Origins of Life Course – Peer Review Assignment

The following assignment aims to encourage a primary goal of the course: to bring new and synthetic thinking to the field of origins of life.

1. *Energetics of metabolism*

Methanogenesis proceeds by the reaction:

$$CO_2 + 4\ H_2 \rightarrow CH_4 + 2\ H_2O$$

and releases -130 kJ of energy per carbon dioxide, as calculated by the standard reduction potential. The aerobic oxidation of glucose occurs through the reaction:

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

with a standard free energy of -2870 kJ, or -478 kJ per carbon in the sugar.

a. Based on your knowledge of the history of Earth and natural selection, why is methanogenesis more likely to be an early evolutionary metabolism, while aerobic oxidation was a later development? Provide at least 1 reason. **(2 points)**
b. If aerobic oxidation is more energetically favorable, why would methanogenesis still exist today? Provide at least 1 reason. **(2 points)**

2. *Life elsewhere*

Congratulations! You have been asked to participate on a mission to locate extraterrestrial life. What geochemical signatures would you want to look for (provide a minimum of 3 with justification) to help you determine if a planet is or has been inhabited in the past, based on the fossil record of the Earth and geochemistries elsewhere in the solar system? **(2 points)**

3. *Phylogenic tree building* (instructions included in "how to generate phylogenic trees")
    a. Generate a phylogenic tree based on a single protein (or nucleotide) sequence **(1 point)**
    b. Generate a phylogenic tree based on the known taxonomy **(1 point)**
    c. Compare your protein and taxonomic trees. Do you notice any differences? (Include at least 1 difference, or state that they are identical) **(1 point)**
    d. What are the challenges with building these trees? (Provide a minimum of 2 challenges) **(2 points)**