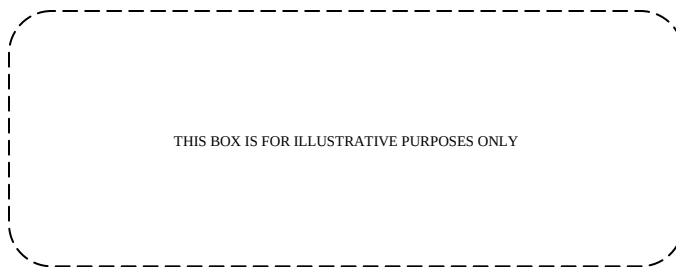




2018 Trial Examination



THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

STUDENT
NUMBER

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Letter

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BIOLOGY

Units 3 & 4 – Written examination

Reading time: 15 minutes

Writing time: 2 hours and 30 minutes

QUESTION & ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	40	40	40
B	11	11	80
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this examination.

Materials supplied

- Question and answer book of 35 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

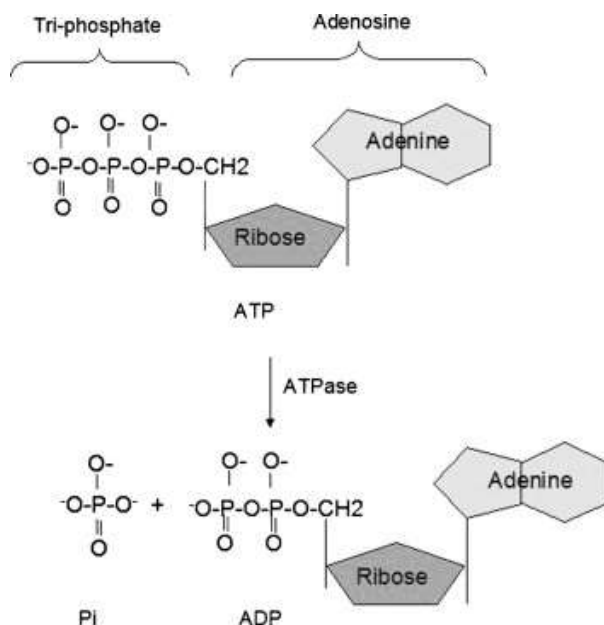
Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.

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

Answer all questions on the Multiple-Choice Answer sheet provided.

Question 1

The diagram below shows the effect of ATPase, an enzyme which catalyses the decomposition of ATP by a hydrolysis reaction.



Which of the following would also be produced as a result of this reaction occurring?

- A. ATP
- B. Water
- C. Energy
- D. Adenine

Question 2

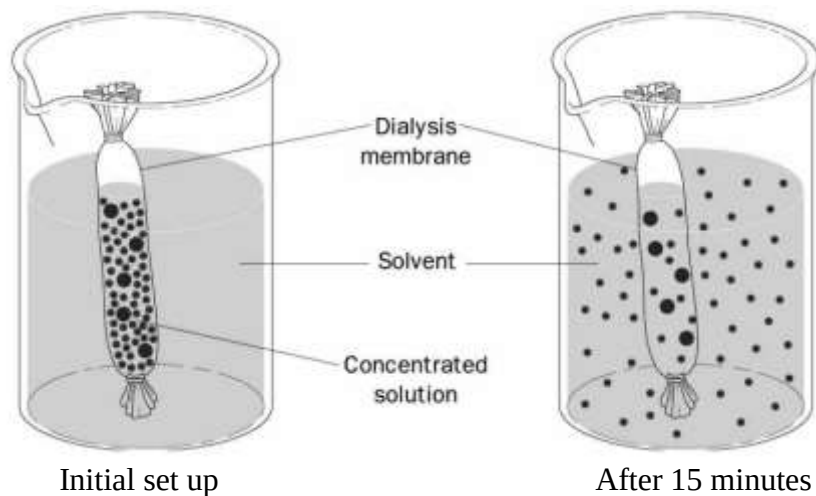
A mutation occurred, preventing the synthesis of ATPase. Which one of the following types of material transport would be unable to occur as a result of this mutation?

- A. Movement of oxygen out of the leaf of a plant by diffusion
- B. Movement of sodium ions into a neuron by active transport
- C. Movement of water into the root cells of a plant by osmosis
- D. Movement of glucose into a liver cell by facilitated diffusion

SECTION A - continued

Question 3

A group of students were conducting an experiment to observe the movement of substances across a dialysis tubing made of cellulose. The students place a solution consisting of glucose (shown as small circles) and starch (shown as larger circles) into the tubing, which they then place into a beaker containing water and iodine. Iodine is an indicator which is normally yellow, but turns dark blue in the presence of starch. It is able to diffuse across the membrane.



Which of the following observations would be expected to occur?

- A. The contents inside the cellulose tubing turn dark blue after 15 minutes
- B. The solution surrounding the tubing is initially dark blue and becomes yellow 15 minutes later
- C. The solution surrounding the tubing is initially yellow and becomes dark blue 15 minutes later
- D. The contents inside the tubing are initially dark blue and become lighter blue due to water diffusing into the tubing

Question 4

A piece of RNA has a poly A tail. This indicates that:

- A. The molecule only contains coding regions
- B. The molecule is a major component of a ribosome
- C. The molecule contains exons, which need to be removed
- D. The RNA molecule also contains the complementary nucleotide, thymine

SECTION A - continued
TURN OVER

Question 5

Which of the following is used to establish the sequence of nucleotides in an mRNA molecule?

