[#03-1]
Microscope for Life Detection in Venus Clouds

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20190601 IVC

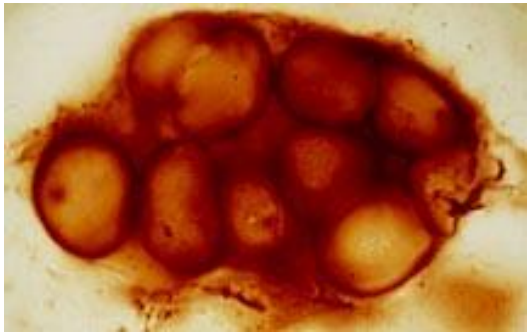
Ancient Venus' climate

could have remained habitable until at least 0.715 Gya.

M. J. Way et al., Geophys. Res. Lett. 43 (2016) 8376-8383.

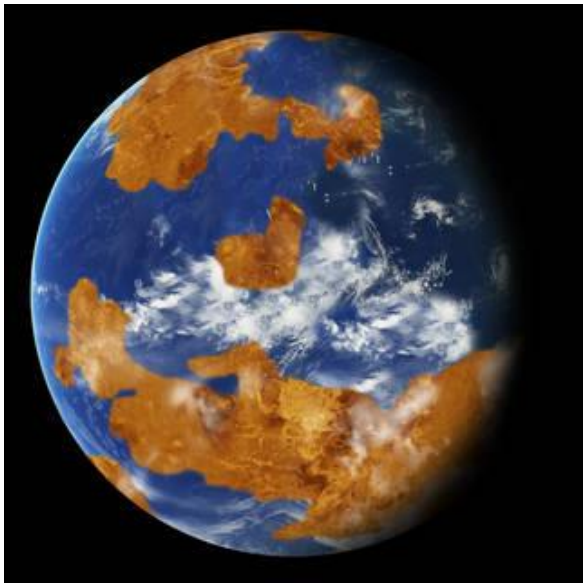
Polybiosphere or biopolysphere

D. Grinspoon



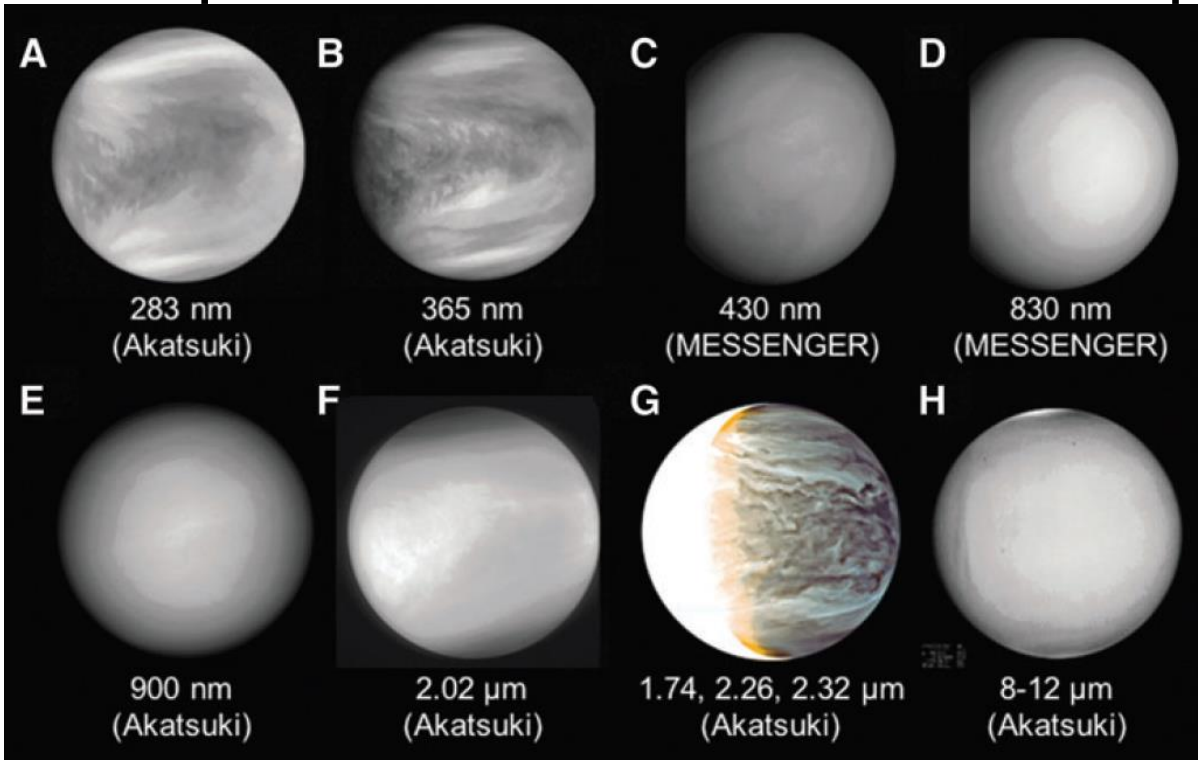
Ancient Fossil Bacteria : Pictured above are two kinds cyanobacteria from the Bitter Springs chert of central Australia, a site dating to the Late Proterozoic, about 850 million years old. On the left is a colonial chroococcalean form, and on the right is the filamentous *Palaeolyngbya*.

https://ucmp.berkeley.edu/bacteria/cyanofr.html



https://www.nasa.gov/feature/goddard/2016/nasa-climate-modeling-suggests-venus-may-have-been-habitable

Venus' Spectral Observations + lab experiments



=> Unknown factor (cell?) in the clouds suspected

Sanjay S. Limaye, Grzegorz P. Słowik et al., ASTROBIOLOGY 18 (2018) 1181-1198.

