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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9700 BIOLOGY

9700/41 Paper 41 (Theory 2), 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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UNIVERSITY of CAMBRIDGE
International Examinations

Section A

Question			Expected Answers	Marks
1	(a)	1	species threatened with extinction ;	
		2	numbers reduced to critical level / population too small ;	
		3	such low numbers that reproduction is affected ;	[2 max]
	(b)	1	(maintain colony) in zoo ;	
		2	captive breeding (programme) ;	
		3	assisted reproduction ; e.g. IVF	
		4	educate public ;	
		5	national parks / conservation areas ;	
		6	habitat protection ;	
		7	ban, hunting / poaching ;	[4 max]
				[Total:6]
2	(a)	1	population increases slowly at first / ref. lag phase ;	
		2	(because) adjusting to pond environment ;	
		3	(then) steep increase / log phase / exponential increase / rapid growth or reproduction phase ;	
		4	(because) abundant food source / named other factor ;	
		5	stationary phase ;	
		6	fall in population size / death phase / decline phase ;	
		7	(due to) predation / build up of waste ;	
		8	competition for named resource ; e.g. food shortage	
		9	idea of further increase and fall / ref. population size may be cyclic ;	[5 max]
	(b)		variation means the presence of different characteristics ;	
			resulting in different survival rates / AW ;	
			(leads to) reproductive, success / failure ;	[2 max]
				[Total: 7]

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3	**(a)**	**(i)**	so that, the bacteria were not killed / enzymes not denatured ;	[1]
		(ii)	1. bacteria put into (solution of) sodium alginate ; 2. place mixture in syringe ; 3. add drops of mixture to calcium chloride solution ; 4. calcium ions replace sodium ions (to form beads) ; 5. bacteria trapped in beads ;	[3 max]
	(b)	**(i)**	*note comparison between blue line and black line* *ignore references to red line - agar* 1. both increase up to, 18 / 24, hours ; 2. both similar, initially / up to 18 hours ; 3. biggest difference at 24 hours / rate of increase for immobilised cells greater than free cells between 18 and 24 hours ; 4. after 24 hours immobilised cells rate decreases while free cells rate continues to increase <u>or</u> after 39 hours free cells rate is greater than immobilised cells rate ; 5. free cells final concentration is still lower than highest value attained by immobilised cells ; 6. use of comparative figures ;	[4 max]
		(ii)	1. (could be) less surface area (to volume ratio) in cubes than beads ; 2. (could be) a greater diffusion distance to centre of cubes than beads ; 3. agar may be less permeable (to substrate) than alginate ; 4. something in agar may inhibit bacterial enzymes ; 5. some protease <u>adsorbed</u> by agar ;	[2 max]

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	(c)	**(i)**	82.14 / 82.1 / 82 (%) ; ; *allow one mark for suitable working if incorrect answer*	[2]
		(ii)	1. can use alginate (beads) many times ; 2. (reduces cost of), materials / energy / labour ; 3. fewer bacterial cultures needed / less time spent immobilising bacteria ; 4. more protease produced (per hour) (using alginate) ; 5. can run fermentation for longer time ; 6. less time wasted between fermentations ; *answers must imply comparison*	[3 max]
				[Total:15]
4	**(a)**		AABBCC ;	[1]
	(b)		*if doubling of chromosomes has not occurred*	
		1	chromosomes would not be able to pair ;	
		2	because chromosomes in the two sets are not homologous ;	
		3	during, prophase 1 / meiosis 1;	
		4	(therefore) gametes cannot be produced ;	[3 max]
	(c)	1	unable to, breed / reproduce ;	
		2	to produce fertile offspring ;	
		3	reproductively isolated ;	[2 max]
	(d)	1	species split into two populations by (geographical) barrier ;	
		2	different, selection pressures / (environmental) conditions, (on the two populations) ;	
		3	different features, selected / advantageous ;	
		4	change in, gene pools / allele frequencies ;	
		5	(over time) become unable to interbreed ;	[3 max]
				[Total: 9]

