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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9700 BIOLOGY

9700/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

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AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	Alternative valid point (examples given as guidance)

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1 **(a)** allopatric **;** [1]

(b) 1. packs / populations, isolated from each other **;**
2. inbreeding / no interbreeding **;**
3. little mutation **;**
4. AVP **;** e.g. small population to start with / small gene pool to start with [2 max]

(c) 1. agriculture / buildings / AW **;**
2. *idea of* wolves dying **;**
3. hunting / trapping / AW **;**
4. hybridisation / infertility / change in (wolf) gene pool / loss of wolf alleles / AW **;** [4]

(d) 28(%) **;;** [2]
allow one mark for number not rounded up or incorrect answer but correct idea regarding working

[Total: 9]

2 **(a)** 1. only three colours (for positive reactions) / only a small range **;**
2. no measurement of actual concentration / no numerical value measured **;** [2]

(b) **(i)** peroxidase **;** [1]

(ii) 1. (catalyses breakdown of hydrogen peroxide) to produce oxygen **;**
2. chromogen, oxidised by / reacts with, (oxygen) **;**
3. produces range of colours **;**
4. more, peroxide / oxygen produced, = greater change / darker colour **;** [2 max]

(iii) 1. to keep out, proteins / enzymes / polymer / named large molecule **;**
R large molecules unqualified
2. to prevent interference (to reactions) **;**
3. to prevent loss of, enzyme / chromogen **;**
4. so still allowing reaction to occur **;** [2 max]

(c) **(i)** 1. **B** has diabetes and **A** does not **;**
2. **A**'s, values / peak, lower because he secretes insulin
or
B's, values / peak, higher because, no / little, insulin **;**
in A
3. (insulin affects), liver / muscle, cells **;**
4. increase in glucose uptake / increase in permeability of membranes (to glucose) **;**
5. increase in use of glucose in respiration **;**
6. (more) glucose converted to glycogen **;**
in B
7. because cells unresponsive to insulin **;** [4 max]
accept quoted values for lower and higher in mark point 2

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(ii) (the concentration of blood glucose), above which some glucose appears in the urine / AW **;** [1]

(iii) 1. (at first), glucose reabsorbed by proximal convoluted tubule **;**
2. ref. co transported with Na^+ / facilitated diffusion / protein carrier **;**
3. above 180mg ($100cm^{-3}$ glucose in blood) no further reabsorption **;**
4. because carriers (in PCT) saturated / AW **;** [3 max]

[Total: 15]

3 (a)

	male		female	
1	produces sperm	**or**	produces, oocyte	;
2	division of cytoplasm is equal	**or**	division of cytoplasm is unequal	;
3	four gametes produced	**or**	one gamete produced	;
4	no polar bodies	**or**	polar bodies	;
5	ref. maturation	**or**	no equivalent maturation stage	;
6	ref. meiosis completed	**or**	ref. incomplete meiosis	;

[3 max]

(b) 1. a ductless gland **;**
2. hormones in the blood **;**
3. ref. target, organ / tissues **;** [2 max]

(c) 1. (both), reduce / stop, secretion (of FSH and LH) **;**
2. (both) involve negative feedback **;**
3. to, anterior pituitary / hypothalamus **;**
4. both are, contraceptives / description **;** [3 max]

[Total: 8]

4 (a) 1. low oxygen (in water) results in anaerobic respiration **;**
2. (anaerobic respiration) produces alcohol **;**
3. rice tolerant to alcohol **;**
4. (because rice has) high levels of, alcohol dehydrogenase / enzyme that breaks down alcohol **;**
5. presence of, aerenchyma / described **;**
6. allows, oxygen / air, to reach roots (from aerial tissues) **;** [3 max]

(b) (i) 1. (immersion in water) stimulates production of ethene **;**
2. (concentration of) ethene produced increased with time (after submergence) **;**
3. very little difference in ethene production between T65 and C9285 **;**
4. use of figures **;** 2 values of ethene **plus** 2 values of time for **either** T65 **or** C9285 [2 max]

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(ii) 1. in T65 ethene does not affect internode elongation **but** in C9285 ethene promotes internode elongation **;**
2. in C9285, greater concentrations of ethene cause greater elongation **;**
3. use of comparative figures to support mark point 1 **or** mark point 2 **;** *both units at least once* [2 max]