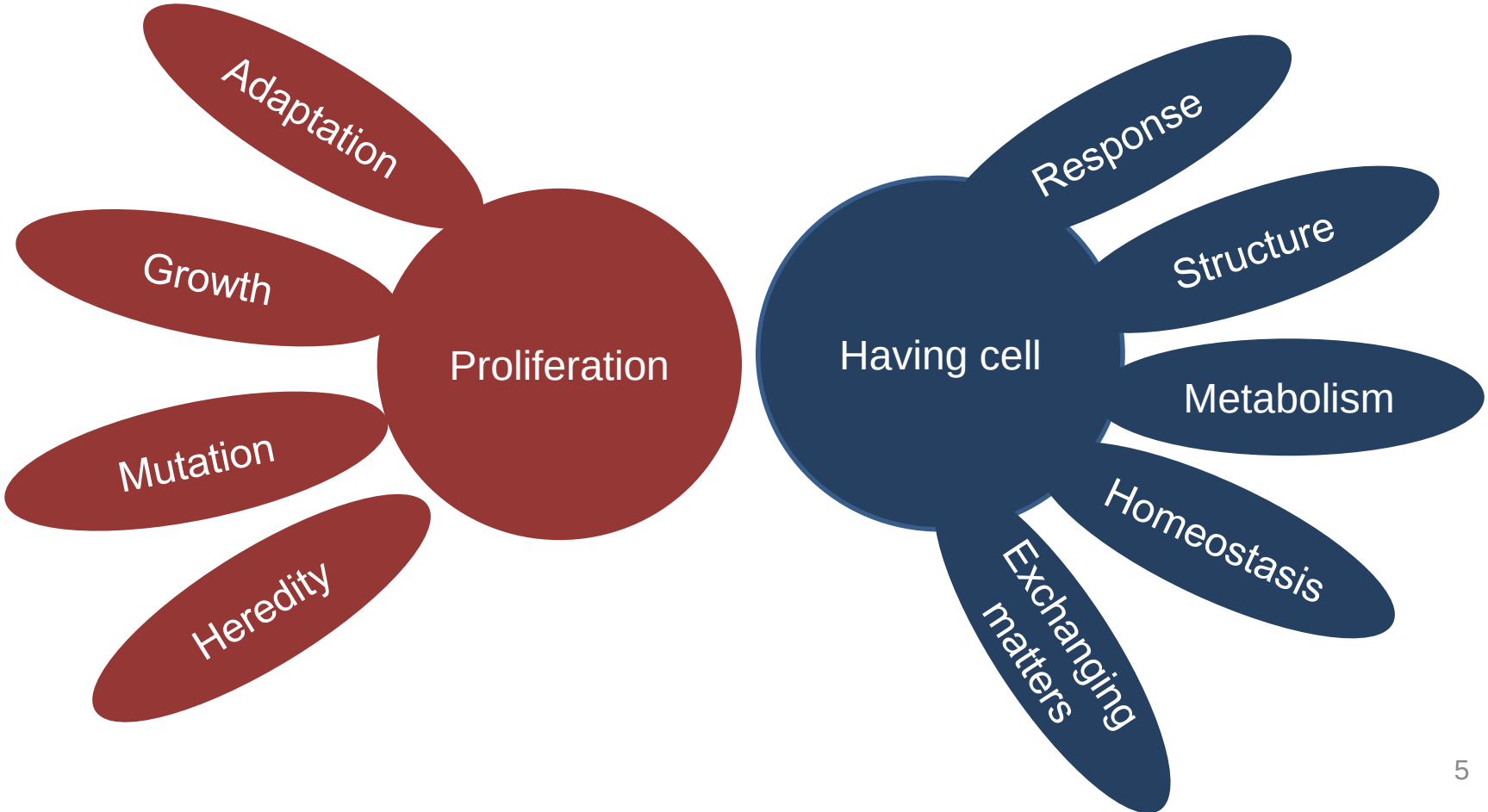
Life Detection => Collection of Particle information

... with the expectation of finding life

- Size
- Shape
- Density
- Possible membrane chemical characteristics (or what's inside)
- Possible chemical reaction inside

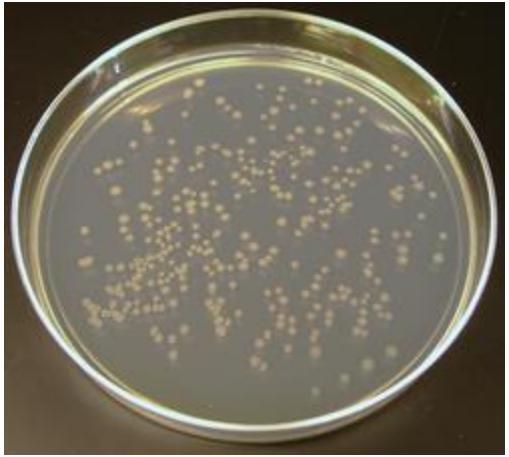
...can be obtained using **Fluorescent Microscope** with suitable fluorescent dyes / ex-em wavelength

1. Biological characteristics that define life

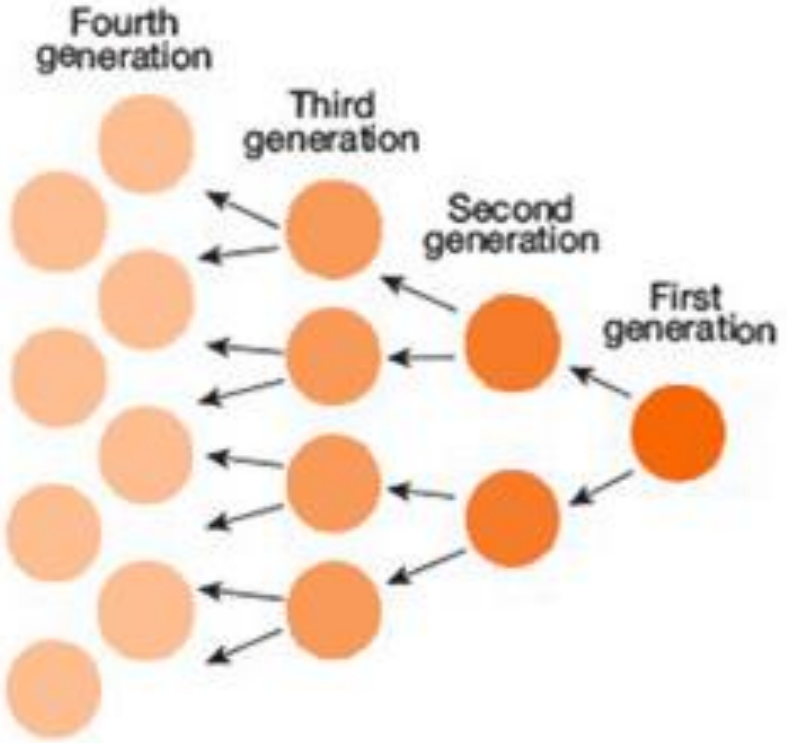


1. Biological characteristics that define life

Division or proliferation of the “cell”



