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YEAR 12 *Trial Exam Paper*

2017

BIOLOGY

Written examination

STUDENT NAME:

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A B	40 10	40 10	40 80 Total 120

- 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 39 pages
- Answer sheet for multiple-choice questions

Instructions

- Write your **name** in the box provided above and on the multiple-choice answer sheet.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- 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 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.

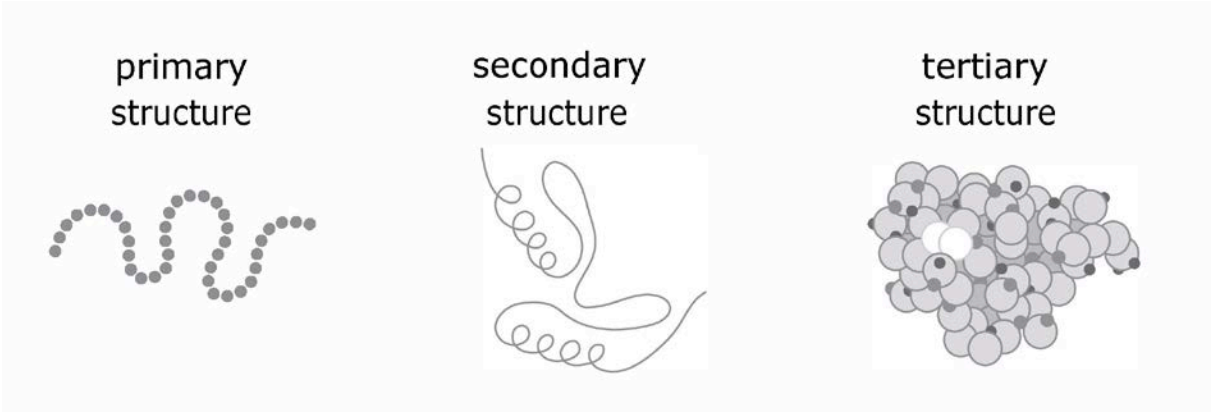
Marks will **not** be deducted for incorrect answers.

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

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

Use the following information to answer Questions 1 to 3.

The structures shown in the diagram below represent different levels of bonding found in proteins.



Source: Adapted from 'The Structure of Proteins', *Vivo Colorado State University*, http://www.vivo.colostate.edu/

Question 1

The bonds between the monomers in the primary structure are called

A. polar bonds.

B. peptide bonds.

C. phosphodiester bonds.

D. ionic bonds.

Question 2

To break the bonds between the monomers in the primary structure, which one of the following is needed?

A. water

B. ADP

C. light energy

D. oxygen

Question 3

Which level of organisation of a protein molecule is coded for by a DNA molecule?

A. primary structure

B. secondary structure

C. tertiary structure

D. quaternary structure

Question 4

Consider the following statements.

1. Enzymes are globular proteins.
2. Enzymes are synthesised in the smooth endoplasmic reticulum.
3. Enzymes are only found in the cytosol of cells.
4. Enzymes can be inhibited by competitive and non-competitive inhibitors.

Which of the above statements is true?

A. 1 and 4 only

B. 2 and 4 only

C. 1, 2 and 3 only

D. all 4

Question 5

Which one of the following options contains molecules in cell membranes that all contribute to cell recognition?

A. cholesterol, glycolipids and phospholipids

B. glycolipids, glycoproteins and proteins

C. cholesterol, phospholipids and proteins

D. phospholipids, glycolipids and proteins

Question 6

Which one of the following statements is correct for simple diffusion and facilitated diffusion?

A. Both depend on the solubility of the transported molecule in the lipid bilayer.

B. Both move substances against a concentration gradient.

C. Both require the use of ATP.

D. Both require the use of membrane proteins.

Use the following information to answer Questions 7 and 8.

Analysis of a strand of DNA found it to contain 200 thymine bases, which is 20 per cent of the total number of bases in the strand.

Question 7

How many guanine bases would be present?

A. 200

B. 300

C. 250

D. 100

Question 8

How many ribose sugar molecules would be present?

A. 2000

B. 800

C. 1000

D. 0

Question 9

A portion of a DNA molecule has the following base sequence

–ATCTTAGGCCAT–

Which one of the following would be the complementary mRNA strand?

A. UAGAATCCGGUA

B. TAGAATCCGGTA

C. UAGAAUCCGGUA

D. UACAUUCCGGUA

Question 10

The equation below is an overview of a process that occurs in living organisms called autotrophs.

$$6CO_2 + 6H_2O \longrightarrow A + 6O_2$$

Product A would be

A. water.

B. ATP.

C. chlorophyll.

D. glucose.

Question 11

In autotrophs, cellular respiration occurs

A. only when photosynthesis is not occurring.

B. only during the day.

C. only during the night.

D. during the day and night.

Question 12

Which one of the following sources of energy could be used by the cells of these autotrophs to begin photosynthesis?

A. oxygen

B. green light

C. red light

D. glucose

Question 13

All cells carry out cellular respiration.

Where in a cell does the first stage of cellular respiration take place?

A. chloroplasts

B. cytosol

C. mitochondria

D. nucleus

Question 14

In human cellular respiration, the electron transport chain

A. occurs in the matrix of the mitochondria.

B. requires oxygen.

C. produces carbon dioxide.

D. produces 26–28 ATP.

Question 15

Why is the base sequence of a mature mRNA strand received by the ribosome shorter than the mRNA strand initially transcribed from the DNA template strand?

A. Exons have been removed by splicing.

B. The promotor sequence has been deleted.

C. Introns have been removed.

D. The stop and start codons have been removed.

Question 16

Which one of the following molecules is used in translation but not in transcription?

A. RNA polymerase

B. DNA polymerase

C. tRNA

D. spliceosomes

Question 17

In some eukaryotic cells, regulatory genes produce transcription factors that bind to the

A. terminator sequence of a structural gene.

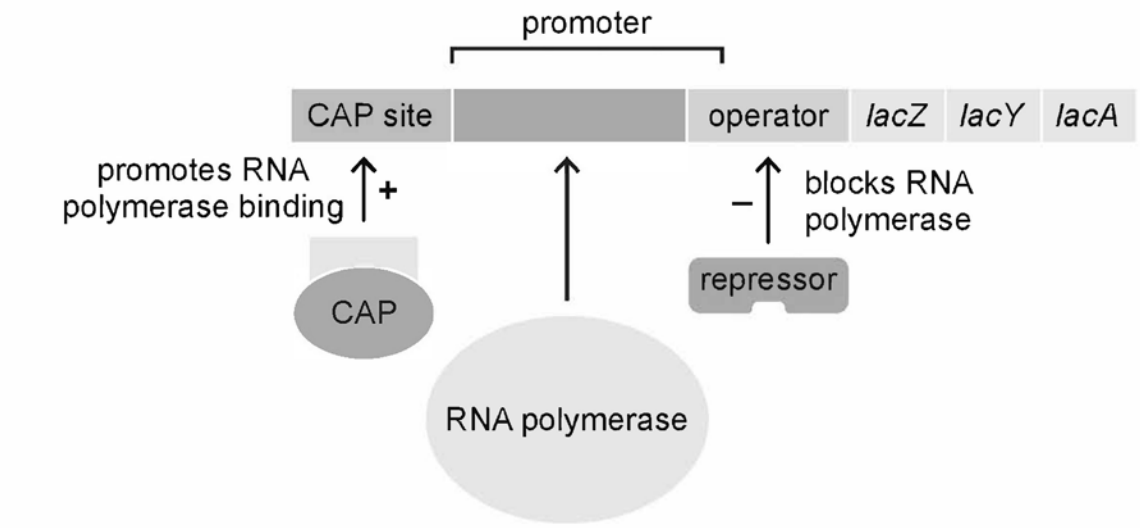
B. promotor sequence of the regulatory gene to switch on expression.

