NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2022

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
[K✓]	The person who proposed the hypothesis of the inheritance of acquired characteristics.	A	Transitional fossil
[A✓]	The preserved remains of an organism that shows traits of both the ancestral and the descendent group.	B	Vestigial
[H✓]	The study of the distribution of plants and animals across the world.	C	Adaptive radiation
[B✓]	A structure or organ that is reduced and has no function in an organism.	D	Galapagos
[D✓]	The islands where Darwin spent time observing various species that led him to develop his theory of evolution.	E	Darwin
[J✓]	A hypothesis that states there is little change in species for long periods of time, followed by a period of rapid change.	F	Gradualism
[I✓]	The independent evolution of similar traits in organisms that are not closely related.	G	Founder effect
[C✓]	The process whereby organisms diversify rapidly into many different forms from an ancestral species.	H	Biogeography
[G✓]	The loss of genetic variation that occurs when a new population is established from a small, isolated number of individuals.	I	Convergent
[F✓]	A hypothesis that states that species evolve at a steady rate over long periods of time.	J	Punctuated equilibrium
		K	Lamarck

(10)

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
Answer	A ✓	C ✓	B ✓	D ✓	B ✓✓	D ✓✓	C ✓✓	C ✓✓

(12)

1.3

Item	Term	Answer
1. Fertilisation usually requires an aquatic environment. 2. Large number of ova are produced.	External fertilisation	C ✓
1. Many offspring are produced. 2. Low survivorship of offspring.	K-strategy species	D ✓
1. Male birds can display elaborate dances to attract females. 2. Little energy expenditure to produce offspring.	Courtship	A ✓
1. Offspring receive nutrients through a placenta. 2. Eggs develop outside the body of the female.	Ovipary	B ✓
1. High parental care. 2. r-strategy animals.	Mammals	A ✓

(5)

1.4 1.4.1 *Homo erectus* ✓ (1)

1.4.2 70 000–50 000 ✓ years ago ✓
(accept both or either one) (2)

1.4.3 search for food ✓ following migration of herds ✓ competition with other groups ✓ seek new territory ✓ climate change ✓
(any 1) (1)

1.4.4 (a) passed from mother to child ✓
can trace maternal lineage ✓/shared genes through the maternal line ✓
mtDNA mutates quickly ✓
mtDNA mutates at a known rate ✓
useful in detecting variations/markers ✓
can determine age of populations ✓
by number of shared markers ✓
(any 2 facts or one well explained) (2)

(b) fossil evidence ✓ oldest *Homo* fossils are found in Africa ✓
archaeological evidence ✓ earliest tools found in Africa ✓
(line of evidence + supporting fact) (2)

1.5

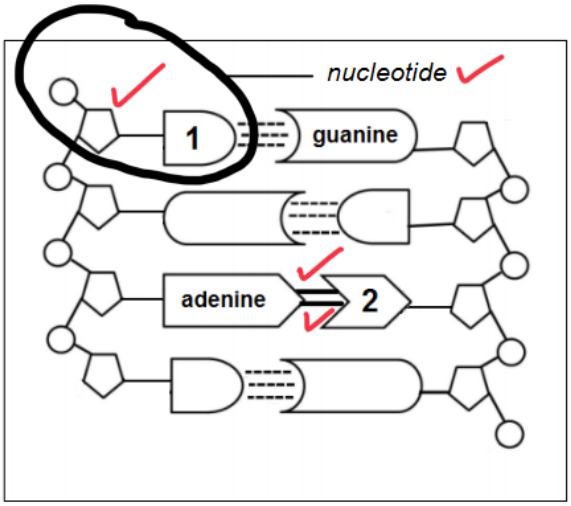
	Statement	A, B or C
1.5.1	Down syndrome is also known as trisomy 21.	A ✓
1.5.2	In South Africa, 0,5% of children born have Down syndrome.	B ✓
1.5.3	There are 46 chromosomes in the nucleus of the somatic cells of a Down syndrome person.	B ✓
1.5.4	The life expectancy of people with Down syndrome has increased.	A ✓
1.5.5	All people with Down syndrome experience cognitive delays and cannot be schooled.	C ✓
1.5.6	People with Down syndrome are at increased risk for heart conditions.	A ✓
1.5.7	Nondisjunction during meiosis causes all cases of Trisomy 21.	B ✓

