NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2021

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
[H]	Improved features in an organism as a result of cross breeding	A	Sex-linked trait
[A]	A characteristic that is influenced by genes on a gonosome	B	Heterozygous
[E]	A section of DNA that codes for a protein	C	Mutation
[B]	Having two different alleles for a particular gene	D	Locus
[J]	An organism whose DNA has been altered using genetic engineering techniques	E	Gene
[I]	Diagram to show the relatedness between individuals over generations	F	Polyploid
[K]	The exchange of genes between homologous chromosomes	G	Diploid
[C]	A random change in the structure of a gene	H	Hybrid vigour
[D]	The physical site of a specific gene on a chromosome	I	Family pedigree
[F]	The condition in which a cell has more than two copies of each chromosome	J	Genetically Modified Organism
		K	Crossing over

1.2

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

1.3

Item	Term	Answer
1. Organisms that look similar 2. Organisms able to breed with each other and produce fertile offspring	Species	B or C
1. Distribution of similar species on different continents 2. Sympatric speciation	Biogeography	A
1. Inheritance of acquired characteristics 2. Law of use and disuse of body structures	Darwin	D
1. Limited gene flow 2. Geographic isolation of a small group of individuals	Founder effect	C
1. Inbreeding 2. Share a common ancestor	Divergent evolution	B

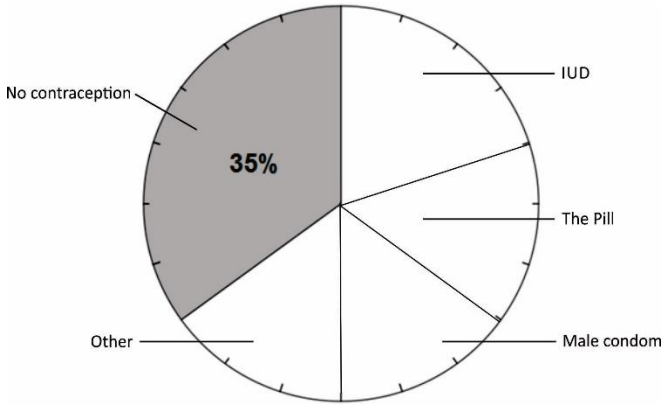
1.4 1.4.1 IUD / intra-uterine device.

1.4.2 doesn't require daily reminders / very convenient
lasts a long time before replacement / long term reliability
women can take full control of their own fertility
the OCP can have bad side effects
can lead to lighter / less painful periods
doesn't interfere with medicines / antibiotic use
IUD more effective than OCP/ IUD 99% effective vs 93% effectiveness in OCP
OCP can cause cancer

1.4.3 SA has high HIV/AIDS rate reduces transmission of STDs/HIV cheap / cost effective / free method
Readily accessible / easily available from clinics, etc.
easy to use
condom use heavily promoted / awareness campaigns in SA

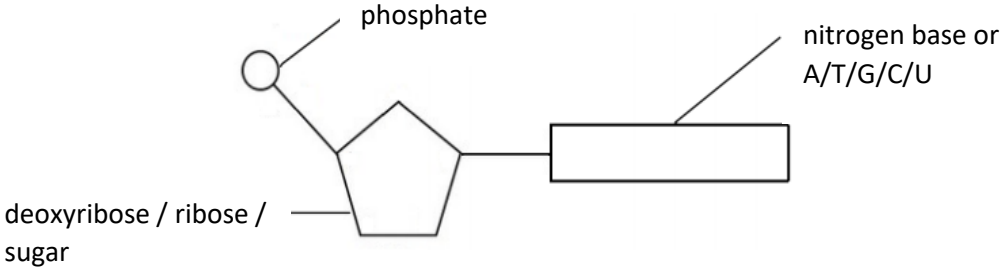
1.4.4 Rhythm method spermicide diaphragm cap contraceptive injections (injectables) sterilisation tubal ligation vasectomy withdrawal abstinence Mirena female condom
hormonal IUD

1.4.5 Heading: Pie Chart showing worldwide use of contraceptive methods
IUD size – 4 'pieces'.
Any other method size – 3 'pieces'.
Labelling IUD and one other contraceptive / any 2 contraceptives labelled.



1.5 1.5.1 form / version / variant of a gene *(must have)*
that will be expressed / produced in the phenotype or heterozygous condition masks the other/ recessive gene.