C. ribosomes to produce proteins.

D. promotor sequence of a structural gene.

Use the following information to answer Questions 18 and 19.

The diagram below shows the lac operon in a prokaryotic cell.



Question 18

Which one of the following codes for the repressor molecule?

A. a regulatory gene

B. lactose molecules in the cell

C. the promotor region

D. RNA nucleotides

Question 19

lacZ, lacY and lacA are all

A. master genes.

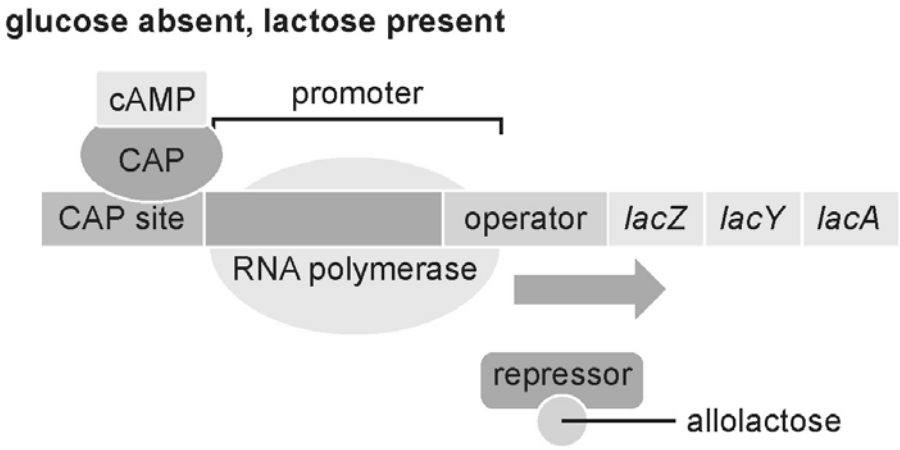
B. regulatory genes.

C. RNA sequences.

D. structural genes.

Question 20

The diagram below shows what happens when lactose is present in the cell.



Which one of the following statements is true?

A. The absence of glucose switches on the expression of the genes.

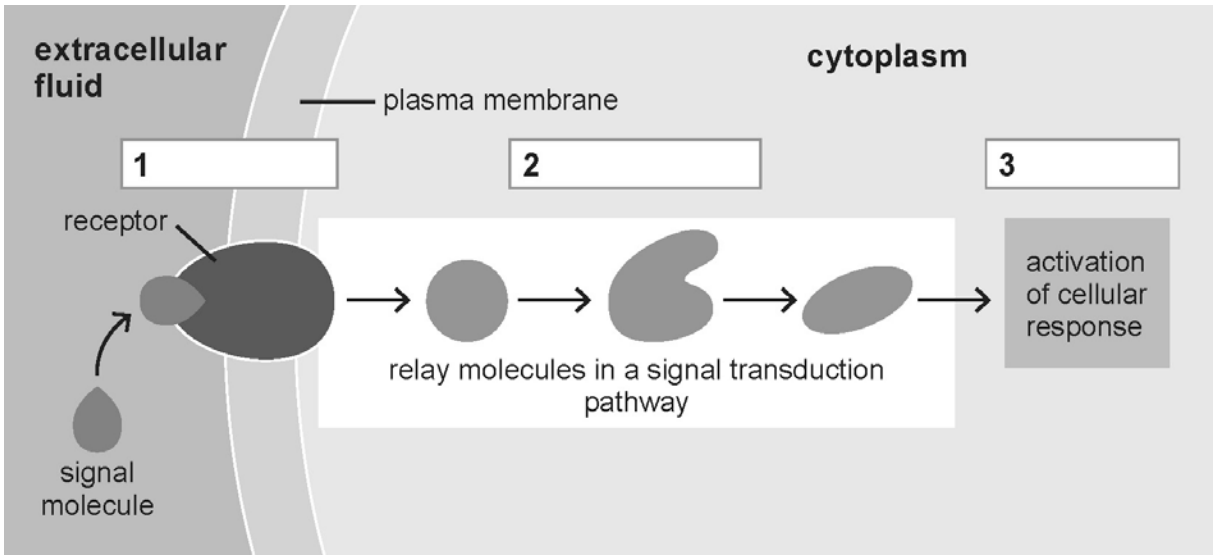
B. The repressor molecule switches on the genes.

C. RNA polymerase inhibits the repressor molecule.

D. Allolactose changes the shape of the repressor molecule.

Question 21

The diagram below shows a summary of signal transduction within a cell.



Which one of the following do boxes 1, 2 and 3 represent?

A. antigen, antibody and apoptosis

B. translation, response and action

C. reception, transduction and response

D. recognition, induction and response

Question 22

In autocrine signalling, the chemical signal affects the

A. cell producing the signal.

B. neighbouring cells.

C. cells around the body via the bloodstream.

D. nerve impulses between adjacent neurons.

Question 23

Which one of the following is true for steroid hormones?

A. They bind to complementary receptors on the cell membrane.

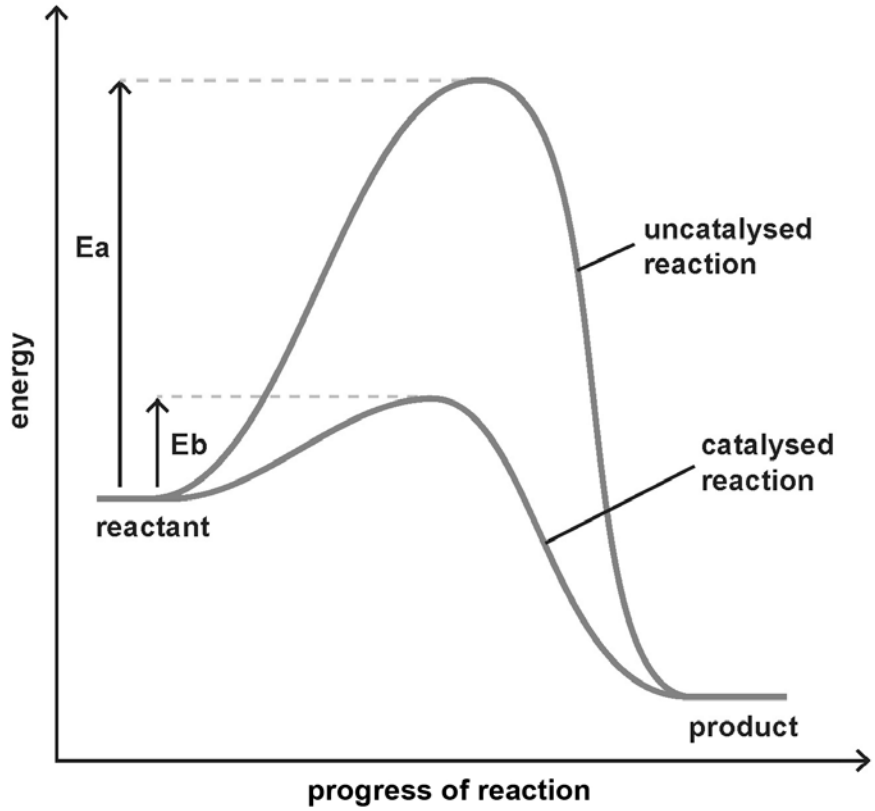
B. They are hydrophilic.

