



waag society

institute for art, science and technology

picture by Gerrit Niezen



BioHack Academy Growth & Production

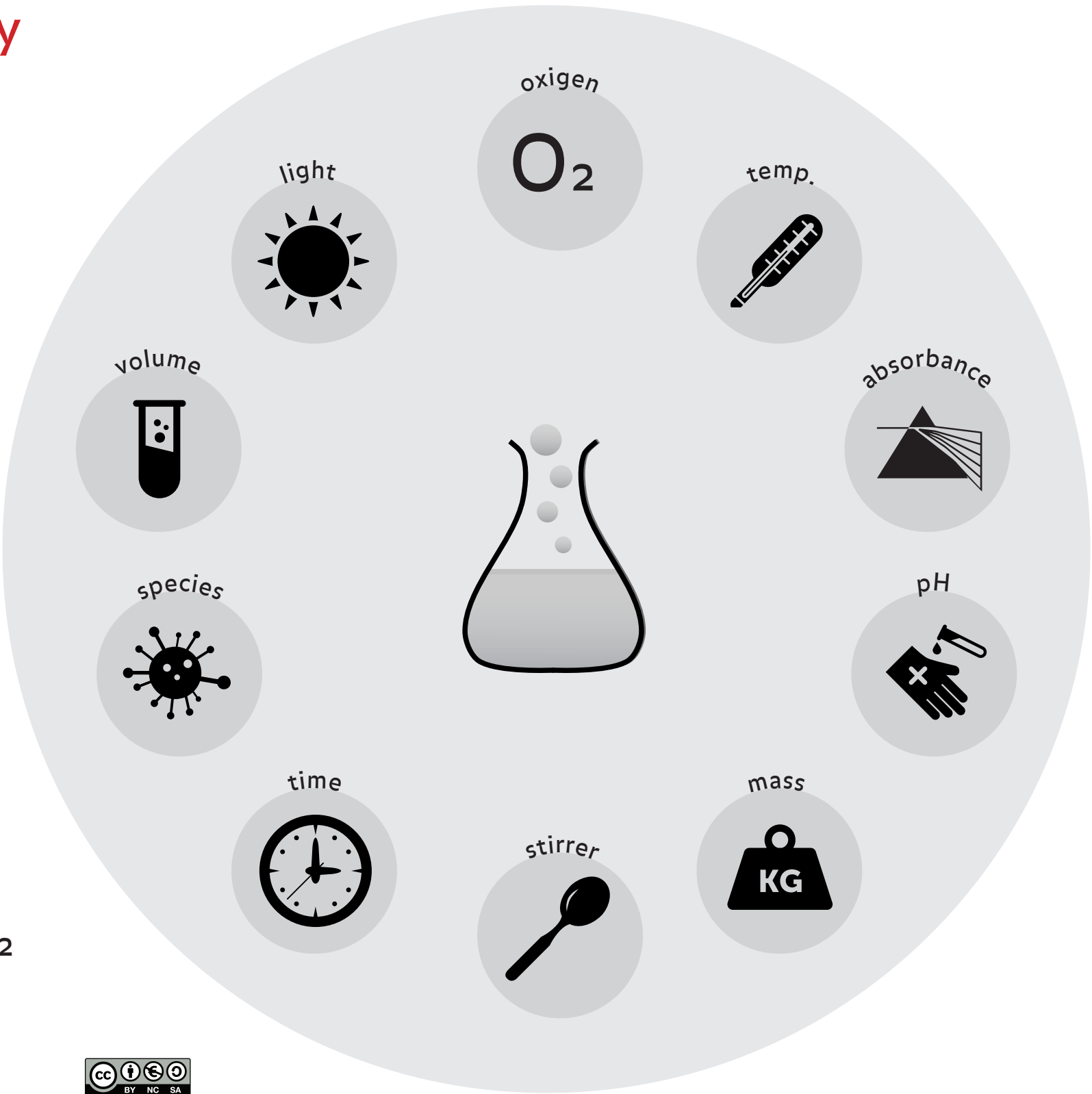


BioFactory canvas




input

_____	C
_____	N
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_____	O ₂
_____	S



observations

day #	
day #	
day #	
day #	
day #	

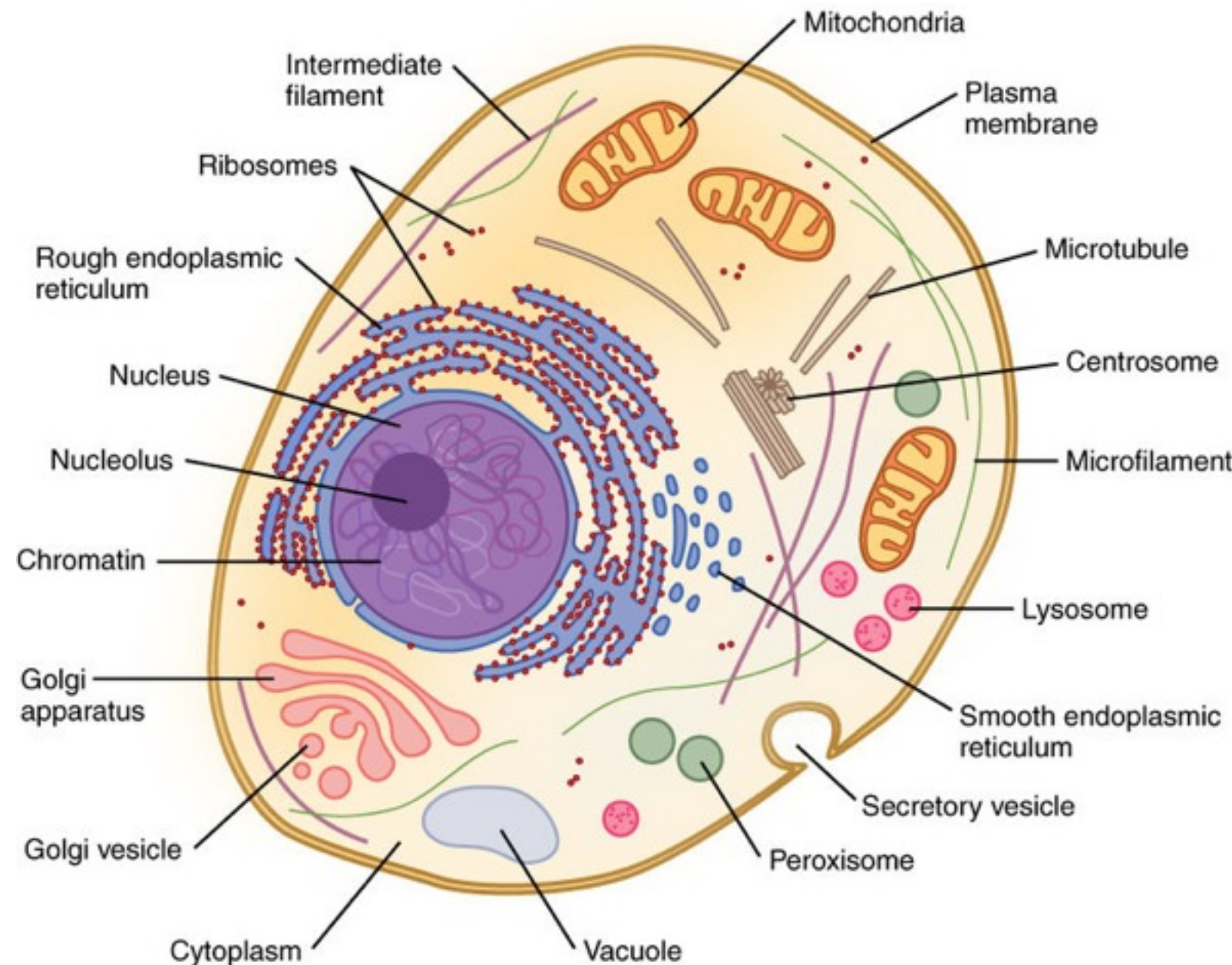


material



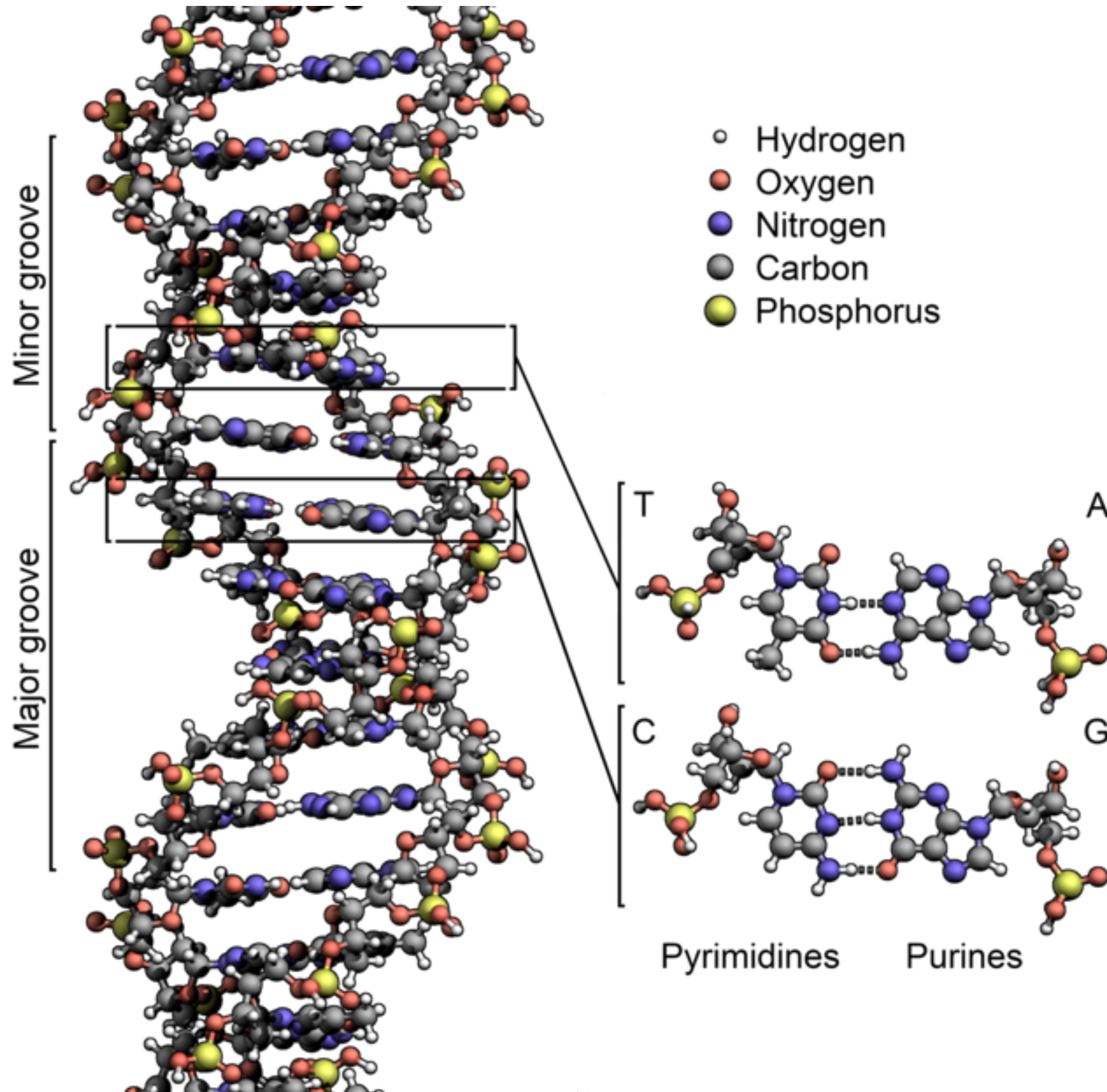
What's a cell made of:

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



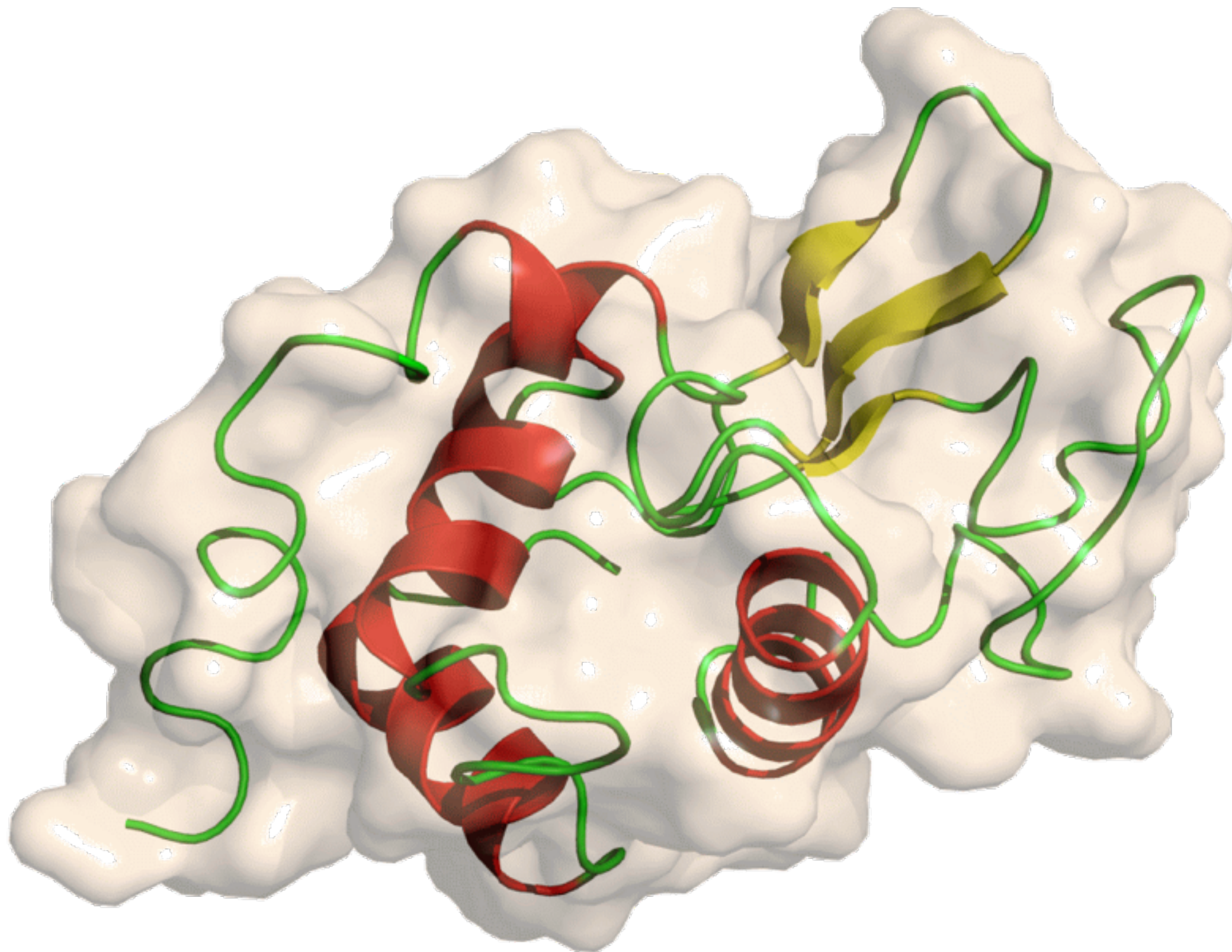


DNA Molecule



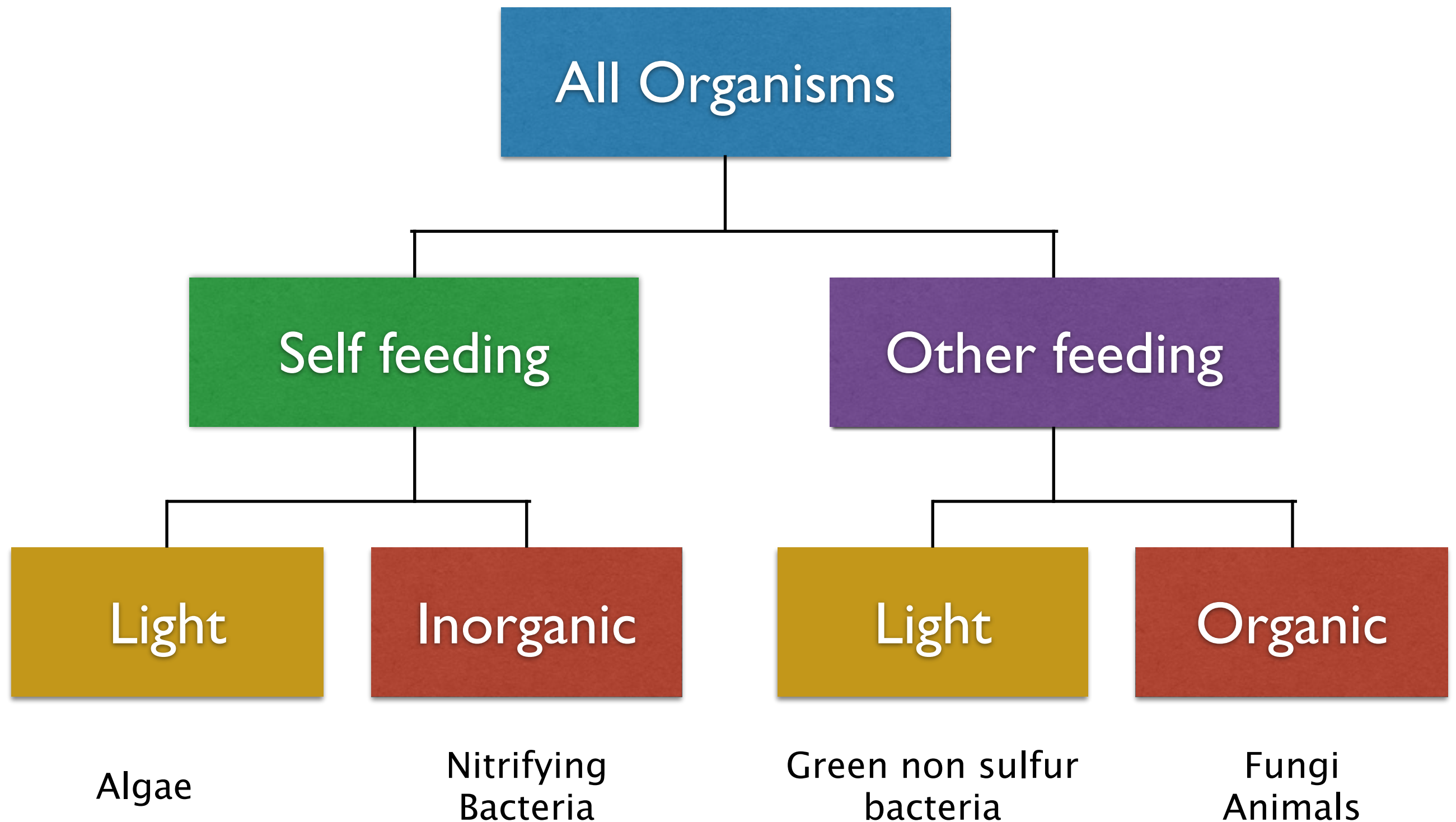


Lysozyme



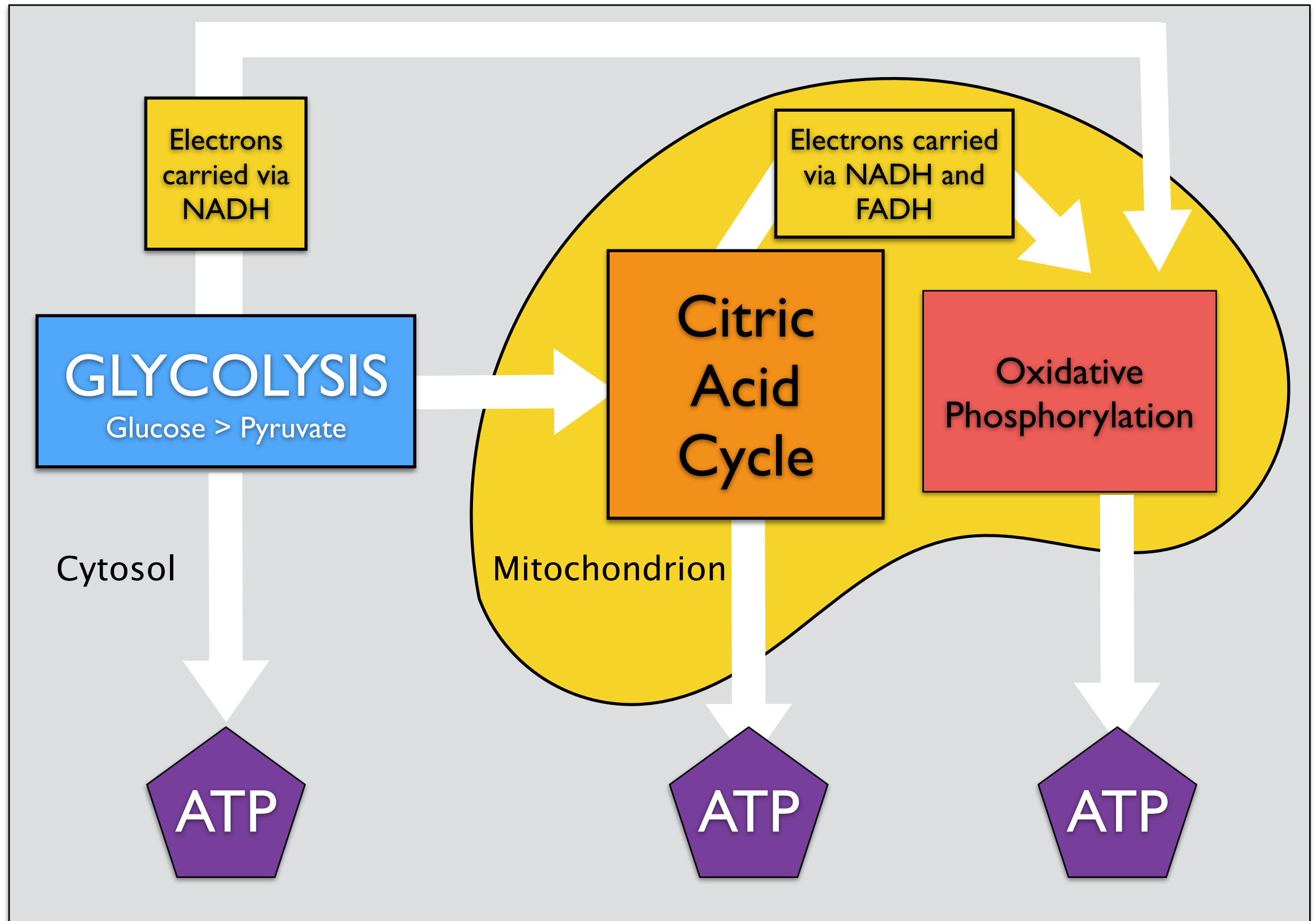


Diversity in Metabolism



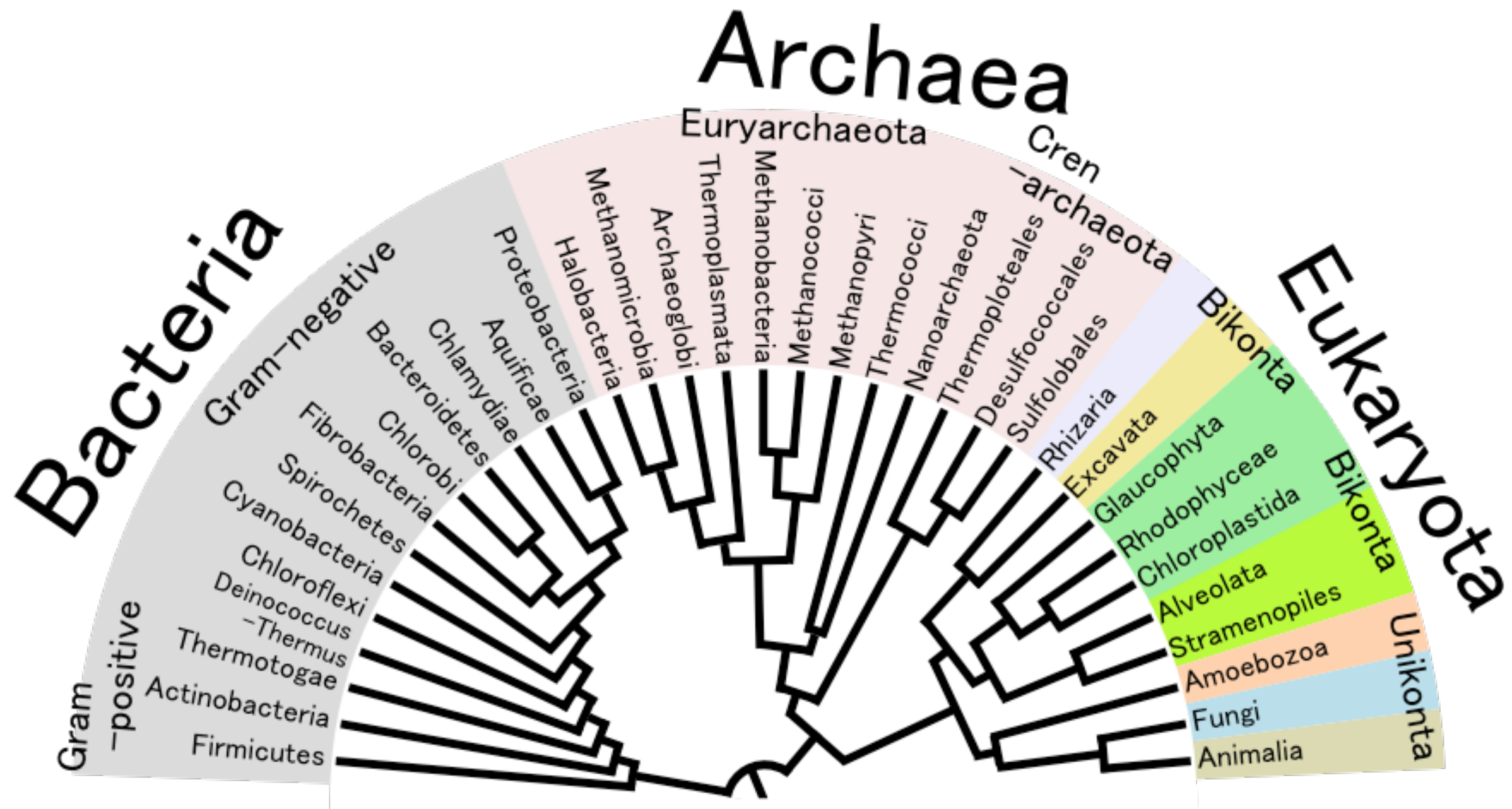


Respiration





Species vs Strains





Culture collections

DSMZ Leibniz-Institut DSMZ-Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH
Leibniz Institute DSMZ-German Collection of Microorganisms and Cell Cultures

DSMZ.de

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Examining the RNAi Mechanism

6 Products

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CBS-KNAW Fungal Biodiversity Centre
An institute of the Royal Netherlands Academy of Arts and Sciences

cbs.knaw.nl

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April 20-25 2015

CBS Symposium Week 2015

Genomics of Neglected Pathogens
Yeasts Taxonomy Workshop
The Second International Workshop on Ascomycete Systematics
ICTF meeting
IMA meeting

