

43.5
50



PART 1 – 27 points total

Chief science officer of the Nadesico; multi-part questions.

Please read the following scenario and then answer the questions with complete sentences using correct grammar and spelling.

You have days to complete these questions, there is no reason for sloppy work to be submitted.



Captain Yurika

43.5 - 6.5

You are the chief science officer on the spaceship Nadesico and have recently collected some unknown samples from Mars. You are to report to Captain Yurika about your findings and use the questions to guide what will become your report.

Using the information provided below, please correctly determine what type of organism is found in the sample in the questions.

Sample 1 - This first sample originated from Martian soil.

You can culture the cells on plates (petri dishes) with media that contains sugar, yeast extract and some nitrogen base (LB media commonly used in the lab). When you observe the cells with a light microscope, they appear to be approximately $1\mu\text{m}$ in length. The cells appear to have a cell wall and a single flagellum at one end of the cells. When observed in water, these cells are able to move with the flagellum.

To examine the subcellular structure, you fixed some of the cells and used the DNA stain DAPI to view the cells under your fluorescence microscope. If the DAPI stain is positive and fluoresces it will allow you to study the structure of the DNA.

The DAPI stain reveals a small amount of DNA in the cytoplasm; it is circular in shape.

You were in luck, some of the cells were fixed during the process of cell division, yet there was no mitotic spindle present.

Questions about sample 1:

1.) What type of metabolism is present in sample 1? Describe the observation that allowed you to conclude this. 2pts

catabolic / heterotroph

The LB broth is very rich amino acid that can be catabolized.

The microbes that grow there, needs the nitrogen source, and sugar as well as yeast extract.

Hence, from the whole nutrient, it is clear that the microbes growing on the nutrient is undergoing glycolytic metabolism just like any other organism *de*

2.) *Is this microorganism a eukaryote or a prokaryote? Describe the observations that allowed you to conclude this. 2pts*

+1 -1

spiral cells have flagella

The type of microorganism growing on the media is prokaryotes. The observation that led arriving at this microbe was the thick cell wall that was present, the flagella which facilitates the bacterial motility, and the presence of the circular DNA.

3.) *What are the two types of fluorescence microscopy that could be used to visualize the DAPI stain? 2pts*

+2

The two types of fluorescence microscopy used in DNA visualization were fluorescence widefield microscopy and point scanning confocal microscopy.

4.) *Which one has greater resolution of fluorescence images and what illumination (excitation source) results in this increased clarity of an image? 4pts*

-4 confocal w/ laser + pinhole.

The microscopy with greater/highest visualization was point scanning microscopy, its source of illumination is from the tungsten-halogen light.

Sample 2 - The second sample was collected from Martian water.

You are able to culture the cells in water under a light source under normal atmospheric conditions with both carbon dioxide and oxygen present.

The cells appear to be green in color and when the cells are exposed to light, they produce bubbles of pure oxygen. When you observe the cells under a light microscope you observe that the green color is a result of organelles that are green in color and about $10\mu\text{m}$ in length; these structures appear to have their own double membrane.

When you fixed the cells and stained with DAPI for DNA, you were able to observe condensed DNA inside of a membrane structure. Some of the cells were fixed during cell division and you saw strands of DNA lined up along the center of the cell attached to what looked like a mitotic spindle.

-5

Questions about sample 2:

5.) What type of metabolism is present in sample 2? Describe the observations that allowed you to conclude this. 2pts

+2

The type of metabolism present in the sample was photoautotroph; this is evident by the presence of light, oxygen bubbles that are produced which suggests that photosynthesis place.

An autotroph microorganism is the one that synthesizes food itself. Photoautotroph uses light energy for photosynthesis and produces food.

6.) Is this microorganism a eukaryote or a prokaryote? Describe the observations that allowed you to conclude this. 2pts

+2

An organism is eukaryotic since it has a green color, double-membrane organelle with a genome that is circular (chloroplast).

Eukaryotic cells are bounded by cell membrane in their nucleus as well as its organelle. Whereas the prokaryotic one does not have a defined nucleus as well as the organelles.

These cells have special green organelles that contain a double-membrane and have a small circular genome.

7.) Where did these organelles come from and what is the name of the theory that gave rise to these organelles? 3pts

+3

The chloroplast has been likely to originate from photosynthetic prokaryotes that are engulfed by a bigger eukaryotic cell. That has evolved eventually to become chloroplast.

The theory behind it was endosymbiosis theory.

8.) What metabolic process is happening in the green organelles? 2pts

The green organelle absorbs light energy from the sunlight that is utilized in the conversion of water and carbon dioxide to carbohydrates and other organic molecules as well as molecular oxygen.

The entire process of metabolism is known as photosynthesis.

