



NAME: _____

UNITS 3 AND 4 PRACTICE EXAMINATION

VCE BIOLOGY

QUESTION AND ANSWER BOOKLET

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

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 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 allowed in this examination.

Materials supplied

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

Instructions

- Write your **name** in the space provided above on this page.
- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** on your answer sheet for multiple-choice questions.
- 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.

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** for 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.

Question 1

Goji berries are a type of berry sometimes called a ‘superfood’ as a result of its high nutrient content and health benefits. It contains long-chain polysaccharides that have been reported to play a role in improving the immune system of an individual consuming the berries.



Source: Wikimedia Commons

The macromolecule comprising the berries would be broken down into monomers of

- A. glycerol
- B. glucose
- C. amino acids
- D. disaccharides.

Question 2

Glycogen-storage disease can affect a type of dog called a Curly-Coated Retriever. The disease occurs when there is a deficiency of the glycogen de-branching enzyme in the areas where glycogen is stored.

Storage areas for glycogen in the Curly-Coated Retriever include the

- A. liver and heart
- B. brain and kidneys
- C. adipose tissue
- D. liver and muscles.

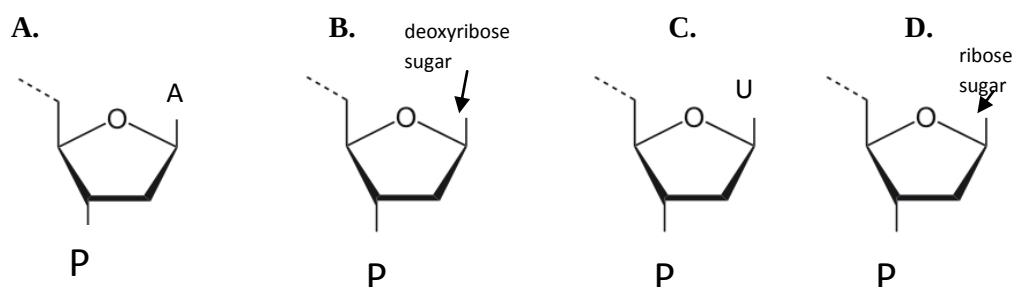
Question 3

The Human Phenome Project takes into account a person's

- A. genotype and phenotype
- B. phenotype not including environmental effects
- C. phenotype including environmental effects
- D. genotype and phenotype including environmental effects.

Question 4

The correct representation of a monomer of DNA is

**Question 5**

The electron micrograph of the organism shown below can be found in both the human gut and in the soil.



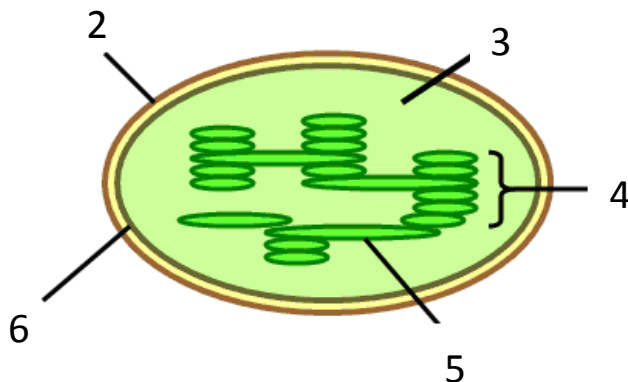
Source: Wikimedia Commons

This organism is most likely to be a

- A. fungi
- B. eukaryote
- C. prokaryote
- D. parasite.

Question 6

The following organelle can be found in high numbers in leaves of the Australian native Wattle plant where sunlight is absorbed in the process of photosynthesis.



Source: Wikimedia Commons

The area where light is converted into chemical energy is

- A. 1
- B. 2
- C. 3
- D. 4

Question 7

Head trauma can lead to a build up of fluid in the brain, as seen in the skull below. The fluid is unable to cross the brain-blood barrier resulting in a condition called hydrocephalus which can lead to permanent brain injury.



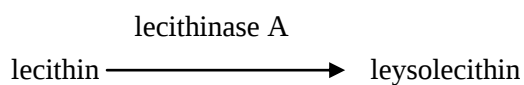
Source: Wikimedia Commons

The maintenance of the blood-brain barrier occurs as a result of

- A. plasmodesmata
- B. occluding junctions
- C. communicating junctions
- D. anchoring junctions.

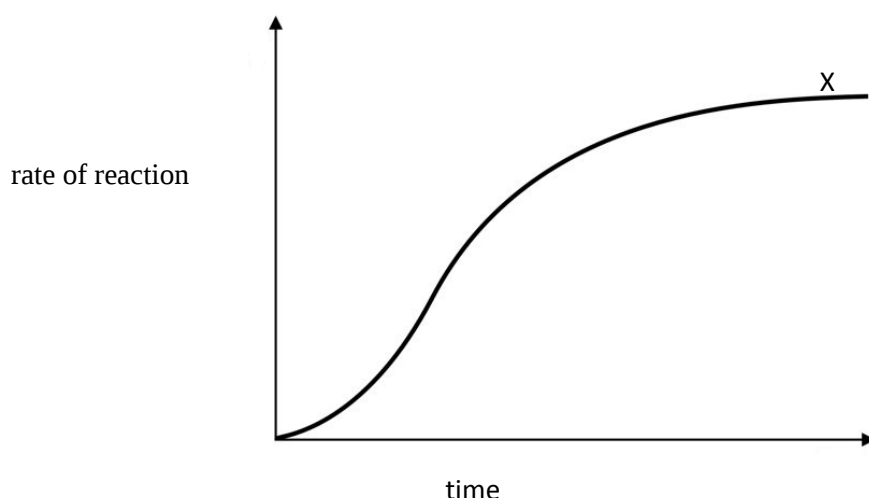
The following information relates to Questions 8 and 9.

The venom of a Cobra includes an enzyme called lecithinase A. This enzyme dissolves the membranes surrounding viruses as well as cell walls. The enzyme reaction is shown below.



Question 8

The graph below shows the rate of the reaction over time at the enzyme's optimum environmental conditions.



In order to increase the reaction rate shown at point X on the graph

- A. more lecithinase A could be added
- B. more leylecithin could be added
- C. the temperature could be decreased
- D. the pH could be increased.

Question 9

An enzyme inhibitor can be used to prevent the action of lecithinase A.

This could work by preventing the

- A. formation of lecithinase
- B. binding of lecithinase A to lecithin
- C. cobra from producing venom
- D. lecithin from forming.

Question 10

A variable NOT controlled by homeostasis in humans is the

- A. amount of insulin released by the pancreas
- B. pH level in the blood
- C. number of calories consumed
- D. carbon dioxide concentration in lung cells.

Question 11

Bees swarm as part of their reproductive behaviour as seen below.



Source: Wikimedia Commons; Author: Mark Osgatharp

If the swarm is interrupted in some way, it is possible the swarm may attack.

This response is most likely to be caused by a particular bee

- A. emitting a cry of distress
- B. signalling the production of a hormone by the Queen Bee
- C. releasing a pheromone
- D. causing the attacked human to release a pheromone.

Question 12

In rural Australia food availability for stock such as cattle decreases over the winter period.

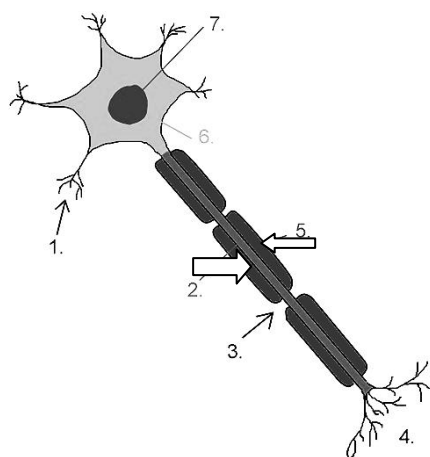
To increase the amount of food available from their pastures, farmers could spray their paddocks with

- A. ethylene
- B. auxins
- C. abscisic acid
- D. gibberellins.

Question 13

Krabbe Disease is a degenerative disorder that is usually fatal within two years when suffered by infants. The disease results in the degeneration of white matter in the brain which is a result of the imperfect growth or development of the myelin sheath.

The diagram below shows an example of a typical neuron that may be affected.



Source: Wikimedia Commons; Attributed to Nick Gorton

According to the diagram above, the number that corresponds to the part of the neuron most affected by Krabbe Disease is

- A. 2
- B. 3
- C. 5
- D. 7

Question 14

The compound Choline is sometimes classified as a vitamin. If a person does not consume enough of it in their diet it can lead to harmful effects. Choline can be used in the treatment of neurological disorders including Presenile Dementia, Alzheimer's Disease and Huntington's Disease.

The most likely role of Choline in the human nervous system is to

- A. assist in the development of a neurotransmitter
- B. ensure the nervous impulse travels in the right direction
- C. maintain the shape of the neuron
- D. replace damaged neurons.

Question 15

The Funnel Web Spider venom works by blocking nerve impulses to the muscles and overstimulating the production of certain neurotransmitters.

Funnel Web Spider



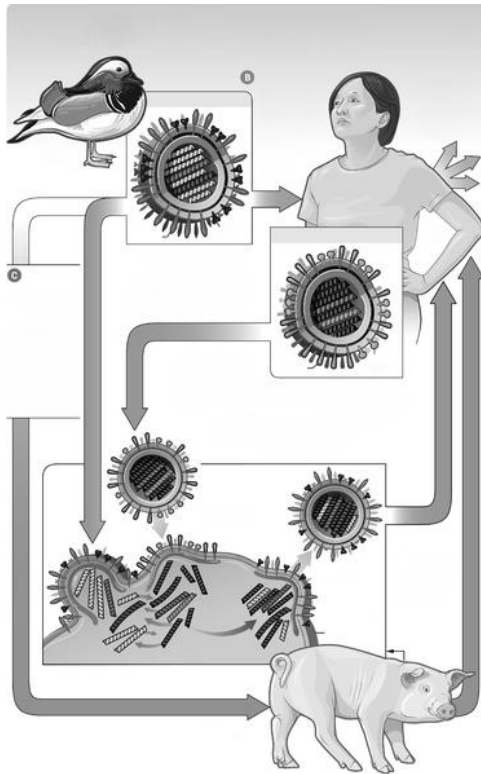
Source: Wikimedia Commons; User: Tirin

Based on the above information, a person who had been bitten by a Funnel Web Spider would be expected to undergo

- A. severe shaking
- B. paralysis
- C. an instant heart attack
- D. no symptoms.

Question 16

The diagram below shows a path Influenza A could take from a bird to a human.



