MICROBES

and their interactions with humans

NAYLAND COLLEGE

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AS 90950

(Science 1.11)

Achieved	Merit	Excellence
Investigate biological ideas relating to interactions between humans and micro-organisms.	Investigate, **in depth**, biological ideas relating to interactions between humans and microorganisms.	Investigate, **comprehensively**, biological ideas relating to interactions between humans and microorganisms.

What you need to know for...

AS 90950 - MICROBES

- 4 credit, internal

TYPES OF MICROBE

	Structure	Feeding	Reproduction	Size
Bacteria	**Capsule** **Cell wall** **Cell membrane** **Genetic Information** Plasmid **Flagellum**	**Extra-cellular digestion** – secretes enzymes and absorbs the digested nutrients.	**Binary Fission** – cell copies its genetic information and splits in half.	Small. Smaller than other cells, e.g. plants and animals. Can be seen with light microscope.
Fungi	**Sporangium** **Spores** **Hyphae**	**Extra-cellular digestion** – secretes enzymes from the hyphae and absorbs the digested nutrients.	Tiny spores released from sporangium act like seeds.	Range from single cellular – **yeast**, to large multicellular – mushrooms, mould, toadstools.
Virus	**Protein Coat** **Genetic information**	*Viruses do not feed*	1. Attaches to a host cell 2. Injects genetic information. 3. Forces host cell to produce more viruses using the host cells own processes. 4. Cell bursts and new viruses are released	Very small. Much smaller than bacteria. Cannot be seen with a normal microscope. More like a large molecule than a cell.

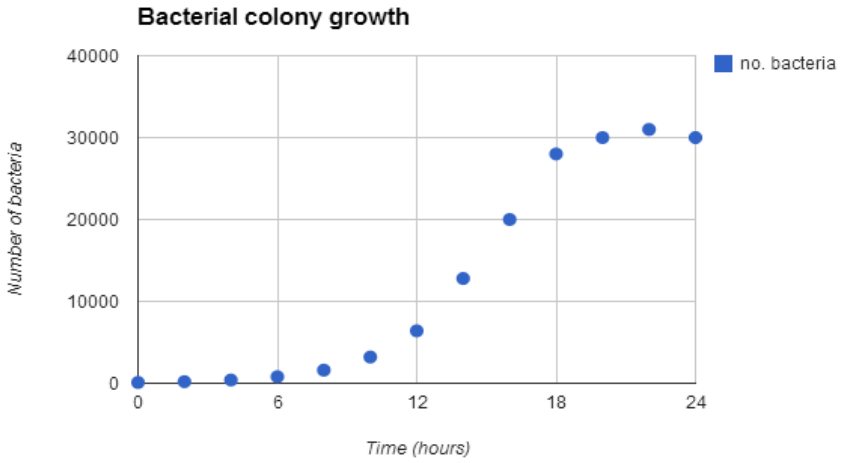
GROWTH AND CULTURE

Bacteria and fungi can be grown on a **nutrient agar plat**e. The plate is **inoculated** (microbes are added) then **incubated** (kept warm).

Viruses need a **living host cell**, so must be grown in a living organism, such as a fertilized chickens egg.

To thrive Fungi and Bacteria need **Food**, **Warmth** and **Moisture**.

In ideal conditions some bacteria can reproduce in 20 minutes. A colony will show the following growth curve:



- It starts *slowly* as there are only a few bacteria reproducing (**lag phase**)
- *speeds up* as there are more and more (**log phase**)
- then *slows* as food and space start to become scarce (**stationary phase**)
- and the numbers may *drop*, as bacteria as well as the reproduction rate dropping. They may also start to be killed by their own **toxins** (**excreted waste**) (**death phase**)

pH and **O_2** availability will also affect growth rates.

MICROBE EXAMPLES

	Helpful	Harmful
Bacteria	Used in **making yoghurt/cheese**. **Decomposers** (**saprophytes**). **Genetic engineering** – making useful chemicals such as **insulin** (for diabetes). Used in **digestion** of animals. Needed in the Carbon and Nitrogen cycles.	Can be **pathogens** (**cause disease**): meningitis, listeria/salmonella (food poisoning) - either **killing cells directly**, or excreting **toxins** that harm cells. Can cause crop damage/ food etc.
Fungi	Used in baking bread. Used in brewing (**fermentation**). Used in making **antibiotics**. Decomposers (**saprophytes**). As **food** - mushrooms, in cheeses.	Can be **pathogens**: ringworm, thrush, athlete's foot. Can cause damage: dry rot, mouldy food, potato blight.
Viruses	Can be used to control pest organisms (e.g. RCD – rabbit calicivirus).	All viruses are **pathogens** as they must destroy host cells to reproduce: common cold, influenza, AIDS.