(7)

1.6 1.6.1 1: cytosine ✓
2: thymine ✓ (2)

1.6.2 (a) circle drawn around any nucleotide ✓
label: nucleotide ✓ (2)
see diagram below

(b) 2 bonds drawn ✓
correct position ✓ (2)
see diagram below



1.6.3 James Watson ✓ Francis Crick ✓ *(accept Watson and Crick)* (2)

1.6.4 60% guanine and cytosine **OR** 30% guanine ✓
30/100 × 1 460 = 438 ✓ guanine bases (2)

1.7

	Description	**Letter**
1.7.1	Phase in which homologous chromosomes move to opposite poles of the cell.	D ✓
1.7.2	Phase in which the homologous chromosome pairs line up at the equator.	E ✓
1.7.3	Phase in which the centromeres split to separate the chromatids.	B ✓
1.7.4	Phase in which crossing over occurs.	A ✓
1.7.5	The final phase of meiosis that will result in the formation of gametes.	C ✓
1.7.6	The first phase of meiosis 1.	A ✓

(6)

1.8 1.8.1 CRISPR can change/edit/cut DNA ✓
by using cas9 enzyme ✓
and guide RNA ✓ to locate position on DNA ✓
used to fix errors in DNA shown by the multiple fingers in cartoon ✓
(any 3) (3)

1.8.2 New technology ✓
long-term effects not known ✓
no regulation on its use ✓
no safety checks in place ✓
can be used by anyone ✓
irresponsible use possible ✓
could cause unintended physical harm ✓
unethical use ✓
malicious use ✓
(any 4) (4)

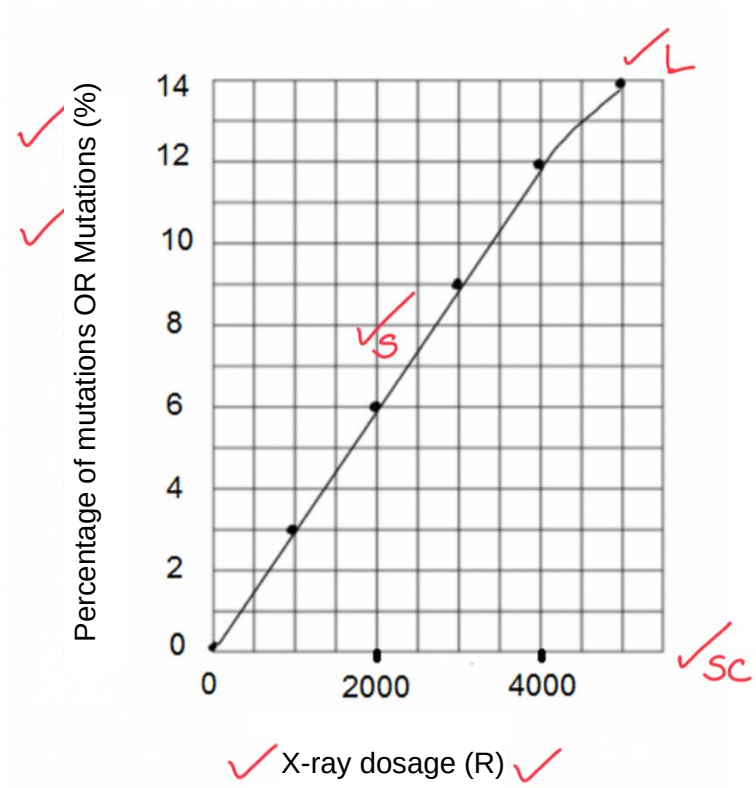
1.9 1.9.1 random change ✓ in DNA/genetic material ✓ change in the order ✓ of the nitrogen bases ✓ in DNA (2)

1.9.2 Point mutation is a single base change ✓ substitution/inversion ✓ doesn't change length of DNA ✓
Frameshift mutation involves addition/deletion of a base ✓ changes how codons are read ✓ can change sequence of amino acids ✓ can change protein function ✓
(any 4) (4)

1.9.3 X-ray dosage ✓ (1)

1.9.4 *Mark according to criteria shown below.*

Graph to show effect of X-ray dosage on the percentage of mutations in *Drosophila sp.*



