BIOLOGY

SmarterEd Maths & Sciences

COMPREHENSIVE REVISION SERIES 2024

Thank you for subscribing to SmarterScience Teacher Edition in 2024.

Key features of the Biology "2024 HSC Comprehensive Revision Series" for include:

- ~16 hours of cherry-picked HSC revision questions by topic
- Targeted at motivated students aiming for a Band 5 or 6 result
- Weighting toward more difficult examples
- Mark allocations given to each topic generally reflect its historical (new syllabus) HSC exam allocation.
- **Attempt, carefully review and annotate** this revision set in Term 3
- This question set provides the foundation of a concise and high quality revision resource for the run into the HSC exam.
- This resource should be used to complement (not replace) the critical final stretch preparation for every student - timed full exam practice papers.

Our analysis on each topic, the common question types, past areas of difficulty and recent HSC trends all combine to create this revision set that ensures students cover a wide cross-section of the key areas.

IMPORTANT: If students have been exposed to questions in these worksheets during the year, we say great. Many top performing students attest to the benefits of doing quality questions 2-3 times before the HSC. This type of revision set is aimed at creating confidence and *speed through the exam*, with cherry picked questions that cover all important elements of revision while avoiding low percentage rabbit hole excursions.

M7 Infectious Disease – Causes (~8.2% historical contribution)
Key Areas addressed by this worksheet

- *M7 Causes of Infectious Disease* has been consistently tested in the band 5-6 range every year and is a key topic area for outperformance.
- *Classifying Pathogens* is an extremely important subtopic that has attracted high-mark longer answer questions in every new syllabus exam to date. Identifying and distinguishing pathogens using a limited description of their features has proven very challenging and features in the chosen revision questions (including *2020 HSC 32b and 2019 HSC 33d*).
- *Indirect Transmission, Direct Transmission* and *Vectors* has also been tested in the extended response three times (most recently in 2022).
- *2019 HSC 31* required an example of a pathogen adaptation to facilitate entry into a host and produced a mean mark of 36%. Smart revision: prepare similar examples that can be concisely incorporated into broad based questions on the topic!
- The works of *Louis Pasteur* and *Robert Koch* have been tested in 3 exams since 2018 and need to be very well understood. In particular, students must be able to efficiently incorporate their knowledge into broad questions looking at causes and transmission of infectious diseases.
- *Microbial Tests* have been examined in the multiple-choice section in 4 of the last 5 years (absent only in 2022). We recommend preparation for the syllabus dot point that states that students be able to "design" a practical investigation in this topic area (yet to be tested).

BIOLOGY
Stage 6

2024 Comprehensive Revision Series
M7 Infectious Disease
  - Causes of Infectious Disease

Exam Equivalent Time: 90 minutes *(based on allocation of 1.5 minutes per mark)*

Questions

1. BIOLOGY, M7 2020 HSC 4 MC

Malaria is a disease in humans caused by a single-celled *Plasmodium* species. It is transmitted by female mosquitoes.

Which of the following is true for malaria?

A. Both *Plasmodium* and the mosquito are vectors

B. Both *Plasmodium* and the mosquito are pathogens

C. The mosquito is the vector and *Plasmodium* is the pathogen

D. The mosquito is the pathogen and *Plasmodium* is the vector

2. BIOLOGY, M7 EQ-Bank 1 MC

All pathogens can be described as

A. infectious.

B. macroscopic.

C. microscopic.

D. viral.

3. BIOLOGY, M8 2019 HSC 1 MC

Which of the following is an example of a non-infectious disease?

A. Polio caused by a virus

B. Cholera caused by a bacterium

C. Wheat rust caused by a fungus

D. Haemophilia caused by a gene mutation

4. BIOLOGY, M7 2019 HSC 7 MC

Two types of bacteria were isolated from a patient's throat swab and grown in pure culture on separate agar plates. On each plate there were FOUR different antibiotic discs, W, X, Y and Z.

The photograph shows the plates seven days later.
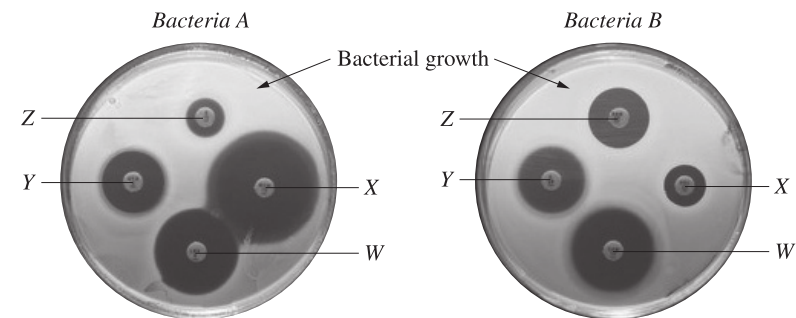
Replacement image.
Original image awaiting copyright.
http://www.bacteriainphotos.com/
disk%20diffusion%20testing.html

Which antibiotic should be used to treat the patient?

