Oxford Cambridge and RSA Examinations

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE | **A2 7881**

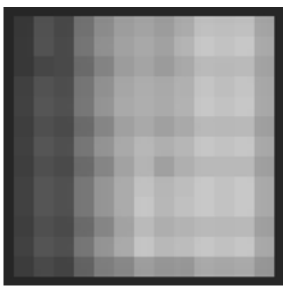
ADVANCED SUBSIDIARY GCE | **AS 3881**

BIOLOGY

COMBINED MARK SCHEME AND REPORT FOR THE UNITS

JANUARY 2005

AS/A2



3881/7881/MS/R/05J

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MARK SCHEME ON THE UNITS

Advanced GCE Biology (7881)

Advanced Subsidiary GCE Biology (3881)

REPORT ON THE UNITS

Mark Scheme 2801
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme			
	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question **Expected Answers** **Marks**

1 *mark two columns separately first. If letter and part of cell both incorrect, look to see if the part of the cell corresponds to this letter. If so, allow 1 mark ecf*

function	part of cell	label
controls activities of the cell	*nucleus*	*A*
carries out aerobic respiration	mitochondrion / mitochondria **;**	D **;**
attaches to mRNA in protein synthesis	ribosome(s) / rough ER / RER **;**	C **;**
produces secretory vesicles	Golgi **;**	B **;**
contains digestive enzymes	lysosome(s) **;**	E **;**

8

[Total: 8]

Question			Expected Answers	Marks
2	(a)	(i)	polypeptide **;** **A** oligopeptide	1
		(ii)	glycine **;** **A** proline / alanine	1
		(iii)	*in this answer assume that* *chain = polypeptide* *molecule = groups of 3 polypeptide chains* **A** *ecf for named amino acid from (ii) but NOT a name of a base* amino acids / glycine **,** small (to allow close packing) **;** the small one is **,** every 3rd amino acid / at every level in the molecule **;** chains **,** form a tight coil / lie close to each other **;** held together by hydrogen bonds **;** *ignore other bonds* bonds form between R groups of lysines **;** molecules form **,** fibres / bonds with adjacent molecules **;** **A** fibril covalent bond between **,** adjacent molecules / CO-NH groups **;** fibres composed of parallel molecules **;** ends of parallel molecules staggered **;** prevents line of weakness **;**	**2 max**
	(b)		cell wall(s) **;** β / beta **;** **A** B glycosidic **;** **NOT** glucosidic 180 **;** straight **;** **A** polysaccharide / unbranched / linear hydrogen / H **;** **NOT** H_2	6

[Total: 10]

Question			Expected Answers	Marks
3	(a)	(i)	long **;** thin cell wall **;** lack of **,** waterproof layer / cuticle **;** large surface area **;** **NOT** if cilia / villi / microvilli / tails / etc present in large numbers **;** (membrane) proteins / carriers / channels / aquaporins **;** many mitochondria **;** AVP **;** (adaptation of part of the cell)	**1 max**
		(ii)	*if candidate gives a list or a choice, all must be correct* active transport / diffusion / facilitated diffusion / described **;** **A** pinocytosis **NOT** passive transport / osmosis / bulk transport	**1**
		(iii)	lower <u>water potential</u> inside / ora **;** movement **,** down water potential gradient / from high Ψ to low Ψ **;** through **,** channel proteins / partially permeable membrane / aquaporins / AW **;** walls freely permeable **;** osmosis **;**	**2 max**
	(b)		U **;** V **;** Z **;** S **;**	**4**

[Total: 8]

Question			Expected Answers	Marks
4	(a)	(i)	4 **;**	1
		(ii)	deoxyribose **;** **NOT** ribose phosphate **;** nitrogen(ous) / organic / named **,** base **;** **A** purine / pyrimidine **NOT** uracil **NOT** letter **NOT** thiamine / thyamine take a correct base from a list unless that list includes uracil	3
	(b)		**1** 2 **,** molecules / helices **,** (of DNA) produced **;** **2** identical (molecules of DNA produced) **;** **3** (each made up of) 1 **,** original / parent / old **,** strand **;** **4** 1 new strand **;** **5** original / parent / old **,** strands **,** act as template / described **;** **6** ref to (free DNA) nucleotides **;**	3 max