- A. The sequence of nucleotides in a tRNA molecule
- B. The sequence of nucleotides in a DNA molecule
- C. The sequence of nucleotides in an rRNA molecule
- D. The sequence of amino acids in a polypeptide chain

Question 6

Consider the function of a regulatory gene. Which one of the following statements about regulatory genes is correct? A regulatory gene:

- A. Codes for the production of an enzyme
- B. Is made up of codons which contain ribose
- C. Activates the promoter region of another gene
- D. Codes for the production of RNA polymerase

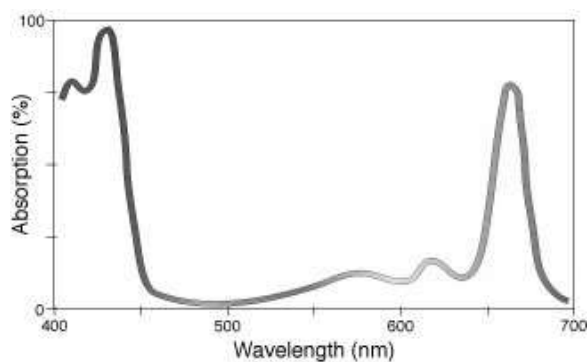
Question 7

Oxygen is not an input into the Krebs's cycle. However, the Krebs's cycle is considered to be an aerobic process. This is because:

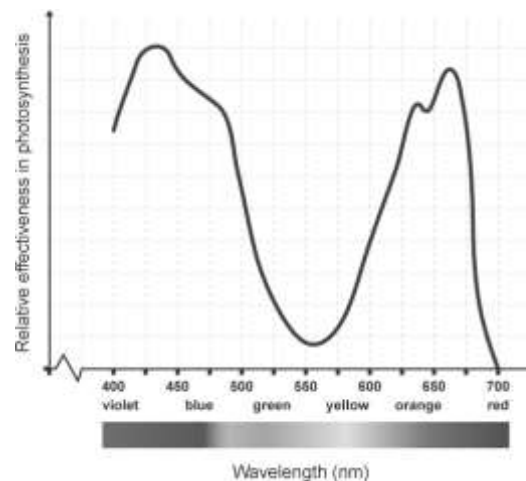
- A. A cell cannot produce ATP in the absence of oxygen
- B. All aerobic cellular processes require an input of oxygen
- C. It will not function if the electron transport chain is non-functional
- D. The presence of oxygen facilitates the production of NADH carrier molecules

Use the following information to answer questions 8 and 9

The graphs below show the absorption and action spectra relating to photosynthesis in plants with green chlorophyll.



Absorption spectrum for chlorophyll



Action spectrum showing relative effectiveness in photosynthesis

SECTION A - continued

Question 8

Based on the data provided, it is correct to state that:

- A. The wavelength of light has no effect on the rate of photosynthesis
- B. The effectiveness of photosynthesis increases as absorption increases
- C. Green light provides the greatest amount of energy for photosynthesis
- D. The most effective wavelength of light for photosynthesis to occur is 500 nm

Question 9

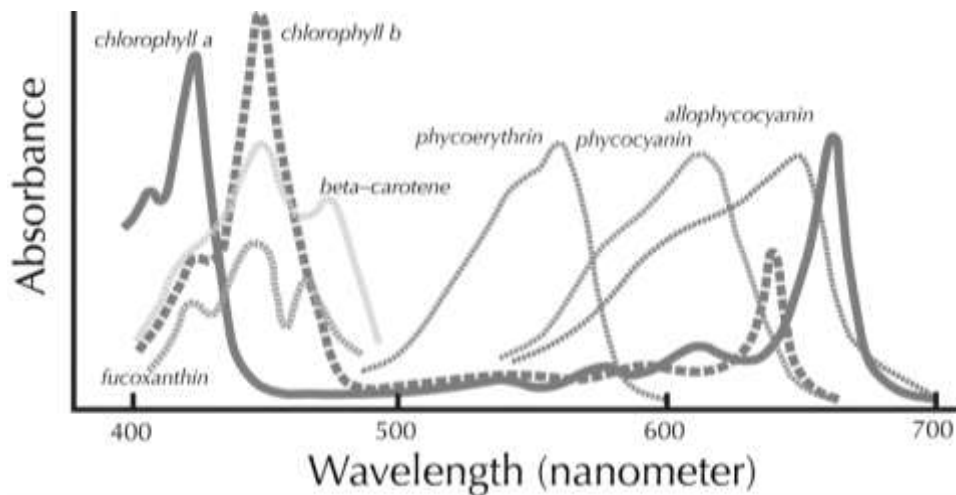
A particular species of plant produces leaves that are orange in colour. Which one of the following conclusions could be made?

- A. The action and absorption spectra will be the same for both types of plant
- B. The colour of the leaves is due to the fact that orange light is being absorbed
- C. The highest point on the action spectrum will occur at approximately 425nm
- D. The lowest point on the absorption spectrum will occur at approximately 625nm

Use the following information to answer questions 10 and 11

Question 10

Plants are capable of producing a range of pigments which are used to absorb light energy. The graph below shows the absorption spectrum for each of these pigments.