C. They cannot travel through the bloodstream in humans.

D. They bind to intracellular receptors.

Question 24

The graph below shows the energy levels of a reaction with and without enzymes.



Which one of the following represents the activation energy of the reaction with enzymes present?

A. Ea + Eb

B. Ea − Eb

C. Ea

D. Eb

Question 25

Which one of the following describes a feature of an active site of an enzyme?

A. part of an enzyme that can bind to non-competitive inhibitors

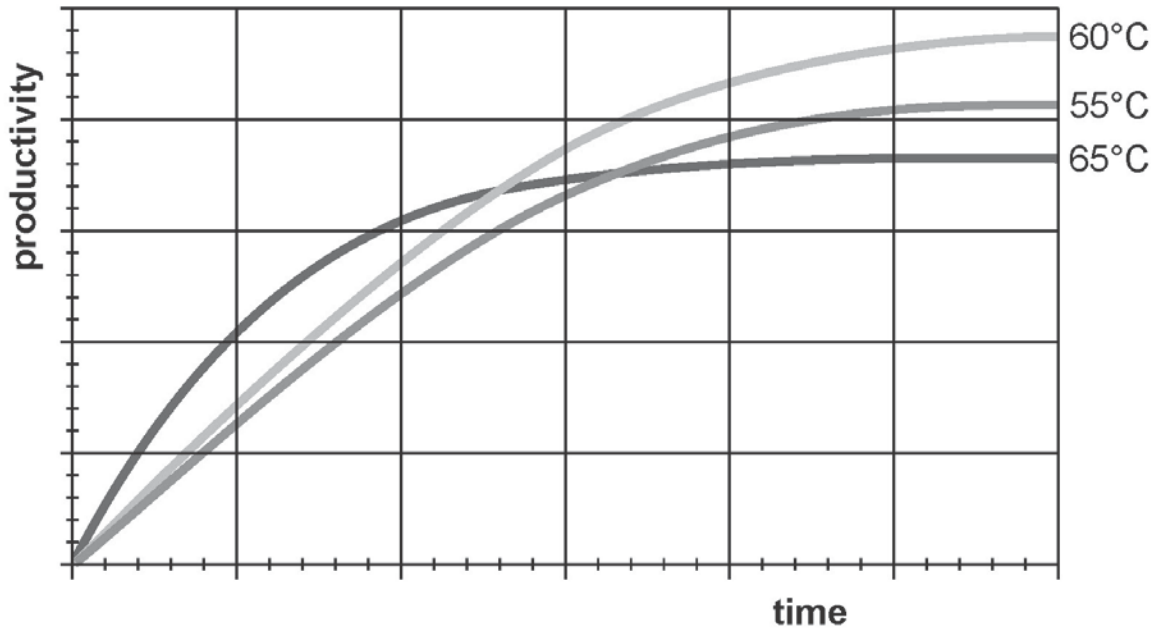
B. part of an enzyme that can bind to the products of the reaction

C. the specific amino acid sequence of the enzyme

D. a specific shape that binds to substrates

Question 26

The graph below shows the reaction rates at various temperatures of an enzyme that is found in bacterial cells that live in thermal springs.



Which one of the following conclusions could be drawn from this data?

A. The optimum temperature is 60°C.

B. The enzyme would not function at 50°C.

C. The optimum temperature is 65°C.

D. The experiment was carried out at the incorrect pH level for the enzyme.

Question 27

A class of Biology students were investigating antibiotic resistance in the bacteria *Escherichia coli*. Each of the students carried out identical tests at the same time and in the same environment.

The results were consistent across the class except for the results of one student.

What type of error caused this one different result?

A. random error

B. systematic error

C. selection bias

D. repeatability

Use the following information to answer Questions 28 to 31.

Each year in Australia, a significant proportion of people who are over 75 years old or very young get an influenza vaccine from their doctor. Scientific studies suggest that this helps reduce the incidence of influenza in a population.

Question 28

What type of immunity is produced by the vaccine in these individuals?

A. artificially acquired

B. herd immunity

C. passive immunity

D. auto immunity

Question 29

In 2016, some local populations in Melbourne and Sydney still experienced large outbreaks of influenza. More cases were recorded in these populations than expected by the local medical authorities.

These outbreaks are examples of

A. epidemics.

B. pandemics.

C. hypersensitivity.

D. clonal selection.

Question 30

People with influenza can be treated with the drug Relenza. Relenza was developed through rational drug design.

Which one of the following is true of Relenza?

A. It inhibits protein synthesis in viruses.

B. It is an antibiotic.

C. It binds to the active sites of viral enzymes.

D. It ruptures viral cell membranes.

Question 31

A few days after being injected with a vaccine, a patient's immune system will

A. produce specific NK cells.

B. increase production of mast cells.

C. produce specific antibodies and memory B cells.

D. produce specific cytotoxic T cells.

Question 32

The proteins BMP4 and CaM affect the size and shape of beaks in finches.

The variations in amounts of these proteins result in numerous varieties of phenotypes in the beaks of finches. Different finches have beaks that range from being short to very elongated, and also range from very wide to narrow beaks.

The BMP4 and CaM proteins are synthesised by master genes.

The role of master genes is to

A. determine relatedness between species.

B. control the rate of evolution.

C. control the expression of other groups of genes.

D. switch enzymes on and off in cells.

Question 33

The BMP4 and CaM proteins are examples of

A. enzymes.

B. hormones.

C. competitive inhibitors.

D. transcription factors.

Question 34

Cytochrome C is a protein made up of a polypeptide containing 104 amino acids. The sequence of the amino acids is largely the same in many species.

However, there are some differences in the amino acid sequence between species.

The measurement of the accumulation of these changes to compare relatedness between species is called

A. a molecular clock.

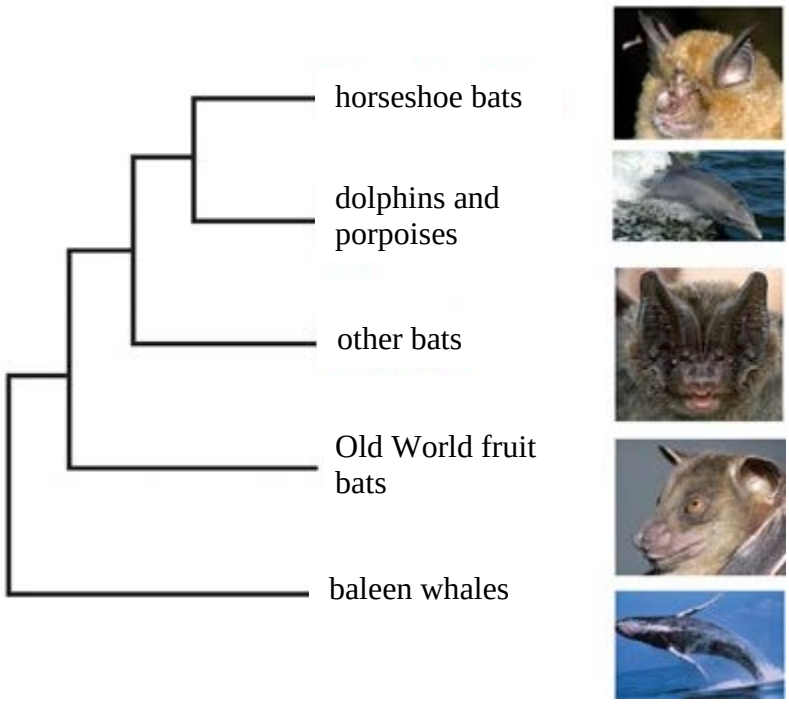
B. DNA hybridisation.

