



JAMES RUSE AGRICULTURAL HIGH SCHOOL

2020

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions	Total Marks – 100
• Reading time – 5 minutes • Working time – 3 hours • Write using black pen. • Draw diagrams using pencil. • NESA approved calculators may be used. • Write your Student Number at the top of the response sheet on page 11	Section I – Pages 2 – 10 20 marks • Attempt Questions 1 – 20 • Allow about 35 minutes for this part Section II – Page 12 – 30 80 marks • Attempt Questions 21– 31 • Allow about 2 hours and 25 minutes for this section

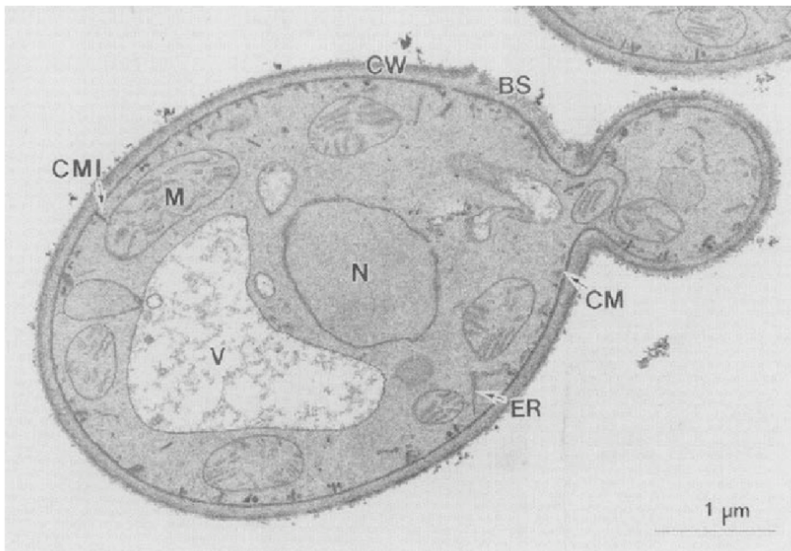
Section I

20 marks

Attempt Questions 1 – 20.

Complete the multiple choice answer sheet on page 11.

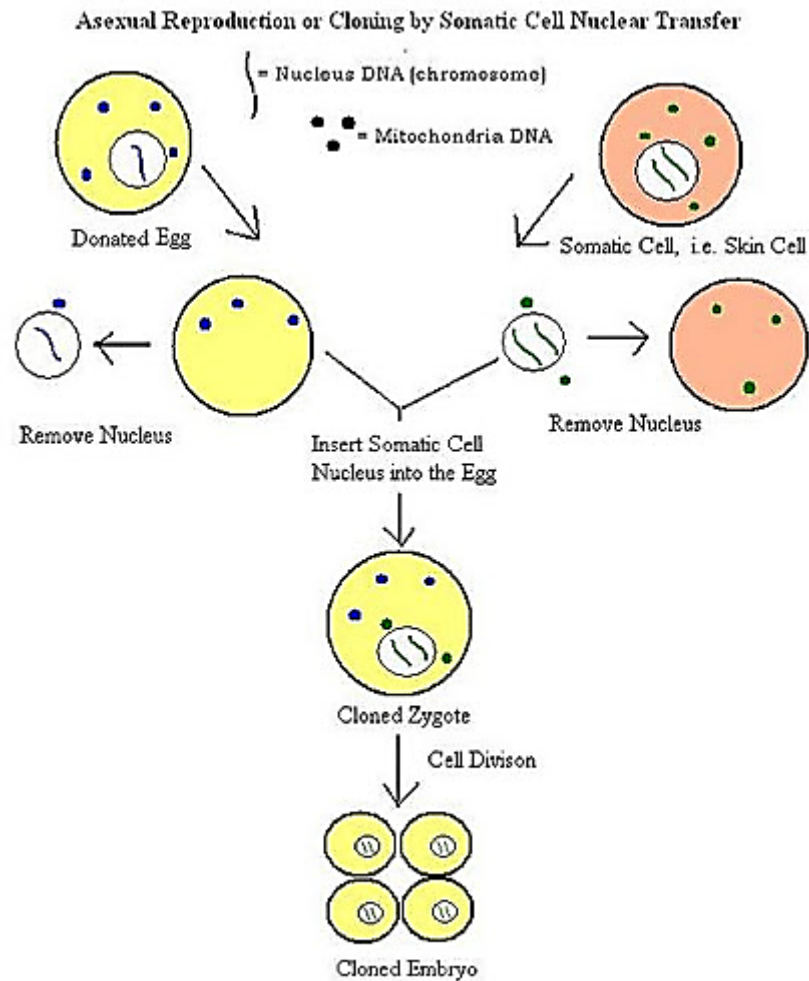
- 1 The nitrogenous base uracil pairs with which other base?
- A. Adenine
 - B. Cytosine
 - C. Guanine
 - D. Thymine
- 2 Examine the following diagram of a pathogen undergoing a reproductive process:



What type of pathogen is it most likely to be?

- A. Virus
- B. Bacteria
- C. Fungus
- D. Protist

- 3 Koch's postulates can be used to determine:
- A. The most appropriate vaccination to combat a pathogen
 - B. How effective a public health campaign is at reducing the risk of contracting a disease
 - C. Whether a pathogen is responsible for causing a particular disease
 - D. The mode of transmission for a pathogen
- 4 Artificial pollination involves transferring pollen from one flower:
- A. to the anther of another flower.
 - B. to the ovary of another flower
 - C. to the stamen of another flower.
 - D. to the stigma of another flower
- 5 An infectious disease was found to be effectively controlled using improved water treatment methods.
What is the most likely method of transmission for this disease?
- A. Direct
 - B. Indirect
 - C. Vector
 - D. Hereditary
- 6 Red-green colour blindness is an X-linked trait. A woman who is red-green colour blind has a son with a man who has normal colour vision.
What is the chance that their son will have red-green colour blindness?
- A. 0%
 - B. 25%
 - C. 50%
 - D. 100%
- 7 In 1996, somatic cell nuclear transfer produced the first artificially cloned mammal, Dolly the sheep.



Which statement about Dolly's complete genome is true?

- A. Dolly was completely genetically identical to the sheep that provided the donor egg.
- B. Dolly was completely genetically identical to the sheep that provided the donated nucleus.
- C. Dolly was completely genetically identical to the sheep that provided the donor egg and the donated nucleus.
- D. Dolly was not completely genetically identical to either the sheep that provided the donor egg or the sheep that provided the donated nucleus.

8 Consider the following processes that occur as part of the cell cycle and reproduction:

A *synthesis* → B *meiosis I* → C *meiosis II* → D *fertilisation* → E

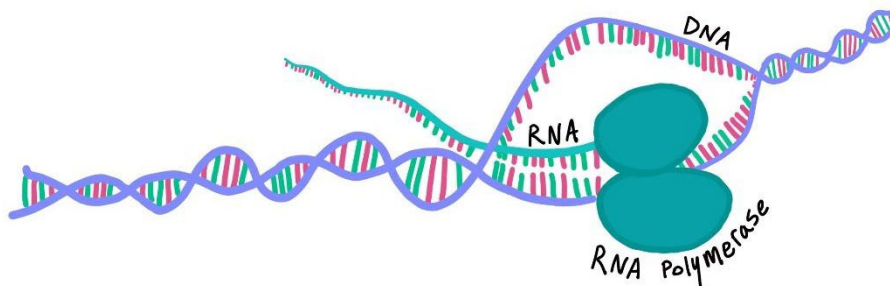
Which statement about the number of chromosomes is true?

- A. N chromosomes are present in an individual cell at stage A
- B. 4N chromosomes are present in an individual cell at stage B
- C. 2N chromosomes are present in an individual cell at stage C
- D. N chromosomes are present in an individual cell at stage D

9 When the temperature of the blood is above its set point, which of the following could occur?

- A. The pituitary gland releases a hormone to sweat glands to induce sweating.
- B. The hypothalamus sends a nervous signal to the muscles to rapidly contract.
- C. The pituitary gland releases a hormone to body cells to increase metabolic rate.
- D. The hypothalamus sends a nervous signal to arterioles to induce vasodilation.

