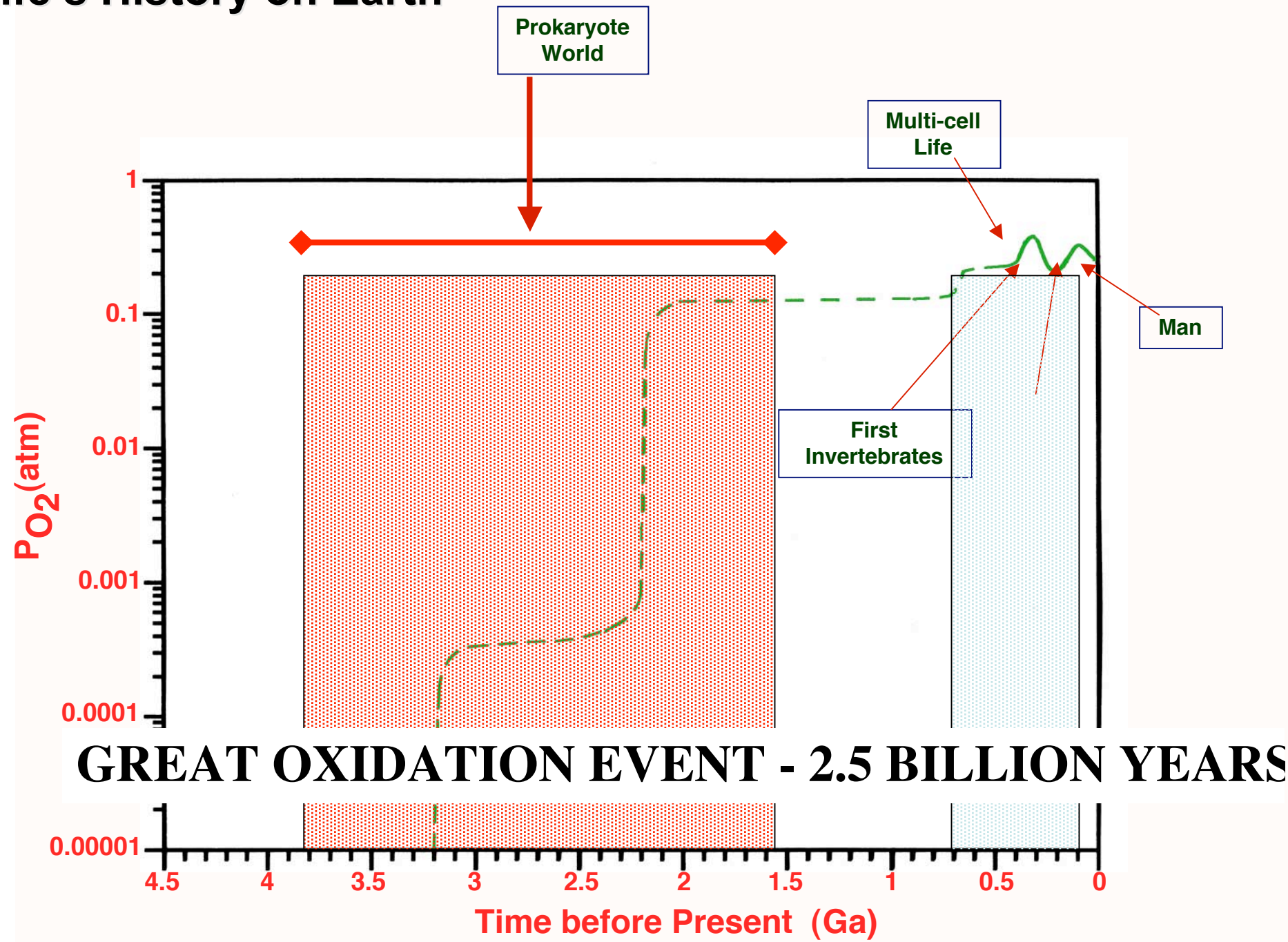
Systems Microbiolog

Monday Sept 11 - Ch 4 & Ch 8.13 (Purcell &

Structure/Function/Motility

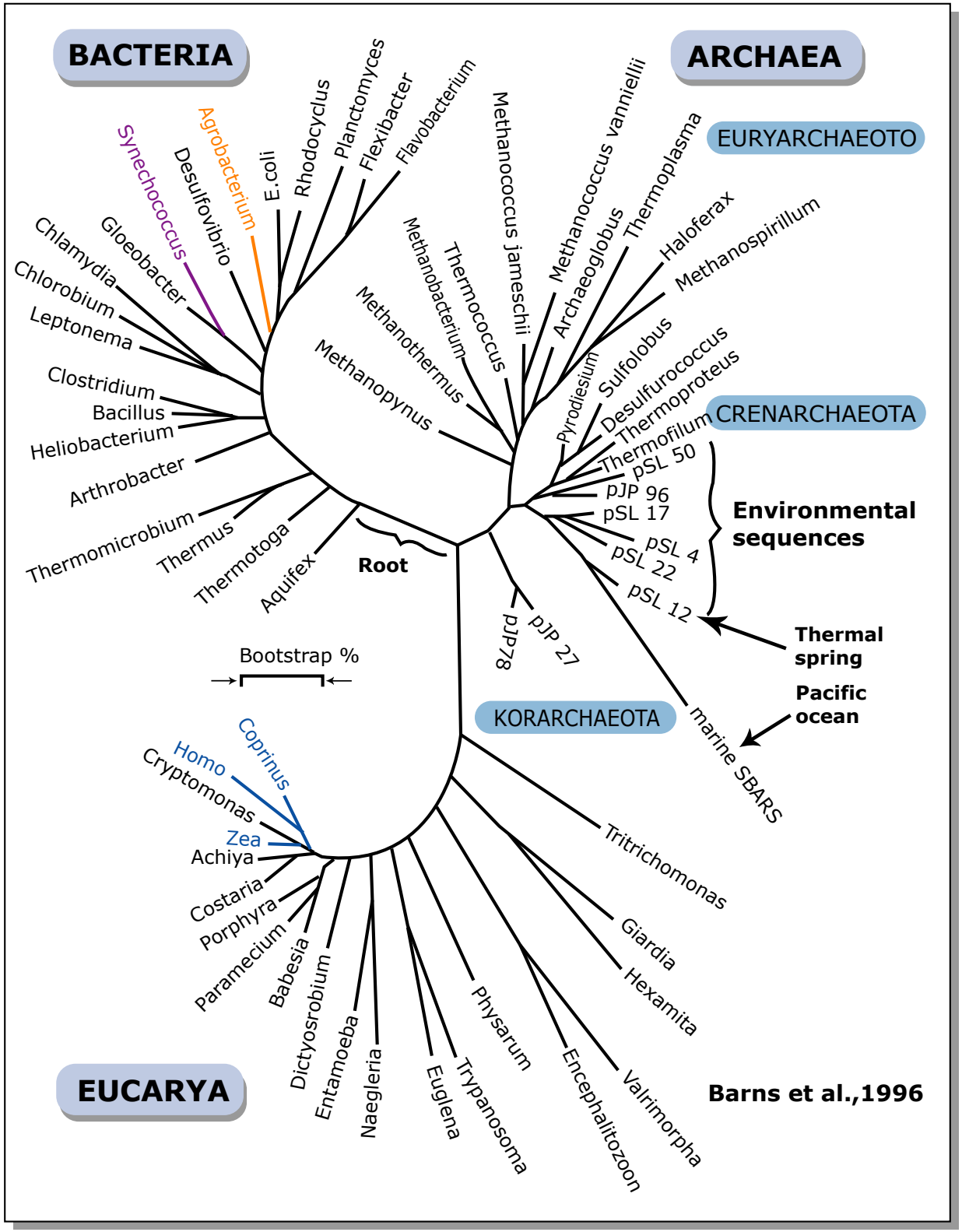
- GENERAL ASPECTs of BEING SMALL
- CELL MEMBRANES AND CELL WALLS
- FLAGELLA STRUCTURE/FUNCTION
- CHEMOTAXIS

Life's History on Earth



GREAT OXIDATION EVENT - 2.5 BILLION YEARS

Photographs of various forms of life removed due to copyright restrictions.



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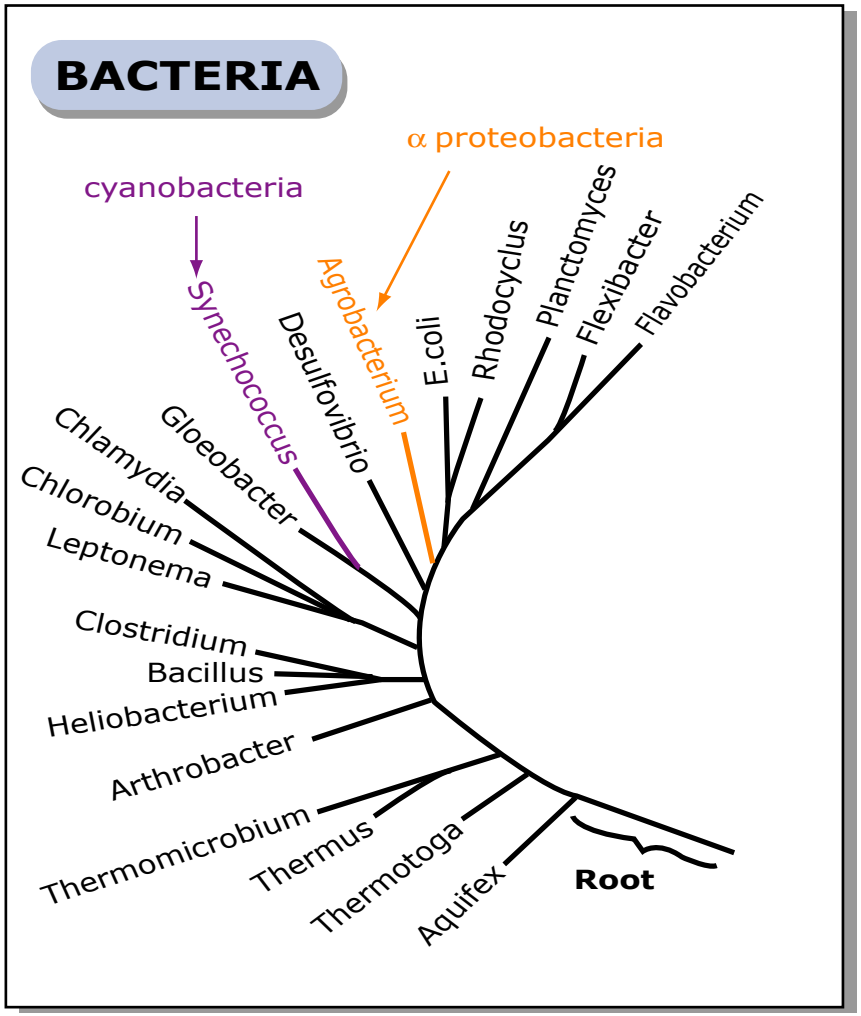
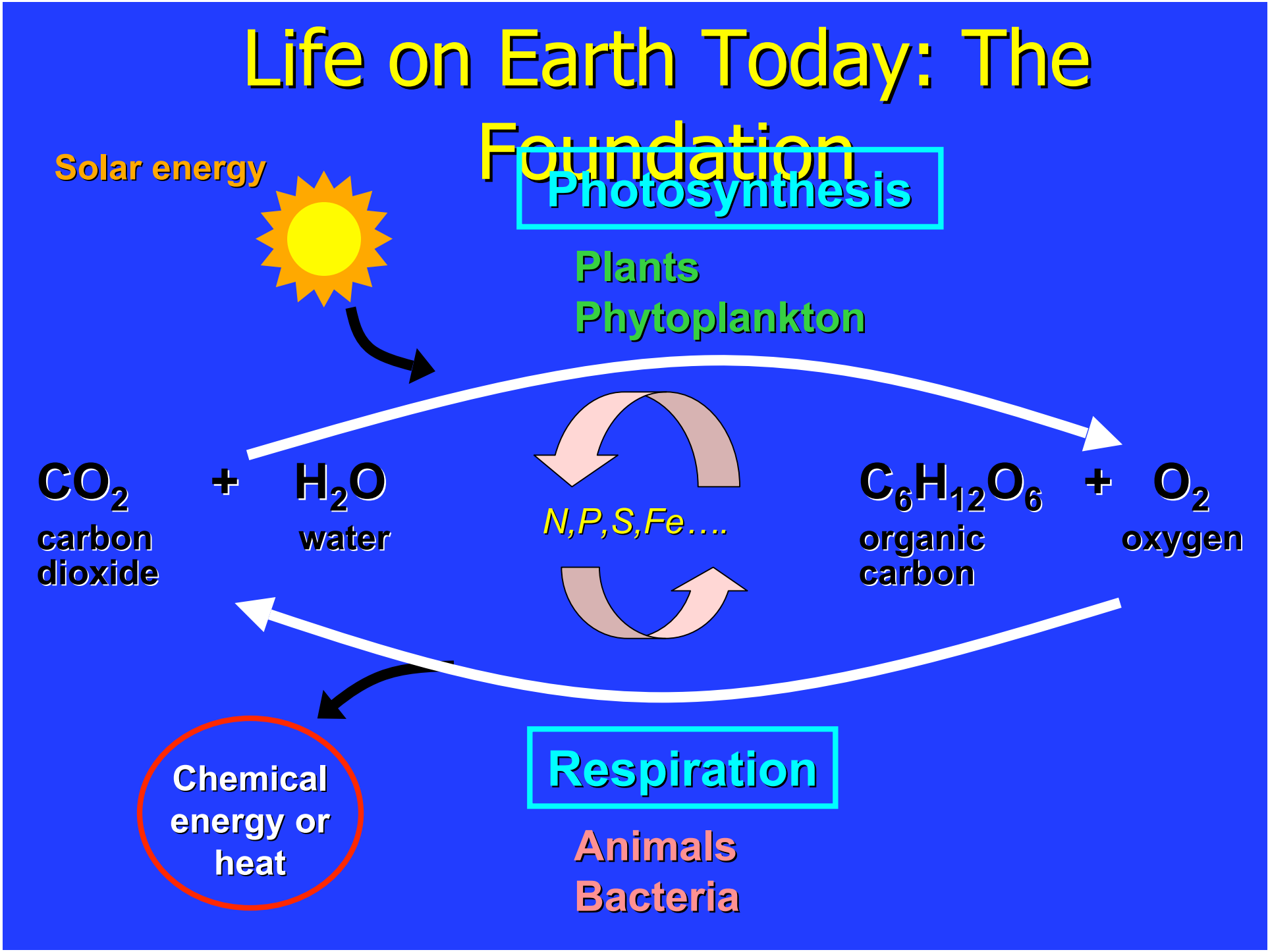


