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OUTSTANDING SCHOLARSHIP EXEMPLAR



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Tick this box if you
have NOT written
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☐

Scholarship 2022 Biology

Time allowed: Three hours
Total score: 24

ANSWER BOOKLET

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

Write your answers in this booklet.

Start your answer to each question on a new page. Carefully number each question.

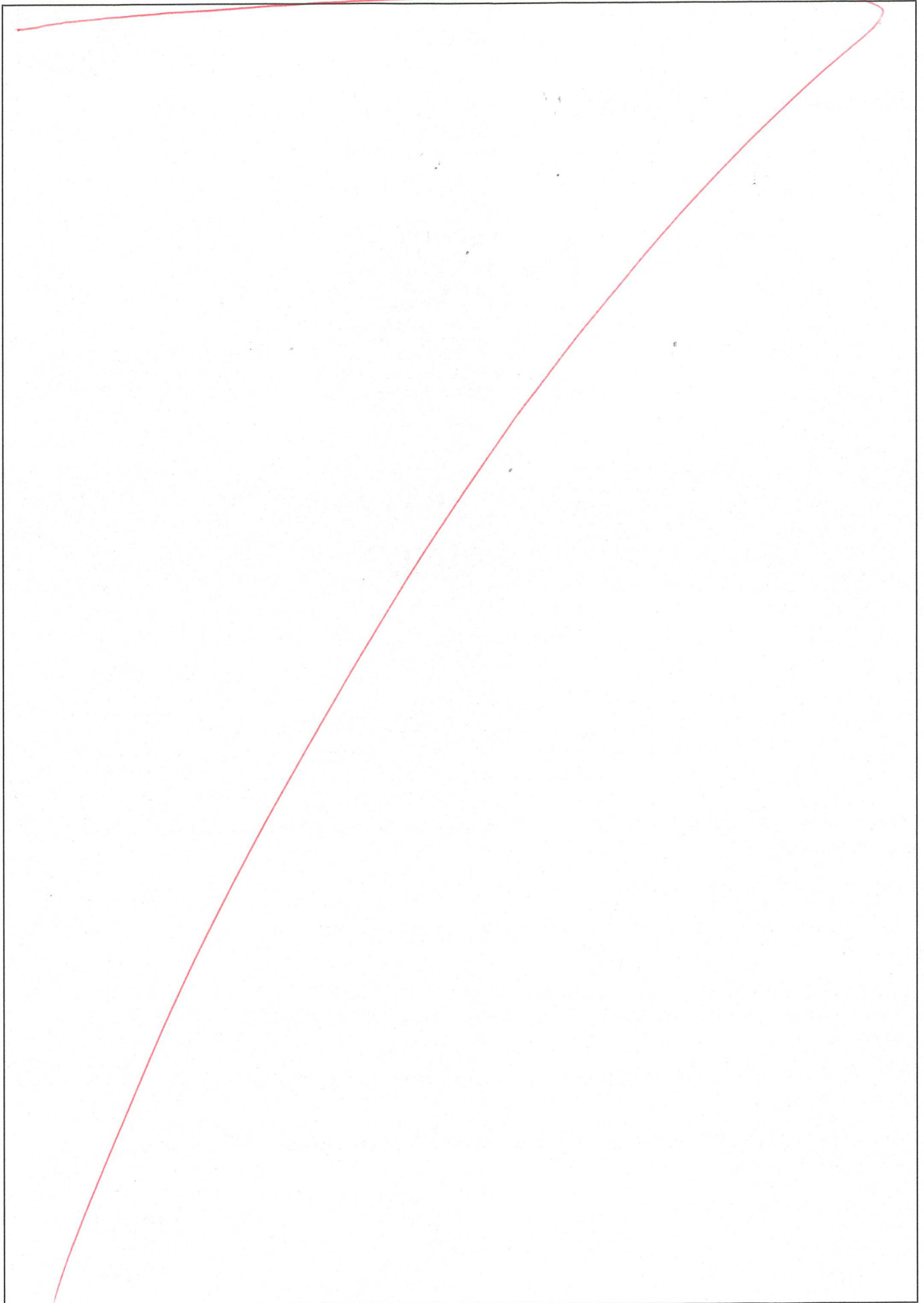
Check that this booklet has pages 2–26 in the correct order. Pages 2–4 are blank and are to be used for planning. Pages 5–26 are lined pages for writing your answers.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Question	Score
ONE	
TWO	
THREE	
TOTAL	