DISEASE CONTROL

Chemicals can be used to control Fungi and Bacteria.

Antibiotic is a chemical used to kill bacteria internally (in the body). Some bacteria have developed a **resistance** to some antibiotics, and can pass this information on.

Disinfectant Kills bacteria and fungi on surfaces.

Antiseptic Used to kill bacteria and fungi on the skin (weaker).

An **immunisation** (**vaccination**) is the process of putting a dead or weakened pathogen into the body. This means that the body can prepare the antibodies that will kill the pathogen if it is ever present. This is called getting **immunity**. For the same reason people usually can't get a disease twice.

RESPIRATION

Like all living things Bacteria and Fungi undergo **respiration**. This means that they obtain *energy* from food (glucose).
This may be:

- **aerobic** - <u>with</u> **O_2** (not "air"): glucose + O_2 $\longrightarrow$ H_2O + CO_2
- **anaerobic** - <u>no</u> **O_2** (not "air"): glucose $\longrightarrow$ **Ethanol** + CO_2

Anaerobic respiration is used in brewing and in baking (the yeast produces CO_2 and makes bread "rise").

You must be able to **link:**

Microbe way of life (MRS GREN) $\Longleftrightarrow$ **the way it affects humans**

MICROBE INCUBATION RESULTS:

1. Where were there the most microbes found (use other peoples results, too)?

2. Why do you think they were there?

3. Where were there not many microbes present?

4. Why do you think they were not there?

5. What does a bacterial colony look like?

6. Why does it look this way (what features of its structure cause its appearance)?

7. What does a fungal (mould) colony look like?

8. Why, do you think?

BACTERIA QUESTIONS

1. Bacteria can reproduce every 20 mins in ideal conditions. What are "ideal conditions"?

2. If you start with one bacterium, how many will you have after:
   a. 1 hour

   b. 2 hours

   c. 8 hours

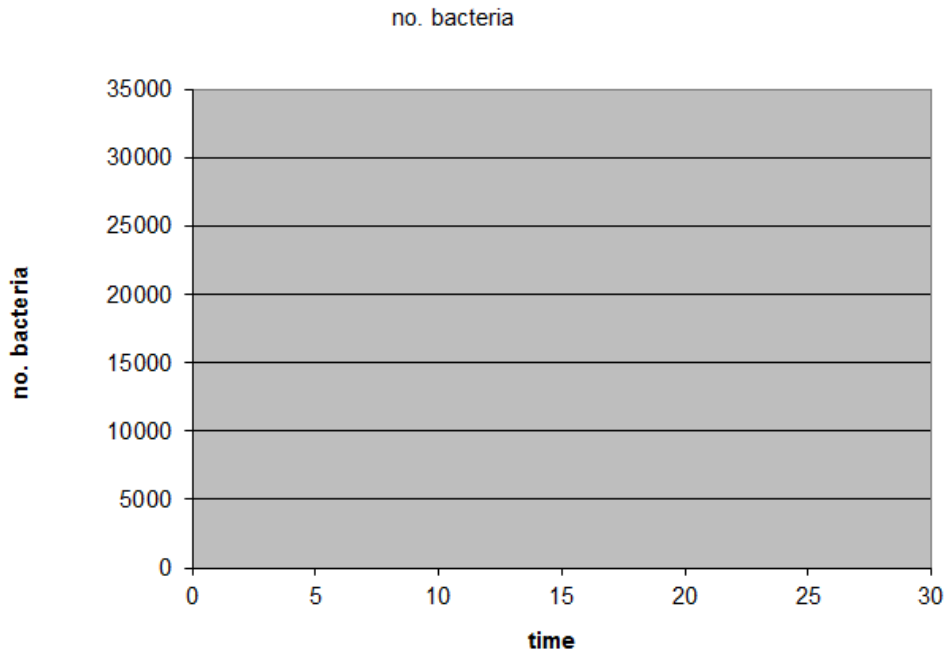
   d. (Experts only) 24 hours

3. Why can bacterial growth not continue for long like that?

4. A more realistic colony growth might look like this:

Time (hrs)	0	2	4	6	8	10	12	14	16	18	20	22	24
no. bacteria	100	200	400	800	1,600	3,200	6,400	12,800	20,000	28,000	30,000	31,000	30,000

   a. Plot this on a graph



b. Explain what is happening at the end of the graph (and why).