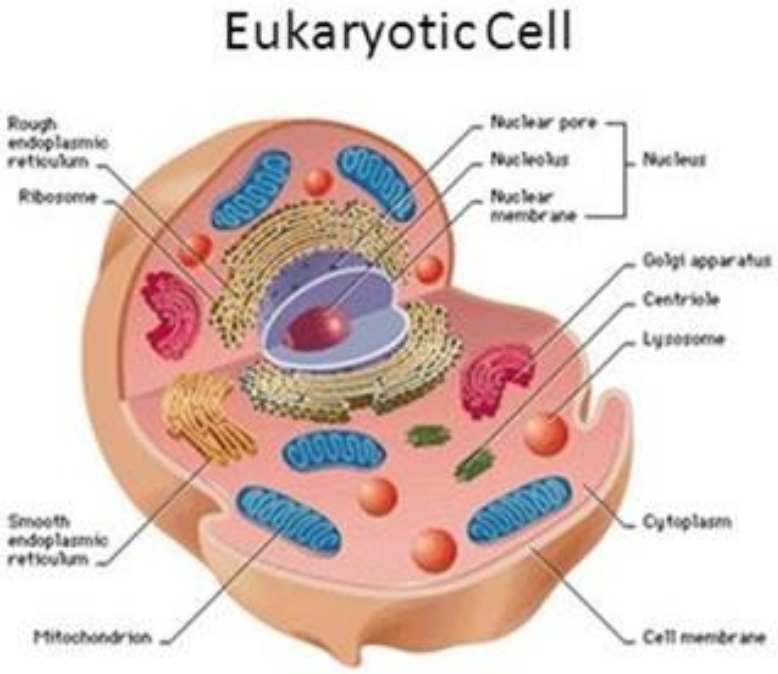
https://en.wikipedia.org/wiki/Agar_plate

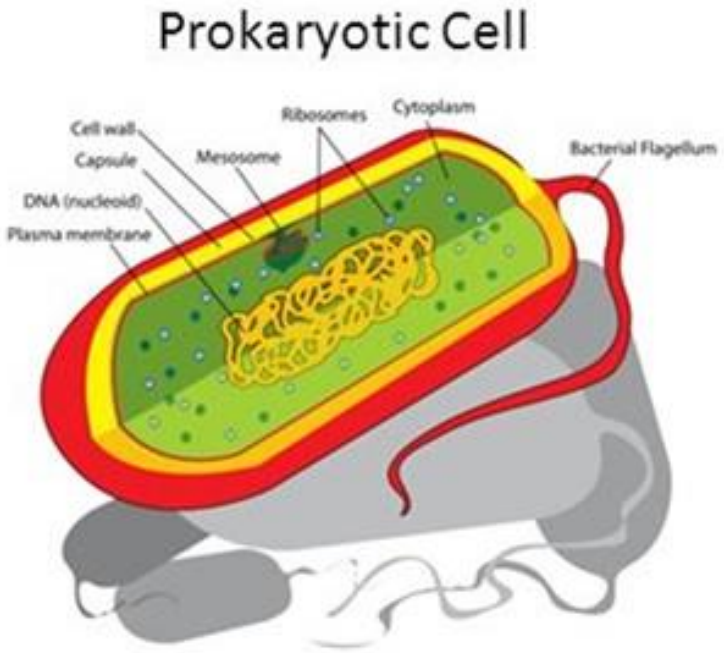


https://www.genecopoeia.com/product/cell-proliferation-assay-2/

1. Biological characteristics that define life

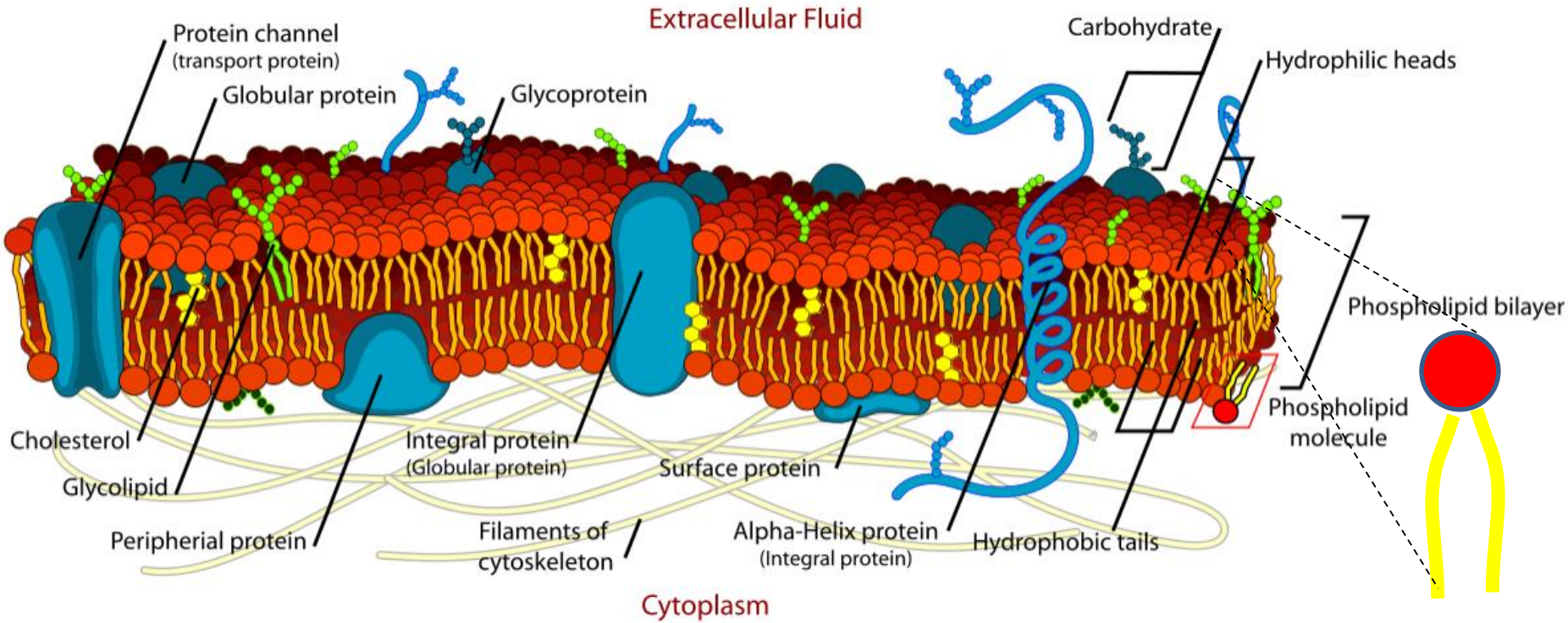
1. Semi-permeable membrane that surrounds the “cell”





https://slideplayer.com/slide/6228179/

1. Biological characteristics that define life



https://ja.wikipedia.org/wiki/%E3%83%95%E3%82%A1%E3%82%A4%E3%83%AB:Cell_membrane_detailed_diagram_en.svg

