NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 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
[E]	Male organ that produces sperm	A	Epididymis
[J]	Muscular sac that surrounds the testes	B	Sperm duct
[H]	State in which the penis is filled with blood under pressure and becomes rigid and enlarged	C	Ejaculation
[A]	A coiled tube on the outside of a testis that carries and stores sperm	D	Foreskin
[D]	The part on the penis that is removed during a circumcision	E	Testes
[B]	The tube that carries sperm from the testes to the urethra	F	Semen
[I]	A gland that produces a fluid that has fructose to provide energy for the sperm	G	Penis
[F]	A fluid that contains sperm cells and secretions from the male reproductive glands	H	Erection
[C]	Expulsion of semen from the male body	I	Seminal vesicle
		J	Scrotum

1.2

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

1.3 1.3.1

Caste	**Role in colony**
A Queen	Produces eggs/reproduces
B Soldier	Defend/protect the colony/kill predators
C Worker	Collect food/feed the queen/larvae/repair/clean the nest/ care for the young/grow food

1.3.2 Soldiers have large heads to block tunnels/defend the colony
Soldiers have large/protruding/sharp mandibles/mouthparts/pincers to attack invaders/defend colony
(1 mark for body structure + 1 mark relate body structure to function.)

1.4 1.4.1

Item	Term	Answer
1. Transports oxygenated blood 2. Transports blood from the amnion to the foetus	Umbilical artery	D
1. Attached to the wall of the uterus 2. Produces hormones to maintain pregnancy	Placenta	C
1. Has fully developed organ systems 2. Formed after implantation of the blastocyst	Embryo	B
1. Protects the foetus by absorbing shock 2. Maintains the temperature around the foetus	Amniotic fluid	C
1. Is the target organ of prolactin 2. Secretes FSH	Mammary gland	A

1.4.2
- (Near week 40) oxytocin increases exponentially to start labour/ begin uterine contractions
- Prolactin increases to start milk production

(Each hormone level described + explained)

1.5 1.5.1

	Statement	A, B or C
(a)	In country B, the percentage of the female population aged between 20 and 24 is between 4% and 6%.	A
(b)	There are more males than females between ages 80 and 84 in country A.	B
(c)	The life expectancy of the population in country A is lower than in country B.	B
(d)	The pyramid of country A represents a more developed country.	A
(e)	Countries A and B have the same ecological footprint.	C
(f)	Country A has a lower birth rate than country B.	A

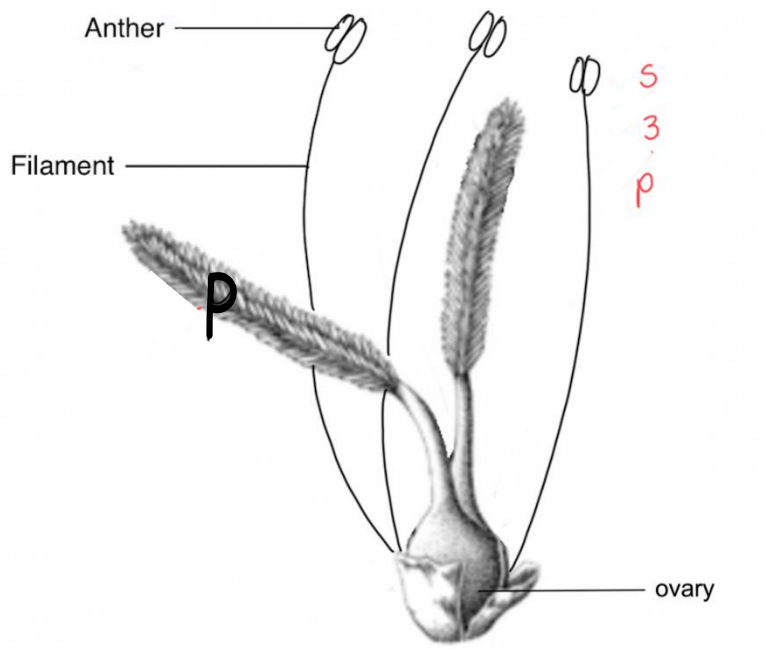
1.5.2
- Direct count/Census *(must have)*
- All households are visited/interviewed/questioned
- Information about the number of people/age/sex/occupations/ incomes of members living in household collected
- Conducted by government employees

