



INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2023

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**

[G]	The observable physical characteristics of an organism.	A	Recessive
[E]	The alternative form of a gene.	B	Dominant
[B]	The gene that is expressed in a heterozygous organism.	C	Locus
[L]	The two strands that make up a chromosome after DNA replication.	D	Gene
[H]	The chromosome number in a somatic cell.	E	Allele
[J]	All the Thread-like structures composed of DNA and histone proteins in the nucleus of the cell.	F	Haploid
[D]	A unit of inheritance composed of DNA.	G	Phenotype
[F]	The ploidy of a gamete.	H	Diploid
[C]	The position of a gene on a chromosome.	I	Nucleotide
[A]	The gene that is not expressed in a heterozygous organism.	J	Chromatin
		K	Homologous
		L	Chromatids

1.2

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6
Answer	C	D	A	B	B	C

1.3

1.3.1 (a) CRISPR

(b) Genetically modified /GMO

1.3.2

Steps in Figure 1.3	Answer
Name the enzyme used in step 1.	Cas 9
Name the gene cut out in step 1.	EACMV-K201
Name the guide molecule.	gRNA/ guide RNA / RNA
Identify ONE gene that might have been added in step 2.	CMD1/CMD2/CMD3

- 1.3.3
- CMV leads to yellowing/ yellow mosaic pattern on the leaf/ wrinkling of the leaves / this has a negative impact on photosynthesis / decreased surface area of the leaf means less sunlight is absorbed limits the storage of starch in tuber
 - Severe stunting of the plant limits amount of nutrients stored
 - Rotting of roots reduces the number of tubers / smaller tubers / plant cannot absorb sufficient nutrients /plant cannot absorb sufficient water
 - Weak plant stem caused plant to easily break/ causes death of plant / less nutrients absorbed / less water absorbed

Accept ONE well-explained answer Look for cause and effect

First mark – identify the feature on the plant that is affected.

Second mark – effect of the feature on the plant / production of tubers

- 1.3.4
- USA has greater advancement in research and this benefitted Kenya and Uganda to achieve the desired results quickly
 - Any form of collaborative research in science is beneficial to countries like Kenya and Uganda who don't have as much access to top scientific research / proper facilities / equipment / technology / infrastructure
 - USA has resources, like money, to ensure that the research can be completed quickly
 - The scientists from Kenya and Uganda can benefit from the research done by the US scientists
 - **Any other suitable answer**

Accept ONE well-explained answer

1.4

1.4.1	1.4.2	1.4.3	1.4.4	1.4.5	1.4.6	1.4.7	1.4.8	1.4.9	1.4.10
A	A	B	B	B	A	B	C	C	C

1.5 1.5.1 nucleotides

1.5.2 Two unaffected / heterozygous / normal parents (1 & 2 / 5 & 6) produced an affected offspring / 4 /Ndasiata

1.5.3 (a) Aa
(b) aa

1.5.4 $1587 / 3 = 529$

1.5.5 A point mutation alters a specific gene by either an addition/ insertion, deletion or substitution of a nucleotide /nitrogenous base / change in base triplet This affects the structure of the protein / different protein produced as amino acids will be different/in a different order and functioning of protein will be altered.

Any four points

- Definition of point mutation
 - Effect on gene
 - Effect on amino acid
 - Effect on protein
- 1.5.6 The zebra has less melanin / she is mostly white therefore cannot easily camouflage / she is easily visible to predators / no protection against the sun
The zebra has poor eyesight therefore cannot easily find food / cannot see predators
- 1.6 1.6.1 A signal/display/action /sign to attract a mate/ for the purpose of mating
- 1.6.2
- The male examines the female's urine for the presence of sex hormones.
 - When high levels of sex hormones are detected the male approaches the female
 - Males display the 'musth walk' During this time, secretions are produced from swollen glands on their face/ urine dribbles from a greenish-appearing penis / frequent mating calls are made
- Accept any ONE of the above, well explained.**
- 1.6.3 progesterone
- 1.6.4 K-strategy only one calf is produced at a time / **high** level of parental care / long gestation period
- 1.7 1.7.1 (a) The soybean plant has a gene from a different species / foreign DNA /not naturally occurring DNA inserted into its genetic material/DNA/genome
OR The soybean plant contains a gene from a different species
- (b) pest resistance insect resistance
- (c) restriction enzyme
- (d) To join/insert/connect/bind/bond the favourable gene to the plasmid /molecule X
- (e) X is circular / ring/plasmid and Y is linear / chromosome
X has fewer genes and Y has more genes
Any one of the above
Mark first answer only
- (f) calcium / phosphorus
- (g)
- A larger yield can be achieved
 - Pest resistant crops
 - More nutritious crops
 - Disease resistant crops
- Mark one of the above; mark first answer only**

