NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2024

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
[D]	The individuals within a colony of social animals that perform a specialised role.	A	Limiting factor
[K]	The type of competition between individuals of the same species.	B	Ecological footprint
[B]	A measure of how dependent humans are on natural resources.	C	Immigration
[J]	The role an organism plays in a community.	D	Castes
[I]	The maximum population size of a species that can be sustained in a specific environment.	E	Mortality
[A]	A resource that is in short supply.	F	Census
[F]	A method of directly counting all individuals in a population.	G	Interspecific
[C]	The movement of individuals into a population.	H	Emigration
[G]	The type of competition between individuals of different species.	I	Carrying capacity
[E]	A measure of the number of deaths in a population.	J	Ecological niche
		K	Intraspecific

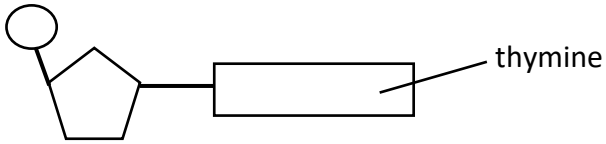
1.2

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

1.3 1.3.1

Statement	Item	Answer
A genotype that increases genetic variation.	1. Heterozygous 2. Homozygous	1
A single set of chromosomes in a cell.	1. Haploid 2. Diploid	1
Possessing more than two complete sets of chromosomes.	1. Hybrid vigour 2. Polygenic	None
Scientist(s) that discovered the shape of the DNA molecule.	1. Gregor Mendel 2. James Watson	2
Vector used to deliver genetic material into an organism.	1. Plasmid 2. Virus	Both

1.3.2 **Diagram of a nucleotide**



Heading to identify name of monomer: nucleotide.
Label to identify base found only in DNA: thymine.
Molecules joined correctly: phosphate to sugar; sugar to base.

1.4 1.4.1

	Statement	A, B or C
(a)	*Australopithecus africanus* has longer arms than legs.	A
(b)	*Homo neanderthalensis* had the ability for language communication.	C
(c)	*Homo neanderthalensis* and *Homo sapiens* did not exist at the same time.	B

1.4.2 (a) To walk on two legs.

(b) Features that would support bipedalism:

- Foramen magnum is centrally positioned/more forward under the skull allowing for the cranium/head to balance on top of spine.
- Spine has an S-shape distributes weight/shifts centre of gravity closer to the body's midline/above the feet/less muscular effort to stand and walk upright/balances vertebral column over the hip joints/better flexibility.
- Pelvis is short and wide to balance upper body over the hips and legs/aids in weight distribution when upright.
- Femur bone is angled/bicondylar angle/acute valgus angle of the knee brings knees closer together so that feet are directly below the centre of gravity/allow to walk more efficiently
- Longer legs than arms/long femur length increased surface area for muscle attachment/larger muscles for the push for walking/better levers for muscle action.
- Enlarged heel bones provides platform to support weight of body/required for walking gait/for better balance
- Smaller toe bones/non-opposable toe/toe bones aligned allows for toes to bend slightly up during push-off when walking/provides flat surface area for walking on/balance, etc.
- Foot arch allows effective distribution of upper body weight/shock absorption.

1.5 1.5.1

Hominid name	**Letters**
Homo sapiens	B C
Homo erectus	A D

1.5.2 The use and control of fire:

- Hominids could adjust their environment to suit needs.
- Offered more permanent dwelling sites.
- Increased social behaviour/communication/storytelling (at night) led to transfer of knowledge
- Fire used for warmth
- Fire used for lighting
- Fire allowed for cooking.
- Cooked food/meats/more diverse food increased nutrients.
- More nutrients increased brain development.
- Helped in cooperative/more successful hunting.
- Fire used to herd animals in a direction to ambush/kill.
- Provided the ability to migrate into colder climates.
- Enabled better/stronger tools to be made.
- Protection from predators/keep predators away (especially at night)
- Afforded a way to create more 'sophisticated' hunting tools.
- Control the environment by burning land to create farmlands
- Allowed for creation of artefacts

1.6 1.6.1 0,75% of world population = SA population

0,0075 × (world population) = 60 710 077
World population = (60 710 077)/0,0075
= 8 094 676 933,33
(Working Correct answer)

