

Chem 452 - Lecture 11

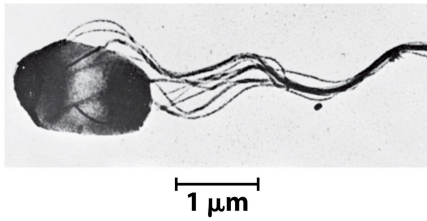
Molecular Motors

Part 2

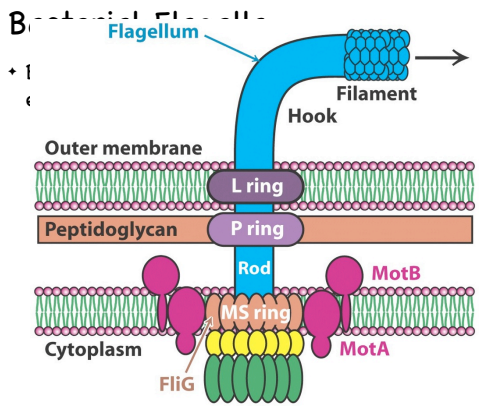
Question of the Day. How is the movement of bacteria like a bumper car ride?

Bacterial Flagella

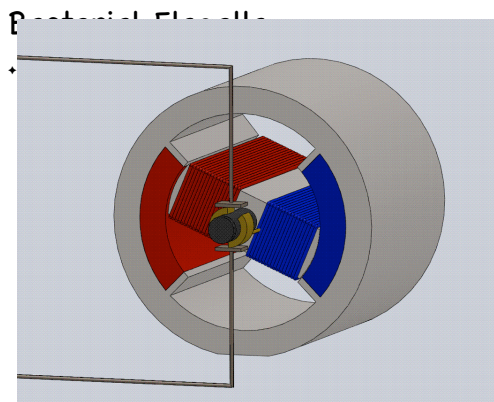
+ Bacterial flagella are remarkably similar to an electrical motor.



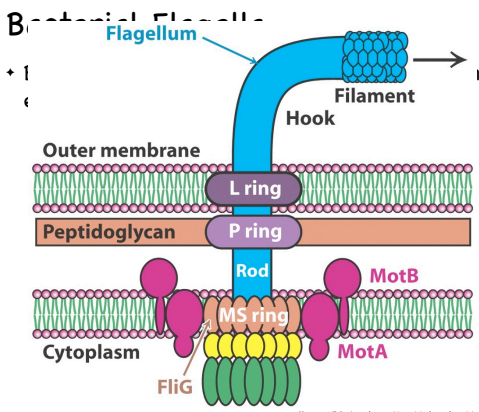
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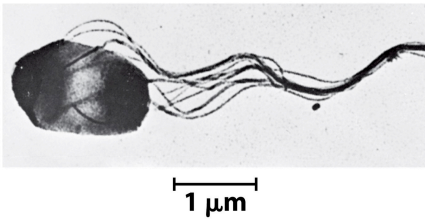
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Bacterial Flagella

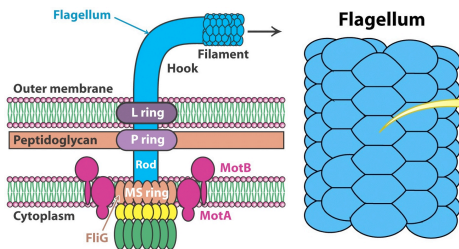
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Bacterial Flagella

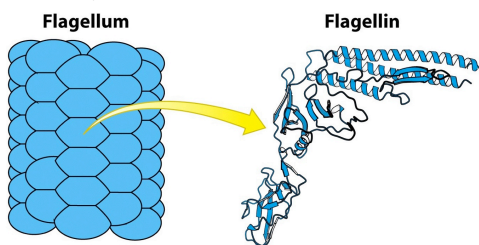
† Bacterial flagella are made from the 56 kd flagellin protein.