(c) 1. *SK* genes present in C9285 / *SK* genes not present in T65 **;**
2. **increased** production of GA in C9285 / little or no increased production of GA in T65 **;**
3. GA stimulates, stem elongation / AW **;**
4. AVP **;** e.g. T65 has no receptors for ethene [3 max]

(d) (i) *SK2* more important **; ora**
O. nivara has mutated *SK2* and does not have deepwater response
or
O. glumaepatula has *SK2* but not *SK1* and does have deepwater response **;** [2]

(ii) 1. (addition / insertion), of a, base / nucleotide, to DNA / to a gene **;**
2. changes a, sequence of three bases / triplet / codon **;** *ignore ref. to frame shift*
3. (triplet) no longer codes for an amino acid **;** [2 max]

(iii) 1. breed deepwater variety with (high-yielding) non-deepwater variety **;**
2. identify / select, offspring with **both** deepwater response and high yield **;**
3. breed selected offspring (with **both** deepwater response and high yield) **;**
4. continue for many generations **;** [3 max]

[Total: 17]

5 (a) 1. caused by a single gene **;**
2. caused by a recessive allele **;**
3. delivery of, correct / dominant / normal, allele (could correct the condition) **;**
4. only need to get allele into a few cells **;**
5. ease of access to affected area **;**
6. serious so worth the risk **;**
7. AVP **;** e.g. only targets eye / no surgery needed [3 max]

(b) 1. virus no longer able to cause infections **;**
2. correct / dominant / normal, allele (of *RPE65*) added **;**
3. promoter added **;** [2 max]

(c) 1. ref. to safety / not known if the technique might have side effects **;**
2. rare condition **;**
3. expense **;**
4. AVP **;** e.g. trial to see if delivery method works [2 max]

[Total: 7]

6 (a) (i) <u>phosphorylation</u> **;** [1]

(ii) <u>lysis</u> **;** [1]

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(iii) dehydrogenation / oxidation ; *ignore reduction of NAD* [1]

(b) provides activation energy / AW ;
for it to split / AW ; [2]

(c) 1. decarboxylated / carbon dioxide given off ;
2. ethanal produced ;
3. ethanal reduced ;
4. by reduced NAD ;
5. to ethanol ;
6. dehydrogenase ; [4 max]

[Total: 9]

7

step	reason for step
obtain copies of gene with sticky ends	the gene codes for the synthesis of insulin
plasmid (used) ;	acts as a vector for the transfer of the gene into the host
use restriction endonuclease enzyme	to produce 'sticky ends' **or** cut at specific, site / sequence ;
mix vector and gene	gene inserts into, vector / plasmid **or** forms recombinant DNA / AW ; **A** detail of complementary base pairing
(use DNA) ligase ;	to seal the sugar-phosphate backbone
insert, plasmid / vector, into host / *E. coli / bacteria* ;	to obtain transformed host *E. coli* cells
screen for, and obtain, successfully transformed cells	so only recombinant host cells cultured / AW;
ref. batch / continuous, culture **or** fermenter **or** bacterial cloning / population growth ;	to obtain large amounts of insulin for extraction and purification

[7]

[Total: 7]

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8 **(a)** *any two from*
(cigarette) smoke **;**
named air pollutant **;**
animal fur / skin flakes / AW **;**
perfumes / aerosol / solvents **;**
dust / mites **;**
pollen / spores **;** [2 max]

(b) **(i)** high tensile strength / withstands pulling forces / fibrous / insoluble / forms fibrils / flexible **;** [1]

(ii) 1. inbreeding **;**
2. little genetic variation / small gene pool / small population **;**
3. many carried faulty allele / AW **;**
4. faulty / mutant, allele, could be dominant or recessive **;**
5. little phenotypic variation **;** [3 max]

[Total: 6]

9 **(a)** *dominant*
(allele) that always expresses itself (in the phenotype) when present
or
(allele) which influences the phenotype even in the presence of an alternative allele **;**

gene
length of DNA / sequence of nucleotides, coding for a (specific) polypeptide **;** **A** protein [2]

(b)

parental phenotypes	man without TSC	woman with TSC	
parental genotypes	**tt**	**Tt**	
gametes	**all t**	**T or t**	**;**
offspring genotypes	**Tt**	**tt**	
offspring phenotypes	**TSC**	**normal**	**;**
probability of child having TSC	**50% / 0.50 / 1in 2 ;**		

[3]

(c) 1. spontaneous / random / chance **;**
2. mutation of, gene / allele **;**
3. AVP **;** e.g. named mutagen / detail of mutation [2 max]