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5	**(a)**		ductless gland ; secretes (hormone) into blood ;	[2]
	(b)	**(i)**	1. follicle, develops / matures / grows ; 2. detail follicle ; e.g. antrum / corona / theca 3. (follicle) secretes oestrogen (and progesterone) ;	[2 max]
		(ii)	trigger ovulation / description ;	[1]
	(c)	1 2 3 4	to produce many (mature) <u>oocytes</u> at same time ; <u>superovulation</u> ; make harvesting easier ; IVF procedure has low success rate ;	[2 max]
	(d)	**(i)**	a change sets off events that counteract the change / AW / example described ;	[1]
		(ii)	oestrogen inhibition of, GnRH / FSH ;	[1]
	(e)	**(i)**	day 9 ;	[1]
		(ii)	prevent ovulation / so <u>oocytes</u> can be harvested ;	[1]
	(f)	1 2 3 4	very little difference in percentage of pregnancies resulting in live birth ; standard (slightly) more oocytes (per cycle) ; ora standard (slightly) more embryos (per cycle) ; ora comparative figs ;	[3 max]
	(g)	1 2 3	(promoter needed) to ensure genes are, expressed / switched on ; to produce, correct product / correct hormone / FSH ; ref. human / eukaryote, gene in, bacteria / prokaryote ;	[2 max]
				[Total: 16]

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6	**(a)**	**(i)**	same band of DNA as, first / affected, child ;	[1]
		(ii)	1. father and mother, have normal and mutant alleles / are heterozygous ; 2. mutant / CF, DNA is, shorter / lighter ; 3. therefore travels further ;	[2 max]
	(b)	1	outcome of test needs explanation / counsellor gives advice on options ;	
		2	already have one affected child to care for or problems / cost, of care ;	
		3	ref. termination ;	
		4	life expectancy increasing with improved drugs ;	
		5	gene therapy, not as yet successful / likely to be temporary ;	
		6	possibility of, pre-implantation genetic diagnosis (PGD) / artificial insemination by donor sperm (AID), on another occasion ;	[4 max]
				[Total: 7]
7	**(a)**		*allele* different / alternative, form of a gene ; **A** variety of a gene *dominant* (allele) that always expresses itself in the phenotype when present / (allele) which influences the phenotype even in the presence of an alternative allele / AW ;	[2]
	(b)		parental phenotype ; e.g. striped / long x striped / long **A** wild x wild parental genotype ; e.g. AaBb x AaBb gametes ; e.g. AB Ab aB ab offspring genotypes ;; offspring phenotypes ; *must be linked to genotypes*	[6]
			accept other symbols if key used *penalise once for no key but only if genetic cross works*	

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(c) (i)

	phenotypes of *Drosophila melanogaster*			
	grey body long wing	grey body vestigial wing	ebony body long wing	ebony body vestigial wing
observed number (O)	207	79	68	30
expected ratio	9	3	3	1
expected number (E)	216	72	72	24
O – E	–9	7	–4	6
$(O - E)^2$	81	49	16	36
$\frac{(O-E)^2}{E}$	0.38	0.68	0.22	1.50

[3]

(ii) 2.78 ; *apply ecf* [1]

(iii) χ^2 value represents probability of > 0.05 ;

no significant difference ;

(probability shows) differences due to chance ; [2 max]

[Total:14]

