

STUDENT NAME:

STUDENT NUMBER

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SUBJECT TEACHER:

Reading Time: 15 Minutes

Writing Time: 2hrs 30 Minutes

Examination Structure

Section	Number of questions	Number of marks
A	40	40
B	9	80
Total		120

INSTRUCTIONS TO CANDIDATES

- Students are to read all instructions carefully and complete all tasks in line with the College's Academic Integrity Policy. There is to be no talking until all papers are collected. If you have a question, raise your hand, and wait for the supervisor to come to you.
- Students are permitted to bring into the trial examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring mobile phones and/ or any other unauthorized electronic devices into the trial examination room. No calculators are allowed in this trial examination.
- Materials supplied**
 - Questions and answer booklet of 29 pages
 - Separate multiple-choice answer sheet
- Instructions**
 - Write your name and student number in the space provided on this page and on the multiple-choice answer sheet.
 - Unless otherwise indicated, the diagrams in this trial examination are **not** drawn to scale.
 - All written responses must be in English.
- At the end of the trial examination**
 - Hand in your trial examination answers and your multiple-choice answer sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this trial examination are **not** drawn to scale.

Question 1

Transfer RNA (tRNA) carries amino acids from the cytosol to the ribosome. The set of 3 nucleotides that are complementary to the mRNA are referred to as

- A. codons
- B. triplets
- C. anticodons
- D. amino acids

Question 2

When comparing protein synthesis in eukaryotes and prokaryotes

- A. transcription is slower in prokaryotes than eukaryotes due to the presence of operons in the bacterial genome.
- B. it is faster in prokaryotes as they do not undergo RNA processing.
- C. translation occurs on ribosomes embedded on the rough endoplasmic reticulum in prokaryotes, and in free floating ribosomes in eukaryotes.
- D. prokaryotes produce pre-mRNA whereas eukaryotes produce mature mRNA.

Question 3

DNA polymerase, shown below, is one of the most abundant proteins on Earth, as it is involved in the synthesis of new DNA strands.



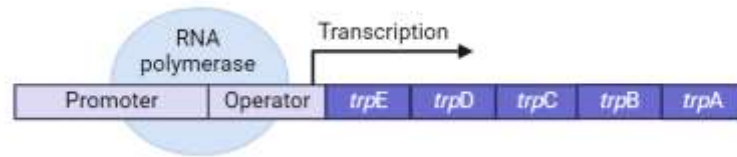
Source: https://en.wikipedia.org/wiki/DNA_polymerase_II

The level of protein structure in functional DNA polymerase is

- A. primary.
- B. secondary.
- C. tertiary.
- D. quaternary.

Question 4

The image below is a simplified diagram of the *trp* operon.



Source: <https://app.biorender.com/illustrations/63c498a7f17c45f9cd3e02d9>

An operon is

- A. a group of regulatory genes that serve the same function.
- B. found in both prokaryotic and eukaryotic cells.
- C. a set of structural genes that contains no exons.
- D. a group of structural genes under the control of the one promoter region.

Question 5

Within the leader region of the *trp* operon, there is an attenuator region that contains two adjacent codons for tryptophan.



If the two adjacent *trp* codons are translated quickly

- A. an anti-terminator hairpin loop forms, and the DNA detaches from the ribosome.
- B. RNA polymerase is transcribing quickly as well.
- C. a terminator hairpin loop forms and the mRNA detaches from the ribosome.
- D. the structural genes are transcribed.

Question 6

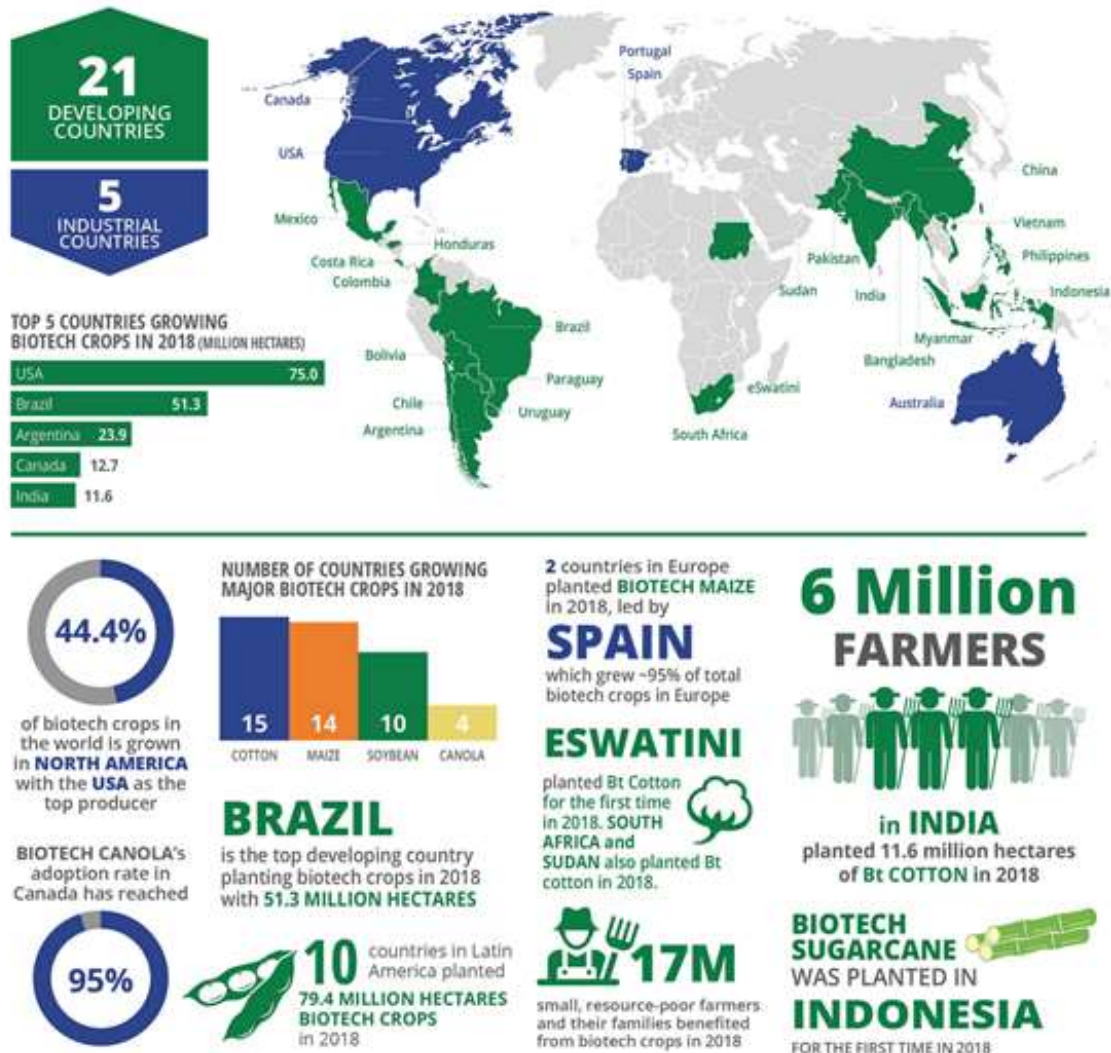
The enzyme Rubisco is comprised of eight large chains and eight small chains and is essential for the light independent stage of photosynthesis to occur. How many STOP amino acids would be found in the resultant protein?