Source: Wikimedia Commons; Author: (modified from) National Institute of Allergy and Infectious Diseases

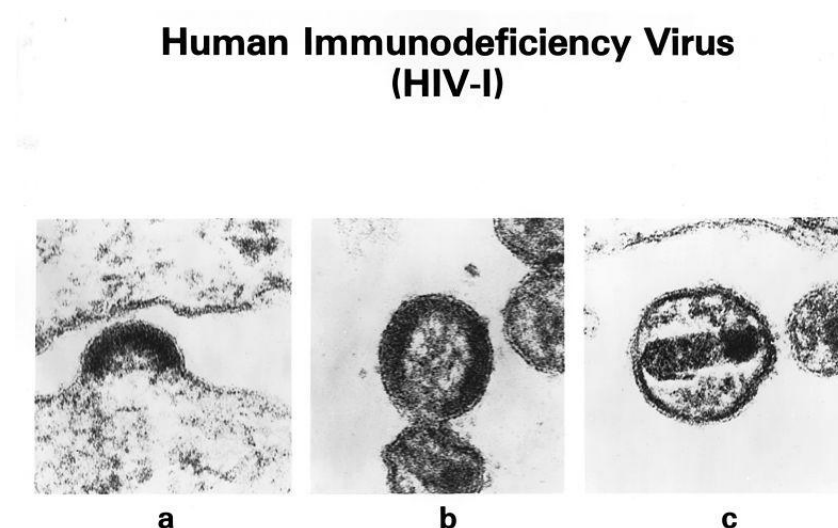
The changes to the Influenza virus shown above can be called

- A. genomics
- B. an antigenic shift
- C. biotechnology
- D. clonal proliferation.

Question 17

The Human Immunodeficiency Virus replicates by initially fusing to a host cell membrane. Viral proteins including Reverse Transcriptase then accumulate under the membrane to create a membrane encapsulated sphere called a Viroid. The virus then separates off to become an extracellular virus.

This process is shown below.



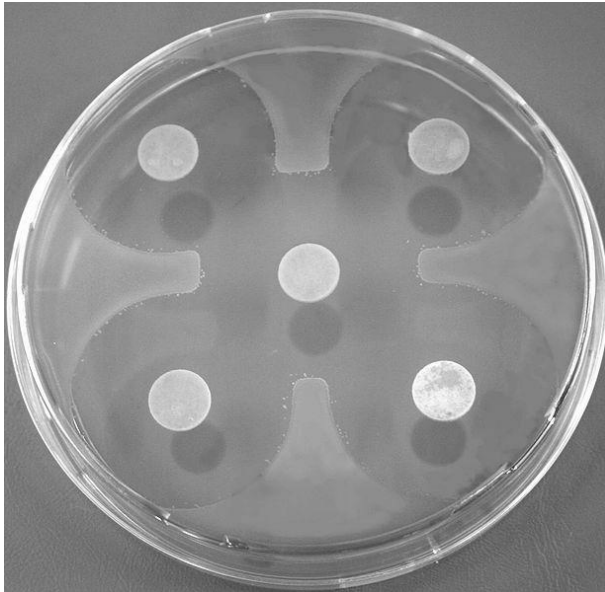
Source: Wikimedia Commons; Author: Dr Matthew Gonda, National Institute of Health

Which of the following processes does NOT happen in the above photo labelled **b**?

- A. Viral DNA integrates into host DNA.
- B. New viral RNA is used as new genomic RNA.
- C. New viral RNA is used to make proteins.
- D. Viral DNA is used to make proteins.

Question 18

Shown below is a petri dish used by a microbiologist in an experiment testing the effectiveness of different antibiotics on a particular organism.



Source: Wikimedia Commons; Author: D.Bahmann

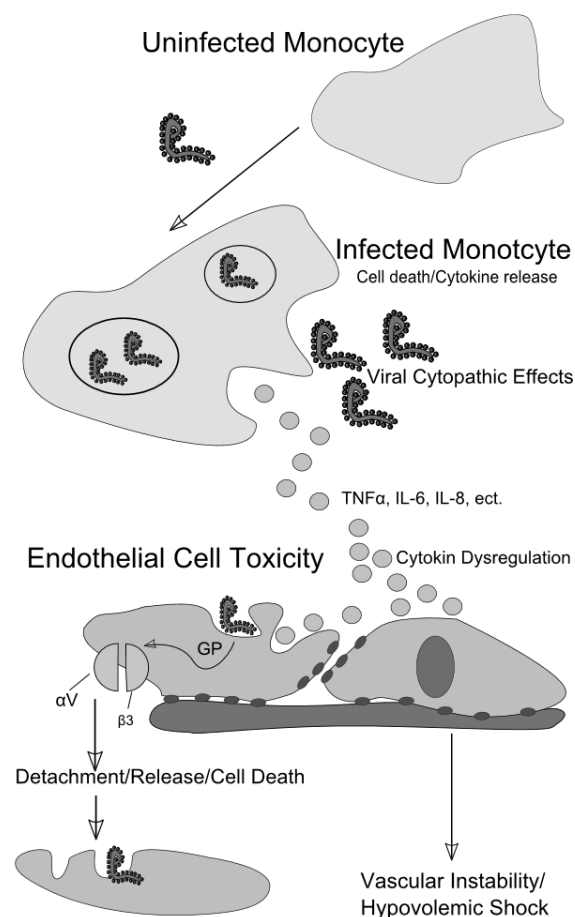
The results indicate

- A.** all the antibiotics would be equally effective against the organism
- B.** some antibiotics were more effective than others
- C.** any of the antibiotics would be effective for the common cold
- D.** the organism has developed resistance to the antibiotics used.

The following information is required for Questions 19 and 20.

Early symptoms of a person infected with the Ebola Haemorrhagic Fever virus include red eyes and a skin rash. Later symptoms include internal and external bleeding. Ebola is often a fatal disease.

The diagram below shows how the Ebola virus can lead to death.



Source: Wikimedia Commons; Ebola_Pathenogenesis.svg.chryanandChloe

Question 19

The Cytokine Dysregulation results in the accumulation of cytokines.

This would result in the Ebola sufferer showing

- A. increased body secretions
- B. a decrease in clonal expansion
- C. inflammation
- D. a lower T cell count.

Question 20

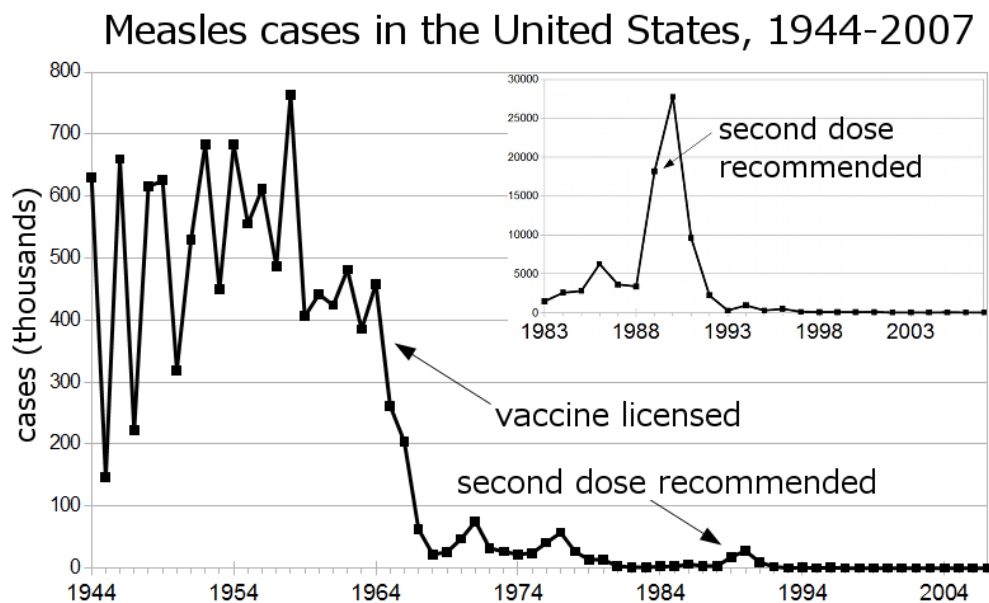
Identifying the Ebola virus is required to take steps to prevent the disease spreading. PCR is performed as part of the analysis.

PCR would assist identification of the virus by allowing the scientists to

- A. denature the double stranded viral DNA
- B. make multiple copies of the viral RNA
- C. make multiple copies of the viral DNA obtained by reverse transcription
- D. create new Ebola virus particles for comparison.

Question 21

The graph below shows the number of measles cases reported in the United States between 1944 and 2007.



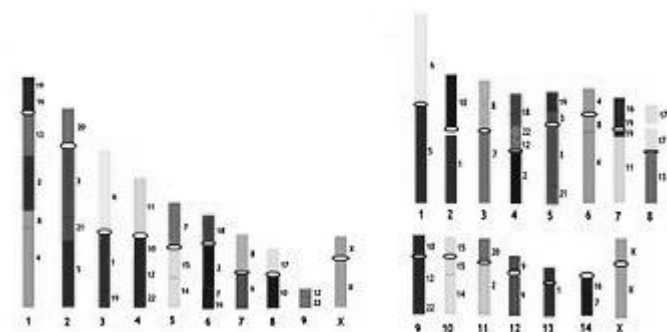
Source: Wikimedia Commons; Author: Zover 0

The number of measles cases shown after the second dose was recommended was most likely due to individuals

- A. not being vaccinated initially
- B. experiencing a depletion in memory B cells before having a second dose
- C. who had contacted measles naturally and not had a vaccination
- D. having no response to the second dose.

The following information is required for Questions 22 and 23.

The karyotypes below are representations of the chromosomes of an Aardvark and a Mink. Homologous chromosome pairs are not shown.



Aardvark karyotype

Mink karyotype

Source: Wikimedia Commons; Authors: Graphodatsky Alexander S, Trifonov Vladimir A, Stanyon, Roscoe

Question 22

The diploid number of the Aardvark is $2n =$

- A. 5
- B. 10
- C. 20
- D. 40

Question 23

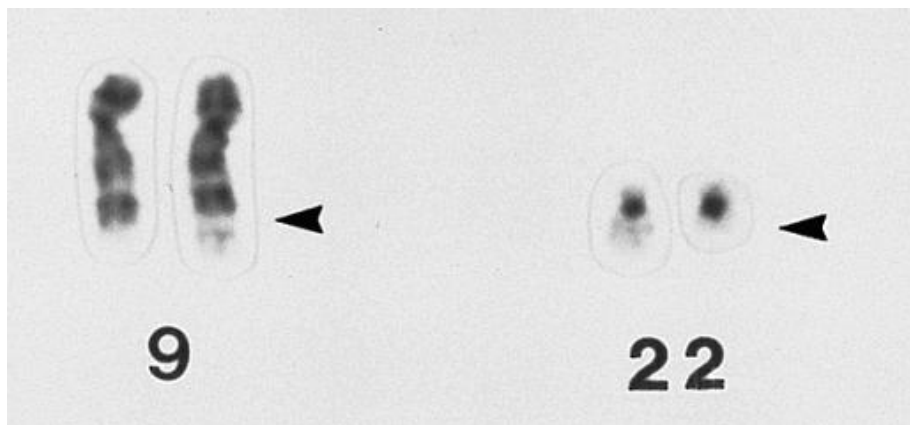
An Aardvark and a Mink would be unable to produce viable and fertile offspring as

- A. the chromosomes are unable to line up to form homologous pairs in meiosis
- B. recombination would produce an embryo that has too much genetic variation
- C. the Mink gametes are haploid while the Aardvark gametes are diploid
- D. spindle fibres would not be able to form properly during meiosis.

Question 24

Chronic Myeloid Leukaemia (CML) is a type of cancer that starts in the bone marrow. It results in the overproduction of immature cells that make granulocytes, a type of white blood cell. CML is characterised by a chromosome called the 'Philadelphia Chromosome' seen below. This condition is most likely to occur in children and middle aged women.