Based on the data provided, it is correct to state that plants benefit by producing a variety of pigments because:

- A. Doing so increases the amount of light that they can absorb
- B. They can carry out photosynthesis effectively during different seasons
- C. When a plant runs out of one pigment it can produce a different type of pigment
- D. Plants are able to change the colour of their leaves when the colour of light changes

**SECTION A - continued
TURN OVER**

Question 11

The graph refers to two types of chlorophyll; a and b, both of which are proteins. Based on the data provided, it is correct to state that:

- A. Chlorophyll a and b are cofactors, with one activating the other
- B. Chlorophyll a and b are produced by expression of the same gene
- C. Chlorophyll a and b have the same primary structure as each other
- D. Chlorophyll a and b would be expected to have similar three-dimensional structures

Question 12

Which one of the following graphs best represents the effect that increasing the substrate concentration will have on the rate of an enzyme catalysed reaction?

**Question 13**

Succinic acid dehydrogenase (SDA) is the enzyme that is responsible for catalysing the reaction in which succinate is converted to fumarate. The following experiment was conducted to determine the effect of adding malonic acid to a test tube that contains SDA and succinate.

Tube	Condition
1	10mL of a solution containing 1% succinate and 1mL of SDA
2	10mL of a solution containing 1% succinate, 1mL of SDA and 1 mL of malonic acid
3	15mL of a solution containing 1% succinate, 1mL of SDA and 1mL of malonic acid

The reaction rate was highest in test tube one, decreased in test tube two and then increased again in test tube three. Based on this information, what role was played by malonic acid?

- A. Malonic acid acted as an inhibitor
- B. Malonic acid acted as a coenzyme
- C. Malonic acid caused SDA to denature
- D. Malonic acid changed the shape of the enzyme

Question 14

Consider the reception stage in the stimulus-response model. Protein based hormones:

- A. Form a complex which binds to a target area of DNA
- B. Bind to a receptor on the external surface of a target cell
- C. Activate enzymes already present in the cytosol of a target cell
- D. Bind to a second messenger on the internal surface of a target cell

SECTION A - continued

Question 15

A cell receiving a signalling molecule can initiate a metabolic cascade involving a number of different stages. Which one of the following statements identifies a benefit of metabolic cascades occurring?

- A. Increasing the number of stages enables the signal to be amplified
- B. The amount of energy required to initiate a cellular response is decreased
- C. The different pathways enable a cellular response to occur even if a mutation occurs
- D. Metabolic cascades reduce the number of types of signalling molecules required to cause a cellular response

Question 16

The p53 gene plays several roles including arrest of the cell cycle, DNA repair and promoting apoptosis. The p53 gene is activated if DNA in a replicating cell is damaged. Which of the following identifies the importance of the p53 gene in this example?

- A. The p53 gene activates other genes which kill off stressed cells
- B. Cells that have been damaged are repaired preventing tissue damage
- C. Cells with irreparable DNA damage die off, preventing tumours forming
- D. Cells which are no longer viable die off, preventing energy from being wasted

Question 17

The thymus gland plays an important role in the immune system. Which of the following functions occur in the thymus gland?

- A. Maturation of T cells
- B. Activation of complement
- C. Clonal expansion of B cells
- D. Development of macrophages

Question 18

Consider the inflammatory response. Which one of the following statements is correct? During the inflammatory response:

- A. Polymorphic neutrophils secrete histamine
- B. Blood flow to the damaged area decreases in order to limit blood loss
- C. Platelets release chemicals which attract phagocytes to the site of injury
- D. Macrophages and mast cells secrete chemicals which cause vasodilation

SECTION A - continued
TURN OVER

Question 19

Under which of the following circumstances would a person acquire passive immunity naturally?

- A. They are an infant consuming breast milk
- B. They are provided with antivenin after being bitten by a spider
- C. They contract an infectious disease which they later recover from
- D. They are injected with a vaccine which contains antigenic fragments

Question 20

The third level of defence in humans is carried out by B cells and T cells. Which one of the following statements correctly identifies the difference between B cells and T cells?

- A. B cells have the ability to present antigens, T cells lack this ability
- B. All T cells have class II MHC markers, which are lacking on B cells
- C. T cells carry out cell mediated immunity, B cells carry out humoral immunity
- D. B cells are responsible for immunological memory, T cells do not play a role in immunological memory

Question 21

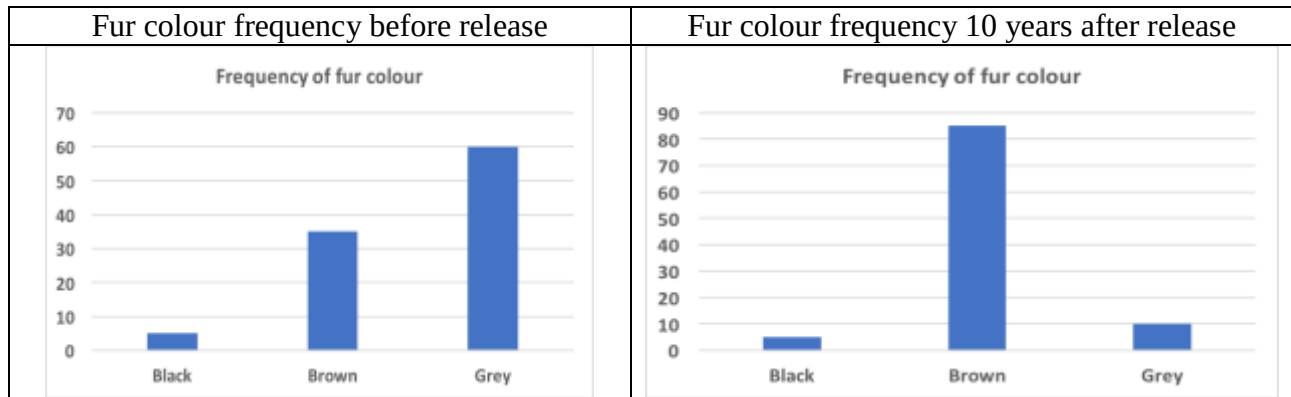
According to the theory of natural selection, which of the following is the best definition of biological fitness?

