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BIOLOGY

Standard Level

Paper 3

14 pages

Option A — Diet and Human Nutrition

A1. (a) (Type II) diabetes; ***[1]***

(b) 350 (%); ***[1]***

(c) 60 (%); ***[1]***

(d) calculation of both BMI / $\text{BMI} = \frac{120}{4} = 30$ and $\text{BMI} = \frac{132}{4} = 33$;
30 (%); *accept correct answer without working for 1 mark.* ***[2]***

(e) obese patients have high (blood) cholesterol/lipid;
increases the risk of CHD;
accumulation on artery wall / atherosclerosis;
clotting\ blocking in coronary artery;
extra body mass / weight places strain on the heart;
high blood pressure; ***[3 max]***

A2. (a) name of additive;
harmful effect;
e.g. tartrazine (E102); asthma / skin rashes / hyperactivity;
e.g. sulfites;
allergic reaction/ asthma;
e.g. olestra;
diarrhea/ dehydration
e.g. nitrates/nitrites;
stomach cancers;
e.g. monosodium glutamate (E622);
allergic reaction/rapid heart beat/ headache/sweating;
e.g. salt;
high blood pressure; ***[2 max]***

(b) antioxidant;
prevents damage by hydrogen peroxide / oxidative compounds; ***[2 max]***
especially in membranes;
can help to prevent sterility;
strengthens capillary walls;
retards cellular ageing;

A3. (a) lack of calciferol / vitamin D;
lack of calcium in diet;
needed for calcium absorption in intestines / keeps calcium levels within limits;
loss of mass or calcium from bones;
bones brittle and fracture / collapsing vertebral column;
calciferol found in milk / egg yolks / liver;
but diet not the only cause / not related to diet;
hormonal changes / low estrogen / menopause;
prolonged treatment with steroid drugs;
lack of exercise;
lack of sunlight decreases vitamin D synthesis; ***[4 max]***

(b) vegans do not include animal products in their diets;
vegetarians exclude meat and fish, but include eggs / dairy products; ***[2]***

Option B — Physiology of Exercise

B1. (a) (i) ATP/ phosphocreatine ***[1]***

(ii) final sprint is at high speed for a short period of time;
ATP is the fastest source of energy;
used by fast/twitch/white muscle fibres;
muscles contain enough ATP for about five seconds contraction (very short time); ***[2 max]***

(b) (i) 60 (%) (± 3) *accept correct answer without any working*: ***[1]***

(ii) group riding uses mainly aerobic respiration while hill climbing uses mainly glycolysis;
group riding uses lower percentage of system capacity than hill climbing;
aerobic is greater than ATP in group riding, but the same in hill climbing;
Statements must show comparison. ***[2 max]***

(c) train a lot aerobically;
as used in all three types of riding;
or
train both types of muscle (twitch and tonic);
as aerobic and anaerobic respiration takes place;
or
adjust training to requirements / types of riding;
as in group riding aerobic is used, in hill climbing glycolysis is used, and in final sprint ATP; ***[2 max]***

B2. (a) (i) bones move out of alignment / out of joint

(ii) (minor) tearing of ligament ***[2]***

(b) flexion and extension / in only one plane; ***[1]***

(c) oxygen and glucose carried in blood;
glycogen stored (in liver) broken down to glucose;
bronchioles widen to increase ventilation;
metabolic rate increases;
heart rate increased to pump blood faster;
dilation of blood vessels leading to muscles / constriction of blood vessels to skin, gut, kidneys and liver;
spleen contracts releasing more blood; ***[3 max]***

B3. (a) (i) (physical condition that allows) performing a particular exercise ***[1]***

(ii) if able to perform quick movements involving change of direction then greater fitness ***[1]***

(b) antagonistic muscles;
inhibitory neurons prevent triceps from contracting;
release neurotransmitter which prevents impulse being propagated to motor neurons; ***[2 max]***

Option C — Cells and Energy

C1. (a) (i) 27 (± 1)

(ii) 90 (± 1) ***[2]***

(b) as the concentration of Mg increases the rate increases;
most rapid increase between 1 and 2 mmol dm^{-3};
peaks at 4 mmol dm^{-3};
until it plateaus (at 5 mmol dm^{-3}) / no more increase/drops slightly; ***[2 max]***

(c) 1:4 ***[1]***

(d) (i) membrane bound is 10 times more efficient (12000 to 1200);
difference is (12618-1215) 11403 arbitrary units greater in membrane bound;
about 1000 % greater / 938.5 % greater; ***[1 max]***

