

# Bacteria

## Question Paper

<b>Level</b>	International A Level
<b>Subject</b>	Biology
<b>Exam Board</b>	Edexcel
<b>Topic</b>	Cells, Development, Biodiversity and Conservation
<b>Sub-Topic</b>	Bacteria
<b>Booklet</b>	Question paper

**Time Allowed:** 72 minutes

**Score:** /60

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

**1 Read the following extract from a student's unfinished draft report on the topic of the correct use of contact lenses.**

1. Contact lenses correct poor vision. They are a lightweight, almost undetectable alternative to glasses. It is estimated that 125 million people use contact lenses worldwide.
2. However, users face the risk of infections from bacteria and fungi that stick to the lens surface causing severe damage, even blindness. The most commonly used lenses are daily-use disposable lenses that are fresh and sterile each day. Another type are longer-use lenses that require the daily use of disinfectant solutions. Both produce waste, people often exceed the recommended wear time of daily-use lenses and the disinfection method can become tedious.
3. A study in 1997 showed that, of the 141 new lens wearers who had participated, by the end of the study, 70% of the lenses were contaminated by bacteria, fungi, yeasts or amoebae.
4. This report proposes a method that would reduce dependency on disinfectants and develop safer lenses that prevent the accumulation of pathogens.
5. The eye uses several defence mechanisms to protect against harmful infections by microbes. Blinking dislodges bacteria, constantly flushing fresh tear fluid across the eye surface. Unfortunately, soft contact lenses reduce the effect of this process, trapping a stagnant pool of tear fluid underneath the lens. This stops the wiping action of the eyelids and provides an ideal environment for harmful organisms such as *Acanthamoeba*, which may lead to microbial keratitis. This painful condition occurs when the cornea becomes inflamed.
6. Soft contact lenses become coated in deposits, called biofilm. Without this biofilm the bacteria would not be able to attach, build up and cause problems.
7. Protein immobilisation is the attachment of bioactive proteins to surfaces and can be used to make anti-fouling lenses. However, a single protein, suitable for immobilisation on lens surfaces, has not yet been identified. It is likely that there would have to be a variety of such proteins across the lens to deal with the huge variations in proteins sticking to the surface.
8. It is possible that, whilst the use of the proposed techniques are plausible for surface treatment of contact lenses in the future, there may be more appropriate solutions on offer (see below).
9. The wearing of contact lenses would become less tedious and time-consuming. The need for clumsy, fiddly packaging would be reduced. The lenses could consequently be kept in longer; the expense may be reduced, having repercussions on quality of life. Those who have been forced to wear the more heavyweight and conspicuous glasses to avoid infection may be relieved. New jobs may even be created. The reduced use of cleaning fluids and daily lenses may reduce waste.
10. However, the proteins may lead to the possibility of worse optical quality. People become overly relaxed in the care of their lenses. Side effects remain unknown at this stage.

11. There may be a reduced burden on healthcare services from infections due to contact lenses. Consumers could spend less money on cleaning fluids. If the life of each lens is extended, new ones can be bought less often. However, there may be higher initial costs from the more complex production process.
12. The introduction of immobilised proteins on the lens results in poorer quality, defeating the point of the lenses in the first place. There is a possibility that not all the surface is treated and therefore any areas without antimicrobial resistance may increase the risk of infection.
13. In the very delicate environment of the eye it is likely that a foreign body or change in pH could cause severe damage and inflammation. As with the drug trialling process, treated lenses need to go through processes to ensure they are safe to use.
14. Polyethylene glycol (PEG) is a repellent substance known to reduce the attractive forces between surfaces and proteins. It is non-toxic and optically transparent. Fimbrinides are substances that inhibit the signalling mechanisms between bacteria in a colony. In a study, Fimbrinide coated lenses reduced the adhesion of bacteria by between 67 and 92% and for *Acanthamoeba*, 70%.

- (a) A visit or issue report requires a problem to be identified.

Identify the problem described in this extract.

(1)

.....

.....

.....

- (b) This unfinished report needs some data, presented in the form of tables or graphs.

The student found the following paragraph in a research paper:

*The causative agent for keratitis was identified in 265 patients. Bacteria accounted for 166 cases, Acanthamoeba for 95 cases and fungi for 4 cases.*

- (i) Calculate the percentage of cases of keratitis caused by each group of pathogens.

Present this information in the form of a suitable table.

