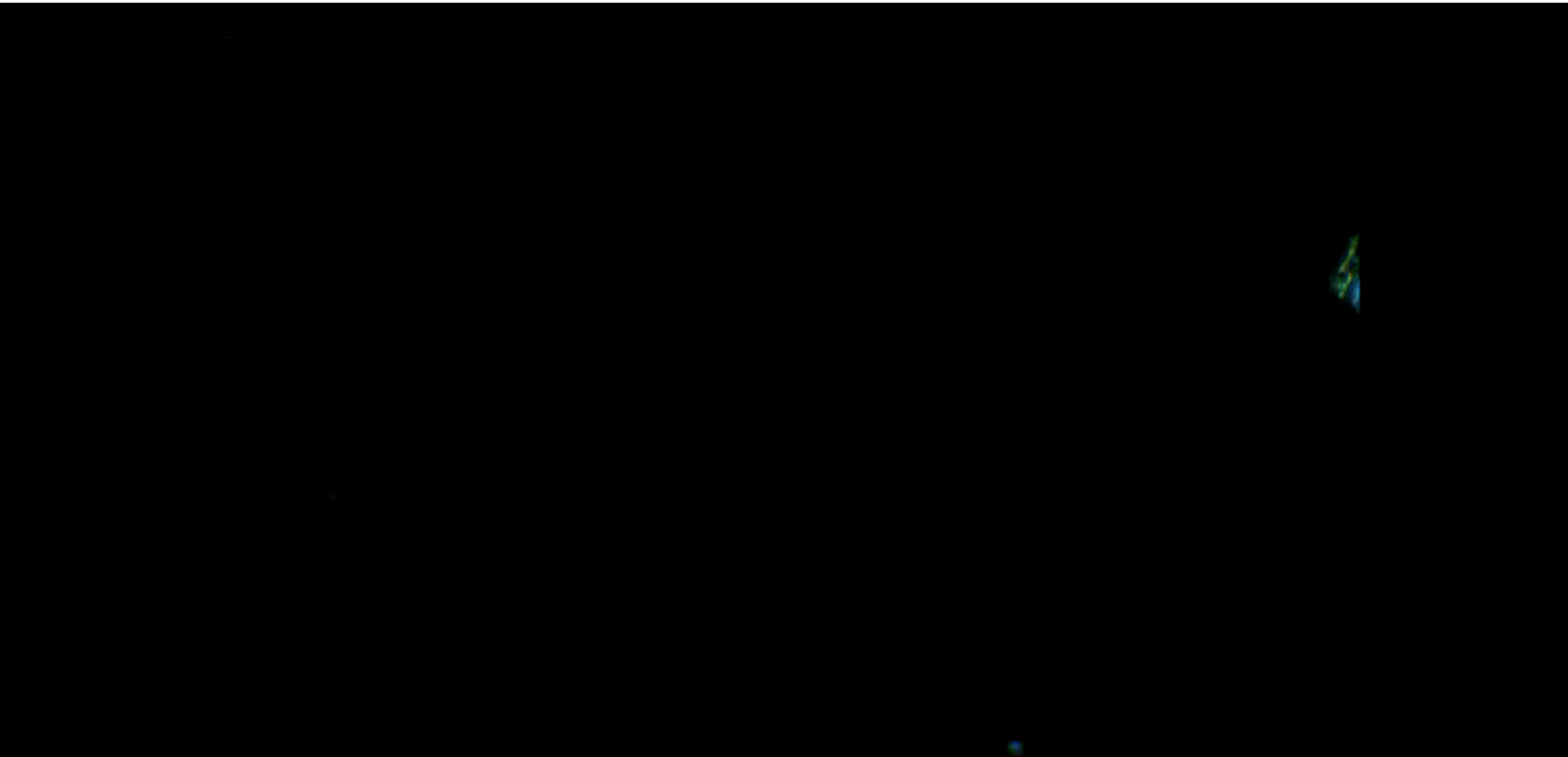
institute for art, science and technology

What is life?

Is this alive?

Is this alive?

Is this alive?



Some characteristics of life

Reproduction

Heredity

Adaptation

Energy consumption

Internal self-regulation

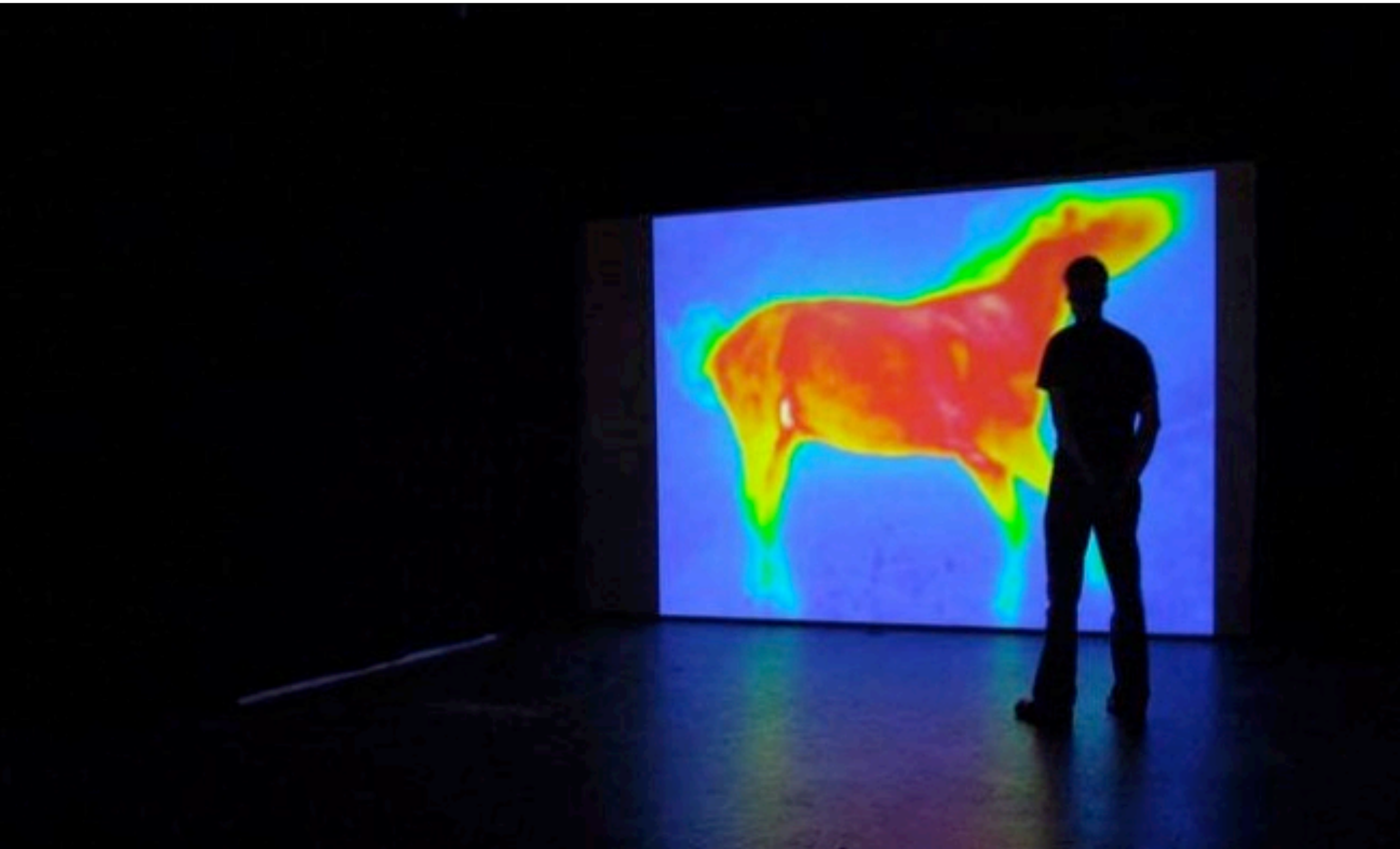
genetic information

Cell devision

Growing bacteria

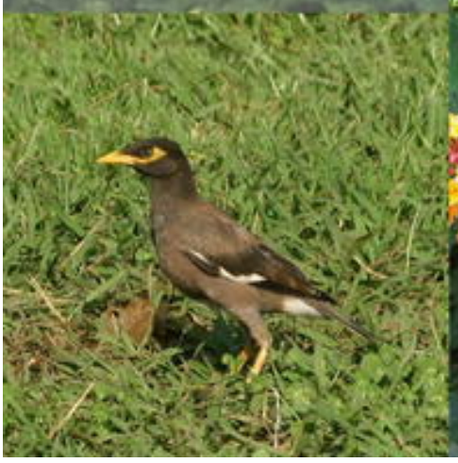
Daniel Izzo - YouTube License

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

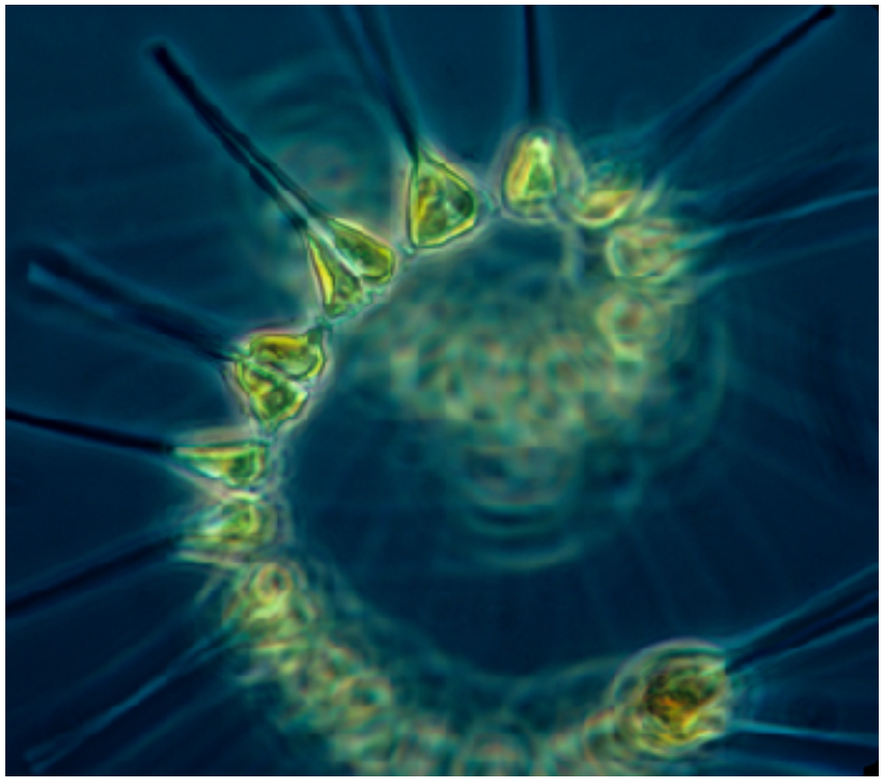
Microbiology

Definition of life

unicellular
(single cell)

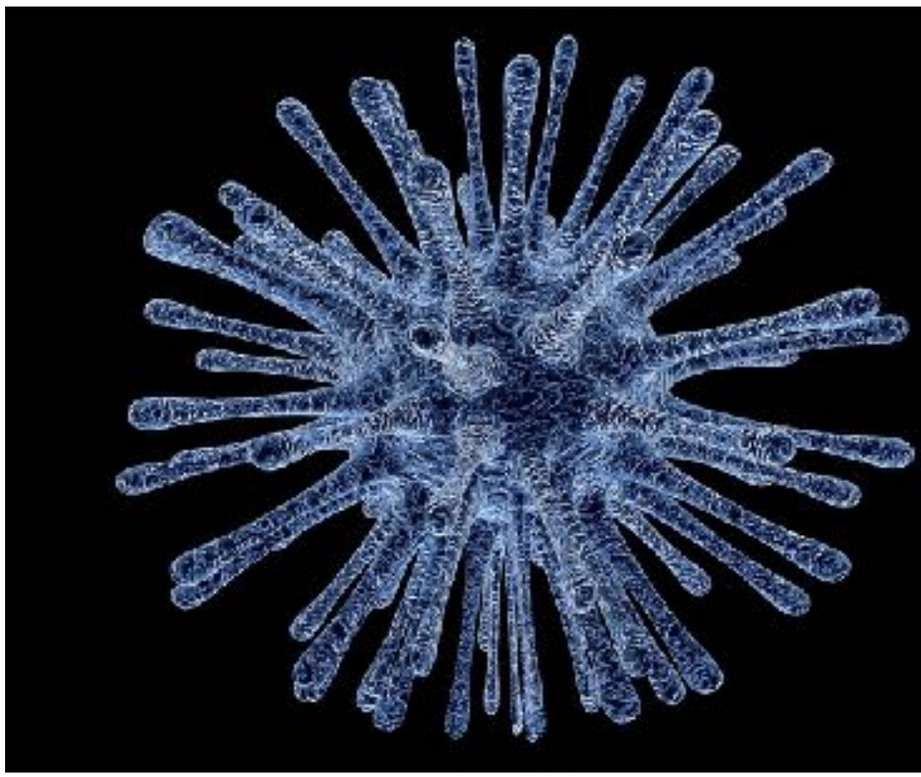
NIAID - CC-BY 2.0

multicellular
(cell colony)