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8	**(a)**	**(i)**	*at low light intensity* 1. rate of photosynthesis increases as light intensity increases ; 2. light <u>intensity</u> is limiting factor ; *at higher light intensity* 3. graph, levels off / forms a plateau / rate becomes constant ; 4. CO_2 / some other factor, becomes limiting ;	[3 max]
		(ii)	1. above light intensity of 1 rate is always higher for expt. 2 ; 2. plateau reached at lower light intensity for expt. 1 ; 3. maximum / plateau, rate is double for expt. 2 ; 4. expt 2 has much more CO_2 (conc) (compared to expt 1) ; 5. CO_2, no longer limiting after 4.2 in expt.2 / is limiting in expt. 1 up to 2.8 ;	[3 max]
	(b)	1	enzymes, denatured / active site changes shape ;	
		2	rubisco / enzyme in cyclic photophosphorylation ;	
		3	Calvin cycle affected / description ;	
		4	less photolysis ;	
		5	less ATP produced ;	
		6	increased rate of respiration ;	
		7	respiration rate faster than photosynthesis rate / ref. compensation point ;	
		8	increased rate of transpiration ;	
		9	stomatal closure ;	
		10	less CO_2 uptake ;	[5 max]
				[Total:11]

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Section B: only one question to be answered.

9	**(a)**	1	(glucose) phosphorylated by ATP ;	
		2	raises energy level / overcomes activation energy ;	
		3	hexose bisphosphate ;	
		4	lysis / splitting, of, glucose / hexose ; **R** sugar splitting	
		5	breaks down to two TP ; **A** GALP / GADP / G3P / PGAL	
		6	6C → 2 x 3C ;	
		7	dehydrogenation / description ;	
		8	2 NAD reduced formed (from each TP to pyruvate formed) ;	
		9	4 ATP produced / net gain of 2 ATP ;	
		10	pyruvate produced ;	
		11	reduced NAD → oxidative phosphorylation / redox ; *accept flow diagram*	[7 max]
	(b)	12	nucleotide ;	
		13	adenine + ribose / pentose + three phosphates ;	
		14	loss of phosphate leads to energy release / hydrolysis releases 30.5 kJ ;	
		15	ADP + Pi ↔ ATP (reversible reaction) ;	
		16	synthesised during, glycolysis / Krebs cycle / substrate level phosphorylation ;	
		17	synthesised, using electron carriers / oxidative phosphorylation / photophosphorylation ;	
		18	in, mitochondria / chloroplasts ;	
		19	ATP synthase / ATP synthetase ;	
		20	chemiosmosis / description;	
		21	used by cells as immediate energy donor ;	
		22	link between energy yielding and energy requiring reactions / AW ;	
		23	active transport / muscle contraction / Calvin cycle / protein synthesis ;	[8 max]
				[Total: 15]

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10	**(a)**	1	strong stimulus in receptor / AW ;	
		2	action potential / impulses, along sensory neurone ;	
		3	dorsal root of spinal nerve ;	
		4	into spinal cord ;	
		5	synapse with intermediate neurone ;	
		6	(then) motor neurone ;	
		7	action potential / impulses, to effector ;	
		8	action potential / impulses, to brain ;	
		9	response ; e.g. knee jerk *5 max can be on diagram*	
		10	fast / immediate ;	
		11	stops / limits, damage / danger ;	
		12	automatic / no conscious thought ;	
		13	innate / stereotyped / instinctive ;	[7 max]
	(b)	14	Schwann cells ;	
		15	wrap around axon ;	
		16	sheath mainly lipid ;	
		17	(sheath) insulates axon (membrane) ;	
		18	Na^+ / K^+, cannot pass through sheath / can only pass through membrane at nodes ;	
		19	depolarisation (of axon membrane) cannot occur where there is sheath / only at nodes of Ranvier ;	
		20	local circuits between nodes ;	
		21	action potentials 'jump' between nodes ;	
		22	saltatory conduction ;	
		23	increases speed / reduces time, of impulse transmission ;	
		24	up to 100 ms^{-1} ;	
		25	speed in non-myelinated neurones about 0.5 ms^{-1} ;	[8 max]
				[Total: 15]

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9700/42 Paper 42 (Theory 2), maximum raw mark 100