1.6.2

Year	**A, B, C**
2050	C
1960	A

1.7. 1.7.1 DNA/nucleic acid histones/proteins

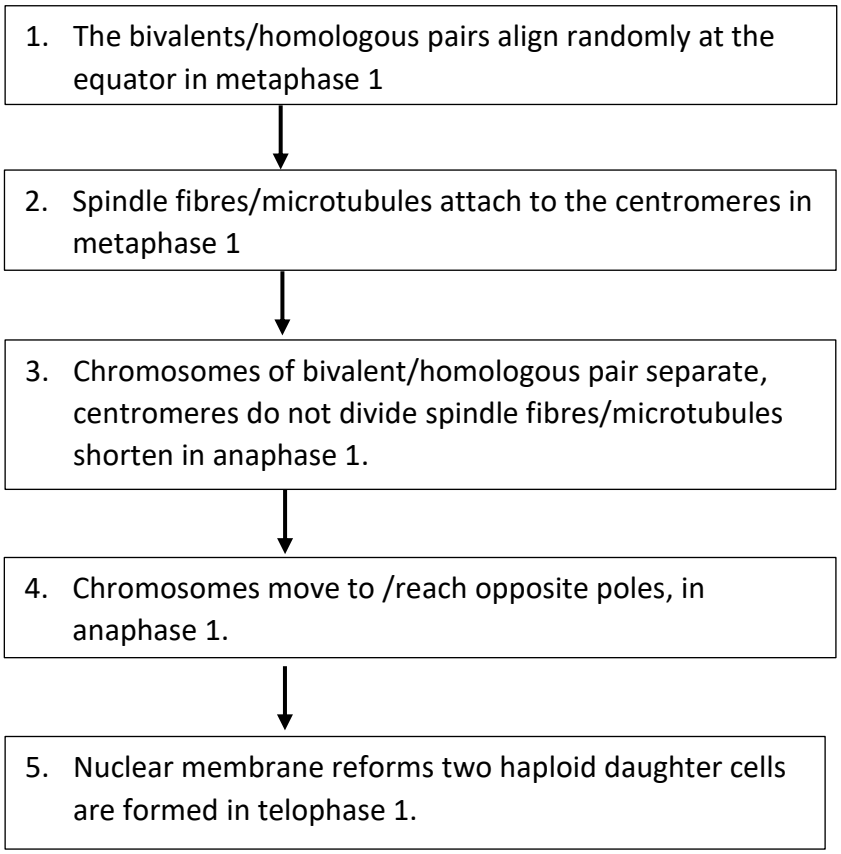
1.7.2 Chromosomes must:
- Code for the same genes.
- Have genes in the same order/locus/position.
- Be the same length/size.

1.7.3 DNA replication

1.7.4 (a) It increases genetic variation/recombines genes between chromosomes/ensures gametes/offspring are genetically different/dissimilar.

(b) *2 chromosomes drawn (2 centromeres).*
4 chromatids (2 strands on each centromere).
Shading shows correct swopping of segments of DNA/ crossing over on each chromatid.

(c) Flow diagram showing process of meiosis I.



(3 facts + correct sequence of phases + heading and flow diagram with short statement separated with arrows)
[Sequence: fact from (1/2) followed by (3/4) end with (5)]
No flow diagram provided, but description of process given: max 3 correct steps in process in correct order

1.8 1.8.1 Improved medical access/interventions/care.
Improved knowledge on (supportive) treatments.
There has been more research.

1.8.2 Gaining employment/limited job opportunities/bullying/teasing/no selection on sport teams, transportation, depression, stares from people, etc.

1.8.3 (a) Incidence of live births for Down's syndrome is higher in South Africa than in less developed countries/the other countries.
(Accept actual data given, such as:
SA has double the incidence than MDC's
Incidence is 1 in 500 in SA but less/1 in 1000 in MDC's/1 in 650 in LDC's)

(b) Possible answers:
- Lack of access to screening/prenatal diagnosis
- Less access to medical/supportive services
- More women having children over age of 40

1.9 1.9.1 2

1.9.2 Nucleus

1.9.3 Phenotype of Parent G: Female without ichthyosis/unaffected female/normal female
Phenotype of Parent H: Male without ichthyosis/unaffected male/normal male

Genotypes: Parent G X^AX^a × Parent H X^AY

Punnett diagram:

Gametes →	X^A	X^a
X^A	X^AX^A	X^AX^a
Y	X^AY	X^aY

1.9.4 25% or 1 in 4 chance

1.9.5 Individual F is a male and ichthyosis is X-linked/occurs only on X chromosome/not on Y chromosome.
Males/fathers pass on the Y chromosome to male children.
Females/mothers pass on the X chromosome to male children.

