Homework #1

Due: Apr 05, 23:59

1. Read the following article to provide a brief summary (1-2 paragraphs).

D. G. J. Larsson and C. -F. Flach, Antibiotic resistance in the environment. Nature Reviews Microbiology, 20, 257-269, 2022.

avaiable at: https://www.nature.com/articles/s41579-021-00649-x

(30 points)

2. Follow the instructions below to rewrite half reactions given in the lecture note.

1) Sulfide-Sulfate couple (Reaction # I-9): Use bisulfate (HSO_4^-) as the only oxidized sulfur species and hydrogen sulfide (H_2S) as the only reduced sulfur species [may represent highly acidic conditions].

(15 points)

2) Carbon dioxide-Glutamate couple (Reaction # O-8): Use bicarbonate (HCO_3^-) as the only oxidized carbon species, free ammonia (NH_3) and ammonium ion (NH_4^+) at a molar ratio of 1:1 as reduced nitrogen species, and the deprotonated form for glutamate [may represent a condition of pH = pK_a of ammonia].

(15 points)

3. You want to develop an eco-friendly and cost-effective process for removal of nitrate (NO_3^-) from groundwater. Your plan is to supply molasses, a byproduct of sugar manufacturing, as an e^- donor to enhance denitrification in groundwater. Assuming that the molecular formular of molasses can be represented by $C_{12}H_{22}O_{11}$ (same as that for sugar), answer the following.

1) Write the electron donor half reaction, R_d, in an electron-equivalent form. Use HCO_3^- as an only form of an oxidized carbon species. (20 points)

2) Write the energy reaction, R_e, in an electron-equivalent form. How much grams of molasses are needed per g of NO_3-N consumed for the energy reaction? (20 points)

3) Write the cell formation half reaction, R_c, in an electron-equivalent form. Use the cell formula of $C_5H_7O_2N$ and NO_3^- as a source of nitrogen (not NH_4^+). Also use HCO_3^- as an only form of oxidized carbon species. (20 points)

4) Write the overall cell synthesis reaction, R_s, in an electron-equivalent form. Use the R_d derived from 1) and the R_c derived from 3). How much grams of molasses are needed per g of NO_3-N consumed for the cell synthesis reaction? (20 points)

5) From the calculations you did for 2) and 4), which growth state do you think is more favorable for efficient use of molasses? (A) a rapidly growing state or (B) a slowly growing state? Briefly describe the reason for your selection. (10 points)