- A. 0
- B. 8
- C. 12
- D. 16

Use the following information to answer Questions 7–9.

Where are Biotech Crops Grown in the World?

26 countries planted 191.7 million hectares of biotech crops in 2018, the 23rd year of global commercialization of biotech crops



For more information, visit ISAAA website:

www.isaaa.org

Source: ISAAA. 2018. Global Status of Commercialized Biotech/GM Crops in 2018. ISAAA Brief No. 54.



isaaavideos

#GMCrops2018
#ISAAARep2018

Source: <https://www.isaaa.org/resources/infographics/wherearebiotechcropsgrown/default.asp>

Question 7

Bt cotton has been planted in over 20 countries, of which 5 are considered industrial. In what year was Bt cotton first planted in Sudan?

- A. 2015
- B. 2016
- C. 2017
- D. 2018

Question 8

Six million farmers in India planted over 11.6 million hectares of Bt corn per annum. Bt corn is both genetically modified and transgenic as

- A. genes from another species have been inserted in the corn genome.
- B. more than one chromosome has been modified.
- C. the modification is not inheritable.
- D. the corn is also naturally occurring.

Question 9

In South America, the greatest producer of biotech crops is

- A. Uruguay.
- B. Paraguay.
- C. Brazil.
- D. Argentina.

Question 10

Polymerase chain reaction has a wide range of applications including medical diagnostics, forensic science and biotechnology. Amplification of DNA is often required to ensure the sample size is large enough. DNA amplified using PCR and run through a gel electrophoresis would

- A. migrate to the negative terminal.
- B. be naturally visible under UV light.
- C. separate based on the size of the fragments.
- D. degrade due to the presence of the buffer solution.

Question 11

When creating a recombinant plasmid of insulin, the reporter gene is

- A. AmpR, as it provides resistance to the antibiotic ampicillin.
- B. ORI, as it shows where replication of the plasmid begins.
- C. B galactosidase, as a colour change occurs in the presence of X gal.
- D. the insulin gene, as it is the gene of interest.

Question 12

Co-enzymes are essential for many biochemical pathways, such as the Krebs cycle and Calvin cycle, which would not occur in their absence. Co-enzymes are not classified as enzymes as

- A. all co-enzymes can bind to multiple substrates.
- B. co-enzymes lower the activation energy of the reaction but do not speed the reaction up.
- C. unlike enzymes, co-enzymes are only found in eukaryotic cells.
- D. co-enzymes change in a reaction.

Question 13

A student investigated the effect of varying concentrations of carbon dioxide on the rate of photosynthesis for their Extended Practical Investigation (EPI). They counted the number of bubbles produced every 30 seconds and graphed their data to illustrate the trends.

The bubbles counted

- A. were formed during the light independent stage of photosynthesis in the stroma.
- B. were formed during the light dependent stage of photosynthesis in the thylakoid membranes.
- C. are due to water being produced in the Krebs cycle.
- D. are due to photorespiration occurring from the excess heat provided from the light source.

Question 14

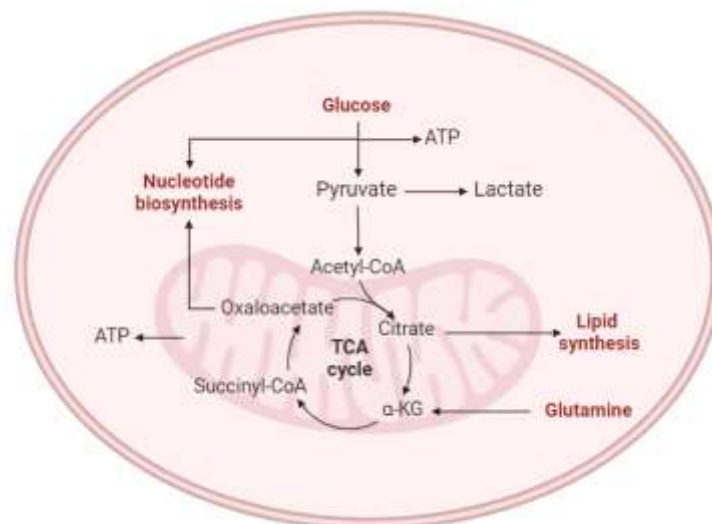
Unlike C₃ plants, C₄ and CAM plants have an additional enzyme – PEP carboxylase. The role of PEP carboxylase is to allow initial carbon fixation to occur, converting carbon dioxide into a 4-carbon molecule – malate.

PEP carboxylase is found in the

- A. mesophyll.
- B. bundle sheath.
- C. matrix.
- D. thylakoid membrane.

Question 15

The diagram below shows an overview of a biochemical pathway that occurs in cells.