C. relative dating.

D. radiometric dating.

Question 35

The phylogenetic tree below shows relatedness of different species of mammals, using the results of analysis of protein sequences in bats and other species, that communicate through echoing.



Source: Reprinted from Jones, G, 'Moleculor evolution: gene convergence in echolocating mammals', *Curr.Biol.*, 20, pp.62–64, 2010, with permission from Elsevier

Based on the information in the phylogenetic tree, which species is most closely related to horseshoe Bats?

A. other bats

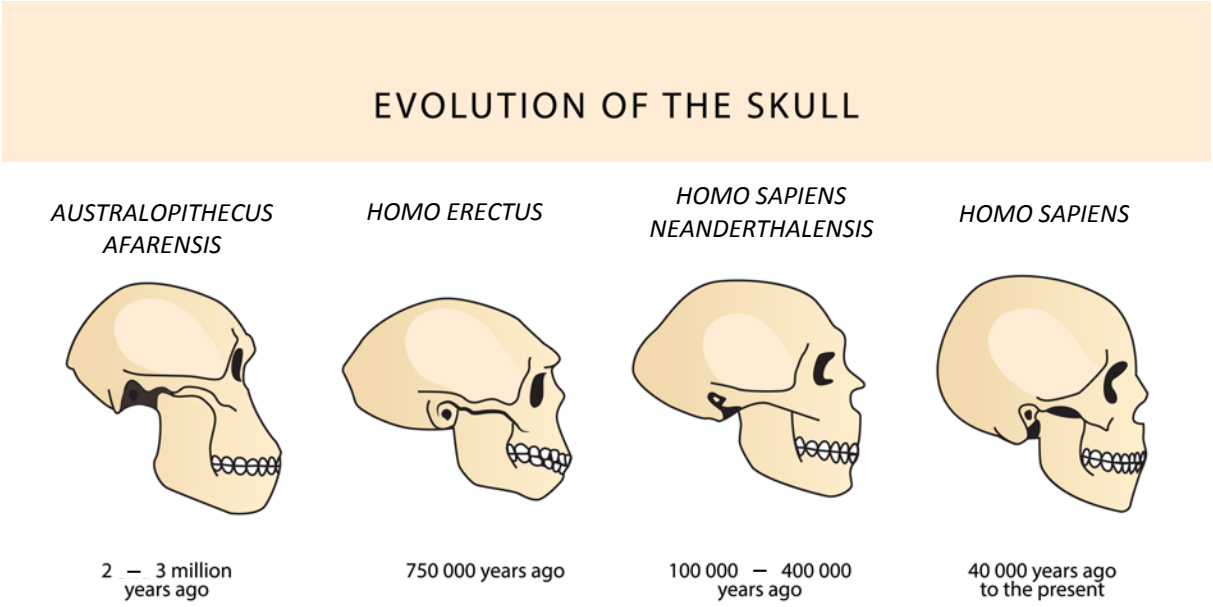
B. Old World fruit bats

C. baleen whales

D. dolphins and porpoises

Use the following information to answer Questions 36 and 37.

Below is an image of the skulls of human ancestors.



Source: Usagi-P / Shutterstock

Question 36

Which one of the following is used in skull anatomy to identify closer relatedness to modern humans, *Homo sapiens*?

A. increased sloping face

B. larger brow ridge

C. higher forehead

D. posterior position of foramen magnum

Question 37

Which one of the following options correctly describes both *Australopithecus afarensis* and *Homo erectus*?

A. hominid, hominin and primate

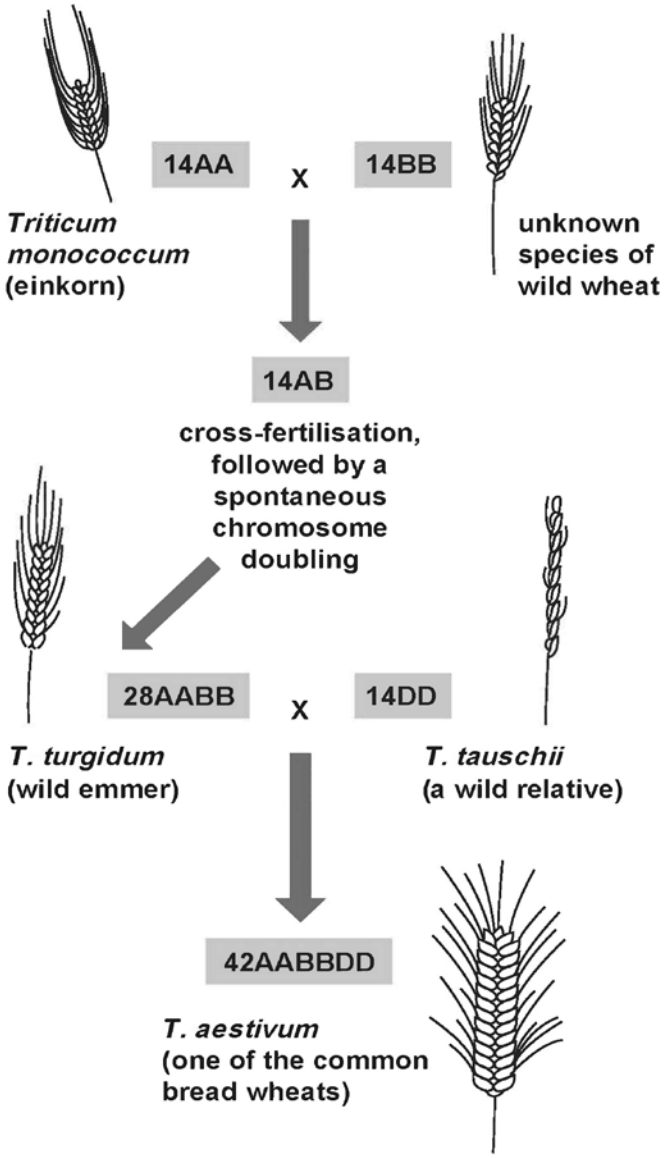
B. primate and hominid, but not hominin

C. primate and hominin, but not hominid

D. none of the above

Question 38

The image below shows the possible evolution of wheat.



Bread wheat was produced by cross-fertilisation of two plant species and a spontaneous chromosome number doubling. The chromosome number in bread wheat is called

A. haploid.

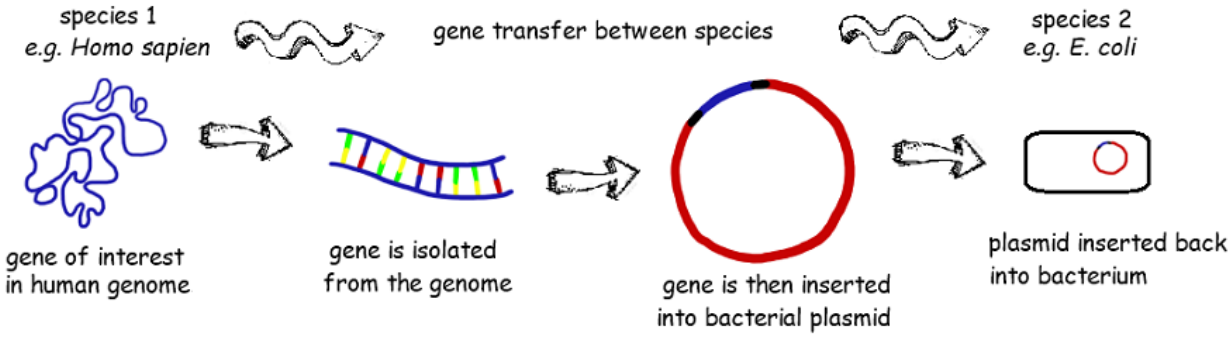
B. diploid.

