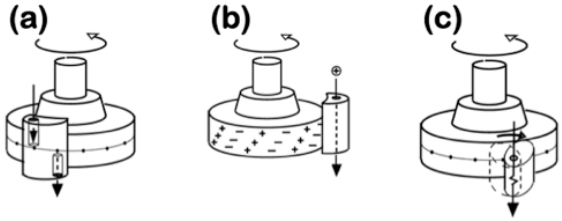
BIO-372 "MICROBIOLOGY" EXERCISES (WEEK 7)

Your Name : _____ Grade : _____

Your Partner: _____ Grade : _____

EXERCISE 1 "BACTERIAL MOTILITY AND CHEMOTAXIS" :

Three different models have been proposed to explain how the bacterial rotary motor works: the *proton turbine* model, the *thermal ratchet* model, and the *mechanochemical* model.



1. Which diagram represents the *proton turbine* model: ☐ (a) ☐ (b) ☐ (c).
Explain how it works:

2. Which diagram represents the *thermal ratchet* model: ☐ (a) ☐ (b) ☐ (c).
Explain how it works:

3. Which diagram represents the *mechanochemical* model: ☐ (a) ☐ (b) ☐ (c).
Explain how it works:

4. In all three models the source of power is:

☐ A. ATP (adenosine triphosphate) hydrolysis
☐ B. PEP (phosphoenolpyruvate) hydrolysis
☐ C. PMF (proton motive force)
☐ D. EMF (electron motive force)
☐ E. (A) and (C)
☐ F. (B) and (D)

5. Imagine a bacterial flagellar motor that rotates at 100 Hz with a torque of 10^{-18} joules and a motor mass of 10^{-4} fg (1 femtogram = 10^{-15} grams). What is the motor's power output per kg? Show your work:

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EXERCISE 2 "BACTERIAL MOTILITY AND CHEMOTAXIS" :

1. Write out the derivation of the Reynolds number (*Re*) equation from the terms defining the component of *inertial forces* (F_i) and the component of *viscous forces* (F_V).

F_i =

F_V =

Re =

2. Swimmers can use reciprocal motions to move themselves through water if…
☐ A. The Reynolds number is < 10
☐ B. The Reynolds number is > 200,000
☐ C. Both (A) and (B)
☐ D. None of the above
Explain:

3. Imagine a microbe swimming at a velocity of 10 μm per second in water with a length of 1 μm and a surface area across the flow of 1 μm^2. What is the Reynolds number (*Re*) of fluid flow around the microbe?
Show your work:

4. Imagine a fish swimming at a velocity of 10 m per second in water with a length of 1 m and a surface area across the flow of 1 m^2. What is the Reynolds number (*Re*) of fluid flow around the fish?
Show your work:

5. Select the statement/s that is/are true for microscopic swimmers like microbes and macroscopic swimmers like fish (multiple responses are possible):
☐ A. Inertial forces are more important for microbes than fish
☐ B. Inertial forces are more important for fish than microbes
☐ C. Inertial forces are equally important for microbes and fish
☐ D. Viscous forces are more important for microbes than fish
☐ E. Viscous forces are more important for fish than microbes
☐ F. Viscous forces are equally important for microbes and fish
Explain:

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EXERCISE 3 "BACTERIAL MOTILITY AND CHEMOTAXIS" :

1. What is "chemotaxis"? Explain.

2. Describe the strategy that *large* eukaryotic cells use for chemotaxis up a gradient of attractant.

3. Describe the strategy that *small* prokaryotic cells use for chemotaxis up a gradient of attractant.

4. A mutant lacking CheA (kinase) would:
☐ Run all the time
☐ Tumble all the time
☐ Run and tumble with increased tumble frequency (shorter runs)
☐ Run and tumble with decreased tumble frequency (longer runs)
☐ Fail to adapt to changes in attractant concentration
Explain:

5. A mutant lacking both CheR (methyltransferase) and CheB (methylesterase) would:
☐ Run all the time
☐ Tumble all the time
☐ Run and tumble with increased tumble frequency (shorter runs)
☐ Run and tumble with decreased tumble frequency (longer runs)
☐ Fail to adapt to changes in attractant concentration
Explain: