B3aD Communicable Diseases and Pathogens: Exam Drill

Total Marks

AQA 8464 · Calculator allowed · about 95 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Pathogens are organisms that cause communicable disease.

(a) Name one type of pathogen. **(1)**

(Total for Question 1 is 1 mark)

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2 A student describes how bacteria and viruses cause disease.

(a) Give one way in which a virus causes disease in host cells. **(1)**

(b) Give one way in which bacteria cause disease. **(1)**

(Total for Question 2 is 2 marks)

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3 Transmission of communicable diseases can be reduced by hygiene measures.

(a) Describe how hand washing reduces the spread of pathogens. **(2)**

(Total for Question 3 is 2 marks)

4 The immune system responds to pathogens. A vaccination programme aims to produce immunity in a population.

(a) Explain, in terms of antibodies and memory cells, how a vaccine protects a person from a future infection by the same pathogen. **(3)**

(Total for Question 4 is 3 marks)

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5 Antibiotics are used to treat bacterial infections but do not work on viruses.

(a) Explain why antibiotics can treat bacterial infections but are ineffective against viruses. **(3)**

(Total for Question 5 is 3 marks)

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6 A local clinic tests 240 patients for infection X. 48 patients test positive. Determine the prevalence.

(a) Calculate the prevalence of infection X in this sample as a percentage. Give the answer to 1 decimal place. **(3)**

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(Total for Question 6 is 3 marks)

7 The table shows numbers of new cases of disease Y in a town over 6 weeks:
Week 1: 4, Week 2: 7, Week 3: 12, Week 4: 20, Week 5: 35, Week 6: 10.

(a) Calculate the mean weekly number of new cases over the 6 weeks. Give your answer to 1 decimal place. **(2)**

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(b) Suggest one public-health reason why week 5 shows a large increase compared with previous weeks. **(2)**

(Total for Question 7 is 4 marks)

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8 An investigator measures the diameter of bacterial colonies on agar after 24 hours at different disinfectant concentrations. Results: 0%: 22 mm, 0.5%: 15 mm, 1.0%: 8 mm.

(a) Explain how the data support the conclusion that higher disinfectant concentration reduces bacterial growth. **(3)**

(Total for Question 8 is 3 marks)

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9 Investigating plant disease involves comparing infected and uninfected plants.

(a) Suggest two controlled variables that should be kept the same when comparing growth of infected and uninfected plants in an experiment, and explain why each should be controlled. **(3)**

(Total for Question 9 is 3 marks)

10 Required practical style: measuring zones of inhibition to test the effectiveness of two antibiotics A and B. Student data: antibiotic A zone diameters (mm): 18, 20, 19. Antibiotic B: 12, 11, 13.

(a) Calculate the mean zone diameter for antibiotic A and for antibiotic B. Give each mean to 1 decimal place. **(2)**

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(b) State which antibiotic is more effective and give one valid experimental improvement to make the comparison fairer. **(2)**

(Total for Question 10 is 4 marks)

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11 A simple test for antibodies in blood gives a positive result if antibodies are present.

(a) Evaluate how reliable a positive antibody test result is for determining current infection. Include one limitation and one strength. **(3)**

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(Total for Question 11 is 3 marks)

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12 A new viral infection has an R number of 2.8. Explain what the R number means and calculate how many people one infected person would infect after two rounds of transmission on average.

(a) Explain what the R number of 2.8 means. **(1)**

(b) Calculate how many people would be infected after two rounds of transmission starting from one infected person, using the R number. Give your answer to 1 decimal place. **(3)**

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(Total for Question 12 is 4 marks)

13 Explain how herd immunity reduces the spread of a communicable disease in a population, and discuss two factors that might prevent herd immunity from being achieved in practice.

(Total for Question 13 is 6 marks)

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14 A scientist tests three disinfectant concentrations against pathogen spores. She finds spore survival rates after treatment: 0%: 95%, 2%: 60%, 5%: 20%, 10%: 5%.

(a) Calculate the percentage reduction in spore survival when concentration increases from 2% to 5%. Give your answer to 1 decimal place. **(2)**

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(b) Explain what this reduction suggests about the relationship between concentration and spore survival. **(2)**

(Total for Question 14 is 4 marks)

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15 A clinic uses PCR testing to detect viral genetic material. The test has a sensitivity of 92% and specificity of 98%. In a population of 10 000 where true prevalence is 2% calculate the expected numbers of true positives, false negatives, true negatives and false positives.

(a) Calculate the expected numbers. Show each step and give final counts. **(5)**

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(Total for Question 15 is 5 marks)

16 Error analysis: A pair of students records the incubation temperature as 37 degrees C but their incubator was actually set to 30 degrees C. Explain two likely effects this error could have on their results when culturing bacteria.

(a) Give two effects of incubating at 30 degrees C instead of 37 degrees C and explain each briefly. **(3)**

(Total for Question 16 is 3 marks)

Mark scheme · B3aD Communicable Diseases and Pathogens: Exam Drill

Question 1

- (a) **B1** one of: virus, bacterium, fungus, protozoan, or helminth (parasitic worm), oe
- **(a) Answer: Virus (or bacterium, fungus, protozoan, helminth).**

Question 2

- (a) **B1** invades host cells and uses the cell machinery to make new viruses causing cell damage or death, oe
- **(a) Answer: Invades host cells and uses the cell machinery to make new viruses, causing cell damage.**
- (b) **B1** produce toxins that damage tissues or disrupt normal body functions, oe
- **(b) Answer: Produce toxins that damage tissues or disrupt body functions.**

Question 3

- (a) **M1** removes pathogens and dirt from the skin surface (mechanical removal), or uses soap to disrupt membranes of some microbes
- (a) **A1** reduced chance of transferring pathogens to other people or surfaces cao
- **(a) Answer: Hand washing removes pathogens and dirt; soap can disrupt membranes of microbes, reducing transfer to other people or surfaces.**

Question 4

- (a) **M1** vaccine contains antigen from pathogen that stimulates immune response leading to production of specific antibodies
- (a) **M1** development of memory B cells specific to that antigen
- (a) **A1** on later exposure the memory cells produce antibodies rapidly preventing disease cao
- **(a) Answer: Vaccine antigens stimulate production of specific antibodies and memory B cells; on later exposure memory cells produce antibodies rapidly, preventing disease.**

Question 5

- (a) **M1** antibiotics target features of bacterial cells such as cell wall synthesis or protein synthesis machinery
- (a) **M1** viruses lack these bacterial structures and replicate inside host cells using host machinery
- (a) **A1** therefore antibiotics cannot target viruses without harming host cells cao
- **(a) Answer: Antibiotics target bacterial cell features like cell wall or protein synthesis; viruses lack these structures and replicate inside host cells using host machinery, so antibiotics cannot target viruses without harming host cells.**

Question 6

- (a) **M1** method: percentage = (number positive / total) x 100, substitutes 48/240 x 100
- (a) **A1** 20.0% cao
- (a) **A1** answer given to 1 decimal place or justified rounding
- **(a) Answer: 20.0%**

Question 7

- (a) **M1** method: mean = sum of values / number of values, substitutes sum = 4+7+12+20+35+10 = 88
- (a) **A1** 14.7 cao
- **(a) Answer: 14.7**
- (b) **M1** any one plausible reason such as a super-spreading event, relaxation of social distancing, school or workplace outbreak, reduced testing earlier then increased testing, or contaminated water/food source
- (b) **A1** explanation linking the reason to an increase in case numbers cao
- **(b) Answer: Possible super-spreading event or relaxation of control measures leading to many new infections in week 5.**

Question 8

- (a) **M1** states the trend: as concentration increases colony diameter decreases
- (a) **M1** gives two numerical comparisons or a clear comparison such as 22 mm to 8 mm showing reduction
- (a) **A1** concludes that this indicates less bacterial growth at higher concentration cao
- **(a) Answer: The colony diameter decreases as disinfectant concentration increases (22 mm at 0% to 8 mm at 1.0%); this**

Question 9

- (a) **M1** states one controlled variable such as light intensity, temperature, water, soil type, or plant age
- (a) **M1** states a second controlled variable
- (a) **A1** gives reasons linking control to fair comparison, eg same light and water so differences are due to infection
- **(a) Answer: Any two controlled variables, e.g. light intensity and watering amount. Control them so that any difference in growth is due to infection not different light or water.**

Question 10

- (a) **M1** method: mean A = (18+20+19)/3 = 57/3 and mean B = (12+11+13)/3 = 36/3
- (a) **A1** means 19.0 mm and 12.0 mm cao
- **(a) Answer: Antibiotic A mean 19.0 mm; Antibiotic B mean 12.0 mm.**
- (b) **M1** A is more effective because it has a larger mean zone
- (b) **A1** suggestion such as use same concentration of each antibiotic, use more replicates, ensure equal sized paper discs, incubate at same temperature
- **(b) Answer: Antibiotic A is more effective (mean 19.0 mm vs 12.0 mm). Improve by using the same antibiotic concentrations or increasing replicates.**

Question 11

- (a) **M1** states a strength such as indicates exposure to pathogen or immune response
- (a) **M1** states a limitation such as antibodies can persist after infection or cross react causing false positives or does not distinguish current from past infection
- (a) **A1** concludes that a positive result suggests exposure but is not definitive evidence of current infection cao
- **(a) Answer: Strength: a positive test shows the immune system has made antibodies to the pathogen. Limitation: antibodies may persist after infection or cross react, so a positive does not prove current infection. Conclusion: indicates exposure but not definitive for current infection.**

Question 12

- (a) **B1** the average number of people infected by one infected person in a population is 2.8
- **(a) Answer: On average one infected person infects 2.8 other people.**
- (b) **M1** method: after two rounds = 1 x R x R = R^2, substitutes 2.8^2
- (b) **A1** calculates 7.84
- (b) **A1** gives answer to 1 decimal place 7.8 cao
- **(b) Answer: 7.8**

Question 13

- **Level 3** (5-6): Detailed explanation of how herd immunity works and two well developed and justified reasons why it may not be achieved in practice. Clear use of subject knowledge and logical evaluation.
- **Level 2** (3-4): Clear explanation of herd immunity and at least one reason why it may not be achieved or two reasons with limited development.
- **Level 1** (1-2): Basic statement about herd immunity or single undeveloped reason why it may fail. Limited or no application of subject knowledge.
- **Indicative content:**
  - Herd immunity: when a high proportion of immune individuals reduces the chance of transmission so vulnerable people are protected
  - Vaccination increases proportion immune and interrupts chains of transmission
  - Critical vaccination threshold depends on R number and vaccine effectiveness
  - Factors preventing herd immunity: vaccine hesitancy or refusal reducing uptake
  - Factors preventing herd immunity: vaccines with low effectiveness or waning immunity over time
  - Factors preventing herd immunity: unequal vaccine distribution or pockets of unvaccinated people, new variants that evade immunity
  - Discussion may include trade offs and real world constraints and conclude how these factors reduce overall population protection

Question 14

- (a) **M1** method: percentage reduction = ((60 - 20) / 60) x 100, substitutes values
- (a) **A1** 66.7% cao
- **(a) Answer: 66.7%**
- (b) **M1** states that as concentration increases spore survival decreases
- (b) **A1** explains that higher concentration is more effective at killing or inactivating spores, shown by the large percentage reduction
- **(b) Answer: It shows that increasing concentration greatly reduces spore survival; higher disinfectant concentration is more effective at killing or inactivating spores.**

Question 15

- (a) **M1** calculates number with disease = 0.02 x 10000 = 200
- (a) **M1** true positives = sensitivity x number with disease = 0.92 x 200 = 184
- (a) **M1** false negatives = number with disease - true positives = 200 - 184 = 16
- (a) **M1** number without disease = 10000 - 200 = 9800; true negatives = specificity x number without disease = 0.98 x 9800 = 9604
- (a) **A1** false positives = number without disease - true negatives = 9800 - 9604 = 196 cao
- **(a) Answer: True positives 184; False negatives 16; True negatives 9604; False positives 196.**

Question 16

- (a) **M1** states lower growth rate or smaller colony sizes due to suboptimal temperature
- (a) **M1** states longer lag or delayed growth so measurements after 24 hours underestimate growth
- (a) **A1** explains that many bacteria have optimal growth near 37 degrees C so lower temperature slows metabolic reactions and division, altering results cao
- **(a) Answer: Possible effects: smaller colonies or lower colony counts because growth rate is slower at 30 degrees C; delayed onset of exponential growth so 24 hour measurements underestimate growth. Many bacteria grow best near 37 degrees C, so lower temperature slows metabolism and division.**