c. Sketch the shape of the bacterial growth (on your graph) if it was grown at a **lower temperature**.

d. Why do we incubate bacteria at about 30°C?

5. Use the graph to help explain why people don't get sick until a while (maybe a day or 2) after being exposed to a disease.

6. Draw and label a generalized bacterial cell.

7. Explain how bacteria feed (you could use a diagram instead).

8. Explain how bacteria reproduce (or with a diagram).

FUNGUS QUESTIONS

1. Fungi are needed for the breakdown and recycling of nutrients. Explain how their feeding helps to recycle nutrients.

2. What is the name for a microbe that breaks down dead things and waste.

3. Draw and label a fungus to show the parts that are involved in digestion of its food source.

4. Fungi have some things in common with bacteria. Compare the feeding and reproduction of fungi and bacteria.

5. Why must the sporangium be high above the substrate (food source)?

VIRUS QUESTIONS

1. Are viruses living things? Explain your answer.

2. Draw and label a virus.

3. Explain why viruses "reproduce", but do not feed.

4. Draw and label diagrams to show how viruses replicate.

5. All viruses destroy their hosts as they replicate. Explain how viruses can be helpful.

PREVENTING THE SPREAD OF DISEASE

Explain (using understanding of viruses) how the following actions help to prevent the spread of disease:

1. Covering nose and mouth when sneezing/coughing

2. Washing hands using soap

3. Putting tissues in the bin

4. Physical distancing

5. Social isolation

GINGER BEER

The microbe used in ginger beer making is baker's yeast (common name) or *Saccharomyces cerevisiae* :
"*Saccharomyces*" derives from latin and means "sugar mould" or "sugar fungus", *saccharo-* being the combining form "sugar-" and *myces* being "fungus".

1. Draw and label a fungus (multicellular).

2. Describe what type of cell processes are happening in the ginger beer to make the bubbles.

3. Write the equation for the process directly producing bubbes.

4. Draw and label a diagram that shows extra cellular digestion.

5. What do we do to assist the yeast in doing its function?

6. What would happen if all the oxygen in the bottle got used up?

7. Write the equation for *anaerobic* respiration.

OYSTER MUSHROOMS

1. Explain how each of the processes in the preparation and growing of the oyster mushrooms aid in their successful production:

    a. Choice of substrate

    b. Boiling/heating the substrate

    c. Letting it cool but not drying it

    d. Adding the spawn

    e. Holes in the container

    f. Leaving it in the dark

    g. Exposing it to light after 10 days

2. Explain how the growing oyster mushrooms “affect personal actions or society”.

YOGHURT

1. Name the bacteria involved in the making of yoghurt.

2. Explain how human control the bacteria involved by linking each of the following to LIFE PROCESSES or BIOLOGICAL IDEAS, e.g. competition:
    a. Adding milk powder

    b. The milk powder is dry and vacuum sealed

    c. The milk powder if refrigerated once opened

    d. Adding warm, but not hot, water

    e. Adding yoghurt powder

    f. Covering the cup with foil

    g. Leaving the mix in the incubator overnight

3. Explain how growing yoghurt "affects personal actions or society".

IMMUNE SYSTEM FAST FOCUSED RESEARCH

Use the computers to find information to answer the following questions.
Keep it fairly simple. If you can't understand it, you won't remember it.
This is quite good: https://www.youtube.com/watch?v=GIJK3dwCWCw
Or this one: http://sciencelearn.org.nz/Contexts/Fighting-Infection/Science-Ideas-and-Concepts/The-body-s-first-line-of-defence

There are **3 layers of defence**:

1st: Keeping microbes out

Microbes are all around us.

List some ways that the body keeps microbes from getting in.

2nd: Non-Specific Immune Response (innate immunity)

Microbes have made it into the body.

