Are there micro-organisms on a mobile phone?

Micro-organisms are everywhere

Micro-organisms such as **bacteria**, **fungi** and **viruses** survive in a number of different places but are often impossible to see without a microscope.

People carry and use mobile phones everywhere they go – sometimes including when going to the toilet. This increases the chance that harmful micro-organism are transferred to the phone. Research has shown that a common bacterium from the human intestine, *E. coli*, is often found on mobile phones.

Reproductive structures of some fungi can be seen

Phones are used everywhere

Is your cell phone covered in micro-organisms? A study of mobile phones carried by university students showed 80% of the phones had bacteria on them and 100% carried at least one type of fungus. When was the last time you cleaned your phone with an anti-bacterial wipe?

Study of bacteria on mobile phones

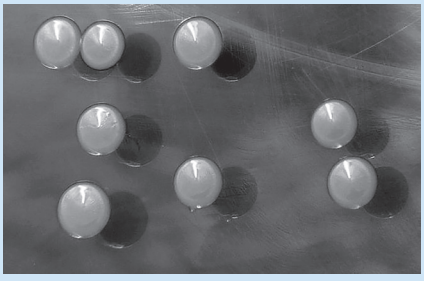
Scientists have found that mobile phones carry their owners' 'bacterial fingerprint'.

A study by US scientists found mobile phone users touch their devices on average 150 times a day.

Each person has trillions of different micro-organisms that live in their gut, mouth, skin and elsewhere on their body. The study found that 82% of the bacteria that make up a person's bacterial fingerprint end up on the screen of their phone.

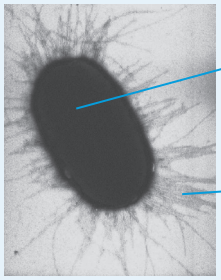
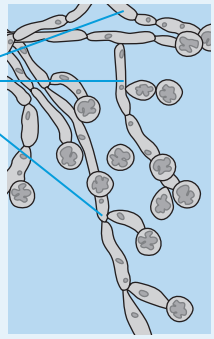
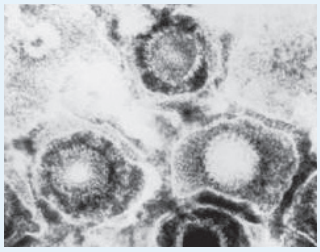
The scientists found 7 000 different types of bacteria in the samples they took from fingertips, thumbs and screens. These included three groups that are commonly found on the skin or in the mouth: *Streptococcus*, *Staphylococcus* and *Corynebacterium*.

In future, personal items such as phones might be useful for monitoring exposure to certain bacteria and tracking the spread of disease.



Staphylococcus colonies

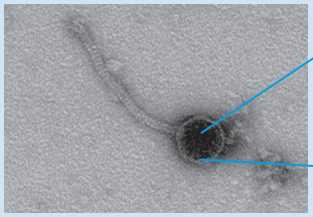
The following table describes some micro-organisms found on mobile phones.

Micro-organism	Description	
E. coli bacteria	On a phone, *E. coli* can survive for several hours and still be able to be transferred to another **host**. A host is a living organism or cell in which the micro-organism can survive. In large numbers, *E. coli* can cause illnesses with stomach cramps, nausea and diarrhoea.	 *E. coli* bacterium sticky filaments help bacterium grip on to surfaces
A fungus from the *Candida* group	The fungus lives in the mouths of around 80% of people without causing a problem. However, the fungus can occasionally change from the usual, single-celled individual to a long thread of several cells that grow out of control, causing the disease known as 'thrush'.	fungal threads that cause 'thrush' seen under a microscope 
Herpes-1 virus	Viruses released from a cold sore can be transferred to the phone and from the phone to another person. The circles in the photo are the Herpes virus seen under an electron microscope.	

