



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

LIFE SCIENCES: 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**

[J]	DNA that has been combined from different biological species	A	Mitochondrial DNA
[H]	Circular DNA used as a vector in genetic engineering	B	Gonosomes
[E]	Position of a gene on a chromosome	C	Ligase
[I]	A phenotypic characteristic that is determined by more than two genes	D	Cloning
[B]	Chromosomes that determine sex	E	Locus
[A]	DNA that is only passed from mother to offspring through the ovum	F	Restriction
[C]	Enzyme used to join small fragments of DNA	G	Autosomes
[G]	Twenty two pairs of chromosomes in humans that are not sex chromosomes	H	Plasmid
[K]	An organism that has had its DNA altered or modified through genetic engineering	I	Polygenic
[D]	Technology used to create genetically identical copies of cells	J	Recombinant DNA
		K	GMO – genetically modified organism

1.2

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6	1.2.7	1.2.8	1.2.9	1.2.10
Answer	B	A	C	B	A	D	C	B	C	D

1.3

Item	Term	Answer
1. Ovary 2. Anther	Meiosis	C
1. Connects two chromatids 2. Found only in animal cells	Centromere	A
1. DNA replication 2. Cytokinesis occurs	Interphase	A
1. Extra X chromosome 2. Polyploid individual	Down syndrome	D
1. DNA profile 2. Indicates chromosome mutations	Karyotype	B

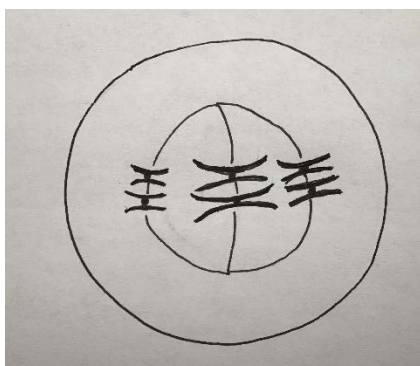
- 1.4 1.4.1 A – chiasma / chiasmata / crossing over✓ of chromatids
 B – spindle / spindle fibre
 C – bivalent / homologous pair / homologous chromosomes / homologues

1.4.2 Prophase 1

1.4.3 Crossing over / exchange of genetic material

1.4.4 Allows for genetic variation / genetic diversity
 Allows for non-identical gametes/chromosomes to be formed
 Swapping of alleles or genes / allows species to change with a change in environment (*any 1*)

1.4.5 **Diagram of cell in metaphase 1**



6 double-threaded chromosomes
 Chromosomes (correctly aligned) at equator
 (3) pairs of chromosomes

1.4.6 Three

1.5	Statement	A, B or C
1.5.1	<i>Triticum turgidum</i> is a hybrid of two grass species.	A
1.5.2	The hexaploid ancestor of bread wheat originated before humans were involved in agriculture.	B
1.5.3	The modern bread wheat genome is composed of 42 chromosomes.	C
1.5.4	A hexaploid has double the chromosome number of a diploid.	B
1.5.5	The ancestral grass species, <i>Aegilops tauschii</i> has two copies of each chromosome, i.e. diploid.	A

1.6 1.6.1 Nucleus / mitochondrion

- 1.6.2 No direct contact with elephant
Elephant dung easy to find
Elephants produce lots of dung
No harm to elephant (*any 1*)

1.6.3 PCR / polymerase chain reaction

- 1.6.4 Breed with one another
Gene flow present
Same ancestors / descended from a common ancestor
Same population
Experience same selection pressures (*any 1*)

- 1.6.5 Does not code for the production of proteins
Highly variable / different for individuals
Lies between genes / coding DNA on chromosomes
Used in DNA profiling (*any 2*)

- 1.6.6 Reason and discussion must match – the following are examples of valid answers:
Can identify area where most poaching takes place can focus efforts on preventing poaching in that area
Can identify elephants that have been poached allows for successful prosecution
Adds value to science can track breeding / evolution of elephants
Accept other reasonable suggestions.
(2 Reasons; each discussed)