- (h)
- Potential harm to human health / any other health concerns e.g., possible allergies /side effects
 - Possible harm to the environment/any other environmental concerns
 - Negative impact on traditional farming practices
 - The technology is not natural / certain cultures / religions are against this technology

Mark any two of the above; mark first two ethical concerns only

1.7.2 (a) B

(b) X

(c) (i) sepal

(ii) protects the flower when still in a bud/ photosynthesis

- (d)
- Sticky to receive the pollen
 - Has hairs to trap pollen
 - Large surface area for insect to land
 - Flat surface for insect to land

Mark any ONE well explained

(e) R

QUESTION 2

- 2.1 2.1.1 (a) biodiversity
(b) (critically) endangered
(c) population
(d) habitat
- 2.1.2 They share the resources / display resource partitioning by using the same resources at different times of the day / using different parts of the same resource / using the same resource in different habitats / monkeys forage in the trees while hippos feed on the ground
- 2.1.3 Intraspecific competition
- 2.1.4 A / higher birth rate/ broader base on graph / lower life expectancy / narrow top part of the graph / smaller proportion of older people
- 2.1.5 Poaching/ illegal farming/ illegal oil mining/ urbanisation / construction / deforestation
- 2.1.6 **Yes**
- Saving the forest habitat means saving species from becoming extinct /saving endangered species
 - Helps the community as it provides more jobs
 - The initiative will reduce/stop the criminal activity
 - Helps the Ijaw people continue with their way of life / farming and fishing
 - Conserves the ancestral land of the Ijaw people
 - Altruistic behaviour / for the good of mankind to preserve biodiversity /preserve for future generations
- Any other suitable answer***
- No**
- There is too much criminal activity taking place for this small group of people to resolve
 - No matter how hard they try they cannot change what is taking place
 - Continuous criminal activity / habitat destruction will still result in extinction of species anyway
- Any other suitable answer***
- YES or NO (no mark) with ONE well-explained reason or two listed reasons***
- 2.1.7 The habitat destruction, caused by external factors e.g., humans will continue to happen regardless the size of the monkey population
- OR**
- No matter how big or small the population all of them will still be affected/lose their habitat.
- 2.1.8 Mortality / death

2.1.9 Yes

- It is aired on the Discovery channel /YouTube/DSTV/international TV, therefore ensuring that many people view /is popular / people will be more aware.

Any other suitable answer

No

- Not many people have access to the Discovery channel / YouTube / DSTV so don't know about the initiative / not aware
- The Discovery channel /YouTube/ DSTV are not accessible to (lack of technology, too costly, no data/wifi) / not popular with all people.

Any other suitable answer

YES or NO (no mark) with ONE well-explained answer

2.1.10 (a) She is committed to increase conservation leadership amongst African females

(b) This will mean more women in leadership / more women will be recognised / will be helping women in her community / women have previously been overlooked / overcome societal boundaries

2.1.11 They are exploring for oil, which is leading to further ecological disturbances / damage to the environment/ecosystem

2.2 2.2.1 B

2.2.2 They are scavengers This prevents rotting carcasses lying around / prevents spread of disease from rotting carcasses / no dead bodies lying around/breaks down carcasses for decomposers to return nutrients to the soil

2.2.3 $9 / 15 \times 100 = 60 \%$

- One mark for identifying 9
- One mark for division by 15
- One mark for 60 – no unit required

2.2.4 Direct method /census counted by an aerial survey / physical counting / no calculations used

2.2.5 Advantage

- vulture nests are difficult to access / too high up
- easier to count from aerial survey
- more accurate since physical counting versus estimations / gives more or less exact numbers
- is quicker