(3)

(ii) The paragraph was found in a paper called “Contact lens-associated microbial keratitis” by Aline Silvera Moriyama and Anna Louise Hofling-Lima.

It was published in 2008, in a journal called *Arquivos Brasileiros de Oftalmologia*. The volume number was 71, and the pages were 32 to 36.

Write a reference to this paper, in a suitable format, for the bibliography.

(3)

.....

.....

.....

.....

.....

(c) Advice is given to wearers of contact lenses on the correct way to use them. The student found the table below about the risk of developing keratitis, if the advice is ignored.

<b>The advice given to lens wearers</b>	<b>Risk of developing keratitis if the advice is ignored</b>
always use correct cleaning fluid	2.1
wash hands before touching lenses	4.5
do not wear lenses whilst sleeping	4.0
replace lenses correctly	4.7
rinse lenses before use	3.6
clean lenses case regularly	4.0

Using the information in the table, state **two** ways in which wearers of contact lenses can minimise their risk of developing keratitis.

(2)

1 .....

.....

2 .....

.....

(d) These reports are expected to identify economic implications of the issue being researched.

State **three** economic implications described in this report.

(3)

1 .....

.....

.....

2 .....

.....

.....

3 .....

.....

.....



(f) Explain **one** benefit to the environment identified in this report.

(2)

.....

.....

.....

.....

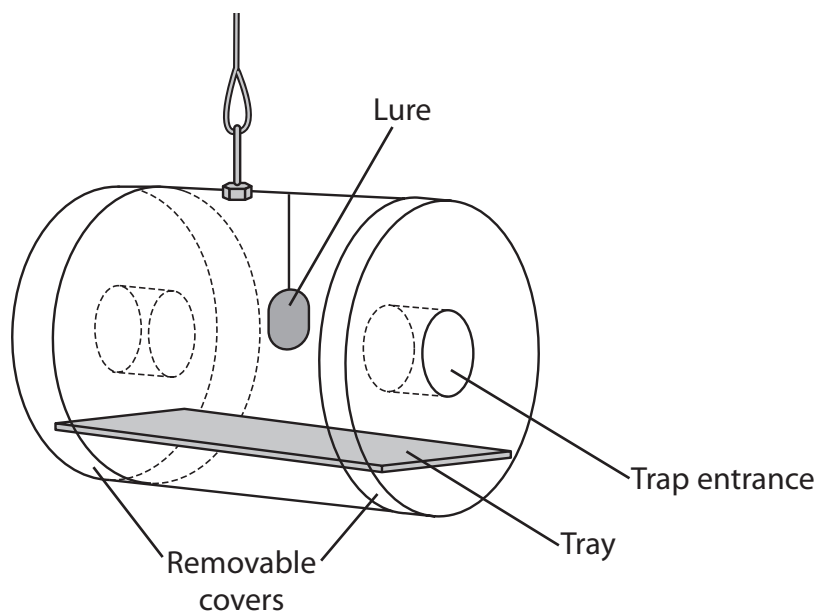
---

**(Total for Question 1 = 20 marks)**



**2 Read the following extract from a student’s unfinished visit or issue report on the topic of the control of the oriental fruit fly (*Bactrocera dorsalis*).**

1. Fruit flies are one of the most destructive insect pests among almost a million different kinds of known living insect. Their economic importance is widely recognised among scientists and farmers. The species discussed in this report, *Bactrocera dorsalis*, is the dominant pest species of the Tephritid family that causes many crop losses for farmers and South East Asian nations.
2. The insect is able to bring about 100% damage to the harvest if not monitored. *B. dorsalis* damages fruit by laying eggs beneath the skin of fruits. Only ripe and nearly ripe fruits are attacked. They lay eggs in the soft spots or cracks in fruit, leaving unsightly holes. This spoils the fruits’ appearance and reduces its value, especially in the case of passion fruit (*Passiflora edulis*).
3. The eggs hatch in one to three days after being laid. The larvae feed for nine to thirty-five days and then pupate in the soil under the host plant. Adult flies emerge after one or two weeks, depending on the climate. The life cycle continues around the year, which means they pose a year-round threat to host plants. Biologists have been working on solutions for many years.
4. The Steiner trap was introduced by Loren Franklin Steiner (1904–1977). The trap is made from a transparent plastic cylinder with removable covers. On both ends, there is a small opening that allows the flies to enter. A tray is placed at the lower part of the trap, to collect specimens for monitoring purposes. A wire hanger, placed on top of the trap body, is used to hang the trap from the plant. The trap should be placed at a height of about 2m from ground level.