10 Examine the following diagram:



Which of the following processes is being represented?

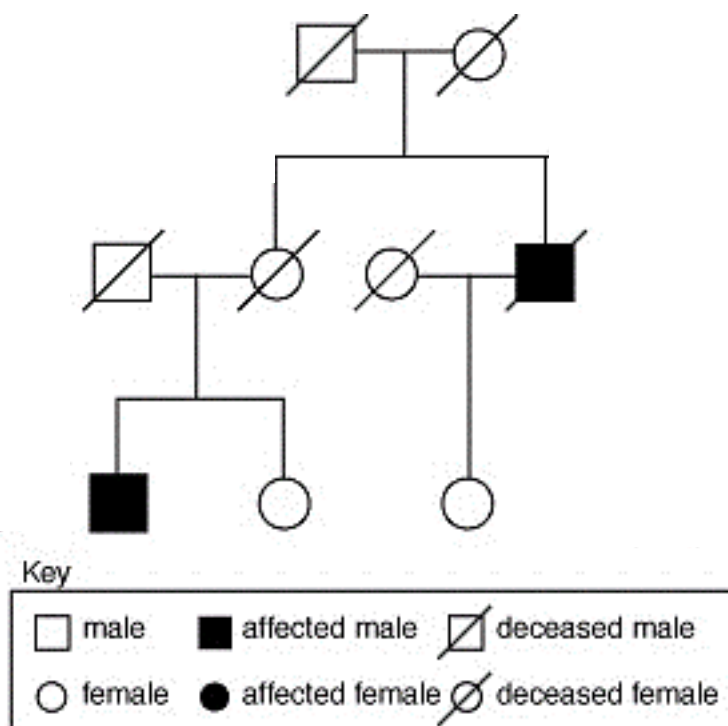
- A. Polymerisation
- B. Replication
- C. Transcription
- D. Translation

- 11 In humans, the rupture of an ovarian follicle occurs after a surge in which of the following hormones?
- A. Oestrogen
 - B. Progesterone
 - C. Luteinising hormone
 - D. Follicle stimulating hormone
- 12 After a careless laboratory injury involving laceration due to a broken test tube, a student observes later that afternoon that the cut is red, hot and swollen.
Which component of the immune system is most likely involved in this response?
- A. Plasma B cells
 - B. Cytotoxic T cells
 - C. Neutrophils
 - D. Antibodies

- 13 Mutation, gene flow and genetic drift can affect the gene pool of populations. Which of the following statements about the effects of these processes is true?

- A. Mutation and gene flow both increase the size of the gene pool.
- B. Mutation and genetic drift both increase the size of the gene pool.
- C. Gene flow and genetic drift both decrease the size of the gene pool.
- D. Mutation and genetic drift both decrease the size of the gene pool.

- 14 Consider the following pedigree chart for a hereditary condition:



The causes of death of the deceased individuals are not related to the heredity condition.

Individual III-3 is expecting a child with a male who is known to be a carrier of the condition.

What is the probability that the child will have the condition?

- A. 0%
- B. 25%
- C. 50%
- D. 100%

- 15** In order to investigate the microbes present in a range of water samples, a group of students carried out the following procedure:
1. 12 identical agar plates were made in sterile petri dishes.
 2. Samples of tap water, rain water and dam water were collected.
 3. 3 agar plates were sealed.
 4. An inoculation loop was heated in a Bunsen flame, cooled, inserted into the tap water sample then swiped over the surface of one of the remaining agar plates.
 5. The agar plate was then sealed.
 6. Steps 4-5 were repeated twice
 7. Steps 4-6 were repeated with the rain water sample and then the dam water sample.
 8. All plates were incubated for 3 days at 35 °C.
 9. Each plate was observed, and the number, appearance, size and shape of each colony was recorded.
 10. The agar plates were heated and then disposed of.

Which of the following statements about the procedure is true?

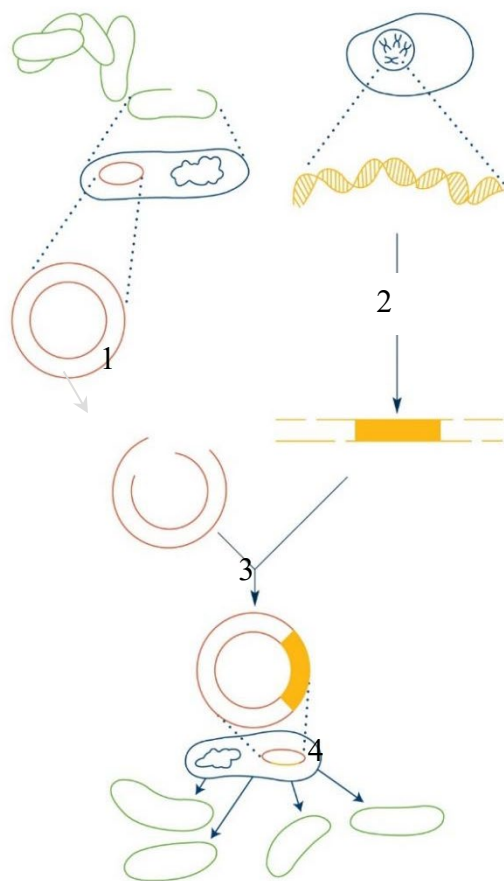
- A. Step 4 is important for ensuring reliability
 - B. Step 3 is important for ensuring controlled variables
 - C. Step 8 is important for ensuring a safe working environment
 - D. Step 1 is important for ensuring validity
- 16** The BRCA 1 gene is a tumour suppressor gene involved in the repair of double stranded breaks. Mutations to this gene are associated with significantly higher risks of cancer, in particular breast and ovarian cancer in women.

Mutations generally render the protein product non-functional. Although an individual only needs one functioning copy of this gene, the risk of developing these cancers is inherited in an autosomal dominant fashion. No patient has ever been observed to have inherited a mutated allele from both parents.

Which of the following statements is consistent with this information?

- A. A mutation in one allele means that the other allele has to work harder, increasing the risk of cancer.
- B. An interaction between the environment and the protein produced by the mutated BRCA1 gene determines whether or not the cancer develops.
- C. Damage to the functional allele is unable to be repaired properly, leading to a cancerous cell.
- D. Being homozygous for the mutation offers a level of protection against cancer.

Use the following diagram of DNA recombination to answer Questions 17 and 18.



17 Which step requires the addition of DNA ligase?

- A. 1
- B. 2
- C. 3
- D. 4

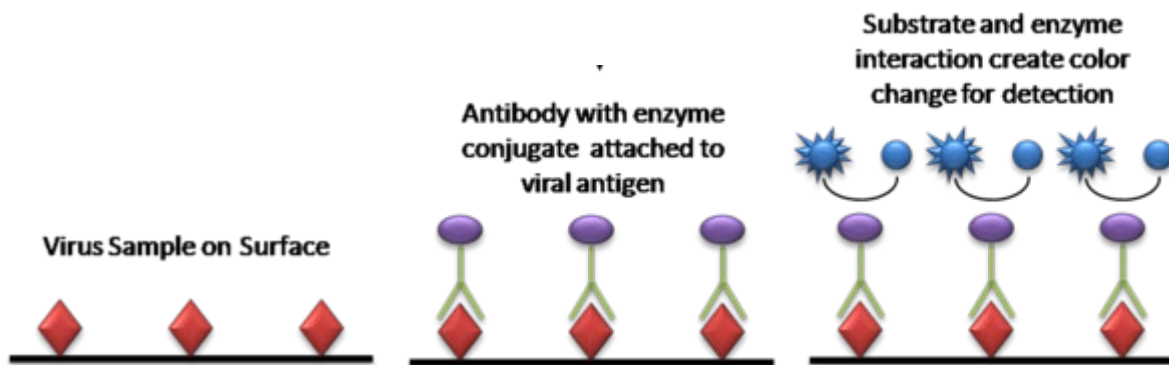
18 Antibiotic resistant genes are commonly included in the bacterial plasmid as part of the DNA recombination process.

