# BIOLOGY

## Units 3 & 4 – Written examination

## 2020 Trial Examination

## ***SOLUTIONS***

**SECTION A : Multiple-choice questions (1 mark each)**

**Question 1**

*Answer:* D

*Explanation:*

Structure X is a protein. The chemical structure of a protein is made up of amino acid monomers composed of carbon, hydrogen, amine group, carboxyl group and a variable R group

**Question 2**

*Answer:* C

*Explanation:*

Lipid soluble molecules are able to dissolve directly though the lipid bilayer via simple diffusion.

**Question 3**

*Answer:* C

*Explanation:*

The synthesis of proteins is anabolic and uses condensation polymerisation.

**Question 4**

*Answer:* B

*Explanation:*

ADP is the only option that does not have stored energy for use in metabolic processes within the cell

**Question 5**

*Answer:* C

*Explanation:*

The proteome is the complete set of proteins expressed by an organism in its lifespan. The genome is the complete set of genes.

**Question 6**

*Answer:* B

*Explanation:*

Both DNA and pre-mRNA contain non-coding DNA that is not used to manufacture polypeptides.

**Question 7**

*Answer:* C

*Explanation:*

Only DNA (molecule A) has complementary base pairing including thymine and deoxyribose as the sugar component. Only pre-mRNA (molecule B) has the base uracil and the sugar ribose.

**Question 8**

*Answer:* A

*Explanation:*

mtDNA is found in the mitochondria, tRNA and mRNA are both found in the cytoplasm.

**Question 9**

*Answer:* B

*Explanation:*

The light dependent phase of photosynthesis occurs in the grana where water is an input.

**Question 10**

*Answer:* D

*Explanation:*

The light independent phase of photosynthesis produces water, glucose, ADP $+P_i$ and NAD+ as a by-product.

**Question 11**

*Answer:* A

*Explanation:*

As the amount of alcohol is increasing it would be assumed that fermentation is occurring, and this would not be found in human muscle cells.

**Question 12**

*Answer:* A

*Explanation:*

The amount of ATP would increase throughout the experiment as glycolysis does not require oxygen to occur.

**Question 13**

*Answer:* A

*Explanation:*

Increasing the concentration of enzyme would increase the speed at which enzyme molecules are able to bind with their substrate. Increasing the concentration of substrate would not increase the speed at which the reaction occurs, but simply increase the amount of product produced.

**Question 14**

*Answer:* D

*Explanation:*

Competitive inhibitor molecules block the active site to prevent the enzyme from binding with the substrate.

**Question 15**

*Answer:* A

*Explanation:*

When producing a functional polypeptide, introns must be removed to ensure that the sequence only contains coding regions.

**Question 16**

*Answer:* A

*Explanation:*

Endocrine signalling occurs when hormones travel through the blood stream to reach their target cell, as estrogen is traveling to various regions this is the most appropriate response.

**Question 17**

*Answer:* C

*Explanation:*

Lipid based hormones are hydrophobic and therefore able to cross the plasma membrane to bind with an intracellular receptor site

**Question 18**

*Answer:* D

*Explanation:*

In some instances, B-memory cells are not life-long and require a booster shot in order to have active immunity against a particular antigen

**Question 19**

*Answer:* D

*Explanation:*

Herd immunity relies on many individuals being vaccinated to reduce the prevalence of the disease within the population, this reduces the number of people with the disease that non-vaccinated children come into contact with.

**Question 20**

*Answer:* C

*Explanation:*
IgE antibodies are associated with a hypersensitive immune response that occurs in an allergic reaction.

**Question 21**

*Answer:* B

*Explanation:*
B and T cells are involved in the third line of defence, and complement proteins are not cellular.

**Question 22**

*Answer:* D

*Explanation:*
It cannot be passive immunity as the individual is producing B cells in response to the antigen. The third line of defence involves the production of antibodies, not the second. This could be a natural or artificial response.

**Question 23**

*Answer:* A

*Explanation:*
Plasma cells are required in order to produce antibodies. Other cell types do not produce antibodies.

**Question 24**

*Answer:* B

*Explanation:*
Bispecific monoclonal antibodies have two different binding sites that allows them to agglutinate both T-cells and cancerous cells in order to stimulate an immune response.