+2

9.) Describe the differences between photosystem II and photosystem I? 4pts

+3.5
-0.5
Photosystem II: it consists of chlorophyll, a saddled beta carotene protein, small quantities of chlorophyll b, and the special pair of reaction center molecules of chlorophylls known as P680. The photosystem has a key electron acceptor for the units

H⁺ gradients? pump

Photosystem I: it consists of a photosynthetic unit with two hundred or more molecules of chlorophyll a, small quantities of chlorophyll b saddled protein carotenoids pigment, and a pair of specialized reaction center molecules of chlorophyll known as P700. All the pigment in the photosystem have the capacity of absorbing photon, but only the reaction center molecules can really exploit light energy.

Sample 3 - The third sample came from water from Mars.

You are able to culture the cells in water with the light source, but only if the cells from sample 2 are in the water. If the cells from sample 2 are not present, the cells in sample 3 will die.

These cells are approximately 500µm in length and have cilia around the outside of the cellular membrane that allow for the cell to swim. Occasionally, the sample 3 cells engulf the cells in sample 2.

When stained with DAPI to detect DNA when viewed with a fluorescence microscope, the DNA is found in a membrane bound structure. You have also observed a mitotic spindle in cells dividing.

10.) What type of metabolism is present in sample 3? Describe the observations that allowed you to conclude this. 2pts

+2

The type of metabolism used was catabolism. When the cell 3 acquire nutrients by engulfing cell 2,

This will eventually breakdown cell 2 in order to acquire nutrient, as well as simpler substances

11.) Is this microorganism a eukaryote or a prokaryote? Describe the observations that allowed you to conclude this. 2pts

+2

The microorganism is eukaryote, since on DNA detection using fluorescence microscope after being stained by DAPI, the results or findings indicate a membrane-bound structure that contains the nucleus. This kind of membrane-bound structure only exists on eukaryotic organisms but not prokaryotic ones. The DNA is located in the nucleus in both prokaryotes and eukaryotic cell.

-0.5

Excellent job with your observations! These will allow for you to write a report for your friendly purple-haired superior officer.

PART 2 – 23 points

Answer the following questions with complete sentences over material covered in cell biology to this point in time.

12.) What does SDS-PAGE separate? 2pts

The SDS-PAGE is used in the separation of protein-based mainly on their mass as an ionic detergent of SDS causes protein denaturation and uniformly binds to them so that the protein will be charged negatively when the current is switched on and then migrates to the positive electrode.

13.) How do you interpret an SDS-PAGE gel? 2pts

- 12
- The lane that has a single band indicates that a given sample has only one protein.
 - The lane that has multiple bands indicates that the given sample has several multiple numbers of proteins.
 - The band in the front that is moving faster is smaller as compared to that one of the marker.

14.) Why do you include a ladder on an SDS-PAGE gel? 2pts

12 A ladder on the SDS-PAGE is normally used to show the molecular weight size, they also call it protein ladder, DNA ladder, RNA ladder. You can see the movement of proteins.

15.) What is Western blotting used to detect? 3pts

13 Western blotting is used to detect certain proteins amongst many proteins. You also use it to analyze protein expression and size.

specific protein better word

16.) How does Western blotting work? 3pts

ok +2 -1

Western blotting is used to separate proteins and they also use it to identify them. The proteins are separated by gel electrophoresis, after it is sent to a membrane. When the electric current is switched on the negatively charged protein will move to positive electrodes. After full separation, the membrane will be incubated with labeled antibodies specific to the protein of interest for 24 hours.

17.) *Is Western blotting a direct or indirect measurement of protein presence or absence? 2pts*

+2 Traditionally, western blotting is an indirect method that involves, incubation of the blot with primary antibody which helps in the identification of the protein of interest. Then incubation with labeled secondary antibody that helps in recognizing the primary antibody for the detection of protein presence or absence.

18.) *Compare the inputs and outputs of photosynthesis and aerobic respiration. What type of energy is required for both processes? 3pts*

	Input	Output
Photosynthesis	Water and carbon dioxide	Oxygen and glucose
Aerobic respiration	Glucose and oxygen	Carbon dioxide and water

+3 During **photosynthesis**, the green plant is able to manufacture their own food by using energy in form of ATP converted from light energy from the sun.
In **aerobic respiration**, chemical energy from glucose is used in the creation of ATP, carbon dioxide, and water molecules.

19.) *Compare the inputs and outputs of photosynthesis and aerobic respiration. Where is a proton gradient formed? 3pts*

+3 During photosynthesis, photosystem II releases the protons into the thylakoid of the chloroplast, and then the lumen takes them up from the stroma, while in cellular respiration, (aerobic respiration) is dependent on the existence of an electrochemical proton gradient in order to cross the inner membrane of the mitochondria.
In photosynthesis, the results is a pH gradient across the membrane of thylakoid with an excess proton when the pH is low, while in respiration oxidative phosphorylation, high energy is an electron being transported along an electron transport chain to the inner membrane of the mitochondria in the eukaryotic cell.

20.) *Compare the inputs and outputs of photosynthesis and aerobic respiration. What is made from the carbon e.g. sugar or carbon dioxide? 3pts*



During photosynthesis, glucose is manufactured from carbon dioxide and water, and the process involved is an anabolic reaction while in the aerobic reaction carbon dioxide is formed from the glucose molecules and the reaction process involved is the catabolic process.

+3