



waag society

institute for art, science and technology

picture by Gerrit Niezen

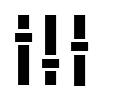


BioHack Academy
Growth & Production



BioFactory

canvas



input

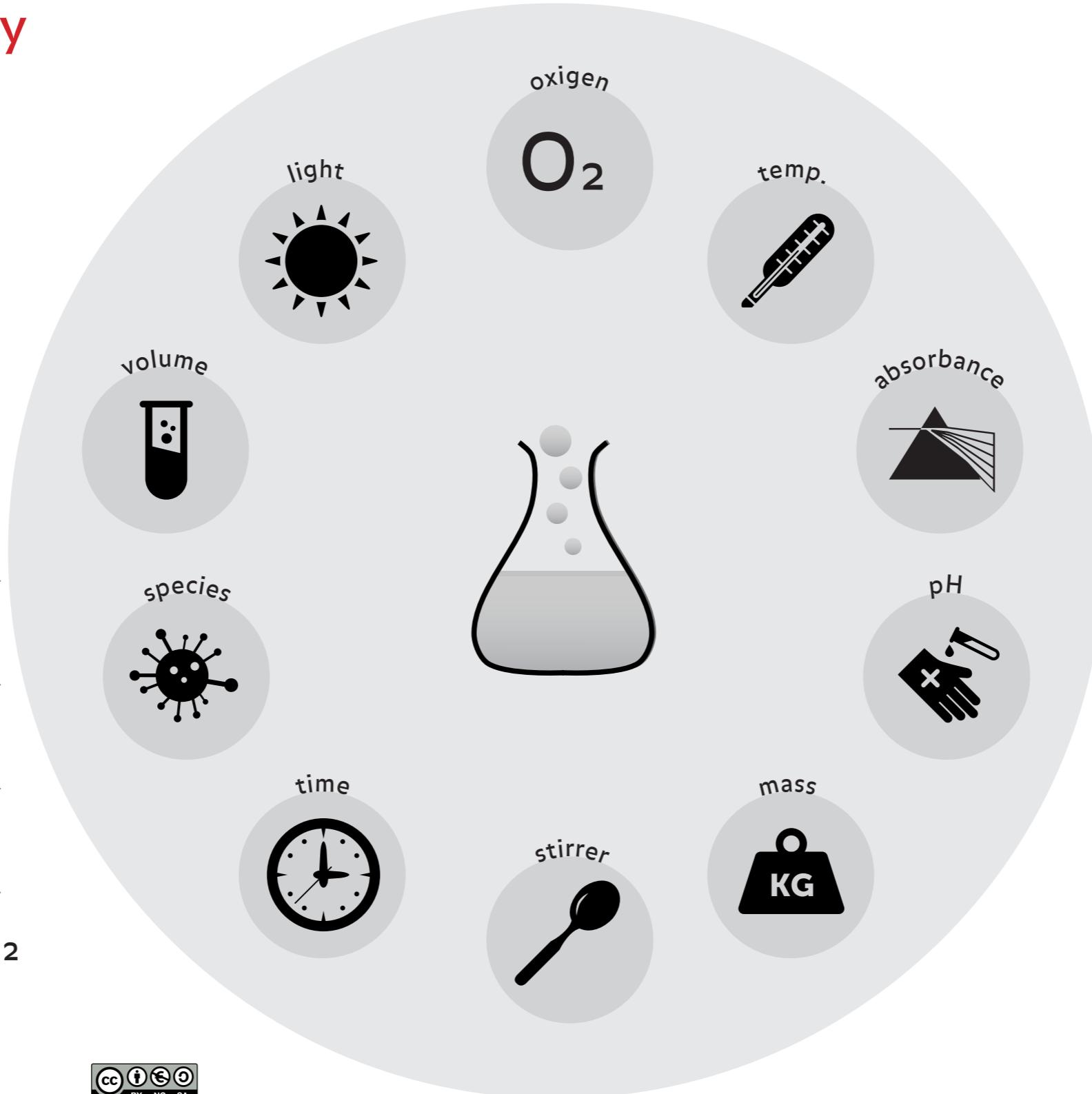
C

N

P

O₂

S



observations

day #

day #

day #

day #

day #

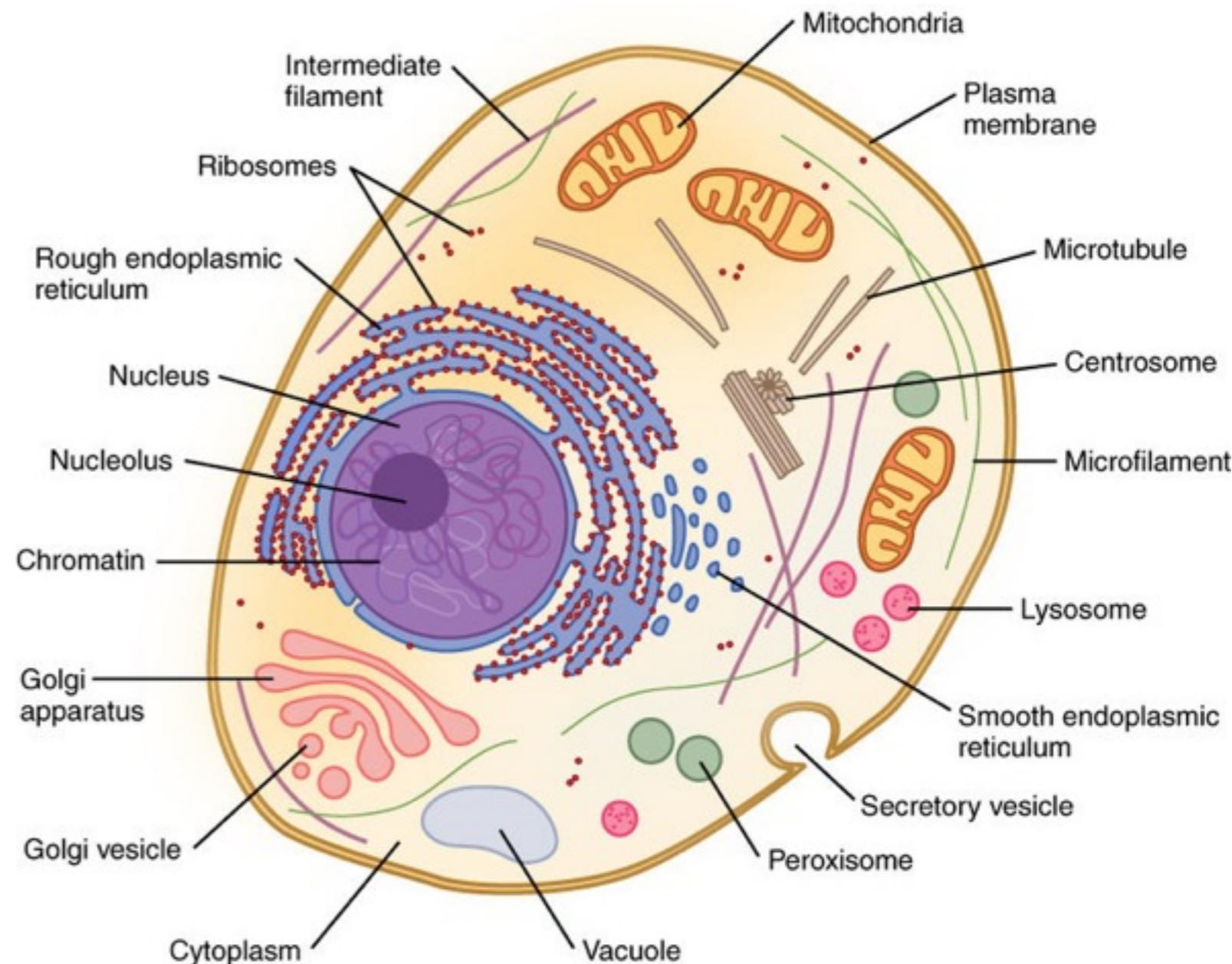


material



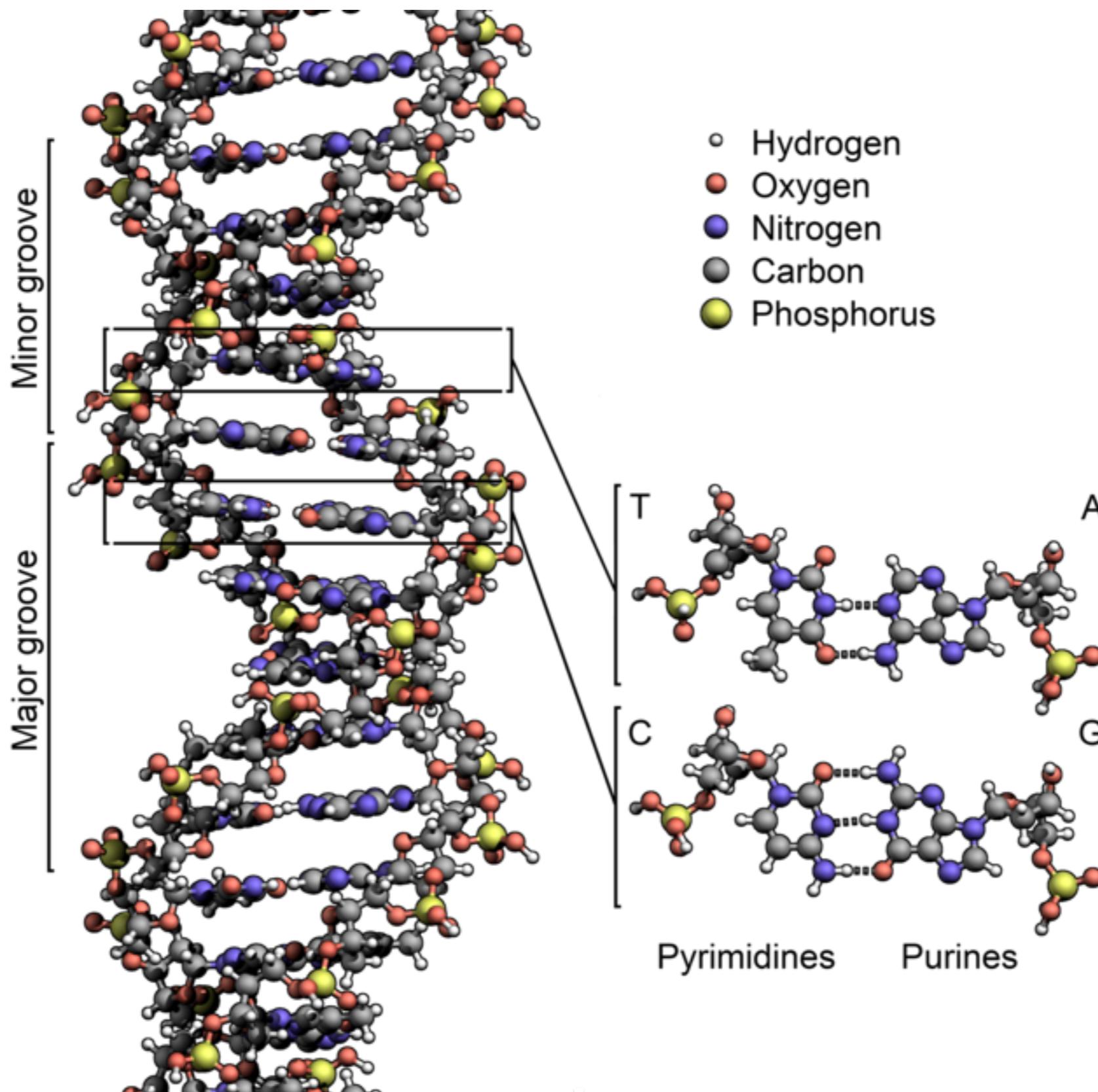
What's a cell made of:

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



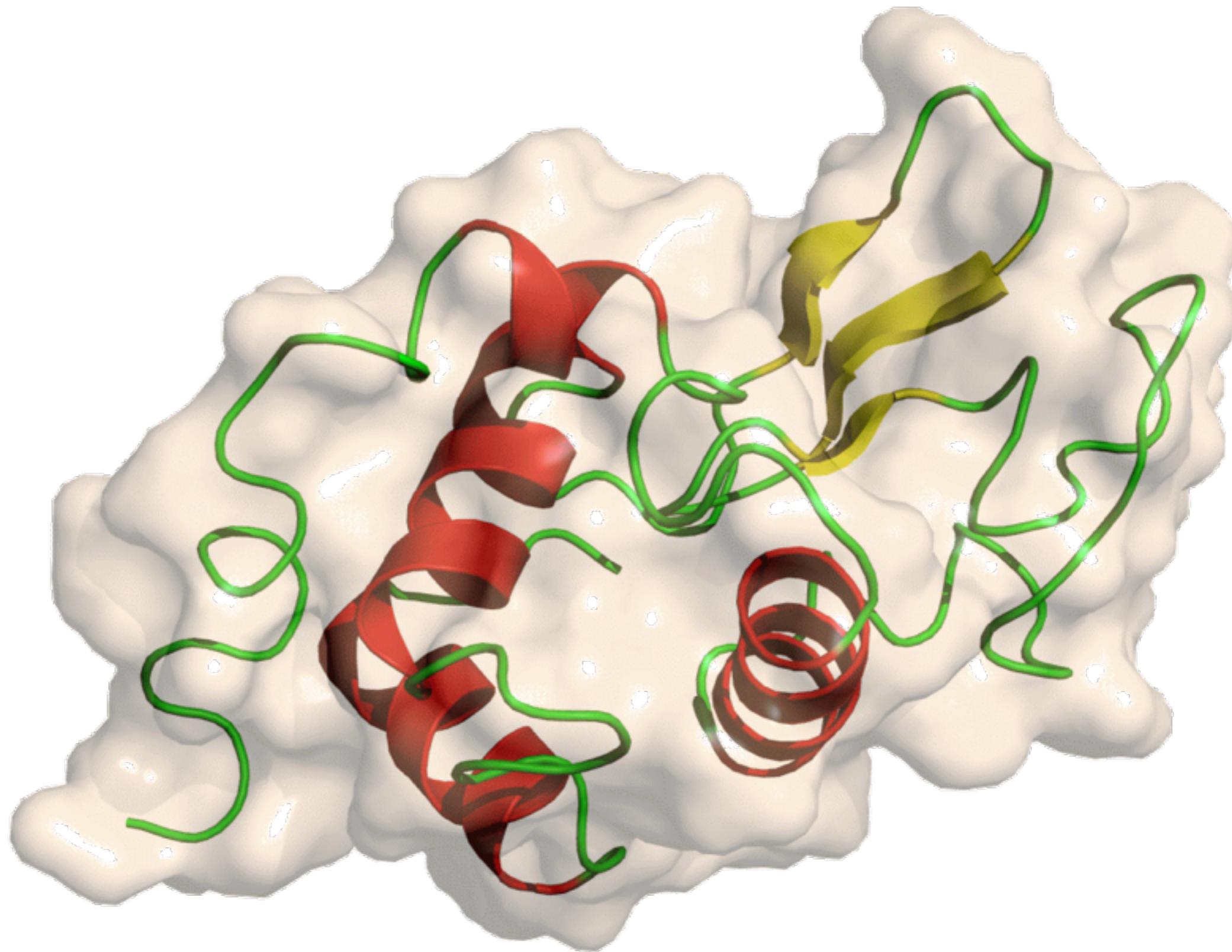


DNA Molecule



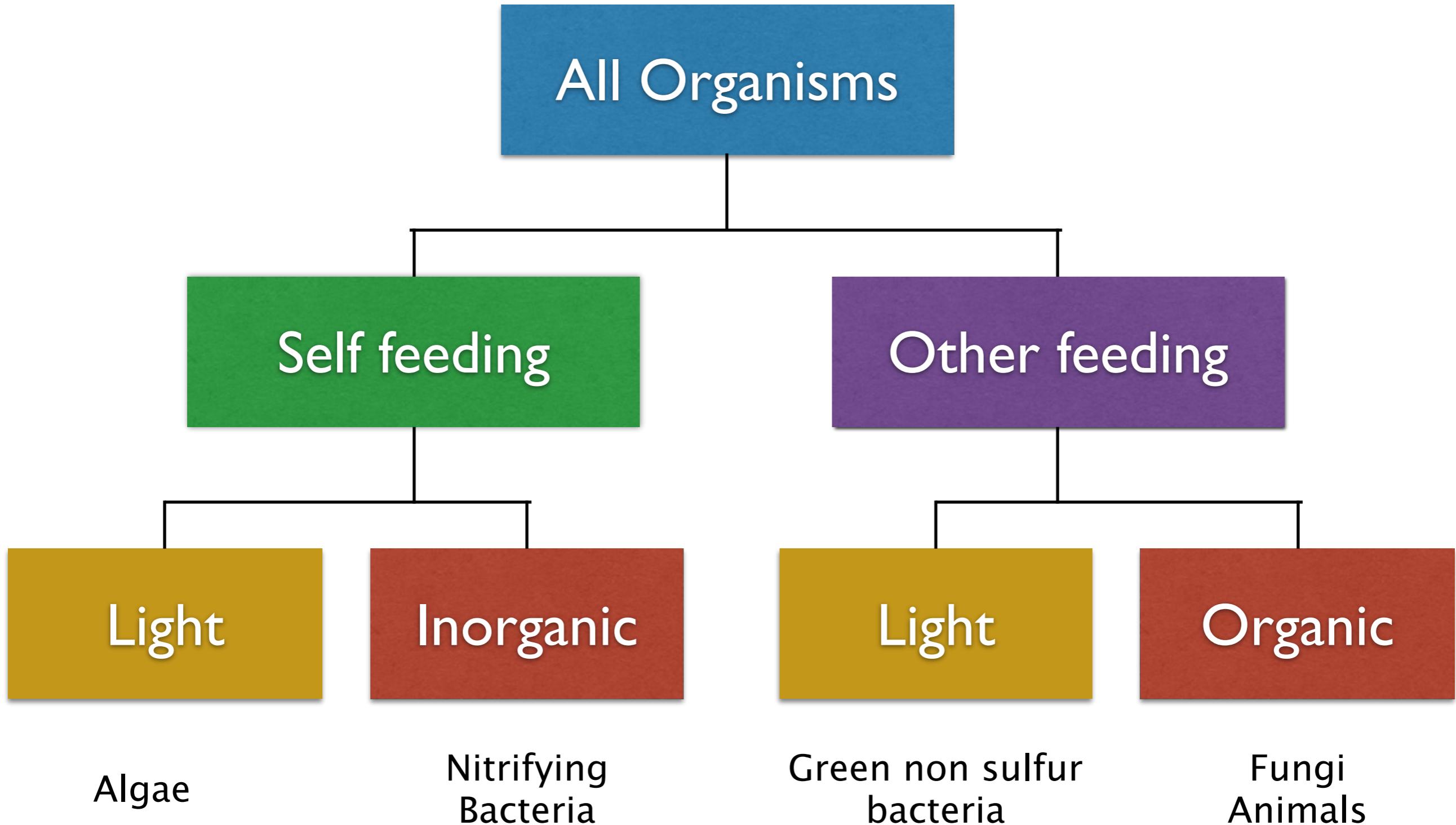


Lysozyme



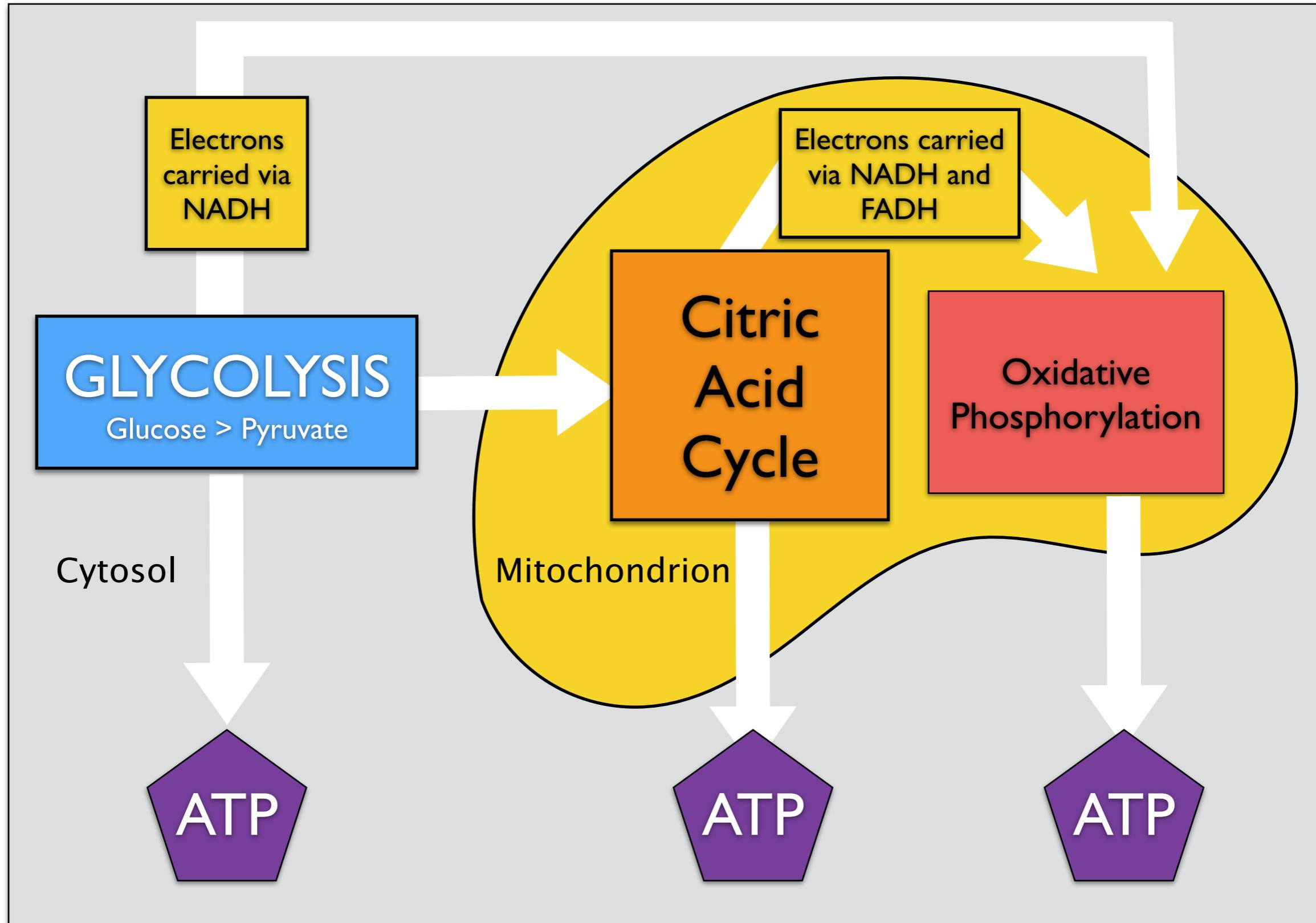


Diversity in Metabolism



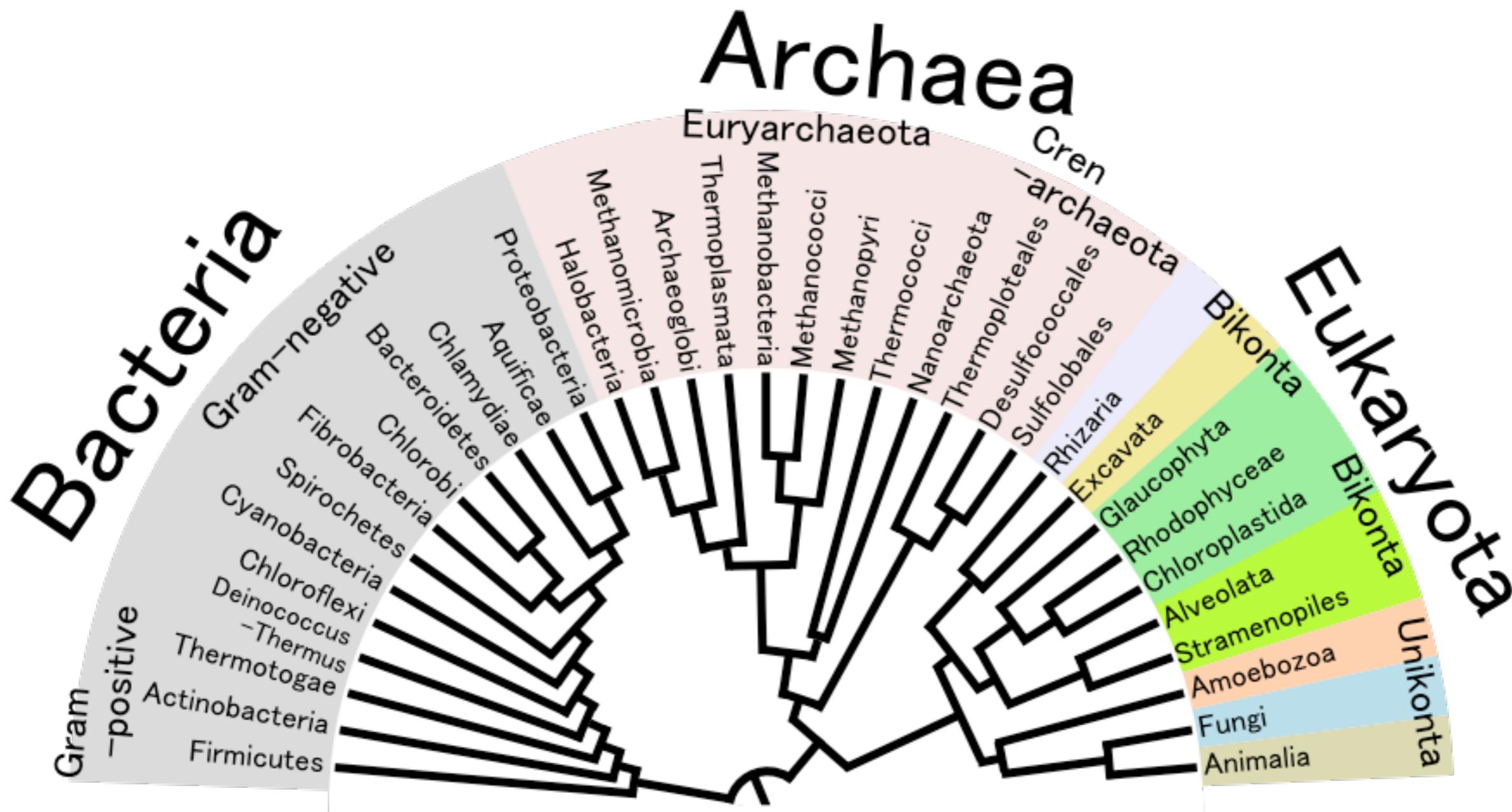


Respiration





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

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

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April 20-25 2015

CBS Symposium Week 2015

Genomics of Neglected Pathogens
Yeast 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