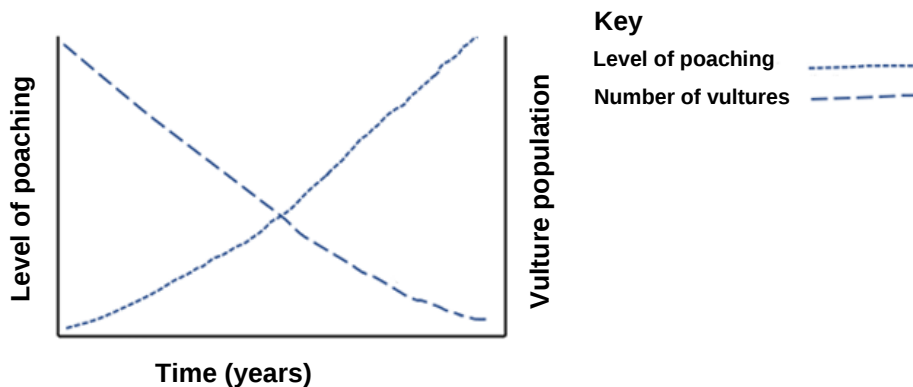
Any other reasonable advantage

Disadvantage

- nests may be hidden / camouflaged / harder to find, so not getting accurate number from aerial survey / human error
- takes long
- can be expensive

Any other reasonable disadvantage**ONE advantage and ONE disadvantage**

2.2.6



If graph goes up and down, look at the end of the two graph lines – trend must be correct

2.2.7 $29 + 9 = 38 \%$ (no units needed)2.2.8 **Yes**

The number of chicks with tracking units will indicate the potential future size of the population / can monitor immediately whether chicks are dead or alive / if chicks are still in the nest or not and work out size of populations / will gain valuable information on habits of chicks to implement policies to keep population numbers stable

any other explanation**No**

This is not a natural method and the tracking unit may impact on the vulture's movement / survival / **any other explanation**

YES or NO (no mark) with ONE well-explained answer

QUESTION 3

3.1 3.1.1 (a) Y (b) X

3.1.2 3 – cervix 4 – vagina

- 3.1.3
- Cultural norms / not used to a C-section / vaginal birth is all they know
 - Lack of autonomy in decision making
 - Level of education / not aware of C-section / scared of C-section
 - Women's lack of social status
 - Natural birth is the natural order of things
 - Any other suitable answer
 - Natural birth is cheaper
 - Lack of technology / lack of equipment/ lack of infrastructure for c-section
 - Longer recovery for c section

3.1.4 **Comparison between natural birth and C-section**

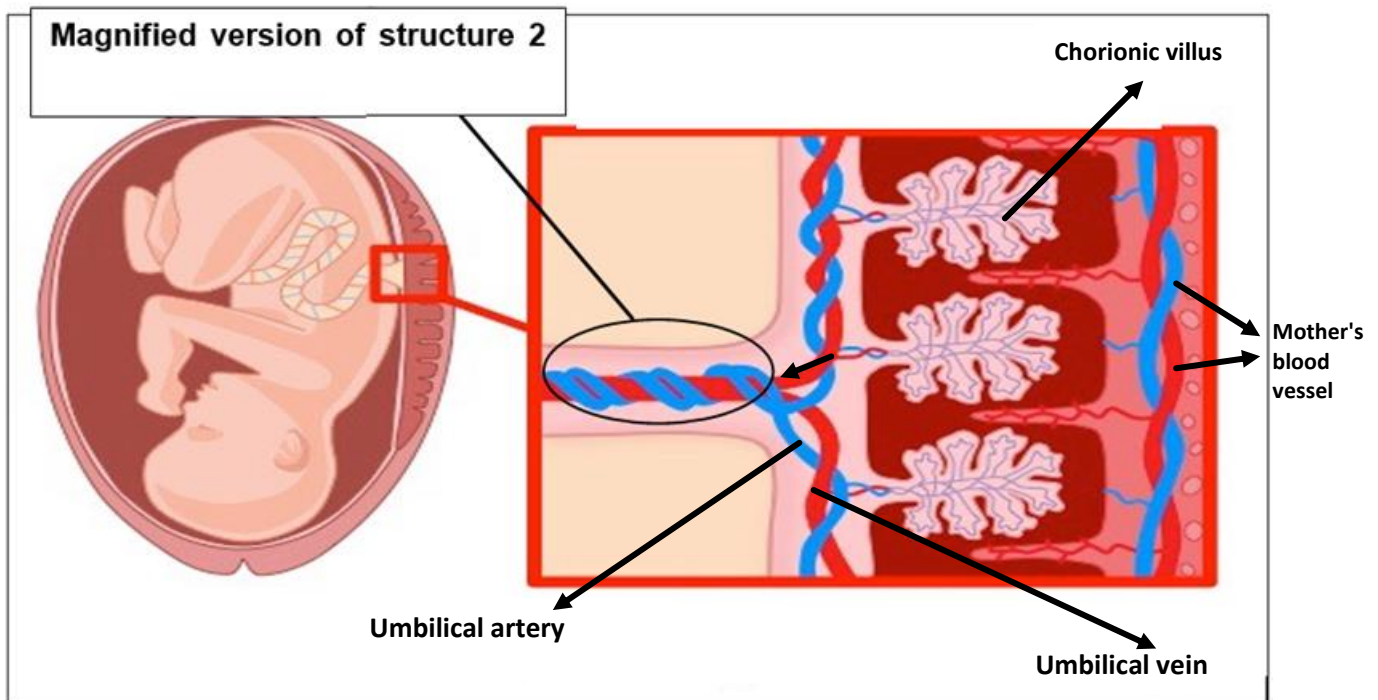
Natural birth	C-section
• Puts mother or baby at risk. • Results in more maternal deaths in Africa. • Baby can be delivered by a midwife. • No surgery needed. • Baby can be born at home. • Baby pushed out of vagina • Cervix dilates • Contractions of the uterus Any other suitable answer.	• Less risk to mother and baby. • Reduction in maternal deaths in Africa. • Obstetrician required. • Surgery required. • Must go to a hospital. • Baby born through cut made in the abdominal wall • No dilation of the cervix • No contractions of the uterus Any other suitable answer.