[Total: 7]

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10 (a) 1. ground substance / stroma ;
2. for, light independent stage / Calvin cycle ;
3. contains enzymes / named enzyme e.g. rubisco ;
4. also, sugars / lipids / starch / ribosomes / DNA ;
5. internal membrane system ;
6. for, light dependent stage ;
7. fluid-filled sacs / thylakoids ;
8. grana are stacks of thylakoids ;
9. (grana) hold (photosynthetic) pigments ;
10. (grana) have large surface area for (maximum) light absorption ;
11. (pigments are arranged in), light harvesting clusters / photosystems ;
12. primary pigment / reaction centre / chlorophyll a, surrounded by accessory pigments ;
13. (accessory pigments) pass energy to, primary pigment / reaction centre / chlorophyll a ;
14. different photosystems absorb light at different wavelengths ;
15. membranes hold, ATP synthase / electron carriers ;
16. for, photophosphorylation / chemiosmosis ; [9 max]

(b) 17. grind leaf with solvent ;
18. example of solvent ; e.g. propanone
19. leaf extract contains mixture of pigments ;
20. ref. concentrate extract ;
21. further detail ; e.g. pencil line drawn / extract placed on chromatography paper / repetitive spotting / drying between spots
22. paper placed (vertically) in jar of (different) solvent ;
23. solvent rises up paper ;
24. each pigment travels at different speed ;
25. pigments separated as they ascend ;
26. distance moved by each pigment is unique ;
27. Rf value ;
28. two dimensional chromatography ;
29. better separation of pigments ; [6 max]

[Total: 15]

11 (a) 1. axon phospholipid bilayer impermeable to K^+ / Na^+ ;
2. sodium – potassium pump ;
3. detail of sodium-potassium pump ; e.g. transmembrane / globular / ATP binding site
4. active process / ATP used / energy needed ;
5. 3 Na^+ (pumped) out / 2 K^+ (pumped) in ;
6. K^+ <u>diffuse</u> out / Na^+ <u>diffuse</u> in ;
7. through, protein channels transport proteins ;
8. more K^+ channels open than Na^+ channels ;
9. therefore, membrane more permeable to K^+ **or** more K^+ leave than Na^+ enter (axon) ;
10. inside relatively more negative than outside ;
11. –65mV ; **A** –70mV
12. *idea of* leaking K^+ responsible for resting potential / AW ;
13. electrochemical gradient ;
14. voltage-gated channels closed ; [9 max]

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(b) *general*

15. respond to stimuli / AW **;**
16. (some) receptors are the ends of sensory neurones **;**
17. (some) receptors are cells **;**
18. they are energy transducers **;**
19. stimulus causes sodium ion channels to open **;**
20. sodium ions enter cell **;**
21. depolarisation **;**
22. receptor / generator, potential **;**
23. if (receptor potential) greater than threshold then action potential generated / all or nothing principle described **;**
24. increased stimulus strength leads to increased frequency of action potentials **;**

examples – allow any two below

receptor	form of energy detected
rods / cones	light **;**
taste buds / olfactory cells	chemical **;**
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hair cells in semicircular canals	movement **;**
hairs cells in cochlea	sound **;**

[max 2]

[6 max]

[Total: 15]

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offspring genotypes	**Tt**	**tt**	
offspring phenotypes	**TSC**	**normal**	**;**
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[3]

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(b) *general*

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examples – allow any two below

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taste buds / olfactory cells	chemical **;**
Pacinian \ Meissner's, corpuscle	pressure / touch **;**
Ruffinis endings	heat **;**
proprioreceptors	mechanical displacement **;**
hair cells in semicircular canals	movement **;**
hairs cells in cochlea	sound **;**

[max 2]

[6 max]

[Total: 15]

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GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9700 BIOLOGY

9700/43 Paper 4 (A2 Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Mark scheme abbreviations:

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	Alternative valid point (examples given as guidance)

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1 **(a)** 96 **;;** [2]
allow one mark for correct working with either incorrect answer or answer not rounded down

(b) 1. stop killing **;**
2. education **;**
3. stop trade in tiger parts **;**
4. zoos / national parks **;**
5. captive breeding / AW **;**
6. release back into wild **;**
7. replant forests / AW **;**
8. protect remaining forest / stop deforestation **;**
9. AVP **;** e.g. incentives to indigenous people / ban use in circuses or as pets [4 max]