1.7

	Statement	True or False
1.7.1	Divergent evolution is shown in the diagram.	True / T
1.7.2	All species have a horn.	False / F
1.7.3	B became extinct before A.	False / F
1.7.4	E is not extinct.	True / T
1.7.5	F and G share a more recent common ancestor than E and F.	True / T
1.7.6	D was present and living on earth for more than 10 million years.	False / F

- 1.8 1.8.1 $A \text{ to } B = 38 \text{ (mm)}$ (acceptable range 37-40 mm)
 $0,5 \text{ (mm)} = 10 \text{ (mm)}$ (acceptable range 9-10 mm)
 $38 \text{ (mm)} \times 0,5 \text{ (mm)} / 10 \text{ (mm)}$
 $= 1,9 \text{ mm}$ (method mark and final mark can still be awarded if values incorrect, but correctly used)
(Answer must include unit. Accept range)
(Check measurements on final printed copy.)
- 1.8.2 Soldiers protect colony
Workers collect food / build nests / look after young
Have different roles / are different castes
(any 2)
- 1.8.3 Queen lays egg / king mate with queen / winged reproductives (allates) start a new colony
- 1.9 1.9.1 Four apelike features:
Long arms
Small cranium
Sloping forehead
Curved fingers
Large jaw
Large brow ridges
Protruding snout / prognathous jaw / sloping face / less prominent chin
Narrow rib cage at the top
Flared hips
Angled clavicle
Prominent zygomatic arch
Prominent sagittal crest
Divergent big toe
Cranial crest/ ridge
(accept any 4)
- 1.9.2 Cradle of humankind / Malapa
- 1.9.3 (a) B
(b) Bipedal organism
- 1.10 1.10.1 C ; A ; B
- 1.10.2 (a) Pioneer
(b) Climax community

QUESTION 2

2.1 2.1.1 Any 2 of the following:

- DNA double stranded, RNA single stranded
- DNA never has uracil, RNA never has thymine
- DNA longer molecule, RNA shorter molecule
- DNA has deoxyribose sugar, RNA has ribose sugar
- DNA is helical, RNA not helical

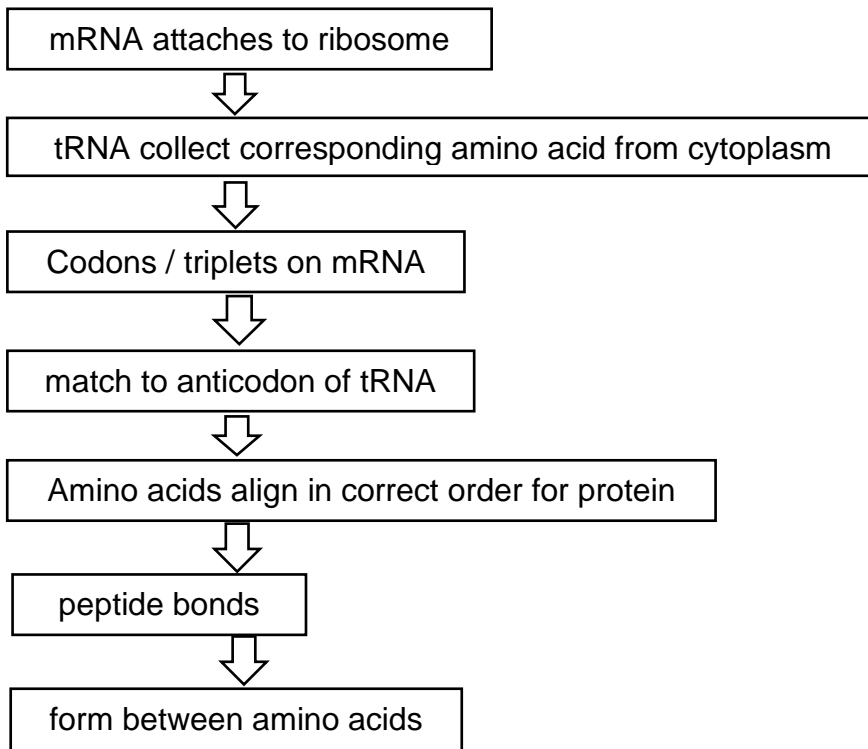
2.1.2 Transcription

2.1.3 Nucleus / nucleoplasm

2.1.4 (a) UGU GGA CUC

(b) Cys Gly Leu (carry over error from 2.1.4 a)

