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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2024

BIOLOGY: PAPER I
MARKING GUIDELINES

Time: 3 hours

200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

1.1

COLUMN A**COLUMN B**

- | | | | |
|------------------|--|----------|-------------------------------|
| [I] | A new gene editing tool that edits specific regions of a DNA molecule. | A | Restriction enzyme |
| [D] | An artificially made DNA strand that has been created from genes taken from different species. | B | Hybrid vigour |
| [E] | An enzyme used to join two small pieces of DNA. | C | Plasmid |
| [G] | The technology used to create genetically identical copies of cells. | D | Recombinant DNA |
| [B] | When an organism displays improved features as a result of cross-breeding. | E | Ligase enzyme |
| [K] | The condition where a cell has more than two sets of chromosomes. | F | Cas 9 enzyme |
| [L] | An organism whose DNA has been altered using genetic engineering. | G | Cloning |
| [A / F] | The enzyme used to cut sections of DNA. | H | Polygenic |
| [H] | A phenotypic characteristic that is determined by more than two genes. | I | CRISPR |
| [C] | Small circular DNA used as a vector in genetic engineering. | J | PCR |
| | | K | Polyploidy |
| | | L | Genetically modified organism |

1.2

1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6	1.2.7
B	D	C	A	C	D	D

1.3

1.3.1	1.3.2	1.3.3	1.3.4	1.3.5	1.3.6
2	1	0	2	0	1

1.4 1.4.1 Dinaledi Chamber

1.4.2 *Homo naledi* disposed of / buried its dead.

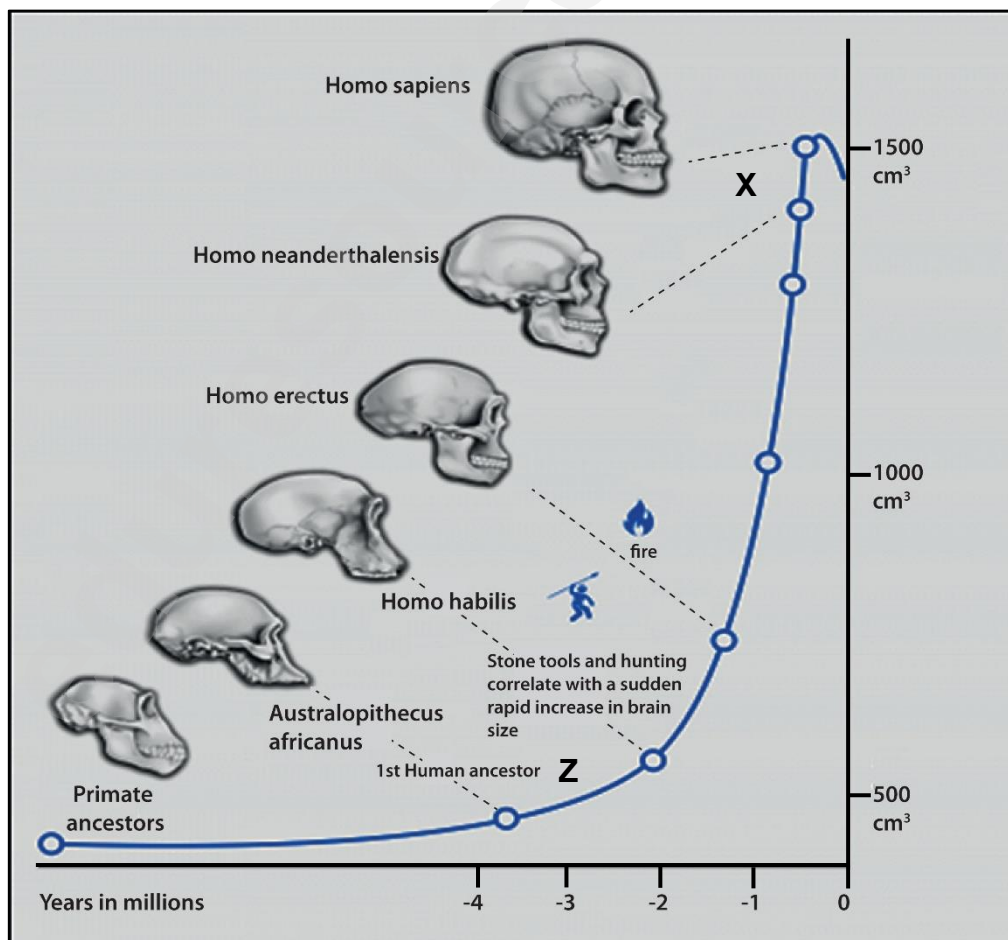
- 1.4.3 (a)
- Long legs / human like feet / big toe in line with other toes which were well-adapted for standing / walking / balancing / weight bearing on two feet / bipedal.
 - Hands / wrists similar to humans / long fingers / finger joints / wrist joint / opposable thumbs indicating powerful grasping / ability to use stone tools.
 - Small teeth less prognathism/smaller jaws for eating softer foods / cooked foods.

