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MARKSCHEME

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BIOLOGY

Higher Level

Paper 3

11 pages

Option D — Evolution

1. (a) both show a (similar) range of life spans;
both have a peak at 12–14 hours;
SFS flies have higher mean life span than NFS flies / vice versa;
(some) SFS flies live longer than 16 hours, NFS flies do not;
(some) NFS flies live less than 10 hours, SFS flies do not; ***[3 max]***

(b) SFS has the drier climate as SFS flies live longer (when subjected to drought stress);
both SFS and NFS have similar climates as both SFS and NFS flies have peak at 12–14 hours; ***[1 max]***

(c) NFS and SFS flies have different gene pools;
abiotic differences between the two slopes create different selection pressures;
genes/alleles for advantageous characteristics passed on from one generation to the next/become genetically different over time;
may not mate / reproductive barriers/isolation leads to speciation;
abiotic/geographical differences may not be sufficient to cause reproductive barrier;
the gene pools may not be separated if flies can fly between sides of canyon/mix at base of canyon; ***[3 max]***

2. (a) (i) the time taken for radioactivity (of a radioisotope) to fall to half of its original level / for half of the atoms of the isotope to decay ***[1]***

(ii) ^{40}K decays into ^{40}Ar;
ratio/proportion of ^{40}K to ^{40}Ar indicates the age of the rock/fossil;
half-life of ^{40}K is 1250 million/1.25 billion years;
^{40}K can (only) be used to date very old samples/older than 100 000 years; ***[2 max]***
Do not accept if make reference to age less than 100 000 years.

(b) (i) 200 – 168 = 32 flies had short wings
$q^2 = 32 / 200 = 0.16$
$q = 0.4$
$p = 0.6$
$2pq = 0.48$;
*Award **[1]** for correct working. (Looking for the logic of the working)*

percentage of heterozygotes = 48 %; ***[2]***
*Award **[1]** for correct answer.*

(ii) large population/random mating/no selection/no migration/no mutation ***[1]***
*Award **[1]** for any **two** correct answers. Mark the first two answers given.*

(c) a group of organisms consisting of <u>all</u> descendants from a common ancestor ***[1]***

3. eukaryotic cells contain mitochondria/chloroplasts that are not found in prokaryotic cells;
organelles evolved from (independent/free living) prokaryotes that were taken into/engulfed by larger cells by endocytosis;
these cells were not digested/survived in mutualistic/symbiotic relationship;
they continued to carry out respiration/photosynthesis;
mitochondria/chloroplasts grow and divide like cells;
mitochondria/chloroplasts have a loop of/naked DNA like prokaryotes;
mitochondria/chloroplasts have <u>70S</u> ribosomes like prokaryotes to synthesise proteins;
mitochondria/chloroplasts have double membranes expected when taken into a vesicle by endocytosis;
thylakoids (in chloroplasts) similar to structures containing chlorophyll in prokaryotes; ***[6 max]***

Option E — Neurobiology and behaviour

4. (a) $0.16\,mg\,min^{-1}$ *(units needed)* ***[1]***
Allow answers in the range 0.15–0.17.

(b) *hypothesis supported:*
general increase in food collection over the twelve day period;
large increases day 1–2/day 6–7/day10–11;

hypothesis not supported:
most food collected on day 7;
on some days there are declines / days 3–5/8–10 no increase overall / large decline day 7–8;
large error bars so data very variable/much overlap between data points;
only 38 bees in study/sample size too small for drawing valid conclusions; ***[3 max]***

(c) (weather) variations in temperature/some days warm, some days cold/rainfall/wet days, dry days / in wind speed;
flowers produce more nectar on some days than on others / different flowers open on different days / more flowers open on some days / flowers different distances away so time spent travelling differs;
bees needed for other duties – defending colony/swarming/ventilating colony;
harvesting behaviour develops after day 1 as foragers find flowers/communicate; ***[2 max]***

5. (a) sound waves/vibrations in air cause ear drum/tympanic membrane to vibrate;
vibrations amplified by middle ear bones/ossicles/malleus, incus, stapes;
causes oval window/fluid in cochlea to vibrate;
stimulates mechanoreceptors/hair cells;
auditory nerve passes nerve impulse to brain; ***[3 max]***

(b) (i)

Rods	**Cones**
function well in dim light / more sensitive to low light	function well in bright light;
absorb all wavelengths of visible light / not responsible for colour vision	sensitive to red, green or blue wavelengths / responsible for colour vision;
poor visual acuity / impulses from several rods pass to a single neuron in the optic nerve	good visual acuity / impulses from a single cone pass to a single neuron in the optic nerve;

[2 max]

Do not accept "rods detect black and white images".