Figure by MIT OCW.

ENDOSYMBIONT HYPOTHESIS

- **Chloroplasts** arose from a symbiotic partnership between an ancestral eukaryote and a cyanobacterium
- **Mitochondria** arose from a symbiotic partnership between an ancestral eukaryote and an "alpha proteobacterium"

Life on Earth Today: The Foundation



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Images removed due to copyright restrictions.

See Figures 4-11, 4-13, and 4-10a in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms.* 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

"Prokaryote"

Eukaryote

Diagrams of Prokaryotic structure vs. Eukaryotic structure removed due to copyright restrictions.
See Figures 2-1a and 2-1b in Madigan, Michael, and John Martinko. Brock Biology of Microorganisms. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

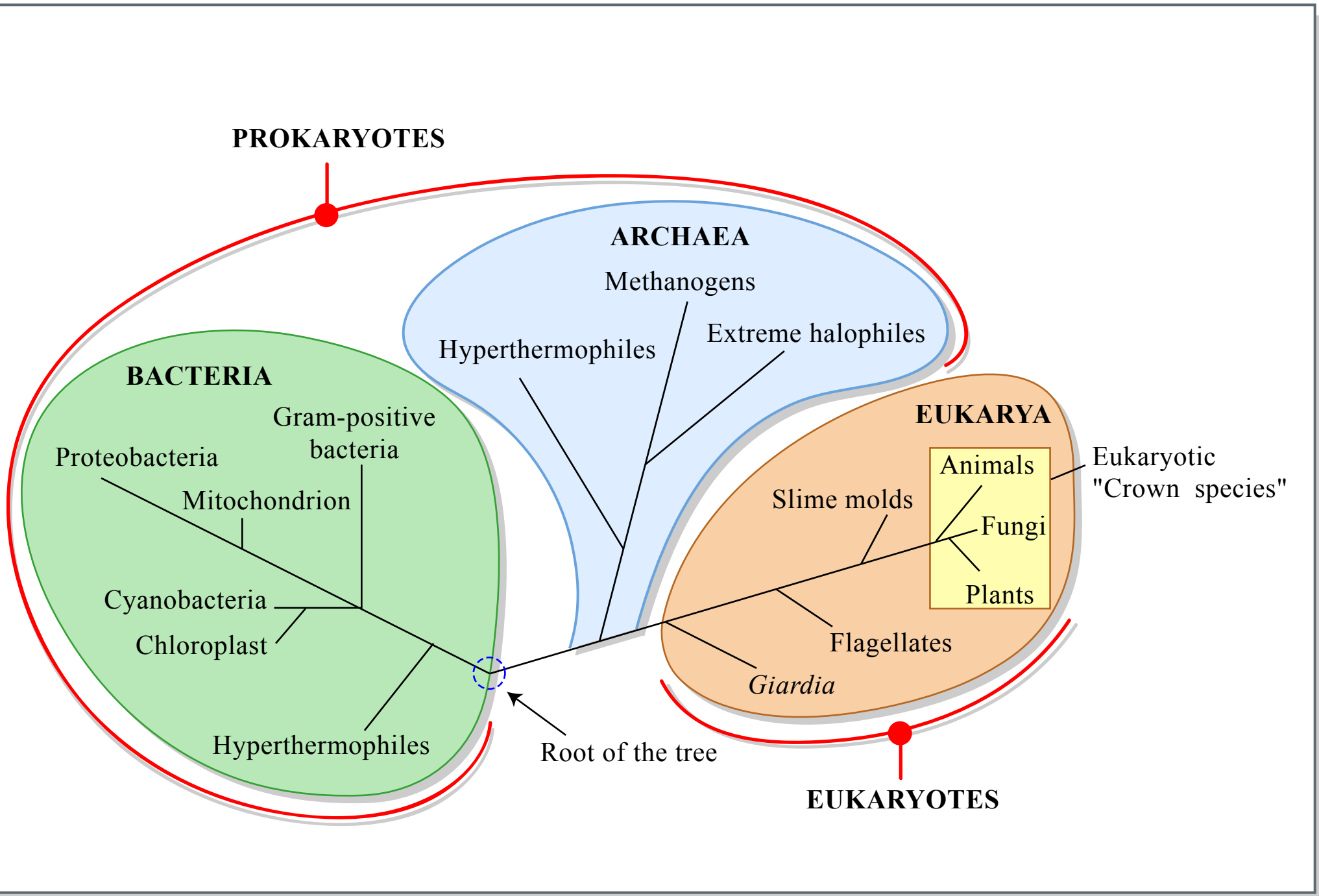
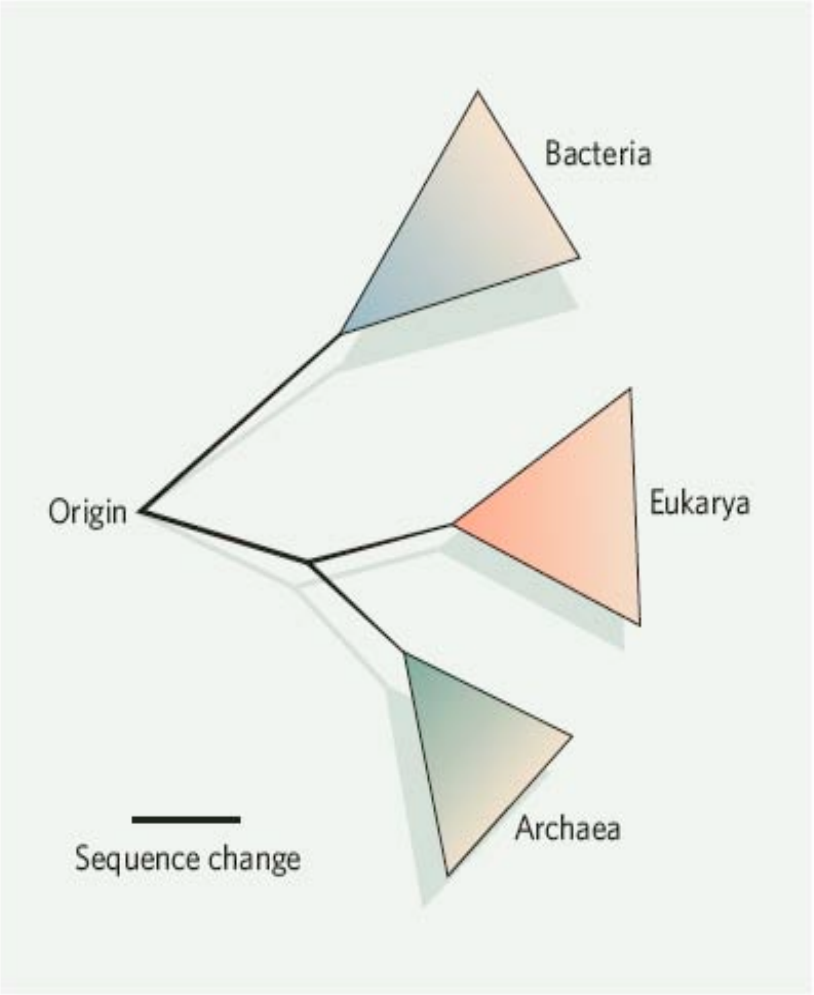


Figure by MIT OCW.

Table summary of the major differential features among Bacteria, Archaea, and Eukarya removed due to copyright restrictions.
See Table 11-3 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed.
Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.



Comparisons of ribosomal RNA sequences reveal a three-domains tree of life, rendering the term 'prokaryote' obsolete.

NATURE|Vol 441|18 May 2006

Time for a change

Prokaryote: gene-sequence comparisons show the tree of life consists of bacteria, eukarya and archaea. The use of the term 'prokaryote' fails to recognize that an idea about life's origins has been proved wrong.

