

YEAR 12 *Trial Exam Paper*

2015

BIOLOGY

Written examination

STUDENT NAME

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	40	40	40
B	12	12	70
			Total 110

- Students are permitted to bring pens, pencils, highlighters, erasers, sharpeners and rulers into the examination.
- Students are NOT permitted to bring blank sheets of paper and/or white-out liquid/tape into the examination.
- Calculators are not allowed in this examination.

Materials provided

- Question and answer book of 47 pages.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **name** in the box provided and on the multiple-choice answer sheet.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the multiple-choice answer sheet.

Choose the response that is **correct** for the question.

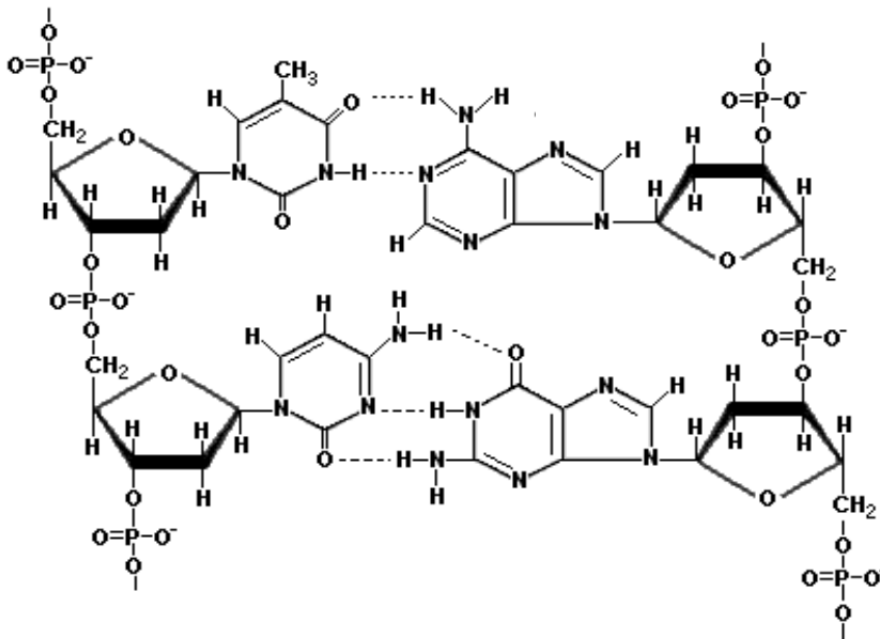
A correct answer scores 1, an incorrect answer scores 0.

Marks will not be taken away for incorrect answers.

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

Use the following information to answer Questions 1, 2 and 3.

Molecule Z is a biomacromolecule. A diagram of part of this molecule is shown below.



Source: <http://www.scientificpsychic.com/fitness/aminoacids1.html>

Question 1

In a cell, molecule Z would be located predominantly in the

- A. nucleus.
- B. plasma membrane.
- C. endoplasmic reticulum.
- D. Golgi apparatus.

Question 2

Water is formed when monomers join to form molecule Z. This reaction is known as

- A. hydrolysis.
- B. lysis.
- C. hybridisation.
- D. condensation.

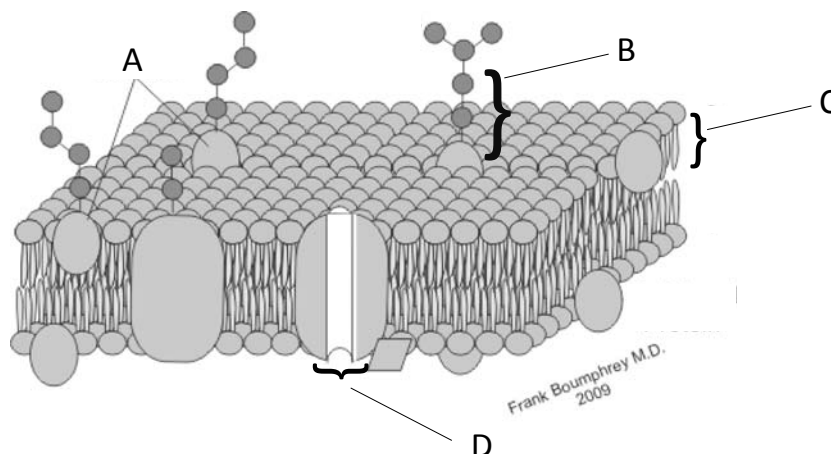
Question 3

It is logical to assume that molecule Z is

- A. ssDNA.
- B. dsDNA.
- C. tRNA.
- D. rRNA.

Question 4

The diagram shows a representation of a section of plasma membrane.



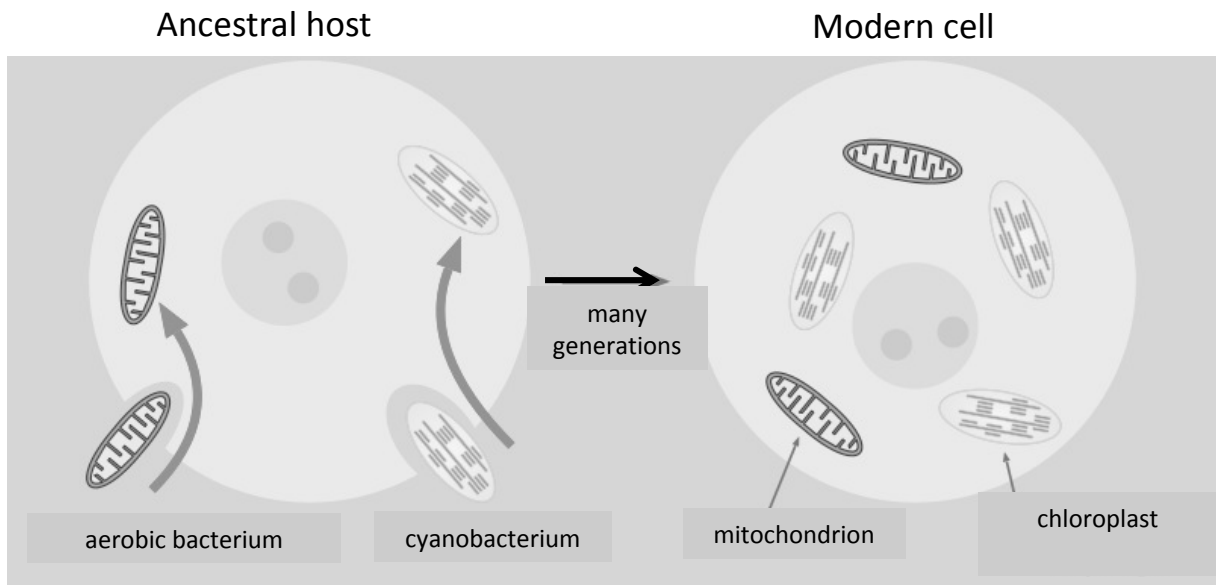
Source: http://commons.wikimedia.org/wiki/File:Cell_membrane3.png

The correct labelling for this diagram is

	Structure A	Structure B	Structure C	Structure D
A.	integral protein	carbohydrate	glycolipid	protein
B.	peripheral protein	glycolipid	phospholipids	channel protein
C.	peripheral proteins	glycolipid	phospholipid	channel protein
D.	glycoprotein	carbohydrate	glycolipid	protein channel

Question 5

Symbiogenesis is a theory that explains how eukaryote cells originated from prokaryotes. The diagram below illustrates that process.