2. What fluorescent microscope can do

DNA: Proliferation ability

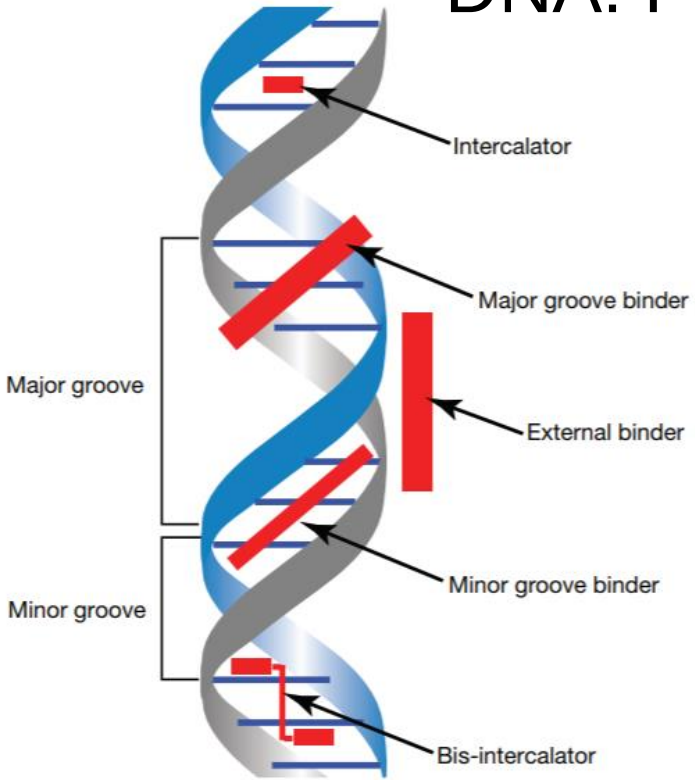


Figure 8.1.1 Schematic diagram showing the different binding modes of dyes (and other ligands) to DNA.

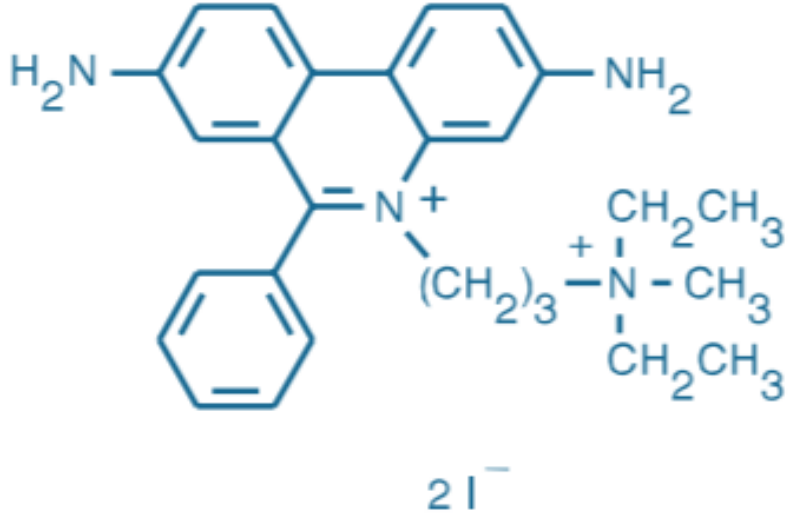
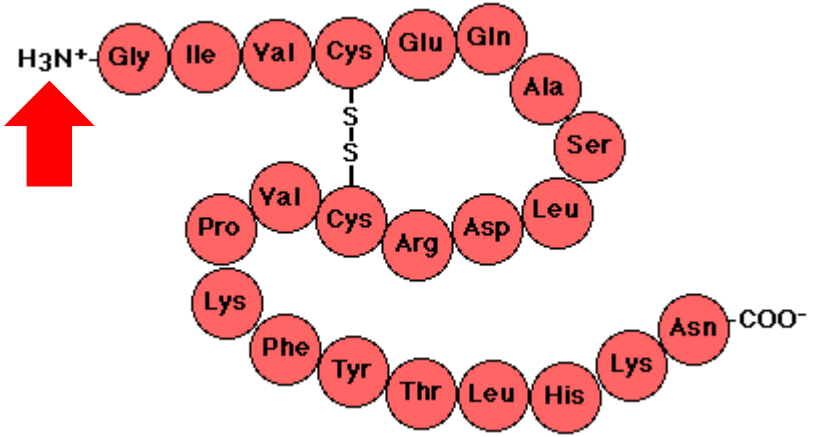


Figure 8.1.20 Propidium iodide (P1304MP).