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PLANNING

PLANNING

Fully dependent on prairie dogs

↳ food

↳ shelter

low reproductive rates + slight R-strategy
as kits are independent after being weaned

solitary hunters, territorial

↳ may result in aggressive behaviour

short lifespan → individuals dying without
reproducing can be fatal.

Bottleneck from disease - 18 individuals (low
genetic variation).

7 successfully bred - further loss of
genetic variation

Higher numbers but at a cost of low CrV.

↓ prairie dog habitat loss + death = fatal

& diseases which are fatal

Big loss of CrV + sperm quality reduction +
low F, PR + LS = severely endangered.

Cloning, CRISPR + transgenesis + IVF

PLANNING

Live underwater due to new niches opening up
↳ adaptive radiation

Have many adaptations which enable them to survive underwater and cold climates

streamlined body (swimming)

dense bones (cold - able to withstand)

increases visual sensitivity - see in water better

enhanced thermoregulation

ability to go for long periods without feeding

100 genes - natural selection

common ancestor with Procell...

adaptive radiation as marine predators gone

50 extinct species - competition

dense bones help to withstand cold but won't help with interspecific competition

smaller penguins - warmer waters
can't withstand cold that well

Acc - helped with dispersal

adaptive radiation.

Great auk - competitor

convergence

analogous structures

Question 1.

5

Penguins are able to thrive today thanks to the rich evolutionary history they possess. They share a common ancestor with the Procellariiformes. However due to the extinction of apex predators such as large sharks and marine reptiles, a new niche was opened up which penguins then inhabited. This is an example for adaptive radiation where the opening up of new niches enable organisms to disperse and occupy them, resulting in those organisms to split from the main population.

As this new niche ~~was~~ had a ~~lot~~ drastically different climate and way of surviving, the selection pressures such as the cold and prolonged swimming for food selected for features that would help penguins survive in that niche. Such features include:

- streamlined body for faster and more effective swimming
- dense bones and bigger body to help live in the cold conditions
- increased visual sensitivity to help see better underwater
- ability to go for long periods without food so biological processes can still continue even in the absence of food.
- insulating layer of feathers to help withstand the cold better.

These features helped the penguin to occupy their niche more effectively.

Considering that penguins were flying birds before the split from the common ancestor, these features that help them to inhabit the colder and wetter climate, would have occurred due to beneficial mutations that were then selected for by natural selection. //

However, even though penguins had features that helped them to survive the new niche, that did not help with competition at the time.

Marine animals such as toothed whales and seals became more abundant ^{25 MYA} which meant competition in that ~~species~~ niche increased significantly. Gause's Law states that no two animals cannot occupy the same ecological niche. The better adapted organism would outcompete the other organisms. //

~~As~~ As a result, giant penguins at that time became extinct. Dense bodies are able to withstand cold much better but are more energy costing to maintain. //

Considering that competition between marine animals was already increasing, food was becoming more scarce as a result, there wasn't enough food to help maintain the large 115kg giant penguins. Thus, extinction of those species occurred. //

Nowadays, penguins are ~~much more~~ smaller with a decreased mass. ^(1.1m with 30kg mass) This ensures that the species can still thrive ~~to~~ even when food is scarce as ~~there~~ less energy is required to help maintain their ~~bodies~~ ^(with 1.6m and 115kg mass) as compared to the ~~giant~~ penguin. Furthermore, increased ability to go for long periods without feeding ensure that penguins are ~~much~~ better adapted to occupy their oceanic niche and deal with food scarcity as a result of interspecific competition. //

Penguins were further diversified around 22 mya into smaller penguins who inhabit warmer ~~regions~~ ^{regions} waters to larger penguins who inhabit colder regions. This is another example of adaptive radiated radiation. The final separation of Antarctica from Australia and South America ~~allowed~~ produced the ACC which enabled penguins to disperse new island groups.

