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A221: Microbiology

Problem 1: Spontaneity

WORKSHEET

Question 1

What is the universal belief on how life (plants, animals etc.) is generated in this universe? Discuss with your team members the reasons supporting your belief.

The universal belief is that life is generated from other living things. According to the cell theory, "All living cells arise from preexisting cells by division".

Question 2

The link below provides an insight on the two schools of thoughts on how life can potentially be generated.http://science.jrank.org/pages/6408/Spontaneous-Generation.html

a) What are the two possible methods in which life can be generated that were mentioned in the above link?

Biogenesis, which refers to generating life through sexual reproduction and asexual reproduction. The other method is abiogenesis, which refers to generating life from inanimate matter or non-living things.

b) Due to the presence of the two schools of thought on how life was generated, Pasteur carried out a series of experiments centuries ago, to provide evidence to support his belief on biogenesis. The following information was extracted from the link above to illustrate his experiments.

> But the matter remained unresolved until two years later when the great French scientist Louis Pasteur, in a series of classic experiments demonstrated that (1) microorganisms are present in the air and can contaminate solutions; and (2) the air itself does not create microbes.
>
> Pasteur filled short-necked flasks with beef broth and boiled them, leaving some opened to the air to cool and sealing others. While the sealed flasks remained free of microorganisms, the open flasks were contaminated within a few days.
>
> In a second set of experiments, Pasteur placed broth in flasks that had open-ended, long necks. After bending the necks of the flasks into S-shaped curves that dipped downward, then swept sharply upward, he boiled the contents. The contents of these uncapped flasks remained uncontaminated even months later. Pasteur explained that the S-shaped curve allowed air to pass into the flask; however, the curved neck trapped airborne microorganisms at the bottom of the curve, preventing them from traveling into the broth.

i. How do you think boiling of the beef broth would have affected the microorganisms present in the broth?

At high temperatures (boiling the beef broth), the bacteria's survivability would have decreased, increasing the chances of dying.

ii. Watch the video provided in the link below to have a better understanding on what might have happened to the open flasks that were contaminated within a few days. http://www.youtube.com/watch?v=gEwzDydciWc&NR=1
After a few days, the microorganisms would have already divided a few times and the flask would be highly contaminated

iii. Why do you think the sealed flask remained free of microorganisms?
The sealed flask remained free of microorganisms because it did not have contact with the surrounding environment. For example, air carries microorganisms which could have entered the flask. This was prevented as the flask was sealed.

iv. How did the open flask with the S-shaped neck remain free of microorganisms for months?
It prevented microorganisms from entering the broth by trapping the airborne microorganisms at the bottom of the curve.

v. Why did the open flask become contaminated when it was tilted?
There might be microorganism settlements in the neck, caused by the microorganisms that are carried by air. So when it is titled, the broth becomes contaminated.

c) What was the final conclusion on the mode in which life was generated?
Life did not arrive from inanimate matter, life can only arise from life.

Question 3

In the desert, the conditions are often harsh, hot, and dry. Most organisms are unable to survive, and perish during the hot periods, so not much of life can be observed during the dry periods. However, when it rains in the desert, many plants and animals suddenly "appear".

a) Do you think they were generated spontaneously from the sand?
They were not generated spontaneously from the sand. When it rains, the environment becomes more suitable for the organisms to live in. Hence, they are able to reproduce at a faster rate, as compared to reproducing in unfavourable conditions. (seeds wait for the right time before it springs out)

b) Many of these plants and animals have special characteristics that allow them and their next generation to remain dormant during the dry seasons. What are some of these special characteristics, and how do they help the plants and animals to survive and propagate in these dry seasons, which could last between several years to several decades?
Some plants store water in their roots, fleshy stems and leaves. Also, some plants such as the cactus have spines to minimise water loss in the desert. Some animals like camels sweat as little as possible to minimise water loss and they also have humps that store fat to provide camels with energy.

c) As you would have understood from Question (3b), some organisms have special mechanisms that can enable them to survive in the desert. Similarly, some bacteria have special mechanisms that enable them to survive in harsh conditions like boiling. When conditions change from favourable to unfavourable, these bacteria are able to go through changes described in the video link: http://www.youtube.com/watch?v=NAcowliknPs

From what you have seen in the video, what is the mechanism that bacteria use to survive harsh conditions? How can this mechanism help the bacteria to survive?
It turns to endospore to survive, as it is resistant to harsh conditions. The DNA divides into 2 copies, where the cell membrane of one of the copy will surround the other copy, protecting it.

d) When conditions change from unfavourable to favourable, what happens to the bacteria which have this special mechanism?http://www.youtube.com/watch?v=NAcowliknPs
These vegetative cells will divide by binary fission

e) Relating back to the problem statement, broth that was boiled and sealed does occasionally have bacteria growing in it (such as in the hay extracts). What does this tell you about the bacteria which are present in the broth at the time of boiling?
They are highly resistant to high temperature.
The bacteria may have undergone spore formation, in order to protect themselves from the high temperature, which could have killed them, allowing them to live even after boiling took place.

f) Does the above experiment support Abiogenesis or Biogenesis?
Biogenesis

Question 4

Leewenhoek invented the early microscope. He placed some rain water sample and observed it under the microscope. The video below shows what Leewenhoek might have seen. http://science.jrank.org/pages/6408/Spontaneous-Generation.html