CC0 - Public Domain

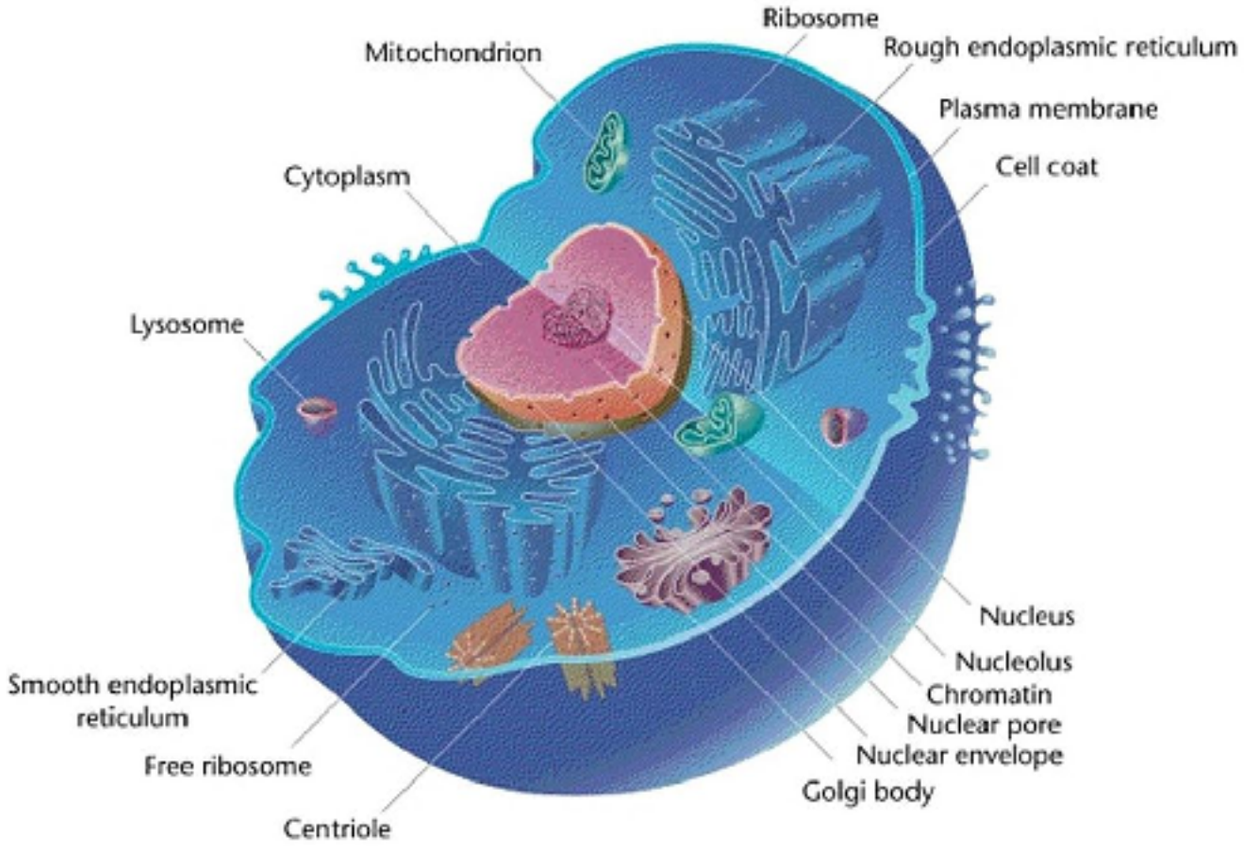
acellular
(lacking cells)



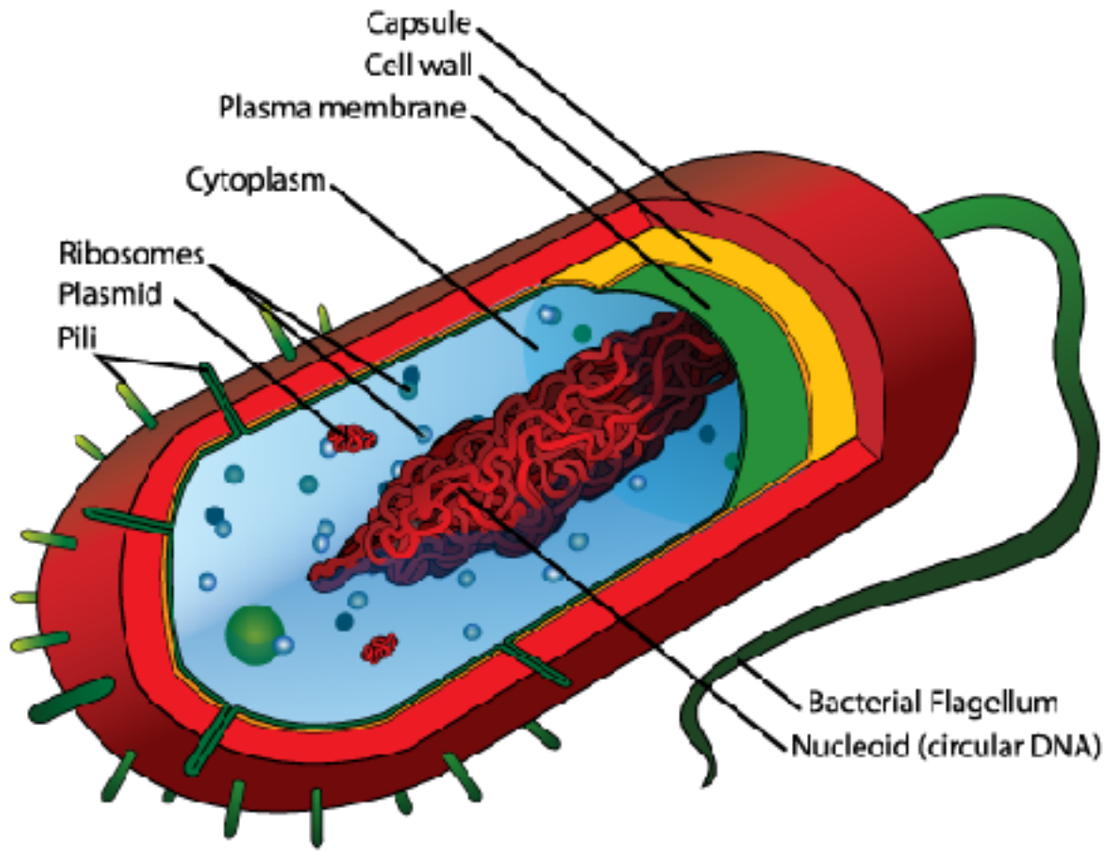
Pixabay - CC0 - Public Domain

Two main categories

Eukaryotic cell



Prokaryotic cell



Marion - CC-BY-SA 3.0

Public Domain

Advantage of being small

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

Exercise

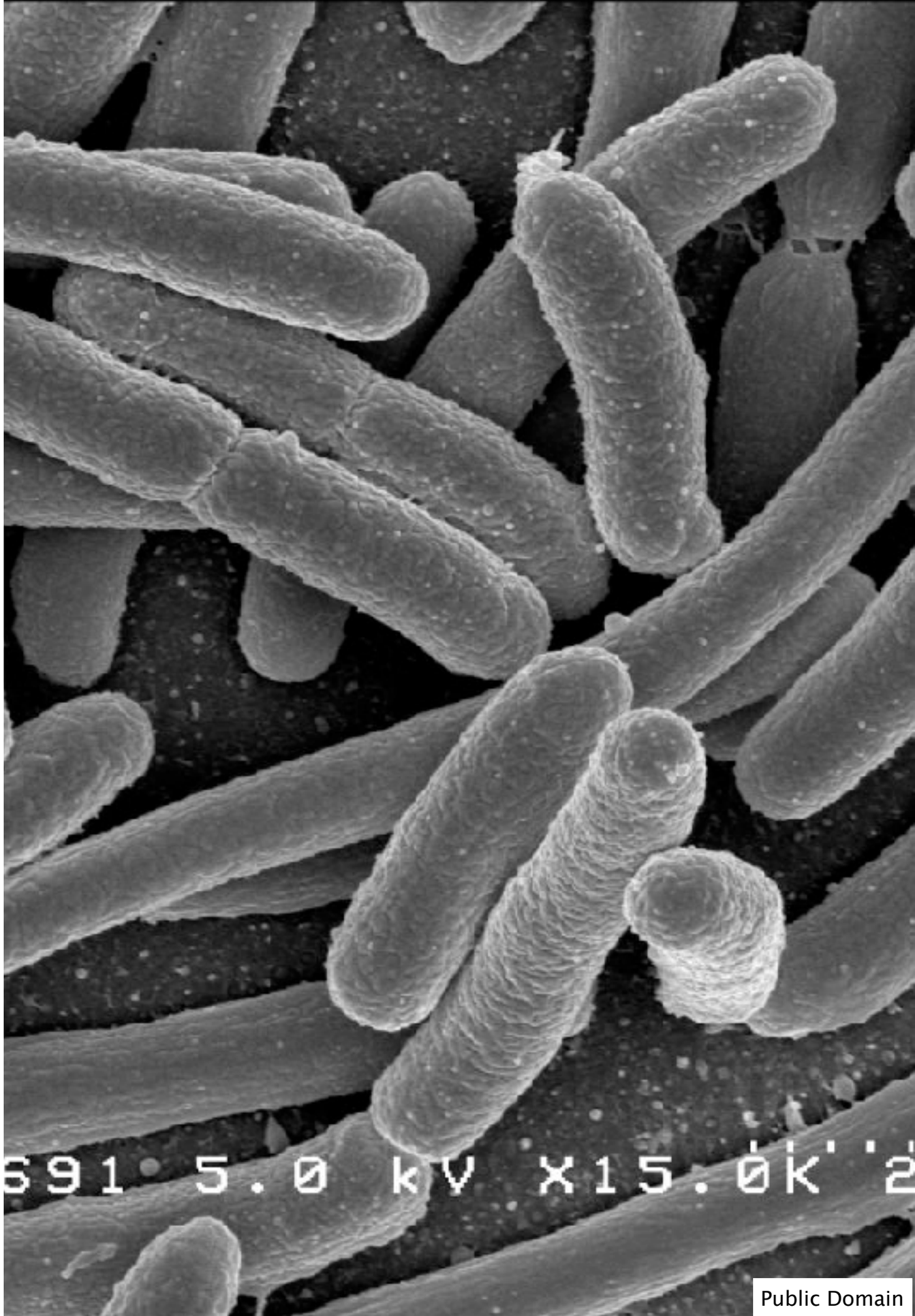
E. coli weighs $3.0 \times 10^{-13} gr.$

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?



Public Domain

Cylinder formulas

$$Top\ area = \pi \times r^2$$

$$Bottom\ area = \pi \times r^2$$

$$Side\ area = 2 \times \pi \times r \times h$$

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

$$Volume\ V = \pi \times r^2 \times h$$

Solution exercise 1

$$1\,gr.\,of\,E.coli \doteq \frac{1}{3\times10^{-13}} = 3.33\times10^{12}\,cells$$

Surface:

$Length\ L = 2\times10^{-6}$

$Radius\ r = 0.4\times10^{-6}$

$2\times\pi\times r\times L + 2\times\pi\times r^2 = 20\,m^2$

Microorganisms: Role in our daily live

Microorganisms: Role in our daily live

Sulfur (purple) bacteria bloom

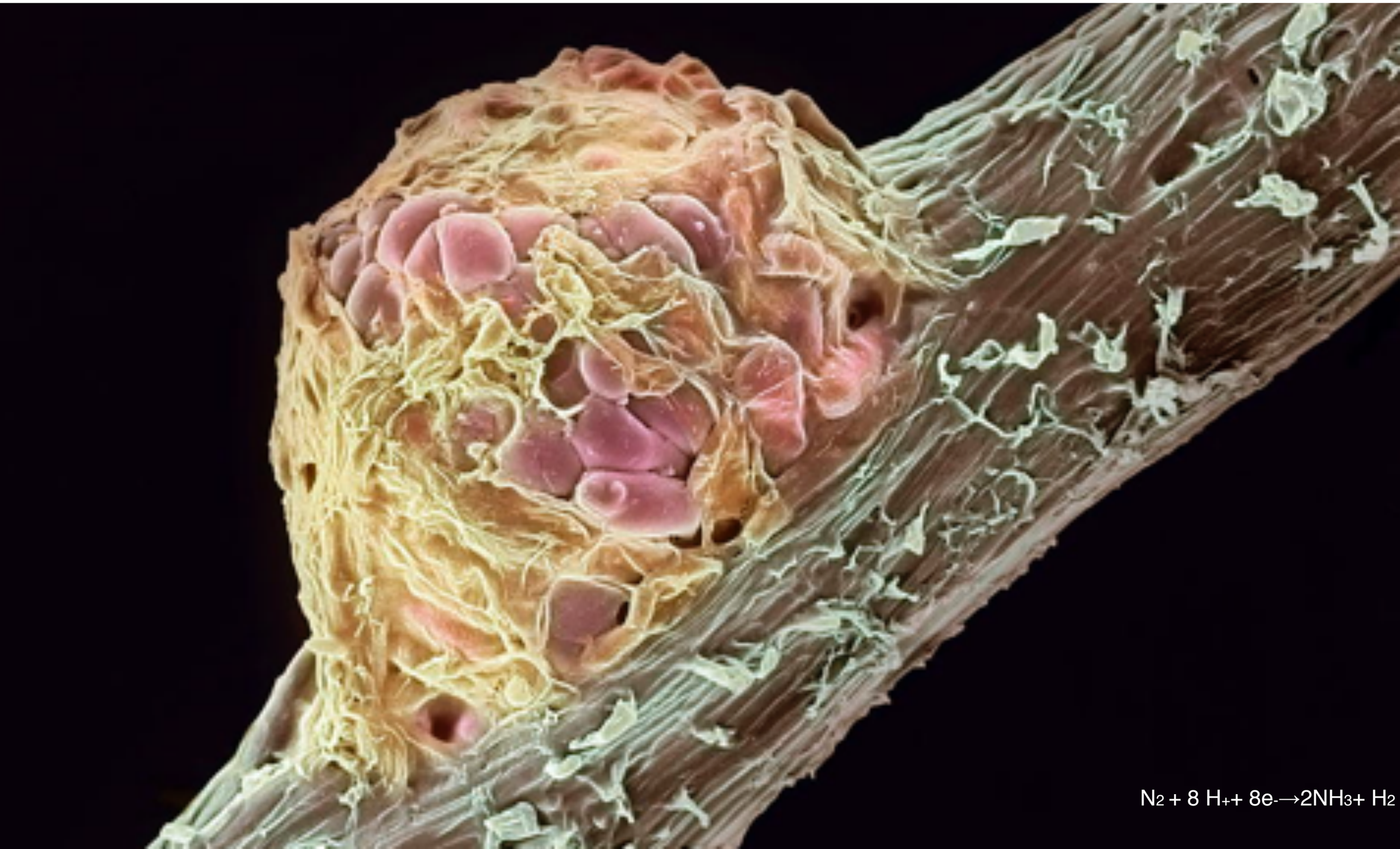
Buse Lake 3 – Cal Kimona Brown

Cyanobacteria (algae)

Pollution?