**Question 25**

*Answer:* B

*Explanation:*
Missense mutations involving a substitution involving the first base of the Ser amino acid codon could be responsible for this change in genetic code that has resulted in Pro amino acid being produced. Other mutations would have a different effect.

**Question 26**

*Answer:* A

*Explanation:*
Translocation mutations in chromosomes result in the movement of a chromosome arm from one position to a position on another chromosome.

**Question 27**

*Answer:* C

*Explanation:*
As population 3 has low genetic diversity it is more vulnerable to the natural selection event outlined.

**Question 28**

*Answer:* A

*Explanation:*
3,2,4,1 order shows a gradual change in phenotypes over a period of time that increases in mutations progressively, with the phenotypes in one population linking the populations.

**Question 29**

*Answer:* D

*Explanation:*
Random mating would maintain genetic within a population. The founder effect would remove a section of the gene pool. Based on the data there no mutation occurred in this population. The population has undergone a population bottleneck due to genetic isolation and a chance event.

**Question 30**

*Answer:* A

*Explanation:*
Biogeography examines the location of particular species over a period of time and the environments in which they live.

**Question 31**

*Answer:* B

*Explanation:*
The *Banksia integrifolia monticola* and *Banksia integrifolia integrifolia* has the greatest amount of nucleotide pairing.

**Question 32**

*Answer:* C

*Explanation:*
Even though two restriction enzymes were added, only BamHI is able to produce a cut and therefore it is the only option that would produce two fragments of complementary DNA. Option D would produce more than two fragments.

**Question 33**

*Answer:* A

*Explanation:*
BamHI is the restriction enzyme that produces sticky ends for this segment of DNA that is best suited for a DNA ligation with a vector. HaeIII will cut, but only produce blunt ends which is less suitable.

**Question 34**

*Answer:* C

*Explanation:*
After 2 cycles of PCR, 4 strands would be present. After 3 cycles 8 strands would be present

**Question 35**

*Answer:* D

*Explanation:*
Neuraminidase inhibitors are used in antiviral drugs like Relenza to prevent the replication of viruses in other cells of the body.

**Question 36**

*Answer:* D

*Explanation:*
Despite being genetically modified in a laboratory the CRISPR tomatoes are not transgenic as DNA from another organisms has not been inserted. The selectively bred tomatoes are still an example of a genetically modified crop; however, this is not done in a laboratory.

**Question 37**

*Answer:* B

*Explanation:*
Due to hunting the population was reduced to a small number, resulting in a population bottleneck.

**Question 38**

*Answer:* C

*Explanation:*
The data presented indicates co-existence between the *Homo habilis* and *Homo erectus* at approximately 1.5-1.8 million years ago

**Question 39**

*Answer:* B

*Explanation:*
*Australopithecus africanus* does not exist until 2.4-3 million years ago and thus it would not have been a source of these footprints.

**Question 40**

*Answer:* C

*Explanation:*
Footprints are an example of a trace fossil

**SECTION B : Short-answer questions**

**Question 1 (5 marks)**

**a.** Sodium is a polar molecule and is unable to diffuse directly across the cell membrane

1 mark

**b.** Exocytosis

1 mark

**c.** Neurotransmitter in vesicles binds with cell membrane

1 mark

ATP energy is used to make a conformational shape change in the plasma membrane

1 mark

Neurotransmitter is released from the cell

1 mark

**Question 2 (13 marks)**

**a.** RNA polymerase

1 mark

**b.** The diagram would result in the production of lactase

1 mark

As the lactose molecule is present and bound to the repressor

1 mark

The operator region is free for RNA polymerase to commence transcription of *lacZ, lacY* and *lacA*

1 mark

**c.** The lac operon has both structural and regulatory gene components.

1 mark

The operator region is regulatory and the *lacZ*, *lacY* and *lacA* region are structural producing a protein.

1 mark

**d.** The code is degenerate as a single amino acid can by coded for by different codons

1 mark

If the mutation does not affect the amino acids in the polypeptude chain then the active site of the enzyme would still be functional and bind with the lactose molecule.

1 mark

**e.** mRNA binds with the ribosome and is fed through the structure.

1 mark

Codons are read by the ribosome and tRNA with a complementary RNA sequence is recruited to the ribosome.

1 mark

Condensation polymerisation of the amino acids at the ribosome results in the production of a polypeptide.