C. polyploid.

D. aneuploid.

Use the following information to answer Questions 39 and 40.

The flow chart below shows a simplified version of the transfer of the gene for human insulin from humans to bacteria.



Source: *IB Biology Help*, http://ibbiologyhelp.com/Genetics/geneticmodification.html

Question 39

Which one of the following statements correctly describes the successful completion of this process?

A. The human gene and bacterial plasmid need to be cut with different restriction enzymes because they are different species.

B. The human gene for insulin is isolated by heating and denaturing the human DNA

C. DNA ligase is used to join the human gene and bacterial plasmid.

D. The bacteria are injected with the human insulin gene.

Question 40

Often a human gene is added to a bacterial plasmid containing a gene for antibiotic resistance.

This is because

A. only transformed bacteria will grow in a medium containing the antibiotic.

B. the non-resistant bacteria can harm the scientists carrying out the procedure.

C. the bacteria will be resistant to infection.

D. it will prevent the emergence of a new disease.

END OF SECTION A

SECTION B – Short-answer questions

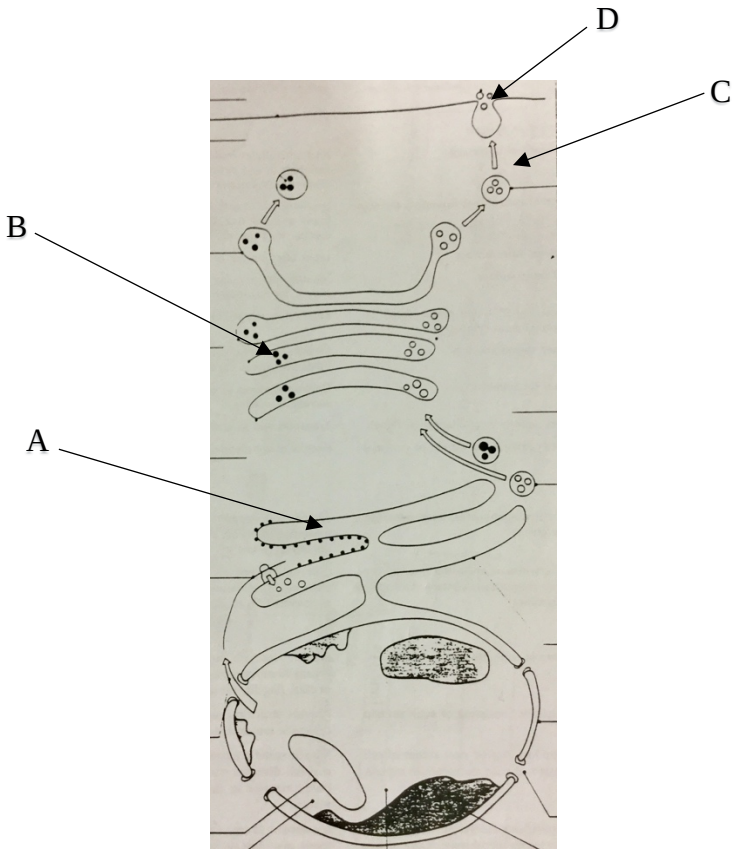
Instructions for Section B

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

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

Question 1 (8 marks)

The diagram below shows the production and export of a protein from a cell.



a. Name the final **cellular process** shown at point D in the diagram.

1 mark

_____

b. Identify the organelles labelled A, B and C in the diagram.

2 marks

_____

_____

_____

c. Describe the process shown in the diagram for exporting a protein from a cell.

3 marks

_____

_____

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d. Explain why proteins cannot move through the lipid bilayer of a cell membrane by simple diffusion.

2 marks

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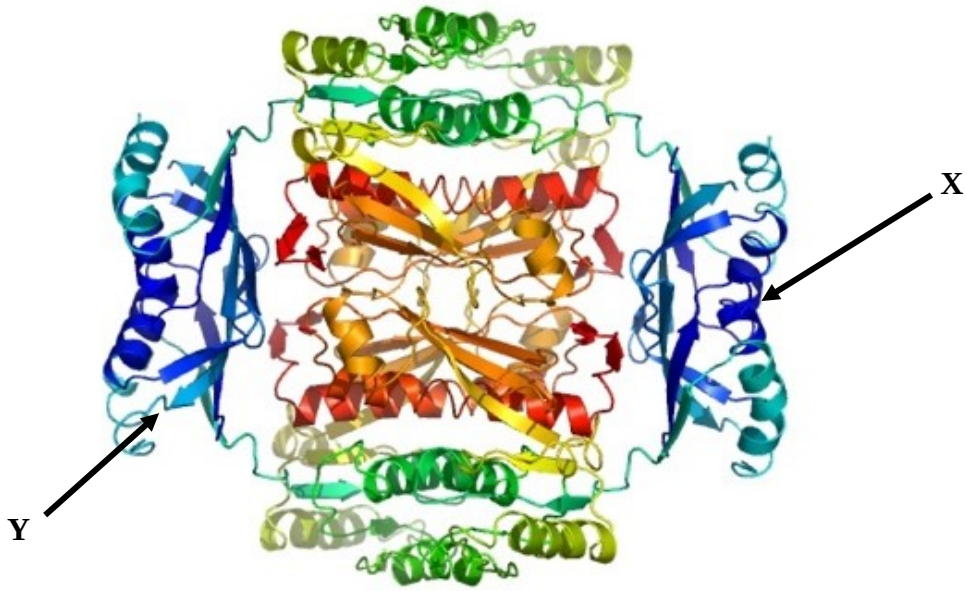
Question 2 (8 marks)

The diagram below shows a transmembrane protein, found in the cell membranes of mice. There are two secondary structures labelled X and Y.



a. Give one function of a transmembrane protein.

1 mark

_____

_____

b. Name the structures labelled **X** and **Y**.

2 marks

_____

_____

c. The protein also displays a tertiary structure. Explain how the tertiary structure would be related to the function of the protein.

2 marks

_____

_____

_____

d. All proteins are polymers, which are made up of a chain of monomers.

In the space below, draw a labelled diagram of the monomer molecule.

3 marks

Question 3 (13 marks)

The equation below describes a reaction that occurs in the liver cells of humans. The enzyme catalase breaks down the toxin hydrogen peroxide into water and oxygen.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

hydrogen peroxide — water — oxygen

a. What is the substrate in the reaction?

1 mark

_____

b. Can the enzyme catalase catalyse other reactions in the liver cells?

Explain your answer.