Source: <http://commons.wikimedia.org/wiki/File:Endosymbiosis.svg>

After Lynn Margulis

The evidence that would NOT support symbiogenesis is

- A. If mitochondria and chloroplasts are removed from a cell, the cells cannot replicate new ones.
- B. Mitochondria and chloroplasts contain single circular DNA that is identical to nuclear DNA.
- C. Transport proteins called porins, found in the outer membranes of mitochondria and chloroplasts, are also found in bacterial cell membrane.
- D. New mitochondria and plastids are formed only through a process similar to binary fission.

Question 6

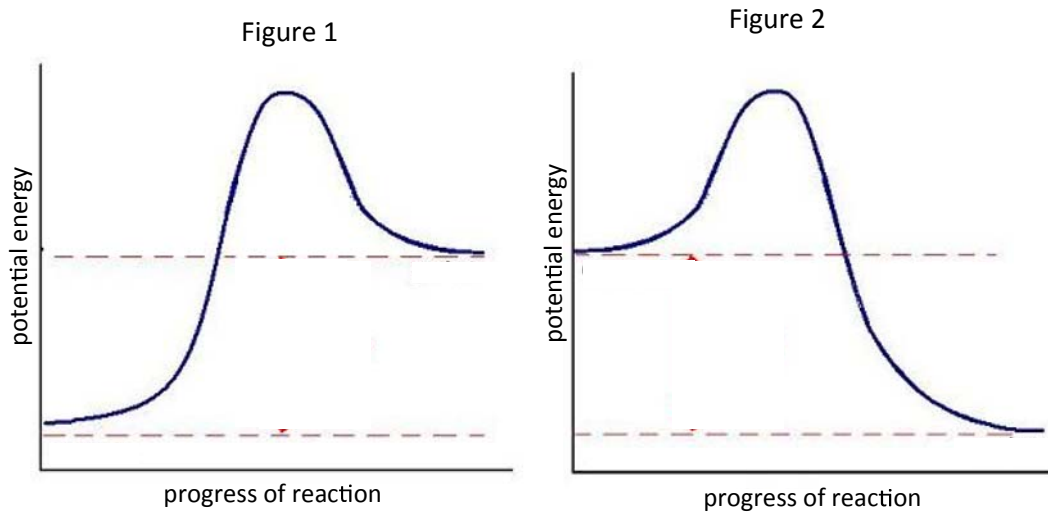
Which of the following is true of necrosis and apoptosis?

	Necrosis	Apoptosis
A.	programmed, detrimental	premature, caused by trauma
B.	premature, caused by toxins	programmed, prevents tumours
C.	programmed, membrane blebbing	premature, detrimental
D.	premature, beneficial	programmed, caused by toxins

Question 7

The stage of photosynthesis that occurs on the thylakoid membrane is

- A.** the Calvin cycle.
- B.** the Krebs cycle.
- C.** independent of light.
- D.** light dependent.

Question 8

Source: http://en.wikibooks.org/wiki/Structural_Biochemistry/Enzyme/Gibbs_free_energy_graph

Figure 1 and Figure 2 show the progress of two different chemical reactions in terms of the potential energy of the molecules taking part in the reaction.

Figure 1 represents

- A. an anabolic reaction, an example of which could be photosynthesis.
- B. an anabolic reaction, an example of which could be cellular respiration.
- C. a catabolic reaction, an example of which could be cellular respiration.
- D. a catabolic reaction, an example of which could be photosynthesis.

Use the following information to answer Questions 9 and 10.

The diagram shows a strategy used by some agriculturalists to protect their crops from insect damage.

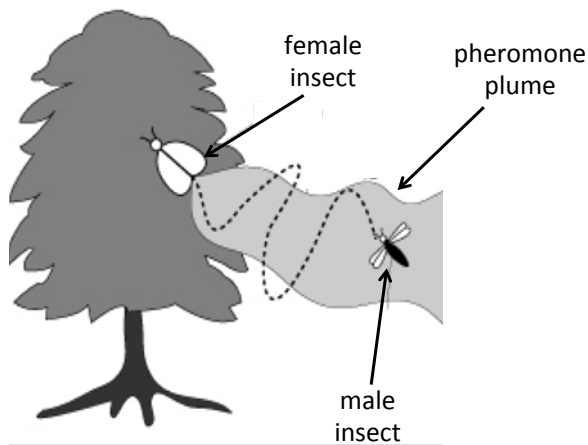


Figure 3. Normal mate location

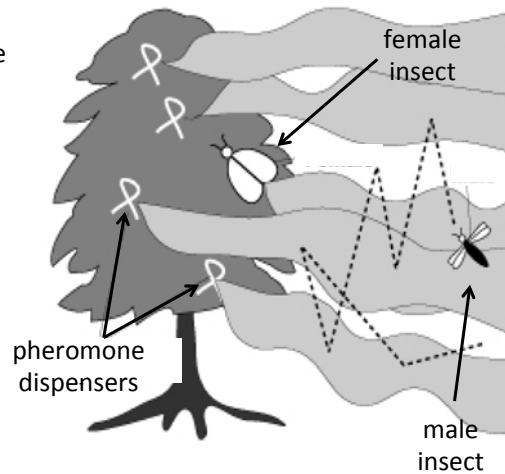


Figure 4. Mating disruption

Source: <http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=-80>

Question 9

A pheromone is

- A. an endocrine hormone that acts between species.
- B. a paracrine hormone that acts within a species.
- C. a signalling molecule that can be detected by organisms from different species.
- D. a signalling molecule that is detected intraspecifically.

Question 10

In this model, mating disruption is most likely to work by disorientating the males with high volume release of pheromone so they fly

- A. towards each other in an attempt to mate.
- B. directly to the female insects.
- C. toward the pheromone dispensers instead of the female insects.
- D. away from the crops because they are repelled by the pheromone plumes.

Use the following information to answer Questions 11 and 12.

Sodium and potassium are two ions found in the body fluids of multicellular animals. They are found in different concentrations in the cytosol and extracellular fluid. This is shown in the following table.

Ion	Ion concentration (mg/L)	
	Extracellular fluid	Cytosol
potassium (K^+)	5	100
sodium (Na^+)	150	15

Question 11

Cells are able to gain sodium ions from the nearby extracellular fluid by

- A. pinocytosis.
- B. active transport through the phospholipid bilayer.
- C. endocytosis.
- D. facilitated diffusion through protein channels.

Question 12

Cells would gain potassium ions from the extracellular fluid by

- A. active uptake by carrier proteins.
- B. facilitated diffusion through protein channels.
- C. phagocytosis.
- D. diffusion through the phospholipid bilayer.

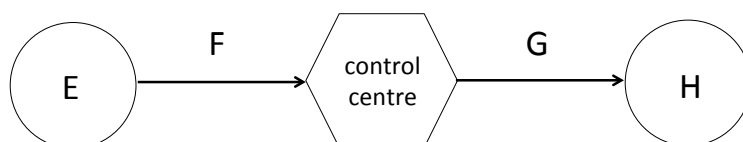
Question 13

Sometimes before performing some procedures on patients, dentists will inject an anaesthetic called lignocaine to block pain. Lignocaine acts by blocking sodium (Na^+) channels. Lignocaine

- A. is a neurotransmitter.
- B. is an endocrine hormone.
- C. prevents depolarisation and the transmission of an action potential.
- D. is a chemical that blocks the transport of all ions across the neural membrane.

