Name _____
First Last
(Please Print)
PID Number _____-_____

**HOUR EXAM I**

**BIOLOGY 108**

**FALL, 2003**

In the spirit of the honor code, I pledge that I have neither given nor received help on this exam.

_____
Signature

1_____

2_____

3_____

4_____

5_____

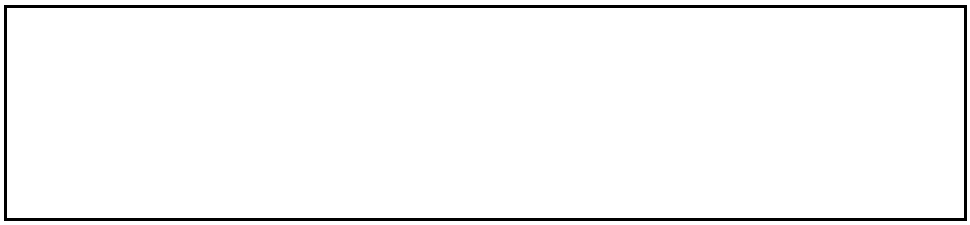
6_____

7_____

8_____

9_____

1. (16 points) Below is a diagram of a bacterium.
Is this a gram-negative or a gram-positive organism? (circle one)
Label the indicated parts.



What is the composition in terms of major macromolecules of

a._____

b._____

c._____

d. _____

If this bacterium were of the other type with respect to the Gram stain, what would be 3 major differences in the cell structure?

1.

2.

3.

Are the flagellae in this bacterium polar or peritrichous? _____

If this organism had a capsule where would it be? _____

What type of molecule would the capsule be likely to be made of? _____

If you were watching this organism swimming under the microscope you would observe

_____ alternating with _____.

2. (20 points) Fill in the following table with respect to bacterial growth.

| Organism and medium | Conditions | Growth rate (fast, medium, slow, or none) | C source | Electron donor | Final electron acceptor |
|---|---|---|---|---|---|
| *E. coli* with glucose and nutrient broth (rich medium) | aerobic $37^o$ | | | | |
| *E. coli* with glucose and nutrient broth | anaerobic $37^o$ | | | | |
| *E. coli* with glucose, $NO_3$, $H_2S$, salts | anaerobic $37^o$ | | | | |
| *Thiobacillus* in medium with $H_2SO_4$ , $Fe^{+3}$ , $NO_3^-$ and salts | aerobic $25^o$ | | | | |
| *Thiobacillus* in medium with $H_2S$ , $Fe^{+2}$ , $NO_3^-$ and salts | aerobic $25^o$ | | | | |

3. (10 points) Arginine is an amino acid. Fill in the following table with respect to the genes which regulate arginine synthesis and which encode the enzymes which synthesize arginine. Use the following symbols; +, +/-, and --.

| Genotype | Enzyme C made | |
|---|---|---|
| | in the presence of arginine | in the absence of arginine |
| wild type | | |
| $argR^{--}$, $p^+o^+argB^+C^+H^+$ | | |
| $argR^{--}$, $p^+o^+\Delta$ (o to ATG of *B*) $argB^+C^+H^+$ | | |

| | | |
|---|---|---|
| $\underline{argR^{--}, p^{+}o^{+}argB^{+}C^{+}H^{+}}$<br>$argR^{+}, p^{+}o^{c}argB^{--}C^{+}H^{+}$ | | |

ArgR is the arginine repressor, ArgBCH are biosynthetic enzymes which make arginine, p is the promoter, $o^c$ is operator constitutive, Δ is a deletion.

*argR* is an autoregulated gene. This means that there is a binding site for ArgR _____ (location) and that the level of ArgR in the cell will increase be unchanged decrease (circle one) when the bacteria are transferred from medium containing arginine to medium lacking this amino acid.