2 marks

_____

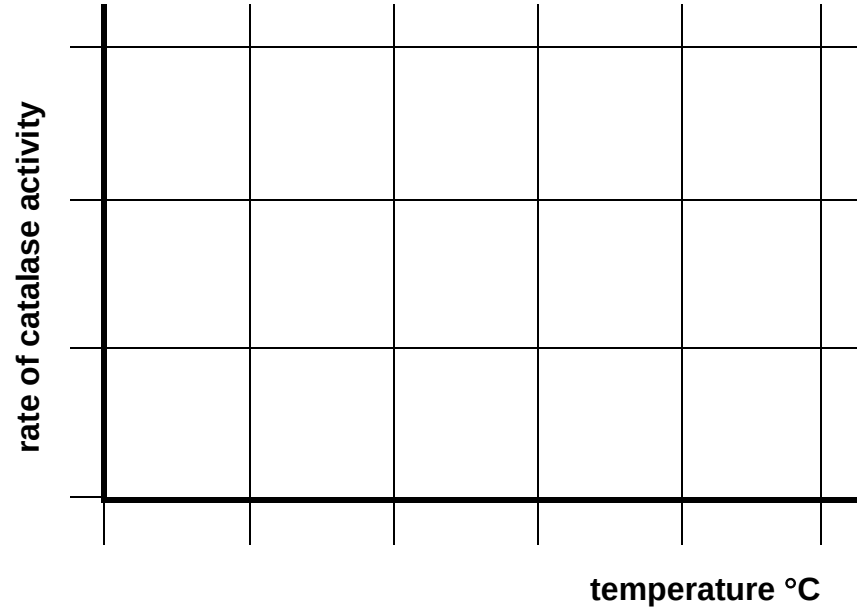
_____

_____

c. The average human body temperature is 37 °C, which is the optimum temperature for catalase.

Complete the graph below to show the rate of catalase-controlled reactions at temperatures above and below 37 °C.

2 marks



d. Explain what happens to the enzyme if the body temperature is over 40 °C for an extended period.

2 marks

e. The human liver usually has a pH of 7. This is the optimum pH level for enzymes in the liver to function.

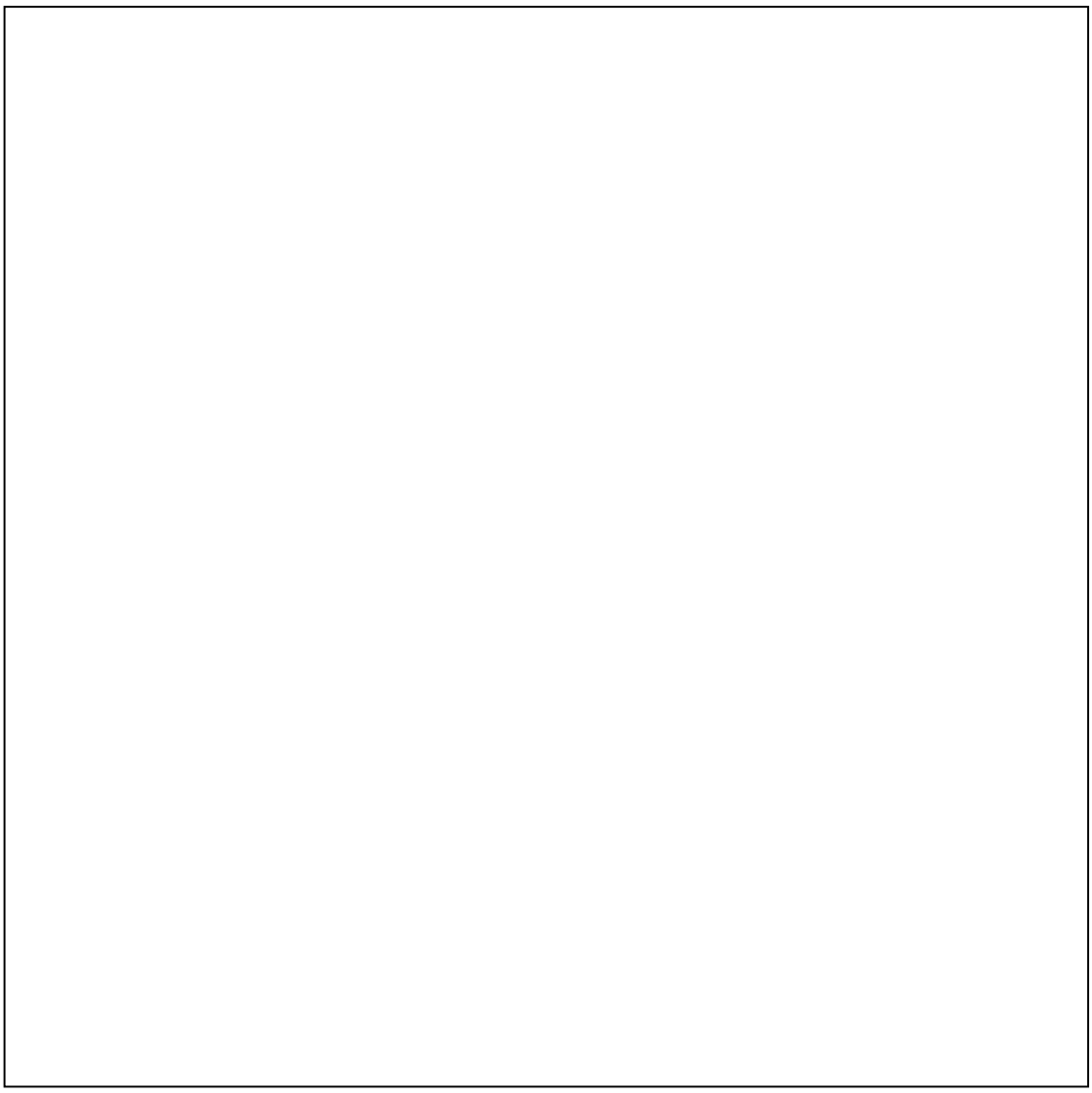
Design an experiment to test this hypothesis for catalase. Assume that the experiment will be repeated many times to generate a large sample.

3 marks

f. Catalase activity in humans can be affected by toxins that act as non-competitive inhibitors.

In the space below, draw labelled diagrams to show the action of non-competitive inhibitors on catalase.

3 marks



Question 4 (12 marks)

ATP is an important molecule for the normal functioning of cells and the control of metabolic pathways. In cellular respiration, cells release chemical energy from glucose and convert it to ATP. The energy is then available to the cells to use. An ATP molecule releases its energy within 60 seconds of its formation.

a. Explain how cells are able to continuously regenerate ATP and how ATP is formed.

2 marks

_____

_____

_____

_____

b. Name the stage of aerobic cellular respiration that produces the most ATP. Explain the main events in this stage that enable ATP to be produced.

3 marks

_____

_____

_____

_____

_____

_____

c. What advantage is there for a cell to be able to perform anaerobic respiration as well as aerobic respiration?

1 mark

_____

_____

d. Explain how ATP is produced in the first stage of photosynthesis and why it is needed.

2 marks

_____

_____

_____

_____

e. Describe the chemical changes, other than the formation of ATP, that take place during the first stage of photosynthesis.

2 marks

_____

_____

_____

f. Other than light availability, what other factors can reduce the rate of photosynthesis in a plant?