Size of micro-organisms

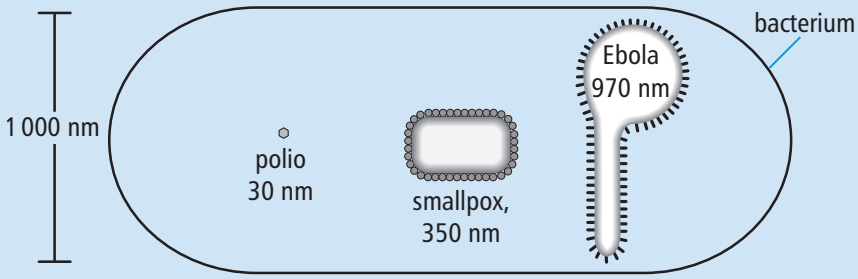
Viruses and bacteria

Viruses are very small. They do not contain cells. The photo, taken using a very powerful electron microscope, shows a single virus. Each virus contains genetic material covered in protein.

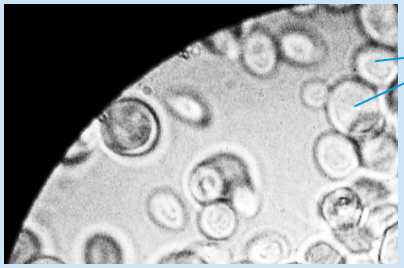


A nanometre, nm, is one billionth of a metre.

Some viruses are only a few nanometres long. The following shows the size and shape of three viruses compared with an average-sized bacterium.



Fungi are larger than bacteria and viruses, but those in which each individual organism is only a single cell are difficult to see. An example is yeast, seen in the following photo under a light microscope. Each cell is a separate individual. Yeast is a **unicellular** fungus.

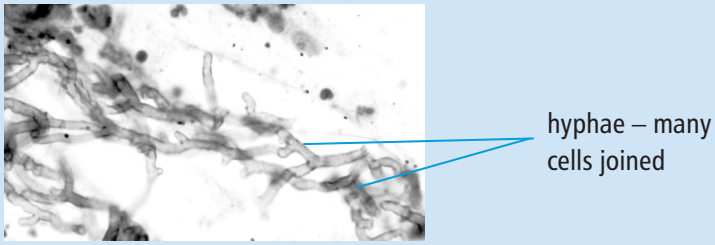


Yeast cells

Most fungi are easier to see than bacteria are, because the fungi form **multicellular** bodies. 'Multicellular' means 'made of many cells'. Some fungi are easy to see because they form very large reproductive structures. Examples are mushrooms and toadstools, the reproductive parts of the fungus, which appear above the food source.

Reproductive structures of a multicellular fungus

The 'body' of a fungus, the **mycelium**, is made of many fine threads called **hyphae**, which grow through the food source of the fungus.



Mycelium of a multicellular fungus

The hyphae secrete enzymes onto the food source. The enzymes break down the food into particles that are small enough to be absorbed into the hyphae.

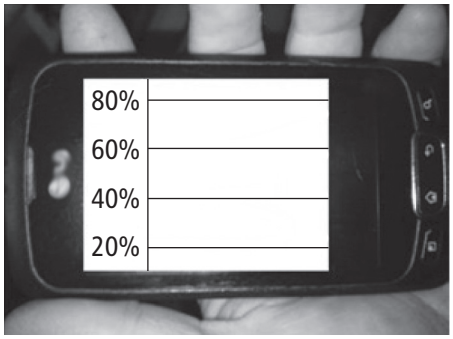
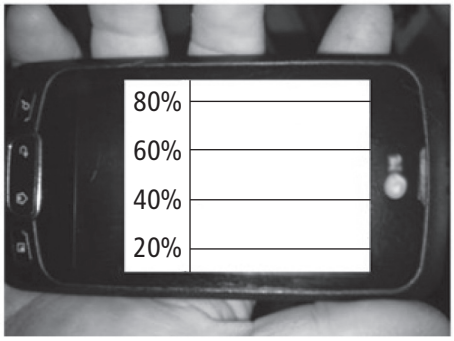
Are there micro-organisms on a mobile phone?