Source: <https://app.biorender.com/illustrations/63c498a7f17c45f9cd3e02d9>

The process shown is

- A. occurring in a prokaryotic cell, producing net 2 ATP.
- B. occurring in an animal cell, producing net 30 or 32 ATP.
- C. occurring in a plant cell, with oxygen being the final acceptor of hydrogen.
- D. occurring in a plant cell when oxygen is absent.

Question 16

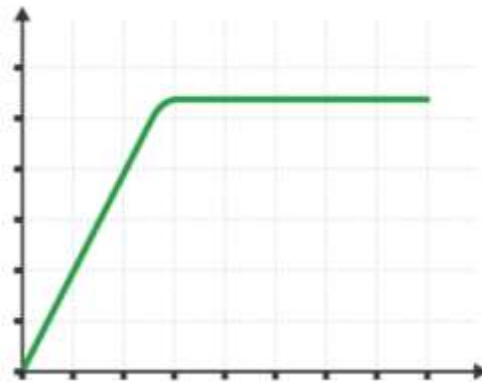
At high temperatures, Rubisco has a high affinity to oxygen. Whilst C₄ and CAM plants have adaptations to overcome this, C₃ plants do not.

It is fair to state that

- A. carbon dioxide acts as a competitive inhibitor, competing for the active site of Rubisco.
- B. C₃ plants require more energy than C₄ and CAM plants to limit oxygen from binding to Rubisco.
- C. C₄ and CAM plants are less prone to photorespiration than C₃ plants.
- D. oxygen binds to an allosteric site on Rubisco, changing the shape of the active site.

Question 17

The following graph was generated from an enzyme driven reaction.



Source: <https://www.bbc.co.uk/bitesize/guides/zgcn97h/revision/4>

The labels for the *x* and *y* axes are most likely to be

- A. *x* = rate of reaction; *y* = substrate concentration.
- B. *x* = temperature; *y* = enzyme concentration.
- C. *x* = pH; *y* = enzyme availability.
- D. *x* = substrate concentration; *y* = rate of reaction.

Question 18

During the electron transport chain, protons are transferred down ATP synthase to generate ATP.

If the mitochondria were subjected to extreme temperatures, it would be expected that

- A. the rate of ATP production would decrease.
- B. the enzyme ATP synthase would denature, therefore only glycolysis and the Krebs cycle would occur.
- C. the rate of ATP production would increase as the molecules would have more kinetic energy.
- D. the cell would freeze, therefore no biochemical pathways could occur.

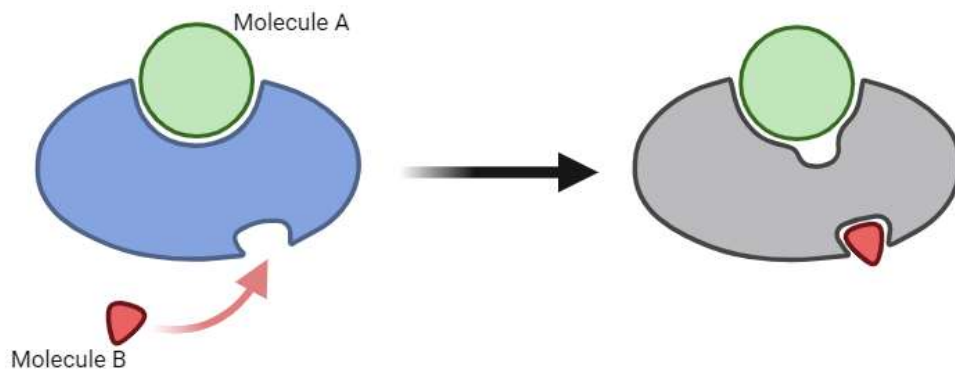
Question 19

The inputs for the light dependent reaction of photosynthesis are

- A. water, NAD⁺ and ADP + Pi
- B. water, NADPH and ADP + Pi
- C. water, carbon dioxide, NADP⁺ and ATP
- D. water, NADP⁺ and ADP + Pi

Question 20

The following diagram shows an enzyme binding to two different types of molecules, A and B.



Source: <https://app.biorender.com/illustrations/63d1aff3efd616bf1730efa>

It is true to state that

- A. molecule A is a competitive inhibitor, binding to the active site of the enzyme.
- B. molecule B is a non-competitive inhibitor, attaching to the binding site of the enzyme.
- C. if the concentration of molecule A is increased, the effect of molecule B is negated.
- D. molecule A binds to the active site whereas molecule B binds to the allosteric site.

Question 21

Corn husk is the inedible outside green leaves that protect the corn kernels inside. Often disposed of, they are a suitable form of biomass for bioethanol production.

Why is bioethanol production considered to be more environmentally friendly than traditional fossil fuels?

- A. Bioethanol consumes carbon dioxide and releases oxygen.
- B. The production of biomass for bioethanol production consumes oxygen.
- C. The production of biomass for bioethanol production consumes carbon dioxide.
- D. Bioethanol is stored deep within the Earth, therefore it does not degrade.

Question 22

Major Histocompatibility Complex (MHC) markers assist the immune system by allowing the cells to differentiate between self and non-self.

Antigen presenting cells have

- A. MHC I and MHC II markers on their surface.
- B. MHC II markers only on their surface.
- C. MHC I markers on their surface and MHC II markers stored in lysosomes.
- D. no MHC I markers, they have surface antigens.

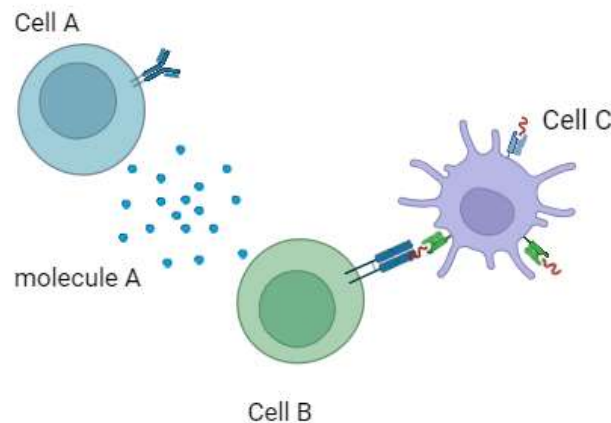
Question 23

Plants have many chemical and physical barriers to protect against disease, including formation of galls and releasing chemicals such as oxalic acid.