(c) *assume animalia unless otherwise stated*
1. heterotrophic / AW **;**
2. locomotion **;** **ora**
3. male gametes motile **;** **ora**
4. detail cell structure **;** e.g. no cell wall / no tonoplast **ora** *ignore ref. to cellulose* [2 max]

[Total: 8]

2 **(a)** 1. allele for lactase deficiency is recessive **;** **A** allele for lactose intolerance
2. parents, heterozygous / carriers **;**
3. child homozygous recessive **;** [2 max]

(b) **(i)** 1. at low temperatures activity of, immobilised lactase is lower (than free lactase) / free lactase is higher (than immobilised lactase) **;**
2. ref 42–43 ^{o}C as changeover point **;**
3. maximum activity of immobilised lactase is lower (than free lactase) / **ora** **;**
4. *idea of* optimum temperature of immobilised lactase 40–45 ^{o}C and optimum for free lactase is 35 ^{o}C **;**
5. comparative figures at any one temperature **;** *(units required for temperature only)* [3 max]

(ii) *assume immobilised accept ora*
1. harder for substrate to reach enzyme **;**
2. harder for product to pass out of bead **;**
3. accumulation of product leads to product inhibition **;**
4. *idea of* enzyme less able to move leading to fewer ES complexes / AW **;** [2 max]

(c) 1. can re-use enzyme / enzyme not lost / AW **;**
2. ref. cost effective **;**
3. *idea of,* easier to purify product / less contamination of product **;**
4. greater stability at higher temperatures / thermostable **;**
5. *idea of,* copes with any pH / pH stable **;** [3 max]

[Total: 10]

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3 (a) (i) mitosis / multiplication / increase in number of cells ; **R** meiosis / growth / maturity / replicating [1]

(ii) meiosis I / reduction division / description ; [1]

(iii) maturation / differentiation / description ; [1]

(b)

statement	letter
contains protective fluid	**J** ;
produces oestrogen	**H** ;
has glycoprotein receptors	**G or H** ;
contains 23 chromosomes	**G or K** ;

[4]

(c)
1. hormone treatment ; **R** LH / HCG
2. to stimulate follicle development ;
3. superovulation / several follicles develop at same time ;
4. oocytes harvested ; *penalise eggs once*
5. detail of harvesting ;
6. semen / sperm, collected from man ;
7. *idea of* sperm activated ;
8. sperm added to oocyte(s) in dish ;
9. (potential embryos) inspected, two – three days later / 6–8 cell stage ;
10. embryo(s) inserted into uterus (through cervix) ;
11. AVP ; any two from e.g. donor oocytes / donor sperm / hormones to prepare uterine lining / ICSI *ignore ref. to oestrogen* [5 max]

(d)
1. percentage of live births decreases / miscarriage rate increases, with age ;
2. (as) fewer hormones / unbalanced hormones (in older woman) ;
3. (as) genetic defects / mutations, increase in oocyte (with age) ;
4. placental function less efficient ; [2 max]

[Total: 14]

4 (a) (i)
1. anthers, versatile / loosely attached /attached at one point (to filaments) ;
2. anthers / stamens / tassels / androecium, on long filaments / hang out (of, plant / flower) ;
3. anthers / stamens / tassels / androecium, above leaves / high up ;
4. stigmas / silks, hang out (of, plant / flower) ;
5. stigmas / silks, large surface area / hairy / feathery / long, (to catch pollen) ;
6. no / small, petals allow access to wind / AW ; *ignore references to pollen* [3 max]

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(ii) 1. increased genetic variation / increased heterozygosity / more diverse gene pool / increased gene pool ;
2. reduced inbreeding / prevents inbreeding depression ;
3. less likely that harmful recessive alleles will be expressed ;
4. hybrid vigour ;
5. ability to respond to named change in conditions ; e.g. climate / disease / pests [2 max]

(b) (i) *must be comparative statements*
1. maize has greater rate of photosynthesis (at all temperatures) / ora ;
2. optimum for maize is at 23°C while optimum for wheat is at 17.5°C ;
or
highest rate for maize is 39 units while highest rate for wheat is 26 units ;
3. after 17.5°C increase for maize while decrease for wheat ; [2 max]

(ii) 1. maize is C4 ;
2. PEP carboxylase more efficient at higher temperatures (than rubisco) ;
3. photorespiration occurring in wheat ; **ora**
4. oxygen, instead of carbon dioxide, combines with RuBP ;
5. less fixation of carbon dioxide ;
6. Calvin cycle slows down ;
7. AVP ; e.g. detail of krantz anatomy **R** ref. denaturation [3 max]