Question 14

The following diagram represents the structures involved after a person steps on a drawing pin.



According to the diagram

- A. structure E is a sensory neuron and structure G is a connector neuron.
- B. structure E is a receptor and structure G is a motor neuron.
- C. structure F is a motor neuron and structure G is an effector.
- D. structure G is a sensory neuron and structure H is an effector.

Question 15

In humans, anandamide is a ligand which increases in concentration in the body on pain stimulation, suggesting it may play a role in suppressing pain. Fatty acid amide hydrolase (FAAH) is an enzyme which breaks down anandamide. If the concentration of FAAH in body tissue was increased there would be

- A. a decrease in the amount of anandamide resulting in a decrease in pain.
- B. a decrease in the amount of anandamide resulting in an increase in pain.
- C. an increase in the amount of anandamide resulting in a decrease in pain.
- D. an increase in the amount of anandamide resulting in an increase in pain.

Question 16

Which of the following is involved in the first line of defence in animals?

- A. insulin
- B. acetylcholine
- C. lysozyme
- D. lysosome

Question 17

The role of natural killer (NK) and cytotoxic T cells is analogous in vertebrate immunity because they are both

- A. involved in innate immune response.
- B. responsible for protecting the host from viral, bacterial and parasitic infections.
- C. erythrocytes that recognise and destroy cancerous cells.
- D. lymphocytes and act against ectoparasites such as ticks and lice.

Question 18

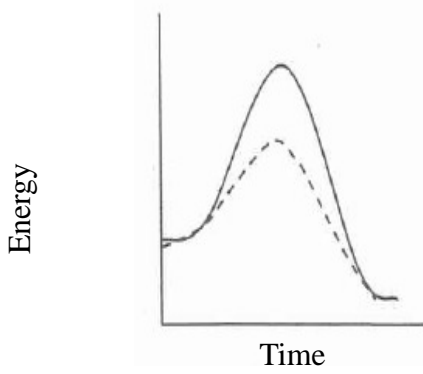
A student presents to the school nurse with a raised body temperature and enlarged lymph nodes around his neck. The nurse explains that the swollen lymph nodes are likely to be caused by

- A. pooling of blood.
- B. release of histamine.
- C. proliferation of stem cells.
- D. proliferation of lymphocytes.

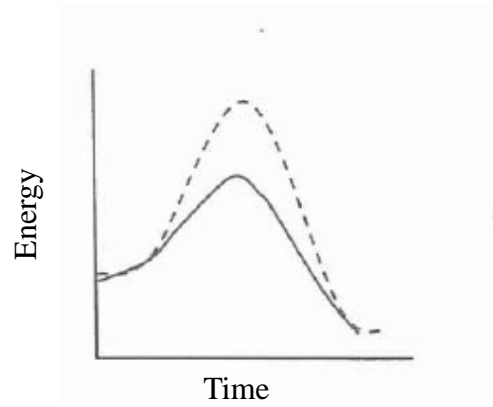
Question 19

The graph best representing the production of galactose and glucose from lactose, with and without an enzyme is

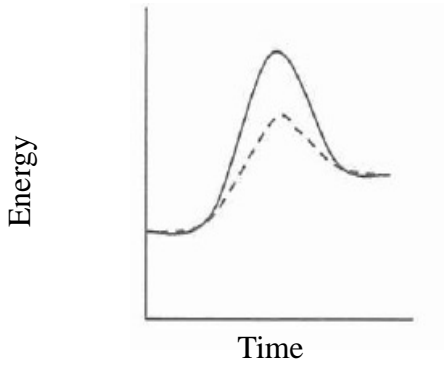
A.



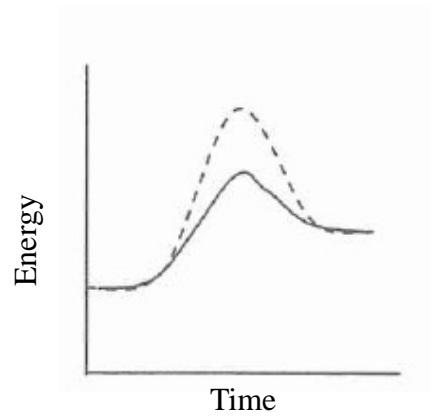
B.



C.



D.



with enzyme - - - - -
without enzyme _____

Question 20

Rubivirus causes rubella, a mild and rapidly passing disease in humans. If a woman is infected by rubella virus during the first 20 weeks of pregnancy the child may be born with congenital rubella syndrome (CRS), which can involve severe heart disorders, blindness or deafness. To reduce the risk of infection by rubella a vaccine was developed in the late 1960s. From 2016 in Australia, the rubella vaccine will be given to children at 12 months and 18 months of age. It is necessary to give children two doses of the rubella vaccine in order to

- A. ensure immunity in the small proportion of children who may not develop immunity to rubella in the first dose.
- B. boost the immune response so that more mast cells are made.
- C. prevent adverse reactions that may occur if the whole dose is given when they are 12 months of age.
- D. enable passive immunity to develop.

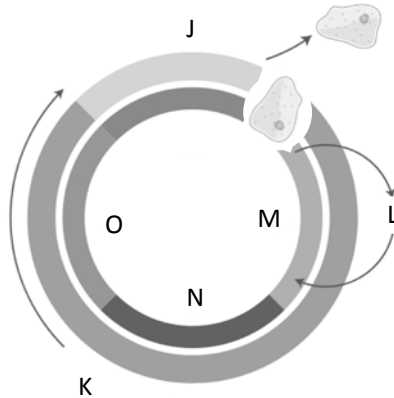
Question 21

A young boy was bitten on the hand by a redback spider while playing in his backyard. After applying an icepack to ease the pain and swelling, his parents took him to the local hospital where he was injected with anti-venom. The effects of the venom subsided and he was released from hospital within a few hours. The anti-venom provided the boy with

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

Question 22

The following diagram is a representation of a cell cycle in a eukaryote organism. The letters represent different parts of the cell cycle.



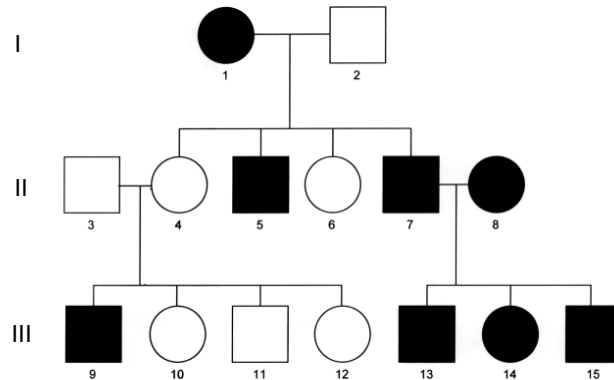
Source: http://commons.wikimedia.org/wiki/File:Cell_Cycle_2.svg

During this cycle

- A. the amount of DNA doubles during L.
- B. the amount of DNA halves during N.
- C. cell growth occurs during K.
- D. cytokinesis occurs during M.

Use the following information to answer Questions 23 and 24.

