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MARKSCHEME

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BIOLOGY

Standard Level

Paper 3

12 pages

Option A – Diet and Human Nutrition

A1. (a) *Award **[1]** for any two of the following*
fat / saturated / unsaturated;
cyanocobalamin / vitamin B_{12};
pantothenic acid;
energy;
carbohydrate;
riboflavin / B_2;
pyridoxin / B_6;
tocopherol;
cholesterol; ***[1 max]***

(b) both are low in carbohydrates / pantothenic acid / tocopherol / unsaturated fats;
both are high in protein / retinol / thiamin / niacin / folic acid;
diet A is high in ascorbic acid / fibre, diet B is low;
diet B is high in energy / fat / cholesterol / riboflavin / niacin / cyanocobalamin,
diet A is low; ***[3 max]***

(c) *Award **[1]** for each diet from the following.*
diet A: weight loss due to lack of energy;
diet A: pernicious anaemia (or any of the symptoms of it);
diet A: high levels of folic acid may mask the initial symptoms of pernicious anaemia;
diet B: lack of fibre may lead to problems in the large intestine or even to colon cancer;
diet B: lack of ascorbic acid may lead to scurvy (or any of the symptoms of it);
diet B: excess of fat / cholesterol may lead to heart disease *(or similar)*;
diet B: excess of fat may lead to overweight or obesity;
diet A/B: lack of pantothenic acid may cause fatigue / numbness / tingling of hands and feet; ***[2 max]***

***note**: dietary deficiencies have not been described for insufficient intake of tocopherols due to lack of documented evidence in humans.*

A2. (a) *Award **[1]** for any **two** of the following.*
cell membranes;
energy reserve;
can be remodelled to make steroids / hormones;
insulation;
protection;
myelin sheath; ***[1 max]***

(b) $\frac{100}{24} \times 16 = 66 - 67$ g (*unit required for mark*) ***[1]***

(c) diets high in lipids may lead to (high blood cholesterol levels which may lead to) coronary heart disease (other circulatory problems);
a causal link has not been established between high blood cholesterol levels and coronary heart disease;
bodies can synthesise cholesterol from unsaturated fats (which do not have a strong correlation with coronary heart disease);
diets high in lipids (are often high in energy which) may lead to obesity; ***[3 max]***

(d) *one function for each needed for* ***[1]***

retinol:
maintainance of mucous membranes of eye and respiratory tract;
formation of rhodopsin / pigments of the retina;
bone / teeth growth;
embryonic growth and development;

tocopherol:
antioxidant / prevents damage to phospholipids in cell membranes / prevents sterility; ***[1 max]***

A3. avoids contamination with potential pathogens / bacteria (*e.g.* botulism / salmonella) / viruses (*e.g*. hepatitis A) / parasites (*e.g*. roundworm eggs);
prevents disease;
avoids food spoilage / keeps longer;
helps to maintain nutritional quality; ***[3 max]***

Option B – Physiology of Exercise

B1. (a) $\frac{446 \text{ mmol s}^{-1}}{74 \text{ mmol}} = 6.03 \text{ s}$ (*unit required for mark*) ***[1]***

(accept 6.0 or 6 s)

(b) rate of ATP use is higher when lactate is produced / rate of ATP use is slower when CO_2 is produced;
when CO_2 produced a longer pathway is used / lactate pathway is shorter / fermentation pathway is shorter;
lactate pathway has less ATP available than CO_2 pathway; ***[2 max]***

(c) muscle ATP and creatine phosphate used first at start of the run / quick energy source;
muscle glycogen is then utilised to lactate;
lactate pathway anaerobic;
aerobic respiration uses glycogen to CO_2 in muscle and liver for energy;
most energy is stored in fat tissue and would be used to complete marathon; ***[2 max]***

B2. (a) *Award **[1]** for warm up and **[1]** for cool down.*
warm-up:
stretch muscles;
prevent muscle strain;
increase blood circulation;
begin fat mobilisation for energy;

cool-down:
remove waste from muscles;
repay O_2 debt;
keep muscles from tightening up / flexibility; ***[2 max]***

(b) *Award **[1]** for specificity and **[1]** for progressive overload.*
specificity:
exercise specific muscle / muscle groups;
increase specific range of motion;
skill acquisition;

progressive overload:
exercise muscles and keep increasing intensity of workout;
increase resistance;
allows adaptation of muscles to increasing intensity of workout; ***[2 max]***

B3. (a) ***[1]*** *for each comparison*

hip	knee
ball and socket joint / femur and pelvis form joint	hinge joint / tibia, fibula and femur
all planes of movement / extension, flexion, abduction, adduction and rotation	allows extension and flexion
more flexible	limited rotation / less flexible

[3 max]