Norman R. Pace

and not derived from either

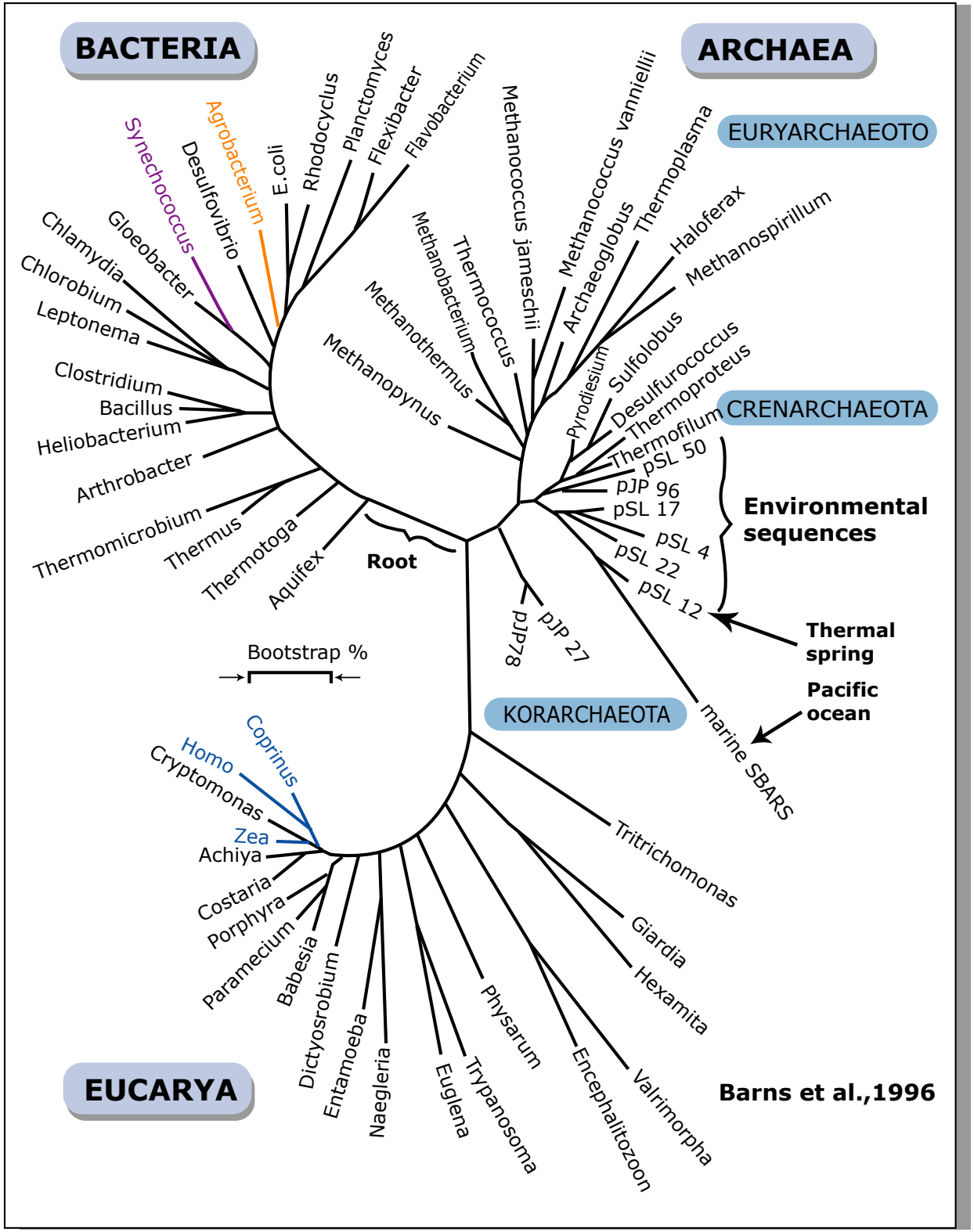


Figure by MIT OCW.

Diagrams of cell membranes removed due to copyright restrictions.
See Figures 4-15b and 4-16 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

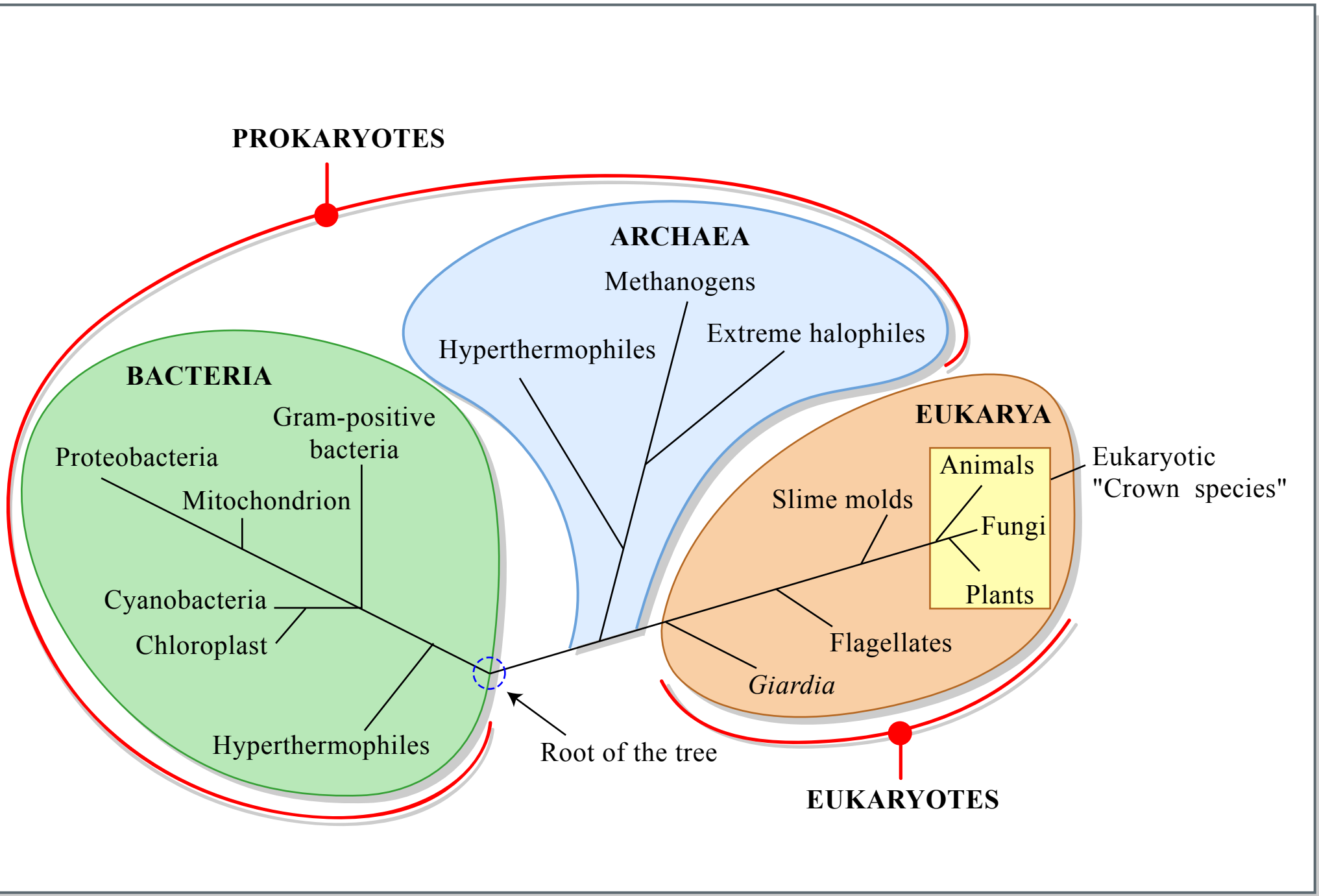


Figure by MIT OCW.

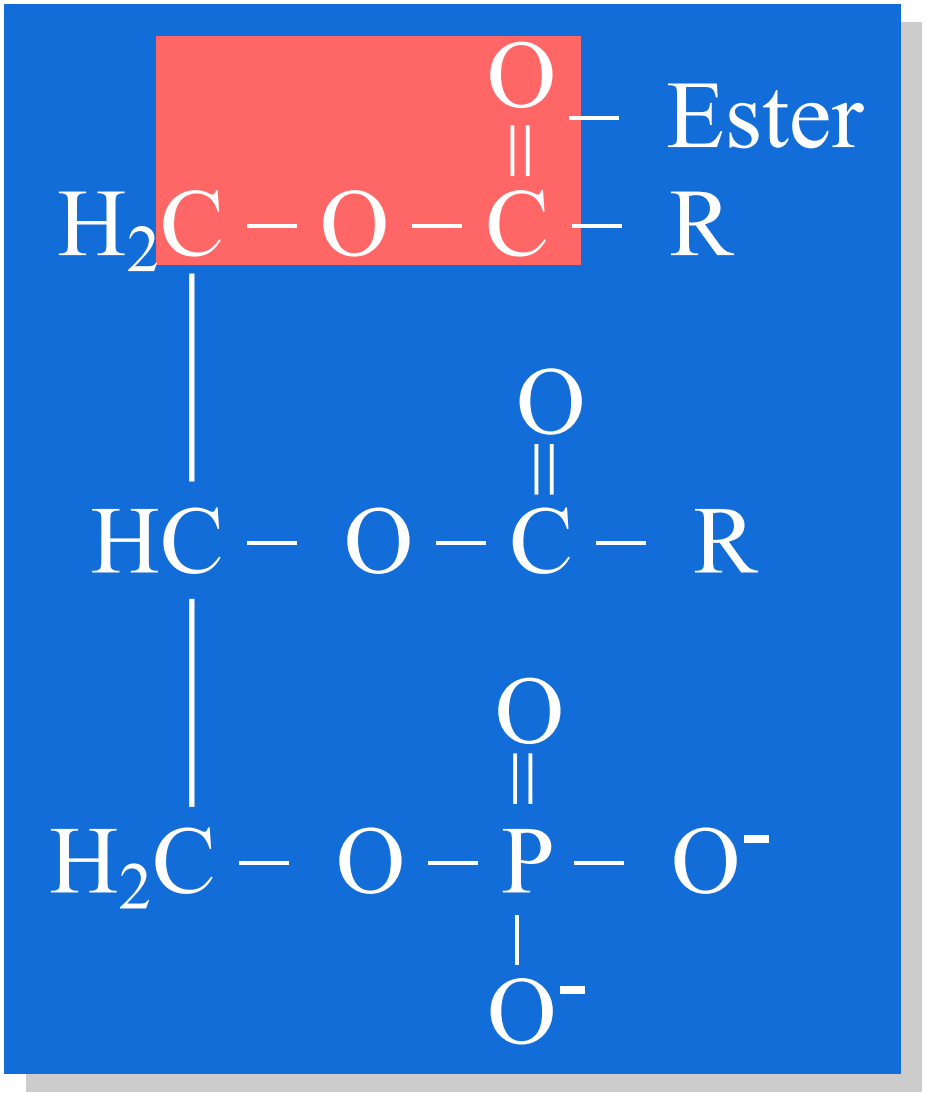


Figure by MIT OCW.

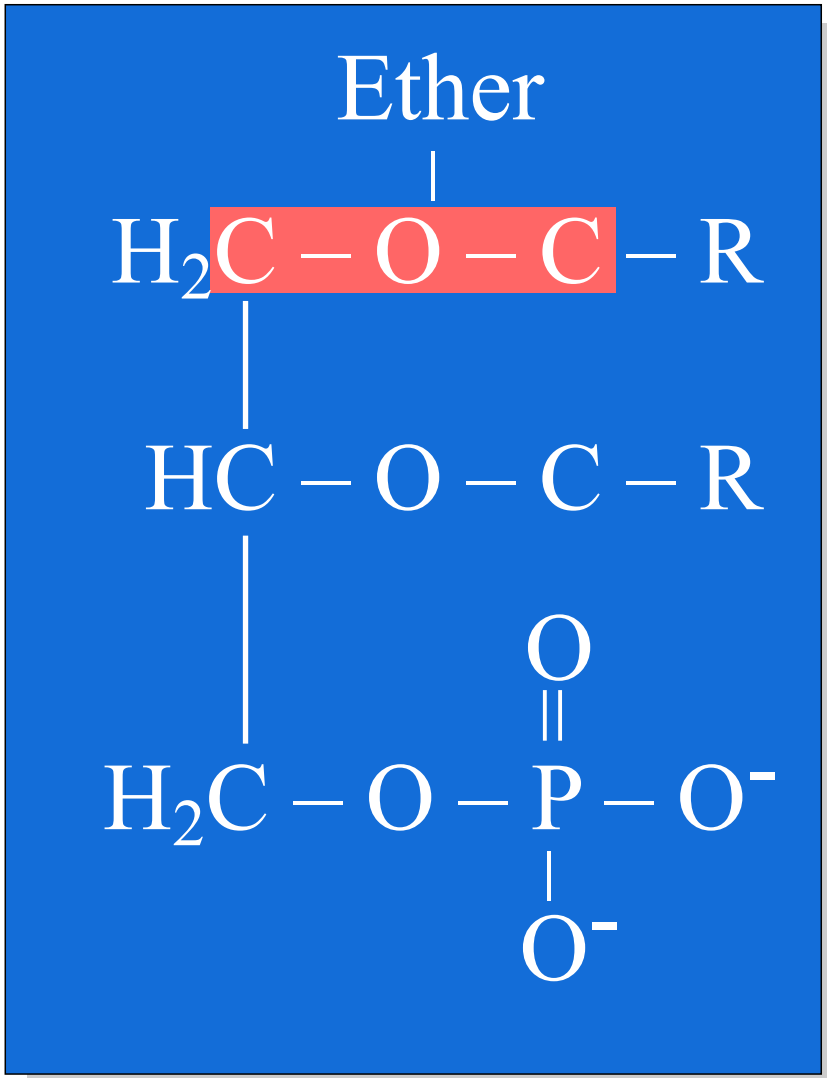


Figure by MIT OCW.