A. W

B. X

C. Y

D. Z

5. BIOLOGY, M7 EQ-Bank 3 MC

The diagram shows a model of disease transmission.
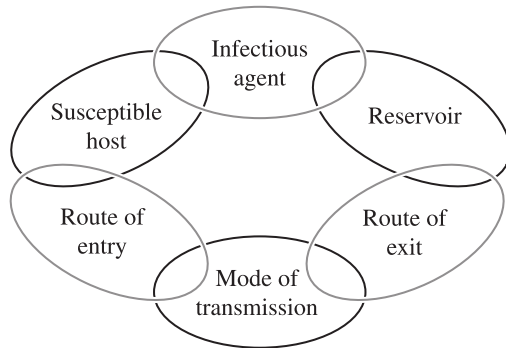
A pathogen was identified as being unadapted to dry conditions and as having the gastrointestinal tract as the 'route of entry' and the 'route of exit'.

Using this information, what is the most likely mode of transmission?

A.   Skin to skin contact

B.   Coughing or sneezing

C.   Contaminated water supplies

D.   Transmission of infected blood products

6. BIOLOGY, M7 2022 HSC 10-11 MC

Refer to the following information to answer Questions 10 – 11.

Pasteur used swan neck flasks to conduct experiments on microbial contamination of broth. One of Pasteur's investigations is shown.
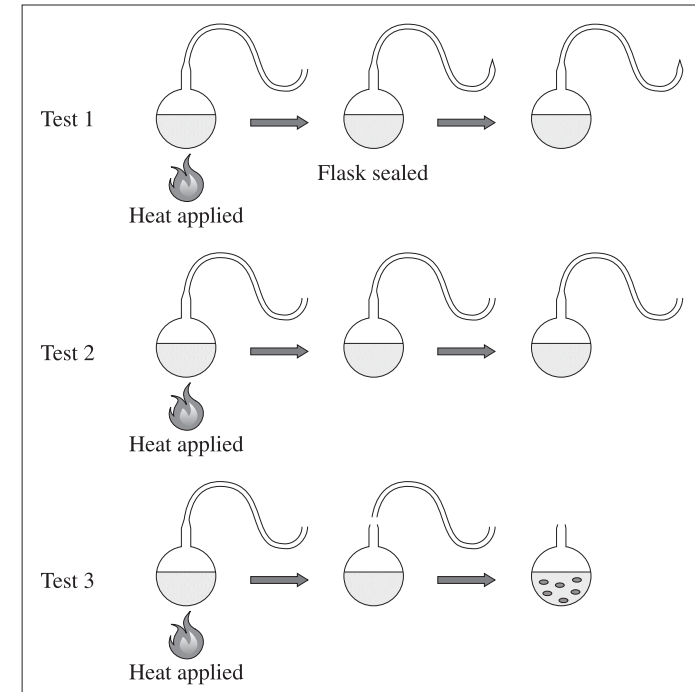
Question 10

Which of the following was the independent variable in this investigation?

A.   The air

B.   The flask

C.   The broth

D.   The microbes

Question 11

What is the best explanation for Pasteur's results?

A.   Cells arise from existing cells

B.   Heating prevents broth spoiling

C.   Gases in the air cause broth to spoil

D.   Cells arise by spontaneous generation

---

7. BIOLOGY, M7 2017 HSC 14 MC

Which statement correctly describes fungi and protozoans?

A.   Fungi and protozoans are unicellular.

B.   Fungi and protozoans have chloroplasts.

C.   Fungi have a cell wall and protozoans do not.

D.   Fungi are procaryotic and protozoans are eucaryotic.

---

8. BIOLOGY, M7 2020 HSC 7 MC

Students designed and conducted an investigation to test for the presence of microbes in THREE different food samples.

They inoculated agar plates with the samples and placed them in an incubator set to 25°C.

Which row of the table represents a valid design for the investigation?