Such defences are important as

- A. plants are at greater risk of disease than animals.
- B. plant cells are prokaryotic, they are prone to bacterial infection.
- C. plants lack an adaptive response so are reliant on innate defences.
- D. the adaptive response in plants is slower than that of animals, therefore they are more reliant on innate responses against pathogens.

Use the following diagram to answer Questions 24 and 25.



Question 24

The diagram above shows a process that occurs as part of the adaptive immune response. The process that is occurring is

- A. clonal expansion in the primary lymphoid organs.
- B. clonal selection in the secondary lymphoid organs.
- C. passive immunity in the circulatory system.
- D. the production of monoclonal antibodies.

Question 25

When considering the relationship between Cell A and Cell C in the diagram above, it is fair to state that

- A. the antigen presented on the MHCI marker of Cell C is complementary to the receptor on the surface of Cell A.
- B. the receptor on Cell A is complementary to molecule A, released following activation from Cell C.
- C. the antigen presented on the MHCII marker on Cell C is complementary to the antibody on the surface of Cell A.
- D. Cell A is produced in the lymph nodes whereas Cell C is produced in the bone marrow, with both Cell A and C stored in the lymph nodes.

Question 26

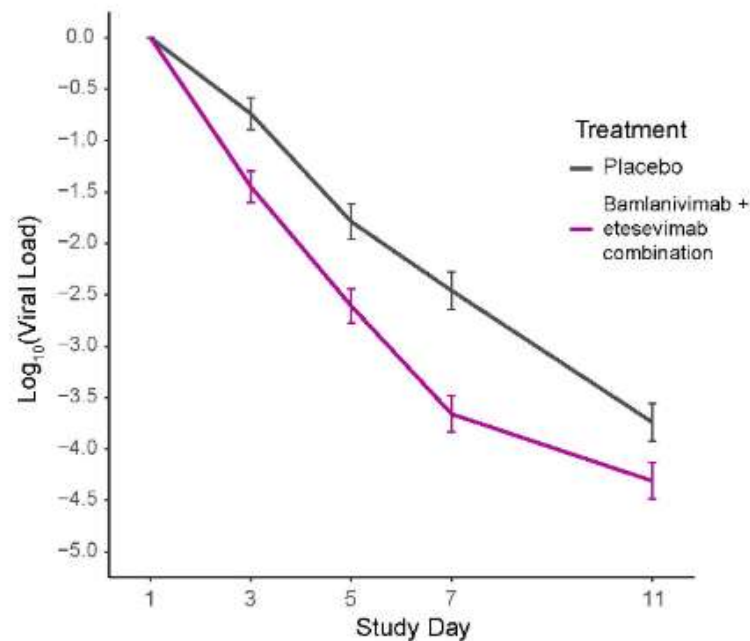
Bamlanivimab is a monoclonal antibody specifically targeting the spike protein of SARS-CoV-2, the virus responsible for COVID-19. It is designed to block the virus's ability to infect human cells, thereby reducing the severity of the disease.

Bamlanivimab binds to the receptor-binding domain of the spike protein on the surface of SARS-CoV-2. By doing so, it prevents the virus from attaching to the angiotensin-converting enzyme 2 (ACE2) receptors on human cells, which is a critical step for viral entry. This inhibition helps to reduce viral replication and spread within the host.

Bamlanivimab provides

- A. active artificial immunity.
- B. active natural immunity.
- C. passive artificial immunity.
- D. passive natural immunity.

Use the following graph to answer Questions 27 and 28.



Source: <https://www.croiconference.org/abstract/bamlanivimabetesevimab-for-treatment-of-covid-19-in-high-risk-ambulatory-patients/>

Question 27

Prior to releasing the drug Bamlanivimab for use in the general population, trials on the effectiveness of the drug were conducted.

The greatest difference between the placebo and the Bamlanivimab + etesevimab combination was on Study Day

- A. 3
- B. 5
- C. 7
- D. 11

Question 28

What is the purpose of the placebo in the drug trial?

- A. to act as a controlled variable
- B. to act as a negative control group
- C. to act as a positive control group
- D. to act as a dependent variable

Question 29

A student presented to their doctor with symptoms including runny nose, fever and wheezing. A rapid antigen test was conducted and the doctor confirmed that they were infected with Respiratory syncytial virus (RSV).

The rapid antigen test relies on the pathogens'

- A. complementary proteins to the antibody.
- B. presence or absence of a cell wall.
- C. reaction to Gram stains.
- D. molecular sequence.

Question 30

Giardiasis is an intestinal infection caused by the parasite *Giardia lamblia*. It is one of the most common causes of waterborne diseases worldwide and can affect both humans and animals. Symptoms of giardiasis can vary and some people may be asymptomatic. When symptoms do occur, they typically begin 1–3 weeks after infection and may include diarrhea, abdominal cramps and nausea.

To minimise the chance of being infected with *Giardia lamblia*, it would be recommended to

- A. wear insect repellent in known affected areas.
- B. drink clean water.
- C. take a course of antibiotics.
- D. wear a face mask and socially distance.

Question 31

Emperor penguins are found in Antarctica and rely on sea ice for breeding and feeding. Changes in sea ice patterns due to climate change can impact their breeding success and food availability. Reduced sea ice can lead to a decline in krill populations, which are a crucial part of the penguin diet. After mating, males incubate the eggs during the harsh winter months. They rely on their body fat reserves and have to withstand fasting for up to two months while they balance the eggs on their feet, covered by a brood pouch to keep them warm.