(ii) purification could have affected structure of protein;
bound to membrane allows interactions / other molecules in membrane may help it / be acting as coenzymes; ***[1 max]***

C2. (a) enzymes (catalytic) / membranes / structural / transport / movement / hormones / defense / gene regulation / storage / pigmentation; ***[2]***
*Award two correct **[2 max]**.*

(b) (i) fats broken down into fatty acids and glycerol;
fatty acids broken down into 2 carbon fragments;
a 2 carbon fragment (is oxidised) to form acetyl CoA;
acetyl CoA goes to Krebs cycle;
by joining with oxaloacetic acid;
to produce energy;
"regulates" rate of fat metabolism; ***[2 max]***

(ii) occurs in the stroma;
produced by the light dependent reaction;
photosystem I is activated by light giving away excited electrons;
electrons pass through a series of carriers;
$NADP^+$ accepts two (high energy) electrons;
$NADP^+$ accepts H^+ (to form $NADPH + H^+$); ***[3 max]***

C3. (a) mitochondria ***[1 max]***

(b) shows membrane of a mitochondrion/ chloroplast;
H^+ is pumped out across membrane;
more H^+ outside (from electron transport chain);
concentration gradient of H^+ is formed / potential energy;
H^+ movement across membrane through protein channels in ATP synthetase;
ADP is phosphorylated / picks up phosphate to ATP;
ATP has more energy than ADP;
chemiosmosis; ***[3 max]***

Option D — Evolution

D1. (a) 1.8 million years ago (± 0.1) ***[1]***

(b) 6.2 to 6.8 million years ***[1]***
Allow any value between these dates.

(c) *H. erectus*, *H. ergaster*, *P. robustus*, *P. boisei* (at 1.5 million years) ***[1]***

(d) *Australopithecus,* because they have more characteristics in common;
both are bipedal and have a small brain;
only difference is size in teeth;
but could be *Homo,* because they lived at the same time; ***[2 max]***

(e) using information from DNA from chimpanzees and humans / molecular clock ***[1]***

(f) potassium 40 / ^{40}K ;
ratio of potassium 40 : argon 40 measured;
gives age in half-life; ***[2 max]***
Do not accept C_{14}.

D2. (a) grow and divide;
contain DNA (like prokaryotes) / naked DNA (looped);
have ribosomes / synthesize proteins;
double membranes/ have own membrane;
cristae of mitochondria similar to mesosomes of prokaryotes;
thylakoids of chloroplasts similar to photosynthetic part of prokaryotes;
sensitive to chloramphenicol antibiotic; ***[3 max]***

(b) ammonia ;
methane ;
hydrogen;
water vapour; ***[2 max]***
Do not accept formulae alone

D3. (a) organisms can acquire / develop characteristics during their lifetime;
characteristics develop through use;
characteristics can be passed to offspring / inherited;
example of an acquired characteristic; ***[2 max]***

(b) limbs in vertebrates are similar in shape / homologous(anatomical) structures;
develop from a five digit limb;
but used in many different ways / divergent evolution;
structural similarities imply a common ancestor;
examples given (*e.g.* bats' wings and horses' leg); ***[3 max]***

Option E — Neurobiology and Behaviour

E1. (a) A ***[1]***

(b) before training rats pressed lever in all sectors / uniformly distributed;
after training they pressed lever when close to reward sector / mainly in sector A / clustered;
rats obtained more reward before than after training. (although in % it is less efficient); ***[2 max]***

(c) 0.18 ($\pm$ 0.02) / $\frac{9 \times 5}{240}$ / 45 to 240; ***[1]***

(d) trial and error ;
rats learnt to anticipate (reward);
food reward is reinforcement;
pressing lever is operant response;
[3 max]

(e) rats are eating their reward, so do not press lever;
as object has passed rats do not press lever;
not hungry any more;
anxiety makes rats press lever before time; ***[1 max]***

E2. (a) ants / termites / mole rats / chimpanzees / humans / dolphins / lions / honey bees / wolf / emperor penguins ***[1]***
*Award **[1]** for each two correct.*

(b) they are fertile males;
if no drones no offspring;
if females already fertilized, no change;
drones are product of unfertilized eggs so colony can (eventually) recuperate; ***[3 max]***

E3. (a)

	Rod	***Cone***
Intensity of light needed	dim/low intensity	bright / high intensity
Number of cells connected to one neurone of optic nerve	many / up to 200	one

[2 max]

