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Student I.D. _____

Environmental Microbiology (EVS3120)
Midterm 2 (November 29, 2016)

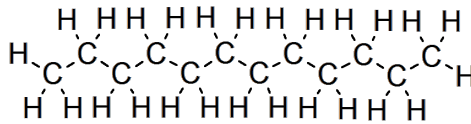
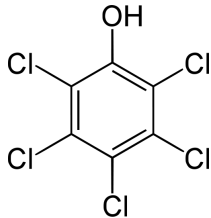
IMPORTANT: Course notes, textbooks, cell phones and any other electronic devices are not allowed.

SHORT ANSWERS (10).

1. Name 3 causes responsible for the lag phase of a bacterial population in the environment. (1.5)

1. low number
2. physiological adaptation to the environmental conditions
3. Absence of the required gene (evolution required)

2. Consider the two following molecules (4):



A : Pentachlorophénol

B : Dodécane

Indicate which molecule will yield the greatest biomass. **Briefly** explain why.

Molecule B will yield the greatest biomass (1 point). B is easier to metabolize than A by microbes because petroleum products have been around for millions of years (0.75 point) and microbes have dedicated pathways to deal with it (0.75 point). On the contrary, compound A is harder to degrade because it contains chlorine and an aromatic ring (0.75 point) and also because it was recently made by humans, microbes did not have the time to evolve an efficient strategy to use this compound (0.75 point).

3. What is the referred to as “the great plate anomaly”? After defining the concept, i) briefly provide an explanation to this phenomenon and ii) explain why current technological advances help scientists solve this issue.

The great plate anomaly refers to the fact that there exists a very large difference between the number of microbes observed under a microscope and the number of microbes actually

culturable on a plate. (1 point) Only 1-10% of the microbes present in the environment are culturable (1 point).

This phenomenon is explained by the fact that nutrients necessary for microbial growth are not present in the laboratory medium (0.5 point). Some microbes depend on nutrients produced by other microbes in the environment (0.5 point).

Recent technological advances allow scientists to sequence the genome of uncultured microbes and design growth media based on the enzymes that are found in the genome (1 point) (e.g., if genes encoding an enzyme degrading nutrient X is found in the genome, then X can be added to the growth medium (0.5 point)).

CASE STUDY (20):

(numbers in the text (x) refer to the figure provided)

You are the mayor of the small city of Microcool (1). The city is connected to a small wastewater treatment plant (WWTP) (2) that releases treated water in the river (3). The tides can bring saltwater up the river and to the city (1). Your city and its surroundings are very popular destinations during the summer. Popular sites include: Trout Lake (6) and Trout beach (7), as well as the nearby ocean (4) and the very popular beach of Angels (5), famous for its windsurfing competitions.

In March 2016, your counsel warns you that the WWTP has reached its maximum treatment capacity. In the summer of 2015, Microcool will be hosting for the first time, the internationally popular Microcool Folk Fest. During this festival, the population of Microcool is expected to increase several folds; hotels and regular camp sites are expected to be full. You are taking the decision of opening more campsites (8) around Trout Beach but you cannot afford to install proper wastewater treatment systems and decide to direct all effluents into the ground hoping that natural attenuation of the pollution in the soil will occur. The soil surrounding Trout Lake is sandy and therefore very permeable and your hydrogeologist on duty informs you that underground intrusions of salt water from the nearby ocean to the lakes are sometimes observed. The composition of seawater includes Na^+ , Cl^- , Mg^{2+} , and SO_4^{2-} . Typically, freshwater does not flow from the lake to the ocean.

As the summer progresses, Microcoolians and tourists are starting to complain of a terrible smell emanating from Trout Lake. The local hospital is documenting an increase in the number of diarrheas, particularly from tourists camping at Trout Beach as well as from bad skin infections from tourists attending the wind surfing competition. One morning, the local newspaper indicates that dead birds were found on Trout beach. This all summer is turning into a complete nightmare.

What went wrong?