Answers p. 55

1. a. Name three types of micro-organism.

_____ _____ _____

b. Colour the two mobile phone screens to show the percentage (%) of mobile phones the study showed had bacteria and the percentage that had fungi on the phone surface.

Percentage of phones with bacteria on their surface	Percentage of phones with fungi on their surface
	

c. Describe what you should use to clean a mobile phone. _____

2. a. Where in the human body is the bacterium *E. coli* usually found? _____

b. Explain how *E. coli* can be transferred to the surface of a phone. _____

_____

_____

c. What is a 'host' organism? _____

d. What symptoms of illness are caused by some types of *E. coli*?

_____

e. Describe how *E. coli* cells stick to surfaces.

_____

_____

3. a. About what percentage of people are thought to have *Candida* fungi in their mouth? _____

b. What can happen when *Candida* changes from being a single cell to forming a long thread?

_____

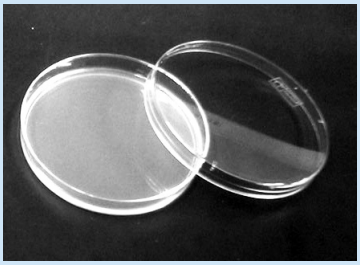
_____

c. What disease does the Herpes-1 virus cause?

_____

Finding and growing micro-organisms

Growing micro-organisms is called **culturing**. Micro-organisms are often grown in broth (a sort of soup) and on plates containing **agar**, which is similar to gelatin. The photo shows an agar plate and its lid.



Agar plate and lid

Different **nutrients** are added to the broth or agar when culturing different types of micro-organisms. For example, a medical laboratory could use a blood agar to culture a **pathogen** (disease-causing micro-organism).

Culturing bacteria

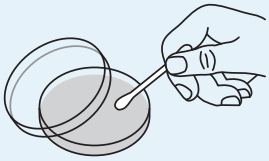
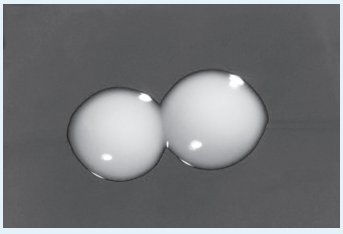
The bacteria on a person's skin cannot be seen because each individual micro-organism is extremely small. However, micro-organisms can be seen on a nutrient agar plate that has been incubated for three to five days in a warm place. Each bacterium on the plate reproduces many times by binary fission to produce many bacteria. Each large 'dot' of bacteria on the agar plate is a **colony**, and is the result of the reproduction of a single micro-organism placed on the plate.

a colony of bacteria, formed as the result of the reproduction of one bacterial cell

Investigations using agar plates

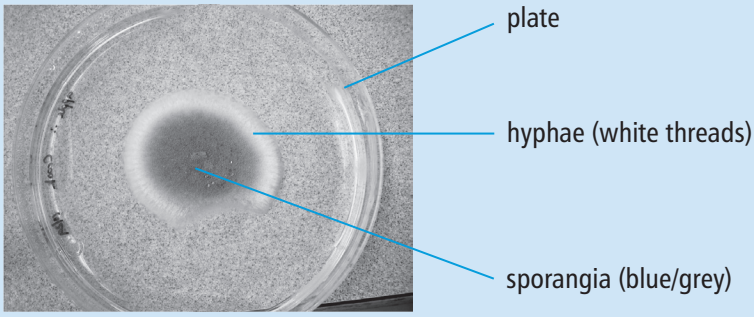
When culturing micro-organisms, assume all are harmful.

- Use a disinfectant to clean work areas before and after use.
- Use a disinfectant soap to wash your hands before and after working with micro-organisms.
- Do not eat or drink in the laboratory and do not store food in areas where micro-organisms are stored.
- Label all materials clearly.
- View sealed, incubated plates only through the clear lid – never remove the lid.
- Dispose of incubated plates safely.