- ✓ Heading
- ✓ X-axis label
- ✓ Y-axis label
- ✓ X-axis unit: R
- ✓ Y-axis unit: %
- ✓ Line graph (L)
- ✓ Scale on axes (SC)
- ✓ Shape (S): straight line

(8)
[80]

QUESTION 2

2.1 2.1.1 (a) epididymis ✓ (1)

(b) testes ✓ (1)

(c) scrotum ✓ (1)

(d) penis ✓ (1)

2.1.2 6 ✓ (1)

2.1.3 muscular sac ✓ able to regulate temperature of testes ✓
distends testes to lower temperature ✓ moves testes towards body to raise temperature ✓
ensures sperm production at optimum temperature ✓
as sperm needs to be produced at lower than normal body temperature ✓
(any 3) (3)

2.1.4 religious practice ✓
cultural/traditional practice ✓
medical reasons: phimosis/foreskin can't retract ✓
reduces risk of infections/reduces HIV infection and transmission of virus ✓
(any 2; or one well explained) (2)

2.2 2.2.1 produces oestrogen ✓ progesterone ✓ relaxin ✓
diffusion of oxygen and nutrients from mother to foetus ✓
removal of foetal metabolic waste ✓
passes maternal antibodies to foetus ✓
barrier to pathogenic microorganisms ✓
(First TWO marked) (2)

2.2.2 position of the placenta obstructs/covers ✓ the cervix ✓
placenta develops at the bottom/not on the side/not at the top of the uterus ✓
which covers/blocks the cervix ✓
prevents the passage/birth of the foetus through the cervix ✓ (2)

2.2.3 1/200 × 100 ✓ = 0,5 ✓ % (2)

2.2.4 umbilical cord ✓ *(must have)*
carries oxygen/ nutrients to foetus ✓
carries waste from foetus to mother ✓
carries blood back and forth between foetus and placenta ✓ (2)
(1 for naming + 1 for fact)

2.2.5 cervix widens/dilates ✓ uterus contracts ✓ (2)

2.3 2.3.1 uncontrolled blood glucose levels ✓
pancreas/ beta cells damaged/ destroyed ✓
no insulin produced ✓
requires insulin injections ✓
(any 2) (2)

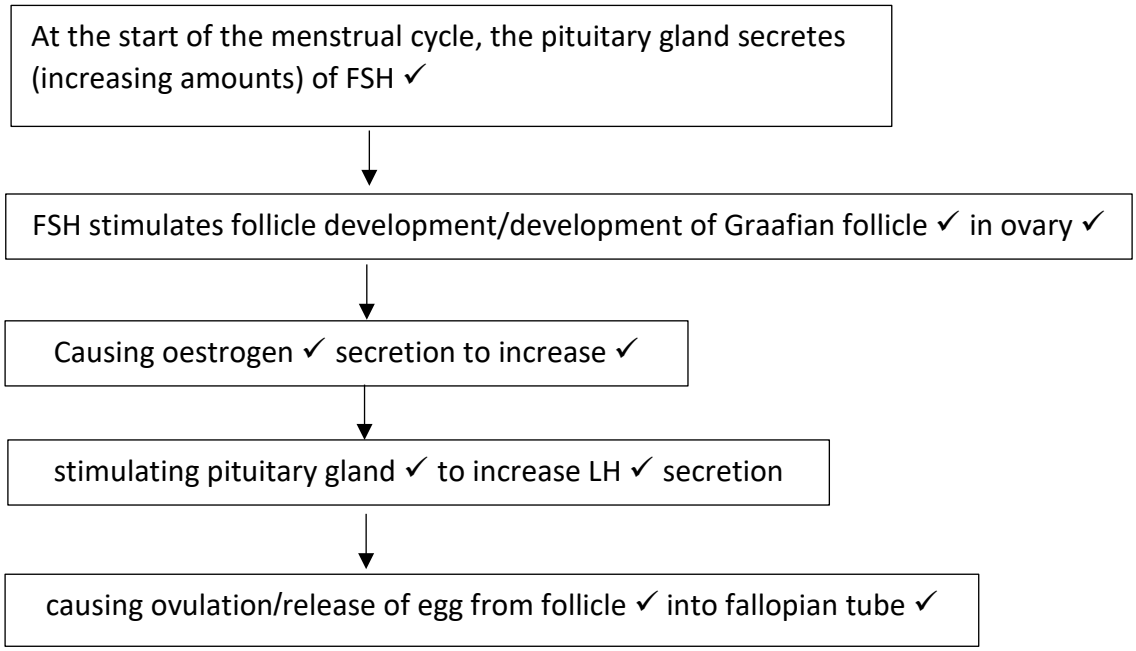
2.3.2 body produces own insulin ✓
don't need to inject ✓
not reliant on constantly checking blood glucose/monitoring blood glucose levels, more convenient ✓
could prevent serious complications/side effects of diabetes ✓
permanent treatment ✓
(any 3) (3)