E.G. Simmons CBS Symposium

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

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

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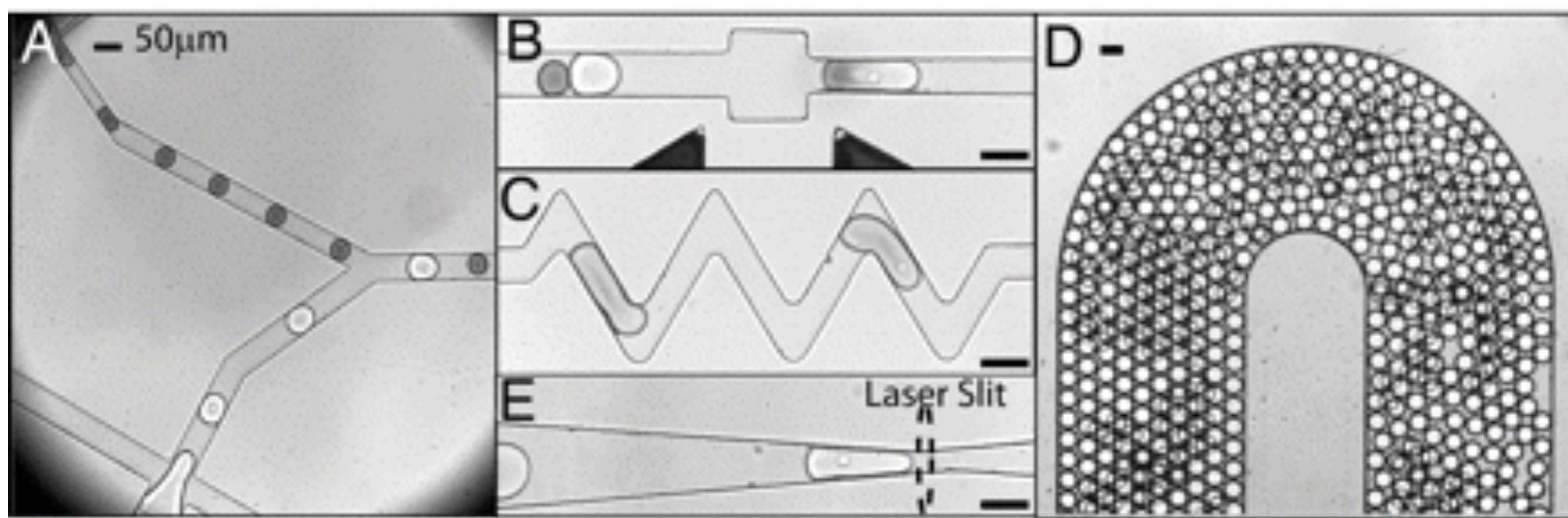
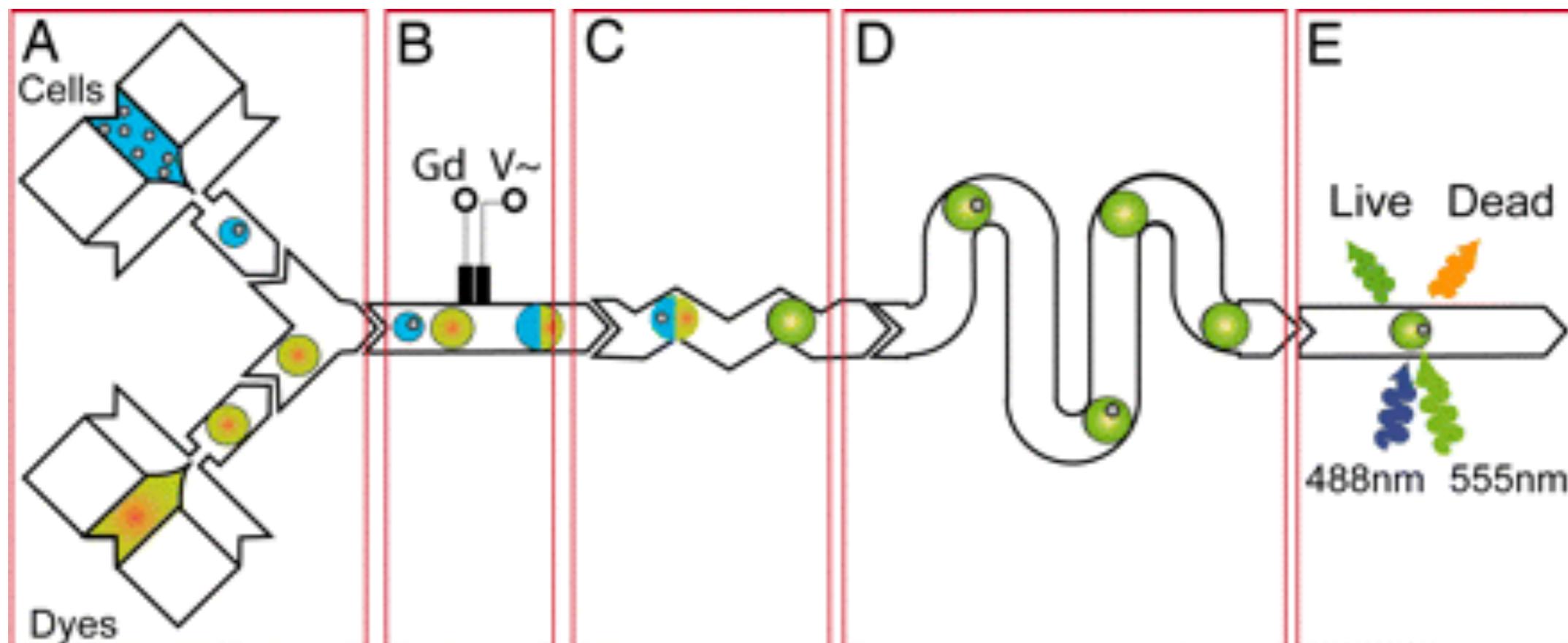
Immortalized Aortic Endothelial Cells
TeloHAEC for angiogenesis and... Learn More ▾

Males and Females CD34+ KIF5C from diverse ethnic groups



High Throughput Screening

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





Electrowetting

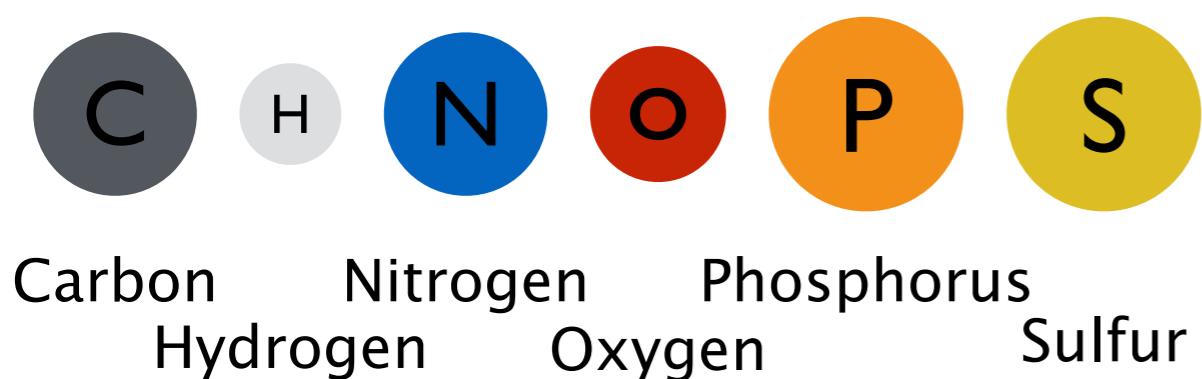
<https://www.youtube.com/watch?v=DJgvBoygmgk>