- A. The ability of a species to survive unchanged for a longer period of time than other species
- B. The ability of a specific population to survive an environmental change compared to other populations
- C. The ability of a species to survive an environmental change compared to different species in the same location
- D. The ability an organism to survive an environmental change compared to other members of the same population

SECTION A - continued

Question 22

The fur colour of 100 mice was recorded before the mice were released into an enclosed space inaccessible to any other mice. Ten years later, non-lethal traps were used to capture 100 mice and the fur colour of these mice was also recorded. The graphs showing the fur colour of the original mice and the later sample are shown below.



Which one of the following best explains the change in the frequency of fur colour in the population of mice?

- A. A strong selection pressure occurred reducing the biological fitness of the mice with grey coats
- B. The allele which causes mice to develop grey coats mutated and became lethal, causing mice with grey coats to die off
- C. The black mice were too well camouflaged to capture and therefore were under-represented in the later sample
- D. The initial and final numbers of mice with a black coat are the same because the mice with black coats did not breed at all

Question 23

A population of lizards was separated into two smaller populations by a river. The separation of these two smaller populations became permanent. Which of the following is **least likely** to occur in the two populations?

- A. Speciation begins to occur immediately
- B. Genetic differences accumulate between the two populations
- C. Each of the populations will develop phenotypic variations over time
- D. The two different populations will be exposed to different selection pressures

SECTION A - continued
TURN OVER

Question 24

In 1953 a small number of koalas were introduced from the mainland onto Phillip Island, a site previously not colonised by koalas. The population increased in size over time, however, many of the current population of koalas appear to have ill health and don't tend to disperse as would normally occur. Which one of the following statements regarding the current population of koalas is correct?

- A. The Phillip Island population will have less genetic variation than the mainland population
- B. The gene pool of the Phillip Island population will be the same as that of the mainland population
- C. The lack of gene flow between the mainland and Phillip Island populations will encourage speciation to occur
- D. The fact that the Phillip Island population is smaller than the mainland population will cause an increase in the rate of mutations in the Phillip Island population

Question 25

A plant was observed to produce berries which are several times larger than those produced by other plants of the same species. Karyotyping was performed in order to try to find out why this plant differed from others of the same species. The result is shown below.



Which one of the following statements best applies to the plant?

- A. The plant is euploid
- B. The plant is aneuploid
- C. The plant is polyploid
- D. The plant is multiploid

Question 26

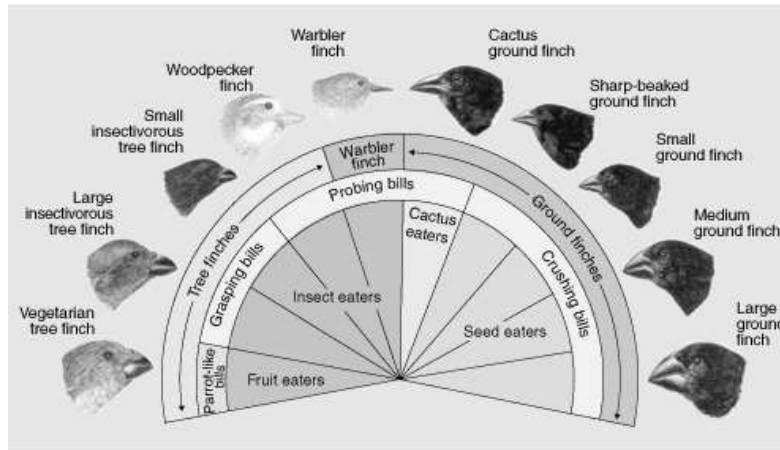
A forest fire caused a dramatic decrease in the population of a particular species. The allele frequency of the surviving population is substantially different to that of the initial population. This is an example of:

- A. Genetic drift
- B. Natural selection
- C. The Founder Effect
- D. Disruptive selection

SECTION A - continued

Use the following information to answer questions 27 to 29.

During his trip to the Galapagos Islands, Charles Darwin observed that there was a large number of different types of finch present on different islands. Some of these are shown in the diagram below.



Question 27

Which one of the following is responsible for the evolution of an ancestral finch into a variety of finches with a large variation of novel phenotypes?

- A. Adaptive radiation
- B. Convergent evolution
- C. Geographical isolation
- D. Polymorphic inheritance

Question 28

It was later concluded that all of the finches found on the islands were members of different, but related species. Which one of the following findings would support this conclusion?

- A. All of the finches have the same genetic material
- B. All of the finches have a number of genes in common with each other
- C. Interbreeding between any of the finches would not result in viable offspring
- D. There is an extensive amount of phenotypic variation between the different types of finch

Question 29

All of the finches shown share a recent common ancestor. Which one of the following terms describes the features that these finches are expected to have?

