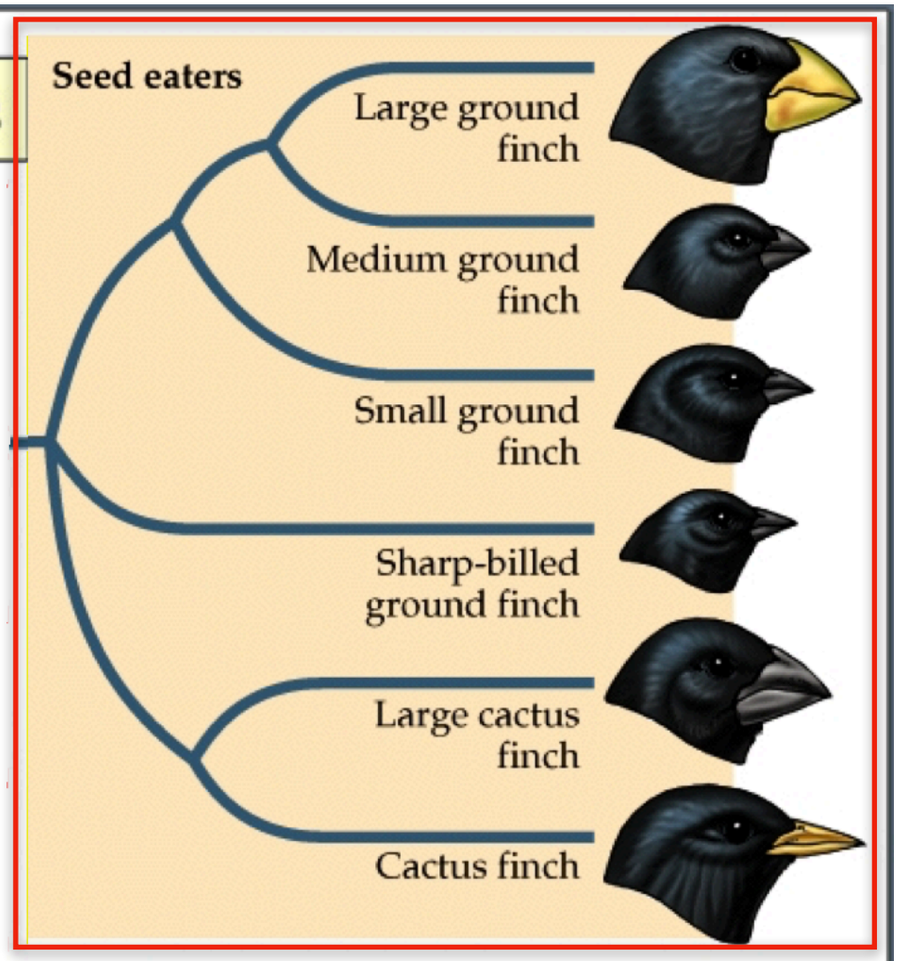
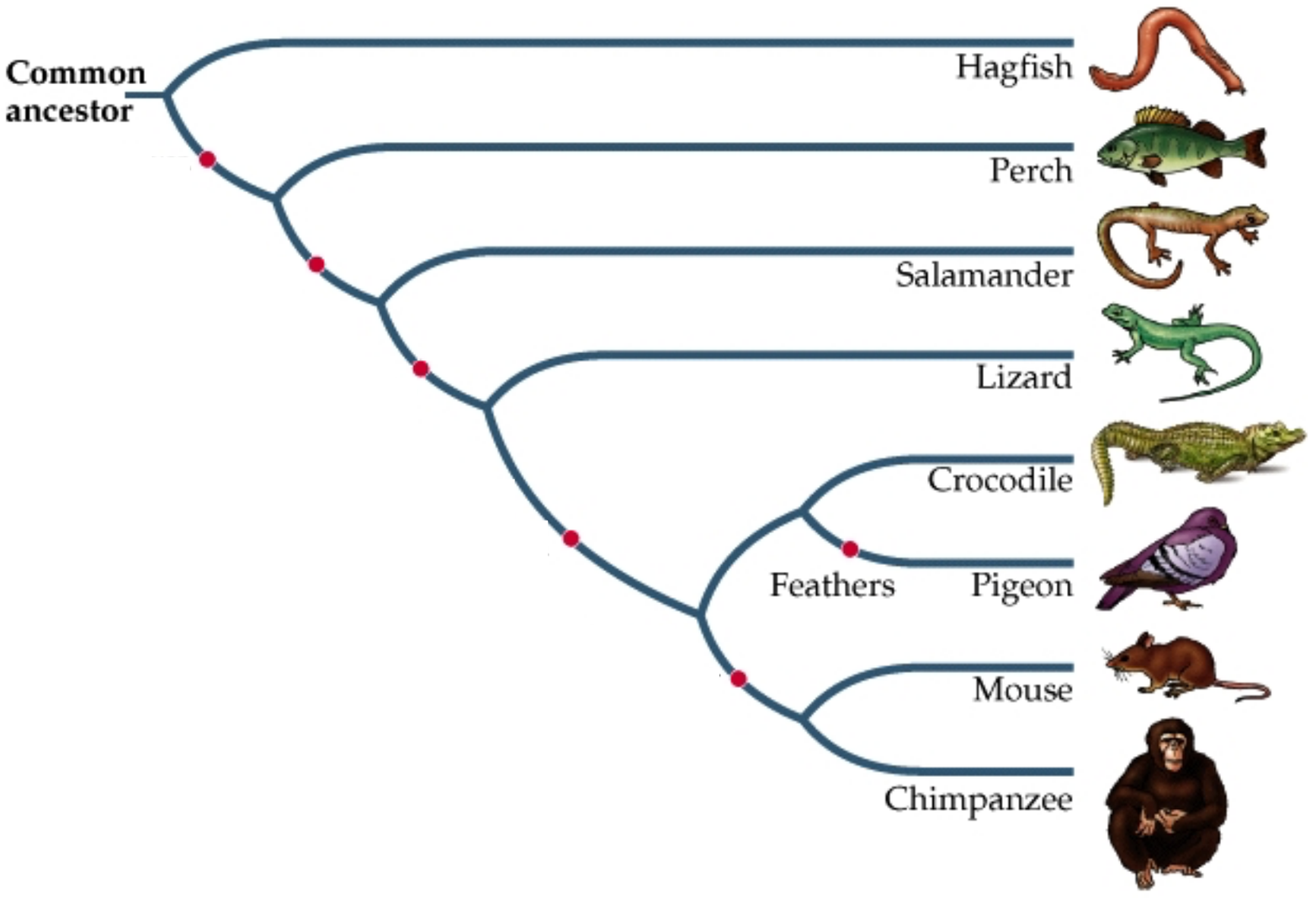
BIOL2107, Fall ’23

Lecture 7

Allopatric speciation: Darwin's finches

ANCESTOR FINCH from South American mainland: Blue-black grassquit




Common ancestor
Hagfish
Perch
Salamander
Lizard
Crocodile
Feathers
Pigeon
Mouse
Chimpanzee

23.1 Eight Vertebrates Ordered According to Unique Shared Derived Traits

TAXON	DERIVED TRAIT[a] JAWS	LUNGS	CLAWS OR NAILS	FEATHERS	FUR	MAMMARY GLANDS	FOUR-CHAMBERED HEART
Hagfish	–	–	–	–	–	–	–
Perch	+	–	–	–	–	–	–
Salamander	+	+	–	–	–	–	–
Lizard	+	+	+	–	–	–	–
Crocodile	+	+	+	–	–	–	+
Pigeon	+	+	+	+	–	–	+
Mouse	+	+	+	–	+	+	+
Chimpanzee	+	+	+	–	+	+	+

[a]A plus sign indicates the trait is present, a minus sign that it is absent.

"Operational Taxonomic Unit"… OTU

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Perch	+	–	–	–	–	–	–
Salamander	+	+	–	–	–	–	–
Lizard	+	+	+	–	–	–	–
Crocodile	+	+	+	–	–	–	+
Pigeon	+	+	+	+	–	–	+
Mouse	+	+	+	–	+	+	+
Chimpanzee	+	+	+	–	+	+	+

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Lizard	+	+	+	–	–	–	–
Crocodile	+	+	+	–	–	–	+
Pigeon	+	+	+	+	–	–	+
Mouse	+	+	+	–	+	+	+
Chimpanzee	+	+	+	–	+	+	+

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Lizard	+	+	+	–	–	–	–
Crocodile	+	+	+	–	–	–	+
Pigeon	+	+	+	+	–	–	+
Mouse	+	+	+	–	+	+	+
Chimpanzee	+	+	+	–	+	+	+

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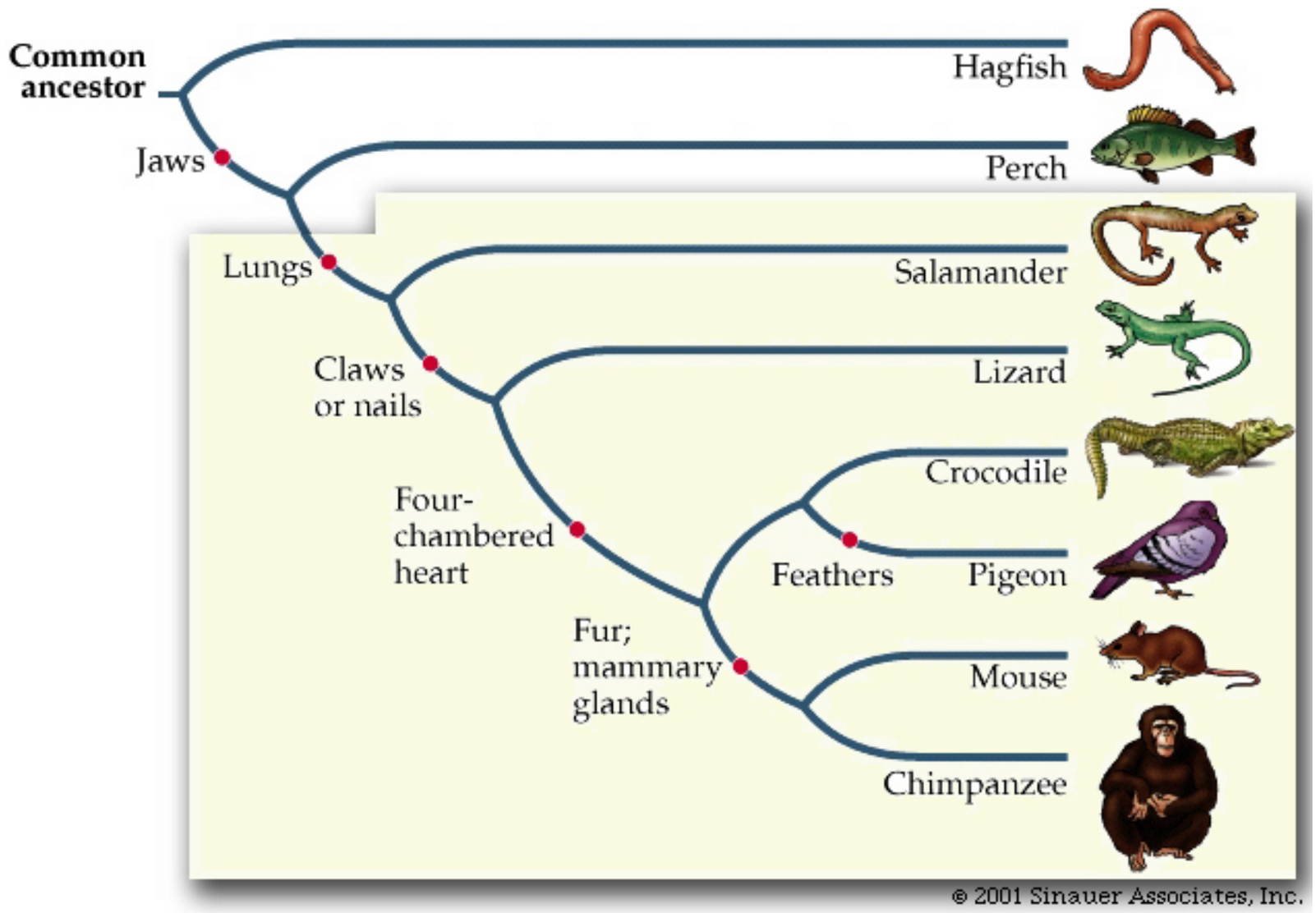
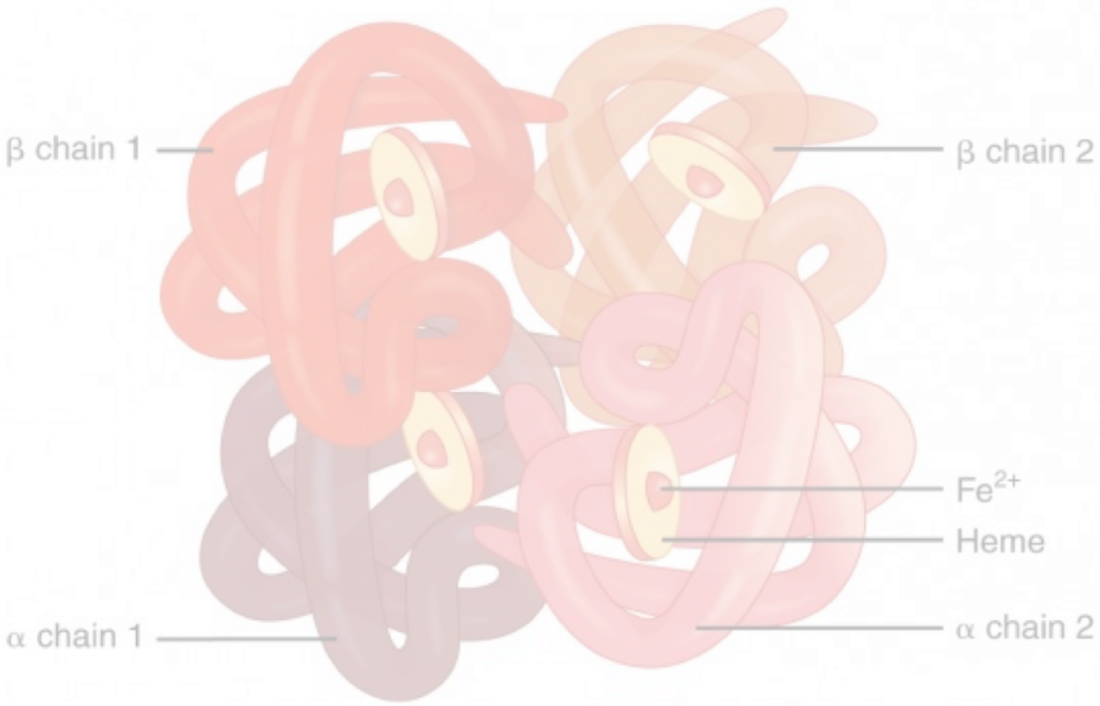
"Operational Taxonomic Unit"… OTU

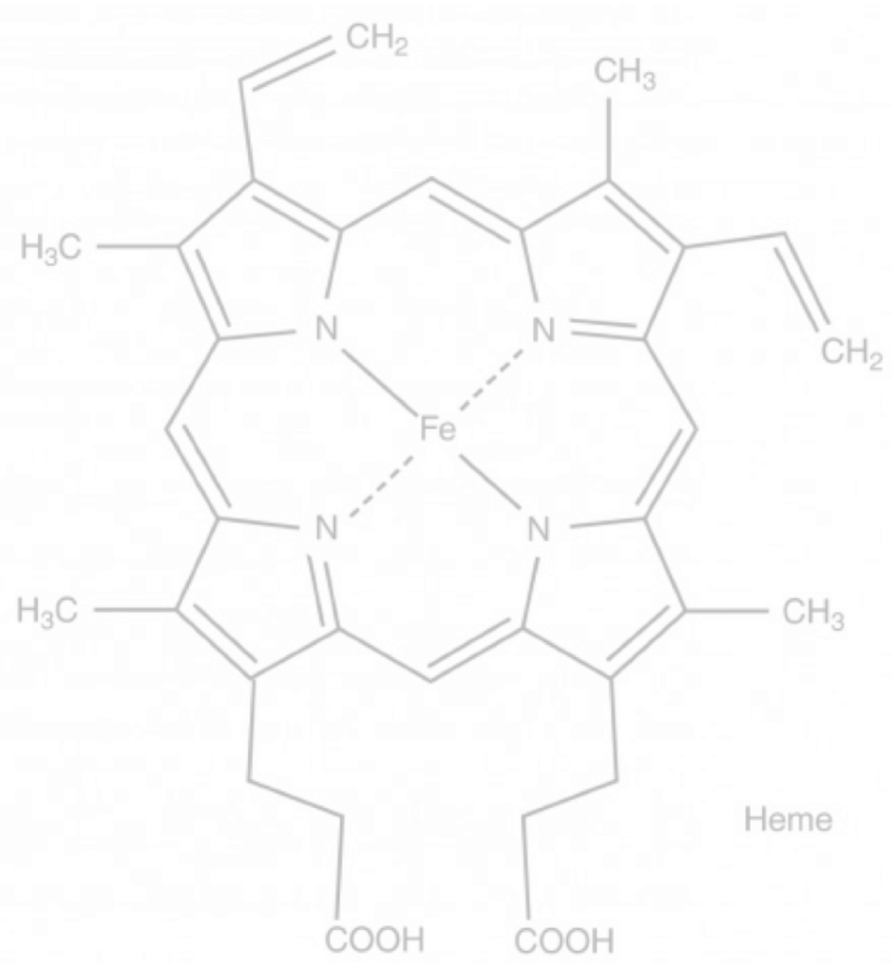


"Operational Taxonomic Unit"… OTU

“Operational Taxonomic Unit”… OTU



(a)



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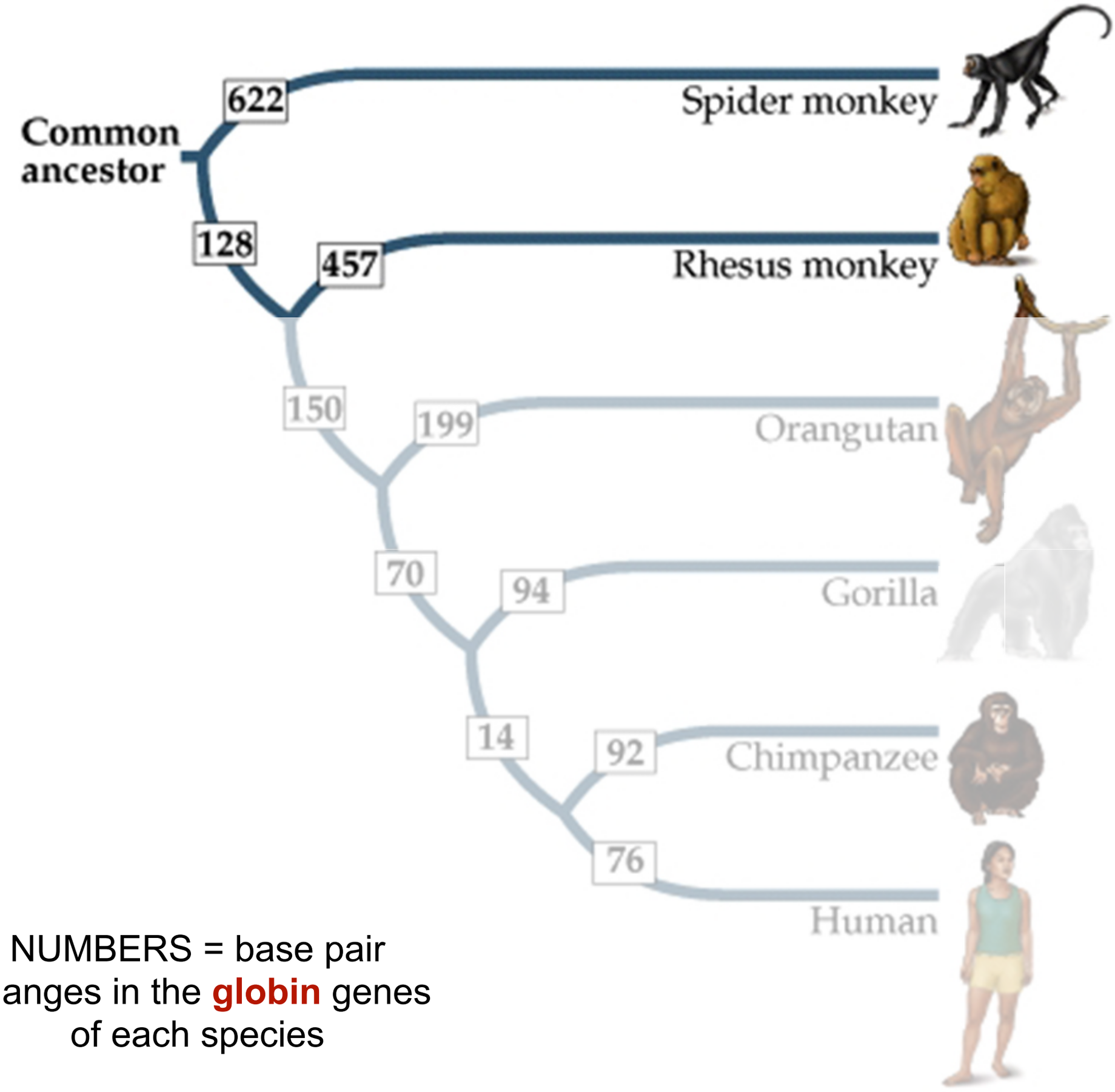
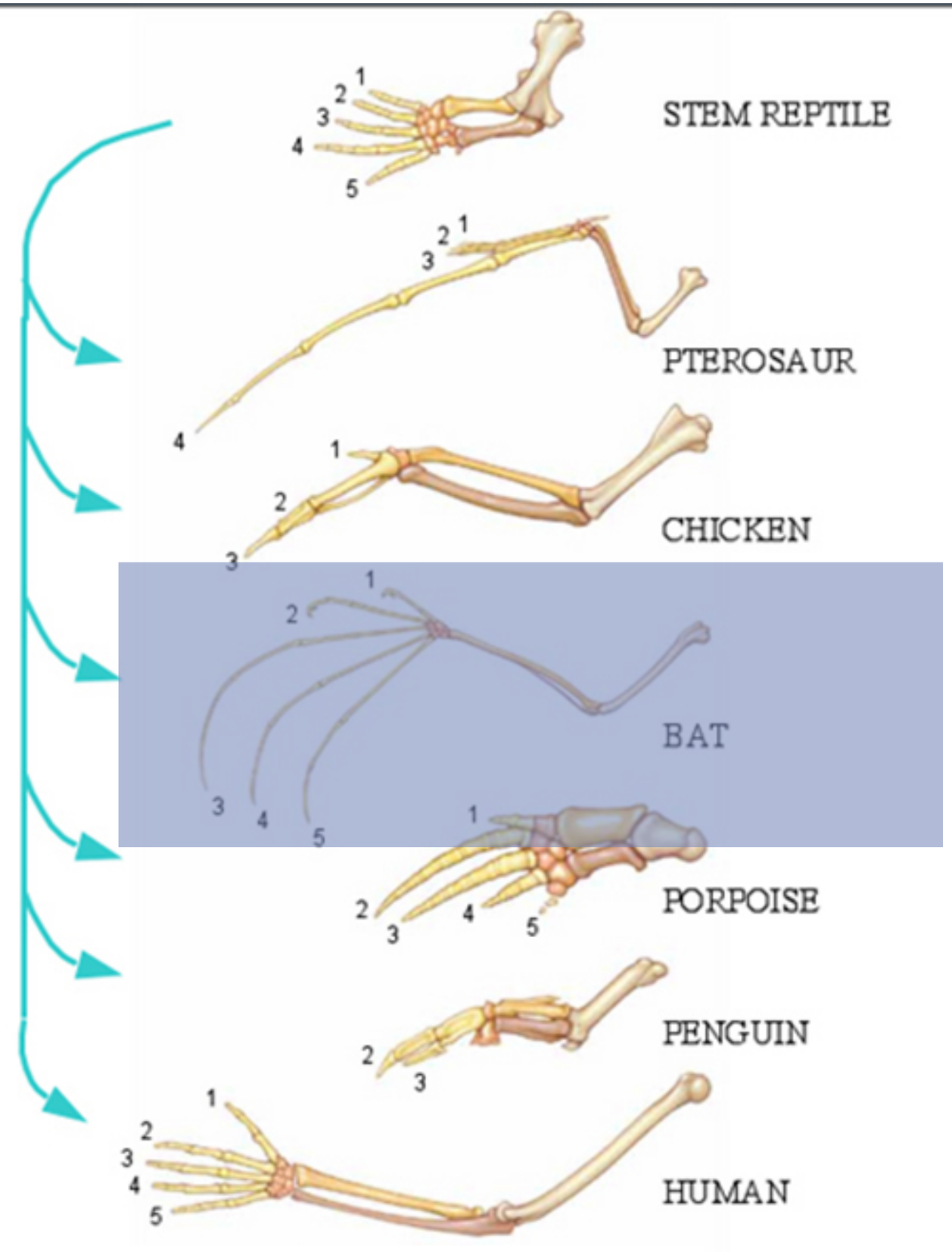
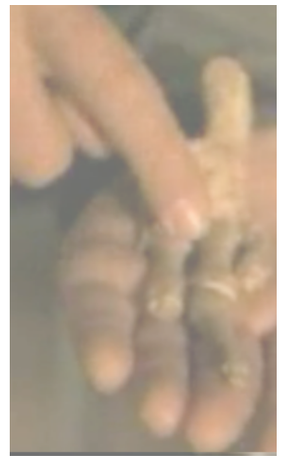


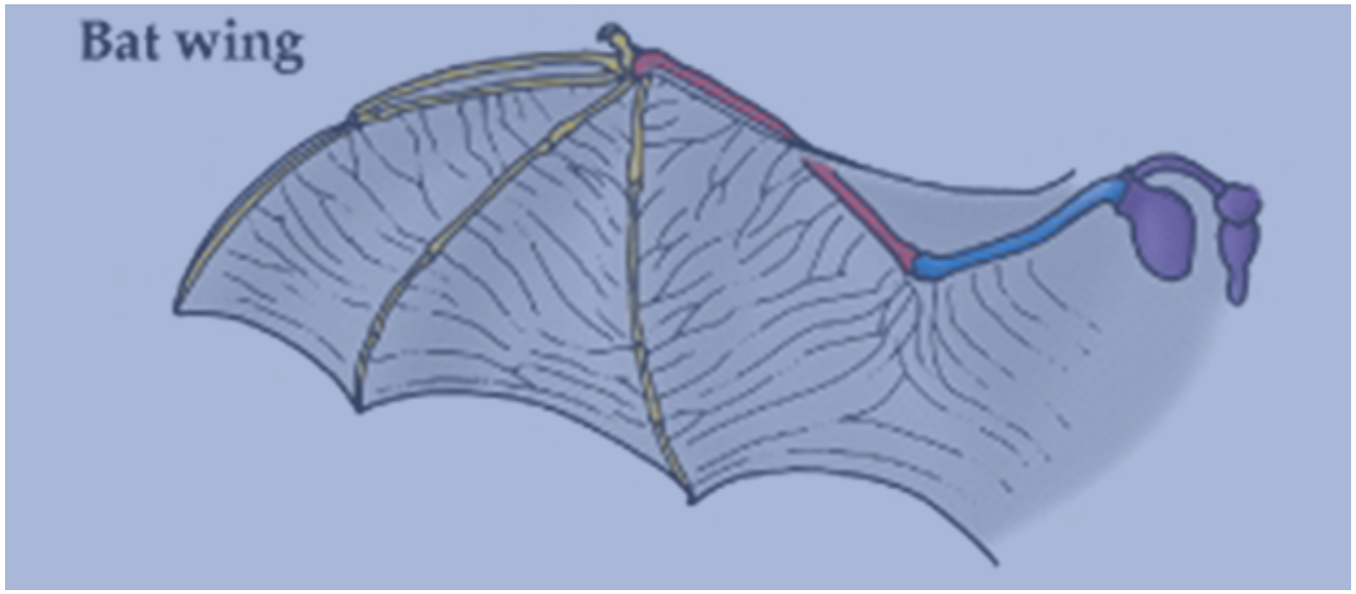
NUMBERS = base pair changes in the **globin** genes of each species

Fossil Records…

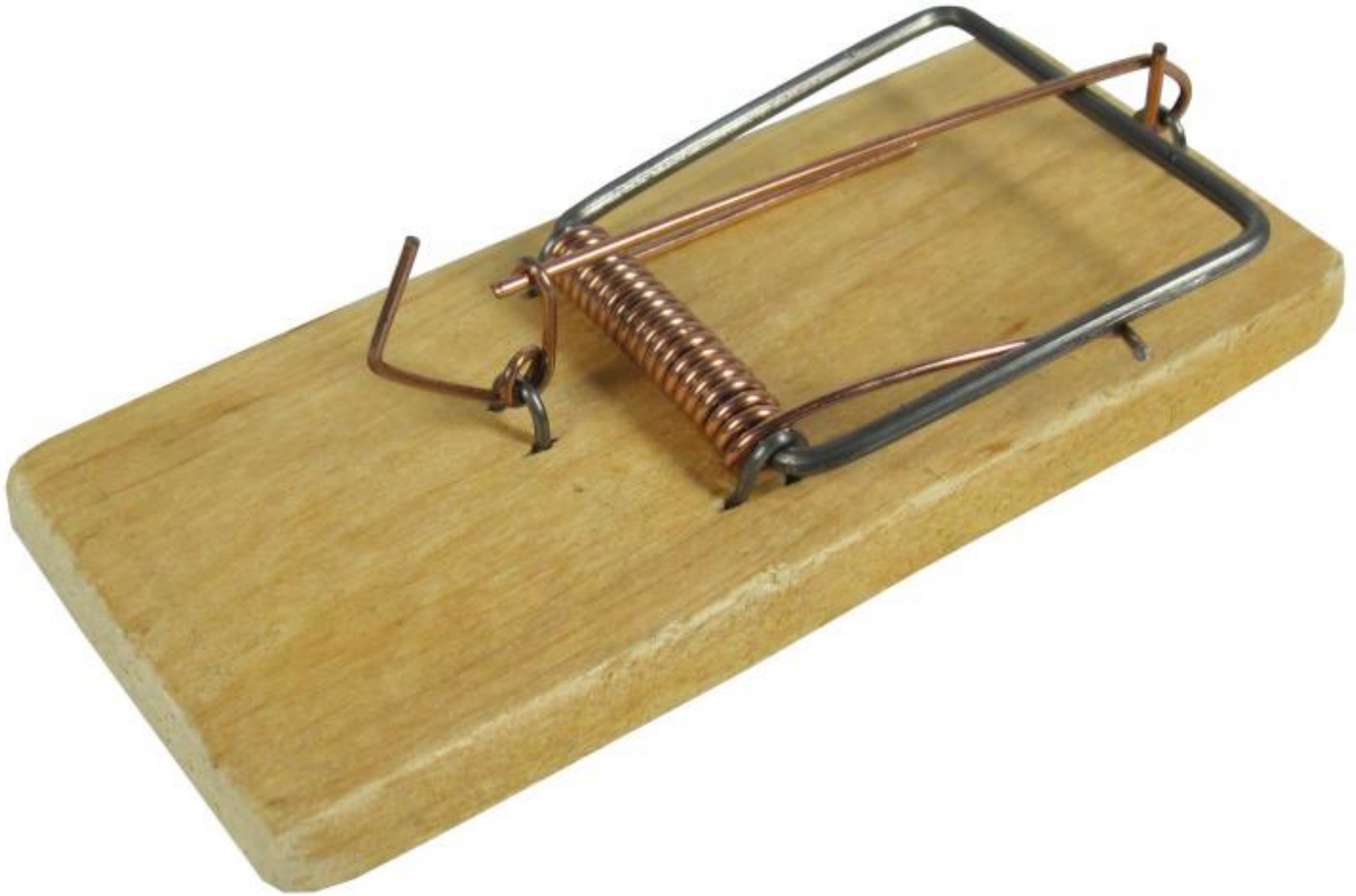
Divergent evolution







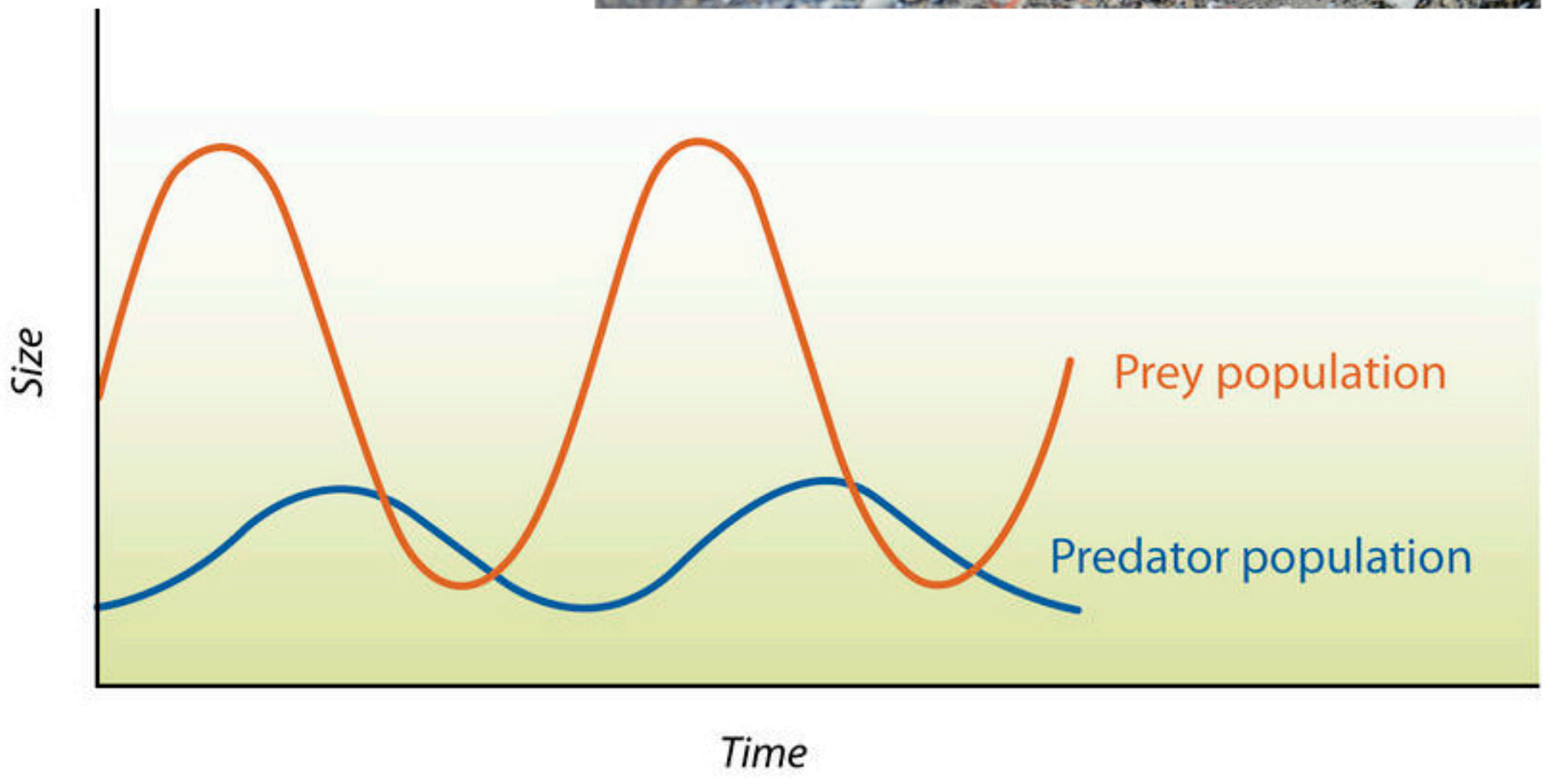
Convergent Evolution



The Mouse Trap… argument

The Mouse Trap ???

Fundamentals of Eye evolution


Size
Prey population
Predator population
Time

Batesian Mimicry

Population Variables

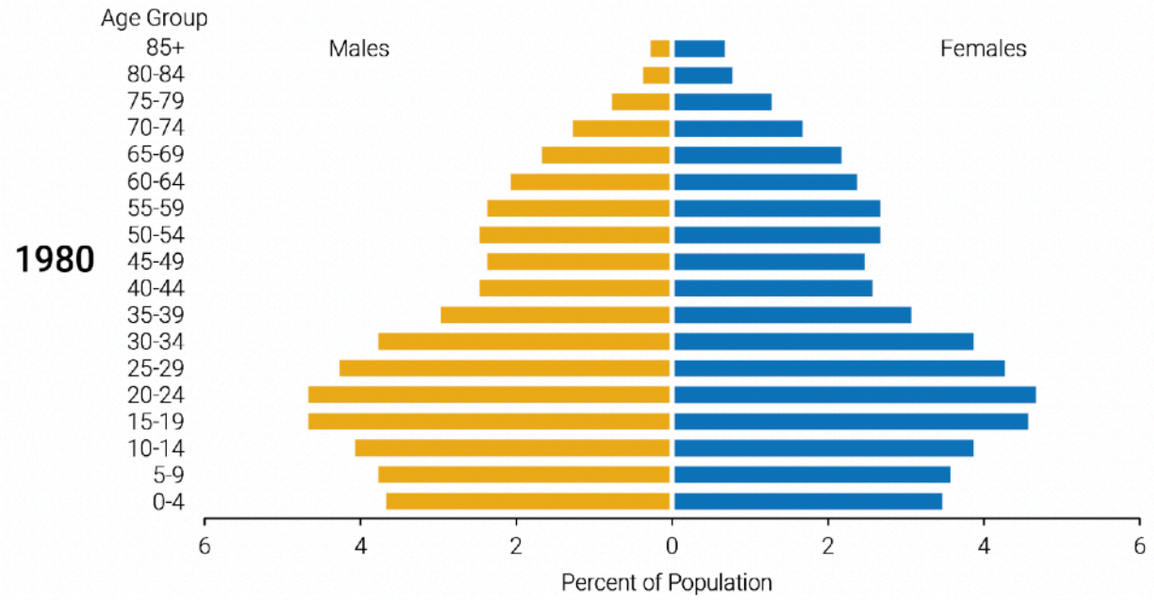
a) population density (Individuals in a population may have uniform, random, or clumped distributions)

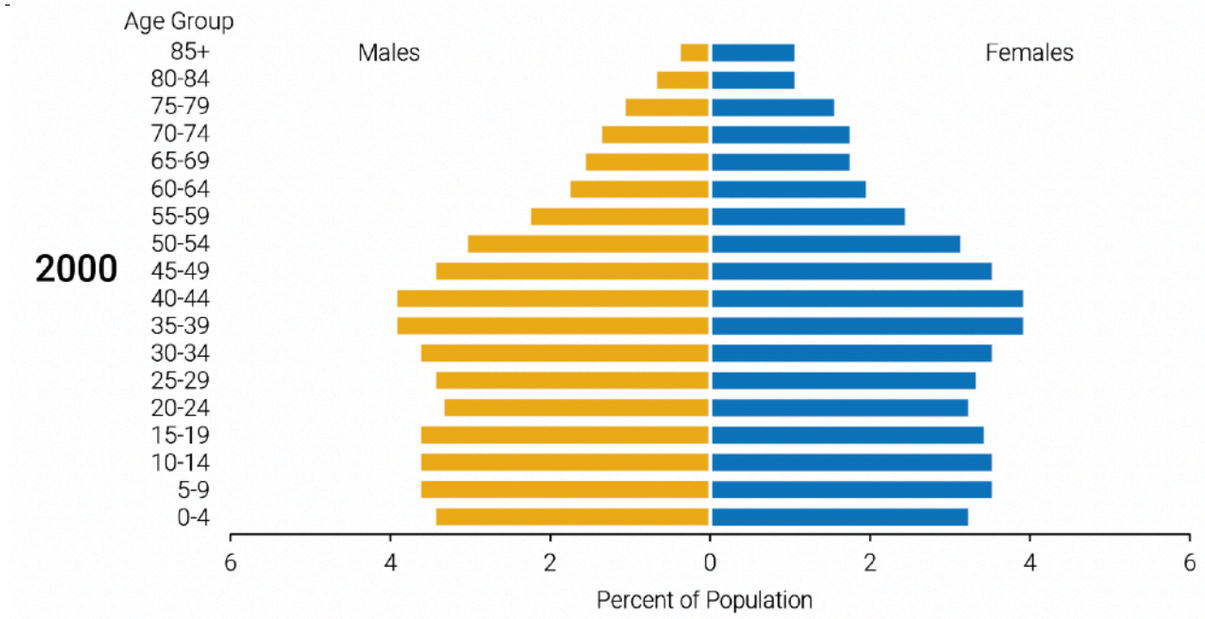
b) Births and Deaths: Births, deaths, immigration, and emigration drive changes in population density and distribution.

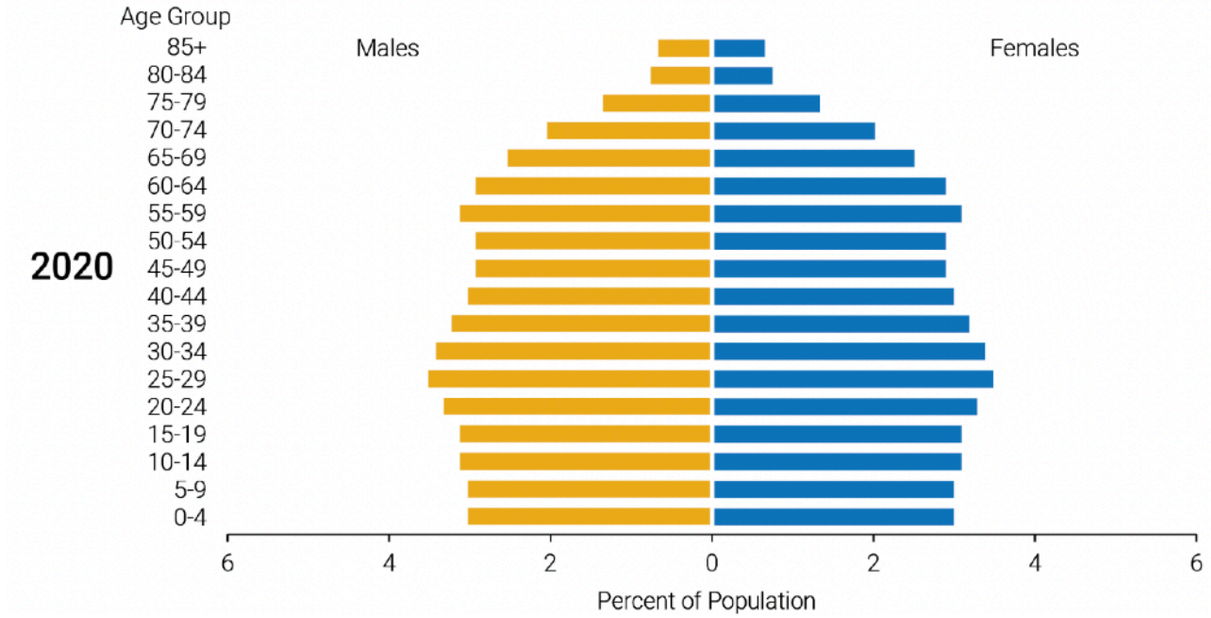
$$\text{Number} = N_0 + \text{Births} - \text{Deaths} + \underbrace{\text{Immigrants} + \text{Emmigrants}}_{\text{Gene Flow}}$$

c) Age distribution (into “cohorts”) within a population, which reveals the recent history of births and deaths.