(b) motor neurone / efferent neurone / effector neurone ***[1]***

(c) signal reaches terminus, vesicles released and travel to cell membrane;
release of neurotransmitter from pre-synaptic membrane / vesicles fuse with membrane / exocytosis;
diffusion of neurotransmitter across synaptic cleft;
reception of neurotransmitter at post-synaptic membrane;
breakdown of neurotransmitter; ***[2 max]***

Option C – Cells and Energy

C1. (a) C_3 uses less energy than C_4 and CAM plants;
C_4 uses (1.6 ×) more energy than a C_3 plant;
CAM uses (2.0 ×) more energy than a C_3 plant;
amount of energy used $C_3 < C_4 <$ CAM = ***[2]***; ***[2 max]***

(b) C_3 plants use less energy but lose more water than either C_4 or CAM plants;
C_4 plants use more energy but lose less water than C_3 plants;
C_4 plants do better in high temperatures / limited water areas than C_3 plants;
CAM plants conserve the most water but need more energy;
CAM plants are found in environments where water is limiting;
CAM plants close stomata during the day and open them at night; ***[4 max]***

C2. (a) vesicles ***[1]***

(b) presence of active site for the substrate / mention of lock and key;
lowering of activation energy;
slight change of enzyme conformation when substrate enters; ***[2 max]***

(c) binding to an allosteric site / not the active site;
causes a change in conformation / shape of active site;
substrate less efficient at binding to active site; ***[2 max]***

C3. ATP provides energy to the light independent reactions / Calvin cycle;
ATP produced by photophosphorylation;
RuBP carboxylase catalyses the reaction with carbon dioxide and RuBP;
no ATP required for RuBP carboxylase reaction;
RuBP carboxylase catalyses the reaction to form two GP molecules;
some of the energy needed to reduce GP comes from ATP / 2 ATPs per CO_2;
energy from ATP is also used to regenerate RuBP; ***[4 max]***

Option D – Evolution

D1. (a) (i) unidentified animal ***[1]***

(ii) human and gibbon ***[1]***

(b) no;
it has 9 of 14 amino acids different / 64 % different / 36 % similar / many amino acids different / poor match of amino acids;
it has less matching amino acids than the gibbon that is not of the same genus; ***[2 max]***

(c) offspring from a common ancestor will undergo mutation;
causing variation in the DNA sequence controlling any protein such as haemoglobin;
accumulated variation in subsequent generations can be traced in a history of evolutionary changes (family tree) of related species;
most closely related species have most similar amino acid sequences for a common molecule such as haemoglobin; ***[2 max]***

D2. (a) clay can concentrate amino acids / organic monomers from dilute solutions;
because monomers bind to charged sites on clay particles;
at some binding sites, metal atoms (iron and zinc) exist;
which can catalyse dehydration synthesis reactions;
linking monomers;
many binding sites on clay allow for the formation of polymers; ***[2 max]***

(b) appropriate size;
have inner membranes with enzyme / transport system;
reproduce by splitting / binary fission;
have their own DNA;
contain ribosomes; ***[2 max]***

(c) peppered moths exist in two forms (light and dark);
dark form was rare before Industrial Revolution;
was easy prey for birds which could see the dark moths resting on light-coloured lichens covering trees;
Industrial Revolution darkened landscape allowing light forms to be seen;
overall population of peppered moths shifted to darkened form;
the environment had 'selected' the variant (dark form) which was most favourably adapted to survive and reproduce; ***[2 max]***

D3. *Award **[1]** for bipedal characteristics, **[1]** for ape-like characteristics, and **[1]** for African origin.*

Bipedal: foramen magnum under skull / skull on top of vertebral column;
short arms and long legs;
knock-kneed;
long heel and short toes;
non-opposable big toe;

Ape: large cranium / brain;
no tail;
opposable thumb;

African origin: early hominid fossils only found in Africa; ***[3 max]***

Option E – Neurobiology and Behaviour

E1. (a) females no change / slight decrease in play behaviour with mothers;
females increase play behaviour with fathers;
females play more with their mothers than males do during the period 5-28 weeks;
females play more with their fathers than males do during the period 29-52 weeks;
play behaviour of males with mothers and fathers is the same at 5-28 weeks after birth; ***[3 max]***
males no change / slight decrease in play behaviour with fathers;
males decrease their play behaviour with mothers;

(b) 74 % ± 2 % ***[1]***

(c) grooming activities show a similar pattern of fluctuations as with play activities;
there is a greater change in frequency of grooming activities during weeks 17-28 than in play;
grooming activities show a dramatic increase whereas joint picking and tugging activities decrease slightly; ***[2 max]***

E2. (a) (i) mechanoreceptors ***[1]***

(ii) *Award **[1]** for any **two** of the following.*
chemoreceptors;
thermoreceptors;
proprioceptors;
baroreceptors;
photoreceptors; ***[1 max]***

