Definition of Biological Terms. Please "clearly" define the following items:
  (1) Energy carriers and Electron carriers in biological systems(6 pt)
  (2) Cellular respiration and fermentation (6 pt)
  (3) Substrate level phosphorylation and Oxidative phosphorylation (8 pt)
  (4) Dehydrogenation and Proton-Motive Force (8 pt)

Diversity of Microbial Ecology Please clearly describe, compare, and contrast physiological characteristics and their environmental significance of the following paired microorganisms:
(1) *Nitrosospira* and *Nitrospira* (8 pt)
(2) Methanogenes and Methanotrophs (8 pt)
(3) *Thiothrix* and *Desulfobacter* (8 pt)

Renewable Biofuels Assuming that you are assigned by the Taiwan Bureau of Energy to propose three feasible plans for production of renewable biofuels from biomass materials. Please outline the scheme of your proposal including (1) the raw biomass materials will be used for production of renewable biofuels (2) what microorganisms and biochemical processes that you will use to produce those biofuels. When you propose you plans, please consider that they must be feasible for Taiwan and explain why they are feasible. (16 pt)

Daily ATP Utilization by Human Adults
  i. A total of 30.5 kJ/mol of free energy is needed to synthesize ATP from ADP and Pi when the reactants and products are at 1 M concentrations (standard state). Because the actual physiological conditions of ATP, ADP, and Pi are not 1 M, the free energy required to synthesize ATP under physiological conditions is different from 30.5 kJ/mol. Calculate the free energy required to synthesize ATP in the human hepatocyte when the physiological concentrations of ATP, ADP, and Pi are 3.5, 1.5, and 5 mM, respectively. (5 pt)
  ii. A 68 kg adult requires a caloric intake of 2000 kcal (8360 kJ) of food per day (24hours). The food is metabolized and the free energy is used to synthesize ATP, which then provides energy for the body's daily chemical and mechanical work. Assuming that the efficiency of converting food energy into ATP is 50%, calculate the weight of ATP used by a human adult in 24 hours. What percentage of the body weight does this represent? (MW for ATP=507 g/mol) (6 pt)
  iii. Although adults synthesize large amounts of ATP daily, their body weight, structure, and composition do not change significantly during this period. Explain this apparent contradiction. (5 pt)

Microbial growth kinetics. A strain of bacteria was grown in a batch culture on glucose and following data were obtained.

Time (h)	Cell Conc. (g/L)	Glucose (g/L)
0	1.25	100
9	2.45	97
16	5.1	90.4
23	10.5	76.9
30	22	48.1
34	33	20.6
36	37.5	9.38
40	41	0.63

a. Calculate the specific growth rate (5 pt)
b. Calculate the growth yield, $Y_{x/s}$. (5 pt)
c. What cell concentration could one expect if 150 g of glucose were used with same size of inoculum? (6 pt)