Timing of these events may influence age distributions for many years







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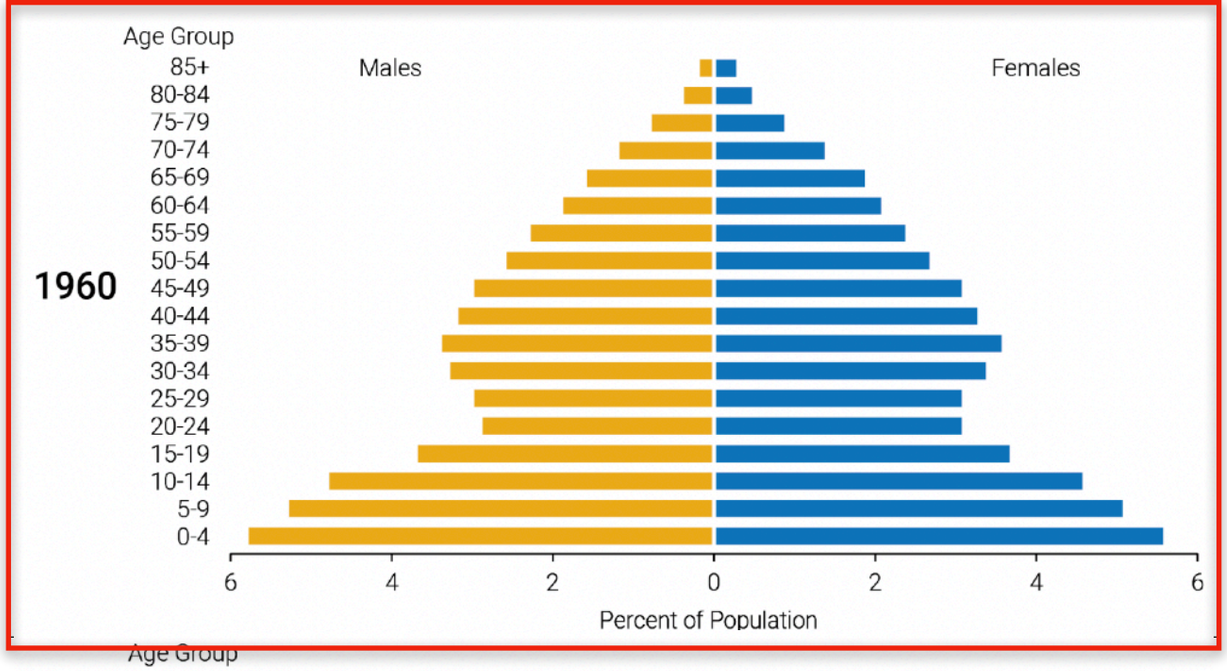

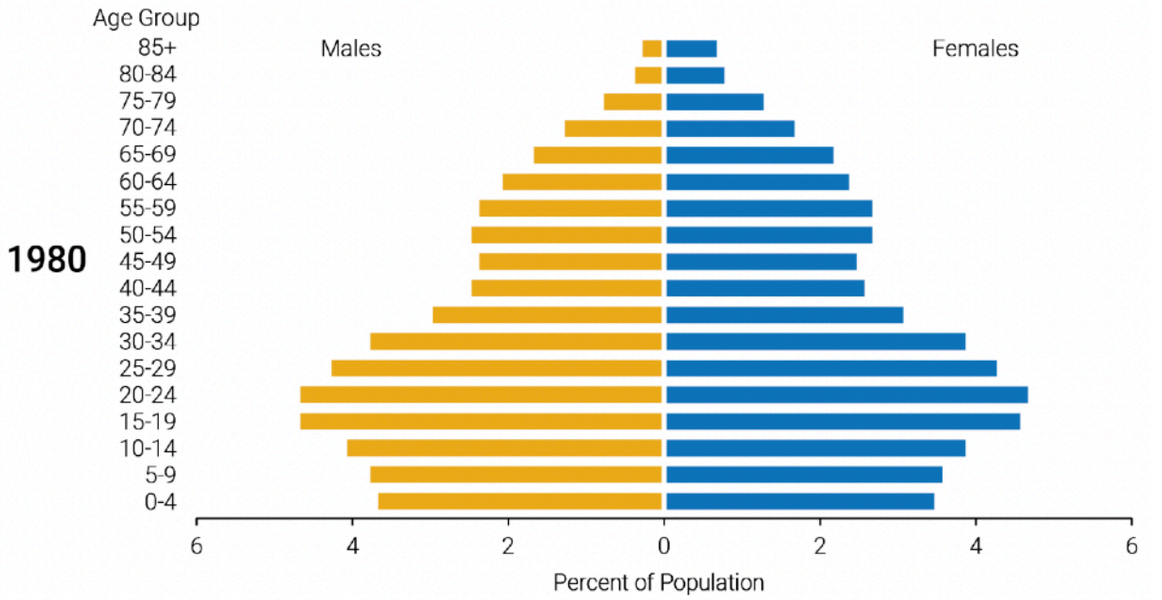

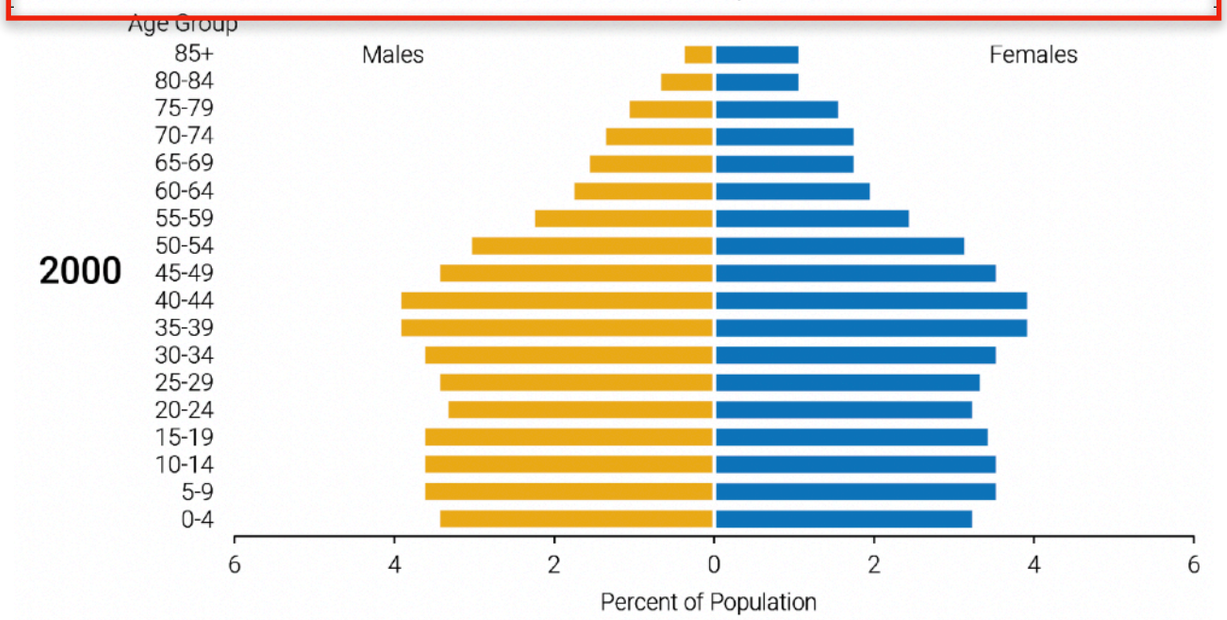

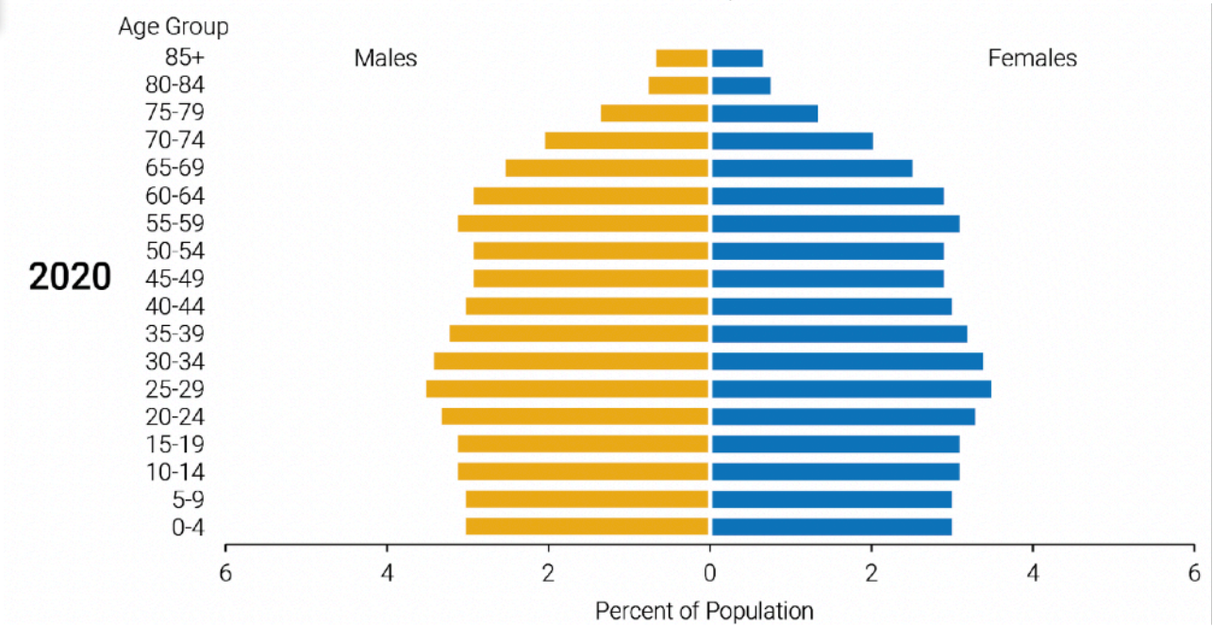

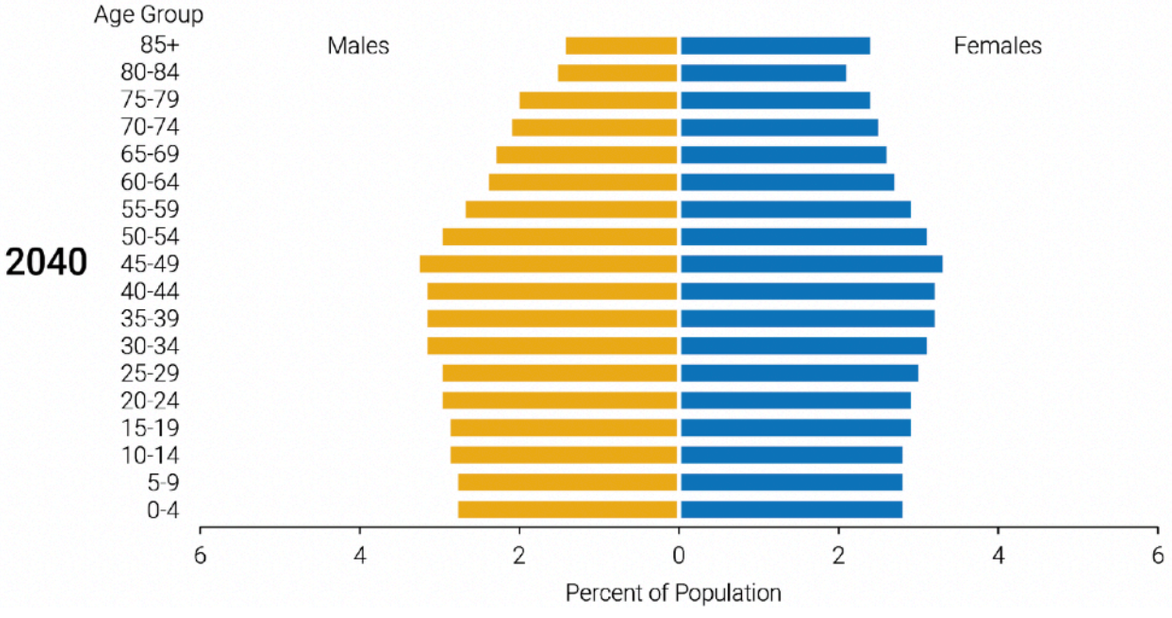

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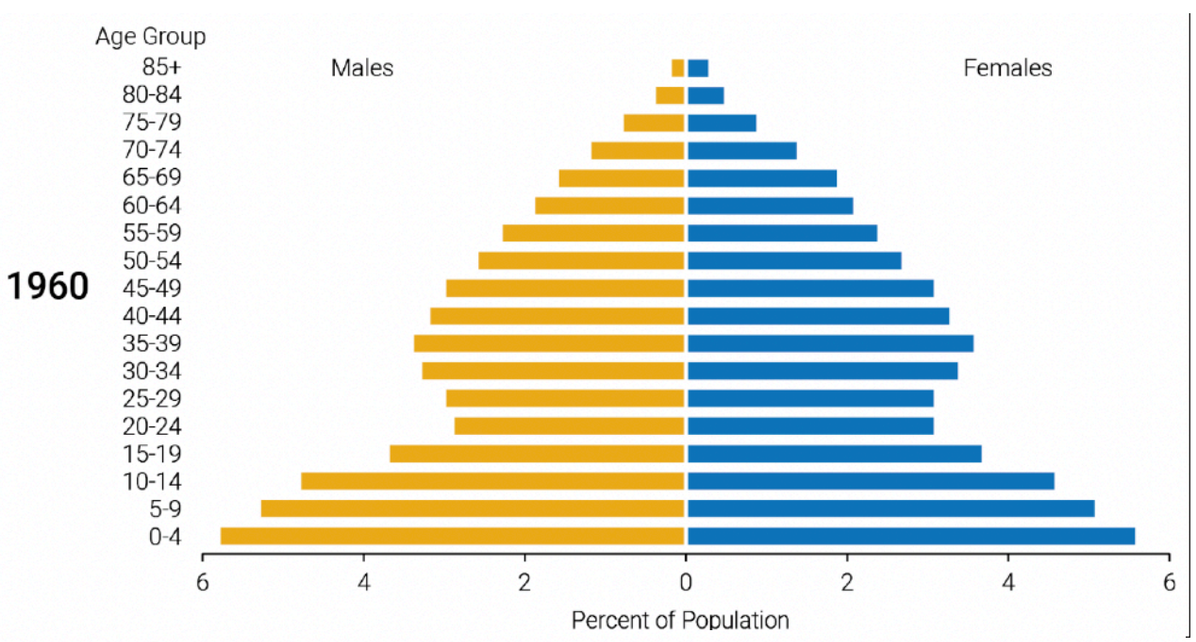

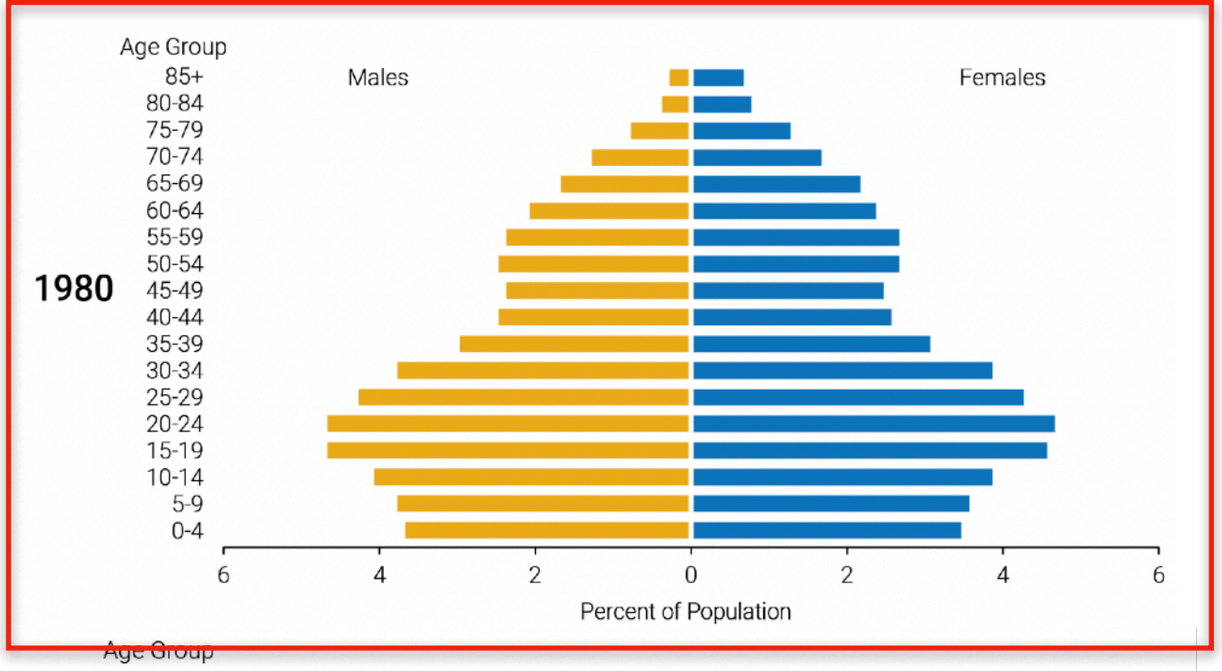

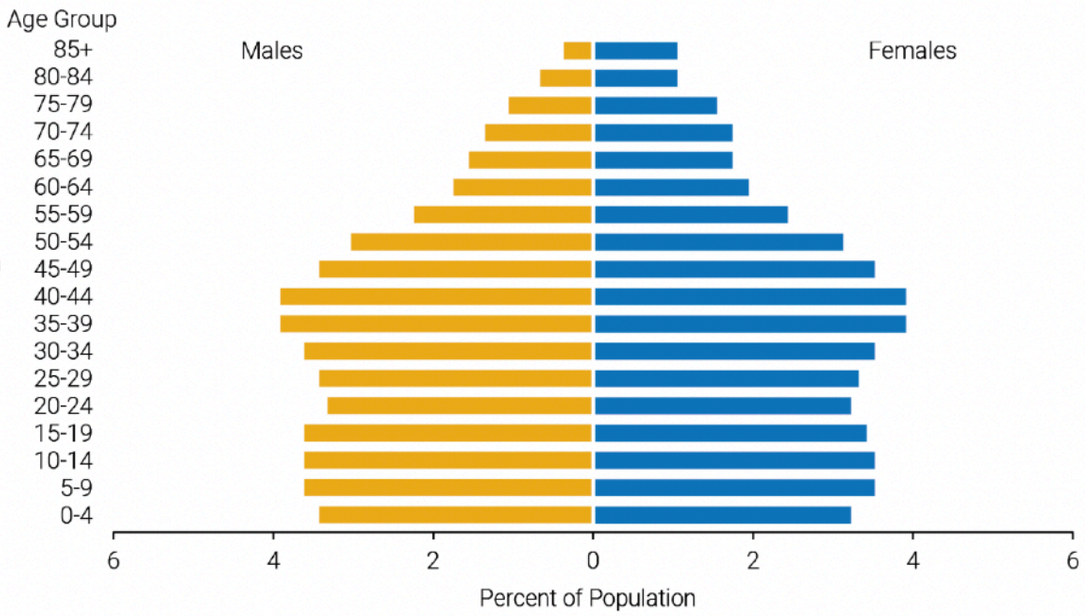

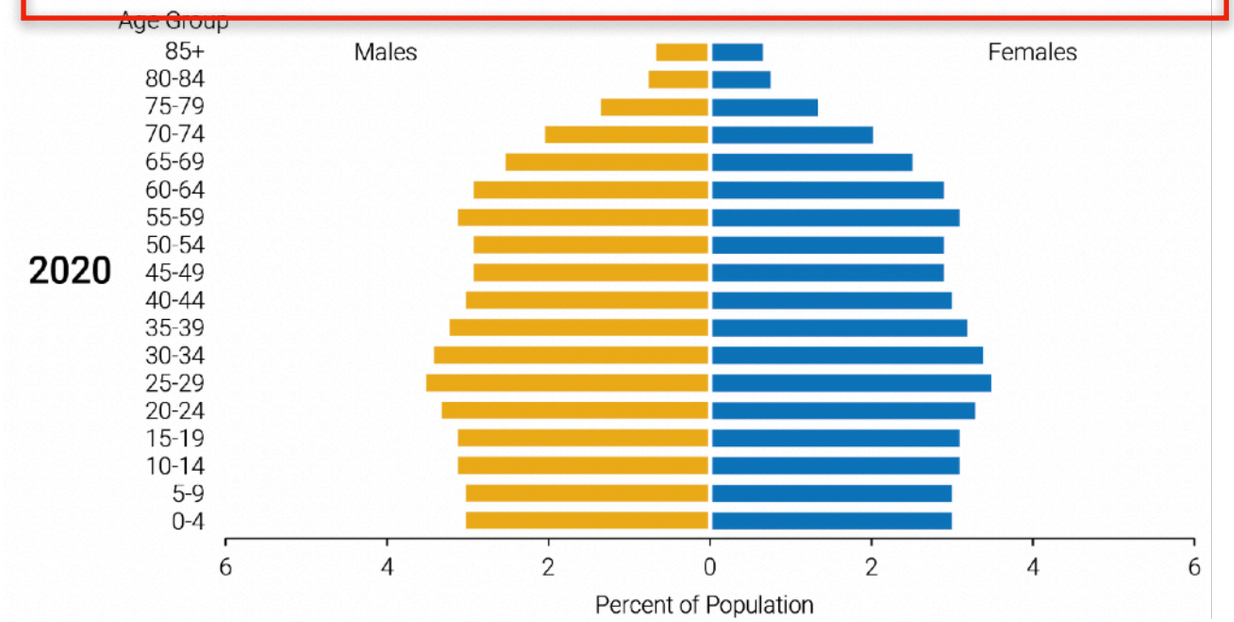

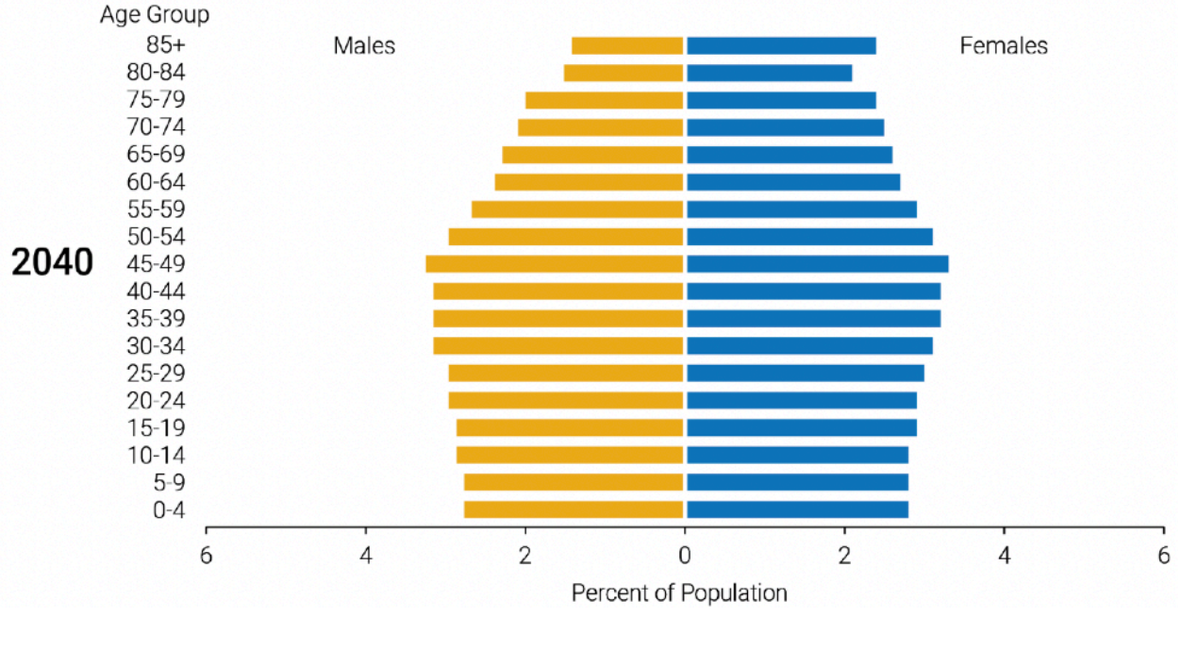

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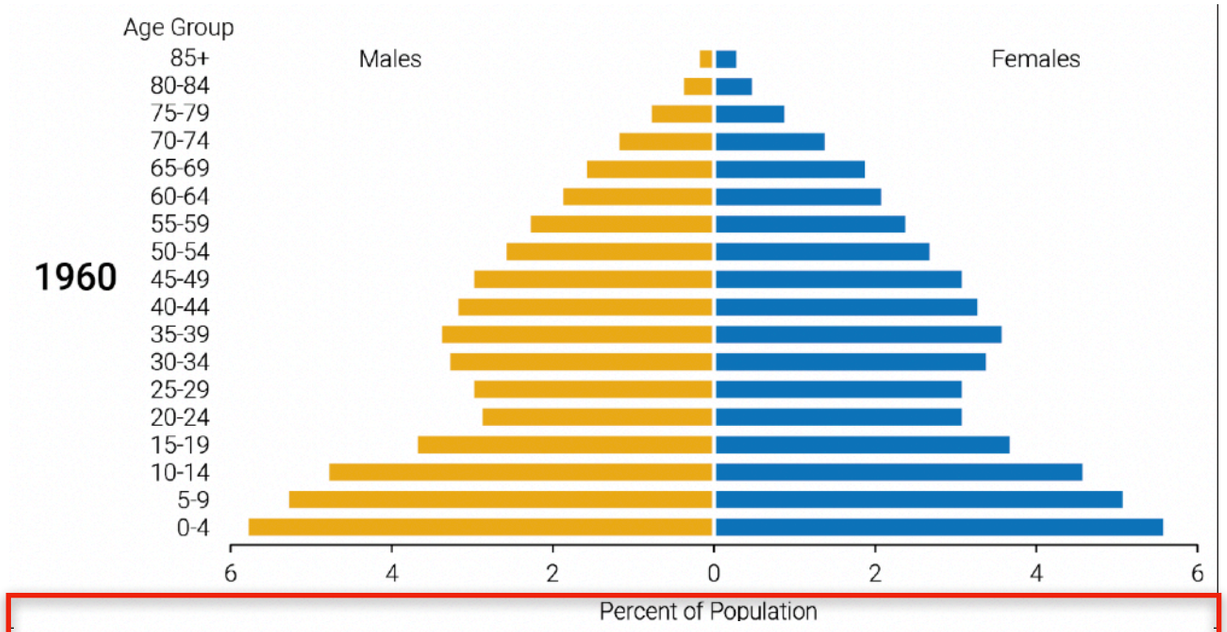

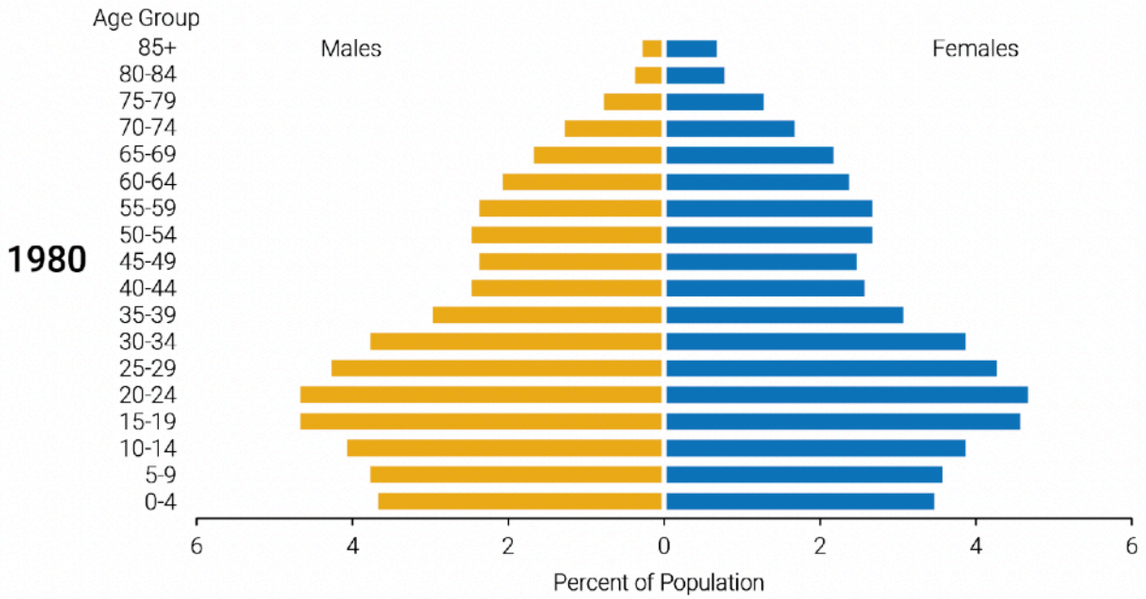

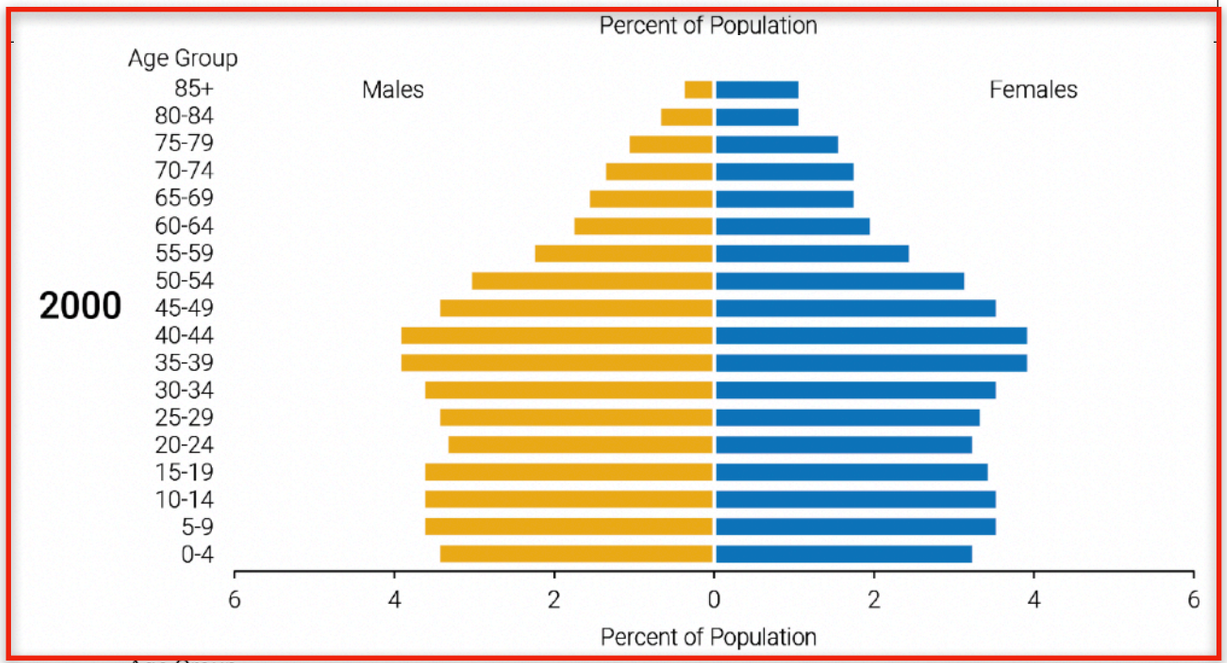

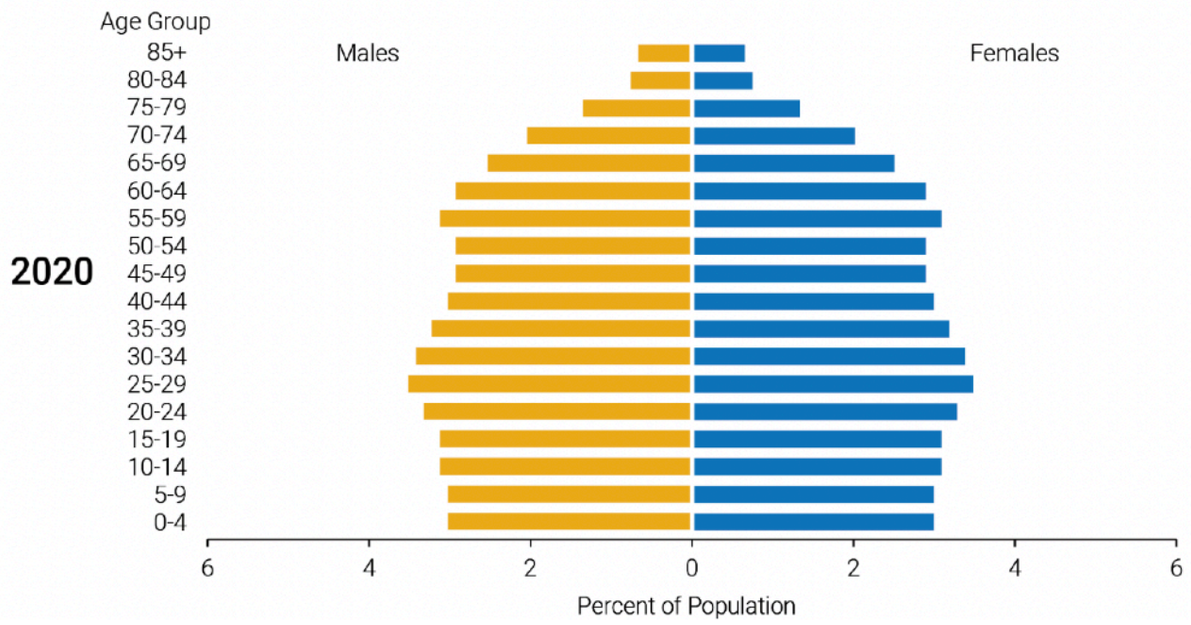

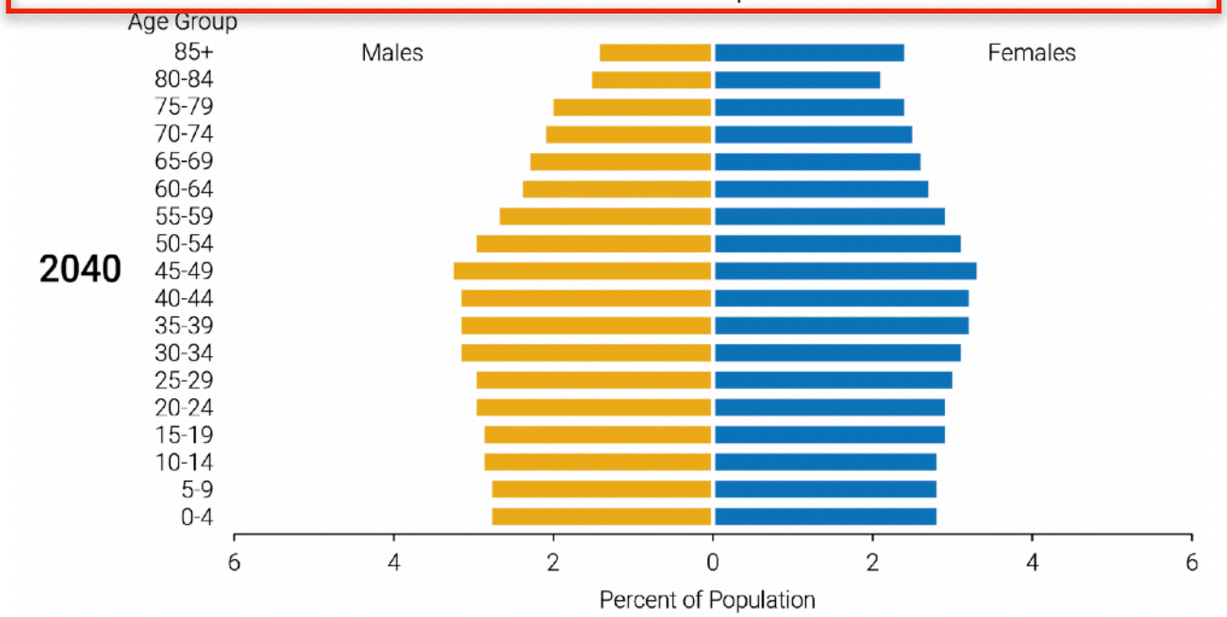

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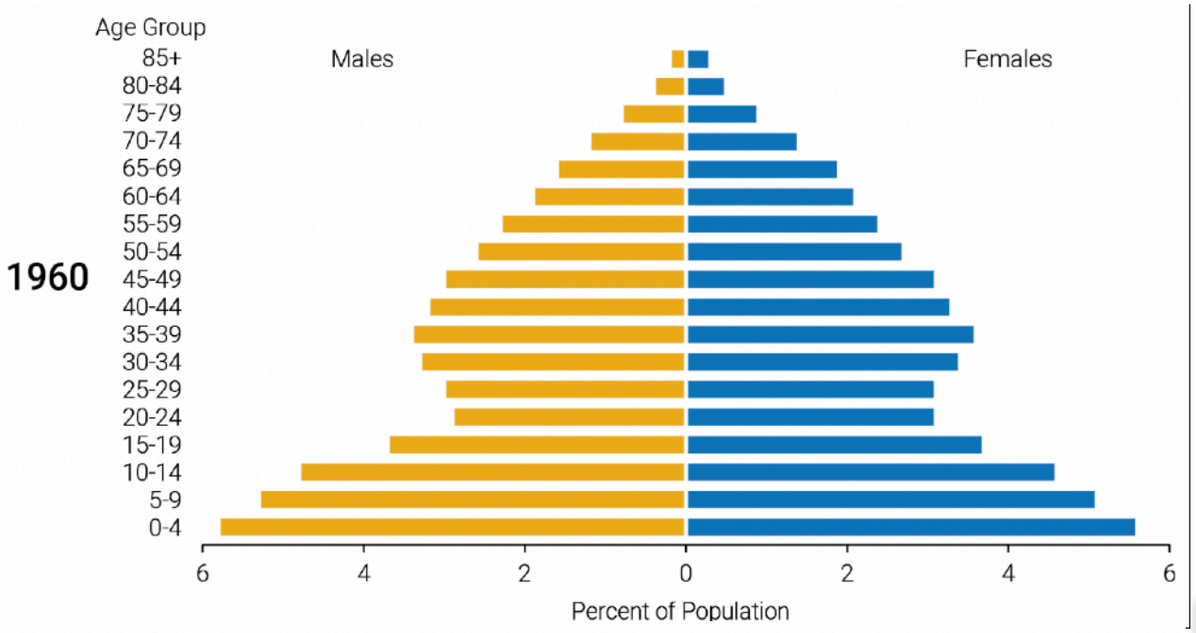

