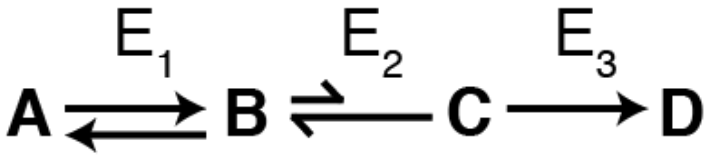
Name:_____ Major: _____ S18BioE11 Biochem Midterm March 22, 2018

1. The Stanley Miller experiment looked at applying a spark to a container filled with inorganic compounds to mimic what was thought to be the environment on primordial earth. What types of molecules were determined to be formed? Hint: Think of what the goal of this experiment was. *(4 pts)*.

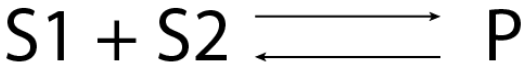
2. RNA is rapidly hydrolyzed in alkaline solution to yield a mixture of nucleotides whose phosphate groups are bonded to either the 2' or 3' positions of the ribose residues. DNA is resistant to alkaline degradation. Explain with an arrow-pushing mechanism using the structure of any RNA polymer (i.e., can be composed of any appropriate base of your choosing). *(5 pts)*.

3. You add A, $E_1$, $E_2$, and $E_3$ to a test tube and incubate at the optimal temperature for $E_1$, $E_2$, and $E_3$ (37°C) for 24 hours. $E_1$, $E_2$, and $E_3$ are all "good enzymes" (i.e., good catalysts and stable for >24 hours). Would you expect there to be more A or D after this 24 hour period? Why? *(5 pts).*




A) More A
B) More D

4. Explain how an enzyme affects the equilibrium constant ($K_{eq}$), describing $K_{eq}$ in terms of concentrations of each metabolite, of the following reaction *(6 pts)*:




5. What are the 3 properties an enzyme must have to catalyze chemical reactions. *(6 pts).*

6. Enzymes are able to catalyze reactions with considerably higher catalytic efficiencies than typical chemical catalysts. Name the four mechanisms enzymes use to achieve these catalytic efficiencies. *(8 pts).*

7. Redox balance is extremely important for achieving high yields, titers, and production rates. Achieving redox balance is a challenge when a fermentation is grown anaerobically. Yeast is a beloved strain for its ability to produce ethanol at unusually high yield when grown anaerobically. Explain chemically why yeast produces ethanol when under anaerobic conditions (but not under aerobic conditions unless fed

very high concentrations of glucose) despite ethanol being toxic to the yeast cell at high concentrations. Use specific chemicals in your explanation. *(6 pts).*

8. A graduate student, Tammy, wants to build an *E. coli* strain capable of biosynthesizing the pigment indigo as a sustainable alternative to the conventional, dirty chemical synthesis. She targets mutagenesis of the limiting enzyme by conducting error-prone PCR. Tammy transforms her diverse library into E. coli, plates onto agar plates and picks the colonies with the most blue color. Is this is isolation of the most blue colonies an example of a (*4 pts.)*:

A. Selection

or

B. Screen?

9. The chemical strategy of glycolysis includes the following (circle all that apply) (*6 pts.)*:

A. Adding phosphoryl groups
B. Reducing glucose ultimately to pyruvate
C. Transfer phosphate groups to create higher energy bonds
D. Couple hydrolysis of reactive intermediates with ATP synthesis

10. One of the chief outcomes of glycolysis is to form a net of 2 molecules of ATP for each molecule of glucose consumed. What is the utility of ATP to the cell? Be precise in your answer. (*6 pts.)*

11. Draw structure of tyrosine as it would exist at pH=7. (*6 pts.)*

12. Compartmentalization of individual library members is essential for sequencing the “hits” of the screen or selection. Plasmid transformation is a method resulting in the compartmentalization of a single library member in the cell. How does a plasmid transformation accomplish only having a single plasmid in a cell? (*8 pts.)*

13. What type of interaction stabilizes an A) alpha helix? B) beta sheets? C) What type of interaction is most important for stabilizing a protein fold? (*7 pts.)*

14. Pete Schultz theorized that antibodies could be raised to act as an enzyme. He termed these “catalytic antibodies.” Explain why Prof. Schultz theorized antibodies could catalyze a reaction. (*6 pts.)*

15. Explain how the negative charge of the triphosphate does not electrostatically block nucleophiles from attacking the phosphate electrophile in the cell? (*4 pts.)*

16. When conducting error-prone PCR, engineers typically target 1-5 mutations per gene. Provide the explanation why this range has empirically been shown to be ideal. Why is not more than 5 mutations? (*8 pts.)*

17. RNA polymerase is able to very rapidly catalyze messenger RNA formation largely because this reaction is highly exergonic. Explain why this reaction is highly exergonic. (*5 pts.)*

Maybe helpful key, maybe not:

ATP