(ii) (bright) light detected by photoreceptors/rods/cones in retina of eye;
(sensory) impulses/messages sent to brain along optic nerve;
medulla oblongata/brain stem processes impulses;
(motor) impulses/messages sent to (circular) muscles of iris (which contract);
pupils constrict; ***[3 max]***

6. development of bird song has both innate and learned components;
when birds hatch they may possess a basic song (crude template);
species specific (so inherited/innate/genetic);
after hatching young birds hear songs from adults of their species;
(so learn as) mimic/memorise/modify the basic template;
song does not develop properly if the young bird does not hear other members of its species singing;
some birds have a sensitive period of development when they learn;
later young birds practise what they have heard;
song becomes modified/improved to form mature adult song/ song perfected when birds become sexually mature; ***[6 max]***
Marks can be awarded if specific named example is used containing the points above.

Option F — Microbes and biotechnology

7. (a) *cases of malaria:* 150 *(accept answers in the range 145–155)*
monthly rainfall: 165 mm *(accept answers in the range 160–170)* ***[1]***
Both needed for ***[1]****.*

(b) both graphs show fluctuating patterns;
malaria rises/falls later than/after rainfall;
malaria peaks in July, rainfall peaks in May/Apr–May;
June to November – little variation in rainfall, decline in cases of malaria;
both decline August to December / during Mar–Apr malaria declines while rain fall increases;
both show lowest value in December; ***[2 max]***

(c) *hypothesis supported:*
increased rainfall is followed by increased malaria / strong positive correlation between rainfall and number of (future) cases of malaria;
rainfall provides pools for mosquito larvae to survive (when adults emerge later they spread the disease);

hypothesis not supported:
very large values of standard deviation suggests data is unreliable / malaria data less reliable than rainfall;
correlation between malaria cases and rainfall does not prove causation; ***[2 max]***

(d) temperature fluctuations;
cycles in breeding and populations of mosquitos;
cycles in populations of malaria parasites in human hosts;
malaria only identified when symptoms show;
immigration of infected workers to tea plantations;
seasonal spraying of mosquitos/insecticide (causes population decline); ***[2 max]***

8. (a) (i) symptom;
transmission;
treatment; ***[3]***

eg Salmonella food poisoning
symptoms: diarrhoea/fever/abdominal cramps/Reiter's syndrome.
transmission: by contact after poor personal hygiene/eating contaminated food (not properly cooked)/transferred from faeces of pets/from reptiles/poor kitchen hygiene/raw eggs/unpasteurised milk.
treatment: rehydration/lots of drinking/intravenous fluids/antibiotics.
*Award **[1 max]** for each symptom, transmission and treatment.*
*Award **[2 max]** if candidate does not mention the type of food poisoning. "Bacterial food poisoning" is too vague.*
Example given must be verifiable.

(ii) *acids:*
low pH/pickling/preservation in vinegar restricts growth of microbes/denatures enzymes;
sugar:
sugar (added to food) dehydrates microbes so it restricts growth / microbes lose water by osmosis; ***[2]***

(b)

Intracellular (*Chlamydia*)	**Extracellular (*Streptococcus*)**
lives inside cells of host	lives outside host cells;
does not produce toxins/no toxins to irritate tissues/does not damage cells	produces toxins/damages cells;
host may not be aware of infection/asymptomatic	produces symptoms (sore throat) so host aware of infection;
not targeted by immune system / (usually) long-term infection	targeted by immune system / (usually) short-term infection;
sexually transmitted disease / infectious conjunctivitis	respiratory infection / pneumonia / skin infections;

[2 max]

Answers do not need to be in table format.

9. prion hypothesis has protein as infecting agent;
prions are abnormal/misfolded forms of proteins (already present);
name of prion protein is called major prion protein/protease–resistant protein/PrP^{SC}/CD230;
the (infecting) protein is found in the brain;
prions can cause normal proteins to change (to abnormal/misfolded) shape;
misfolded proteins form chains/agglutinate/accumulate;
cause chain reaction/positive feedback creating more and more abnormal proteins;
chains interfere with normal cellular functions/cause disease symptoms;
prion hypothesis supported as no foreign/viral/bacterial DNA/RNA found;
named example of prion disease *eg* scrapie/CJD/BSE/kuru; ***[6 max]***

Option G — Ecology and conservation

10. (a) 2006 ***[1]***

(b) increases steadily from 1998 to 2002 and plateaus between 2002 and 2006;
overall increasing trend / lowest percentage in 1998 and highest in 2006; ***[1 max]***

(c) fledging success is always greater than breeding success;
show opposite trends before 2002; *(accept a description)*
follow (closely) similar trends after 2002; *(accept a description)*
maximum difference (in percentage) in 1998;
difference remains smallest between 2002 and 2006; ***[2 max]***