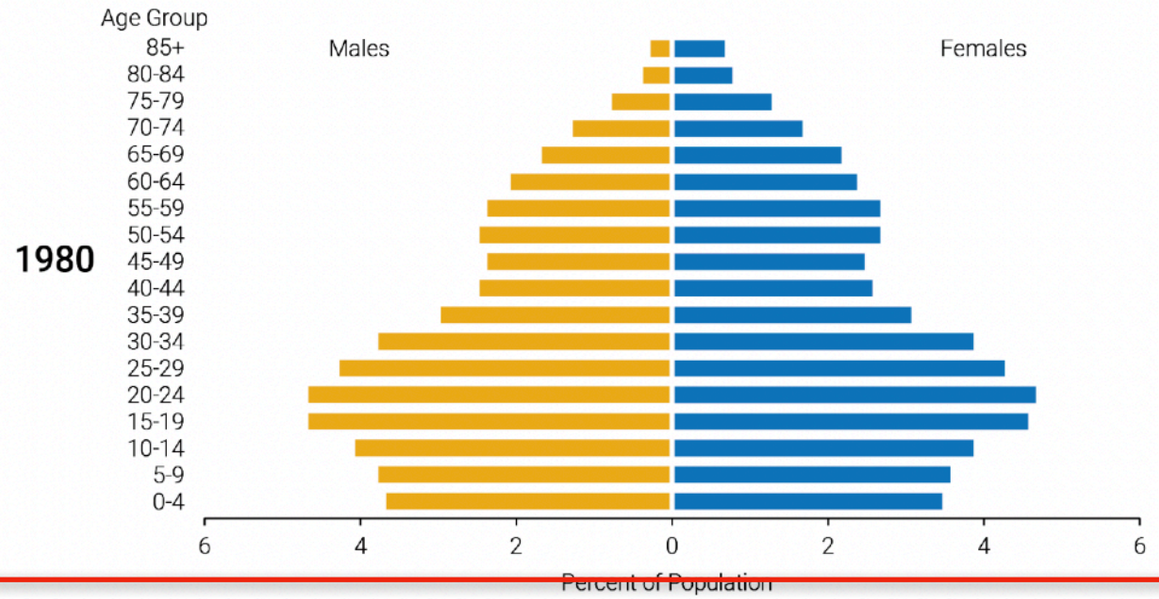

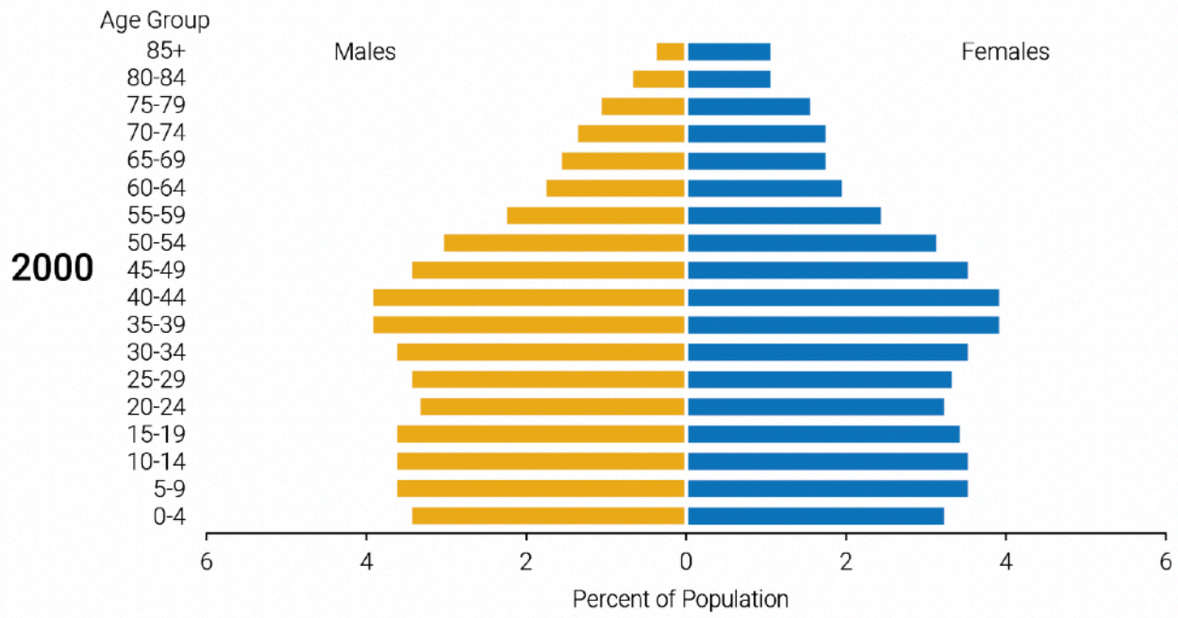

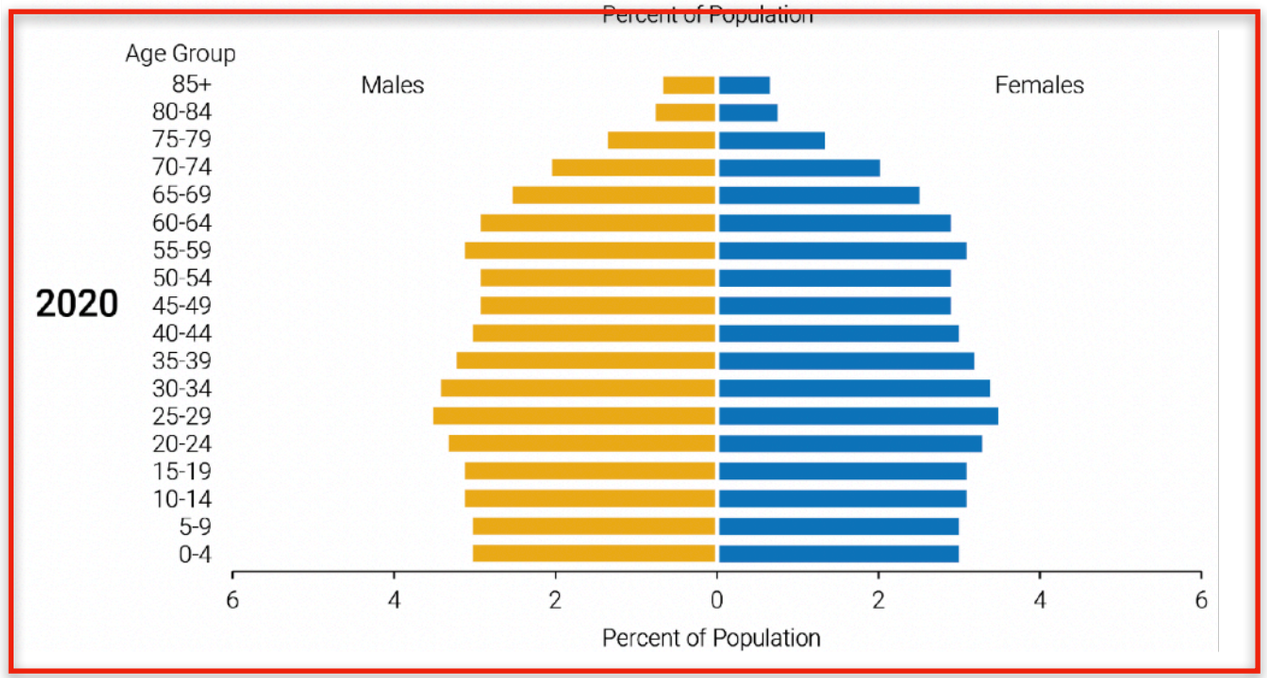

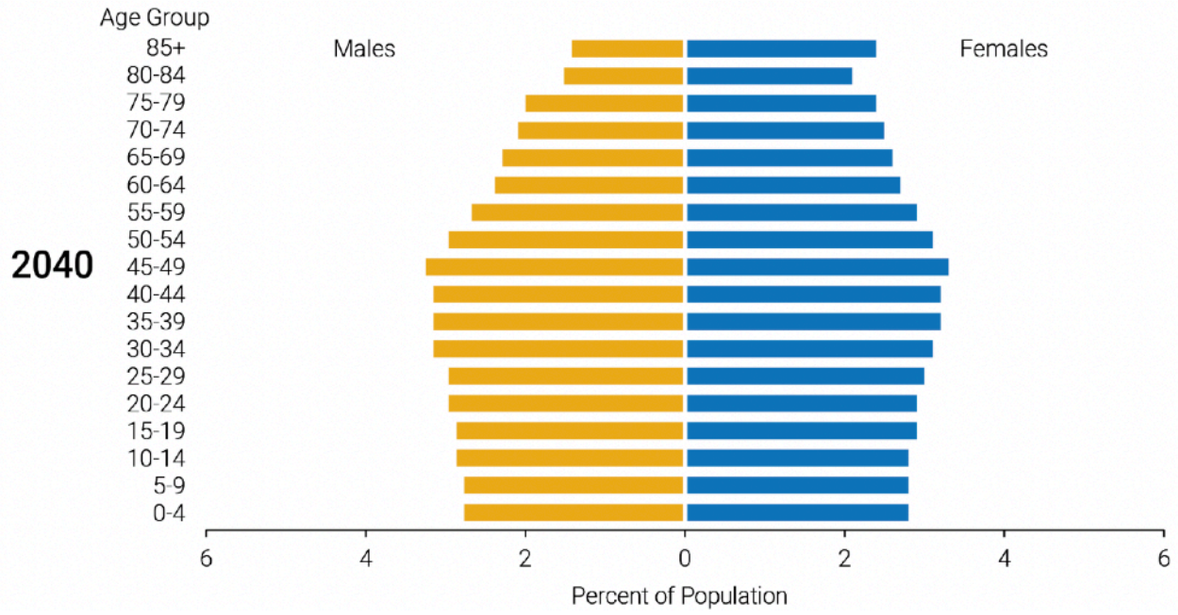

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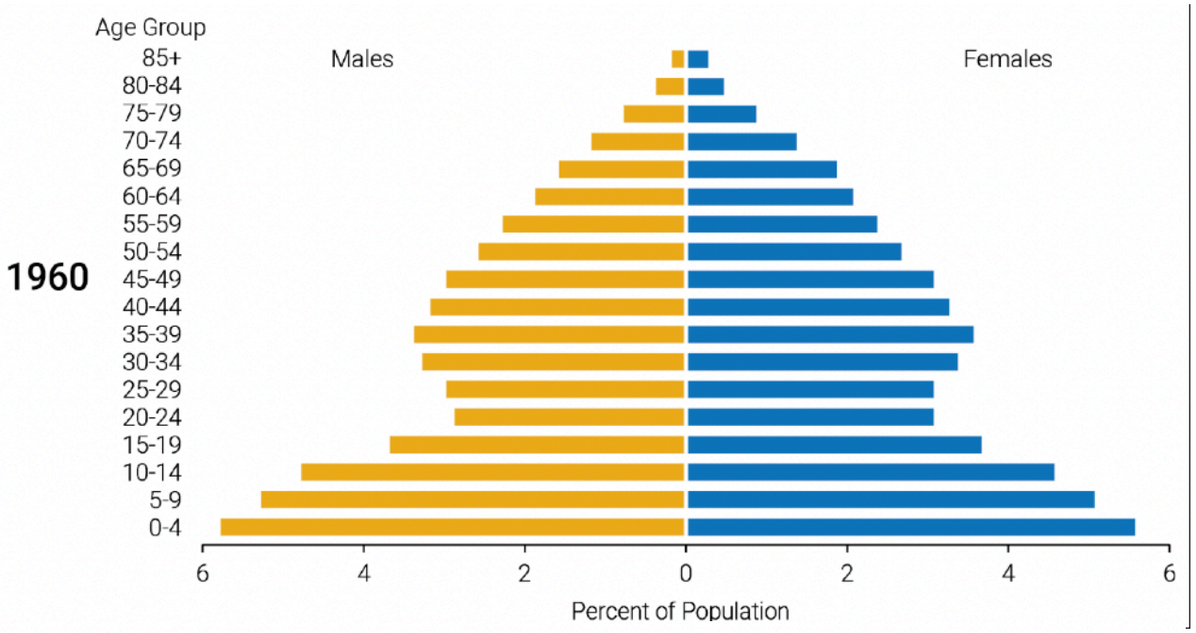

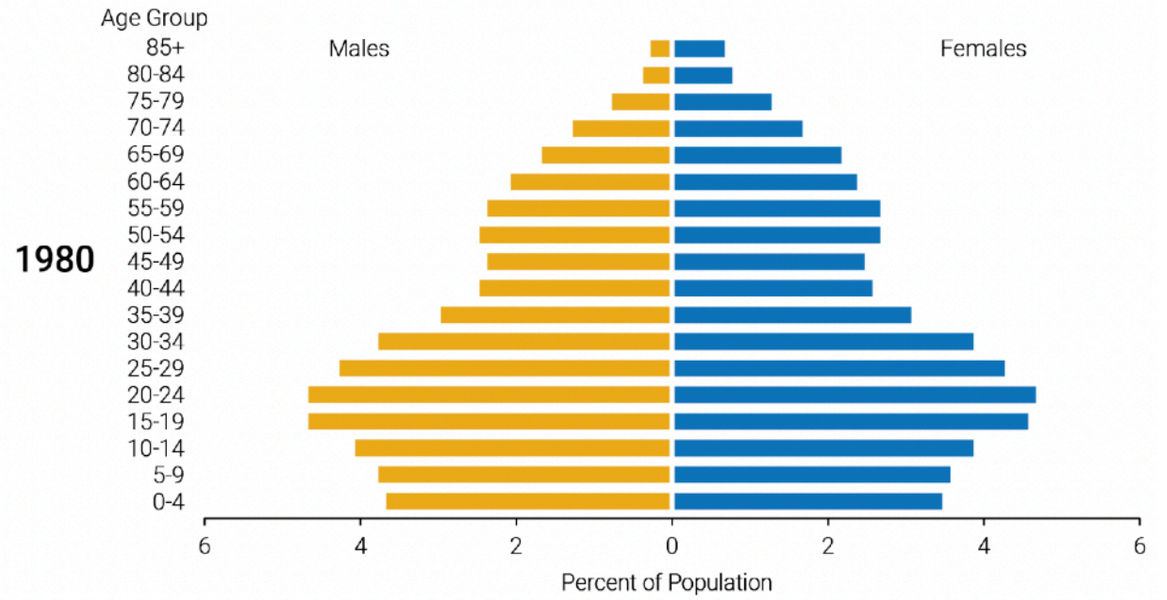

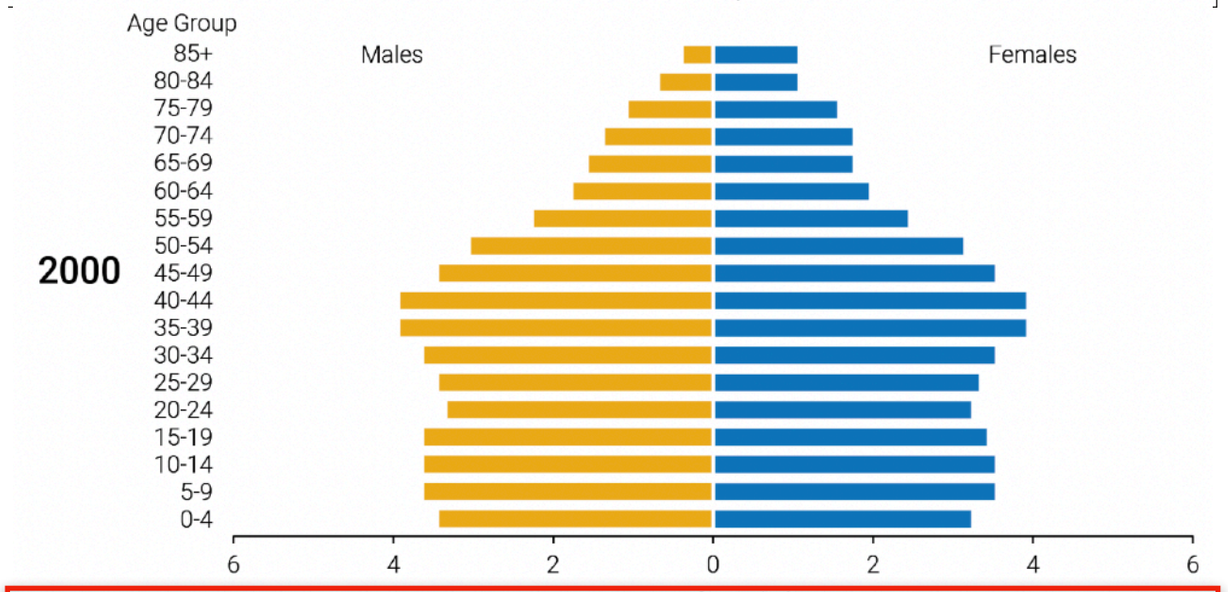

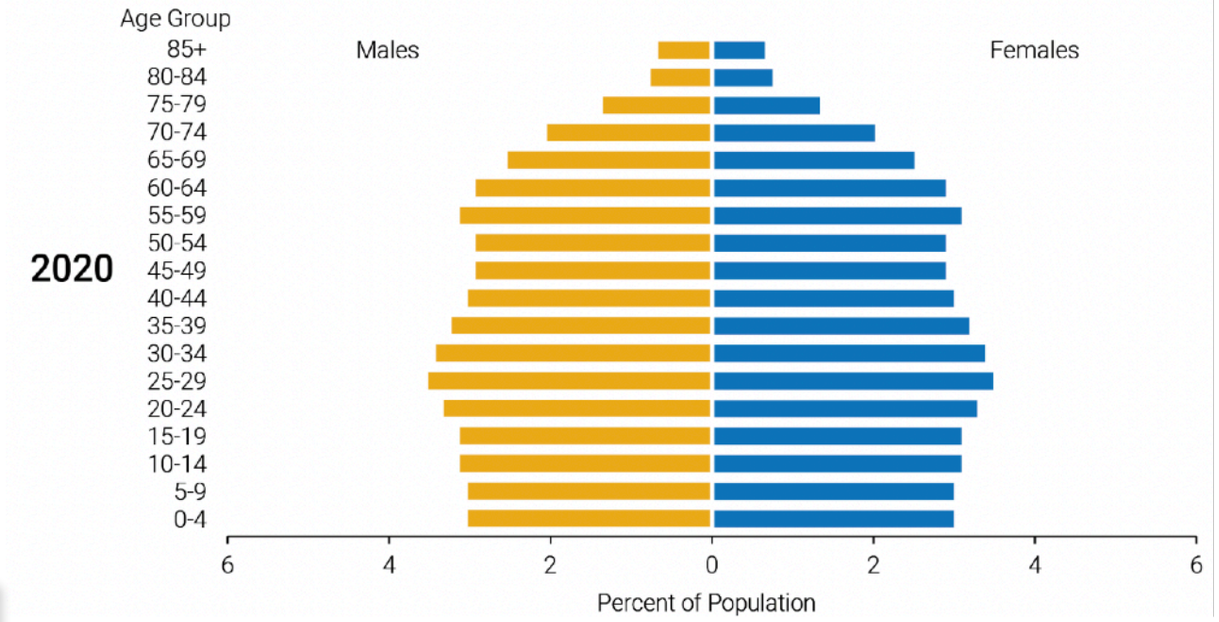

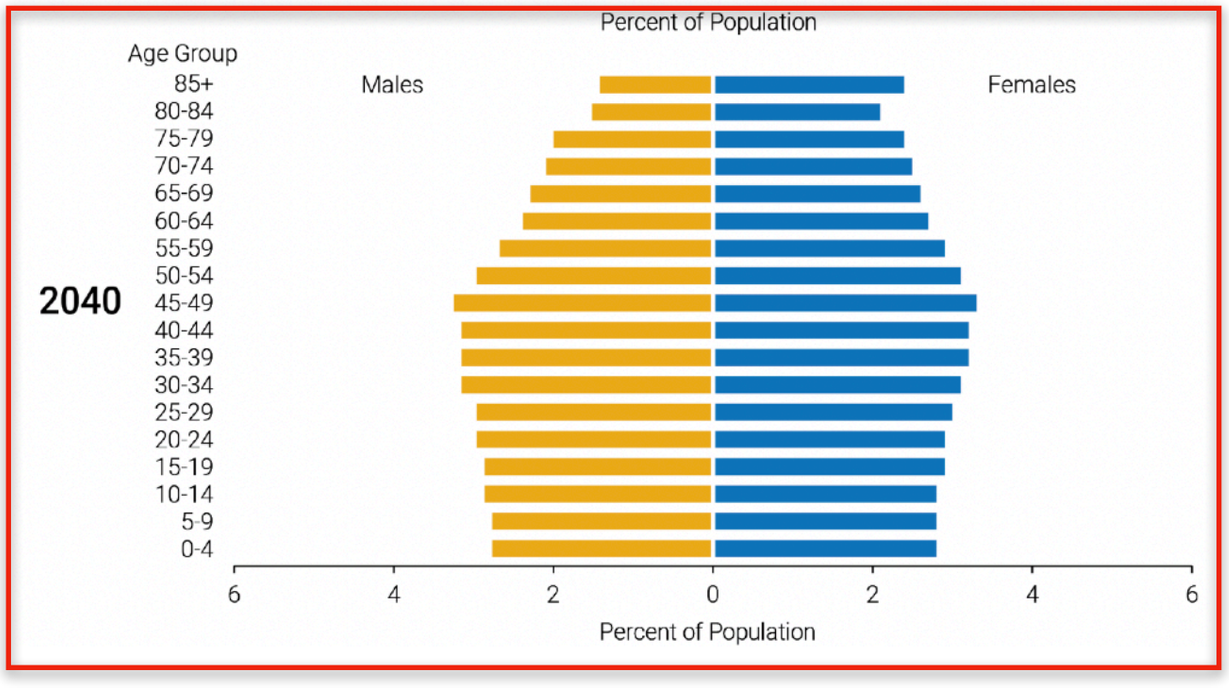

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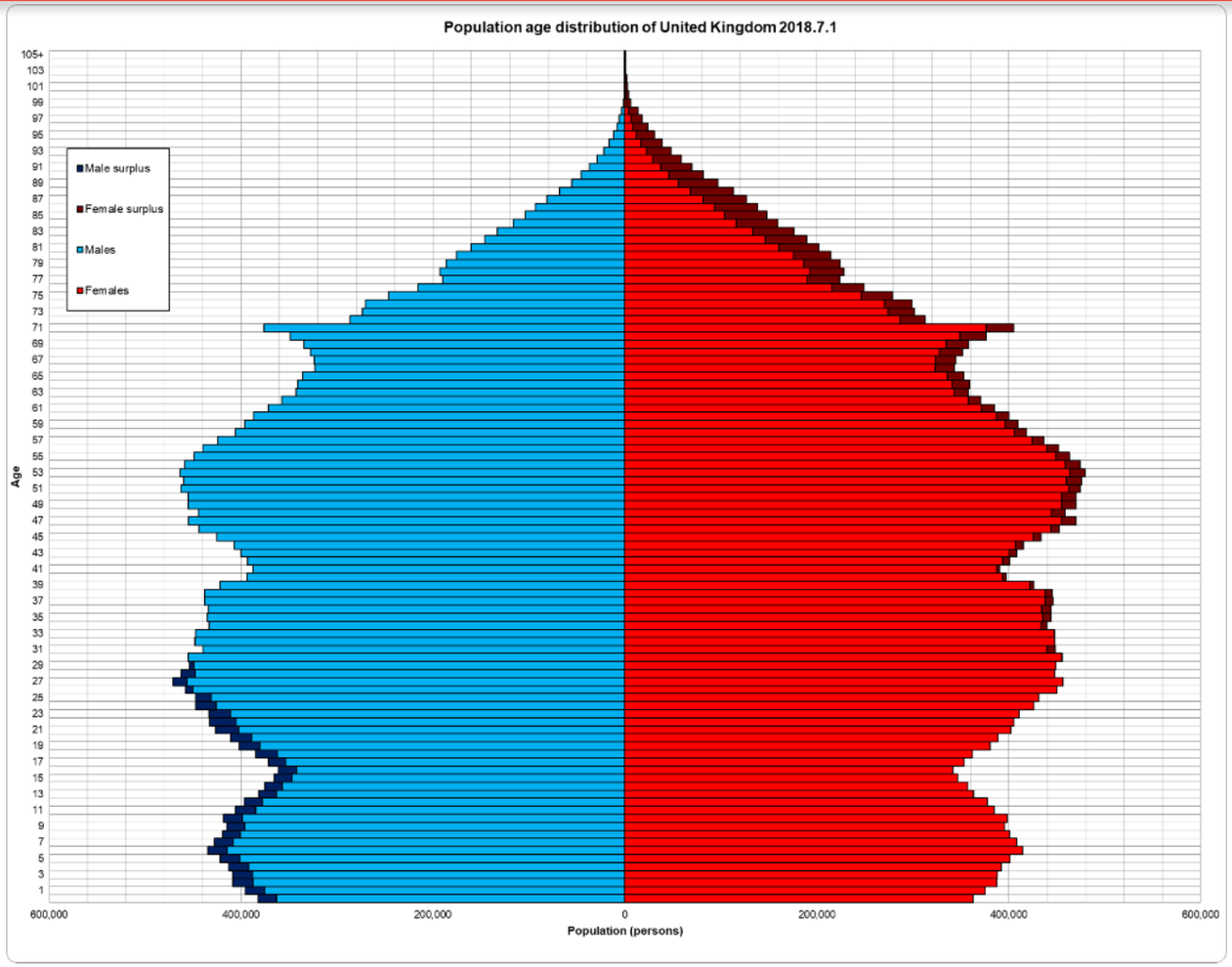
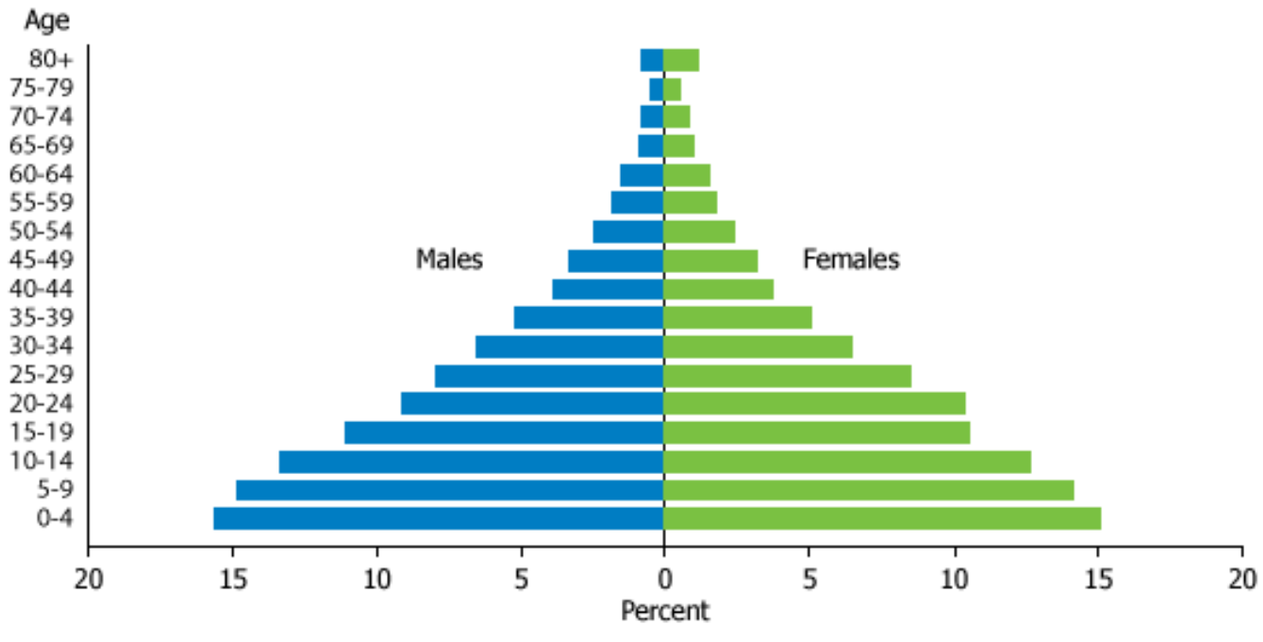
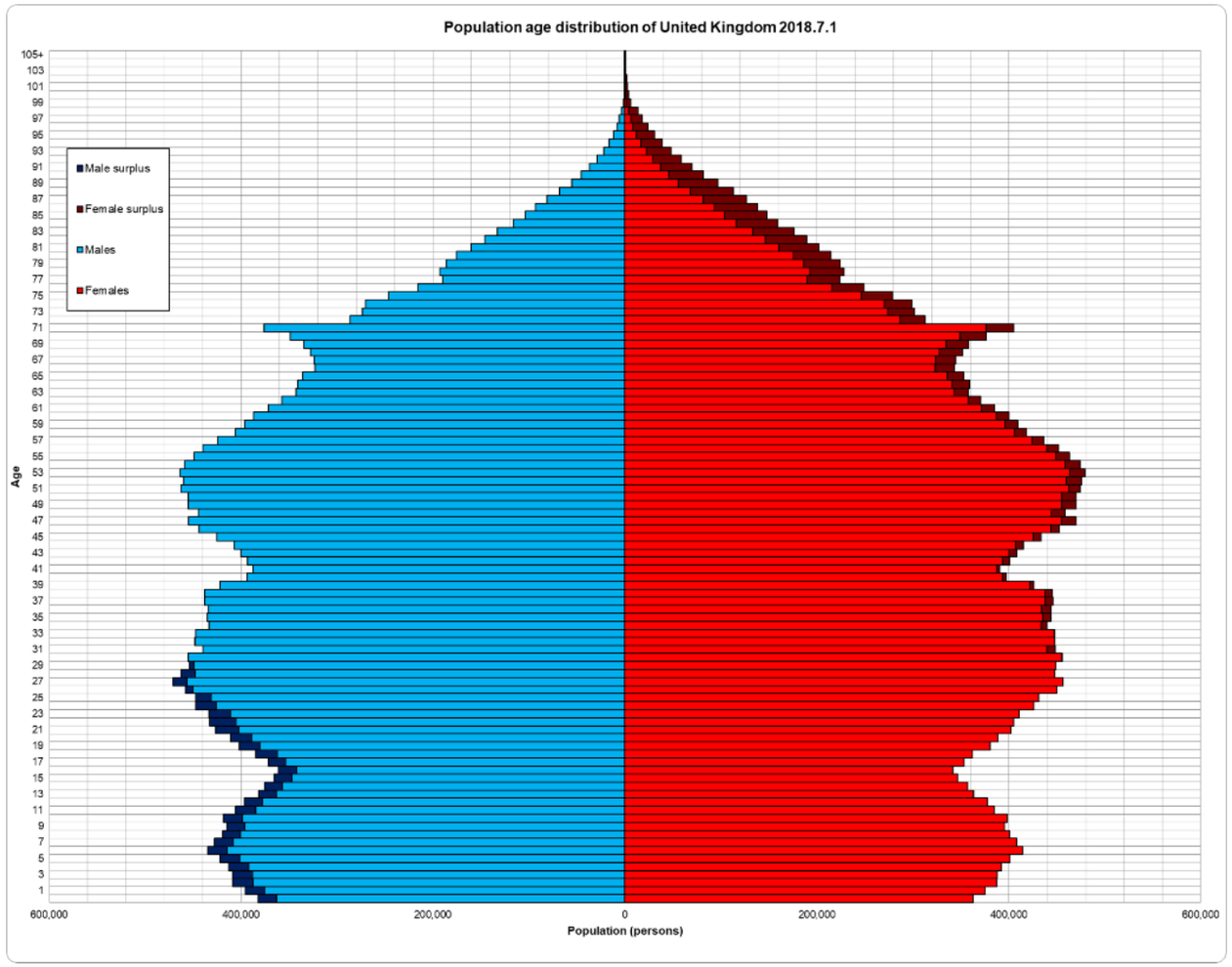


UK's Age and demographics ~ 2018

Kenya's Age and demographics ~ 2011





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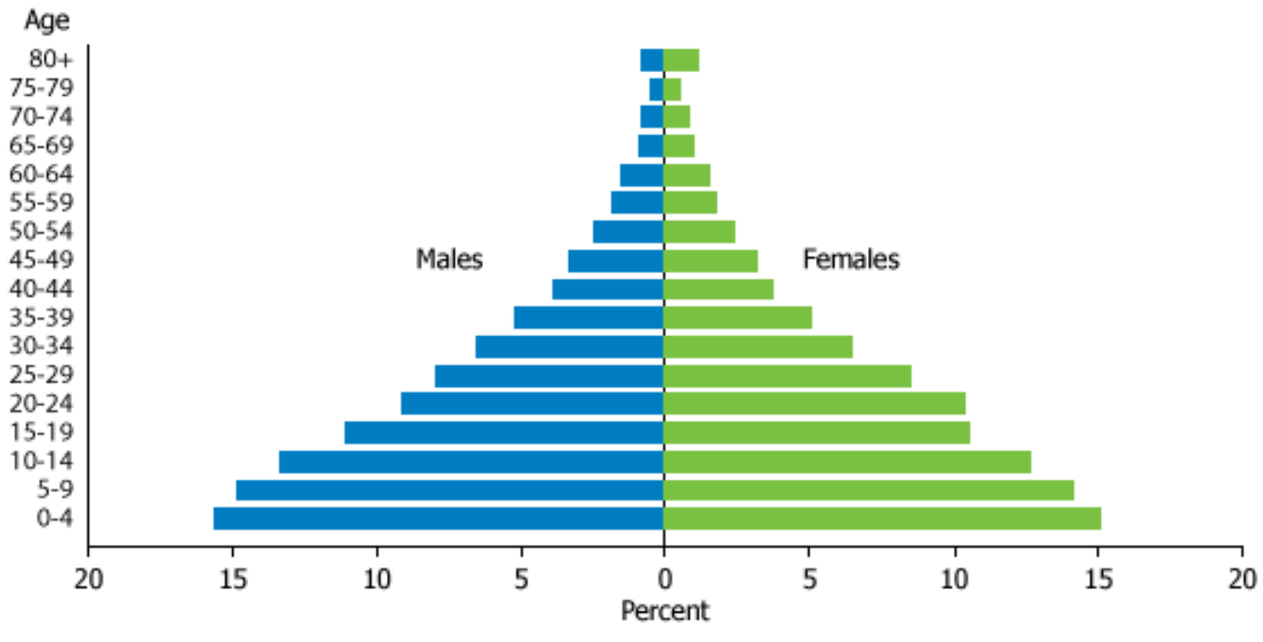

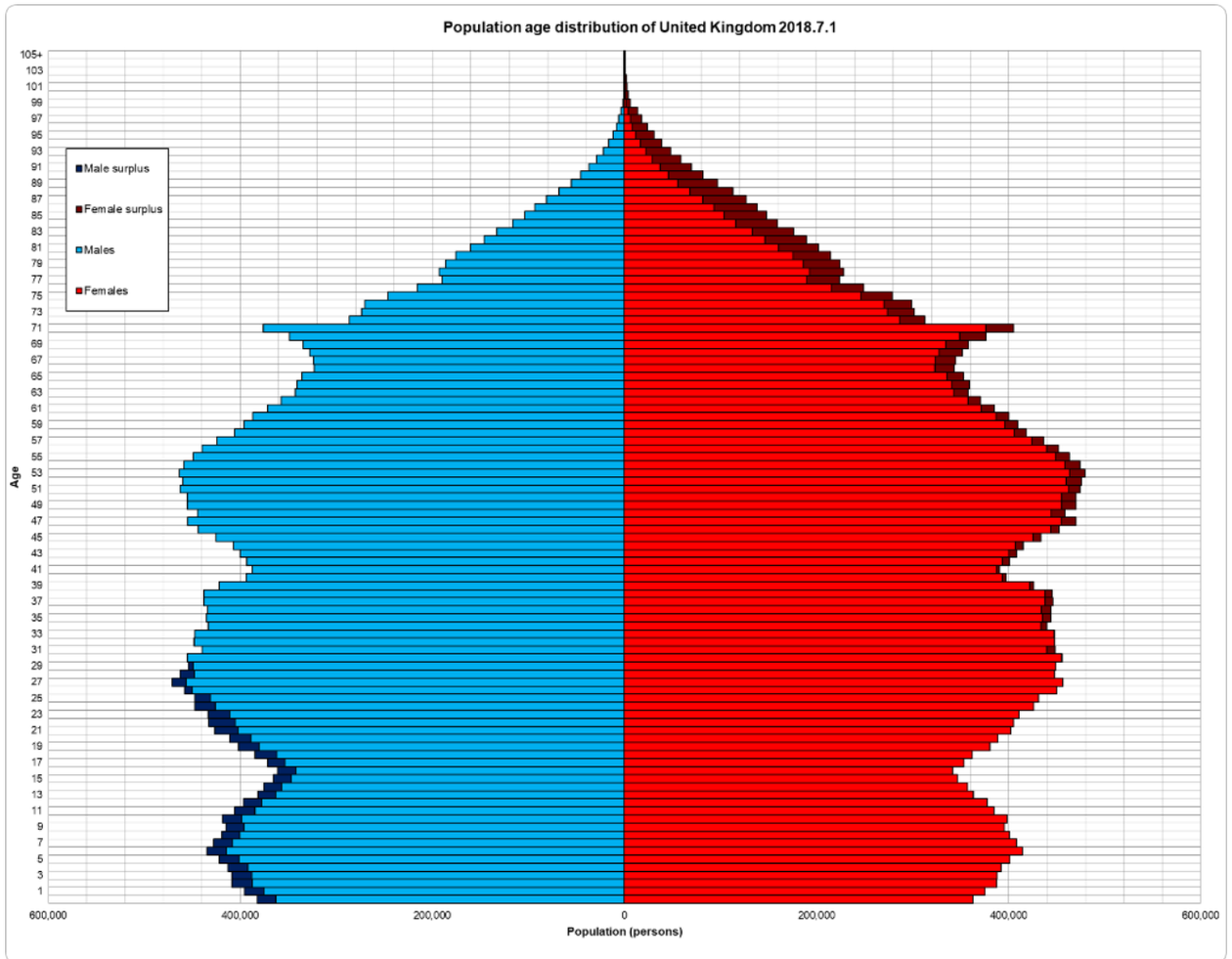

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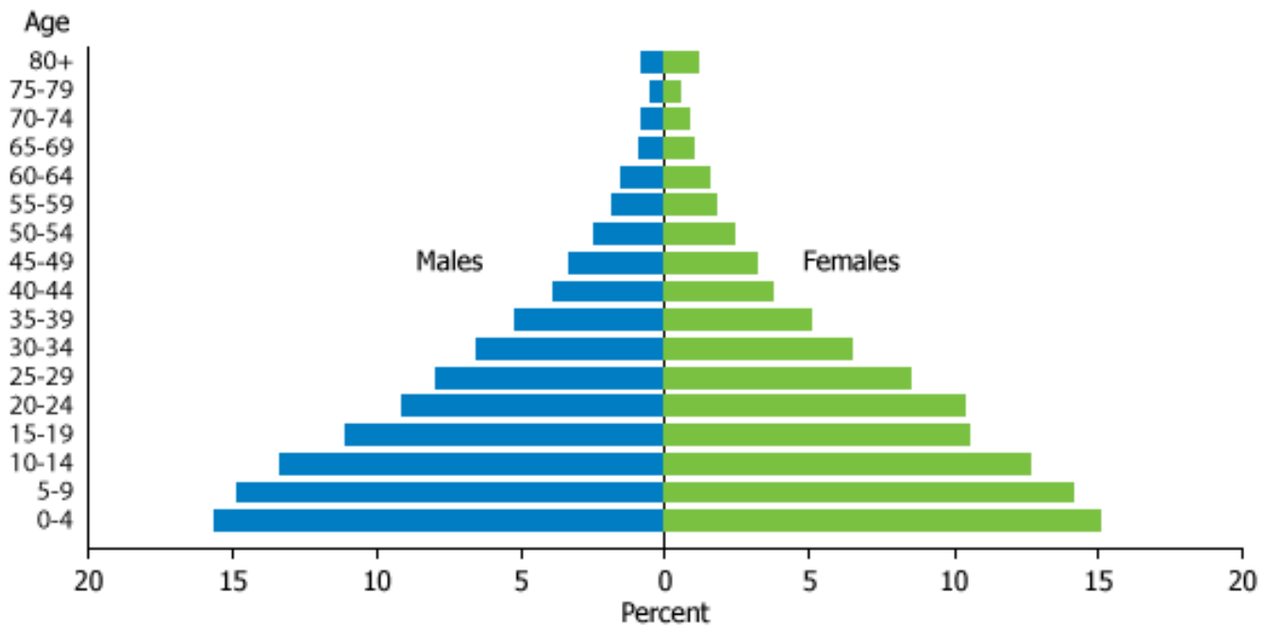
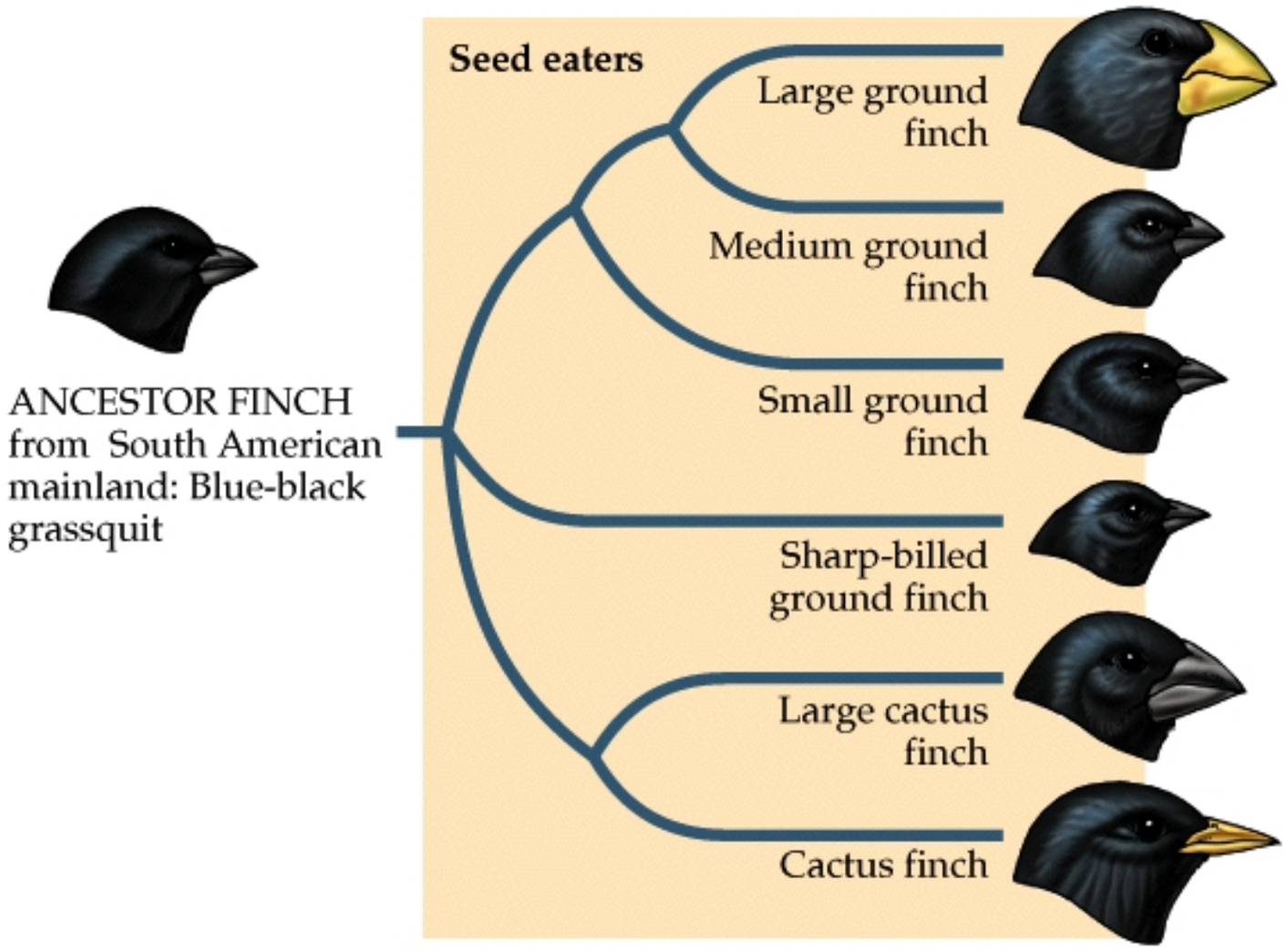
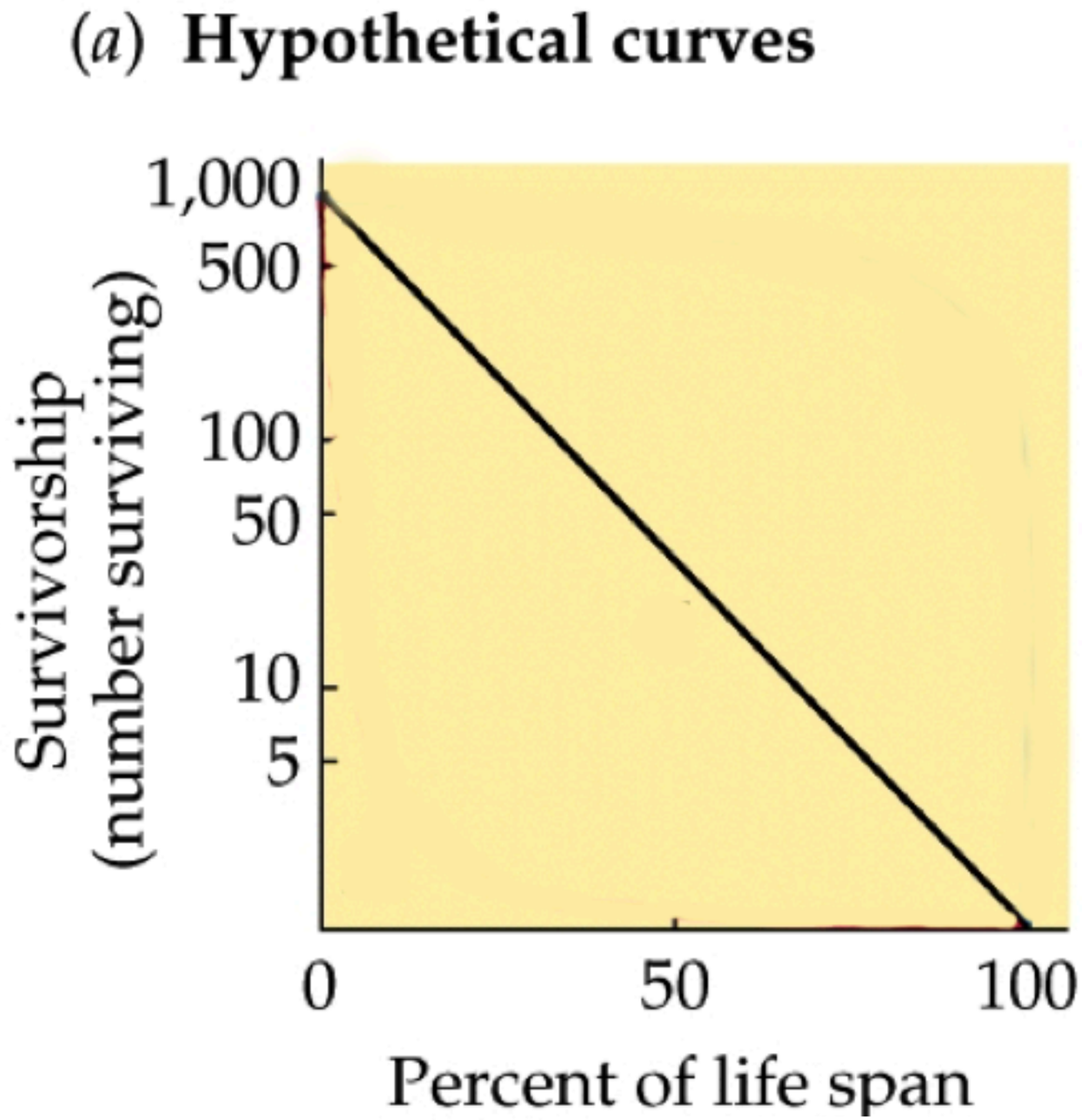




s Ground Finch

			VIVAL RATE[b]	MORTALITY RATE[c]
			0.434	0.566
			0.855	0.143
			0.898	0.102
			0.928	0.072
			0.955	0.045
			0.678	0.322
			0.545	0.455
			0.651	0.349
			0.944	0.056
			0.776	0.224
			0.923	0.077
11	10	0.048	0.396	0.604
12	4	0.019	0.737	0.263
13	3	0.014	0.714	0.004

[a]Survivorship = the proportion of newborns who survive to age x.
[b]Survival rate = the proportion of individuals of age x who survive to age $x + 1$.
[c]Mortality rate = the proportion of individuals of age x who die before the age of $x + 1$.

