Rewarding Learning

ADVANCED
General Certificate of Education
2012

Biology

Assessment Unit A2 2

assessing

Biochemistry, Genetics and Evolutionary Trends

[AB221]

MONDAY 21 MAY, AFTERNOON

MARK SCHEME

/ denotes alternative points
; denotes separate points
Comments on mark values are given in bold
Comments on marking points are given in italics

Section A

1 Both processes involve gene interaction/more than one gene for expression (of trait);
in polygenic inheritance more than one gene is involved in a characteristic/ results in continuous variation (or by appropriate example);
in epistasis one gene interferes/has an overriding effect on the expression of another gene;
[Terminology must be correct, i.e. gene interaction not allelic interaction] [3] 3

2 **(a)** **(i)** To enable sperm to swim (to the egg); [1]

(ii) Any two from
- rhizomes allow (lateral) spread
- plants can extend some distance away from site of original gametophyte *[must specify gametophyte/prothallus]*
- and the moist environment (required for gametophytes)
- other appropriate suggestion [2]

(iii) Any two from
- provides shade/shelter (to reduce evaporation/transpiration)
- increases humus/nutrient content of the soil (due to decomposition of previous years' fronds)
- increased moisture level of the soil (due to increased humus levels)/humidity in air (due to shading)
- rhizomes stabilise soil
- area around bracken less likely to be trampled/grazed
- other appropriate suggestion [2]

(b) Any two from
- body supported by the aqueous medium/hydrostatic skeleton
- food is obtained in water/dependent on water currents to bring food
- tentacles/stinging cells only function in aqueous medium
- some cnidarians adapted for locomotion in water
- lacks a water resistant layer
- other appropriate response [2] 7

3 **(a)** **(i)** **Any four from**
- the DNA double helix unzips/hydrogen bonds break
- through action of enzyme helicase
- mRNA forms on the template strand/nucleotides assemble on template strand
- through forming complementary base pairs (with DNA strand)/ examples of RNA to DNA base pairing **[at least two]**
- catalysed by RNA polymerase [4]

(ii) **Any two from**
- in RNA uracil replaces thymine
- mRNA is shorter than DNA
- mRNA is single stranded

[Allow converse for any of the above] [2]

(b) **(i)** One gene one protein less accurate as some proteins have more than one polypeptide/other genes required to code for other polypeptides; one gene one enzyme less accurate as not all proteins/polypeptides are enzymes; [2]

(ii) A gene (represented by a sequence of bases) codes for the sequence of amino acids/primary structure (of a polypeptide); [1]

(c) **(i)** 252/(255/258) **[flexibility to allow for initiation and/or termination codes]**; [1]

(ii) Gene contains non-coding sections (introns)/part of polypeptide is subsequently removed; [1] 11

4 **(a)** **(i)** Glycerate phosphate (GP/PGA); [1]

(ii) **Any two from**
- more time allows additional/all compounds (in light-independent stage) to become labelled
- a finite number of compounds are produced (in the light-independent stage)
- compounds are recycled [2]

(iii) If time interval longer the sequence of individual molecules could not be worked out/groups of compounds would become labelled/ compounds are changed rapidly (enzymatically) from one into another; [1]

(iv) Maximise light reaching *Chlorella*/reduce shading effects/ensuring that all *Chlorella* were photosynthesising at same rate; [1]

(b) **(i)** Compensation point; [1]

(ii) Some negative values present/carbon dioxide output indicated; show influence of respiration; [2]

(iii) **Any four from**
- during the morning/evening, light is limiting (and so temperature will not influence photosynthesis)
- between noon and 6 pm, light is not limiting/photosynthesis is light saturated
- between noon and 6 pm, temperature may limit (influence) the rate of photosynthesis/increased temperature may increase the rate of photosynthesis
- as temperature increases the action of enzymes/temperature optimum for enzyme action
- (the light-independent stage of) photosynthesis is linked to increased growth/crop/profit
- increased temperature may increase respiration (during darkness)/ may influence respiration more than photosynthesis in dim conditions
- as temperature increases the action of enzymes **[allow once only]**
- resulting in a loss of stored food (carbohydrates/lipids)/more food used than produced [4] 12

5 **(a)** **(i)** A small/extra-chromosomal ring of DNA (found in bacteria); [1]

(ii) A vector carries foreign (human) DNA into a host (bacterial) cell; [1]

(b) **(i)** 1. A gene could be cut directly from a chromosome using restriction endonucleases;
which recognise specific base sequences/cut either side of the desired gene/leave sticky ends;

2. Some mRNA could be used along with reverse transcriptase (to create single stranded cDNA);
this can then be converted into double stranded DNA (using DNA polymerase); [4]

(ii) The plasmid is cut open with the same restriction endonucleases *[insist on use of "same"]*;
which creates complementary sticky ends *[insist on use of "complementary"]*;
the gene is then annealed using DNA ligase;
or
Sticky ends (sections of single stranded DNA) are added to the DNA;
the plasmid is cut open using a restriction endonuclease producing complementary ends;
the gene is then annealed using DNA ligase; [3]

(c) **(i)** The bacterial membrane is made more permeable by use of Ca^{2+} ions/electric shock/heat shock; [1]

(ii) Create two replica plates (use of Southern blot) to which streptomycin or tetracycline have been added;
colonies growing on the tetracycline but not on the streptomycin plates are the transformed bacteria; [2]

(iii) Only those that produce the product are using up food/elimination of competitors/reduces downstream processing; [1]