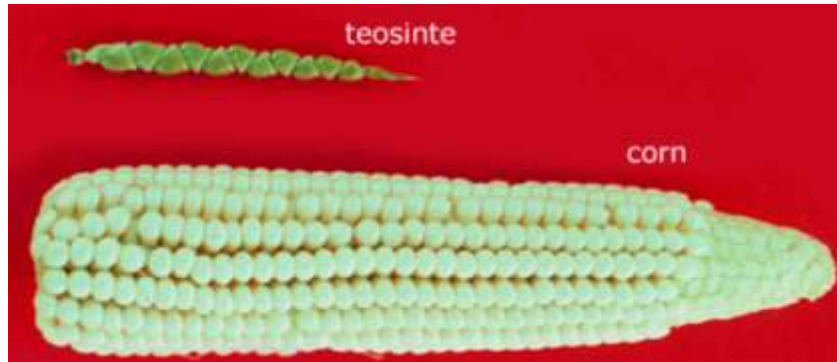
What selection pressure is acting upon the Emperor penguins?

- A. availability of krill
- B. availability of mates
- C. excess sea ice
- D. excess body fat

Question 32

Early humans in Mesoamerica began to cultivate teosinte around 9,000 years ago. The initial motivation might have been the plant's edible kernels, despite their small size and hard casing.

Early farmers bred plants that produced larger kernels. Larger kernels meant more food per plant and easier harvesting. Over time, plants with softer kernels and that produced more kernels per cob were favoured as they were easier to process and consume. The genetic makeup of teosinte was altered to what we now know as corn.



Source: <https://evolution.berkeley.edu/evo-news/the-other-green-revolution/>

The rapid change in the genetic makeup of teosinte is due to

- A. natural selection.
- B. sympatric selection.
- C. the founder effect.
- D. artificial selection.

Question 33

Carbon dating is a useful means to calculate the absolute age of a fossil by measuring the amount of C14 (Carbon 14) that has decayed into N14 (Nitrogen 14).

The level of C14 and N14 would be equal after

- A. 5730 years.
- B. 11 460 years.
- C. 17 190 years.
- D. 22 920 years.

Question 34

A phylogenetic tree was created that showed the relationship between *Homo sapiens* and other members of the primate genus based upon comparisons of the amino acid sequence for the enzyme Cytochrome C.

The data used to create the phylogenetic tree was based upon

- A. structural morphology.
- B. molecular homology.
- C. vestigial structures.
- D. comparative anatomy.

Question 35

Orcas, or killer whales, exist within overlapping geographic regions. Resident orcas primarily inhabit coastal waters and have a diet focused on fish, especially salmon, forming large, stable pods with complex social interactions and specific vocal dialects. Transient orcas, also known as Bigg's orcas, roam coastal and offshore areas hunting marine mammals such as seals and porpoises. They form smaller, less stable groups and utilise different vocalisations suited to stealthy hunting. Offshore orcas, which inhabit deeper oceanic waters, have a more varied diet including fish and sharks, travelling in larger groups with distinct vocal patterns from both resident and transient orcas. Despite overlapping ranges, these ecotypes exhibit genetic and behavioural differences and cannot produce fertile offspring.

The orcas are an example of

- A. the bottleneck effect.
- B. genetic drift.
- C. sympatric speciation.
- D. selective breeding.

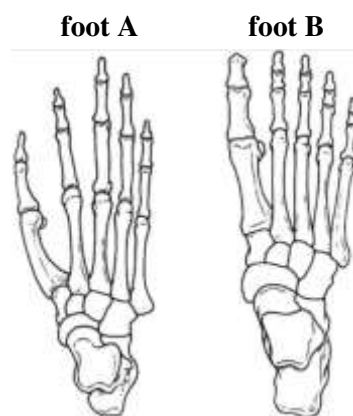
Question 36

The bowl-shaped pelvis found in members of the genus *Homo* allows for

- A. a more central foramen magnum.
- B. a forward facing big toe.
- C. an opposable thumb.
- D. a large attachment area for the gluteus maximus muscles.

Question 37

The image below shows two feet – one from a chimpanzee and one from a hominin.



Source: Wang, Weijie & Abboud, Rami & Günther, Michael & Crompton, Robin. (2014). Analysis of joint force and torque for the human and non-human ape foot during bipedal walking with implications for the evolution of the foot. *Journal of anatomy*. 225. 10.1111/joa.12201.

From these feet, it is fair to state that

- A. foot A is from a human as it has longer toe bones.
- B. foot B is from a chimpanzee as it has a larger heel.
- C. foot A is from a human as it has an opposable toe.
- D. foot B is from a human as it has a more prominent big toe.

Question 38

To determine if an experiment is reproducible

- A. the same experimenter should follow the same method and obtain similar results.
- B. a different experimenter should follow the same method and obtain similar results.
- C. the experiment should be repeated at the same location under similar conditions and obtain similar results.
- D. the experiment should be repeated within a short time frame.

Question 39

For their extended practical investigation (EPI) a student opted to complete a planned observation and recording of events and behaviours that have not been manipulated or controlled to understand the relationships that existed between the variables.

This is an example of a

- A. controlled experiment.
- B. literature review.
- C. correlational study.
- D. product, process or system development.

Question 40

The true value of a measurement can be found through

- A. repetition and obtaining repeated concordant results.
- B. the value obtained from an experiment conducted in optimal conditions.
- C. calibrating the equipment used prior to use.
- D. an experiment measuring what it intends to measure.

END OF SECTION A

SECTION B**Instructions for Section B**

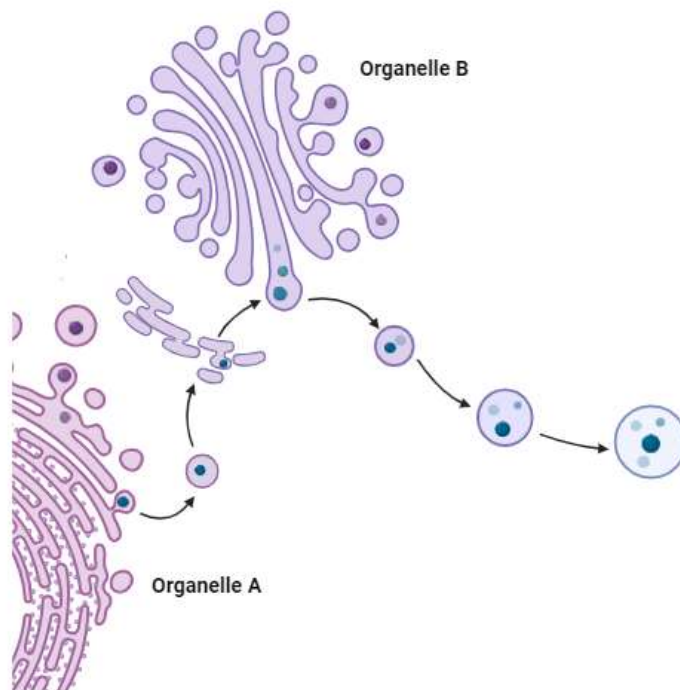
Answer **all** questions in the spaces provided.