Ornithine transcarbamylase deficiency (OTC) is a condition in which the body is unable to process and remove the waste, ammonia. As a result, dangerous amounts of ammonia begin to build up in the blood. This can result in severe mental disability, seizures, and a variety of other life-threatening medical problems. Through newborn screening, early detection of OTC is possible and the condition can be managed with a low-protein diet, drug therapy, and ongoing health care. The pedigree shows the inheritance of OTC in a family.



Question 23

The mode of inheritance for OTC is most likely to be

- A. autosomal dominant.
- B. Y-linked.
- C. X-linked dominant.
- D. X-linked recessive.

Question 24

If Individual III10 carries the allele for OTC and has a child with a person who also has the condition, what is the chance they will produce a son with OTC?

- A. one in eight
- B. one in four
- C. one in two
- D. none

Question 25

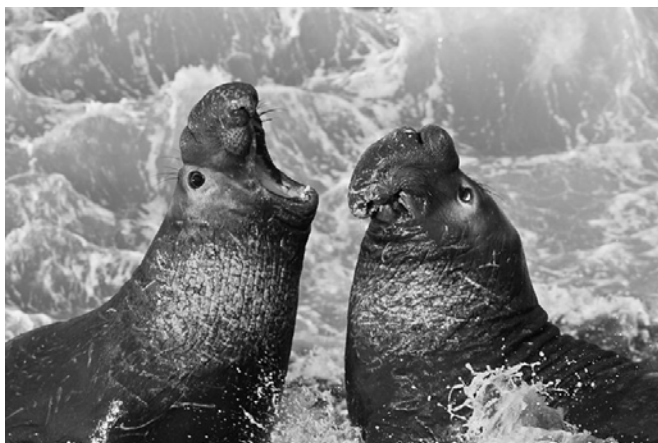
A small segment of DNA has the sequence

5' CTTAGCTAACGTAC 3'

The complementary strand will be

- A. 5' GTACGTTAGCTAAG 3'
- B. 5' GAATCGATTGCATG 3'
- C. 5' GAAUCGAUUGCAUG 3'
- D. 5' GUACGUUAGCUAAG 3'

Use the following information to answer Questions 26 and 27.



Source: http://commons.wikimedia.org/wiki/File:Northern_Elephant_Seal,_San_Simeon2.jpg

In the 18th century, the Northern elephant seal (*Mirounga angustirostris*) was hunted for its blubber, which was used for oil. The elephant seal was thought to be extinct; however, a remnant population of eight individuals was discovered on Guadalupe Island (west coast of Mexico) in 1892 by a group of expeditioners, who killed seven of the eight for their collections. In spite of this intensive hunting, the elephant seals survived and numbers have recovered to over 100 000.

Question 26

As a result of such intense hunting, the Northern elephant seal experienced

- A. natural selection.
- B. gene flow.
- C. a population bottleneck.
- D. increased genetic variation.

Question 27

Dominant bulls are able to mate with up to 100 females in a breeding season. With so much of a colony's offspring descended from one dominant male

- A. genetic diversity increases.
- B. the species is more vulnerable to diseases and genetic mutations.
- C. the genome of the Northern elephant seal decreases.
- D. there will be an increase in genetic mutations in the population.

Question 28

Which of the following steps would NOT occur in recombinant DNA technology?

- A. The gene of interest must be cut with a restriction enzyme to leave blunt ends.
- B. Antibiotic resistance genes are introduced into the plasmid to differentiate between bacteria that have taken up the plasmid and those that have not.
- C. Bacteria may be subject to heat shock therapy to introduce the plasmid into the bacterial cells.
- D. Bacterial plasmids are cut with the same restriction enzyme as used for the gene of interest.

Question 29

In recombinant DNA methods, the term *vector* can refer to

- A. a plasmid used to transfer DNA into a living cell.
- B. the enzyme that cuts DNA into restriction fragments.
- C. the sticky end of a DNA fragment.
- D. the blunt end of a DNA fragment.

Question 30

Divergent evolution is often seen among species on different islands because

- A. island populations are usually smaller and more affected by genetic drift.
- B. natural selection does not occur on islands.
- C. when islands are first colonised, many ecological resources are unused, allowing descendants of a colonising species to diversify so descendants have the adaptations that enable them to survive in many different parts of the environment.
- D. island species experience identical conditions on each of their respective islands.

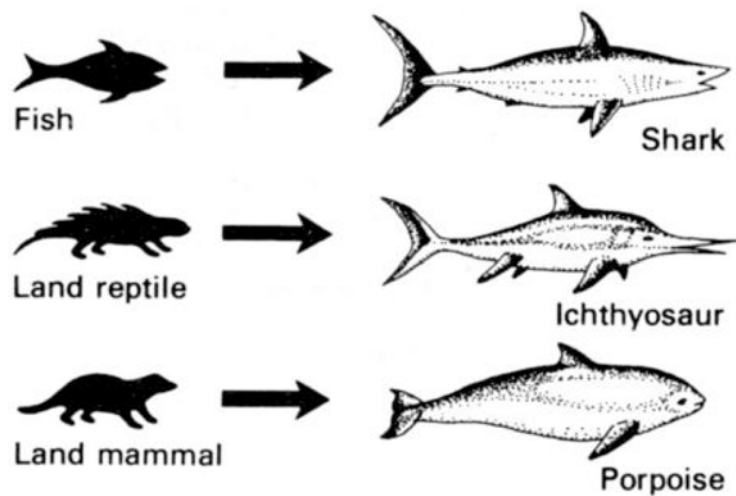
Question 31

New species arise from a common ancestor when

- A. populations of the ancestral species become geographically isolated from one another.
- B. populations of the ancestral species become reproductively isolated from one another.
- C. both A and B.
- D. neither A or B.

Question 32

The shark (cartilaginous fish), ichthyosaur (extinct marine reptile) and porpoise (mammal) show a similar body shape despite having evolved from different ancestors. Their streamlined body shape enables them to move efficiently through aquatic environments. This image shows these three animals.



Source: http://bio-ditrl.sunsite.ualberta.ca/detail/?P_MNO=1800

Body shape in sharks, ichthyosaurs and porpoise is an example of

- A. divergent evolution which has occurred because these animals occupy similar niches and face similar selection pressures.
- B. convergent evolution which has occurred because these animals occupy similar niches and face similar selection pressures.
- C. allopatric speciation as a result of geographical isolation between fish and land vertebrates.
- D. adaptive radiation from a recent common ancestor.

Question 33

In 1962, the biologist Emile Zuckerkandl and biochemist Linus Pauling noticed that the number of amino acid differences in haemoglobin between different related species changes linearly with time, as estimated from fossil evidence. They developed the molecular clock hypothesis from their observations. The molecular clock can be used to

- A. estimate the dates of evolutionary events such as the divergence of a species.
- B. confirm phylogenetic relationships as different species experience the same amino acid changes at the same time.
- C. assign an absolute age to a fossil.
- D. determine the time elapsed since a species diverged by comparing the rates of change in a random combination of different proteins from these species.

