

Application and Questionnaire for “Molecule to Organism” (2013-14)

Please follow these instructions CAREFULLY:

- Please answer the questions below – please type your answers.
- Complete answers on this sheet (front and back) ONLY. Do NOT use more than the space given.
- Submit application to Lydia McKinstry via email (mckinstl@evergreen.edu), by May 6. **Earlier is better.**
- Send your application from your evergreen.edu email account otherwise it will likely end up in a junkmail folder.
- **Complete technical questions on your own (no outside help), using only a calculator, a periodic table and a genetic codon table. Please note: we expect you to readily know this material coming into this program.**

Full Name:

A# (we must have this to give you a faculty signature):

Evergreen email address:

Class standing in Fall 2013 (soph, jun, sen)?

When are you planning to graduate (year and quarter)?

Are you planning to take this program for all three quarters, or just fall, or just fall/winter?

What are your career goals?

List the programs with science content you have taken at Evergreen (include when and faculty).

Program Name	Year and Quarter	Faculty

Have you attended other colleges? If yes, list the **science** courses with grades.

Science Course	Year	Grade

You will need an academic reference. We will contact this professor via email. Please give at least TWO faculty who can attest to your work and who answer email promptly.

Name of Professor	Department	Academic Institution	Email address

Answer the following questions. Show your work clearly!

1. In an acid-base reaction, 48.0 mL of a 0.210 M solution of calcium hydroxide are required to neutralize 35.0 mL of HCl.

a) What was the molarity of the original HCl solution?

b) How many grams of calcium hydroxide were contained in the original 48.0 mL solution?

2. Aluminum sulfide reacts with water to form aluminum hydroxide and hydrogen sulfide. How many grams of aluminum hydroxide are obtained from 12.78 g of aluminum sulfide, assuming an 83% yield of product?

3. You have a DNA stock solution that is 0.5 $\mu\text{g}/\mu\text{L}$ and you want 75 μL that is 25 $\text{ng}/\mu\text{L}$. How would you make this?

4. Acetic acid has a $K_a = 1.8 \times 10^{-5}$. What is the pH of a 0.250 M solution of acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$)?

5. Use the diagram to answer the questions below:

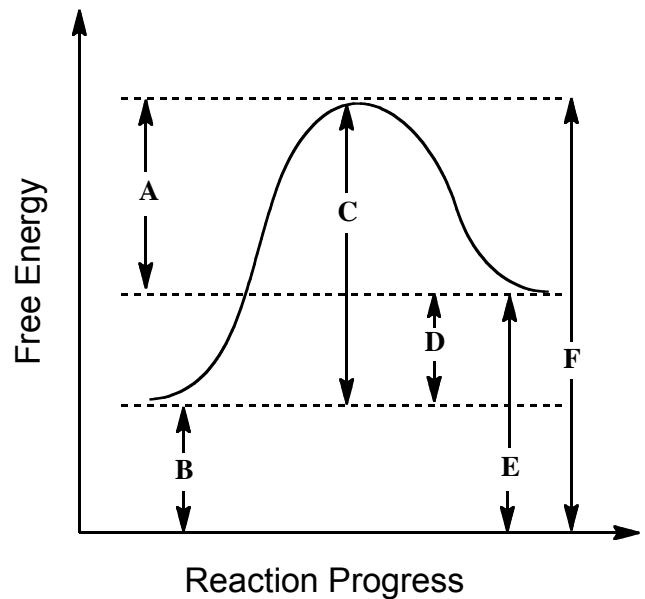
a) Match the letters that correspond to the following quantities.

- ___ the energy of the transition state
- ___ the energy of the reactants
- ___ the activation energy for the reverse reaction
- ___ the change in energy for the reaction

b) This reaction is spontaneous. True or False?

c) One can increase the rate of this reaction by (circle/highlight one choice only):

- i. Increasing the temperature
- ii. Providing a different mechanism
- iii. Adding a catalyst
- iv. All of the above
- v. None of the above



7. Use the following sequence of a DNA molecule with no introns to answer the questions below:

5' ACTGCT**AC**GGGTACGCTTTCATGTACGTTATCGTCATACT 3'
 3' TGACGATGCCCATGCGAAAGTACATGCAATAGCAGTATGA 5'

a) What is the sequence of an mRNA transcribed using the top strand as the template? (circle/highlight one choice only):

- i. 5' AGUAUGACGAUAACGUACAUGAAAGCGUACCCGUAGCAGU 3'
- ii. 5' UGACGAUGCCCAUGCGAAAGUACAUGCAAUAGCAGUAUGA 3'
- iii. 5' UCAUACUGCUAUUGCAUGUACUUUCGCAUGGGCAUCGUCA 3'
- iv. 5' ACUGCUACGGGUACGCUUUCAUGUACGUUAUCGUCAUACU 3'