Which of the following best explains the inclusion of antibiotic resistant genes?

	Fate of antibiotic resistant gene in successful DNA recombination	Purpose of antibiotic resistant gene
A.	Broken	To determine if recombination has occurred
B.	Broken	To determine if transformation has occurred
C.	Intact	To determine if recombination has occurred
D.	Intact	To determine if transformation has occurred

Use the following information to answer Questions 19-20.

Enzyme-linked immunosorbent assay (ELISA) is a technique that can be used to detect antigens. In the first step of an ELISA, antigens from the sample (e.g. a virus) to be tested are attached to a surface. Then, in the second step, a matching antibody is applied over the surface so it can bind to the antigen. This antibody is linked to an enzyme and then any unbound antibodies/enzymes are removed. In the third and final step, a substance containing the enzyme's substrate is added. If the antigen is present, the subsequent reaction produces a detectable signal, most commonly a colour change.



- 19 Which component of an ELISA is responsible for detecting a specific antigen?
- A. Antigen
 - B. Antibody
 - C. Enzyme
 - D. Substrate
- 20 Which component of an ELISA is responsible for the ability to detect an antigen at low concentration?
- A. Antigen
 - B. Antibody
 - C. Enzyme
 - D. Substrate

Section I**Multiple Choice Answer Sheet**

- | | | | | |
|-----|----------------------------|----------------------------|----------------------------|----------------------------|
| 1. | A ☐ | B ☐ | C ☐ | D ☐ |
| 2. | A ☐ | B ☐ | C ☐ | D ☐ |
| 3. | A ☐ | B ☐ | C ☐ | D ☐ |
| 4. | A ☐ | B ☐ | C ☐ | D ☐ |
| 5. | A ☐ | B ☐ | C ☐ | D ☐ |
| 6. | A ☐ | B ☐ | C ☐ | D ☐ |
| 7. | A ☐ | B ☐ | C ☐ | D ☐ |
| 8. | A ☐ | B ☐ | C ☐ | D ☐ |
| 9. | A ☐ | B ☐ | C ☐ | D ☐ |
| 10. | A ☐ | B ☐ | C ☐ | D ☐ |
| 11. | A ☐ | B ☐ | C ☐ | D ☐ |
| 12. | A ☐ | B ☐ | C ☐ | D ☐ |
| 13. | A ☐ | B ☐ | C ☐ | D ☐ |
| 14. | A ☐ | B ☐ | C ☐ | D ☐ |
| 15. | A ☐ | B ☐ | C ☐ | D ☐ |
| 16. | A ☐ | B ☐ | C ☐ | D ☐ |
| 17. | A ☐ | B ☐ | C ☐ | D ☐ |
| 18. | A ☐ | B ☐ | C ☐ | D ☐ |
| 19. | A ☐ | B ☐ | C ☐ | D ☐ |
| 20. | A ☐ | B ☐ | C ☐ | D ☐ |

/20

Section II – 80 marks

Attempt Questions 21 – 31

Allow about 2 hour and 25 minutes for this part.

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
 - Show all relevant working in questions involving calculations
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Question 21 (3 marks)

Describe ONE response of a named Australian plant to a named pathogen.

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Question 22 (3 marks)

Compare the features of bacteria and viruses.

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Question 23 (5 Marks)

Complete the following table for a named non-infectious disease.

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Name of disease	
Cause of disease	
Effect of disease	
1 st method of prevention	
2 nd method of prevention	

Question 24 (3 marks)

Outline the process of translation.

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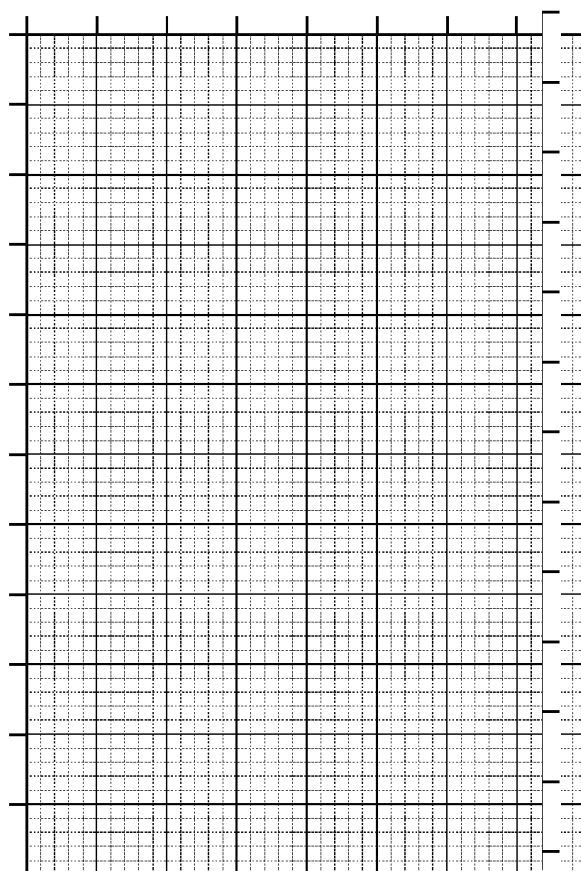
Question 25 (13 Marks)

The following data refer to the effect of soil temperature on the germination of onion seeds.

Temperature (°C)	% Seeds germinating	Time taken for seeds to emerge (days)
0	90	136
5	98	31
10	98	13
15	98	7
20	99	5
25	97	4
30	91	4
35	73	13
40	2	25

(a) Graph all the data on the grid provided.

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Question 25 continues on the next page

Question 25 (continued)

(b) Describe the trends in the graph.

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(c) With reference to your graph in part (a), discuss the optimal temperature for planting onion seeds.

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(d) Evaluate the impact of scientific knowledge on the manipulation of plant reproduction in agriculture using ONE example other than germination temperature.