- A. Analogous structures
- B. Homologous structures
- C. Characteristic structures
- D. Morphological structures

SECTION A - continued
TURN OVER

Question 30

The endosymbiotic theory proposes that chloroplasts and mitochondria both evolved as separate organisms from early forms of bacteria, which were later taken up by and became dependent on eukaryotic host cells. Which one of the following findings is not used as supporting evidence for this theory?

- A. Chloroplasts and mitochondria both contain non-nuclear DNA
- B. Chloroplasts and mitochondria are both able to synthesise proteins
- C. Chloroplasts and mitochondria both have an extensive membranous structure
- D. Chloroplasts and mitochondria both replicate by binary fission at different times compared to the cell in which they are located

Question 31

Mammals and birds both have hearts which have four chambers. It has been established that this feature evolved independently in both types of organisms. If an individual was unaware of this fact, which of the following conclusions would be most plausible?

- A. Early species of mammals must have had feathers
- B. The ancestors of birds and mammals experienced similar selection pressures
- C. Birds evolved a four-chambered heart before this feature occurred in mammals
- D. Birds and mammals shared a recent common ancestor, which had a four-chambered heart

Question 32

Mitochondrial DNA (mtDNA) is able to be used as a molecular clock because:

- A. It is passed down the maternal line
- B. mtDNA is different to nuclear DNA
- C. Mutations occur in mtDNA at a known rate
- D. All individuals have more copies of mtDNA than of nuclear DNA

Question 33

The diagram below represents some undisturbed layers of sedimentary rock

Layer 1
Layer 2
Layer 3
Layer 4

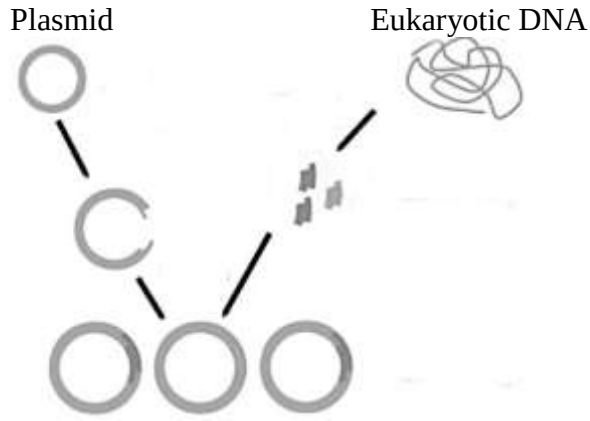
Which one of the following conclusions is accurate?

- A. The greatest number of fossils would be present in layer 1
- B. The fossils in layer 3 are ancestors of the fossils in layers 2 and 1
- C. Fossils of related organisms would be found in each of the layers
- D. The fossils in layer 2 would have a greater absolute age than those in layer 1

SECTION A - continued

Use the following information to answer questions 34 to 36.

The following diagram shows an overview of the process of gene cloning. The gene to be cloned is inserted into bacterial plasmids. The eukaryotic DNA is the source of the gene that will be cloned.



Question 34

Prior to inserting the eukaryotic DNA into the plasmid, a large number of copies of the DNA must be produced. Identify which one of the following is the name of the process used to accomplish this goal.

- A. DNA amplification
- B. DNA magnification
- C. Polymerase chain reaction
- D. Exponential copy reaction

Question 35

The second stage of the diagram shows that the plasmid has been cut open and the gene of interest has been cut out from the eukaryotic DNA. This is accomplished using the enzyme:

- A. Ligase
- B. Helicase
- C. Polymerase
- D. Endonuclease

SECTION A - continued
TURN OVER

Question 36

As shown in the diagram, plasmids containing the DNA insert are produced. Which one of the following terms is used to describe the plasmids at this stage?

- A. Vector
- B. Annealed
- C. Transformed
- D. Recombinant

Question 37

Rational drug design is a method that is used by pharmaceutical companies to manufacture drugs used to treat a variety of conditions, some of which are infectious and others of which are metabolic disorders. There are three main stages that are carried out during rational drug design. Which one of the following **is not** one of these three stages?

- A. Sequence the DNA of an appropriate target structure
- B. Design a molecule which will bind to a specific target structure
- C. Identify an appropriate target which is associated with the cause of the disease
- D. Determine the structure of a target which is associated with the cause of the disease

Question 38

Cells that produce monoclonal antibodies are produced after a tumour cell is fused with a mammalian spleen cell, which produces antibodies. Which one of the following identifies the type of cell that is produced by fusing these cells together?

- A. Sarcoma
- B. Myeloma
- C. Hybridoma
- D. Lymphoma

Question 39

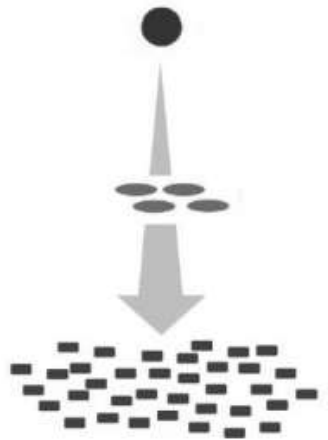
Vaccination programmes contribute to increasing a population's resistance to infection as well as limiting the spread of the pathogen responsible. This is known as:

- A. Herd immunity
- B. Active immunity
- C. Infection prevention
- D. Resistance generation

SECTION A - continued

Question 40

Each of the shapes in the diagram below represents a gene. The diagram is a flow cart which shows the impact of a single gene on other genes.