Heading**Any TWO related differences****Format with table headings**

3.1.5 6 3 5 1 4 2

If learner gets zero, mark correct sequence for a maximum mark of two i.e. mark two consecutive steps in sequence

3.2



3.2.1 See diagram:

- (a) blue is artery /a
- (b) red is vein /b
- (c) pink/white structures/c
- (d) any red /blue blood vessel on the placenta /d

3.2.2 Artery – CO₂ / deoxygenated blood, metabolic waste products e.g., urea, etc.

Vein – O₂ /oxygenated blood, nutrients e.g., glucose, vitamins, minerals, etc.

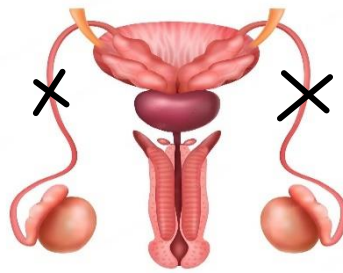
Any ONE for artery and any ONE for vein; mark first one for each.

- 3.2.3
- Allows exchange of substances between mother & foetus
 - Allows important nutrients/ oxygen to diffuse (exchange) from mother to foetus
 - Allows waste / carbon dioxide to diffuse from foetus to mother
 - Allows antibodies to pass (from mother) to foetus
 - Provides immunity against disease / infection.
 - Protects the foetus by preventing pathogens / toxins from crossing placenta.
 - Produces progesterone during pregnancy which maintains the endometrium

Any 2 × 2

- 3.3 3.3.1
- (a) A – prostate gland B – epididymis
 - (b) meiosis / spermatogenesis/gametogenesis
 - (c) testosterone

(d)



2 marks for any one side done correctly. Can be anywhere on the vas deferens

3.3.2 fallopian tube / oviduct

3.3.3 It is inexpensive / simple / effective/ men can control own fertility/ prevents conception/prevents pregnancy/method of contraception / quick process / not a major surgery
Accept any other suitable answer

- 3.3.4
- No knowledge of the procedure /lack of awareness
 - Cultural beliefs /religious beliefs
 - Afraid of stigma
 - Myth of reduction in sexual drive

Mark only the first answer

3.3.5 21.9% (**must have %**)

3.3.6 (a) Tanzania

- (b)
- The results were not collected in the same year
 - Cannot compare results if from different years
 - People not always honest in a survey /different answers on different days
 - People may be different ages, so might not have the same knowledge
 - Data has not been verified
 - Study was not peer reviewed

