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2017 Trial Examination

STUDENT NUMBER | | | | | | | | | Letter |

BIOLOGY

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	9	9	70
			Total 110

- 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 30 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 movement of large numbers of macromolecules out of the cell is most likely to take place via

A. bulk transport
B. endocytosis
C. exocytosis
D. facilitated diffusion

Question 2

An organelle that could be expected in large numbers in a phagocytic white blood cell is:

A. lysozymes
B. nucleus
C. lysosomes
D. rough endoplasmic reticulum

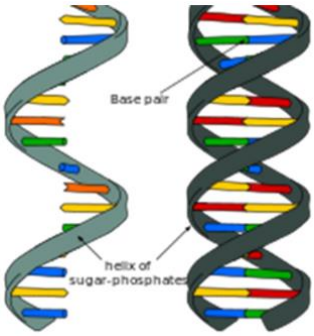
Question 3

Fish living in Arctic waters are likely to have plasma membranes that have a particularly high concentration of

A. carrier proteins
B. phospholipids
C. hydrophilic heads
D. cholesterol

SECTION A - continued

The diagram below refers to Questions 4 and 5



Molecule A Molecule B

Question 4

In reference to the diagram it can be expected that

A. molecule A will only be found in the cytoplasm

B. 25% of molecule B is composed of thymine

C. molecule A can have different functions

D. a strand of molecule A will contain twice as many bases as a strand of the same length as molecule B

Question 5

In reference to the diagram, which of the following is correct?

A. molecule A is the product of translation

B. molecule B binds to ribosomes to direct protein synthesis

C. molecule B contains uracil

D. molecule A carries the genetic code from the nucleus to the ribosome

Question 6

How is it possible for approximately 100000 proteins to be coded for by only approximately 20000 genes?

A. Nuclear proteins regulate the removal of introns. If different introns are removed, different polypeptides can be made from the same gene.

B. Amino acids are removed from a polypeptide after translation, so different polypeptides can be made from the same gene

C. The methyl cap can be added in different arrangements, so different polypeptides can be made from the same gene

D. Nuclear proteins always remove exons from a sequence of mRNA, so different polypeptides can be made from the same genes

Question 7

A polypeptide has 21 amino acids, starting with methionine. How many nucleotides are needed to code for the complete polypeptide?

A. 63

B. 7

C. 66

D. 21

Question 8

Which of the following does not result in the formation of ATP from ADP and Pi?

A. the light independent stage of photosynthesis

B. the Kreb's cycle in aerobic respiration

C. the electron transport chain in aerobic respiration

D. the light dependent stage of photosynthesis

Question 9

The enzyme human alkaline phosphatase is found in bone. Bone cells also have a high concentration of Ca^{2+}, which is an alkaline metal. It can be predicted that

A. the optimum temperature for alkaline phosphatase is $37^{o}C$

B. the optimum pH for alkaline phosphatase is between 6-8

C. alkaline phosphatase will denature in weak alkaline conditions

D. alkaline phosphatase will irreversibly denature at low temperatures

Question 10

The poison cyanide causes cell death. This is due to the fact that it binds to a regulatory region on cytochrome oxidase and thus prevents it from binding with its substrate, therefore halting the electron transport chain. Which of the following statements regarding cyanide is correct?

A. cyanide is a competitive inhibitor of cytochrome oxidase

B. cyanide is the same shape as the substrate for cytochrome oxidase

C. cyanide is a cofactor for cytochrome oxidase

D. cyanide is a non-competitive inhibitor of cytochrome oxidase

SECTION A - continued

Question 11

Rubisco is the enzyme that enables carbon dioxide to join with the 5 C intermediate Ribulose bisphosphate in order to continue through the metabolic pathway that eventuates in glucose synthesis. It would be expected that rubisco is found in high concentrations in the:

A. cytoplasm

B. matrix

C. stroma

D. thylakoid

Question 12

Cytokines are chemicals released by cells in the immune system. An example can be seen when NK cells release cytokines to induce apoptosis when they bind to cells showing altered MHC1 markers. This is an example of:

A. contact-dependent signalling

B. autocrine signalling

C. endocrine signalling

D. pheromone signalling

Question 13

A hormone binds to an intracellular receptor. The hormone-receptor complex then acts as a transcription factor, resulting in a protein being synthesised. With reference to the mode of hormone action, which of the following is correct?