	Independent variable	Dependent variable	Experimental control
A.	Food sample	Number of microbes	An agar plate without a sample
B.	Number of microbes	Food sample	Temperature set to 25°C
C.	Food sample	Number of microbes	Temperature set to 25°C
D.	Number of microbes	Food sample	An agar plate without a sample

---

9. BIOLOGY, M7 2021 HSC 14 MC

The human *PRNP* gene codes for the prion protein. Misfolding of this protein may be the result of ingesting tissue that contains misfolded prion protein or a mutation. Accumulation of misfolded prion protein causes serious diseases such as Creutzfeldt-Jakob disease (CJD).

Which of the following statements best classifies CJD?

A.   It is both a genetic disease and an infectious disease.

B.   It is a genetic disease only, since it is encoded by a gene.

C.   It is not an infectious disease because the prion is non-cellular.

D.   It is an infectious disease and the normal prion protein is the pathogen.

---

10. BIOLOGY, M7 2015 HSC 9 MC

A pathogen and a red blood cell are drawn to the same scale, with some features indicated.
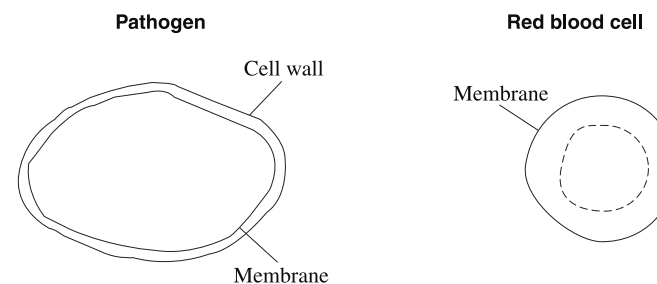
What type of pathogen is this?

A.   A virus

B.   A prion

C.   A fungus

D.   A bacterium

11. BIOLOGY, M7 2015 HSC 25

A group of students wanted to test whether water purifying tablets were effective in making creek water free from bacteria.

They conducted an experiment using a water sample collected from the creek and found that the tablets were effective.

a. Describe a means of addressing ONE identified hazard relevant to this investigation. *(2 marks)*

....

....

....

....

b. Illustrate the results of this experiment in diagrammatic form.

Use labels to clearly identify the data collected. *(3 marks)*

12. BIOLOGY, M7 2021 HSC 21

a. Label TWO features on the diagram below that would help to classify this pathogen as a bacterium. *(2 marks)*

1 μm
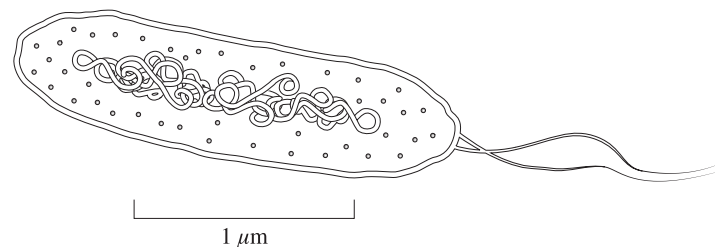
b. A scientist followed Koch's postulates to confirm that this bacterium was causing diarrhoea in pigs on a local farm.

Complete the boxes in the flowchart provided to show the steps taken by the scientist. *(2 marks)*

Pig 2
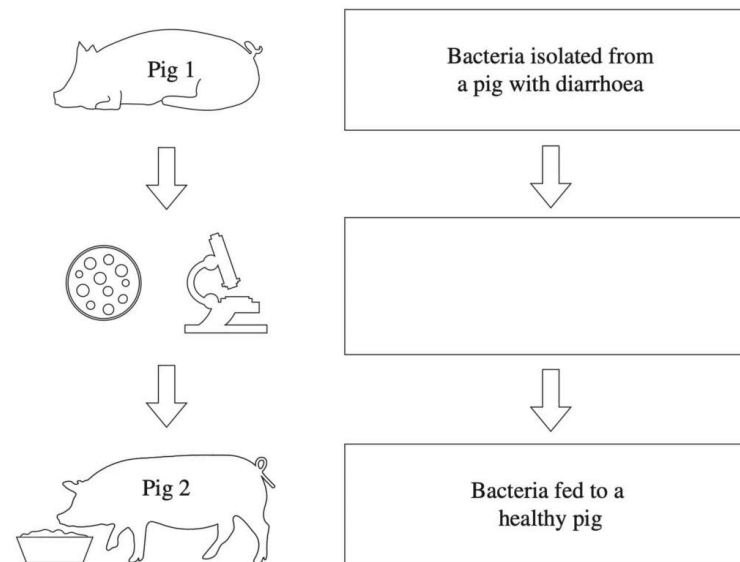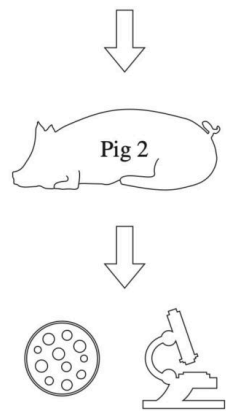
Bacteria isolated from
Pig 2 are compared
with bacteria from Pig 1

c. Two pig farmers on neighbouring farms noticed that their pigs were suffering from diarrhoea and gradually losing weight. The farmers each adopted a different strategy to deal with this disease, as shown in the table.