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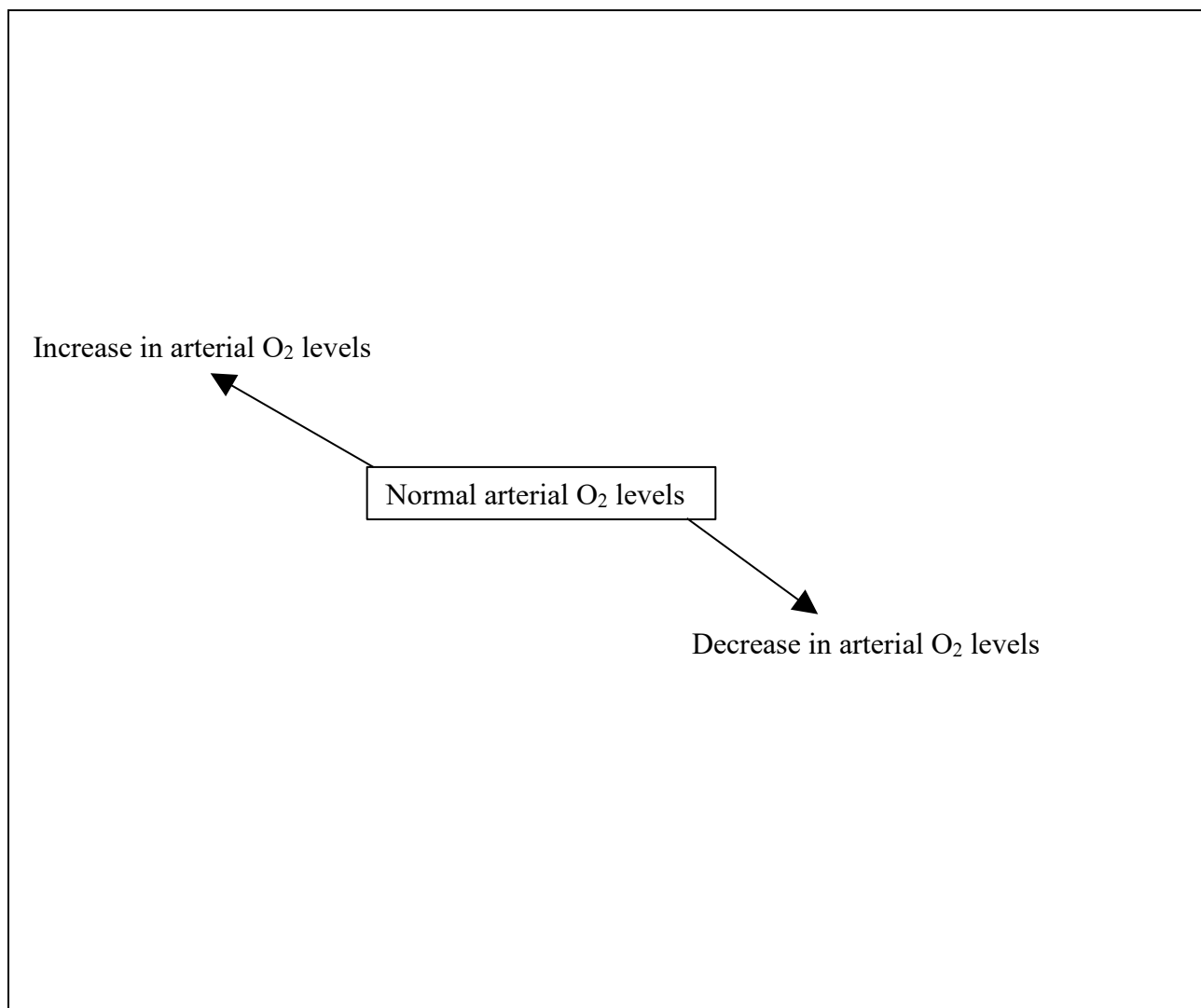
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Question 26 (8 Marks)

The average resting heart rate in an adult is about 70 beats per minute. The contraction of heart muscle cells is controlled by pacemaker cells which create rhythmic impulses. The pacemaker cells are controlled by the sympathetic nervous system, which acts to increase the heart rate and the parasympathetic nervous system, which acts to decrease the heart rate.

A number of factors affect the heart rate, in particular the partial pressure of oxygen in arterial blood. When low oxygen levels (hypoxia) are detected by chemoreceptors in the carotid body, a message is sent to cardiorespiratory centre in the medulla oblongata and the sympathetic nervous response is increased. When high oxygen levels (hyperoxia) are detected, the parasympathetic nervous response is increased.

- (a) Complete the following diagram showing the homeostasis of arterial oxygen levels, identifying stimuli, receptors, effectors and responses. **6**



Question 26 continues on the next page

Question 26 (continued)

- (b) Explain why the control of heart rate due to changes in oxygen levels is controlled by the nervous system rather than the endocrine system. **2**

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Question 27 (8 Marks)

The basic coat colours of horses include bay, chestnut and black.

The MC1R gene controls the production of red and black pigment. There are three alleles of this gene: E, e, and e^a. The e and e^a alleles are recessive to E. In individuals with the E allele, black pigment is produced. In those individuals without the E allele red pigment is produced instead.

The ASIP gene, also known as Agouti, controls the distribution of black pigment, if there is any black pigment. The dominant allele (A) restricts black pigment to the points of the horse (mane, tail, lower legs, ear rims), while the recessive form (a) distributes black pigment uniformly over the body.



(a) Using the example above, explain the meaning of the term “multiple alleles”.

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(b) Identify TWO possible genotypes of the bay horse, as shown above.

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Possible genotype 1	
Possible genotype 2	

Question 27 continues on the next page

Question 27 (continued)

(c) A chestnut horse is being considered for a breeding program to produce black horses.

(i) Explain why genetic testing would be needed.

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(ii) Justify which of DNA sequencing or DNA profiling would be necessary to determine if the horse is suitable for the breeding program.

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Question 28 (10 Marks)

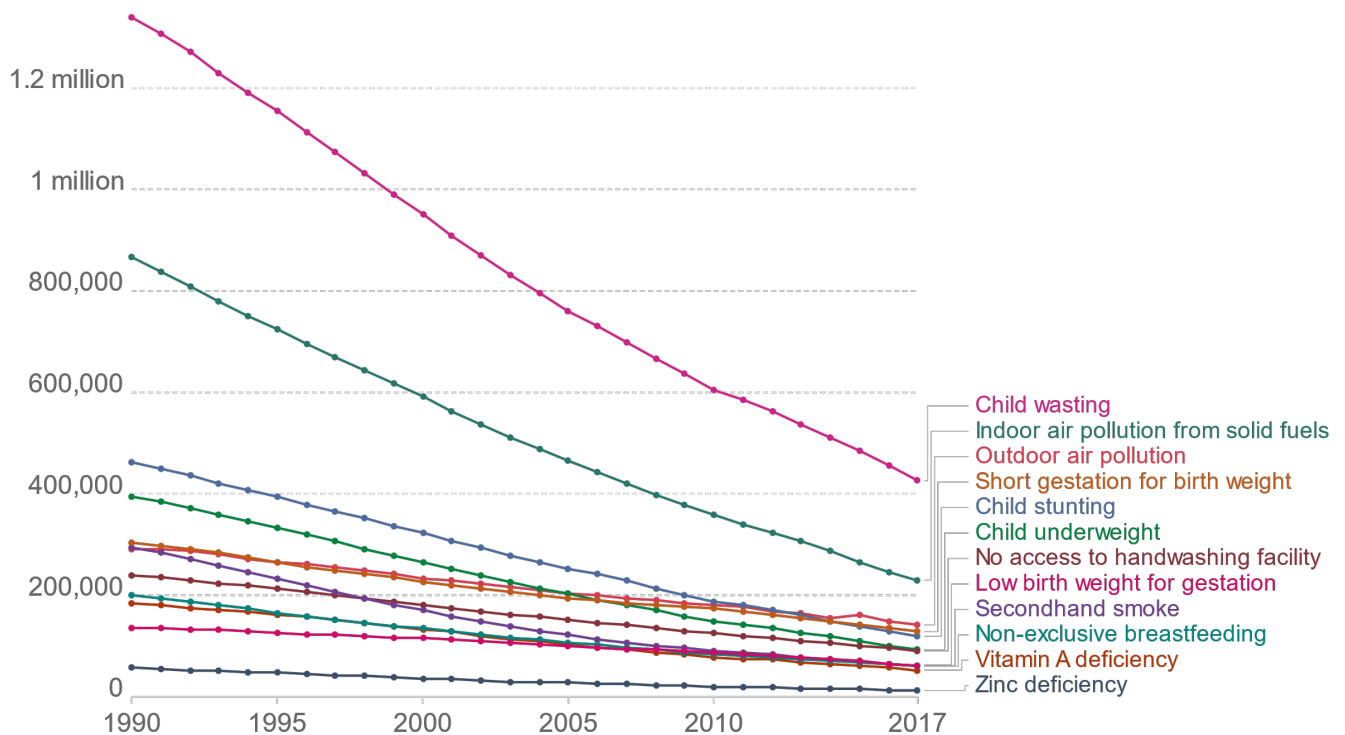
Pneumonia is an alveolar infection caused by a range of pathogens, including bacteria, viruses and fungi. The alveoli fill with pus and fluid, reducing oxygen intake and making breathing painful.

In 2017, pneumonia was the leading cause of death in children under the age of 5, responsible for over 800,000 fatalities, down from over 2 million per year in 1990. Although it is transmitted by air droplets, it is not highly contagious and is frequently the result of the consequences of poverty, with the largest risk factor having a weight too low for height (child wasting).