Images of cell membranes removed due to copyright restrictions.
See Figures 4-19, 4-20, 4-22, 4-23, 4-36, and Table 4-2 in Madigan, Michael, and John Martinko.
Brock Biology of Microorganisms. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

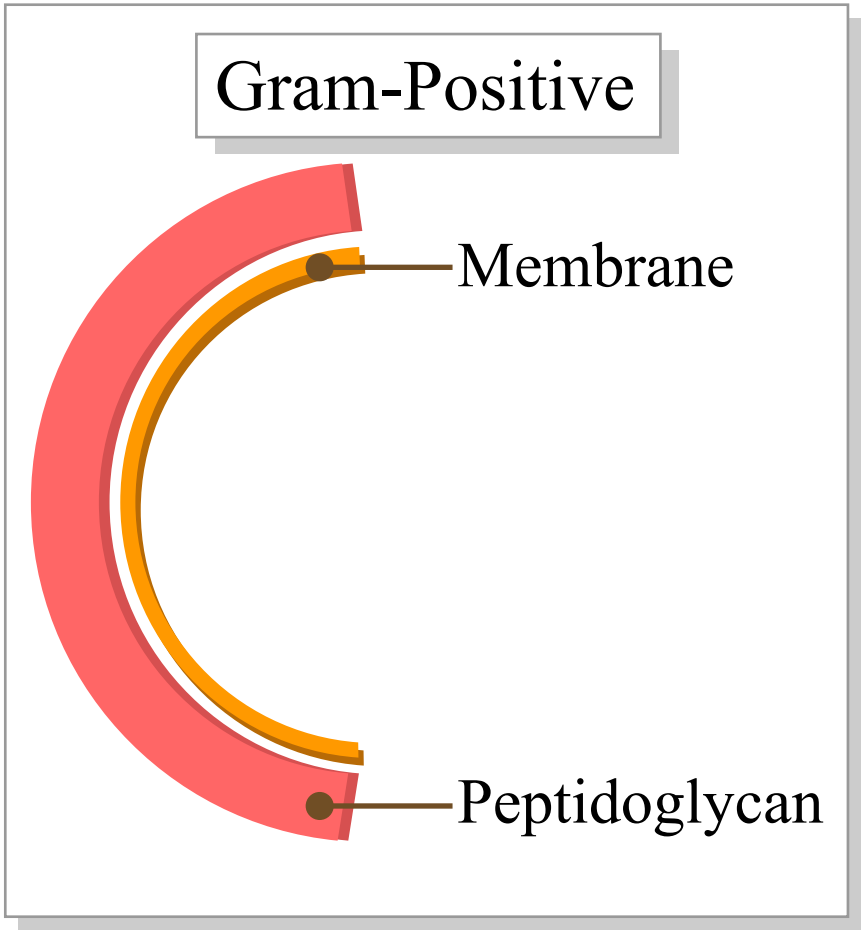


Figure by MIT OCW.

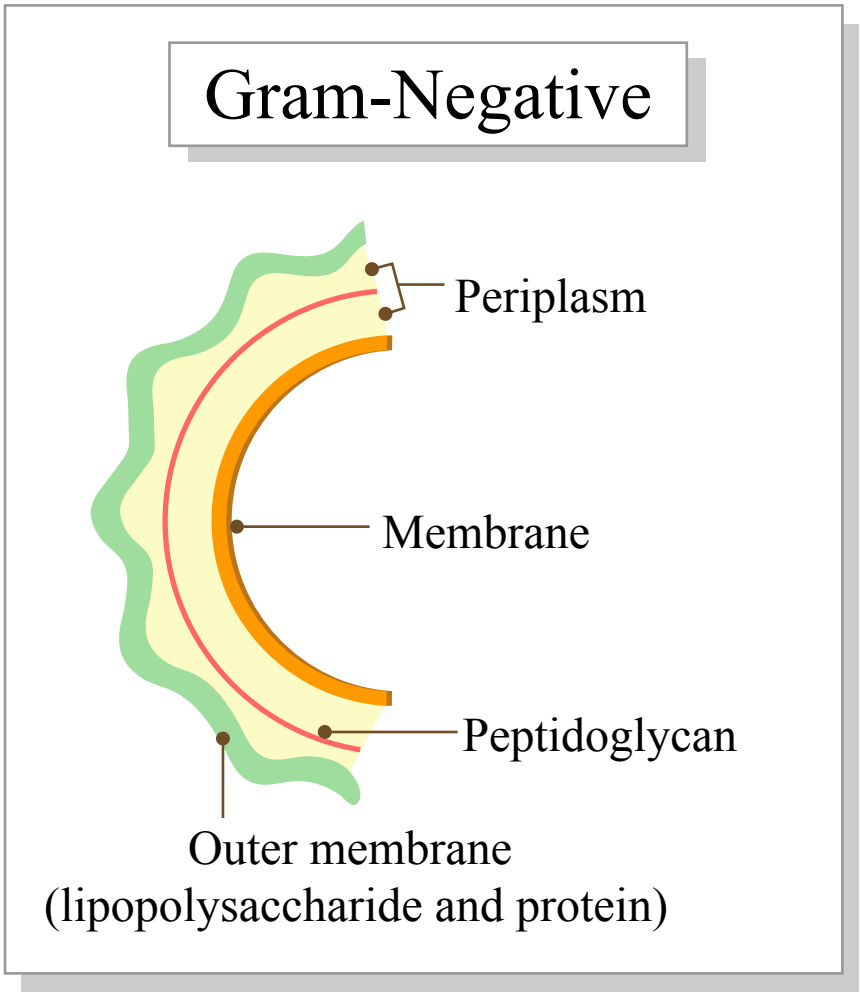
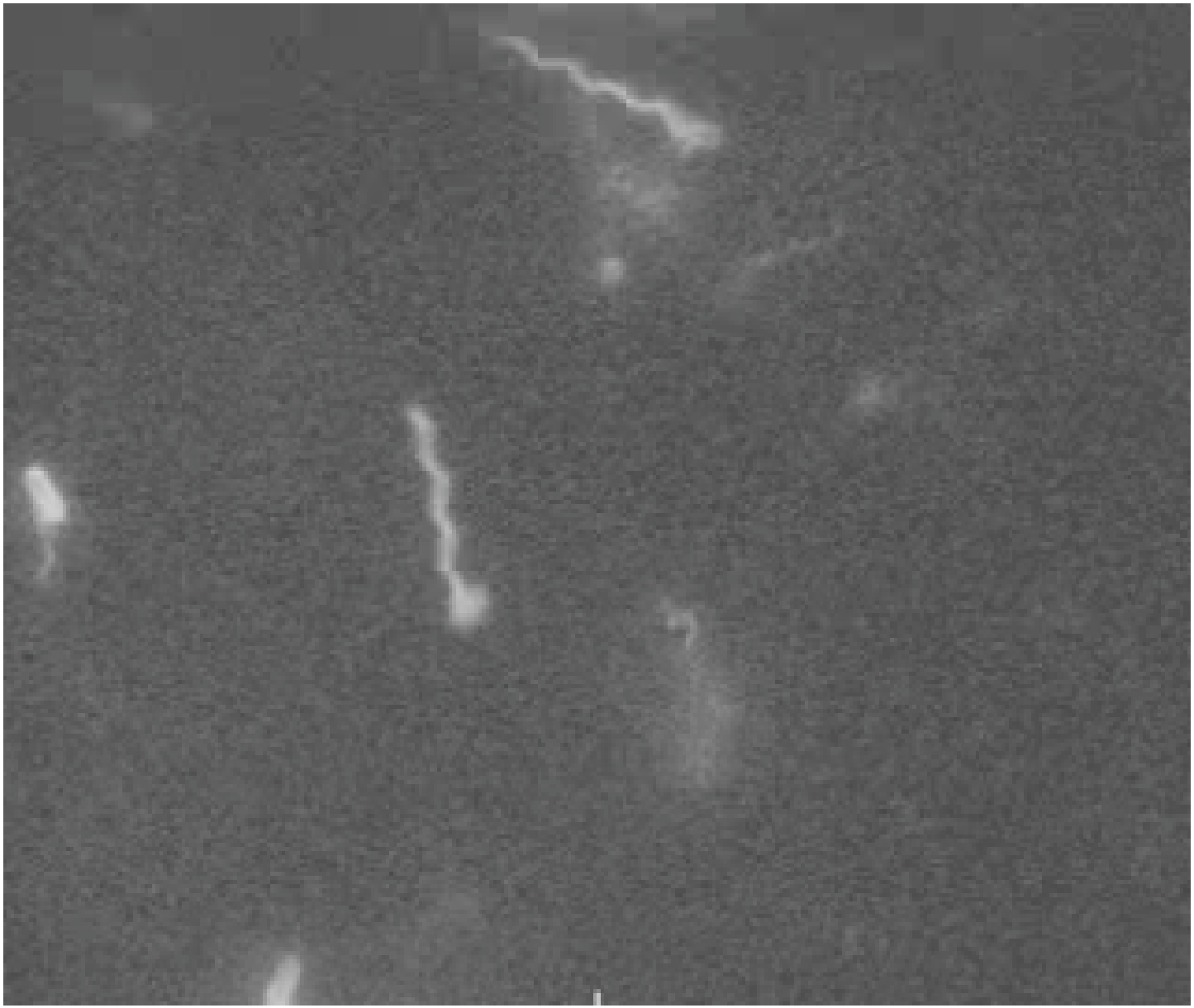


Figure by MIT OCW.

Images of cell membranes and peptidoglycan removed due to copyright restrictions.
See Figures 4-27d, 4-29, 4-30, 4-35a, 4-31b, and 4-32 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms.* 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN:0131443291.

Images of flagella and pili removed due to copyright restrictions.
See Figures 4-37, 4-54, and 4-38 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.



http://www.rowland.harvard.edu/labs/bacteria/projects_filament.html, Howard Berg

Filaments in the bundle are usually normal, i.e., left-handed helices with pitch about 2.5 μm and diameter about (
with the motors turning counterclockwise. During the tumble, one or more motors switch to clockwise, and their fi
leave the bundle and transform to semi-coiled, i.e., right handed helices with pitch about half of normal.