[Total: 7]

Question			Expected Answers	Marks
5	(a)		caused by **,** mutation / damage to DNA / ref oncogene / AW **;** uncontrolled **,** mitosis / cell division **; NOT** growth mass of cells / tumour **;** **A** group of cells (product) unspecialised / abnormal **;**	**2 max**
	(b)	(i)	(X) 10 / 900% (increase) **;** **NOT** 10% increase ignore 1000% increase	**1**
		(ii)	*candidates may use information from the passage* *e.g. typical [NOT average] = 20 units* *threshold = 200 units* **1** no increase **,** between 0 and 20 units / at low levels / well below threshold **,** of radon **;** **2** radon increasing **,** from 20 to 200 units / towards threshold **,** increases risk **;** **3** by 10X / 900% **;** **4** high radon and smoking gives greatest risk **;** **5 & 6** other suitable quantitative <u>risk</u> statement **; ;** **7** consequence / relevant effect on cell **;**	**2 max**
	(c)		*advantage* make people aware of risk / let people know that their area is safe / could reduce other risks / other suitable suggestion **;**	**1**
			disadvantage worry people / lower house prices / migration / other suitable suggestion **;**	**1**

Question	Expected Answers	Marks

(d) *only award marking points 1, 6, 9, 14 and 16 if descriptions of the stages are correct- do not award simply for identifying the stages - ignore ref to centrioles*

prophase

1 C **;**
2 chromosomes / chromatids **,** condense / coil / shorten <u>and</u> thicken **;**
3 become visible **;**
4 consist of two <u>chromatids</u> **;**
5 joined by a centromere **;** **A** kinetochore **NOT** centrosome

metaphase

6 A **;**
7 chromosomes align <u>at</u> **,** equator / metaphase plate **;**
8 attached to spindle by centromeres **;**

anaphase

9 B **;**
10 centromere splits **;**
11 chromatids separate **;**
12 move to opposite poles **;**
13 by **,** contraction / shortening **,** of spindle **;**

telophase

14 E **;**
15 chromosomes uncoil **;**

interphase

16 D **;** **A** for a <u>description</u> of early prophase
17 <u>DNA</u> replication **;**
18 transcription / formation of mRNA **;**

19 AVP **;** *these must relate to behaviour of chromosomes*
20 AVP **;** e.g. spindle made of microtubules
chromatin becomes chromosomes (in prophase)
ora in interphase
centromere leads chromatid to pole
gene switching during interphase **9 max**

QWC – clear well organised using specialist terms ; **1**

award the QWC mark if three of the following are used in correct context, but Q = 0 if names of names of stages of mitosis are used inappropriately

chromatin	equator / metaphase plate
chromatid	DNA replication
centromere	transcription
spindle	

[Total: 17]

Question		Expected Answers	Marks
6	(a)	idea that arachidonate is substrate **;** phospholipid source in membrane **;** prostaglandin / product **,** can be **,** transported / stored **;** (S)ER for **,** lipid / steroid **,** synthesis / transport **;** AVP **;** AVP **;** e.g. separate from other reactions cytoplasm environment not suitable for , reaction / enzyme ora idea that prostaglandin isolated COX does not , damage / use phospholipids from, other membranes	**2 max**
	(b)	*ibuprofen* competitive **;** ibuprofen blocks / arachidonate cannot enter **,** channel **;** **A** substrate cannot reach active site **;** *aspirin* non-competitive **;** changes shape (of) / blocks **;** active site **;** AVP **;** e.g. <u>allosteric</u> no ESC formed / AW **;** *allow once only*	**4 max**
	(c)	**A** *reverse argument as long as question is answered in terms of low temperature* slows , reaction / rate / activity of enzyme / AW **;** ref kinetic energy **;** molecules moving **,** slowly / less **;** few collisions / collisions less likely **;** few ESC formed / ESC less likely to be formed **;** reversible / enzyme not denatured / enzyme still works **;** ref activation energy **;** ref Q_{10} = 2 **;**	**4 max**