Child deaths from pneumonia by risk factor, World, 1990 to 2017



Shown is the number of deaths of children younger than five from pneumonia and other lower respiratory diseases by risk factor that was estimated to be responsible for these deaths.



Source: IHME, Global Burden of Disease Study (2017)

OurWorldInData.org/pneumonia • CC BY

Note: Risk factors can interact and overlap for a given cause of death; therefore the sum of deaths attributed to risk factors will exceed the total number of deaths from pneumonia.

Slightly more than half of fatal infections of children under the age of 5 were caused by the bacterium *Streptococcus pneumoniae*, which normally lives in the upper respiratory tract without causing illness. If the upper respiratory tract becomes compromised, then the bacterium can infect the lower respiratory tract, causing symptoms. A vaccine covering several strains of *Streptococcus pneumoniae* is available, which is 80% effective against the included strains.

Question 28 continues on the next page

Question 28 (continued)

- (a) Explain how the use of a vaccine may prevent an infection of *Streptococcus pneumoniae*.

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- (a) Using the data provided, justify THREE public health campaigns, apart from vaccination, that could significantly reduce the death rate of children under 5 due to pneumonia.

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Question 28 continues on the next page

Question 28 (continued)

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End of Question 28

Question 29 (3 marks)

Describe the use of ONE technology to assist with the effects of a non-infectious disease or disorder.

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Question 30 (7 Marks)

Epidemiological studies can be used to investigate both infectious and non-infectious diseases.

(a) Read the following extract from an article about the infectious disease diphtheria:

Diphtheria patients presented with fever, pharyngitis, and a patch in the throat. Data collected for each patient included age, clinical presentation, morbidity, mortality, bacteria isolated from culture, and immunization status.

Of the 61 950 admissions from January 2008 to December 2012, 2925 (4.7%) had clinical diphtheria; 1194 had been immunized and 1731 were non-immunized. Immunized patients had a milder disease. Culture-positive immunized patients were positive for *Corynebacterium* other than diphtheriae (COD; $n = 104$) or *Corynebacterium diphtheriae* (CD; $n = 23$); these patients suffered mild disease and recovered completely. In contrast, culture-positive non-immunized patients were positive for COD ($n = 11$) or CD ($n = 412$). Eighty-one patients (3%) died, 77 of whom were non-immunized; death was usually as a result of myocarditis. Seventy-three percent of deaths were in patients aged <5 years.

(a) Using the information above, complete the following table:

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	Infectious Disease
Study	Diphtheria in Andhra Pradesh
Type of study	
Summary of study findings	

Question 30 continues on the following page

Question 30 (continued)

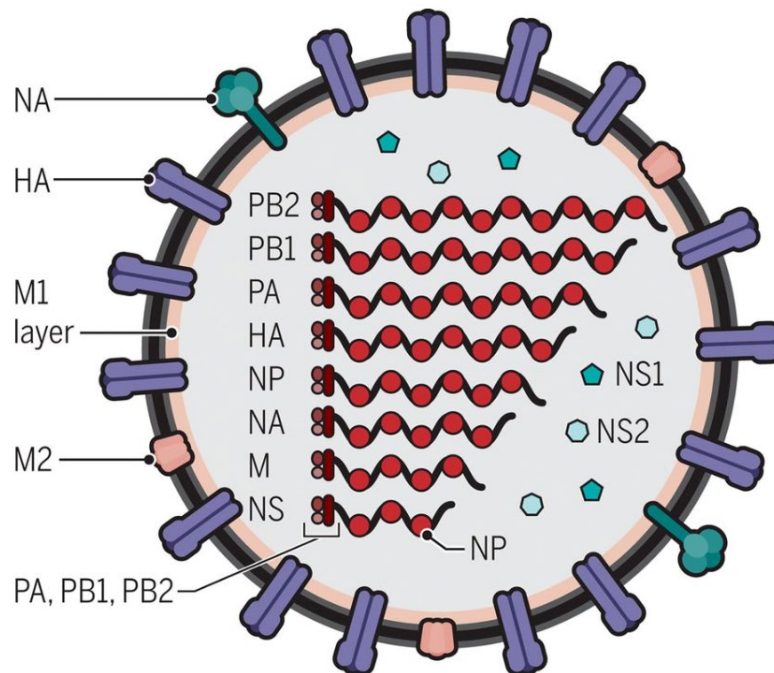
- (b) As part of your studies, you investigated an epidemiological study of a non-infectious disease.
Using your investigation complete the following table. 4

	Non-infectious Disease
Study	
Type of study	
Summary of study findings	

Question 31 (17 Marks)

The influenza A virus is an RNA virus that infects birds and some mammals, including humans. There are a number of subtypes, described by the type of HA protein and NA protein e.g. H1N1, H5N2. Within a subtype there are multiple strains, which vary in their pathogenic ability between host species.

The genome of influenza A is spread across 8 segments and contains at least 10 genes as shown below in the diagram of the virus.



Each segment comprises single-stranded negative-sense RNA, which needs to be transcribed to a positive-sense mRNA using RNA polymerase before translation by the host. The genes PA, PB1 and PB2 together form the RNA polymerase. Each segment is transcribed in the host nucleus, with segment M containing two genes for matrix proteins (M1 and M2) and segment NS containing two genes for non-structural proteins (NS1 and NS2). The other segments each contain one gene.

The virus infects the host using surface HA proteins which bind to epithelial cells in the upper respiratory tract. These cells then import the virus by endocytosis. Once inside the cell, the viral RNA and proteins are released into the cytoplasm, then transported into the nucleus where viral replication and protein synthesis occur.

New virus particles form when the copied RNA and proteins enter a cluster of HA and NA which forms the new membrane and buds off from the host cell. The NA protein allows the newly-formed virus particle to leave the surface of the host cell and subsequently infect another cell.

Infected cells release a range of molecules which prevent viral entry into nearby cells and attract natural killer cells, macrophages and neutrophils. Dendritic cells present viral antigens to naïve T cells, and eventually antibodies are produced.

Question 31 continues on the next page

Question 31 (continued)

- (a) The RNA polymerase has no proof-reading function, leading to high rate of mutation, about one error per replication. This is termed antigenic drift. Immunity to one strain is likely to result in immunity to a mutated form when the difference in antigens is small.

Outline TWO possible consequences of point mutation in the coding regions of influenza A.

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- (b) In which of the influenza A genes is point mutation most likely to affect the ability of the adaptive immune system to combat the pathogen after a secondary infection?

Justify your response.

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Question 31 continues on the next page

Question 31 (continued)

- (c) If more than one type of influenza A virus particle infects a cell, different combinations of segments can combine to make new viral particles through reassortment. This is termed antigenic shift. For example, there are 18 variants of the HA gene and 11 variants of the NA gene. Immunity to one subtype is unlike to result in immunity to another subtype. Recombination can also occur in an analogous manner to crossing over during meiosis.

New strains which become responsible for epidemics occasionally form in regions of poultry farming.

Propose how this might occur.

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Question 31 continues on the next page

Question 31 (continued)

(d) How important is it for genetic material to be replicated exactly?

Consider the lifecycles of both pathogen and host, using at least TWO examples from infectious diseases that you have studied.

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Question 31 continues on the next page

Question 31 (continued)

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End of Question 31

End of exam

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dotted lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

Question 1

A. Uracil pairs with adenine. It replaces thymine in RNA. Cytosine and guanine pair. (Av 0.93)

Question 2

C. The process shown is budding. The cell has a nucleus and a cell wall, so can not be a prokaryote or protist. It is a fungus. (Av 0.53)

Question 3.

C. Koch's postulates is a set of criteria which are used to determine if a pathogen is responsible for an infectious disease. (Av 0.93)

Question 4.

D. Pollination involves transferring the pollen from the anther to the stigma. The pollen then buries through the style until it reaches the ovary where fertilization may occur. (Av 0.63)

Question 5.

B. Since water treatment reduces the rate of disease, it is most likely transmitted through drinking water, which is an indirect means of transmission. (Av 0.79)

Question 6.