(b) phototaxis is movement away or towards light;
photosynthetic protists or prokaryotes move toward light and thereby improve their food production capabilities;
juvenile blowflies move away from light in search of food; ***[2 max]***

E3. (a) example of Lorenz experiment with geese or other suitable example with the following elements:
imprinting is learning that is limited to a specific time period (immediately after hatching for geese);
goslings identify with the imprinting stimulus (Lorenz and his ticking clock);
the imprinted behaviour has an impact on later interactions (geese preferred human companionship over geese); ***[2 max]***

(b) involves a behaviour that benefits others while reducing individual fitness;
example: a ground squirrel will send a warning signal that causes others to hide when a predator is present;
this behaviour puts the ground squirrel at greater risk for being caught by a predator;
survival of the population is improved by the loss of individual fitness; ***[3 max]***

Option F – Applied Plant and Animal Science

F1. (a) Red flour beetle / *Tribolium castaneum* ***[1]***

(b) 36 ± 2 units ***[1]***

(c) 60 ± 2 units ***[1]***

(d) different sizes so amount of avidin which is toxic will vary;
a different enzyme system in each beetle / species results in a different amount of avidin becoming available for combination with biotin;
(corn is not primary diet for all three species so) amount ingested / eaten will vary;
amount of biotin needed by each beetle / species varies so amount of avidin which will combine will vary;
innate resistance to avidin varies between species; ***[2 max]***

F2. (a) concentrating experts from around the world on solving food problems in a particular region;
having certain regions specialise in production of crops most suited to the region so that worldwide efficiency is improved;
solve distribution problems when excesses are grown in one region;
shared use of advanced technology to improve communication between producers and consumers on a world-wide level;
guaranteed economic incentives for farmers in crop-rich nations to produce more food for international markets; ***[3 max]***

(b) measure relative growth rate where dry mass in unit time is divided by dry mass of plant;
measure net assimilation rate where increase in dry mass in unit time is divided by leaf area;
for aquatic plants do light bottle / dark bottle study where oxygen consumed by phytoplankton in dark bottle is compared to oxygen produced and consumed by phytoplankton in light bottle;
measure plant uptake of C-14 tracer through photosynthetic activity; ***[2 max]***

(c) selective hybridisation;
has led to disease (stem rust) resistant wheat;
and semi-dwarf forms which can tolerate heavy applications of fertiliser without falling over;
allowing for easy harvesting;
and high yield;
genetic modification; ***[2 max]***

F3. through inbreeding;
animals with desired traits (phenotypes) are bred with close relatives to retain desired traits;
through outbreeding;
unrelated individuals, each with beneficial traits, are bred together to combine the desired traits in the offspring; ***[3 max]***

Option G – Ecology and Conservation

G1. (a) ① primary consumer / herbivore, ② secondary consumer, ③ tertiary consumer / top consumer ***[1]***

(b) gross = net + respiration;
$44,070 + 50,111 = 94,181$ kJ m^{-2} y^{-1}; (*unit required for mark*) ***[1 max]***

(c) theoretical transfer is 10 %;
the biggest transfer of energy was from the producers to primary consumers;
primary to secondary 14 % / more than the theoretical was transferred;
1st to 2nd, 4.5 % / less than the theoretical was transferred;
2nd to 3rd, 8.9 % / less than the theoretical was transferred;
most efficient transfer was producer to consumer;
2nd and 3rd levels had higher respiration rates; ***[3 max]***

G2. (a) *Award **[1]** for each of the following.*
water:
more rainfall allows more plants species to grow / under 25 cm of rain is a desert, fewer species grow (tundra / desert);
seasonality, rain falls during growing season;
too much water limits plant distribution as well / causes water logged soil (flooding);
some species are best adapted to low water levels (*e.g.* cacti) / some species are adapted to high water levels (*e.g.* rice);

temperature:
warm temperatures more conducive to growth;
cool temperatures shorter growing season, fewer plant species;
seasonal fluctuations of temperature also limits plant distribution;

water × temperature:
warm temperatures with water (tropical rain forest) more plants;
hot temperatures with lack of water (desert), fewer species adapted;
cold temperatures water frozen for part of the year (tundra), fewer plant species;
water during growing season with warm temperatures, frozen during winter (temperate deciduous forest);
lack of water during warm summer, (temperate conifer forest) mild winters, warm summer, low rainfall (Chaparral); ***[4 max]***
cold and dry (*e.g.* high altitude deserts);

(b) as photosynthetic plant it is a producer;
it could be a consumer by eating insects;
it could be primary, secondary or tertiary consumer of insects; ***[2 max]***

G3. (a) maintain genetic diversity;
do not have to reintroduce species;
other species dependent on them also conserved; ***[2 max]***

(b) can spread more easily (air, ship, train);
no natural predators to stop spread;
destruction of native species / ecosystems by species;
introduce with other species;
changes in climate / global warming;
greater human movement makes it possible; ***[2 max]***