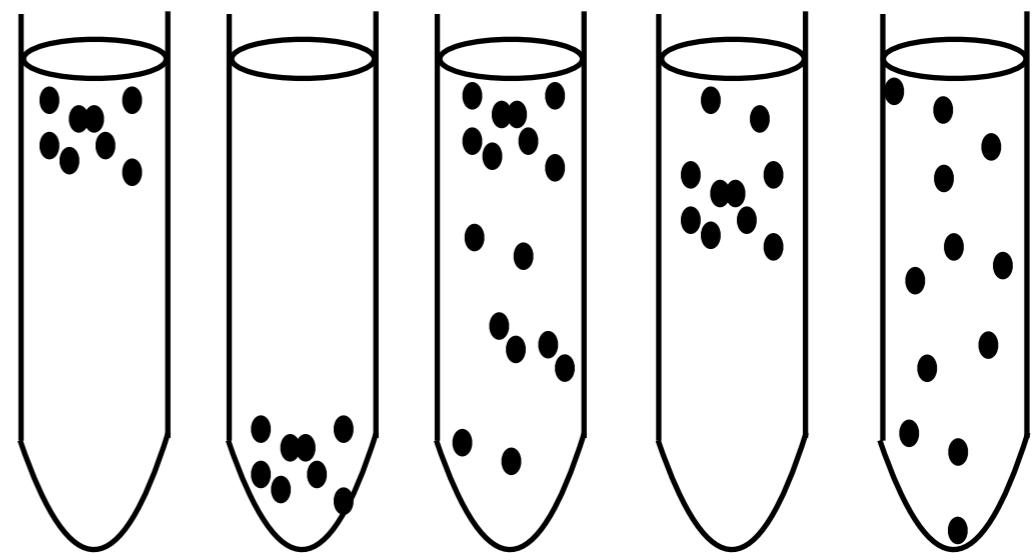


Diversity due to growth conditions

Nutrients



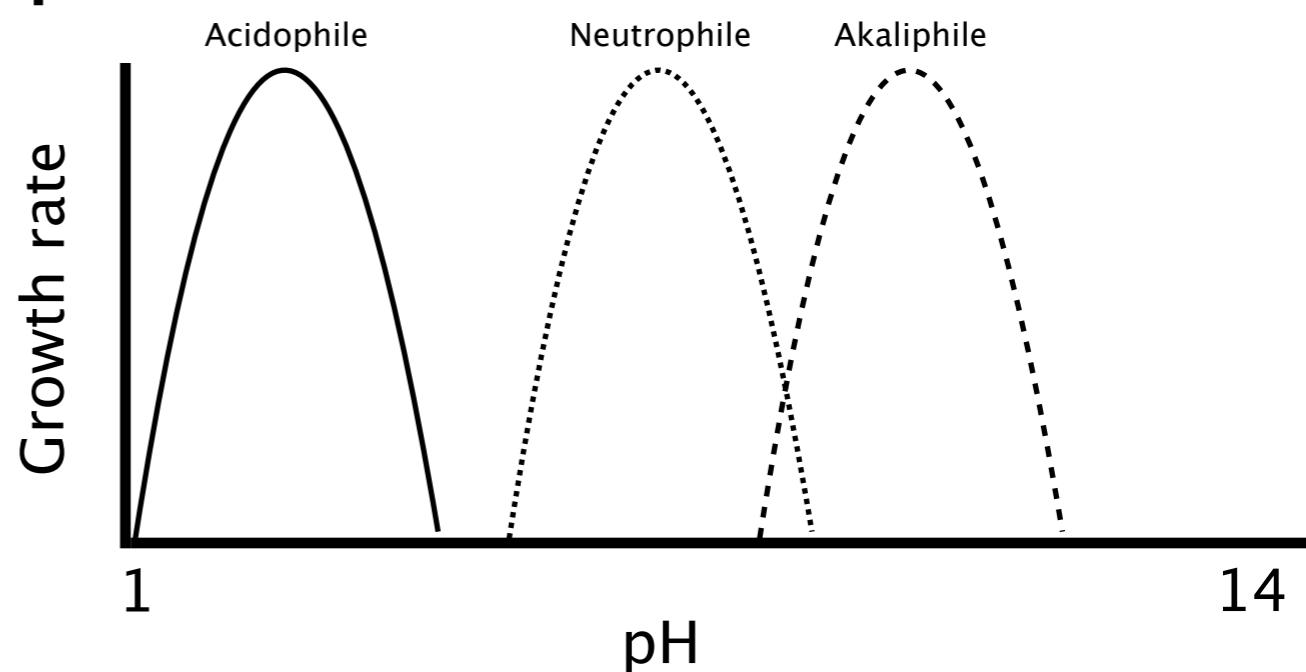
Atmosphere



Temperature

