12.1
Summary Questions
1 a Disease that can be passed from one organism to another (1).
   b Pie chart should show: 9% injuries (1); 23% communicable diseases (1); and 9% injuries (1).
2 Table should summarise key comparisons between the four. For example, whether they are
   prokaryote/eukaryote, whether they have plasmids or not, whether they are heterotroph/autotroph,
   whether they are beneficial/pathogenic/neutral, comparison of cellular structure, whether they have a
   nucleus or not. Extra credit for students who remember 70s and 80s ribosomes for
   prokaryotes/eukaryotes.
3 13 000 000 is 23% of all deaths 68% of all deaths are caused by non-communicable diseases (1)
   68% is 13 000 000/23 \times 68 (1) = 36–37 million (1); then approximate because working with
   approximate numbers (1).
4 Take over cell metabolism, viral genetic material inserted into host DNA (2); take over cell and
   digest contents (e.g., some Protista) (1); completely digest living cells and destroy them (e.g., fungi)
   (1); produce toxins which poison or damage host cells, some toxins break down cell membranes or
   inactivate enzymes or prevent cell division (e.g., most bacteria) (2).
5 a Viruses insert genetic material into host DNA (1); and take over cell metabolism to make new
   viruses before breaking out of cell (1); protists take over cells and feed on cell contents (1); and divide
   before breaking out of the cell (1).
   b Viruses only active when inside a host cell (1); have little structure and take over whole host cell (1).

12.2
The threat to English Oak trees
Acute oak decline caused by bacterium found on or in oak jewel beetles showing they may transfer
   disease (2); trees become infected in regions where no oak jewel beetles so they are not
   vectors/cause of disease or not the only vector/cause of disease (2). Any other sensible suggestions.

Banana diseases and food security
1 30 000 000 000 kg bananas (1)
2 Increased malnutrition as people deprived of their main staple food (1); increased disease and
   death as people less able to resist disease due to malnutrition (1); shortages of other foods as people
   try to buy other staples (1); increased food prices as a result of short supplies driving up demand (1)
   any other sensible point
3 a lack of awareness of causes of disease (1); lack of biocontrol on farms (1); contamination
   between farms (1) (max 2)
   b Cloned Cavendish plants so if one plant susceptible to disease, they all will be and therefore whole
   plantations can be wiped out (1).

TB, cows, and badgers
1 Wild animals such as badgers and possums which are infected with TB regularly use same
   pastures and so bacterium is around in the grass (2).
2 It isn’t possible to tell if animal is infected with TB or has been vaccinated so would be impossible to
   protect consumers against infected milk products etc (2).
3 Any sensible suggestions for example: People’s perception of badgers are different to that of cattle;
   some people put a higher value on wildlife than the health of farm animals and people; some people
   feel that there are more humane alternatives that would protect both badgers and cattle (max 2).
4 Catching the animals to deliver vaccine would be difficult and stressful for animals and people;
   would never know what proportion of the population was vaccinated; difficult to tell if an animal is
   vaccinated or not; if vaccine in food difficult to quantify how many badgers eat food and impossible to
   control dose. Any other sensible point (4).
5 Look for clear evidence of good research skills, balanced approach, citing sources etc.

Zoonotic influenza
1 Viruses not affected by antibiotics so cannot be cured (1).
2 Enables scientists to identify cause of outbreak (1); track its spread (1); and helps in the
   development of vaccines (1); and (if bacterial) medicines to treat the disease (1).
   a They were much younger than usual flu victims – up to 80% were under 65, whereas in normal flu
   outbreaks, around 90% of deaths are in people over 65.
b H1N1 was a new strain of flu which crossed species barrier from animals to people. It has happened before – older people may have met a similar virus earlier in their lives whereas people under 65 had not encountered a similar virus before and so it was extremely damaging to them (3).

Identifying pathogens
1 Appropriate treatment can be used (1); and appropriate steps taken to prevent the spread of the pathogen (1).
2 Benefits: Relatively cheap (1); available in all hospitals (1); special stains show up classes of organisms easily (1). Limitations: can take some time for culture to grow (1); some organisms e.g. viruses can be very difficult to culture (1); light microscope limited e.g. viruses not visible (1).
3 Look for evidence of good research skills, clear explanations, citing of sources etc.