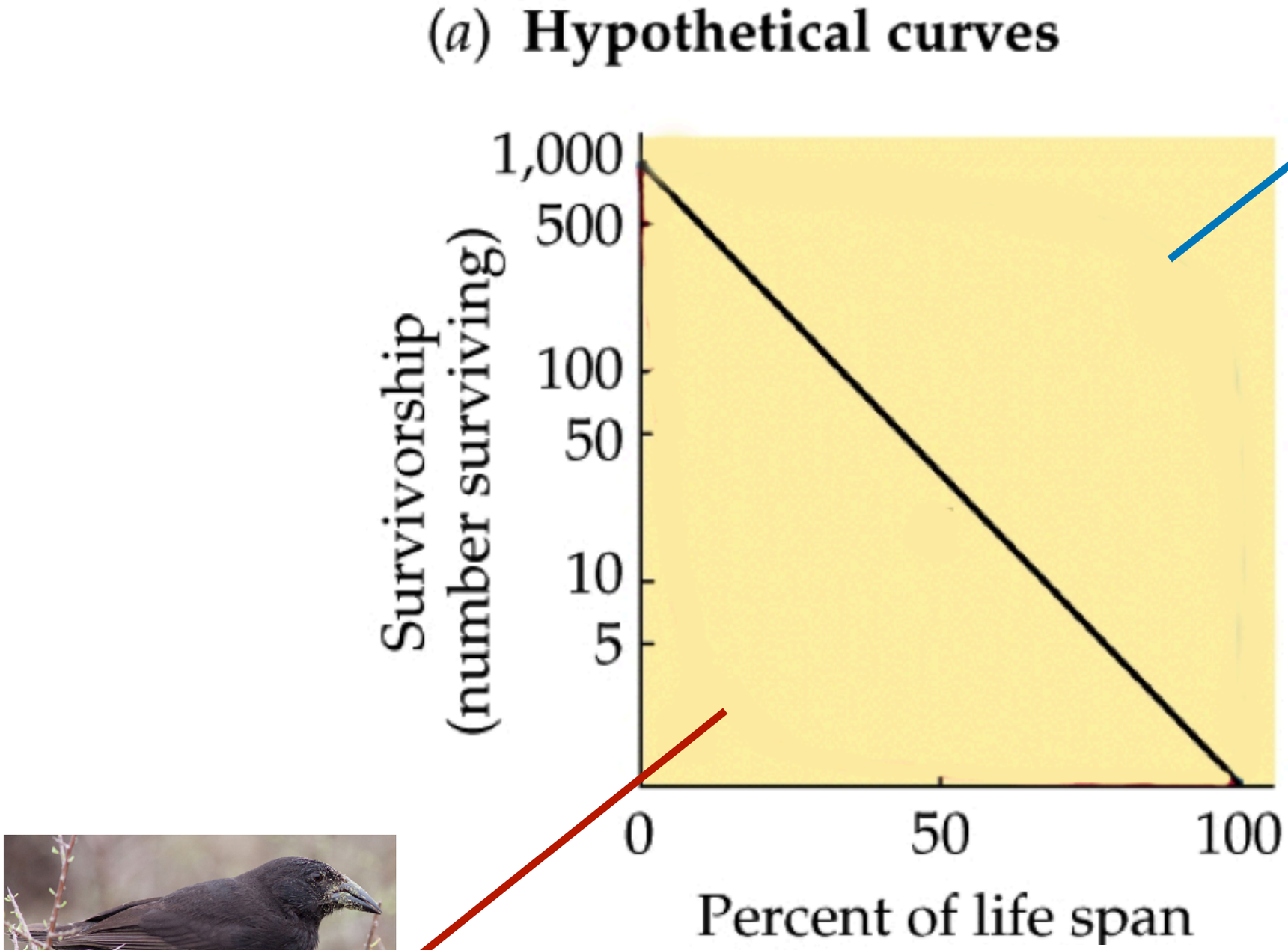


Survivorship

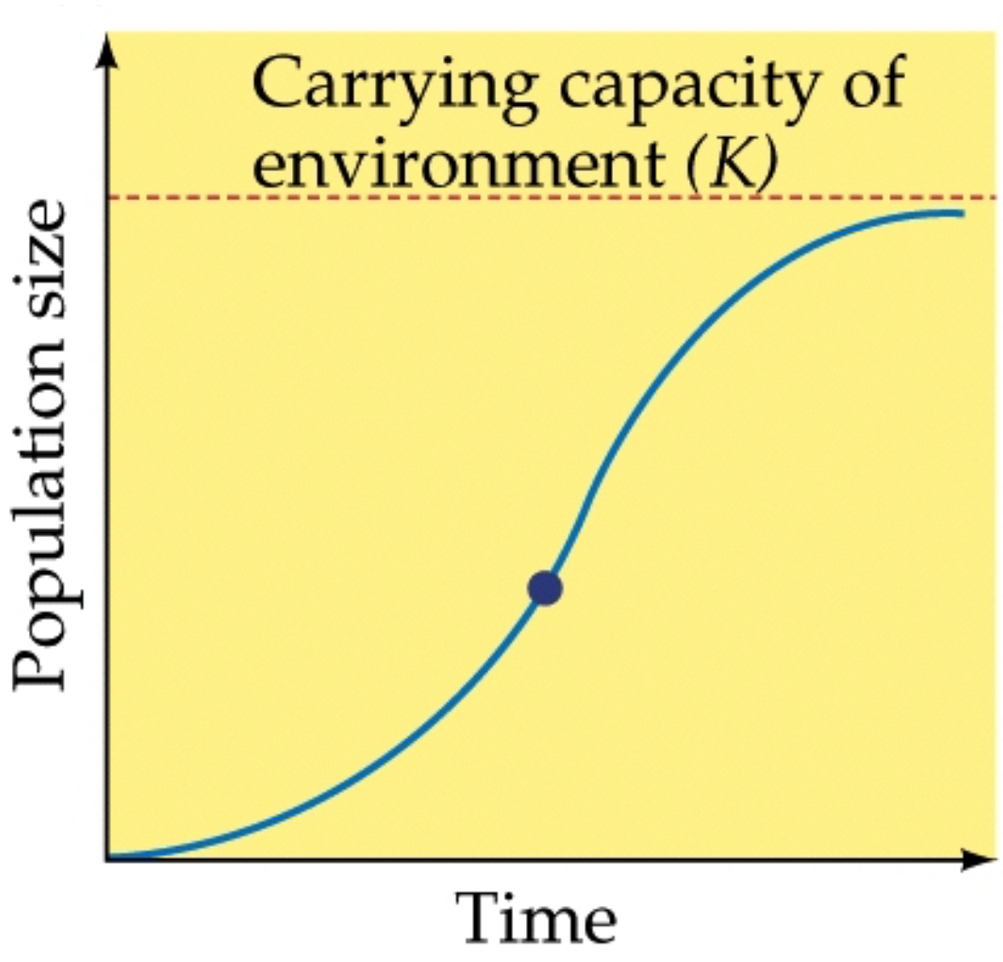
54.1 Life Table of the 1978 Cohort of Darwin's Ground Finch (Geospiza scandens) on Isla Daphne

AGE IN YEARS (X)	NUMBER ALIVE	SURVIVORSHIP[a]	SURVIVAL RATE[b]	MORTALITY RATE[c]
0	210	1.000	0.434	0.566
1	91	0.434	0.855	0.143
2	78	0.371	0.898	0.102
3	70	0.333	0.928	0.072
4	65	0.309	0.955	0.045
5	62	0.295	0.678	0.322
6	42	0.200	0.545	0.455
7	23	0.109	0.651	0.349
8	15	0.071	0.944	0.056
9	14	0.067	0.776	0.224
10	11	0.052	0.923	0.077
11	10	0.048	0.396	0.604
12	4	0.019	0.737	0.263
13	3	0.014	0.714	0.004

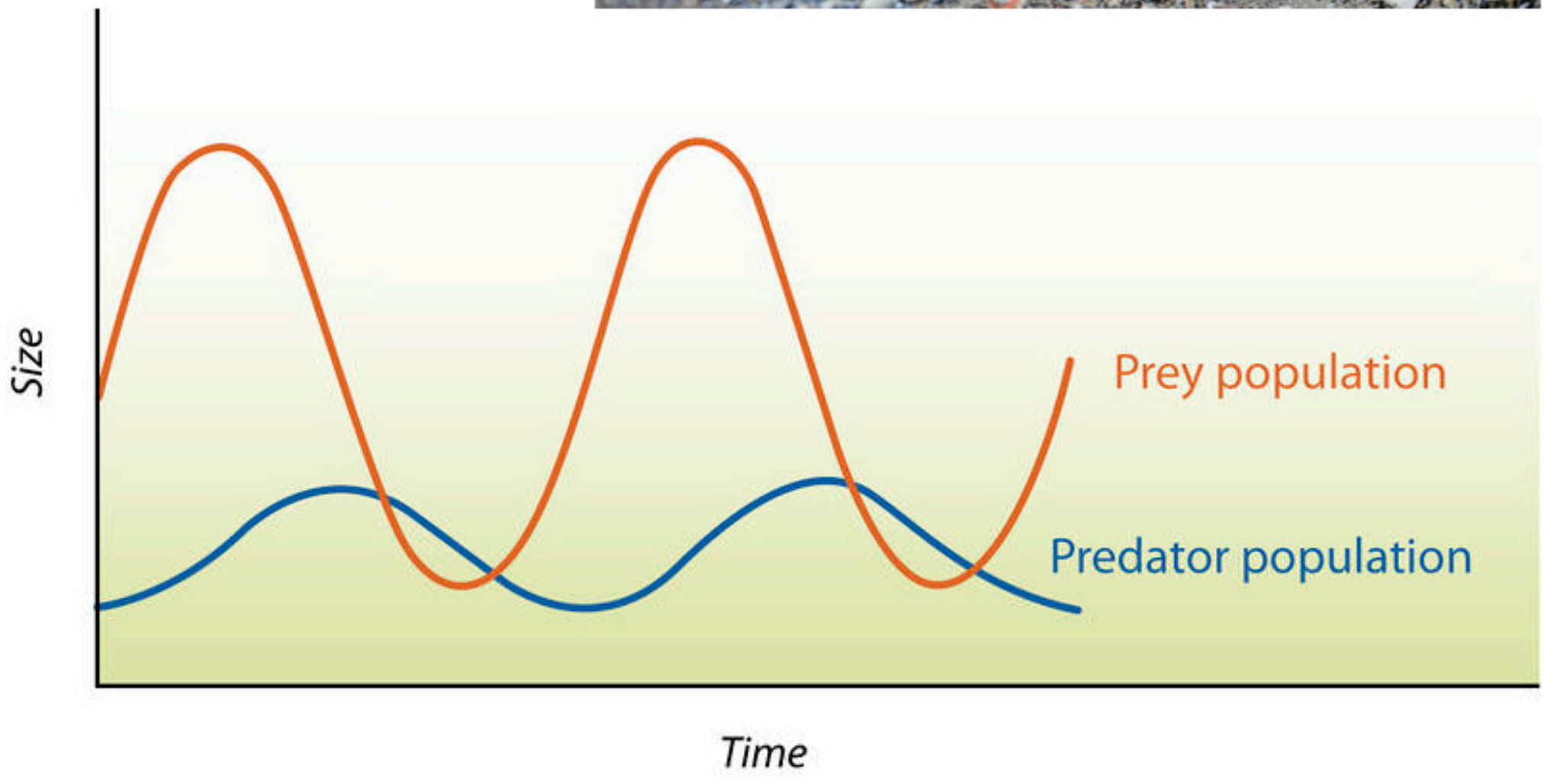
[a]Survivorship = the proportion of newborns who survive to age x.
[b]Survival rate = the proportion of individuals of age x who survive to age $x + 1$.
[c]Mortality rate = the proportion of individuals of age x who die before the age of $x + 1$.



Geospiza scandens



Theoretical Population Growth
-with No limitations.


Size
Prey population
Predator population
Time

https://www.worldometers.info/world-population/

Current World Population

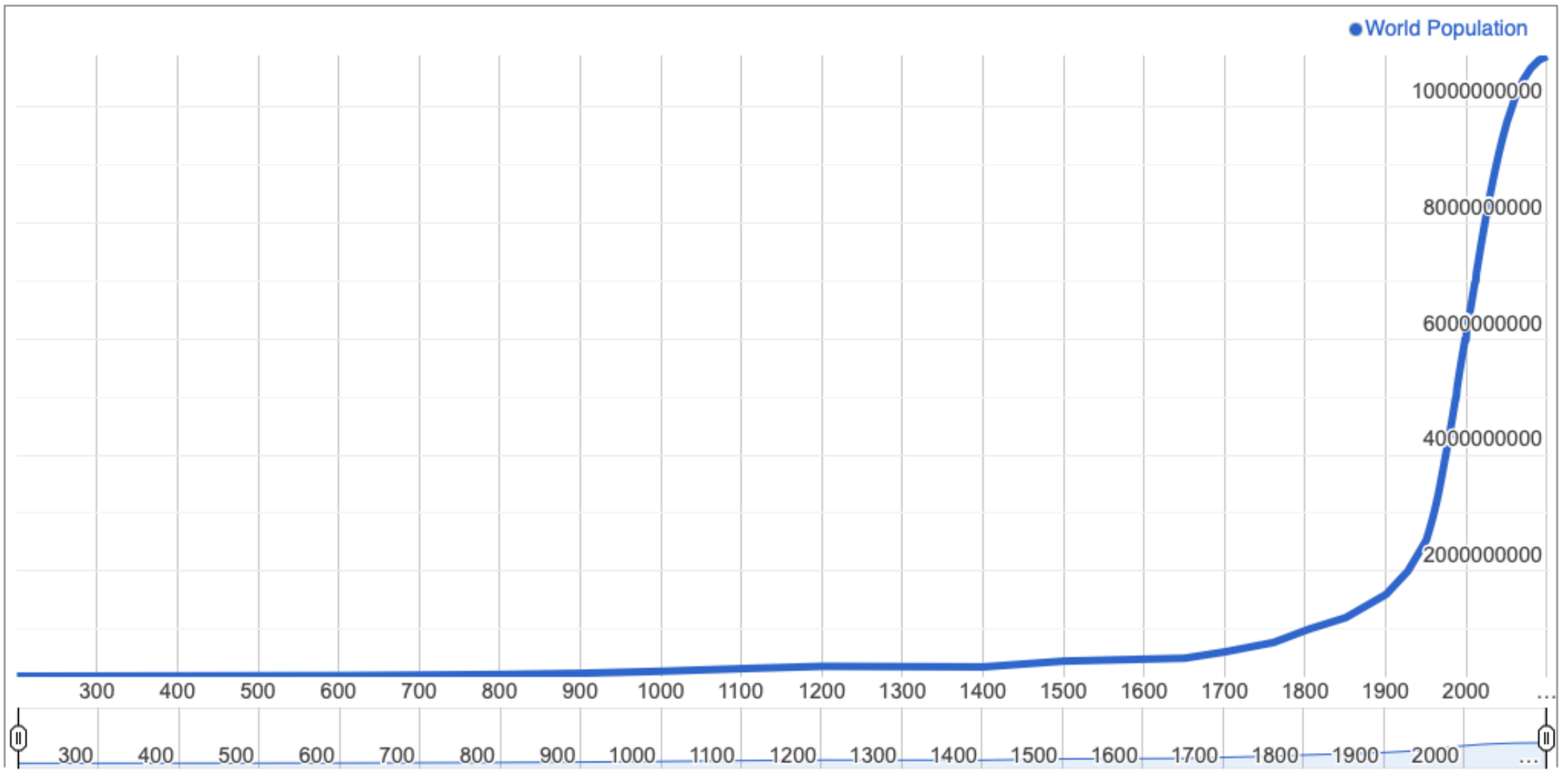
8,012,797,165

view all people on 1 page >

World Population: Past, Present, and Future

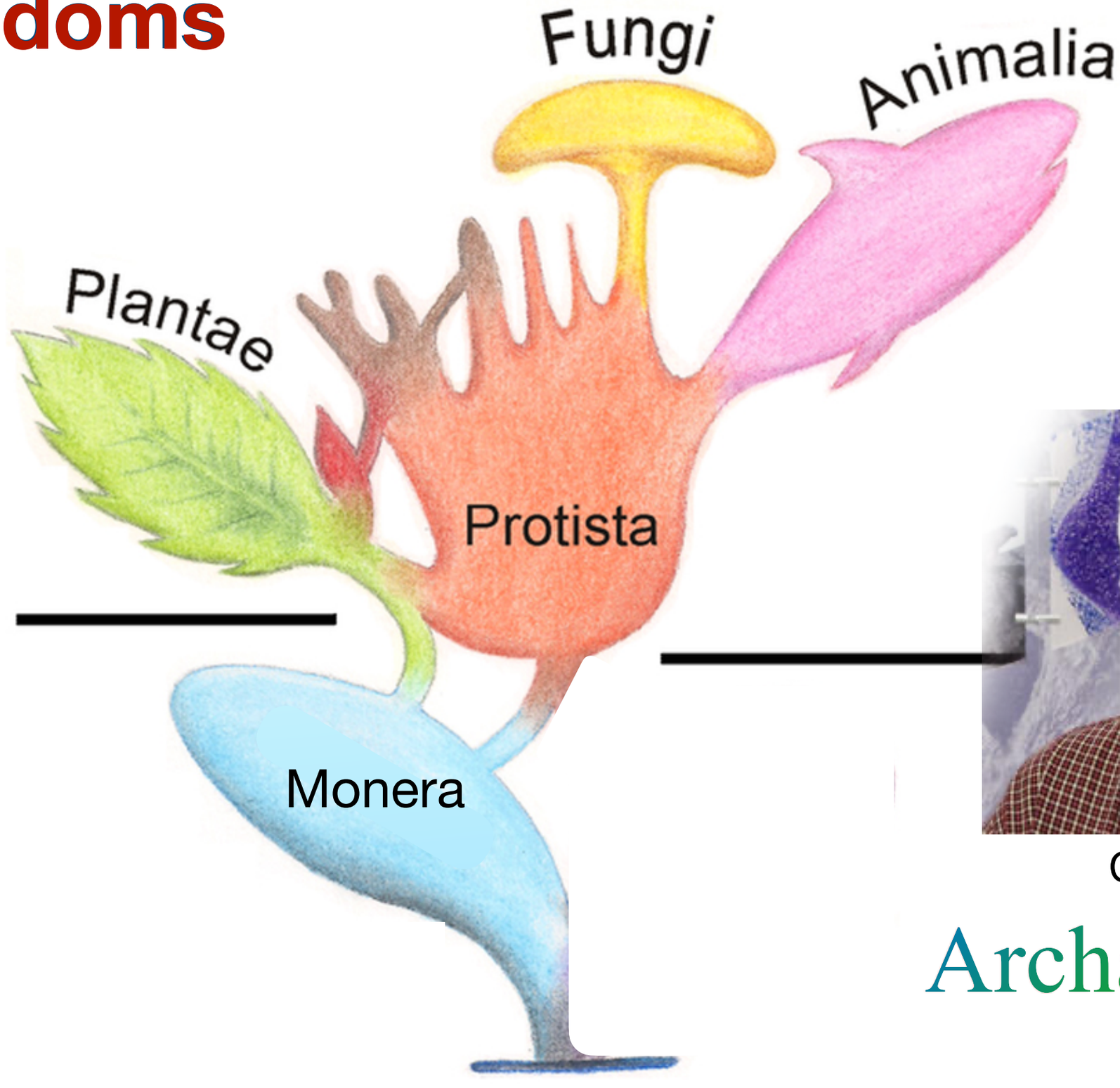
(move and expand the bar at the bottom of the chart to navigate through time)

back to top ↑



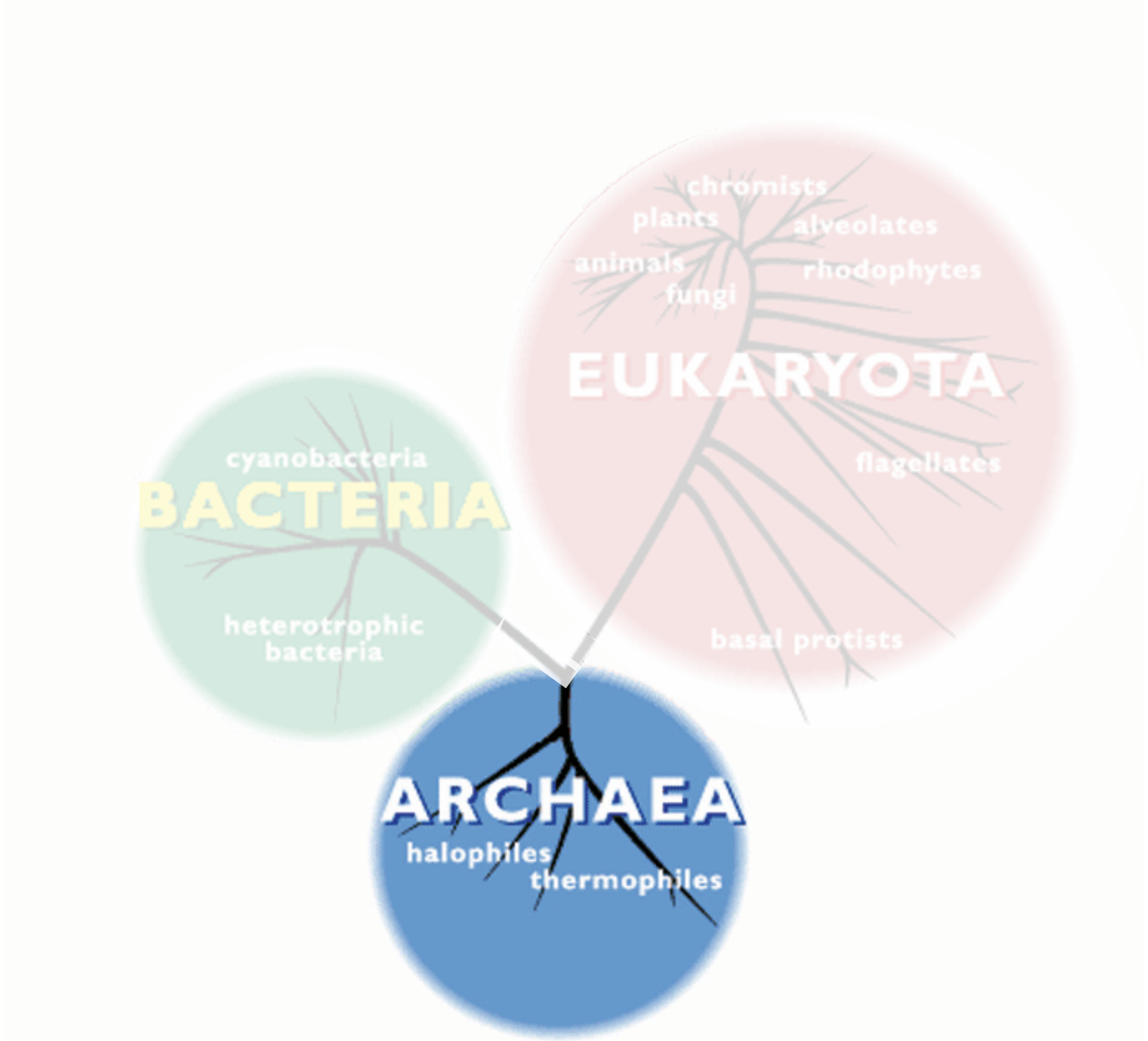
The chart above illustrates how world population has changed throughout history. View the full tabulated data.

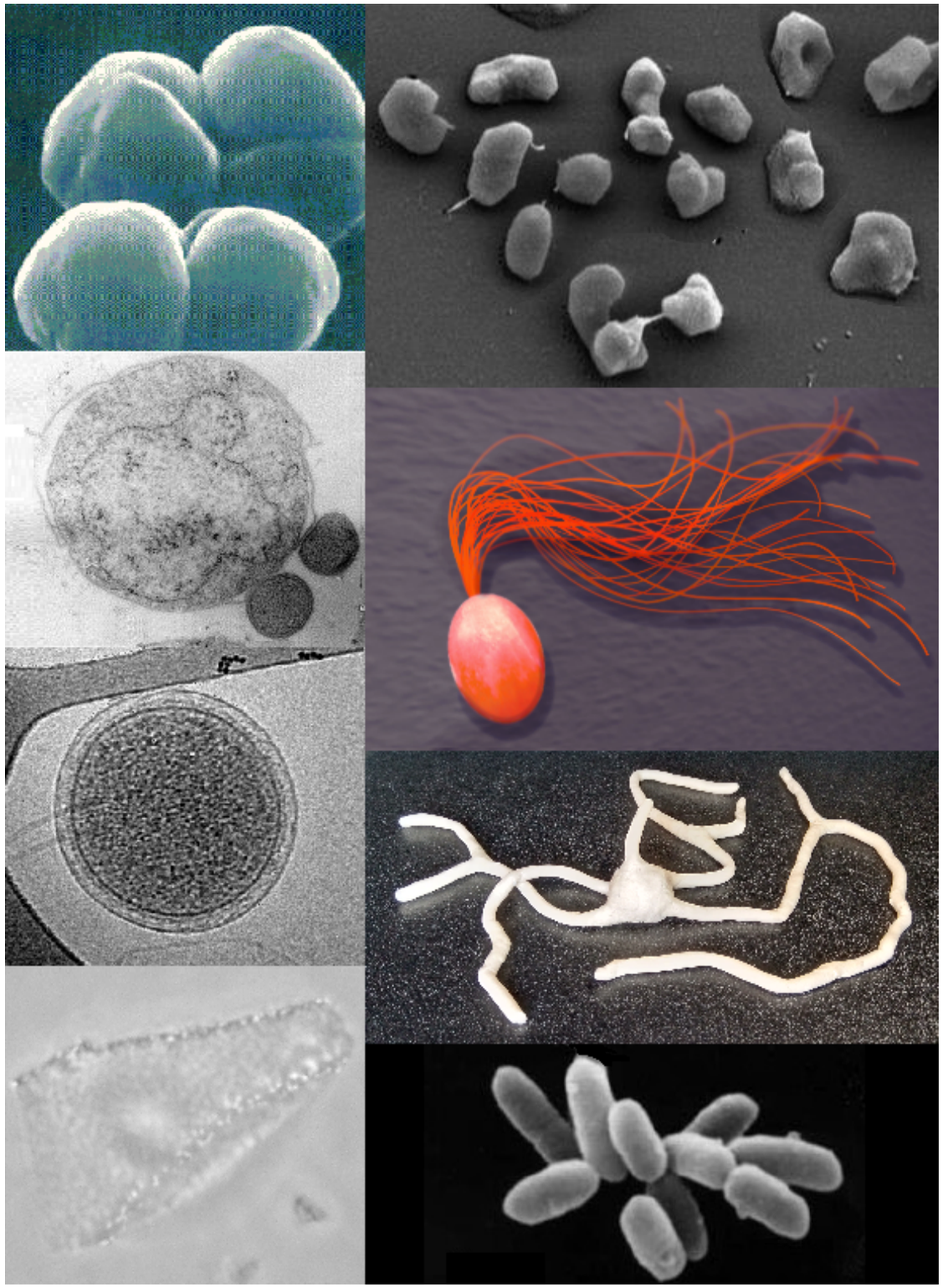
6 kingdoms

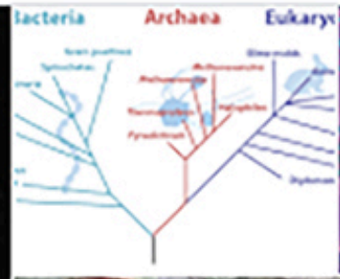


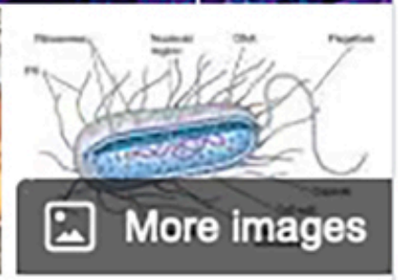
Carl Woes

Archaea


chromists
plants
alveolates
animals
rhodophytes
fungi
EUKARYOTA
flagellates
basal protists
cyanobacteria
BACTERIA
heterotrophic
bacteria
ARCHAEA
halophiles
thermophiles







Archaeans

Archaea constitute a domain of single-celled organisms. These microorganisms lack cell nuclei and are therefore prokaryotes. Archaea were initially classified as bacteria, receiving the name archaebacteria, but this classification is outmoded. Wikipedia

Organism classification: Euryarchaeota

Scientific name: Archaea

Rank: Domain

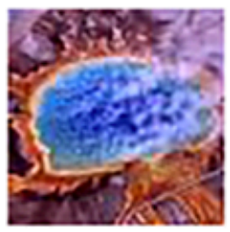
Higher classification: Neomura

Lower classifications

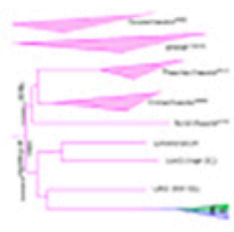
View 2+ more


Euryarch…


Crenarch…


Bathyarc…

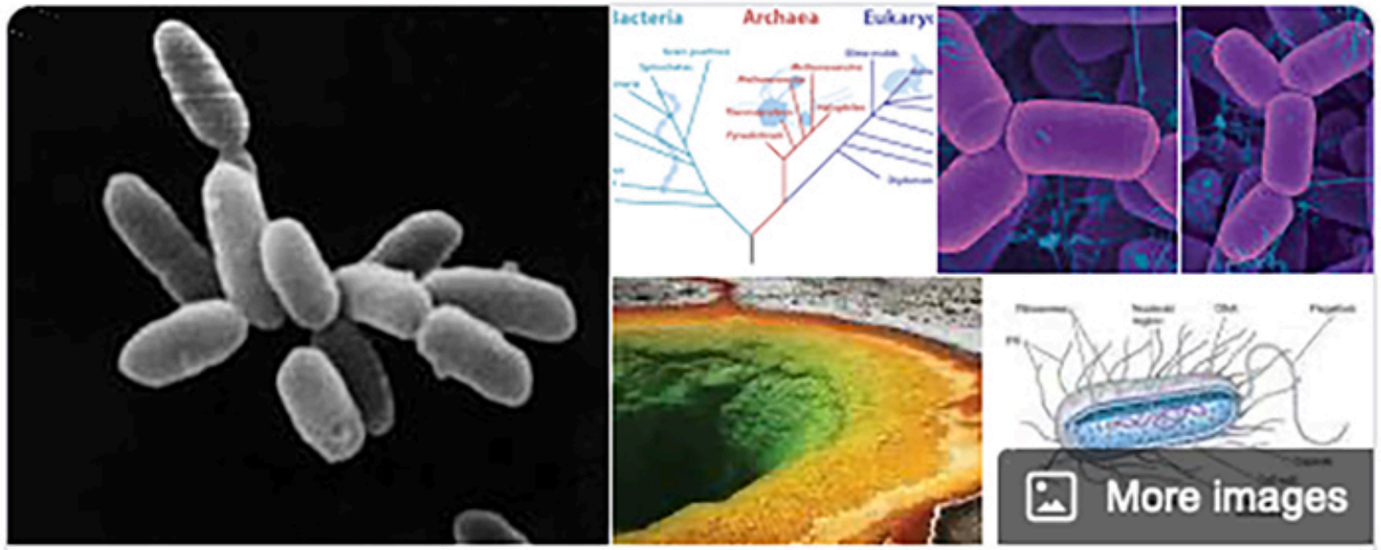

Thaumar…


Lokiarch…

Diversity of Archaea

Though archaeans are involved in many important ecological processes and present across Earth's ecosystems, they are most known for being **extremophiles**, existing in conditions that prevent most organisms from functioning:

- **thermophiles** live at high temperatures
- **hyperthermophiles** live at really high temperatures (present record is 121°C!)
- **psychrophiles** (also called cryophiles) like it cold (one in the Antarctic grows best at 4°C)
- **halophiles** live in very saline environments (like the Dead Sea)
- **acidophiles** live at low pH (as low as pH 1 and who die at pH 7!)
- **alkaliphiles** thrive at a high pH.



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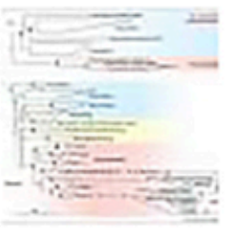
Lower classifications

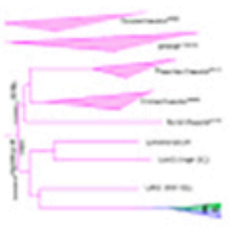
View 2+ more


Euryarch…


Crenarch…


Bathyarc…


Thaumar…


Lokiarch…

	Domain		
	Bacteria	**Archea**	**Eukarya**
Nucleus	absent	absent	present
Organelles	absent (?)	absent (?)	present
Peptidoglycan Wall	present	absent	absent
RNA polymerase	only one	several	several
Initiating tRNA amino acid	F-methionine	methionine	methionine
Introns	very rare	some	very common
Response to antibiotics strep and chloramphenicol	no growth	growth	growth
Circular chromosome	present	present	absent
Histones surround DNA	absent	some species	present
Growth at >100 C	No	some species	No

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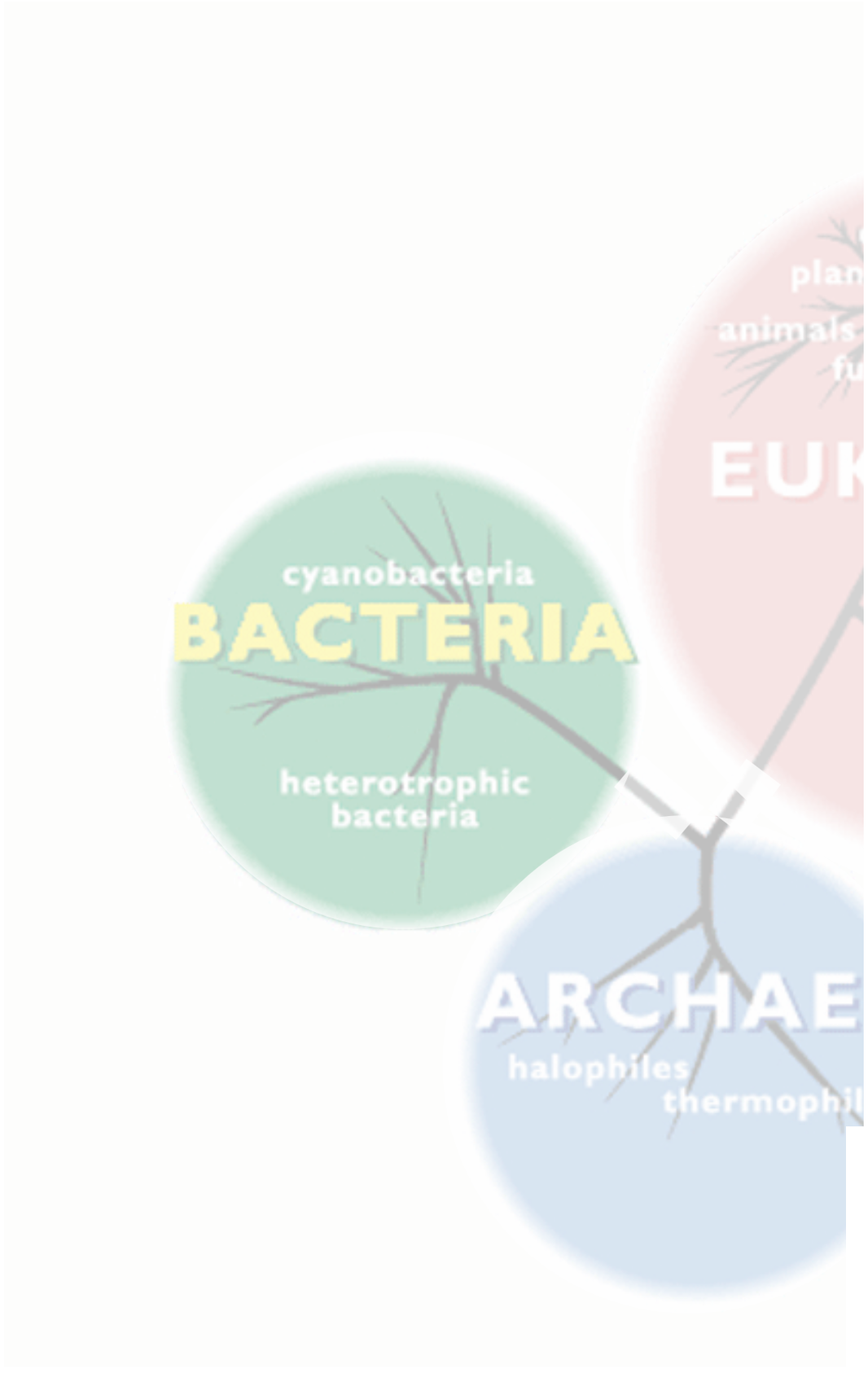
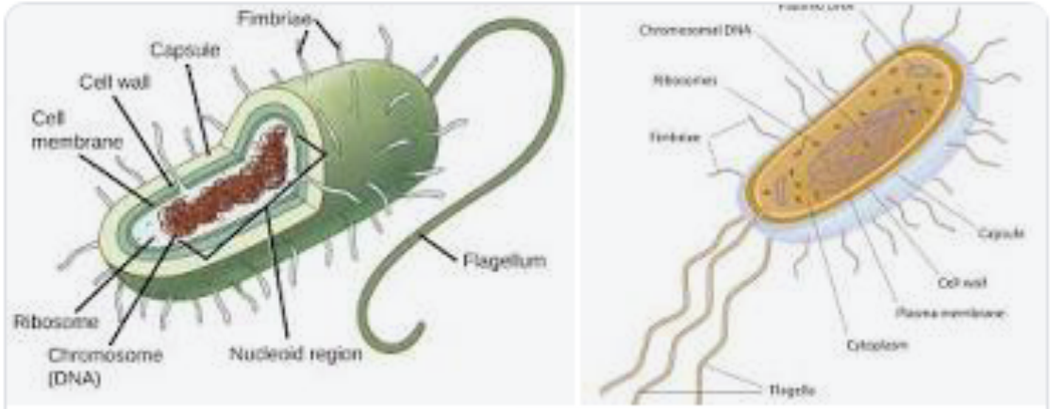
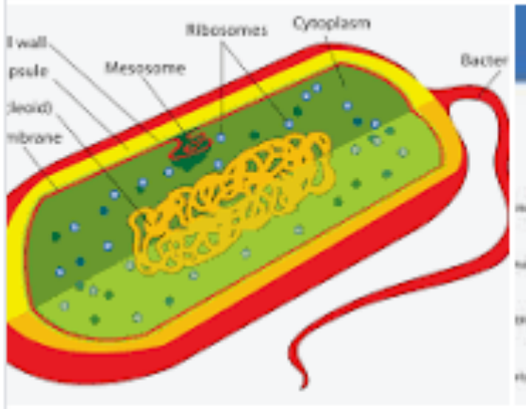
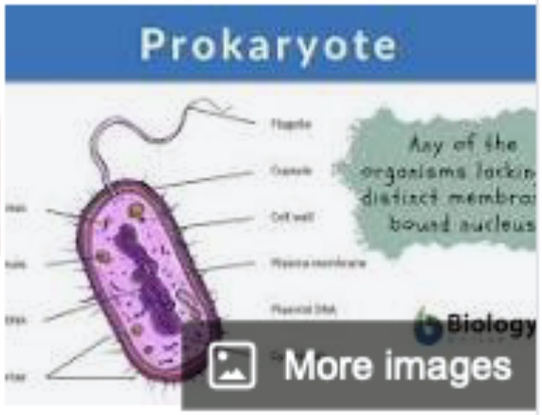








Prokaryote

A prokaryote is a typically unicellular organism that lacks a nuclear membrane-enclosed nucleus. The word prokaryote comes from the Greek πρό and κάρυον. In the two-empire system arising from the work of Édouard Chatton, prokaryotes were classified within the empire Prokaryota. Wikipedia

Bacteria prokaryotic

View 35+ more

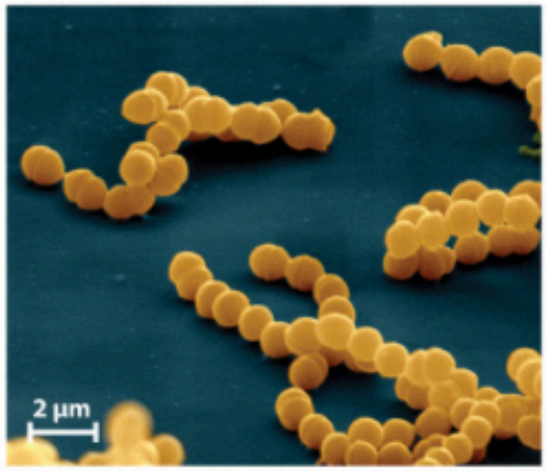

Cyanoba…


Spirocha…

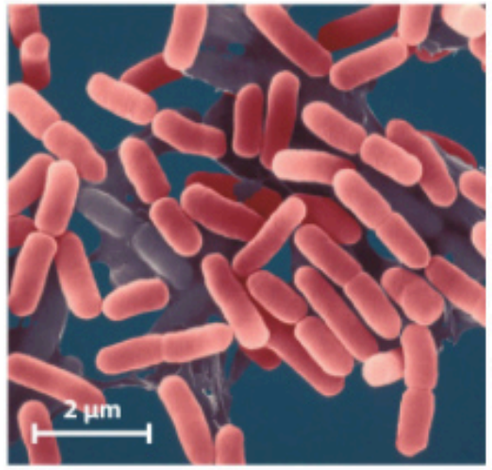

Escheric…


Proteoba…

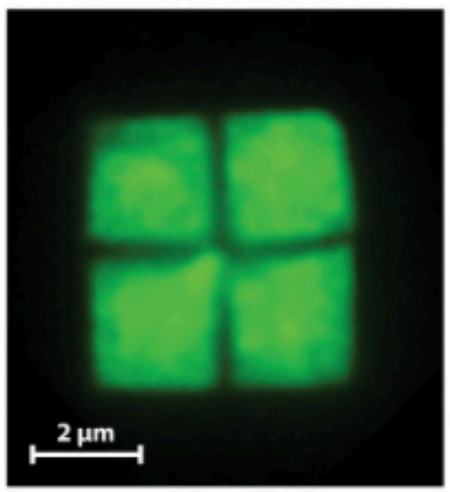
a. *Streptococcus*, strings of spheroidal or coccoidal bacteria