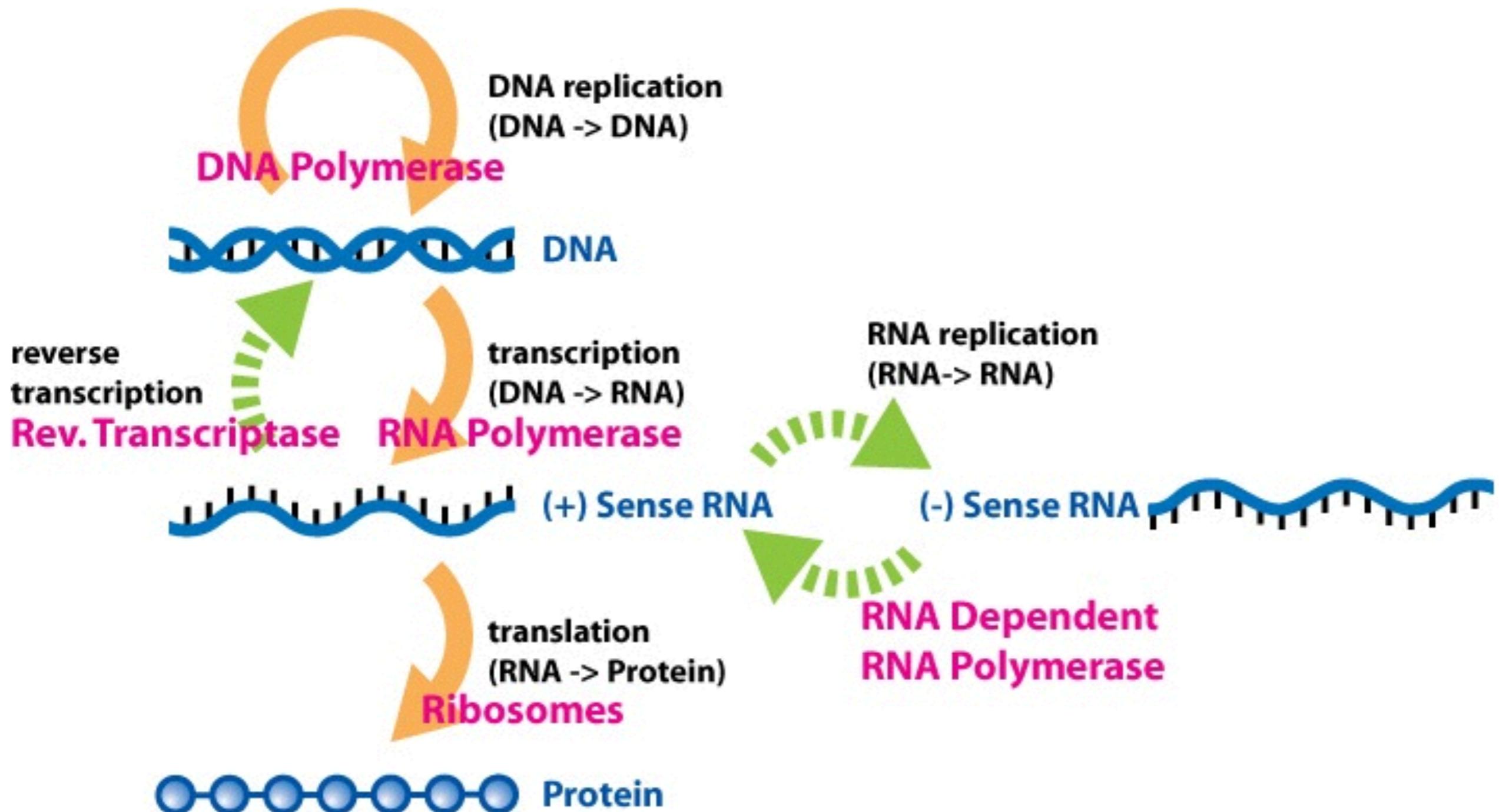


pH





Influencing gene expression



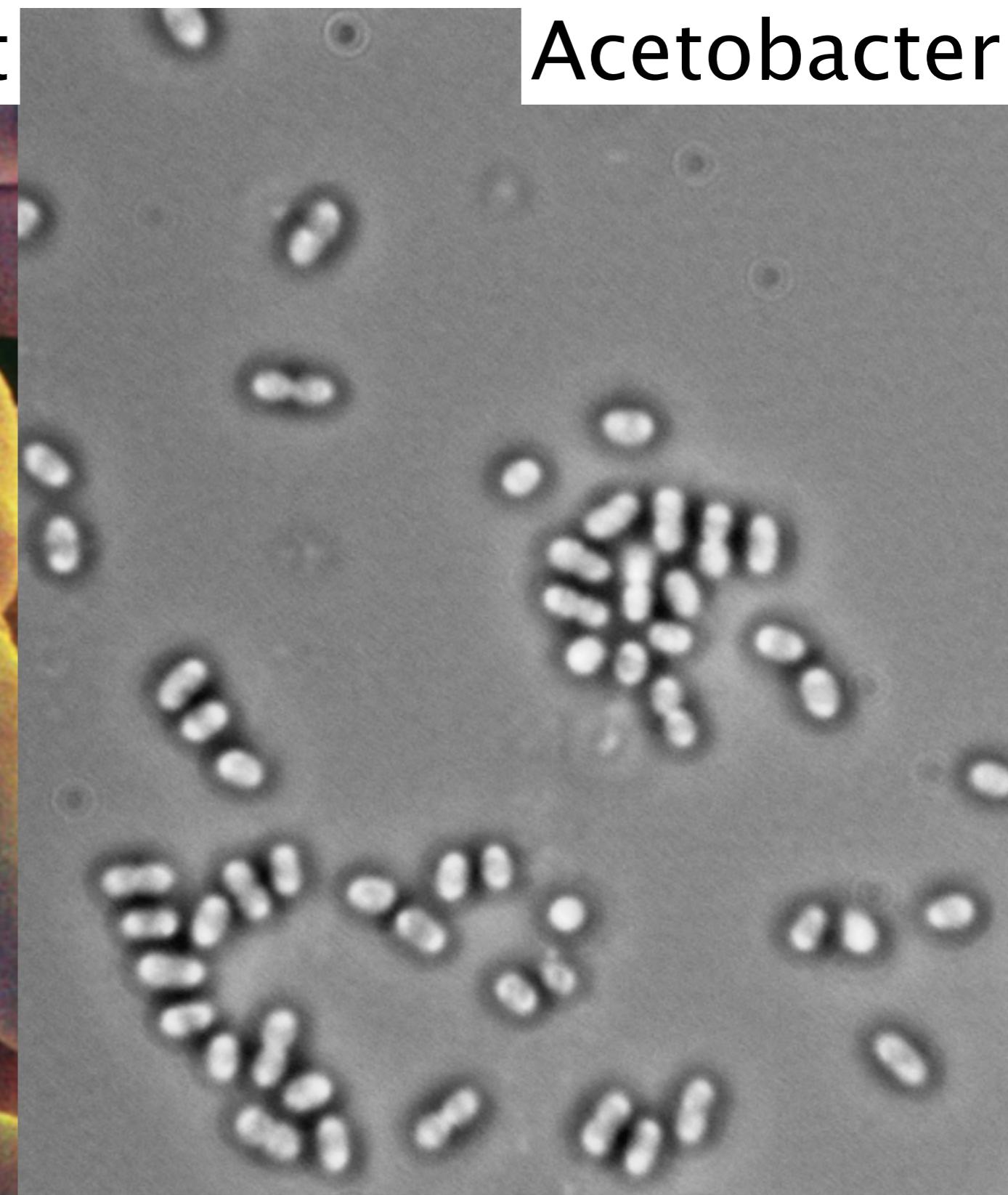
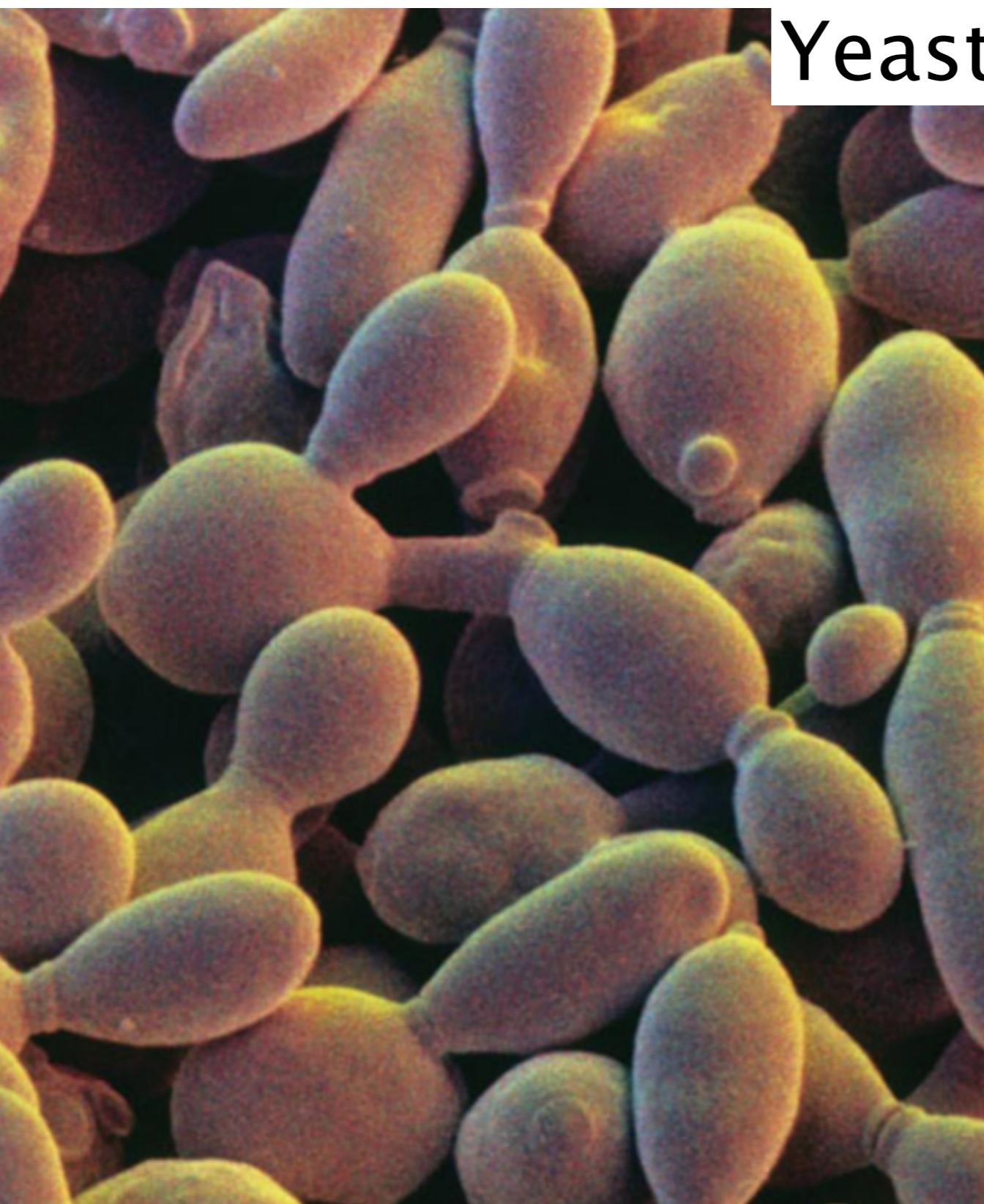