Venue: CBS-KNAW Fungal Biodiversity Centre, Utrecht, Trippenhuis, Royal Netherlands Academy of Arts and Sciences, Amsterdam and Artis zoo Amsterdam

Studies in Mycology 80 (March 2015)
Hypocrealean lineages of industrial and phytopathological importance

NEW

Studies in Mycology 79 (September 2014)
Fungal pathogens of food and fibre crops

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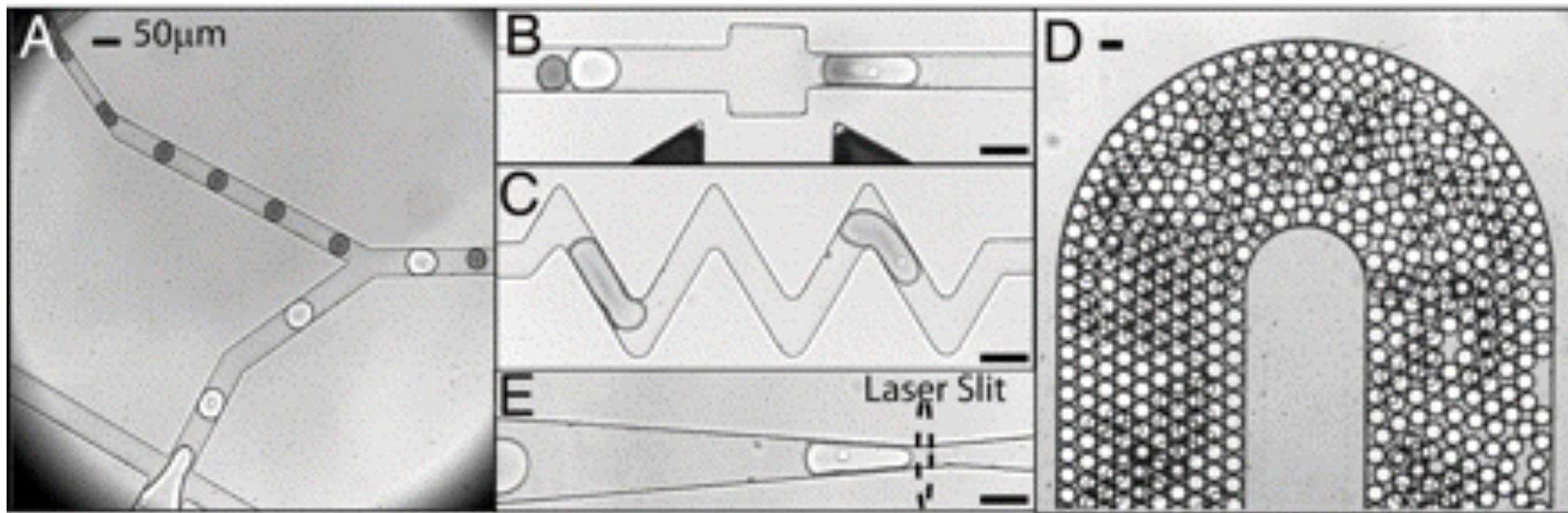
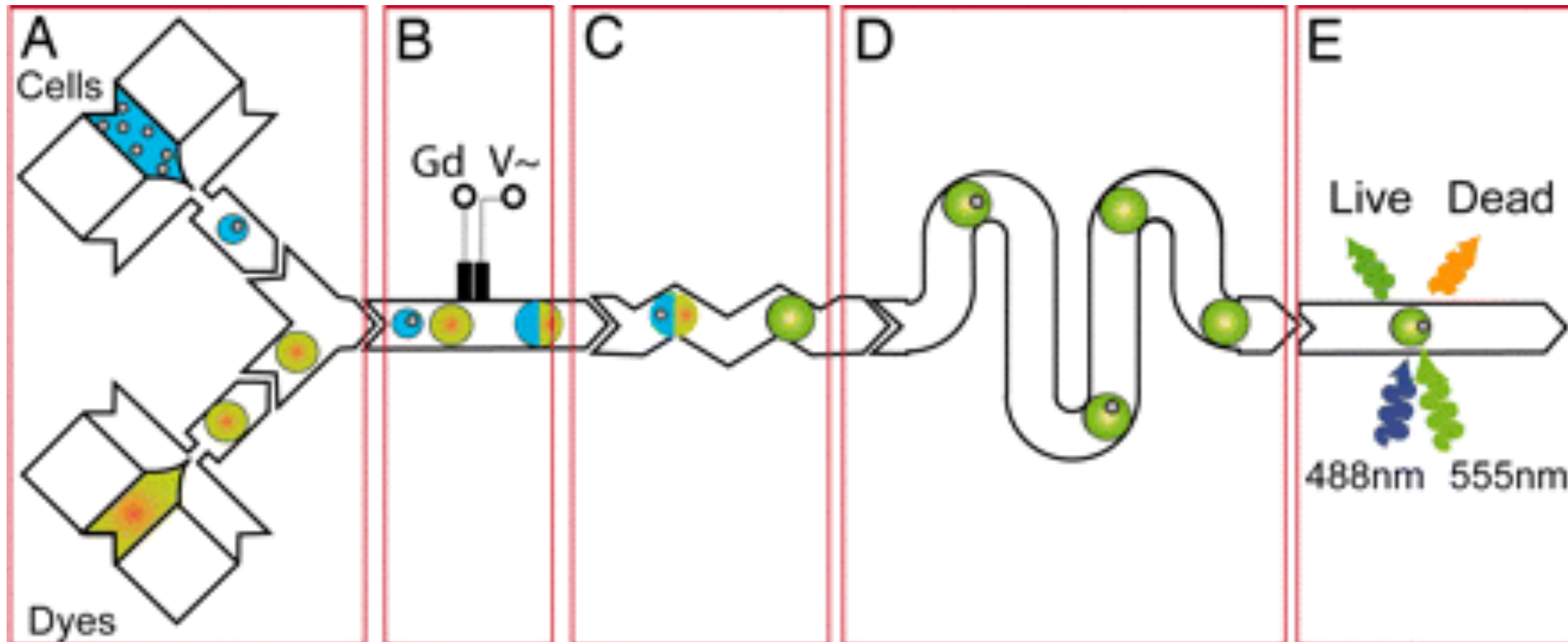
Immortalized Aortic Endothelial Cells
TelHAEC for angiogenesis and ...
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Male and Female CD34+



High Throughput Screening

Eric Brouzes et al. PNAS 2009;106:14195-14200





Electrowetting

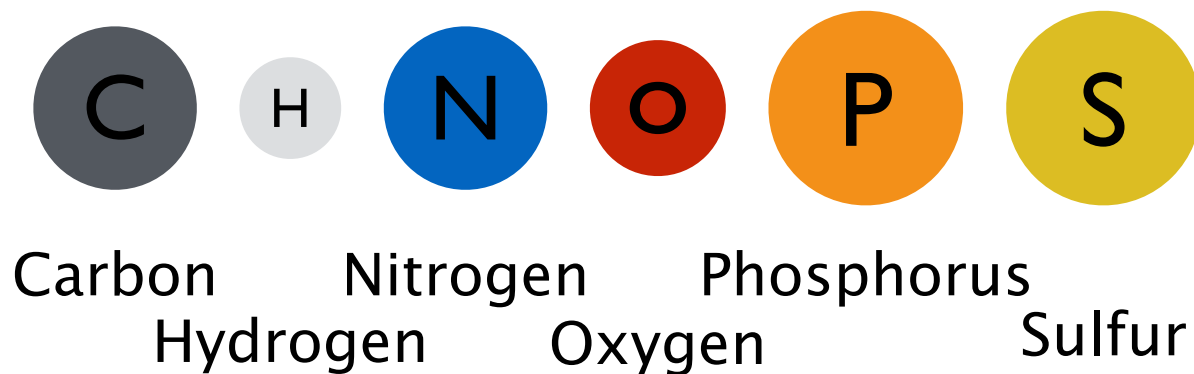
<https://www.youtube.com/watch?v=DJgvBoygmGk>