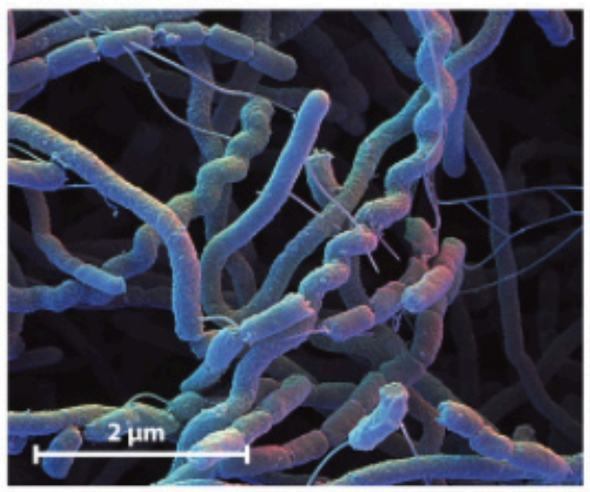
b. *E. coli*, bacterial rods



c. *Haloquadratum walsbyi*, a square archaeon that lives in salt ponds

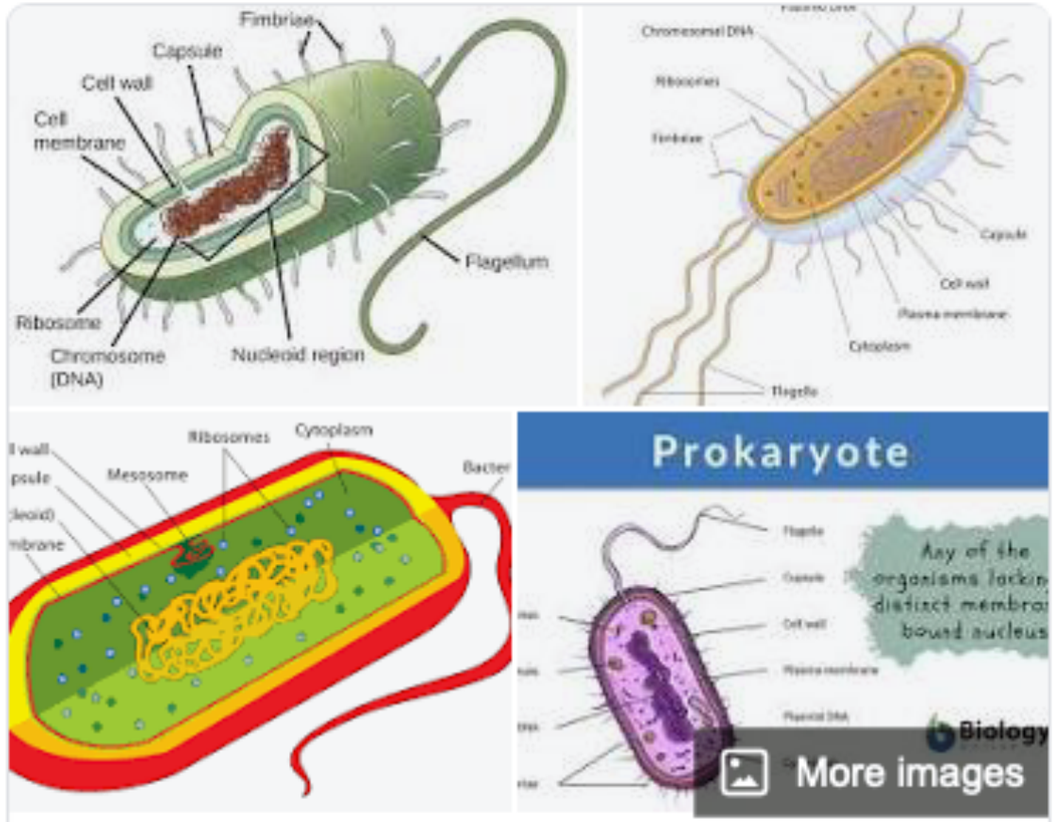


d. *Streptomyces*, helical bacteria that produce antibiotics



e. A myxobacterium, a bacterium in which cells aggregate to form fruiting bodies

Figure 26.2: **Cell shape and size in Bacteria and Archaea.**



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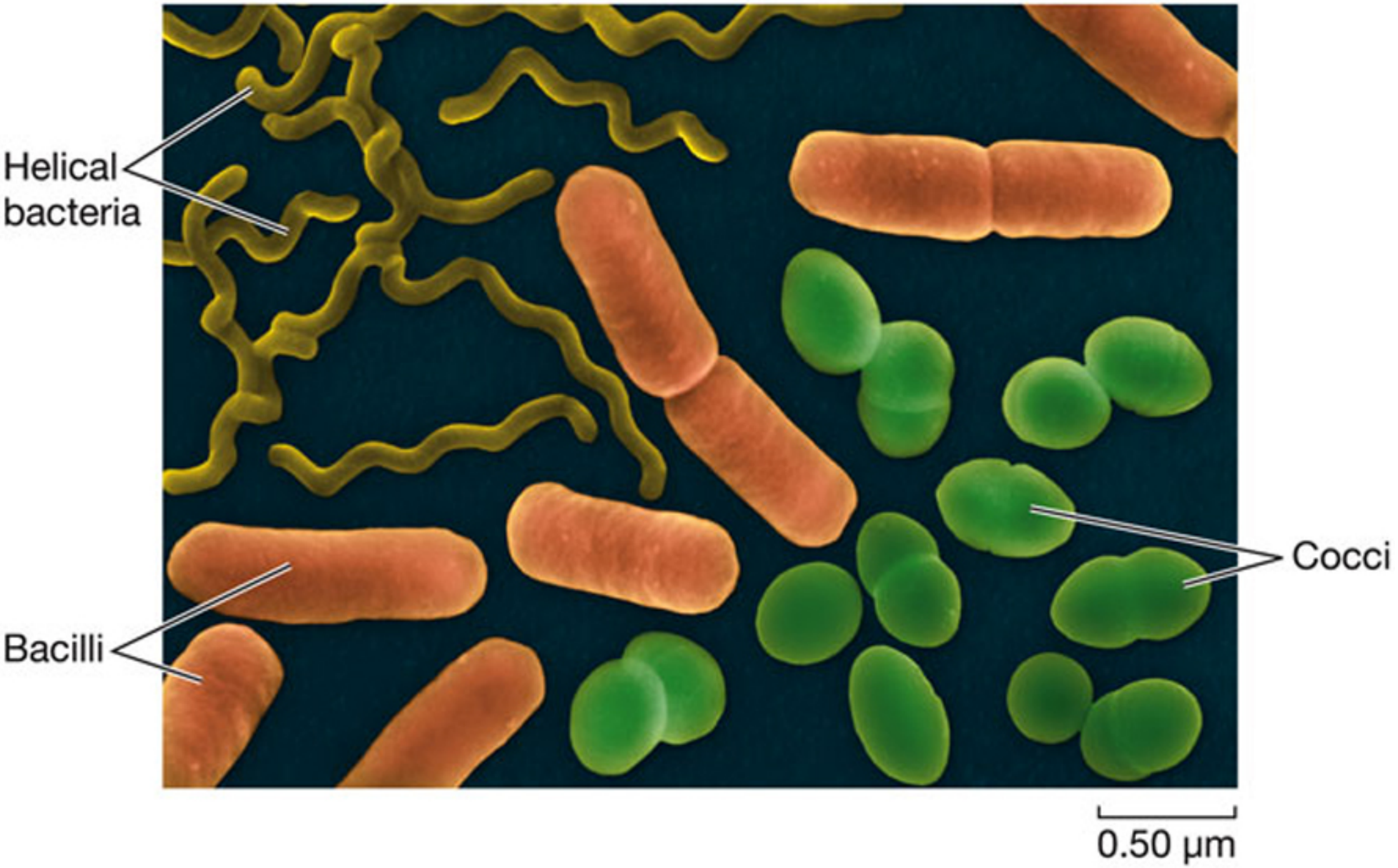
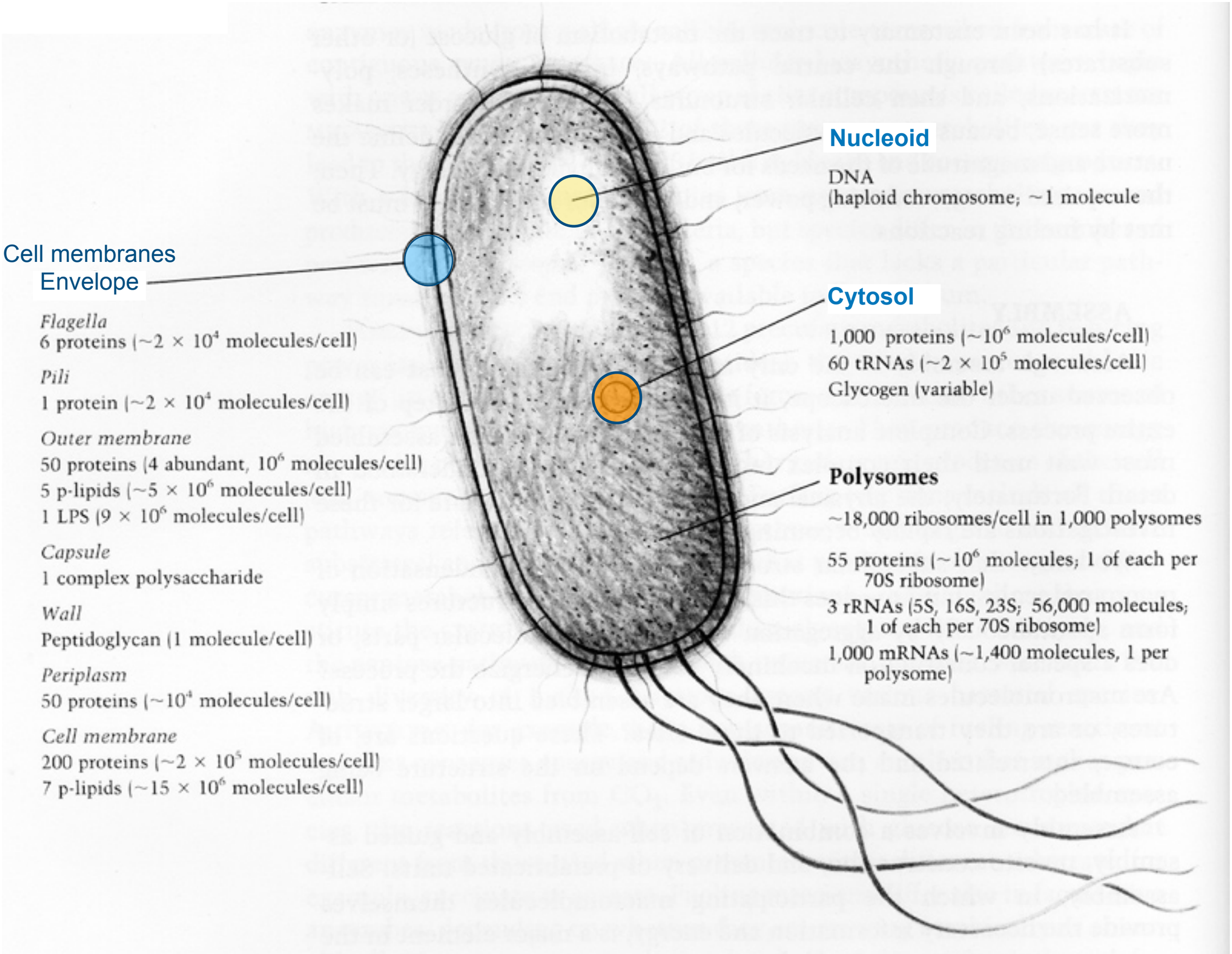
Bacteria prokaryotic

View 35+ more

Cyanoba… Spirocha… Escheric… Proteoba…


Helical bacteria
Bacilli
Cocci
0.50 µm


Cell membranes
Envelope
Flagella
6 proteins (~2 × 10⁴ molecules/cell)
Pili
1 protein (~2 × 10⁴ molecules/cell)
Outer membrane
50 proteins (4 abundant, 10⁶ molecules/cell)
5 p-lipids (~5 × 10⁶ molecules/cell)
1 LPS (9 × 10⁶ molecules/cell)
Capsule
1 complex polysaccharide
Wall
Peptidoglycan (1 molecule/cell)
Periplasm
50 proteins (~10⁴ molecules/cell)
Cell membrane
200 proteins (~2 × 10⁵ molecules/cell)
7 p-lipids (~15 × 10⁶ molecules/cell)
Nucleoid
DNA
(haploid chromosome; ~1 molecule
Cytosol
1,000 proteins (~10⁶ molecules/cell)
60 tRNAs (~2 × 10⁵ molecules/cell)
Glycogen (variable)
Polysomes
~18,000 ribosomes/cell in 1,000 polysomes
55 proteins (~10⁶ molecules; 1 of each per 70S ribosome)
3 rRNAs (5S, 16S, 23S; 56,000 molecules; 1 of each per 70S ribosome)
1,000 mRNAs (~1,400 molecules, 1 per polysome)

C H O N P S

1 H 1.0079																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.4778	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.4	47 Ag 107.870	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	71 Lu 174.97	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 (269)	111 (272)	112 (277)	113	114 (285)	115 (289)	116	117	118 (293)

Chemical symbol

Atomic number

Atomic mass (average of all isotopes)

Lanthanide series	57 La 138.906	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04
Actinide series	89 Ac 227.028	90 Th 232.038	91 Pa 231.0359	92 U 238.02	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)

C H O Carbon cycle

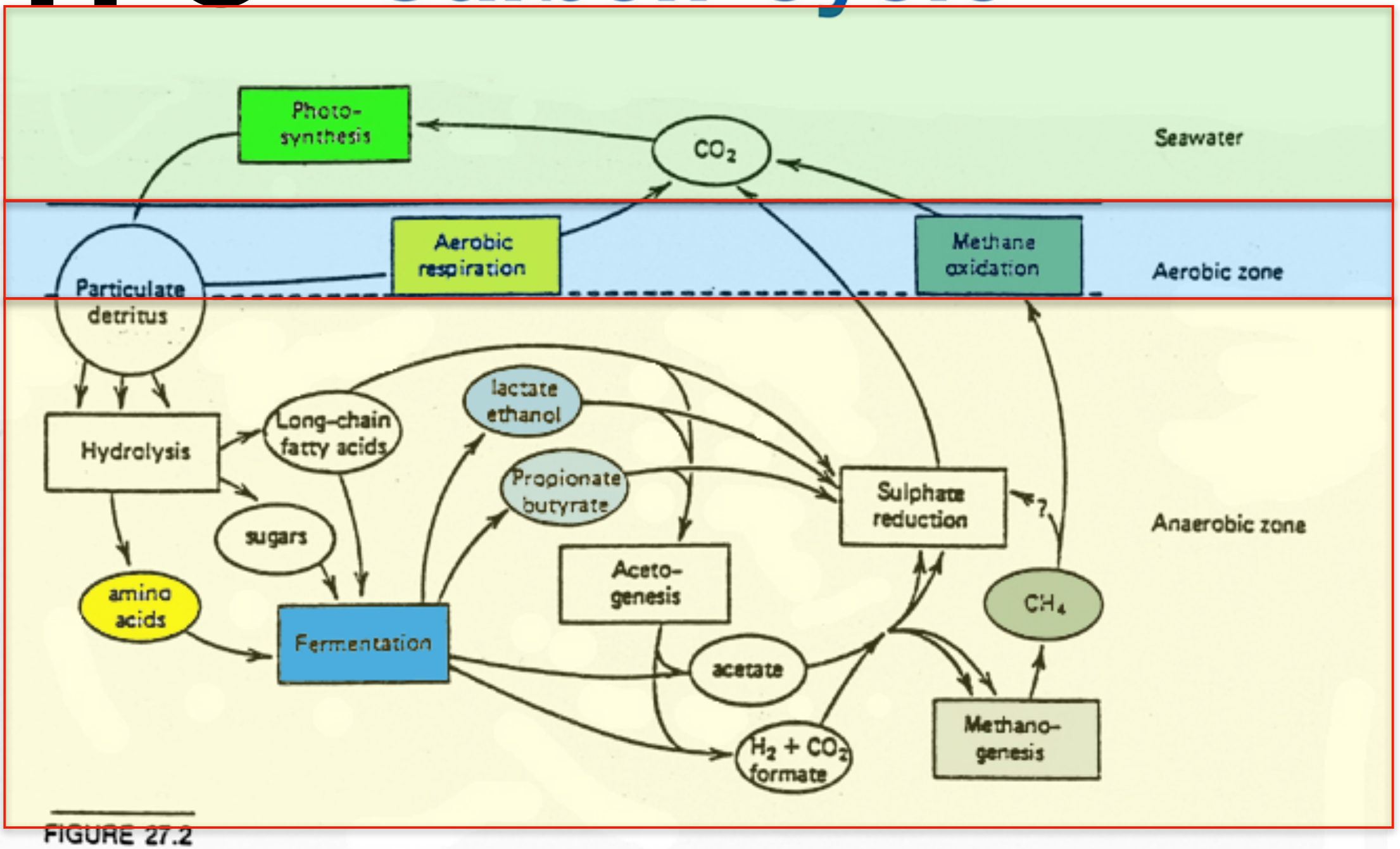
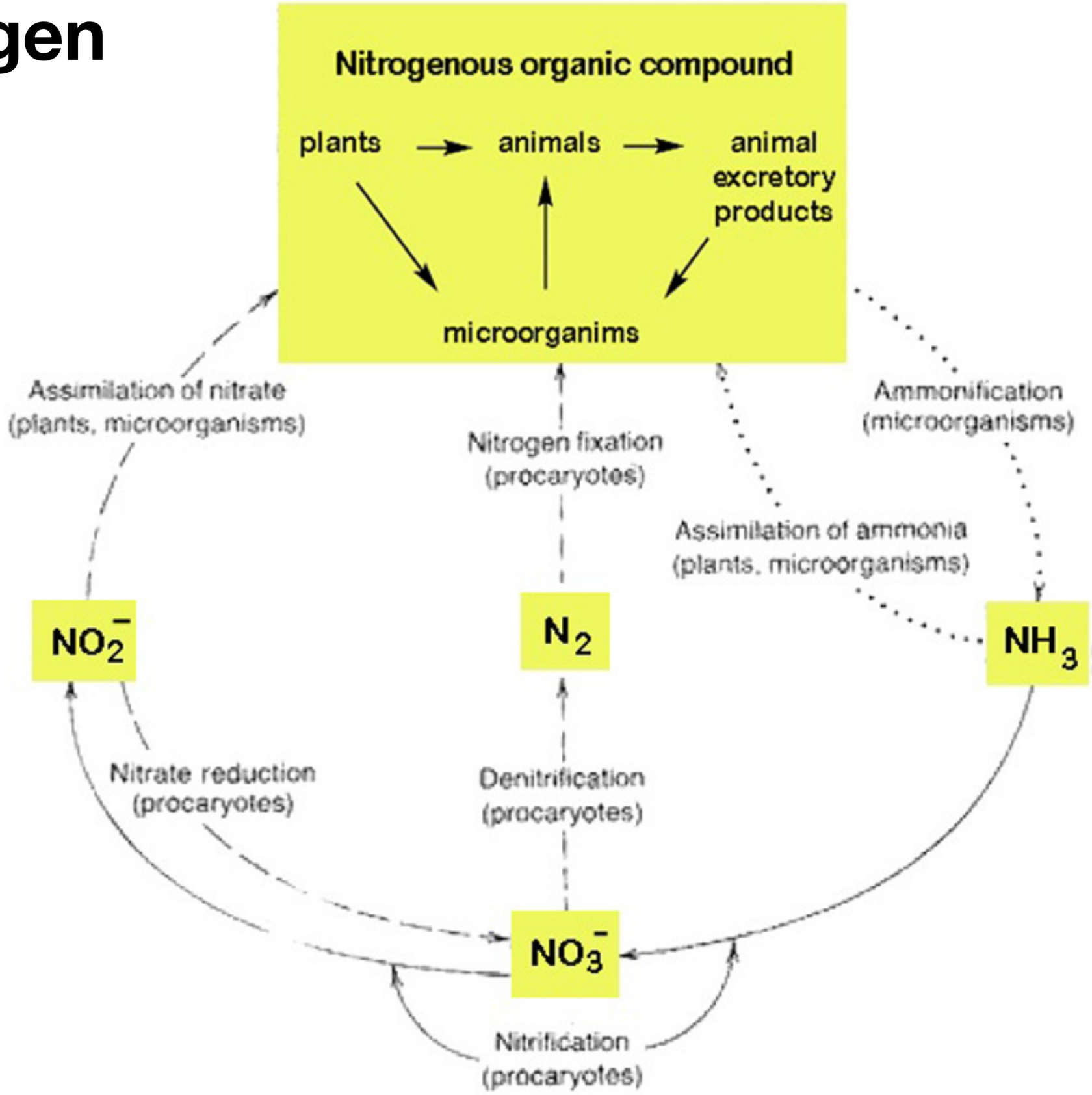


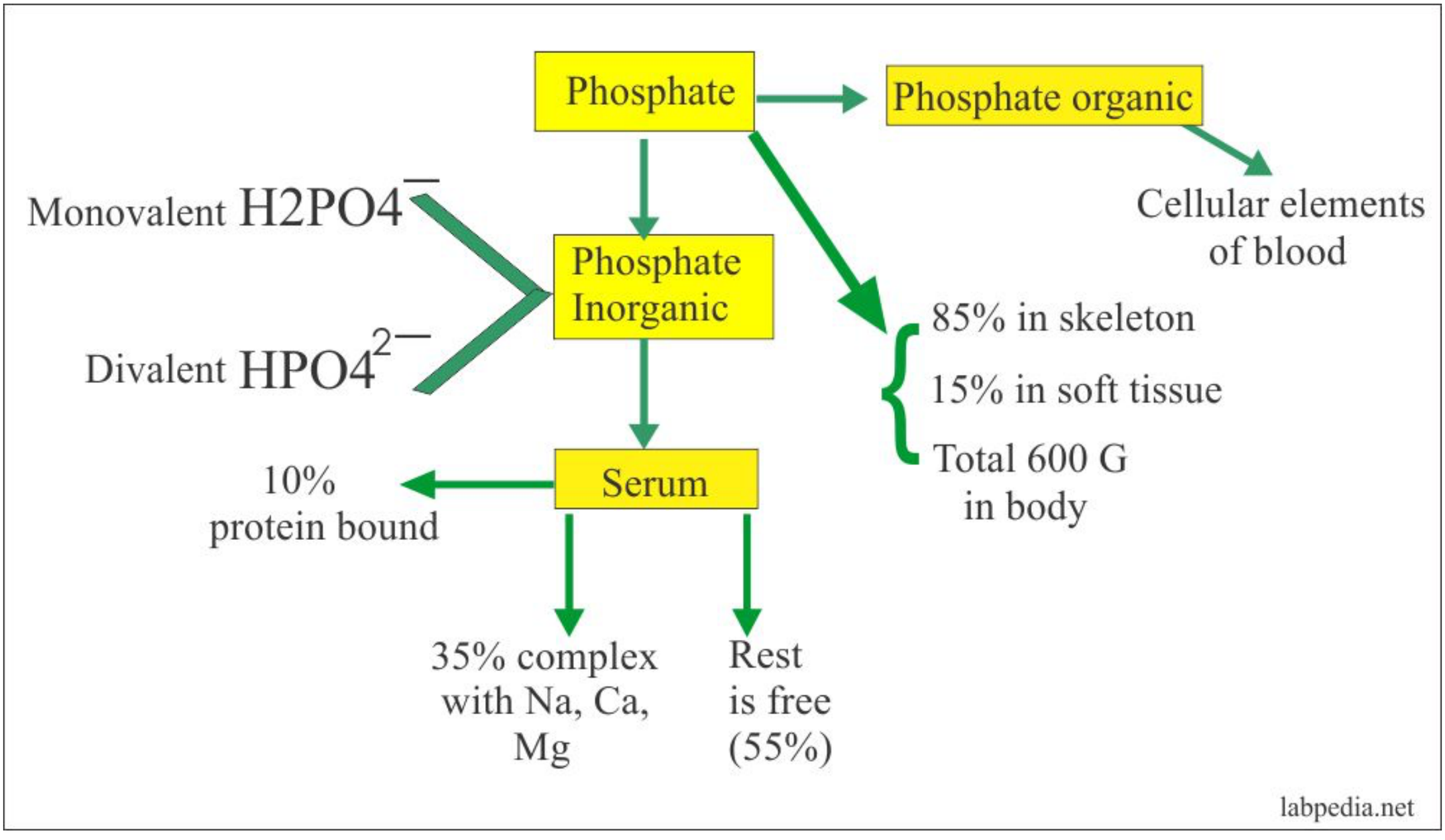
FIGURE 27.2

Degradation and cycling of organic matter in sediments in relation to bacterial sulphate reduction and methanogenesis. After T. H. Blackburn, "The Microbial Nitrogen Cycle," in Krumbein, W. E., ed., *Microbial Geochemistry*, Boston: Blackwell Publications (1983).

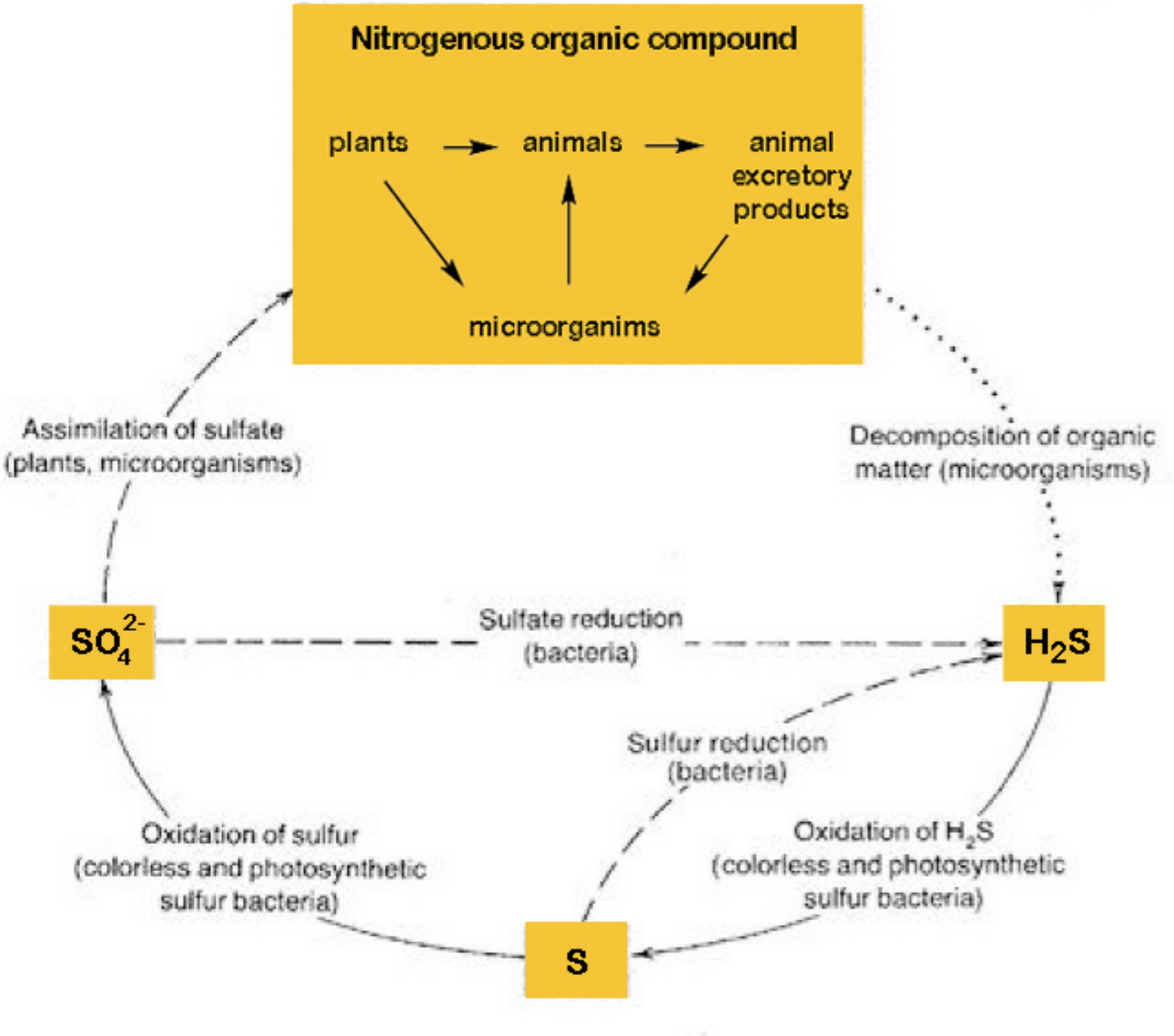
Nitrogen


Nitrogenous organic compound
plants
animals
animal excretory products
microorganims
Assimilation of nitrate (plants, microorganisms)
Nitrogen fixation (procaryotes)
Assimilation of ammonia (plants, microorganisms)
Ammonification (microorganisms)
NO_2^-
N_2
NH_3
Nitrate reduction (procaryotes)
Denitrification (procaryotes)
NO_3^-
Nitrification (procaryotes)

Phosphorus


Phosphate
Phosphate organic
Cellular elements of blood
Monovalent $H2PO4^-$
Divalent $HPO4^{2-}$
Phosphate Inorganic
85% in skeleton
15% in soft tissue
Total 600 G in body
10% protein bound
Serum
35% complex with Na, Ca, Mg
Rest is free (55%)
labpedia.net

Sulphur

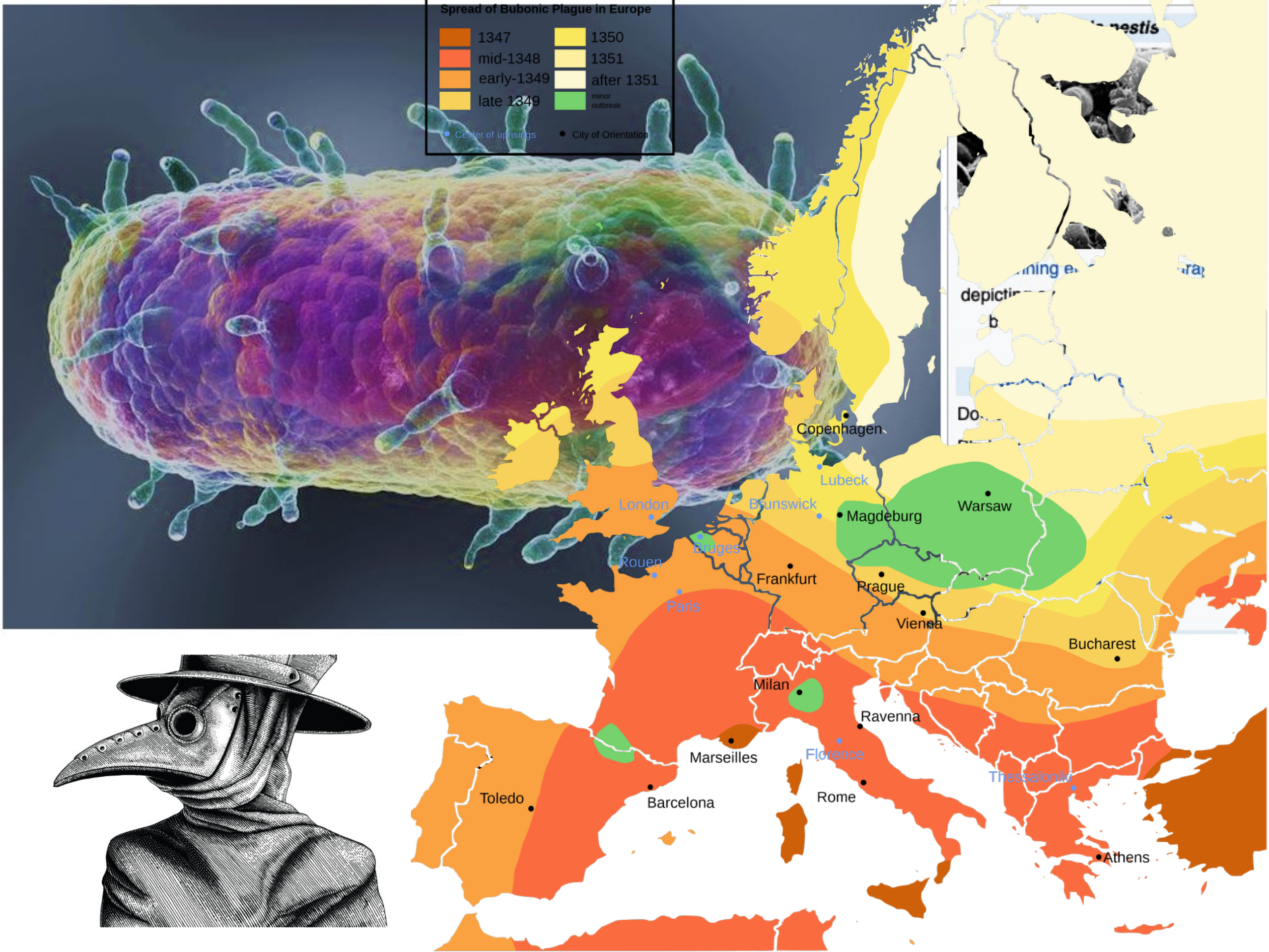

Nitrogenous organic compound
plants
animals
animal excretory products
microorganims
Assimilation of sulfate (plants, microorganisms)
Decomposition of organic matter (microorganisms)
SO_4^{2-}
Sulfate reduction (bacteria)
H_2S
Sulfur reduction (bacteria)
Oxidation of sulfur (colorless and photosynthetic sulfur bacteria)
Oxidation of H_2S (colorless and photosynthetic sulfur bacteria)
S

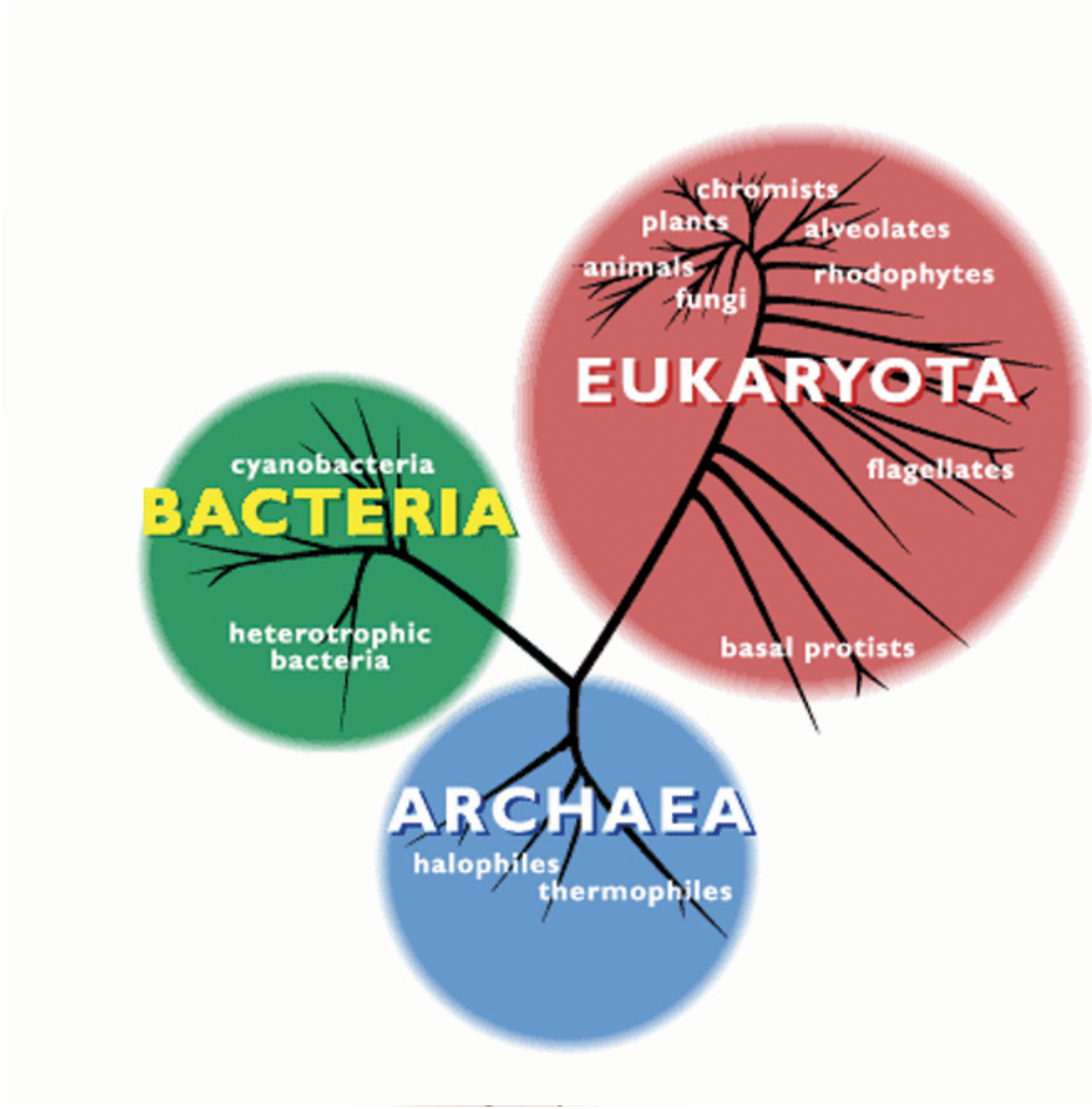
Yersinia pestis

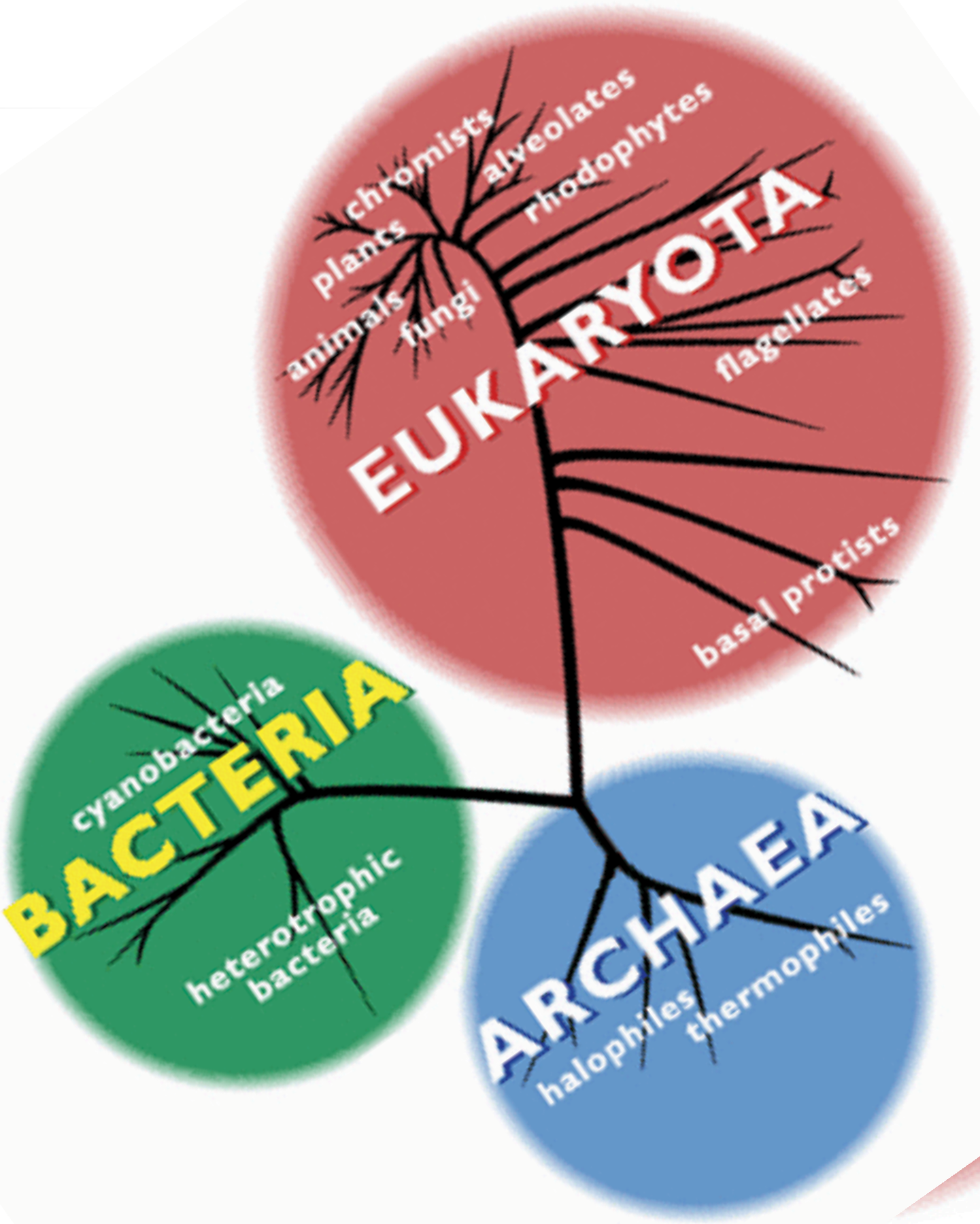
A scanning electron micrograph depicting a mass of *Yersinia pestis* bacteria in the foregut of an infected flea