Purcell, Life @ Low R

Kinematic viscosity

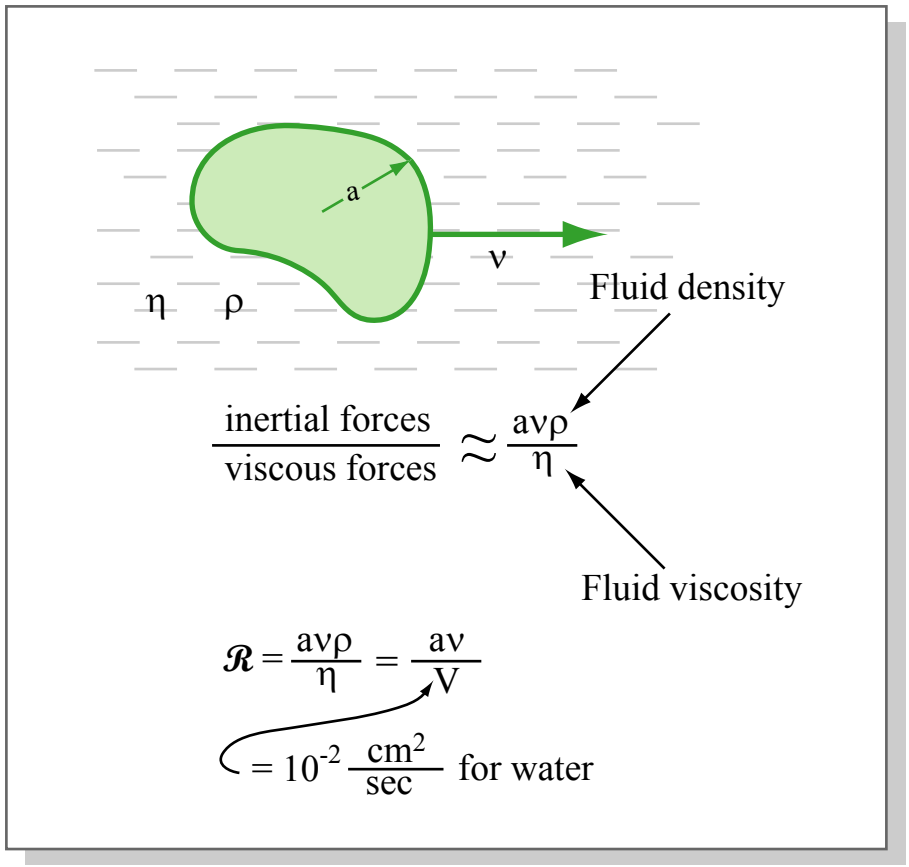


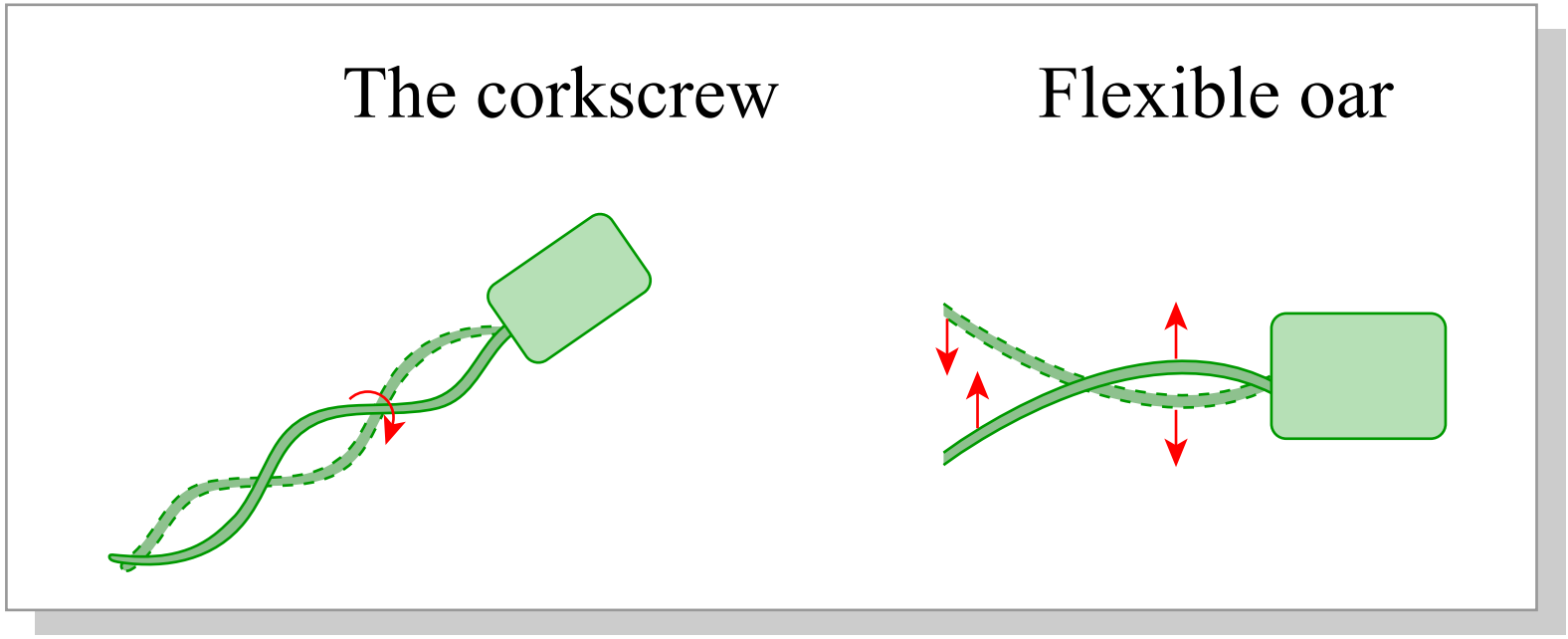
Figure by MIT OCW.

The ‘clamshell hypothesis’

Purcell, Life @ Low R

Reciprocal motion doesn’t work at low Reynolds number !

So, what does work ?

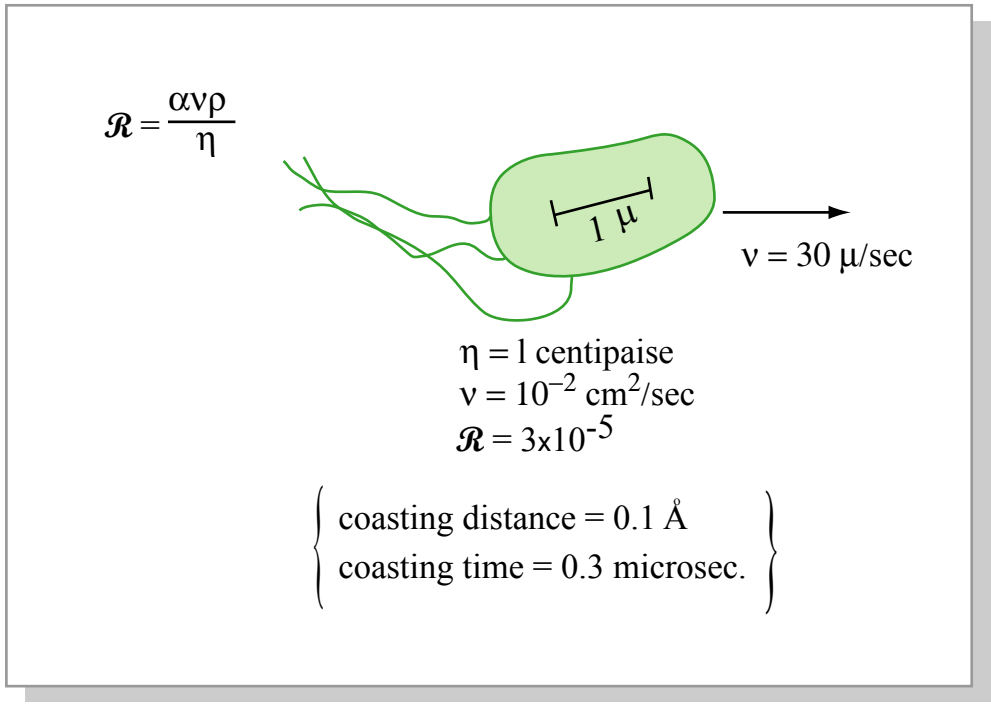


Figures by MIT OCW.

Purcell, Life @ Low

$R_{man}=10^4$

$R_{goldfish}= 10^2$



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Images of flagella removed due to copyright restrictions.

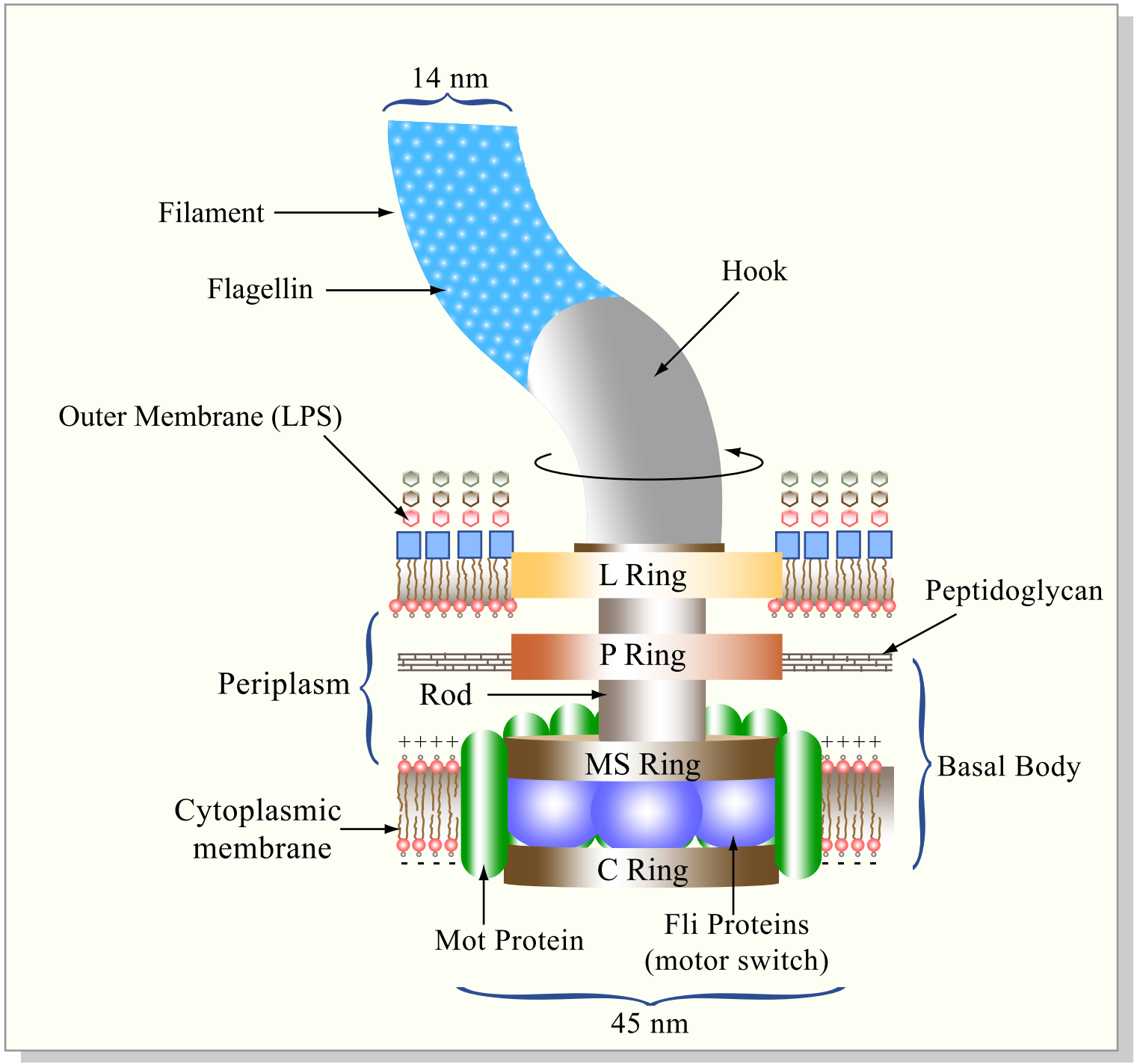


Figure by MIT OCW.

Flagellar motor

Motor is located in the membrane, 40 genes code for this protein complex

Membrane part resemble to Fo subunit of ATPase

S and M rings are separated from membrane by intramembrane proteins (mot A)
A rod connects fillament to a ring

Ring M carries 100 mot B proteins

Motion of protons through motA and motB drives the rotation of rings and associated rod and fillament

Rotation is driven by proton gradient across the membrane not by ATP hydrolyses

Diagrams of the flagellar motor removed due to copyright restrictions.