What are the cells that **engulf and destroy** invaders in the blood stream?

When you are sick you may notice you have **swollen glands** (lymph nodes). What causes this?

A doctor might say you have a **high white cell count**. What does this mean?

3rd: Specific Immune Response (acquired immunity)

Special cells in your body called Lymphocytes recognise _____on the surface of pathogens and make _____.

How does this help destroy the pathogen?

VACCINATION INFORMATION FAST FOCUSED RESEARCH

1. How does a vaccine work?

2. A free vaccination program runs for all children in New Zealand. Some people (now about 6% nationwide) chose not to vaccinate their children. Use the websites given (or any others) to get informed.

Immunisation Advisory Centre: www.immune.org.nz

Anti-vaccination site: www.alternative-doctor.com/vaccination/16reasons.htm

2019 Samoan measles outbreak

2016 - Measles outbreak closes school

Radio NZ site: Measles outbreaks due to 80s and 90s kids

Penn Teller Vaccine - Clean Version

If you don't vaccinate your kids you're a "bloody idiot" - parent

Use some of the information above to fill in the table.

Good reasons to vaccinate	Good reasons to NOT vaccinate	Misunderstandings about vaccination

What do *you* think? Would you vaccinate *your* kiddies?

COMPOSTING

The process: A simple compost how to guide	Compost Microbes CORNELL Composting - Compost Microorganisms (and phases)

The best clip you will ever see on composting for Level 1 Microbes 90950. Wink.

1. Both bacteria and fungi are involved in composting. Complete the table. Diagrams may help.

	Bacteria	Fungi
Feeding		
Structure		
Reproduction		

2. Describe the process of composting.

3. Explain how we can help the processes to take place. LINK TO LIFE PROCESSES OF THE MICROBES.

4. Explain how composting has an impact on personal actions and/or everyday life.

ANSWERS

MICROBE INCUBATION RESULTS

1. Pretty much everywhere
2. Because they are everywhere. *Everywhere.*
3. Recently washed places, maybe too hot, too dry, too salty, or somewhere with chemicals that kill microbes (like some places in your body)
4. As above
5. A greasy/oily spot
6. Slimy capsule
7. Wispy/fluffy/dusty
8. Sporangia/spores

BACTERIA QUESTIONS

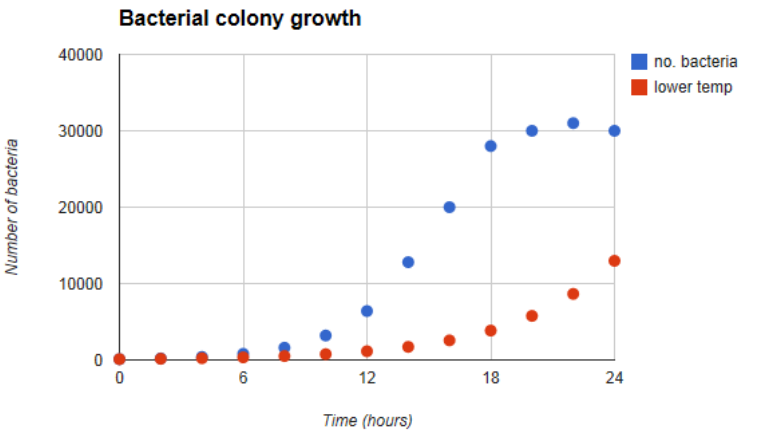
1. Warm (not hot), moist, plenty of food and space (and oxygen if needed)
2. See table
3. Run out of the stuff in no. 1… there is too much competition
4.
a.

time (hrs)	no. bacteria
0	100
2	200
4	400
6	800
8	1600
10	3200
12	6400
14	12800
16	20000
18	28000
20	30000
22	31000
24	30000

b. The bacteria are dying as they run out of food and space, etc.
c. See red line
d. Warm enough so bacteria reproduce well, but below human body temp - so we don't incubate diseases.