(c) (i) 1. protein in aleurone layer ;
2. which is removed in white rice ; **A** outer layer(s) removed
3. ref. different species ; [2 max]

(ii) 1. wheat has more iron / comparative figs ;
2. ref. haemoglobin ;
3. low haemoglobin linked to anaemia ; [2 max]

[Total: 14]

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5 (a) (i)

correct order	letter of step
1	C
2	**H**
3	**F**
4	**A**
5	D
6	**B**
7	**E**
8	**G**

H F A all above **D ;**
H F A in correct order **;**

B E G all below **D ;**
B E G in correct order **;** [4]

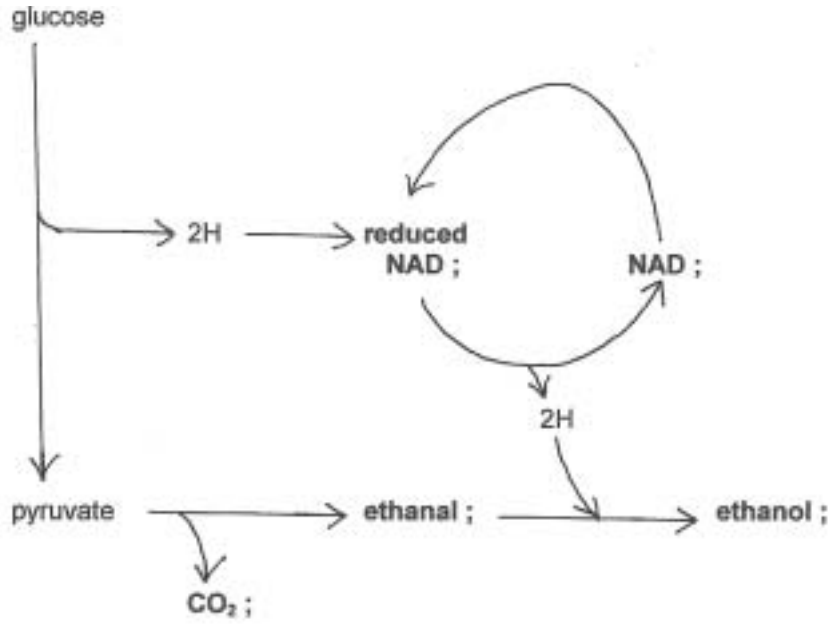
(ii) **A** – (DNA) ligase **;**
H – reverse transcriptase **;** [2]

(b) 1. it is identical to human insulin / **ora** **;**
2. (more) rapid response **;**
3. no / fewer, rejection problems / side effects / allergic reactions **;** **R** immune response
4. ref. to ethical / moral / religious, issues **;**
5. cheaper to produce in large volume / unlimited availability **;** **R** cheap to produce
6. less risk of, transmitting disease / infection **;**
7. good for people who have developed tolerance to animal insulin **;** [2 max]

[Total: 8]

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6 (a)



[5]

(b) *in mammals*

1. lactate produced / no ethanol produced **;**
2. no, decarboxylation / carbon dioxide released **;**
3. single step **;**
4. lactate dehydrogenase **;**
5. reversible **;** [3 max]

(c) *in anaerobic respiration*

1. only glycolysis occurs / Krebs cycle stops / link reaction stops **;**
2. glucose, not fully broken down / still contains energy **;**
3. pyruvate does not enter mitochondrion **;**
4. (no oxygen) so no final electron acceptor (in ETC) **;**
5. ETC stops **;**
6. no oxidative phosphorylation **;** [3 max]

[Total: 11]

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7 (a)

	initial effect of event on blood concentration of		
event	**glucose**	**insulin**	**glucagon**
meal containing sucrose	**increase**	**increase**	**decrease**
meal containing only protein	**no effect**	**no effect**	**no effect ;**
fasting	**decrease**	**decrease**	**increase ;**
exercising	**decrease**	**decrease**	**increase ;**
meal containing starch	**increase**	**increase**	**decrease ;**

[4]

(b) 1. affects liver cells **;** **R** muscle cells / liver and muscle cells
2. promotes glycogenolysis / AW **;**
3. promotes use of fatty acids in respiration **;**
4. promotes gluconeogenesis / AW **;**
5. results in rise in (blood) glucose concentration **;**
6. back to, norm / set point **;** [3 max]