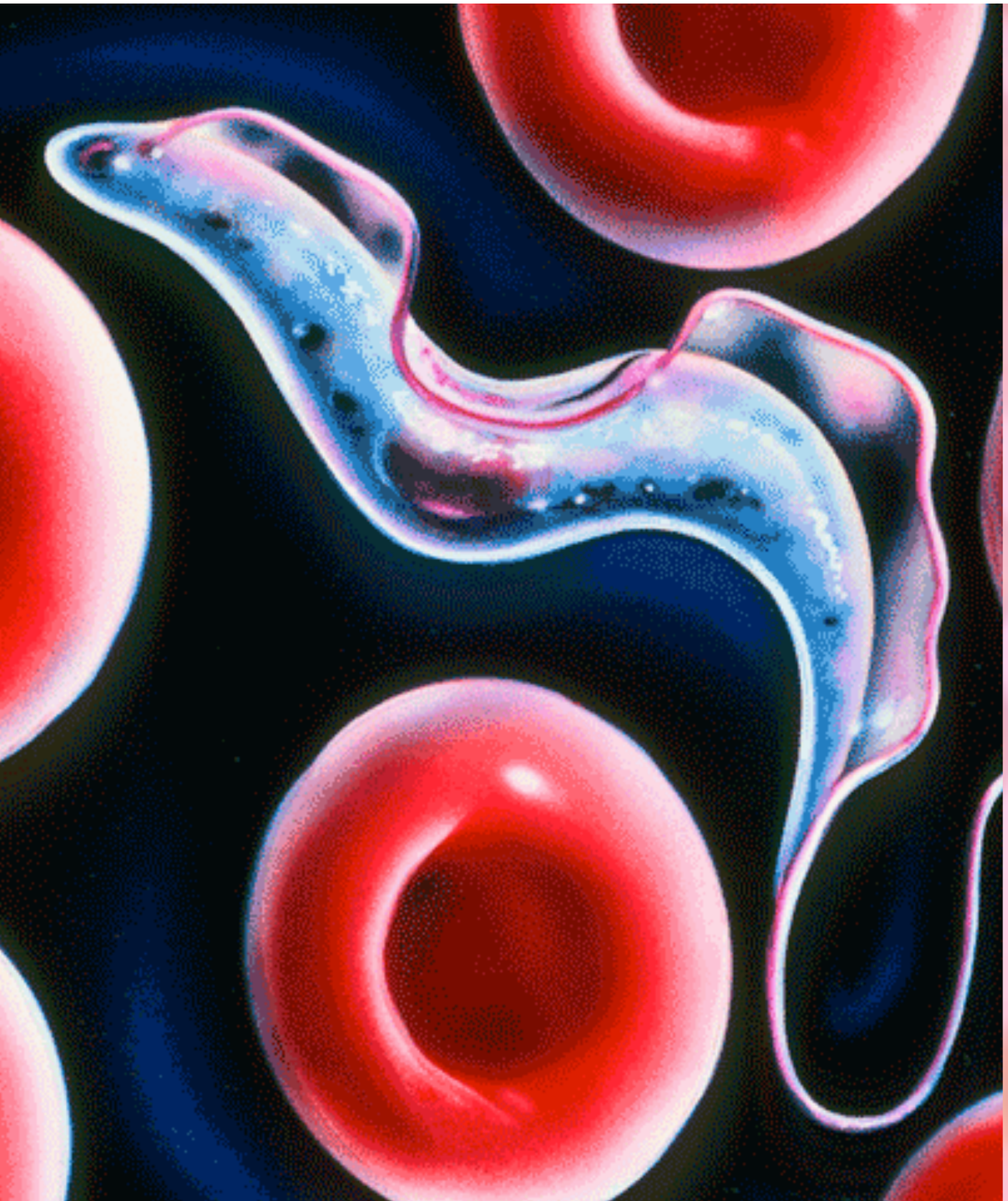
Christian Fischer - CC-BY-SA 3.0

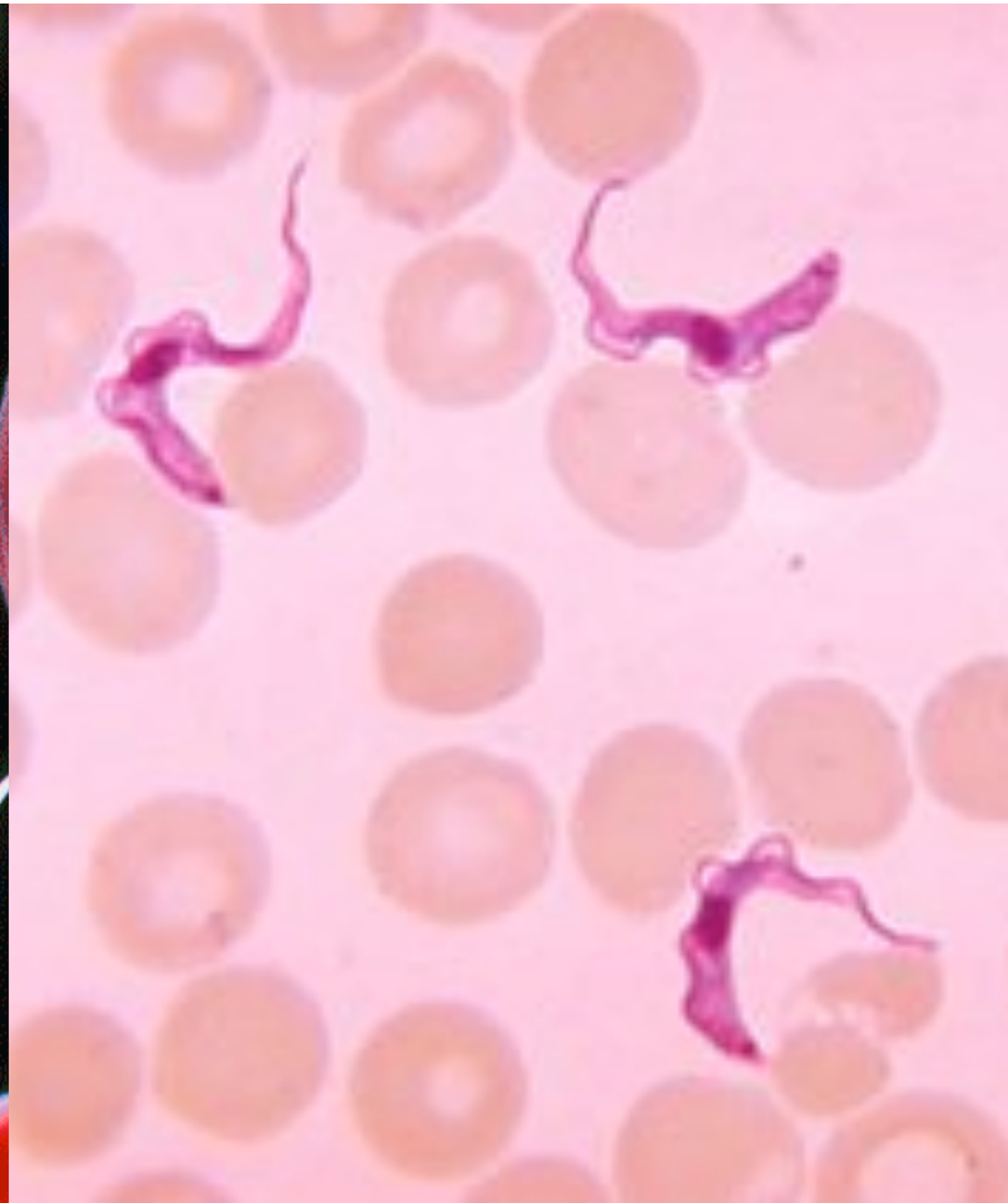
Fixate nitrogen



$$N_2 + 8\ H_+ + 8e^- \rightarrow 2NH_3 + H_2$$

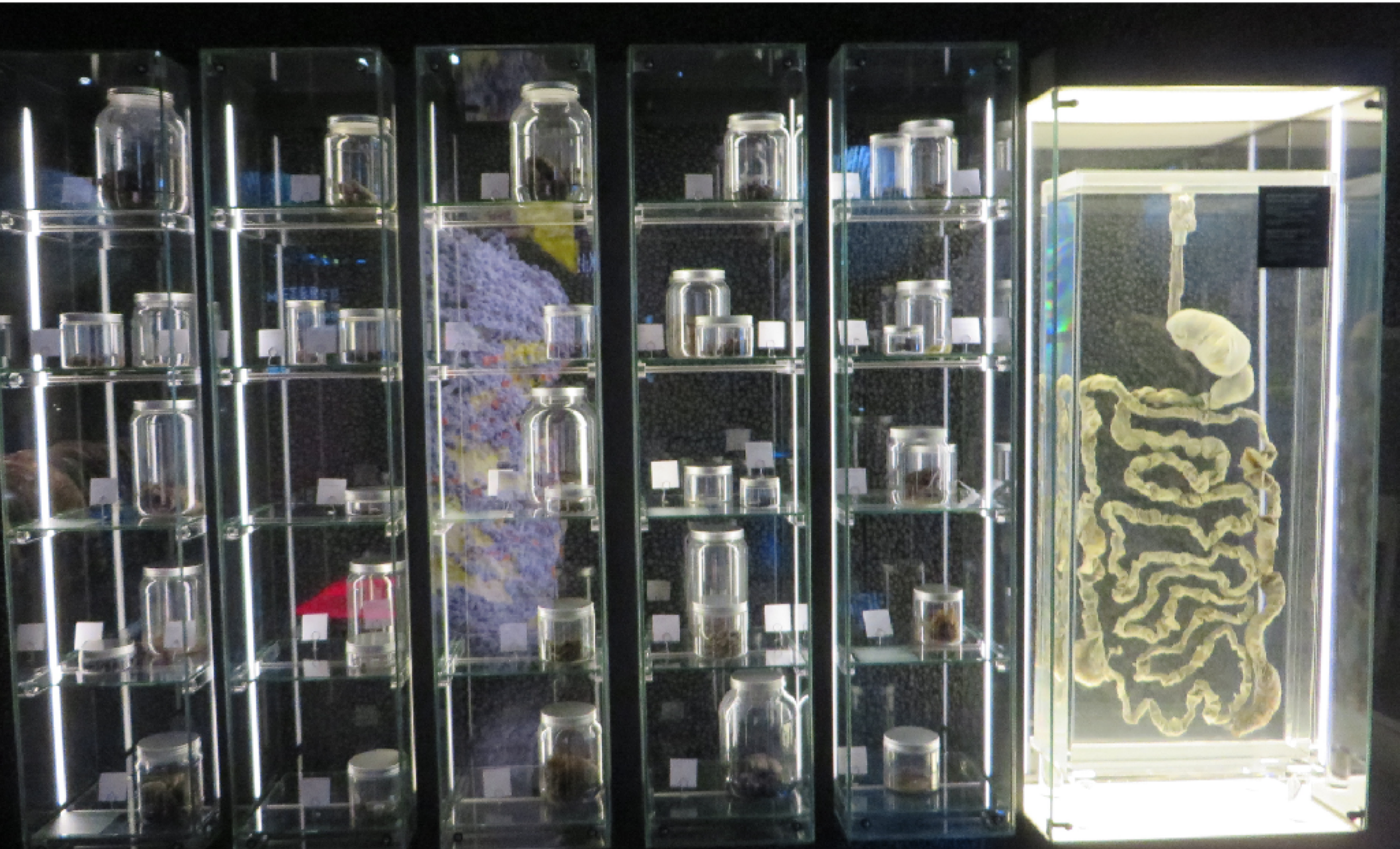
Cause disease - Trypanosoma brucei





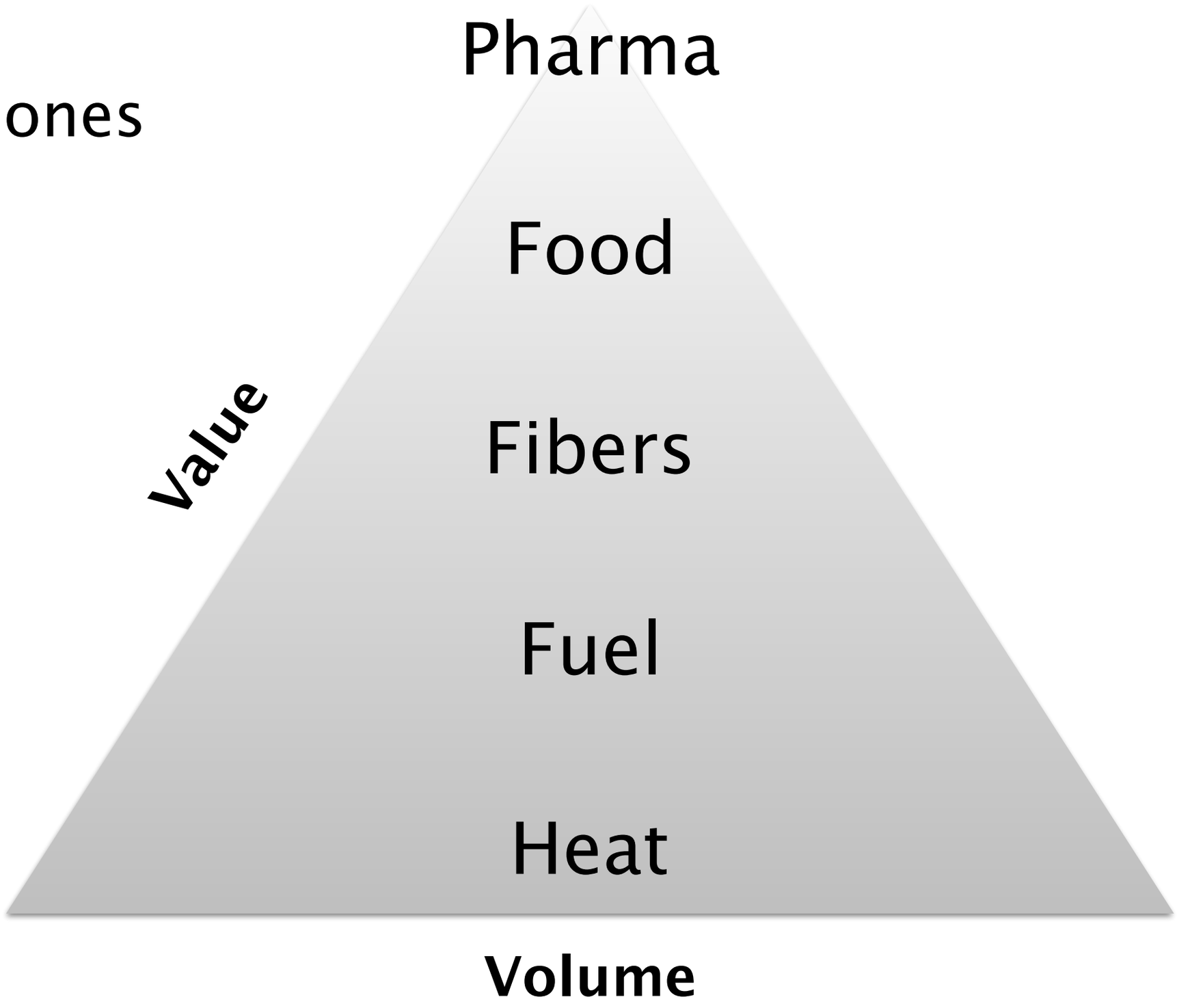
Second brain?