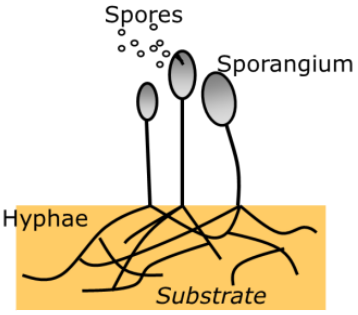
Bacterial Growth

cycle	time	bacteria no.	mass (g)	mass (kg)
0	0.0	1	0.0	0.0
1	0.3	2	0.0	0.0
2	0.7	4	0.0	0.0
3	1.0	8	0.0	0.0
4	1.3	16	0.0	0.0
5	1.7	32	0.0	0.0
6	2.0	64	0.0	0.0
7	2.3	128	0.0	0.0
8	2.7	256	0.0	0.0
9	3.0	512	0.0	0.0
10	3.3	1024	0.0	0.0
11	3.7	2048	0.0	0.0
12	4.0	4096	0.0	0.0
13	4.3	8192	0.0	0.0
23	7.7	8388608	0.1	0.0
24	8.0	16777216	0.1	0.0
25	8.3	33554432	0.2	0.0
42	14.0	4398046511104	27487.8	27.5
43	**14.3**	**8796093022208**	**54975.6**	**55.0**
44	14.7	17592186044416	109951.2	110.0
45	15.0	35184372088832	219902.3	219.9
71	23.7	2361183241434822600000	14757395258967.6	14757395259.0
72	24.0	4722366482869645000000	29514790517935.3	29514790517.9
73	24.3	9444732965739290000000	59029581035870.6	59029581035.9



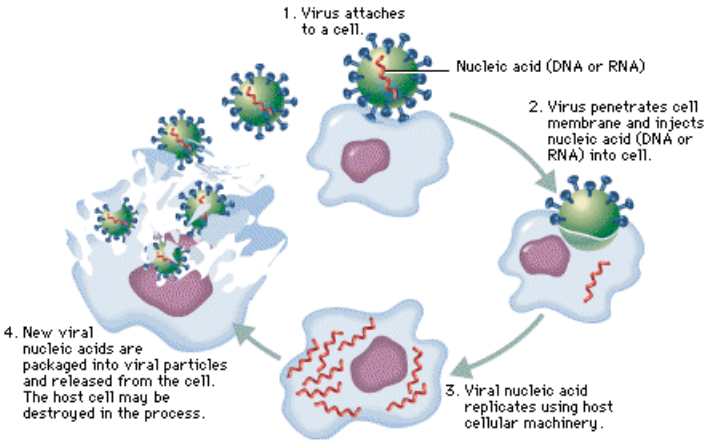
FUNGUS QUESTIONS

1. ECD – secrete, **dig**, abs… their food is broken down… recycled
2. Saprophyte
3.
4. Feeding is the same: Extracellular digestion
   Reproduction either: Fungi – spores
   Or Bacteria – binary fission
5. Spread the spores around as far as possible. If it was underground this wouldn't happen.



VIRUS QUESTIONS

1. No. They don't do all (hardly any) of MRS GREN
2. See diagram
3. Viruses replicate, not reproduce. They are constructed into the size they are; they do not grow, have no need for food, so do not feed.
4. See diagram
5. If they are killing something that we do not want; a pest or parasite, for instants rabbits and RCD. Also, upcoming new technologies may use viruses to deliver DNA to cells to repair genetic diceases ("gene therapy") or as a way of creating Genetically Modified Organisms.

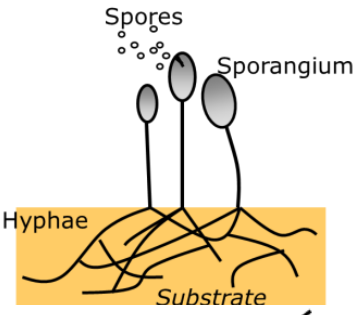


PREVENTING THE SPREAD OF DISEASE QUESTIONS

1. Viruses can be carried in the cough and sneeze for several metres. This can spread the virus to other people or surfaces.
2. Soap breaks down the (lipid bilayer) coating on the virus (or bacteria). This destroys it.
3. Carrying tissues in your hand or pocket means the hand or pocket is like a stockpile of the virus. Leaving them lying around allows the virus to transfer to other people or surfaces.
4. Staying away from others means that the virus can't be spread through the population. People can pass on the virus without knowing that they have it. Physical distancing stops the spread.
5. People suspected of having a disease, or who are very susceptable to it, keep away from others. This pretty much eliminates the risk of transfer by mutual contact with surfaces or with other people. Quarantine is used until tansmission is no longer possible.