A Steiner Trap

5. The Steiner trap attracts flies using male-specific parapheromone lures, namely:
- TML (trimedlure, t-butyl-4-(or 5)-chloro-2-methyl cyclohexane carboxylate)
  - ME (methyl eugenol)
  - CUE-lure (4-(p-acetoxyphenyl)-2-butanone).

The lure is a piece of cotton soaked in 2cm<sup>3</sup> to 3cm<sup>3</sup> of a mixture of the parapheromone and an insecticide, usually Malathion.

6. The design of the Steiner trap has been revised several times when used in different regions of the world, according to its suitability. The original model of trap is very labour intensive. The removal of dead flies is time-consuming and not economic. The trap is made from plastic, which is expensive.
7. Field workers and orchard owners around the world have improved the original Steiner trap, depending on local needs and conditions.
8. The Revolutionary Modified Steiner trap is a popular model widely applied in the orchards of Malaysia. The trap uses methyl eugenol in the lure, but insecticide is excluded. The name "Revolutionary" was given to it as no insecticide is used, thus helping the environment. Openings of the trap, situated around the middle section of 1.5 dm<sup>3</sup> plastic bottles, allow only a one-way passage for the flies. A layer of oil or water (mixed with a small amount of soap or detergent, to reduce surface tension) is poured into the trap to drown the flies.
9. Although there are no data to prove the effectiveness of this modified trap, farmers and orchard owners in the region claim that it is the most effective way to eradicate and control populations of *B. dorsalis*, because of its low cost and it is easy to set up.
10. There are other ways to control fruit flies. For example, millions of sterile male flies are produced by gene technology. These male flies are then released into the wild, to allow mating between wild females and sterile males. The male flies either carry modified genes that stop the fertilisation of eggs, or genes that are inactive. This solution to the problem is very effective, because it uses the wide dispersal range of these flies. When the sterile flies mate with wild females, flies are wiped out over a wide area. This method of eliminating *B. dorsalis* from newly infested regions has been proven to be effective in the Ogasawara Islands, Japan.
11. This species of fruit fly is found to be the pollinator of *Bulbophyllum* orchids, the largest genus in the family Orchidaceae. This genus is the main source of most of the economically important ornamental orchids and consists of a number of threatened species. It is clear that, if the delicately balanced relationship between these two organisms is disturbed or destroyed, many of the *Bulbophyllum* species will face extinction due to the absence of pollinating insects.

- (a) The student's teacher suggested that the report needed data and graphs to illustrate some of the points. The student did a web search and found the following table in a paper by G. H. S. Hooper and R. A. I. Drew in which they compared the Steiner trap with the Bateman trap using methyl eugenol as the lure.

Species	Number of fruit flies caught in traps over a 40-week period	
	Bateman	Steiner
<i>Bactrocera cacuminatus</i>	223	220
<i>Bactrocera endriandea</i>	242	502
<i>Bactrocera mayi</i>	87	126
<b>Totals</b>	<b>552</b>	<b>848</b>

- (i) Make a sketch to show how you would make these data into a visual form to put into this report.

(4)

- (ii) State which paragraph is the most appropriate place for this sketch.

(1)

Paragraph .....



(c) The report is expected to address environmental, economic and social implications.

(i) Explain **one** environmental and **one** economic implication considered in this report.

(4)

Environmental implication .....

.....

.....

.....

.....

.....

Economic implication .....

.....

.....

.....

.....

.....

(ii) Explain **one** social implication of the successful control of fruit flies for people in South East Asia.

(2)

.....

.....

.....

.....

.....

(d) Question 2(a) refers to a paper by G. H. S. Hooper and R. A. I. Drew.