2.3.3 type 2 diabetics can produce insulin ✓
islets/beta cells are not damaged ✓
cells are unable to use insulin/ not sensitive to insulin ✓
transplant surgery in type 2 diabetic will only increase amount of insulin produced ✓
transplant surgery does not treat the ability of cells to respond to insulin/increase glucose uptake ✓
(any 3) (3)

2.3.4 **NO:** (no mark for decision)
not correcting a faulty gene ✓
vectors not used to deliver genes ✓
transplant/replacement of damaged tissue/cells with healthy tissue/ cells ✓
YES:
healthy DNA from another individual is being used ✓
donor genes are coding for insulin ✓
(2 facts ✓✓) (2)

2.4 2.4.1 between 2 lobes of brain/beneath the hypothalamus ✓
(*accept other relevant descriptions of position)* (1)

2.4.2 Flow diagram to show how pituitary hormones stimulate egg development and ovulation. ✓



(✓ Heading) + (✓ arrows for correct sequence of events) +
(✓✓✓✓✓ 5 correct facts) (7)

2.4.3 Growth hormone/GH ✓
Bones/muscles/all tissues of the body/ brain and other organs, e.g. skin (any one target organ) (2)
[40]

QUESTION 3

3.1 3.1.1 high in nutritional value✓
contain proteins/fats/good source of fats/proteins ✓
easy to transport ✓
store for a long time ✓
staple diet for many people ✓
relatively cheap source of nutrients ✓
(any 2) (2)

3.1.2 grows in variety of soils ✓
suitable to variety of climates ✓
drought tolerant ✓
frost tolerant ✓
requires less fertiliser ✓
does not spread uncontrollably ✓
aesthetic as remains green all year ✓
(first 4) (4)

3.1.3 (a) humans develop new organisms ✓ with desirable traits ✓ by choosing beneficial/favourable phenotypes ✓ in the parents/ cross breed ✓ two individuals with desirable traits ✓ to produce offspring with chosen features ✓
(any 2) (2)

(b) trait selected is large seeds ✓
parent plants that produce large seeds chosen ✓
parents with large seeds reproduce/ crossed with each other ✓
their seeds planted ✓and only plants producing large seeds in these offspring are chosen ✓
repeat the process ✓
for many generations/over a long time ✓
(any 4) (4)

3.2 3.2.1 section of DNA/genetic code ✓
gene not located on a sex chromosome/found on chromosomes 1–22 ✓ (2)

3.2.2 polygenic/polygene ✓ (1)

3.2.3 parents (9 and 10) unaffected ✓ but have son (15) who is affected ✓

OR

Parent 2 is affected ✓ but has sons 3 and 7 unaffected ✓
(accept all other examples of suitable crosses) (2)

3.2.4 (a) aa ✓ (1)

(b) Aa ✓ × Aa ✓(correct parent genotypes or correct gametes in Punnett diagram)

	A	a	
A	AA	Aa	✓
a	Aa	aa	✓

3 Normal :✓ 1 albino ✓ (can use ratio, fraction or %)
[If incorrect genotype for parents carry error forward and mark only offspring in Punnett accordingly; ✓✓ no marks for phenotype]. (6)

3.2.5 X^aY ✓ (1)

3.3 3.3.1 variation in resistance to antibiotics in bacterial population ✓
bacteria with *Mfd* protein more likely to survive/bacteria without *Mfd* die from antibiotics ✓
bacteria with *Mfd* protein reproduce ✓
gene for *Mfd* protein passed on to offspring ✓
over time ✓
bacterial population has greater number with *Mfd* protein/antibiotic ✓
(any 5) (5)