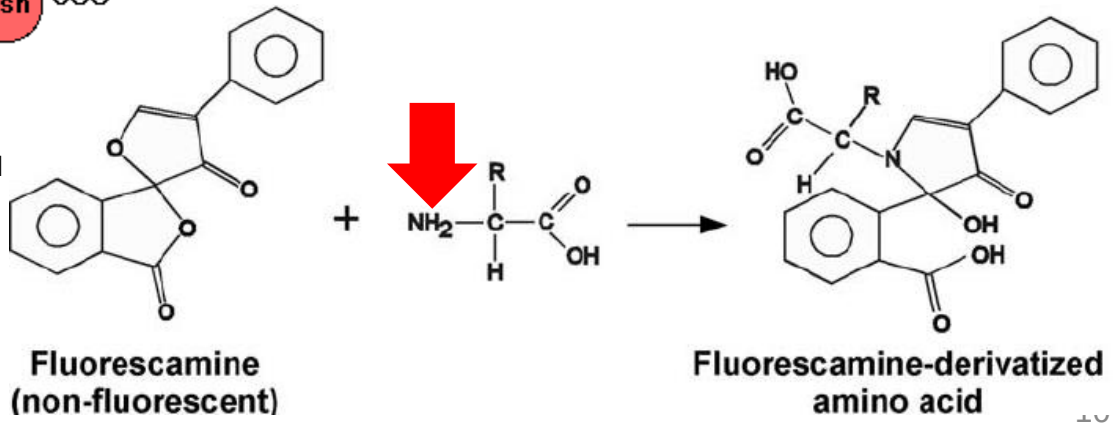
2. What fluorescent microscope can do

Amino group
: Membrane structure with biological compound



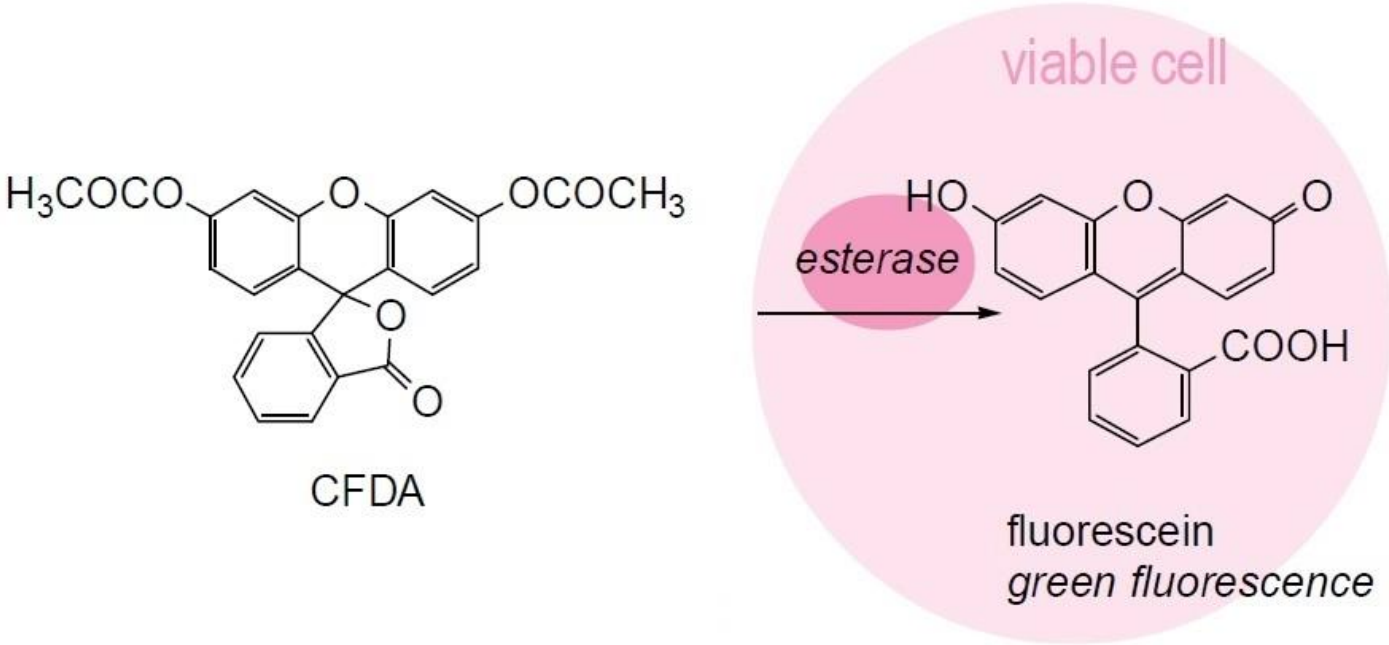
http://www.biology-pages.info/P/Polypeptides.html

https://www.researchgate.net/figure/Reaction-of-fluorescamine-with-an-amino-acid-Dye-is-dissolved-in-acetone-1-mM-added_fig5_252305883



2. What fluorescent microscope can do

Product: Ability of metabolism



https://www.dojindo.com/store/p/149-Bacstain-CFDA-Solution.html

2. What fluorescent microscope can do

Live cells : membrane without pinholes

=> strong fluorescence (concentrated)