Shaun Moshasha

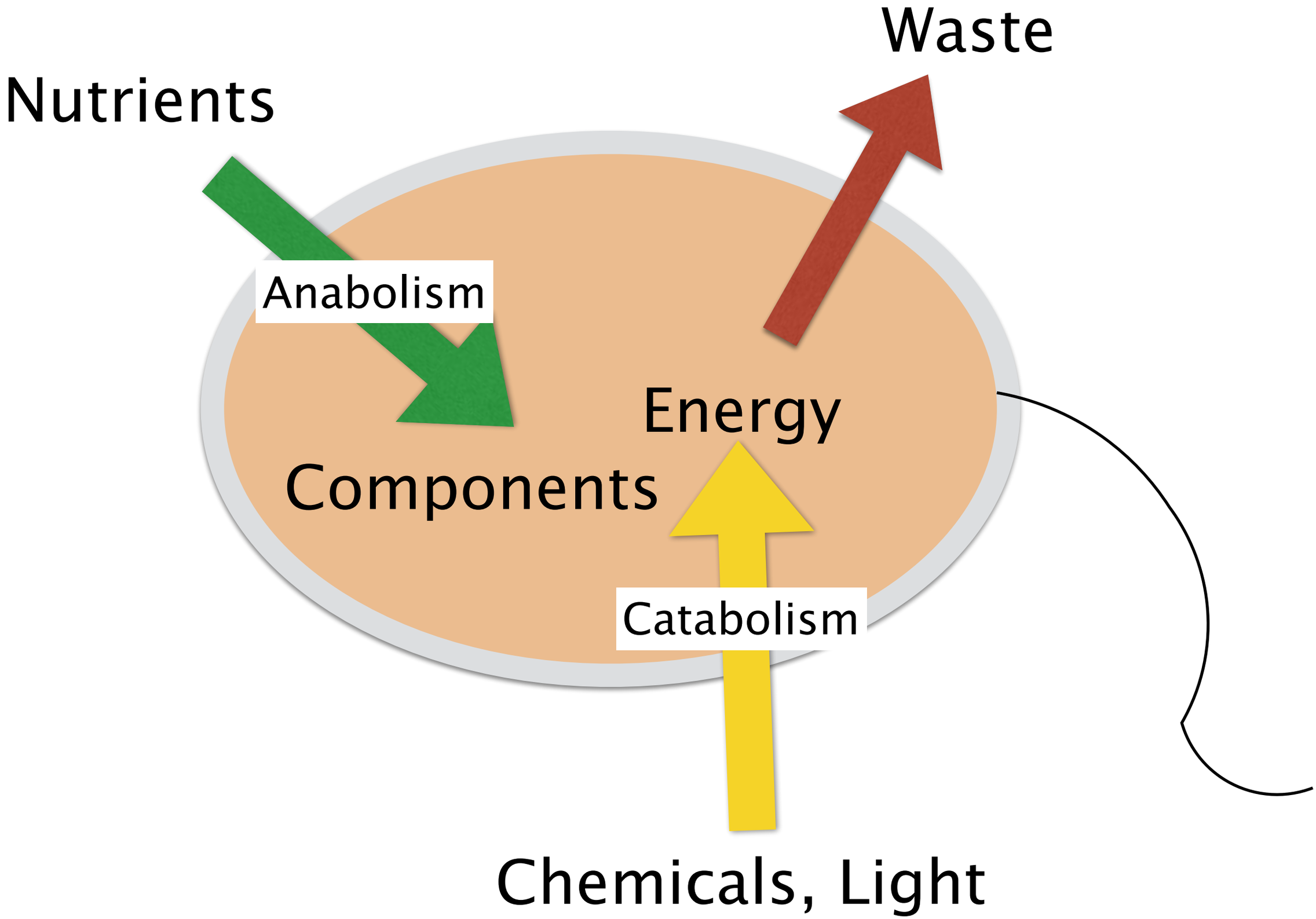


Bioreactor value pyramid

- 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

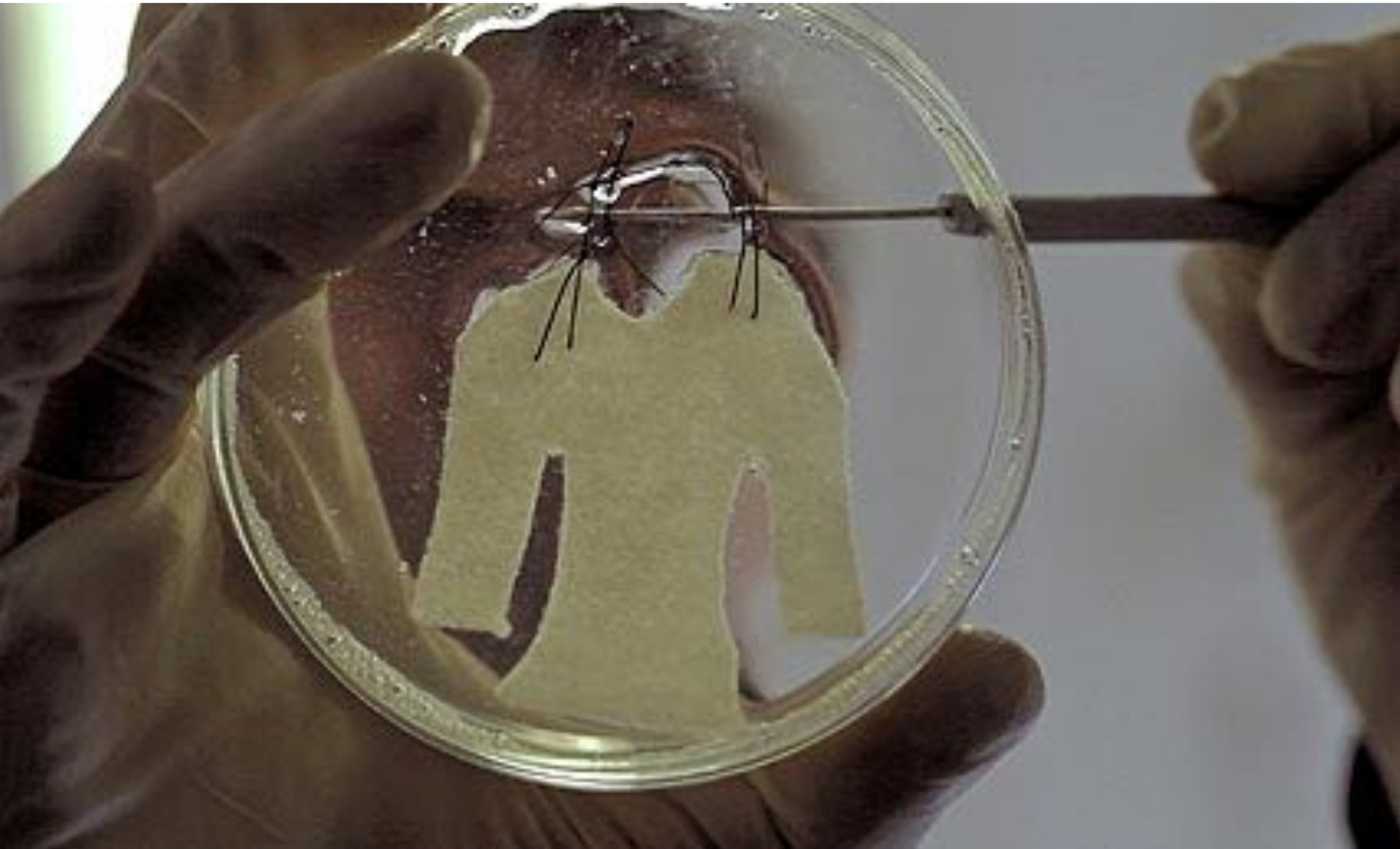
Fungi products

Maurizio Montalti – Growing Lab

BioSteel fiber

Fragrant Moss

Victimless Leather

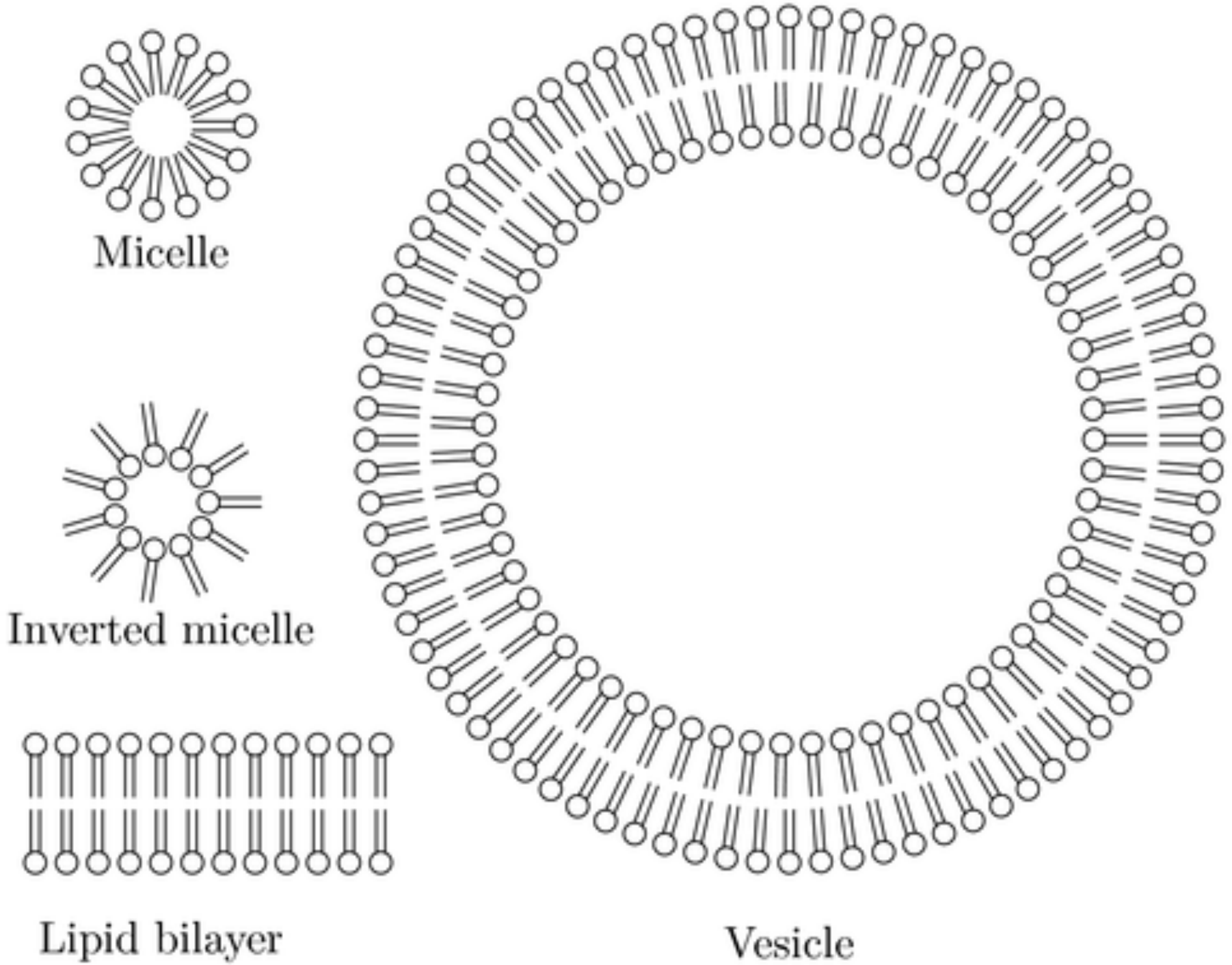


waag society

institute for art, science and technology

The Cell

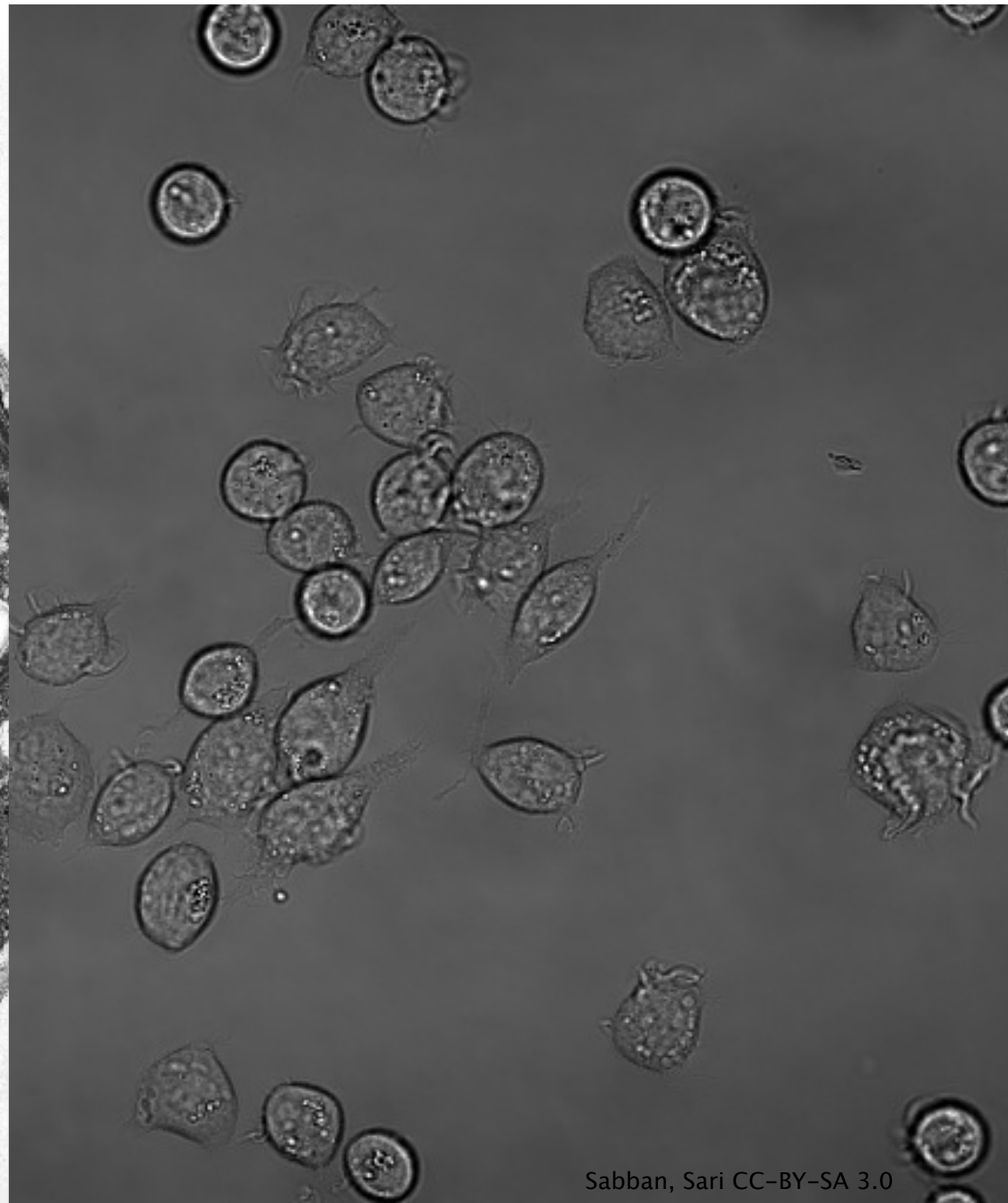
Lipid bilayer cell



Henrik Skov Midtiby - CC-BY 2.5

Life is made out of cells

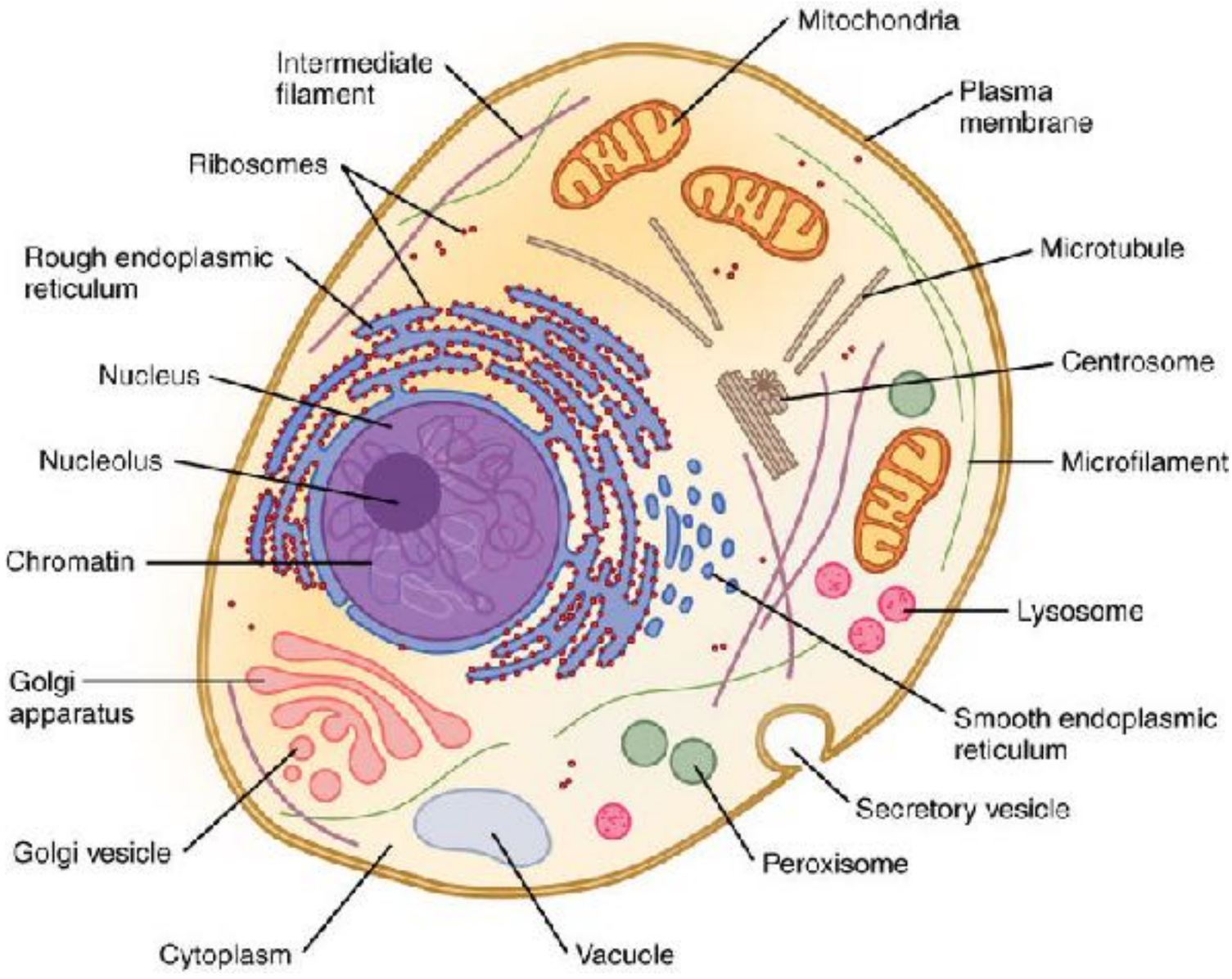
Public Domain



Sabban, Sari CC-BY-SA 3.0

What cells are made of

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



OpenStax College CC-BY-SA 3.0

IT vs Bio

Digital code (atgc)

Open standards (codons)

Modular code (genes)

Error protection (DNA repair)

Data compression (overlapping ORFs)

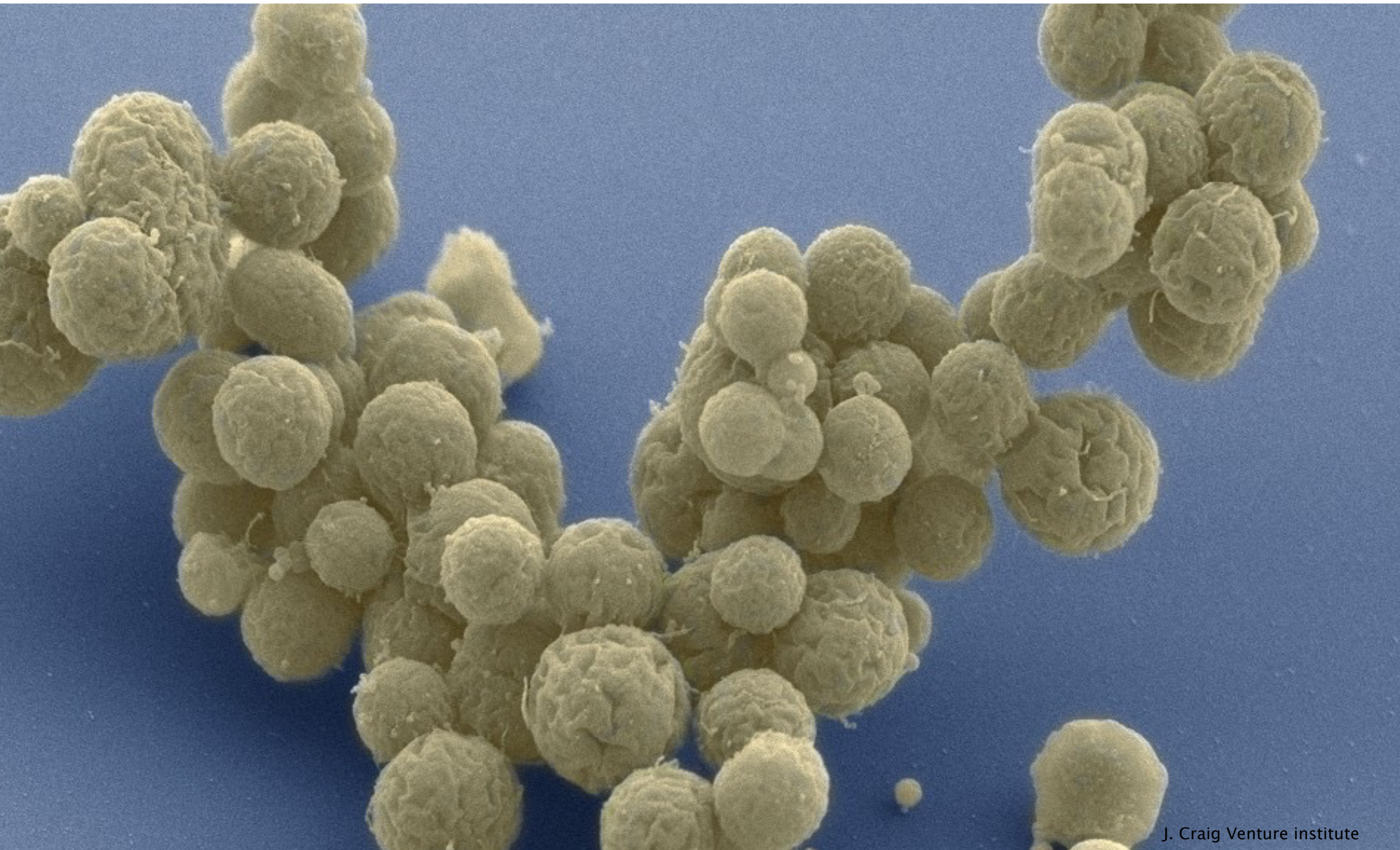
Redundant backups (double helix, copy number)