***Accept other suitable answers.
Any ONE***

QUESTION 4

4.1

	STATEMENT	TRUE / FALSE	CORRECT WORD
4.1.1	A child that is homozygous recessive for the condition will be <u>unaffected</u> .	False	Affected
4.1.2	The point mutation resulting in sickle cell anaemia is a <u>deletion</u> mutation.	False	Substitution
4.1.3	Sickle cell anaemia is an <u>autosomal</u> condition because the mutation happens on chromosome 11.	True	
4.1.4	Haemoglobin is produced during <u>protein synthesis</u> .	True	
4.1.5	CCU on the mRNA strand codes for the amino acid <u>proline (Pro)</u> .	True	

4.2

Normal red blood cell	Sickle red blood cell
Round /bi-concave	Sickle-shaped/half-moon shaped/ crescent shaped
Flexible	Rigid
Moves easily through the blood vessels	Moves slowly through the blood vessels / sticky so blocks blood flow
Normal haemoglobin	Abnormal haemoglobin

Mark first difference only / does not have to be in a table

4.3 longitudinal section

4.4 150 000 / 7 million = 2.14 /2.14285/2% (no unit needed)

4.5 11p15.5 / on top part of chromatid/chromosome 11

4.6

DNA nucleotide	RNA nucleotide
Thymine (nitrogenous base)	Uracil (nitrogenous base)
Deoxyribose (sugar)	Ribose (sugar)

Mark first difference only / does not have to be in a table

4.7 CCU GAG GAG

4.8 The (nitrogenous base) T was substituted/replaced with an A (max one mark if only speaks about substitution with no context) The amino acid glutamic acid (Glu) in the protein chain was replaced by valine (Val) (max one mark if only speaks about change in amino acid with no context) This change altered the structure of the haemoglobin being made and this altered the structure of the red blood cell **ANY four**

4.9 Flowchart showing transcription of the haemoglobin molecule in the nucleus.

The double-stranded DNA unwinds at the haemoglobin gene and hydrogen bonds break.

Free-floating RNA nucleotides are attached to the exposed DNA nitrogenous bases / DNA template strand by the action of RNA polymerase.

New hydrogen bonds are formed between complementary bases.

Once mRNA containing haemoglobin instructions is produced, it leaves the nucleus and travels to the ribosome.

Correct heading that makes sense

Only transcription (T) described in a logical sequence

Any 5 steps – one must be in context © of haemoglobin (otherwise max 4)

4.10 ribosome

4.11 (a) (i) Parental Phenotype: Heterozygous male × Heterozygous female
 Parental Genotype: Dd × Dd (can award this mark in the punnett square)
 Gametes:

	D	d			D	d
			X			
				D	d	
D				DD	Dd	
d				Dd	dd	

If sex linked punnett square was done, maximum ONE mark, only if entire punnet is correct with correct genotype for female ($X^D X^d$)

- (ii) **F1:**
 Genotype: 1 (25%) DD, 2 (50%) Dd, 1 (25%) dd / DD, Dd, Dd, dd
 Phenotype: 3 (75%) unaffected(normal), 1 (25%) affected / 1 (25%) homozygous dominant **DD**, 2 (50%) heterozygous **Dd**, 1 (25%) homozygous recessive **dd**
- (iii) Therefore 25%/1 in 4 / $\frac{1}{4}$ probability of the couple having a child with sickle cell anaemia

(b) They **should** have a baby:

Punnett square – There is a 75% /high probability of having unaffected children, therefore small/ 25% chance of having an affected child.

Own knowledge – If a sickle cell child is born, there is the possibility of treatment with a blood and bone marrow transplant Can get advice on how to emotionally deal with child Now with IVF, embryos can be preselected.

They **should not** have a baby:

Punnett square – There is still a small /25% chance of sickle cell anaemia

Own knowledge – any % too great a chance of having an affected child

- Rather adopt a child
- Debilitating disease / list symptoms from text
- Child dies at a young age / traumatic
- Treatments are still experimental
- Might not be emotionally ready

Should / Should not – with one valid reason

One mark for evidence from Punnett square

One mark for using own knowledge to support

4.12 More new-born genetic screening so that children can be diagnosed early/ treatment can be started early

OR there must be more education / awareness around the disorder so that parents know to check / screen before they have children

Total: 200 marks