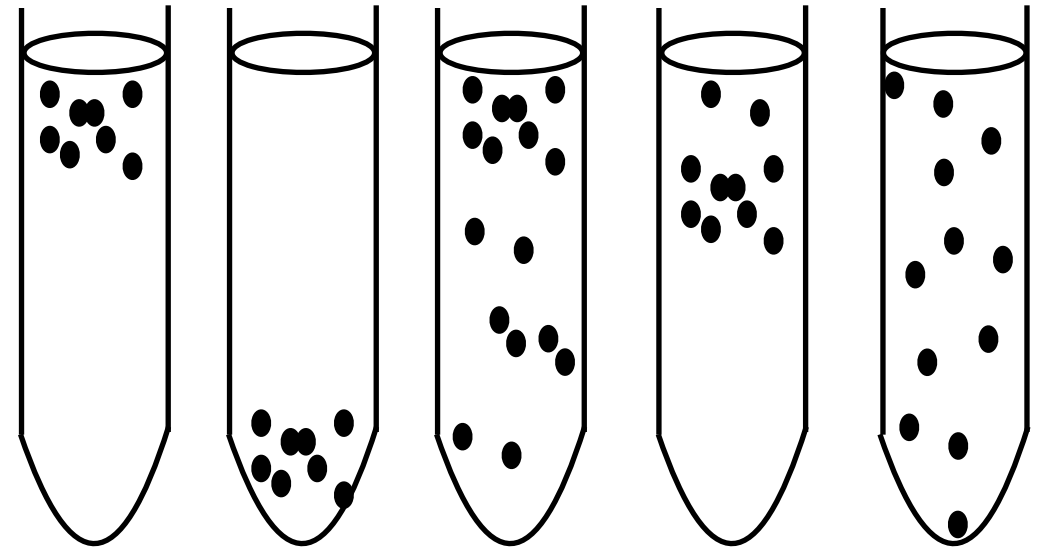


Diversity due to growth conditions

Nutrients



Atmosphere

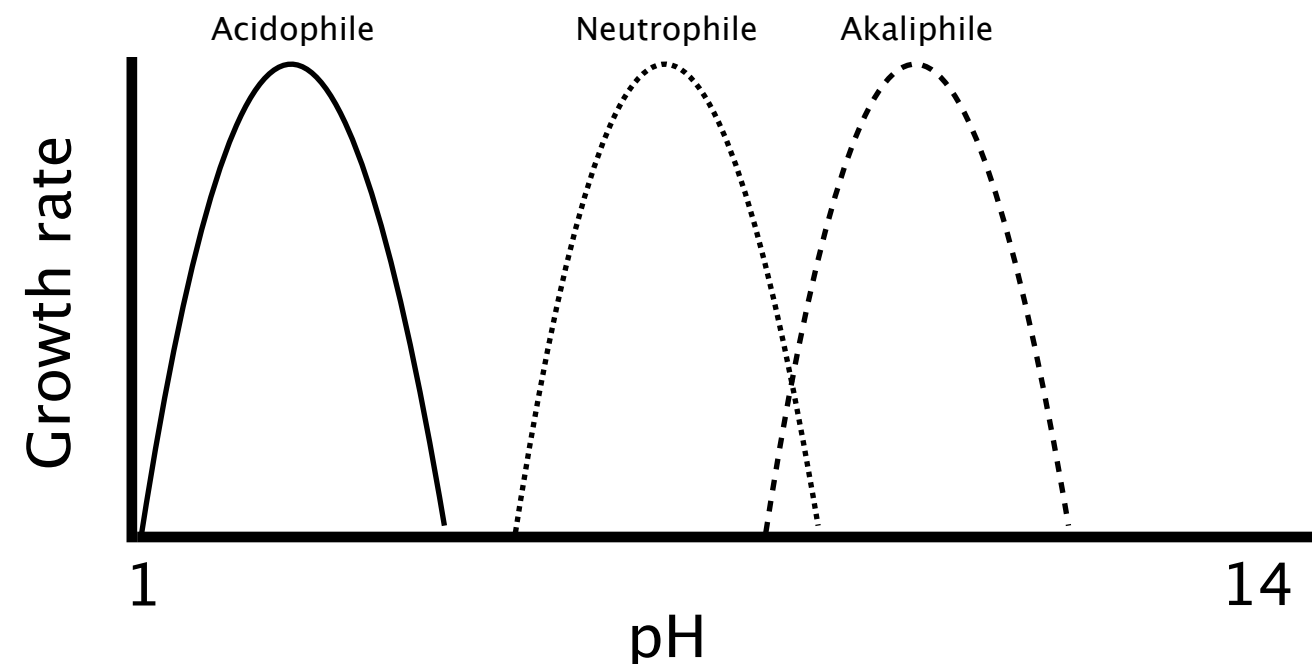


Temperature



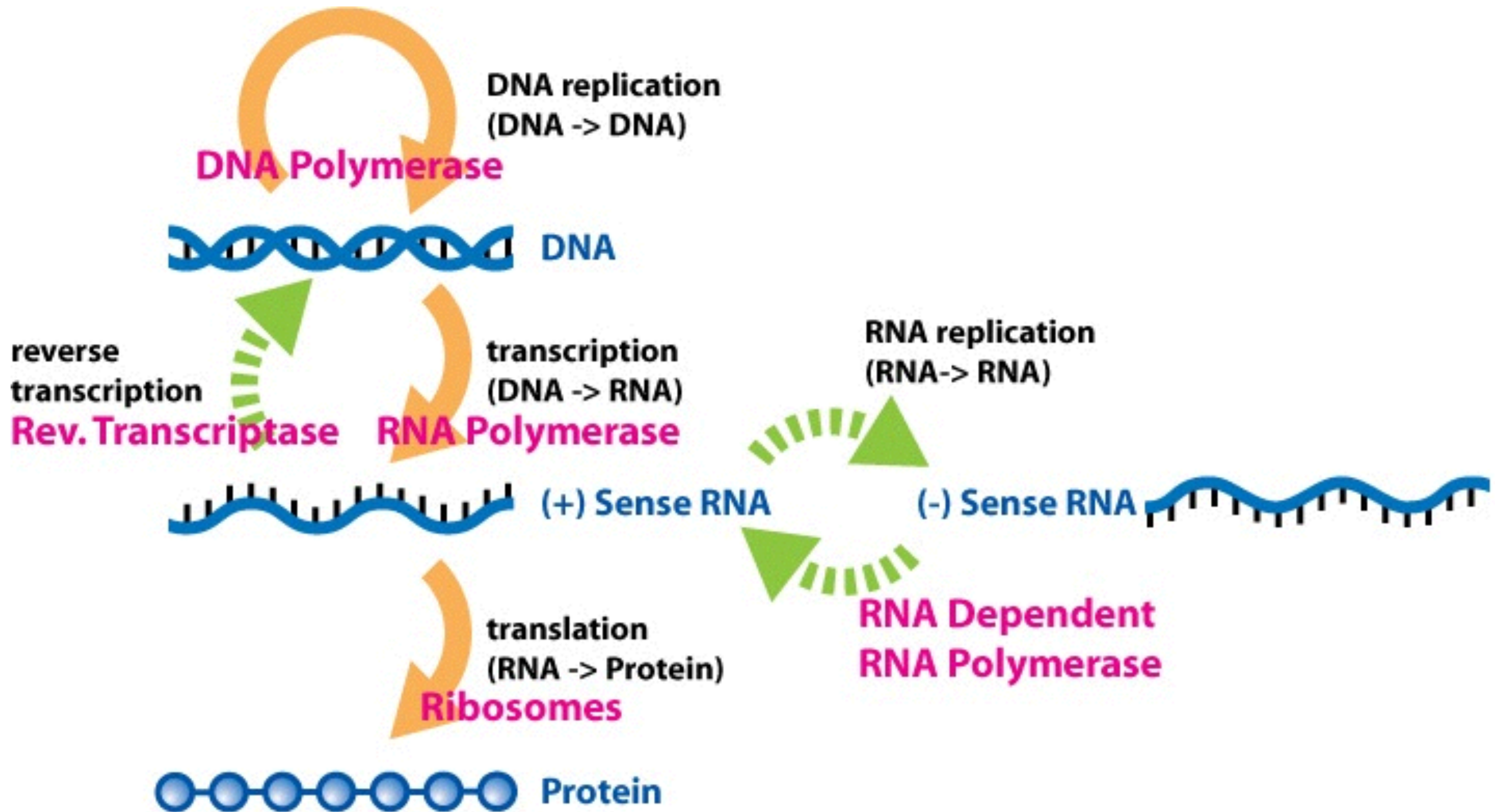
Pixabay - CC0

pH





Influencing gene expression





What we are looking for

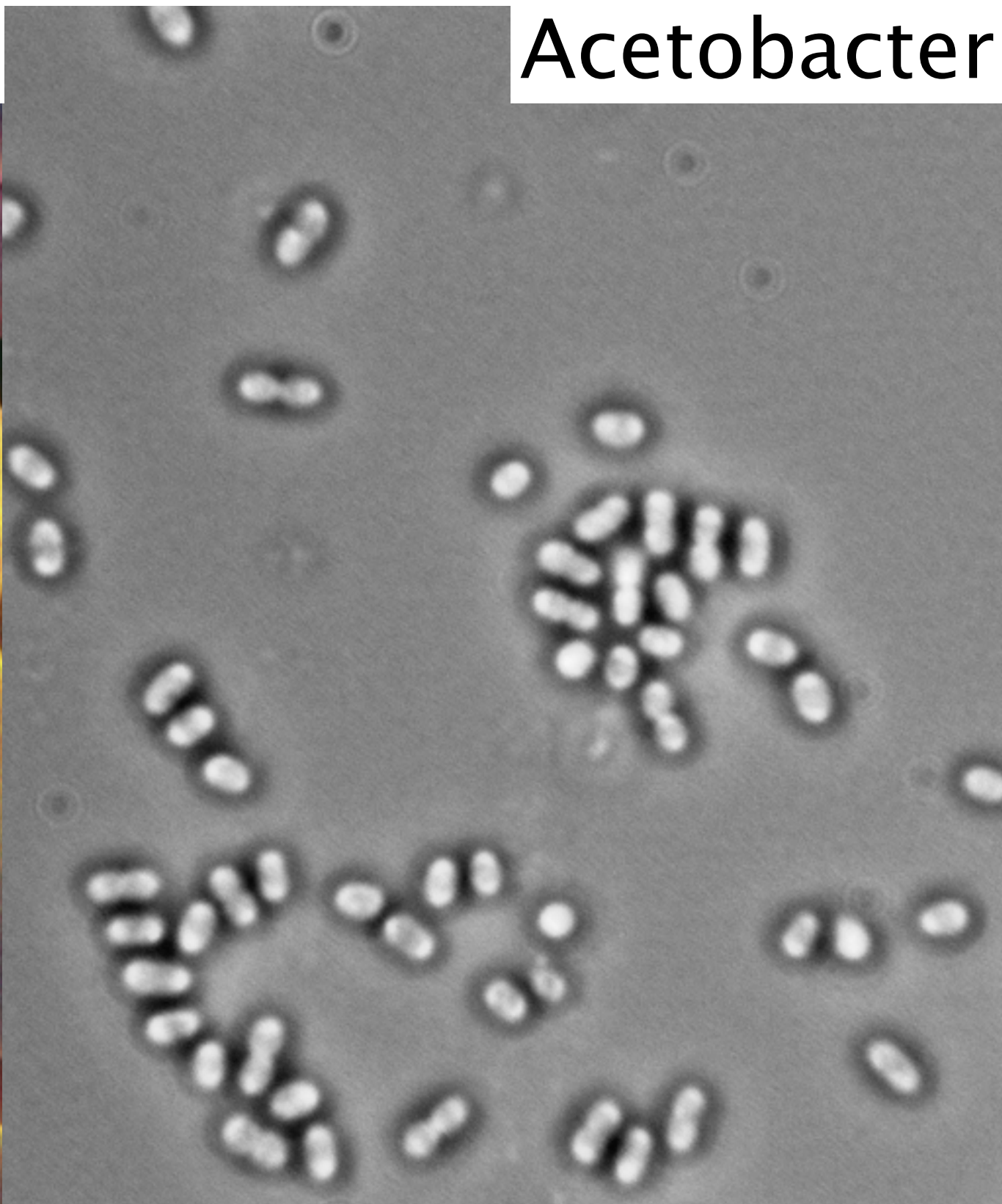
- High yield
 - Conversion of substrate into product
- Fast growing
- Low amount of (toxic) by-products
- Easy to purify
- Robust cells