Question 34

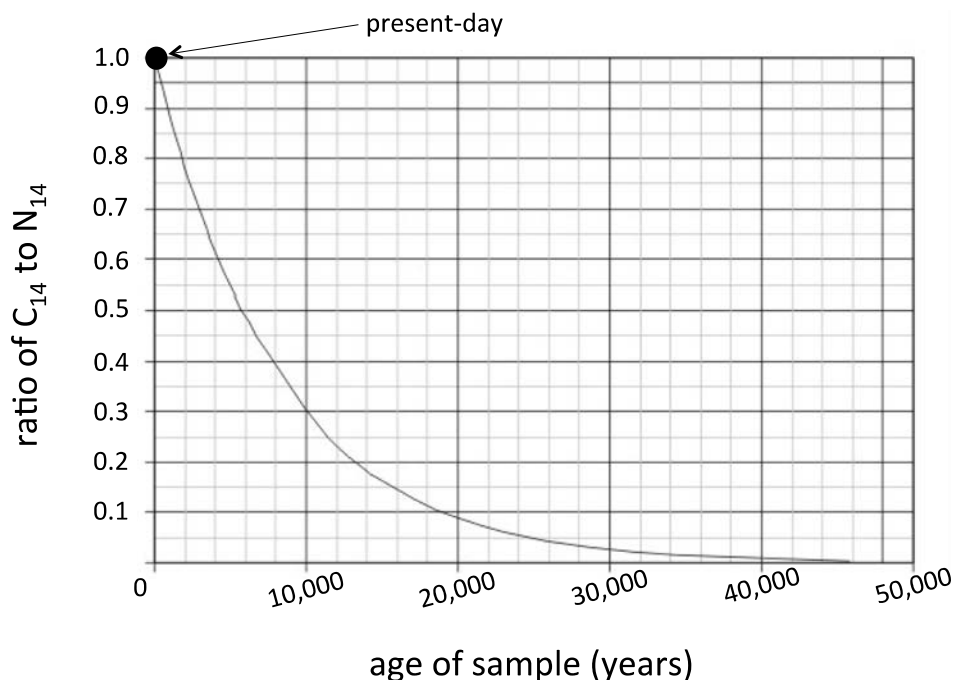
Fossils are the preserved remains or traces of animals, plants and other organisms from the past. Organisms are only rarely preserved as fossils, and only a fraction of these fossils have been discovered. The number of species known through the fossil record is less than 5% of the number of known living species. A condition that would favour the fossilisation of an organism is

- A. possession of soft body parts which are easily compressed under sediment.
- B. possession of hard body parts.
- C. slow burial, which reduces damage to remains.
- D. an environment with strong winds or water currents.

Use the following information to answer Questions 35 and 36.

Radioactive carbon dating can be used to date the age of fossils. The technique determines the proportion of carbon-14 to nitrogen-14 ($C_{14}:N_{14}$) in the fossil, which is then compared with the $C_{14}:N_{14}$ ratio in a living organism.

The graph shows the rate of decay for carbon-14; present-day indicates the amount of $C_{14}:N_{14}$ found in present-day organisms.



Source: http://en.wikibooks.org/wiki/High_School_Earth_Science/Absolute_Ages_of_Rocks#mediaviewer/File:Radioactive_decay_of_Carbon-14.png

Question 35

A possum skull discovered in a cave was found to contain two-fifths of the carbon-14 of a possum that died in 2015. The $C_{14}:N_{14}$ ratio of the fossil possum skull is

- A. 0.25
- B. 0.35
- C. 0.40
- D. 0.85

Question 36

It is not always possible to use carbon dating to determine the age of a fossil because

- A. carbon dating is a relatively new technique and is still being developed.
- B. the fossil may be too old and carbon dating is only good for fossils up to 50 000 years old.
- C. the carbon in the fossil leaches into the surrounding rock and is no longer available for analysis.
- D. the carbon has not had time to accumulate in the fossil.

Question 37

Ammonites are an extinct group of marine invertebrate animals whose fossils are found in rock layers. They are found commonly and are used by geologists to determine the age of a sedimentary rock layer. The image below shows the fossil remains of an ammonite.

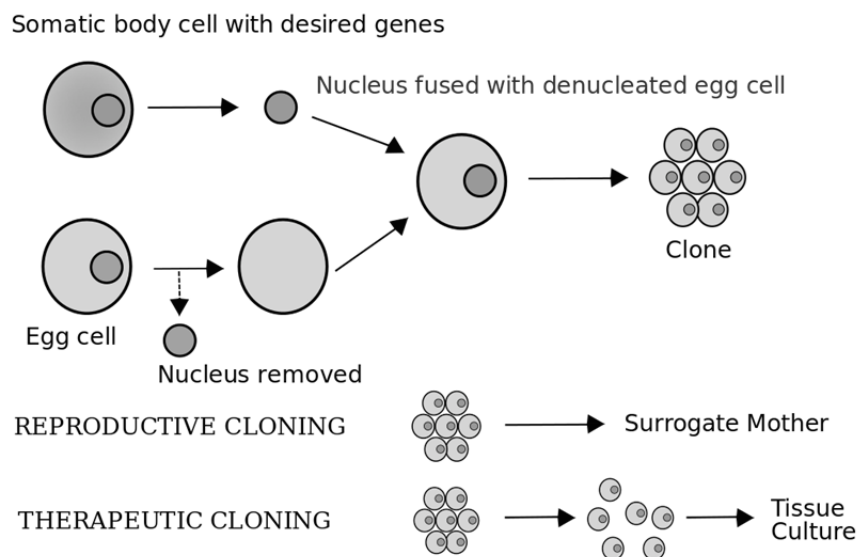


Source: http://commons.wikimedia.org/wiki/File:Ammonite_Asteroceras.jpg

Ammonites are index fossils and are used for

- A. potassium–argon dating.
- B. uranium dating.
- C. absolute dating.
- D. relative dating.

The following information relates to Questions 38 and 39.



Source: http://commons.wikimedia.org/wiki/File:Cloning_diagram_english.svg

Question 38

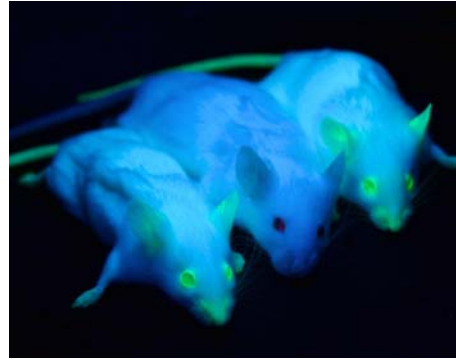
A clone

- A. is an organism that is genetically identical to another.
- B. has an identical phenotype to another.
- C. could be a pair of dizygotic twins.
- D. gains half of its DNA from either parent.

Question 39

If an analysis were performed on the DNA from the cells in the tissue culture and the foetus of the surrogate mother, it would be found to

- A. be identical to the DNA from the egg nuclei.
- B. be different from the DNA of the nucleus of the somatic body cell.
- C. show nothing in common.
- D. be identical, whilst at the same time code for the production of different proteins.

Question 40

Source: <http://en.wikipedia.org/wiki/GloFish> and http://en.wikipedia.org/wiki/Genetically_modified_mouse

Glo-Fish and fluorescent mice are examples of transgenic organisms. A transgenic organism is an organism

- A. whose phenotype has been favoured by natural selection.
- B. whose genome has been altered by recombination during meiosis.
- C. that carries one or more genes that have been artificially introduced from another species.
- D. that carries one or more genes that have been artificially introduced from the same species.