(1 compulsory + 1 other fact)

1.5.3
- Informs government about the needs for infrastructure roads housing to be built
- Informs how tax money should be spent
- Understand growth of population
- Plan for schools
- Plan for medical facilities/hospitals
- Plan to provide social grants/dependency on government welfare
- Plan for employment opportunities/job creation

(Any 2)

1.6



1.6.1 (a) stamen drawn:
filament and anther longer than carpel
three stamens drawn
position: attached to carpel anywhere on ovary
(see diagram above)

(b) filament label
anther label
(see diagram above)

(c) Letter 'P' placed on anywhere on the stigma
(see diagram above)

(d) ovary label *(must not be placed on sepal)*
(see diagram above)

1.6.2

	Asexual	**Sexual**
Energy use	[low / high]	[low / high]
Number of parents	[one / two]	[one / two]
Gametes produced	[yes / no]	[yes / no]

(*mark for each correct row*)

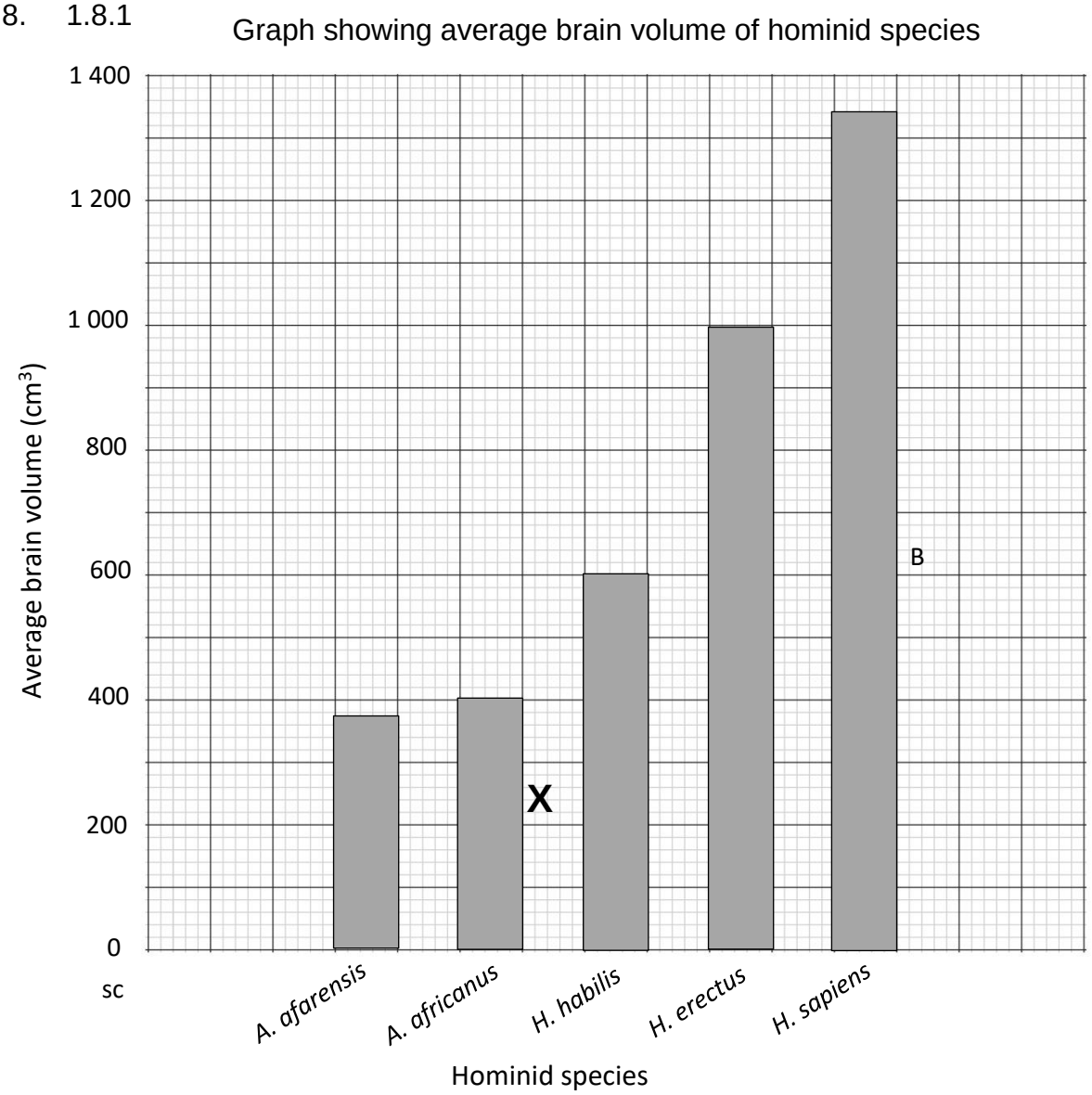
1.6.3
- Stem cuttings are easy to do/not labour intensive
- Farmer can select plants with known phenotype/features/ characteristics so phenotype of subsequent generations is predictable
- Asexual reproduction is easier/more successful since sexual reproduction occurs in low rates in sugar cane
- Farmers do not need to wait for seed production so shorter time until harvest
- More profitable for farmer as do not need to buy/collect seeds
- Faster/quicker reproduction don't have to wait for seeds/shorter growth time/don't need to wait for fertilisation
- Increase productivity multiple plants develop from cutting/cutting has multiple buds