Natural talents



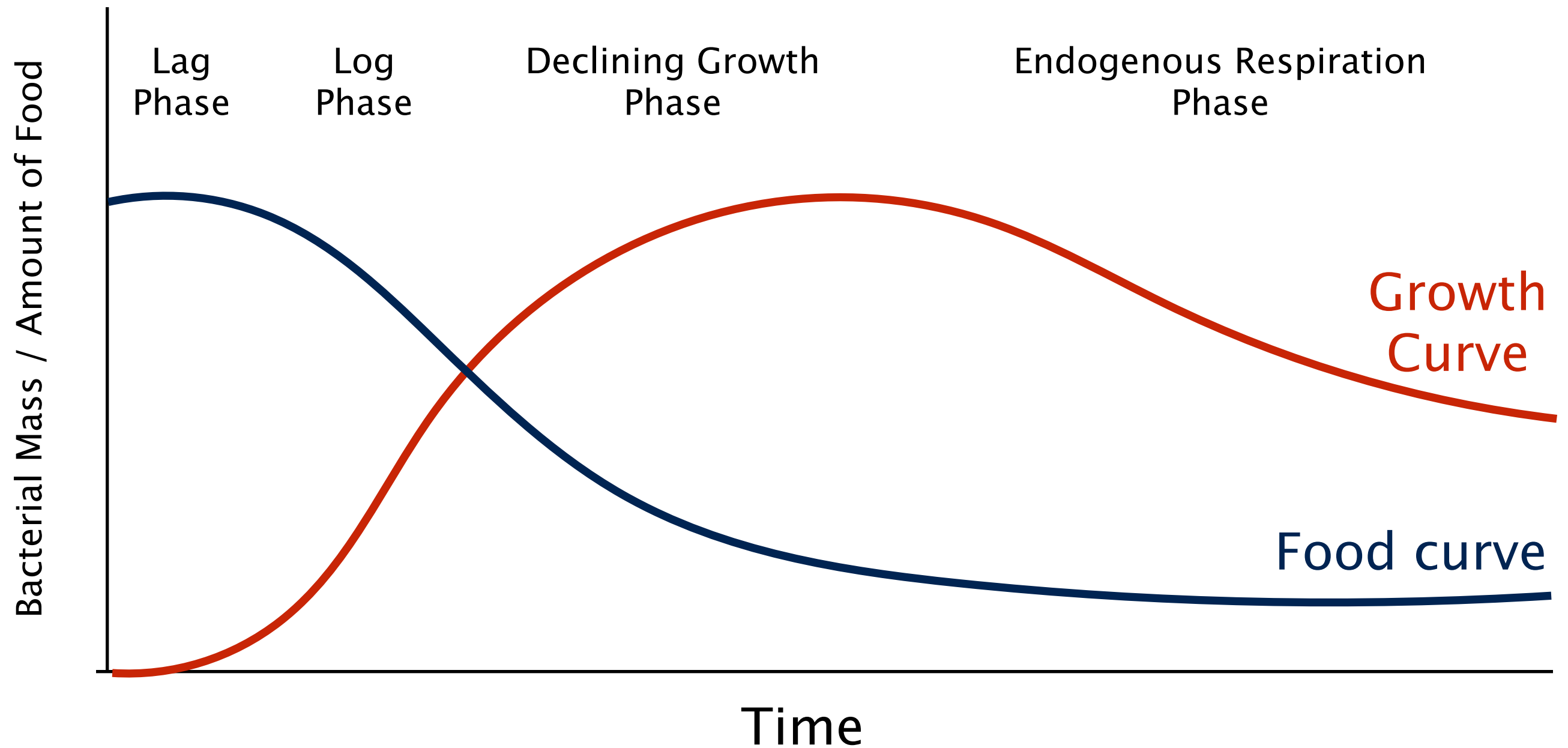
Yeast



Acetobacter

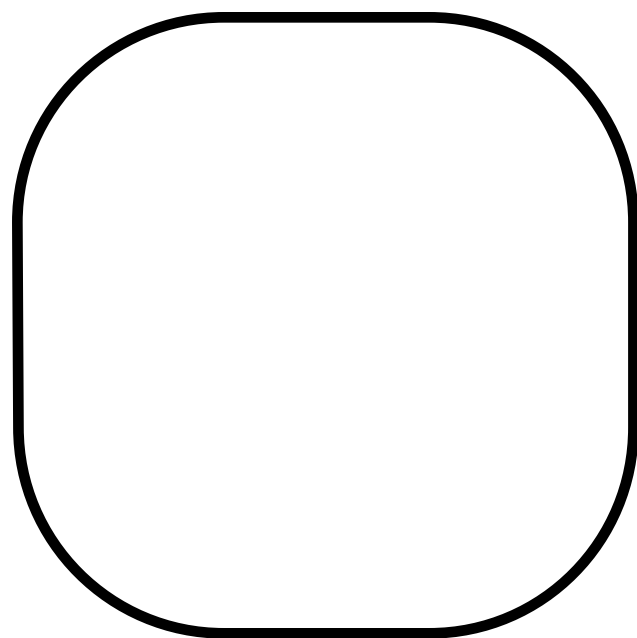


Bacterial growth curve – Batch

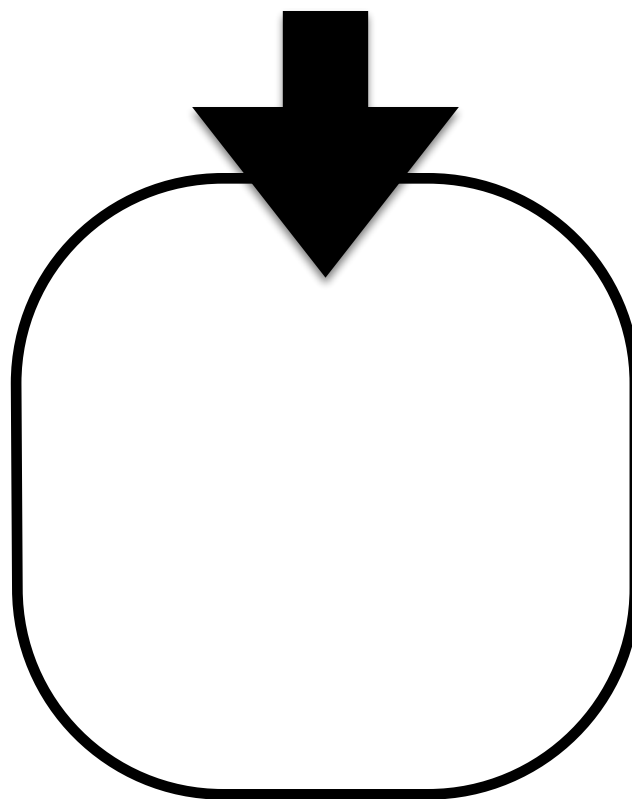




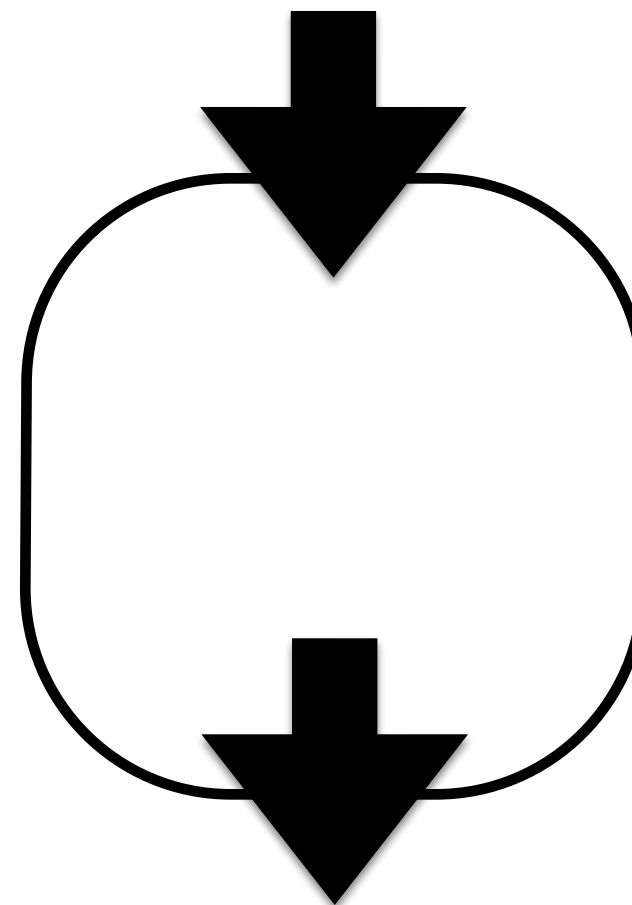
Growth strategies



Batch



Fed Batch



Chemostat



Advantages of chemostat

- Measure specific growth speed
- Investigate effect of medium
- Measure & control environmental parameters





Large scale chemostats



Fusarium graminearum



Saccharomyces cerevisiae



Single use bioreactors

- Instability
- Contamination risk
- Flexibility
- Down stream processing is discontinuous





