N13/4/BIOLO/HP2/ENG/TZ0/XX/M

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MARKSCHEME

November 2013

BIOLOGY

Higher Level

Paper 2

13 pages

Subject Details: Biology HL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A **[32 marks]** and **TWO** questions in Section B **[2 ˜ 20 marks]**. Maximum total = **[72 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 <u>underlined</u> 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.

Section B

Extended response questions - quality of construction

- Extended response questions for HL P2 carry a mark total of ***[20]***. Of these marks, ***[18]*** are awarded for content and ***[2]*** for the quality of construction of the answer.

- Two aspects are considered:
  expression of relevant ideas with clarity
  structure of the answers.

- ***[1]*** quality mark is to be awarded when the candidate satisfies **EACH** of the following criteria. Thus ***[2]*** quality marks are awarded when a candidate satisfies **BOTH** criteria.

Clarity of expression:
The candidate has made a serious and full attempt to answer all parts of the question and the answers are expressed clearly enough to be understood with little or no re-reading.

Structure of answer:
The candidate has linked relevant ideas to form a logical sequence ***within*** *at least two parts of the* ***same question*** *(eg within part a and within part b, or within part a and within part c etc. but* ***not between*** *part a and part b or between part a and part c etc.).*

SECTION A

1. (a) *type I*: European / E
type II: Native American / NA *(both needed)* ***[1]***

(b) *(accept range)* 18–20 (cases per 100 000) ***[1]***

(c) type I shows same/similar pattern of rate in both age groups;
rates of type II were (much) greater among those aged 10–19 years than <10 years; ***[2]***

(d) (i) Europeans/E have lowest rate of type II / only Europeans/E (10+) have a higher rate for type I (than type II);
API/NA 10+ rate higher for type II (than type I);
LA/A rates for both similar at 10+;
NA(10+) has the lowest cases of type I but highest number of type II / NA under 10 have lowest rates for both types; ***[2 max]***

(ii) different genetic factors (affect fat metabolism);
(rise) due to increase in fat/carbohydrate intake/junk food/low in fibre;
"western" diet (in US) very different from traditional diets; ***[1 max]***

(e) negative/inverse relationship/negative correlation / as one variable increases the other decreases / as plasma fatty acid increases, enzyme activity decreases / *vice versa* ***[1]***

(f) (a decrease of) 45 (%) *(accept answers in the range of 44 (%) to 47 (%))* ***[1]***

(g) yes, effect is reversible as activity returns to (approximately) original level (when lipids/fatty acids decrease);
when lipid/fatty acids washed out enzyme is more active/activity increases;
difference between starting and final levels of enzyme activity is insignificant because of error bars;
three hours/experimental time may be insufficient to reverse the effect; ***[2 max]***

(h) increased insulin concentration causes more glucose absorption (up to 10^3 μU ml^{-1});
glucose absorption in muscle bathed in lipid always less than control;
no further increase/slight decrease in glucose absorption beyond 10^3 (μU ml^{-1}) insulin; ***[2 max]***

(i) *Referring to first graph:*
plasma lipids lower activity of enzyme (needed for glucose absorption);

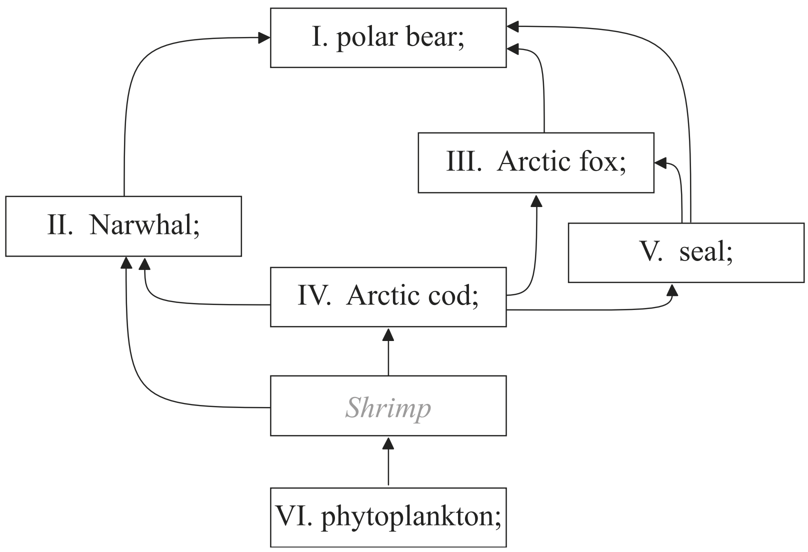
Referring to second graph:
more/higher glucose uptake with higher insulin levels in muscles without lipids (compared to muscles bathed in lipids);
lipids reduce glucose absorption (even at raised insulin concentrations);
isolated muscle used in experiments so results may differ in whole organisms; ***[2 max]***