Chem 452, Lecture 11 - Molecular Motors 3

Bacterial Flagella

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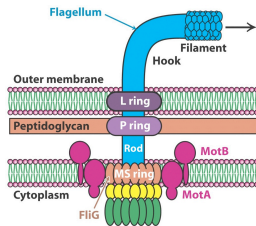
Bacterial Flagella

- † Bacterial flagella are made from the 56 kd flagellin protein.
- † Flagella grow from their distal ends
- † Unlike G-actin and tubulin, flagellin is not an NTPase.

Chem 452, Lecture 11 - Molecular Motors 5

Bacterial Flagella

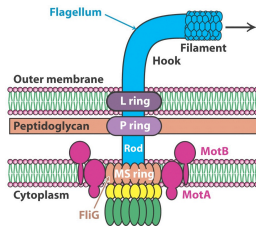
- † The MotA and MotB proteins are paired.
 - Approximately 11 copies assemble together to make up the stator at the base of the flagellum.



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Bacterial Flagella

- † The FliG, FliM and FliN assemble to form the MS (membrane and supramembrane) ring.
 - Approximately 30 copies of FliG form the rotor that is located in the cytoplasmic membrane.



Chem 452, Lecture 11 - Molecular Motors 7

Bacterial Flagella

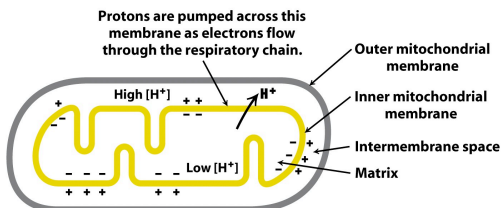
- † The MotA/MotB stator and the FliG rotor work together to couple proton flow across the membrane to rotation of the flagellum.
 - The mechanism is believed to be similar to that used by ATP Synthase, which couples proton flow across the membrane to the synthesis of ATP

Chem 452, Lecture 11 - Molecular Motors 8

ATP Synthase

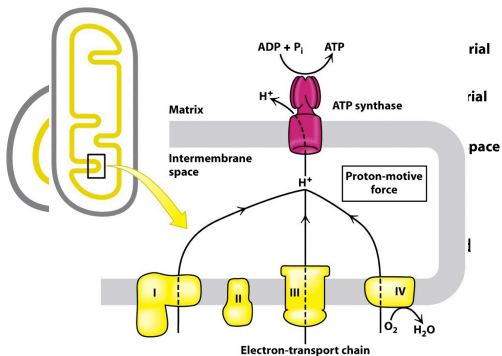
- + ATP Synthase is used by bacteria, plants and animals to synthesize ATP.
- ATP Synthase (pp.545-550, Chapter 18)
- The free energy ultimately comes either from photosynthesis or from the oxidation of food molecules.
- This free energy is used to establish a proton gradient accross membranes.
 - cell membrane in bacteria
 - inner mitochondrial membrane in animals and plants
 - thylakoid membrane in photosynthetic plants

ATP Synthase

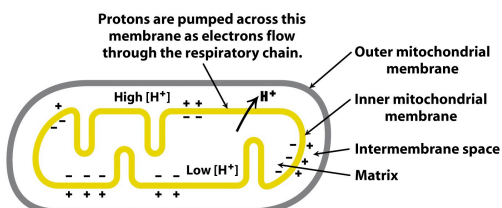


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ATP Synthase



ATP Synthase



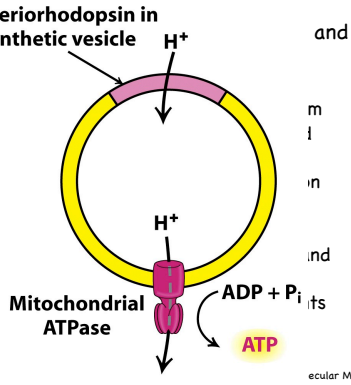
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ATP Synthase