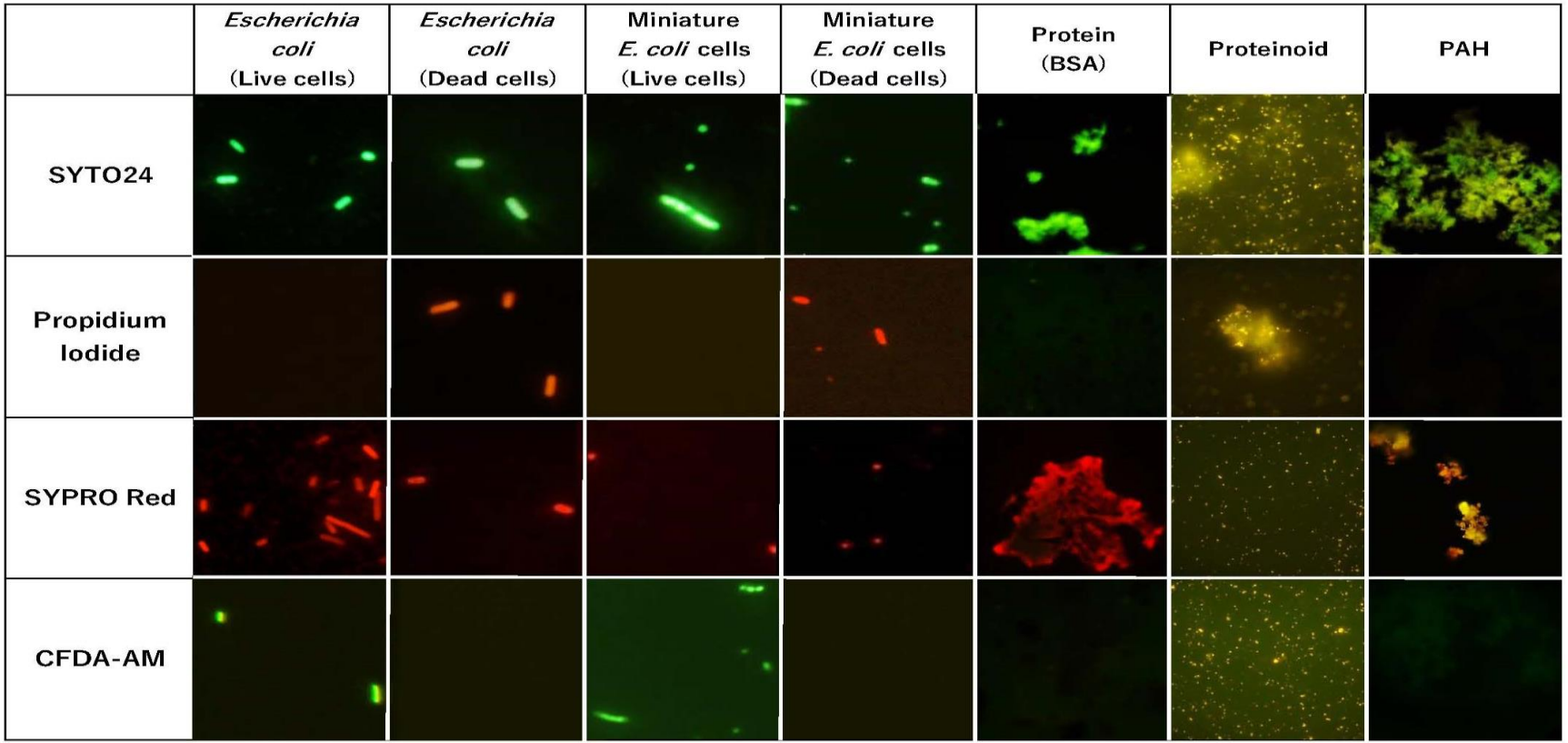
+ only hydrophobic dye positive

Dead cells : membrane with holes (or no membrane)

=> no fluorescence

+ both hydrophobic/hydrophilic dye positive

2. What fluorescent microscope can do

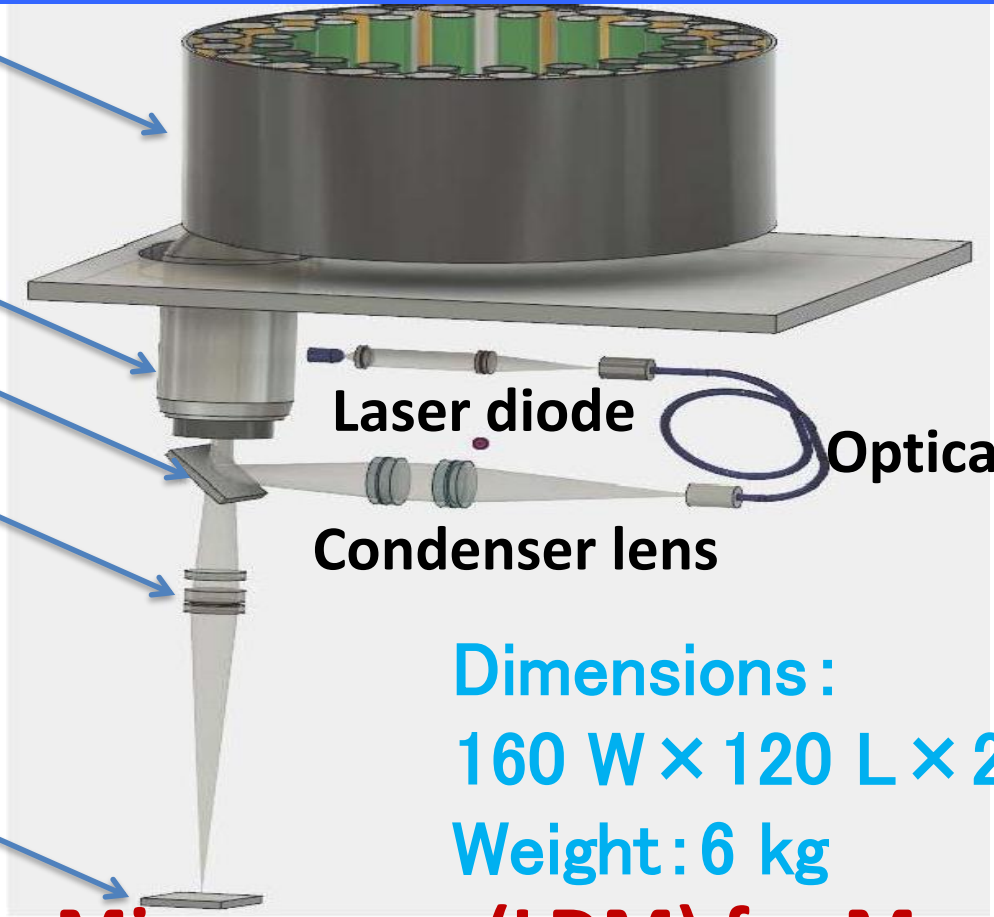


Microbes, miniature cells, proteins, proteinoid, polycyclic aromatic hydrocarbons (PAH) can be detected.

2. What fluorescent microscope can do

	Live cells (membrane with selectivity)	Dead cells (membrane w/o selectivity)	Protein (certain molecule)	PAH (certain molecule)
(1) SYTO24	○	○	○	○
(2)Propidium iodide		○		
(3) SYPRO Red	○	○	○	○
(4) CFDA-AM	○			

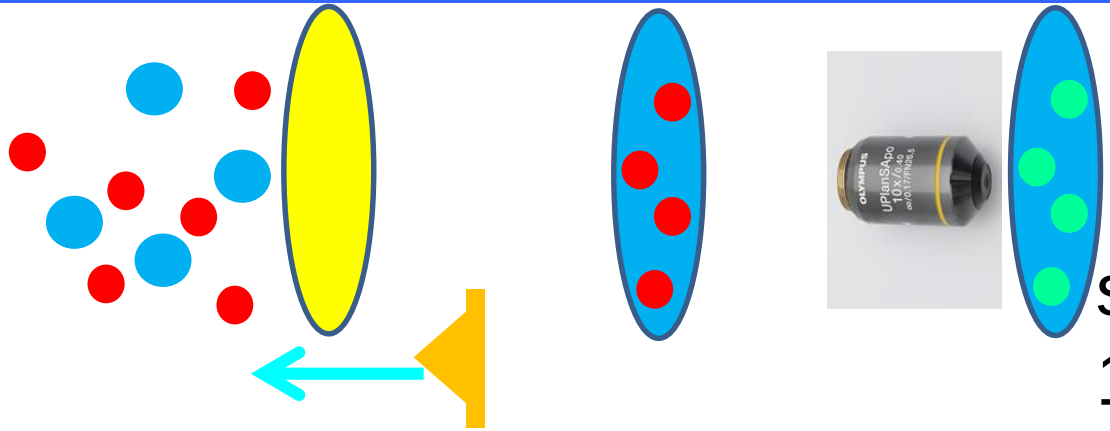
2. What fluorescent microscope can do



Dimensions：
160 W × 120 L × 240 H (mm),
Weight：6 kg

Life Detection Microscope (LDM) for Mars (BBM)