Unless otherwise indicated, the diagrams in this trial examination are **not** drawn to scale.

Question 1 (7 marks)

Many eukaryotic organisms are comprised of many different cells, with varying functions. Different cells produce different products that may be exported from the cell.

The diagram below shows a simplified overview of the protein secretory pathway.



Source: <https://app.biorender.com/illustrations/63d1aff3efd616bf1730efa>

- a. Name and state the function of both Organelle A and Organelle B in the protein secretory pathway.

(2 marks)

- b. On the diagram above, circle a transport vesicle.

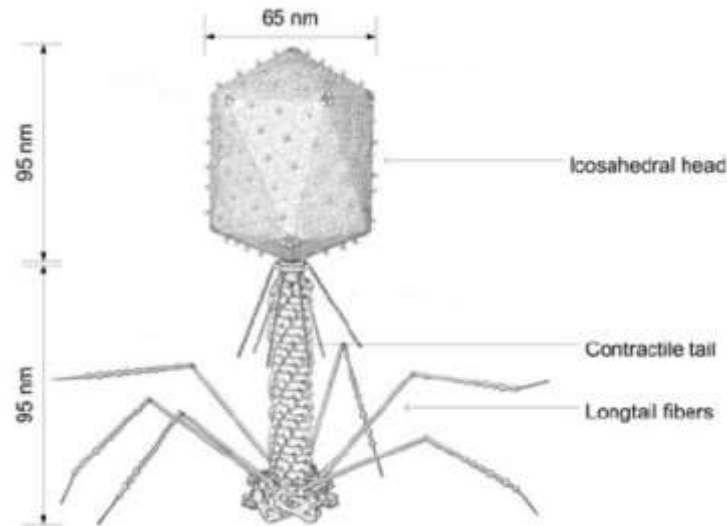
(1 mark)

- c. Describe how the regulation of protein synthesis can differ between prokaryotic and eukaryotic cells.

(4 marks)

Question 2 (4 marks)

Bacteriophage T4 infects the bacterium *Escherichia coli* (*E. coli*). It has an icosahedral head containing double-stranded DNA and a long, contractile tail with a sheath, tail tube, and tail fibres that are crucial for recognising and binding to the bacterial cell.



Source: Jabrane, Tarik & Laloï, Meije & Dubé, Martin & Mangin, Patrice. (2010). Printing and coating of T4 phage based bioactive paper. *Advances in Printing and Media Technology*. 37. 351-358.

During infection, T4 binds to specific receptors on the surface of *E. coli* using its tail fibres. The tail sheath contracts, injecting the viral DNA into the cytosol. T4 has a relatively large genome of approximately 169 000 base pairs encoding over 200 proteins and as such, can carry out complex interactions with its host.

- a. Outline the process by which *E. coli* would incorporate the T4 DNA into its CRISPR genome.

(2 marks)

- b. Determine why it is essential that the Cas9 enzyme cuts through both strands of the T4 genome.

(2 marks)

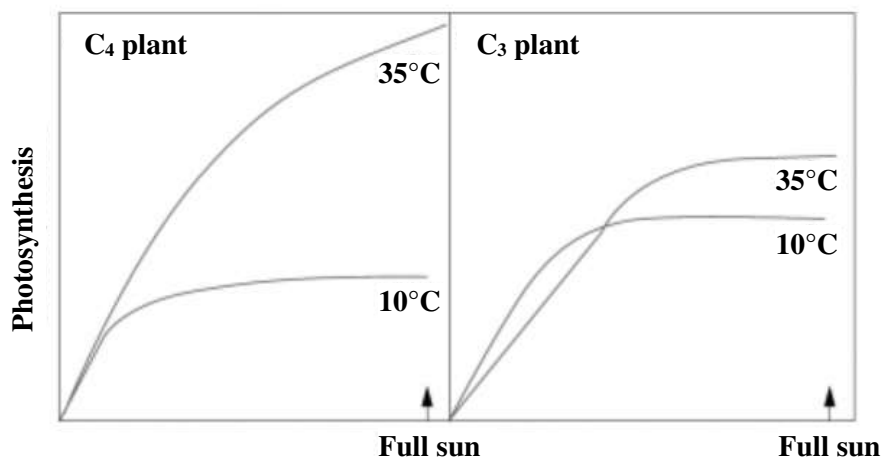
Question 3 (10 marks)

All plants photosynthesise whereby they convert inorganic carbon products into an organic carbon molecule. Some plants have adaptations that allow them to thrive in different environments, such as high temperatures or low annual rainfall.

- a** Identify the enzyme(s) responsible for initial carbon fixation in C3 and C4 plants.

(1 mark)

The graphs below compare the rate of photosynthesis in C3 and C4 plants as light intensity increases.



Source: <https://www.rseco.org/content/223-energetics-c4-photosynthesis.html>

- b.** Explain the most likely reason for the difference in the rate of photosynthesis at 10°C and at 35°C.

(4 marks)

- c. La Niña weather events are characterised by above average rainfall and humidity. If CAM plants were abundant in regions where La Niña was observed, describe how this would affect the rate of photosynthesis. Justify your response.

(2 marks)

- d. Like photosynthesis, cellular respiration relies on co-enzymes, such as NADH and FADH₂ to generate ATP. Describe the role of these co-enzymes in the synthesis of ATP during the electron transport chain.