1.5.2



1.5.3 uracil / U

1.5.4 In the mutated section of mRNA the amino acids would be Gln and Gln/Gln would repeated
In the normal section of mRNA the amino acids would be Gln then Ala/ Gln is not repeated

1.5.5 longer polypeptide / protein / molecule
protein folds differently
change in function
abnormal form/ folding of protein
extra amino acid in protein

1.5.6 **Flow diagram to show transcription/how mRNA is made**

DNA unwinds and unzips / strands separate / hydrogen bonds between strands break.
↓
RNA polymerase moves along DNA strand / reads DNA sequence/ enzyme that is responsible for copying a DNA sequence into an **RNA** sequence.
↓
Corresponding RNA bases link/ align with complementary DNA example of complementary base pairing (A – U and G – C).
↓
Sugar phosphate backbone is added to form new mRNA strand.
↓
mRNA detaches mRNA leaves nucleus / moves to cytoplasm.
↓
DNA rewinds

1.6 1.6.1

	Statement	**A, B or C**
(a)	*Rana berlandieri* is observed to breed all year round.	A
(b)	All three species of leopard frog live in the same ecological niche.	B
(c)	Over 20 mating events were observed for *Rana blairi.*	A
(d)	*Rana sphenocephala* only mates from January to March every year.	B

1.6.2 Allopatric speciation
Populations are geographically isolated/different ecological niches.

1.7 1.7.1 (a) Percentage of attacks.

(b) 28–32% (*check final print copy*) (*accept range*)

(c) sand dunes are lighter inland fields are darker
on sand dunes brown fur more visible than white fur to predators / white fur on inland fields more visible to predators compared to brown fur
more brown mice attacked on dunes compared to white mice /
more white mice attacked inland compared to brown mice
70% brown mice attacked on coast vs 20% inland/ 70% white mice attacked inland vs 20% on coast

1.7.2 variation in fur colour in the population
mice with lighter fur colour had better camouflage against white sand
whiter mice had greater chance of surviving / avoiding predation
white mice would reproduce more often / more successfully reproducing
gene for light fur colour trait passed onto offspring more often
over time population had a greater number of lighter fur individuals.

1.7.3 small changes / only fur colour changed
in a short period of time
small scale changes in a small population
within the same species

1.7.4

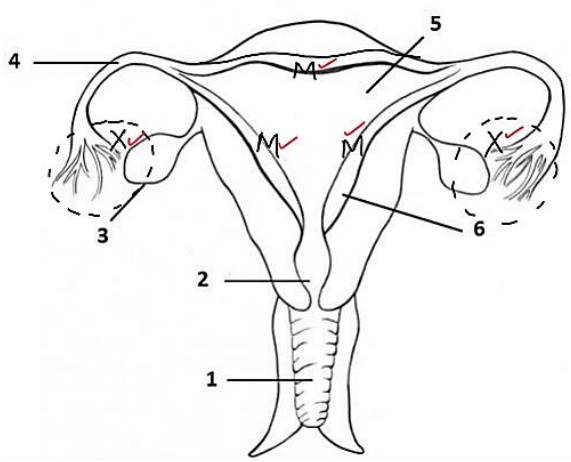
		Natural selection	Artificial selection
1.	Cause of change	Environment	Human
2.	Rate of change	Slow	Fast
3.	Variation	Increase in variation	Decrease in variation

1.8 1.8.1

Statement	Number
Non-permanent layer richly supplied with blood vessels.	6
Muscle action and cilia move developing zygote.	4
Place where sperm is deposited during sexual intercourse.	1
Cavity where the foetus grows and develops during gestation.	5

1.8.2 (a) "X" placed on the ovary *(see diagram)*

(b) "M" placed anywhere on the endometrium *(see diagram)*



QUESTION 2

2.1 2.1.1 nucleus / nucleoplasm

2.1.2 autosomes

2.1.3 Missing a sex chromosome/gonosome
1 sex chromosome instead of 2 sex chromosomes/ second X gonosome not present
only 45 chromosomes present / not 46 chromosomes
not a homologous pair of gonosomes
aneuploidy of chromosome 23/ gonosomes

2.1.4 somatic cell *(must have)*
homologous chromosomes present / diploid / 2 of each homologue pair
23 single chromosomes in gamete.

2.1.5 Turner syndrome does not run in families/ is not hereditary/ not passed onto next generation
Occurs by chance.
Random event during meiosis when chromosomes do not separate properly
Non-disjunction of gonosomes in meiosis
Turner syndrome individuals are sterile/infertile therefore can't pass onto next generation/offspring

2.1.6 invasive/dangerous procedure to get foetal cells
expensive
requires expertise which is not available
can cause miscarriage
if no family history of abnormalities, not needed
mutations not common/ are rare
risk of mutations in young women is low while older women at higher risk of mutations

2.2 2.2.1 (a) pituitary gland / hypophysis

(b) progesterone oestrogen

2.2.2 expert in genetics / inheritance
trained medical person
understanding of psychology
social work.