1.9.6 Individual A has the gene/allele for ichthyosis.
Individual A is not affected by ichthyosis.
Female has 1 copy of the allele
As ichthyosis is recessive/masked by the presence of the normal allele.
So individual A is heterozygous.

QUESTION 2

2.1 2.1.1 (a) Erasmus Darwin

(b) Alfred Wallace

(c) Charles Darwin

(d) Jean Baptiste Lamarck

2.1.2 (a) Society/people:

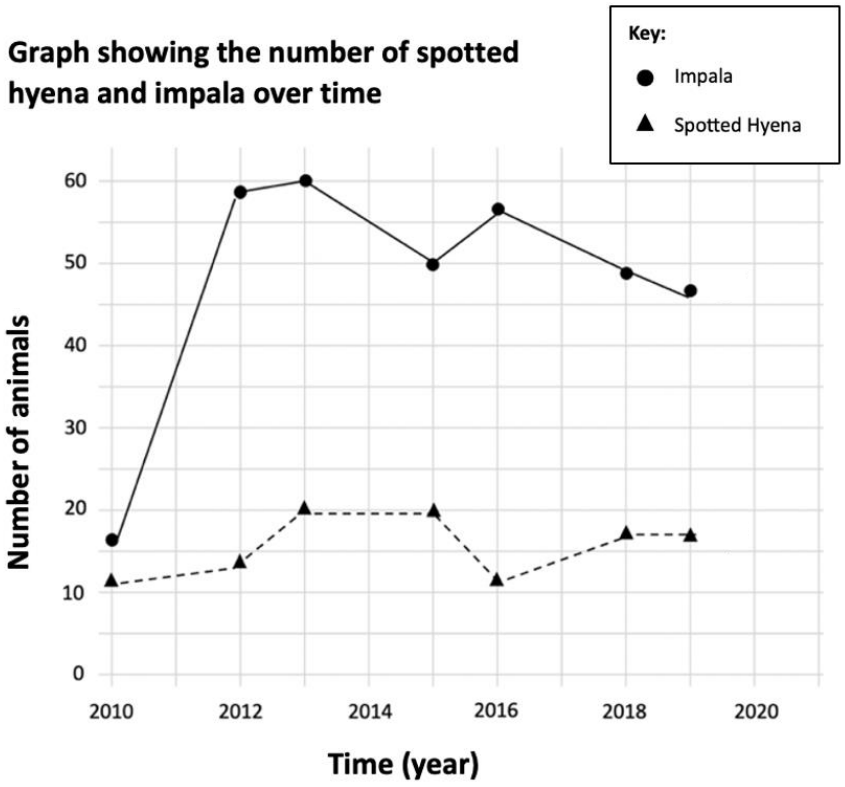
- were scared of challenging current ideas on origins of life.
- against religious beliefs of the time/conflicting religious beliefs with creationism.
- church/religious backlash.
- had long held beliefs that were questioned.
- thought the ideas were blasphemous.
- did not have adequate education/exposure to science.
- did not understand the ideas/theory.

(b) Scientific community responded negatively because:

- the ideas were difficult to test.
- the ideas were revolutionary
- ideas were contrary to the belief that all life was created once/that life was unchanged since biblical creation.
- there was not a lot of evidence available.
- the fossil record was limited.
- there was no/limited literature available in support of idea.
- the church establishments had a large stake in science endeavours as the church ruled the state, it should not be challenged
- limited understanding of genetics and inheritance
- Challenged the current ideas of speciation

2.2 2.2.1 Mark graph as follows:

Heading (number + both named animals + time.)
x-axis label (time or years). 'Years' or 'Time in years' – and not just 'Time'.
y-axis label (number of animals).
Line graph (L) (All points joined to form line).
Key (symbols drawn in and correct for impala and spotted hyena).
Plotting (last points for each animal – 2019)



L

2.2.2 Predator-prey relationship/predation

2.2.3 Accept between 35–40

2.2.4 Strategy used by impala to avoid predation:

- Assemble in large groups/herds so there are many animals that can detect/alert others of predators/provides safety in numbers/ less chance of each individual being caught.
- Young/weaker members remain in the centre of the herd and so have greater protection.
- Some members are positioned on edge of the herd to look out for predators/members share their time on vigilance while other members are in the centre of the herd to graze.
- Herds of impala avoid areas with woody cover/prefer open grasslands so predators are more easily spotted/have difficulty ambushing the impala.