*Award **[1]** for each correct row or column, up to **[2 max]**.*

(b) *I*: association/ relay neurone/ ;
II: muscle / effector; ***[1]***
*Both answers are required for **[1].***

(c) named bird or mammal;
place where it moves from and place where it moves to;
cues/reason for moving / how it navigates;
e.g. Greater shearwaters;
from Scandinavia to the South Atlantic;
migrate to avoid cold winters / low food availability;
shortening of day triggers migration;
navigation involves using sun position ;
or
arctic tern;
from Alaska/ UK to Antarctica;
shortening of day;
navigation by sun;
or
grey whale;
along Californian coast;
for food/ to breeding grounds;
or
swallows;
from UK to S Africa;
shortening of day;
navigation by sun;
or
white storks;
from N. Europe to Africa;
shortening of day;
compass; ***[3 max]***

Option F — Applied Plant and Animal Science

F1. (a) $8.5\,t\,ha^{-1}$ (± 0.2) *(units required)* ***[1]***

(b) 3 (± 0.2) ($t\,ha^{-1}$) ;
6.5 (± 0.1) –3.5 (± 0.1); ***[2]***

(c) IR8 had lower yield than HYC (except in 1975 and 1983);
both had a negative correlation / as years passed both had less yield;
yield of IR8 decreased more throughout years than HYC; ***[2]***

(d) best fit / regression line;
line should pass through point representing mean value;
distribution of points above and below should be (approx.) equal/show trend;
proximity of points to the line gives degree of correlation; ***[3 max]***

F2. (a) select characteristic *e.g.* cows with highest milk yield / sheep with best meat / poultry which lay more eggs ;
breed or cross;
repeat process (or a number of generations);
selective breeding; ***[2max]***

(b) obtaining offspring by crossing unrelated individuals from different varieties /strains;
Do not accept different species.
e.g. mule = donkey + mare/horse ***or*** crossing unrelated varieties of maize(sweetcorn); ***[2]***

(c) increase in fertility/fecundity of livestock;
semen of bulls of poor health is not used;
semen of many different bulls can be used;
many cows can be served at a time;
semen can be frozen for future use;
semen can be diluted so one sample can serve many inseminations; ***[3 max]***

F3. *auxin*: stimulation of cell growth and division / callus formation/root initiation; control apical dominance;
g*ibberellin*: induce/ increase shoot growth/ prevents dormancy;
cytokinin: stimulates cell division / leaf growth; ***[3]***

Option G — Ecology and Conservation

G1. (a) (i) 0.06 ($\pm$ 0.01) mg m^{-3} (*units are required*) ***[1]***

(ii) 60 ***[1]***

(b) increases just below sea level / between 0 and 5 m / greatest amount 5 m below sea level;
decreases as depth increases / greatest decrease after 15 m;
slight increase at 90 m: ***[2 max]***

(c) more food near surface therefore more copepods;
but only some correlation between numbers of microalgae and copepods;
two other named causes such as predators, pH, salinity, temperature, light ;
explanation of a possible cause *e.g.* warmer nearer surface therefore faster growth; ***[3 max]***

G2. (a) (i) members of different species that live together (in a close relationship) where both benefit/neither suffers ***[1]***

(ii) rumen bacteria / protozoa;
algae and fungus (lichen);
shark and remora;
cleaner wrasse and other fish;
accept hippos and oxpecker bird;
sea anemone and hermit crab;
Rhizobium and root nodules;
Mycorrhiza (fungus) and *tree roots;*
Zoochlorella and *Hydra* or corals; ***[1 max]***

(b) if two organisms have the same niche;
they shall compete for food / habitat/ breeding site;
the best adapted will cause the disappearance of the other;
e.g. (Gause's) experiment with *P.aurelia* and *P.candatum*; ***[3 max]***

G3. (a) name of extinct animal;
cause for extinction; ***[2]***

e.g. Ararà / Blue Guacamayo (*Anodorhynchus glaucus*);
loss of breeding habitat / sold as pet;
dodo;
by rats eating eggs/ overhunting;
Carolina parakeet;
loss of habitat/farmers killing them/ feathers used in clothing/ pets;
Passenger pigeon;
overhunting/eaten;
Tasmanian wolf;
overhunting/ competition from introduced dingo;

(b) monitoring stocks and reproduction rates;
quotas/limits of catches by season;
quotas/limits of catches by fishing zones;
moratoria (legal measures to block) on catching endangered species;
minimum mesh sizes;
banning drift nets;
stop “pirate” ships:
enforcement difficult / policing necessary; ***[4 max]***