SECTION B – Short-answer questions

Instructions for Section B

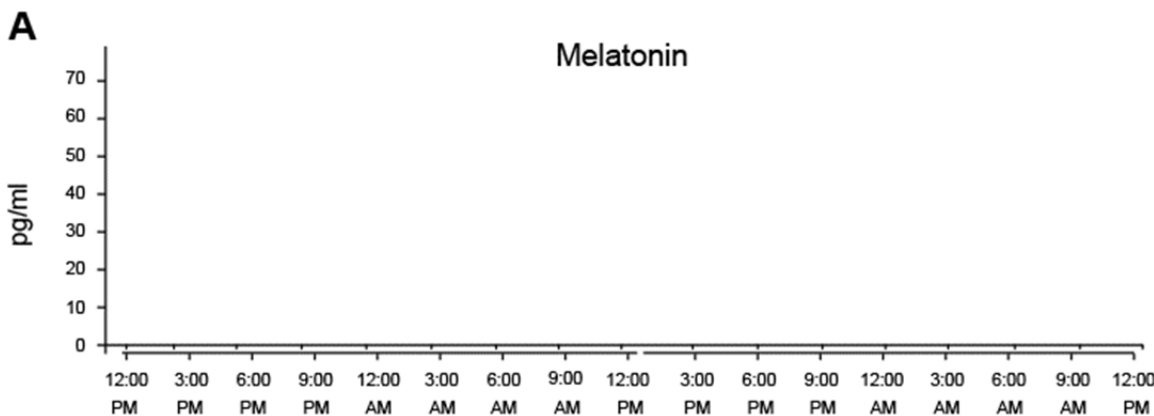
Answer **all** questions in the spaces provided. Use a black or blue pen.

Question 1 (6 marks)

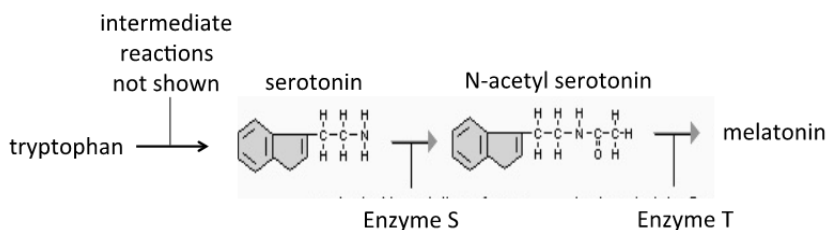
Melatonin is a hormone produced in most living organisms in response to darkness. It is produced by the pineal gland in the brain at night regardless of the diurnal (daytime) or nocturnal (night-time) activity of the animals. Melatonin levels remain high during the night and production tapers in response to light.

a. Draw the pattern of melatonin production over a 48-hour period on the axis below.

1 mark



The precursor to melatonin is serotonin, a neurotransmitter that is derived from the amino acid tryptophan. A simplified representation of the metabolic pathway for the production of melatonin is shown below.



modified from <http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/otherendo/pineal.html>

b. How does ‘Enzyme T’ perform its role?

2 marks

Cortisol is a steroid hormone which also shows diurnal cycles in humans.

- c. Explain the significance of its chemical nature in relation to its role as a signalling molecule.

1 mark

Research has shown that medical professionals who work at night show significantly greater difficulty achieving sleep compared with those who work during the day.

- d. i. Suggest a likely reason for this difference.

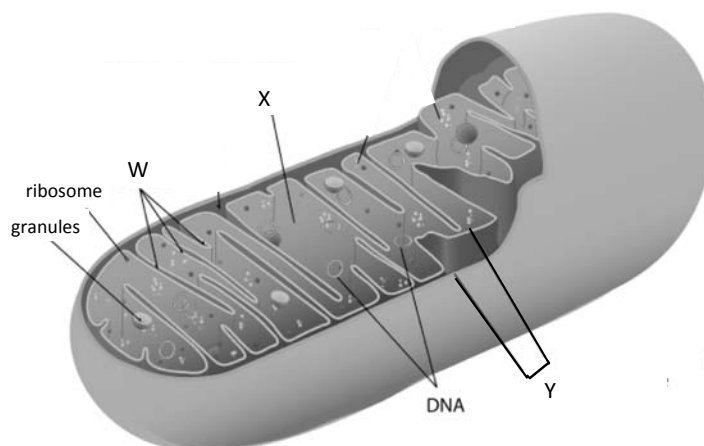
1 mark

- d. ii. A nurse who can only work nightshifts has been having serious difficulties with sleep but does not want to take sleeping tablets. What could he do to improve his sleep patterns?

1 mark

Question 2 (5 marks)

The organelle shown in the diagram below is found in eukaryote cells.



modified from http://upload.wikimedia.org/wikipedia/commons/3/3b/Animal_mitochondrion_diagram_en.svg

- a. Identify the structures W, X and Y.

2 marks

Structure	Name
W	
X	
Y	

- b. Explain the significance of X in this structure.

1 mark

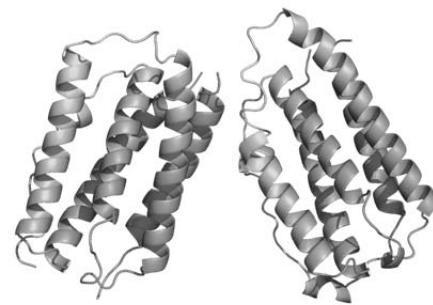
When there is insufficient oxygen, fungi are unlikely to use the organelle shown in the above diagram.

- c. Explain how the fungi will catabolise pyruvate which is the end product of glycolysis.

2 marks

Question 3 (6 marks)

Interferons (IFNs) are proteins released by host cells in response to the presence of pathogens. The image shows a representation of interferon beta 1.



Source: from <http://en.wikipedia.org/wiki/IFNB1>

- a.** What type and level of protein structure is most evident in the image of interferon beta 1?

1 mark

- b. i.** What is a pathogen?

1 mark

- b. ii.** Identify a pathogen that is likely to trigger a response by interferon.

1 mark

- c.** Describe how protein signalling molecules, such as interferon, can trigger the protective defences of the immune system in response to infection by a pathogen.

2 marks

- d.** Suggest why some pathogens may show resistance to interferon. How might this occur?

1 mark

SECTION B – continued

Question 4 (7 marks)

Source: <http://commons.wikimedia.org/wiki/File:3linedskink1.jpg>

In lizards, the sex chromosomes of females are of equal length and are referred to as the XX chromosomes. Male lizards have the sex chromosomes XY, which are of unequal length. The image shows the Eastern three-lined skink *Bassiana duperreyi*, which has a diploid number of 30.

a. How many chromosomes will be present in the following cells?

1 mark

- zygote of an Eastern three-lined skink _____
- ovum of an Eastern three-lined skink _____

b. The processes of mitosis and meiosis occur in particular cells of the Eastern three-lined skink. Explain the biological significance of mitosis and meiosis.

2 marks

A study on egg yolk size and sex of hatchlings in *Bassiana duperreyi* produced some unexpected results. The following table summarises the results of the study.

Sex chromosomes in <i>Bassiana duperreyi</i> hatchling	Egg yolk size	Sex of <i>Bassiana duperreyi</i> hatchling
XX	small	male
XX	large	female
XY	small	male
XY	large	female

c. What conclusion might be drawn from the results of this study?