[Total: 10]

RECOGNISING ACHIEVEMENT

Mark Scheme 2802
January 2005

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Question		Expected Answers		Marks
1	**(a)**	mental **;** deficiency **;** degenerative **;** self inflicted **;** physical **;** non-infectious / non-communicable **;**	 **R** malnutritional **R** social	**2 max**
	(b) (i)	*award two marks if correct answer (40) is given* *award one mark if not rounded up* 47 x 85/100 **;** 40 **;**		**2**
	(ii)	an X on the (descending) curve at 40 kg **;** accept anywhere on or below 40 kg must be on curve or touching *allow ecf*		**1**
	(c)	obsession about food **;** **A** dysfunctional relationship with food eat very little / AW **;** **R** poor appetite muscle / heart muscle, wasting **;** loss of body fat **;** **R** loss of weight and disrupted menstrual cycle thin / sparse / brittle, hair **;** cold, hands / feet *or* poor circulation **;** lanugo / extra growth of fine body hair **;** low blood pressure **;** obsession with, exercise / death **;** poor body image / low self esteem / perception of being fat / depression **;** weak immune system / susceptible to infectious diseases **;** weakness / tiredness / apathy / lacking energy **;** AVP **;** e.g. limited growth, limited sexual development obsessional behaviour (not food related) bad breath – qualified e.g. ketosis deficiency explained - calcium and tooth decay - iron and pale skin **R** ref to bulimia / vomiting		**4 max**

[Total: 9]

Question		Expected Answers	Marks
2	(a)	*Plasmodium / P. vivax / P. falciparum* **;** *Anopheles* **;** infected **;** blood **;** vector **;** **R** carrier (blood) transfusion / shared needle / across placenta / at birth / AW **;** **R** mixing blood unless qualified	6
	(b)	*reduce mosquito numbers* stock ponds with fish (*Gambusia*) to eat larvae **;** **R** kill mosquitoes oil on surface **;** spray bacteria (*Bacillus thuringiensis*) to kill mosquito larvae **;** DDT / pesticide spray **;** release of sterile male mosquitoes **;** draining, ponds / bodies of water **;** *avoid being bitten by mosquitoes* wear insect repellant **;** long sleeved clothes **;** sleep under nets **;** nets soaked in, insecticide / repellant **;** sleep with, pigs / dogs **;** *use drugs to prevent infection* use, prophylactic drug / quinine / chloroquine / larium / artimesinin / vibrimycin / tetracycline / antimalarial **;** use malaria vaccine **;**	2 max

[Total: 8]

Question			Expected Answers	Marks
3	(a)		rickets **;** **R** osteomalacia	1
	(b)		(more) exposure to, sunlight / uv light **;**	1
	(c)	(i)	enough to meet needs of almost all the population / AW **;** **R** ref to average amount needed, or enough for every person	1
		(ii)	strengthen / harden, bones *or* prevent rickets **;** **R** growth of bone strengthen / harden, teeth **;** ref to (control of) muscle contraction **;** used in, synapse / neuromuscular junction **;** involved in blood clotting **;** enzyme cofactor **;** AVP **;** e.g. ref to breast milk	2 max
	(d)	(i)	calcium levels in blood of group 2 higher than group 1 after treatment / ora **;** % showing some healing is higher than group 1 (vit D treatment) / ora **;** % showing complete healing is much higher than group 1 (vit D treatment) / ora **;** reference to figures **with units** comparing one of above **;** e.g. calcium concentration 90 mg dm^{-3} against 83 (7 mg dm^{-3} higher) % showing some healing 86 against 83 (3% difference) % showing complete healing 61 against 19 (42% difference) calcium levels in blood of group 2 match levels in, group 3 (treatment with both vit D and calcium) / group 4 (control) **;**	3 max
		(ii)	members of the group do not realise they are having a different treatment / ora **;** members of the group do not expect to show better healing than others / ora **;** (when X-rays re-examined) doctors unaware which treatment each individual had **;** doctors do not look for better results in one group than another **;** AVP **;** e.g. double blind test *or* single blind test if doctors know the treatment	2 max
		(iii)	for comparison **;** **R** control of extent of healing / of blood calcium levels / of X-rays **;** to see, how well treatment has worked / what values are normal **;** use of figs **with units ;** AVP **;**	2 max