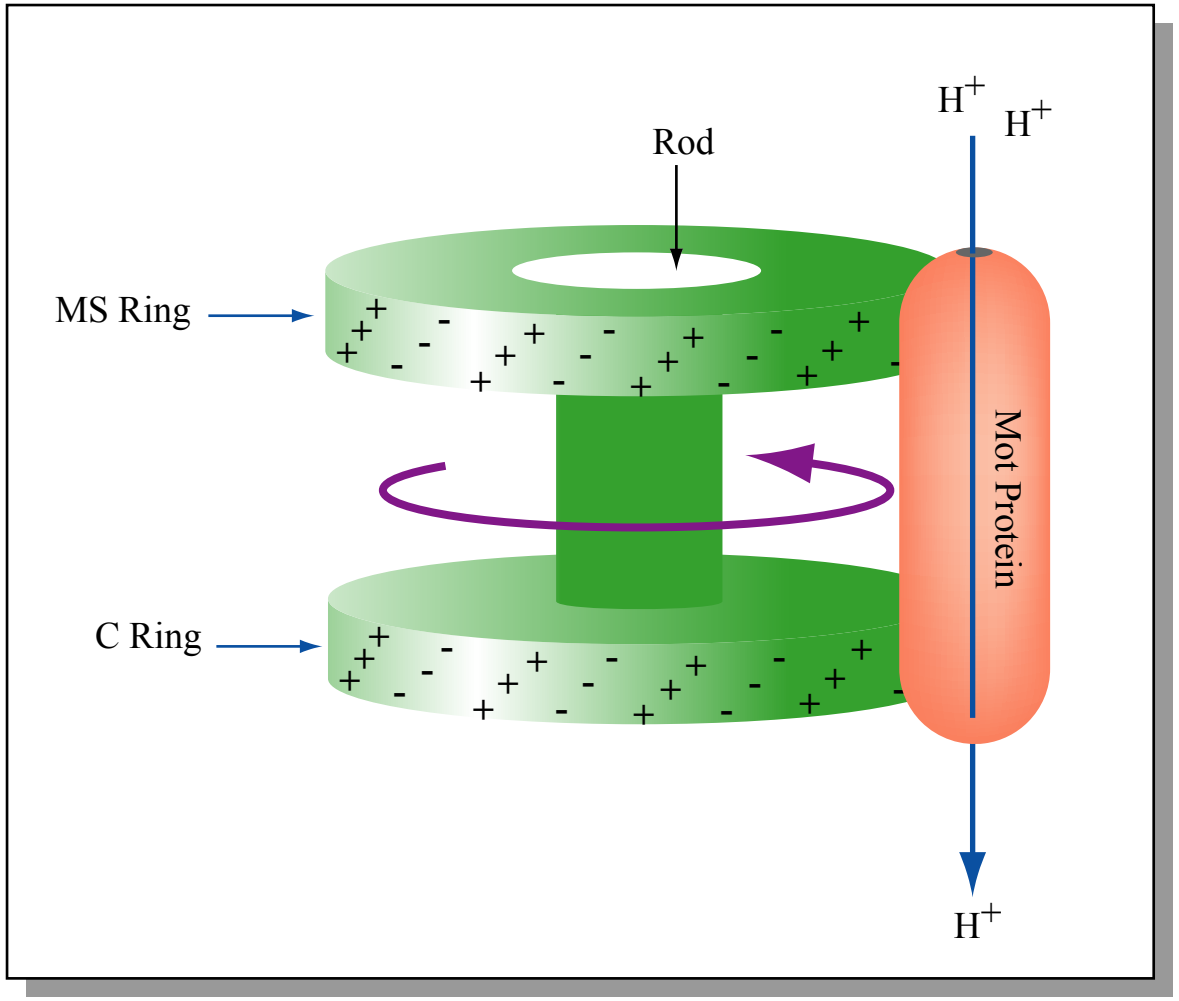


Figure by MIT OCW.

V. parahaemolyticus

100,000 rpm, 60um/sec

Sodium driven motor

Polar flagella motor senses torque, induces laf genes !

Photographs of flagella removed due to copyright restrictions.

Ann Rev Microbiol 57: 77-100 (2003) R. Macnab, How Bacteira Assemble Flagella

Images of flagella removed due to copyright restrictions.

Diagram of flagellar assembly removed due to copyright restrictions.
See Figure 4-57 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.

Flagellar assembly

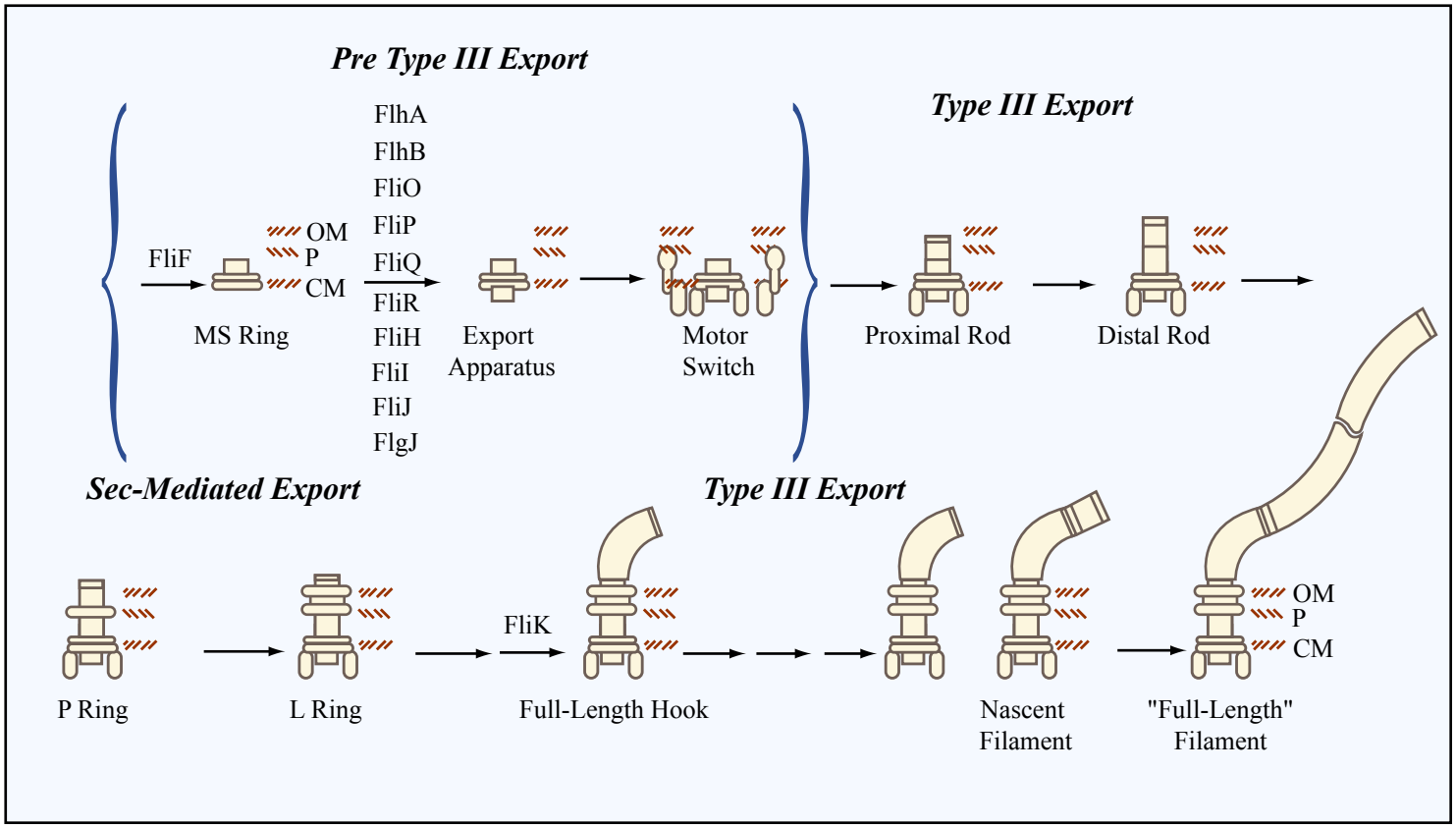
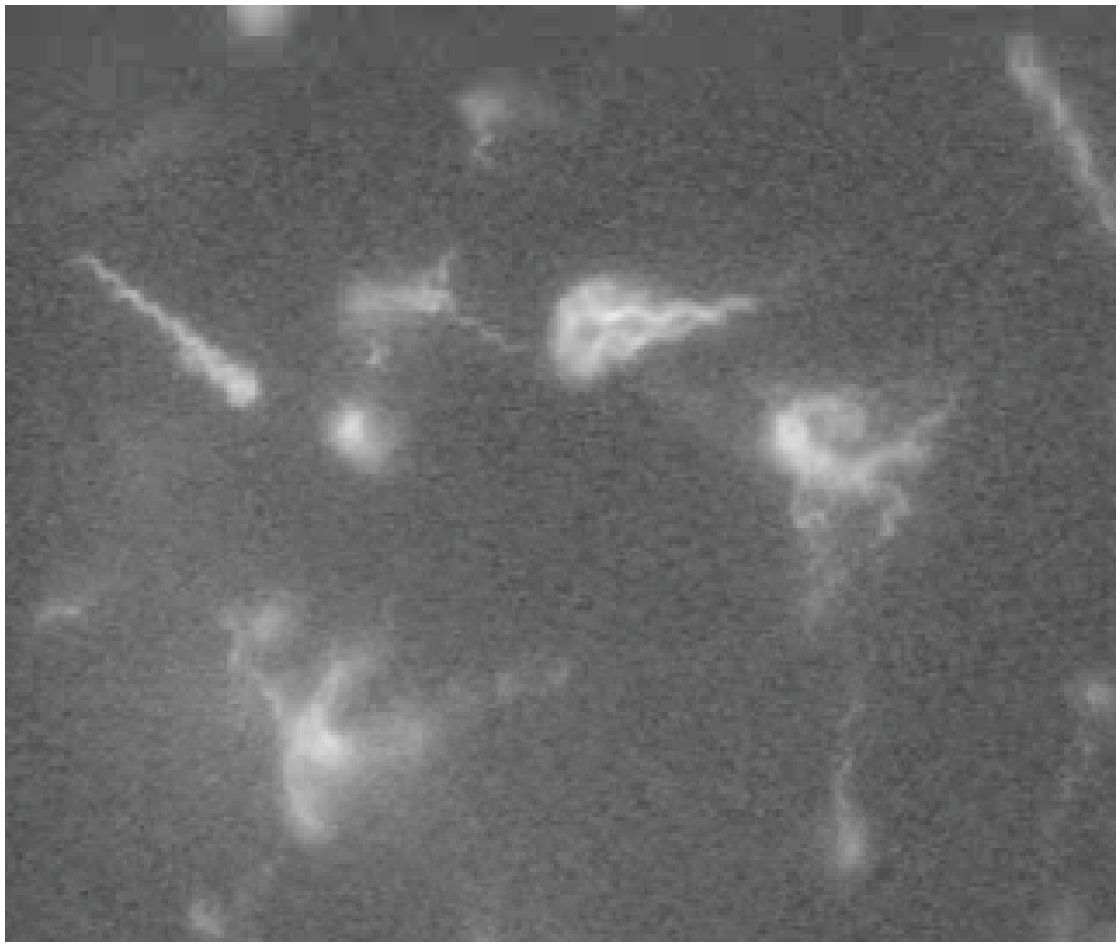


Figure by MIT OCW.