Farm	Strategy	Result
1	Treatment with antibiotics	All pigs recovered after two weeks
2	Elimination of rats and mice from pig sheds to improve hygiene	Decrease in number of sick animals over three months

Outline ONE benefit and ONE limitation of the strategies used on each farm. *(3 marks)*

....

....

....

....

....

....

13. BIOLOGY, M7 2018 HSC 22b

Describe the contribution of Robert Koch to our understanding of disease. *(3 marks)*

..

....

....

....

....

....

14. BIOLOGY, M7 2018 HSC 22a

Pasteur performed an experiment to identify the role of microbes in decay.

Justify a conclusion that can be drawn from his results. *(2 marks)*

....

....

....

....

....

15. BIOLOGY, M7 EQ-Bank 11

Complete the following table to show the distinguishing characteristic of each pathogen and a disease caused by each. *(3 marks)*

Pathogen	Distinguishing characteristic of the pathogen	Disease caused by the pathogen
Bacteria		
Fungi		
Protozoans		

16. BIOLOGY, M7 2019 HSC 31

a. Outline ONE adaptation of a specific pathogen that facilitates its entry into a host. *(2 marks)*

....

....

....

....

b. Explain how the mode of transmission of pathogens influences the spread of diseases. *(3 marks)*

....

....

....

....

....

17. BIOLOGY, M7 2016 HSC 25

Rabies is a disease caused by a virus that affects mammals.

In 1880 Louis Pasteur investigated dogs that were suffering from rabies in order to find the cause. He believed rabies was caused by a microorganism but could not culture it in broth nor observe it under the light microscope. However, he could cause the disease in healthy dogs by injecting them with saliva from infected dogs. He was able to repeat the disease cycle in this way.

a. Why was Pasteur NOT able to observe the rabies virus? *(2 marks)*

....

....

....

b. Explain why Pasteur needed to identify and culture the microorganism in order to meet the scientific standards for establishing the cause of rabies. *(4 marks)*
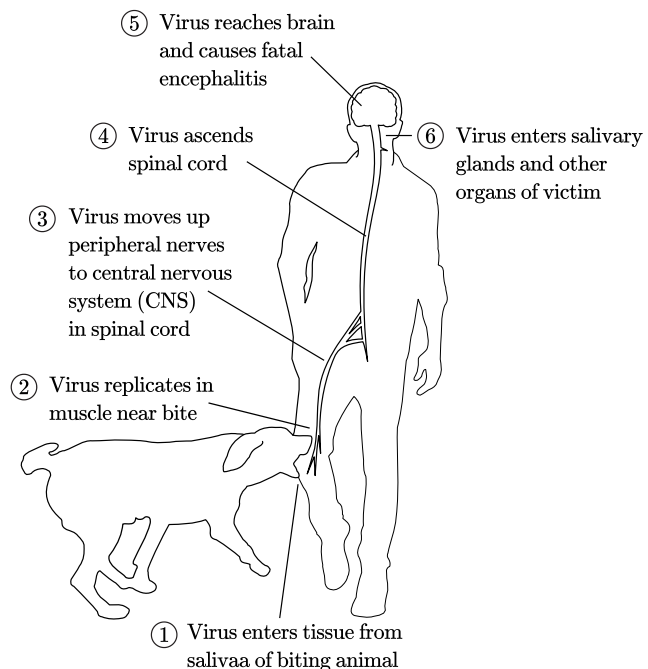
....

....

....

....

....

....

....

18. BIOLOGY, M7 2020 HSC 32a

Rabies is a disease that can affect all mammals and is caused by the rabies virus. It is transmitted by the bite of an infected animal. Without treatment it almost always results in death.

Use the information provided to identify TWO features of the rabies infection that facilitate transmission of the pathogen to a new host. *(2 marks)*

....

....

....

....

....

19. BIOLOGY, M5 2020 HSC 32b

The rabies virus is a single-stranded RNA virus. It contains and codes for only five proteins. The diagrams show the structure and reproduction of the virus.