Any TWO well-explained (accept other correct fossil features)

- (b)
- The shape of the shoulders indicate climbing abilities.
 - Curved fingers good for climbing/grasping branches.
 - Smaller brain/reduced cranial volume / reduced cranial capacity / brain is the size of orange indicates that they were not as advanced / intelligent as *Homo sapiens*.

Any TWO well-explained (accept other correct features)

1.5 1.5.1



- (a) See X on the graph – can be placed anywhere between *H. neanderthalensis* and *H. sapiens*. *X can be placed on x-axis between 0 and -1.*
- (b) See Z on the graph – can be placed anywhere between *H. habilis* and *A. africanus*. *Z can be placed on y-axis between H.habilis and A.africanus.*

1.5.2 *H. erectus*

1.5.3 (a) Accept 540 – 570 cm³ **see final printout (must have unit to get mark)**

(b) Accept range of 1.8 mya to 2.2 mya **see final printout (must have mya unit to get the mark)**

1.5.4

- Larger cranial capacity / bigger brain therefore possibility of larger/more advanced brain made more advanced/sophisticated tool for hunting.
- Discovery of fire encouraged social cooperation/hunting in groups.
- **Accept any other suitable answer**
- **One well explained**

1.5.5 Mrs Ples/Taung child

1.5.6 (a)

- The foramen magnum has moved forward / is more centralised / under the skull;
- spinal cord / vertebral column directly / vertically under head.
- Any 1 x 2

- (b)
- Upright bodies expose a smaller surface area to the sun which reduces risk of overheating while hunting.
 - Upright bodies expose a larger surface area to air currents which causes cooling.
 - Hands are free to use tools / prepare food / hunt / fight.
 - Vision extends further over tall grass to look for food or to avoid predators.

Mark first one only

1.6 1.6.1 Using various biological processes within living organisms (to create products) to benefit humans.

Using technology (to create products) for human use/benefit.

1.6.2 (a) Modified varieties of sorghum / integrating multiple traits into the genome of a single sorghum plant / new varieties of sorghum enhanced with Vitamin A.

(b) This gene was integrated into the genome of the sorghum plant

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- 1.6.3
- The BCMO1 gene is extracted/cut using the restriction enzyme.
 - A plasmid from a bacterial cell is extracted and cut using the restriction enzyme.
 - The BCMO1 gene is inserted into the plasmid using ligase enzyme.
 - The plasmid is inserted back into the bacterial cell (where replication occurs).
 - The bacteria with the BCMO1 gene / the BCMO1 gene is inserted / the bacterium / plasmid acts as a vector to carry new gene into the cellular material of the sorghum plant.
 - The BCMO1 gene is integrated into the sorghum plant's DNA.

- 1.6.4 **Advantage** – High in protein / fibre / vitamin B / meet the nutritional needs of children.

Disadvantage – Lacks vitamin A/minerals such as iron and zinc.

- 1.6.5 (a) Will reduce blindness and deaths from infections for children under five years. The new variety contained more vitamin A/32 times more vitamin A / meet nutritional needs.
- (b)
- Not produced naturally.
 - Unethical to alter organisms/transfer genes between organisms.
 - May cause allergic reactions in humans/negative impact on human health side effects.
 - People are scared of the unknown effects of GM foods.
 - Goes against religious beliefs

Accept two

- 1.7 1.7.1 (a) Census

- (b)
- Too many bats cannot count correctly/may miscount them.
 - They fly too quickly thus cannot count correctly/may miscount them.
 - Mostly fly at night – too dark to see them.

Accept one well-explained reason or two facts listed.

- 1.7.2 (a)
- Inexpensive
 - Fast
 - Repeatable
 - Can count large numbers of moving organisms
 - Less chance of human error
 -

1.7.2 (b)

- Not all countries will have access to AI technology/any reference to lack in some aspect of AI.
- Lack of electricity

Accept any related answers.