The population that dispersed to the new island groups would have been exposed to different selection pressures ~~for~~ from a warmer climate. Since larger bodies are less efficient to lose and manage in such conditions, mutation that resulted in a smaller size would have ~~helped~~ been selected for by natural selection, enabling the population in the warmer island groups to ~~be~~ ^{be} more efficiently adapted to ~~their~~

that climate. As a result, nowadays we can see larger penguins occupying colder regions while smaller penguins can ~~see~~ inhabit ~~a~~ much warmer regions. //

Due to geographic isolating mechanisms, ~~additionally~~, ~~the~~ penguins are the ~~two~~ ~~to~~ different species would not be able to interbreed due to stopped gene flow between the populations. Thus accumulation of mechanical, ~~and~~ temporal, ecological and behavioral RIMS ensured that ~~these~~ ~~these~~ these populations became separate species. //

~~Just~~ penguins can be seen as masters of their niche due to the extinction of the great auk. ~~Convergence enable~~ ^{resulted ~~to~~ due to} them to occupy a similar niche and analogous structures can ~~be~~ be seen such as webbed feet and swimming capabilities. Since Gause's Law states that the better adapted species would outcompete the other species, the great auk was driven to extinction while penguins are still able to inhabit and thrive in their niche today. //

Due to the rich evolutionary history penguins possess, they are a diverse and bulky adapted oceanic sealid to this day. //



Question 2.

10

Black-footed ferrets ~~are solitary and territorial~~ animals ^a are severely endangered species due to a variety of factors. //

They are solitary and territorial species that live in prairies. These open spaces make them more susceptible to be seen by predators. Being solitary organisms, they don't have the support of other group members who can help them to look out for predators and other threats. Furthermore, they are territorial animals. This can result in aggressive behaviour ~~which can result in death~~. ~~Between other black-footed ferrets~~ which can ^{lead to} ~~result in~~ death. // Coupled with the fact that these organisms have a very short lifespan, these factors ~~can result in it may be a factor to~~ may all have contributed to the critically endangered status that these organisms possess. //

These ferrets have a short lifespan of 1 year and in some cases 3 years. Additionally they have low reproductive rates. This means that individuals that die ^{successfully} ~~die~~ before they are able to reproduce is fatal for the species as this results in less individuals who are able to pass on alleles to ensure the continuation of the species. //

females ~~not~~ give birth to ~~an~~ an average ~~small~~ litter of 3-4 kits but utilize ~~implement~~ slight R-strategy which results in kits having to maintain ~~themselves~~ themselves independently ~~in a~~ after a short period of time. If these kits were to die ~~&~~ before reaching sexual maturity, this results in the decline of the species as once again, there are less individuals that are able to successfully reproduce to pass on alleles to the next generation. //

Furthermore, black-footed ferrets are completely ~~&~~ dependent on prairie dogs for survival. This competitive relationship means that the decline of the prairie dog populations will result in the ~~the~~ decline of the ferret population. This is due to the fact that 90% of the ~~ferret's~~ ferret's diet is composed of prairie dogs; coupled with the fact that ~~pr~~ prairie dog burrows are relied on by black footed ferrets for shelter, protection and raising of young. //

This fully dependent competitive relationship's effects can be seen in this day as prairie dog populations are rapidly declining. The 95% loss of prairie dog habitat, collapsing of their burrows and population control through poisoning has resulted in a lot of prairie dog population pressure. //

Considering how reliant black ~~ferret~~ ferrets are on the

prairie dogs, they are all also subjected to the same pressure. ~~this is because the loss of~~ The loss of the beaver's food and shelter loss has made them more susceptible to death and eventual extinction. //

Furthermore, the bottleneck effect in 1986 of the Wyoming black beaver population resulted in a significant loss of genetic variation due to the remaining population having a much smaller gene pool than the original population. Additionally, only 7 ~~of~~ out of the 18 successfully bred. As a result, a further loss of genetic variation resulted. This leads to inbreeding depression and harmful alleles can become more prominent which may lead to further decline in the population. Even though the captive bred population resulted in 620 black-footed beavers living, the loss of genetic variation makes them severely susceptible to being wiped out from environmental pressures. //

This can be seen where the beaver population is susceptible to diseases such as sylvatic ~~plague~~ plague and the ~~the~~ disease caused by the CPV virus which is usually fatal.