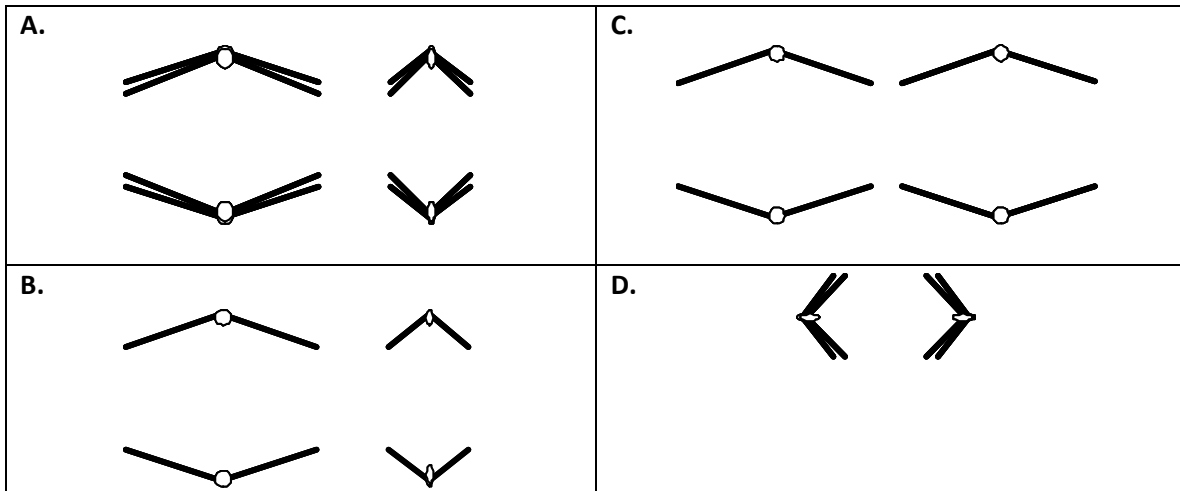
b) What is the sequence of the peptide that this region would make? (circle/highlight one choice only):

- i. Met-Thr-Ile-Thr-Tyr-Met-Lys-Ala-Tyr-Pro
- ii. Met-Pro-Met-Arg-Lys-Tyr-Met-Glu
- iii. Met-Tyr-Phe-Arg-Met-Gly-Ile-Val
- iv. Met-Tyr-Val-Ile-Val-Ile-Leu

c) If there was a point mutation at the nucleotide in bold that changed it from an "A" to a "G" base pair, what would be the effect on the mRNA and peptide produced?

8. From the question above, assuming we are in a eukaryotic cell.
- Where did the transcription take place?
 - Where did the translation happen?
 - What other cellular organelles or machinery are needed for translation?
9. Consider the cross: *AaBbCcddEe* X *AABBccDDEe*. What is the probability that any offspring will have the genotype *AABBCCDDee*? (circle/highlight one choice only)
- 25%
 - 0%
 - 75%
 - 0%
10. You have a liposome containing an interior aqueous solution containing 200 mM of NaCl. If you want to shrink the liposome, what should be the concentration of solution of NaCl in which you would you drop it? Give a specific concentration in milimolar (mM).
11. Illustrate the meaning of the terms “hydrophobic” and “hydrophilic” using a basic diagram of a phospholipid bilayer. Which of the following substances can readily cross a pure phospholipid bilayer?: Water, ATP, Cholesterol, Ca^{2+} , O_2 , Glucose, Urea, Benzene
12. Within the same individual organism, muscle cells and nerve cells owe their differences in structure to: (circle/highlight one choice only)
- having different genes.
 - having different chromosomes.
 - using different genetic codes.
 - differential gene expression.
 - having unique ribosomes.

13. Which one of the diagrams below best represents chromosomes in anaphase of meiosis II of a cell where $2N=4$? Assume that homologous chromosomes are the same length with one set shorter than the other. (circle/highlight one choice only)



14. How many chromosomes does a $2N=6$ cell have in teleophase of meiosis II? (circle/highlight one only)

a) 9 b) 3 c) 12 d) 6

15. A phenotypic ratio of 3:1 in the offspring of a mating of two organisms heterozygous for a single trait is expected when: (circle/highlight one only)

a) the alleles segregate during meiosis.
 b) each allele contains two mutations.
 c) the alleles are identical.
 d) the alleles are incompletely dominant.
 e) only recessive traits are scored.

16. In Mendel's "Experiment 1," true-breeding pea plants with spherical seeds were crossed with true breeding plants with dented seeds. (Spherical seeds are the dominant characteristic.) Mendel collected the seeds from this cross, grew F1-generation plants, let them self-pollinate to form a second generation, and analyzed the seeds of the resulting F2 generation. The results that he obtained, and that you would predict for this experiment are: (circle/highlight one only)

a) $1/2$ the F1 and $3/4$ of the F2 generation seeds were spherical.
 b) $1/2$ the F1 and $1/4$ of the F2 generation seeds were dented.
 c) All of the F1 and F2 generation seeds were spherical.
 d) $3/4$ of the F1 and $9/16$ of the F2 generation seeds were spherical.
 e) All the F1 and $3/4$ of the F2 generation seeds were spherical.

17. Match the terms left with the phrases right.

A. DISRUPTIVE SELECTION

B. STABILIZING SELECTION

C. SEXUAL SELECTION

D. FIXATION

E. FUNDAMENTAL ASYMMETRY OF SEX

F. MUTATION

G. ALLELE FREQUENCY

H. GENETIC DRIFT

_____	Changes in the genetic material; creation of new alleles
_____	When only one copy of a gene exists as a result of genetic drift
_____	The proportion of the gene that an allele exists in a population
_____	Affects small populations strongest
_____	Weeds out the extreme values of a trait but does not alter the mean value
_____	Favors the extreme values over the mean but does not alter that value
_____	Difference between male and female investment in reproduction
_____	Results in having male-male competition

18. The following table lists different hypothetical organisms on the top and traits (left) that they may possess (indicated by an X).

	Wazil	Bit	Pogin	Mooshu
furry eyes	X	X	X	
six toes	X			
three limbs	X		X	

- Construct a phylogenetic tree of all the organisms.
- Draw a square around the organism that is the outgroup.
- Circle one monophyletic group.
- Draw lines on the tree branches indicating when the lineage acquired a particular trait.