Diagram 1 – structure
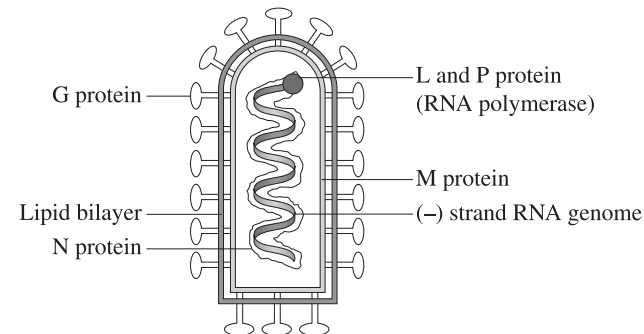
Diagram 2 – reproduction
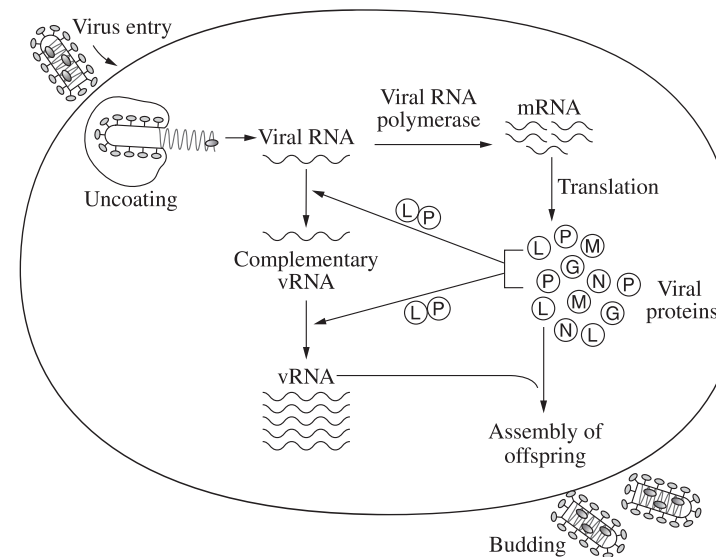
i. Use the information provided in Diagram 1 to explain why the rabies virus cannot be classified as a cellular pathogen. *(3 marks)*

....

....

....

....

....

ii. After infection the virus reproduces in muscle cells near the bite site and in the central nervous system. This requires the single-stranded rabies RNA to be transcribed, translated and replicated in the cytoplasm of host cells. These processes are shown in Diagram 2.

Use the information provided in Diagrams 1 and 2 to explain the role of viral RNA polymerase in the reproduction of the virus. *(5 marks)*

....

....

....

....

....

....

....

....

20. BIOLOGY, M7 2019 HSC 33d

Alzheimer's disease causes destruction of brain tissue, dementia and eventually death.

The diagram shows the effect of Alzheimer's disease on the brain.
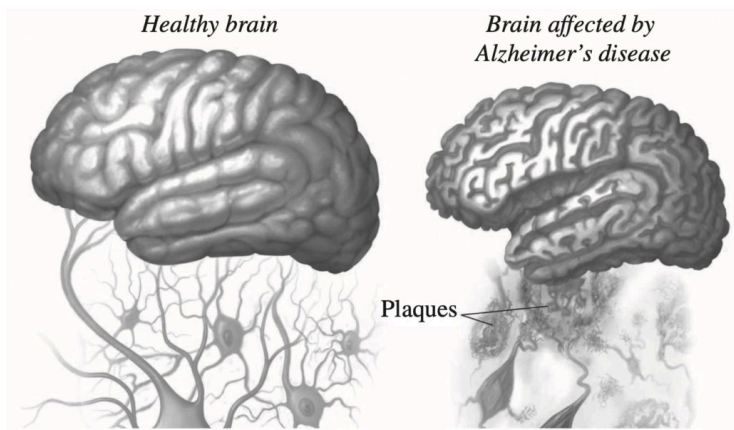
Amyloid beta protein is produced in the human brain throughout life. In people with Alzheimer's disease, it accumulates in excessive amounts.

The gene with the greatest known effect on the risk of developing late-onset Alzheimer's disease is called APOE. It is found on chromosome 19.

The APOE gene has multiple alleles, including e2, e3 and e4 .

The table shows the risk of developing Alzheimer's disease for various APOE genotypes compared to average risk in the population.