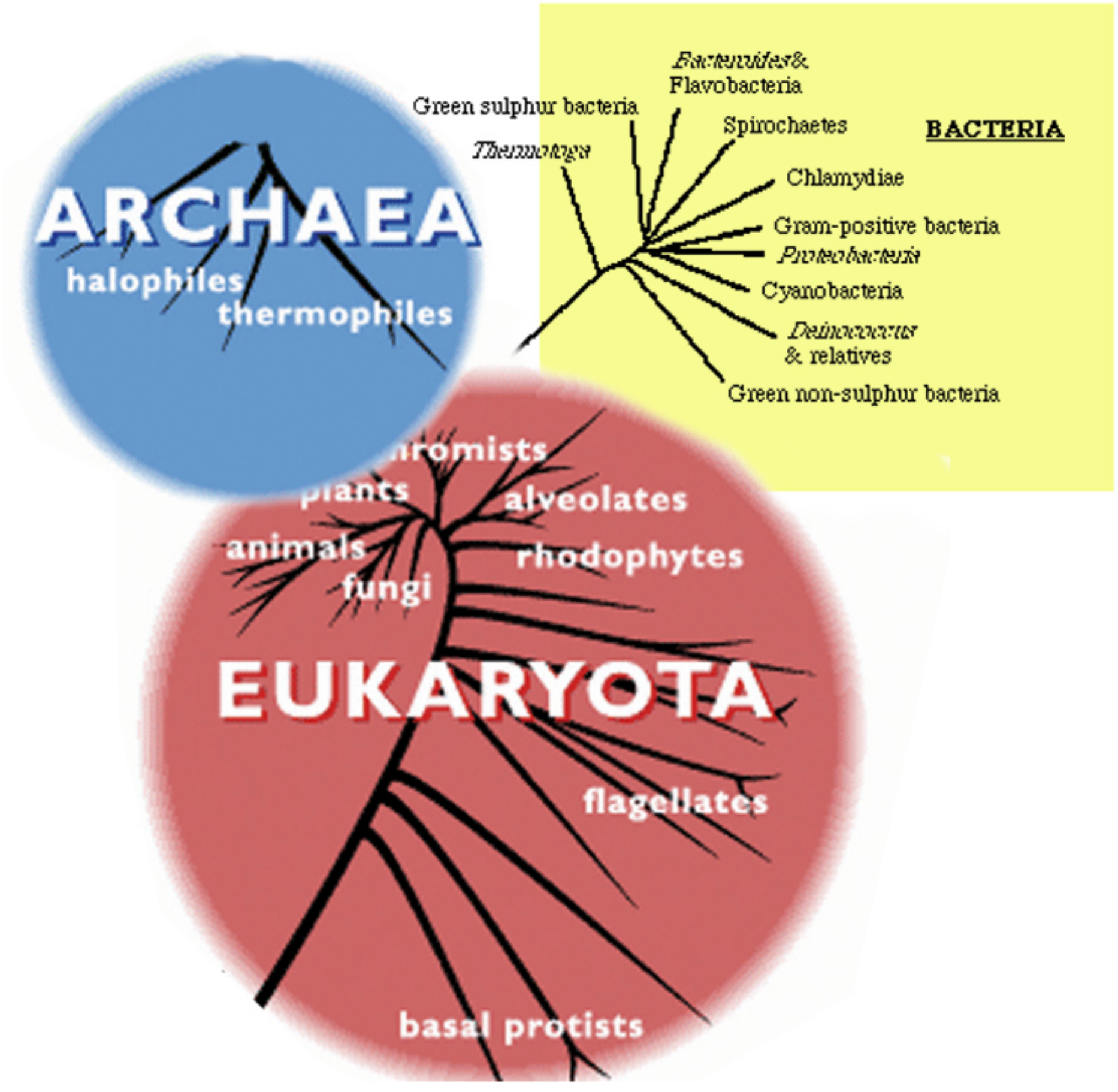
Scientific classification

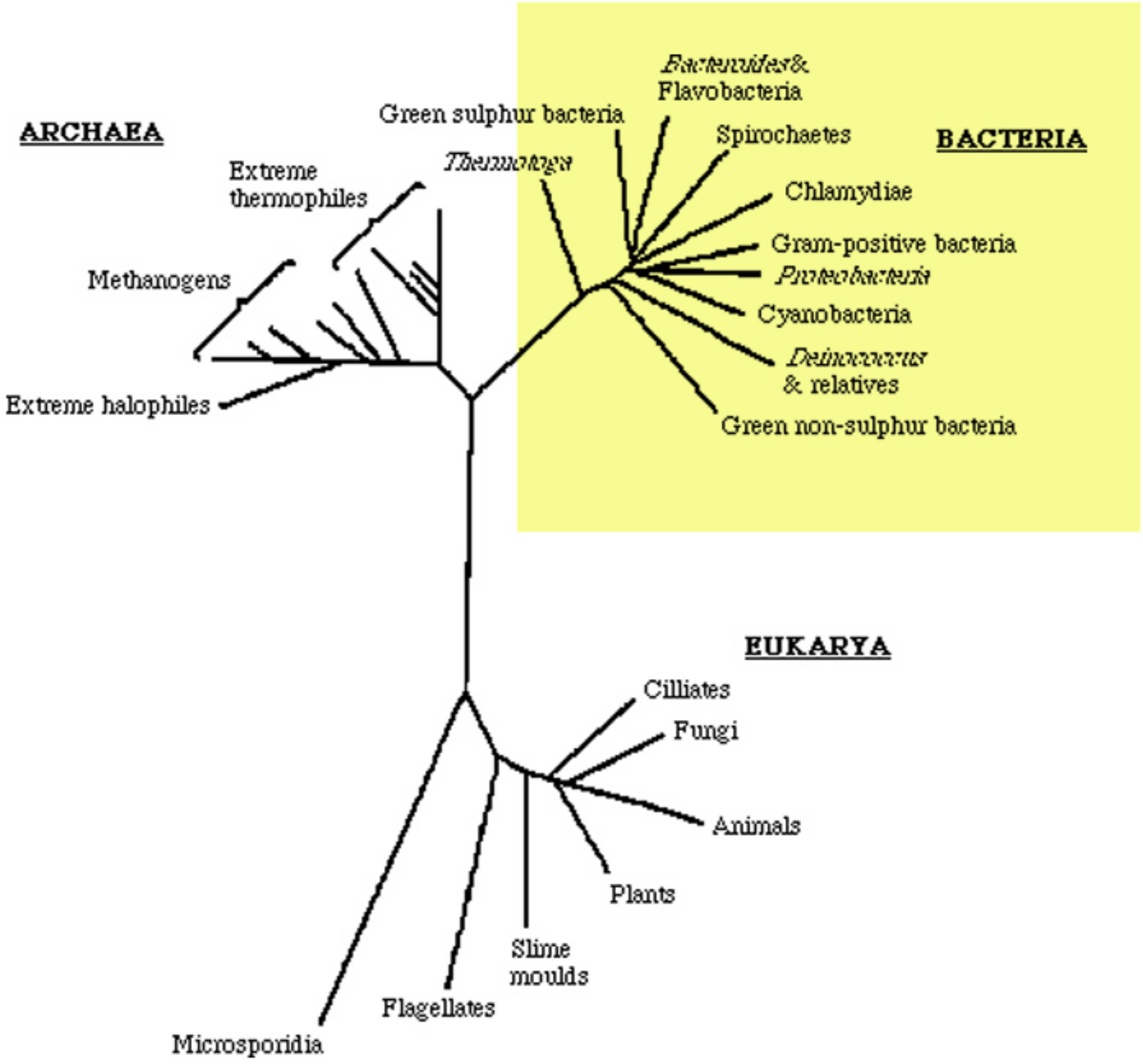
Domain:	Bacteria
Phylum:	Proteobacteria
Class:	Gammaproteobacteria
Order:	Enterobacterales
Family:	Yersiniaceae
Genus:	*Yersinia*
Species:	***Y. pestis***


Spread of Bubonic Plague in Europe
1347
mid-1348
early-1349
late 1349
1350
1351
after 1351
minor outbreak
Center of uprisings
City of Orientation
Copenhagen
Lubeck
London
Brunswick
Magdeburg
Warsaw
Bruges
Rouen
Frankfurt
Prague
Paris
Vienna
Bucharest
Milan
Ravenna
Marseilles
Florence
Thessaloniki
Toledo
Barcelona
Rome
Athens


chromists
plants
alveolates
animals
rhodophytes
fungi
EUKARYOTA
flagellates
cyanobacteria
BACTERIA
heterotrophic
bacteria
basal protists
ARCHAEA
halophiles
thermophiles

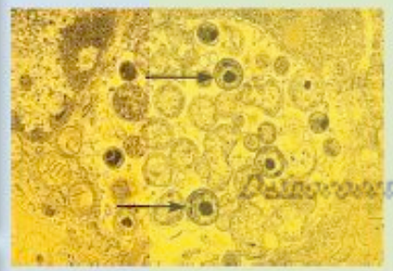

chromists
alveolates
rhodophytes
plants
animals
fungi
EUKARYOTA
flagellates
basal protists
cyanobacteria
BACTERIA
heterotrophic bacteria
ARCHAEA
halophiles
thermophiles


ARCHAEA
halophiles
thermophiles
Green sulphur bacteria
Thermotoga
Bacteroides &
Flavobacteria
Spirochaetes
BACTERIA
Chlamydiae
Gram-positive bacteria
Proteobacteria
Cyanobacteria
Deinococcus
& relatives
Green non-sulphur bacteria
chromists
plants
alveolates
animals
rhodophytes
fungi
EUKARYOTA
flagellates
basal protists


ARCHAEA
Extreme thermophiles
Methanogens
Extreme halophiles
Green sulphur bacteria
Thermotoga
Fusobacteria & Flavobacteria
Spirochaetes
BACTERIA
Chlamydiae
Gram-positive bacteria
Planctomycetes
Cyanobacteria
Deinococcus & relatives
Green non-sulphur bacteria
EUKARYA
Cilliates
Fungi
Animals
Plants
Slime moulds
Flagellates
Microsporidia

Chlamydias

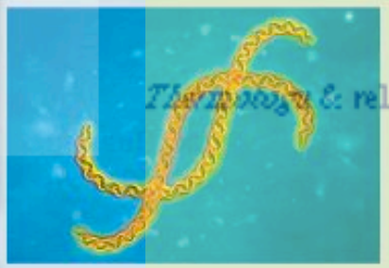
These parasites can survive only within animal cells, depending on their hosts for resources as basic as ATP. The gram-negative walls of chlamydias are unusual in that they lack peptidoglycan. One species, *Chlamydia trachomatis*, is the most common cause of blindness in the world and also causes nongonococcal urethritis, the most common sexually transmitted disease in the United States.



Chlamydia (arrows) inside an animal cell (colorized TEM)

Spirochetes

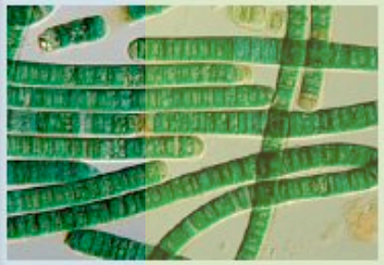
These helical heterotrophs spiral through their environment by means of rotating, internal, flagellum-like filaments. Many spirochetes are free-living, but others are notorious pathogenic parasites: *Treponema pallidum* causes syphilis, and *Borrelia burgdorferi* causes Lyme disease (see Figure 27.20).



Leptospira, a spirochete (colorized TEM)

Cyanobacteria

These photoautotrophs are the only prokaryotes with plantlike, oxygen-generating photosynthesis. (In fact, as we'll discuss in Chapter 28, chloroplasts likely evolved from an endosymbiotic cyanobacterium.) Both solitary and filamentous cyanobacteria are abundant components of freshwater and marine *phytoplankton*, the collection of photosynthetic organisms that drift near the water's surface. Some filaments have cells specialized for nitrogen fixation, the process that incorporates atmospheric N_2 into inorganic compounds that can be used in the synthesis of amino acids and other organic molecules (see Figure 27.14).



Oscillatoria, a filamentous cyanobacterium

Gram-Positive Bacteria

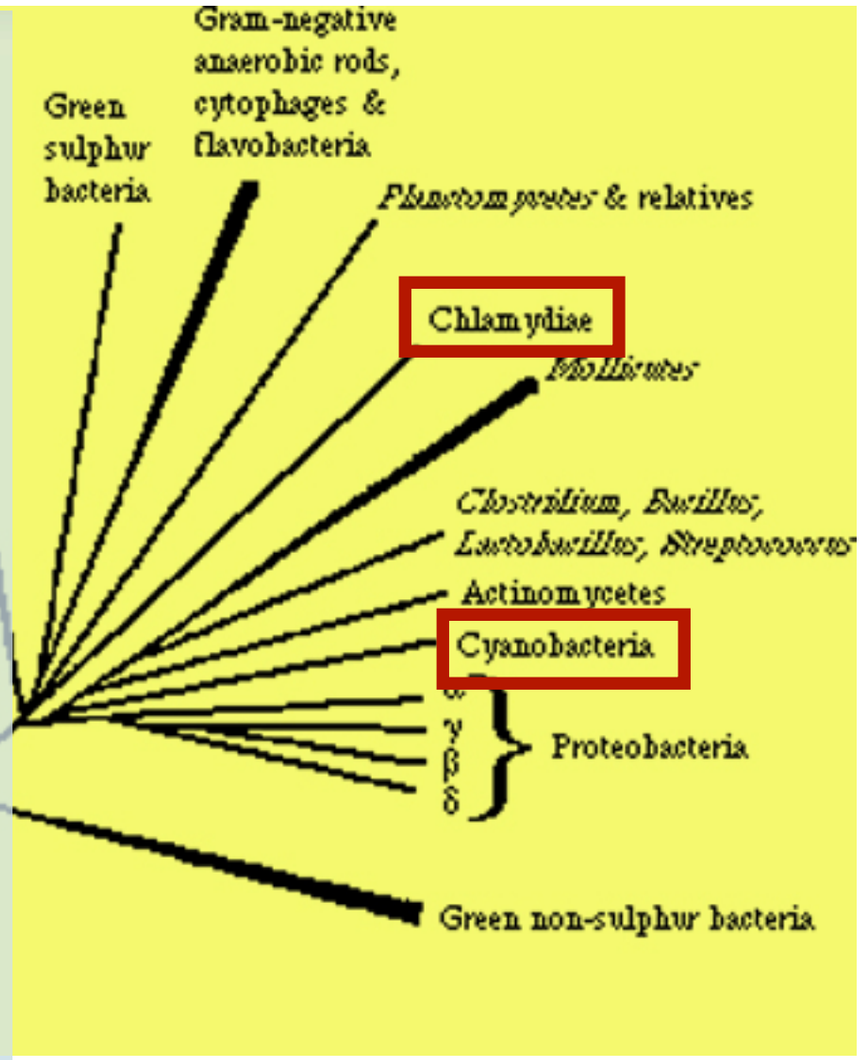
Gram-positive bacteria rival the proteobacteria in diversity. Species in one subgroup, the actinomycetes (from the Greek *mykes*, fungus, for which these bacteria were once mistaken), form colonies containing branched chains of cells. Two species of actinomycetes cause tuberculosis and leprosy. However, most actinomycetes are free-living species that help decompose the organic matter in soil; their secretions are partly responsible for the "earthy" odor of rich soil. Soil-dwelling species in the genus *Streptomyces* (top) are cultured by pharmaceutical companies as a source of many antibiotics, including streptomycin.

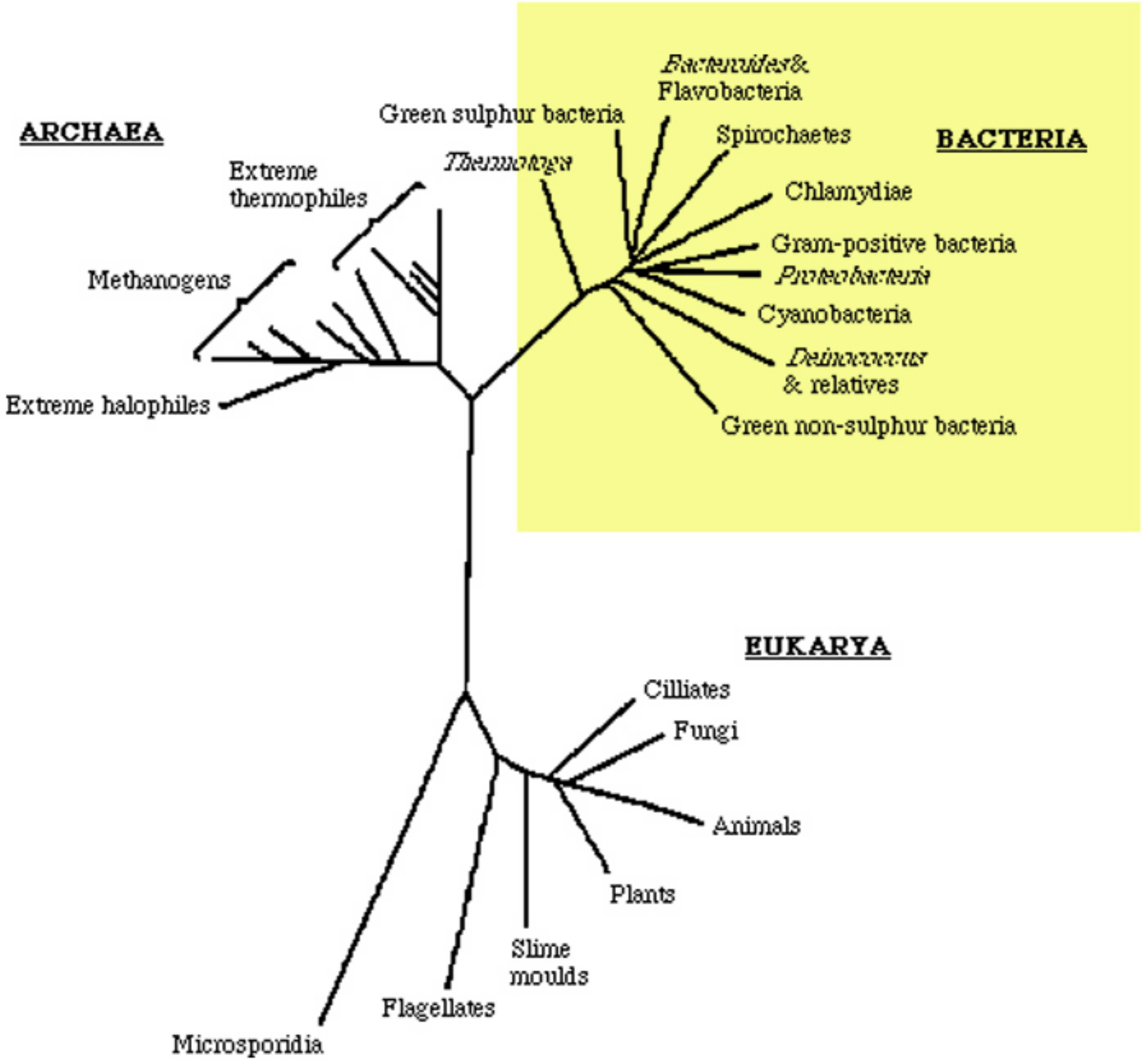
Gram-positive bacteria include many solitary species, such as *Bacillus anthracis* (see Figure 27.9), which causes anthrax, and *Clostridium botulinum*, which causes botulism. The various species of *Staphylococcus* and *Streptococcus* are also gram-positive bacteria.

Mycoplasmas (bottom) are the only bacteria known to lack cell walls. They are also the tiniest known cells, with diameters as small as 0.1 µm, only about five times as large as a ribosome. Mycoplasmas have small genomes—*Mycoplasma genitalium* has only 517 genes, for example. Many mycoplasmas are free-living soil bacteria, but others are pathogens.

Streptomyces, the source of many antibiotics (SEM)

Hundreds of mycoplasmas covering a human fibroblast cell (colorized SEM)




ARCHAEA
Extreme thermophiles
Methanogens
Extreme halophiles
Green sulphur bacteria
Thermotoga
Fusobacteria & Flavobacteria
Spirochaetes
BACTERIA
Chlamydiae
Gram-positive bacteria
Planctomycetes
Cyanobacteria
Deinococcus & relatives
Green non-sulphur bacteria
EUKARYA
Cilliates
Fungi
Animals
Plants
Slime moulds
Flagellates
Microsporidia

Gram Stain

Gram negative

Gram positive

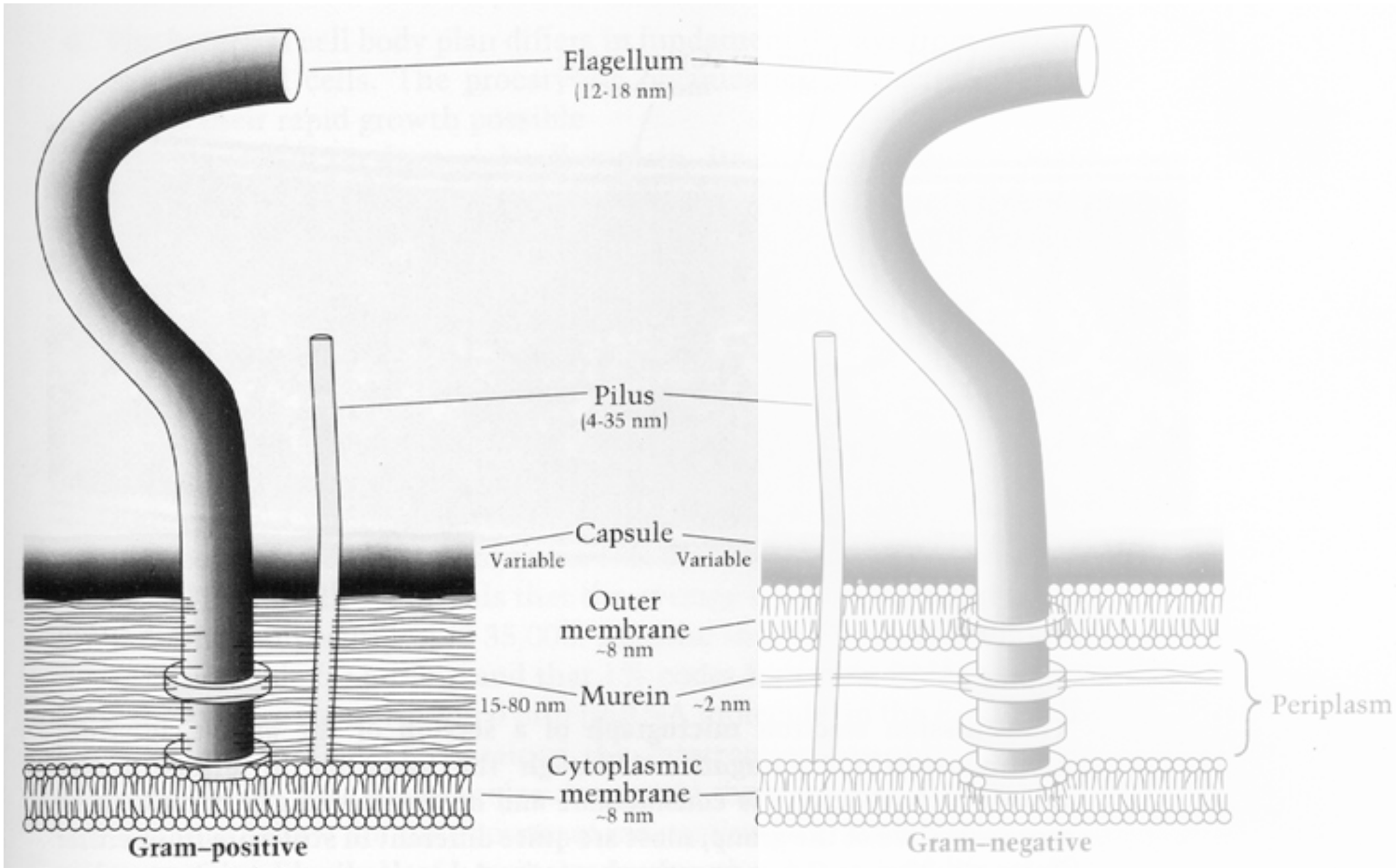
(a) Application of crystal violet

(b) Application of iodine

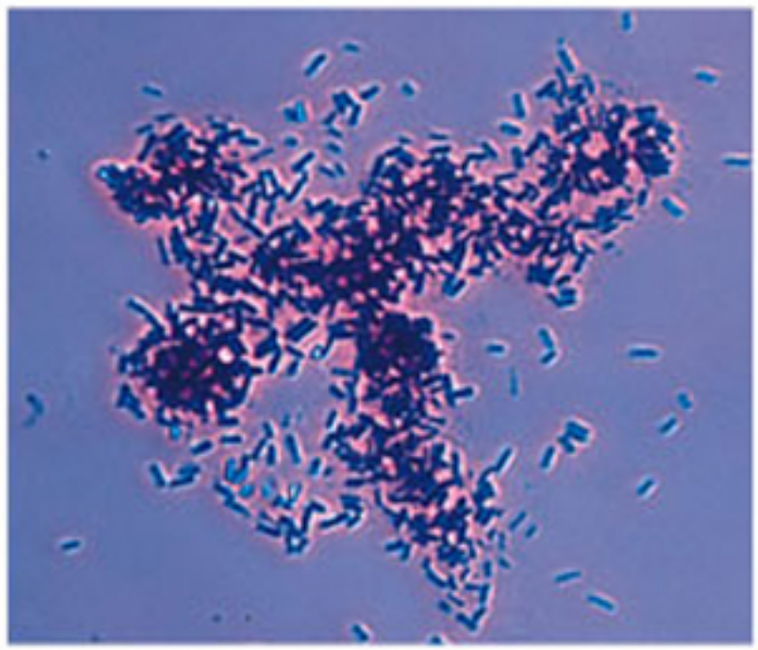
(c) Alcohol wash

(d) Application of safranin

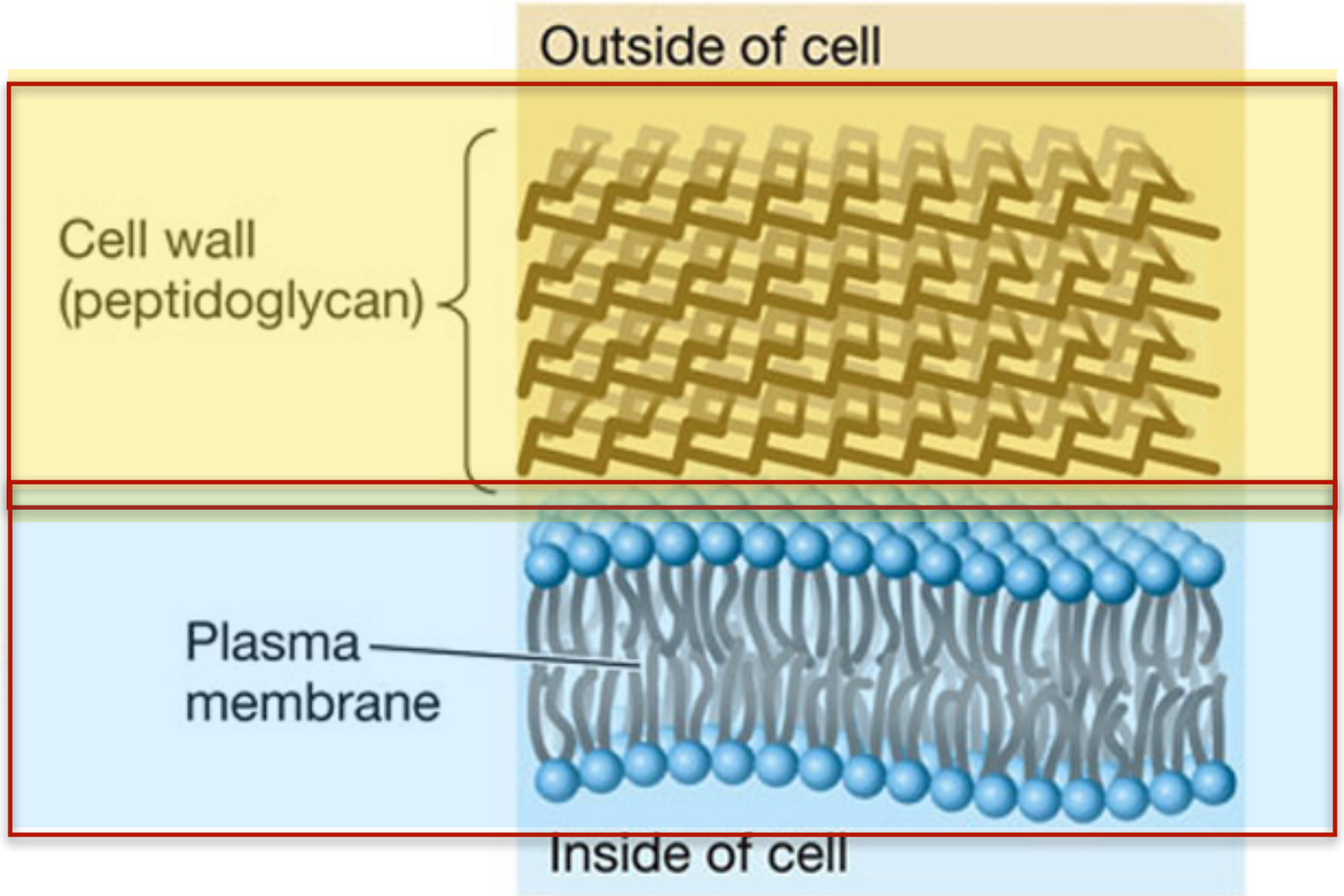
http://www.sirinet.net/~jgjohnso/monerans.html


Flagellum
(12-18 nm)
Pilus
(4-35 nm)
Capsule
Variable
Variable
Outer membrane
~8 nm
15-80 nm
Murein
~2 nm
Cytoplasmic membrane
~8 nm
Periplasm
Gram–positive
Gram–negative

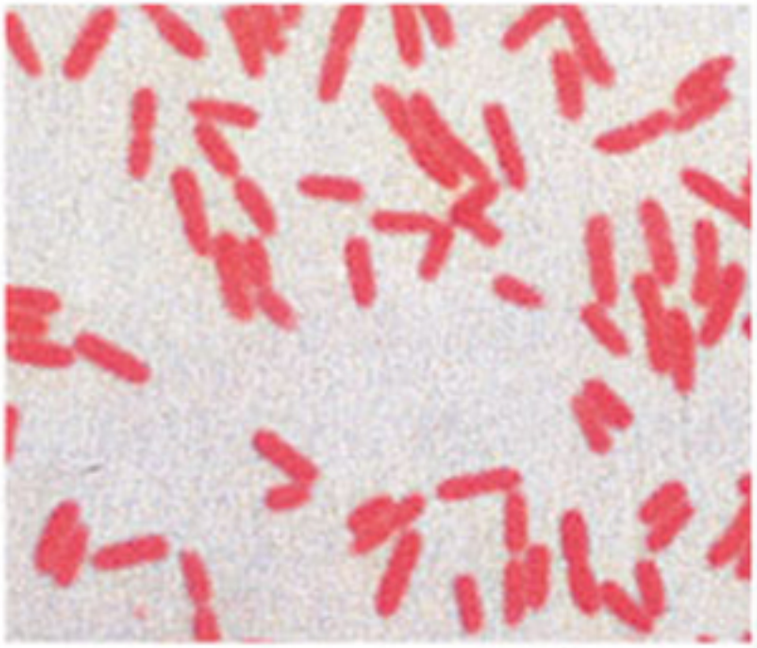
(A)



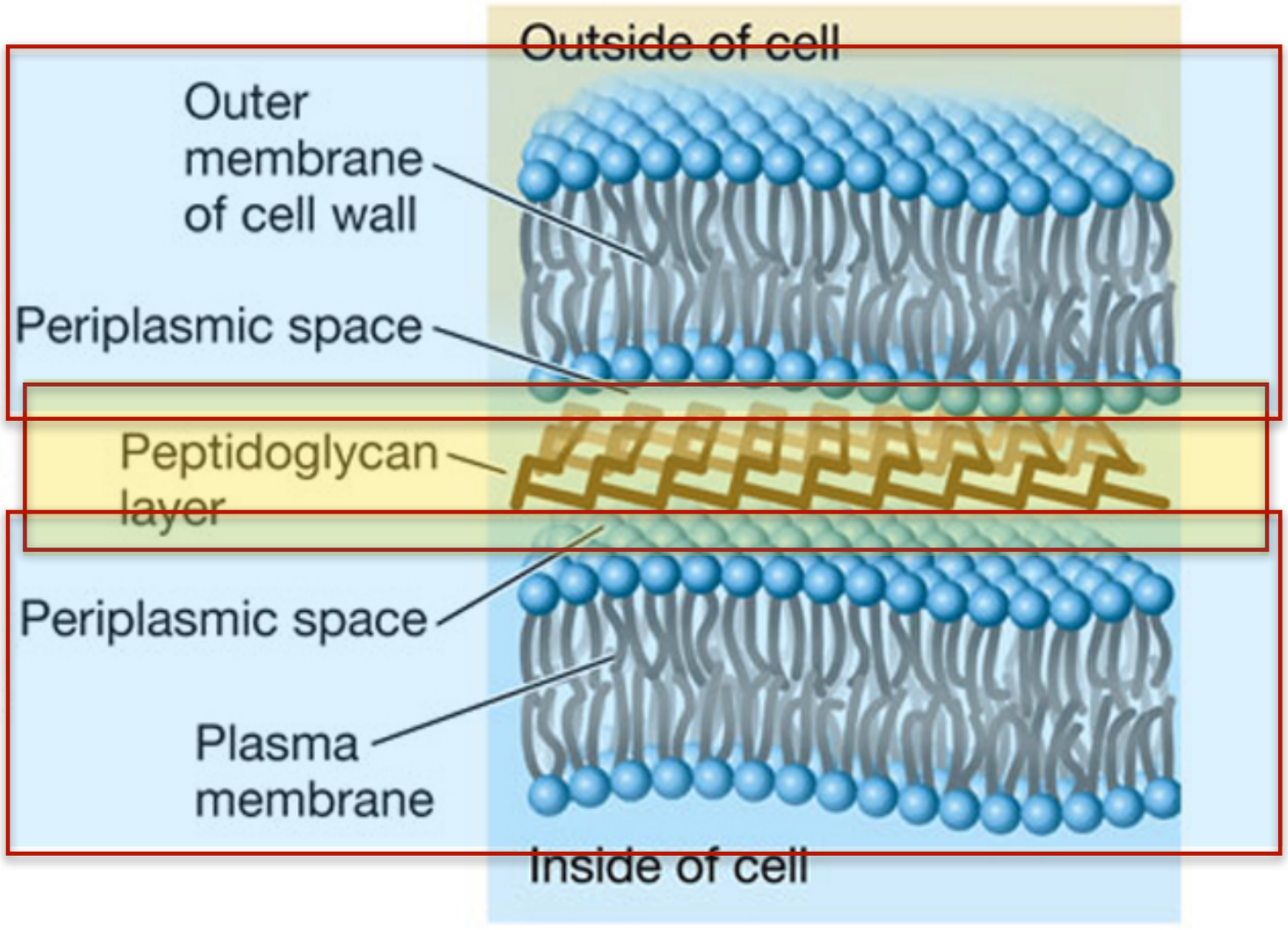
10 μm

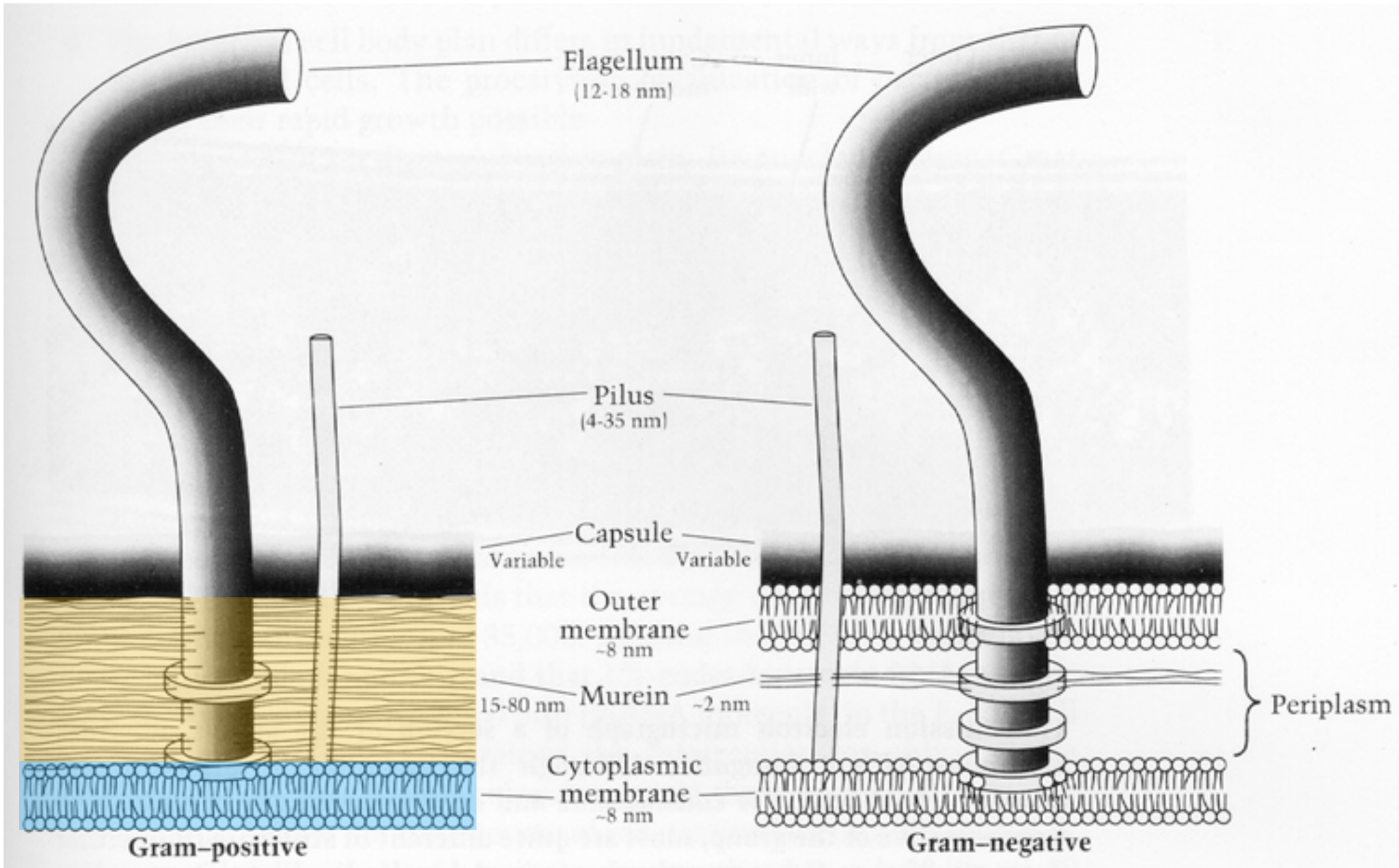

Outside of cell
Cell wall
(peptidoglycan)
Plasma
membrane
Inside of cell

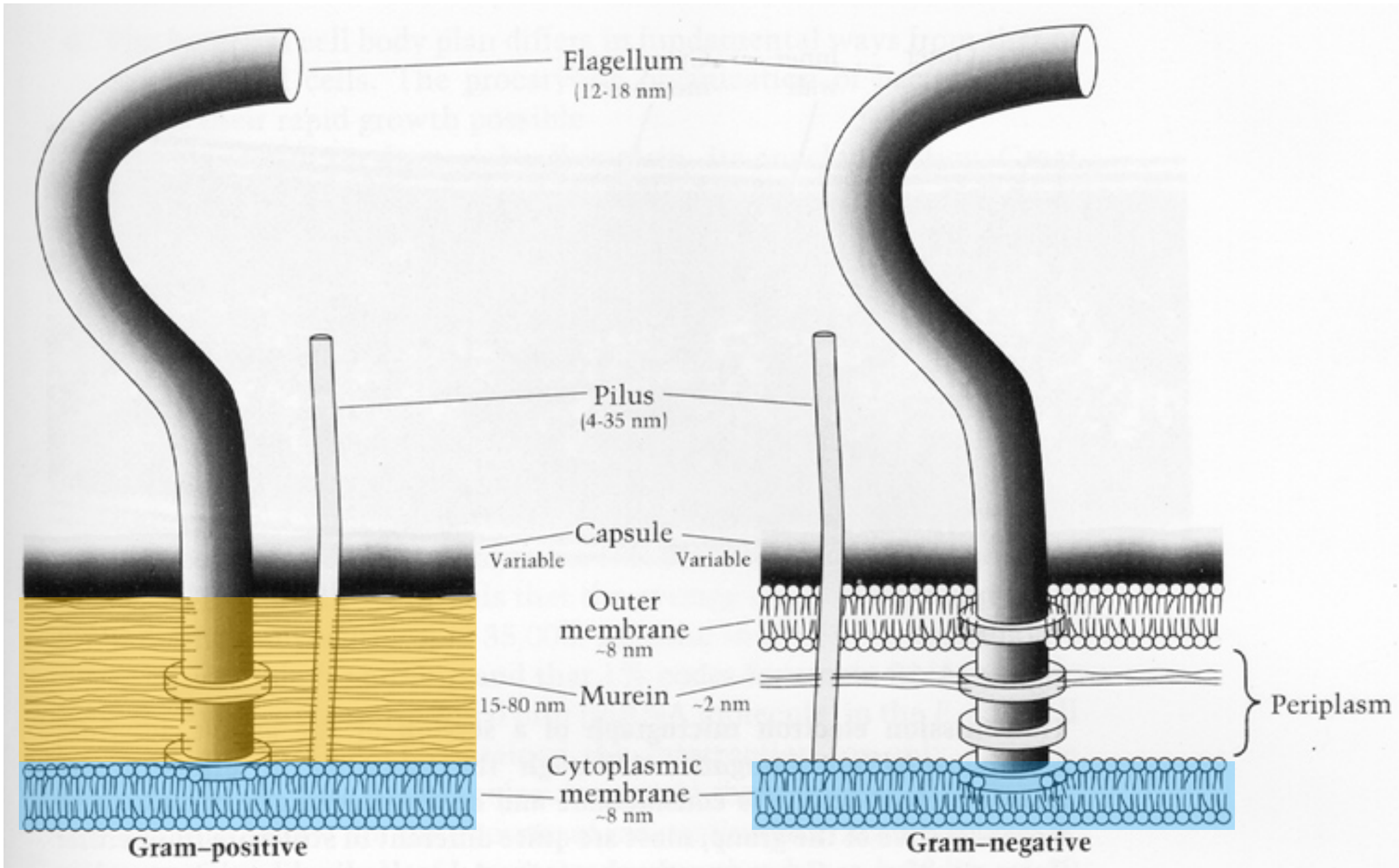
(B)