Self-diagnostics (apoptosis)

Firewalls (species)

Operating system (ribosomes)

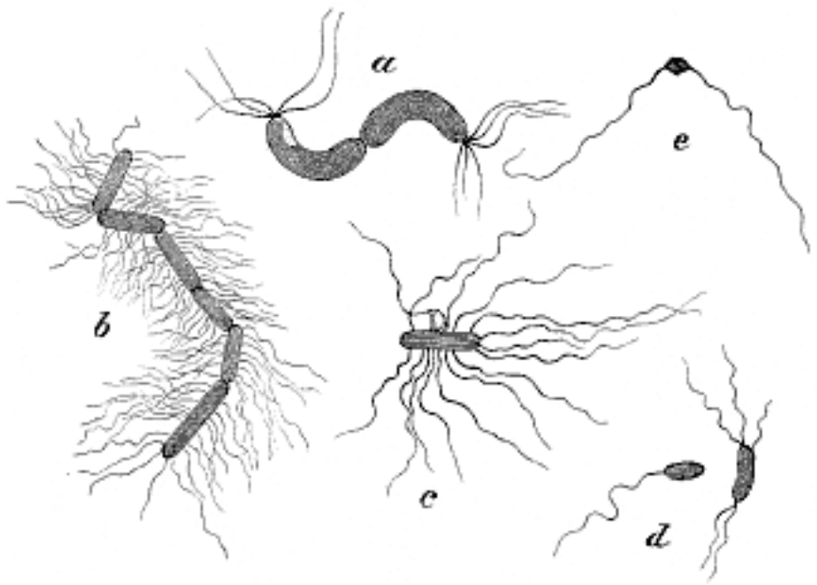
Minimal genome 473 genes



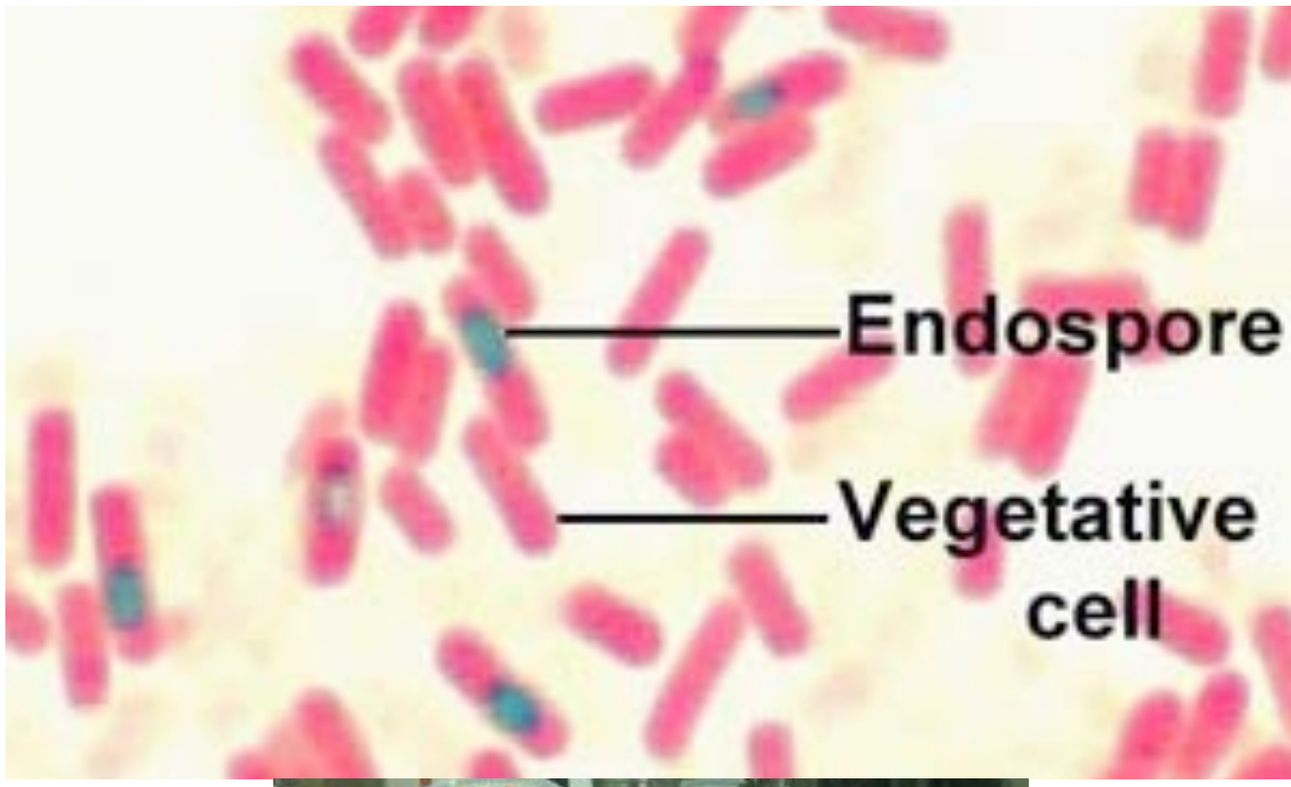
J. Craig Venture institute

Ferdinand Cohn

Pure Bacillus subtilis cultures, thanks to heat-resistant endospores

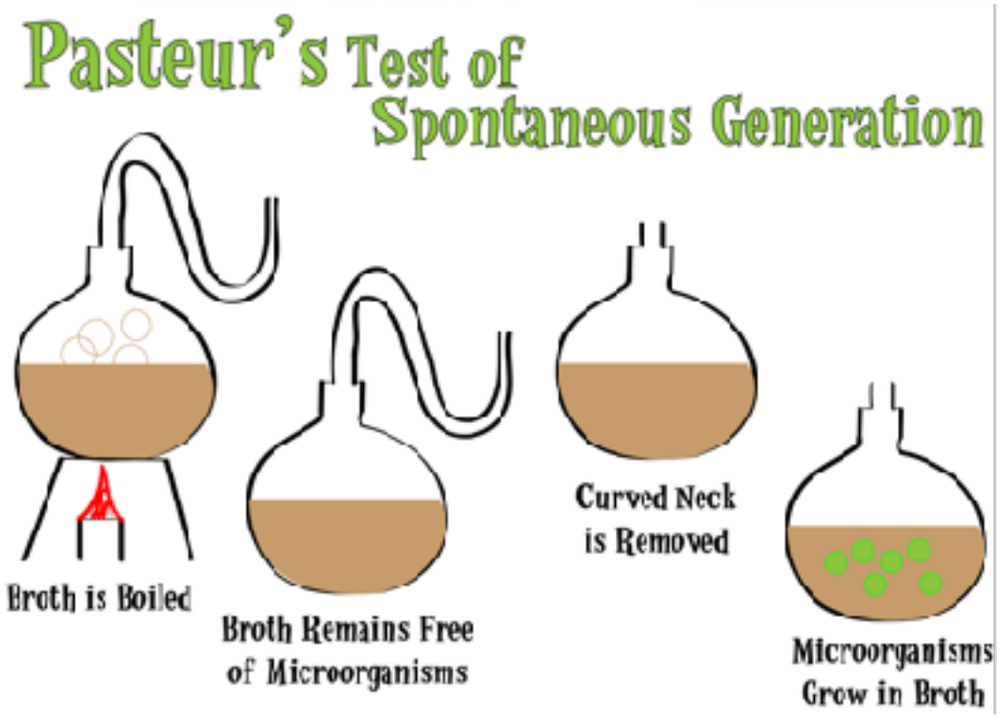


Geißeln der Bakterien
a von Spirillum Undula in der Theilung; b vom Heubacillus (Bacillus subtilis), Faden bildend; c einzelnes Stäbchen des Heubacillus; d von Fäulnißbakterien (Ba-



Louis Pasteur (19th century)

Proof that microbes do not “spontaneously appear”