D. The mother possesses the alleles X^rX^r and the father X^RY . Any son would inherit one X^r from his mother and one Y from the father, giving a genotype X^rY and a colourblind phenotype. (Av 0.88)

Question 7.

D. Dolly's complete genome consisted of her chromosomal DNA and mitochondrial DNA. Although the chromosomal DNA is identical to the DNA from the somatic cell donor, there is mitochondrial DNA from the egg donor. (Av 0.12)

Question 8.

D. There are $2N$ at stages A, B, and E. There are N at stages C and D. (Av 0.63)

Question 9.

D. Sweating is a nervous response, shivering and an increase in metabolic rate would be induced if the temperature were too low. (Av 0.65)

Question 10.

C. Transcription occurs when a DNA template is used to form an mRNA molecule. (Av 0.84)

Question 11.

C. Ovulation occurs shortly after a narrow, tall peak in the hormone LH. (Av 0.49)

Question 12.

C. The other three responses involve the third line of defence, and do not generally occur as quickly or to induce inflammation. (Av 0.77)

Question 13.

A. Mutation and gene flow increase the size of the gene pool and genetic drift reduces the size of the gene pool. (Av 0.79)

Question 14.

B. It is an autosomal recessive condition (otherwise a male could not be a carrier). Individual III-3 must be Aa (since one of her parents has the condition, but she does not), as does the father of the child. There is a 25% chance that their child will be AA. (Av 0.84)

Question 15.

D. Steps 1, 3, 4 improve validity. Step 8 would not be particularly safe as the incubation is close to body temperature and may cause potential pathogens to be preferentially incubated. (Av 0.72)

Question 16.

C. A heterozygous patient will be able to correctly repair defects until the functioning allele is damaged (normally, the damaged allele could be repaired using the other healthy allele). Having two damaged alleles would result in an inability to correct defects, and is likely to not survive to birth, hence no observed homozygous patients with the mutated allele. (Av 0.46)

Question 17.

C. In step 3, the DNA fragments and plasmid, having been cut with the same restriction enzyme, bind together with the same sticky ends. DNA ligase joins the sugar-phosphate backbone. (Av 0.86)

Question 18.

D. In bacteria which have taken up the plasmid (transformed), the application of the antibiotic will have no effect. In bacteria which have not taken up the plasmid (not transformed), the application of the antibiotic will kill the colony. (Note, a LacZ gene may also be used, this is broken and used to determine if recombination has occurred; colonies which are blue have been transformed with the unrecombined plasmid). (Av 0.3)

Question 19.

B. The antibody binds to the specific antigen, it will not bind to other antigens. (Av 0.6)

Question 20.

C. The presence of the enzyme will catalyse large amount of the substrate, meaning that low levels of the antigen will eventually show some colour change. (Av 0.35)

Question 21

3 marks	Identifies one Australian plant Identifies one pathogen of named plant Describes response of plant to pathogen
2 marks	Describes response of plant to class of pathogen OR Two of the above
1 mark	Identifies a response of plant to infection

Lomandra longiformia responds to *Phytophthora cinnamoni* by producing hydrogen peroxide, a reactive oxygen species which can kill the pathogen, reinforce the cell wall and trigger plant cell death to limit the spread of disease.

Comments: use specific examples of native Australian plants and names of pathogens rather than disease. Symptoms and responses are not necessarily the same thing. (Av 1.7, range 0-3)

Question 22

3 marks	Compares at least three structural and/or functional features
2 marks	Compares at least two structural and/or functional features
1 mark	Provides some relevant information

Bacteria	Viruses
Living	Non-living
Microscopic	Microscopic
Cellular	Non-cellular
Reproduce by binary fission	Reproduce by inserting DNA into host's genome and using host cell's machinery
Cell wall	No cell wall
Genetic material as DNA in chromosome and plasmid	Genetic material as RNA or DNA
No membrane bound organelles	No membrane bound organelles

Comments: A lot of students didn't compare features, just listing several without matching them. A table would help with this. There were many misconceptions: viruses are not eukaryotic, do not have a nucleus. Bacteria have a large chromosome. Viruses can have RNA or DNA. (Av 2.3, range 1-3)

Question 23

5 marks	Identifies name of non-infectious disease Provides specific cause of disease Provides detail on effects of disease Describes two suitable methods for prevention of disease
4 marks	4 of the above OR All of the above lacking minor detail
3 marks	3 of the above OR All of the above lacking detail
2 marks	2 of the above OR 3-4 of the above lacking detail
1 mark	Provides some relevant information

Mesothelioma

Cancer (uncontrolled cell division) of the mesothelium. 80% of cases caused by exposure to asbestos

Shortness of breath and fluid around the lungs

Legislation banning the use of asbestos in residential buildings

Wearing protective clothing and using respiration equipment when working with asbestos.

Comments: Students should be careful when selecting a disease to choose one that suits the question, in this case you needed two methods of prevention. (Av 4.5, range 3-5)

Question 24

3 marks	Outlines the role of mRNA and codons Outlines the role of tRNA and amino acids Identifies the function of translation
2 marks	Two of the above
1 mark	Provides some relevant information

Translation occurs when the information on a strand of mRNA is used to form a polypeptide. The mRNA enters the ribosome, and when a start codon is encountered, a tRNA molecule with the anticodon and corresponding amino acid binds to the mRNA. The mRNA chain then moves through the ribosome, with each triplet codon pairing with the complementary anticodon on a tRNA molecule and the corresponding amino acid is added to the growing amino acid chain, forming a polypeptide. When a stop codon is encountered, the mRNA leaves the ribosome and the polypeptide detaches.

Comments: a few students mixed up the processes of replication, translation and transcription. Some students confused protein and amino acids, and others did not mention tRNA or amino acids. (Av 2.2, range 0-3)

Question 25(a)

5 marks	Gives title and labelled axes with units Chooses suitable scale Correctly plots points Draws suitable line of best fit Distinguishes between the two sets of data
4 marks	4 of the above
3 marks	3 of the above
2 marks	2 of the above
1 mark	1 of the above

Comments: This was done fairly well. There should be a line of best fit, not dot-to-dot (Av 4.7, range 3-5)

Question 25(b)

2 marks	Describes the trends in both the curves
1 mark	Describes the trends in 1 of the curves OR Identifies a feature in both of the curves

The % germination rate at 0 °C is high at 90%, and increases to the high 90s between 5-25 °C, after which it rapidly decreases. The time taken for seedlings to emerge at 0 °C is very high at 136 days, before rapidly lowering to single digits between 15-30 °C, after which it increases with increasing temperature.

Comments: just describe the trends as they occur. This is not meant to be a trick question. (Av 1.6, range 1-2)

Question 25(c)

2 marks	Justifies optimal temperature in the range 20-25 degrees
1 mark	Identifies optimal temperature in the range 20-25 degrees

From the graph, we can see that the highest % germination rate is around 20 °C, and the lowest time to seedling emergence is 25 °C, As the time taken for seedlings to emerge at 20 °C is only one day longer than 25 °C, but a higher % germination rate, then around 20 °C is the optimal temperature.

Comments: This was fairly well done, but try to give a narrow range to show that you can interpret the graph. (Av 1.9, range 1-2)

Question 25(d)

4 marks	Describes scientific knowledge Describes the process of using the scientific knowledge to manipulating plant reproduction Describes the outcome of using the scientific knowledge to manipulating plant reproduction Evaluates impact of scientific knowledge on success of manipulating plant reproduction
1.93 marks	Identifies scientific knowledge Identifies the process of using the scientific knowledge to manipulating plant reproduction Identifies the outcome of using the scientific knowledge to manipulating plant reproduction
2 marks	2 of the above
1 mark	Provides some relevant information

The knowledge of the role of hormones in plants has been successful in manipulating plant reproduction in agriculture. Auxins are hormones with many roles in plants, including the promotion of root growth. The success rate of plant cuttings taking root is enhanced if auxins are applied to the cutting. For example, seedless watermelons can be propagated using asexual reproduction by taking a cutting, applying a powder or gel containing auxins to the cutting, and then planting the cutting in a sterile mixture.