1.7.3 (a) Natality

- (b) Bats roost in tall trees. Bats can sense the location of the tree by sensing the air currents around the tree. With an increase in wind turbines, bats confuse air currents around wind turbines with air currents from trees and get lost/cannot get back to nest, especially on days that are less windy. They may also approach the wind turbine to roost but are killed by the blades of the turbine.

Any 4 logical facts.

1.7.4 **Ecosystem** – decrease in dispersal of seeds could result in extinction of species decrease in biodiversity. has a negative impact on the food chain / affects predators that feed on them (Accept other ecology related answers.)

Economy – fewer tourists means less money for the country / decrease in economy.

QUESTION 2

2.1 2.1.1 mutation/s

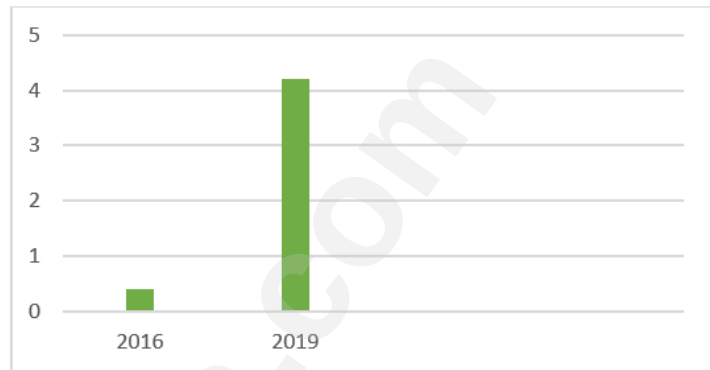
2.1.2 12,4% (**must have unit**)

2.1.3

Percentage of patients where ACT /drugs failed to clear malaria / parasites (%) OR

Success rate of anti-malarial drugs (%) OR

Drug parasite clearance rate (%)



Time (years)

- 2.1.4 (a)
- There is variation in the population of the parasite. Some are resistant to artemisinin while others are not.
 - Due to random changes/mutations in the *kelch 13* gene, some parasites survived to reproduce.
 - The (artemisinin) resistant gene was passed on to offspring / inherited.
 - Those parasites that were not resistant died out.
 - Over many generations, there was a higher frequency of parasites that were resistant (to artemisinin), creating a larger population of (artemisinin-)resistant parasites.

Any six logical points related to artemisinin-resistant *Plasmodium falciparum*

(b) Charles Darwin/Darwin

2.1.5

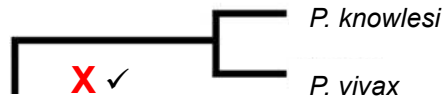
- The parasite did not change / the genetic makeup remains unchanged for 50 million years / for a long time
- Recently there were many mutations / the parasite evolved suddenly in a short period of time.
- Rapid changes in the parasite carrying the mutated gene
- Resistance developed quickly /suddenly/in a short time

2.1.6 *Plasmodium falciparum* had to adapt to its changing environment and this was not controlled by man.

2.1.7 The study was published in a journal / New England Journal of Medicine indicating that the results were peer reviewed before being published. **OR**

The study was done over a three-year period which gave the scientists enough of time to collect enough data to make comparisons/establish a consistent pattern in results.

- 2.1.8 (a) X can be placed anywhere on the line.



- (b)

STATEMENT	ANSWER COLUMN
<i>P. berghei</i> affects rodents only.	()
<i>P. gallinaceum</i> and <i>P. relictum</i> are closely related to each other.	()
<i>P. falciparum</i> causes malaria in monkeys.	()
<i>P. berghei</i> is more closely related to <i>P. chabaudi</i> than to <i>P. yoelii</i> .	()

- 2.2 2.2.1 (a) 'exchange of genetic material'

- (b) The complete set of genes/genetic makeup in an organism.

- 2.2.2 • **Shared anatomy** – similarities in anatomy/structures may be homologous due to shared ancestry.
- **Biogeography** – geographical distribution of organisms provide evidence of how species evolved.
- **Fossils** – shows extinct organisms and how evolutionary changes occurred in these organisms/how they compare to organisms that exist today / compare structures / look for similarities.

Any 1 × 2

- 2.2.3 (a) The Great Rift Valley has separated the giraffe populations into two groups. / The Great Rift Valley acts as a barrier separating the two giraffe populations. / The two giraffe populations remain isolated due to the Great Rift Valley separated by steep cliffs.

- (b)
- The population of giraffes are separated into two groups due to the presence of a geographical barrier. They are separated by the Great Rift Valley/steep cliffs.
 - The two populations are (reproductively) isolated and gene flow will stop.
 - Each group will start adapting to new environmental conditions.
 - Random mutations/new variations will occur within the two small populations.
 - Over time, an accumulation of these genetic changes will result in two new species of giraffe developing.