The decreased immunity ~~to~~ to such diseases means that individuals who may have been able to successfully reproduce are wiped out

before they can do so. The remaining population would have another huge loss of genetic variation which results in males with a reduced sperm quality mating. The reduced fertility, pregnancy rates and litter size due to this account for unfit individuals being reproducing and passing on unfit alleles which result in the species being less adapted to survive in their environment. //

Thus the black-footed ferrets become critically endangered as a species. //

In order to improve the ferret's very vulnerable status, cloning of the male SB2 may help. As the female Willa had 3 times more genetic variety than the current black ferret population, these individuals may be able to boost the genetic variation of the black ~~ferret~~ ^{deal with} population, making them better adapted to their own environmental pressures. //

IVF treatments can ~~assist~~ ^{assist} with ensuring that better pregnancy rates occur which will increase the chances of successful birth and an increased number of offspring to continue the species. //

The insecticide control of fleas in prairie dog populations can reduce the effect of the

sylvatic plague making that disease less widespread which gives both prairie dogs and black-footed ferrets better chances of survival. //

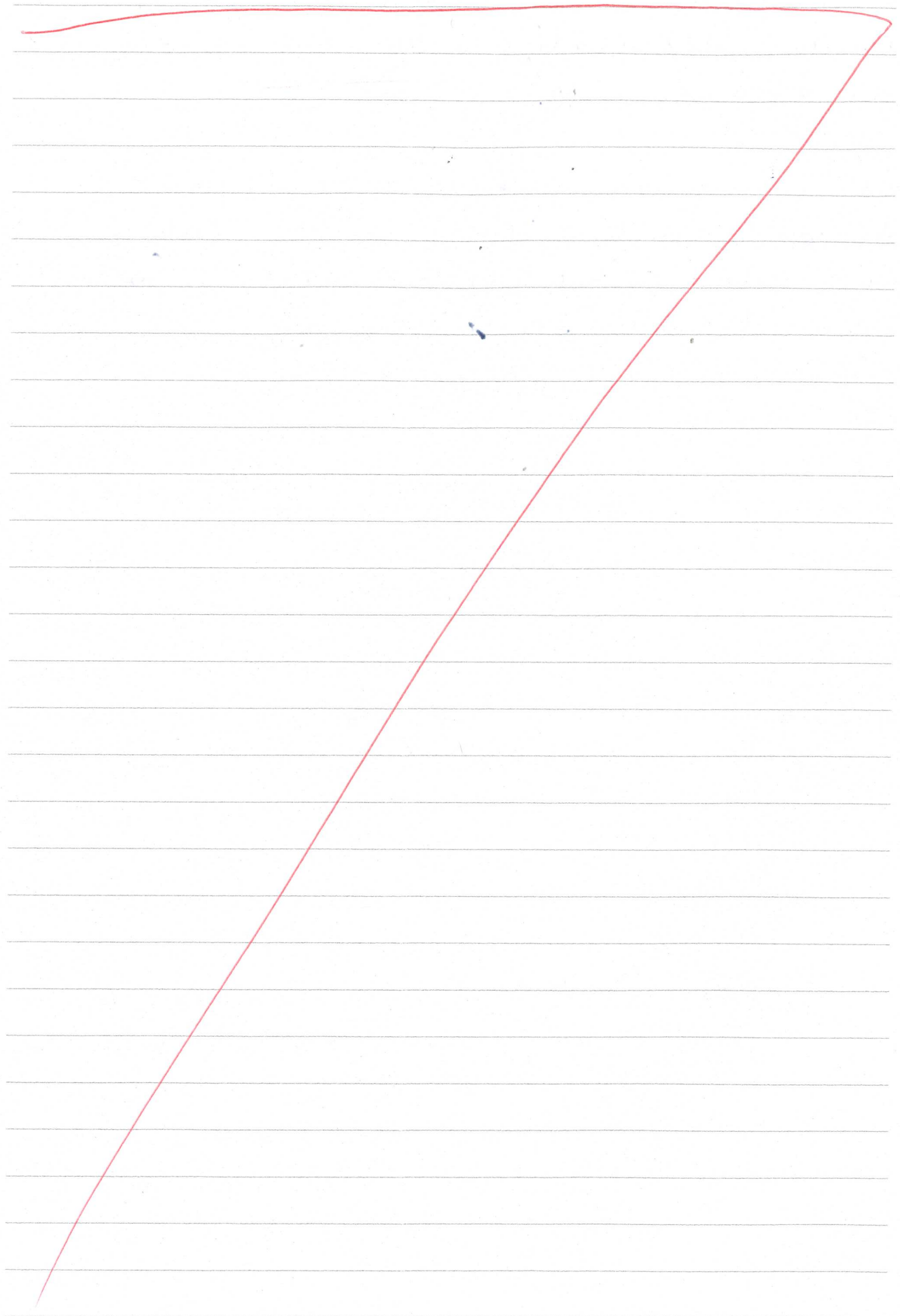
Vaccination of the ferrets against both diseases can boost their immunity to both diseases. As a result, less deaths from disease occurs which helps the population to stay alive to reproduce successfully and receive healthy offspring. //