3.3.2 over-prescription of antibiotics/over-use of antibiotics ✓
patients don't complete course of antibiotic medication ✓
patients take antibiotics when it's not needed ✓
poor infection control in health-care settings ✓
routine use of antibiotics in livestock farming ✓
(any 2 facts) (2)

3.3.3 (a) AUG ✓ CCG ✓ AUA ✓ (3)

(b) DNA has deoxyribose/RNA has ribose ✓
DNA is double stranded/RNA is single stranded ✓
DNA is a larger/longer molecule/RNA smaller/shorter ✓
DNA has thymine base/RNA does not have thymine base ✓
DNA does not have uracil base/RNA has uracil base ✓
(any 1) (1)

(c) translation occurs ✓
mRNA ✓ moves to ribosome ✓
codons on mRNA link with anticodons on tRNA ✓
tRNA brings corresponding amino acids ✓
peptide bonds ✓ form between amino acids ✓ to make a protein/polypeptide molecule✓
(any 4 facts) (4)

[40]

QUESTION 4

4.1 4.1.1 ancestor/common ancestor ✓ (1)

4.1.2 Hippopotamus ✓ (1)

4.1.3 Yangtze River dolphin ✓ (1)

4.1.4 5 ✓ million years ago ✓ (2)

4.2 4.2.1 2 ✓
B and C able to breed and produce fertile offspring making them same species ✓
Mating between A and C (and A and B) does not produce fertile offspring, making A a different species ✓ (3)

4.2.2
1. Mutations in DNA ✓ sudden unexpected change in genetic structure or DNA/new genes may arise/modify ✓
2. Meiosis ✓ in gamete formation through crossing over and/or random arrangement of homologous chromosome pairs ✓
3. Random fertilisation ✓ chance process so unsure of which sperm cell fertilises which ovum / all sperm produced by male are different and all ova produced by female are different so offspring of these parents will differ from one another ✓
4. Random mating between organisms within a species ✓ is a chance process with different combinations of genes to parents' ✓

(✓✓ first two named + ✓✓ described) (4)

4.2.3 if the river is permanent:
allopatric speciation will occur ✓ *(must have this point)*
due to physical/geographic separation ✓ of B and C populations gene flow/reproduction between B and C cannot occur ✓
each population will have different environmental conditions (food/ predators/vegetation etc) ✓
each population undergoes natural selection independently ✓ and develop differently over time ✓
resulting in new species ✓
(max 5) (5)

4.3 4.3.1 Foramen magnum ✓ is more central in skull ✓
Pelvis ✓ is shorter/broader ✓
Spine ✓ is S-shaped ✓
Foot bones ✓ more human-like big toe does not diverge ✓
Femur bone ✓ is longer and angled ✓
(✓✓✓3 features + ✓✓✓3 description of each feature) (6)

4.3.2 they co-existed/lived on Earth in same time period ✓ (1)

4.3.3 international team ✓ 52 scientists ✓ published research ✓ peer reviewed ✓ collaboration between universities ✓
(any 2) (2)

4.3.4 encourages discussion ✓ alternate hypotheses considered ✓ reduces mistakes ✓ careful evaluation of evidence encouraged ✓ demands further investigation ✓ fosters collaboration between scientists ✓
challenges pre-conceived ideas ✓
(any 5) (5)

4.3.5 Current understanding is: the older the hominid species, the smaller the brain size/the more recently evolved the hominid species, the larger the brain size ✓ *(must have trend)*
H. naledi is dated young/335 000 years old ✓ but has a small cranial capacity/465 to 610 cm^3 ✓ which is similar cc to *A. afarensis* ✓ which is much older/ lived 3 mya ✓
(✓ trend ✓✓ 2 facts) (3)

4.4 **Table showing differences between the jaws and teeth of *H. habilis* and *A. africanus* mandible** ✓

H. habilis	***A. africanus***
Smaller molars ✓	Larger molars ✓
Greater difference in size between different teeth ✓	Less variation in size between different teeth ✓
Smaller/shorter canine ✓	Larger/longer canine ✓
Smaller mandible ✓	Larger mandible ✓
U shaped mandible ✓	V shaped mandible ✓

✓

(✓ *Heading) (table format/row/column headings)* +
(2 correct differences for each species ✓✓✓✓) (6)
[40]

Total: 200 marks