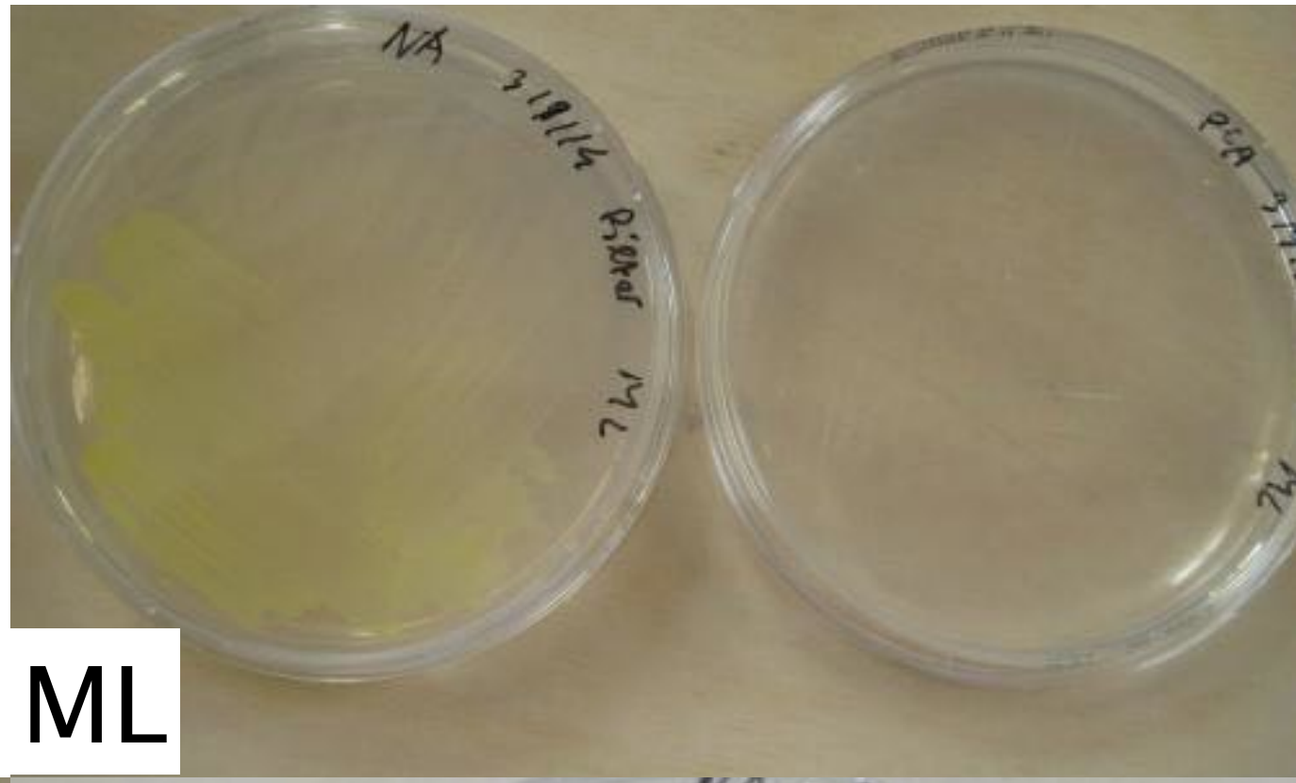


Culture Collection

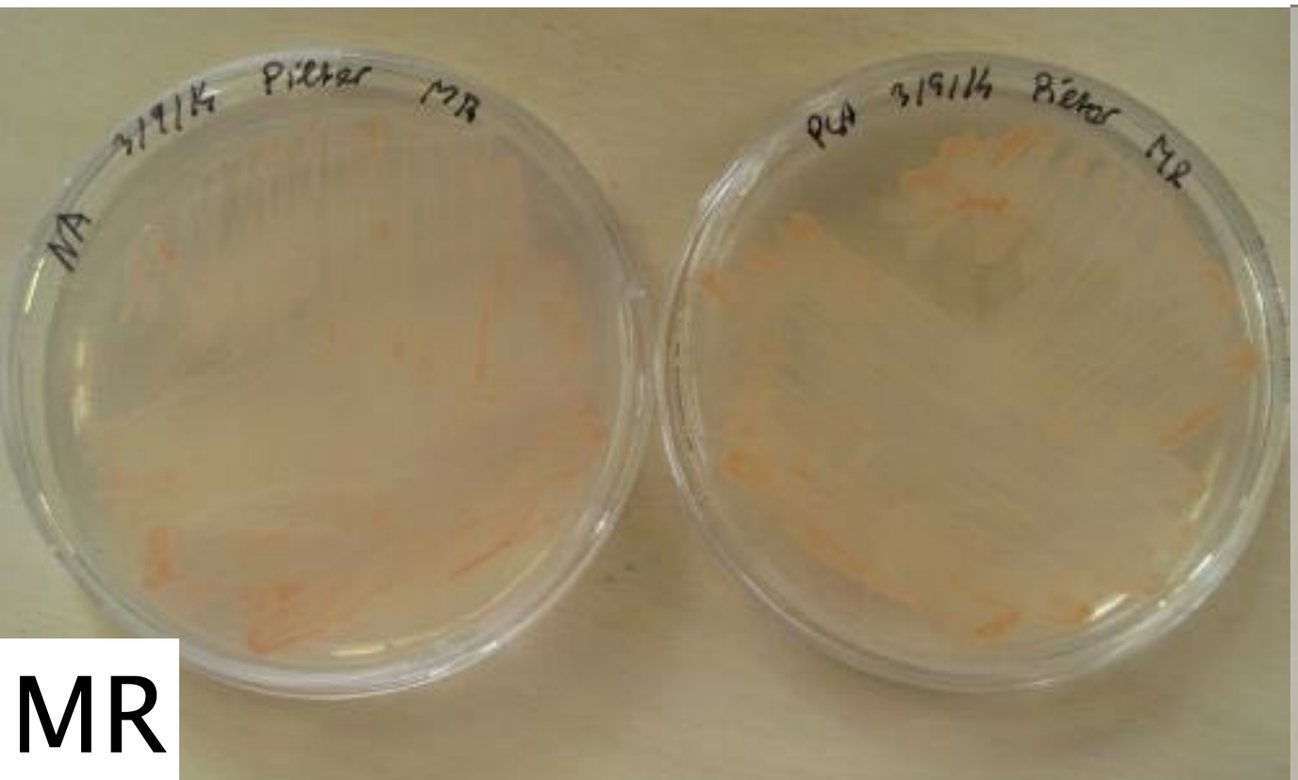
Pigmented bacteria

Pigments
Antibiotics

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



ML



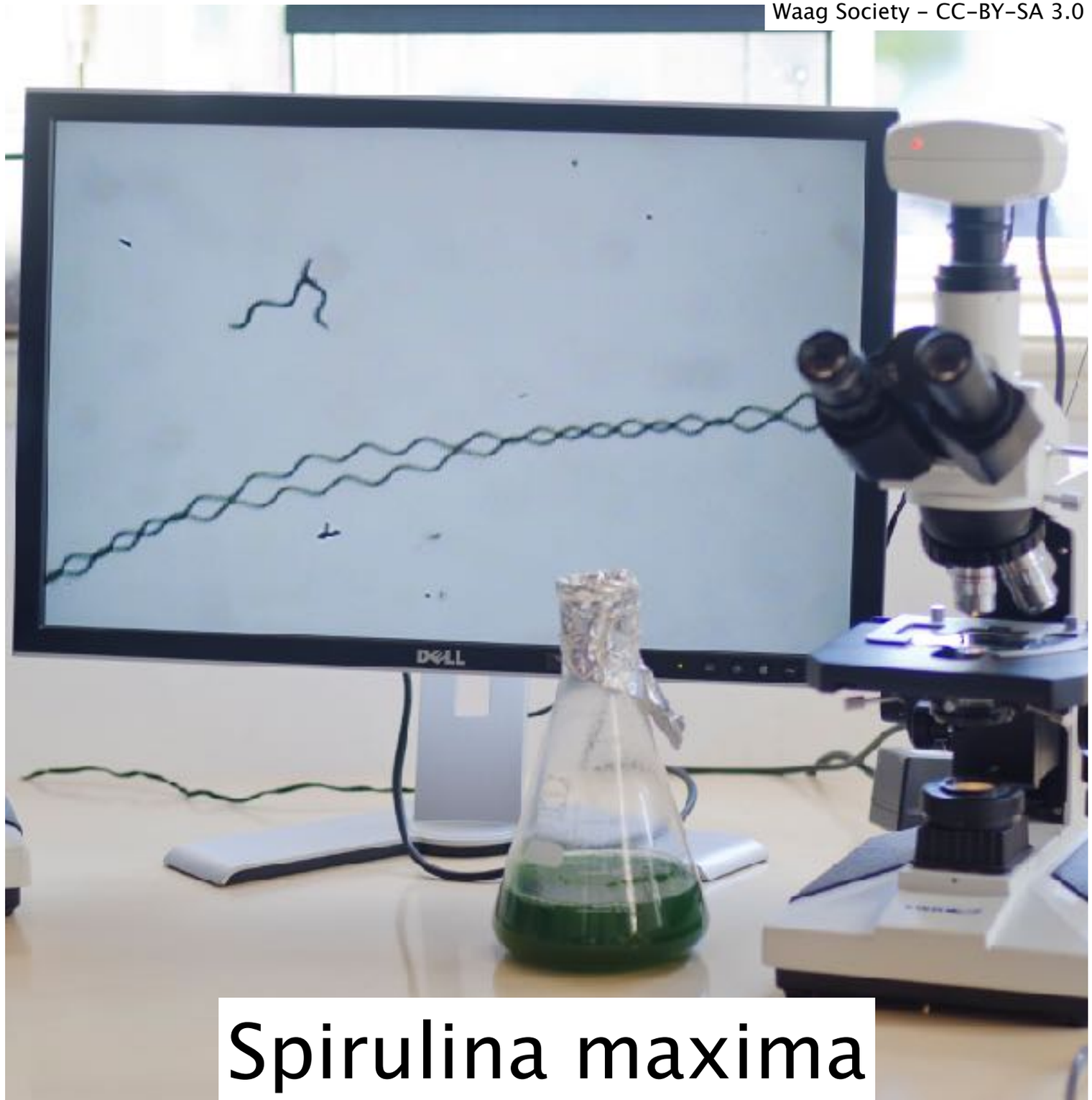
MR

JL

Algae

Pigments
Food

Waag Society - CC-BY-SA 3.0



Spirulina maxima

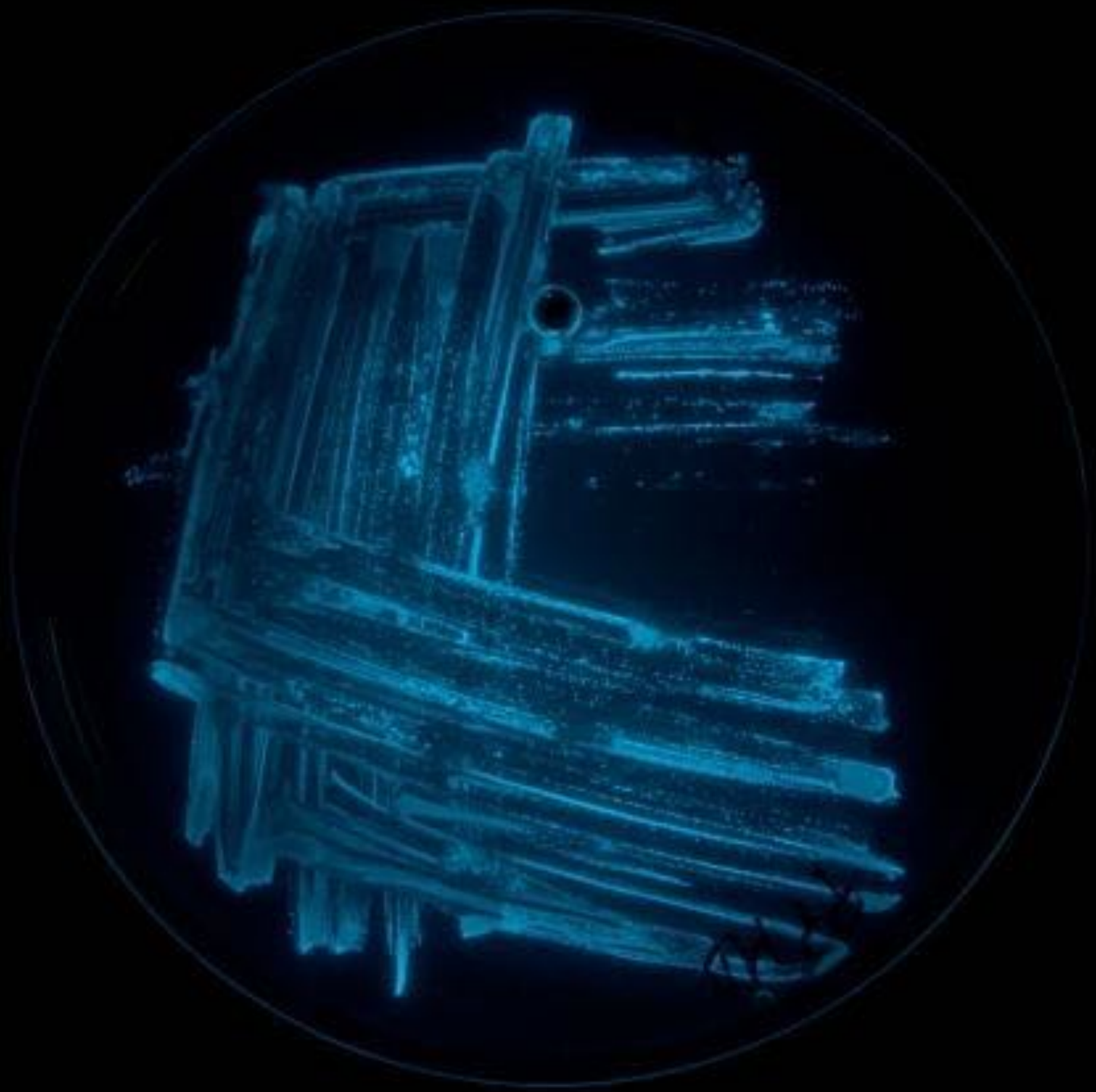
Yeast

Alcohol
CO2

Photobacterium phospherium

Light

Waag Society - CC-BY-SA 3.0



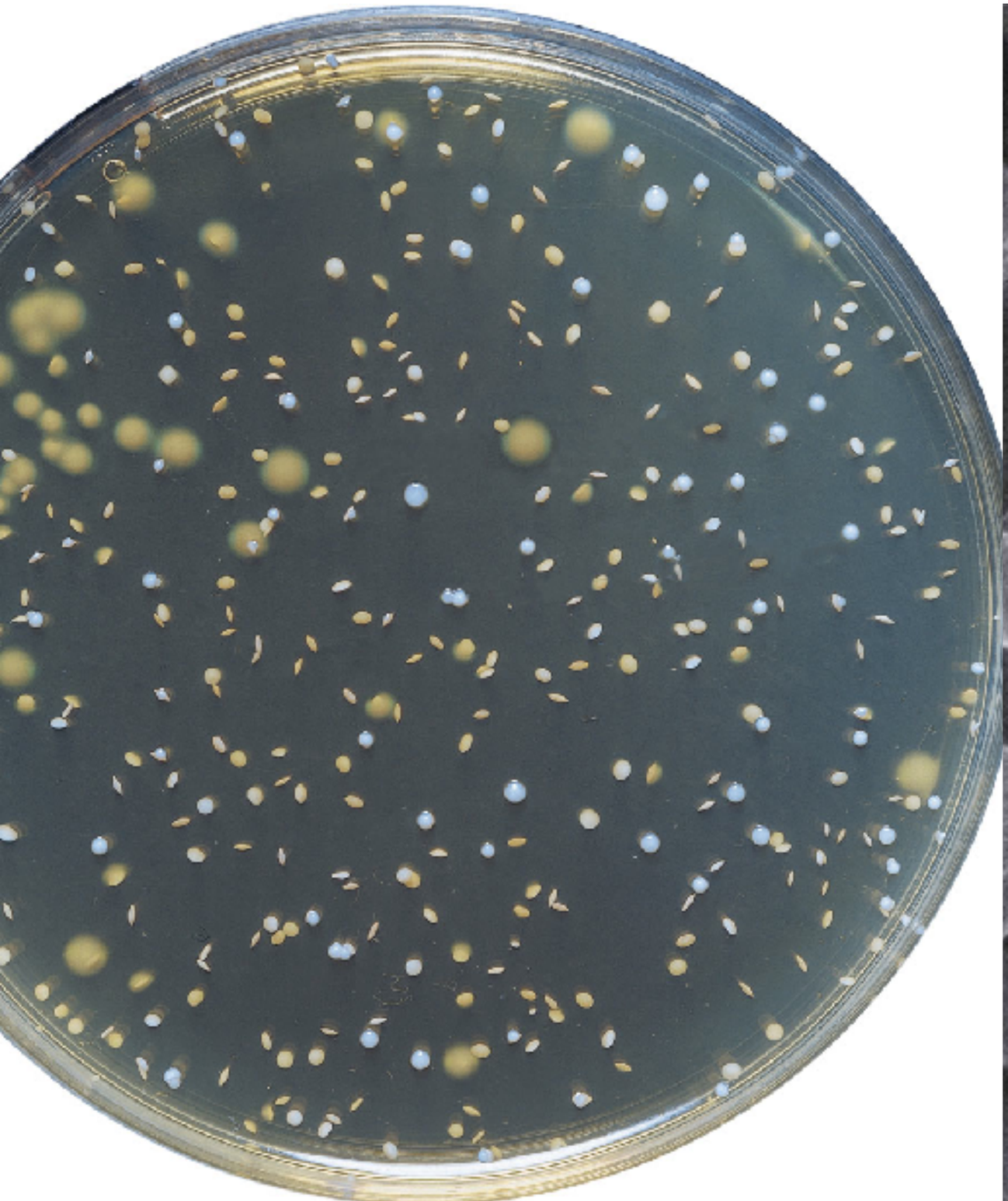
SCOBY

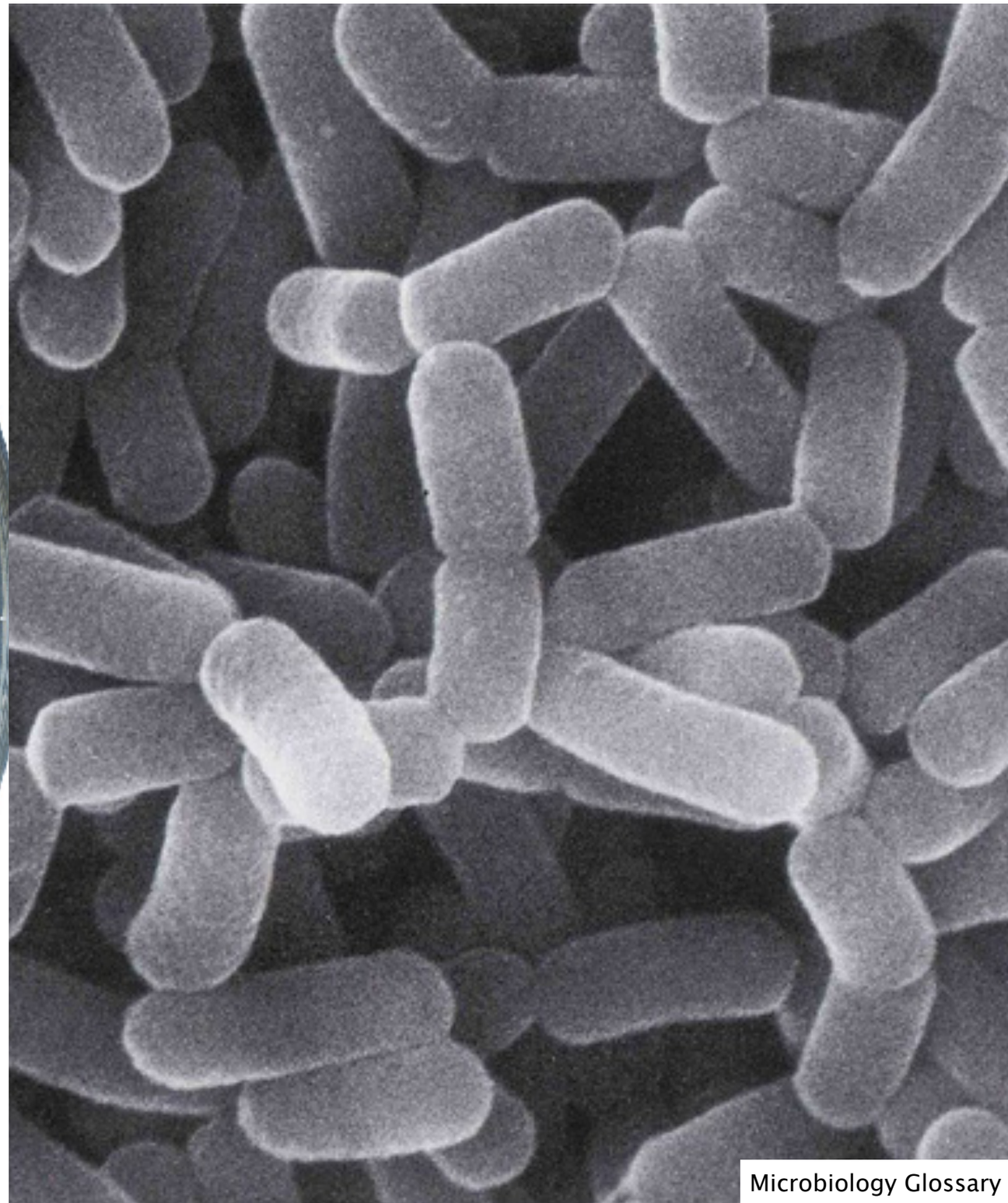
Cellulose
Vinegar

Symbiotic Culture of Bacteria and Yeast

Lactobacillus

Yoghurt
Lactic acid





Mycelium

Filaments

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

Tobi Kelner - CC-BY-SA 3.0

Eric Klarenbeek - CC-BY 3.0

Slime mold

Physarum polycephalum

Intelligence

Public Domain