Biochimica et Biophysica Acta 1694 (2004) 207–217

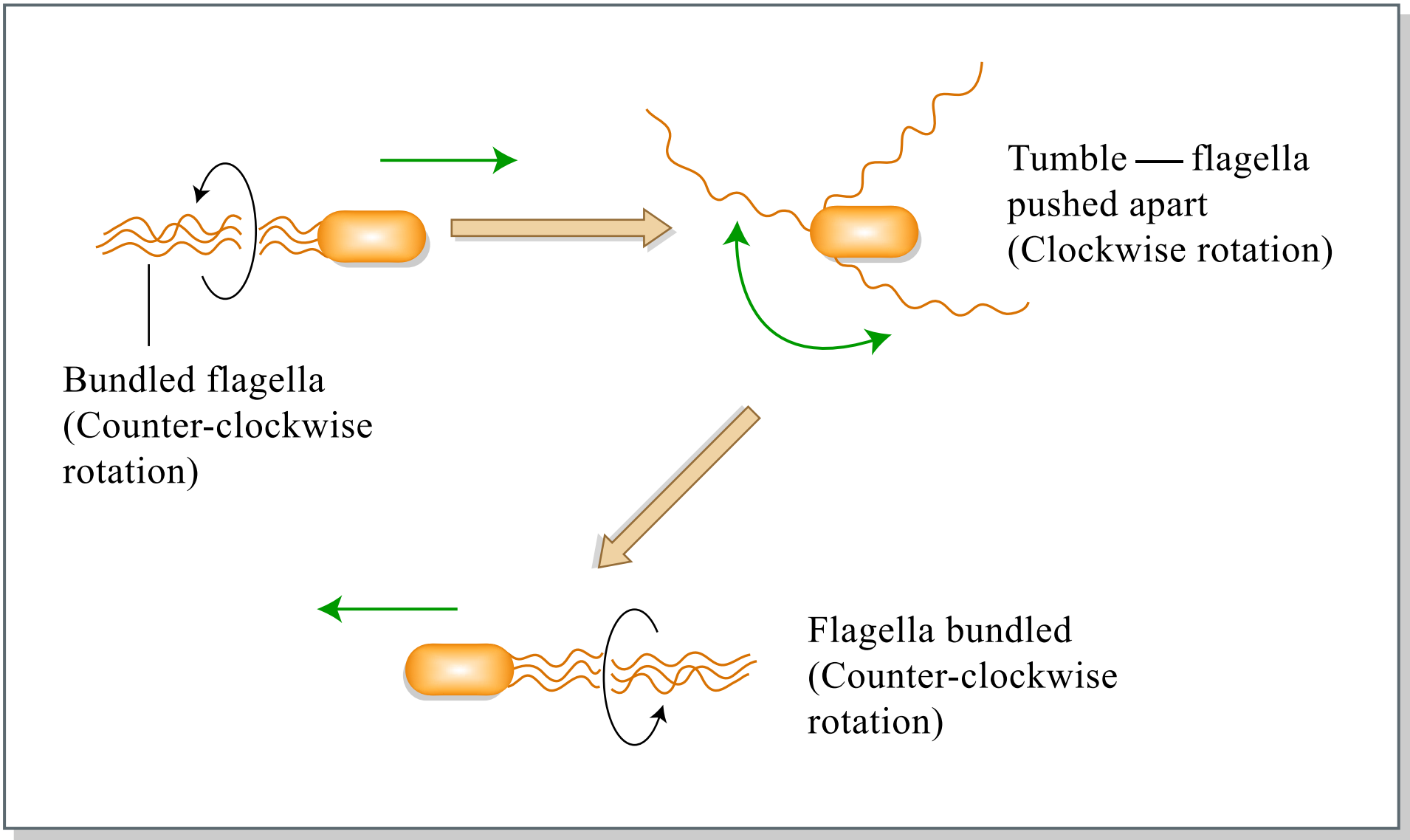
R. Macnab



Howard Berg

http://www.rowland.harvard.edu/labs/bacteria/projects_filament.html

Diagram of flagellar motion removed due to copyright restrictions.
See Figure 4-58 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.



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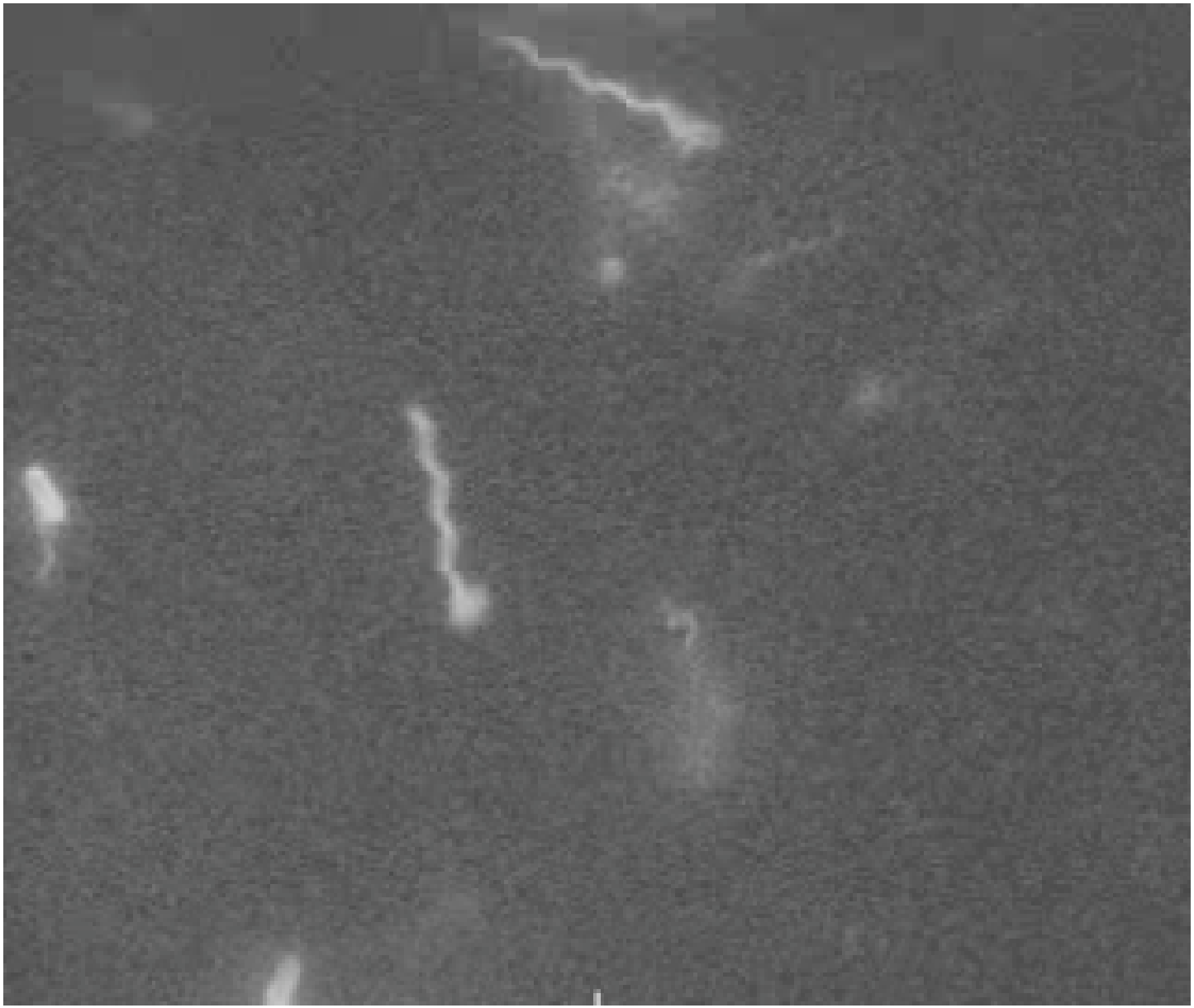

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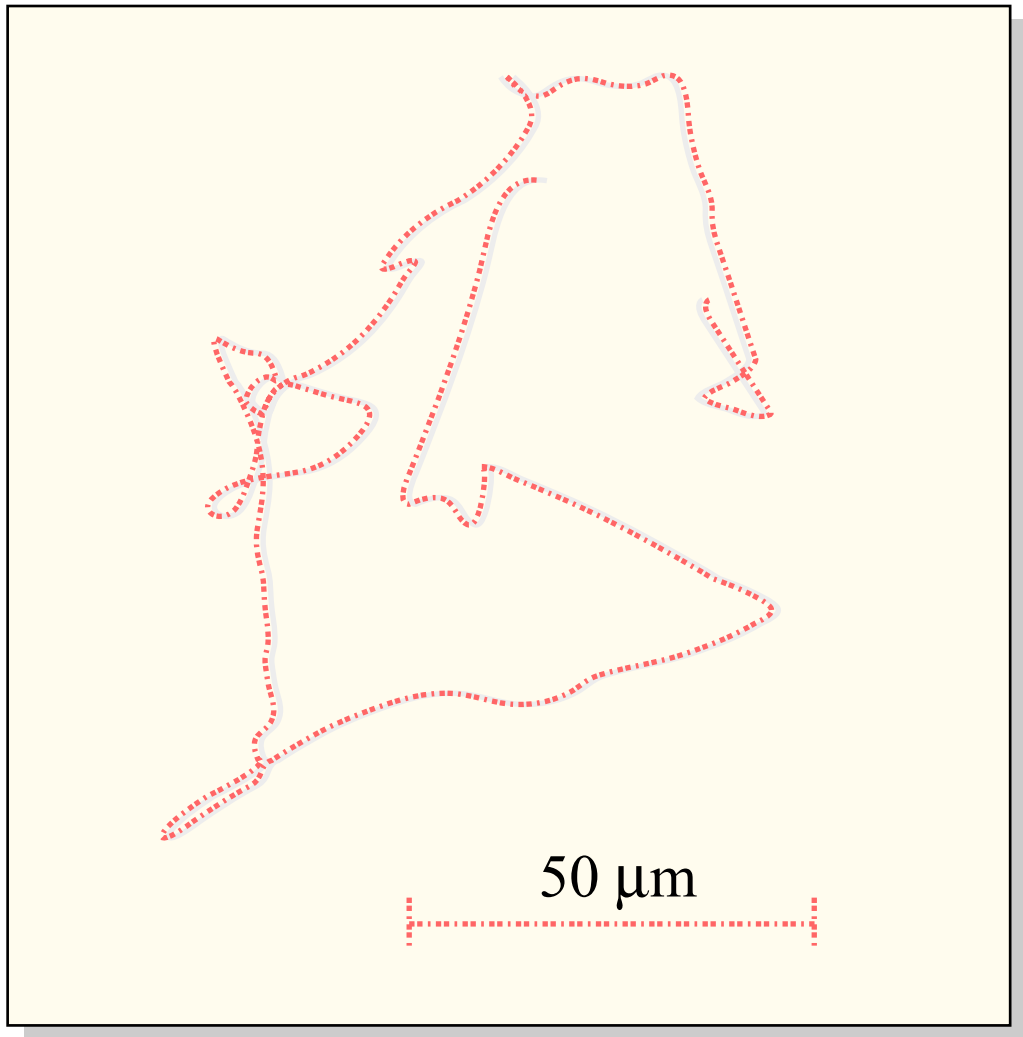


Figure by MIT OCW.