The Philadelphia Chromosome (number 9 chromosome)



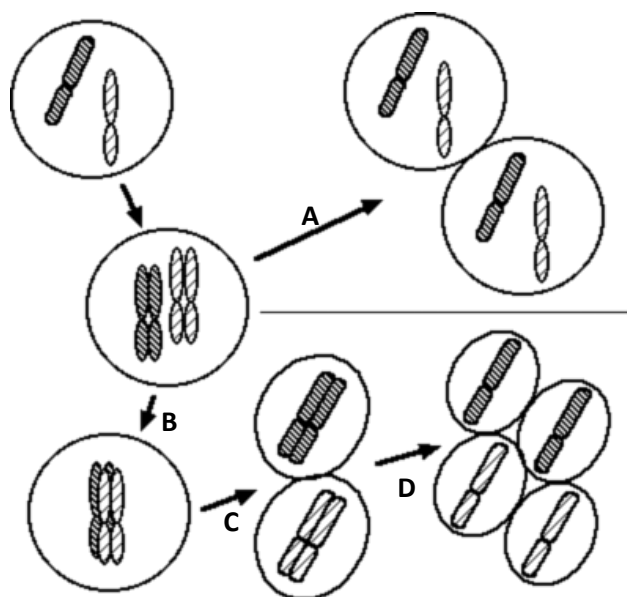
Source: Wikimedia Commons – Author: The Armed Institute of Pathology

The Philadelphia Chromosome has been caused by

- A. addition of new DNA caused by overproduction of granulocytes
- B. deletion of part of one member of the pair of homologous chromosomes 9
- C. errors in crossing over during meiosis
- D. translocation of part of one member of the pair of homologous chromosomes 22 to one member of the pair of homologous chromosomes 9.

Question 25

The following types and stages of cell division can be seen in different cells of a chicken. Each arrow represents a stage that occurs to produce the cell or cells shown.



Source: Wikimedia Commons; Author: Electric Goat

The stage which produces the greatest amount of variation amongst a chicken population is

- A. A
- B. B
- C. C
- D. D

Question 26

Cyclin-Dependent protein Kinase (CDK) enzymes are essential for DNA replication and mitosis. Cyclins bind to proteins which then provide a substrate for CDK. Cyclins accumulate to help end the G1 phase and start events leading to DNA replication.

The levels of CDK enzymes would be highest in mitosis during

- A. interphase
- B. prophase
- C. metaphase
- D. anaphase.

Question 27

Squirrels, like the one pictured below, can have a variety of coat colours such as grey on top and white below, red or all grey. The variations are caused by the production of melanin which is produced in two forms - eumelanin (producing brown/black colour) and phaeomelanin (producing red/yellow colour). The different combinations of these produce the different coat colours.



source: Wikimedia Commons; User: ray eye

An allele for the squirrel could be described as being

- A. its coat colour
- B. a grey coat with white underneath
- C. the amount of eumelanin and phaeomelanin produced.
- D. melanin.

The following information is required for Questions 28 and 29.

Aplicheilus latipes, also known as Medaka, is a small fish commonly found in Japan's streams and paddies. The colour of the Medaka is controlled by two genes located on different chromosomes. The Medaka can be red or white and variegated or not variegated. The gene controlling the colour is autosomal with red the dominant colour. Variegation is sex-linked dominant with the unusual difference that the Y chromosome can also carry an allele for the trait.

Question 28

A homozygous variegated red female and a white non-variegated male produced offspring. The expected phenotypic outcome is

- A. all white males and all red females
- B. all red males and all white females
- C. all red males and all red females
- D. red males, white males and red females.

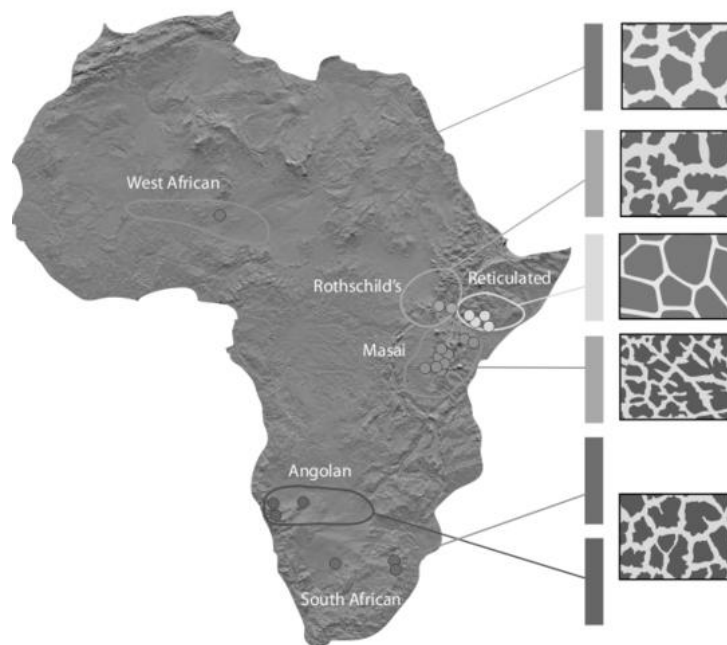
Question 29

The cross described above could be called a

- A. monohybrid cross
- B. linkage experiment
- C. test cross
- D. dihybrid cross.

Question 30

The picture below show the approximate geographic ranges for giraffe subspecies based on their mitochondrial DNA.



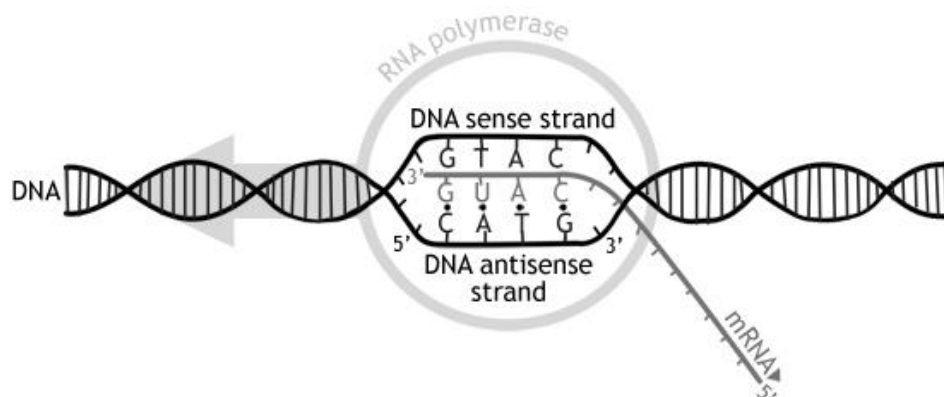
Source: Wikimedia Commons; Authors: Brown, David; Rick Brenneman, Klaus-Peter Koepfli, John Pollinger, Borja Mila, Nicholas Georgiadis, Edward Louis, Gregory Grether, David Jacobs, Robert Wayne (2007). "[Extensive population genetic structure in the giraffe](#)".

Mitochondrial DNA was used rather than nuclear DNA because it

- A. has a lower mutation rate
- B. is it easier to extract
- C. expresses more genes
- D. shows haplogroups in different populations.

Question 31

The process by which a mRNA strand is produced as part of protein synthesis is shown below.



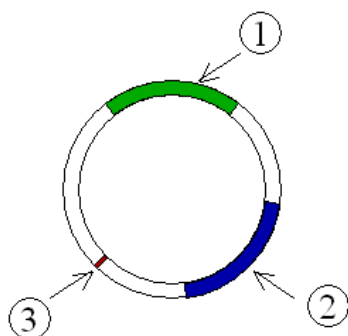
Source: Wikimedia Commons; Author: Dovelike

The next step of the process involves the removal of the

- A. exons
- B. introns
- C. poly A tail
- D. primers.

Question 32

The plasmid below is typical of those used in recombinant DNA technology. Sections 1 and 2 represent genes that confer antibiotic resistance while point 3 is the origin of replication.



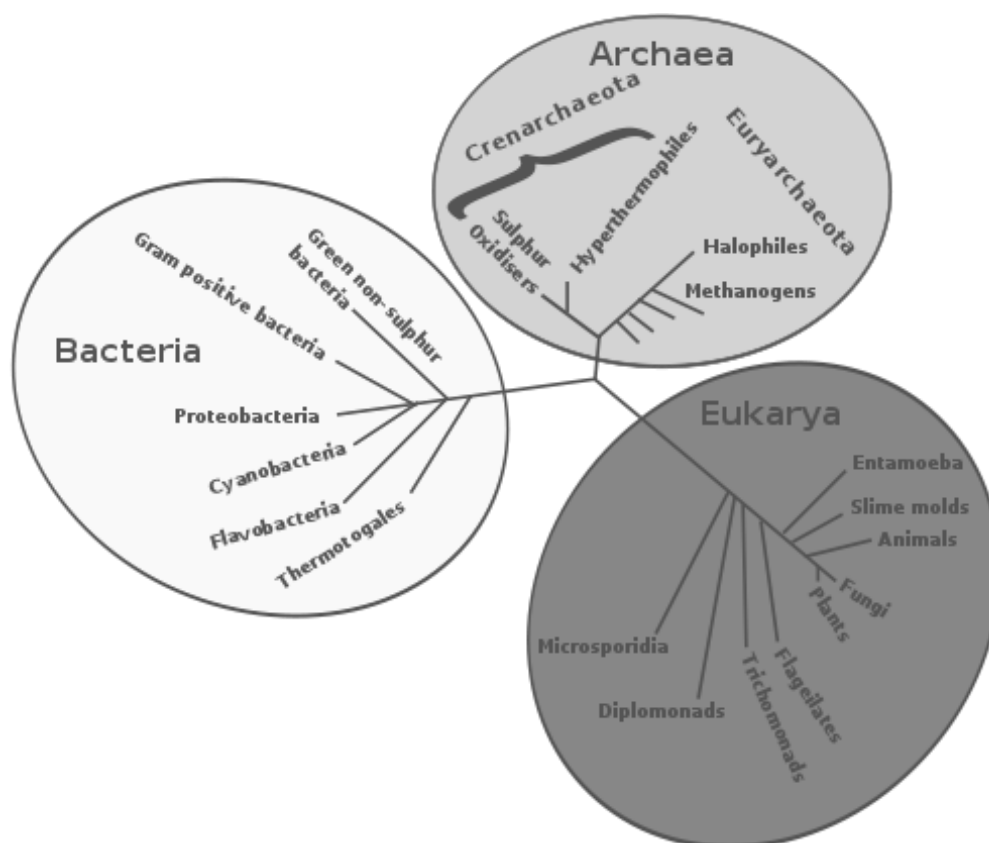
Source: Wikimedia Commons; Author: Magnus Manske

The correct enzyme involvement and number of strands produced by the replication of a plasmid and a human gene is

	plasmid	human gene
A	DNA polymerase is involved to produce a double stranded molecule	DNA polymerase is involved to produce a double stranded molecule
B	DNA polymerase is involved to produce a single stranded molecule	RNA polymerase is involved to produce a single stranded molecule
C	RNA polymerase is involved to produce a single stranded molecule	DNA polymerase is involved to produce a double stranded molecule
D	RNA polymerase is involved to produce a single stranded molecule	RNA polymerase is involved to produce a double stranded molecule

The following information is required for Questions 33 and 34.