(3 marks)

Question 4 (8 marks)

In a recent pharmaceutical drug trial, scientists investigated the effectiveness of a new anti-inflammatory drug, AID-X, by intentionally infecting healthy volunteers with a harmless strain of bacteria to trigger an inflammatory response. The study included 100 participants aged 18 to 45, divided into two groups; one received an injection of the drug AID-X, and the other received a placebo. Over two weeks, researchers measured changes in inflammatory markers like C-reactive protein (CRP), white blood cell (WBC) count, and cytokine levels, as well as symptoms such as fever, pain and swelling. The results showed that those who took AID-X had significantly lower levels of CRP, WBC counts, and cytokines, along with milder symptoms compared to the placebo group. However, those who took AID-X reported frequent incidences of nausea and vomiting compared to the placebo group.

- a.** Describe the purpose of the placebo group in this drug trial.

(1 mark)

- b.** Explain how inflammation causes the symptoms of pain and swelling.

(3 marks)

- c.** Propose a reason for why the scientists chose to inject the bacteria rather than provide it in an oral form.

(2 marks)

- d.** Based on the information provided, name and describe an ethical concept that the scientists may have breached while conducting the drug trial.

(2 marks)

Question 5 (12 marks)

The 2009 swine flu epidemic, caused by a novel strain of the H1N1 influenza A virus, emerged in April 2009 and quickly spread worldwide, leading the World Health Organization (WHO) to declare it a pandemic in June 2009.

This new H1N1 virus, a genetic mix of human, swine and avian flu viruses, caused widespread illness, affecting millions of people. Unlike typical seasonal flu, it disproportionately affected younger populations, including healthy adults, children and pregnant women, while older adults showed some immunity. Symptoms mirrored those of seasonal flu, such as fever, cough, sore throat, body aches and fatigue, but severe cases led to pneumonia and respiratory failure.

Public health responses included widespread vaccination campaigns, distribution of antiviral medications like oseltamivir (Tamiflu) and implementation of preventive measures to control the virus's spread. By August 2010, the WHO declared the pandemic over, but the H1N1 virus has since become one of the seasonal flu strains that continue to circulate globally.

- a.** Describe the difference between an epidemic and a pandemic.

(1 mark)

- b. (i)** Name the chemical that is released from cells infected with H1N1 to alert neighbouring cells of its infection.

- (ii)** Describe two ways in which the chemical stated in **b. (i)** can act on neighbouring cells.

(1 + 2 = 3 marks)

- c.** Outline the sequence of events that would occur in response to antigenic fragments of H1N1 being present in the extracellular fluid.

(5 marks)

- d.** Public health responses to the H1N1 virus included widespread vaccination campaigns and distribution of antiviral medications like oseltamivir. Suggest an additional measure that could be taken to prevent another outbreak of H1N1.

(1 mark)

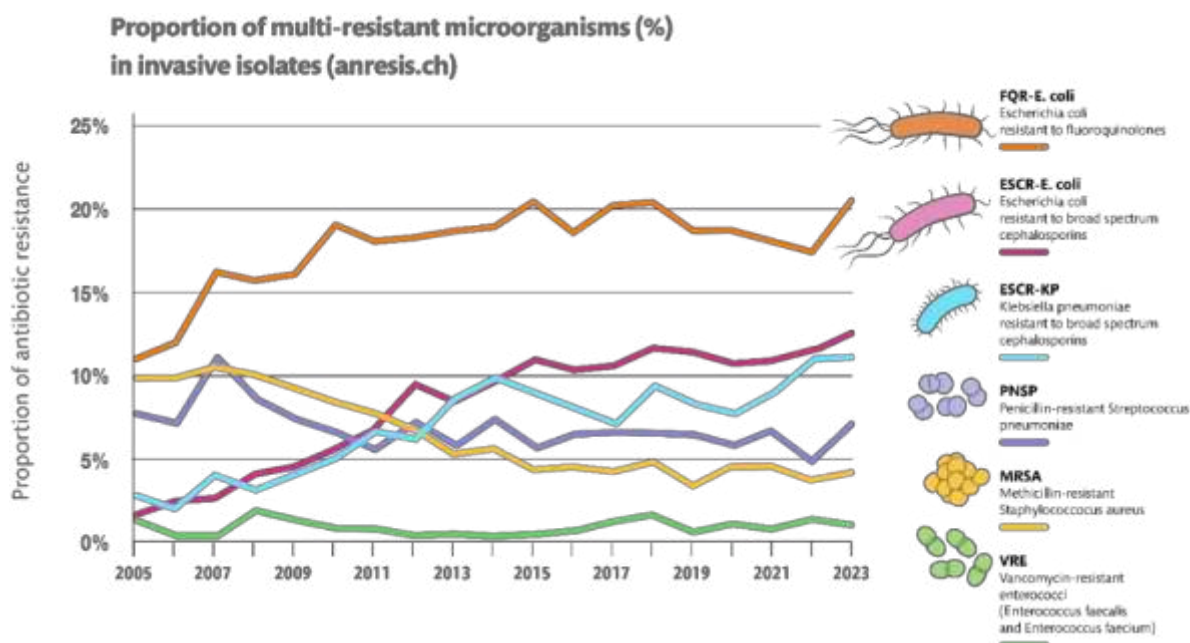
Monoclonal antibodies can be used to complement antiviral medications. Many monoclonal antibodies are produced from fusing plasma cells from vaccinated mice with myeloma cells from humans. The subsequent antibodies contain both human and mouse protein and are referred to as chimeric.

- e.** Suggest a reason as to why the effectiveness of these antibodies decreases over time.

(2 marks)

Question 6 (8 marks)

Antibiotic resistance is a growing global health concern where bacteria become resistant to the effects of antibiotics, rendering standard treatments ineffective and leading to persistent infections and increased risk of spread to others. This occurs due to various factors, including overuse and misuse of antibiotics in humans and animals, improper prescriptions, and lack of new antibiotics being developed. Resistant infections result in longer hospital stays, higher medical costs, and increased mortality.



Source: <https://www.bag.admin.ch/bag/en/home/krankheiten/infektionskrankheiten-bekaempfen/antibiotikaresistenzen/wie-entwickelt-sich-die-antibiotikaresistenz---.html>

- a. With reference to the data above, describe the trend in *ESCR-E. coli*'s resistance to antibiotics.