[Total: 12]

Question		Expected Answers	Marks
4	(a)	(substance that) causes, cancer / tumour / abnormal growth / AW **;**	
		invasive / spreading / destructive / results in secondary tumours / metastasis / AW **;**	**2**
	(b)	acts on, genes / chromosomes / DNA **;** causing, mutation / change in genetic code **;** of genes that control cell division / oncogenes **;** cells divide out of control / AW **;** **R** rapidly **R** grow AVP **;** e.g. detail of change / substitution / deletion / insertion / chromosome abnormality cells do not undergo apoptosis	**3 max**
	(c)	shortage of breath / difficult to breathe / AW **;** **R** wheezing persistent / constant, cough **;** **R** smoker's *or* severe cough coughing up blood **;** chest pain / pain when breathing **;** swollen / painful, lymph glands **;** weight loss **;**	**2 max**
	(d)	bronchoscopy / use of an endoscope / described **;** (chest) X-ray **;** CT (computed tomography) scan **;** **A** CAT **A** MRI **R** scan unqualified AVP **;** e.g. position of distinct, patch / shadow, is position of tumour use of stethoscope to tell if tumour is in left or right, lung / lobe lung volume test	
		R biopsy, ultrasound	**2 max**
			[Total: 9]

Question			Expected Answers	Marks
5	(a)	(i)	X = (smooth) muscle **; A** involuntary muscle / non striated muscle Y = (ciliated) epithelium **;**	
		(ii)	Z = (branch of) blood vessel / artery / vein / arteriole / venule **;** **R** capillary	**3**
	(b)		*cartilage*	
		1	in, trachea / bronchi **;**	
		2	holds airway open / prevents collapse **;**	
		3	prevents bursting (of trachea / bronchi as air pressure changes) **;**	
		4	low resistance to air movement **;**	
			ciliated epithelium / cilia	
		5	move mucus **;**	
		6	ref to how movement brought about **;** e.g. metachronal rhythm / wave / sweep / waft	
			goblet cells	
		7	secrete mucus **;**	
		8	trap, bacteria / dust / pollen / particles **;**	
		9	remove particles from lungs **;**	
			blood vessels	
		10	supply, oxygen / nutrients (to tissues of lung) **;**	
		11	surround alveoli / good blood supply to alveoli **;**	
		12	deliver carbon dioxide / pick up oxygen **;**	
		13	ref to wall of capillary being thin **;**	
		14	ease of / rapid, gaseous exchange *or* short diffusion pathway **;**	
			smooth muscle	
		15	adjust size of airways (in, exercise / asthma) **;**	
			connective tissue / elastin / elastic tissue	
		16	stretch (inhalation) **;**	
		17	prevents alveoli bursting **;**	
		18	recoil **;** **R** contract	
		19	helps exhalation / forces air out (of lungs) **;**	
			squamous epithelium / described	
		20	alveolus wall thin **;**	
		21	ease of / rapid, gaseous exchange *or* short diffusion pathway **;**	
		22	AVP **;** e.g. ref to large surface area of numerous alveoli	
		23	AVP **;** ref to macrophages removing pathogens	**8 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 12]