2.1.5

*(Arrows) + (5 facts in correct order)*2.1.6 $147 \times 3 = 441$ 2.2 2.2.1 **Table showing differences between normal red blood cells and sickle cells**

Red blood cells	Sickle cells
Soft and flexible	Hard
Break down after 120 days	Break down after 16 days
Normal haemoglobin / no strands	Abnormal haemoglobin / contains strands
Biconcave shape	Sickle shape
Flow freely in vessels	Block blood flow in vessels

(Heading) + (column headings) + (3 correct differences)

2.2.2 P_1 Nn X Nn (parent genotypes can be marked in Punnett square if this step omitted)

F_1

	N	n
N	NN	Nn
n	Nn	nn

Punnett square correct

75% / 3 no sickle cell : 25% / 1 sickle cell

[If parental genotypes incorrect,
carry error forward and mark Punnett square accordingly. No marks for ratio. (max 2)]

- 2.3 2.3.1 (a) True / T
(b) True / T
(c) False / F
(d) True / T

2.3.2 Test effectiveness of therapy
Check if unknown side-effects
Check if correct part of genome targeted
Statistical data required
Monitor long-term effects
No testing can be dangerous to patients
Confirm results of non-human trials
Determine if side effects acceptable vs potential benefit
Accept other reasonable answers.

- 2.4 Variation in presence of sickle cell mutation in population
Individuals with sickle cell mutation resistant to malaria
More likely to survive
Reproduce
Pass recessive mutation / trait onto offspring
Over time
Carriers more prevalent in population
5 good facts

QUESTION 3

- 3.1 3.1.1 Organisms with similar characteristics / look similar / genetically similar
able to breed with one another
and produce fertile / viable offspring
- 3.1.2 Sympatric found in same area / not geographically isolated
- 3.1.3 Pollen placed on different position on the fly's body / No gene flow between plants
as pollen cannot be transferred between different forms of plant
No reproduction can take place (no seeds can be formed)
No intermediate species / flower sizes
(max 3)
- 3.1.4 Small changes
little change to floral tube
Over a short period of time
only 15 years
Accept 2 facts or 1 well explained.
- 3.1.5 (a) $677 \times 560 / 35 = 10\ 832$
- (b) Use of non-toxic paint
Enough time given for beetles to mix freely with the rest of the population
Short period of time between sampling to reduce numbers of births / deaths
Repeated several times over 5 years
Large sample size
(any 2)
- (c) Not counting every individual
Using a random sample
Estimate population size / using a formula to estimate size
(any 2)
- (d) If the numbers collected remained similar / consistent
Suggests maximum number of beetles that environment can support has been reached
Food, living space, water has limited size of population
Numbers fluctuate around a consistently high level
Variation in ages of beetles
Consistent source of food
Don't see many dead beetles
Can calculate how much food/living space a beetle requires
(any 3)
- 3.2 3.2.1 (a) Groups of different species / organisms that interact with each other and the environment
- (b) Groups of same species in same area that are able to breed freely with one another (max 2)

- 3.2.2 Source of food for fish
Protect young fish / acts as nurseries
Food source for urchins
(Any 2)
- 3.2.3 Amount of food
Predators
Disease
Living space
(Any 3)
- 3.2.4 (a) Sea urchin
(b) Sea otter
- 3.3 3.3.1 6 / 7 / m² / per square meter
Check final answer on printed copy
- 3.3.2 Otters eat more sea urchins
Sea urchin numbers decline
Eat less kelp
- 3.4 Otters are keystone species (*must have this point*)
Presence of sea otters allows for more biodiversity
Greater distribution / larger kelp forests
Sea urchin numbers controlled
Greater diversity of fish
(Any 3 reasons)
Accept other suitable suggestions.