Purcell, Life @ Low

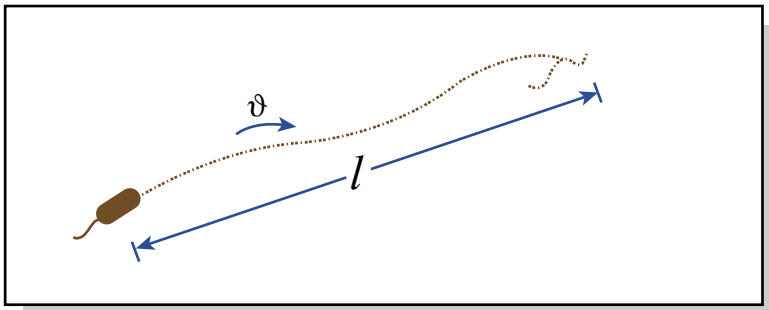


Figure by MIT OCW.

to out-swim diffusion:

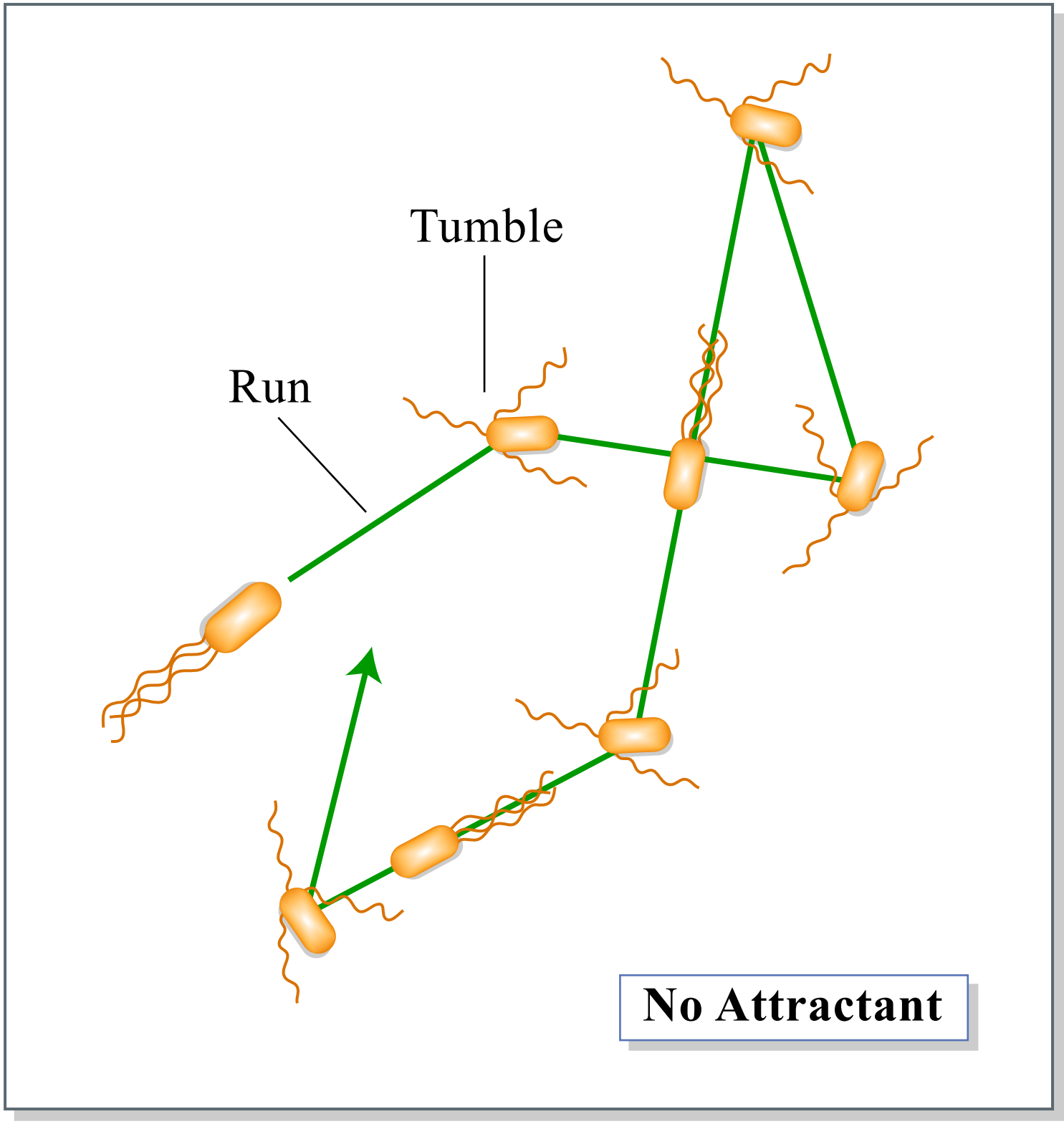
$$l \geq D/v$$

if $D = 10^{-5}$ cm²/sec, $v = .003$ cm/sec

$$l \geq 30\,\mu$$

"If you don't swim that far you haven't gone anywhere."

Diagram removed due to copyright restrictions.
See Figure 4-62 in Madigan, Michael, and John Martinko. *Brock Biology of Microorganisms*. 11th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006. ISBN: 0131443291.



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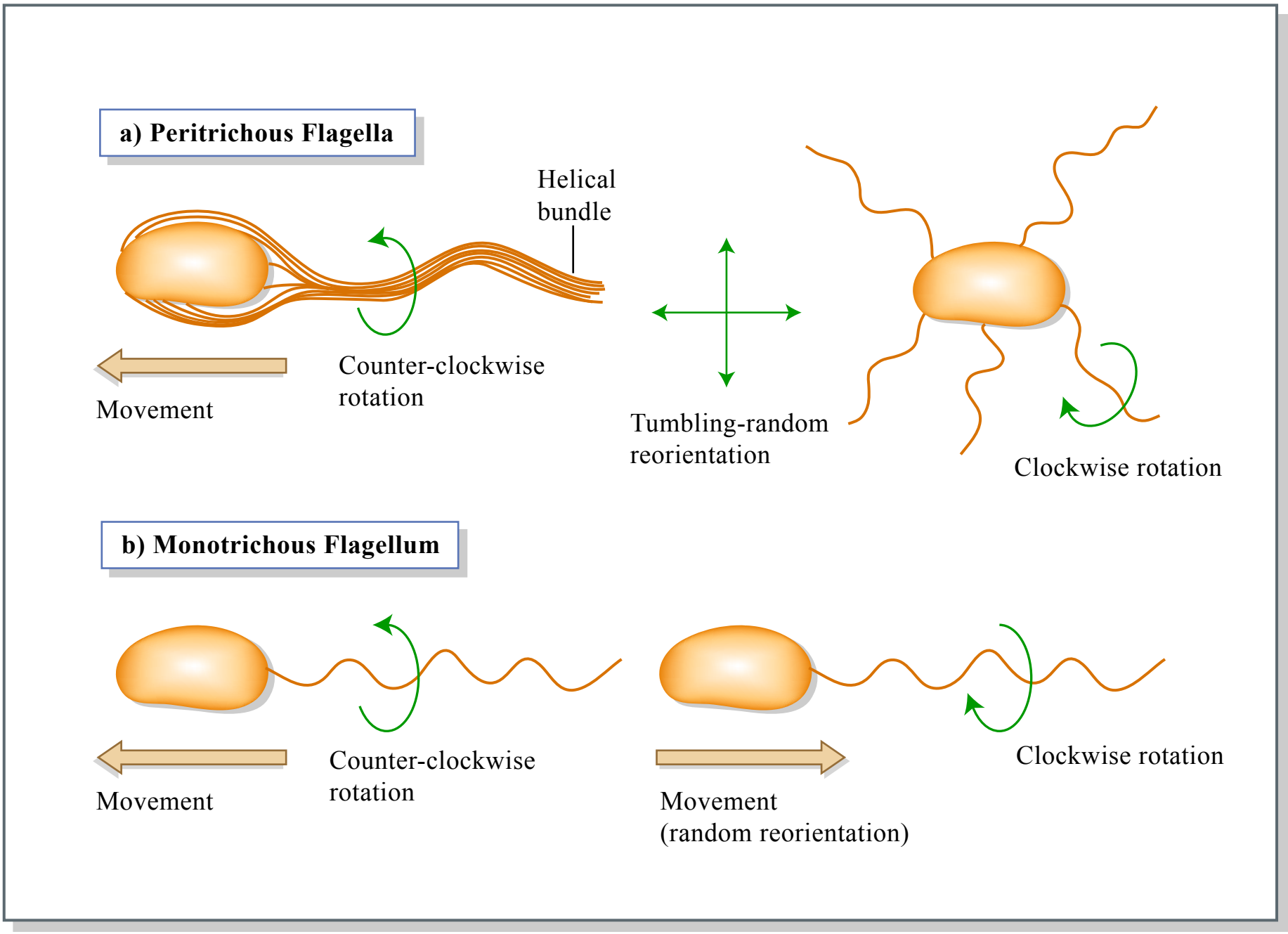

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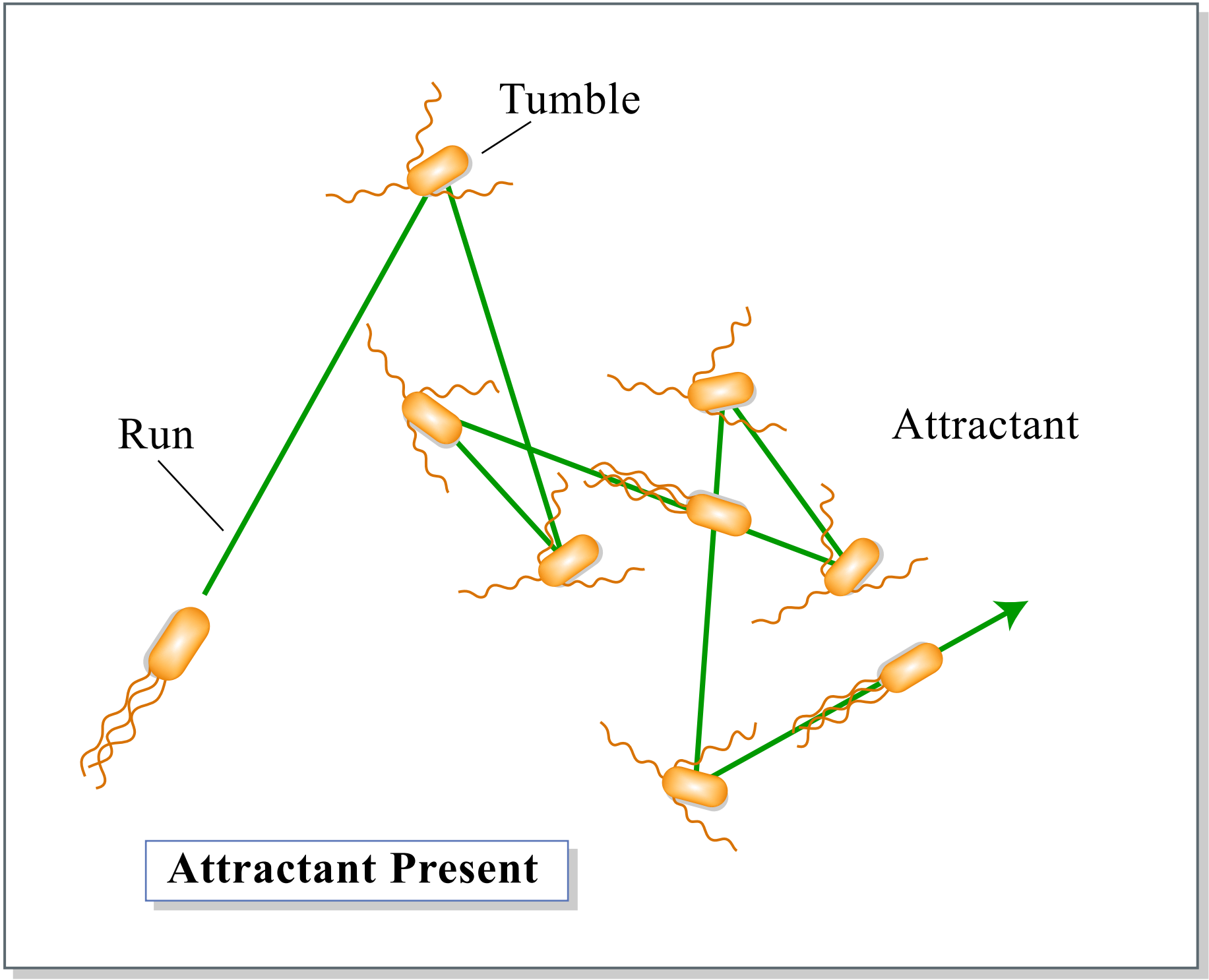

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