2. (a) male has (one X and) one Y chromosome / X chromosome is bigger than Y chromosome;
non-disjunction leads to three copies of chromosome 13/trisomy 13; ***[2]***

(b) sex-linked/on X chromosome;
recessive allele / X^h;
more common in males than females;
heterozygous females are carriers / only females can be carriers; ***[2 max]***

(c) more than one gene contribute to/control same characteristic;
as number of genes increase so does possible number of phenotypes;
leads to continuous variation;
specific example; } *(eg human skin color (due to differing amounts of melanin))* ***[3 max]***
*Award **[2 max]** for general points with no example.*

3. (a) (i) *Award **[1]** for any three correct answers:*
All 6 = 2 marks
3–5 = 1 mark
0–2 = 0 marks.



[2 max]

(ii) secondary consumer ***[1]***
Do not accept third trophic level.

(b) energy moves through/enters and leaves ecosystems / need a constant source of energy;
nutrients cycled between biotic and abiotic environment/in cycles such as C/N; ***[2]***

4. (a) (i) line slightly above absorption spectrum with peaks in red and blue and a trough between but not as low as for absorption spectrum ***[1]***

(ii) energy/light absorbed by pigments/chlorophyll is used for photosynthesis;
peaks in action spectrum correspond to peak absorption by chlorophyll;
differences due to absorption by accessory/other pigments (*eg* carotene);
least absorption in green range/approximately 600nm as most light reflected; ***[2 max]***

(b) light/photon absorbed by pigment molecules (in photosystem II)/chlorophyll;
energy/electrons passed to chlorophyll molecule at the reaction centre;
causes electron to be raised to higher energy level / electron is excited;
this electron passed along chain of carrier molecules in photosystem II; ***[2 max]***

SECTION B

Remember, up to TWO "quality of construction" marks per essay.

5. (a) *solvent*: ***[2 max]***
good solvent;
due to polarity of water molecules many different substances dissolve in it;
most chemical reactions of living organisms occur in solution / transport medium;

cohesion: ***[2 max]***
cohesive/cohesion between adjacent water molecules;
due to hydrogen bonds;
long columns of water in xylem/transpiration stream / surface tension;

heat: ***[2 max]***
high heat capacity / large amounts of energy needed to change temperature;
energy needed to break hydrogen bonds;
important habitat as temperature more stable / blood disperses heat through body;

cooling: ***[2 max]***
evaporative cooling / high heat of vaporization/latent heat;
heat used to break hydrogen bonds so water can change to gas;
cooling effect of transpiration on leaves/sweat evaporation from skin/dogs panting;

greatest density at 4^{o}C:
allows ice to form on top of water;
fish/living organisms are insulated below; ***[4 max]***
(Accept first two properties only)

(b) water moves from soil (to roots to stem) to leaves via transpiration stream;
transported in xylem;
xylem vessels made of dead cells whose walls are highly lignified;
due to evaporation of water from (cell walls inside) leaf;
transpiration pull formed;
water that evaporates replaced by water from xylem (vessel in leaf);
water pulled through pores in xylem to cell walls of (spongy) mesophyll cells;
low pressure created at top of xylem;
which extends down to roots;
columns of water do not break due to cohesion of water molecules;
process also helped by adhesion of water molecules to walls of xylem; ***[6 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