Summary Questions
1 Bacterial: Ring rot (caused by Clavibacter michiganense) affects potatoes, aubergine, and tomatoes. TB (Mycobacterium tuberculosis and M. bovis) affects humans, cows, badgers, deer. Bacterial meningitis affects humans. Viral: Tobacco mosaic virus affects tobacco plants and 150 other species. HIV/aids affects humans and some apes. Influenza (Orthomyxoviridae spp affects mammals including humans, pigs, and birds. Protist: Potato blight (Phytophthora infestans) affects potatoes and tomatoes. Fungal: Black sigatoka (Mycosphaerella fijensis) affects bananas and plantains. Ring worm (Trichophyton verrucosum) affects cattle (other spp. Affects most animals including people). Athlete’s foot (Tinea pedia) affects human feet (max 6).
2 Show evidence of understanding of the ways in which bacteria attack animal and plant populations and the different effects they have. For example: ring rot (plants) and TB (animal), any diseases may be chosen as long as bacterial (1); both caused by bacteria, both cause tissue destruction, both remain infective in the environment (3); animal disease can be cured by antibiotics/prevented by vaccination, no treatment or vaccine for plant disease (2).
3 Students should show awareness of the variety of ways in which the diseases they have chosen can be spread for example: For animals direct transmission from one animal to another via direct contact, inoculation, and ingestion and indirect transmission e.g., droplet infection, fomites vectors etc. For plants direct transmission plant to plant and indirect transmission including soil contamination and different types of vectors e.g., wind, water, animals, humans. 3 for any three correct animal methods, 3 for any three correct plant methods including up to 2 for specific types of vectors.

12.3 Preventing the spread of communicable diseases in humans
1 Removes and destroys pathogens so not transmitted through direct contact, ingestion, or leaving on fomites.
2 Living close together increases droplet infection risk and contagion (2); poor sanitation increases risk of contagion, contaminated water and food, and vectors (2); and poor nutrition means people are more vulnerable to infection (1); all increase the risk of the spread of communicable diseases so improving them lowers the risk (1).
3 Mosquitoes breed in water (1); mosquitoes carry malaria (1); any waste container which holds water provides a breeding space for mosquitoes (1); and so increases malaria (1); removing the waste reduces breeding opportunities for mosquitoes(1); and so reduces the incidence of malaria (1).
4 Any sensible well-structured answer using variety of sources.

Preventing the spread of communicable diseases in plants
Points could include: If pathogen getting to plant prevented there will be no disease so methods of reducing spread of pathogens would be key (e.g., human hygiene not spreading spores, disposing diseased plant tissue carefully, removing all traces of damaged plant tissue, insect vector control, any other sensible points); breed plants that are not susceptible to infection or disease resistant; if conditions favourable for healthy plant growth plants will increase disease resistance (so good management e.g., soil fertilising, pest control); need to balance all three elements to avoid disease.

Summary Questions
1 Direct pathogen is spread directly from one organism to another (1). Indirect – the pathogen is spread from one organism to another through another medium, e.g. the air, a vector (1). Show awareness of the differences between organisms that can move around and organisms that cannot.
2 Similarities: being crowded close together increases risk of direct and indirect transmission. Weakened individuals more at risk of infection. Damage to protective outer layers can allow
pathogens in (2). **Differences**: Animals actively exchange body fluids (sex, kissing, bites) plants don’t. Animals transfer food and drink into body through mouth which plants don’t (2).

3 Show awareness of the differences between organisms that can move around and organisms that cannot. **Similarities**: animals, wind and water can act as vectors, fomite, e.g. bedding, sacks, machinery can carry disease from one individual to another, soil contamination is common indirect method of disease spread in plants and can affect animals too. **Differences**: droplet infection from coughs and sneezes doesn’t affect plants BUT droplets and splashes from one leaf to another can do.

4 Treating people to reduce pool of infection using medicines against disease (1); or using vaccines (no really effective ones developed yet); destroying mosquitoes that spread the disease (insecticide sprays on water and homes) (1); preventing mosquitoes breeding (1), draining swamps (1), removing waste filled with water (1); preventing mosquitoes reaching people (mosquito nets over beds, screens at doors and windows) (1) (max 5).

12.4 **Summary Questions**
1 Receptors respond to molecules from pathogens (1); or to chemicals produced by the plant cell wall when it is attacked (1); these attach to receptors, stimulating the release of signalling molecules to switch on genes in the nucleus, triggering cellular responses (1).
2 **Diagram of table to include**: Production of defensive chemicals, e.g., insect repellants, insecticides, antibacterial compounds including antibiotics, antifungal compounds, anti-oomycetes, general toxins (2); physical defences, e.g.; callose barriers immediately, callose and lignin deposition in cell walls longer term, callose blocking sieve plates to prevent spreading through the phloem, callose deposited in plasmodesmata to prevent spread of pathogens from one cell to another (2); sending alarm signals to uninfected cells so they can put defences in place (2).
3 **Show evidence of careful research from reputable sources and reference their sources** (6).