1 mark

**f.** The polypeptide enters the endoplasmic reticulum for polypeptide folding

1 mark

Further modifications and packaging into vesicles occurs at the Golgi

1 mark

The lactase molecule leaves the cell via exocytosis

1 mark

**Question 3(10 marks)**

**a.**

| | Letter of location | Input | Output |
|---|---|---|---|
| Electron transport chain | R | *Any of*<br>NADH<br>FADH<br>Oxygen | *Any of*<br>NAD+<br>FAD+<br>Water |
| Krebs cycle | P | *Any of*<br>NAD+<br>FAD+<br>Pyruvate | *Any of*<br>NADH<br>$FADH_2$<br>Carbon dioxide |
| Glycolysis | T | *Any of*<br>Glucose<br>NAD+ | *Any of*<br>NADH<br>Pyruvate |

1 mark per each correct row

3 marks total

**b.** An enzyme would assist in biochemical reactions within the mitochondria

1 mark

It would have a tertiary protein structure with an active site.

1 mark

**c.** Chloroplast

1 mark

**d.** A double membrane

OR

Presence of ribosomes that resemble bacterial ribosomes

OR

Any other reasonable response.

1 mark

**e.** Through the maternal line, from mother to offspring in the mtDNA

1 mark

**f.** Ethical – as a few viable cells are implanted during IVF there is an increased chance of twin or triplet births and if this is beneficial to the children being raised

1 mark

Biological – there is no guarantee that the offspring will not have the mutation as only low risk embryos are used, not no risk.

1 mark

OR

*Any other reasonable response*

**Question 4 (2 marks)**

a. A pheromone as the signal is being transmitted from one organism to another organism.

1 mark

b. The secretion of sap to act as a toxin against the organism trying to consume it.

Or

*Any other reasonable response*.

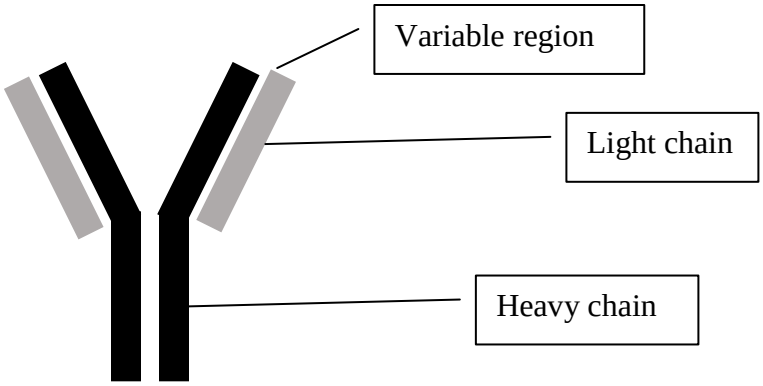
1 mark

**Question 5 (8 marks)**

**a.** Non-self antigens

1 mark

**b.**




1 mark light chain and label, 1 mark heavy chain and label, 1 mark variable region label

**c.** Release of cytokines
OR
Cell proliferation of more CD-8 T cells with complementary antigen-MHC-II receptors
OR
*Any other reasonable response*

1 mark

**d.** Individual A

1 mark

Has an autoimmune disease as indicated by the increased of CD-4 T over a period of time

