BIOLOGY 345 **Name** _____

Midterm II - 17 November 2008

PART I. Multiple choice questions – (4 points each, 32 points total).

1. Considering the multitude of potential metabolic processes available to Bacteria and Archaea, which of the following is used to *best* describe specific types of **<u>hetero</u>trophic** metabolisms?

A. Energy source
B. Carbon source
C. Electron source
D. Hydrogen source
E. All of the above

2. Regarding the lessons leaned from the Big Tree of Life, which of the following statements best describes the most probable earliest forms of cellular life?

A. The earliest life forms were most likely phototrophs.
B. The earliest life forms were most likely acidophiles.
C. The earliest life forms were most likely iron-oxidizers.
D. The earliest life forms were most likely endosymbionts.
E. The earliest life forms were most likely thermophiles.

3. There are many ways to produce organic carbon inside the cell, which of the following is NOT considered a mechanisms for fixing CO_2?

A. Calvin cycle
B. Reverse TCA
C. Proteorhodopsin
D. Hydroxyproprionate
E. Methanogenesis

4. Which of the following **energy and/or electron carriers** contains a nucleotide as part of its molecular structure?

A. $NADP^+ + H^+$
B. $FADH_2$
C. ATP
D. Acetyl CoA
E. All of the above

5. During anaerobic respirations, there can be both assimilative and dissimilative metabolic pathways. During sulfate reduction, which of the following is used exclusively during the assimilative process?

A. APS (Adenosine 5'-phosphosulfate)
B. PAPS (Phosphoadenosine 5'-phosphosulfate)
C. ATP (Adenosine tri-phosphate)
D. Thiosulphate
E. Acetyl-CoA

6. We know that nearly all oxygen on earth originated from the splitting of water molecules by phototrophs, primarily the cyanobacteria. Presently, where has the majority of all that oxygen wound up?

A. Hydrosphere
B. Atmosphere
C. Blogosphere
D. Lithosphere
E. Biosphere

7. Which of the following **electron donors** has the greatest potential to provide the largest amount of free energy?

A. H_2S
B. H_2
C. O_2
D. Fe^{2+}
E. NH_4^+

8. **Two parts:** (A)Which fermentation pathway is using in the production of Swiss cheese? AND (B) Which fermentation pathway is carried out non-exclusively by *Zymomonas mobilis* (as opposed to yeast that do it exclusively)? Make sure to circle two answers!

A. Butanediol fermentation
B. Mixed acid fermentation
C. Ethanol fermentation
D. Lactic acid fermentation
E. Proprionic acid fermentation
F. Acetone/Butanol fermentation

PART II. Short answer questions – (Number of points in parentheses, 88 points total).

9. (6 points) What is simply meant by the statement that: "All bacteria are **osmotrophs**"?

10. (8 points) List one **advantage** AND **disadvantage** regarding the presence or absence of phosphofructokinase in the Entner-Doudoroff pathway as compared to the classical Embden-Myerhof pathway.

11. (12 points) The porphyrin ring (a tetrapyrrole) played a major role in the development of metabolic diversity. This was primarily due to the incorperation of various metals at the center of the ring. For each of the following metals, list the name of the **associated porphyrin ring structure** AND name the **metabolic process** that makes use of it.

(A) Fe:

(B) Mg:

(C) Co (and/or Ni):

12. (6 points) What is meant by the term **mixotrophy**?

13. (8 points) High energy bonds are important for the transfer of energy. There are two important types of high energy bonds used throughout metabolism. Name these two specific types of **high energy bonds** and a representative **molecule** for each of them.

14. (6 points) Name two of the three key **accessory pigments** used in photosynthesis by cyanobacteria. What is the advantage gained by having an accessory pigment?

15. (8 points) Consider the process of **reverse electron flow** in a photoautotroph. Explain when this process is necessary AND name a type of photoautotrophic organism that requires it.

16. (6 points) Which type of **fermentation** is strictly anaerobic?

17. (6 points) How many **ATP equivalents** does it take to produce one glucose via the Calvin cycle AND is this more or less than a best case scenario for glucose catabolism?

18. (8 points) What is the purpose of a **chlorosome** AND why does it not fit into the usual paradigm regarding membrane bound organelles?

19. (6 points) What is the **primary problem** that arises as a result of glycolysis that fermentation attends to AND why is this not a problem for anaerobic respirations?

20. (8 points) In what two types of metabolic pathways might you find **methylmalonyl-CoA** as well as other interesting-CoA compounds? Also in general terms, what are these CoA compounds used for?

PART III. Short Essay – (Number of points in parentheses, 30 points total).

21. (15 points) Consider the **Pasteur Effect.** (1) How does this concept apply to the utilization of glucose in terms of what metabolic pathways are possible considering the alternative outcomes? (2) How is the production of ATP numerically impacted and how does ATP get specifically made (name specific process)? (3) How do the possible alternative outcomes impact the accumulation of biomass?

22. (15 points) Consider the metabolic menu of microorganisms. **(A)** Compare and contrast the primary sources of energy, electrons, and carbon for the metabolic processes collectively known as **aerobic respiration** and **anaerobic respiration**. You should pick a specific pathway for each to make your point. **(B)** Describe what types of habitats might support each of these types of metabolic processes in nature. **(C)** In general, when it comes to the physical amounts of substrates that must get processed for a given amount of microbial growth, which of these two mechanisms is more efficient, i.e., requires less substrate?

Extra Credit Questions:

23. (6 points) Compare and contrast the roles of **ferredoxin** with cytoplasmic/soluble **hydrogenase**. In other words, what "feature" do they share in common and in what way are they different (i.e., in what types of metabolisms would you find each)?

24. (6 points) Describe both a chemotrophic and a phototrophic type of **"two-step"** metabolism that you might consider as the first one to simply generate ATP (i.e., one that you might find in LUCA). What step do they have in common?