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Level 1 Biology, 2017

90927 Demonstrate understanding of biological ideas relating to micro-organisms

9.30 a.m. Thursday 16 November 2017
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of biological ideas relating to micro-organisms.	Demonstrate in-depth understanding of biological ideas relating to micro-organisms.	Demonstrate comprehensive understanding of biological ideas relating to micro-organisms.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 22

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QUESTION ONE: FOOD PRODUCTION AND STORAGE – YOGHURT

One way to preserve milk is by fermentation. Yoghurt is made by fermenting milk, using bacteria such as *Lactobacillus* that produce lactic acid. The increase in acidity changes the flavour and texture of the milk, making yoghurt.

Lucas and Sarah each followed the steps below to make yoghurt.

Yoghurt making instructions:

- Heat 200 mL of milk to 80°C.
- Cool the milk to 30°C.
- Add 50 mL of yoghurt that contains *Lactobacillus* bacteria and stir gently.
- Leave in a warm place for 8 hours.

After eight hours they checked the yoghurt, and noticed that it looked thick and white, just like store-bought yoghurt. Sarah then put hers in an airtight container in the fridge. Lucas left his on the bench.

When they came back two days later, Lucas noticed that there were fungi growing on his yoghurt, and that Sarah's still looked fresh and did not have fungi growing on it.

Lucas's yoghurt with fungal growth.

www.ehow.co.uk/info-tip_7984683_dangerous-eat-moldy-yogurt.html

Sarah's yoghurt.

Discuss how the life processes of microbes allow bacteria to be used to make yoghurt, and how the life processes of microbes determine how we need to store food to keep it fresh.

In your answer:

- describe the process of fermentation that occurs in bacteria such as *Lactobacillus*
- describe the environmental factors required for the growth of the bacteria (*Lactobacillus*) in the yoghurt
- explain how the life processes of bacteria allow them to be used in making foods like yoghurt
- discuss the importance of storing the finished yoghurt in an airtight container in the fridge to keep it fresh.

Fermentation is a process involving anaerobic respiration (respiration that does not require oxygen) that converts carbohydrate into acids, gases and/or alcohols. In this case acid is produced. As the bacteria respire anaerobically they produce lactic acid and water (lactose (milk) → lactic acid + ~~water~~ carbon dioxide + 2ATP).

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I will use ECO as a shorter way of writing out extracellular digestion throughout this paper

The lactic acid produced in fermentation increases the acidity of the milk which produces yoghurt. Environmental factors are required to encourage the growth of bacteria such as warmth, plentiful space and nutrients, correct pH and moisture. In such optimal conditions, enzyme activity is increased leading to bacteria being able to carry out life processes such as reproduction, respiration and assimilation of nutrients at an efficient pace causing rapid microbial growth. Bacteria use this life process in producing foods like yoghurt. For example, the bacteria find food/gain nutrition via a process known as extracellular digestion (ECD). In this process, bacteria secrete digestive enzymes on to a food source eg. milk (lactose). These enzymes break the lactose down (digest it) into smaller, soluble molecules which are re absorbed back into the bacteria through the cell wall and membrane. To release the energy from this food, the bacteria will go through respiration. To make yoghurt, anaerobic respiration is used to ferment the milk.

(lactose (milk) → lactic acid + carbon dioxide + 2ATP (energy)

The bacteria will then reproduce asexually via a process known as binary fission after gaining the energy required to do so. In binary fission, a mature bacterium replicate its genetic material within itself. This genetic material is then pulled to the cell poles as the cell elongates. The cell wall and membrane then begin to grow together as the cytoplasm pinches the cell in half producing 2 daughter cells identical to the original parent cell. As the bacteria feed, respire and reproduce, their population experiences rapid microbial growth due to optimal conditions provided eg. warmth - yoghurt is left in a warm place for 8 hours and plentiful space and nutrients. As the population increases as more and more bacteria are respiring anaerobically, a lot of lactic acid is produced allowing the milk to ferment and produce products such as cheese and in this case, yoghurt. The yoghurt should then be stored in an airtight container with a lid in the fridge. This is to prevent any unwanted microbes from getting in (including harmful pathogens) as well as to ensure that the bacteria do not respire aerobically which would produce carbon dioxide and water (lactose + oxygen → carbon dioxide + water + 36ATP)