QUESTION 4

- 4.1 4.1.1 When a trait is determined by one pair of alleles
Characteristic determined by one gene
Cross between two pure breeding parents
One characteristic passed from one generation to the next
- 4.1.2 Dominant alleles show their effect even if the individual has only one copy of the allele / homozygous or heterozygous form / dominance masks recessive gene, e.g. tall / green seedpod / round seed
Recessive alleles only show their effect if the individual has two copies of the allele / homozygous form masked by dominant genes, e.g. dwarf height / yellow seedpod / wrinkled seed
- 4.1.3 Based on empirical observable data, i.e. seed colour.
Used thousands of plants / repeated his experiments / completed over many years making his data reliable / making sample number larger.
Got consistent results making his conclusion valid.
Objective ✓ as results were based on empirical data.
His results could be verified if other scientists repeated his experiments.
Systematic as followed an organised plan in collection and analysis of data.
Started with pure breeding parents easy to determine dominance.
Precise as was using exact numbers.
Accept other reasonable suggestions.
3 Reasons and each explained.
- 4.1.4 (a) Different to current beliefs scientists were not using statistics
- (b) Preconceived ideas of the time may influence whether work is accepted
New findings can influence that a fact that was once rejected, can now be accepted
Scientists can be influenced by the ideas of society at the time
Lots of competition in science
May refute another scientist's work
Scientists are slow to accept new ideas
Scientists need to test extensively to accept; requires critical thinking – takes time
(any 2)
Accept other reasonable suggestions.
- 4.2 4.2.1 Use of land
Use of water
Produces greenhouse gas emissions

- 4.2.2 More likely to have increased irrigation of crops
Use of machines in agriculture produce emissions
Increased food wastage
Amount of food eaten is greater
Increased demand for out of season foods
Food transported over greater distances
Eating more processed foods extra packaging on foods
Wealthy population so can spend on technology
(max 2)
Accept other reasonable suggestions

- 4.2.3 **No.**
Agriculture already consuming 70% of water
Would lead to more greenhouse emissions
Increasing climate change effects
Pollution levels increase
Temperature increases past critical thresholds
Crops not able to adapt to such changes
Decline in 8 major crops in Africa expected
Changes in rainfall patterns
Affect where crops can be grown
Less available land due to rising sea levels
Changes in river flow / ground water affect agriculture
Requires increased use of land

OR

- Yes.**
Humans developing GMO crops
Improves crop productivity
Reduces production costs
Reduces climate change effects
Lowers pesticide usage
Higher yields of food expected
Less space would be required to plant crops
Conserving biodiversity
Reduces CO₂ emissions or greenhouse gases
(max 5)
Accept other reasonable suggestions.

- 4.3 4.3.1 Fossils of *Australopithecus afarensis* found in same sediment layer
Age of footprints similar to *Australopithecus afarensis*
Toes parallel and in line
(max 2)
- 4.3.2 Ape-like – toe more divergent
Human-like – big toe aligned with other toes

4.3.3 Heritage site

Showing early evolution of hominids

Provides more information on *A. afarensis*

May indicate if individuals were bipedal

Open to elements so plan must be made to protect from erosion

Tourist attraction

May be a source of revenue

Suggests to public the importance of evolution

Oldest hominin footprints found in the world

New technology may arise to evaluate the footprints in a different way

(max 2)

Accept other reasonable suggestions.

- 4.4 4.4.1 To determine whether Laetoli individuals walked with a more human-like bipedalism / ape-like movement

OR

To investigate if toe depth can determine bipedalism

4.4.2 Toe depth

- 4.4.3 Laetoli more similar to normal human walk as toe depth of Laetoli close in value to normal walk of humans

OR

No certain conclusion can be drawn as Laetoli toe depth not similar to normal walk of human or bent-knee, bent-hip of ape-like movement

4.4.4 No

Humans don't naturally walk with an ape-like movement therefore footprints won't accurately depict this movement

Laetoli individuals had shorter legs than humans so walking movement and footprints would be too different

Laetoli individuals walked in ash experiment requires walking in sand

Humans and Laetoli individuals had different masses and so would have different toe depths

OR

Yes

Carried out by scientists / university so would follow scientific process

Published in journal so results peer reviewed

(max 2)

Accept other reasonable suggestions.

Total: 200 marks