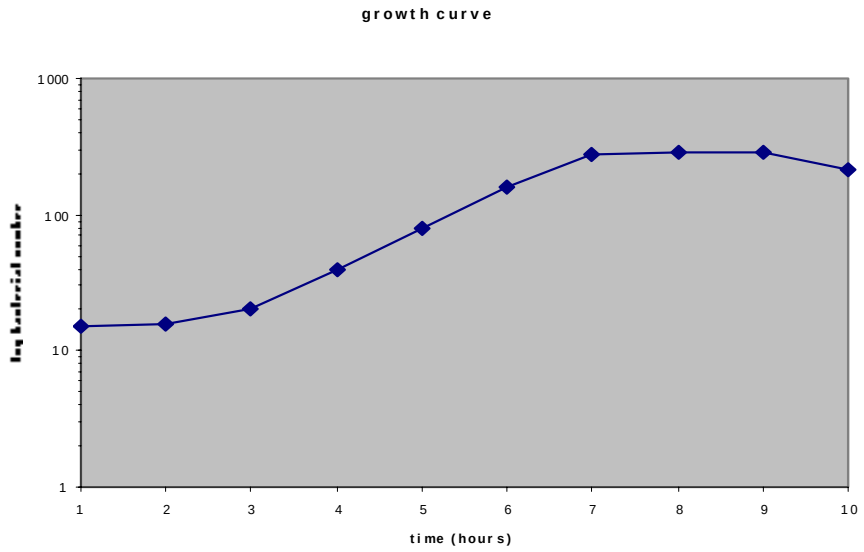
4. (8 points) Even in cells in which *argR* and the region between the promoter and *argB* are deleted, the level of arginine remains relatively constant.
Propose a hypothesis to explain this observation.

| |
|---|
| |

How would you test your hypothesis?

| |
|---|
| |

5. (10 points)




Identify each of the phases of bacterial growth shown in the above graph.

A_____

B_____

C_____

D_____

E_____

What is the doubling time of the cells in phase B (to within 3 min.)? _____ (note $\log_{10}2 = 0.3$)

In which phase are most bacteria in nature?_____

When (A, B, C, D, or E) would penicillin be most effective in killing cells? _____

Draw a growth curve for *E. coli* in medium containing a very small amount of glucose and a large amount of maltose ( a sugar).

0 120 min.
Time

6. (16 points) Fill in the following table with respect to the requirements for transcription and replication of viral genomes.

| process | virus | | host factors required | virus encoded factors required | genes trans |
|---|---|---|---|---|---|
| transcription | T4 | early genes | | | |
| | | late genes | | | |
| | Herpes simplex | immediate early genes | | | |
| | | late genes | | | |
| genome replication | ds DNA virus such as T4 | | | | XXXXXX<br>XXXXXX<br>XXXXXX |
| | ss RNA virus (+ strand) such as polio | | | | XXXXXX<br>XXXXXX<br>XXXXXX |

7. (10 points) Fill out the following indicating the type of plaques (clear, cloudy, or none) which would be formed if λ of the indicated genotype infected the strains of *E. coli* shown. The genetic map of λ is given below.

$P_R$ cro $t_{R1}$ CII $t_{R2}$ Q $t_{R3}$ $P_{Rlate}$ SR...A...

xis att int CIII $t_{L1}$ N $P_L$ CI $P_{RM}$ $P_{RE}$

| λ genotype | bacterial host | |
|---|---|---|
| | *E. coli* K12 (-) | *E. coli* K12 (λ) |
| wild type | | |
| *cIII*$^-$ | | |
| $P_R$ no longer binds CI | | |
| $P_R$ replaced with $P_{lac}$ and the cells are grown on lactose | | |

What happens to the appearance of the plaques produced on K12 (-) if you increase the strength of $P_{RE}$ (make it a better promoter)? _____

What happens to the appearance of the plaques produced on K12 (-) if you delete $t_{L2}$? _____
_____

8. (6 points) Below is a diagram of the components of the chemotaxis system of *E. coli.* Fill in the table to indicate the phenotype of each of the listed mutants.

| mutation | phenotype |
|---|---|
| delete *cheR* | |
| delete histidine in CheA which accepts the phosphate from ATP | |
| delete *cheZ* | |

9. (4 points)
Histidine is an amino acid. In a *hisR*$^{-}$ (R = repressor gene) bacterium, if you deleted region 1 of the attenuator, will histidine biosynthetic enzymes be made in the presence of histidine? _____
in the absence of histidine? _____

If you change the base sequence of region 2 of the attenuator so that it can no longer base pairs with region 3 will histidine biosynthetic enzymes be made in the presence of histidine? _____
in the absence of histidine? _____