2.2.3 (a) restriction enzyme / restriction endonuclease.

(b) (DNA) ligase
used to join the piece of DNA / gene into the plasmid.

(c) bacteria reproduce quickly so many copies of the desired gene can be made
bacteria can undergo asexual reproduction so energy efficient
all bacterial cells produced are genetically identical so phenotype is known / will contain recombinant gene
bacteria readily available
small area / facility can be utilised for growth of bacteria nutrients can be controlled / monitored for optimum growth
large quantities of GH can be produced
GH produced is specific to humans
Bacteria have plasmids which allows for easy transfer of new DNA

2.3 2.3.1 increases/controls metabolic rate
controls rate of cellular respiration
promotes normal heart function
promotes nervous system function

2.3.2 mental / physical tiredness / lethargic
low blood pressure
low body temperature
lower heart rate
lower respiratory rate
weight gain

2.3.3 **Table showing differences between thyroid tissue of a sick cat and a healthy cat**

Sick cat thyroid tissue	**Healthy cat thyroid tissue**
Fewer blood capillaries	Many blood capillaries
Larger blood capillaries	Smaller blood capillaries
Fewer thyroid sacs	Many thyroid sacs
Large thyroid sacs	Smaller thyroid sacs
Fewer thyroxin secreting/ cuboidal cells	Many thyroxin secreting/ cuboidal cells
Larger cuboidal cells	Smaller cuboidal cells

2.3.4 Line X – Y measurement = range 51→53 (mm)
Scale line = 21→23 (mm)
(51 → 53) / (21→ 23) × 50 µm or (51→53) / (21→ 23) × 0,05 mm
= 110 → 126 µm = 0,11 → 0,12 mm
(*Answer must include unit. Accept range. Accept answers in mm*)
(*Check measurements on final printed copy.*)

2.3.5 Thyroxin hormones travel in blood thyroid is an endocrine gland deliver nutrients and oxygen to cells in thyroid remove waste

2.3.6 (a) The percentage of radioactive iodine in the blood plasma of a sick and healthy cat after time/ hours/ days injected.

(b) Yes
percentage of original radioactive iodine in blood plasma in sick cat remained high / above 80%
indicating iodine was not taken up by thyroid gland / remained in the blood
no / little thyroxin produced
impaired metabolism
healthy cat's results showed decrease in radioactive iodine after injection / less than 20% radioactive iodine
in blood after time passed / 30 hours
sick cat had above 80% radioactive iodine after 30 hours
indicating iodine taken up by thyroid gland of healthy cat
thyroxine is produced normal metabolism.

QUESTION 3

3.1 3.1.1 complete set of genes in a cell / organism / species.

3.1.2 all genes determined
gene functions determined
position / loci of genes on chromosomes determined
order of bases in genes determined
proteins produced by gene determined

3.1.3 (a) 250 million years ago

(b) Dasypus and Loxodonta diverged from a common ancestor forming two new species
in a short space of time / change happened quickly approximately 90 mya
lineage remained unchanged / long period of no change
gradualism requires much longer time with small, periodic changes in lineage

(c) share a more recent common ancestor

3.1.4 organisms no longer dependent on water bodies for reproduction/ breeding on land/ occupy more terrestrial habitats/ lay eggs on land
embryo have food supply within egg
protection of embryo with shell or in uterus
shell protects from drying out/ dessication
reduces competition for pools of water in which larvae mature
avoid predation by aquatic predators
embryos can develop more quickly / to a greater extent prior to hatching

3.1.5 share information
gain valuable indigenous knowledge on tuatara
information on location
build trust in the local community
educational opportunity / collaboration between scientists and community
promote conservation/ protect biodiversity
show importance of indigenous fauna
reduce/ avoid conflict
ethical to include local community

3.2 3.2.1 bipedal

3.2.2 forward / central position of foramen magnum in the skull
shorter broader pelvis
S-shaped spine
Longer legs compared to arms
Larger heel bone on foot
Big toe aligned with other toes
Arched foot
Femur angled inwards

3.2.3 free arms to carry food / offspring / tools / weapons
see further to observe predators
decrease surface area of body exposed to sun
energy efficient

3.2.4 caves used as a habitat / home for hominids
could fall into cave and die
mineral content allows for easy fossilisation
water present for fossilisation
no predators to eat the remains
environment has less oxygen for easier fossilisation
skeletons more protected, etc.