(Any 4 or 2 well explained)

1.7

Statement/Description	**Number**
(a) Regulates blood glucose levels	4
(b) Produces testosterone	6
(c) Produces hormones that regulate many other endocrine glands	1
(d) TSH targets this gland	2
(e) Stops producing insulin, which results in diabetes type 1	4
(f) Secretes thyroxin to regulate metabolism	2
(g) The adrenal gland	3

1.8. 1.8.1



Heading: Graph showing average brain volume of hominid species
X-axis label: Hominid species indicated
Y-axis label: Average brain volume
Y-axis unit: cm³
Scale on Y axis
Bar graph (spaces between bars equal width/bars do not touch)
Plotting: A. africanus at 400 cm³ and H. sapiens at 1 350 cm³

1.8.2 *Homo erectus*
(Accept Homo sapiens)

1.8.3
- Source of warmth so could move to colder climates
- Inhabit areas previously inhabitable due to climate
- Co-operative behaviour/ communication such as rituals/ ceremonies/controlling fire requires planning
- Protection from predators
- Could cook food so had more diverse foods/meat
- Increase in nutrition/nutritional value as foods become more easily digested so improved brain development
- Could create/improve hunting tools/weapons
- Provide lighting so increased social time/gathering at night

(Any 2 or 1 well explained)

1.8.4 Position of X on graph anywhere between *A. africanus* and *H. habilis*

1.9

	A. Description of the physical feature of skeleton	**B. Importance of the skeletal feature for bipedalism**
1	Position of foramen magnum is in the centre/middle/directly under the skull	Maintenance of balance Vertebral column directly under head to support body in upright position
2	S-shaped spine/lower spinal column is strongly curved	Provide support/balance/weight of upper body Absorbs shock of walking Less energy spent on balancing
3	Femur angled inwards/femur angled towards the knee/femur and tibia join at an angle/femur is not directly straight with tibia	Foot is closer to body's centre of gravity helping with balance Relieves stress of the knee joint Can lock knees and stand for longer periods of time
4	Increased leg length	Larger leg muscle supported for upright gait
5	Foot bones are short and curved/arched feet	Allows for energy-efficient walking Supports weight of trunk/upper body Acts as a lever to transmit forces from leg muscles as the foot pushes against the ground Retains sufficient energy to function like a spring/pushes body forward
6	Enlarged hip joint/ broader/shorter pelvis	Better support for increased amount of body weight Support weight of body Lower centre of gravity
7	Big toe is aligned with other toes/not opposable/non-divergent big toe	Allows for a more efficient push-off
8	Enlarged heel bone on foot	Supports the weight of the body

(Any 3 skeletal features described + the importance of feature for bipedalism)

QUESTION 2

2.1 2.1.1 fertilisation

2.1.2 fallopian tube/oviduct

2.1.3 (a) middle piece/midpiece

(b) head

2.1.4 to provide energy for swimming through female reproductive tract

2.1.5
- the acrosome of the sperm contains (digestive) enzymes
- enzymes are released when sperm in contact with ovum
- enzymes break down/digest the (outer) walls of the ovum
- sperm nucleus released into cytoplasm of ovum

(Any 3)

2.2 2.2.1
- Missed/irregular period
- Infertility
- Acne
- Increased facial/body hair
- Weight gain
- Depression
- Mood swings