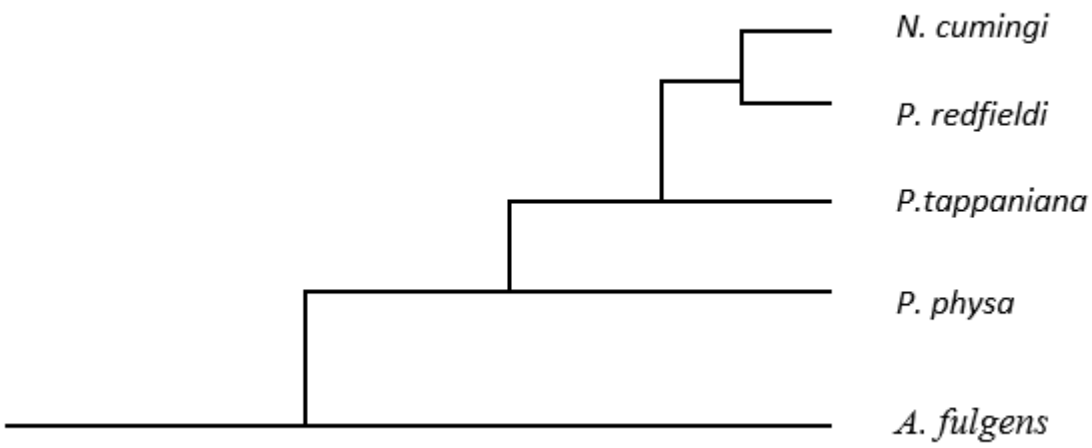
1 mark

**e.** This could be caused by a newly contracted infection.

1 mark

**Question 6 (11 marks)**

**a.** Phylogenic tree suggested diagram




1 mark tree drawn correctly, 1 mark labeled correctly

2 marks total

**b.** *N.cumingi* and *P.redfieldi*

1 mark

**c.** A small group of genotypically and phenotypically diverse individuals from the *A.fulgens* population migrated to Hawaii

1 mark

Selective pressures existed on the Hawaii island that were not present on the Oahu island and this resulted natural selection for different phenotypes over a period of generations

1 mark

The new population is no longer able to reproduce with the original *A.fulgens* population to produce viable offspring and this resulted in the new species *P.Physa.*

1 mark

**d.** Allopatric speciation

1 mark

**e.** A segment of DNA would be isolated from all 5 species using gene probes.

1 mark

All samples are heated to 95°C to break hydrogen bonds

1 mark

The individual strands of DNA from two species at a time are combined and allowed to cool to form hybrid DNA

1 mark

The hybrid DNA is then reheated and the temperature needed to separate these molecules is recorded. The hybrid DNA that has the highest temperature required to separate the DNA is the most similar and hence those species are the most closely related.

1 mark

**Question 7 (4 marks)**

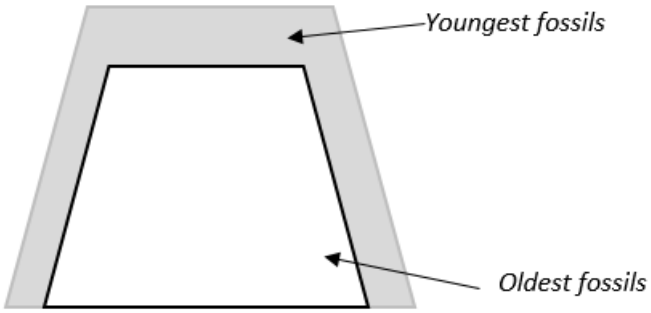
**a.** Animals falling in the cave reduced disruption from other organisms

OR

The constant temperature in the caves reduced the rate of decomposition of organisms

1 mark

**b.** Suggested diagram




1 mark

**c.** As the remains fell into a pile the oldest fossils would be found on the bottom of the pile and youngest at the top, however, there would be some spread of younger fossils over the sides of the pile as it would not be possible to conclude that these have not spilled over the edge as seen in the diagram.

1 mark

**d.** Humans used resources that the megafauna relied on

OR

*Any other reasonable response*.