1 mark

Temperature-dependent sex determination (TSD) occurs in turtles. Eggs are affected by the temperature at which they are incubated during a critical thermosensitive period (TSP), which occurs during the middle one-third of embryonic development. At cooler temperatures ranging between 22.5 – 27°C mostly male turtles arise, and at warmer temperatures around 30°C only female turtles arise. These observations are presented in the table below.

Sex chromosomes in turtles	Temperature during TSP	Sex of turtle hatchling
XX	22.5 – 27°C	male
XX	30°C	female
XY	22.5 – 27°C	male
XY	30°C	female

A researcher wanted to investigate whether temperature has any influence on sex determination in the Eastern three-lined skink. The researcher obtains 100 eggs from a group of 10 skinks (10 eggs from each skink) and puts 5 eggs from each skink into Group A and 5 eggs from each skink into Group B.

d. Outline the remaining steps the researcher would take to answer the question.

3 marks

Question 5 (5 marks)

A severe allergic reaction to a bee sting can be life-threatening for some people. A man is stung by a bee for the first time in his life. He experiences pain, redness, mild to moderate swelling and itching around the site of the sting.

- a.** Explain why he experiences redness and swelling at the site of the sting.

2 marks

The man is advised that he has experienced a mild allergic response to the bee venom.

- b. i.** Explain, by referring to the immune response, what happens when the man is stung the first time.

1 mark

- b. ii.** Why should the man avoid bee stings in the future?

1 mark

Unfortunately, the man is stung a second time while going for a run. He experiences a potentially fatal drop in blood pressure and requires immediate medical treatment.

- c.** What causes the rapid decrease in the man's blood pressure?

1 mark

Question 6 (7 marks)

Tay–Sachs disease is a rare autosomal recessive disease that can result from single base insertion or deletion (INDEL) mutations in the *HEXA* gene, located on human chromosome 15.

- a. In terms of the *HEXA* gene, what is the consequence of an INDEL?

1 mark

HEXA mutations are rare and are more commonly concentrated in particular genetically isolated human populations. It is believed that Tay–Sachs may have first entered a specific population about 1 000 years ago. It has increased significantly in frequency to the present day.

- b. Is the increase in frequency of the *HEXA* mutation more likely due to genetic drift or gene flow? Explain your response.

2 marks

In its most common form, Tay–Sachs disease causes a progressive degeneration of nerve cells and mental and physical abilities, commencing around the age of six months and usually resulting in death by four years. All individuals with Tay–Sachs disease have a ‘cherry-red’ macula (spot) on the retina of the eye. In 2005, a research team proposed a link between Tay–Sachs and intelligence.

Possible genotypes and phenotypes with respect to Tay–Sachs are shown in Table 1. The incidence of carriers of Tay–Sachs disease in two populations is shown in Table 2.

Table 1

Genotype	Phenotype		
	Macula	Dendrite growth	Intelligence
TT	normal macula	normal	normal
Tt	normal macula	enhanced	higher
tt	cherry-red macula	–	–

Table 2

	Population A	Population B
Incidence of Tay–Sachs carriers	1 in 27	1 in 300

- c. Use the information in Table 1 and Table 2 to suggest what has resulted in such a high number of Tay–Sachs carriers in Population A when it is a condition with such low life expectancy.

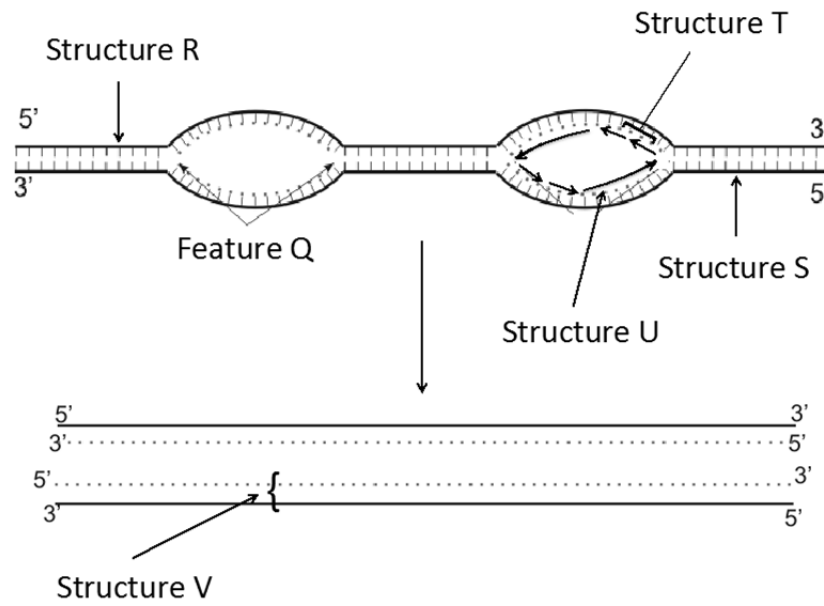
2 marks

- d.** A couple have a child with Tay–Sachs disease. Explain with reference to genotype(s) and phenotype(s) how the parents could have produced a child with Tay–Sachs disease.

2 marks

Question 7 (6 marks)

The diagram below outlines a process that occurs in eukaryote cells.



Source <http://upload.wikimedia.org/wikipedia/commons>

a. i. What is the name given to the process shown in the diagram? 1 mark

ii. In the cell cycle, when does the process named in **7a.i.** occur? 1 mark

b. By referring to the labels and the enzymes DNA helicase, DNA polymerase, DNA ligase, outline the steps in this process. 3 marks

c. In the space below, draw and label a monomer that would be found in Structure V.

1 mark

Question 8 (8 marks)

Freckles are inherited as a dominant trait in the Caucasian population. They first appear at about 5 years of age as light-brown pigmented macules on light-exposed skin and they are mainly confined to the face, arms and back. They increase in number, size, and depth of pigmentation during the summer months, and are smaller, lighter, and fewer in number in the winter. The gene for freckles is located on an autosome.

- a. A freckled couple, both of whom have one parent with no freckles, plan to have children. Predict whether their offspring will be freckled or not. Assign appropriate symbols to represent the alleles for freckles and show all working including genotypes of parents, genotypes and phenotypes of offspring and ratios where appropriate.

3 marks

In humans, the gene for hair type is also found on an autosome. There are three known phenotypes for hair type – curly, straight and wavy.

Genotype symbols: Curly: H^c Straight: H^s Wavy: H^cH^s

b. Explain whether hair type in humans is an example of Mendelian inheritance.

2 marks

c. A wavy-haired, freckled woman, whose mother was unfreckled, has children with a straight-haired, unfreckled man. Predict the appearances of their offspring. Show all working including genotypes of parents, genotypes and phenotypes of offspring and ratios where appropriate.

3 marks

Question 9 (6 marks)

Woodpeckers (birds belonging to the family Picidae) use their beaks to hammer into wood to obtain food such as wood-boring grubs or tree sap. They have specific adaptations including

- skulls that resist the effects of percussive hammering
- strong, sharp beaks and elongated, sticky tongues with bristles to extract insects
- ‘sawdust protection’ for the eyes and nostrils
- stiff tail feathers that serve as props.

Even though it does not show any morphological adaptations seen in woodpeckers, the woodpecker finch (subfamily Geospizinae; *Camarhynchus pallidus*) has gained its name because it has evolved woodpecker-like habits, using its beak to peck at tree trunks and branches to search for insects.