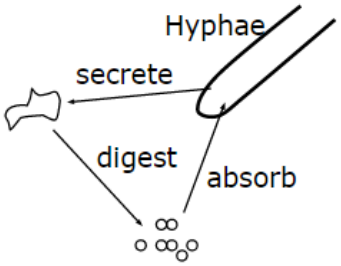
GINGER BEER QUESTIONS

1. Diagram.
2. Respiration
3. Food (sugar) + $O_2 \rightarrow CO_2 + H_2O$
4. Diagram
5. We give it plenty of **food** so that it can grow, reproduce and respire as much as possible, keep it **warm** so that reproduction and feeding is faster, we **sterilise** the bottle to reduce competition, etc...
6. Respiration would be anaeriobic (or would stop)
7. Food (sugar) $\rightarrow CO_2$ + Ethanol (alcohol)



OYSTER MUSHROOMS

1. a. Mushrooms will feed on some things better than others
   b. To kill off any **competing** microbes
   c. To avoid killing off the oyster mushrooms, but allowing them the **moisture** they need to grow
   d. **Inoculating** the substrate to start the colony growing
   e. Let **oxygen** in
   f. Mushrooms often grow better in dark places, and reduces them drying out
   g. Encourages them to produce fruiting bodies (sporangia)
2. Humans can use the mushrooms to break down otherwise unhelpful materials, like sawdust. In doing so we can make food for ourselves (something from nothing). There is a high nutritional value in mushrooms, containing many important minerals and compounds.



IMMUNE SYSTEM

1st: Skin (barrier); urine, tears, mucous, stomach acid, etc kill microbes that make it into any body cavities.

2nd: Phagocytes (a type of WBC)
Glands swell to try and remove the microbe; they are a filter.
WBCs are produced to try and fight infection. A high WBC count is a sign of infection.

3rd: Specific Immune response
Recognise antigens and produce antibodies
Antibodies attach to the anitigens and tag them for destruction or neutralise the invader

Science 1.11(v3) (AS 90950): Investigate biological ideas relating to interactions between humans and micro-organisms

Credits: 4

Achievement	Achievement with Merit	Achievement with Excellence
Investigate biological ideas relating to interactions between humans and micro-organisms.	Investigate, in depth, biological ideas relating to interactions between humans and micro-organisms.	Investigate, comprehensively, biological ideas relating to interactions between humans and micro-organisms.

Student information

On the following pages are the questions that will be in the test. You are to use the next 3 lessons to prepare for the test by answering the questions.

You may use knowledge learned in **class**, **experiments** you have carried out, **research** information from the internet/books/etc.

You may work individually, or in small groups as directed by your teacher.

You may not take any of the information with you into the test, so you need to know it well.

RESOURCE LIST:

How humans may use/be affected by microbes:

- disposal of organic wastes
- composting
- food production
- food poisoning
- microbial action on everyday materials (helpful and harmful micro-organisms)
- disease in humans and animals they are in contact with
- antibiotics
- resistance to antibiotics
- origins and control of pandemics
- use of viruses to control pests
- others?
- NOT SEWAGE TREATMENT – given in worked example

Worked example:

Sewage treatment

Many types of bacteria are present in sewage treatment. These include **faecal coliforms** – bacteria associated with human excrement. This includes ***Escherichia coli***, present in the human gut. **Saprophytic bacteria** such as these are what break the sewage down.

Names the bacteria. Any of these 4 attempts would be sufficient (for achieved) as these is no single species. "Many types" would probably be insufficient for merit.

Some of the bacteria have **flagella**, allowing them to move around to gather food. However, most are simply a **cell wall** surrounding a membrane, with **genetic material** within.

Structure given. Could have been from diagram.

The bacteria **reproduce quickly** in ideal conditions by **binary fission**, where the bacteria split in 2. This causes exponential growth of a population.

Reproduction by binary fission, fast

One of the goals in sewage treatment is to continue to **supply the bacteria** with the ideal conditions necessary to allow them to grow, reproduce and feed as fast as possible[1]. It is also important to provide them with plenty of **oxygen**. Oxygen allows the bacteria to respire aerobically, rather than anaerobically[2]. Anaerobic respiration can cause unwanted or harmful product formation[3].