3.3 3.3.1 brow ridge is smaller in humans / brow ridge in Little Foot more pronounced.
mandible is smaller in humans / larger mandible in Little Foot.
cranium is larger in humans / cranium is smaller in Little Foot.
vertical face in humans / sloping face in Little Foot.

3.3.2 dating of fossils supports "Out of Africa" hypothesis
understand relatedness amongst extinct hominids
little is known about it so gives evidence / gaps in knowledge can be filled in
gives ideas of how and where they lived/ create a timeline
better understanding of modern humans
insight into environmental changes related to physiological changes
determine oldest extant (San) population.

3.3.3 difficult excavation/ takes a long time to excavate
Studying / examining fossils is time consuming
fossils are cleaned
recording / cataloguing is intensive
need time for verification / collaboration with other scientists in field peer review before publication takes time
improvement in technology for dating of fossil.

3.3.4 new information showing features unusual / different to *A. africanus* Little Foot is actually dated older / 3,76 million years old than *A. africanus.*
Unusual skull bones and teeth suggesting a different/distinct species.

3.3.5 Mrs Ples Taung child

3.4 3.4.1 increased/more change in biological/hominid evolution leads to an increase in change in cultural evolution/tool making.
(Indicate the two variables and the relationship between the two)

3.4.2 Development of weapons led to improved hunting.
Improved tool development / bone / stone tools led to new sources of food higher in protein and fat / could butcher meat / transport food when moving / build structures / make clothes.
Could make fire important in social gatherings/ceremonies could cook food better nutrition
Language development led to oral traditions/ storytelling/ communication
Used objects / substances / pigments from environment which led to artistic expression / symbol drawing / art / jewellery making / bead making / rock painting / recording of information.
Greater creativity

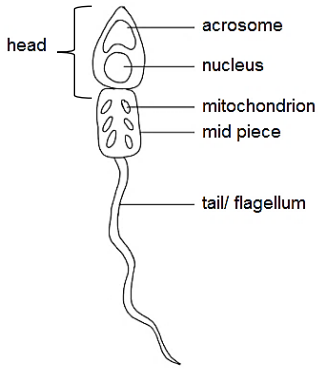
QUESTION 4

4.1 4.1.1 external fertilisation
sperm and eggs released into water
fertilisation takes place outside the female's body

4.1.2 easy to keep in aquaria
release sperm easily
gametes are easy to collect
external fertilisation is easy to observe
similar to human gametes

4.1.3 (a) testes

(b) Diagram of a sperm cell



Position of acrosome correct
Proportion (longer tail in relation to head)
3 correct labels

(c) Yes (*no mark for decision*)
sea urchin gametes are similar to human gametes
embryo development is easy to observe
less ethical considerations to use sea urchins
no humans are harmed
OR
No (*no mark for decision*)
sea urchins and humans are very different organisms
sea urchins are not mammals development will be different to humans
sea urchins have different reproductive strategies to humans/ vivipary in humans and ovipary in sea urchins
humans show internal fertilisation while sea urchins show external fertilisation
embryo develops inside female body in humans but develops outside the female's body in sea urchins

4.1.4 human sperm cells require more energy *(must have)*
to propel through female tract don't rely on water currents travel greater distance mucus is denser than water so more difficult to move through

4.1.5 C
Sea urchins produce a large amount of offspring
most offspring don't survive / are eaten by predators
very few offspring reach maximum life span
no parental care.

4.2 4.2.1 A: ovule
B: ovary
C: filament
D: stigma

4.2.2 produces sticky substance receives pollen/ site of pollination
site of pollen germination

4.2.3 longitudinal section

4.2.4 A

4.2.5 (a) aa / homozygous recessive

(b) Aa × Aa (*can mark parent genotypes in Punnett square*)
$F_{1:}$

	A	a
A	AA	Aa
a	Aa	aa

Punnett square correct (1 mark = correct row)
25% AA: 50% Aa: 25% aa OR 1AA: 2Aa: 1aa

[**If parental genotypes incorrect:**
carry error forward and mark Punnett square accordingly.
No marks for genotypic ratios.

(c) removed/cut anthers from flowers
hand pollinate from parent plant of choice

4.2.6 showed traits are controlled by two factors that did not blend / one factor expressed while the other was masked
allowed us to understand dominant and recessive traits
showed that pairs of factors segregated during reproduction segregation of factors was random
experiments were well done can be reproduced for further use results are trusted and still applicable today

Total: 200 marks