APOE genotype	e2/e2	e2/e3	e2/e4	e3/e3	e3/e4	e4/e4
Risk of developing Alzheimer's disease (compared to average)	40% less likely	40% less likely	2.6 times more likely	Average	3.2 times more likely	14.9 times more likely

Risk of susceptibility, based on alleles. © Alzheimer.org

A large epidemiological study was conducted. It used historical data to investigate the association between Herpes simplex virus (HSV) infection and dementia. Dementia is caused by a variety of brain illnesses. Alzheimer's disease is the most common cause of dementia.

The study used the records of 8362 patients with HSV infection and 25086 randomly selected sex- and age-matched control patients without HSV infection. Some of the patients with HSV had been treated with antiviral medication.

The graph below shows some results of the study.
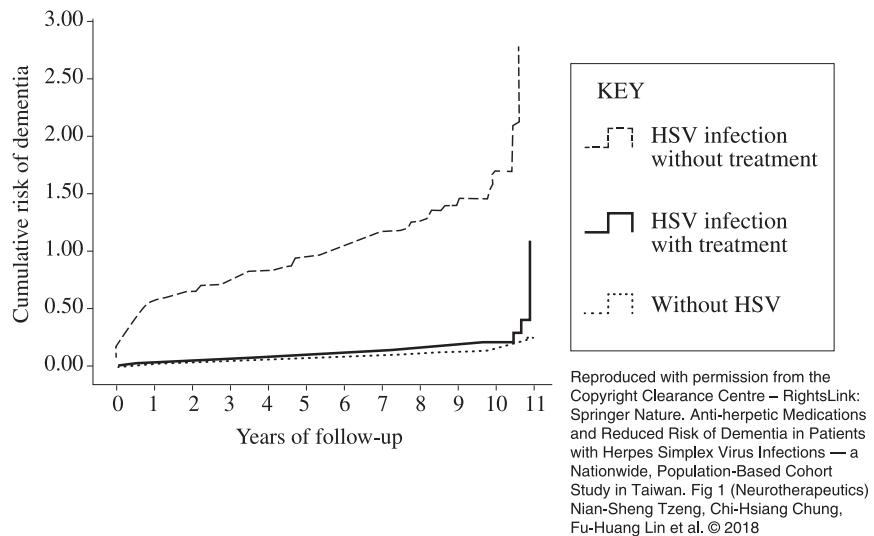
KEY

- - - HSV infection without treatment

� HSV infection with treatment

····· Without HSV

Reproduced with permission from the Copyright Clearance Centre – RightsLink: Springer Nature. Anti-herpetic Medications and Reduced Risk of Dementia in Patients with Herpes Simplex Virus Infections — a Nationwide, Population-Based Cohort Study in Taiwan. Fig 1 (Neurotherapeutics) Nian-Sheng Tzeng, Chi-Hsiang Chung, Fu-Huang Lin et al. © 2018

Diseases are classified as infectious or non-infectious.

Evaluate whether Alzheimer's disease should be classified as an infectious disease or a non-infectious disease. In your answer, include reference to the information and data provided above. *(8 marks)*

Worked Solutions

Worked Solutions

1. BIOLOGY, M7 2020 HSC 4 MC

The *Plasmodium* is the pathogen that causes malaria disease, while the mosquito transmits the pathogen and is therefore the vector.

$\Rightarrow C$

2. BIOLOGY, M7 EQ-Bank 1 MC

→ Pathogens can be macroscopic, microscopic or viral, but are all fundamentally agents of infectious disease.

$\Rightarrow A$

3. BIOLOGY, M8 2019 HSC 1 MC

→ Virus, bacteria and fungi are all pathogens; disease carriers which can be transmitted between hosts.

→ Gene mutations are changes in DNA and cannot be transmitted to others by contact or vectors.

$\Rightarrow D$

4. BIOLOGY, M7 2019 HSC 7 MC

→ The area of each circle shows the amount of bacterial growth each antibiotic has inhibited.

→ The larger the circle, the more effective that antibiotic is at inhibiting bacterial growth.

→ Antibiotic W has the most consistently large disc, and should be used to treat the patient.

$\Rightarrow A$

5. BIOLOGY, M7 EQ-Bank 3 MC

→ The pathogen is most likely to have adapted to be transmitted through conditions which are moist and can be more effective at entering through the gastrointestinal tract.

$\Rightarrow C$

6. BIOLOGY, M7 2022 HSC 10-11 MC

Q10.

→ The flask was changed in each test therefore it is the independent variable.

$\Rightarrow B$

Q11.

→ Pasteur's experiment was conducted to show that microbes arise from existing cells in the air, disproving spontaneous generation.

♦ Mean mark (Q11) 40%.