The phylogenetic tree below shows the separation of Bacteria, Archaea and Eukaryotes based on rRNA data. The distance along the phylogenetic tree branches is NOT representative of the closeness of relationships.



Source: Wikimedia Commons - User: Ben Tillman

Question 33

The most closely related organisms are

- A. Microsporidia and Thermotogales
- B. Methanogens and Hyperthermophiles
- C. Fungi and Trichomonads
- D. Halophiles and Microsporidia.

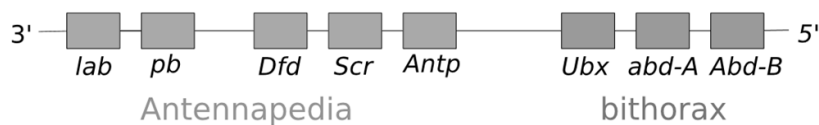
Question 34

rRNA is produced in large quantities in the eukaryotic cell in the

- A. ribosomes
- B. rough endoplasmic reticulum
- C. nucleus
- D. nucleolar organiser regions.

Question 35

The diagram below shows a section of DNA from a *Drosophila*.



Source: Wikimedia Commons; Author: Retama

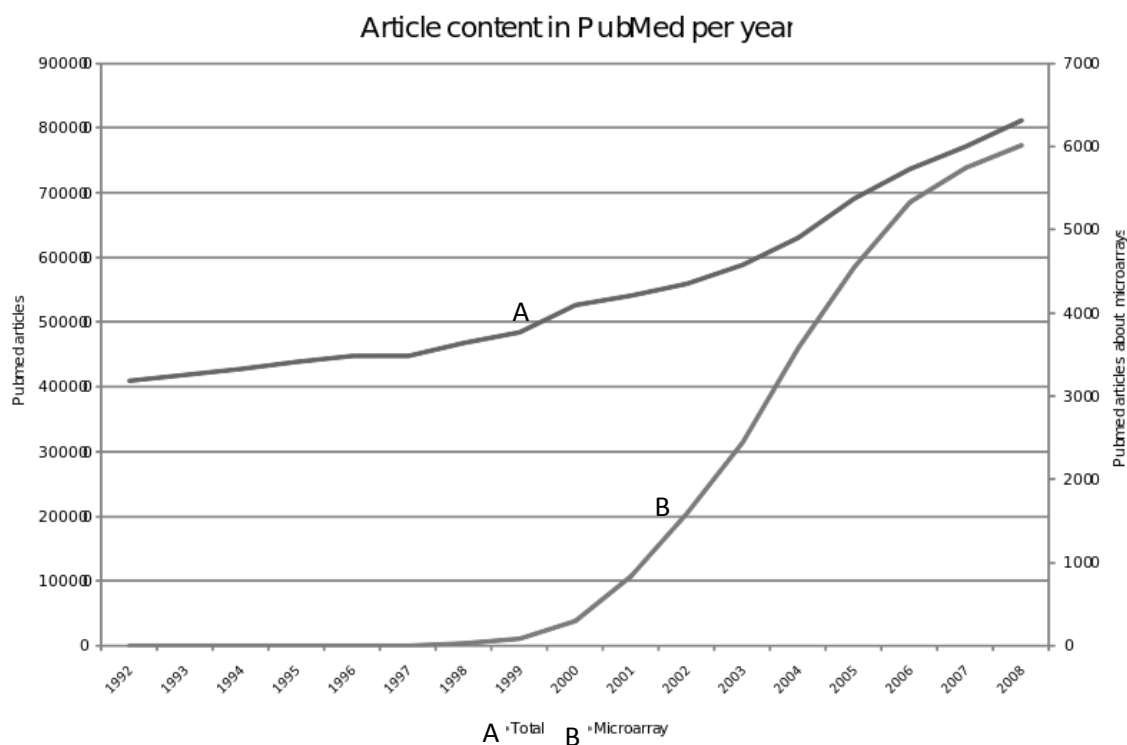
The Antennapedia sections control the differences among the thoracic and head segments, while the Bithorax sections control the differences among the thoracic and abdominal segments.

This length of DNA could be classified as a

- A. signalling protein
- B. homeotic gene
- C. structural gene
- D. spliced gene.

Question 36

PubMed is a free data base with links to biomedical and life science journals, citations and articles. The graph below shows the number of articles published in total (line A) and the number of articles published about microarrays (line B) in PubMed from 1992 until 2009.



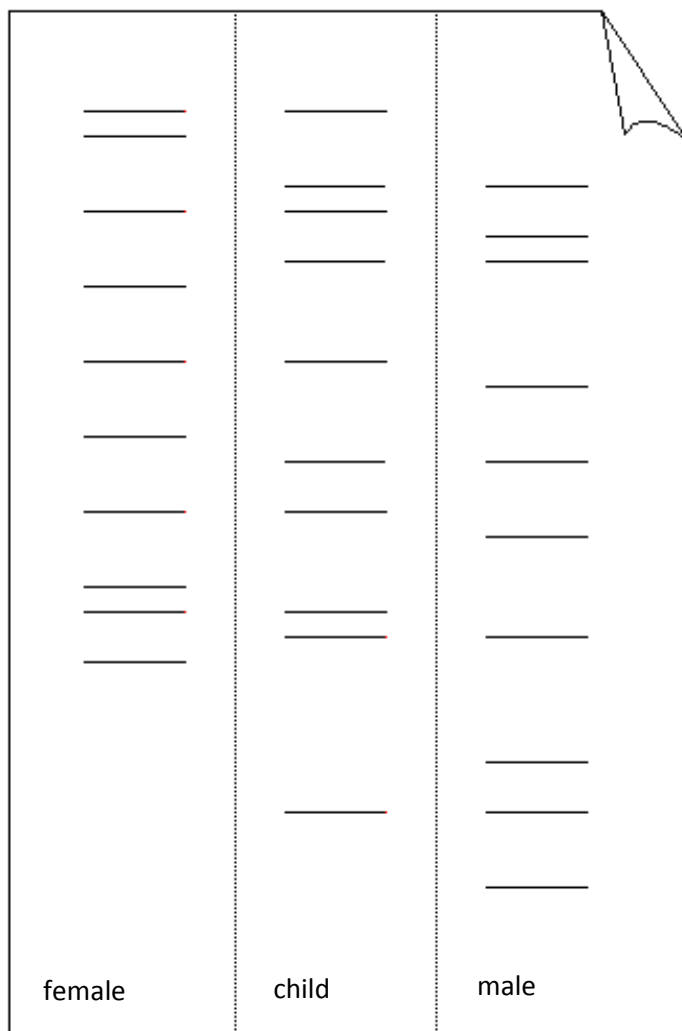
Source: modified from Wikimedia Commons; Author: Squidonius

The number of microarray articles published has changed as microarrays

- A. are very cheap to use
- B. are not very effective at determining the expression of a single gene
- C. are only useful in examining the human genome
- D. allow the examination of the expression of many genes in one experiment.

Question 37

DNA Fingerprinting can be used to identify the maternity and paternity of a child. Below are the results of the electrophoresis of PCR amplified DNA fragments from a male, female and a child.



Source: modified from Wikimedia Commons Nupedia; Author: Magnus Manske

According to the results above the

- A.** female could not be the mother of the child but the male could be the father
- B.** female could be the child's mother and the male could be the child's father
- C.** the male could not be the father of the child but the female could be the mother
- D.** neither the male nor the female could be the child's parent.

Question 38

The kernel colour of wheat is determined through polygenic inheritance.

This means that the trait

- A. will show continuous variation
- B. will show discontinuous variation
- C. is monomorphic
- D. will change over time.

Question 39

The Hummingbird and the Fork-Tailed Sunbird, pictured below, are examples of convergent evolution.



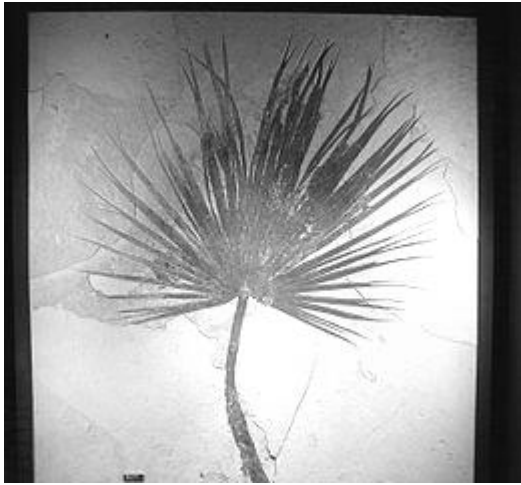
Source: Wikimedia Commons; Author: Charles Lam

This means that the two birds

- A. have similar traits but are unrelated
- B. are the same species with different common names
- C. share a recent common ancestor
- D. evolved at the same time in different locations.

Question 40

The fossil Fan Palm Leaf below belongs to the *Sabalites* species. It existed approximately 50 million years ago and could be found in California.



Source: Wikimedia Commons

The most accurate method to date the Fan Palm Leaf fossil would be to use

- A. carbon dating
- B. potassium- argon dating
- C. stratigraphy
- D. index fossils.

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

Answer this section in **pen**.

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

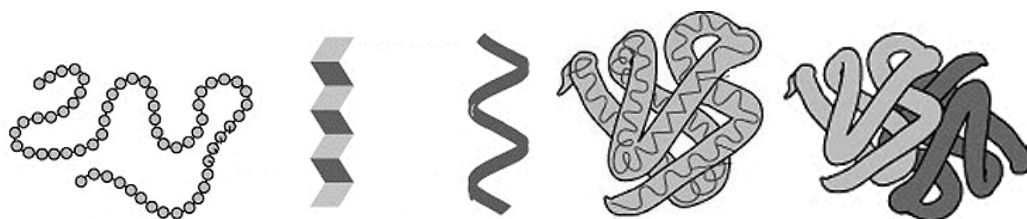
Question 1 (8 marks)

In early 2013 it was alleged that members of an AFL team had unknowingly been injecting growth-hormone-releasing peptides (GHRP). Some of these are not approved for humans and are banned for use. One such hormone called GHRP-6 is shown in liquid form below.



Source: altered from Wikipedia

a.i) Circle the diagram below which represents the protein structure of a GHRP. 1 mark



ii) Explain your choice.

1 mark

The diagram below shows a segment of the inside of a eukaryotic cell as seen under a light microscope. Several of the cell organelles can be seen.



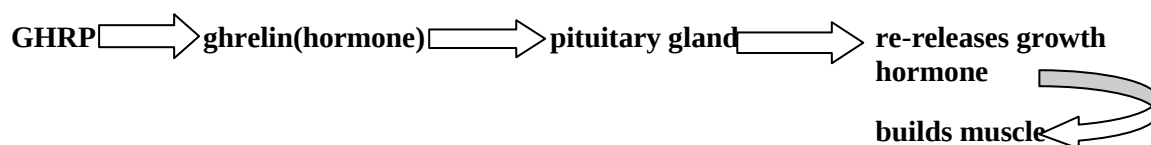
Source: Wikipedia

b. On the diagram above clearly label 2 organelles involved in the process of manufacturing a protein **and** explain its function. 2 marks

Structure 1:

Structure 2:

The flow chart below shows the how the effects of GHRP are generated.