State what further information you would need to be able to write a full reference for this paper.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

---

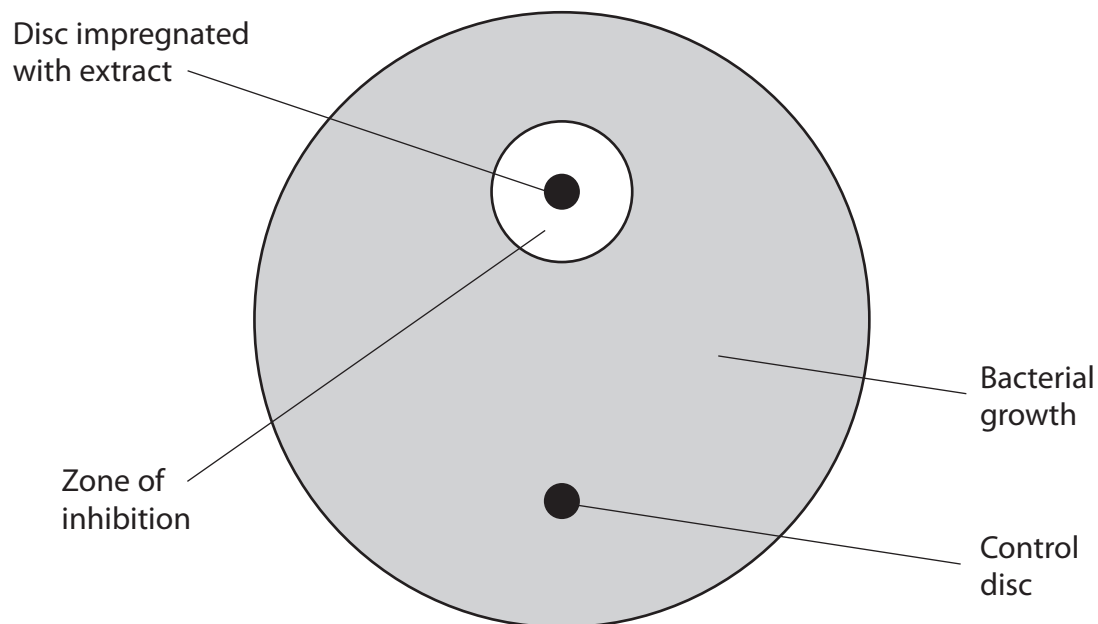
**(Total for Question 2 = 20 marks)**

- 3 Chinese Senna (*Senna obtusifolia*) is a common plant found in many parts of the world. It is traditionally used to treat a number of bacterial infections.

Some scientists decided to investigate the antimicrobial properties of extracts from *S. obtusifolia* leaves.

The following method was used.

- Dried leaves were crushed in sterile water, to produce an extract.
- The extract was pipetted onto discs of filter paper.
- Other discs of filter paper were soaked in sterile water to use as controls.
- All of the discs were then dried.
- Plates were prepared using agar containing the bacterium *Salmonella typhi*.
- A disc containing the extract *and* a control disc were placed on each of three agar plates.
- The agar plates were incubated for 48 hours.
- The diameter of the zone of inhibition was then measured for each disc as shown in the diagram.



This method was repeated using three organic solvents, A, B and C, to obtain extracts from the leaves, instead of using sterile water.



(a) (i) Name the independent variable in this investigation.

(1)

.....

(ii) Name the dependent variable in this investigation.

Suggest how this variable was measured.

(2)

.....

.....

.....

.....

(iii) Name **one** variable that should have been controlled in this investigation.

Describe how this variable could be controlled.

(2)

.....

.....

.....

.....

.....

.....