Any six logical steps.

- 2.2.4 There will be inbreeding due to the founder effect. This will reduce variation, create harmful mutations, poor quality sperm, inherited disorders, increase in homozygosity / increase in recessive genes which could result in extinction / decrease in survival / decrease in population size of the Masai giraffe.

Last fact on survival outcome is an essential fact.

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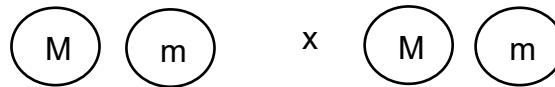
QUESTION 3

- 3.1 3.1.1 (a) phenotype
- (b) locus
- (c) amino acid
- 3.1.2 (a) A segment of DNA/sequence of nucleotides that codes for a protein / characteristic / trait /the basic unit of heredity passed from parent to child /genes are made up of sequences of DNA arranged, at specific locations on chromosomes.
- (b) $317 \times 3 = 951$
- 3.1.3 Autosomal – the gene coding for melanin occurs on chromosome 16/ not on the X or Y chromosome.
Recessive – melanistic cubs can be born to two spotted/normal parents / two genes required for melanism / each parent contributes one recessive gene each.
- 3.1.4 mRNA is straight / linear / not looped / not folded / many exposed bases = codons tRNA is folded / looped / 3 exposed bases = anticodon
- 3.1.5 (a) AUU GCG AGA
- (b) deletion
- (c) The guanine (G) from the second codon was deleted. This altered the entire sequence of amino acids from the point of deletion. The original sequence of amino acids was ile – **ala** – arg – leu – gly – pro but the new sequence of amino acids is ile – **gly** – asp – stop – ala. This results in altered protein structure / incorrect protein, which produces excess melanin
Essential fact = excess melanin production
Essential fact + Any three points
- 3.1.6
- The mRNA with the **MC1R gene** code arrives at the ribosome. The ribosome reads the chain of codons in the strand of mRNA.
 - tRNA picks up the relevant amino acid in the cytoplasm.
 - tRNA arrives at the ribosome with amino acid – codon on mRNA is complementary to anticodon on tRNA.
 - As amino acids are placed next to each other, peptide bonds form between adjacent amino acids, forming a polypeptide / protein / **production of melanin.**
- Essential fact – must relate to MC1R gene / production of melanin**
Essential fact + Any four logical steps.
- 3.1.7 Leopards are predators they are nocturnal / active / hunt at night; live in shaded forests; well-camouflaged prey will not easily spot them.

3.1.8 **Phenotype** –normal × normal

Genotype – Mm x Mm (this mark can be awarded below in punnet square)

Gametes – M or m x M or m



	M	m
M	MM	Mm
m	Mm	mm

All genotypes correct
on punnet square ✓

F1 genotype: 25% MM: 50% Mm: 25% mm

F1 phenotype: 75% normal leopards: 25% melanistic leopards

If a sex-linked cross is done, possible marks that learners can achieve:

- 1 mark for the correct punnet square
- 1 mark for correct interpretation of genotypes from the Punnet square

3.2 3.2.1 Rietvlei Reserve the bands/genes / DNA from the horn matches the pattern from Rietvlei Reserve.

3.2.2 **Yes,**

- poaching of rhinos has increased and they are endangered/ facing extinction.
- this can help us reduce poaching / stop the attempts made by smugglers / help in arrests conserve the rhino population / prevent extinction.

Accept any other suitable answer.

No,

- this process is expensive and not worth the effort since rhinos are still being poached.
- money could have more important use in research for well-being of humans / anti-poaching campaigns

Accept any other suitable answer.

Yes / No (no mark awarded) with one well-explained reason.

3.2.3 C

3.2.4 (a) PCR/polymerase chain reaction

(b) DNA polymerase/polymerase

QUESTION 4

- 4.1 4.1.1 **Population** – a group of organisms of the same species living in the same area that can breed with one another/produce viable offspring.
(max 2 marks)

Species – a group of organisms with similar characteristics or features/look the same that can interbreed and produce fertile offspring.
(max 2 marks)

OR Species does not include living in the same area whereas population includes living in the same area

OR Species includes production of fertile offspring whereas population does not include production of fertile offspring.

Accept definitions or differences between definitions.

- 4.1.2 Secondary, the area was used before / previously established community / soil was already present.