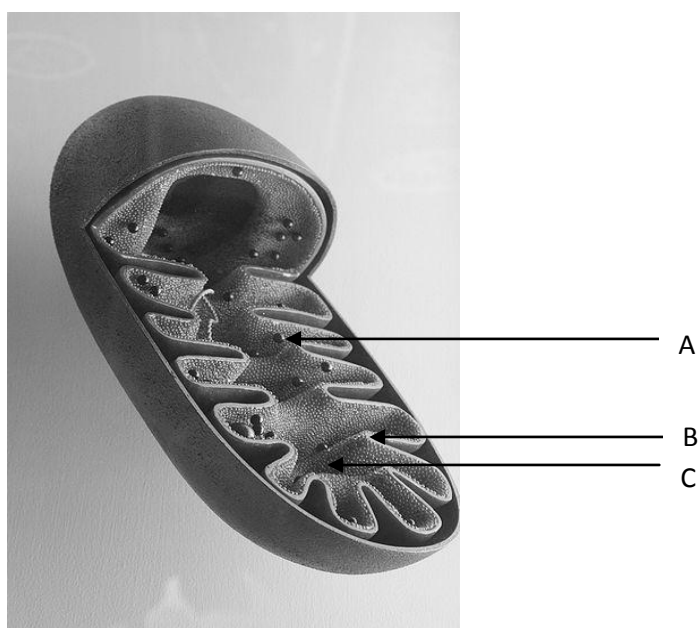


c. Describe how the growth-hormone-releasing peptide is able to initiate a response in the cell in the pituitary gland. 3 marks

d. Explain how signal transduction is involved in the re-release of growth hormone. 1 mark

Question 2 (6 marks)

Usain Bolt can run at speeds around 98km/hr while a Cheetah can run at speeds over 98km/hr. Both these individuals require large amounts of the organelle shown below.



Source: Modified from Wikimedia Commons

a. Explain which tissue type would contain the largest number of this organelle in the cheetah and human. 1 mark

b. Referring to the diagram above, write the name of structures A and B and explain their function. 2 marks

A:structure:_____

function:

B:structure:_____

function:

When Usain Bolt has been running for a period of time, he does not have enough of a particular required substrate to undertake the part of the metabolic reaction occurring in area C as shown on the previous diagram.

c.i) Write the name and explain the process that usually occurs in part **a**. Include the substrates and products involved. 1 mark

ii) Write the word equation for the reaction that occurs when Usain Bolt can not undertake the process you described. 1 mark

A particular group of cheetahs has been found to have genetic uniformity at a number of gene loci. Looking at mitochondrial DNA and VNTR loci has enabled scientists to suggest a bottleneck occurred in the cheetah population around 10,000 years ago.

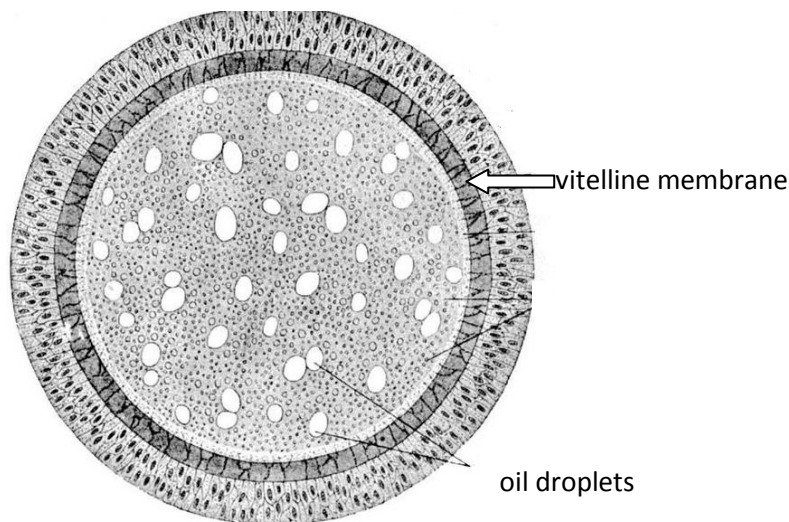
d. How would a bottleneck effect have caused this genetic uniformity?

1 mark

Question 3 (4 marks)

The vitelline membrane is a thin extracellular coat that surrounds the egg. It is the structure which the sperm binds to during fertilisation.

Below is an echidna's egg showing the location of the vitelline membrane.



Source: modified from Wikimedia Commons

The vitelline membrane of a hen is a multilayered structure comprising networks of sheets and thin fibrils. It is made up of 81.6% protein.

a. Describe two differences between the vitelline membrane and the plasma membrane of a hen cell.

2 marks

Difference 1:



Difference 2:

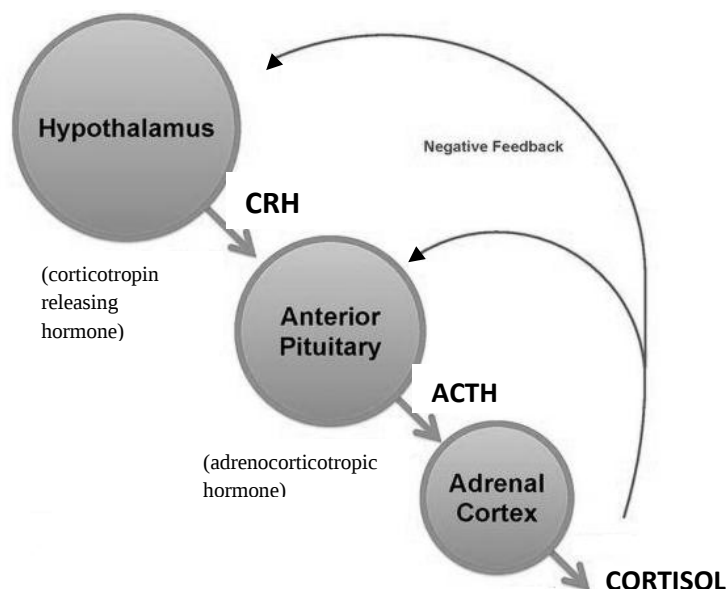
The hen's vitelline membrane is semi-permeable but is freely permeable to glucose.

b. Explain the difference between the process by which glucose crosses the vitelline membrane and the plasma membrane. 2 marks

Question 4 (4 marks)

Pituitary adenomas are usually benign (non-cancerous) tumours that occur in the pituitary gland. This type of tumour can produce large amounts of corticotrophin hormone in the form of ACTH.

The diagram below shows the feedback system involving ACTH.



Source: Wikimedia Commons; Author: Brian M Sweis

- a.** Name the effector(s) in the above feedback model and explain the reason(s) for your choice. 1 mark

The tumour can also cause Cushing's Syndrome which causes negative feedback inhibition. Cushing's Syndrome results in a specific type of obesity in sufferers.

- b.** Explain the result of Cushing's Syndrome on ACTH production. 1 mark

If the pituitary adenoma is more than one centimetre in size it can compress and damage nerves that come from the brain as well as parts of the brain itself. Loss of vision can occur.

- c.** Explain how compression of the nerves can lead to loss of vision. 1 mark

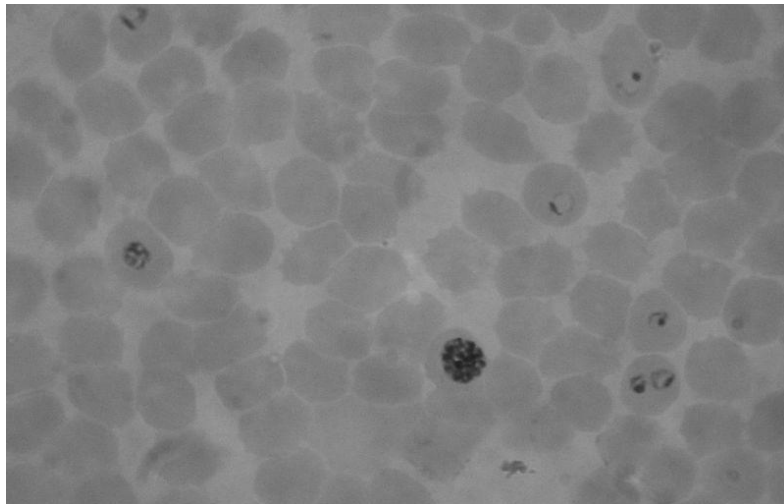
Tumours can be formed when apoptosis is disrupted.

- d.** State two factors that may cause this disruption including one natural biological factor.

1 mark

Question 5 (6 marks)

Plasmodium falciparum is a parasite which causes severe malaria. The slide below shows the interaction between the parasite and red blood cells. *Plasmodium falciparum* is introduced into the bloodstream by mosquitoes, although no development of the parasite occurs in the mosquito.



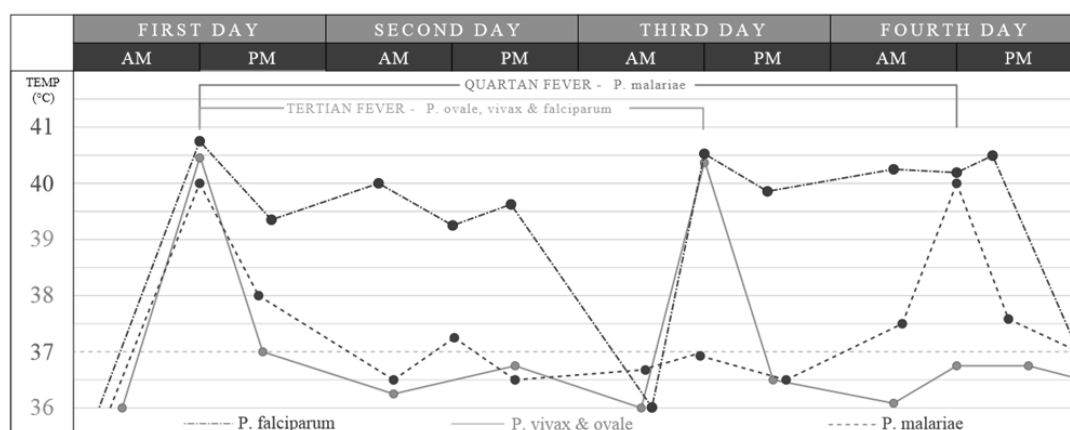
Source: Wikimedia Commons

a. What is the term given to the human and the mosquito in relation to the relationship with the parasite. 1 mark

human: _____

mosquito: _____

Malaria is characterised by a particular fever pattern. Different parasites that cause malaria vary slightly in the fever pattern as shown on the graph below.



Source: Wikimedia Commons- Author: Brady8

b.i) Referring to the graph, describe the temperature changes and associated symptoms on the first day shown by a person infected by *Plasmodium falciparum*. 1 mark

ii) Explain whether having a fever is an example of negative or positive feedback. 1 mark

c. Around 655,000 people die from malaria every year. Recent research has suggested that overdosing the parasite with salt will kill it in hours. A drug has been developed which prevents the parasite from pumping the salt from its body.