1 mark

**Question 8 (8 marks)**

**a.** A chemical that is able to cut DNA at a specific recognition site of DNA

**b.**

i. To increase the amount of DNA present in the sample

ii. Free nucleotides

AND

Taq polymerase

OR

Primers

1 mark

**c.**

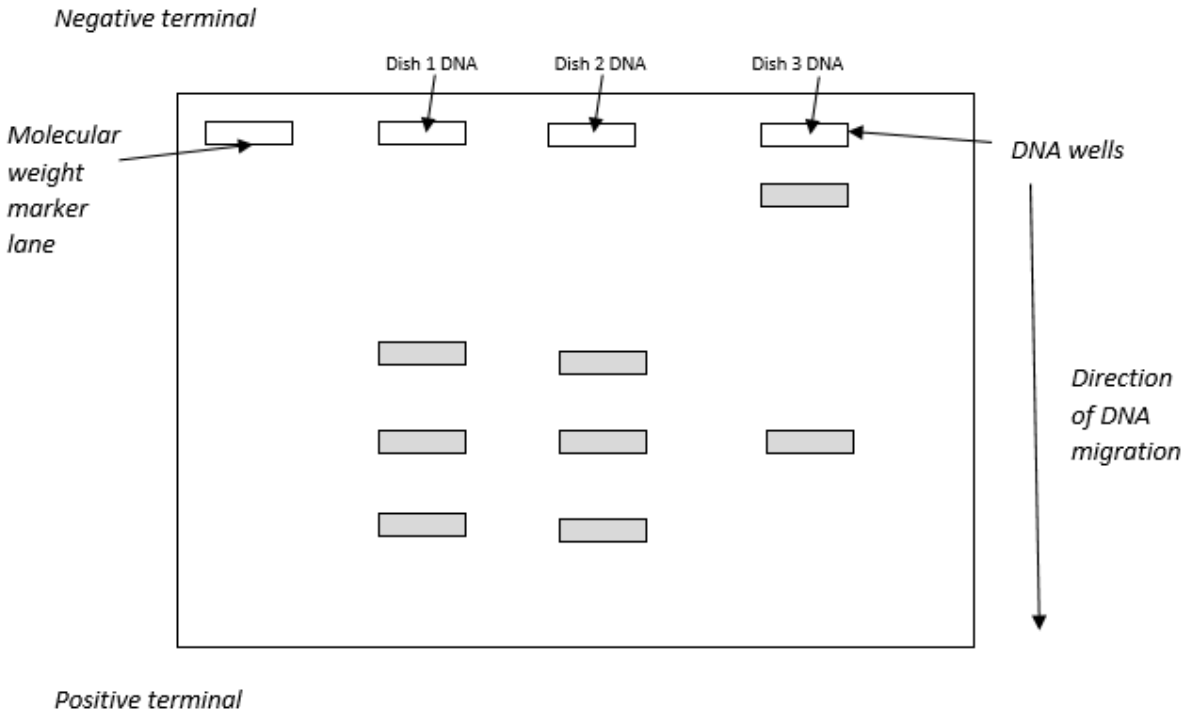
i. The recognition site for one of the restriction enzymes has mutated

1 mark

As the restriction enzyme is no longer able to cut the DNA fragment it has resulted in a larger single fragment of DNA shown in the gel electrophoresis

1 mark

ii.




1 mark labelled correctly, 1 mark for correct number of fragments for lanes 1 and 2, 1 mark for correct number of fragements and a larger piece of DNA for lane 3, with the bands matching the lane 1 or two sample.

3 marks total

**Question 9 (10 marks)**

**a.** Relative dating

1 mark

Comparing the age of the fossils based on their position in sedimentary layers with index fossils

1 mark

**b.** Bipedal foot and leg structure

OR

*Any other reasonable response*

1 mark

**c.**

i. Hominin A

1 mark

ii. Narrower pelvis

OR

*Any other reasonable response*

1 mark

Increased arch in the foot with greater metatasal angle to propel forward.

OR

*Any other reasonable response*

1 mark

iii. Being able to travel longer distances to increase food availability and resources.

OR

*Any other reasonable response*

1 mark

**d.** Having increased tooth surface area and ridges to grip meat

OR

*Any other reasonable response*

1 mark

AND

Having increased frontal lobe cranial space to accommodate higher order thinking to hunt and catch animals in groups.

OR

*Any other reasonable response*

1 mark

**e.** Evidence in the area of cut bone fragments or hunting tools indicating the hunting and consumption of animals.

OR

*Any other reasonable response*

1 mark

**Question 10 (8 marks)**

**a.** *sample answer (other answers also accepted)*

Set up 3 beakers with 20ml of lactase solution on heating mats at 30°C, 37°C, 45°C and one beaker with 20ml of lactase solution at room temperature.

1 mark

Record the glucose concentration and temperature of each sample using the glucose data logger and thermometer

1 mark

Add 40mls of lactose to each beaker and record the changes in glucose concentration

1 mark

Repeat the experiment 10 times to validate the results.

1 mark

**b.** The amount of lactase and lactose solution

AND

The concentration of lactase and lactose solution

OR

*Any other reasonable response*

1 mark

**c.** The response must match a variable outlined in part B

If the concentration of lactose solution was not maintained across the four beakers then there may have been an increase in the final amount of glucose produced that is due to increased substrate and not temperature.

OR

*Any other reasonable response*

1 mark

**d.** The enzyme would become denatured

1 mark

It would no longer be able have an active site that is able to bind with the lactose substrate in order to produce glucose and galactose.

1 mark