2 marks

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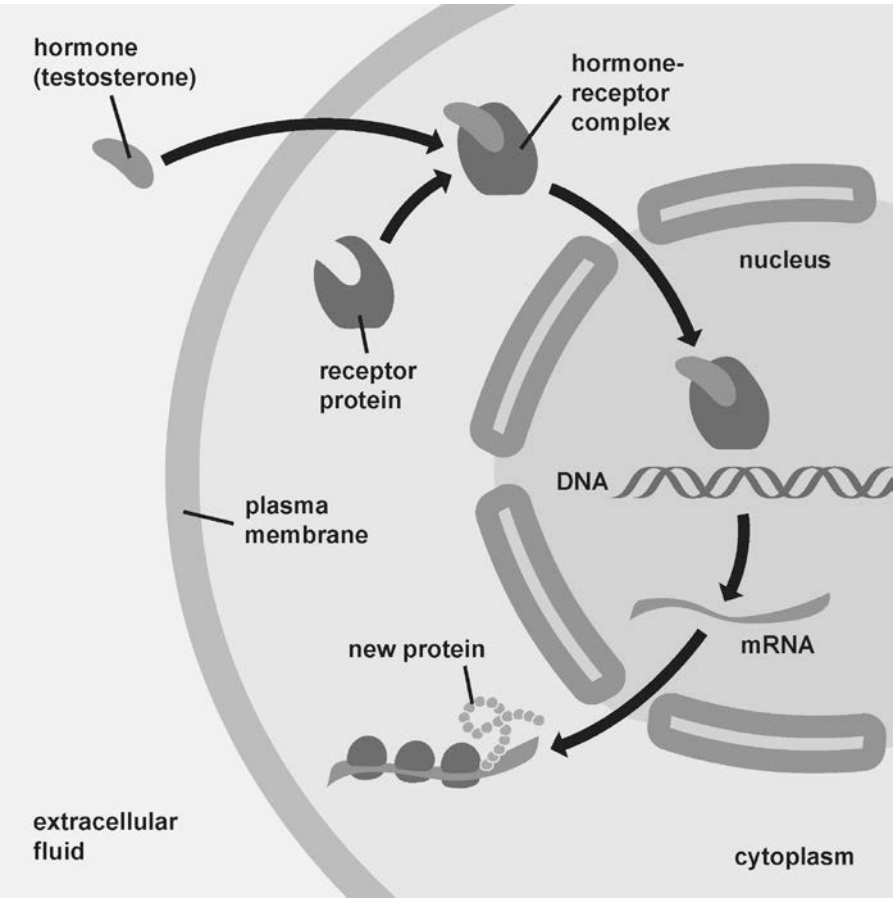
_____

_____

Question 5 (4 marks)

The diagram below shows the signal transduction of a target cell of the hormone testosterone.



a. Referring to the information in the diagram, explain the effect of testosterone on the cellular process in the cell.

2 marks

_____

_____

_____

b. Using the information in the diagram, describe the chemical composition of testosterone. Explain your answer.

2 marks

_____

_____

_____

Question 6 (7 marks)

A novel influenza virus, H1N1, caused a pandemic in 2009. The first outbreak in Mexico was called swine flu. The global death toll of the pandemic has been estimated at 284 000 lives.

a. Why has this outbreak been referred to as a pandemic?

1 mark

_____

_____

b. Describe some of the conditions that can cause a pandemic.

3 marks

_____

_____

_____

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_____

The H1N1 influenza virus originated in pigs. The virus was also able to infect humans.

c. Explain how a new influenza strain can come into existence.

3 marks

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_____

Question 7 (7 marks)

Cichlids are a large family of brightly coloured freshwater fish. There are over 1600 different species worldwide. All species originated from a common ancestor.

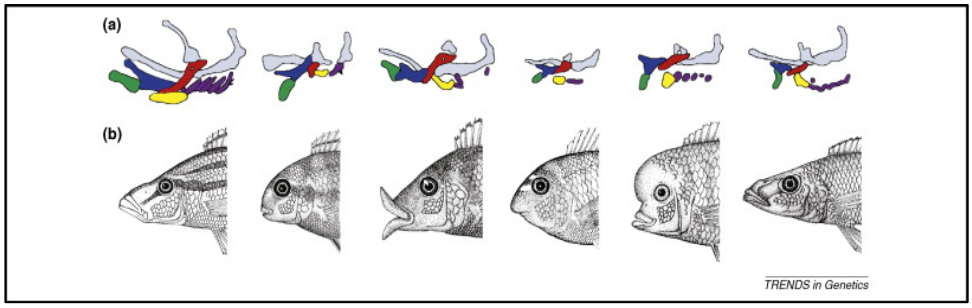
a. What type of evolution is this an example of?

1 mark

_____

Three geographically isolated lakes in East Africa are home to over 500 species of cichlids.

The diagram below shows the different jaw phenotypes found in all three lakes. The top row shows the difference in jaw bones and the second row shows the phenotype. The length of each bone in the jaw is controlled by a different gene.



Source: Reprinted from Albertson et al. 2009, 'Evolutionary mutant models for human disease', *Trends in Genetics*, Vol. 25, No. 2, pp.74–81, with permission from Elsevier

Scientists have proposed two hypotheses to explain the appearance of all phenotypes in the three lakes:

A: Each fish population developed the same mutations in the same genes at the same time. The gradual changes have all accumulated in the same way over time in the three lakes.

B: A single mutation occurred in a master gene, BMP4, in each of the three populations and caused the fish to develop in similar ways.

b. Which hypothesis is correct? Explain your answer.

3 marks

_____

_____

_____

_____

_____

_____

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_____

The BMP4 master gene codes for a transcription factor. The rate of production of this transcription factor affects the expression of other genes.

c. In the space below, draw a diagram to show how transcription factors switch on the transcription of another gene in a eukaryotic cell.

3 marks

Question 8 (7 marks)

Scientists investigating a transgenic strain of the *Arabidopsis* plant called kojak carried out a gel electrophoresis to find the root hair gene that had been transferred into the kojak strain from a species of barley.

The root hair gene was removed along with some other DNA using restriction enzymes, and underwent PCR prior to the gel electrophoresis being run.

a. Why was PCR performed on the DNA sample prior to the gel electrophoresis being carried out?

1 mark

_____

_____

b. Outline the three major steps in PCR.

3 marks

_____

_____

_____

_____

_____

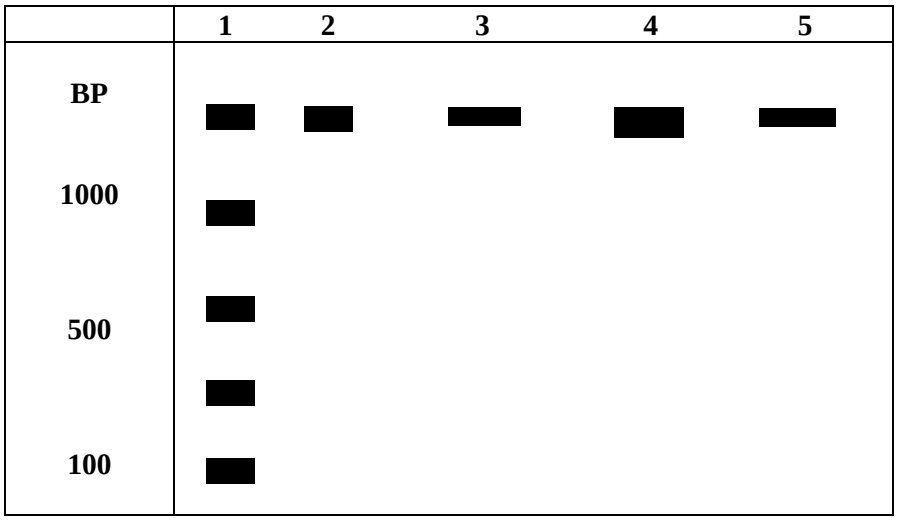
_____

The table below gives the sizes of the various DNA fragments (genes) used in the genetic engineering of the *Arabidopsis* plant.