Design an experiment to test the hypothesis that taking this drug will prevent symptoms of malaria occurring. 3 marks

Question 6 (4 marks)

Sufferers of Coeliac Disease are known to be intolerant to gliadin, a peptide that originates from gluten. When gluten containing foods, such as wheat, are ingested they are presented to helper T cells which bind to the antigen-presenting cell. This leads to the production of anti-gliadin antibodies.

a. Draw a labelled diagram of an anti-gliadin antibody. 2 marks

b. Explain how the anti-gliadin antibodies are produced. 1 mark

If a Coeliac sufferer continues to eat foods containing gluten, they may have side effects such as bloating and stomach pain and it may cause infertility.

The table below shows the level of Anti-Gliadin Antibodies (AGA) in the blood of a Coeliac sufferer over a period of one year on a gluten-free diet.

Days on GF diet	AGA
0	203
7 (1 wk)	195
30 (1 mo.)	171
61 (2 mo.)	144
91 (3 mo)	121
122 (4 mo)	101
183 (6 mo)	72
274 (9 mo)	44
365 (1 yr)	27
548 (18 mo)	11
730 (2 yr)	6

AGA values below 10 are normal

c. Explain why the AGA values have decreased throughout the year. 1 mark

Question 7 (8 marks)

The Chinese Crested Dog has two variants - wild type with normal hair coverage and hairless, shown below.



Source: Wikipedia; Author: Tommy Gildseth

The gene responsible for the variation is on chromosome 17. The gene is referred to as Canine Ectodermal Dysplasia (CED) and inherited as a monogenic autosomal incomplete dominant trait.

- a. What is meant by a 'monogenic autosomal incomplete dominant trait'? 1 mark

The gene sequence for the wild type and hairless dog are shown below.

wild type	C	T	G	C	C	C	C	C	G	C	C	C	G	C	C	G	C	C	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>
hair less	C	T	G	C	C	C	C	C	G	C	C	C	G	C	C	G	C	C	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>

- b. By examining the differences between the two sequences, what type of mutation has occurred to produce the hairless variant? 1 mark

Below is a table showing the genetic code showing the amino acids coded for by **DNA codons**.

1st base	2nd base				3rd base
	T	C	A	G	
T	TTT (Phe)	TCT	TAT (Tyr)	TGT (Cys)	T
	TTC <u>Phenylalanine</u>	TCC	TAC <u>Tyrosine</u>	TGC <u>Cysteine</u>	C
	TTA	TCA (Ser) <u>Serine</u>	TAA Stop	TGA Stop	A
	TTG	TCG	TAG Stop	TGG (Trp) <u>Tryptophan</u>	G
C	CTT (Leu) <u>Leucine</u>	CCT	CAT (His)	CGT	T
	CTC	CCC (Pro)	CAC <u>Histidine</u>	CGC (Arg)	C
	CTA	CCA <u>Proline</u>	CAA (Gln)	CGA <u>Arginine</u>	A
	CTG	CCG	CAG Glutamine	CGG	G
A	ATT	ACT	AAT (Asn)	AGT (Ser)	T
	ATC (Ile) Isoleucine	ACC	AAC <u>Asparagine</u>	AGC Serine	C
	ATA	ACA (Thr) <u>Threonine</u>	AAA (Lys)	AGA (Arg)	A
	ATG (Met) <u>Methionine</u>	ACG	AAG <u>Lysine</u>	AGG Arginine	G
G	GTT	GCT	GAT (Asp)	GGT	T
	GTC	GCC (Ala)	GAC <u>Aspartic acid</u>	GGC (Gly)	C
	GTA (Val) <u>Valine</u>	GCA <u>Alanine</u>	GAA (Glu)	GGA <u>Glycine</u>	A
	GTG	GCG	GAG <u>Glutamic acid</u>	GGG	G

Source: modified from Wikipedia

c. Using the table above write the amino acids coded for by the underlined DNA sequences in the previous gene sequence table for the wild type and hairless dog. 1 mark

wild dog amino acid sequence	
hairless dog amino acid sequence	

d. At a molecular level, what would be the consequence of the gene mutation? 1 mark

e. Write the corresponding mRNA and tRNA sequences for the hairless dog.

1 mark

hairless	C	T	G	C	C	C	C	C	G	C	C	C	G	C	C	G	C	C	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>
mRNA																											
tRNA																											

f. Describe the steps involved in the second stage of synthesising a protein coded for by the CED gene.

3 marks

Question 8 (7 marks)

Hops is a crop, pictured below, that is used by the brewing industry for making beer and also used in natural deodorants.



Source: Wikimedia Commons - Author: Magnus Manske



Source: Wikimedia Commons - Author: Gilles San Marti

The 2-Spotted Spider Mite, pictured above, preys on Hops by removing the contents of individual plant cells. This results in lower quality Hops and a decrease in crop yield. A pesticide called tebufenpyrad is used to kill the pest. Tebufenpyrad belongs to a group of pesticides called METI-acaracides which are mitochondrial electron transport chain inhibitors.

- a.** Explain how inhibiting the electron transport chain would affect the 2-spotted spider mite. 1 mark

Some 2-Spotted Spider Mites have been found to be METI-acaracide resistant. This has been found to be inherited as a sex-linked, incomplete dominant trait with the resistance being dominant.

- b.** What is the probability a partially-resistant female mite and a resistant male mite will produce a resistant offspring? Show all workings in your answer. 3 marks

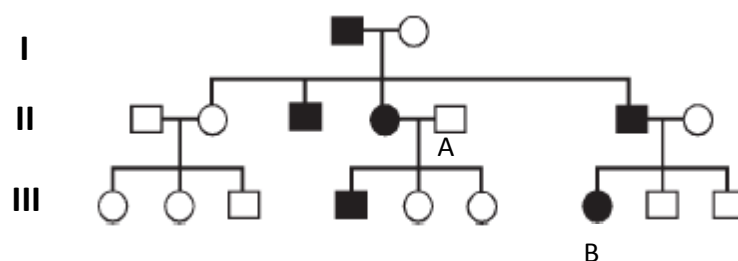
In China, the 2-spotted spider mite had two distinct forms - red and green. It was proposed that they were in fact two different species.

c. Explain what must have occurred to produce two different mite species. 3 marks

Question 9 (5 marks)

Porphyria Variegata is a metabolic disorder that leads to skin blistering and increased sensitivity to light.

The pedigree below shows inheritance of this trait.



Individual III 4 later had a child with a female who had Porphyria Variegata. Their child was unaffected.

a. List the possible modes(s) of inheritance for Porphyria Variegata? 1 mark

b. i) Assign appropriate alleles for the trait. 1 mark

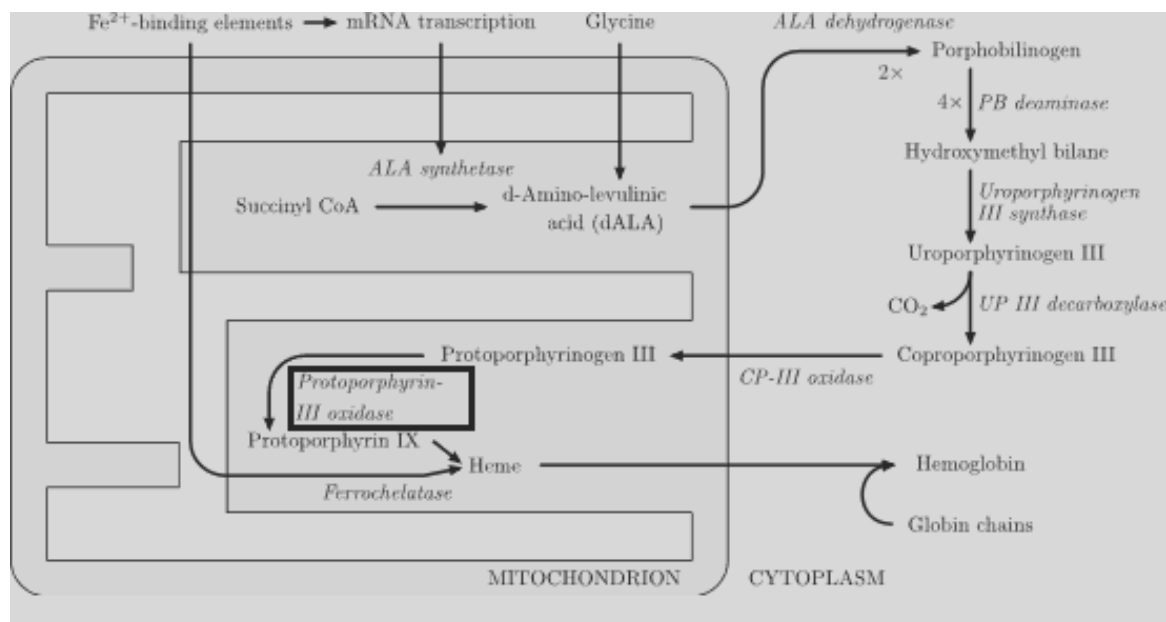
ii) Using the allele symbols you assigned above, write the possible genotype(s) for: 1 mark

individual A: _____

individual B: _____

Porphyria Variegata is caused by a build up of porphyrins. This occurs when there is a deficiency in the enzyme Protoporphyrin-III oxidase shown in a box in the diagram below. If not enough enzyme is produced this leads to a build up of Heme which plays an important role in cellular metabolism.

The diagram below shows the pathway of production of Heme. The porphyrin produced in the pathway is shown as Protoporphyrin IX.



Source: Wikimedia Commons; Author: Wmheric

c. If the enzyme ALA dehydrogenase was unable to function explain how this would affect the level of porphyrin. Assume all other enzymes are fully functional. 1 mark

Cats can inherit Feline Porphyria which results in discoloured teeth, urine and tissue as well as light sensitivity. Cat breeders ensure they avoid breeding from these individuals.

d. What is the term used to describe this method of breeding? 1 mark

Question 10 (9 marks)

The axolotl, pictured below, has the ability to regenerate body parts. It can regrow missing limbs and even parts of its heart.



Source: Wikimedia Commons

Several active genes have been found which are thought to be involved in the regeneration process. These genes code for the enzyme Amblox. Amblox is thought to support the formation of a transmitter which causes cells to turn into progenitor cells.

Progenitor cells can not replicate and divide indefinitely but are otherwise similar to stem cells.

a. What is the function of the progenitor cells in the regeneration process? 1 mark

Scientists use transgenic axolotls that contain genes allowing specific cell types to fluoresce under UV light.

b. What is the advantage of the axolotls containing the foreign DNA? 1 mark

The transgenic process involves injecting foreign DNA directly into a fertilised egg and adding an enzyme to make sure the foreign DNA is incorporated into a chromosome of the animal.

c. i) What would the foreign DNA include? 1 mark

ii) Describe how you could create a transgenic axolotl using a plasmid as a vector instead of directly injecting DNA into the animal. 3 marks

d. Why might the scientists use the direct injection method to create the transgenic axolotl rather than using a plasmid? 1 mark

Humans can regenerate during embryonic development while very young children are able to regrow fingertips.

e. Provide a possible explanation for this shared common regenerative ability between humans and axolotls. 1 mark

Humans have been found to respond to the transmitter which plays a key role in the axolotl regeneration. However, many scientists consider it extremely unlikely the research will lead to any medical applications for humans.

f. Why might this research be considered by some scientists to have no practical use for humans? 1 mark

Question 11 (4 marks)

The whale shark is the largest known fish in the world with an average size of 7.6m long. It has distinctive markings and pigmentation patterns on its body as seen below. There are many hypotheses as to why these markings evolved. One hypothesis is that they are used for camouflage.