(d) Health:
Bacterially produced insulin is structurally identical to that produced in the body/less chance of rejection/allergic reaction/larger amounts can be produced to meet needs of increased numbers of people with diabetes;
Ethical:
Traditional methods extracted insulin from animal pancreas, which is unacceptable to vegetarians/religious beliefs; [2] 15

6 **(a)** **(i)** Sex-linked as only/normally occurs in males; [1]

(ii) Recessive as parents of individual 4/9/16/17 did not have condition/can skip a generation/other appropriate response; [1]

(b) X^HX^h (Hh);
X^hY (h –/hy); [2]

(c) Haemophilia $X^HX^h \times X^HY$;

	X^H	X^h
X^H	$X^H X^H$	$X^H X^h$
Y	$X^H Y$	$X^h Y$

;

Albinism Aa × Aa;

	A	a
A	AA	Aa
a	Aa	aa

;

Probability of male child with both haemophilia and albinism $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$;

or

$AaX^HX^h \times AaX^HY$;

AX^H AX^h aX^H aX^h; × AX^H AY aX^H aY;

	AX^H	AY	aX^H	aY
AX^H	AAX^HX^H	AAX^HY	AaX^HX^H	AaX^HY
AX^h	AAX^HX^h	AAX^hY	AaX^HX^h	AaX^hY
aX^H	AaX^HX^h	AaX^HY	aaX^HX^H	aaX^HY
aX^h	AaX^HX^h	AaX^hY	aaX^HX^h	aaX^hY

;

Probability of male child with both haemophilia and albinism = $\frac{1}{16}$; [5]

(d) Mutation; [1] 10

7 **(a)** Petri dish with well containing (cooled boiled) water; [1]

(b) **(i)** Tabulated t value, at p = 0.05 and d.f. = 9, is 2.262;
95% confidence limits = 53 (mean) ± 2.262 × 0.442 (0.99/1)
[consequential to t-value used];
upper limit = 54 and lower limit = 52 **[consequent to value above]**; [3]

(ii) 95% limits added accurately **[consequent to (i)]**; [1]

(iii) Null hypothesis rejected;
A. nemorosa significantly different from other plant extracts/95% confidence limits of *A. nemorosa* do not overlap with other plant extracts;
[consequent to values calculated in (i) and/or displayed in (ii)] [2]

(c) Greatest protection to fungal attack in delicate seedling stage/when most vulnerable/when most growth (reproduction) occurring;
(reduced effect when canopy closes) will not slow down process of decomposition/older plants are more resistant; [2]

(d) **(i)** Annelida; [1]

(ii) **Any four from**
- earthworms break up leaves/remove effect of protective cuticle
- earthworms produce waste (excreta) containing ammonia
- formation of casts increases surface area of decomposable matter
- for other decomposers/bacteria/fungi
- (burrows) create air pockets/aerate soil
- for nitrification/nitrogen fixation
- burrows help drainage/prevents waterlogging of soil
- reduces development of anaerobic conditions/denitrification
- helps with spread of fungi/fungal spores/bacteria/decomposed material/nutrients through soil
- other appropriate response [4]

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Section A **72**

Section B

8 (a) Eleven points (a maximum of seven in either section)

Respiration

- in glycolysis, 4 ATP are produced directly/there is a net yield of 2 ATP
- in the Krebs cycle, 1 ATP is produced directly/in substrate phosphorylation
- dehydrogenation in glycolysis/Krebs cycle
- results in the production of NADH and $FADH_2$/reduced NAD^+ and FAD
- which carry the hydrogens to the ETC
- where they pass down a series of carriers at progressively lower energy levels
- the hydrogens subsequently split into H^+ ions (protons) and electrons
- the electrons pass along the cytochromes
- (at certain stages sufficient) energy is released to create an ATP molecule
- NADH yields 3 ATPs while $FADH_2$ only yields 2 ATPs

Photosynthesis

- in the light-dependent stage of photosynthesis light energy is trapped by photosystems/pigments
- the light energy causes excitation/raises energy level of electrons
- energy is funnelled to the reaction centre (of a photosystem) by resonance
- electrons are emitted from chlorophyll a/primary pigment
- and picked up by an electron acceptor
- electrons are passed down an ETC/cytochrome chain
- resulting in synthesis of ATP [11]

(b) Five points (a maximum of three in either section)

Similarities

- both processes involve an ETC (containing cytochromes)/use of electrons
- which are arranged in sequence in a (intracellular) membrane/carriers at progressively lower energy levels
- carriers are successively oxidised and reduced/involve REDOX reactions
- phosphorylation is associated with electron transfer

Differences

- membranes are thylakoids (in chloroplasts) for photosynthesis and the cristae (of mitochondria) for respiration *[both needed]*
- in respiration the starting point is the delivery of hydrogen atoms to the ETC/chemical energy of glucose
- so that ATP production is described as oxidative phosphorylation
- in photosynthesis the starting point involves light energy
- hence ATP production is described as photophosphorylation
- different hydrogen carriers used/NADP in photophosphorylation, while NAD and FAD in respiration
- terminal electron acceptors different/terminal acceptor is O_2 in respiration, $NADP^+$ in photosynthesis [5]

Quality of written communication

2 marks: The candidate expresses ideas clearly and fluently through well-linked sentences, which present relationships and not mere list features. Points are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling

1 mark: The candidate expresses ideas clearly, if not always fluently. The account may stray from the point or may not indicate relationships. There are some errors of grammar, punctuation and spelling.

0 marks: The candidate produces an account that is of doubtful relevance or obscurely presented with little evidence of linking ideas. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the account. [2] 18

Section B **18**

Total **90**