(2 marks)

- b. Name the process by which bacteria become resistant to antibiotics and outline how overuse of antibiotics allowed for bacteria such as *ESCR-E. coli* to become resistant.

(5 marks)

- c. Bacteria are a primitive organism. It is widely accepted that they have existed on Earth for over 3 billion years. Determine why there is little fossil evidence of this timeline.

(1 mark)

Question 7 (13 marks)

Juukan Gorge, located in Western Australia's Pilbara region, was an ancient and significant Aboriginal heritage site. The area contained two rock shelters that had been occupied for over 46 000 years, making it one of the oldest known sites of human habitation in Australia.



Source: <https://www.sbs.com.au/news/article/rio-tinto-just-blasted-away-an-ancient-aboriginal-site-heres-why-that-was-allowed/u3z24uw2h>

Archaeological excavations revealed grinding stones, a 28 000 year-old kangaroo bone sharpened into a tool and a belt made from human hair that provided a genetic link to the Puutu Kunti Kurrama and Pinikura (PKKP) people, who are the traditional custodians of the land.

The destruction of Juukan Gorge by Rio Tinto during a mining operation in 2020 resulted in the irreversible loss of this irreplaceable heritage, prompting global outrage and calls for stronger protection for Indigenous cultural sites.

- a. Describe the process by which the kangaroo bone was dated.

(3 marks)

- b. The hair provided a genetic link to the Puutu Kunti Kurrama and Pinikura people. Describe how molecular homology could be used to provide this link.

(2 marks)

- c. Describe how Rio Tinto did not demonstrate the ethical concept of **Respect** during their mining operation.

(2 marks)

- d. Aboriginal peoples have a strong connection to Country. Suggest how the actions of Rio Tinto may have affected this connection.

(3 marks)

Within Aboriginal peoples' culture, songlines are passed on to future generations.

- e. Identify the information conveyed in songlines and describe how the destruction of the rock shelters within Juukan Gorge would impact the songlines of the PKKP people.

(3 marks)

Question 8 (9 marks)

In Iberá National Park in Argentina, two wren-size, nearly identical species of bird live side by side, spending their days foraging for the same kinds of seeds and nesting in the same kinds of places. These species can breed together successfully but normally don't. Differences in belly colour and song appear to be enough to keep the birds from mating with one another, generation after generation.

The finding helps explain how the two different species arose, despite being genetically very similar. To see whether the two species really didn't mate with each other in the wild, Turbek, an evolutionary biologist and her colleagues banded 126 birds of both species, tracked the activities of the adults and 80 of the young produced, and sampled the DNA from each. Genetic analysis confirmed the two species do not interbreed. That suggests females prefer mates of one plumage and song or another; their choices may have sent the birds down speciation's track.

It's hard to study the identical-looking females as they choose mates, but numerous studies in birds have found that the traits used in female choice are also used by males to recognise sexual competitors. So Turbek examined how males reacted to other males of each species. Often, male birds of one species tend to tolerate the males of another, but react more strongly to males they recognise as of their own kind and with whom they, therefore, compete for mates.

Turbek's team painted appropriately coloured models of males of both species and then evaluated the responses of actual males to the model. She sometimes played recordings of the song of either species while displaying the models. Males most strongly attacked the models that both looked and sounded most like them, apparently seeing those models as fierce rivals for mates, Turbek and her colleagues report today in *Science*.

Further genetic comparison of the two species uncovered just three gene regions - totalling 12 genes - that distinguish them, including previously unrecognised differences in regulatory DNA that control plumage colouring. Those small genetic and plumage changes were apparently enough for some females to start preferring a specific colouring, setting the stage for the birds to be "isolated" in place. "Differences in song and plumage alone may be sufficient to maintain species boundaries extremely early in divergence", Turbek says.

Source: <https://www.science.org/content/article/tiny-differences-plumage-and-song-have-split-two-nearly-identical-birds-different>

- a.** Name the type of speciation shown between the two wren-size bird species in Argentina.

(1 mark)

- b.** Identify the type of barrier preventing the birds from interbreeding. Provide evidence to support your response.

(3 marks)

- c.** The biologists used genetic analysis to confirm the small wren-like species do not interbreed, rather than rely solely on morphology. Describe the advantage of genetic analysis over other methods.

(2 marks)

Mammals and birds share the same phylum (Chordata), but diverged after this into Mammals and Aves respectively.

- d.** State three features of birds that prevent them from being classified as mammals.

(3 marks)

Question 9 (9 marks)

A student wanted to identify the best type of apple for bioethanol production. They compared the concentration of carbon dioxide (CO₂) produced during the fermentation of different types of apples, including Granny Smith, Jonathon, Gala and Fuji. Each type of apple was washed, cored and juiced to obtain pure apple juice. Equal volumes of each juice were placed in separate conical flasks and an equal amount of yeast dissolved in warm water was added to each. A CO₂ meter measured the CO₂ concentration every 10 minutes for 40 minutes. The conical flasks were kept in a 40°C water bath.

The following results were obtained.

apple type	Carbon dioxide concentration (%)				
	0 mins	10 mins	20 mins	30 mins	40 mins
Granny Smith	3	8	11	12	12
Jonathon	4	5	7	7	8
Gala	1	7	14	12	17
Fuji	6	10	14	15	18

- a. State the process that occurred during the experiment and the final product(s).

(2 marks)

- b. Identify if this was a controlled experiment. Justify your response.

(2 marks)

- c. The student's teacher checked their data and suggested to the student that there may be an error in the data collected. Identify the error in the data above, name the type of error and suggest a way to overcome this error.

(3 marks)

- d.** The student was required to produce a graph of their data for the extended practical investigation poster. They discussed with their practical partner the best way to display their data. Student 1 thought that a bar chart would be most appropriate, whilst student 2 thought that a line graph would be a better option. Identify which student is correct. Justify your response with reference to the type of data.

(2 marks)

END OF TRIAL EXAMINATION