Source: Wikimedia Commons; Author: Zac Wolf

a. Explain how the whale shark evolved to have pigmentation patterns.

3 marks

Although whale sharks have a broad distribution shown below, there are no reliable estimates of current numbers. There has been a significant decrease in whale shark numbers leading to them being declared a vulnerable species.



Source: Wikimedia Commons; Copyright holder: TheEmirr

A female whale shark caught by fishermen was found to have over 300 live embryos in her uteri. Whale sharks reproduce by giving birth to live young that hatch from eggs within the uterus. Researchers genetically analysed the paternity of the embryos to find out if more than one male was the father.

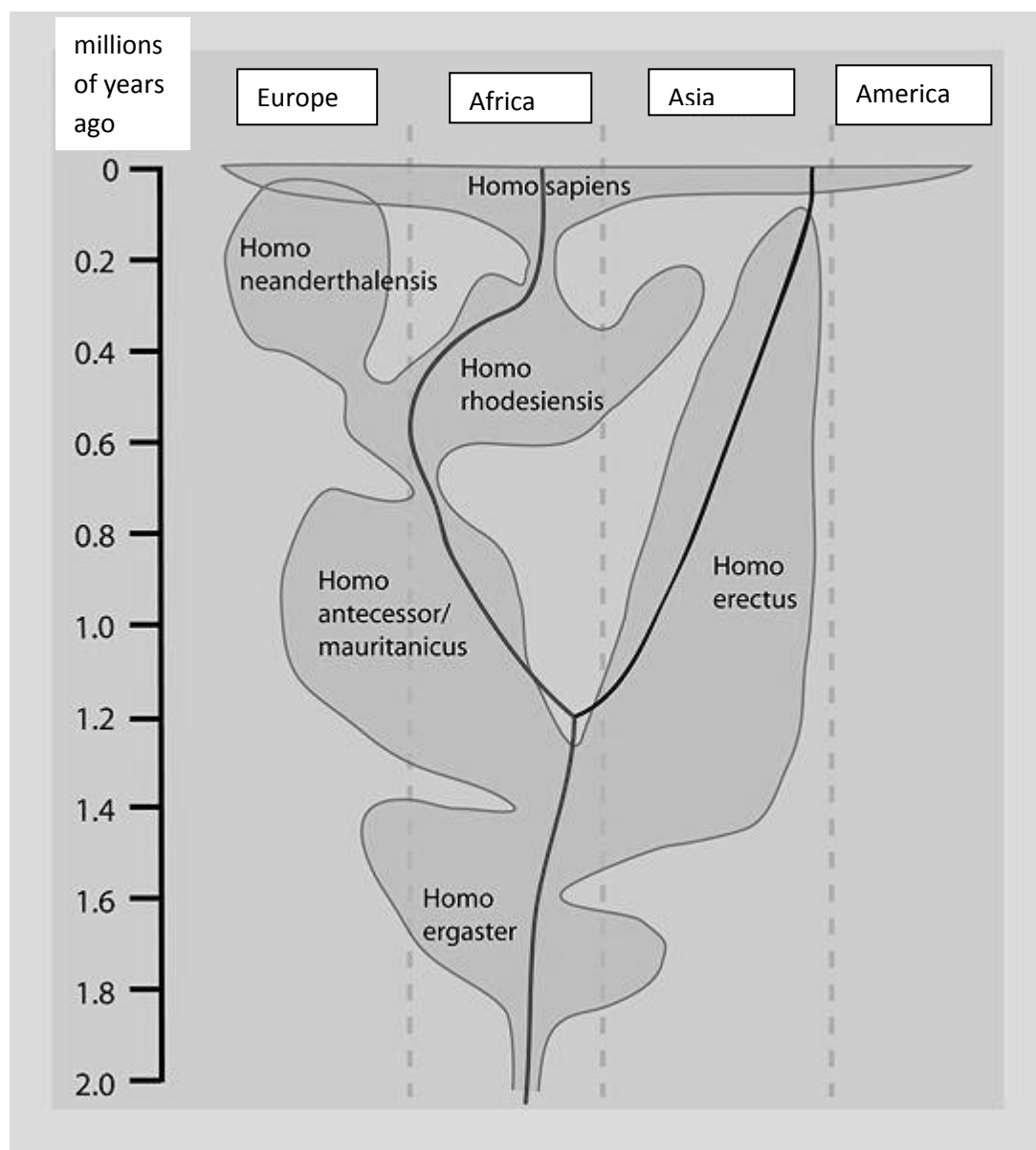
b. Explain why it is important to know whether or not the embryos had the same father.

1 mark

Question 12 (5 marks)

The fossil record provides opportunities for evolutionary biologists to formulate different theories as to the evolution of hominids.

The phyletic tree below shows one theory of hominid evolution including the proposed temporal distribution of each hominid species.



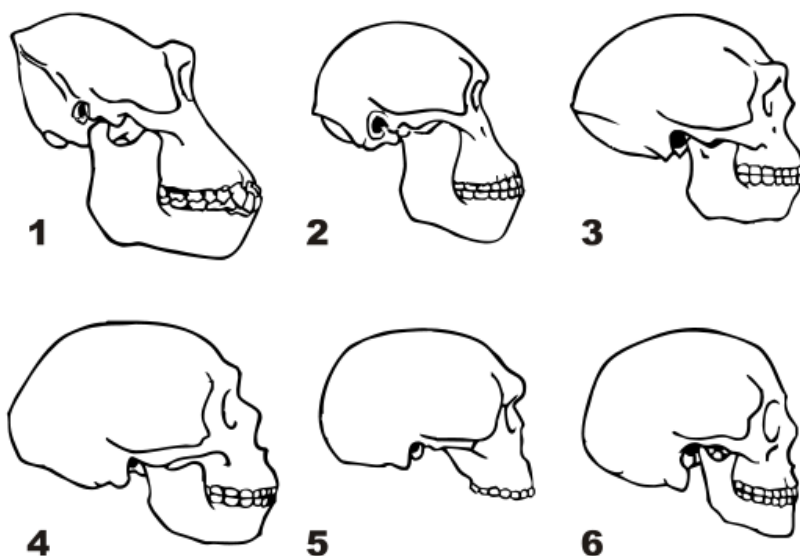
Source: Wikimedia Commons; Authors: Reed DL, Smith VS, Hammond SL, Rogers AR, Clayton DH

a. Why is the fossil record open to different interpretations?

1 mark

b. According to the above diagram, which species of hominid may have been in competition with *Homo rhodesiensis*? 1 mark

c. According to the phyletic tree, which important event occurred around 1.2 million years ago? 1 mark



Source: Wikimedia Commons; Author: user-Vladlen666

The diagrams above show various hominoid skulls.

d. Which skull is the one most likely to be that of an Australopithecine? Explain your choice.

1 mark

There has been evidence that the species skull number 3 belongs to displayed cultural evolution.

e. Describe evidence that has been found to deduce that cultural evolution occurred in this species. 1 mark

END OF QUESTION AND ANSWER BOOK

MULTIPLE CHOICE ANSWER SHEET**Name:.....**

Instructions: Circle the letter corresponding to the correct response for each question

- | | | | | |
|-----|---|---|---|---|
| 1. | A | B | C | D |
| 2. | A | B | C | D |
| 3. | A | B | C | D |
| 4. | A | B | C | D |
| 5. | A | B | C | D |
| 6. | A | B | C | D |
| 7. | A | B | C | D |
| 8. | A | B | C | D |
| 9. | A | B | C | D |
| 10. | A | B | C | D |
| 11. | A | B | C | D |
| 12. | A | B | C | D |
| 13. | A | B | C | D |
| 14. | A | B | C | D |
| 15. | A | B | C | D |
| 16. | A | B | C | D |
| 17. | A | B | C | D |
| 18. | A | B | C | D |
| 19. | A | B | C | D |
| 20. | A | B | C | D |
| 21. | A | B | C | D |
| 22. | A | B | C | D |
| 23. | A | B | C | D |
| 24. | A | B | C | D |
| 25. | A | B | C | D |
| 26. | A | B | C | D |
| 27. | A | B | C | D |

28.	A	B	C	D
29.	A	B	C	D
30.	A	B	C	D
31.	A	B	C	D
32.	A	B	C	D
33.	A	B	C	D
34.	A	B	C	D
35.	A	B	C	D
36.	A	B	C	D
37.	A	B	C	D
38.	A	B	C	D
39.	A	B	C	D
40.	A	B	C	D

SOLUTION PATHWAY**Answers to Section A: Multiple choice**

Question	Correct Answer	Explanation
1	B	The monomer of a polysaccharide is glucose and the berries are composed of polysaccharides.
2	D	Glycogen is stored in the liver and muscles of animals.
3	D	The phenome takes into account the genotype and phenotype including environmental effects.
4	A	The monomer of DNA is composed of a deoxyribose sugar, (the structure drawn), with a phosphate and nitrogenous base attached.
5	C	No internal organelles or structures are visible and there are no details to indicate it is parasitic.
6	D	The area where the light dependent stage occurs is in the grana.
7	B	Occluding junctions prevent movement of substances between cells.
8	A	Adding more enzyme will increase the rate of reaction as the substrate can be converted into product more quickly.
9	B	If the enzyme and substrate can not bind then no product can be formed.
10	C	How much food is consumed is voluntary.
11	C	Pheromones influence the behaviour of individuals of the same species.
12	D	Giberellins promote plant growth.
13	C	5. is indicating the myelin sheath.
14	A	Choline is used to manufacture acetylcholine - a neurotransmitter.
15	B	If nerve impulses can not cross from one neuron to the next then paralysis will result.
16	B	An antigenic shift occurs when more than one viral strain exists in an individual at the same time. This can result in the formation of a new virus.
17	D	Viral RNA is initially used to create proteins.
18	A	The cleared areas around each antibiotic disc indicate they are all

		equally effective.
19	C	Cytokine dysregulation results in inflammation explaining some of the early symptoms of Ebola.
20	C	Viral RNA must undergo reverse transcription to obtain a DNA copy to be used in PCR.
21	B	The rise in cases at this point results from previously vaccinated individuals experiencing a depletion of memory cells created by the first vaccination. They are therefore susceptible to being infected with measles.
22	C	The Aardvark shows 10 chromosomes hence $2N = 20$ as each chromosome has a homologous pair not shown in the diagram as stated in the information.
23	A	The differing number of chromosomes means that not every chromosome will have a homologous one to pair with during metaphase 1 of meiosis.
24	D	The photo indicates a section of one chromosome 22 has been added to one chromosome 9.
25	B	Crossing over occurs in meiosis in Prophase 1 which provides variation.
26	A	DNA replication occurs during interphase of mitosis.
27	B	An allele is an alternative form of a gene.
28	C	The cross to complete is $RRX^V X^V \times rrX^v Y^v$
29	D	Two genes are involved hence it is a dihybrid cross.
30	D	Mitochondrial DNA allows haplogroups to be detected.
31	B	Introns are removed as part of post-transcription modification.
32	A	Both a human gene and a plasmid have the same helix formation of double stranded DNA and replicate using DNA polymerase.
33	C	Fungi and Trichomonads share the most common recent ancestor.
34	C	rRNA is produced in the nucleus.
35	B	Homeotic genes control many genes that are responsible for the correct formation of body parts of an insect.
36	D	Microarrays are extremely useful for examining the expression of many genes but are expensive.