Making the plates  Agar plates cooling	The bottom of a **sterile** Petri dish is covered in a thin layer of warm, runny nutrient agar and the lid is put on. (A sterile dish contains no micro-organisms.) The agar is allowed to cool. At the start of an investigation, it is a good idea to seal and incubate one of the plates so that it can be used as a '**control**'. A control plate is a check that the agar plates were free of micro-organisms at the start of the investigation.
Inoculation 	'Inoculation' is getting the micro-organisms onto the plate. A common method is by using the sticky side of Sellotape, or a cotton bud, to transfer micro-organisms from a surface to the agar. Care is taken not to damage the agar surface.
Incubation 	Inoculated plates are labelled, sealed, turned upside down, and placed in an incubator. The plates are turned upside down so that any moisture formed from the respiration of organisms growing on the agar will drip away from the agar. The incubator is set at between 20 °C and 25 °C, because most micro-organisms grow best in mid-range temperatures. The plates are left in the incubator for three to five days.
Viewing 	Plates are viewed without opening. Bacteria usually appear as shiny colonies. Each different-coloured colony contains a different type of bacterium.
Incineration	The unopened plates are destroyed in an incinerator or disposed of by another safe method.

Fungi on nutrient agar plates

Fungi appear as fuzzy patches. The *Penicillium* mould in the following photo is an example.



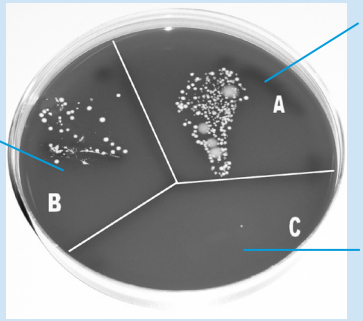
Penicillium fungus on agar

Investigations

Agar-plate investigations

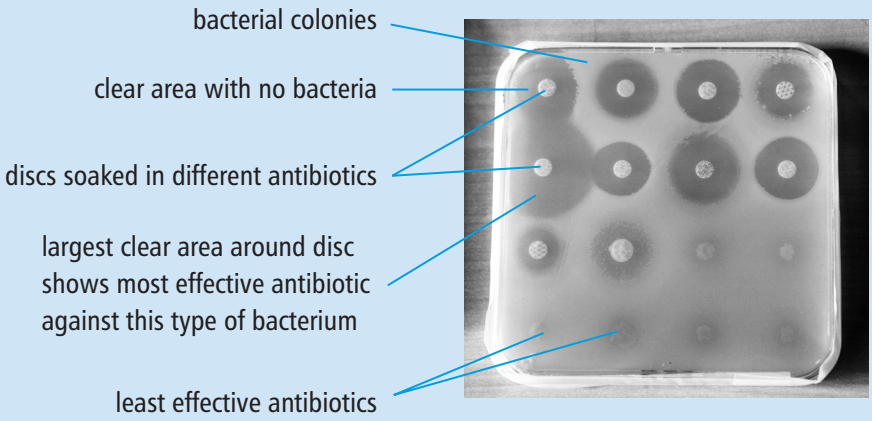
Hand-washing effectiveness

The growth of micro-organisms on the nutrient agar plate in the following photo shows the effects of three different hand-washing techniques. Which seems most effective?



The effect of antibiotics and antiseptics

Antibiotics and **antiseptics** are chemicals that stop the growth and reproduction of micro-organisms. The large square agar plate in the photo shows the effectiveness of different antibiotics in reducing the growth of micro-organisms. The larger the clear area around the disc, showing no bacterial growth, the more effective is the antibiotic.



Factors that affect the life processes of micro-organisms

Temperature and pH

There are environmental conditions that are optimum for the growth and reproduction of each different type of micro-organism. Low temperatures slow the activity of micro-organisms, because chemical reactions occur more slowly in the cold. High temperatures can kill micro-organisms, because the enzymes the micro-organisms contain are destroyed by heat – the enzymes are said to '**denature**' by losing their shape. Some micro-organisms, such as lactic-acid bacteria, grow well in conditions of low pH (acidic) while others grow best in a neutral pH.

