Unit 5 · Applied Biology

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 46

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 More than the share

ANSWER A · 4

i. $1 - 1 \div 15 = 0.933$, about **93%**.
ii. $0.933 \div 0.97 = 0.962$, about **96%**.
iii. $0.962 \times 1{,}200 \approx$ **1,155 students**.
iv. 90% vaccinated gives only about $0.90 \times 0.97 = 87\%$ immune, well below 93%, so each case can pass measles to more than one other person on average, and an outbreak can spread.

MARKING SCHEME

✓ About 93%.
✓ About 96%.
✓ About 1,155 students.
✓ Only 87% immune, below 93%, so measles can spread.

2 Check the claim

ANSWER HA · 5

(The readings are made up, to show the pattern the unit describes.)

i. First meeting: between days 5 and 10. Second: already rising by day 42, from day 40.
ii. $600 \div 20 =$ **30 times**.
iii. On day 40 only 4 units are left, a fifth of the first peak, far too few; yet in two days there are 50, and by day 50 there are 600. New antibodies are being made, fast.
iv. **Memory cells**, left from the first meeting, which quickly start the secondary response.
v. The first: for several days there were no antibodies at all while the germ multiplied.

MARKING SCHEME

✓ Days 5–10; within two days of day 40.
✓ 30 times.
✓ Only 4 units on day 40, then a fast rise of new antibodies.
✓ Memory cells.
✓ The first meeting: no antibodies for days, so the germ multiplied.

3 Two kinds, one story

ANSWER U · 4

i. Artificial active.
ii. Natural passive: her antibodies cross the placenta.
iii. Artificial passive.
iv. **No.** Ready-made antibodies make no memory cells, and they are broken down in weeks to months.

MARKING SCHEME

✓ Artificial active.
✓ Natural passive, across the placenta.
✓ Artificial passive.
✓ No: no memory cells, and the antibodies fade.

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4 Spot the error

ANSWER U · 3

He forgot to take the fraction away from 1. The share is $1 - 1 \div 5 = 1 - 0.2 =$ **0.8**, or 80%, and 0.8×500 = **400 students**. His answer can't be right, since a disease that spreads more easily needs more people immune, not fewer.

MARKING SCHEME

- ✓ The share is $1 - 1 \div R_0$, not $1 \div R_0$.
- ✓ 0.8, or 80%.
- ✓ 400 students.

5 Which step fails?

ANSWER HA · 3

i. **Chemotaxis** fails: it doesn't move toward the bacterium, so the bacterium goes on multiplying unless it happens to touch the cell.
ii. **Digestion** fails: the bacterium is taken in, but stays undigested in its phagosome.
iii. **Ingestion** fails: the phagocyte can stick to the bacterium but can't enclose it.

MARKING SCHEME

- ✓ Chemotaxis: it doesn't reach the bacterium.
- ✓ Digestion: the bacterium stays undigested in the phagosome.
- ✓ Ingestion: it can't be enclosed.

6 What went wrong?

ANSWER U · 4

i. **Cilia**: mucus pools in his airways, so he coughs, and has bronchitis and pneumonia more often.
ii. **Skin**: bacteria can easily get into the tissues below.
iii. **Helper T cells** (destroyed by HIV): the response is no longer directed, so infections that a healthy body would beat can kill.
iv. **Friendly bacteria**: with many killed, harmful ones or fungi such as *Candida* can take over, giving diarrhea or thrush.

MARKING SCHEME

- ✓ Cilia, with coughs and chest infections.
- ✓ Skin, with bacteria getting in.
- ✓ Helper T cells, with infections a healthy body would beat.
- ✓ Friendly bacteria, with diarrhea or thrush.

7 Correct the misconceptions

ANSWER U · 4

1. An antigen is a foreign molecule; an antibody is the protein made by the body.
2. Plasma cells, which come from B lymphocytes, make antibodies.
3. A vaccine makes the body produce its own antibodies and memory cells; ready-made antibodies are passive immunity.
4. A few bacteria already have the resistance by chance; the antibiotic kills the others, so these survive and multiply.

MARKING SCHEME

- ✓ Antigen is foreign; antibody is the body's.
- ✓ Plasma cells make antibodies.
- ✓ A vaccine gives active immunity.
- ✓ The antibiotic selects resistance and doesn't cause it.

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8 Design a fair test

ANSWER A · 4

i. She changes the place (road or classroom) and counts the specks per 1 cm square.
ii. Any three: the same kind and thickness of jelly; the same size of slide; the same time; both out of the rain; the same height and way of facing.
iii. Specks don't land evenly, so one square could mislead; an average is fairer.
iv. The mucus of the nose and windpipe. It doesn't carry away what it catches, as cilia do.

MARKING SCHEME

✓ Changes place; counts specks.
✓ Any three things kept the same.
✓ An average is fairer than one square.
✓ Mucus; a slide has no cilia to carry dust away.

9 Predict, then explain

ANSWER HA · 3

a. **No.** Penicillin stops bacteria building their wall, and this one has no wall to build.
b. **Yes.** Tetracycline jams the bacterial 70S ribosomes, which it still has.

Measles is a virus, with no cell wall or ribosomes of its own, so neither has anything to act on.

MARKING SCHEME

✓ Penicillin won't work: no wall.
✓ Tetracycline will: it jams its ribosomes.
✓ Measles is a virus without those parts.

10 The survivors take over

ANSWER A · 4

i. Before: $10 \div 1{,}000{,}000 \times 100 = \mathbf{0.001\%}$. After: **100%**.
ii. $10 \times 2C \geq 1{,}000{,}000$, so $2C \geq 100{,}000$. $2^{16} = 65{,}536$ is too small; $2^{17} = 131{,}072$ is enough, so $\mathbf{n = 17}$.
iii. $17 \times 30 = 510$ minutes = **8 hours 30 minutes**.
iv. **No.** They had it by chance already. The antibiotic only removed their competitors.

MARKING SCHEME

✓ 0.001% and 100%.
✓ 17 divisions.
✓ 8 hours 30 minutes.
✓ No: it was there by chance, and the antibiotic removed the rest.

11 Estimate it

ANSWER A · 3

i. $15 \times 60 \times 60 \times 24 = 1{,}296{,}000$, about **1.3 million**.
ii. $10 \div 1 = 10$ minutes; $10 \div 0.5 = 20$ minutes: **10 to 20 minutes**.
iii. $10{,}000 \div 24 \approx$ **420 liters**.

MARKING SCHEME

✓ About 1.3 million beats.
✓ 10 to 20 minutes.
✓ About 420 liters.

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12 Think

ANSWER HA · 3

Memory cells remember the measles antigens, so a second meeting gets the fast secondary response. Colds are caused by more than 200 viruses, each with its own antigens, so immunity to one doesn't protect against the others. Flu viruses change their surface antigens a little every year, so a new vaccine is matched to them.

MARKING SCHEME

- ✓ Measles: memory cells give a fast secondary response.
- ✓ Colds: many viruses with different antigens.
- ✓ Flu: its surface antigens change each year.

13 Make your own

ANSWER HA · 2

For example: a village of 600 people meets a disease with $R_0 = 3$. How many must be immune? Share $= 1 - 1 \div 3 = 2 \div 3$; $2 \div 3 \times 600 = 400$ people.

MARKING SCHEME

- ✓ A clear problem with an R_0 above 1 and a number of people.
- ✓ A correct solution by $1 - 1 \div R_0$.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	0	15	15	16	**46**

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