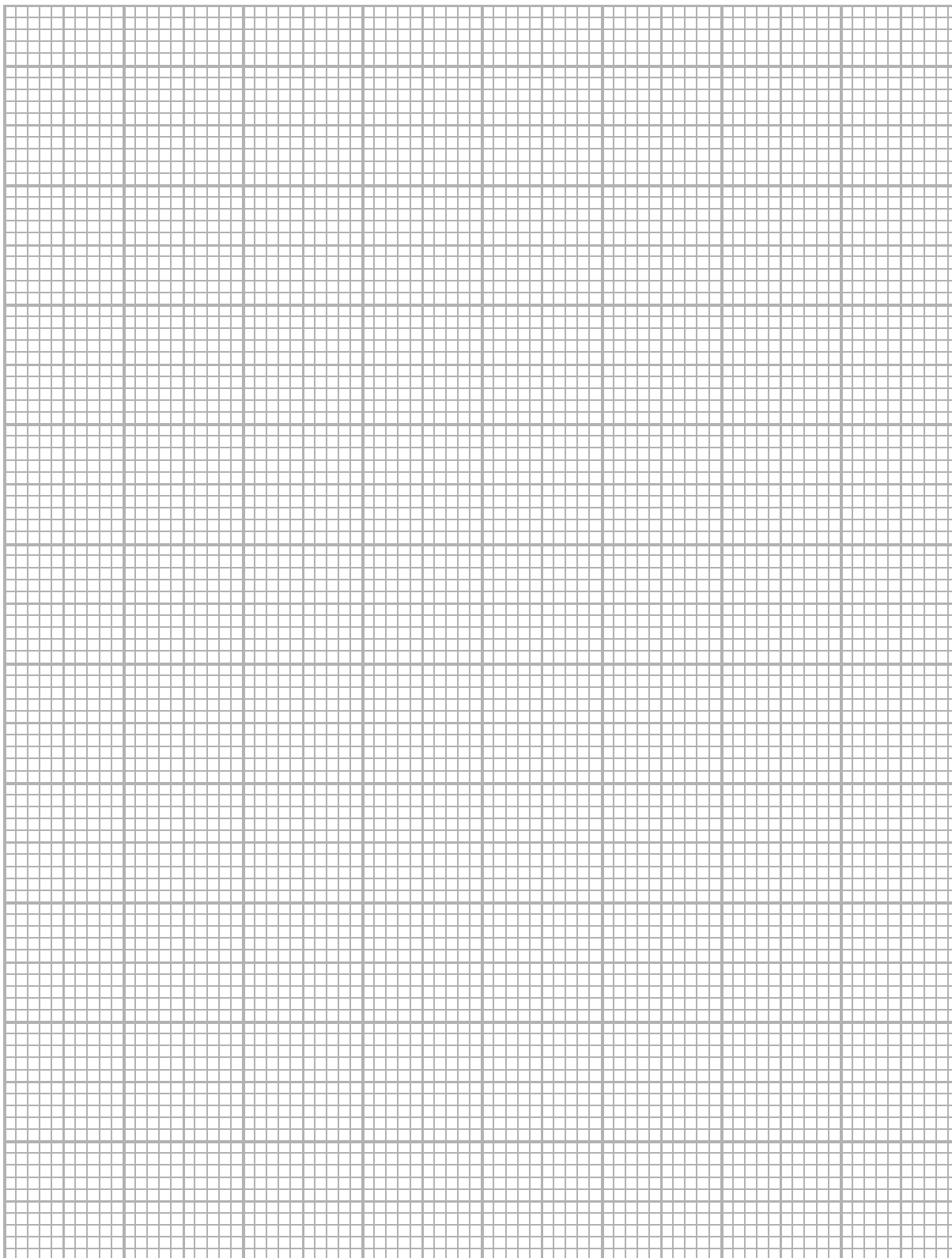
.....

(b) The table below shows the results of the investigation.

<b>Solvent used to prepare extract</b>	<b>Mean diameter of zone of inhibition / mm</b>	<b>Standard deviation</b>
Water	2.1	0.10
Solvent A	11.9	0.51
Solvent B	2.1	0.09
Solvent C	5.8	0.29
None of the control discs had zones of inhibition.		

- (i) Plot the information about the solvent used to prepare the extract and the mean diameter of the zone of inhibition in a suitable graphical form.

(4)



(ii) Comment on the reliability of these data.

(2)

.....

.....

.....

.....

.....

.....

(iii) Explain which solvent produces the most effective antimicrobial extract.

(3)

.....

.....

.....

.....

.....

.....

- (c) The scientists then studied the effect of **extracts** of *S. obtusifolia* on three more species of bacteria. The table below shows some of their results.

Species of bacterium	Mean diameter of zone of inhibition / mm			
	Water	Solvent A	Solvent B	Solvent C
<i>Streptococcus aeruginosa</i>	2.1	8.1	5.8	5.8
<i>Escherichia coli</i>	5.0	10.0	4.1	6.9
<i>Staphylococcus aureus</i>	5.8	6.2	4.9	4.1

Suggest how these data support the validity of the investigation using *Salmonella typhi*.

(2)

.....

.....

.....

.....

.....

.....

.....

- (d) Traditional cures may again be useful as bacteria become resistant to antibiotics. Some antibiotics are expensive and difficult to obtain.

The scientists used the antibiotic Ofloxacin and found that it produces a mean zone of inhibition of 12.0 mm for *Escherichia coli*.

Suggest the advantages and disadvantages of using Senna extract instead of Ofloxacin to treat infections caused by *Escherichia coli*.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

---

**(Total for Question 3= 20 marks)**