Oxygen

Aerobic bacteria and fungi need oxygen. Without oxygen, they cannot respire, so they die. Anaerobic micro-organisms do not need oxygen. Yeast cells are aerobic when oxygen is present and they can also produce ATP for energy by anaerobic fermentation when oxygen is not available.

Water

Water forms part of the **cytoplasm** in bacterial cells and in the hyphae of fungi. The cytoplasm is a watery medium in which chemicals dissolve. In it, enzymes and chemicals can move towards each other and cause a chemical reaction. Lack of water slows life processes because chemical reactions occur slowly or not at all.

Toxins

Toxins are waste products released by bacteria. As the number of bacteria increases, the concentration of toxins increases until the toxins begin to kill the bacteria themselves. Toxins produced by many fungi are poisonous to humans and animals.

The *Amanita* fungus is deadly

Finding and growing micro-organisms

Answers p. 56

1. a. What is meant by 'culturing' micro-organisms?

b. Name the gelatin-like substance used to culture micro-organisms.

c. What is a 'pathogen'?

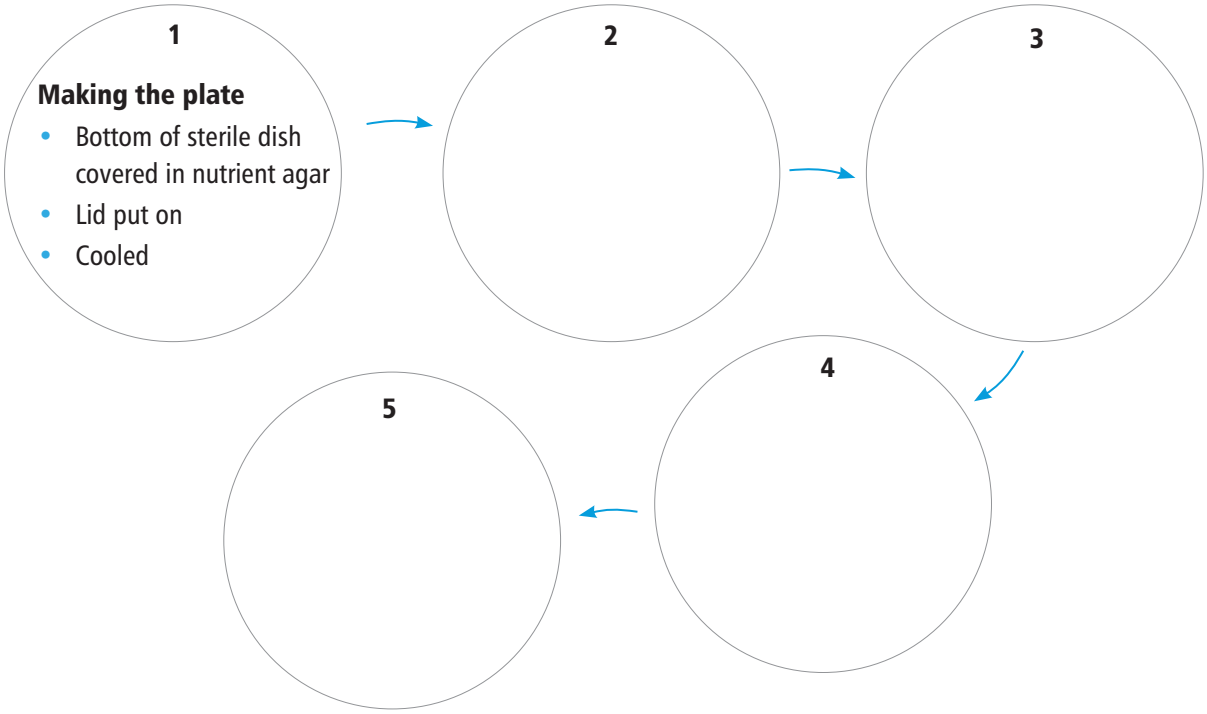
2. a. Why is it not possible to see individual micro-organisms with the naked eye?

b. What is a 'colony'?

c. Explain what happens on an agar plate that allows micro-organisms to be seen.

d. Suggest why scientists in a medical laboratory might use 'blood agar' to culture a micro-organism.