$\Rightarrow A$

7. BIOLOGY, M7 2017 HSC 14 MC

→ Protozoans are unicellular organisms with no cell walls.

→ Fungi cells have cell walls.

♦ Mean mark 43%.

$\Rightarrow C$

8. BIOLOGY, M7 2020 HSC 7 MC

→ The different food samples are deliberately selected (independent).

→ The number of microbes is a consequence of the specific food samples (dependent).

→ An agar plate with a food sample would be a base of comparison (experimental control) while temperature would be a controlled variable.

$\Rightarrow A$

♦ Mean mark 49%.

9. BIOLOGY, M7 2021 HSC 14 MC

→ Infectious, as CJD can be caused by an infectious agent, i.e. ingesting tissue that contains the misfolded protein.

→ Genetic, as CJD can be caused by mutation.

$\Rightarrow A$

♦♦ Mean mark 39%.

10. BIOLOGY, M7 2015 HSC 9 MC

→ Pathogen structure and size are indicative of a fungus.

$\Rightarrow C$

♦♦♦ Mean mark 27%.

11. BIOLOGY, M7 2015 HSC 25

a. Successful answers could include one of the following:

→ A pathogenic microbe might be cultured during the process.

→ Post experiment, agar plates must be heated under high pressure to kill any microbes cultured before disposal.

b. Results of experiment:
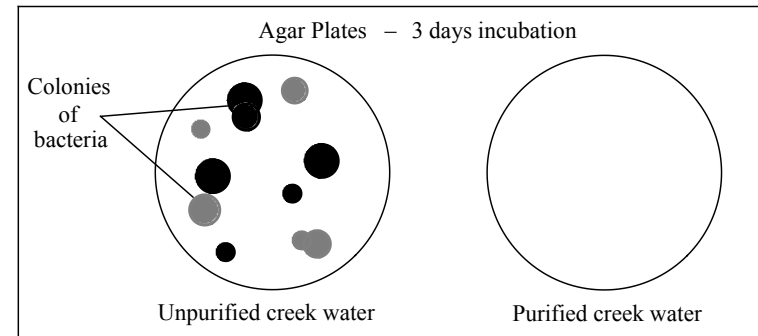
12. BIOLOGY, M7 2021 HSC 21

a. Include two of the following labels:
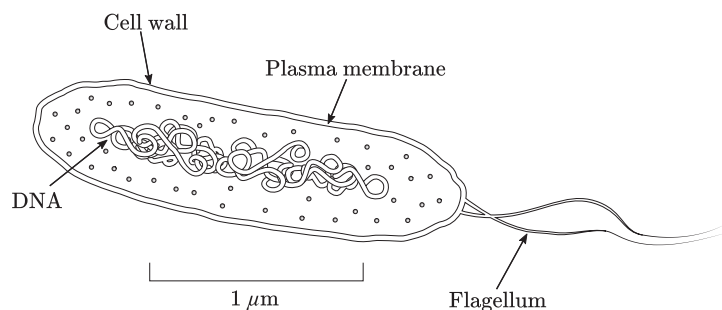
b. Box 2: Bacteria grown in pure culture and identified.

Box 4: Healthy pig became ill with diarrhoea.

c. Benefits and Limitations of the strategies used on each farm.

The use of antibiotics on farm 1 has resulted in a rapid elimination of diarrhoea cases, however may induce antibiotic resistance in the future, rendering the strategy less effective.

The removal of rats and mice from pig sheds to increase hygiene on farm 2 is slow to eliminate diarrhoea cases, however provides reassurance to prevent future outbreaks.

Other correct answers:

- Proper hygiene practices can reduce incidence of other diseases, not just diarrhoea.

13. BIOLOGY, M7 2018 HSC 22b

→ Robert Koch demonstrated a relationship between microbes and infectious disease.

Mean mark 58%.

→ Koch revealed that specific infectious diseases were caused by specific microbes.

→ He developed Koch's postulates which allow for the identification of specific diseases.

14. BIOLOGY, M7 2018 HSC 22a

Pasteur's swan-neck flask experiment

→ The straight necked flask became contaminated after a few days, whereas, the sterile swan-neck flask confined the germs in the curved section of the neck and no contamination occurred.

♦ Mean mark (b)(i) 41%.

Mean mark (b)(ii) 51%

→ This proved that microbes are produced from pre-existing microbes and not from the air itself.