Conservation of prairie and grassland habitats ensure that the threats those areas face from humans decreases. Prairie dog burrows would become less susceptible to collapsing which will help black-footed ferrets to retain the protection, shelter and raising of young advantages that the burrows gave to the ferrets. Furthermore, the prairie dog population can increase which means that the ferrets receive their food supply back, thus improving life for them. //

Lastly, CRISPR treatments and transgenic techniques can be used to improve immunity of prairie dog which makes them more adapted to deal with diseases in the future. This ensures that even if further diseases that can affect the

berrets occur in the population, the boosted immunity would greatly enable them to ~~but~~ fight those diseases. //

These conservation methods are all valid and would be beneficial to ensure that the black-footed berrets do not remain in ~~an~~ a critically endangered status ~~for~~ in the future. //



Question 3.

17

Homo floresiensis (H.F) have several features that indicate whether is part of the *Homo habilis* group or *Homo erectus* group. //

Flores being a heavily forested island with limited food sources indicates that features that helped with ^{both} living in trees and walking on ground was selected for. This can be seen where the long-foot and a flat arch were features that ~~where~~ are seen in the skeleton. Since these features are similar to ancient hominins such as *H. habilis* and *australopithecines*, this shows that ~~climbing~~ features that helped with climbing were being selected for again. Furthermore, the "heavily forested" area would have prevented running as running would require more open ground. //

Limited food sources ensure that there were not enough nutrients to fuel bigger bodies. Thus, the H.F species would have been significantly smaller than *H. habilis* and *H. erectus*.

Less food for brain would ~~be~~ mean that brain would become smaller. ~~As a result,~~ ~~a large cranium to hold a smaller brain~~ would have been ~~unnecessary~~ unnecessary.

Thus, ~~cranium size decreased~~. Less food would also mean that smaller individuals that require ~~the small forehead~~ less energy to maintain their

bodies would get selected for. This resulted in a decreased height and weight of H.F. //

The small forehead means that frontal lobe of the brain is much smaller ~~and~~ which is responsible for social activities and making decisions. //

All this would point toward the smaller similar body form of H. habilis and H. f. ~~dispersing~~ from Africa 2 million years ago. //

However, H.F. was able to control fire as seen by the evidence of the charred bones of the Stegodon. H. erectus is the first species to ^{use} ~~have had~~ control fire as discovered by evidence unearthed of charred bones of animals. This means that H.F. ~~would~~ origin would fit the evolutionary model of H. erectus leaving Africa and moving through Indonesia and heavily forested Flores where limited food supply resulted in them becoming smaller. //