- 4.1.3
- More forest area is cleared to make way for more agricultural land / as more food is required / trees chopped down for land / trees chopped down for food.
 - More timber harvested / trees chopped down required for more charcoal / to provide more energy / more building requirements.
 - Burning more timber for charcoal/results in more uncontrolled forest fires.

Any 2 × 2

- 4.1.4 **No**
They recently auctioned off permits allowing for oil and gas exploration in untouched parts of the forest. Oil and gas exploration in untouched parts of the forest will decrease biodiversity/reduce size of forest / less trees.

The ban on logging will soon be lifted indicating that more trees will be chopped down/not conserved.

Accept other relevant explanations; reasons with explanations.

- 4.1.5 (a) clearing land for agriculture / cattle ranching / illegal logging
(b) 0,5 million hectares **(must have unit)**
(c) 2016 and 2021 **OR** 2017 and 2019 **OR** 2018 and 2019

- 4.1.6 **B**
There is a wide base / a high birth rate the DRC has a rapidly growing population. **(Text answer = Essential fact – must relate to growing population. Must not refer to low life expectancy/high death rate)**

4.2 4.2.1 interspecific

4.2.2 predation (predators) / lack of food / lack of vegetation to make nests / declining area / space (using land for agriculture)

Any 2

- 4.2.3 (a)
- A number of individuals are captured and marked in the first sample using a suitable method.
 - Individuals are released back into their environment.
 - After a suitable amount of time (up to 1 week), a second sample of individuals is captured and the total number of individuals is counted.
 - The no. of originally marked individuals in the second sample is counted and recorded.
 - A formula is used to estimate the population size.

Any four logical steps.

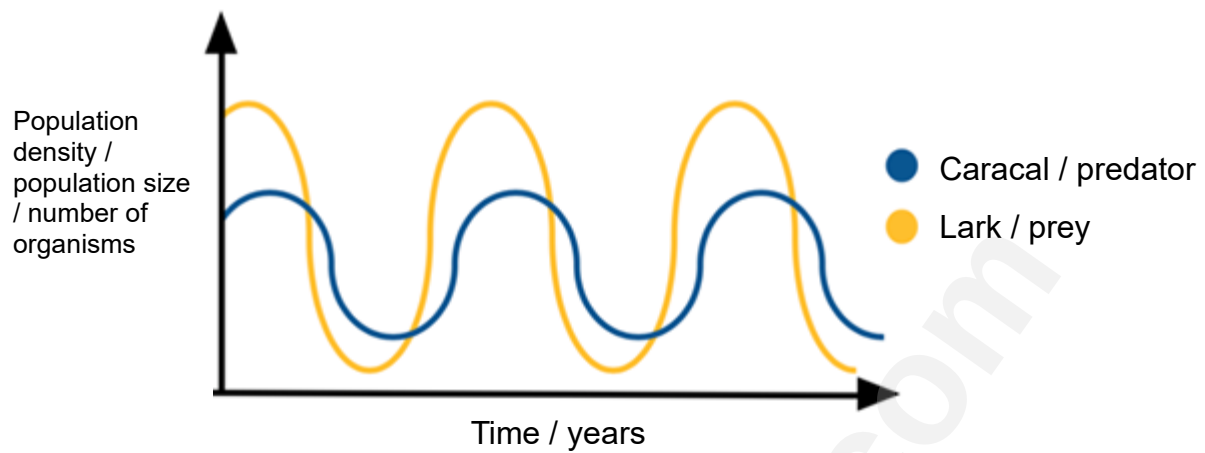
- (b)
- The mark must not damage / harm the organism.
 - The mark should be visible for the duration of the investigation.
 - The marking method must not affect the movement/behaviour of the organism.
 - The marked organisms should be allowed enough of time to mix freely with the rest of the population, before the second sample is taken.
 - The population must remain closed / no emigration and immigration should take place.
 - The period between the two sample captures should be brief, so that no births or deaths occur.

Any two

- 4.2.4
- Lack of vegetation meant that the nest could not be well camouflaged so eggs / chicks were eaten by predators.
 - Not enough vegetation for chicks to hide before taking flight, so the chicks were eaten by predators.
 - Lack of space / vegetation to build nests so they were vulnerable to predators
 - Not enough vegetation so could not find food therefore they will die

4.2.5 The adult larks aggressively defend their nest by mobbing in large flocks, squawking or flying at predators to chase them away.

4.2.6



- Y - y-axis title
- X - x-axis title
- T - both trend lines accurate – predator lower than prey and predator lags after prey
- K - correct key that matches the trend lines on graph

Total: 200 marks