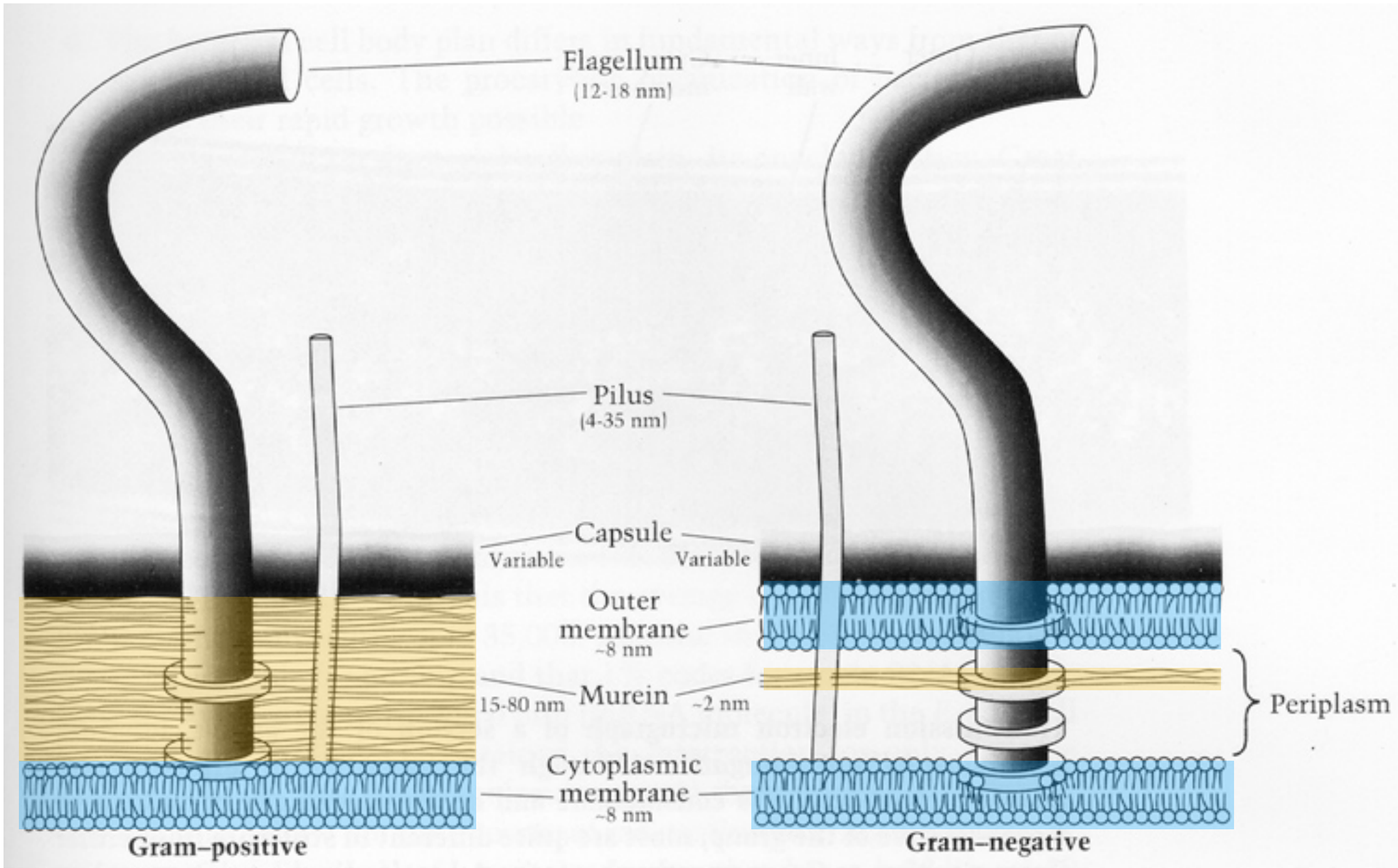


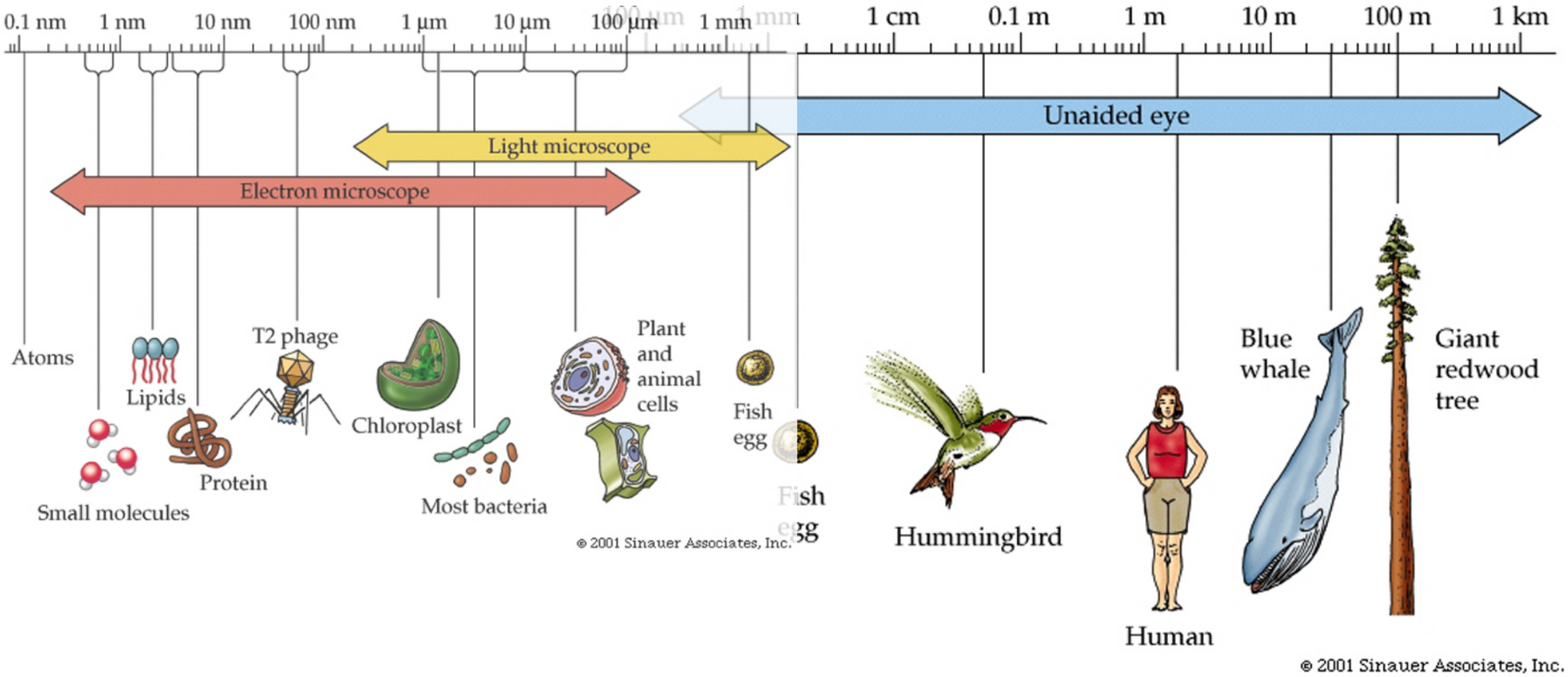
5 µm

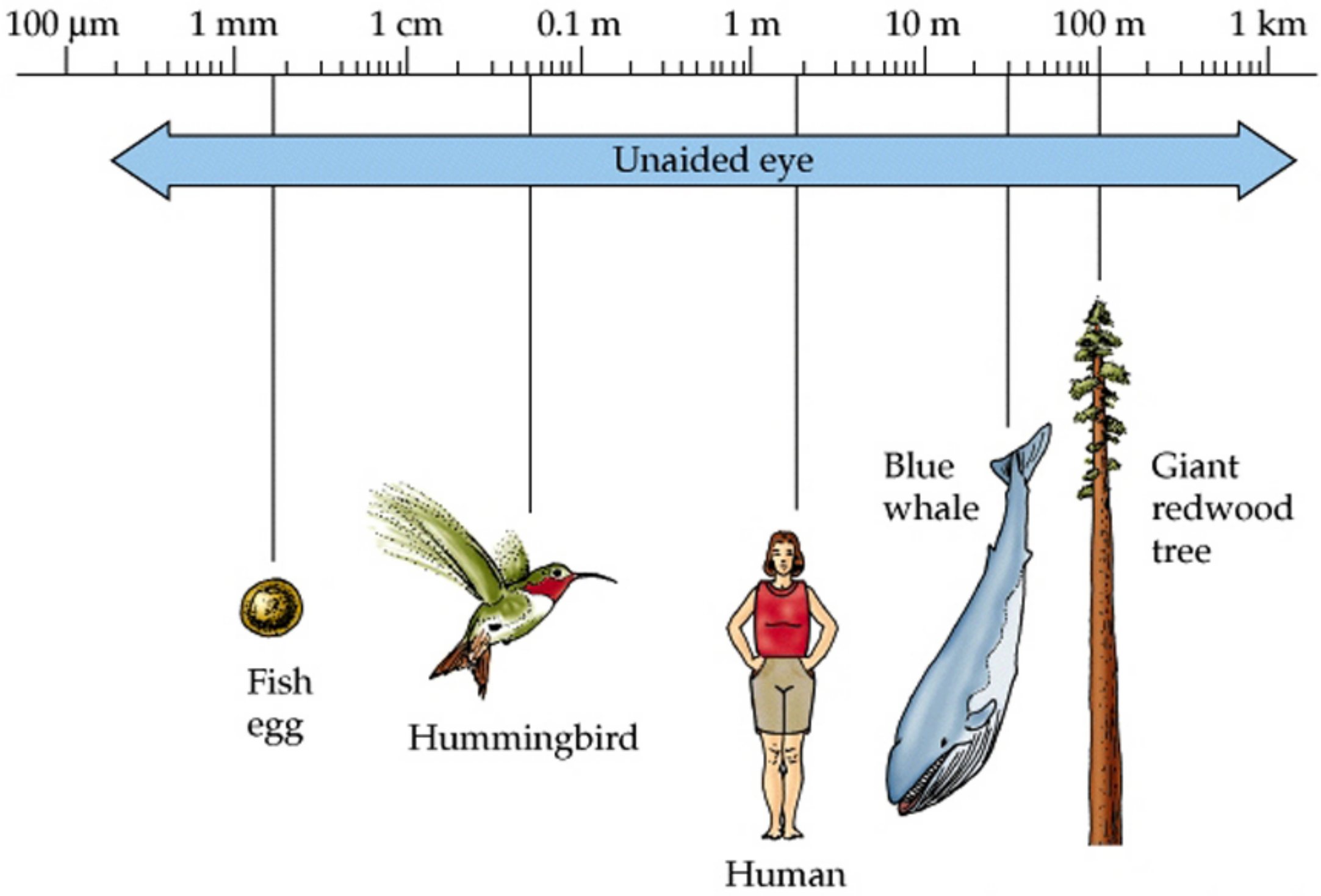

Outside of cell
Outer membrane of cell wall
Periplasmic space
Peptidoglycan layer
Periplasmic space
Plasma membrane
Inside of cell

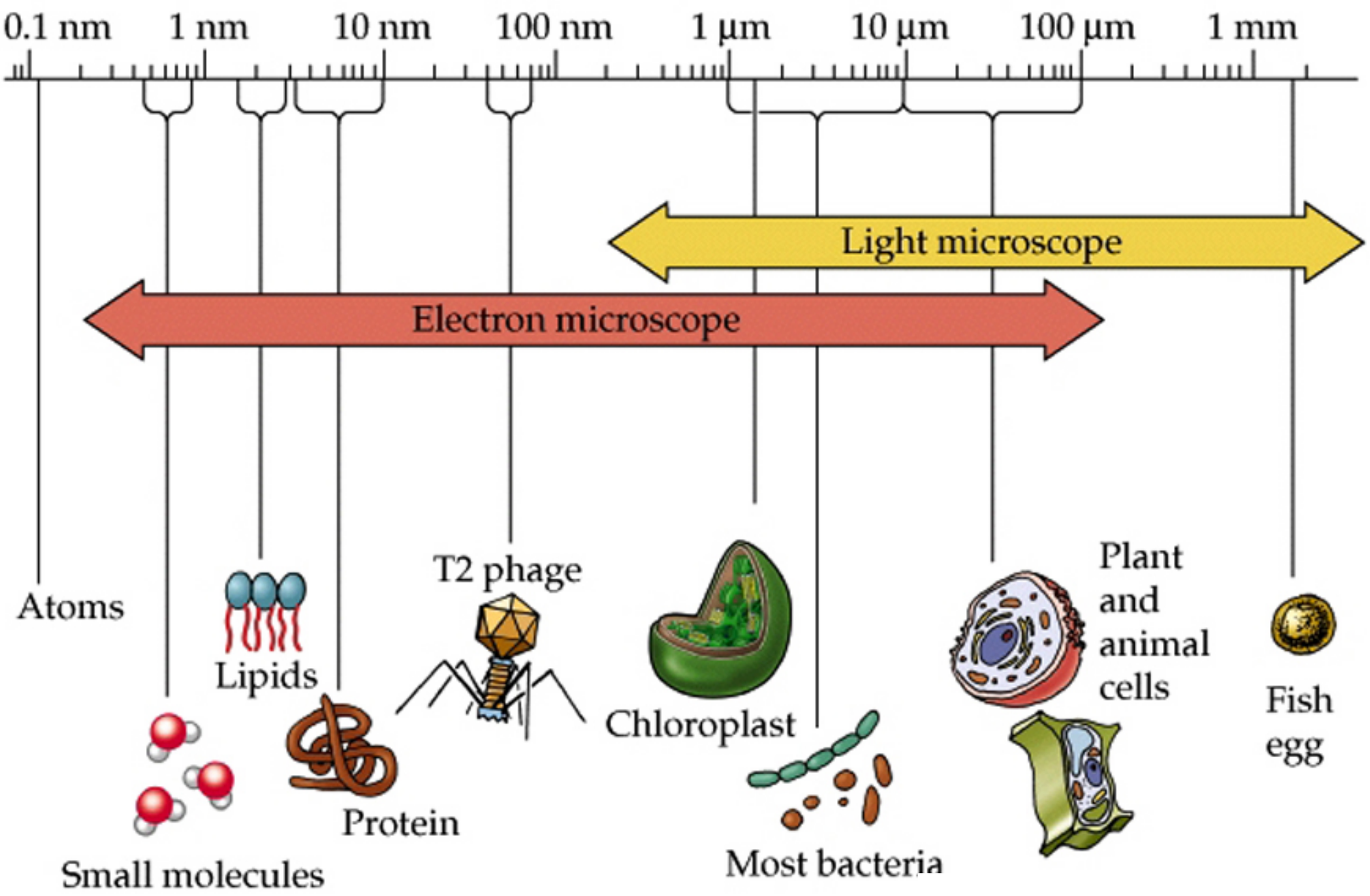

Flagellum
(12-18 nm)
Pilus
(4-35 nm)
Capsule
Variable
Variable
Outer membrane
~8 nm
15-80 nm
Murein
~2 nm
Periplasm
Cytoplasmic membrane
~8 nm
Gram–positive
Gram–negative

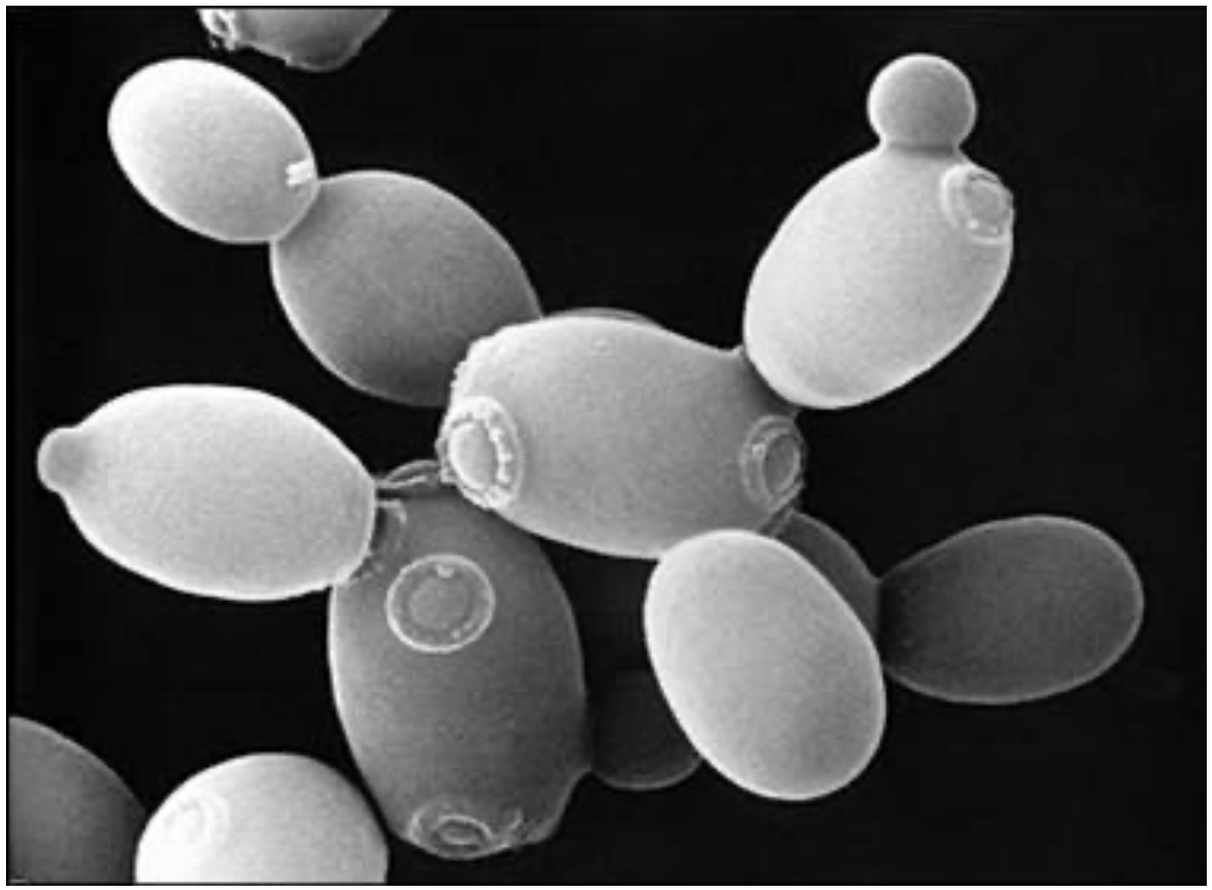

Flagellum
(12-18 nm)
Pilus
(4-35 nm)
Capsule
Variable
Variable
Outer membrane
~8 nm
15-80 nm
Murein
~2 nm
Periplasm
Cytoplasmic membrane
~8 nm
Gram–positive
Gram–negative


Flagellum
(12-18 nm)
Pilus
(4-35 nm)
Capsule
Variable
Variable
Outer membrane
~8 nm
15-80 nm
Murein
~2 nm
Periplasm
Cytoplasmic membrane
~8 nm
Gram–positive
Gram–negative


0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
1 cm
0.1 m
1 m
10 m
100 m
1 km
Unaided eye
Light microscope
Electron microscope
Atoms
Lipids
T2 phage
Chloroplast
Plant and animal cells
Fish egg
Small molecules
Protein
Most bacteria
Hummingbird
Human
Blue whale
Giant redwood tree
© 2001 Sinauer Associates, Inc.

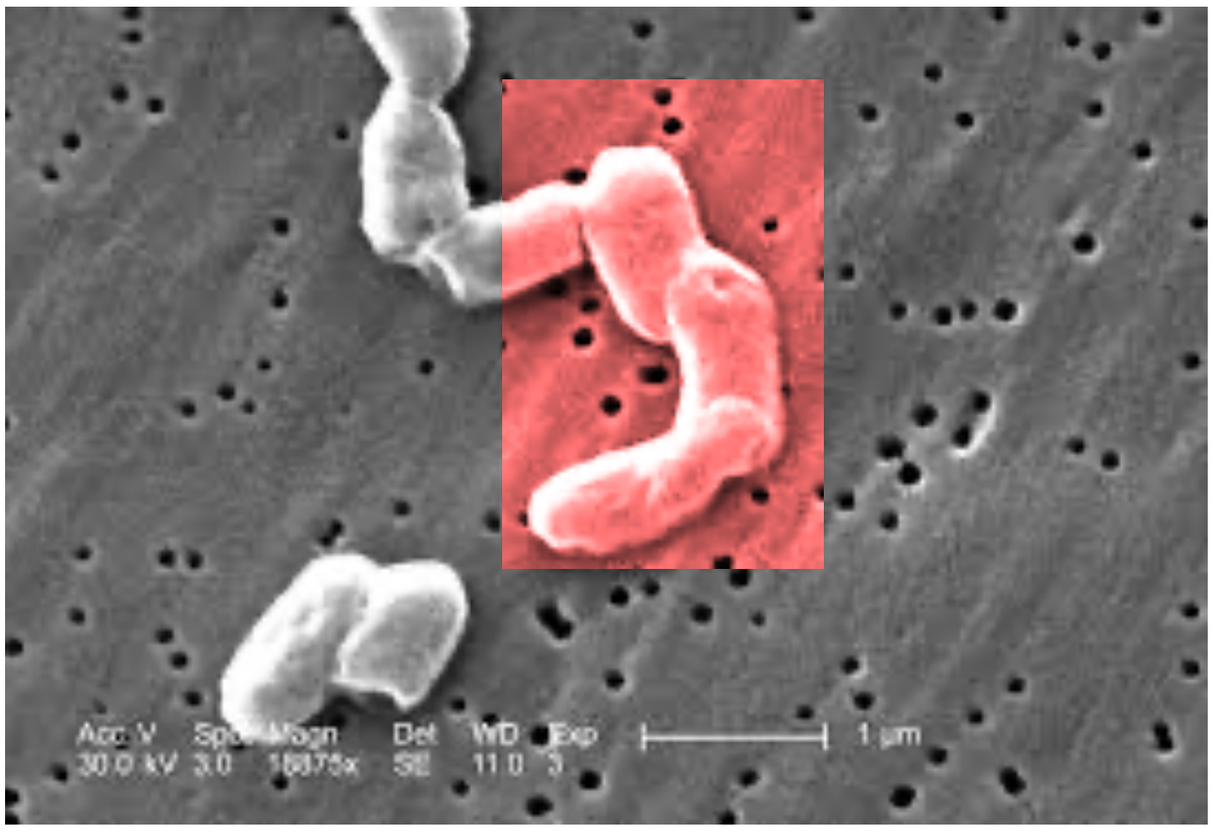

100 µm
1 mm
1 cm
0.1 m
1 m
10 m
100 m
1 km
Unaided eye
Fish egg
Hummingbird
Human
Blue whale
Giant redwood tree


0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
Light microscope
Electron microscope
Atoms
Lipids
T2 phage
Chloroplast
Plant and animal cells
Fish egg
Small molecules
Protein
Most bacteria



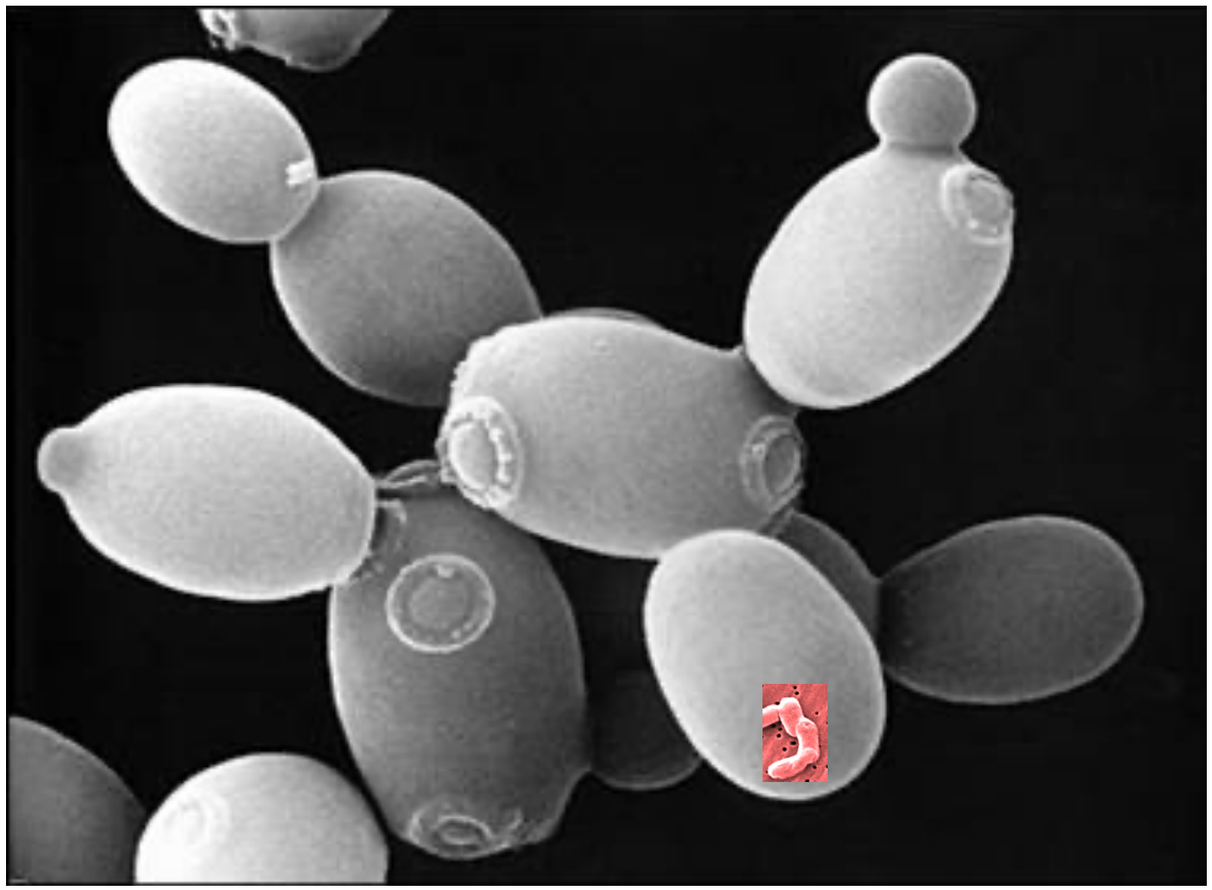
Yeast
S. cerevisiae

(~34 - 45 uM^2)



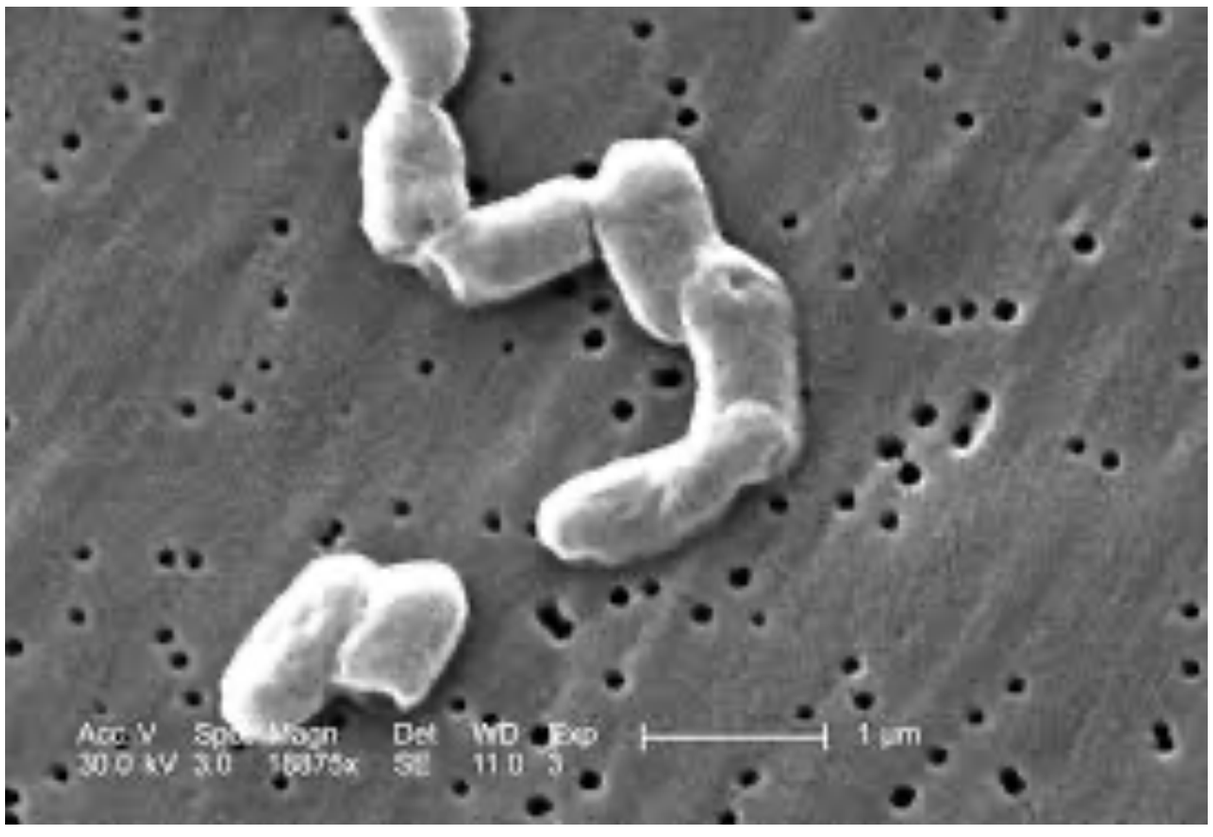
Bacterium
E. coli

(~1.5 - 3 uM^2)



Yeast
S. cerevisiae

(~34 - 45 uM^2)



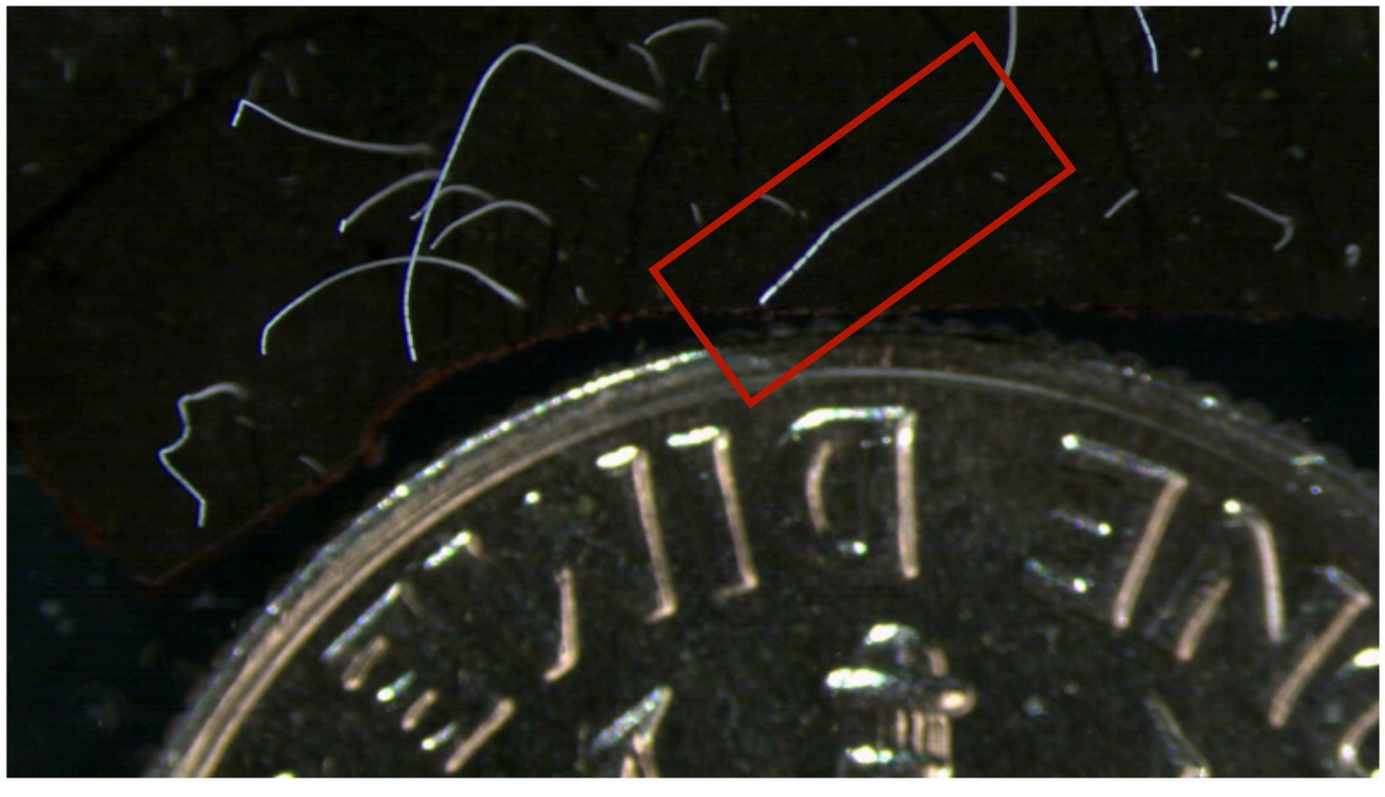
Bacterium
E. coli

(~1.5 - 3 uM^2)

NEWS MICROBES

This giant bacterium is the largest one found yet

On average, *Thiomargarita magnifica* measures 1 centimeter long



With an average length of 1 centimeter, *Thiomargarita magnifica* bacteria (several pictured) are big enough to see with the naked eye.

TOMAS TYML

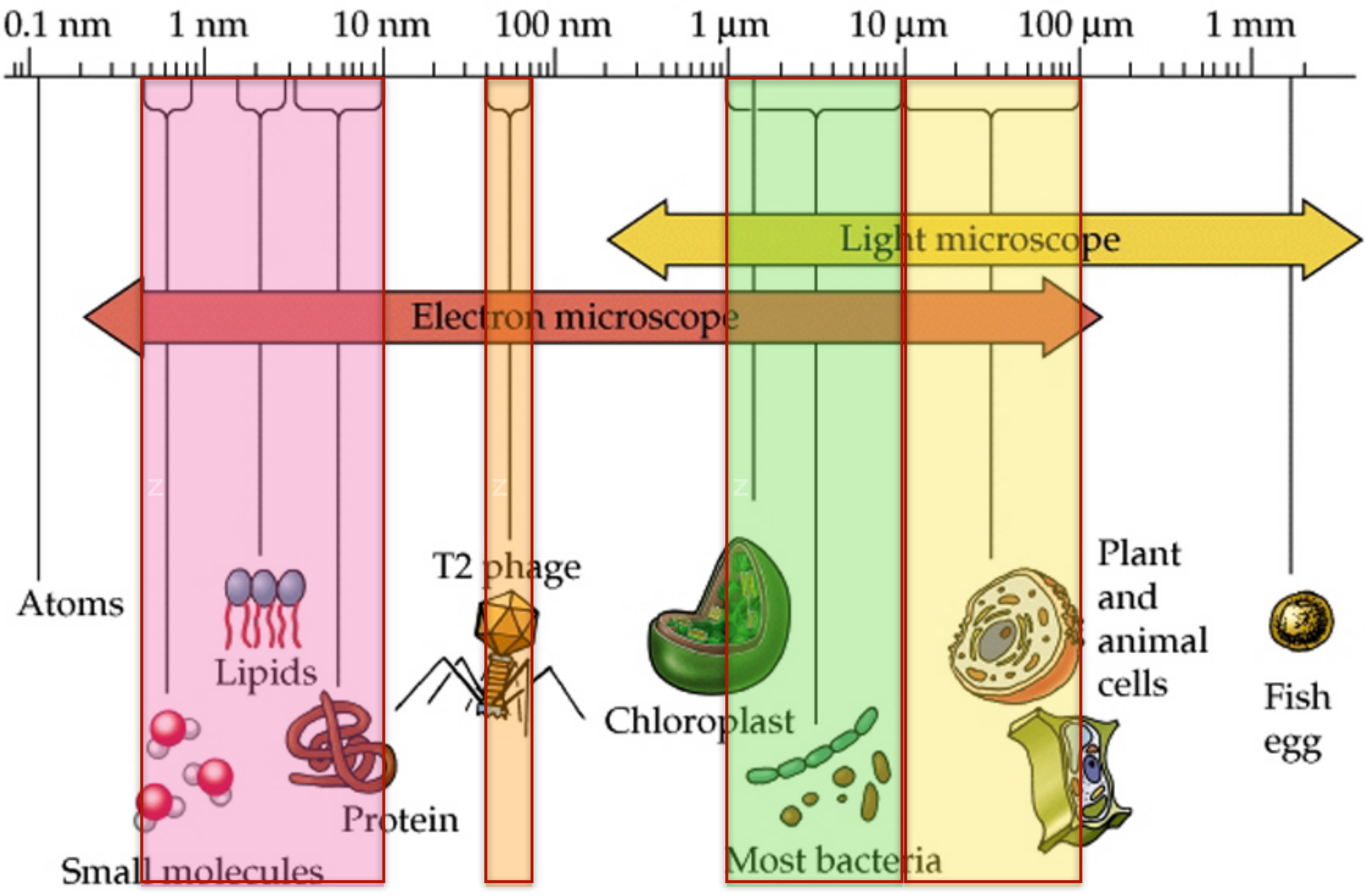
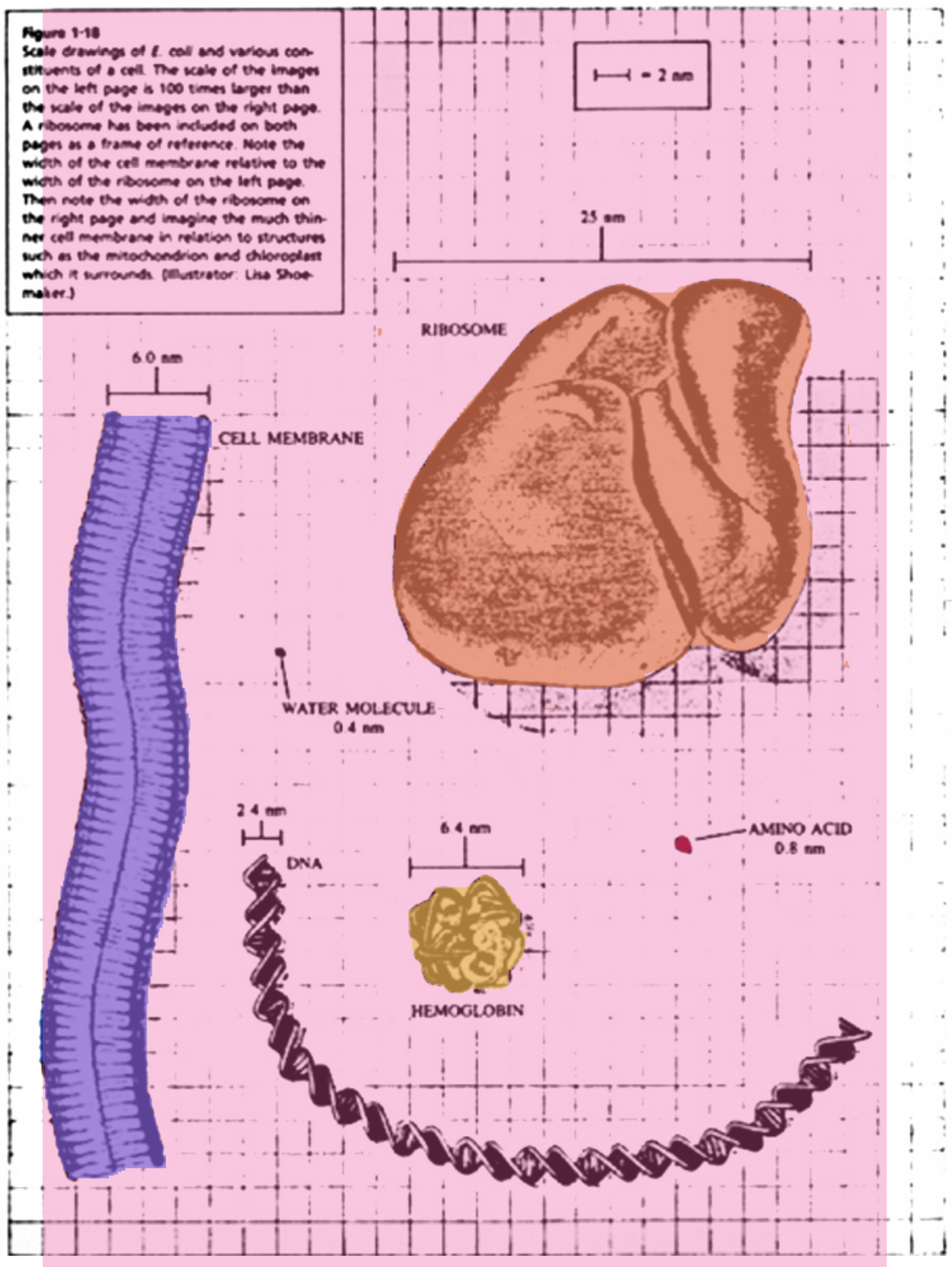


Figure 1-18
Scale drawings of *E. coli* and various constituents of a cell. The scale of the images on the left page is 100 times larger than the scale of the images on the right page. A ribosome has been included on both pages as a frame of reference. Note the width of the cell membrane relative to the width of the ribosome on the left page. Then note the width of the ribosome on the right page and imagine the much thinner cell membrane in relation to structures such as the mitochondrion and chloroplast which it surrounds. (Illustrator: Lisa Shoemaker.)



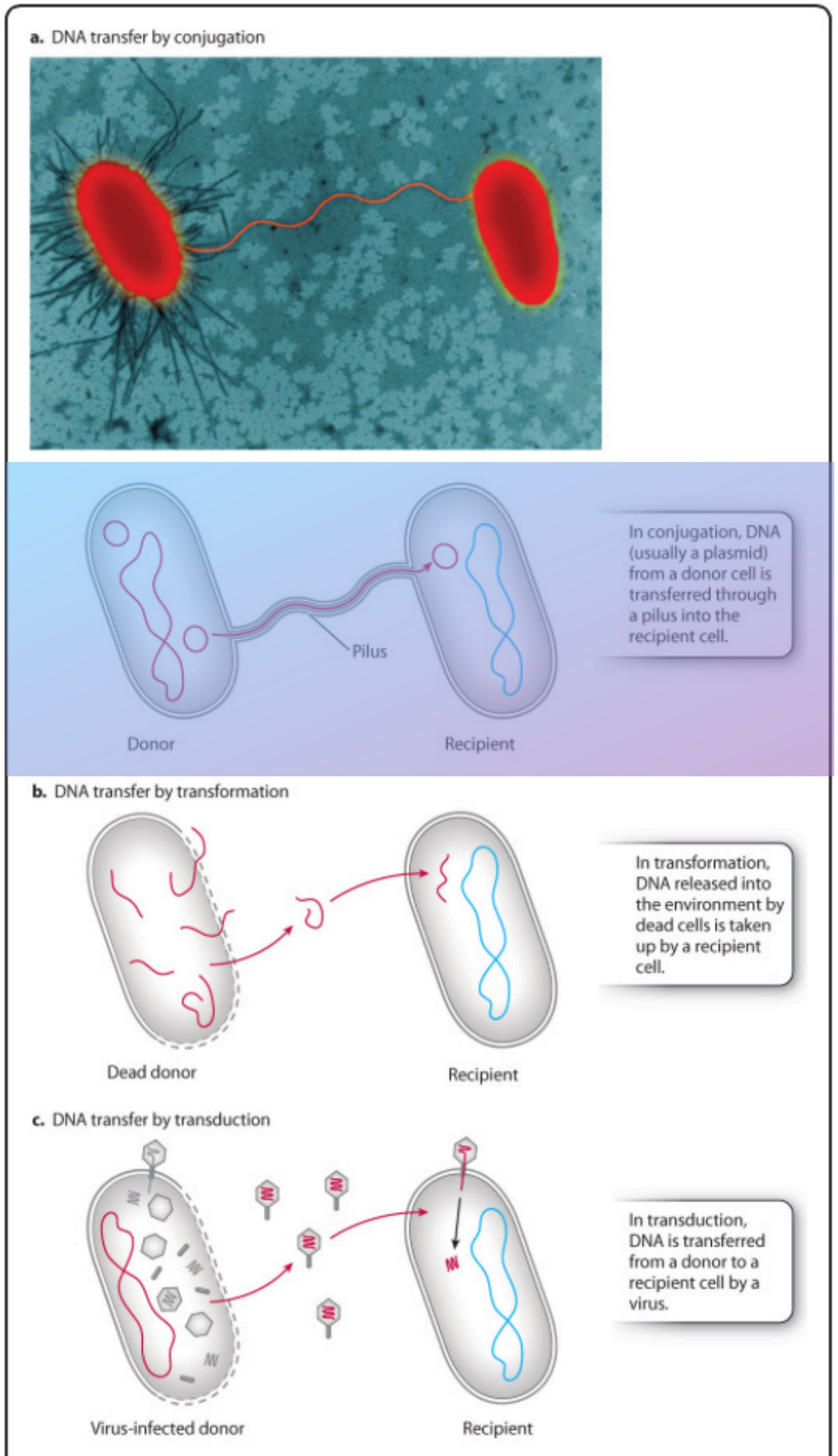


Figure 26.4: Horizontal gene transfer in bacteria. DNA shown in red originates from the donor cell. DNA shown in blue is that of the recipient cell.

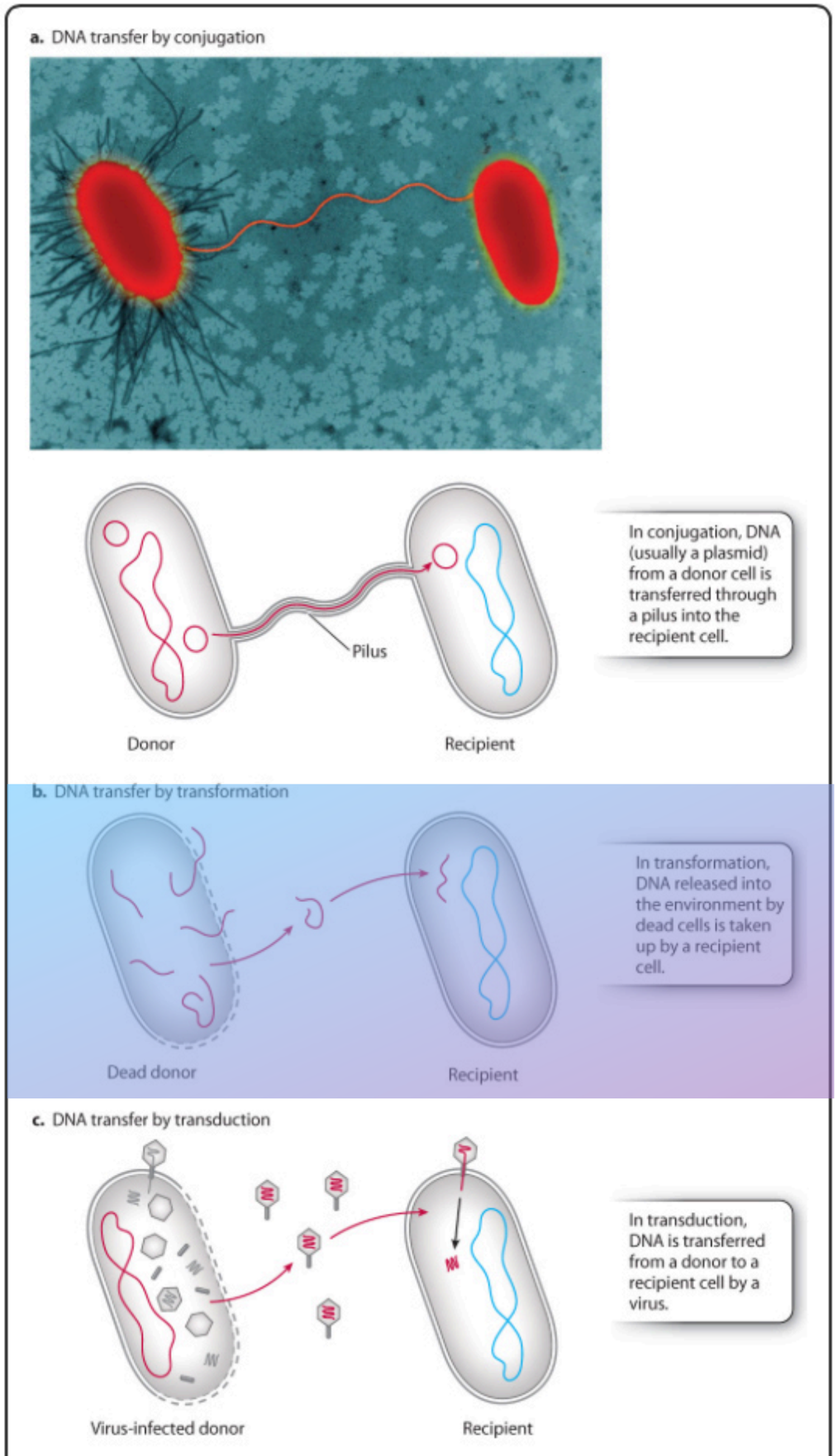


Figure 26.4: Horizontal gene transfer in bacteria. DNA shown in red originates from the donor cell. DNA shown in blue is that of the recipient cell.