E7

CONTINUED ON EXTRA

QUESTION TWO: ANTIBIOTICS, BACTERIA, AND VIRUSES

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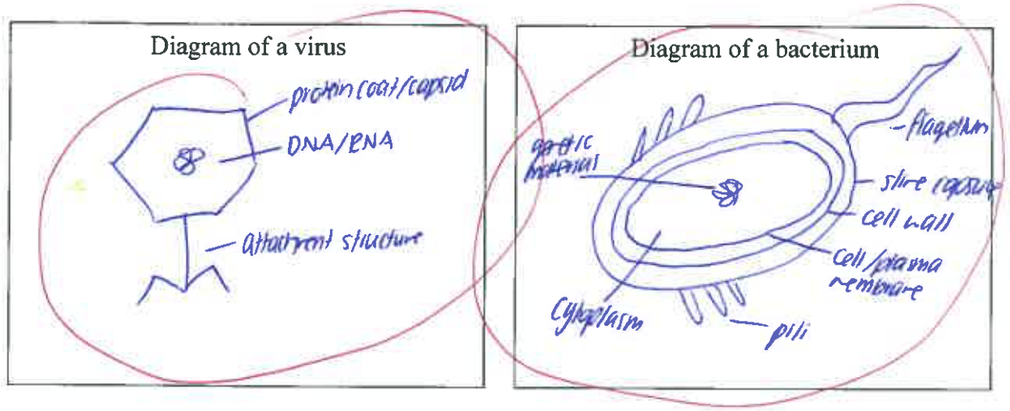
The use of antibiotics has reduced the number of deaths due to bacterial infections around the world. Antibiotics can kill bacteria, but are not effective against viruses.

(a) Draw a labelled diagram of a virus and a bacterium.



(b) In recent years, some pathogenic bacteria have become resistant to antibiotics.

www.futuretimeline.net/blog/2013/04/25-2.htm#.WDTxXaJ968o

Discuss the use of antibiotics to treat bacterial infections.

In your answer:

- describe the trend in the percentage of antibiotic resistance shown in the graph
- explain the effects of antibiotics on the life processes of bacteria
- explain why bacterial infections can be treated with antibiotics, while viral infections cannot
- discuss how antibiotic resistance in bacterial populations can develop, and how it can be reduced.

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According to the graph, the antibiotic resistance of bacteria A has been steadily increasing since the year just before 1990. Between 1990 and 1995, the line for bacteria A plateau showing a steady constant in the percentage of antibiotic resistance. The percentage of antibiotic resistance of bacteria B and C have also been increasing since around the 1990s. Overall, the percentage of antibiotic resistance in bacterial populations has been increasing, bacteria A since 1990 and B and C since 1990.

Antibiotics are produced naturally and can be made of fungi, a certain type, who in nature, are found competing against bacteria for food and space. Antibiotics can work in various ways to stop bacteria from causing infections. For example, some antibiotics prevent the synthesis of the cell wall or cell membrane. As a result, the pathogenic bacteria can no longer feed (through ECO as digestive enzymes can no longer be secreted onto a food source (e.g. our body tissue/cell) and the digested/broken down soluble pieces can no longer be absorbed) and as a result cannot respire (release energy from food) to produce the energy required to carry out reproduction. So as a result microbial growth is stopped and toxins (natural poisons) can no longer be excreted which may also cause sickness. Other antibiotics stop the bacteria from replicating its genetic material during reproduction via binary fission. As no DNA is copied over, the new daughter cell formed will not have any instructions and will be left unable to carry out any further life processes including feeding/nutrition, reproduction or growth.