15. BIOLOGY, M7 EQ-Bank 11

Pathogen	Distinguishing characteristic of the pathogen	Disease caused by the pathogen
Bacteria	DNA not enclosed in membrane, flagella.	Whooping cough, salmonella
Fungi	No organelles, cell wall.	Tinea
Protozoans	Single cell, eukaryotic.	Malaria

16. BIOLOGY, M7 2019 HSC 31

a. → *Helicobacter pylori* is a bacteria that causes stomach ulcers.

→ It has flagellum which allows it to move in the stomach and penetrate the stomach wall.

♦♦ Mean mark (a) 36%.

Other answers could include:

→ *Salmonella* and its ability to adapt to host blood temperature.

b. → Diseases will be able to spread faster and easier with certain modes of transmission.

→ Airborne disease such as influenza are able to spread faster as the virus can be passed through droplets of air by infected individuals sneezing/coughing.

→ Diseases that can only spread via direct contact will have lower infection rates as there is a less effective mode of transmission.

Other answers could include the effectiveness of modes such as

→ Vectors and their presence in an area influencing infection rate.

→ Foodborne/waterborne diseases.

→ Zoonotic diseases.

17. BIOLOGY, M7 2016 HSC 25

a. → The rabies virus is very small in size.

→ It is unable to be seen by the naked eye under light microscopes.

Mean mark (a) 52%.

b. → Dog saliva contains many microorganisms.

→ Any of these could have been responsible for causing rabies.

Mean mark (b) 54%.

→ It was necessary for Pasteur to isolate and culture the specific microorganism he believed to be causing the disease.

→ A healthy host without symptoms needed to be injected with one of the isolated microorganisms and develop the disease.

→ By trial and error of this process, Pasteur could deduce which microorganism had caused the rabies.

18. BIOLOGY, M7 2020 HSC 32a

Successful answers should include two of the following:

→ The rabies virus can travel through the nervous system which allows it to reach the salivary glands.

Mean mark 51%.

→ The virus can then be directly transmitted to another host with a bite from the infected host.

→ The virus can replicate in muscle after an infected bite.

19. BIOLOGY, M5 2020 HSC 32b

i. Rabies virus cannot be a singular pathogen:

→ This pathogen contains only a single strand of RNA which only codes for five proteins.

→ Cellular pathogens such as bacteria contain a much larger genome in the form of DNA that allows the pathogen to perform complex processes without relying on a host.

♦♦ Mean mark (i) 33%.

ii. The Role of Viral RNA

→ The viral RNA polymerase (which is made from L and P proteins) is responsible for the production of the viral proteins and RNA which are components of the rabies viruses.

→ RNA polymerase is responsible for transcription of viral RNA into mRNA, which is then used by the host's ribosomes to produce viral proteins.

→ RNA polymerase is also responsible for the replication of the viral RNA. In this process, a complementary RNA strand is produced from the original RNA strand. This strand is then used as a template for RNA polymerase to rapidly produce more RNA, complementary to the template. The new RNA will therefore be identical to the original.

→ In this way, RNA polymerase is essential in producing viral proteins and new RNA strands which form new rabies virus particles.

♦♦♦ Mean mark (ii) 29%.

20. BIOLOGY, M7 2019 HSC 33d

Infectious vs non-infection disease classification

→ Infectious diseases are a result of pathogens, biological agents of disease, which transmit disease between hosts. A pathogen is a cause of a certain disease if it meets the criteria in Koch's postulates.

→ The study above shows the association between HSV and Alzheimer's.

→ The study is conducted over a long period and includes a large and controlled sample size, so the assumption can be made that the findings are valid.

→ HSV is an infectious disease as it is caused by a pathogen, the virus *Herpes simplex*.

→ The findings show that treating HSV with antiviral medication also reduces the risk of developing Alzheimer's.

→ This may mean that Alzheimer's is also a virus and therefore an infectious disease.

→ Non-infectious diseases are not contagious and do not spread from person to person. They are a result of environmental factors or genetic conditions.

→ Alzheimer's is the result of a build-up of the amyloid beta protein, which is produced in the brain.

→ The synthesis of this protein is regulated by the APOE gene. This gene also has various alleles, each of which in different combinations can increase or decrease a individual's risk of developing Alzheimer's.

→ This indicates that Alzheimer's is a non-infectious disease, as it is not transmitted by a pathogen. Rather, it results from a natural build up of a specific protein, which may be accelerated or reduced based on genotype.

Conclusion

→ From the information provided it is not possible to accurately classify Alzheimer's as either an infectious or non-infectious disease.

→ There is evidence to support that the risk of developing Alzheimer's can be linked to both antiviral and virus traits as

♦♦ Mean mark 46%.

well as genotype.