The gene represented by the circle at the top of the diagram is:

- A. A master gene
- B. A control gene
- C. A structural gene
- D. An induction gene

**END OF SECTION A
TURN OVER**

SECTION B - Short-answer questions**Instructions for Section B**

Complete all answers in the spaces provided.

Question 1 (9 marks)

A student designed and carried out an experiment to demonstrate the relationship between aerobic cellular respiration and photosynthesis. They decided to use water, bromothymol blue, ammonia (a basic substance), aquatic snails and elodea, an aquatic plant. Four test tubes were set up as shown below. Each was placed under a constant light source and observed 24 hours later.

If carbon dioxide is present in the water, some of it will react with the water to produce carbonic acid.

Bromothymol blue is a pH indicator which is blue under basic conditions, turns green in neutral conditions and turns yellow under acidic conditions.

Tube	Condition
1	Water, ammonia and bromothymol blue
2	Water, ammonia, bromothymol blue and elodea
3	Water, ammonia, bromothymol blue and 5 aquatic snails
4	Water, ammonia, bromothymol blue, elodea and 5 aquatic snails

- a. Identify the purpose setting up test tube 1.

1 mark

- b. What was the purpose of adding ammonia to each of the test tubes.

1 mark

- c. Identify the dependent variable in this experiment.

1 mark

SECTION B – Question 1 - continued

- d.** Identify in which of the tubes photosynthesis would be occurring and in which of the tubes aerobic cellular respiration would be occurring.

2 marks

- e.** Predict the colour of the indicator which would be expected to be observed in each test tube at the end of the 24-hour period.

2 marks

- f.** Explain how this experiment enables the student to establish the relationship between photosynthesis and aerobic cellular respiration.

2 marks

SECTION B – Question 1 - continued
TURN OVER

Question 2 (9 marks)

The trp operon is a group of genes, called trp genes, which code for the production of the amino acid tryptophan in bacteria. The trp operon is regulated by a repressor protein. The diagram below shows an overview of the structure of the trp operon.

Promoter	Operator	trpE	trpD	trpC	trpB	trpA
----------	----------	------	------	------	------	------

- a. Under which conditions would the repressor protein be expected to bind to the operator gene? Provide a reason to support your answer.

2 marks

- b. What type of gene codes for the production of a repressor protein? Provide a reason to support your answer.

2 marks

- c. Explain how the bacteria benefits by being able to regulate the trp operon.

2 marks

SECTION B – Question 2 - continued

- d. Identify and describe the process which occurs when the repressor protein is not bound to the operator gene.

3 marks

SECTION B – continued
TURN OVER

Question 3 (6 marks)

A segment of mRNA is 276 nucleotides long, however, the DNA template from which it was transcribed was 360 nucleotides long.

- a.** Explain why there is a difference between the number of nucleotides in the mRNA to that in the DNA template strand.

2 marks

- b.** Identify the number of amino acids that would be present in the polypeptide chain produced by translation. Provide a reason to support your answer.

2 marks

- c.** Identify two other ways in which the structure of DNA differs from that of mRNA.

2 marks

SECTION B – continued

Question 4 (7 marks)

In 1981 a series of events occurred, which were subsequently known as the “skippy scandal”. A shipment of beef to the USA was found to contain kangaroo meat. Upon further inspection, other shipments of beef were found to contain kangaroo and horse meat.

- a. The protein content of beef is approximately 27%. Identify the organelle which is essential for protein synthesis.

1 mark

-
- b. Identify a type of chemical reaction which can be used to explain the presence of water in cells which produce proteins.

1 mark

-
- c. The presence of different types of meat in a sample can be established using DNA profiling. Explain how DNA profiling is carried out.

2 marks

-
-
-
-
- d. The person who conducted the DNA profiling required a sample of DNA taken from a sample of pure beef. What is the purpose of this requirement? How could this sample be used to determine whether the sample of beef also contained protein from other species or not? How would the results vary if the sample was pure beef compared to a sample that contained proteins from other organisms?

3 marks

SECTION B – continued
TURN OVER

Question 5 (7 marks)

Rhagolettis pomonella is a type of fly that is native to North America. Initially this fly only consumed fruit from native Hawthorn trees. Female flies also laid eggs in the Hawthorn fruit. These native flies were known as “Hawthorn Maggot Flies”. The first apple orchard was planted in North America in 1625. The first reported case of maggot flies colonising apples was in 1864. These flies are known as “Apple Maggot Flies”. Apple maggot flies and Hawthorn maggot flies are virtually identical in appearance, but are genetically distinct from each other. In several studies, the two types of maggot flies are referred to as “races”.

Apples ripen between July 25 and September 27. Hawthorn fruit ripen between September 1st and November 17th. The life cycles of both types of fly are coordinated with the life cycle of the type of tree that they inhabit. Each type of fly generally lives in the same host plant that it hatched in and has the ability to recognise flies with the same habitat preference and usually reject mates that have a different habitat preference. Viable hybridisation between the two populations occurs at a rate of about 5%.

- a. Explain the significance that food and habitat preference has played in the development of differences between the Hawthorn Maggot Flies and the Apple Maggot Flies.

2 marks

- b. Referring to the information provided, suggest a conclusion that could be made about the rate of divergence between the two types of flies. Provide a reason to support your answer.