(Any 2)

2.2.2 (a) pituitary gland/hypophysis

(b) in the brain/between 2 lobes of brain/attached to/under hypothalamus

2.2.3 1/10 × 100 = 10%
(working + correct answer)

2.2.4 **Table showing differences in menstrual cycles in women with and without PCOS.**

Difference in menstrual cycle	Women with PCOS	Women without PCOS/ regular cycle
Ovulation/ ovarian cycle	No ovulation/ovulation unlikely/ova/eggs form cysts	Ovulation occurs/ova/eggs released
LH	LH levels remain high/do not fluctuate/consistently higher than FSH On average 15 µg/L	LH levels lower than FSH and peak near day 14 On average 10 µg/L
FSH	FSH levels are low/ do not fluctuate/ consistently lower than LH < 5 µg/L (less than)	FSH levels slightly higher than LH/peak near day 14 > 10 µg/L (greater than)
Menstruation	Missed or irregular menstruation	Regular menstruation
Follicles	Develop into cysts	Normal development

(*Heading*) + (*column headings*) + (*table format/construction*) + (*3 correct comparative differences*)

2.2.5 LH levels are lowered/decreased

2.2.6
- LH levels remain high/do not change/there is no surge or peak
- FSH levels remain very low in PCOS menstrual cycle
- Egg/follicle development does not occur/is not stimulated therefore no egg cells are released/no ovulation

(1 correct fact: LH + 1 correct fact: FSH + impact on infertility)

2.2.7
- May have painful periods which could result in absenteeism from work/school
- Cultural stigmas because of difficulty/inability in conceiving a child/women expected to have children/ carry on family lineage
- Financial cost to treat PCOS symptoms or to seek assisted reproductive technology (IVF, etc.)
- Emotional difficulties/mood swings/depression

(Any 2 or 1 well explained)

2.3 2.3.1 (a) Fish are a food source
There is a decline in wild populations
To conserve this species
To reproduce more offspring
(Any 2)

(b) Overfishing/pollution/pesticide use/urban development/ habitat fragmentation/habitat loss/introduction of invasive species
(Accept other feasible answers)

2.3.2
- Large number of offspring produced
- Short gestation periods
- Short time until sexually mature
- Short life spans
- Shorter life expectancies
- Few offspring reach maximum life span
- Little to no parental care
- Population growth is exponential
- Lots of eggs produced

(Any 3)

2.3.3 Saline is used as a control group to compare to the other treatments and to verify the effect of the independent variable/type of hormone/ hormone treatments used
(Any 2)

2.3.4
- Increase the sample size/number of fish per treatment
- Repeat the investigation many times to verify results
- Increase the number of hormone treatments
- Use different hormone concentrations
- Peer-review of results

(Any 2)

2.3.5
- Hormone Y *(must have)*
- Ovulation is increased/more likely/more fish ovulated 9 fish ovulated compared with 5 fish
- Greater number of eggs produced (2457 vs 1519) (78-79% compared to 60-61%)
- Highest number/1941 of offspring reaching maturity

(Correct hormone + any 2 supporting facts + 1 fact refers to data)

QUESTION 3

3.1 3.1.1 (Charles) Darwin

3.1.2
- Determine if organisms are genetically similar
- Determine DNA similarities/sequences shared
- Observe morphological similarities/look the same/share same physical features such as body shape/beak size/shape/structure
- Observe if able to interbreed/mate with one another
- Produce viable offspring after mating

(Any 2)

3.1.3 (a) A niche provides the resources and conditions needed for the species to survive allowing the species to maintain a viable population
(Any 2)

(b)
- Resources/food in area is shared/used differently
- Beak sizes/shapes are different
- Access to resources is varied
- Reduces competition between species
- Species won't compete for space
- Species won't compete for food as 1 species eats worms while another eats seeds

(Accept any examples of different diets)
(Any 3)

3.1.4 Divergent evolution
All species derived from one ancestral species/share a common ancestor/ similar in structure but different in function
(1 compulsory + reason)

3.1.5 Islands like the Galápagos are difficult to get to/isolated
as oceans are geographical barriers
so species that colonise the island
are reproductively isolated
may be limited food sources/resources
need to diversify so don't come into direct competition
islands have empty niches to be filled
so opportunity for adaptive radiation
(Any 2)