A. the hormone is hydrophilic and the cellular response is activation of an enzyme

B. the hormone is hydrophobic and the cellular response is transcription of a gene and translation to produce a protein

C. the hormone is hydrophilic and inhibits transcription

D. the hormone is hydrophobic and cannot move into the cell

Question 14

Apoptosis can be caused by either intracellular or extracellular signaling. An example of a pro-apoptotic intracellular signal is

A. damage of the mitochondrial membrane, which causes mitochondrial proteins to leak into the cytoplasm and initiate apoptosis

B. presence of anti-apoptotic membranes that help to stabilise the mitochondrial membrane and prevent apoptosis

C. cytotoxic T cells releasing cytokines that initiate cell death of virally infected cells

D. release of caspases inside the cell, which digest intracellular proteins

SECTION A - continued
TURN OVER

Question 15

The prevention of apoptosis is an important step in tumour formation. This is because:

A. apoptosis is required to kill normal body cells, so that the tumour cells can proliferate

B. it prevents death of cells carrying mutated DNA

C. if a cancerous cell survives, it will signal to other cells to divide

D. it enables tumour suppressing genes to be activated and so prevent tumour growth

Question 16

The specific part of a pathogen that triggers an immune response is called the

A. antibody

B. pathogenic agent

C. antigen

D. allergen

Question 17

Viruses are obligate parasites, as they cannot function outside of a host cell. In relation to viral function, which of the following is not correct?

A. Viral DNA is assembled into the host's genome and transcribed and translated to make viral proteins

B. The virus has specific proteins in the coat which bind to receptors on the host cell

C. After multiple virus copies have been created, the host cell may undergo lysis and releases the viral particles

D. Viruses produce toxins, which prevent the normal metabolic functions of the host cell

Question 18

TSE (transmissible spongiform encephalopathies) is a group of diseases characterized by degeneration of brain tissue. It is transmitted by the consumption of:

A. meat that has not been sufficiently heated

B. meat that has been infected with a parasite

C. meat that has been infected with a virus

D. meat containing the abnormally folded form of prion proteins

Question 19

When comparing the innate and adaptive immune responses, it is correct to state that:

A. the innate response is non-specific, whereas the adaptive immune response is specific for particular pathogens

B. the innate response is slower acting, the adaptive response is more immediate

C. the adaptive response is present from birth, the innate response is acquired throughout life

D. the innate response involves antibodies, the adaptive response involves phagocytosis

Question 20

Monoclonal antibodies can be produced synthetically in order to treat certain diseases, including cancer. Which of the following is true for monoclonal antibodies?

A. monoclonal antibodies produced by the same hybrid cell may show variation

B. monoclonal antibodies may be used to suppress the immune response

C. monoclonal antibodies can aid in blocking the signals produced by oncogenes

D. monoclonal antibodies only bind to specific antigens on the cancer infected cell

Question 21

The gene pool can be defined as

A. the sum total of all of the genes present in a population

B. the sum total of all of the alleles present in a population

C. the sum total of all of the alleles of breeding individuals present in a population

D. the change in allele frequencies over time

Question 22

The Galapagos Islands have many examples of animals that are endemic. One of these is the Giant Tortoise, which has many different populations. Scientists have found that a population of the Giant Tortoise which is found on the side of the Alcedo volcano has much less genetic diversity than the other populations of Giant Tortoises on the island. This is likely to be a result of:

A. natural selection

B. the founder effect

C. the bottleneck effect

D. artificial selection

Question 23

Environmental factors can act on traits in a population and increase the likelihood of individuals with certain traits surviving and passing on their alleles. Such factors can be called:

A. biotic factors

B. selection pressures

C. disruptive selection

D. selective breeding

Question 24

Rabbits were introduced to Australia in the 18th century and quickly became widespread. In order to control the population, the *myxoma* virus was introduced in the 1950s. This led to a vast reduction in the population size, however some of the rabbits were able to survive. They reproduced and passed on their alleles and now the population is at similar levels to before. The *myxoma* virus no longer affects most rabbits. This is an example of:

A. genetic drift

B. speciation

C. evolution

D. artificial selection

Question 25

Which of the following is not a pre-reproductive isolating mechanism?