Gene	Size (base pairs)	Well (gel electrophoresis)
Normal *Arabidopsis* root hair gene	520	2
Mutant kojak *Arabidopsis* gene	450	3
Barley root hair gene	600	4
Recombined mutant *Arabidopsis* + barley genes	1050	5

c. On the diagram below, indicate where each of the DNA fragments would be positioned after the gel electrophoresis has been run.

2 marks



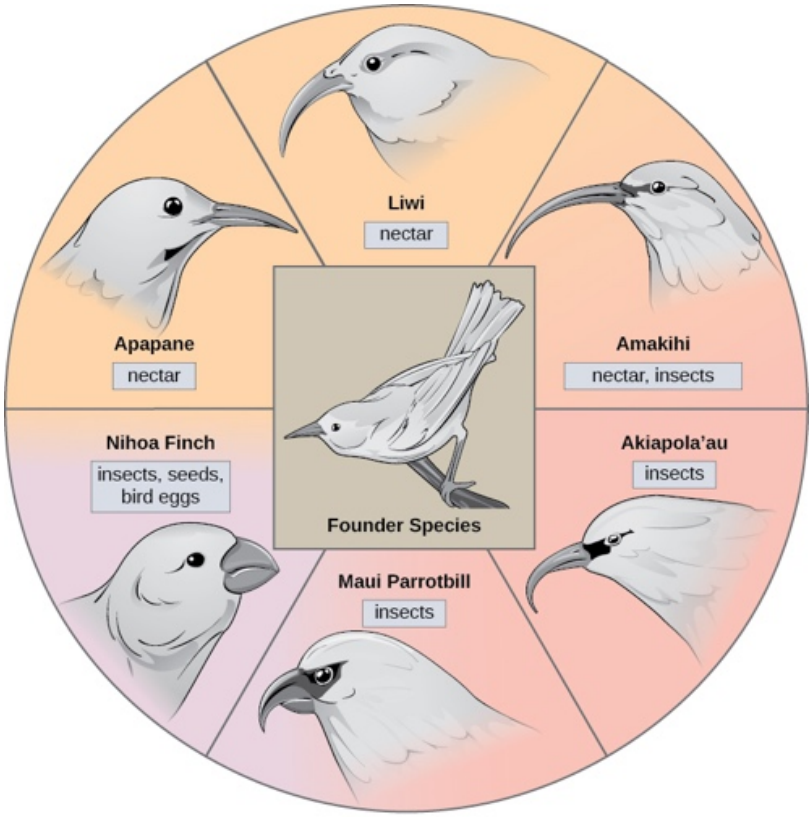
d. What is placed in well 1?

1 mark

_____

Question 9 (7 marks)

The image below shows six modern species of finches that are found on six different islands in the Pacific Ocean.



Source: Avissar et al. 2014, *OpenStax College Biology*, p.494

Scientists believe that each of the six modern species of finches evolved through natural selection from populations of the founder species arriving on each of the islands.

a. What term do scientists use to describe the emergence of these six species from the original founder species?

1 mark

_____

b. Explain how the six different species of finches evolved from populations of the founder species on the different islands.

4 marks

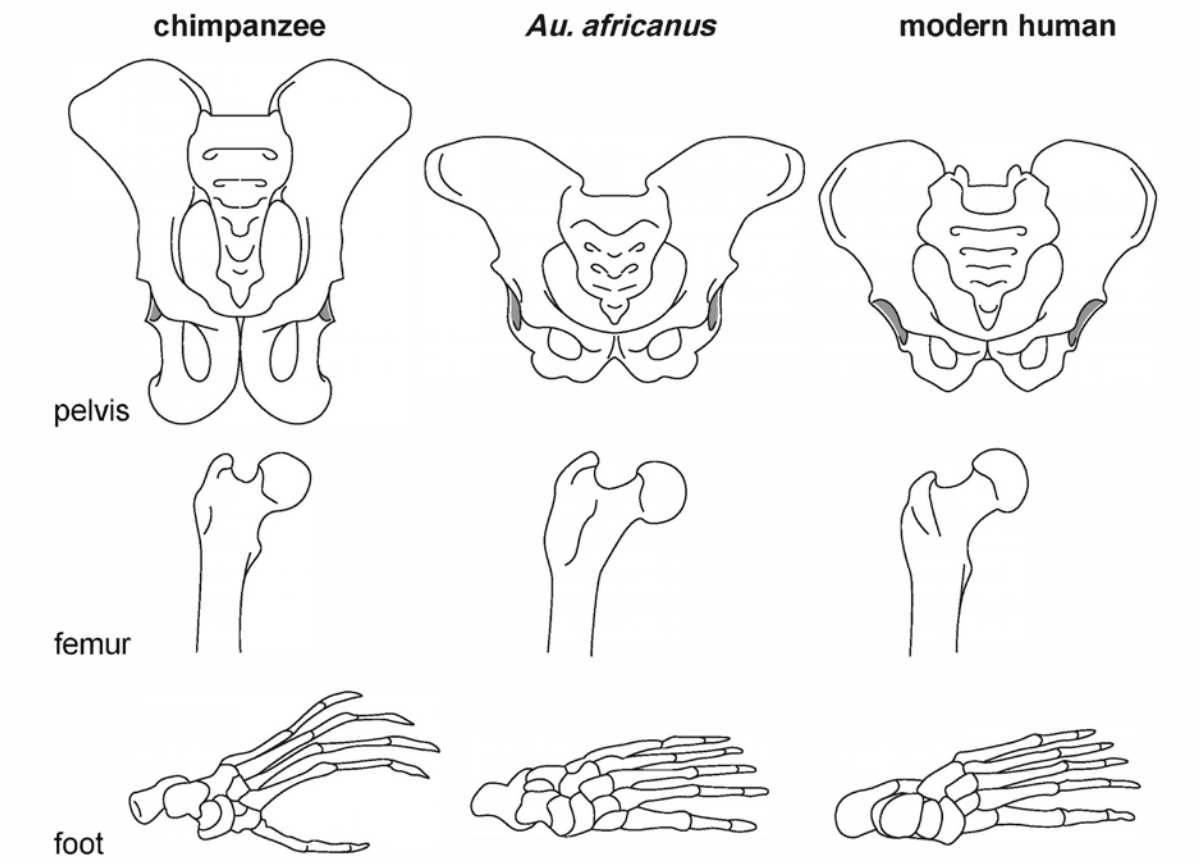
Local human populations on the islands capture some of the more brightly coloured finches. These finches are then bred and sold as pets. This is called selective breeding.

c. Explain the difference between natural selection and selective breeding.

2 marks

Question 10 (7 marks)

The diagram below shows comparisons between the pelvis, femur and foot of a chimpanzee, *Australopithecus africanus* and a modern human.



Scientists used these structures as evidence to show relatedness of modern humans to common ancestors and the evolution of bipedalism in humans.

a. Using evidence from the diagram, explain how structures have changed to support the idea of the evolution of bipedalism in humans.

3 marks

Pelvis _____

Femur _____

Foot _____

b. Describe one other structural feature of modern humans that enables them to stand upright.

1 mark

_____

_____

c. DNA hybridisation techniques have shown that chimpanzee DNA has a 97.6 per cent similarity to modern human DNA.

Describe the steps to determine the similarity in modern human and chimpanzee DNA, using DNA hybridisation.

3 marks

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END OF QUESTION AND ANSWER BOOK