3.2
- Fossil evidence preserved remain/traces of organisms from the past/simple to more complex organisms in fossil record/ as they can be dated to create a timeline/fossils show changes over time
- Biogeography closely related species would be located nearby from having descended from common ancestor/ study of the distribution of species across the world
- Comparative anatomy similarities in homologous structures indicate common ancestry/analogous structures indicate organisms do not share common ancestry
- Comparative embryology the similarities in the development of the embryo of species support ancestry
- DNA/Genetics shared DNA sequences between organisms can show relatedness/descent from a common ancestor
- Molecular biology/comparative biochemistry fewer sequences/proteins, etc shared between organisms the more distantly related
- Vestigial structures functional homologous structure suggests common ancestry
- Modification by descent similar species descended from a common ancestor

(line of evidence named × 2 + description of line of evidence × 2)

3.3 3.3.1 Natural selection/ survival of the fittest

3.3.2 Number/amount of objects captured/picked up **OR** Type of food

3.3.3 B

3.3.4 Shape at the end of peg too thick/blunt/large/indented so can't touch /won't fit/difficult to grip rice grain
Rice grain too small to be gripped by end of the peg
Mouth of peg too far back/too little room to grip
Tip of forceps is sharp/allows for precise grip on rice grains so will pick up rice grains faster forceps have a larger opening so easier to pick up rice grains
(1 facts relating to peg + 1 fact relating to forceps + 1 other)

3.3.5 Yes
Variation of beak sizes is represented by the various shapes of instruments/different instruments used
A struggle for survival is represented by the time limit to access food/competition between other 'beak types'
If an organism is poorly adapted it will not survive
No
Reproduction and inheritance of variation is not represented the instruments are unable to reproduce

(1 fact referring to principles of nat.sel shown + explanation)

3.4 3.4.1 Organisms change during their life acquire structures/phenotypic changes/organs to adapt to the environment and these changes to structures/phenotypic changes/organs are passed onto the offspring
(Any 2)

3.4.2
- Understand how biological concepts have changed
- Provide ideas which other scientists can work from
- Know what earlier scientists understood
- Know what mistakes were made/such as phenotypic changes can't be passed onto offspring
- Encourage open mindedness/don't dismiss other hypotheses/ other viewpoints
- Promote critical thinking
- Some of Lamarck's observations were correct living species are different to some fossils indicating species have changed over time
- Environmental factors do affect phenotype
- His observation in domestication of plants and animals indicates changes have occurred
- Lamarck's theory highlights that science should be testable

(Any 3)
(Accept other reasonable answers, e.g., epigenetic link)

3.5 3.5.1 Allopatric speciation is the formation of new species due to a physical/geographical barrier while sympatric speciation is the formation of new species while both species continue to inhabit the same geographic region

3.5.2 Reproductive isolation in pincushion proteas:
- Different flowering seasons
  pollen produced at different times
  L. tottum has shorter flowering season (late spring to early summer) while *L. arenarium* has longer flowering season (late winter to early summer)
- Adaptations to different pollinators *L. tottum* is pollinated by birds while *L. arenarium* is pollinated by mice *L. tottum* branches grow upright while *L. arenarium* branches grow towards the ground

(2 Facts + description)

3.5.3 (a) Powderpuffs
Share a more recent common ancestor/speciation event between powderpuffs and vexators more recent/ divergence time is more recent

(b) 80 million years ago (accept mya)
(check final printed copy)

(c) White trees

QUESTION 4

4.1 4.1.1 individuals in the group must:
- be the same species/all *Loxodonta africana*
- live in the same/defined area
- be able to interbreed/produce viable offspring

4.1.2 (a) Elephant populations have decreased over time/from 1800 until 2015
(Answer must refer to both variables correct relationship identified)

(b) mortality

(c) 5 million

4.1.3
- Human population expansion/movement/urbanisation causing land conversion or habitat transformation from savannah to farming land and urban areas
- Increased human population growth demand more land for towns/cities/infrastructure resulting in habitat loss for elephants
- Commercial hunting for ivory products/ivory trade
- Wars/conflict in Africa resulted in hunting of elephants for meat
- Poaching of elephant for meat/ivory/skins to sell
- Formation of game reserves which reduce elephant range/less area to roam
- Culling policies in reserves to counteract habitat destruction/to align with carrying capacity of reserves
- Disease/parasite infestation affecting elephants resulting in lowered fertility/increased deaths, etc.
- Climate change/drought/global warming so habitat reduced/forests retreated/lack of water/food
- Building of fences/Habitat fragmentation causes change in migration routes