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Section A

Question			Expected Answers	Marks
1			<table><tr><th rowspan="2">process or feature</th><th colspan="5">kingdom</th></tr><tr><th>Prokaryotae</th><th>Protoctista</th><th>Fungi</th><th>Plantae</th><th>Animalia</th></tr><tr><td>80s ribosomes</td><td>✗</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr><tr><td>cell walls contain chitin</td><td>✗</td><td>✗</td><td>✓</td><td>✗</td><td>✗ ;</td></tr><tr><td>circular DNA</td><td>✓</td><td>✗</td><td>✗</td><td>✗</td><td>✗ ;</td></tr><tr><td>endoplasmic reticulum</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓ ;</td></tr><tr><td>most species unicellular</td><td>✓</td><td>✓</td><td>✗</td><td>✗</td><td>✗ ;</td></tr><tr><td>autotrophic</td><td>✓</td><td>✓</td><td>✗</td><td>✓</td><td>✗ ;</td></tr><tr><td>heterotrophic</td><td>✓</td><td>✓</td><td>✓</td><td>✗</td><td>✓ ;</td></tr></table> *one mark for each correct row* *if there are any blanks in a row then award no marks for that row*	[6]
				[Total: 6]
2	**(a)**		*isolating mechanism* - geographical / mountains / physical barrier **;** *type of speciation* – allopatric **;**	[2]
	(b)	1	mouse populations separated by mountains **;**	
		2	no, breeding / gene flow, between populations **;**	
		3	mutations occur **;**	
		4	different selection pressures / different (environmental) conditions **;**	
		5	genetic change **;** e.g. different alleles selected for / change in allele frequency / change in gene pool / advantageous alleles passed **on ;**	
		6	(results in) different chromosome numbers **;**	
		7	genetic drift **;**	
		8	(different populations ultimately) cannot interbreed **;** **R** different species	[5 max]
				[Total: 7]

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3	**(a)**	**(i)**	condensation ;	[1]
		(ii)	1. autolysins ; 2. make holes in cell walls ; 3. in, growing / developing, bacteria ; 4. (antibiotic), inhibits / acts on, (another) enzyme ; 5. so peptidoglycan chains cannot link up / stops cross-links forming ; 6. cell wall becomes weaker / AW ; 7. turgor of cell not resisted (by cell wall) / AW ; 8. cell bursts ;	[4 max]
		(iii)	(glycoprotein) peptidase ; R other peptidase	[1]
	(b)		viruses have no cell wall ;	[1]
	(c)		*assume gram+ unless otherwise stated*	
		1	(gram+) penicillin can reach, cell wall / peptidoglycan, directly /AW / (gram-) ora ;	
		2	(gram-) outer membrane provides protection (from penicillin) / (gram+) ora ;	
		3	(gram+) more % peptidoglycan in wall (so greater effect from penicillin) / (gram-) ora ;	[2 max]

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	(d)		*accept antibiotic for penicillin and bacteria for S. pneumoniae throughout*	
		1	increase in resistance (throughout time period) ;	
		2	paired figs + units ;	
		3	overuse / misuse, of penicillin ;	
		4	some *S. pneumoniae* survive ;	
		5	mutation (in *S. pneumoniae)* ;	
		6	resistance, gene / allele ;	
		7	resistance passed to other bacteria ; e.g. plasmid transfer	
		8	resistant strain, multiplies ; *idea of many produced*	
		9	beta – lactamase produced ;	
		10	breaks down penicillin ;	
			point 7 accept vertical or horizontal transfer *point 8 accept vertical transfer only*	[5 max]
				[Total: 14]
4	**(a)**	**(i)**	1. yield for sorghum is greater than yield for wheat (in any soil type) ;	
			2. yield for wheat is better in HWC soil / little difference in yield for sorgham ;	
			3. paired figs ; *only award if linked correctly to mp 1 or mp2*	
			4. sorghum is adapted to live in arid environment / AW ;	
			5. and 6. *any two of the following* ;;	

feature	function
extensive / deep, root system	maximises water absorption
curled leaves / leaves small surface area / wazy leaves / bulliform leaf cells / hinged leaf cells / reduced stomata numbers / stomata in pits	reduces water loss
high silica content / more sclerenchyma / more strengthening tissue	reduces wilting