What we are looking for

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

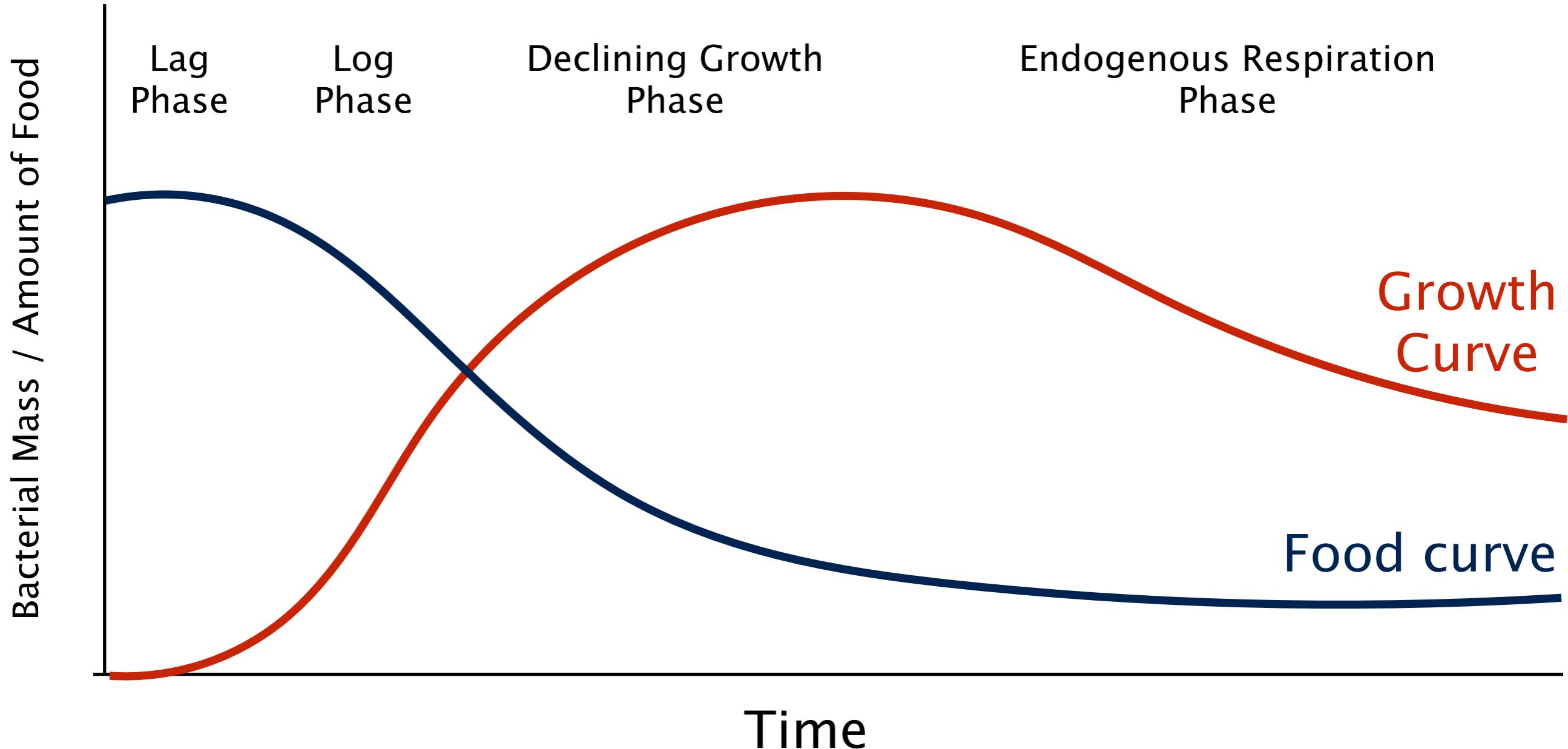


Natural talents



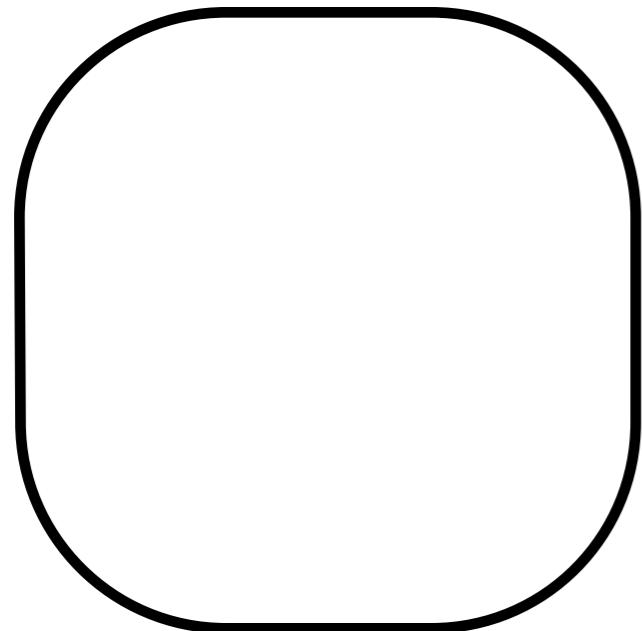


Bacterial growth curve – Batch

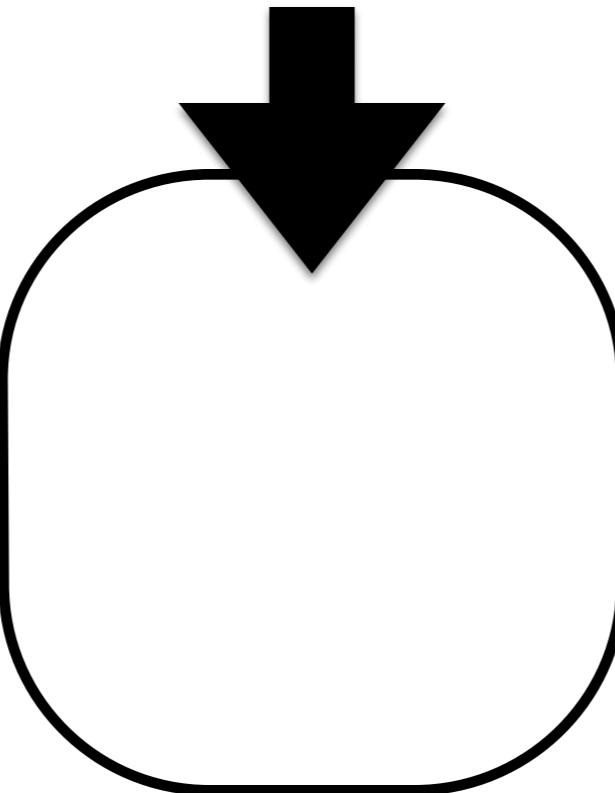




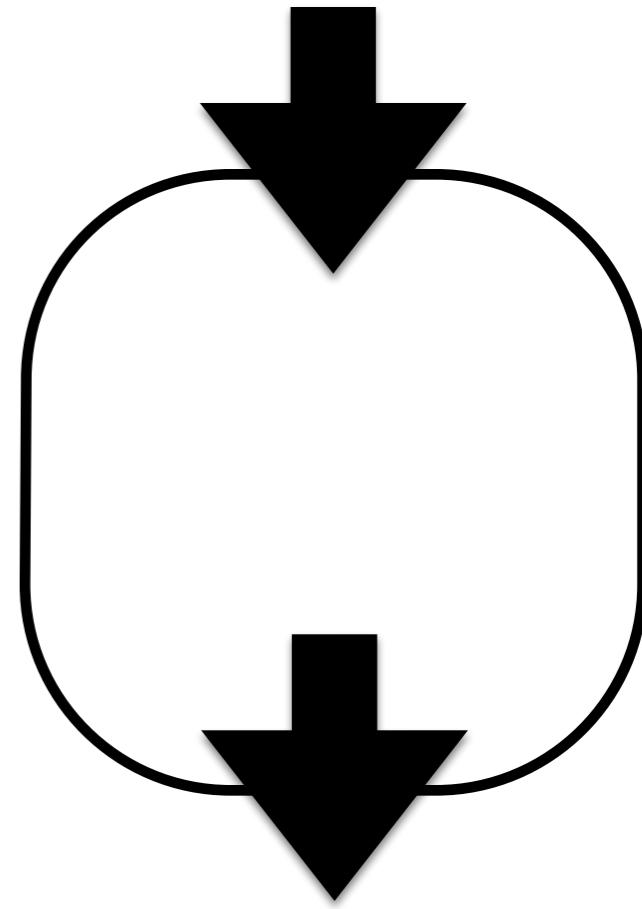
Growth strategies



Batch



Fed Batch



Chemosstat



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





