N12/4/BIOLO/HP3/ENG/TZ0/XX/M

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MARKSCHEME

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BIOLOGY

Higher Level

Paper 3

15 pages

Subject Details: Biology HL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options **[2 ˜ 20 marks]**.
Maximum total = **[40 marks]**

1. A markscheme often has more marking points than the total allows. This is intentional.

2. Each marking point has a separate line and the end is shown by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking indicate this by adding **ECF** (error carried forward) on the script.

10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Option D — Evolution

D1. (a) 600 to 1150 (cm^3) ***[1]***
Accept answers in the range of 575–625 to 1125–1175 (cm^3).
Do not accept answers only giving the difference (eg: 550 (cm^3)).

(b) *Australopithecus* is shorter than *H. erectus*;
Australopithecus has a greater range in height than *H. erectus*;
Australopithecus has a smaller brain size than *H. erectus*;
Australopithecus has a very small range in brain size compared to *H. erectus*; ***[2 max]***
Accept converse. Do not accept numbers only.

(c) *(hypothesis appears to be supported by the data as)*
H. sapiens has the greatest height and the largest brain size / *H. floresiensis* has smallest height and smallest brain size;
the diagram shows a positive correlation/trend;

(hypothesis not supported by the data as)
H. erectus and *H. sapiens* almost the same height but different brain size / *Australopithecus* and *H. floresiensis* different height but similar brain size;
Australopithecus has large height range but a small brain size range;
fossil record incomplete/possible limited specimens;
no causal connection established; ***[3 max]***

(d) jaw projection/size;
teeth size;
brow ridge size;
receding/slant of forehead
flatness of the face;
position of hole for spinal cord/foramen magnum; ***[2 max]***
Comparing elements not necessary.

D2. (a) (i) all the genes in an interbreeding <u>population</u> (at a certain time) ***[1]***
Do not accept "species" instead of "population".

(ii) geographical isolation;
hybrid infertility;
temporal isolation;
behavioural isolation; ***[1 max]***
*Award **[1]** for any examples from **two** of the above.*

(b) heterozygotes have two alleles/Hb^AHb^S which gives them (partial) resistance to malaria;
heterozygotes/Hb^AHb^S more likely to survive and reproduce than either homozygote/Hb^AHb^A <u>and</u> Hb^SHb^S;
Hb^AHb^A may die from malaria / Hb^SHb^S are more likely to die from sickle-cell anemia;
an equilibrium between allele frequency is established / lethal allele retained in population; ***[2 max]***

(c) Hardy–Weinberg equation (*e.g.* $p^2 + 2pq + q^2 = 1$) / calculation of p (*e.g.* $p = 1 - q = 0.98$) / $p^2 = 0.9604$;
calculation of total of babies without allele $= N \times p^2$ ***or*** $281\,884 \times 0.9604 = \underline{270\,721}$; ***[2]***

D3. universality of DNA means all organisms share same DNA bases/nucleotides;
universality of protein structures means same amino acids in proteins/polypeptides;
amino acids placed in proteins/polypeptides according to DNA base sequence;
shows common ancestry / all organisms related;
variations in specific molecules are the result of mutations;
mutations result from change in base/nucleotide sequence;
cumulation of mutations cause organisms to diverge from common ancestry;
can be tracked down to show phylogeny/ancestry;
can be used to estimate evolution times; ***[6 max]***

Option E — Neurobiology and behaviour

E1. (a) (peptide) F ***[1]***

(b) (peptides) A, B, C and H more abundant in pollen foragers;
(peptides) D, E, F and G more abundant in nectar foragers;
greater abundance (differences) for nectar foragers;
A and C showed little difference; ***[2 max]***
Do not accept numerical statements only.

(c) *(arguments supporting the hypothesis)*
each group of foragers is always associated with the same group of peptides;
trends inverse between nectar (foragers) and pollen (foragers)/arriving and departing / *OWTTE*;
error bars on the graph show that the differences are likely to be significant;

(arguments not supporting the hypothesis)
no data about nectar/pollen actually collected / sample size;
there is no evidence of causation/that the peptide in the brain is determining the type of foraging itself; ***[2 max]***

(d) (predisposition/instinct/natural selection) ensures that both pollen and nectar will be collected;
allows the bees to collect whichever food source is in abundance at the time / increases food collection efficiency;
both pollen and nectar are diet requirements;
this behaviour is part of division of labour/specialization; ***[2 max]***

E2. (a)

brain part	*function*
cerebellum	unconscious movements / balance / coordination;
medulla oblongata	homeostatic activities / swallowing / digestion / vomiting / breathing / circulation;

[2]