3. a. Plate 1 in the following diagram has notes to show how an agar plate is made. Add a heading and notes to each of the other plates to show the steps in *using* an agar plate to culture micro-organisms.



b. What is a control plate? Why is it used?

_____

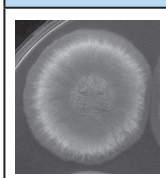
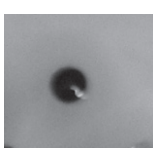
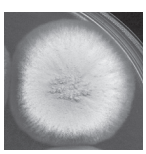
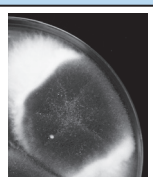
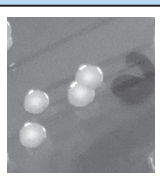
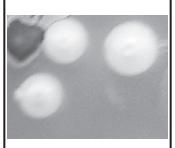
_____

_____

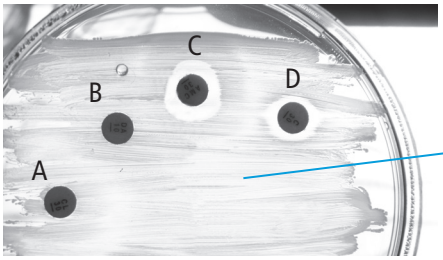
c. Rules to remember when culturing micro-organisms are written amongst the notes in this section. Rewrite three rules here.

- _____
  _____
- _____
  _____
- _____
  _____

4. Plates A to G in the photos are of growing colonies of micro-organisms. In the space below each photo, write whether the colonies on the plate are of fungi or of bacteria.

A	B	C	D	E	F	G
						

5. The following diagram shows the results of an investigation into the effectiveness of three antibiotics – B, C and D. Disc A is the control and was soaked in pure water. Describe what each of discs A, B, C and D shows.



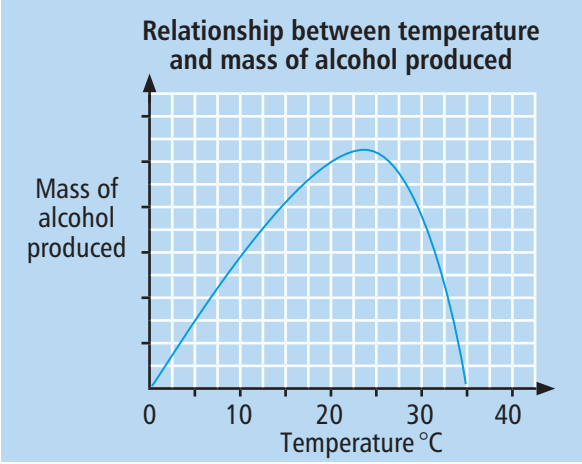
Disc A: _____

Disc B: _____

Disc C: _____

Disc D: _____

6. In wine-making, yeast converts sugar in grapes to alcohol, by fermentation. The following graph shows how temperature affects the fermentation of sugar by a particular species of yeast. Use the graph to answer the questions.



a. At which two temperatures does no fermentation take place?

_____ and _____

b. At which temperature is most alcohol being produced? _____

c. Write a statement describing the relationship between temperature and fermentation of sugar by yeast. Use the words 'optimum temperature' in your statement.

_____

_____

_____

_____

_____

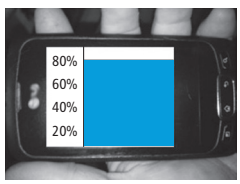
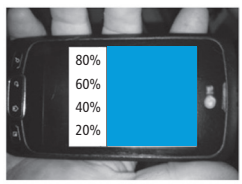
_____

Answers

Are there micro-organisms on a mobile phone? (page 4)

1. **a.** viruses, fungi, bacteria

b.