A. geographic isolation

B. behavioural isolation

C. morphological isolation

D. hybrid sterility

Question 26

A mutation has occurred in an individual, in which a section of a chromosome 19 has mistakenly attached to the middle of chromosome 4. This is an example of:

A. a point mutation

B. a silent mutation

C. translocation

D. inversion

SECTION A - continued

Question 27

Lampreys are a jawless fish thought to have originated in the early Carboniferous period. While there are extant species of lampreys alive today, fossilized specimens from this period are very rare. This is most likely to be because:

A. fossil specimens of the lamprey have been destroyed by scavengers

B. the lampreys were not very widespread in the Carboniferous period

C. lampreys contain cartilage, not bone

D. the currents in the aquatic environments prevented fossilisation

Question 28

Biogeography is

A. the study of continental drift

B. the study of the distribution of organisms across the globe

C. the study of how the environment affects an organism

D. the study of how climate changes at different geographical locations

Question 29

Pythons and boa constrictors have small bones present in the muscle tissue near their tails. These bones are similar in structure to the pelvis and the femur of mammals, but, unlike in mammals these bones have no connection to the spine. These bones can be referred to as:

A. vestigial structures

B. analogous structures

C. erroneous structures

D. comparative structures

Question 30

A fossil specimen is analyzed and contains a carbon-14 to nitrogen-14 ratio of 1:3. Carbon-14 has a half-life of approximately 5500 years. The fossil is approximately

A. 11000 years old

B. 16500 years old

C. 5500 years old

D. Not enough information to determine

Question 31

Pterosaurs were a group of flying reptiles that lived from the early Cretaceous to the late Triassic period. The wings of pterosaurs had an elongated first digit, which provided support for the rest of the wing. The wings of birds also have elongated digits that serve a similar function, but in this case it is the second digit that is elongated. This is an example of

A. homologous structures

B. parallel evolution

C. divergent evolution

D. convergent evolution

Question 32

Which of the following is NOT a molecular method used to examine evolutionary relationships between species?