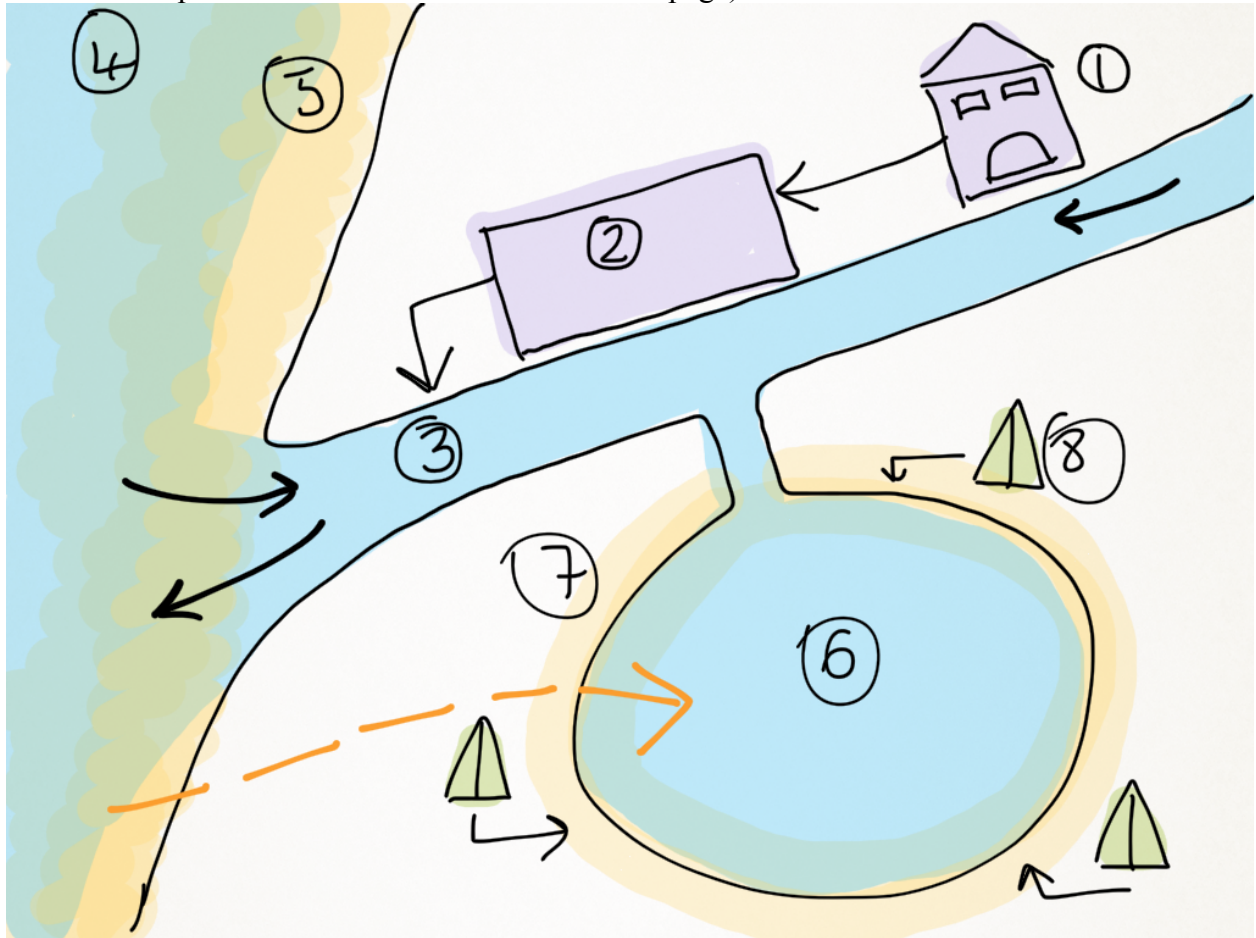
Organize your answer using the following points:

1. Describe a logical succession of events that led up to the development of the smell at Trout beach; use the information provided in the text and your knowledge of the carbon and oxygen cycles. (7)
2. Identify the origin of the smell. (2)
3. Identify the cause of the bird deaths. (2)
4. Identify the causes of increased hospital visits and explain why the tourists around Trout

Lake were more susceptible to develop diarrheas while tourists at the beach of Angels developed skin infections? (4)

5. Explain to the Mayor why it may be a good idea to consider having the festival during the winter (5).

(see schematic representation of Microcool on the next page)



1) Several possible sources of organic matter could explain the smell (identify only one).

1 point for a properly identified source

Source 1: waste effluent from the campsites that leaked into the lake due to the sandy permeable soil.

Source 2: effluent from the wastewater treatment plant that was carried back into the lake due to the tide influence

Source 3: Organic matter originating from an algal bloom triggered by nutrients released by sewage (either from the camping or the city).

Succession of events:

Large input into the lake of organic carbon that is an energy, carbon and electron source for aerobic chemoorganoheterotrophs.

0.5 point per keyword properly identified = 2.5 points

These bacteria oxidize the organic matter while consuming oxygen until it is completely depleted, turning the lake into an anoxic environment. 0.5 point

Under anoxic conditions, bacteria run their metabolism using either anaerobic respiration (0.5 point) (using nitrate, ferric iron or sulfate as terminal electron acceptors (0.5 point) or fermentation (1 point).

=> Q1 is 6 points

2). The smell originates from the utilization of SO₄²⁻ as a terminal electron acceptor which produces H₂S; a smelly substance. In addition, the smell can also be caused by the production of fermentation products (e.g., putrescine or cadaverine). 2 points

=> Q2 is 2 points

3). The birds died of botulism because of the production of the botulism toxin by fermentative bacteria (Clostridium). 2 points

=> Q3 is 2 points

4). Typically wastewater effluents contain Enterobacteria (e.g., *E. coli*) (0.5 point) that can remain alive in warm freshwaters. This is the case of Trout lake. Enterobacteria cause diarrheas (0.5 point). High human density situations are a source of *Staphylococcus aureus* (0.5 point) which can cause skin infections (0.5 point). This bacterium is halotolerant and therefore will be able to affect tourist spending time by the ocean (0.5 point). Enterobacteria are not halotolerant and therefore cannot survive in the seawater (0.5 point).

=> Q4 is 3 points

5). It is better to have the festival in the winter because it will limit the development of anoxia. The cooler temperature will i) increase oxygen concentration in the water (1 point) and ii) will slow down aerobic metabolisms (1 point).

=> Q5 is 2 points

Total case study is 15 / 2 = 7.5