2 marks

SECTION B – Question 5 - continued
TURN OVER

- c. Referring to the information provided, explain why a low degree of hybridisation occurs between the two types of flies.

1 mark

- d. Referring to the information provided, is it more correct to describe these two types of fly as being “races” or “species”. Provide a reason to support your answer.

2 marks

SECTION B – continued
TURN OVER

Question 6 (8 marks)

The table below compares the first ten amino acids in a protein taken from four organisms of the same species.

Organism	1	2	3	4	5	6	7	8	9	10
1	Met	Ala	Leu	His	Val	Glu	Thr	Iso	Val	Asp
2	Met	Ala	Leu	His	Arg	Glu	Thr	Iso	Val	Asp
3	Met	Ala	Leu	His	Val	Glu	Iso	Val	Thr	Met
4	Met	Ala	Leu	His	Val	Trp	Arg	Pro	His	Asp

- a. Identify the type of mutation that is most likely to have caused the differences in the protein between organisms 1 and 2. Use the data to provide a reason to support your answer.

2 marks

SECTION B – Question 6 - continued

- b. The sequence from the protein taken from organism 1 has been proved to be the original allele. Each of the other sequences represent a different allele. A student has predicted that there are three possible effects on the structure and function of the protein produced by the allele in organism 2. The predicted effects are shown in the table below. Complete the table by providing a justification for each predicted effect.

3 marks

PREDICTED EFFECT	JUSTIFICATION
The protein structure and function are unaffected.	
The protein may have a different structure but retains the same function.	
The protein may have a different structure and a slightly different function.	

- c. A student stated that the change in the protein in organism 3 is due to a frameshift occurring. Discuss the accuracy of this statement. Use the data to provide a reason to support your answer.

2 marks

SECTION B – Question 6 - continued
TURN OVER

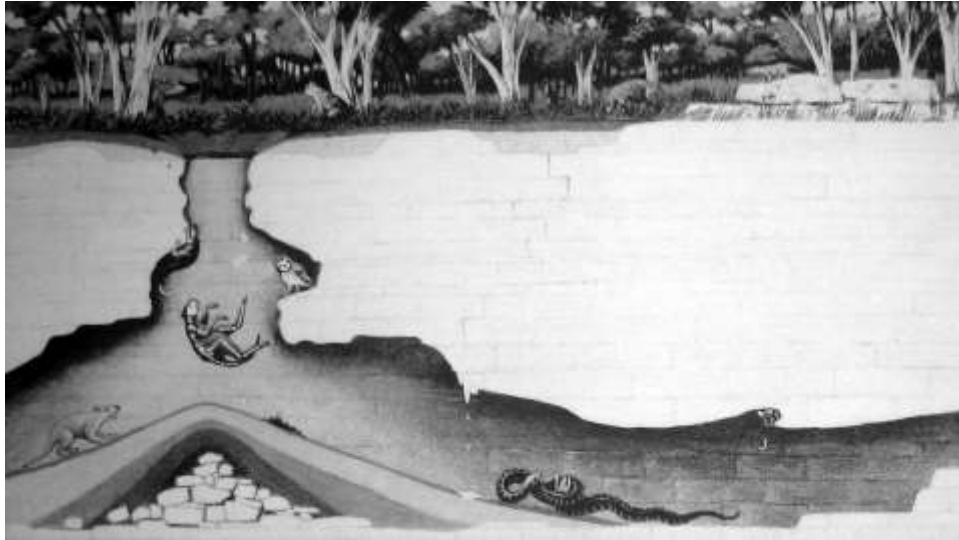
- d. Comparing the extent of similarity between proteins is an example of molecular homology. Discuss how molecular homology is used to provide evidence regarding the degree of relatedness between different species.

1 mark

SECTION B – continued

Question 7 (8 marks)

The diagram below shows a cross section of one of the caves found in Naracoorte, South Australia. It is highly valued as being the source of a large number of fossils of a variety of species. This occurred because a large number of terrestrial organisms fell into the open caves and were prevented from leaving due to the presence of the steep walls. Different strata containing fossils formed when soil and other debris were washed into the cave.



- a. Explain why the conditions in the Naracoorte caves were appropriate for fossilisation to occur. Refer to the steps in fossilisation in your answer.

2 marks

SECTION B – Question 7 - continued
TURN OVER

- b. The oldest fossil is believed to be over 300 000 years old. Identify a form of absolute dating that could be used to verify this estimate.

1 mark

- c. Most of the fossils were body fossils, however, some trace fossils were also located. Explain the difference between body fossils and trace fossils. Discuss the different types of information that are obtained from each type of fossil.

3 marks

- d. Recently, a fossil of a small marsupial lion *Microleo attenboroughi* was found. This marsupial lion was arboreal (capable of living in trees) and had a mass of about 600g. Although this species had its own distinct appearance, the fossil had features in common with ancestral possums and larger marsupial lions, which appeared later in the fossil record. Identify the term used to describe fossils such as that of *Microleo attenboroughi*. Explain the value of this type of fossil

2 marks

SECTION B – continued

Question 8 (11 marks)

In 2008 a single finger bone from a child was discovered in a Siberian cave. It was subsequently determined to be 40 000 years old. Initially it was assumed to be either a bone from *Homo sapiens* or *Homo neanderthalensis* as both species had been known to have colonised the area. However, in March 2010 it was found that mitochondrial DNA extracted from the fossil was different to that of both other hominin species. The individual was named “X woman” and declared to be a member of a new species of hominin, *Homo denisova*.