Although bacterial infections can be treated in the ways stated above, viral infections cannot be. This is because viruses are not considered living as they do not carry out life processes (except for viral replication). They also do not have a cell wall or membrane which is affected with the use of antibiotics. As viruses do not have life processes, they cannot be stopped/killed with antibiotics and require vaccines to do so. Antibiotic resistance can emerge in bacterial populations due to the misuse or overuse of antibiotics. When a person uses

Mature bacterium replicates its genetic material first. This is then pulled towards the cell poles. As the cell elongates, the cell wall & membrane grow together & the cytoplasm pinches the cell in half producing 2 identical daughter cells

E8

CONTINUED ON EXTRA PAPER

QUESTION THREE: SOOTY MOULD

Sooty mould is a common fungus that grows on beech/tawai trees in New Zealand. It feeds on honeydew, which is an energy-rich substance made by insects that also live on the trees.

Sooty mould growing on the trunk of a beech/ tawai tree.

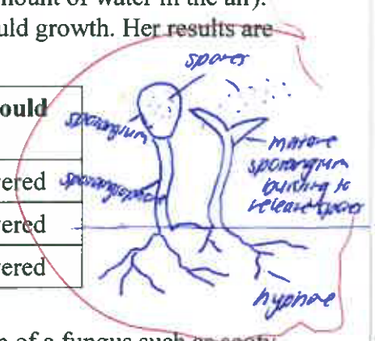
www.sciencelearn.org.nz/images/1738-sooty-mould

Sooty mould hyphae as seen under a microscope.

www.researchgate.net/publication/264275370_The_sooty_moulds

One environmental factor that affects the growth of sooty mould is humidity (amount of water in the air). A student collected some data to investigate the effect of humidity on sooty mould growth. Her results are in the table below:

Humidity (amount of water in the air)	Percentage cover of sooty mould on beech/tawai trees
High humidity	Average of 90% of trunks covered
Medium humidity	Average of 50% of trunks covered
Low humidity	Average of 20% of trunks covered



Discuss how environmental factors, life processes and the structure and function of a fungus such as sooty mould, work together to allow it to live successfully on New Zealand's beech/tawai trees.

In your answer:

- describe the structure and function of a fungus such as sooty mould
- explain the environmental factors required for a fungus such as sooty mould to live successfully
- explain how a fungus such as sooty mould feeds, grows, and reproduces
- discuss how the life processes of sooty mould are affected by humidity and other environmental factors such as temperature, oxygen availability, nutrients, moisture and competition.

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Sooty mould is a type of fungi that has a sporangium (spore case) filled with unicellular, reproductive parts known as spores. The sporagum is held up by the sporangiophore which exposes it to wind (so that spores can be released and carried by the wind as they are light). Below the sporangium are branch-like structures known as hyphae of which there are reproductive hyphae and feeding hyphae. (look at diagram) The environmental conditions required for sooty mould to live successfully include warmth, moisture (humidity), oxygen, plentiful space and nutrients (nutrients are provided by the honey dew). These optimal conditions increase enzyme activity and allow fungi to carry out their life processes at an efficient rate leading to fungal population growth. Fungi such as sooty mould also feed via ECO. They release digestive enzymes through the tips of their feeding hyphae onto a food source e.g. honey dew. The digestive enzymes break the food down into smaller, soluble molecules which are then absorbed back into the fungi through the tips of its feeding hyphae. To gain energy from this food, the sooty mould then respires. it can use this energy for other life processes such as reproduction. Fungi reproduce through spores. Fungi have a sporangium which contains unicellular reproductive spores. When mature, the sporangium bursts and releases these spores. As they are light, they are easily carried by wind/air. These spores then land on a food source and germinate and grow their hyphae downwards. These life processes are all affected by the sooty mould's environmental conditions. According to the students table, high humidity (moisture) results in 90% of tree trunks covered in the mould as opposed to low humidity which results in an average of 20% of the tree covered. Moisture is an essential condition for microbes including fungi to carry out their life processes in order to increase their population. Warm temperatures (optimal is around 25°C to 35°) encourage enzyme activity which allows fungi to carry out their life processes at a rate faster than as if it was cold. Assuming sooty mould respires aerobically (requires O_2) (Glucose + oxygen → carbon dioxide + water + 36 ATP),

E7

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Extra paper if required.
Write the question number(s) if applicable.