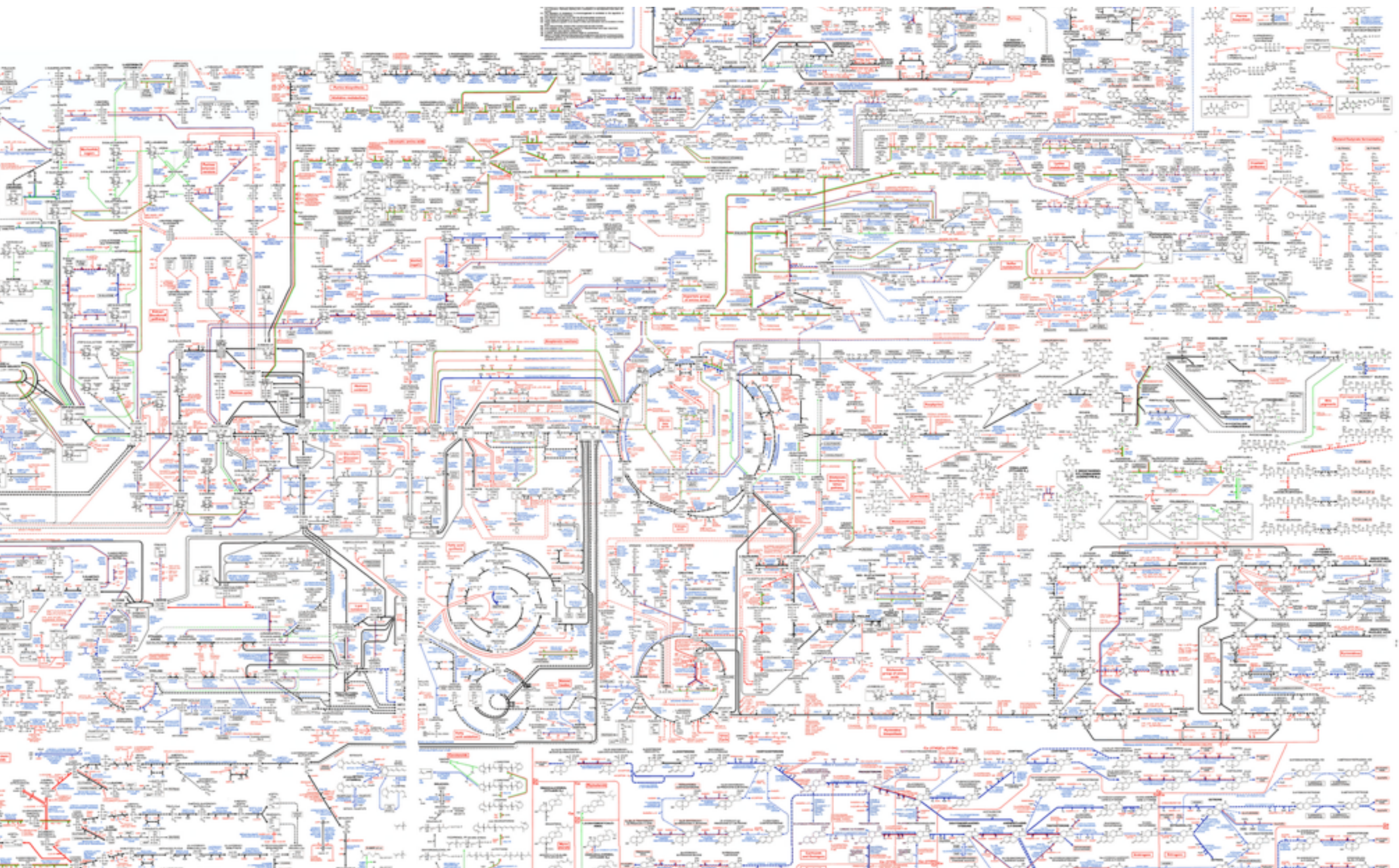
100 m³ reactor

- Yeast production
- Yield = product / substrate
- Fermentation: 2 ATP per sugar
- Respiration: 16 ATP per sugar
- Even at full aeration risk of low yield: Respirofermentive metabolism





Metabolic engineering





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Growth Stoichiometry



Divide by
Molecular
Weight

Multiply

$$6.022 \times 10^{23}$$

Grams

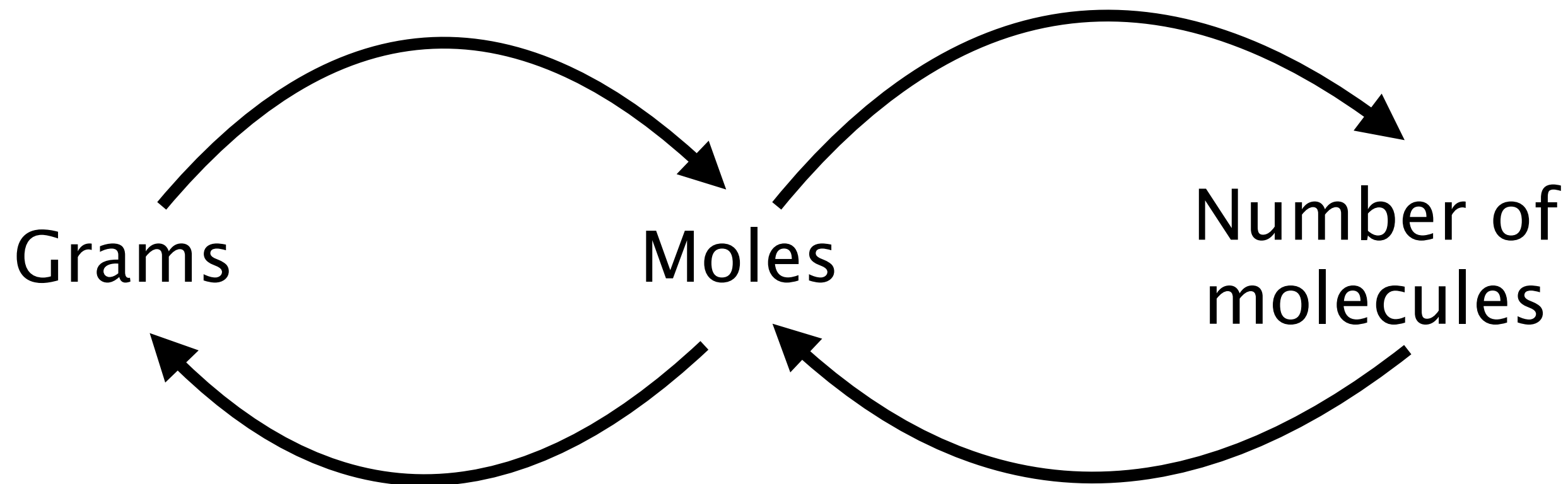
Moles

Number of
molecules

Multiply
Molecular
Weight

Divide by

$$6.022 \times 10^{23}$$





Finally, the real chemistry!