12.5 **Summary Questions**

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>How it prevents entry of pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin</td>
<td>impermeable barrier between air/water and inside the body</td>
</tr>
<tr>
<td>sebum</td>
<td>chemical produced by skin which inhibits growth of pathogens</td>
</tr>
<tr>
<td>mucus</td>
<td>traps pathogens in nose/trachea etc uses lysosomes to destroy bacteria/fungal spores, phagocytes to engulf and digest pathogens</td>
</tr>
<tr>
<td>tears</td>
<td>lysozymes break down pathogens</td>
</tr>
<tr>
<td>urine</td>
<td>lysozymes break down pathogens</td>
</tr>
<tr>
<td>stomach acid</td>
<td>destroys most bacteria and fungal spores entering the gut</td>
</tr>
<tr>
<td>expulsive reflexes</td>
<td>coughing/sneezing expel pathogens from gas exchange system</td>
</tr>
<tr>
<td></td>
<td>vomiting and diarrhoea expel pathogens from digestive system</td>
</tr>
<tr>
<td>blood clotting</td>
<td>protects again the entry of pathogens through broken skin</td>
</tr>
</tbody>
</table>

2 Localised inflammatory response to pathogens at site of wound, mast cells activated and release histamines and cytokines (1); histamines cause vasodilatation causing localised heat and redness (1); raised temperature helps prevent pathogens reproducing; histamines make blood vessels leaky forcing tissue fluid out, causing oedema and pain (1); cytokines attract phagocytes to site which phagocytose pathogens; accumulation of dead phagocytes and pathogens forms visible pus layer (1).

3 a Pathogens produce chemicals which attract phagocytes (1); phagocytes recognise nonhuman proteins in pathogen (1); this is not a response to a specific type of pathogen, simply to a cell or organism which is ‘not self’(1); phagocyte engulfs the pathogen and encloses it in a vacuole called a phagosome (1); phagosome combines with a lysosome to form a phagolysosome (1); enzymes from lysosome digest and destroy pathogen (1).

b **Cytokines** act as cell signalling molecules (1); that stimulate phagocytes to move to a site of infection or inflammation (1). **Opsonins** bind to pathogens (1); and tag them so they are more easily recognised by phagocytes (1); because phagocytes have receptors on their membranes which bind to common opsonins, e.g., antibodies (1).
12.6 Summary Questions
1 Immunoglobulins, Y shaped glycoproteins that bind to specific antigens on pathogens/toxins/foreign cells. Specific antibody for every antigen. Made up of two heavy and two light polypeptide chains with an active site made up of 110 amino acids which fits the antigen (1). Work by binding to antigen forming antigen-antibody complex which is then either engulfed by phagocytes or simply cannot function as a pathogen anymore (1).

2 Similarities: Both T and B cells form clones of active cells (1); both form memory cells which mean that when they meet a pathogen a second time there is a rapid response, destroying the pathogen before it can cause disease (1). Differences: T cells stimulate B cells (1); T cells destroy pathogens directly (1); B cells produce antibodies which act as opsonins stimulating phagocytes to engulf pathogens (1); T cells also regulate immune response so it stops once a pathogen is removed and doesn’t turn against body cells (1).

3 In autoimmune disease immune system stops recognising ‘self’ and starts attacking healthy cells. Immunosuppressant drugs reduce activity of immune system (1); preventing/reducing destruction of healthy tissue BUT susceptibility to infection increases (1); as immune system less effective at recognising pathogens (1).

4 Humoral immune system responds to antigens outside of cells (1); bacterial and fungal cells present in body have antigens to which humoral system can respond (1); system makes antibodies to bacterial and fungal surface antigens, forms antigen-antibody complexes so macrophages readily engulf pathogen (1). Cell-mediated system responds to changes in cells (1). Viruses get into body cells and take over cell metabolism (1) – not so obvious in blood presenting antigens e.g., bacteria. However, cell-mediated response detects changes in-virus infected cells and killer T cells attack and destroy them.

12.7 Case study: Influenza
1 Vaccination (if available); isolating infected people as soon as any symptoms appear; preventing travel into and out of infected countries (1) any other sensible point.

Summary Questions
1 Flow diagram that covers every step of how artificial active immunity is induced and is clear and easy to follow as well as accurate and informative. (4 marks)
2 Any four sensible reasons including: Some diseases so severe that patient killed before body can develop antibodies (1); some people do not have children vaccinated against diseases (1); if child immunocompromised, has a comorbidity, or neglected/malnourished will be more vulnerable to infections (1); bacterial disease may be resistant to current antibiotics (max 4).
3 a day 56 (1) b approximately 8600(1) c approximately 800 (1) d 86% (1)
4 a Most people vaccinated, so if bitten they are given course of injections to deliver antibodies (produced in another animal) directly into blood stream (1); antibodies form antigen–antibody complex with rabies virus, allowing phagocytes to destroy pathogen (an example of artificial passive immunity).

b Epidemic occurs when communicable disease spreads rapidly to a lot of people at either local/ national level (1); in vaccination, immune system stimulated to make antibodies to a pathogen by exposure to safe form of an antigen injected into blood stream (1); if an epidemic begins to build, mass vaccination (1); can protect people in the community by building immunity to infecting pathogen and prevent pathogen spreading disease into the wider population (1).
5 Health departments increase public health awareness decreasing levels of communicable disease (1); chlorinated water reduces water-borne infections and reduces number of deaths (1); public hygiene will mean fewer rats etc to act as vectors of disease (e.g., plague) (1); penicillin reduces deaths from bacterial diseases but does not affect viral diseases such as flu and polio (2); vaccines such as polio reduced deaths from infectious diseases where a vaccine has been developed (1); Any other sensible pint could be substituted for one of these.