[4 max]

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		(ii)	number of seeds sown ; density of seeds sown / area of plot ; minerals / fertilisers ; wind / shelter ; soil pH;	[2 max]
	(b)		1. ref. bundle sheath cells; 2. light independent stage occurs / RuBP found (in bundle sheath cells) ; 3. RuBP / rubisco, kept away from, air / oxygen ; 4. by mesophyll cells ; 5. limits uptake of O_2 / maintains high CO_2 concentration (in bundle sheath cells) ; 6. enzymes / PEP carboxylase, have high optimum temperature ; 7. approx 45^0C ; 8. not denatured ;	[4 max]
				[Total: 10]
5	**(a)**		**A** – Leydig cell / interstitial cell ; **B** – (wall of) seminiferous tubule ;	[2]
	(b)	**(i)**	1 ;	[1]
		(ii)	*mark first two answers* E ; **A** secondary spermatocyte F ; **A** spermatid spermatozoan ;	[2 max]
		(iii)	cells grow in size / cells grow larger ;	[1]
	(c)	1 2 3	ATP production / provides energy ; **R** produces energy (for) movement of flagellum ; **R** tail (for) production of acrosomal enzymes ;	[2 max]

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	(d)	**(i)**	1. infectious disease causes damage ; **A** mumps / Chlamydia / STDs 2. lower sperm count / absence of sperm ; 3. damaged / abnormal / immobile / lazy , sperm ; 4. blocked sperm ducts / lack of seminal fluid ; 5. named genetic condition ; e.g. CF 6. autoimmune reaction to sperm ; 7. reduced testosterone ; 8. effect of chemical damage ; e.g. chemotherapy / hormones in drinking water	[3 max]
		(ii)	(fertilisation of) <u>oocyte</u> by sperm ; in glass dish ; **A** appropriate glassware **R** test tube AVP ; e.g. sperm injected into oocyte	[2 max]
		(iii)	1. ovulation less likely ; 2. (older) <u>oocytes</u> less likely to be fertilised / <u>oocytes</u> less viable ; 3. implantation less likely (in uterus of older woman) ; 4. miscarriage rate increases (with age) ; 5. (as) lower concentration of hormones / unbalanced hormones (in older woman) / start of menopause ; 6. (as) genetic defects / mutations, increase (with age) ;	[3 max]
				[Total: 16]
6	**(a)**	**(i)**	*ignore refs to function* <u>islets of Langerhans</u> ; scattered throughout pancreas / AW ; alpha and beta cells ; blood supply (to carry hormones away) ;	[3 max]
		(ii)	<u>globular protein</u> ;	[1]

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	(b)	1	it is identical to human insulin / fits membrane receptor on (target) cells ;	
		2	(more) rapid response ;	
		3	no / fewer, rejection problems / side effects / allergic reactions ;	
		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 <u>animal</u> insulin ;	[3 max]
				[Total: 7]
7	**(a)**		parents, carriers / heterozygous ; child homozygous recessive ; ¼ / 0.25 / 25%, chance ; mutation ;	[3 max]
	(b)	**(i)**	gene technology / genetic engineering / description ;	[1]
		(ii)	<u>glucagon</u> ;	[1]
		(iii)	low <u>blood</u> <u>glucose</u> concentration / during or after exercise ; **R** sugar	[1]
	(c)		foreign / non-self / cell recognition ; stimulates immune response / AW ;	[1 max]
	(d)		*parental genotypes* L^ML^N x L^ML^N *gametes* L^M or L^N L^M or L^N ; *parental genotypes and gametes for one mark* *offspring genotypes* L^ML^M L^ML^N L^ML^N L^NL^N ; *offspring phenotypes* MM MN MN NN ;	[3]
			*penalise once for omission of **L***	

