Unit 5 · Applied Biology

ANSWER KEY · FOR TEACHERS

Full marks 44

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

1 Key words

1. pathogen
2. keratin
3. goblet
4. lysozyme
5. antigen
6. immunoglobulins
7. toxoid
8. colostrum

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. antigen-binding sites
2. light chain
3. antigen
4. heavy chains

K · 2

Each carries 0.5 mark.

3 Multiple choice

i. **c.** mucus in the nose — U · 1

The first line is the barriers at the surface: skin, mucous membranes and their mucus, tears, saliva, stomach acid. Neutrophils belong to the second line; antibodies and memory cells to the third.

ii. **b.** cilia — K · 1

Cilia on the ciliated cells of the windpipe and bronchi beat toward the throat. Villi line the small intestine; flagella are long whips that move some bacteria and sperm; pseudopodia are the arms of a phagocyte.

iii. **a.** neutrophils — K · 1

Neutrophils make up about 40 to 70% of the white cells and reach an infection within hours, where they eat bacteria and die, forming pus.

iv. **b.** natural passive immunity — U · 1

The baby receives ready-made antibodies (passive) in a natural way, through breast milk and, before birth, across the placenta (natural). It fades in months, since the baby makes no memory cells from it.

v. **c.** tetanus vaccine — U · 1

The tetanus vaccine contains the tetanus toxin made harmless by chemicals: a toxoid. BCG, oral polio and MR are live, weakened vaccines.

vi. **b.** Alexander Fleming — K · 1

Alexander Fleming noticed that a *Penicillium* mold killed the bacteria round it. Jenner tested the smallpox vaccine (1796), Metchnikoff discovered phagocytes (1882), and Waksman's laboratory found streptomycin (1943).

4 Match the columns

1. live, weakened → **c.** the living germ, which can't cause the disease in a healthy person
2. killed → **d.** the whole germ, not alive
3. toxoid → **a.** the germ's toxin, made harmless
4. subunit → **e.** only one part of the germ

K · 2

Each carries 0.5 mark.

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5 True or false

i. ✗ **False**: They push it up toward the throat. U · 3

ii. ✓ **True**

iii. ✗ **False**: Monocytes grow into macrophages; B cells become plasma cells.

iv. ✓ **True**

v. ✗ **False**: The common cold is caused by viruses, on which antibiotics don't act.

vi. ✗ **False**: A vaccine prevents a disease.

Each carries 0.5 mark.

6 Very short answers

a. MARKING SCHEME K · 1

✓ Edward Jenner.

b. MARKING SCHEME K · 1

✓ About pH 5.

c. MARKING SCHEME U · 1

✓ Helper T cells.

7 Short answers

a. MARKING SCHEME U · 2

✓ Smoke slows and destroys the cilia, so mucus collects in the airways and has to be coughed out.

✓ Germs trapped in the mucus stay and multiply, causing bronchitis and pneumonia.

b. MARKING SCHEME U · 2

✓ Neutrophils rush to the wound, eat bacteria and die.

✓ The dead neutrophils and bacteria, broken tissue and fluid collect as pus.

c. MARKING SCHEME U · 2

✓ Own antibodies, against antibodies given.

✓ Slow and long-lasting with memory cells, against immediate and short.

d. MARKING SCHEME U · 2

✓ Antibiotics attack bacterial parts: the cell wall, ribosomes or DNA copying.

✓ Viruses have none of these of their own.

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8 Long answers

a. ANSWER U · 6

Phagocytosis is the process by which certain white blood cells (phagocytes: neutrophils and macrophages) take in germs, dead cells and other particles, enclose them in a bag of membrane and digest them. Its steps:

1. **Chemotaxis:** the phagocyte senses chemicals released by the bacteria and damaged tissue and moves toward them.
2. **Adherence:** it attaches to the bacterium, most easily when the bacterium is coated with antibodies.
3. **Ingestion:** it surrounds the bacterium with pseudopodia, which meet and fuse, enclosing it in a phagosome inside the cell.
4. **Digestion:** lysosomes fuse with the phagosome to form a phagolysosome, whose enzymes kill and digest the bacterium.
5. **Release:** the undigested remains are thrown out of the cell by exocytosis.

MARKING SCHEME

- ✓ Phagocytes take in germs and particles, enclose them in a bag of membrane and digest them.
- ✓ Chemotaxis: it moves toward the chemicals.
- ✓ Adherence: it attaches to the bacterium.
- ✓ Ingestion: pseudopodia enclose it in a phagosome.
- ✓ Digestion: lysosomes join to make a phagolysosome, whose enzymes kill it.
- ✓ Release: remains are thrown out by exocytosis.

b. ANSWER U · 4

Immunity is the body's ability to resist a disease by preventing the germ's entry or destroying it or its toxin before it causes illness. Acquired immunity is gained during life, and is of four kinds:

- **Natural active:** the body makes its own antibodies after catching a disease and recovering. Example: immunity to chickenpox after having it.
- **Artificial active:** the body makes its own antibodies after a vaccine. Example: immunity to measles after the MR vaccine.
- **Natural passive:** ready-made antibodies pass from mother to baby across the placenta and in breast milk. Example: a newborn's protection in the first months.
- **Artificial passive:** ready-made antibodies are injected. Example: antivenom after a snakebite, rabies immunoglobulin after a dog bite.

Active immunity is slow to develop but lasts long; passive immunity acts at once but fades in weeks to months.

MARKING SCHEME

- ✓ Natural active: own antibodies after a disease, such as chickenpox.
- ✓ Artificial active: own antibodies after a vaccine, such as MR.
- ✓ Natural passive: from mother to baby, across the placenta or in milk.
- ✓ Artificial passive: injected antibodies, such as antivenom.

9 Working it out

ANSWER A · 3

Share needed = $1 - 1 \div 10 = 1 - 0.1 = 0.9$, that is 90%.
Students who must be immune = $0.9 \times 800 =$ **720 students**.
If more than 720 of the 800 are immune (from having had chickenpox or from the vaccine), each case passes it on to fewer than one other student on average, and the outbreak dies out. (A real school isn't perfectly mixed, so this is a rough figure.)

MARKING SCHEME

- ✓ Share needed = $1 - 1 \div 10$.
- ✓ Share = 0.9, that is 90%.
- ✓ $0.9 \times 800 = 720$ students.

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10 Think

ANSWER HA · 3

Tetanus bacteria in the soil and dung on the nail can enter the wound and release a toxin that acts within days. Pemba has not been vaccinated recently, so his body has no antibodies ready.

- The **anti-tetanus serum** gives **artificial passive immunity**: ready-made antibodies that neutralize the toxin at once, but last only a few weeks.
- The **vaccine** (a toxoid) gives **artificial active immunity**: his own body starts making antibodies and memory cells, which takes one to two weeks but then lasts for years, after the rest of the doses.

So the serum protects him now, and the vaccine protects him later, after the serum has faded.

MARKING SCHEME

✓ Serum: artificial passive immunity, neutralizing the toxin at once but lasting only a few weeks.
✓ Vaccine: artificial active immunity, taking one to two weeks but then lasting years.
✓ So the serum protects him now and the vaccine later, after the serum has faded.

11 Activity: What a sticky surface catches

(not marked)

WHAT STUDENTS SHOULD FIND

The sticky slide catches many more specks and holds them when tipped or blown on; the dry slide loses most of what landed on it. The mucus of the nose and windpipe works like the sticky slide, and the cilia carry away what it catches.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	13	25	3	3	**44**

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