(Any 3 well explained facts)

4.1.4
- Improve access to food/resources
- Increase range/territory while avoiding roads/human infra-structure
- Support the spread of seeds to enhance biodiversity
- Prevent soil erosion/habitat destruction allow vegetation to recover from grazing
- Increase genetic variation by cross breeding
- Allow natural migration routes

(Any 2)

4.1.5
- Large areas can be surveyed so less time consuming/more efficient than surveying on foot
- Allows surveying of terrain/areas that are difficult to access on the ground so more areas can be surveyed/improves reliability of determining population size
- Elephants can be dangerous/other dangerous wildlife can be encountered on the ground so aerial survey limits these encounters/is safer/not too close elephants
- Elephants are large/slow moving so it is easier to sample from above

(2 advantages explained)
(Accept other feasible advantages)

4.1.6
- Eliminates bias
- Allows an equal chance for individuals to be chosen
- Populations are not always evenly distributed
- Improves fairness/validity/reliability of method
- Allows for an accurate conclusion

(Any 2)

4.1.7 (a)
- Secondary succession *(must have)*
- Soil is present/colonisation is not on bare rock/there had already been plants in the area
- Seeds present in the soil

(1 compulsory fact + 1 other fact)

(b) Pioneer/colonisers

4.2 4.2.1 There are more individuals/members in a group
- Increase in protection/safety as predators can be spotted more easily/ can surround and intimidate predators
- Increased care/defence for the young as young are placed in the centre of the herd
- Improved access to resources as more members to look out for food
- Allows for development of relationships/meets social needs as elephants are highly social animals

(Any 4 or 2 well explained facts)

4.2.2 Intraspecific competition
Elephants belong to the same species/all are *Loxodonta africana*

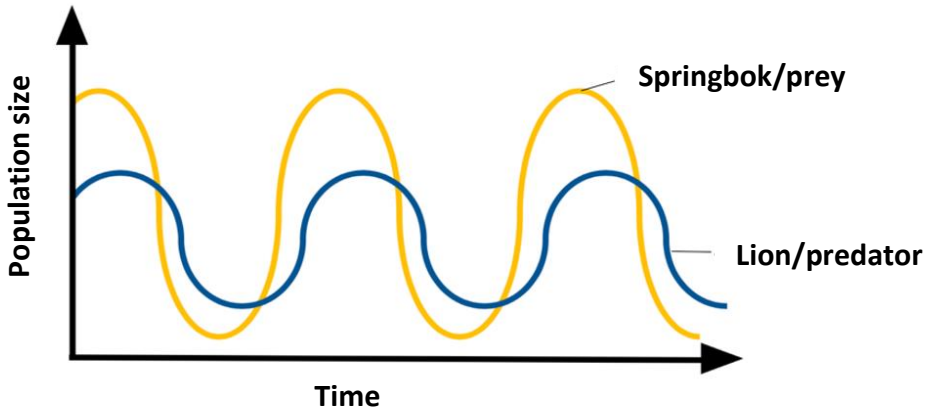
4.2.3 (a)
- Lack of food
- Limited space/habitat
- Increase in disease
- Lack of mates
- Lack of water to drink
- Predators

(Factor identified)

(b)
- Lack of food – elephant die from starvation
- Limited space/habitat – vegetation is destroyed/decrease in food/no area to raise and protect young
- Increased number of predators/predations – elephants die
- Increase in disease – poor health may cause death
- Lack of mates – lowers reproductive potential
- Lack of water to drink – die due to dehydration

(Check reason corresponds with Question 4.2.3 (a))

4.3 4.3.1 **Graph showing predator-prey relationship**



Heading
x-axis label: time
y-axis label: population size/growth/number of animals
prey line above predator line
predator line lags behind prey line

4.3.2
- Lion removes old/weak/diseased individuals
- So keep the population genetically fit as strongest survive to reproduce
- So lowers the number of prey that could serve as hosts to parasites/to reduce overgrazing/allow vegetation to recover
- Keystone species so maintain biodiversity

(Any 3)

Total: 200 marks