(b) (i) *X*: (cell body of) sensory neuron;
Y: (cell body of) motor neuron; } *(both needed)* ***[1 max]***

(ii) from the sensory neuron/X to the motor neuron/Y ***[1]***

(iii) a rapid <u>and</u> unconscious response (to a stimulus / of the nervous system) ***[1]***

(c) *Award **[1]** for every two correct responses.*

psychoactive drug	*excitatory or inhibitory*
alcohol	inhibitory;
amphetamines	excitatory;
benzodiazepines	inhibitory;
nicotine	excitatory;

[2 max]

E3. eardrum/tympanic membrane vibrates with sound (waves);
movements of eardrum/tympanic membrane amplified by bones of middle ear/stapes;
bones are malleus/hammer, incus/anvil, stapes/stirrup;
movement transmitted to oval window;
creates pressure waves in the liquid within cochlea;
waves travel up to/dissipate at round window;
hairs in cochlea vibrate according to movement (of liquid/waves);
different frequencies detected by different hair cells (on different parts of membrane);
movement of hairs cause action potential/depolarization/hyperpolarization of hair cells;
cause nerve impulses to be transmitted through auditory nerve; ***[6 max]***

Option F — Microbes and biotechnology

F1. (a) 30 (arbitrary units) *(accept answer in the range of 29 to 31 (arbitrary units))* ***[1]***

(b) rapid increase at the beginning/up to around day 8;
stable phase between days 7/8 to 15;
keeps increasing (not as much) after plateau / gradual increase after day 15; ***[2 max]***

(c) increase in respiration means more bacteria are present;
increase in gene ratio means the numbers of bacteria with C23O gene are increasing;
more bacteria with C23O gene breaks down more hydrocarbons;
after day 30 proportion of bacteria with C23O gene decreases so no longer effective/required; ***[2 max]***

(d) chemoheterotroph ***[1]***

(e) halophiles ***[1]***

F2. (a) *Award marks for clearly drawn and correctly labelled Anabaena.*
photosynthetic cell;
heterocyst; *(shown larger than the photosynthetic cell)* ***[2]***

(b) study of occurrence and distribution and control of diseases / *OWTTE* ***[1]***

(c) *Award marks only if corresponding elements are opposed.*

endotoxins	exotoxins
liposaccharides	proteins;
in the cell walls	secreted;
Gram-negative bacteria	all bacteria;
cause fever / aches	cause spasms/tetanus / diarrhea;

[2 max]

A table format is not necessary.

(d) create high osmotic concentration difference in water potential/hypertonic;
water drawn out of microorganisms / microorganisms dehydrate;
microorganism cannot absorb nutrients/dies; ***[2 max]***
Do not accept "microorganism dies" as a sole answer.

F3. spongiform encephalopathies include Creutzfeldt-Jakob disease / (new) variant CJD/ bovine spongiform encephalopathy/BSE/scrapie/kuru / (these are all) degenerative diseases of the brain;
a prion suspected as being the cause / prion is an infectious protein;
exist in normal (harmless) form/PrP^{c} and abnormal (infectious) form/PrP^{Sc};
normal form/PrP^{c} present in the body;
abnormal form results from spontaneous change/mutation in gene (for the protein);
normal form/PrP^{c} can change to abnormal form/PrP^{Sc};
introduced abnormal form/PrP^{Sc} causes more and more conversion of PrP^{c} when present / acts as a template for conversion / causes a cascade effect;
abnormal form can be transmitted / could be caught from consumption of infected animals/through direct contact with body fluids/instruments;
prion resists sterilization;
no existing cure; ***[6 max]***

Option G — Ecology and conservation

G1. (a) 1550 (m) *(accept answers in the range of 1450 (m) to 1650 (m))* ***[1]***

(b) (i) both show decrease in abundance as depth increases;
both show similar/low abundance at depths greater than 3000 (m); *(accept values in range 2500 (m) to 3000 (m))*
for depths less than 2500 (m) the abundance is (much) greater in the early period than in the late period; *(accept values in range 2000 (m) to 2500 (m))*
the highest abundance occurs in the late period (although) this is isolated; ***[2 max]***

(ii) overfishing / pollution / change in sea temperature / change in food sources ***[1]***

(c) no evidence that there are fewer species;
difficult to compare as more trawls in the early period /early period of longer duration than late period;
diversity may have increased from (around) 2000 (m) to 4000 (m) / outliers for greater species diversity are all late period;
not enough details about time of year/duration of trawls; *(accept any other valid argument)* ***[2 max]***
Do not accept answers stating only "not enough data".