Woodpecker finches do not possess an elongated, sticky bristled tongue to extract insects from tree trunks.

- a.** How might the woodpecker finches overcome this morphological difference in their search for food?

1 mark

- b.** Explain whether pecking behaviour in woodpeckers and woodpecker finches is likely to be an example of convergent or divergent evolution.

2 marks

The pileated woodpecker (*Dryocopus pileatus*) is a very large North American woodpecker, inhabiting deciduous forests in eastern North America, the Great Lakes, forests of Canada, and parts of the Pacific coast. In eastern North America, pileated woodpeckers declined in number as their forest habitats were systematically logged in the 19th and 20th centuries. In recent decades, many forests have regenerated, and woodpecker species have enjoyed corresponding growth. There are two recognised subspecies, the southern pileated woodpecker (*Dryocopus pileatus pileatus*) and the northern pileated woodpecker (*Dryocopus pileatus abieticola*).

Geographic distribution	Subspecies
South-eastern United States of America	<i>Dryocopus pileatus pileatus</i>
Canadian prairies, eastern Canada, north-eastern United States of America	<i>Dryocopus pileatus abieticola</i>

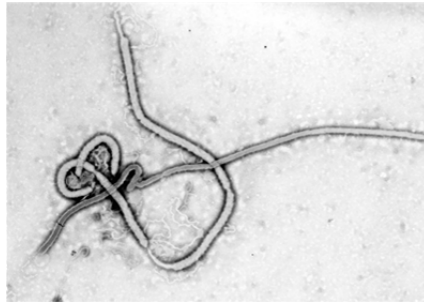
Canada and the United States of America



modified from http://commons.wikimedia.org/wiki/File:BlankMap-USA-states-Canada-provinces,_HI_closer.svg

- c. Explain how deforestation contributes to subspeciation in the original population of *Dryocopus pileatus*.

3 marks

Question 10 (5 marks)

Source: http://en.wikipedia.org/wiki/Ebola_virus#mediaviewer/File:Ebola_virus_em.png
 Photo by Cynthia Goldsmith

Ebola virus disease (EVD), formerly known as Ebola haemorrhagic fever, is a severe, often fatal illness in humans. The Ebola virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. It is caused by a highly virulent pathogen which expresses glycoprotein (GP) as the only protein on its outer surface. The Ebola virus is shown in the diagram above.

Niemann–Pick C1 (NPC1) is a cholesterol transporter protein found on the plasma membrane of host cells. The table below shows the results of a study from 2012 in which mice were exposed to mouse-adapted Ebola virus.

	NPC1 present	NPC1 absent
Survival rate after 15 days	10%	80%

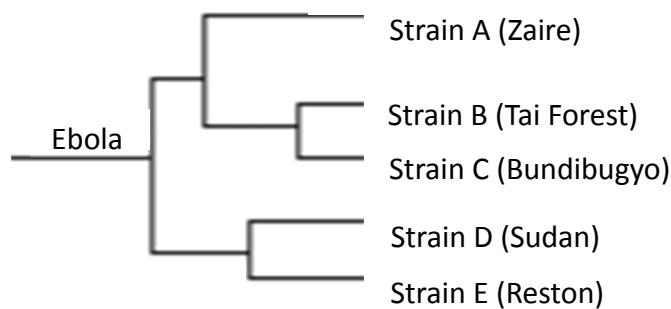
- a. Explain the role of NPC1 in Ebola virus infection using the results shown in the table above.

2 marks

- b.** Suggest why 10% of the mouse cells manage to survive when NPC1 is present. 1 mark

- c.** In September 2014, despite an intensive global search, there were no licensed Ebola vaccines. If an antiviral drug was developed, how could it act to stop the infection of Ebola virus? 1 mark

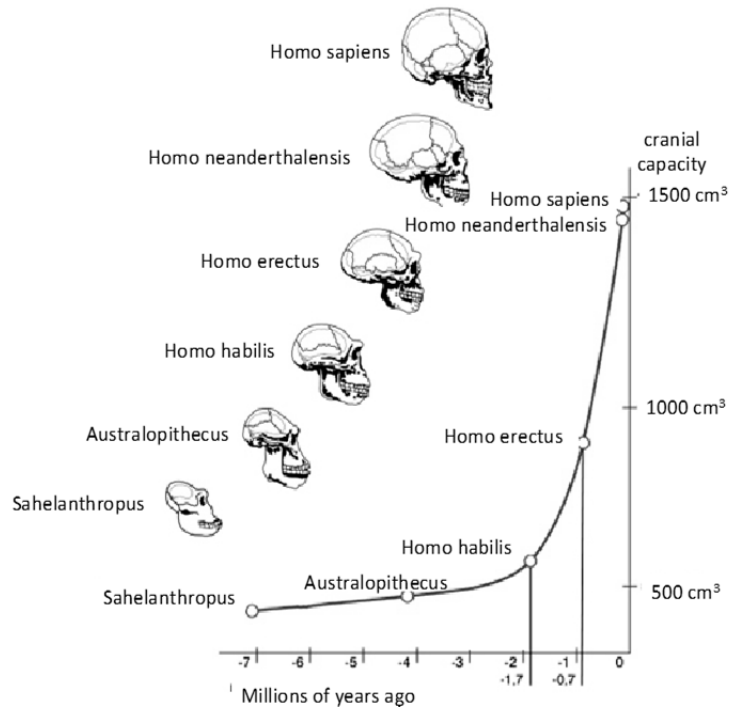
The Ebola virus genome is a single-stranded RNA sequence approximately 19 000 nucleotides long. The results of RNA sequencing have enabled researchers to construct a phylogenetic tree comparing full length genomes for the five different strains of the Ebola virus.



- d.** What molecular information have the researchers obtained from sequencing the nucleic acid of the five strains of Ebola virus? 1 mark

Question 11 (5 marks)

There are several acknowledged trends in hominin evolution.



modified from <https://ib-biology2010-12.wikispaces.com/Human+evolution>

a. Define the term *hominin*.

1 mark

b. Identify the trend in hominin evolution shown in the graph above and outline how it may have occurred.

1 mark

Two conflicting trends exist in the evolutionary development of hominins. The first is shown in the graph above. The second is the decrease in size of the birth canal.

c i. Explain the conflict between these two evolutionary trends.

2 marks

c. ii. Describe how this conflict has been overcome in hominins.

1 mark

Question 12 (4 marks)

Wheat (*Triticum* spp.) is a cereal grain that has been cultivated for more than 9 000 years and has undergone many genetic changes over this time. Rye (*Secale cereale*) is a grass grown as a grain, and as cover or forage crop. It is closely related to barley (*Hordeum*) and wheat (*Triticum*).

A new variety of grain has been created by humans by fertilising the gametes of *Triticum turgidum* (n=14) and *Secale cereale* (n=7). This breeding produces a new species known as triticale (n=21), which has the desirable qualities from wheat and rye.

- a. What is the term used to describe triticale, the new species of grain which has been produced by artificially breeding rye and wheat?

1 mark

- b. Explain why triticale will be infertile.

2 marks

Colchicine, a natural extract from the bulb of the *Colchicum* plant, stops spindle formation during mitosis.

- c. Suggest how colchicine can be used to treat infertility in triticale.

1 mark

END OF QUESTION AND ANSWER BOOK