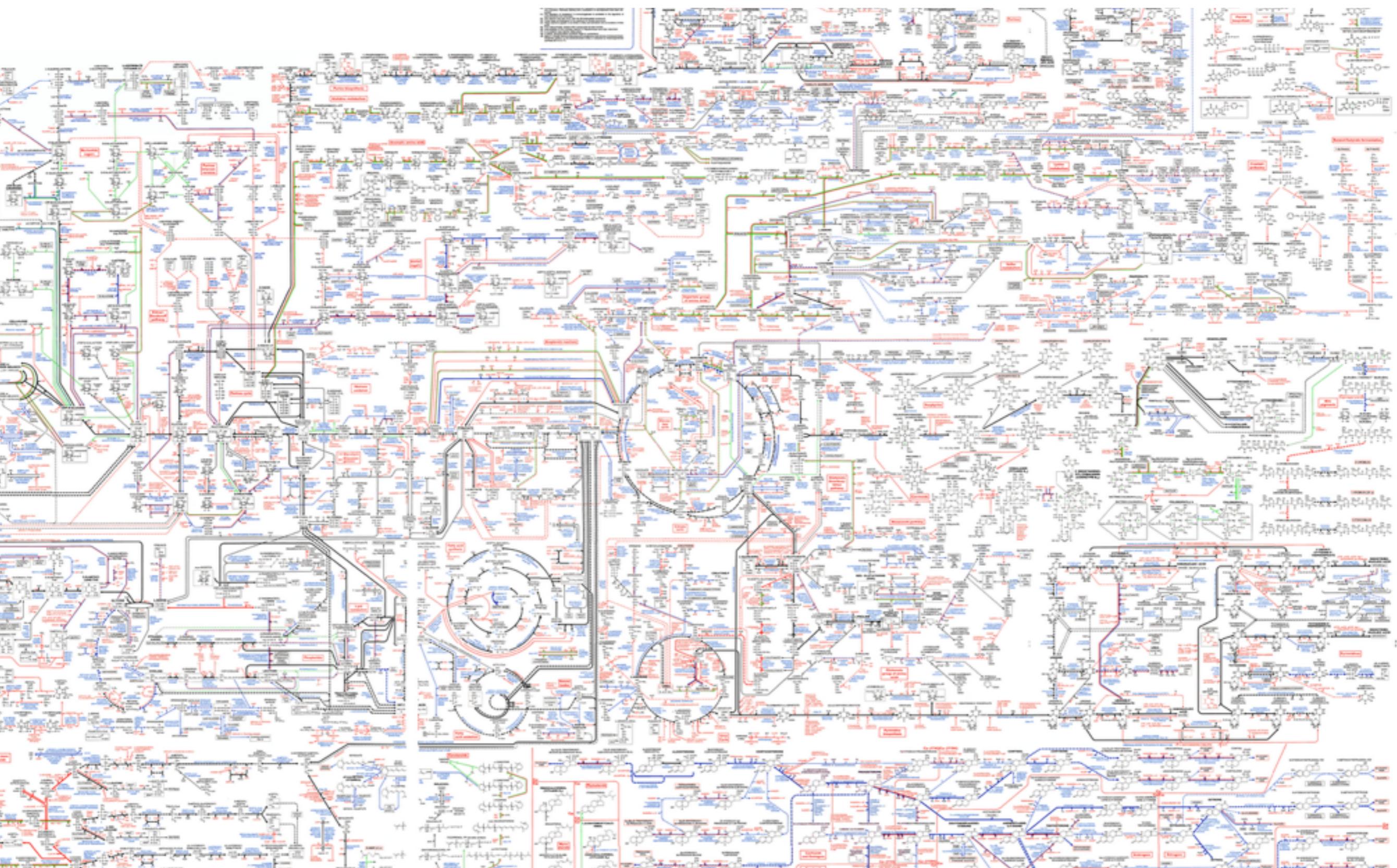
100 m³ reactor

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





Metabolic engineering





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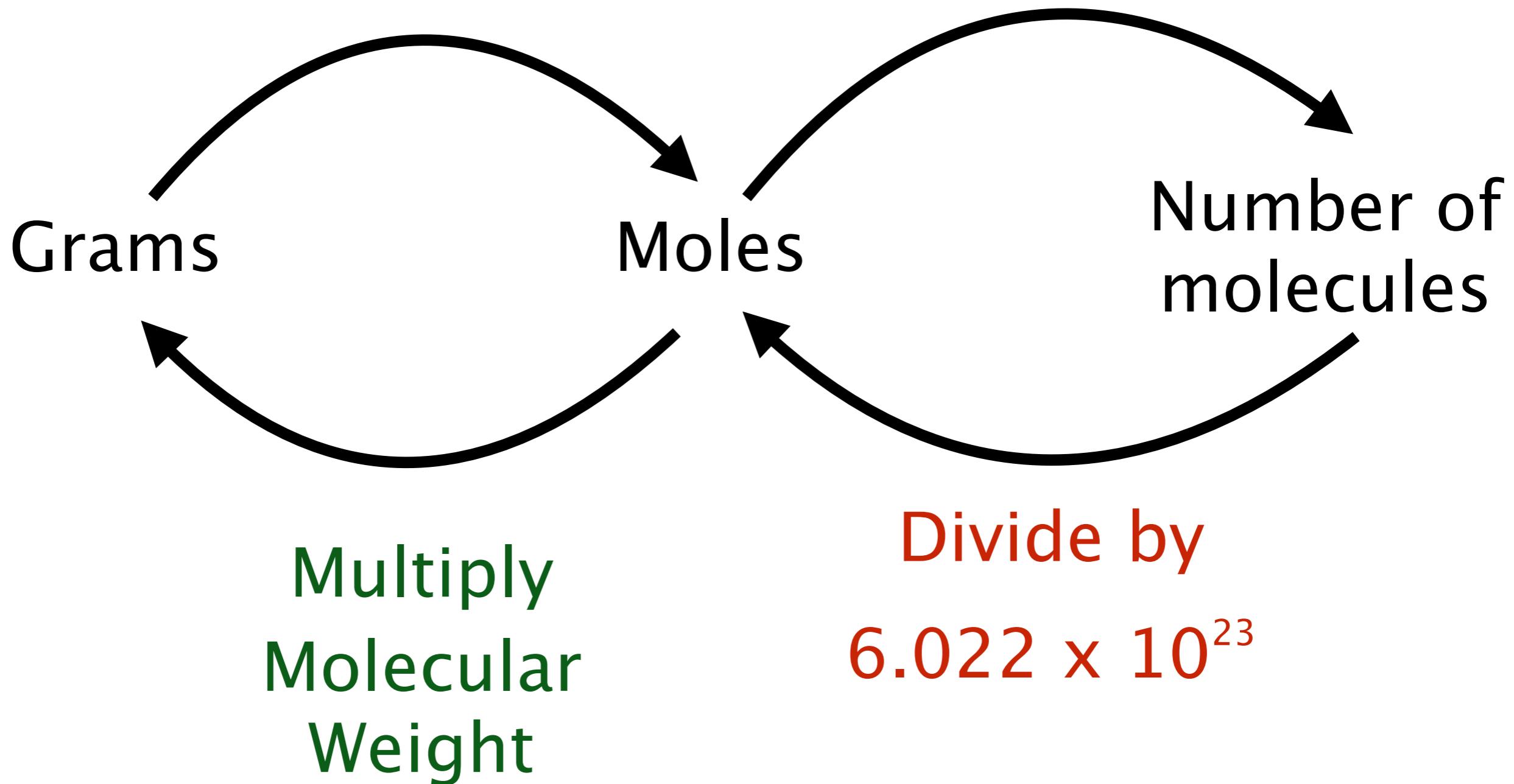
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Growth Stoichiometry



Divide by
Molecular
Weight

Multiply
 6.022×10^{23}

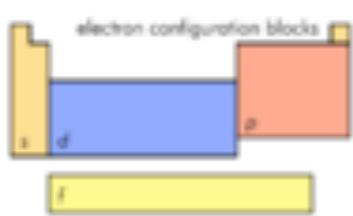




Finally, the real chemistry!