- a. Discuss the impact of the 2008 finding on theories relating to human evolution at that time.

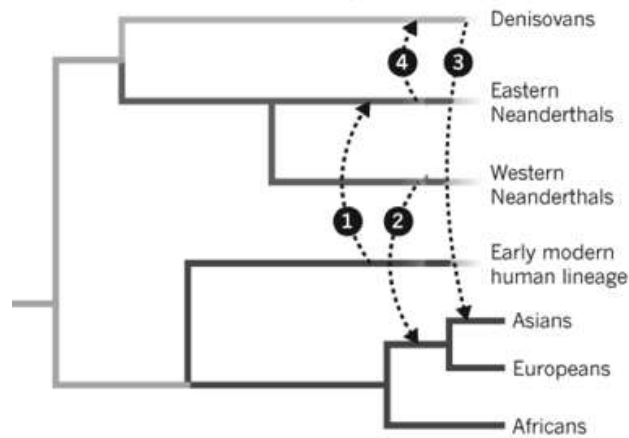
1 mark

- b. Scientists were only able to extract mitochondrial DNA from the finger bone. Discuss the accuracy of the name “X woman” with regard to the gender of this hominin. Provide a reason to support your answer.

2 marks

SECTION B – Question 8 - continued
TURN OVER

The cladogram below shows an overview of the divergence of modern hominins.



- c. Explain why Neanderthals and Denisovans are believed to have more features in common with each other than either has in common with modern *Homo sapiens*.

2 marks

- d. Identify which modern humans have some Denisovan DNA. Explain why some modern humans have a small percentage of Denisovan DNA whilst others do not.

2 marks

SECTION B – Question 8 - continued

Homo erectus fossils have also been found at various locations in Europe. *Homo erectus* is believed to have existed from 2 million years ago up until approximately fifty thousand years ago.

- e. Identify two differences that would be expected to be observed between a skull from *Homo erectus* and a skull from *Homo sapiens*.

2 marks

- f. In 2014, some shell carvings produced by members of *Homo erectus* were discovered and found to be approximately 540 000 years old. There was evidence that the hinges of the shells had been drilled open and there was also evidence of fire in the same location. Discuss the significance of this finding in terms of cognitive ability and cultural evolution in *Homo erectus*.

2 marks

SECTION B – continued
TURN OVER

Question 9 (5 marks)

Multiple sclerosis is an ongoing degenerative condition. It is characterised by demyelination; damage to, and removal of, the myelin sheath which surrounds the axon of sensory and motor neurons. Although the cause of Multiple Sclerosis remains unknown, one theory states that this condition begins because macrophages engulf the myelin sheath which surrounds neurons.

- a. Identify the term used to describe conditions, such as multiple sclerosis. Identify an immunological reason to explain why these conditions should not occur.

2 marks

- b. Assuming that the identified theory is correct, describe all of the following stages that would occur causing demyelination. Include a mention of all involved cells and chemicals in your answer.

3 marks

SECTION B – continued

Question 10 (5 marks)

The idea of colonising Mars has been the subject of many science fiction books, however, currently this is being taken very seriously with one organisation stating that it may be possible to begin sending colonists by 2024. This first round of colonists is planned to consist of approximately one hundred individuals. Scientists have stated that it will be difficult to accomplish this goal, with human genetics being one of the potential obstacles.

- a. In terms of the size of the gene pool, explain why some scientists have identified that human genetics are a potential obstacle.

1 mark

- b. If this proposed colonisation went ahead, what term should be applied to this type of situation? What is likely to happen to allele frequencies and traits in the descendents of this population compared to that of the entire human population?

2 marks

- c. Some scientists have stated that the solution to this problem relies maximizing the diversity of the colonising population. Explain the importance of this decision with regard to both population genetics and natural selection.

2 marks

SECTION B – continued
TURN OVER

Question 11 (5 marks)

Chikungunya disease is caused by the chikungunya virus, which is transmitted by the tiger mosquito. In the past, cases of the disease were confined to tropical regions surrounding the Indian Ocean, however, more than 100 cases of the disease occurred in Italy 2007. Subsequently outbreaks have occurred in other countries located in in Europe as well as Asia, Africa, and the Americas. Chikungunya disease is classified as an emerging disease because it is an example of a known pathogenic agent spreading to a new geographic location and infecting new populations.

- a.** Why was Chikungunya disease classified as being a pandemic?

1 mark

- b.** It took time for medical professionals to diagnose the initial cases of Chikungunya disease in Italy. One of the first tests involved putting samples from the infected individuals onto agar in Petri dishes and incubating them. Explain why this approach was unsuccessful in isolating the Chikungunya virus.

1 mark

- c.** In 2007, the World Health Organisation warned that infectious diseases were emerging at a previously unprecedented rate. This has been partially attributed to human actions and living conditions. Identify two of these factors which would lead to the spread of emerging diseases.

2 marks

SECTION B – Question 11 - continued

- d.** There are a range of strategies that have been implemented on a global scale in order to attempt to prevent the spread of emerging diseases. Many of these ongoing strategies relate to ongoing surveillance and monitoring. Explain the importance of carrying out these strategies.

1 mark

END OF QUESTION AND ANSWER BOOK