Percentage of phones with bacteria on their surface	Percentage of phones with fungi on their surface
	

c. An anti-bacterial wipe

2. **a.** Intestines

b. *An answer such as: E. coli* can get on a person's hands when they use the toilet. If they do not wash their hands carefully, the *E. coli* on their hands is transferred to the phone when they touch the phone.

c. A living organism or cell in which a micro-organism can survive.

d. stomach cramps, nausea, diarrhoea.

e. *E. coli* cells have sticky filaments that grip surfaces.

3. **a.** 80%

b. The fungus causes the infection known as 'thrush'.

c. Cold sores

d.

Capsid (protein covering)	Genetic material (RNA or DNA)
A, C, E	B, D, F

e. Viruses are only a few nanometres long / viruses are extremely small.

4. **a.** Made of many cells

b. Having only one cell

5.

a.	hyphae (single strands)
b.	mycelium (body of mushroom)
c.	cap
d.	gills
e.	stalk

Is my yoghurt alive? (page 8)

1. **a.** A starter culture contains bacteria that are added to milk to start the yoghurt-making process.

b. Two or more different species of bacteria

c. The bacteria in different starter cultures cause different textures, flavours and sharp/sour lactic-acid tastes.

2. **a.** Reproduction where one cell divides into two cells and so on.

b. Every 20 minutes

3. **a.** = DNA, **b.** = cell wall, **c.** = extension, **d.** = division, **e.** = division almost complete, **f.** = two daughter cells

4. The bacterium is in the final stage of becoming two daughter cells, because the cell wall has almost completely divided.

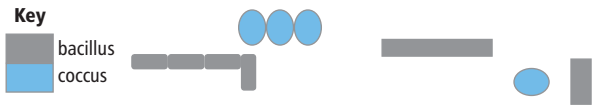
5. **a.** lacto – milk, bacillus – rod-like in shape, acidophilus – acid loving

b. mouth, intestine

c. can survive in a pH of 4.5

d. ball, chains

e.



6. **a.** A micro-organism that can survive the acid in the stomach and, in suitable amounts, benefit health.

b. increased numbers of helpful bacteria in the gut / reduced growth of harmful or disease-causing bacteria / improved digestion and gut function

c. lactase

d. Bacteria in the yoghurt remove the lactose by turning it into lactic acid.

Fermentation in yoghurt making (page 12)

1. **a.** Lactic-acid bacteria ferment lactose and turn it into lactic acid. Lactic acid tastes sour.

b. The bacteria use the energy carried in ATP to carry out life processes such as growth and reproduction.

c. Casein protein molecules in the milk join to form the gel.

d. The formation of lactic acid in the yoghurt lowers the pH, which makes the environment in the yoghurt unsuitable for the growth of other bacteria.

2. **a.** and **b.**

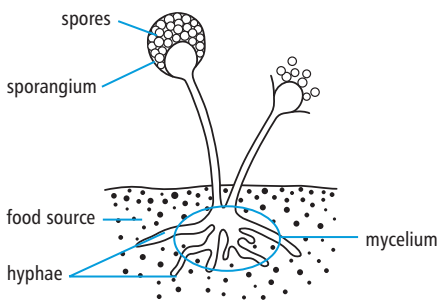
Step	Other information	Reason for this step in the process
1. Pasteurise milk	Temperature: 85–95 °C Time: 15–30 minutes	To kill any micro-organisms in the milk
2. Homogenise milk		To keep cream mixed into milk
3. Cool milk	Temperature: 40–46 °C	Can add bacteria
4. Add starter culture	Contains: live lactic-acid bacteria	So bacteria can ferment the milk and turn the lactose into lactic acid
5. Incubate	Temperature: 40–46 °C Time: 4–5 hours pH: around 4.3	To allow the bacteria to grow quickly, reproduce, and ferment the milk
6. Stir and cool	Temperature: 5 °C	To slow the activity of the lactic-acid bacteria