Additionally, to get to Flores, a boat was required as the sea level was at least 24 km even at low sea level. Some degree of intelligence would have been required to construct a raft or boat to reach Flores. A level of intelligence that H. habilis is not known to possess. //

The stone tools that were found ~~to~~ are similar in shape and form to the Acheulean tools that *H. erectus* was known to use, despite being smaller. The method of preparing these tools can be seen as requiring more intelligence than preparing the Oldowan tools that *H. habilis* used. ~~The~~ The tools seem to have more flakes in them than Oldowan tools, which suggests that a H.F. possessed a *H. erectus* level of intelligence which means that the second model would best represent the evolutionary origin of H.F. //

The number of tools is also greater, meaning that they were used for a bigger variety of purposes such as cutting meat, chopping wood, accessing bone marrow and ~~for~~ more effective hunting of the *Stegodon*. //

Once again, the level of intelligence better represents that of *H. erectus*. //

This model can be further proved from the wrists of H.F. being more similar to African apes and australopithecines. This shows that due to the different environment of shores, climbing features were once again being selected for. //

In conclusion, the evidence points to the second model to indicate the evolutionary history of H.F.

This means that the more intelligent *H. erectus* left Africa and moved through Indonesia and Korea where the changing environment resulted in *H. erectus* evolving primate features suitable for ^{both} climbing trees and walking on ground in the ~~more~~ heavily forested environment. //

Annotated Outstanding Scholarship Exemplar Template

Subject	Biology Scholarship	Standard	93101	Total score	20
Q	Grade score	Annotation			
1	6	<p>This candidate gained 5 justified points and 3 describe points for this question. They described adaptive radiation correctly but did not link this to <i>vacant/newly unoccupied</i> niches due to the extinction of apex predators. Selection for features seen in penguins was well described but no link was made to these features increasing reproductive success so this limited the points given. This candidate cited Gause's principle correctly, with detail on the interspecific competition for food/resources that occurred when marine mammal numbers increased, leading to giant penguin extinction. The second adaptive radiation event was well discussed and also the selection for larger/smaller bodied penguins due to adaptive advantage with respect to thermoregulation in specific niches. A deeper understanding of the convergent evolution of giant Auks and penguins with clarity around them not sharing a common ancestor, would have led to an improved grade. Generally, a solid understanding of the ecological and evolutionary processes that have resulted in modern day penguin species.</p>			
2	7	<p>6 justified points and 2 describe points were given in this question. The reproductive behaviour of the ferrets was discussed with the consequence of slow population recovery, but the K-strategy was not named explicitly. The interspecific relationship between the black footed ferrets and the prairie dogs was not clearly named (predator/prey or exploitation) which was required to access the EP points. The bottleneck effect was comprehensively discussed, with genetic diversity and inbreeding consequences explained well. Management of the vulnerable ferret population by captive breeding programs to overcome some of the negative consequences of inbreeding (eg sperm quality) and increase reproductive success was clearly justified. In addition, the use of genetic tools, such as cloning, to reintroduce genetic diversity and increase adaptability of the population to environmental change was comprehensively discussed. With deeper discussion into other management techniques, such as insecticides and vaccination to stop the spread of the diseases and the long-term positive effect on survivability, reproductive success and eradication of these illnesses, this grade would have increased.</p>			
3	7	<p>5 justified points and 4 describe points were given for question 3. The primitive biological features of <i>Homo floresiensis</i>, such as the foot structure and general size of body and brain, were attributed to a possible <i>Homo habilis</i> origin. Selection for small/dwarf body size was linked to the low energy, heavily forested island habitat and also to the features that enhance climbing ability. Despite describing aspects of the culture of <i>Homo floresiensis</i>, such as controlled use of fire and ability to construct rafts/boats, and attributing these to more advanced behaviour and a likely <i>Homo erectus</i> origin, the detailed justification regarding planning/communication/complex thinking/Brodmann's area 10 was lacking. The advanced tool culture exhibited by <i>Homo floresiensis</i> was comprehensively discussed, with links to acheulean tools and improved hunting. This candidate constructed a well written answer with the model of <i>Homo erectus</i> origin supported with evidence and justification.</p>			