2.2.5 Need for protected areas:

- To preserve/conserve nature/habitats so that future generations can enjoy.
- Provide a safe haven for wildlife populations/control hunting so that populations can be managed/prevent extinction of species
- Safe place for breeding so population numbers can be increased/endangered species can safely breed.
- To increase tourism and so provide job opportunities/increase income.
- To provide areas for study/research of natural populations so scientists can monitor population growth/collect data on species, etc.
- To maintain biodiversity so ecosystems are healthy.

2.2.6 (a) The mating/breeding/crossing/production of offspring between closely related individuals.

(b) Disadvantages of inbreeding:

- Leads to poor reproductive health.
- Higher frequency of genetic abnormalities.
- Lowers genetic variation.
- Increases pup mortality.
- Poor sperm quality.
- Decreases hybrid vigour.
- Higher susceptibility to diseases.
- Increases homozygosity
- Decreases ability to survive in a changing environment
- Vulnerable to extinction

2.3 2.3.1 (a) Groups have the same number of chromosomes/2 n = 60.
(Successful) breeding between individuals of the two groups/ occurs in the mixed herds.

(b) No breeding takes place between the two types of impalas.
No viable/fertile offspring produced.
Offspring produced between black-faced impala and common impala are infertile.

2.3.2 Geographical isolation between the two groups of impalas:

- This is allopatric speciation
- Groups are reproductively isolated.
- Prevents gene flow between groups.
- Environments in 2 areas are different.
- Selection pressures are different in the 2 areas
- Natural selection occurs independently in 2 environments
- Genetic changes occur
- Due to mutations.
- Changes/mutations accumulate.
- Mutations are not shared/are different between groups/different genotypes/genetically different individuals.
- Organisms from each group are unable to breed with each other/produce fertile offspring.

2.3.3 (a) Fossil record:

- Provides evidence of species that existed in the past.
- Shows the change/differences from ancestral to present day species.
- Indicates descent with modification.
- Fossil record shows increase in diversity/number of species
- Fossil record shows increasing complexity of organisms
- Shows the changes that arose in species over time as they adapted to a changing environment.
- Shows new species rising from ancestral species.
- Fossils can be dated/age determined.
- Can be used to create a timeline.
- Determine evolutionary relationships/show relatedness.
- Shows intermediate forms/transitional fossils.

(b)

- Biogeography
- DNA / genetics / biochemical similarities / molecular biology
- Comparative anatomy
- Embryology
- Modification by descent
- Vestigial organs

QUESTION 3

3.1 3.1.1
- Same species.
- Living in the same area.
- Living at the same time.
- Individuals can breed with each other.

3.1.2 Reasons to use the quadrat method:
- Sea anemones are small.
- Sea anemones are mostly stationary/sessile/sedentary.
- Sea anemones will likely remain in quadrat/area when sampling.
- There are a lot of them, so it is difficult to do a direct count.
- Quadrat method saves time as not every individual is counted.
- Sea anemones are soft bodied/live in water, so it is difficult to mark/tag them.

3.1.3 (a) **Yes**
Numbers/letters were drawn from a container by a colleague/ were not selected by the biologist.
So, it eliminated selection bias quadrats were selected by chance.

No
Drawing numbers from the containers is not scientific and may be biased.
Her colleague selected the quadrats and may be biased

(b) $(2 + 4 + 3)/3 = 3$

(c) $\frac{3\ (\times\ 2\ 400)}{100} = 72$

(d) **Not accurate**
The estimated population size is higher than the direct count 72 estimated vs 40 actual.
There is uneven distribution not true representation of the spread of the population.

Accurate
The quadrat method is only an estimate.
More samples could be done and averaged to get closer to actual value.
(Clear decision on accuracy + 2 supporting facts)
(Decision mark only awarded if supported with facts)

3.1.4 (a) Food space water oxygen

(b) Competitive coexistence/resource partitioning/sharing of resources by each species/niche differentiation
Species use the resources in different ways/may feed on different foods/live on different parts of rocks, etc.

3.2 3.2.1 A forest ecosystem:

- All the organisms/biotic factors (in a forest e.g., trees, plants animals) interacting with each other
- and the non-living environment/abiotic factors.