- + ATP :
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 - ATP
 - The pho
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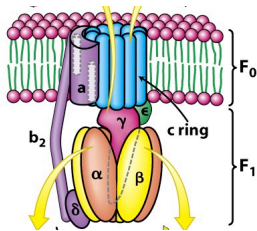


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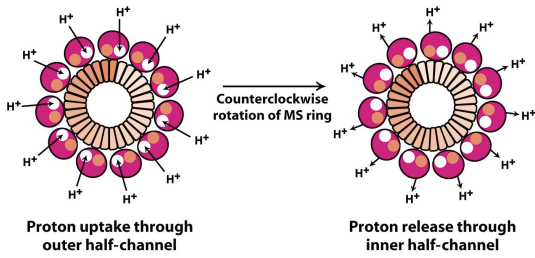
ATP Synthase

- + ATP Synthase couple the flow of H^+ back down the concentration gradient to the synthesis of ATP.



Bacterial Flagella

- † Bacterial flagella are believed to also have two half-channels.



Chem 452, Lecture II - Molecular Motors 14

Bacterial Flagella

- † Like secondary active transporters, they are driven not by the hydrolysis of ATP, but by ion gradients across the cell membrane.

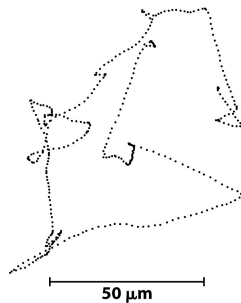


Chem 452, Lecture II - Molecular Motors 15

Bacterial Flagella

- † Bacteria move in a random walk.

- † Reversing the direction of flagellar rotation from counterclockwise to counter clockwise causes them to change direction.

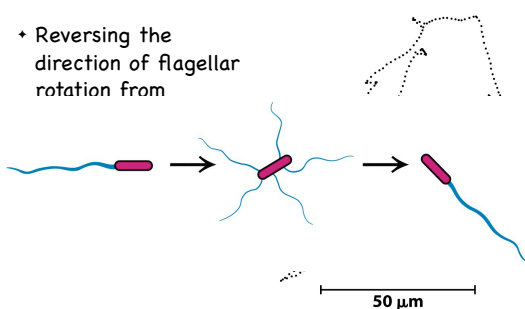


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Bacterial Flagella

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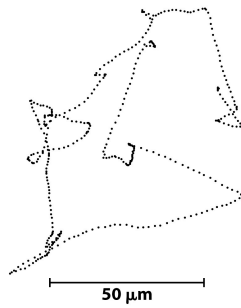


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Bacterial Flagella

• Bacteria move in a random walk.

• Reversing the direction of flagellar rotation from counterclockwise to counter clockwise causes them to change direction.



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Bacterial Flagella

• The random walk can be biased by **chemotaxis**.

• Bacteria are more likely to swim towards a **chemoattractant**.

• Such as a food source, like glucose

• Bacteria are also more likely to swim away from a **chemorepellant**.

• Such as a toxic chemical, like phenol

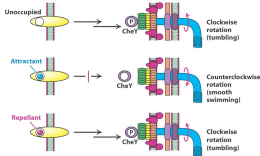
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Bacterial Flagella

• Chemotaxis is facilitated by the Che proteins.

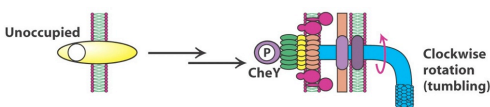
• When the CheY protein is phosphorylated it associates with the flagellar motor, which promotes clockwise rotation (tumbling).

• When the CheY protein is dephosphorylated it dissociates from the flagellar motor, which promotes counterclockwise rotation (swimming).



Chem 452, Lecture 11 - Molecular Motors 18

Bacterial Flagella



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Next up

- The Epilogue - A preview to what is next.
- Final exam on Units (I through V)
 - Wednesday, Dec 19 at 8:00am in Phillips 281