3. Cloud Particles



https://www.olympus-lifescience.com/ja/support/learn/02/038/

"soft" impactor

suppose
10 liquid droplets cm^{-3}
10^4 particles m^{-3}

VAMP LEAF 20 m s^{-1}

Insect collecting net

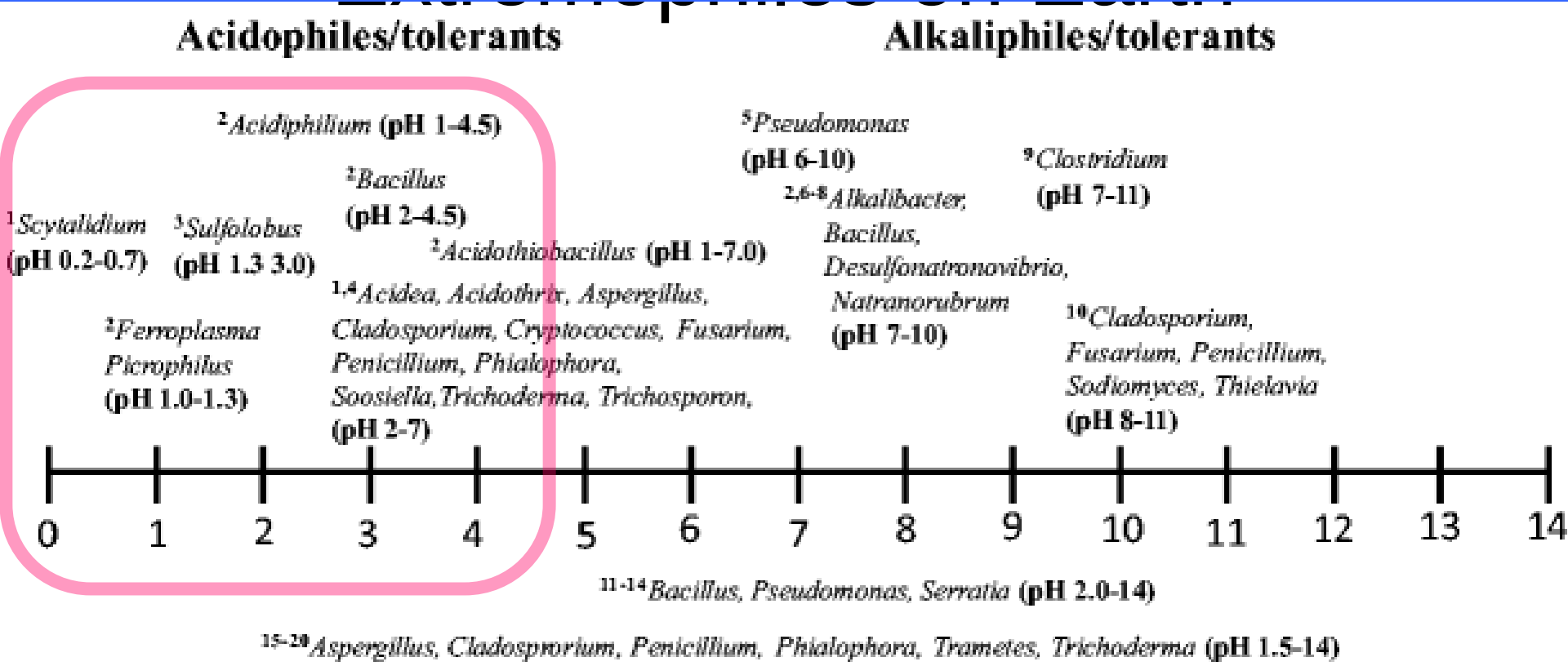
1 m^2 area x 100 m
several microL liquid with ~10^6 particles

https://microscopetalk.wordpress.com/tag/collecting-insects/

Liquid particle

- Impactor: Size, Shape, Density information available (but sample transfer to microscope complicated)
- Microchannel: Size, Shape, Density information lost (but sample transfer to microscope simple)

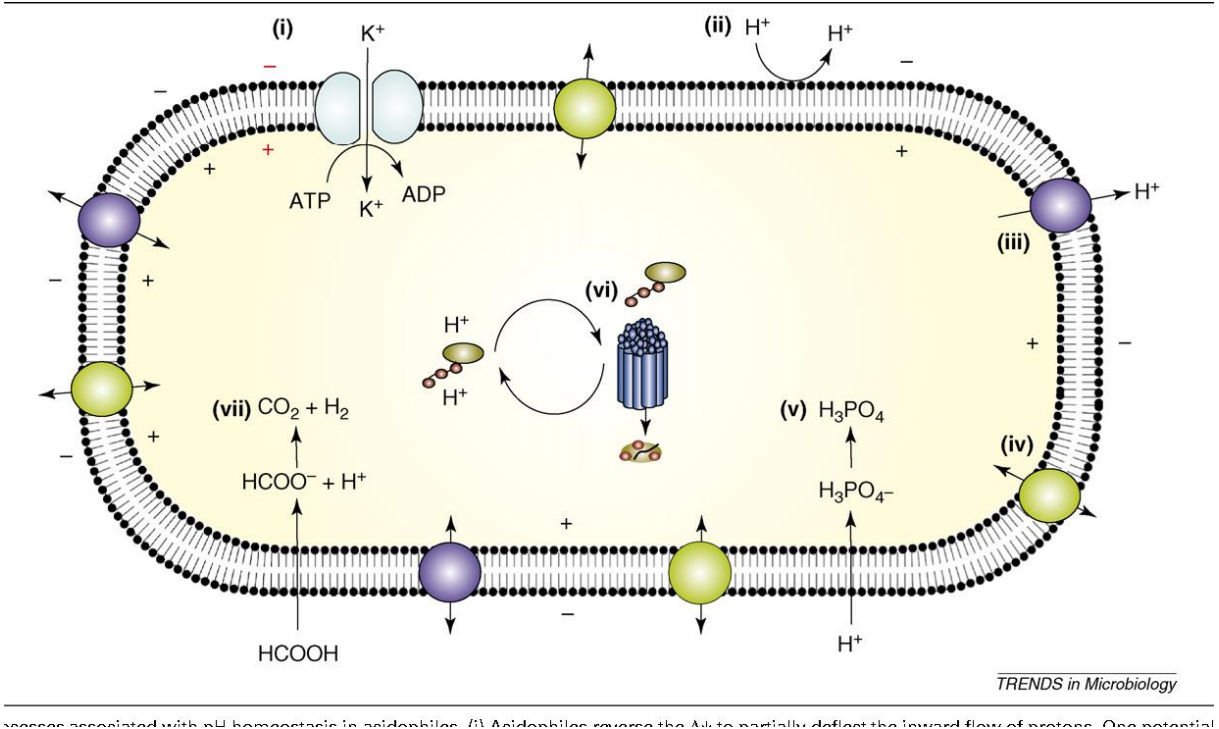
4. In the Cloud



Appl Microbiol Biotechnol (2016)