(c) water is filtered freely from blood to Bowman's capsule;
majority/80 % of water in filtrate reabsorbed in proximal convoluted tubule;
water balance in blood controlled as filtrate passes through collecting duct;
descending loop of Henle has water channels/aquaporins/is permeable to water;
loop of Henle creates hypertonic conditions in medulla;
water moves from tubule to hypertonic more concentrated medulla;
ascending loop (of Henle) impermeable to water;
Na^+/NaCl actively transported out of (thick portion of) ascending limb;
anti-diuretic hormone/ADH controls permeability of collecting duct to water;
ADH released when blood too concentrated/hypertonic / *vice versa*;
aquaporin channels (in collecting duct) allow water to exit;
collecting duct passes through increasing gradient in kidney/medulla;
gradient causes reabsorption of more water by osmosis;
small volumes excreted if solute concentration too high/blood too concentrated / *vice versa*; ***[8 max]***

*(Plus up to **[2]** for quality)*

6. (a) *Award **[1]** for each structure clearly drawn and correctly labeled.*
cell wall; *(with some thickness)*
plasma membrane; *(shown as single line or very thin)*
cytoplasm;
pilus/pili; *(shown as single lines coming from the cell wall)*
flagellum/flagella; *(thicker and longer than pili and embedded in cell wall)*
70S ribosomes; *(shown as small dots)*
nucleoid / naked DNA;
approximate width 0.5 μm / approximate length 2.0 μm; ***[4 max]***
*Award **[3 max]** if the bacterium drawn does not have the shape of a bacillus (rounded-corner rectangle with length approximately twice its width).*
*Award **[3 max]** if any eukaryotic structures included.*

(b) transcription, synthesis of RNA identical to one strand/coding strand of DNA;
antisense stand acts as template/is transcribed;
RNA polymerase attaches to sequence of DNA known as promoter (region);
RNA polymerase separates the two strands of DNA;
(unwinding) exposes (10–20) DNA bases for pairing with RNA nucleotides;
RNA nucleotides matched to complementary bases;
<u>adenine</u> with <u>uracil</u> and <u>cytosine</u> with <u>guanine</u> / uracil replaces <u>thymine</u>;
H bonds between RNA nucleotide and complementary base on DNA strand;
(RNA) nucleoside triphosphates used;
hydrolysis of (two) phosphate molecules provides energy for reaction;
adds nucleotides to the 3′ end of RNA molecule/in 5′ → 3′ direction;
terminator is sequence of DNA signaling end of transcription;
RNA molecule separates completely from DNA; ***[8 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

(c) skin and mucous membranes form barriers to pathogens as first line of defence;
macrophage recognizes antigens and ingests pathogen (in blood/body tissues);
presents antigen/MHC on cell surface;
macrophage activates helper T-cells that are complementary to antigen;
complementary B-cell becomes activated/stimulated by T-helper cells;
activated B-cell increases in size and divides by mitosis / creates clone of B-cells;
B-cells differentiate into plasma cells <u>and</u> memory cells; *(both needed)*
plasma cells secrete specific antibodies;
memory cells remain/form basis of long-term immunity;
polyclonal response / multiple B-cells activated by different molecules of antigen; ***[6 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

*(Plus up to **[2]** for quality)*

7. (a) *Award **[1]** for each of the following clearly drawn and correctly labeled.*
phospholipid bilayer; *(double row of opposing phospholipids, tails to inside)*
hydrophilic/phosphate/polar (heads) and hydrophobic/hydrocarbon/fatty acid/non-polar (tails) labeled;
integral protein; *(embedded in the phospholipid bilayer)*
protein channel/channel protein; *(integral protein showing clear channel/pore)*
peripheral protein; *(shown on surface or slightly embedded on either side)*
glycoprotein; *(with carbohydrate attached on outer side)*
cholesterol; *(shown embedded in bilayer and smaller than the hydrophobic tail)* ***[4 max]***