A. protein sequencing

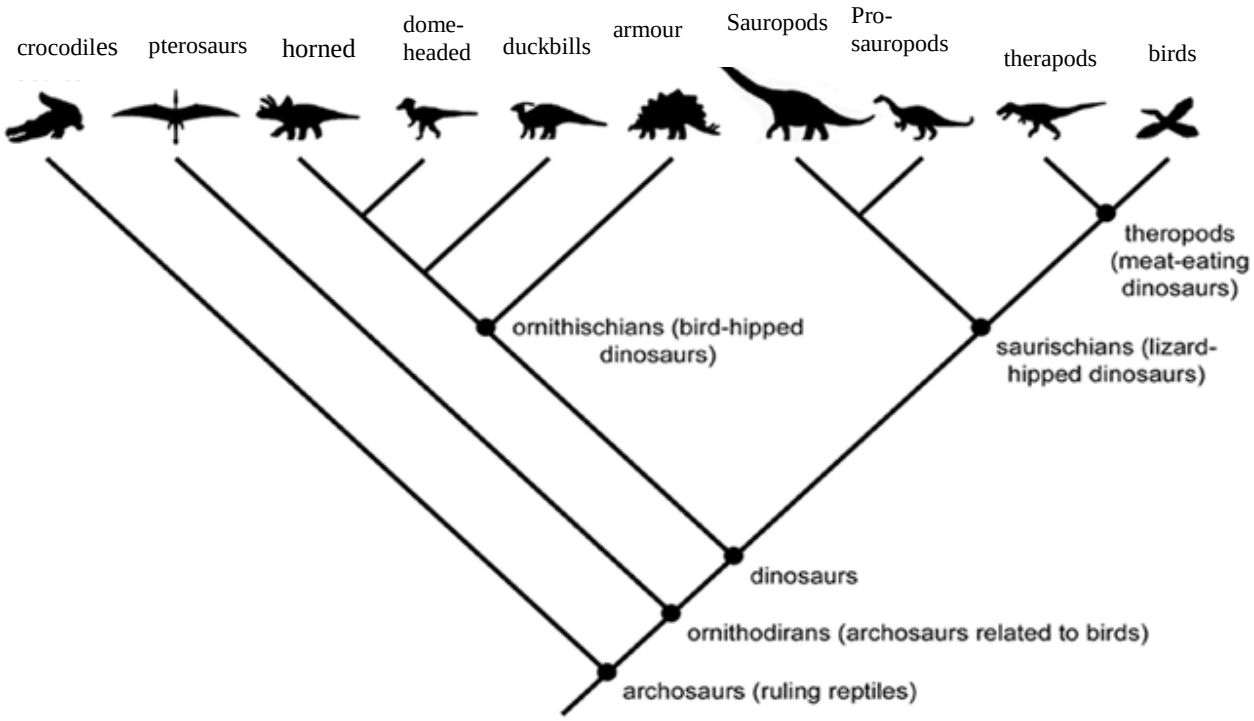
B. comparative anatomy

C. DNA hybridisation

D. comparing mutations in mitochondrial DNA

Question 33

The phylogenetic tree for dinosaurs and related species is shown below



From this information, it can be stated that:

A. dome-headed dinosaurs belong to the saurischian (lizard-hipped) group

B. therapods are more closely related to prosauropods than sauropods

C. pterosaurs are not classed as dinosaurs

D. therapods were herbivores

Question 34

The *Bmp4* gene is a master control gene that has been identified as influencing beak development in birds. For example, in Galapagos Finches, it has been found that larger beak sizes are determined by the *Bmp4* gene being expressed early in development and to a greater extent. From this observation, it can be predicted that:

A. birds with slender beaks show low *Bmp4* expression

B. birds with a medium beak size do not show any *Bmp4* expression

C. birds with low *Bmp4* expression will develop larger beaks

D. the size of the beak is inversely proportional to *Bmp4* expression

Question 35

Homo erectus is a human ancestor that is thought to have been able to run long distances. This enabled them to cover large areas of ground and gave them a selective advantage. It has been hypothesized that some of the other adaptations shown by *Homo erectus* are a direct result of the need to prevent overheating whilst running. Such features include:

A. fine manipulation of tools

B. development of fire and cooking

C. reduced hair across the body

D. enlarged brain size

Question 36

The evolution of hominins shows a number of changes in the skull. Which of these trends is not correct?

A. increased size of dentition

B. reduced eyebrow ridge

C. increased cranial capacity

D. Foramen magnum moves to the centre of the skull

Question 37

In the Polymerase Chain Reaction which of the following stages and temperatures is correct?

A. Denaturation – the DNA is heated to 72^{o}C in order to separate the strands

B. Annealing – the sample is cooled to 55^{o}C and primers attach

C. Extension – the sample is heated to 95^{o}C to enable *taq* polymerase to add new primers

D. Lysis – the sample is cooled to 40^{o}C to allow restriction endonucleases to cut the DNA

Question 38

Gel electrophoresis relies on the movement of DNA in order to separate the strands. The movement of DNA occurs because

A. DNA is able to diffuse through the gel

B. DNA is composed of nucleotides, joined by phosphodiester bonds

C. Smaller sections of DNA are able to move further through the gel than larger sections

D. DNA is negatively charged and will therefore move towards a positive electrode

SECTION A - continued

Question 39

A sample of DNA was treated with the restriction enzyme *EcoR1*. After separating the sample with gel electrophoresis it was found that it had been separated into 3 strands. The same sample was also treated with the restriction enzyme *BamH1*. The sample was separated and only 1 band was shown on the gel. From these results, it can be concluded that:

A. The DNA sample had 2 restriction sites for *EcoR1*, but none for *BamH1*

B. The DNA sample had 3 restriction sites for *EcoR1*, and 1 for *BamH1*

C. The DNA sample had 1 restriction site for *EcoR1*, but none for *BamH1*

D. The DNA sample had 2 restriction sites for *EcoR1*, and 1 for *BamH1*

Question 40

Which of the following examples describes a transgenic organism?