4. In the Cloud

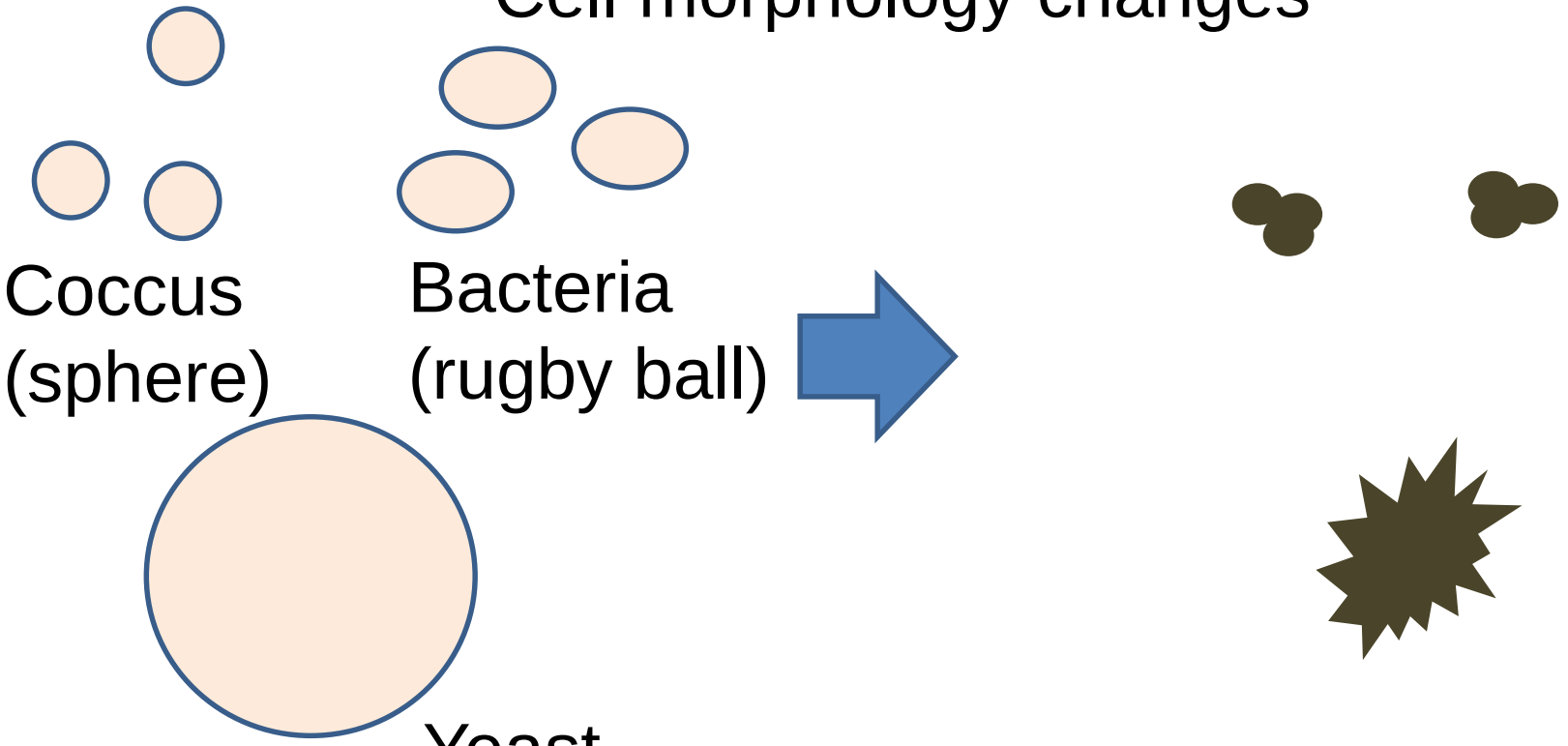
pH homeostasis in acidophiles



Life in acid: pH homeostasis in acidophiles.
Craig Baker-Austin, Mark DopsonPublished 2007 in Trends in microbiology

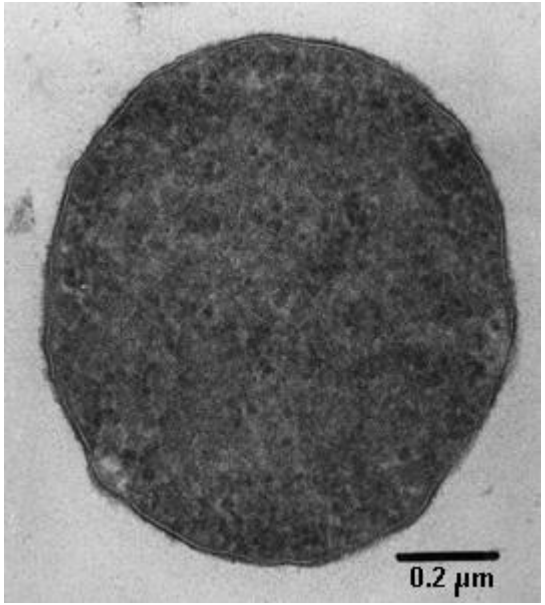
5. So far

Cell morphology changes



5. So far

- Model microorganisms
  - Acidphiles
  - Bacteria
  - Yeast
- Dyes
  - **Some works** in 75% H_2SO_4



Thermoplasma acidophilum grows best in hot environments, usually between 55 and 60 degrees Celsius. This genus is most famous for its acidophilia, preferring pH range of 0.5-4.

https://microbewiki.kenyon.edu/index.php/Thermoplasma