7. Add flavourings and fruit		To change the flavour of the yoghurt
8. Pack and refrigerate	Temperature: below 4 °C	To stop yoghurt becoming contaminated by the growth of other micro-organisms, e.g. yeast

3. a. Slow life processes
   b. Life processes take place quickly
   c. Life processes stop or bacteria killed

Is there alcohol in freshly baked bread? (page 16)

1. a. sugar and alcohol
   b. yeast
2. a. flour, water, sugar, salt
   b. From left: Step 2, Step 4, Step 3, Step 1
   c. Yeast cells release enzymes that digest starch in the flour. The starch becomes sugar, which is absorbed by the yeast.
   d. The yeast cells need sugar to produce energy (ATP) for their life processes.
   e. glucose → carbon dioxide + alcohol + energy (ATP)
   f. The warmth increases the activity of the yeast cells, so they grow, reproduce, and ferment the sugars in the dough. The fermentation releases carbon dioxide, which makes the dough increase in volume.
3. Offspring grow out of the side of a parent cell and drop off.
4. a. and b.



   c. If the spores grow on a new food source there will not be competition for food between the offspring and the parent fungus.
   d. Hyphae grow on or through the food source to release enzymes into the food and absorb the digested material. Sporangia grow above the food source so spores can be dispersed to new food sources.
5. Bread dough is kept at 26 °C for the first hour because this is the best temperature for the yeast to reproduce, producing many yeast cells to ferment the sugar. Then the dough is kept at 35 °C because this temperature is in the range of temperatures that are best for fermentation. Plenty of carbon dioxide is produced, which gives the bread a network of holes and a light fluffy texture when cooked. Baking until the centre reaches 100 °C kills the yeast so fermentation stops.

Finding and growing micro-organisms (page 22)

1. a. 'Culturing' means to grow micro-organisms.
   b. Agar
   c. A micro-organism that causes disease
2. a. They are too small.
   b. A colony is a group of many bacterial or fungal cells.
   c. In the optimum conditions on the agar plate, the micro-organisms grow and reproduce for three to five days, which is enough time for them to produce colonies that can be seen.
   d. 'Blood agar' would contain similar nutrients to those found in human tissue, which would stimulate the growth of human pathogens.
3. a. Plate 2: Inoculation – micro-organisms transferred to plate
   Plate 3: Incubation – plate is labelled, sealed, turned upside down and kept at 20 °C to 25 °C for 3 to 5 days
   Plate 4: Viewing – plate viewed without opening; bacteria are shiny; fungi are furry
   Plate 5: Incineration – plate burnt in incinerator (or disposed of safely)
   b. Unopened plate that has not been inoculated with micro-organisms. The control plate shows that no micro-organisms were originally on the plates, so all micro-organisms that grow are the result of the inoculation.
   c. When culturing micro-organisms, assume all are harmful; clean hands and lab bench with disinfectant before and after each time micro-organisms are investigated; view the sealed incubated plates through the clear lid – never remove the lid. Dispose of plates safely.
4.

A	B	C	D	E	F	G
Fungi	Bacteria	Bacteria	Fungi	Fungi	Bacteria	Bacteria

5. Disc A shows that any effects are not caused by the disc or by water.
   Disc B shows that antibiotic B does not kill these bacteria
   Disc C shows that antibiotic C is the most effective of these antibiotics against these bacteria.
   Disc D shows that antibiotic D kills some of these bacteria.
6. a. 0 °C and 35 °C
   b. Approximately 24 °C
   c. As temperature increases, so does the rate of fermentation, until an optimum temperature for fermentation is reached. Above that temperature, fermentation quickly slows and stops.

Micro-organisms and human skin (page 28)

1. a. 1 000 different species
   b. Moist, dry, and oily
   c. 400 million
   d. C – the size of a pea
   e.