A. Inserting the GFP gene from jelly fish into bacteria

B. Activation of a specific gene already present in an organism

C. Inactivation of a specific gene already present in an organism

D. Selection of organisms that show desired characteristics to breed

END OF SECTION A
TURN OVER

SECTION B - Short-answer questions

Instructions for Section B

Complete all answers in the spaces provided.

Question 1 (12 marks)

A student carries out an experiment to investigate the effect of temperature on the integrity of the plasma membrane. She places 10 x 1cm^3 cubes of beetroot into a beaker. She heats the beetroot on a hotplate to a set temperature, then places each of the cubes into test tubes of cold water for 20 minutes. She then records the colour of the water. The table below shows her data.

Temperature (^{o}C)	**Colour of water after 20mins**
20	Light pink
40	Medium pink
60	Dark pink
80	Very Dark purple

a. State and explain a hypothesis for this investigation

_____

_____

_____

_____

2 marks

b. Identify two other variables that need to be controlled for this experiment.

_____

_____

2 marks

SECTION B – Question 1 - continued

c. What would be a suitable control for this experiment?

_____

_____

1 mark

d. Describe 2 limitations with this experimental method. Identify how these could be improved

_____

_____

_____

_____

2 marks

Another student wanted to carry out a similar experiment using detergent. Detergent is hydrophobic and works by dissolving molecules that are also hydrophobic.

e. Describe how the addition of detergent would affect the plasma membrane. Explain your answer in terms of the nature of molecules

_____

_____

_____

_____

2 marks

SECTION B – Question 1 - continued

TURN OVER

f. Design an experiment to investigate the integrity of the membrane with and without detergent. You should identify independent, dependent and controlled variables and also predict what the results will be, with reference to the structure of the plasma membrane.

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_____

3 marks

Total 12 marks

Question 2 (10 marks)

Proteins are important macromolecules that enable the cell to carry out its functions and all of the metabolic processes. Different proteins are expressed by different cells at different time.

a. What term is given to all of the proteins expressed by a cell?

_____

1 mark

b. Why is it more useful to investigate all of the proteins expressed by a cell together, rather than looking at each protein individually?

_____

_____

1 mark

c. Proteins can have a wide variety of different functions in the cell. Give an example of a protein with a structural function and a protein with a regulatory function.

_____

_____

_____

_____

2 marks

d. Draw the structure of a subunit of a polypeptide. Explain how this relates to the tertiary structure of a protein.

_____

_____

_____

_____

3 marks

Tay-Sachs disease (TSD) is a fatal genetic disorder that occurs in children. Sufferers of TSD are unable to synthesise the enzyme hexosaminidase-A (Hex-A), which results in the accumulation of a fatty substance, or lipid, called GM2 ganglioside in the nerve cells of the brain. This ongoing accumulation causes progressive damage to the cells. TSD is caused by a mutation in a gene on chromosome 15, in which a single nucleotide is deleted. This prevents the formation of a stop codon.

e. Explain, in terms of transcription and translation, why a single mutation can have such a severe effect on protein structure. You should include the name of this form of mutation in your answer.

_____

_____

_____

_____

_____

_____

3 marks

Total 10 marks

SECTION B – continued

Question 3 (7 marks)

Aerobic respiration is an important biochemical process that occurs in all eukaryotic cells

a. Why is aerobic respiration essential to the survival of a cell?

_____

1 mark

b. State the balanced symbol equation for respiration

_____

1 mark

The first stage of cellular respiration occurs in the cytoplasm and results in the production of an important cellular compound. In a mammalian muscle cell, this compound can enter different pathways, depending on the environment of the cell.

c. State the name of these pathways and state two difference between these pathways.

_____

_____

_____

_____

3 marks

d. Energy carriers play an important role in both aerobic respiration and photosynthesis. Describe the role they play in each of these biochemical reactions.

_____

_____

_____

_____

2 marks

Total 7 marks

SECTION B – continued

TURN OVER

Question 4 (5 marks)

The urine of male mice has been found to contain a chemical known as darcin. When female mice come into contact with darcin, they are more likely to stay close to the urine trail and therefore remain in the proximity of the male.

a. What is the term used to describe chemicals involved in this form of signalling?

_____

1 mark

b. Other animals are not affected by this chemical. Explain why this is so.