[Total: 7]

8 pressure **;**
mothers / sisters / (female) relatives / (female) offspring **;**
alleles **;**
generations **;**
inbreeding **;** [5]

[Total: 5]

9 (a) 1. myelin sheath insulates axon **;**
2. *idea of* depolarisation / action potentials, only at nodes of Ranvier **;**
3. ref. saltatory conduction / AW **;** [2 max]

(b) (i) 1. (impulse from TENS) causes release of endorphins **;**
2. endorphins attach to morphine receptors **;**
3. slows / stops, ACh release **;**
4. no / less, binding of ACh on receptors **;**
5. in postsynaptic membrane **;**
6. fewer / no, action potentials/ impulses, to pain centre (in brain) **;**
7. AVP **;** e.g. ref role of Ca^{2+} [4 max]

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(ii) *any two from*
1. no need to use drugs ;
2. no addiction to drugs ;
3. patient can control the treatment / AW ;
4. fewer / no, side effects ;
5. cheaper ; [2 max]

[Total: 8]

10 (a)
1. closely packed to absorb (maximum) light ;
2. vertical / at right angles to surface of leaf to reduce number of cross walls ;
3. large vacuole pushes chloroplasts to edge of cell ;
4. chloroplasts at edge short diffusion path for carbon dioxide ;
5. chloroplasts at edge to absorb (maximum) light ;
6. large number of chloroplasts to absorb (maximum) light ;
7. cylindrical cells **or** air spaces to circulate gases / provide a reservoir of CO_2 ;
8. moist cell surfaces for diffusion of gases ;
9. cell walls thin for (maximum) light penetration / diffusion (of gases) ;
10. chloroplasts can move towards light to absorb (maximum) light ;
11. chloroplasts can move away from high light intensity to avoid damage ; [7 max]

(b) *accept annotated diagram*
12. arranged in light harvesting, clusters / system ;
13. primary pigments / chlorophyll a ;
14. at reaction centre ;
15. P700 / PI, absorbs at 700(nm) ;
16. P680 / PII, absorbs at 680(nm) ;
17. accessory pigments / chlorophyll b / carotenoids, surround, primary pigment / reaction centre / chlorophyll a ;
18. pass energy to, primary pigment / reaction centre / chlorophyll a ;
19. P700 / PI, involved (in cyclic photophosphorylation) ;
20. (light absorbed results in) electron excited / AW ;
21. emitted from, chlorophyll / photosystem ;
22. flows along, chain of electron carriers / ETC ;
23. ATP synthesis ;
24. electron returns to, P700 / PI ; [8 max]

[Total: 15]

11 (a)
1. (amino acid) code is three, bases / nucleotides ; **A** triplet code
2. (gene) mutation ; **R** chromosome mutation
3. base / nucleotide, substitution / addition / deletion
4. addition / deletion, has large effect (on amino acid sequence) ;
5. frame shift ;
6. completely new code after mutation / alters every 3 base sequence which follows ;
7. substitution may have little or no effect / silent mutation ;
8. different triplet but same amino acid / new amino acid in non-functional part of protein ;
9. substitution may have big effect (on amino acid sequence) ;
10. could produce 'stop' codon ;
11. sickle cell anaemia / PKU / cystic fibrosis ;
12. reference to transcription or translation in correct context ; **A** description [8 max]

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(b) 13. (haemophilia) allele on X chromosome ; **A** gene
14. sex-linked ;
15. (haemophilia) allele recessive ;
16. man, homogametic / has one X chromosome ;
17. Y chromosome does not have blood clotting gene ;
18. only daughter(s) get his X chromosome ;
19. daughter(s) carrier(s) of (haemophilia) allele ;
20. grandson(s) 50% chance of having, (haemophilia) allele / haemophilia ;
21. granddaughter(s) 50% chance of carrying, (haemophilia) allele ;

allow following marks from diagram

22. correct symbols ; e.g. X^H and X^h explained
23. man's genotype ; e.g. X^hY *ignore partner's genotype*
24. F1 (daughter's) genotype ; e.g. X^HX^h *ignore her partner's genotype*
25. F2 (grandson's) genotypes ; e.g. X^hY X^HY *both required*
26. F2 (granddaughter's) genotypes ; e.g. X^HX^H X^HX^h *both required* **or** X^hX^h X^HX^h [7 max]

[Total: 15]

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