(d) competition <u>and</u> predatory/predation *(both needed)* ***[1]***

(e) is the maximum number of fishes of a species that can be caught/harvested without causing a population decline / still allowing a population to regenerate;
corresponds to the turning point of a population growth curve;
below that point yield is lower <u>and</u> population grows / above that point yield and population will decline;
used to determine fishing quotas;
difficulty in estimating populations; ***[2 max]***

G2. (a) process by which chemical substances become more concentrated at each trophic level ***[1]***

(b) (i) $GP = NP + R$ ***or*** $GP - R = NP$ ***or*** equation with values to that effect;
$70300\,KJ\,m^{-2}\,year^{-1}$; *(exact value and units required)* ***[1 max]***

(ii) total <u>dry</u> mass of organic matter in organisms/trophic level ***[1]***

(c) (mice are) are captured marked and released (in first cycle);
(mice are) are recaptured and number of marked ones recorded (in second cycle);
population size $= \frac{n_1 \times n_2}{n_3}$; *(accept other symbols)* ***[2 max]***

G3. *r*-strategies involve many offspring/short life-span/early maturity/reproducing only once;
in unstable environment *r*-strategies efficient;
better to produce as many offspring as quickly as possible;
r-strategies favoured by ecological disruption/in primary succession;
such as pathogens and pest species / other example of *r*-strategist;
K-strategies involve longer life-span/late maturity/likely to involve parental care/the production of few offspring/reproducing more than once;
K-strategies efficient in stable environment/climax communities;
pays to invest resources in long-term development and long-life;
example of a *K*-strategist;
some populations switch strategies depending on environmental conditions; ***[6 max]***
*Award **[3 max]** if only one strategy is discussed.*

Option H — Further human physiology

H1. (a) 625% *(percentage required) (accept answers in the range of 600% to 650%)* ***[1]***

(b) (i) pH rises in Hyde Park and falls along Oxford Street;
back to pre-walk level in six hours in Hype Park but not along Oxford Street; ***[2]***

(ii) asthma (attack) constricts bronchioles (while walking);
exercise/walking increases cell respiration producing more CO_2;
lower ventilation causes CO_2 build-up thus lower pH;
CO_2/pollutants in the air could be causing/triggering acidification;
inflammation (by-products) lower pH; ***[2 max]***

(iii) bronchioles constriction demonstrated by lower pH;
inflammation by higher myeloperoxidase; ***[1 max]***

(c) allergens / dust mites / pollen / cold (temperature) / viral illness / exercise / anxiety/stress ***[1]***
*Award **[1]** for any **two** causes.*

H2. (a)

factor	***outline***
parent/relative with coronary heart disease (CHD) / genetic	different populations may have different genetic backgrounds / *OWTTE*;
age	older population in some countries, CHD increases with age / *OWTTE*;
smoking	may be more widespread in some countries, smokers more prone to CHD;
obesity	maybe more widespread in some countries, obesity linked with CHD;
diet	high saturated fat/cholesterol (increases risk) / food habits/sources differ between countries;
lack of exercise	some populations may have a more sedentary lifestyle / *OWTTE*;
high blood pressure	populations with high rates of high blood pressure (caused by stress/salt consumption/other) more prone to atherosclerosis;
sex ratios	populations with higher proportion of males will have higher rates of CHD;
alcohol consumption	populations with high alcohol consumption have high rate of CHD;

[3 max]

*Award **[1]** for a factor and a corresponding outline.*

(b) (i) *Award **[1]** for two correct glands.*
salivary glands;
gastric glands;
pancreas;
wall of the small intestine; ***[2 max]***

(ii) pepsinogen converted to pepsin by stomach acidity/low pH/HCl;
trypsinogen converted to trypsin by enteropeptidase/enterokinase (in small intestine); ***[2]***

H3. *(circulation of blood through liver tissues – accept properly annotated diagram)*
hepatic artery brings oxygenated blood;
hepatic portal vein brings nutrients (from small intestine);
merge to form sinusoids where liver cells/hepatocytes store and regulate nutrients;
blood leaves through hepatic vein;

(storage and regulation of nutrients)
one named stored nutrient; { *(e.g. carbohydrates/glycogen / iron / vitamin A/retinol / vitamin D/calciferol)* } { *(award **[1 max]** for naming nutrients)* }
hepatocytes regulate blood sugar level by storing glucose as glycogen / releasing glucose from breakdown of glycogen (facilitated by arrival from portal vein);
under influence of insulin/glucagon (respectively) (carried by hepatic artery);
blood lipids/cholesterol synthesized/broken down if required / secreted through bile;
iron stored from breakdown of hemoglobin/released when Po_2 is low; ***[6 max]***