_____

_____

1 mark

c. The chemical structure of darcin was analysed and it was found to contain large numbers of carbon, hydrogen, oxygen and nitrogen atoms, as well as smaller numbers of a wide variety of other atoms. Using this information, draw a labelled diagram showing how darcin binds to a receptor and initiates a cellular response.

_____

_____

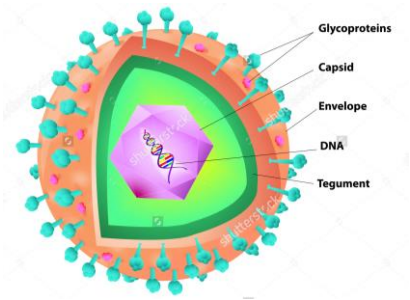
3 marks

Total 5 marks

SECTION B – continued

Question 5 (7 marks)

Herpes simplex Type I is a virus that is responsible for cold sores. Cold sores are highly contagious, as virus particles can be easily transferred via contact from one infected individual to another. The structure of the virus is shown below.



Source: shutterstock.com

a. Is a virus a cellular or non-cellular pathogen? Explain your answer

_____

_____

2 marks

b. How does a virus particle reproduce? Include reference to the host cell in your answer

_____

_____

_____

_____

3 marks

SECTION B – Question 5 - continued

TURN OVER

c. Many cold sore remedies sold in pharmacies include an antiviral agent called aciclovir. Suggest how aciclovir may work.

_____

_____

_____

2 marks

Total 7 marks

Question 6 (10 marks)

The human body has a number of responses which help fight off infection from pathogens. These can be classified as specific or non-specific.

a. State two differences between the specific and non-specific responses.

_____

_____

_____

_____

2 marks

b. The specific response can be further sub-divided into the humoral and the cell mediated response. For each of these responses, state one cell involved and explain its function.

_____

_____

_____

_____

2 marks

SECTION B – Question 6 - continued

Tetanus is a disease caused by the bacteria *Clostridium tetani*. The bacteria produce a toxin, tetanospasmin, which results in severe muscle spasms and in some cases death. In 1889 it was discovered that the toxin could be neutralized by certain antibodies and in 1924, a vaccine for tetanus was developed.

c. Suggest how the tetanus vaccine works to prevent infection.

_____

_____

_____

_____

_____

_____

3 marks

The vaccine is given to infants and again during adolescence. Adults are advised to have a booster injection (containing the antibodies to the toxin) if they have had possible exposure to the tetanus bacteria, such as being cut with a rusty nail.

d. What kind of immunity is provided by the booster injection?

_____

1 mark

e. Suggest why this is necessary in adults, even if they were vaccinated as a child.

_____

_____

_____

_____

2 marks

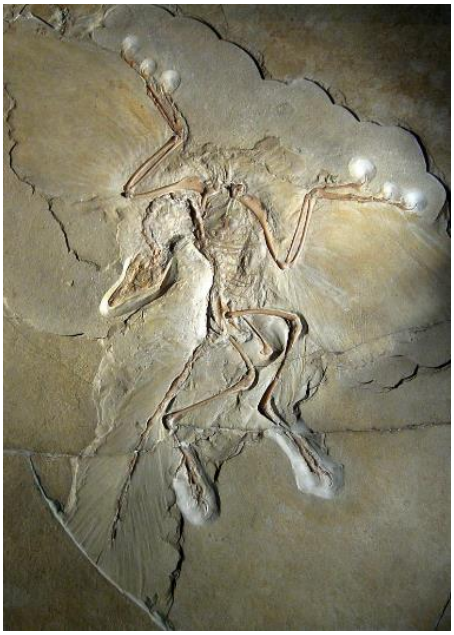
Total 10 marks

SECTION B – continued

TURN OVER

Question 7 (6 marks)

Archaeopteryx was a species of reptile that lived in the Late Jurassic period, around 150 million years ago. It is widely accepted as showing the evolution of birds from dinosaurs. An image of an *archaeopteryx* fossil is shown below.



a. What term is given to fossils which show the evolution of one species from another?

_____

1 mark

b. Give two features of *Archaeopteryx* that suggest it shows the evolution from dinosaurs to birds.