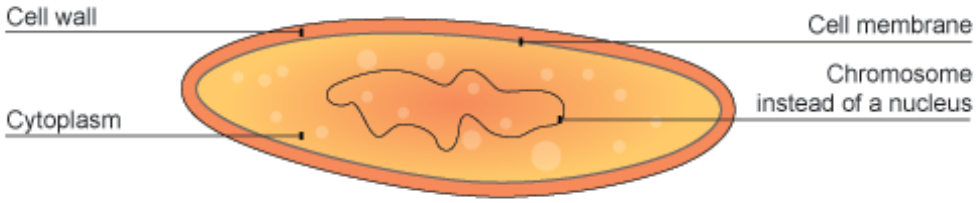
How bacterial **potential is maximised** – control of environment.

The **pH, temperature** and other conditions like **salt** concentration are carefully controlled to maximise helpful bacterial health.

Given the appropriate conditions the bacteria feed on waste matter, such as faeces, by secreting digestive enzymes through their membrane[4]. These enzymes break down the waste matter into nutrients[5], which can be absorbed by the bacteria. In doing so the sewage, **potentially harmful to humans, is turned into harmless chemicals**. This also means that the **nutrients contained can be released**. The more bacteria present, the faster this breakdown and recycling is achieved[6].

Feeding by extracellular digestion (described)

How **humans are affected** – nutrients recycled, waste removed (link to personal actions/society)



LINKS: (underlined in the passage above)

1. Environment control and reproduction rate
2. Environment control and respiration type
3. Respiration type and products produced
4. Structure (membrane) and feeding (ECD)
5. Feeding and waste breakdown
6. Population size and reaction rate

Marking schedule:

Achieved	Merit	Excellence
Investigate involves using **observations or findings** to describe how humans **use or are affected** by micro-organisms.	*Investigate in depth* involves using **findings and biological ideas** to **explain how or why humans use or are affected** by micro-organisms.	*Investigate comprehensively* involves using **findings and biological** ideas to make **significant links** about the interactions between humans and micro-organisms, including the impacts of this knowledge on **human's personal actions** or everyday life. It may involve explaining, elaborating, applying, justifying, relating, evaluating, comparing and contrasting, and analysing.
	Biological ideas relating to how humans use and are affected by micro-organisms may include the following: o structure and life processes of micro-organisms o culturing of micro-organisms o factors that affect the life processes of micro-organisms	
• Names bacteria Description of: • Feeding • Reproduction • Structure AND • How this relates to a human context *e.g.* • *Many types of bacteria are used in sewage treatment.* • *Structure, see below* • *The bacteria reproduce by binary fission, which is fast.* • *The bacteria feed by extra cellular digestion.* • *As they feed they break down dead things and waste. We use these in sewage treatment to get rid of our excrement and stuff.*	• Names bacteria Description of: • Feeding • Reproduction • Structure AND • How their use in the human context is controlled/ manipulated to give best results <u>Biological ideas (links) are underlined in the example</u> *e.g.* *As per achieved, plus* • *Bacteria reproduce best in ideal conditions. Conditions in treatment plants are controlled to maximise bacterial reproduction. This includes agitating the sewage to let in oxygen so respiration is aerobic.*	• Names bacteria Description of: • Feeding • Reproduction • Structure AND • How their use in the human context is controlled/ manipulated to give best results INCLUDING • <u>Significant links throughout the response</u> including links to personal actions or society.

Choose an idea from the *RESOURCE LIST*.

Using this idea, describe how a **NAMED BACTERIA** affects humans.

In your answer you should LINK information on:

- the bacteria feeding, structure, reproducing
- how humans are affected or control the bacteria in terms of **life processes**
- how understanding the bacteria affects personal actions or society

Choose a DIFFERENT idea from the *RESOURCE LIST*.

Using this idea, describe how a **NAMED FUNGUS** affects humans.

In your answer you should LINK information on:

- the fungus feeding, structure, reproducing
- how humans are affected or control the fungus in terms of **life processes**
- how understanding the fungus affects personal actions or society

Choose a DIFFERENT idea from the *RESOURCE LIST*.

Using this idea, describe how a **NAMED VIRUS** affects humans.

In your answer you should LINK information on:

- the virus feeding, structure, reproducing
- how humans are affected or control the virus in terms of **life processes**
- how understanding the virus affects personal actions or society