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	(e)		Canadian Inuit, allele frequencies / L^ML^N ratio, different from others ; high frequency of L^M / low frequency of L^N , compared to other populations ; **R** just highest L^M / lowest L^N less outbreeding / more inbreeding ; AVP; e.g. L^M has selective advantage in Inuit environment	[3 max]
				[Total: 13]
8	**(a)**	1 2 3 4 5 6 7	stomata ; air spaces (between cells) ; thin cell walls ; moist internal walls ; thin leaf ; cylindrical palisade cells ; large surface area of, palisade / mesophyll, cells ;	[4 max]
	(b)		0.0025 / 2.5 x 10^{-3}; **A** 0.003 only if 0.0025 in answer	[1]
	©	1 2 3 4	photosynthesis takes place ; oxygen is produced ; collects, inside disc / on surface of disc ; disc, less dense / more buoyant ;	[3 max]
	(d)		rate of photosynthesis increases as light intensity increases ; paired data quotes from columns 2 and 4 ;	[2]
	(e)	1 2 3	light intensity no longer limiting ; carbon dioxide, concentration / rate of diffusion, now limiting ; temperature, too high / denatures enzymes ;	[2 max]
				[Total: 12]

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Section B: only one question to be answered.

9	**(a)**	1	acetyl CoA combines with oxaloacetate ;	
		2	to form citrate ;	
		3	4C to 6C ;	
		4	decarboxylation / CO_2 released ;	
		5	dehydrogenation / oxidation / release of hydrogen ;	
		6	reduced NAD produced / NAD accepts hydrogen ;	
		7	reduced FAD produced / FAD accepts hydrogen ;	
		8	ATP produced ;	
		9	substrate level phosphorylation ;	
		10	series of, steps / intermediates ; **A** many named steps off a diagram	
		11	enzyme catalysed reactions ;	
		12	oxaloacaetate regenerated ;	
		13	occurs in mitochondrial matrix ;	[9 max]
			accept diagram	
	(b)	14	coenzyme ;	
		15	for dehydrogenase ;	
		16	reduced ;	
		17	carries, electrons and protons / hydrogen / NAD	
		18	from Krebs cycle ;	
		19	and glycolysis ;	
		20	to ETC / electron carrier chain / oxidation ;	
		21	reoxidised / regenerated hydrogen removed ;	
		22	ATP produced ;	[6 max]
				[Total: 15]

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10	**(a)**	1	action potential / depolarisation, reaches presynaptic membrane ;	
		2	(Ca^{2+}) channels open in presynaptic membrane / presynaptic membrane becomes more permeable to (Ca^{2+}) ; **R** calcium / Ca / Ca^{+}	
		3	Ca^{2+} (flood) into presynaptic, neurone / knob ; **R** membrane	
		4	(this causes) vesicles of, acetylcholine / ACh ;	
		5	(to) move towards presynaptic membrane / (to) fuse with presynaptic membrane;	
		6	ACh released into synaptic cleft / exocytosis of ACh ;	
		7	ACh diffuses across (cleft) ;	
		8	ACh binds to receptor (proteins) / AW ;	
		9	on postsynaptic membrane ;	
		10	proteins change shape / channels open ;	
		11	sodium ions (rush) into postsynaptic neurone ; **R** membrane	
		12	postsynaptic membrane depolarised ;	
		13	action potential / nerve impulse ;	
		14	action of acetylcholinesterase ;	[9 max]
	(b)	15	ensure one-way transmission;	
		16	receptor (proteins) only in postsynaptic, membrane / neurone ; *ora*	
		17	vesicles only in presynaptic neurone ; *ora*	
		18	adaptation / ACh amount reduces due to overuse of synapse ;	
		19	wide range of responses ;	
		20	due to interconnection of many nerve pathways ;	
		21	inhibitory synapses affect other synapses ;	
		22	involved in memory / learning ;	
		23	due to new synapses being formed ;	
		24	summation / discrimination ;	[6 max]
				[Total: 15]

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