EN2002 - PYP 18/19 Sem 1

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1.

(i) a (ii) b (iii) d (iv) c (v) b

(vi) a (vii) b (viii) c (ix) b (x) c

2.

(a) (i)

$\text{Conc. of N} = 4.0mg/L\ , i.e,\ \frac{1}{14} = 0.286\ mM$

$\text{Conc. of P} = 0.2mg/L\ , i.e,\ \frac{0.2}{31} = 0.0645\ mM$

$\text{Since N:P} = 16{:}1 \text{ and } 0.0645\text{x}16 = 0.103 < 0.286, \text{Pis the limiting nutrient}$

(ii)

$\text{C:P} = 103{:}1 \Rightarrow \text{Conc. of C} = \frac{0.0645}{103} = 0.000626\ mM$

$as\ 1C\ gives\ 1\ CO_2$

$\text{Maximum amount of } CO_2 = (50000m^3)(\frac{1000L}{m^3})(0.000626mM)(44g/mol)$

$= 1377.2kg$

(b) (i)

$5.81{C_2O_4}^{2-} + 0.2{NH_4}^+ + 1.87O_2 + 0.8H^+ + 5.41H_2O$
$\rightarrow 10.63{HCO_3}^- + CH_{1.8}O_{0.5}N_{0.2}$

$\Rightarrow$

$\text{To get 1 mole of biomass, we need 0.2 moles of } {NH_4}^+ \text{ and 1.87 moles of } O_2$

(ii)

$\text{Amount of } O_2 \text{ needed} = 1.87 \text{ moles}$

${C_2O_4}^{2-} + \frac{1}{2}O_2 + H_2O \rightarrow 2{HCO_3}^-$

$\Rightarrow \text{Amount of oxalate needed} = \frac{1.87}{1/2} = 3.74\ moles$

(iii)

$\text{Total oxalate needed} = 5.81 \text{ moles}$

$\text{Amount of oxalate used for anabolism} = 5.81 - 3.74 = 2.07 \text{ moles}$

$$\Rightarrow \frac{2.07}{5.81} \text{x} 100\% = 35.6\% \text{ of oxalate is consumed for anabolism}$$

3.

(a)

Respiration	Fermentation
glycolysis	Glycolysis
Krebs cycle	No Krebs cycle
Electron transport system	No ETS
Outside electron acceptor	Uses inside organic molecules as final electron acceptors
Chemiosmosis (ATP synthesis)	Generate little energy
Either aerobic or anaerobic	No oxygen required

(b)

Horizontal gene transfer is the movement of genetic materials among peer bacterial cells

- Transformation: a DNA released from one bacterial cell is directly taken up by another bacteria
- Transduction: the movement of DNA is mediated by bacteria-phages
- Conjugation: plasmid DNA is moved by direct physical contact from a donor to a recipient

(c)

The *S. oligofermentans* mutant lacking lactate oxidase would have reduced inhibitory effects against *S. mutans* and also exhibit impaired growth in the presence of *S. mutans*.

(d)

Bacteria	Electron donor	Electron acceptor
AOB	NH_4^+	O_2
NOB	NO_2^-	O_2
Anammox	NH_4^+	NO_2^-

(e)

A1 and A2 can use X because they have enzymes that can help them digest X. B1 and B2 can not use X because they do not have that enzyme. In the water envir that has A1, X is used and converted into other substances. These substances can be used by B1. This is reasonable because A1 and B1 live in the water, which allows substances produced by A1 to diffuse and be used by B1. On the other hand, B2 and A2 live in the air env; hence, substances produced by A2 can not be diffused to B2. Therefore, B2 cannot grow in the presence of A2 and X.

4.

(a) $\text{Choose dilution } 10^{-4}, \text{ Avg CFU per plate} = (...)/6 = 60 \text{ CFU/plate}$

$$\text{Conc. in original sample} = \frac{60}{0.1} : 10^{-4} = 6\text{x}10^{6} \text{ CFU/plate}$$

(b)

The results from (a) are very different. There is Great Plate Count Anomaly (GPCA) occurring. GPCA is due to:

- Dead cells are counted in DAPI counting but do not form colonies in plate method.
- There are viable but non-culturable cells, i.e., alive but have very low metabolic state or do not form colonies. This phenomenon is due to unfavorable conditions in the culture media or the leak of symbiotic/parasitic microorganisms.

(c)

- Mineralization (by X): Complete conversion of organic compounds into simpler inorganic compounds
- Immobilization (by Y): Removal of contaminants, typically metals, by means of biosorption, bioaccumulation, or biotransformation, to insoluble forms.

(d)

- Nitrifying bacteria converts ammonium ${NH_4}^+$ into nitrate or nitrite
- Denitrifying bacteria removes ${NO_3}^-$ from the ecosystem by converting ${NO_3}^-$ into N_2
- Anammox bacteria uses nitrite as electron acceptor to produce N_2 from ${NH_4}^+$

5.

(a) (i) Enhanced biological phosphorus removal

(ii) Phosphorus accumulating organisms

(iii) Aerobic conditions

(iv) Anaerobic conditions

(v) Anaerobic conditions

(vi) Anaerobic conditions

(vii) PHB

(viii) Poly P

(b)

Microorganisms produce biofilms, which are organic compounds. These compounds contain microbial extracellular polymeric substances (EPS), which is a source of DBPs.

(c)

- Do not reproduce in contaminated water.
- Its concentration reflects the degree of fecal pollution.
- Suitable for analysis of all types of water.
- Harmless to humans.
- Detected by highly specific test.
- Present whenever enteric pathogens are present.
- Survives longer than hardiest enteric pathogen.

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