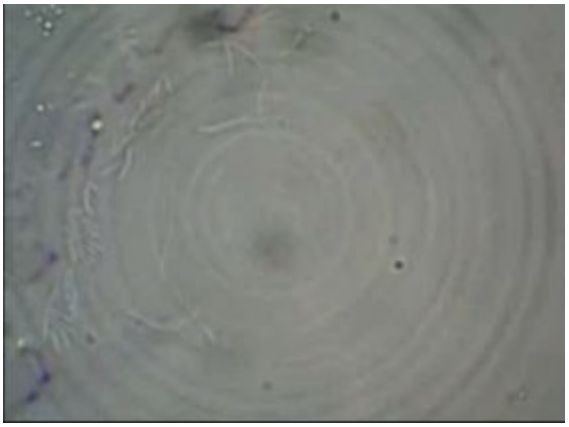
P1 Video 1.mp4

a) What do you think might be the tiny, rapidly moving, “animalcules” that Leewenhoek saw in rain water when viewed under microscope?http://science.jrank.org/pages/6408/Spontaneous-Generation.html
Microorganisms

b) Why is it necessary to make use of microscope when viewing microorganisms?
We are unable to see microorganisms with our naked eyes as microorganisms

are too small.

c) The figure below is a snapshot of what Leewenhoek had seen in rain water.



i. How many types of microorganism can be seen from the snapshot? How did you come to conclusion on the types of microorganisms seen from the snapshot?
2 types. can only see 2 (Rod and spherical)

ii. What is the color of the microorganisms seen in the above snapshot? Suggest what can be done to improve visibility of the microorganisms viewed under microscope.
The microorganism are white in color. Having a light source under it and putting a white piece of paper under the glass slide can improve the visibility of the microorganisms.

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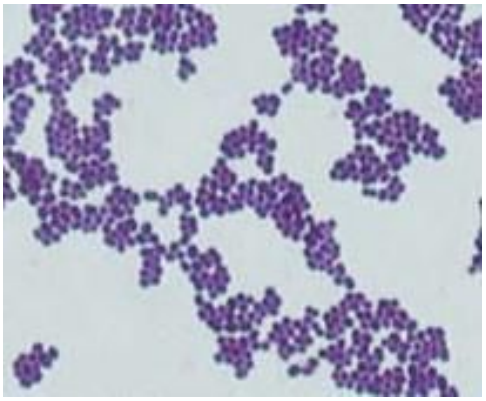
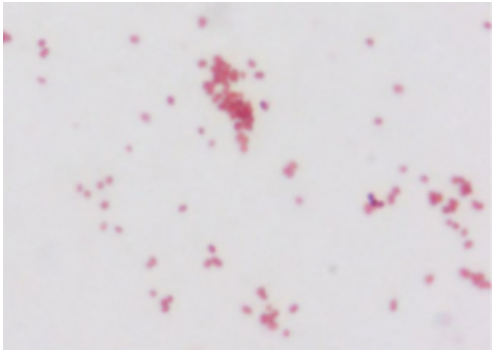
Question 5

Four different types of bacteria were stained by dyes and viewed under microscope. The microscopic views of the stained bacteria were illustrated in the table below.

a) Compare the shape of the bacteria listed in the table below.

	Shape of bacteria
Bacteria A 	Coccus (Spherical)
Bacteria B 	Coccus (Spherical)
Bacteria C 	Vibrio (Comma)
Bacteria D	Spirochete (Spiral)

b) Do all types of bacteria have a common shape? What are the general bacterial shapes you have observed from the above table?
No, all types of bacteria do not have a common shape. The bacterial shapes we have observed from the above table are spherical, rod, comma and spiral shaped.

c) Besides the general shapes you have given as answer to Part b, are there any other less common shapes that bacteria have? If so, what are they?
Corkscrew, Bacillus cereus (Rod)

Question 6

To facilitate accurate communication between those who work with specific bacteria strains, it is important that standard nomenclature is used.

Complete the table to have a better understanding on what the individual component of scientific name means and the proper way of writing scientific name.

	Human Name	Bacterial Name
	Tan Meimei	*Escherichia coli*
What does the first word represent?	Surname	Genus name
What does the second word represent?	First name	Species name
Name must be italicized?	No	Yes
Name must be capitalized?	Yes, first letter of both words	No. First letter of the first word must be

		capitalized while the species name is non-capitalized
What is a shorter representation of the name?	Tan, M.M	*E.coli*
What is the proper way to write the name with pen on a piece of paper?	Tan Mei Mei	E.coli or Escherichia coli (underlined)

Going further (Optional):

a) Many bacteria are motile. How do you think being motile will benefit the bacteria?
The bacteria being motile can allow it to move towards move favourable environments for better chances of survival.

b) The video below is an animation on a common way in which bacteria move around.


flagella.flv

What is the distinct structure that the bacterium possesses to contribute to its motility? What is the characteristic of the distinct structure and how does it help the bacterium to move?

This distinct structure is the flagella. Bacterial flagella are helically shaped structures containing the protein flagellin. The base of the flagellum (the hook) near the cell surface is attached to the basal body enclosed in the cell envelope. The flagellum rotates in a clockwise or counterclockwise direction, in a motion similar to that of a propeller. Thus, moving the bacteria cell as it propels. Helps the bacteria to “swim”.

References:

1. http://www.biotecharticles.com/Biology-Article/How-do-we-Name-a-Bacterium-591.html
2. http://www.micro.cornell.edu/cals/micro/research/labs/angert-lab/bacterialendo.cfm
3. http://grow.cals.wisc.edu/health/how-bacteria-move