Comments: remember to give details on the scientific knowledge and how it is used successfully (or not). (Av 3.0, range 1-4)

Question 26(a)

6 marks	Identifies stimuli, receptors, effectors and responses Correctly completes both pathways
5 marks	Identifies most of stimuli, receptors, effectors and responses

	Correctly completes both pathways OR Identifies stimuli, receptors, effectors and responses Completes both pathways missing one step
4 marks	Identifies some of stimuli, receptors, effectors and responses Correctly completes both pathways OR Identifies most of stimuli, receptors, effectors and responses Completes both pathways missing one step
3 marks	Correctly completes both pathways OR Identifies some of stimuli, receptors, effectors and responses Completes both pathways missing two steps
2 marks	Correctly completes one pathway OR Completes two pathways missing two steps
1 mark	Completes 1 pathway missing some steps

Comments: this was very similar to a question in last year's trial. A bit disappointing. A number of students did not know that an effector was a muscle or a gland i.e. the heart in this case. Some students did not identify the stimulus, response etc. (Av 4.3, range 2-6)

Question 26(b)

2 marks	Identifies that the nervous system is faster/shorter acting than endocrine system Identifies that incorrect O ₂ levels need to be corrected quickly
1 mark	One of the above

Incorrect oxygen levels in the blood need to be rapidly corrected to avoid damage to tissues. As the nervous system acts more quickly than the endocrine system, it is more appropriate.

Comments: many students did not demonstrate an understanding of the different roles of the nervous and endocrine systems. Students who gained one mark probably need to work on providing clearer explanations. (Av 1.0, range 0-2)

Question 27(a)

2 marks	Defines term allele Uses stimulus to demonstrate understanding of multiple alleles
1 mark	One of the above (without examples)

Alleles are variants of a gene. Multiple alleles occur when there are more than two variants in a population e.g. E, e, e^a

Comments: there was some confusion surrounding multiple genes controlling phenotype and multiple alleles. Students are reminded to define all terms. (Av 0.8, range 0-2)

Question 27(b)

2 marks	Provides two correct genotypes (no incorrect ones)
1 mark	Provides one correct genotype (and no more than 1 incorrect one) OR Provides two correct genotypes for 1 gene

E_A_

Comments: Some students seemed confused about writing genotypes for 2 genes. Otherwise, fairly well done. (Av 1.6, range 0-2)

Question 27(c)(i)

2 marks	Uses cause and effect statement to explain need for genetic testing Refers to possible genotypes of chestnut horse and offspring produced
1 mark	Identifies that chestnut horse may have recessive traits that produce bay horse

The chestnut horse does not have the dominant E allele, however if bred with a true-breeding black horse, the offspring will be able to produce black pigment. It is impossible to determine from the chestnut phenotype which alleles are present for the ASIP gene, if the chestnut horse has an A allele, then the offspring could be bay. Hence, genetic testing is needed to determine the genotype for the ASIP gene.

Comments: this was fairly well done. (Av 1.8, range 0-2)

Question 27(c)(ii)

2 marks	Uses cause and effect statement to explain need for gene sequencing rather than DNA profiling
1 mark	Identifies that genetic sequencing is needed OR Identifies that the allele needs to be determined

Genetic sequencing provides the order of bases in a gene. This would be necessary to determine which of the alleles for the ASIP gene is/are present. DNA profiling would give information about the relatedness of the chestnut horse to other horses but would not definitively provide information about the genotype.

Comments: this was fairly well done (Av 1.3, range 0-2)

Question 28(a)

3 marks	Identifies possible component(s) of vaccine Uses cause and effect statement linking the role of antigen in developing memory cells Uses cause and effect statement linking memory cells to immunity to pathogen
2 marks	Identifies development of memory cells Identifies role of memory cells to immunity OR Uses cause and effect statement linking vaccination to reduced spread of the disease
1 mark	Identifies previous exposure to antigen resulting in protective immune response OR Identifies role of vaccination in public health campaigns

The vaccine may contain weakened or dead strep bacteria. These will expose the child to the antigens, and T and B cells with matching receptors may bind, causing the production of antibodies as well as T and B memory cells. Upon subsequent exposure to the same antigen, the B memory cells may rapidly produce plasma B cells which release antibodies to disable the pathogen, preventing an infection.

Comments: there was some confusion about the roles of cells in the immune system. Memory cells do not have memory (no nervous system). If they happen to bind with the matching antigen, then they can become activated. (Av 2.5, range 1-3)

Question 28(b)

7 marks	Proposes 3 suitable and significant public health campaigns in poverty-stricken regions Uses data to justify these campaigns
6 marks	Proposes 3 suitable and significant public health programs Uses data to justify these programs
5 marks	Proposes 3 suitable public health programs Uses data to justify some of these programs
4 marks	Proposes 2 suitable public health programs Uses data to justify one of the programs OR Proposes 3 suitable public health programs
3 marks	Identifies 3 suitable programs
2 marks	Identifies two suitable programs OR Identifies one suitable program and justifies it using data
1 mark	Identifies one suitable program

Public health campaigns aim to change the behaviour and/or beliefs of the population.

Approximately 500,000 deaths are believed to have child wasting as a contributory factor. A public health campaign which encouraged families to monitor their child's weight gain, and

to educate about food pyramids and the necessity of using a wide variety of traditional sources of food, including extended breastfeeding, could help reduce this. It could also act to reduce the contribution due to stunting, low birthweight, Vitamin A and zinc deficiency as well.

Approximately 250, 000 deaths are believed to have indoor smoke from solid fuels as a factor. A public health campaign which raised awareness of the risk, and promoted increased ventilation, cooking outdoors and/or sending children outdoors when cooking could help to reduce this factor.

Approximately 100, 000 deaths are believed to have second hand smoke as a factor. A public health campaign which encouraged smoking away from children, quitting smoking, not taking up smoking amongst youngsters could also help to reduce this.

Comments: Use data. Distinguish between public health campaigns and programs. Non-exclusive breastfeeding doesn't mean sharing the baby around, it means introducing other foods before 6 months. Tiny solid sooty particles from burning coals, logs, sticks for cooking cause indoor air pollution in children. Under 5s are unlikely to go to school. Lack of access to handwashing facilities results in e.g. gastrointestinal infections, which cause weight loss, increasing wasting. You didn't need to write much, but planning your ideas was important. (Av 4.9, range 2-7)

Question 29

3 marks	Describes normal function of body part affected by disorder Describes technology used to replace function of body part Describes use of technology to assist with disorder
2 marks	Describes TWO of the above OR Identifies three of the above
1 mark	Identifies two of the above

The role of a kidney is to remove waste and maintain homeostasis of a number of compounds (e.g. water, sodium) in the blood. In the case of kidney failure, these functions are not carried out effectively and dialysis may be required. In haemodialysis, blood is removed from the body, and pumped through dialysis tubing, a semi-permeable membrane bathed in dialysate. The dialysate contains water, salts and glucose at ideal blood levels. As it passes the dialysis tubing in a counter-current direction, wastes such as urea diffuse from the blood, and salts and glucose diffuse across the membrane to maintain ideal levels in the blood. This process is carried out several times a week for 3-4 hours in a hospital or clinic setting.

Comments: There were some students who were a little confused about the technologies. Several students also mentioned techniques involving genetic manipulation; I'm not sure that this is the intention of the syllabus (since it is dealt with elsewhere) and you may be penalised in the HSC exam. (Av 2.0, range 0-3)

Question 30(a)

3 marks	Identifies three significant findings OR Describes two significant findings
2 marks	Identifies two significant findings OR Describes one significant finding
1 mark	Identifies one significant finding

This is a retrospective cohort study.

Immunised patients had a milder disease and were less likely to die than non-immunised patients.