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QUESTION NUMBER

1 seen

as this would ruin the yoghurt. By keeping it stored in the fridge, enzyme activity is slowed and as a result so are the bacteria's life processes. This is to ensure that the yoghurt does not go off like Lucas's and when he left his on the kitchen bench it is generally warm. This means that the bacteria now feed, reproduce, respire etc at a much slower rate and cannot spoil the food with rapid population growth that optimal conditions would provide.

2 seen

antibiotics, due to natural selection, a bacterium will either die or live and adapt. If a single bacterium lives on, it will eventually mutate. A mutation is a permanent change in DNA. Because of this mutation, a previously prescribed antibiotic will may not be effective on this new strain of bacteria. In optimal conditions e.g. warmth, plentiful space and nutrients, the single mutated bacterium will manage to feed via ECD on our body tissue or cells & will respire to release energy to use for reproduction via binary fission. This leaving behind antibiotic resistant bacteria. It will pass on its mutation on to its offspring causing rapid bacterial growth. Antibiotic resistance can be reduced by not overusing misusing antibiotics or by finishing the full course of antibiotics prescribed as many people stop taking them after they "feel fine" meaning that some bacteria may live → mutate → reproduce → antibiotic resistant population.

3 seen

Oxygen availability is crucial. Aerobic respiration also produces a greater amount of energy (36 ATP) compared to anaerobic respiration (2 ATP). A greater amount of energy can be used to carry out other life processes such as reproduction. The honey dew provides the fungi with essential nutrients from which they can release energy through respiration. (feed via ECD) Without plentiful nutrients, no energy can be released and no other life processes can occur as a result. Competition is also an important environmental condition as sooty mould populations will decline if there is competition from other microbes for food and space - which are both factors that fungi require to grow. These optimal conditions

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Annotated Exemplar Template

Excellence exemplar 2017

Subject:	Biology	Standard:	90927	Total score:	22

Q	Grade score	Annotation
1	7	This response is an E7 because it demonstrates understanding through description, demonstrates in-depth understanding through explanation (saying how or why something occurs) and demonstrates comprehensive understanding by applying and linking biological ideas. In particular, this response is an E7 because it describes and explains the life processes of fermentation, extra-cellular digestion and reproduction and the environmental factors required for the growth of bacteria in the yoghurt. It also explains how the life processes of bacteria are useful in making foods such as yoghurt. The response links the idea of optimal environmental conditions to optimal growth of bacteria in the making of yoghurt. It goes on to make links between the ideas of why it is important to store the yoghurt in an airtight container. In order to score E8 this response would need to link the impact of lower temperatures in the fridge on the rate of enzyme activity involved in bacterial life processes.
2	8	This response is an E8 because it demonstrates understanding through description, demonstrates in-depth understanding through explanation (saying how or why something occurs) and demonstrates comprehensive understanding by applying and linking biological ideas. In particular, this response describes the trend in antibiotic resistance as shown in the graph, ways that antibiotics work to kill bacteria, why antibiotics are ineffective against viruses and how antibiotic resistance occurs. The response demonstrates in-depth understanding by further explaining why antibiotics are ineffective against viruses and how antibiotic resistance can occur in a bacterial population. The response goes further to link the idea of how antibiotic resistance occurs to a way that resistance can be reduced.
3	7	This response is an E7 because it demonstrates understanding through description, demonstrates in-depth understanding through explanation (saying how or why something occurs) and demonstrates comprehensive understanding by applying and linking biological ideas. In particular, this response describes fungal life processes and the environmental factors required for sooty mould to live successfully. The response demonstrates in-depth understanding by further explaining the impact of oxygen availability on the rate of respiration and linked this to the energy available to carry out other life processes eg reproduction. In order to score an E8 this response would need to make more comprehensive links between an environmental factor and multiple life processes.