The Periodic Table of the Elements																	
group 1																	18
1	2															9	10
1.00794 H Hydrogen																4.002602 He Helium	2
6.941 Li Lithium	9.012182 Be Beryllium															19	20
22.98976 Na Sodium	24.3050 Mg Magnesium															31	32
39.0983 K Potassium	40.078 Ca Calcium	44.95591 Sc Scandium	47.867 Ti Titanium	50.9415 V Vanadium	51.9962 Cr Chromium	54.93804 Mn Manganese	55.845 Fe Iron	58.93319 Co Cobalt	58.6934 Ni Nickel	63.546 Cu Copper	65.38 Zn Zinc	69.723 Ga Gallium	72.64 Ge Germanium	74.92160 As Arsenic	78.96 Se Selenium	79.904 Br Bromine	83.798 Kr Krypton
85.4678 Rb Rubidium	87.62 Sr Strontium	88.90585 Y Yttrium	91.224 Zr Zirconium	92.90638 Nb Niobium	95.96 Mo Molybdenum	98 Tc Technetium	101.07 Ru Ruthenium	102.9055 Rh Rhodium	106.42 Pd Palladium	107.8682 Ag Silver	112.441 Cd Cadmium	114.818 In Indium	118.710 Sn Tin	121.760 Sb Antimony	127.60 Te Tellurium	126.9044 I Iodine	131.293 Xe Xenon
132.9054 Cs Cesium	137.327 Ba Barium	174.9668 Lu Lutetium	178.49 Hf Hafnium	180.9478 Ta Tantalum	183.84 W Tungsten	186.207 Re Rhenium	190.23 Os Osmium	192.217 Ir Iridium	195.084 Pt Platinum	196.9665 Au Gold	200.59 Hg Mercury	204.3833 Tl Thallium	207.2 Pb Lead	208.9804 Bi Bismuth	(210) Po Polonium	(210) At Astatine	(220) Rn Radon
(223) Fr Francium	(226) Ra Radium	(262) Lr Lawrencium	(261) Rf Rutherfordium	(262) Db Dubnium	(266) Sg Seaborgium	(264) Bh Bohrium	(277) Hs Hassium	(268) Mt Meitnerium	(271) Ds Darmstadtium	(272) Rg Roentgenium	(285) Cn Copernicium	(284) Uut Ununtrium	(289) Uuq Ununquadium	(288) Uup Ununpentium	(292) Uuh Ununhexium	117 Uus Ununseptium	(294) Uuo Ununoctium

atomic mass
or most stable mass number

1st ionization energy
in kJ/mol

chemical symbol

name

electron configuration

55.845

26

Fe

Iron

[Ar] 3d⁶ 4s²

atomic number

electronegativity

oxidation states
most common are bold

alkali metals

alkaline metals

other metals

transition metals

lanthanoids

actinoids

metalloids

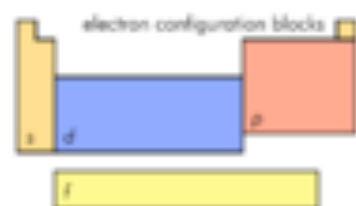
nonmetals

halogens

noble gases

unknown elements

radioactive elements have
masses in parenthesis



notes

- as of yet, elements 113-118 have no official name designated by the IUPAC.
- 1 kJ/mol = 96.485 eV.
- all elements are implied to have an oxidation state of zero.

138.9054 La Lanthanum	140.116 Ce Cerium	140.9076 Pr Praseodymium	144.242 Nd Neodymium	(145) Pm Promethium	150.36 Sm Samarium	151.964 Eu Europium	157.25 Gd Gadolinium	158.9253 Tb Terbium	162.500 Dy Dysprosium	164.9303 Ho Holmium	167.259 Er Erbium	168.9342 Tm Thulium	173.054 Yb Ytterbium
(227) Ac Actinium	232.0380 Th Thorium	231.0358 Pa Protactinium	238.0289 U Uranium	(237) Np Neptunium	(244) Pu Plutonium	(243) Am Americium	(247) Cm Curium	(247) Bk Berkelium	(251) Cf Californium	(252) Es Einsteinium	(257) Fm Fermium	(258) Md Mendelevium	(259) No Nobelium



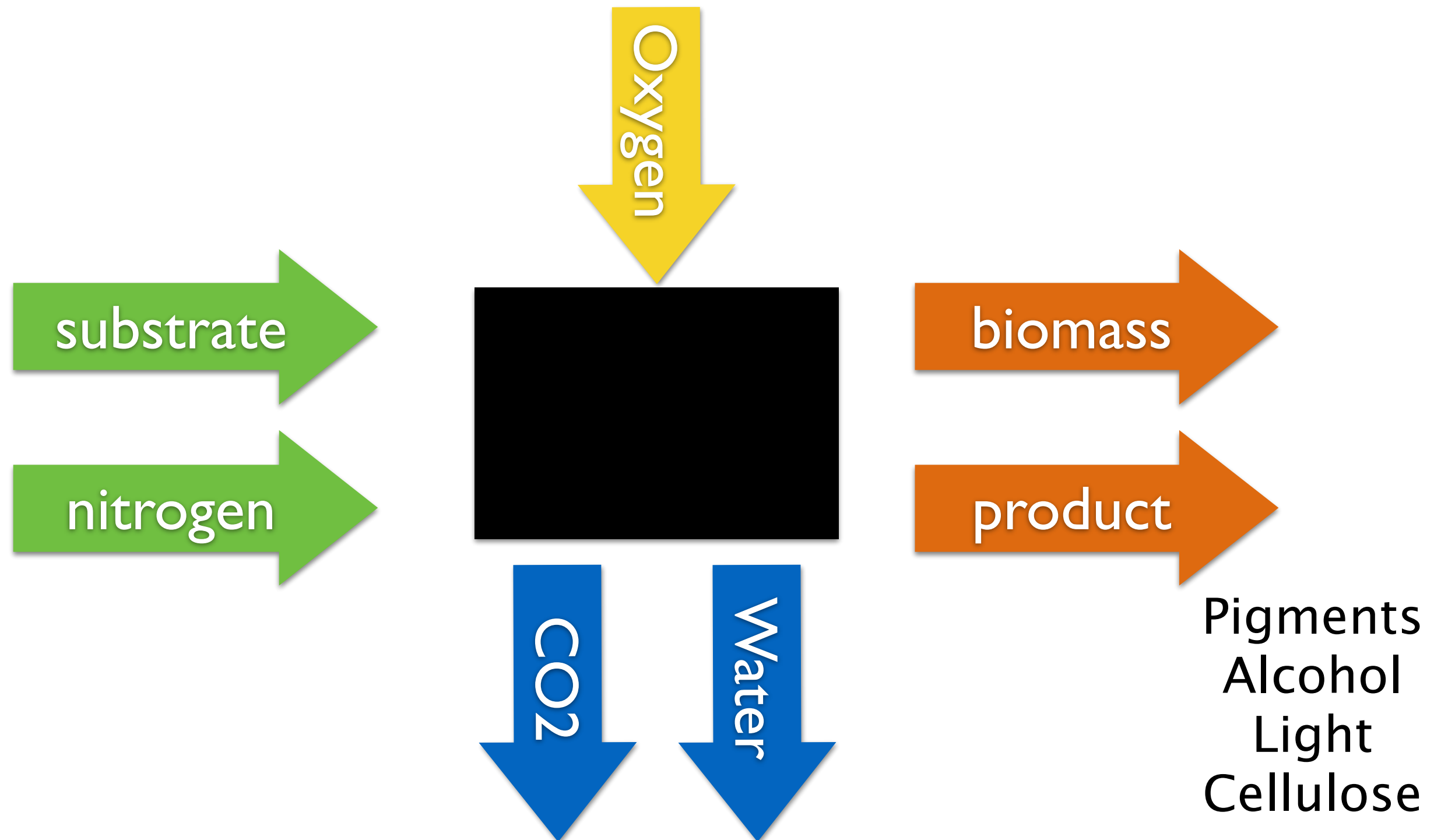
Molecular Weight of Water

Atom	Number in molecule	Atomic Weight	Total Mass
H	2	1	2
O	1	16	16

Molecular weight: 18
One mole of water: 18 grams



Black box approach





Elementary composition Lactobacillus

4,201 PROT + 0,074 DNA +
0,329 RNA + 0,015 LTA +
0,032 LIP + 0,119 PG + 0,064
POLYS + 18.15 ATP

->

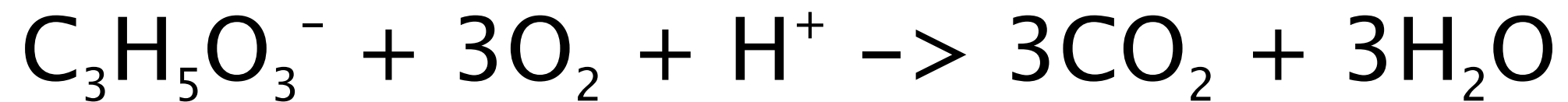
BIOMASS + 18.15 ADP + 18.15
phosphate

BIOMASS: $\text{CH}_{1,95}\text{O}_{0,63}\text{N}_{0,22}\text{P}_{0,02}\text{S}_{0,01}$

BIOMASS mol weight: 27.8 g/C-mol



P. Roqueforti eating lactate



Acid is consumed



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