Immunised patients were less likely to return a positive culture than non-immunised patients.

Immunised patients were more likely to culture COD, non-immunized patients more likely to culture CD.

Most deaths were in under-5 year old patients.

This was generally well done, but try to summarise by putting into your own words. (Av 2.9, range 2-3)

Question 30(b)

4 marks	Identifies epidemiological study for non-infectious disease Identifies type of epidemiological study Identifies two significant findings
3 marks	Identifies epidemiological study for non-infectious disease AND Identifies type of epidemiological study Identifies one significant finding OR Identifies two significant findings
2 marks	Identifies epidemiological study Identifies type of epidemiological study OR Identifies epidemiological study Identifies one significant finding OR Describes an unnamed example epidemiological study and its findings
1 mark	Identifies one significant finding of an unnamed epidemiological study

The Framingham heart study is a cohort study. Key findings include:

Smoking, high cholesterol, high blood pressure and obesity increase the risk of heart disease.

Exercise reduces the risk of heart disease.

High blood pressure increases the risk of stroke.

Comments: this question was not well done. This question was designed to assess your understanding of epidemiology, not whether you could list some risk factors for a disease.

(Av 1.9, range 1-4)

Question 31(a)

2 marks	Outlines two consequences of a point mutation in a coding region
1 mark	Identifies one consequence of a point mutation in a coding region

A mutation such as a nonsense mutation, missense mutation, insertion or deletion may result in a dysfunctional protein being translated. This could hinder the ability of the virus to infect cells.

A mutation such as a silent mutation, which still codes for the same amino acid (due to triplet codon redundancy) would have no effect on the structure and function of the virus.

Comments: this question was done fairly well. (Average 1.9, range 1-2)

Question 31(b)

3 marks	Identifies HA and/or NA genes as antigens Explains the process of the secondary immune response Links change in antigens with reducing success of secondary immune response
2 marks	Identifies HA and/or NA genes Identifies the process of the secondary immune response OR Explains the process of the secondary immune response Links change in antigens with affecting success of secondary immune response
1 mark	Identifies HA and/or NA genes OR Identifies the process of the secondary immune response OR Links change in antigens with affecting success of secondary immune response

The HA and NA proteins are on the surface of the virus particle and are most likely recognised as antigens by the immune system. In the primary infection, memory B and T

cells with receptors which were complementary to these antigens would have been formed. If a mutation to the HA or NA genes formed a different protein, the new antigen would not be recognised by the memory cells in a secondary infection, and hence immune response would not be strong e.g. antibodies would not be produced as quickly.

Comments: some students seemed to confuse the effect on the virus with the effect on the immune system. (Av 2.1, range 0-3)

Question 31(c)

4 marks	Identifies the presence of influenza A in humans and birds Identifies that different strains may be present in the two populations Identifies that close proximity may result in one cell becoming infected with two strains leading to antigenic shift or recombination Identifies that this may cause new strain which humans do not have immunity to, leading to epidemic
3 marks	3 of the above
2 marks	2 of the above OR Relates overcrowding of poultry with multiple strains in birds leading to antigenic shift
1 mark	1 of the above OR Relates overcrowding of poultry to new formation of variants to which birds have no immunity

In poultry growing regions, there is a large concentration of birds in close contact with humans. Both birds and humans can host influenza A, although they will typically host different strains. Due to the frequent contact, it is likely that an organism will become infected with multiple strains, and that some cells will be infected by more than one different strain. This could result in antigenic shift, and a new strain forming. Humans working in this environment are unlikely to be immune to the new strain, and will become unwell, spreading it to the wider population, which is also unlikely to be immune, and an epidemic may occur.

Comments: epidemics = in humans, separate to vaccine, some confusion about where the analogous crossing over occurs (Av 2.0, range 0-4)

Question 31(d)

8 marks	Demonstrates a thorough understanding of replication Assesses importance of correct replication to lifecycle of two pathogens Assesses importance of correct replication to lifecycle of relevant host(s) Assesses importance of mutation to pathogen/host interaction Uses correct biological terminology
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	Provides succinct, logical and coherent response
7 marks	Demonstrates extensive understanding of replication Assesses importance of correct replication to lifecycle of two pathogens Assesses importance of correct replication to lifecycle or relevant host(s) Describes mutation in pathogen/host interaction Uses correct biological terminology
6 marks	Demonstrates good understanding of replication Describes lifecycle of two pathogens Describes lifecycle of relevant host Identifies role of mutation in pathogen/host interaction
5 marks	Demonstrates good understanding of replication Outlines lifecycle of one pathogen Outlines lifecycle of host Identifies role of mutation in pathogen/host interaction OR Demonstrates good understanding of replication Describes lifecycle of two pathogens Describes lifecycle of relevant host
4 marks	Demonstrates good understanding of replication Outlines lifecycle of one pathogen Outlines lifecycle of host
3 marks	Demonstrates limited understanding of replication Outlines lifecycle of one pathogen OR host
2 marks	Outlines the role of replication in the continuity of species
1 mark	Provides some relevant information

Genetic material is stored in a sequence of bases in a DNA or RNA molecule, typically wrapped around protein molecules in a structure termed a chromosome. Prior to cell division, this molecule is copied using specialised enzymes in a process that is tightly regulated to ensure its accuracy. One strand is used as a template for a new strand, and in eukaryotes there are multiple DNA polymerases which carry out this function, some of which have an error checking function. Considerable energy is expended by the organism in ensuring that it is copied correctly. As the genetic material codes for proteins that are essential for functioning of the cell, any mistakes in replication of the genetic material can be catastrophic for the organism. For example, genetic diseases such as sickle cell anaemia, cystic fibrosis and haemophilia as well as cancers can result from the incorrect replication of genetic material.

In humans, genetic material is replicated to prior to mitosis and meiosis. Meiosis is used to make gametes, and after fertilization, mitosis is used to increase the number of cells from a single-celled zygote until maturity. Mitosis is also used for the repair of damaged tissues and the replacement of dead cells.

In a pathogen such as the Plasmodium protozoa responsible for malaria, both mitosis and meiosis also need to be carried out. Specialised functions allow the protozoan to have a complex lifecycle which involves using the mosquito anopheles as a vector, and they spend a stage in

the salivary glands of the mosquito, another in the liver cells of the human host, and another stage in the red blood cells. Incorrect replication could break any of these adaptations, or other important functions.

In a pathogen such as rhinovirus, the virus particle, although non-cellular, needs to replicate its genetic material as accurately as possible. The virus enters the upper respiratory tract and adheres to nasal cells where it replicates and releases viral particles, infecting neighbouring cells. These are then ejected in mucous particles where they can remain airborne or survive for many hours on surfaces, ready to re-infect another host. Errors in proteins such as RNA polymerase may render the particle unable to replicate its RNA and hence unable to exit a host cell. Due to its small size, there is not space for multiple polymerases with specialised error-checking functions.

Pathogens have a much shorter lifecycle than their hosts in general, and the host's immune system attempts to eliminate the threat. This has led to a need for some level of mutation, or incorrect replication of genetic material, in the pathogen-host interaction. For example, the plasmodium protozoa has developed resistance to anti-malarial drugs such as quinone, the anopheles mosquito has developed resistance to insecticides such as DDT. Rhinoviruses have a high rate of mutation in the viral capsid proteins, which means that subsequent infections may not be easily eliminated by antibodies produced from memory cells derived from earlier infections. The human immune system undergoes a process termed hypermutation whereby B cells which are activated by an antigen rapidly mutate to produce related antibodies which may bind more tightly (or not), rendering antibodies more effective during an infection. Additionally, a genetic mutation for the sickle cell allele has become common in malaria-infected regions, conferring a level of immunity against malaria to the carrier of the allele despite the serious consequences of being homozygous for the condition.

Comments: prions don't have DNA/RNA. No malaria vaccine. Confusion about expression of surface markers and genetic change. (Av 5.2, range 2-8)