(d) many of the eggs laid do not hatch but those that do hatch fledge successfully ***[1]***

(e) eggs may have been laid late in the breeding season so warmer temperatures / shorter time for parental care (leading to low fledging success);
predation of parents/chicks;
weather conditions at time of fledging may have been unusually harsh;
food sources may have been reduced; ***[2 max]***

11. (a) (i) temperature;
water;
breeding sites;
food supply;
territory;
predators / parasites / pathogens; ***[2 max]***

(ii) only one species can occupy a niche indefinitely;
more than one species results in competition for breeding sites/food/other resource;
one species will disappear from the ecosystem/be excluded; ***[2 max]***

(b) sufficiently large sample size/area of study for both capture and recapture samples;
appropriate time interval between capture and recapture;
marking techniques must be suitable for the animal species being studied / marking must not directly harm/increase chance of predation/bias results;
$\frac{n_1 \times n_2}{n_3}$ gives estimate of population size;
n_1 = number captured in first sample
n_2 = number captured in second sample
n_3 = number in second sample that are marked
All three needed for the mark;
[3 max]

12. alien species is one introduced (by humans) to an area in which it does not naturally occur;
inter-specific competition – competition between different species for resources/ food/light/space/other valid answers;
valid example stated *eg* in the UK the larger grey squirrel is better adapted to utilize food resources than the native red squirrel / *eg Salvinia molesta/*floating fern grows very rapidly over the surface of tropical lakes eliminating native plant species; ***[2 max]***

predation – one species feeding on another;
evalid example stated *eg* lampreys in St. Lawrence Seaway depleting stocks of lake trout and whitefish / *eg* rats (*Rattus rattus*) introduced onto islands in New Zealand fed on eggs/young birds/adults of native species (which were not behaviourally able to resist them); ***[2 max]***

species extinction – one species causing another to become extinct;
valid example stated *eg* many species of cichlids in Lake Victoria extinct after introduction of nile perch (introduced to increase fish population) ; ***[2 max]***

biological control of pest species – species introduced deliberately to control a pest;
valid example stated *eg* purple loosestrife in USA and Canada invades wetlands and displaces native species / *eg Salvinia* weevil introduced to feed on *Salvina*/floating fern that has damaged many lakes in the (sub) tropics; ***[2 max]*** ***[6 max]***

Option H — Further human physiology

13. (a) $510 - 90 = 420$ (beats min^{-1}) *(accept 420/–420/decrease of 420)* ***[1]***
Accept answers in the range 400–440.

(b) during diving heart rate decreases while arterial blood pressure increases;
swimming causes little/no change from control in both heart rate and arterial blood pressure;
diving produces greater change than swimming in heart rate and arterial blood pressure;
little/no differences between rats diving voluntarily or submerged involuntarily; ***[2 max]***
*Award **[1]** if candidate describes swimming and diving for heart rate and then swimming and diving for arterial bp correctly.*

(c) diving rats hold their breath while swimming rats do not;
so heart rate decreases/peripheral blood vessels constrict in diving/submerged rats;
swimming rats have no need for the diving response so little/no change from control;
constriction of blood vessels in diving rats raises arterial blood pressure;
diving response conserves oxygen (for essential functions); ***[2 max]***

(d) heat loss (from skin) is greater in cold water therefore vasoconstriction is greater / vice versa;
diving response slows heart rate so less blood flows to skin so less heat lost in cold water;
increased vasoconstriction increases arterial blood pressure;
vasoconstriction/increased blood pressure helps to maintain core temperature in cold water;
decrease in body temperature causes heart rate to slow; ***[2 max]***

14. (a) (i) *steroid hormone:* oestrogen/progesterone/testosterone;
protein hormone: ADH (vasopressin)/insulin/TRH;
other valid examples; ***[2 max]***

(ii) presence of food/stretching of stomach stimulates endocrine glands (in stomach wall);
gastrin secreted;
gastrin/hormone stimulates increased secretion of HCl; ***[2 max]***

(b) increased CO_2 in blood / lower blood pH;
detected by chemosensors/chemoreceptors/receptors in aortic/carotid arteries;
nerve impulses/messages sent to breathing centre of medulla/brain;
breathing centres/medulla also monitor blood pH/CO_2;
(more) nerve impulses/messages sent to diaphragm and intercostal muscles (causing increased muscle contraction); ***[3 max]***

15. erythrocytes have a lifespan of approximately 120 days;
erythrocytes rupture releasing hemoglobin into bloodstream;
phagocytosis removes hemoglobin/erythrocytes;
by Kupffer cells/macrophages;
hemoglobin split into heme and globin;
globins hydrolysed into amino acids;
iron removed from heme;
(heme) converted into (biliverdin then) bilirubin (bile pigment);
iron stored/released into blood; ***[6 max]***