3.2.2 2

3.2.3 (a) Secondary
Soil/organisms present before disturbance

(b) 3

3.2.4 **Ethically correct:**

- Governments of countries have a duty to protect/secure the natural resources.
- It is important for sustainability/conserving resources/conserving biodiversity.
- Preserve forests for future generations.
- Indigenous forests are important to sustain natural wildlife/provide distinct habitats for organisms.
- Species have a right to life
- It can lower the ecological footprint
- Protect plants in forests with medicinal value/used in indigenous knowledge systems

3.2.5 **Grasslands:**

- have fewer trees
- have more grasses
- dominant species in grasslands are grasses.
- have many herbivores/grazers.
- have less/lower tree or plant density/have more open spaces.
- receive lower rainfall than forests.
- Increases flower diversity

Forests:

- have many larger trees/hardwood trees/dominant species are trees/greater tree density/ have plants such as ferns, mosses, creepers.
- stratification with plants at multiple different heights
- support larger diversity of plants/animals.
- have fewer open spaces.
- end point is influenced by high rainfall, which influences the type of plant growth.

3.3 3.3.1

Statement	**Term**
A nucleic acid.	DNA
An enzyme used in PCR.	Polymerase
An organism's complete set of genes.	Genome

3.3.2 PCR will amplify DNA/produce multiple copies of DNA/make a larger volume.
From a limited amount/small sample.
Able to run multiple tests.

3.3.3
- A genome is all the genes that make up an organism.
- There is variation in sequences of genes.
- Some of these genes/segments are non-coding DNA.
- Non-coding DNA is unique to an individual.
- Non-coding DNA is used to make a DNA profile

QUESTION 4

4.1 4.1.1 (a) tRNA

(b) Amino acid/polypeptide

(c) Ribosome

4.1.2 Translation *(compulsory)*
mRNA attaches to ribosome
tRNA carries amino acid from cytoplasm
Anticodons on tRNA
Match with mRNA codons
Amino acid placed in correct order for polypeptide/protein synthesis.
Peptide bonds form between amino acids.
(1 compulsory fact + 4 other facts)

4.1.3

	Statement	**Number**
(a)	Antibiotic that will prevent the anticodon from linking with the codon.	3
(b)	Antibiotic that prevents peptide bond formation.	2

4.1.4 Stops the bacteria from synthesising proteins/enzymes that are essential for growth/development of the cell wall/cell membrane/ reproduction/survival.

4.2 4.2.1 (a) UV radiation/radioactive substances/X-rays/gamma rays/ tobacco products/viruses/mutagens/carcinogens

(b) (i) Substitution/point mutation.

(ii) No addition/deletion of a base/still the same number of codons/same number of amino acids added/one base is replaced with another base.

(c) Beneficial mutation as it improves the ability of the bacteria to survive/able to resist antibiotics.

4.2.2 (a) AUG CUG UCG

(b) 1824 / 3 = 608
(Accept 607 for incorporation of stop codon)
(Working + correct answer)

4.2.3 (a) Ser

(b) Ala

4.2.4 C

4.2.5 There is genetic variation in resistance to antibiotics in the bacterial population.
Bacteria with mutation are resistant to antibiotics
and are more likely to survive the presence of antibiotics
and reproduce/multiply.
Mutation is inherited by next generation
over time.
Frequency of bacteria resistant to antibiotics more prevalent in population.

4.3 4.3.1 Genetic engineering is:
- The modification/manipulation.
- Of (an organism's) genes/DNA.
- Using technologies/laboratory techniques.
- For human benefit
- To achieve desirable traits

4.3.2 Restriction enzyme/endonuclease/Cas9

4.3.3 Similarities between CRISPR and artificial selection:
- Both involve choosing a trait/gene in an organism.
- Chosen trait can be enhanced or removed.
- Both processes are done by humans.
- Both processes involve modifications where the change in organism/species benefit humans
- Environmental pressures are not involved in selection of traits in organisms.

4.3.4 Artificial selection example:
- Organism named (e.g. maize / Bonsmara cattle / pedigree dogs, etc).
- Description of feature altered in named organism.

4.3.5
- To determine its effectiveness in treating disease.
- To make sure it is safe.
- Ensure it does not cause harm/determine its side effects.
- Ensure no unwanted complications.
- To provide reliable statistical data.
- To see potential long-term effects.
- To see if benefits outweigh the risks.
- It is a new technology/should be researched.
- Go through long process of clinical trials.
- To determine if there are off target cuts

Total: 200 marks