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

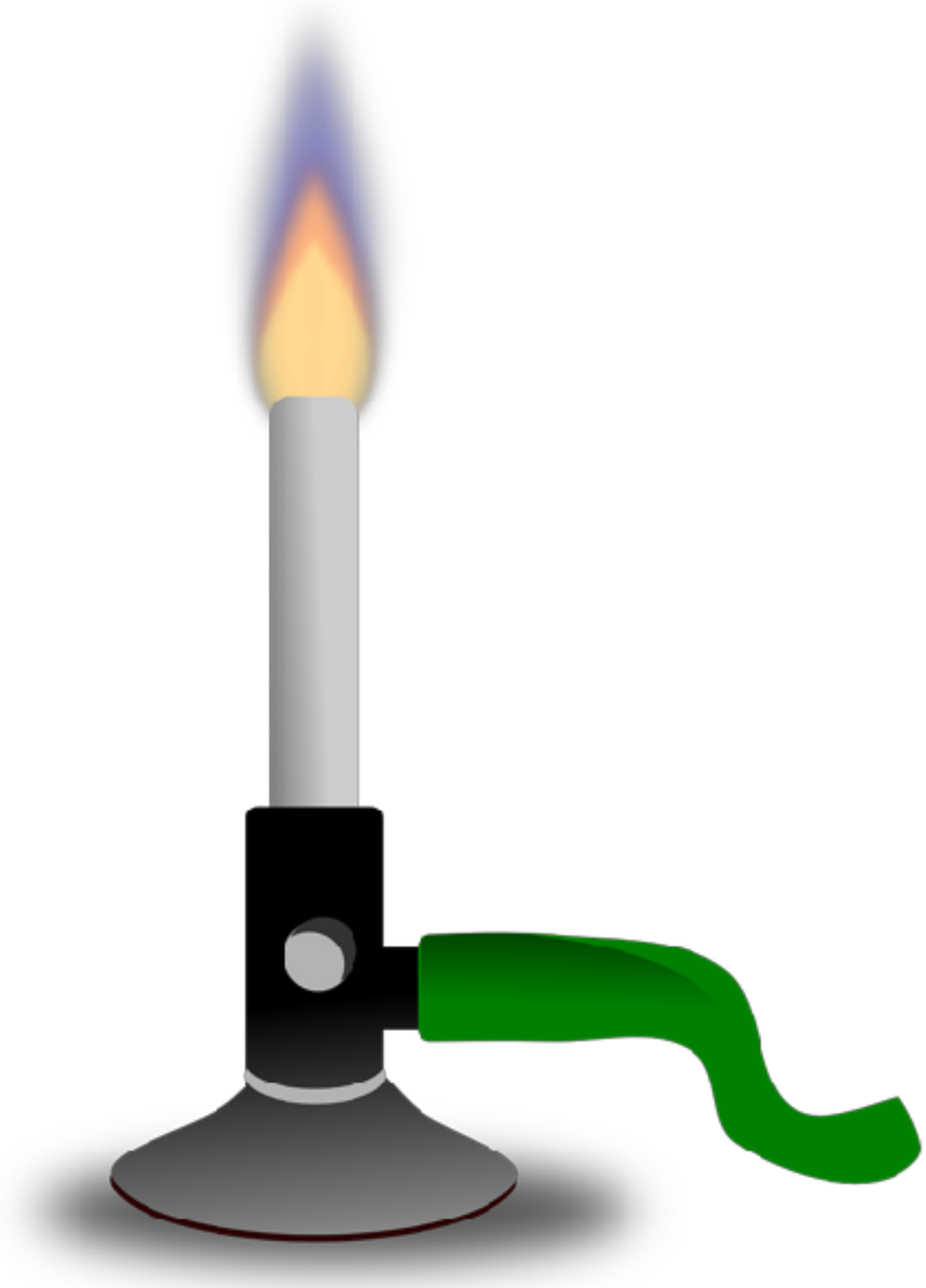
- Bioluminescent
  - http://biohackacademy.github.io/biofactory/class/1-incubator/bioluminescent-bacteria-isolation/
- Nitrogen fixating
  - http://biohackacademy.github.io/biofactory/class/1-incubator/isolation-of-nitrogen-fixating-bacteria/
- Sulphur-oxidizing
  - http://biohackacademy.github.io/biofactory/class/1-incubator/isolation-of-sulphur-oxidizing-bacte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

waag society

institute for art, science and technology

Working with Microbes

Working sterile with gas burner



Pixabay – Public Domain

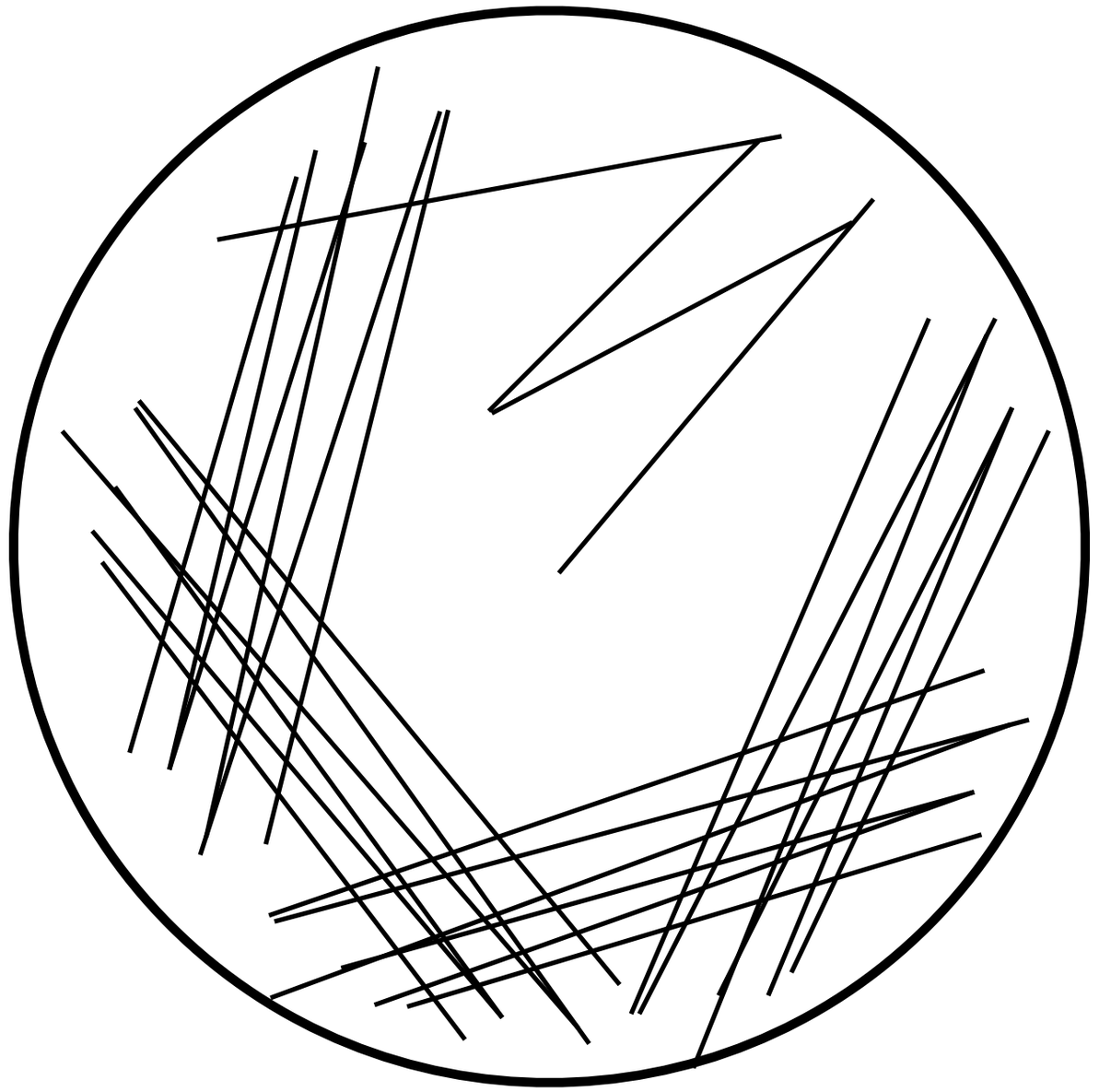
Preparing plates

Autoclaving for 20 min

Stephan-Xp - CC-BY-SA 3.0

Pouring petri dishes

https://vimeo.com/193707826

Inoculation

Marco Tolo – Public Domain