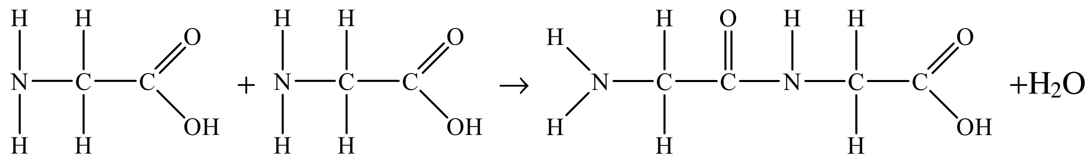
(b) induced fit model; *(do not accept lock and key hypothesis)*
accounts for ability of some enzymes to bind to several substrates;
enzyme with active site to which substrate(s) binds;
enzyme active site and substrate do not match up exactly;
enzyme-substrate complex forms;
enzyme changes shape once bound / enzyme moulds to substrate/ hand in glove;
change in shape strains bonds/facilitates bonds breaking/product formation;
reduces activation energy;
once reaction is complete, products leave and enzyme can work again; ***[6 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

(c) synapse is gap between adjacent neurons;
(arriving) action potential depolarizes pre-synaptic membrane;
opens (voltage-gated) calcium channels in membrane;
causes influx of calcium ions;
causes synaptic vesicles to fuse with pre-synaptic membrane;
vesicles release/exocytose neurotransmitter into the synaptic cleft;
neurotransmitter diffuses/moves across synaptic cleft;
neurotransmitter binds to receptors on post-synaptic membrane;
opens channels allowing sodium ions/potassium ions to diffuse;
initiation of action potential/depolarization in post-synaptic membrane;
removal/breakdown of neurotransmitter stops effect on post-synaptic membrane; ***[8 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

*(Plus up to **[2]** for quality)*

8. (a) *Award **[3 max]** for condensation reactions*

Condensation reactions:
condensation is two molecules joining (by a covalent bond) with the loss of a water molecule;
example of condensation reaction;
eg



formation of peptide bond between amino acids;
(covalent) bond between carboxyl end of one amino acid molecule and amino end of other;
many amino acids joined by condensation to form polypeptide;

Hydrolysis reactions:
hydrolysis is the addition of water to break a large molecule into smaller ones;
polypeptide broken down into amino acids/dipeptides by hydrolysis; ***[4 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

(b) pyruvate decarboxylated/CO_2 is removed <u>and</u> reduced NAD/NADH + H^+ is formed (when entering mitochondrion); *(both needed)*
2-C molecule/acetyl group reacts with (reduced) coenzyme A to form acetyl CoA;
acetyl CoA enters Krebs cycle;
2 CO_2 molecules removed (as waste);
energy/electron rich NADH + H^+/$FADH_2$ formed;
for each turn of cycle/each pyruvate, 3 NADH + H^+ <u>and</u> 1 $FADH_2$ formed;
1 ATP formed per pyruvate each turn (by substrate-level phosphorylation);
reduced NAD/NADH + H^+ and $FADH_2$ enter electron transport chain/ETC;
oxidative phosphorylation uses energy released by ETC to synthesise ATP;
as electrons move along ETC, protons/H+ move into intermembrane space;
creates H^+ gradient across the membrane;
ATP synthesized by flow of H^+ back <u>across membrane</u> through ATP synthase;
ATP synthesized by chemiosmosis;
ETC reduces oxygen/oxygen is final hydrogen (and electron) acceptor forming water; ***[8 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

Accept reduced NAD and $NAD^+ + H^+$ as alternatives to each other.

(c) caused by single base substitution (mutation);
mutation in gene coding for (one of) polypeptide chain in hemoglobin/HbA;
GAG (on sense strand of DNA) mutated to GTG;
when transcribed, RNA sequence/codon becomes GUG rather than GAG;
during translation, have one amino acid substituted for another;
causes glutamic acid/glutamate to be replaced by valine;
change alters folding of Hb protein/makes RBCs sickle-shaped (in low oxygen);
sickle shaped cells block capillaries/cause tissue damage and pain; ***[6 max]***
Award any of the above points for a clearly drawn correctly annotated diagram.

*(Plus up to **[2]** for quality)*