_____

_____

_____

_____

2 marks

SECTION B – Question 7 - continued

Birds are closely related to dinosaurs. They were able to survive the mass-extinction event at the end of the Cretaceous period. In the 5 to 10 million years following the end of the Cretaceous period they were able to rapidly evolve, resulting in the huge diversity of species seen today.

c. What term is used to describe evolution of many different species from one common ancestor?

_____

1 mark

d. Suggest how this type of evolution could have occurred after the mass-extinction event at the end of the Cretaceous period, resulting in over 9000 bird species today.

_____

_____

_____

_____

2 marks

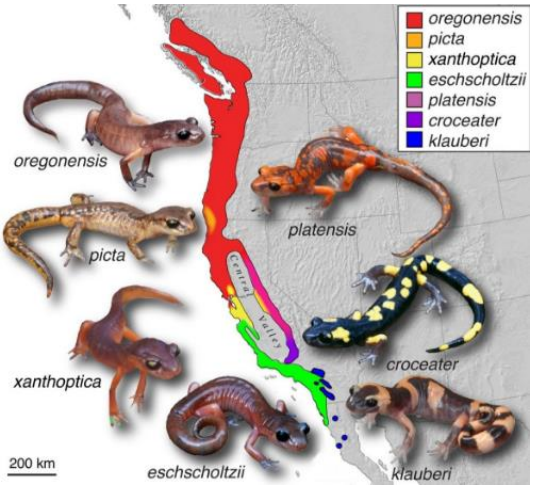
Total 6 marks

SECTION B – continued

TURN OVER

Question 8 (6 marks)

Salamanders in Southern California demostrate an interesting example of evolution. The original, ancestral population (*E.e oregonesis*) lived in a forest environment north of a great central valley. Over time, populations have moved south to either side of the valley. Populations to the east of the valley lived in forest environments, while those to the west lived in coastal environments. The central valley prevented populations on either side from interacting and breeding together. Two sub-species that have subsequently developed, *E.e. eschsholtzi* and *E.e. klauberi,* are no longer able to interbreed.



a. Suggest why the populations to the east and west of the great central valley look different to each other.

_____

_____

_____

_____

2 marks

SECTION B – Question 8 - continued

b. Has speciation occurred between these populations? Support your answer

_____

_____

_____

_____

1 mark

c. Outline the steps that would result in speciation in the salamanders.

_____

_____

_____

_____

_____

_____

3 marks

Total 6 marks

SECTION B – continued

TURN OVER

Question 9 (7 marks)

A robbery has occurred. Police are trying to find the perpetrators however there seems to be few clues within the crime scene. Witnesses have suggested that there are three possible suspects.

The police therefore ask for assistance from forensic experts. They find a sample of DNA that does not match any of the owners of the property and think it could belong to the perpetrator.

a. Before the sample can be analysed larger amounts of the DNA are required. Name the technique that can use to achieve this and outline the steps that occur during this technique.

_____

_____

_____

_____

_____

_____

3 marks

After the sample has been amplified it is treated with a restriction enzyme. DNA samples from the three suspects are also treated with the same restriction enzyme and compared to the crime scene sample using gel electrophoresis.

b. Describe how gel electrophoresis is carried out. You should include a labelled diagram to assist your answer.

_____

_____

_____

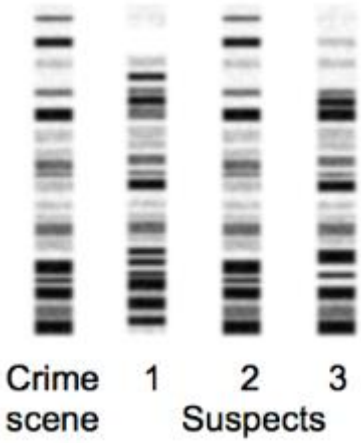
_____

2 marks

SECTION B – Question 9 – continued

TURN OVER

The results from the gel electrophoresis are below.



c. Use this information to identify the burglar. Justify your answer

_____

_____

1 mark

d. Is this evidence enough to prove that the individual committed the crime? Explain your answer.

_____

_____

_____

_____

1 mark

Total 7 marks

END OF QUESTION AND ANSWER BOOK