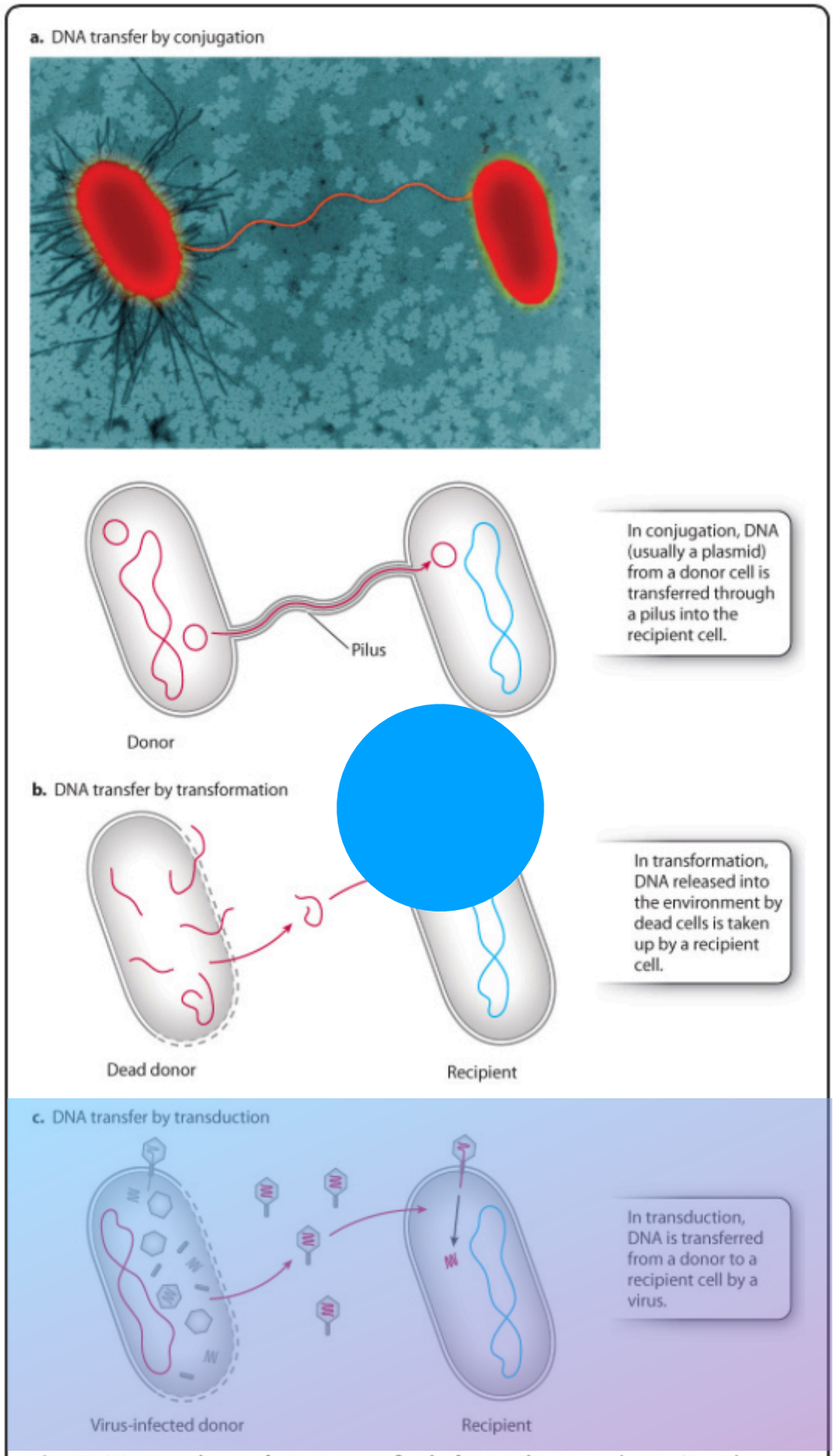
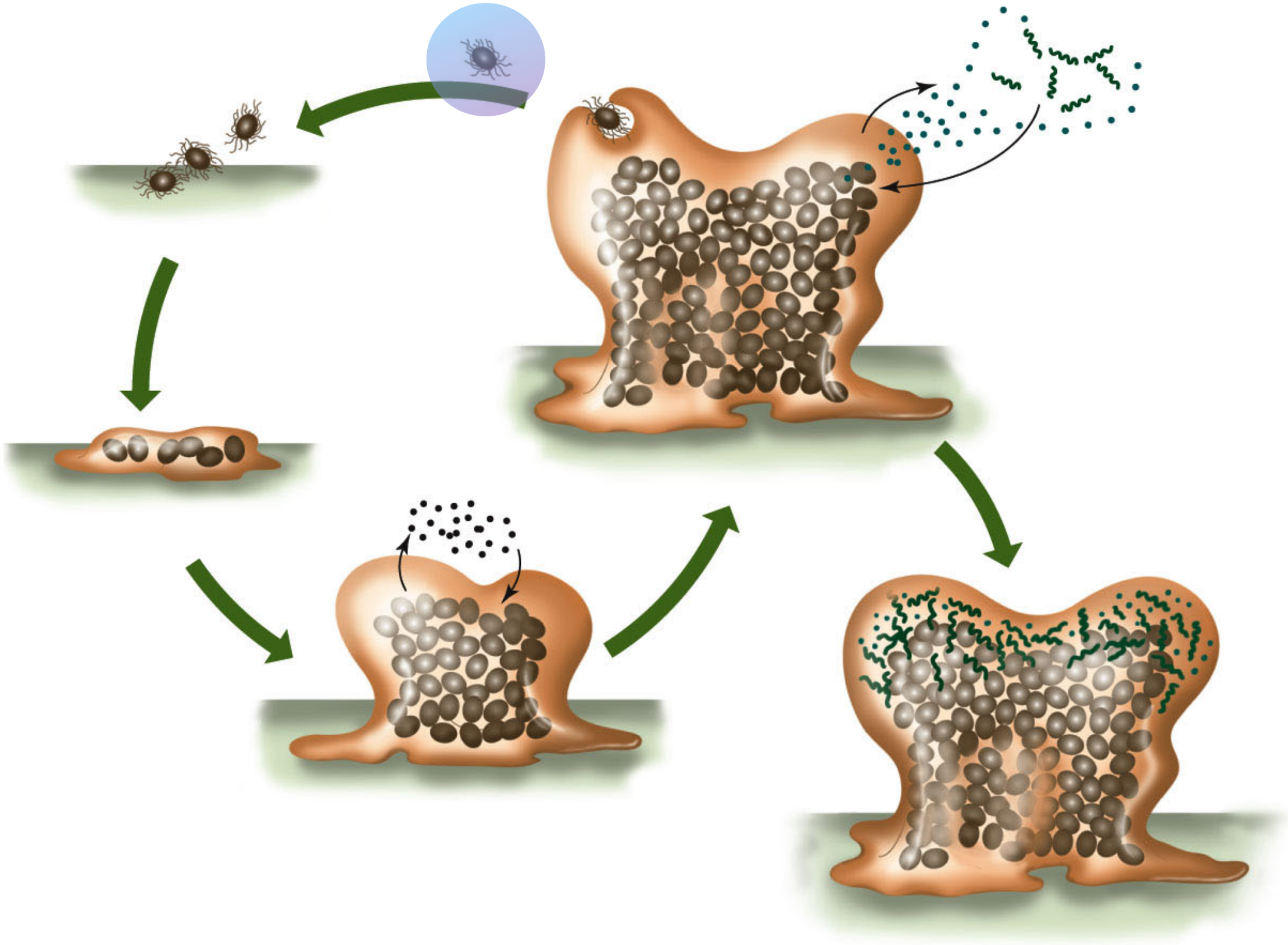
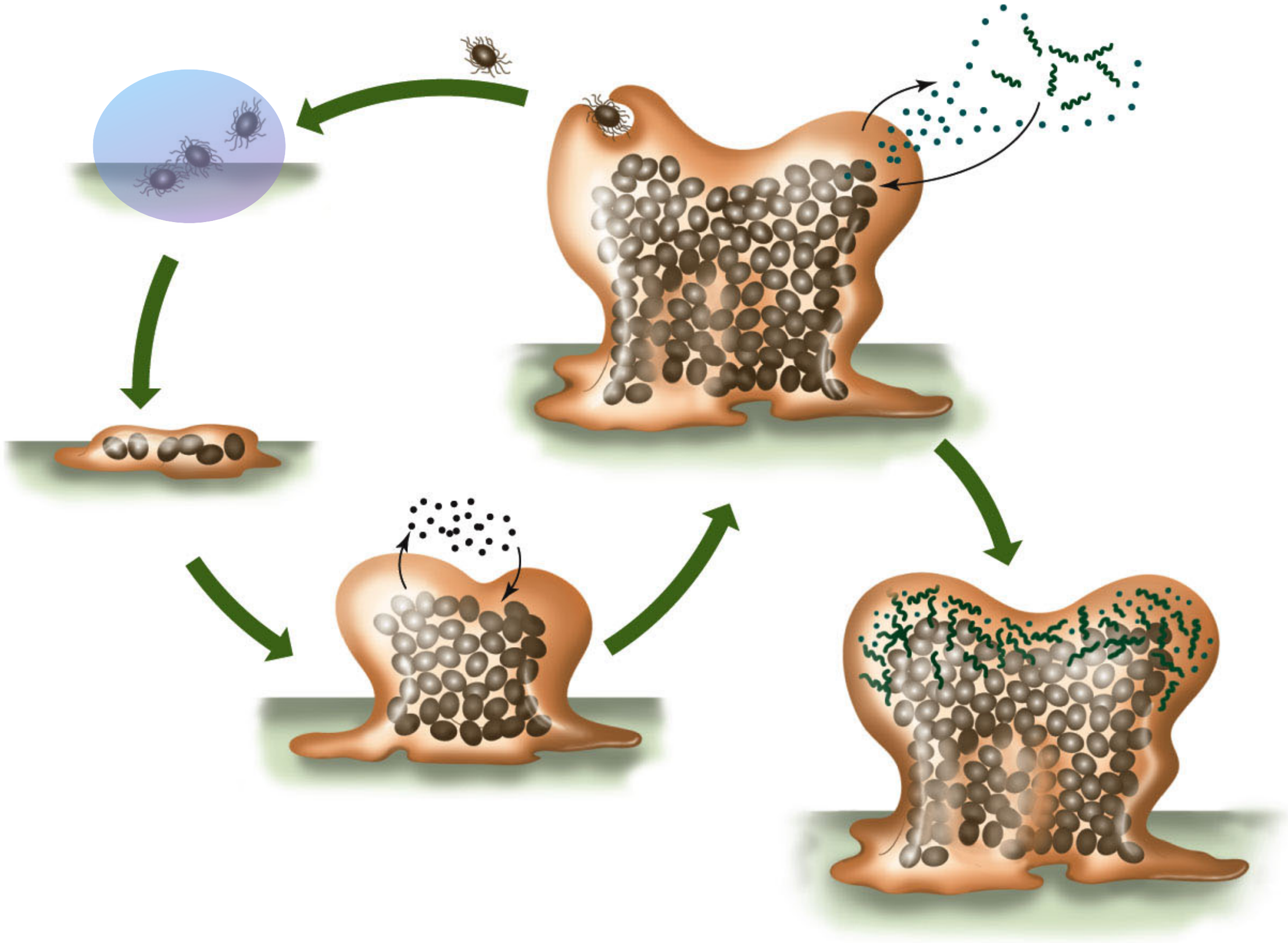
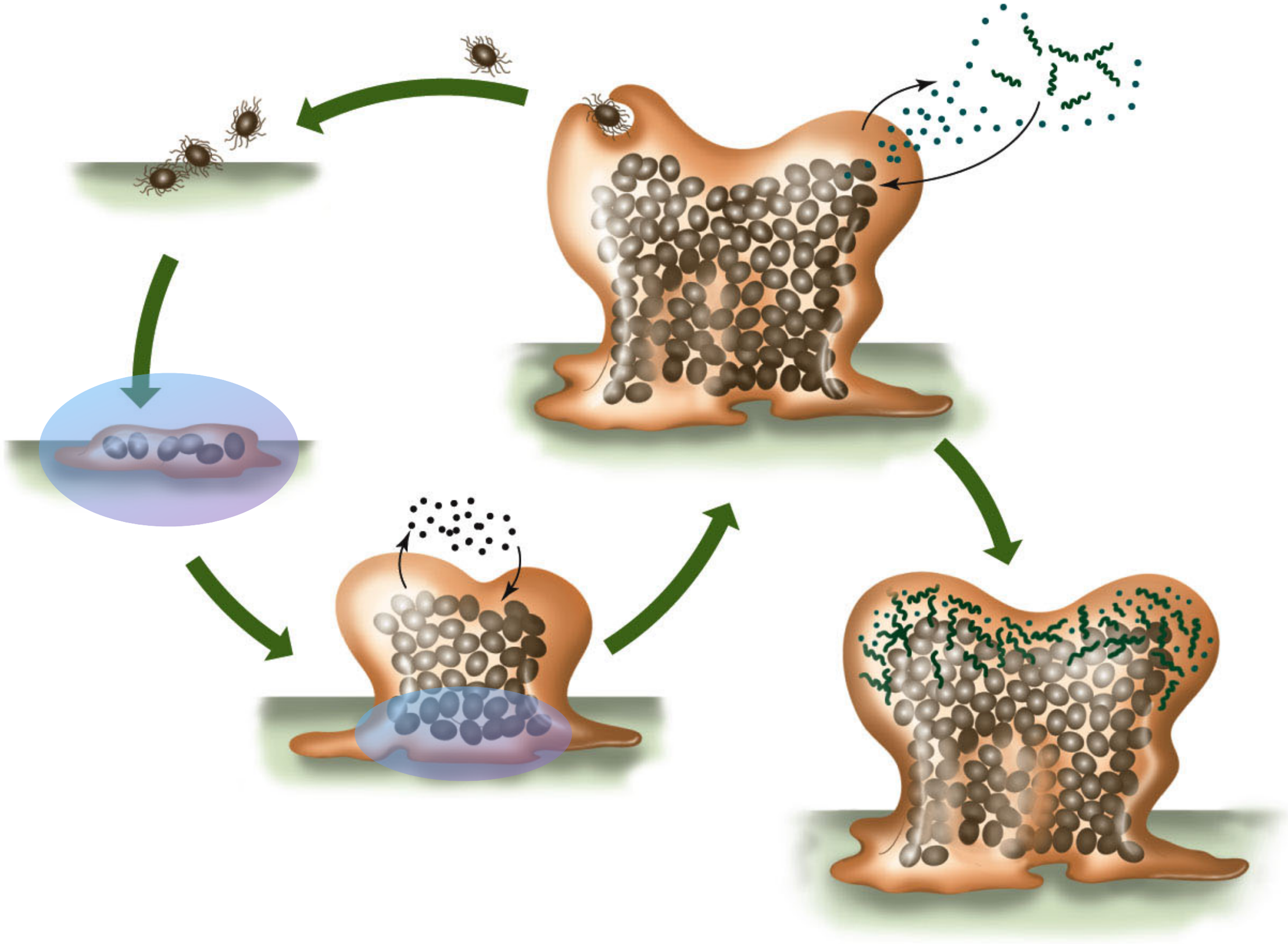
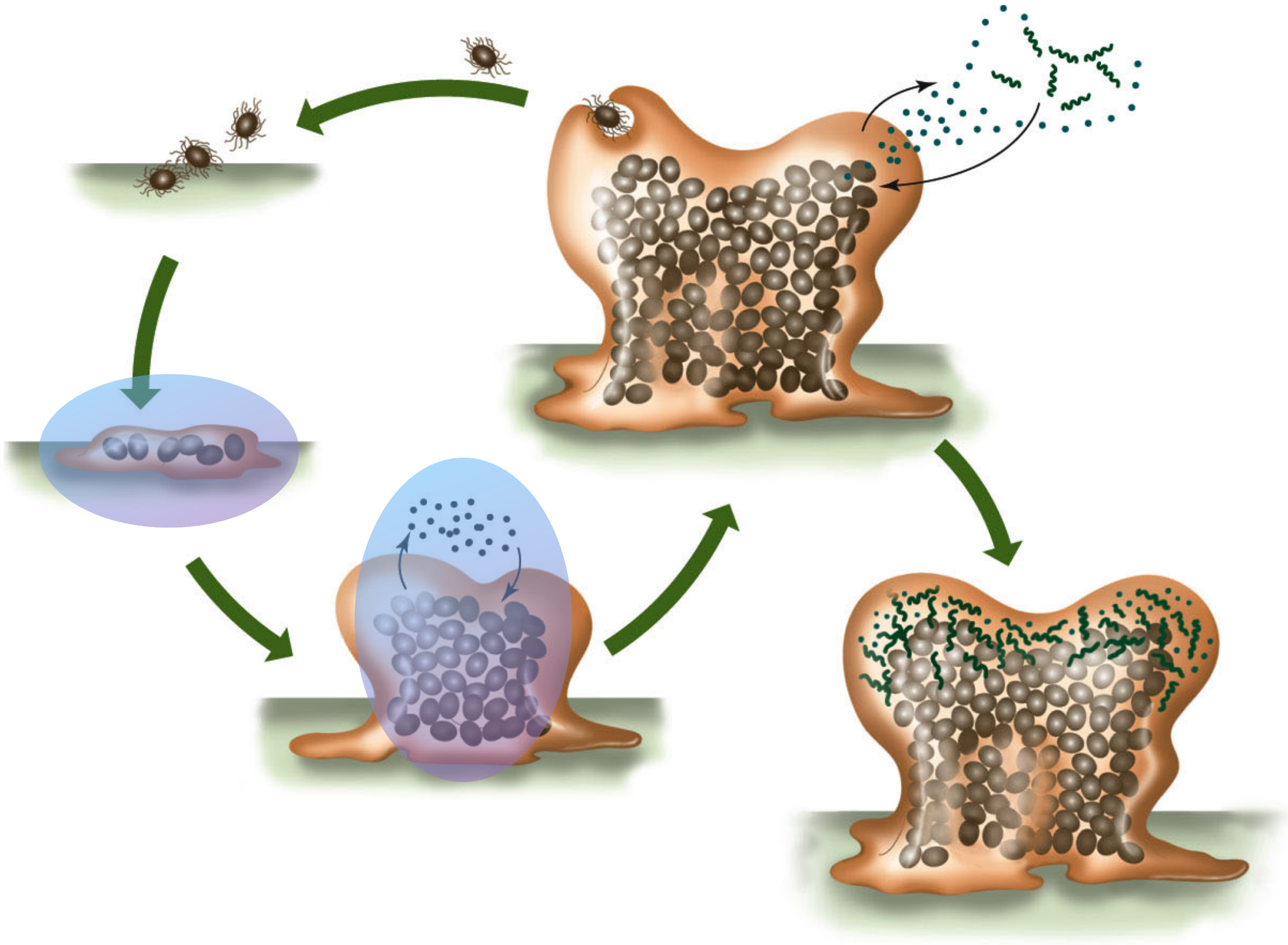


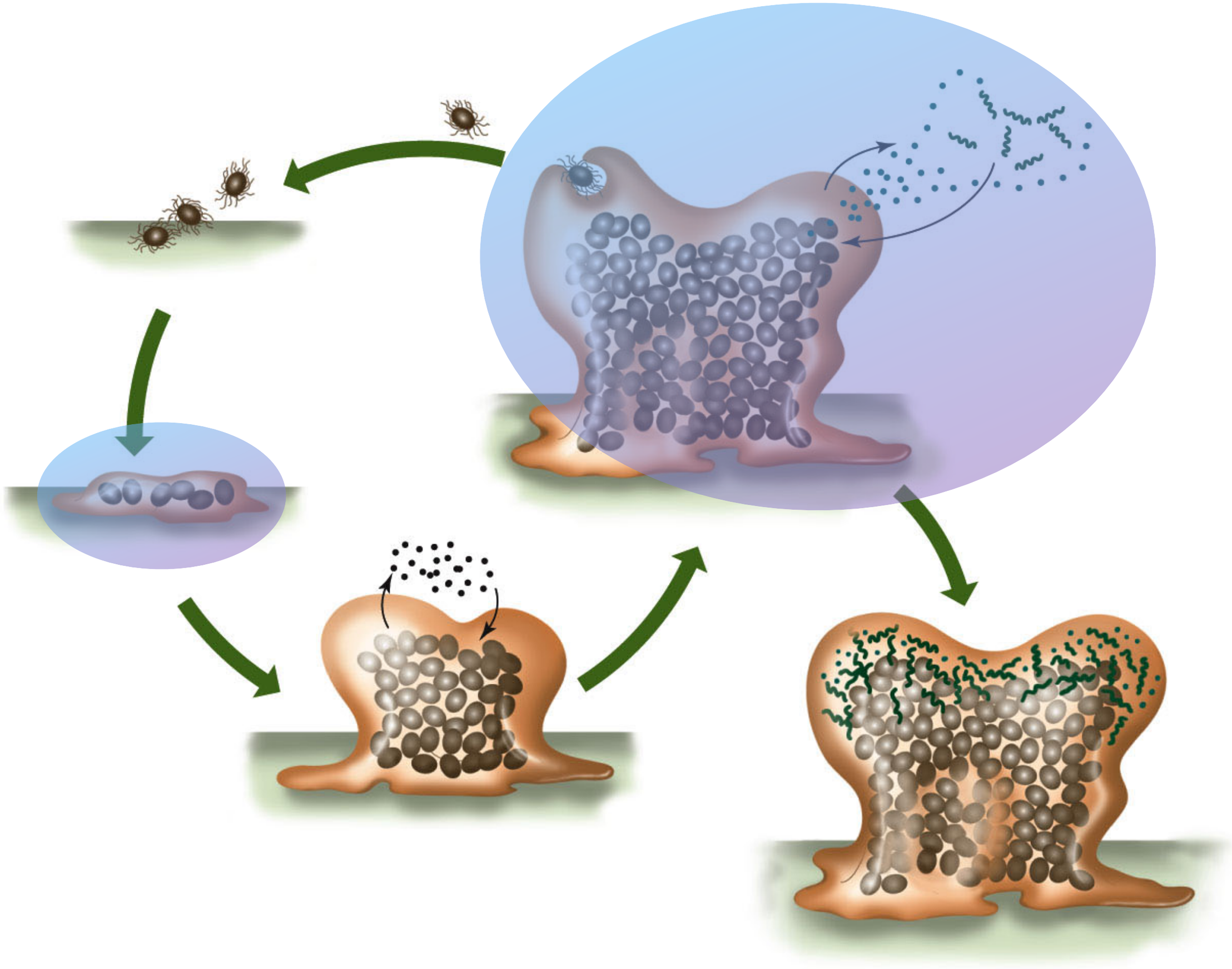
Figure 26.4: Horizontal gene transfer in bacteria. DNA shown in red originates from the donor cell. DNA shown in blue is that of the recipient cell.











1. The circular bacterial DNA molecule is attached by proteins to the inner membrane (red).

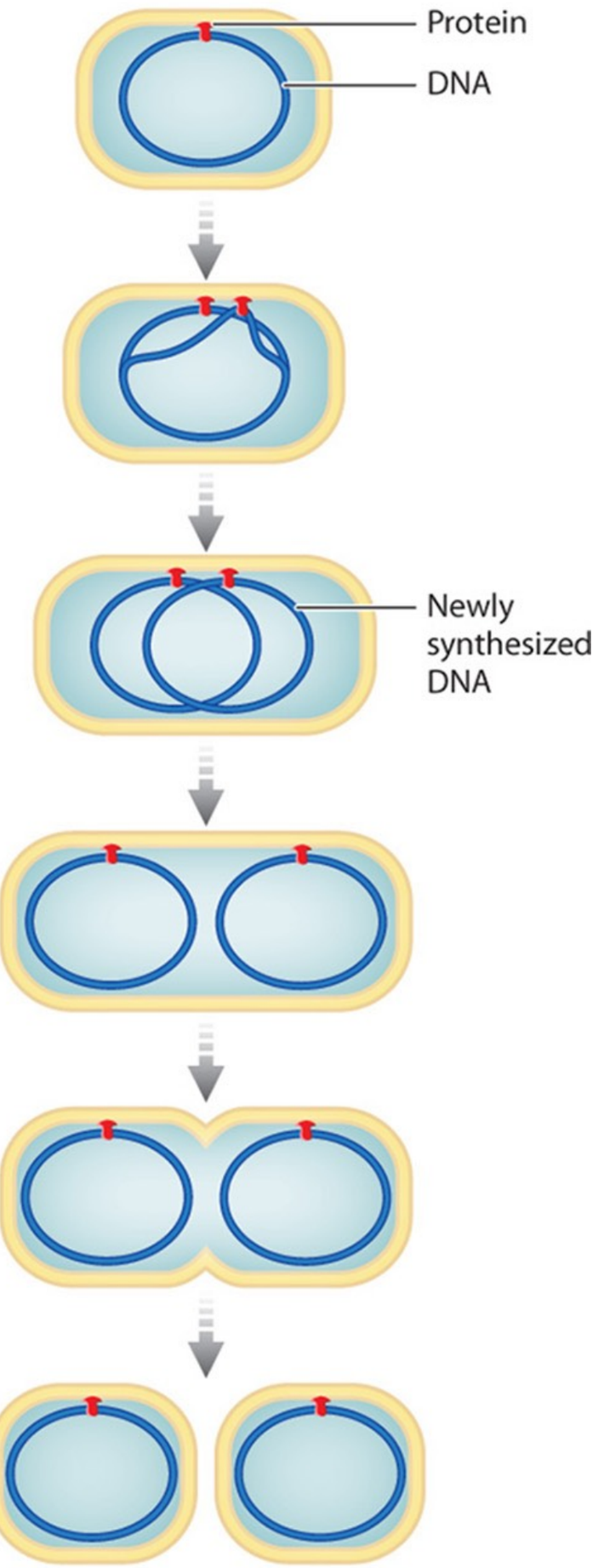
2. DNA replication begins at a specific location and proceeds bidirectionally around the circle.

3. The newly synthesized DNA molecule is also attached to the inner membrane, near the attachment site of the initial molecule.

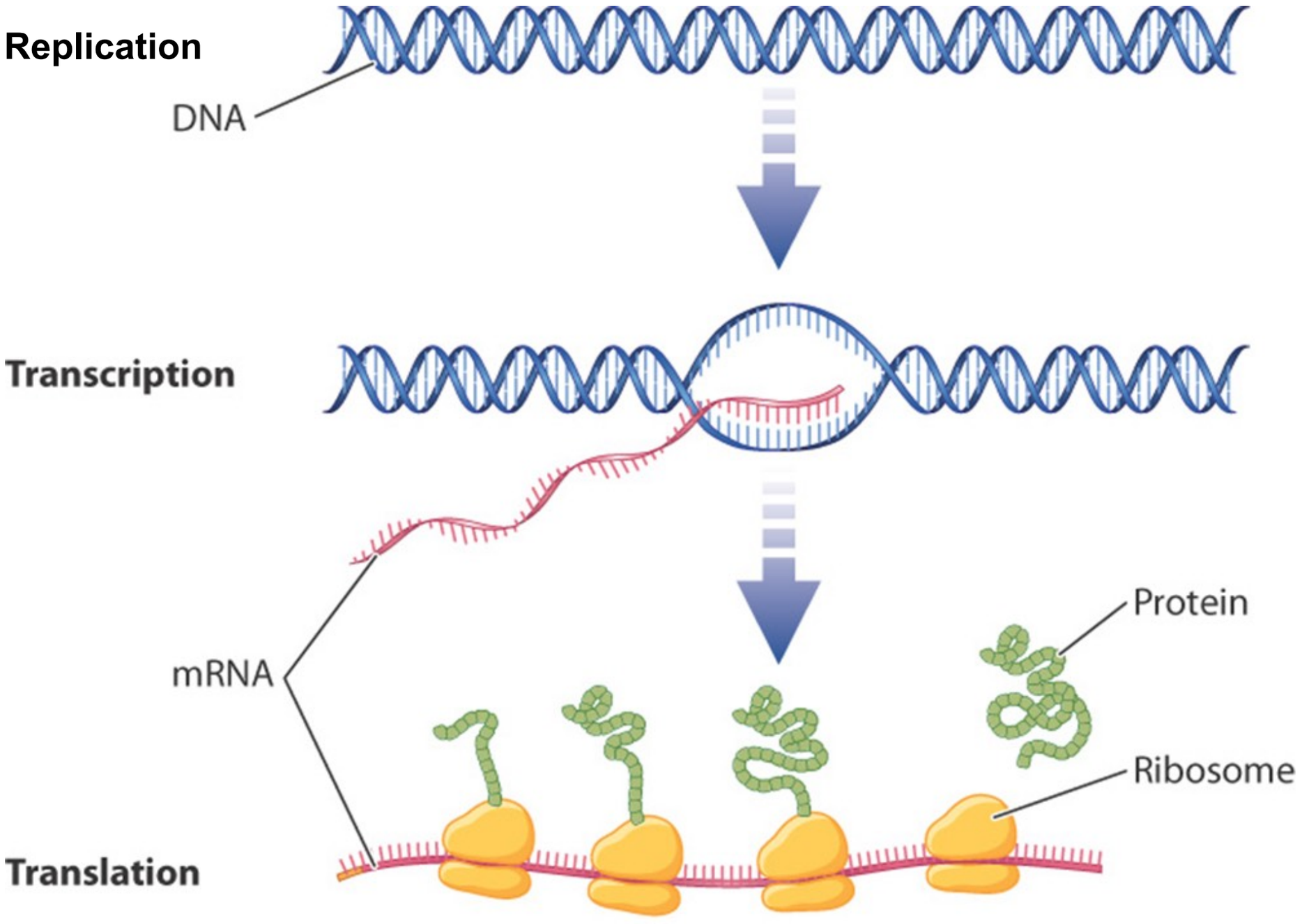
4. As replication proceeds, the cell elongates symmetrically around the midpoint, separating the DNA attachment sites.

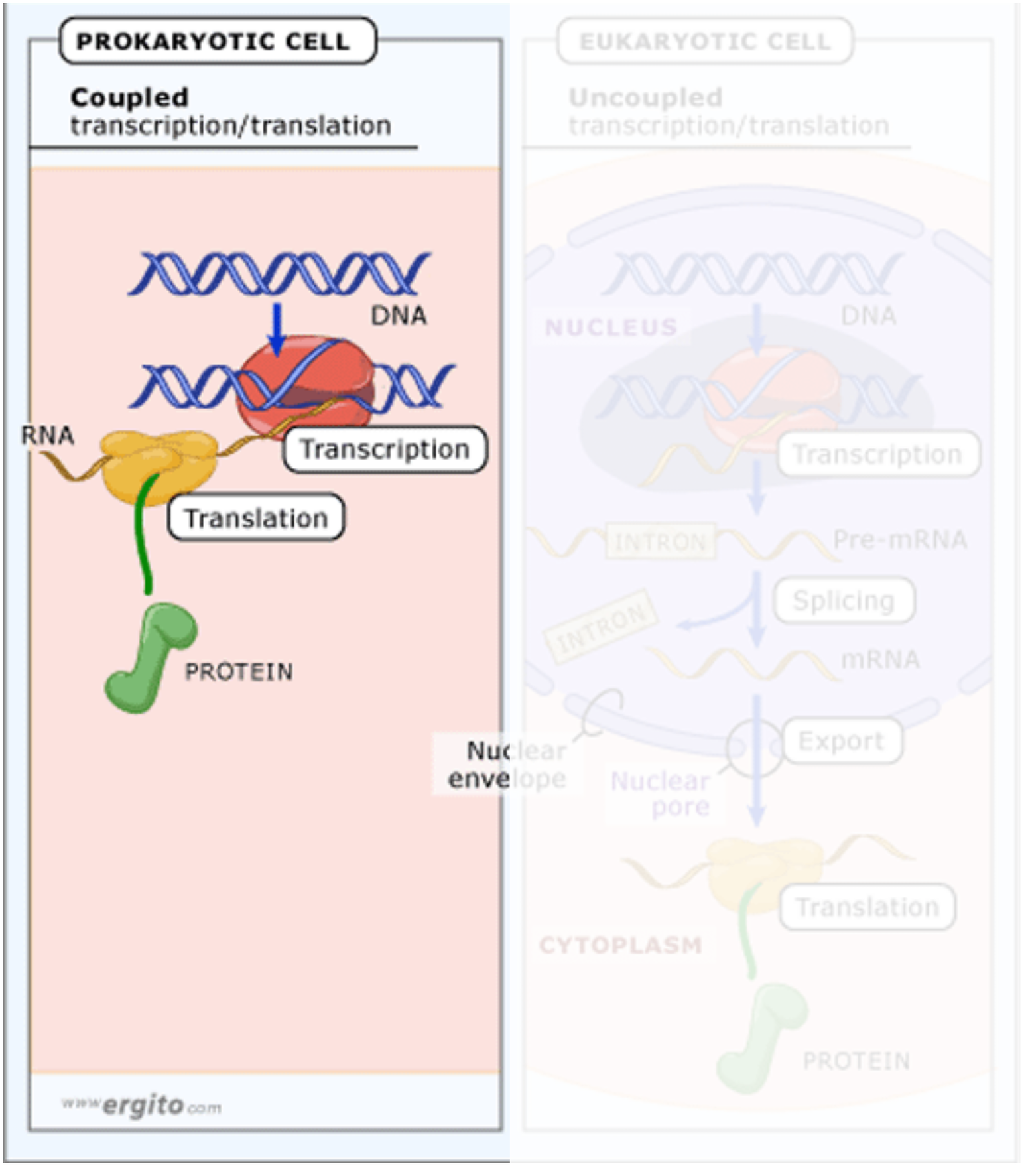
5. Cell division begins with the synthesis of new membrane and wall material at the midpoint.

6. Continued synthesis completes the constriction and separates the daughter cells.



Central Dogma




PROKARYOTIC CELL
Coupled
transcription/translation
DNA
RNA
Transcription
Translation
PROTEIN
www.ergito.com
EUKARYOTIC CELL
Uncoupled
transcription/translation
NUCLEUS
DNA
Transcription
INTRON
Pre-mRNA
Splicing
mRNA
Export
Nuclear
pore
Translation
CYTOPLASM
PROTEIN

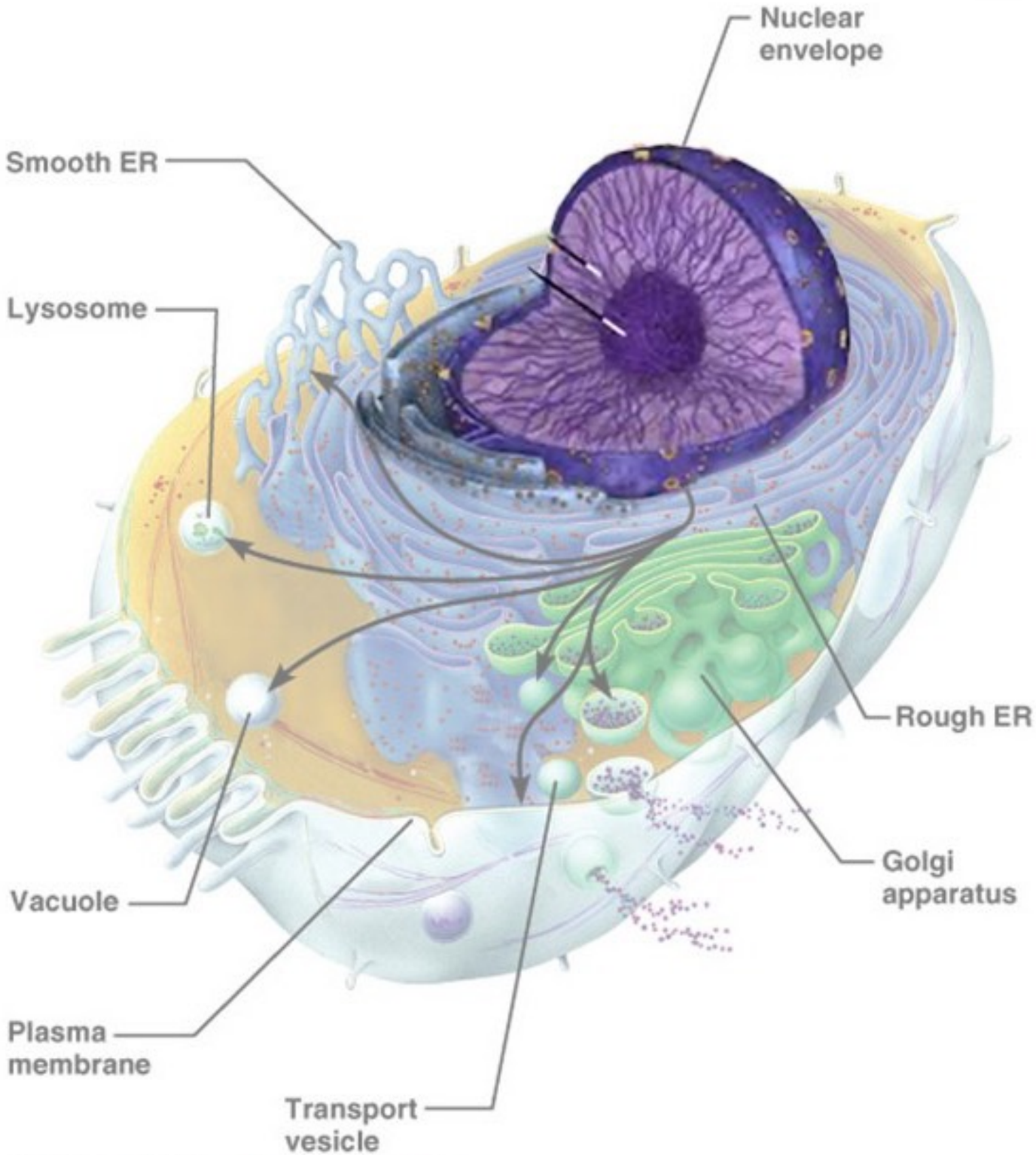
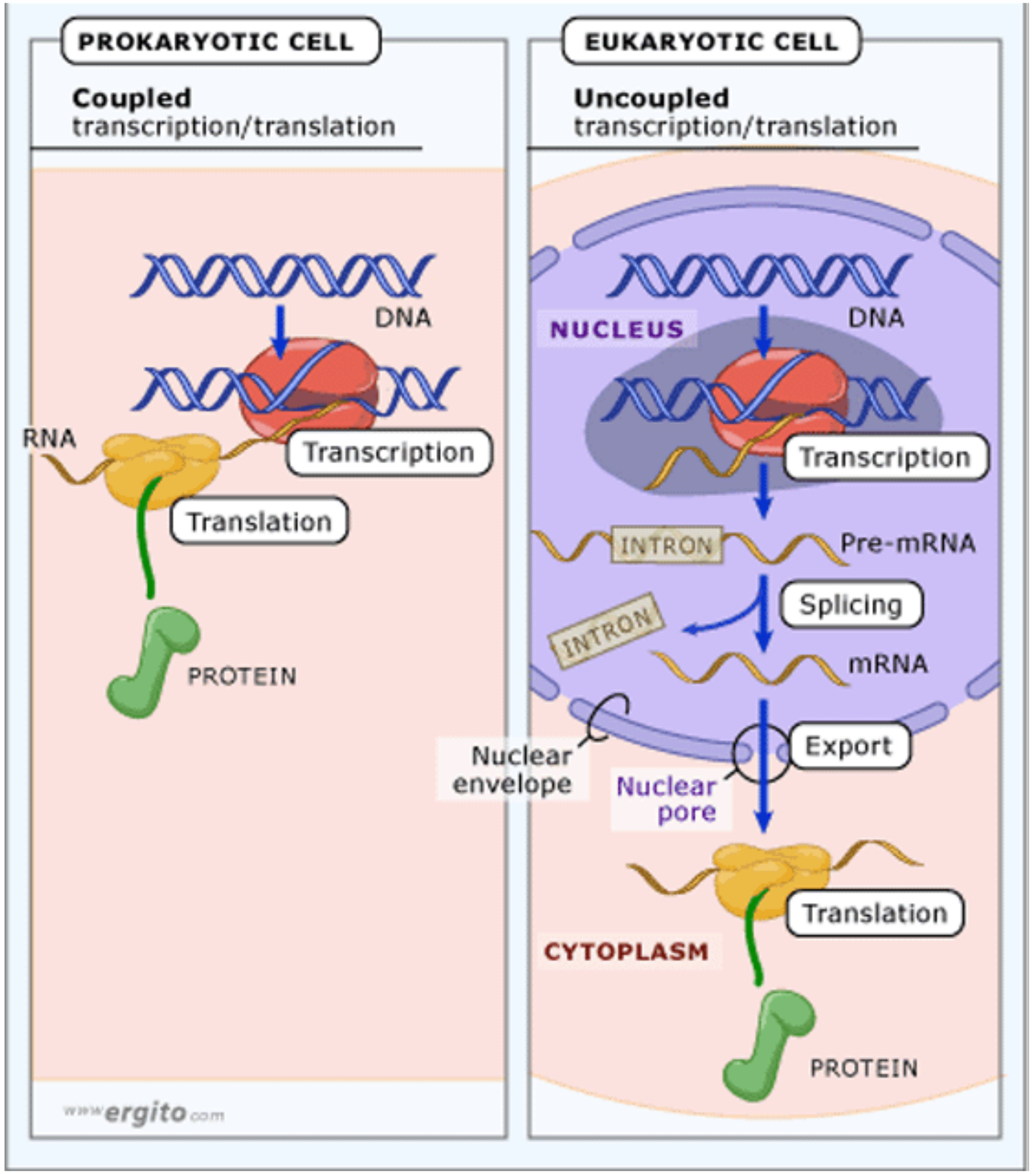


Figure 3.23


PROKARYOTIC CELL
Coupled
transcription/translation
DNA
RNA
Transcription
Translation
PROTEIN
EUKARYOTIC CELL
Uncoupled
transcription/translation
NUCLEUS
DNA
Transcription
INTRON
Pre-mRNA
Splicing
INTRON
mRNA
Export
Nuclear envelope
Nuclear pore
Translation
CYTOPLASM
PROTEIN
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