The Periodic Table of the Elements

group 1		The Periodic Table of the Elements																		group 18															
H	Hydrogen																			He	Helium														
1.00794 1.008	1																			4.002600 4.002600	2														
6.941 6.941	3	9.012182 9.012182	4																			20.1797 20.1797	10												
Li	Lithium	Be	Beryllium																			Ne	Neon												
22.98976 22.98976	11	24.3050 24.3050	12																			39.948 39.948	18												
Na	Sodium	Mg	Magnesium																			Ar	Argon												
39.0983 39.0983	19	40.078 40.078	20	44.95591 44.95591	21	47.867 47.867	22	50.9415 50.9415	23	51.9962 51.9962	24	54.93804 54.93804	25	55.845 55.845	26	58.93319 58.93319	27	58.6934 58.6934	28	63.545 63.545	29	65.38 65.38	30	69.723 69.723	31	72.64 72.64	32	74.92160 74.92160	33	78.96 78.96	34	79.904 79.904	35	83.798 83.798	36
K	Potassium	Ca	Calcium	Sc	Scandium	Ti	Titanium	V	Vanadium	Cr	Chromium	Mn	Manganese	Fe	Iron	Co	Cobalt	Ni	Nickel	Cu	Copper	Zn	Zinc	Ga	Gallium	Ge	Germanium	As	Arsenic	Se	Selenium	Br	Bromine	Kr	Krypton
85.4678 85.4678	37	87.62 87.62	38	88.90585 88.90585	39	91.224 91.224	40	92.90638 92.90638	41	95.96 95.96	42	98.07 98.07	43	101.07 101.07	44	102.9055 102.9055	45	106.42 106.42	46	107.8682 107.8682	47	112.441 112.441	48	114.818 114.818	49	118.710 118.710	50	121.760 121.760	51	127.60 127.60	52	126.9044 126.9044	53	131.293 131.293	54
Rb	Rubidium	Sr	Strontrium	Y	Yttrium	Zr	Zirconium	Nb	Niobium	Mo	Molybdenum	Tc	Technetium	Ru	Ruthenium	Rh	Rhodium	Pd	Palladium	Ag	Silver	Cd	Cadmium	In	Indium	Sn	Tin	Sb	Antimony	Te	Tellurium	I	Iodine	Xe	Xenon
132.9054 132.9054	55	137.327 137.327	56	134.9668 134.9668	71	138.49 138.49	72	140.9478 140.9478	73	143.84 143.84	74	146.207 146.207	75	149.23 149.23	76	149.217 149.217	77	149.084 149.084	78	149.665 149.665	79	150.59 150.59	80	154.3833 154.3833	81	157.2 157.2	82	160.9804 160.9804	83	(210) (210)	84	(210) (210)	85	(220) (220)	86
Cs	Ceasium	Ba	Boron	Lu	Lanthanum	Hf	Hafnium	Ta	Tantalum	W	Tungsten	Re	Rhenium	Os	Osmium	Ir	Iridium	Pt	Platinum	Au	Gold	Hg	Mercury	Tl	Thallium	Pb	Lead	Bi	Bismuth	Po	Polonium	At	Astatine	Rn	Radon
(223) (223)	87	(226) (226)	88	(261) (261)	103	(262) (262)	104	(266) (266)	105	(264) (264)	106	(277) (277)	107	(268) (268)	108	(271) (271)	109	(272) (272)	110	(273) (273)	111	(285) (285)	112	(284) (284)	113	(289) (289)	114	(288) (288)	115	(292) (292)	116	117	(294) (294)	118	
Fr	Francium	Ra	Radium	Lr	Lawrencium	Rf	Rutherfordium	Db	Dubnium	Sg	Seaborgium	Bh	Bohrium	Hs	Hassium	Mt	Melmerium	Ds	Darmstadtium	Rg	Roentgenium	Cn	Copernicum	Uut	Ununtrium	Uup	Ununquadium	Uuh	Ununhexium	Uus	Ununoctium	Uuo	Ununoctium		



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 57 138.1 1.30	140.116 58 140.6 1.32	140.9076 59 140.7 1.32	144.242 60 144.1 1.34	(145) 61 145.0	150.36 62 150.3 1.37	151.984 63 151.9 1.39	157.25 64 157.1 1.39	158.9253 65 158.9 1.39	162.500 66 162.0 1.39	164.9303 67 164.9 1.39	167.259 68 167.2 1.39	168.9342 69 168.7 1.39	173.054 70 173.0 1.39
La Lanthanum (6s 4f 5d 6s)	Ce Cerium (6s 4f 5d 6s)	Pr Praseodymium (6s 4f 5d 6s)	Nd Neodymium (6s 4f 5d 6s)	Pm Promethium (6s 4f 5d 6s)	Sm Samarium (6s 4f 5d 6s)	Eu Europium (6s 4f 5d 6s)	Gd Gadolinium (6s 4f 5d 6s)	Tb Terbium (6s 4f 5d 6s)	Dy Dysprosium (6s 4f 5d 6s)	Ho Holmium (6s 4f 5d 6s)	Er Erbium (6s 4f 5d 6s)	Tm Thulium (6s 4f 5d 6s)	Yb Ytterbium (6s 4f 5d 6s)
(227) 89 499.0 1.39	232.0380 90 387.0 1.39	231.0358 91 348.0 1.39	238.0289 92 317.0 1.39	(237) 93 404.0 1.39	(244) 94 384.7 1.39	(243) 95 378.0 1.39	(247) 96 381.0 1.39	(247) 97 403.0 1.39	(251) 98 411.0 1.39	(252) 99 427.0 1.39	(257) 100 427.0 1.39	(258) 101 425.0 1.39	(259) 102 442.0 1.39
Ac Actinium (6s 4f 5d 6p)	Th Thorium (6s 4f 5d 7s)	Pa Protactinium (6s 4f 5d 7p)	U Uranium (6s 4f 5d 8p)	Np Neptunium (6s 4f 5d 8p)	Pu Plutonium (6s 4f 5d 8p)	Am Americium (6s 4f 5d 8p)	Cm Curium (6s 4f 5d 8p)	Bk Berkelium (6s 4f 5d 8p)	Cf Californium (6s 4f 5d 8p)	Es Einsteinium (6s 4f 5d 8p)	Fm Fermium (6s 4f 5d 8p)	Md Mendelevium (6s 4f 5d 8p)	No Nobelium (6s 4f 5d 8p)



Molecular Weight of Water

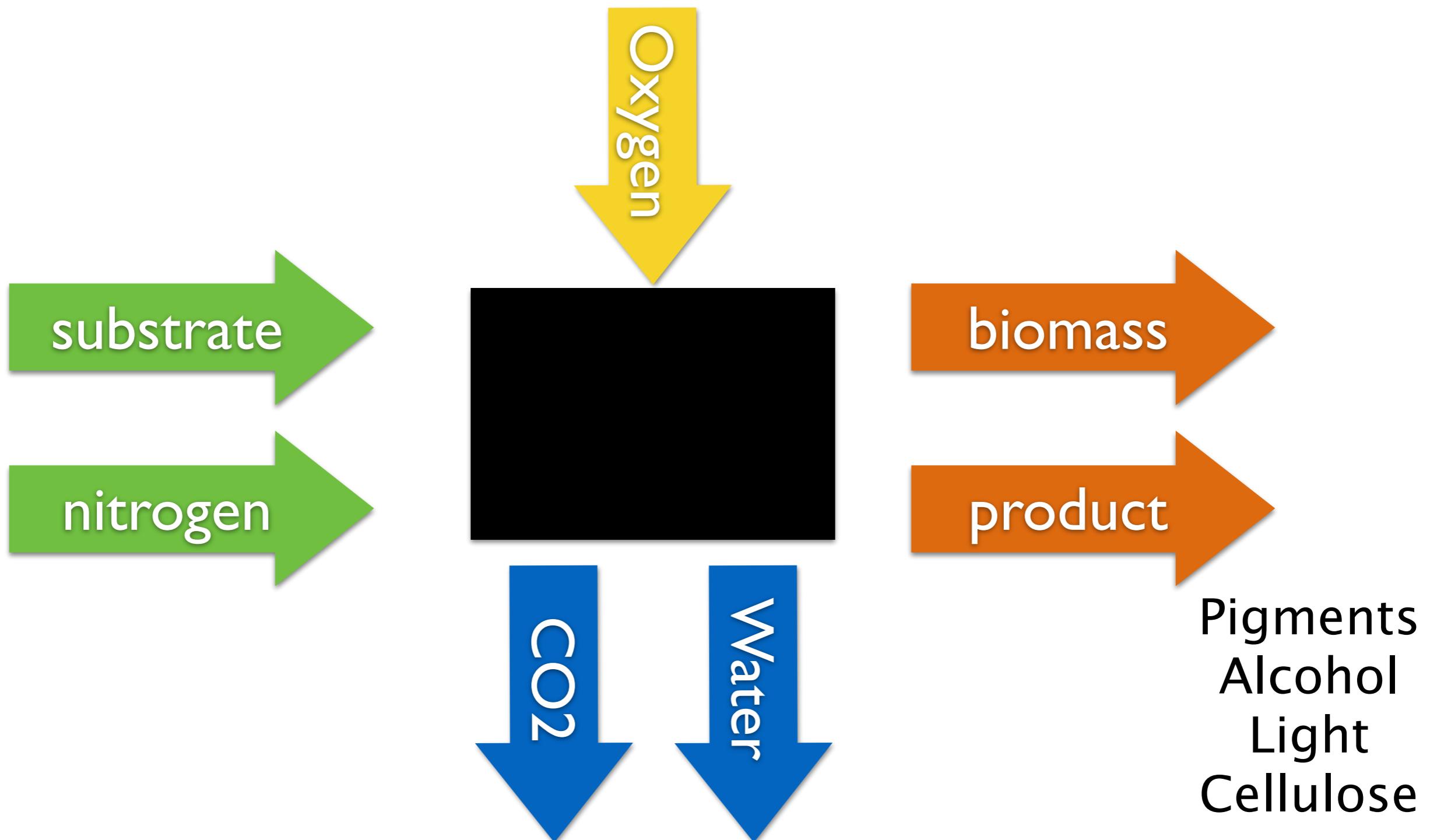
Atom	Number in molecule	Atomic Weight	Total Mass
H	2	1	2
O	1	16	16

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

->

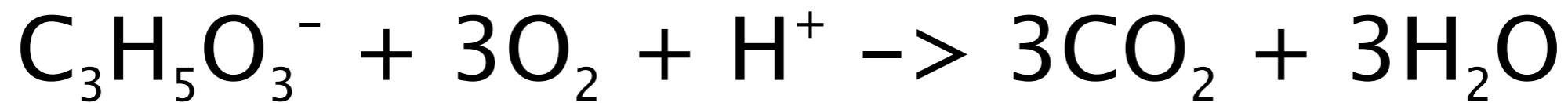
BIOMASS + 18.15 ADP + 18.15
phosphate

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



some
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