37	B	The child has common alleles with both the male and the female.
38	A	Polygenic inheritance results in a variation of phenotypes that can be plotted as a bell shaped curve.
39	A	Convergent evolution occurs when there is no recent common ancestor but the different species occupy a similar niche in their habitat.
40	B	Potassium-argon dating is the only method listed that can give an absolute age of a fossil that is 50 million years old.

Section B: Short answer questions**Question 1**

a.i) The diagram on the far right, the last in the sequence, should be circled. **1 mark**

ii). GHRP-6 is a hormone and thus is a protein with a quaternary structure. **1 mark**

b. Two of:

- Rough Endoplasmic Reticulum. Its function is to transport proteins around the cell.
- Golgi body/apparatus/complex. Its function is to package and transport proteins out of the cell.
- Ribosomes. The function is to provide a site for the synthesis of proteins.

1 mark for each of two correctly labelled structures and function.

c. The growth-hormone releasing peptide is a peptide hormone that is soluble in water and can not pass through the cell membrane. **1mark**

AND/OR

It therefore binds to receptors on the surface of a pituitary cell. **1 mark**

AND

This activates a second messenger (such as a G protein) **1 mark**

AND

This then triggers the re-release of growth hormone. **1 mark**

Maximum of 3 marks total.

d. The binding of GHRP to the appropriate receptors triggers the reactions that involve many substrates finally producing growth hormone. **1 mark**

Question 2

a. Muscle tissue would contain the largest number of mitochondria as they are the site of ATP production which produces energy. The muscles require large amounts of energy for respiration when they are being used by the individual running. **1 mark**

b. Structure A: enzyme (ATPase). **Function:** to catalyse respiration. **1 mark**

Structure B: cristae. **Function:** to increase the surface area available for aerobic respiration. **1 mark**

c.i) The Krebs cycle.

The substrate involved is pyruvate. The product is carbon dioxide. (Acetyl co-enzyme A is also acceptable).

(Acceptor molecules - NAD and FAD as substrates gathering Hydrogen atoms is also acceptable but the above information must also be included). **1 mark**

ii) glucose $\longrightarrow$ lactate (and water) **1 mark**

d. There are a small number of cheetahs in an isolated population that interbreed. The original individuals are not representative of the population they were isolated from. Inbreeding leads to reduced genetic diversity as allele frequencies change leading to genetic uniformity.

1 mark

Question 3

a. Difference 1: The vitelline membrane is multilayered while the plasma membrane is a (phospholipid) bilayer. **1 mark**

Difference 2: The vitelline membrane is mostly composed of protein while the plasma membrane is mostly composed of phospholipids. **1 mark**

b. Glucose crosses the vitelline membrane through simple diffusion. Glucose molecules travel from where they are in a high concentration of themselves to where they are in a low concentration of themselves across the membrane. **1 mark**

Glucose crosses the plasma membrane by the process of facilitated diffusion. Carrier molecules are required to allow the glucose molecules to pass through the membrane by diffusion. **1 mark**

Question 4

a. The effector is the anterior pituitary. This responds to the stimulus and leads to the increase of cortisol to alter the variable by releasing more or less ACTH thereby maintaining the cortisol levels. **1 mark**

b. There would be a build up of ACTH as there is no negative feedback occurring to prevent the anterior pituitary producing it. **1 mark**

c. The compression of nerves damages the neurons leaving them unable to send messages/transmit impulses across synapses required to elicit the appropriate responses normally leading to vision. **1 mark**

d. Biological factor: Ageing

Non- biological factor: Radiation/UV.

Any other appropriate examples.

1 mark for both correct

Question 5

a. human: host
mosquito: vector

1 mark for both correct

b. i) In the a.m time period the temperature increased to around 40.7 degrees Celsius. The individual would be sweating yet feeling alternately hot and cold. They may be shivering and feeling nauseous. (Any appropriate description of symptoms of a fever). In the p.m the individual's temperature decreased over time and the symptoms would also decrease in severity although their temperature only drops to 39.4 degrees Celsius so they would still be experiencing symptoms of a fever. **1 mark**

ii) It is an example of positive feedback as the high temperature leads to excessive sweating which promotes shivering causing the muscles to generate heat which then raises the body temperature further and increases sweating. Therefore the stimulus is enhanced by the response. **1 mark**

c. Four groups of people would need to be set up. One group would take a placebo for both the drug and the salt (or no drug and no salt) ie. the control group. Another group would take the drug but no salt, another would take no drug but take the salt, and the last group would take the drug and the salt. **1 mark**

Each group would have at least ten people in it. **1 mark**

OR

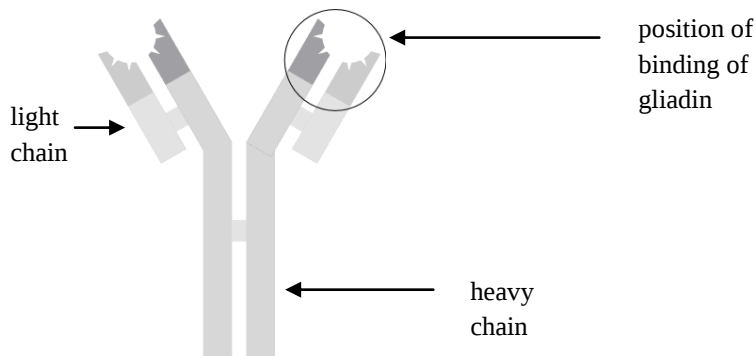
All other variables would be controlled eg. gender of individuals, weight, height, age. amount of drug, amount of salt...

(Either general statement or example)

1 mark

Record the results and repeat the experiment

1 mark

Question 6**a.**

Source: Wikimedia Commons; Author: Artur Jan Fikalkowski

1 mark for correct structure and 1 mark for correct labels

b. The helper T cells bind to the antigen-producing cell. This then promotes the B cells to create plasma cells which in turn produce antibodies. Memory B cells are also created.

1 mark

c. No gluten is eaten therefore no gliadin is produced. As there are no antigens being presented the AGA levels drop with time until no more is present.

1 mark**Question 7**

a. There is one gene pair involved. The gene is located on a non-sex determining chromosome. The heterozygote phenotype shows a trait that is a combination of the dominant and recessive traits.

1 mark

b. A frameshift mutation OR insertion.

1 mark**c.**

wild dog amino acid sequence	Ala-Ala-Ala
hairless dog amino acid sequence	Arg-Arg-Arg

1 mark

d. A different protein is produced that is non-functional.

1 mark**e.**

hairless	C	T	G	C	C	C	C	C	G	C	C	C	G	C	C	G	C	C	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>
mRNA	G	A	C	G	G	G	G	G	C	G	G	G	C	G	G	C	G	G	<u>G</u>	<u>C</u>	<u>G</u>	<u>G</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>G</u>	<u>C</u>
tRNA	C	U	G	C	C	C	C	C	G	C	C	C	G	C	C	G	C	C	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>	<u>C</u>	<u>G</u>	<u>C</u>

1 mark

f. mRNA attaches to the ribosome after it moves out of the nucleus.

A tRNA molecule that has a complementary anti-codon binds to the codon of the mRNA.

1 mark

A tRNA molecule carrying a specific amino acid binds its anti-codon to the complementary codon of the mRNA at the ribosome.

1 mark

This amino acid is then left at the ribosome while the tRNA moves away. Each amino acid is then joined and eventually the protein is produced. **1 mark**

Question 8

a. Inhibiting the electron transport chain results in a deficiency of ATP being produced by aerobic respiration. Therefore insufficient energy would be produced leading to death of the mite. **1 mark**

b.

Allele symbols

X^R : resistant mite

X^r : non-resistant mite

Phenotype of parents: partially resistant female x resistant male

Genotype of parents: $X^R X^r$ x $X^R Y$ **1 mark**

	X^R	X^r
X^R	$X^R X^R$	$X^R X^r$
Y	$X^R Y$	$X^r Y$

1 mark

There is a 50% (1/2) chance they will produce a resistant offspring. **1 mark**

c. Members of one mite population were geographically isolated from the other members. **1 mark**

The environments they lived in differed and therefore the two groups were subject to different selection pressures. One group was advantaged by the red colour and the other by the green. **1 mark**

As a result of the different selection pressures the two groups of mites developed different gene pools. If they were brought back together they would be unable to mate under natural conditions to produce fertile and viable offspring. **1 mark**

The answer must refer specifically to mites. A general answer must be fully correct and can only be awarded one mark in total.

Question 9

a. Autosomal dominant **1 mark**

b. i) A: has Porphyria Variegata; a: does not have Porphyria **1 mark**

ii) Individual A: aa

Individual B: Aa **1 mark**

c. This would stop the production of Heme as the enzyme and reaction pathway stops when no Porphobilinogen is produced. Therefore no Protoporphyrin is produced and the level of Porphyrin decreases. **1 mark**

d. Artificial selection OR selective breeding. **1 mark**

Question 10

a. They differentiate into different types of cells to regrow the missing limb. **1 mark**

b. This allows scientists to more easily see the cells of interest and they can track cell movements and interactions. **1 mark**

- c.i)** It would include genes with information to express a fluorescent protein in a particular type of cell. **1 mark**
- ii)** Cut a section of a plasmid with a specific restriction enzyme. Introduce foreign DNA with matching sticky ends into the plasmid. **1 mark**
Use DNA ligase to seal the sticky ends. **1 mark**
Introduce the plasmid into the axolotl using a specified method eg. bacteria. **1 mark**
- d.** There would be less likelihood of experimental error. **1 mark**
- e.** They share a common evolutionary ancestor (both are vertebrates). **1 mark**
- f.** Humans and axolotls have different genomes. **1 mark**

Question 11

- a.** There was initially variation in the population with some whale sharks having pigmentation and some not having pigmentation. **1 mark**
The whale sharks without pigmentation were more easily seen by predators and selected against and died. **1 mark**
Whale sharks with pigmentation survived and were able to mate and produce offspring with pigmentation. **1 mark**
- b.** The whale sharks are broadly distributed and their numbers are low. Having different fathers increases the genetic diversity of the population and increases the chance of the species surviving. **1 mark**

Question 12

- a.** There are gaps in the fossil record allowing different interpretations. **1 mark**
- b.** *Homo neanderthalensis* **1 mark**
- c.** The divergence from the common ancestor of *Homo erectus* and *Homo antecessor/mauritanicus*. **1 mark**
- d.** Skull number 2. It has a much smaller cranial capacity OR more protruding jaw AND has smaller teeth than skull number 1. **1 mark**
- e.** (Skull number 3 belongs to *Homo erectus*). Fire pits found near fossils / concentrations of charcoal and ash deposits found near fossils/ burned bones.
OR
Stone tools/ hunting tools found near fossils. **1 mark**