Question			Expected Answers	Marks
6	(a)		(a disease that) spreads quickly / affects many people **;**	**1**
	(b)		pandemic **;**	**1**
	(c)	(i)	(antigens) injected / taken orally **;** ora ('not caught') **R** vaccination	**1**
		(ii)	**1** injection of antigen *or* attenuated / weakened / dead / similar, pathogen **;** **R** disease **2** immune system activated / causes immune response **;** **3** attacked / engulfed, by, phagocytes / macrophages **;** **4** ref antigens presented **;** **5** selection / production, of active T, cells / lymphocytes **;** **6** T cells, clone / divide / mitosis **;** **7** secretion of cytokines **;** **8** activation of B cells**;** **9** B cells, clone / divide / mitosis **;** **10** production of, plasma / effector, cells **;** **11** production of antibodies (by plasma cells) **;** **12** production of memory cells **;** **13** memory cells remain in body **;** **14** (secondary) response to infection quicker **;** **15** (secondary) response to infection greater **;** **16** no symptoms when infected / AW **;**	**4 max**
		(iii)	herd vaccination **;** vaccinate, most / all, people **;** stops infection spreading (within population) / lack of people to pass infection on to **;** ring vaccination **;** vaccinate all people around victim **;** contains spread (within ring) **;** surveillance / spotting and reporting victims **;** isolation of victim **;** trace contacts **;** isolation of contacts **;** ref to making it notifiable **;** travel restrictions **;** AVP **;** e.g. if notified can organise ring vaccination	**3 max**
				[Total: 10]

Mark Scheme 2803/01
January 2005

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Question **Expected Answers** **Marks**

1 **(a)** 3 to 5 armed star of xylem with phloem more or less between **;**
R if star too close to the edge
xylem and phloem correctly labelled **;**

ecf - if stem drawn, credit correct xylem and phloem labels **2**

(b) lack of contents / no cytoplasm / hollow / lumen / continuous / AW **;** **A** lack of end walls
less resistance to flow / more space linked to idea of lack of contents / AW **;**
treat large as neutral

thickening / rings / spirals / lignin (in the wall) **;** *treat cellulose as neutral*
prevents collapse / gives support / adhesion of water **;**
R strength / rigid, unqualified **R** ideas on resisting positive pressure

pits / AW **;** **A** pores / holes (in side walls)
allow lateral movement / AW**;** **R** 'let things in or out' unqualified **4 max**

(c) **(i)** *source* – leaf / storage organ / named storage organ **;** **A** root qualified
sink – root / tuber / storage organ / (young) growing region / leaf qualified / flower / bud / fruit / seed **;**

R individual cells but **A** tissue <u>areas</u> such as mesophyll **2**

(ii) *max 2 if no reference to diagram*

water will enter source **;**
by osmosis **;**
down / AW , a <u>water potential</u> gradient **;**
increase in (hydrostatic) pressure**;**
as source / sink cannot expand / AW **;**
force / AW, solution along (tube to sink) **;**
AVP **;** e.g. explanation of mass flow **4 max**

(d) **(i)** ATP involved / respiration involved / many mitochondria in companion cells / reduced by metabolic inhibitors / oxygen dependent / temperature dependent / loading against a concentration gradient / AVP **;**

if evidence not given here look for it and credit it in part (ii) **1**

(ii) loading, into companion cell / from transfer cell / into sieve tube / into phloem – implied **;**
H ions / protons, pumped out of, companion cell / sieve tube / phloem **;**
diffuse back in with sucrose **;**
protein carrier / co-transporter **;**
possible active unloading by reverse mechanism **;**

AVP to cover alternative mechanisms **;;;**
e.g. electro-osmotic theory
K^+ pump
via companion cell
electrochemical gradient
sieve pores provide a capillary bed / AW **3 max**

[Total: 16]

Question		**Expected Answers**	**Marks**
2	**(a)**	iron / Fe **;** **A** $\mathbf{Fe^{++}}$ four / 4 **;** Bohr, effect / shift **;** carbonic anhydrase **;** haemoglobinic acid **;** **A** reduced haemoglobin **A** HHb	**5**

[Total: 5]

Question			Expected Answers	Marks
3	**(a)**	**(i)**	(blood flows) twice through the heart / AW **;** for one circuit / cycle (of the whole body) / AW **;** **A** for one heart beat ref pulmonary **and** systemic systems / to lungs **and** to (rest of) body **; R** systematic	**2 max**
		(ii)	*read whole answer and look for any two linked ideas from* • *size* • *activity* • *SA:V ratio* *ora if answered in terms of* Paramecium *size* (mammals) larger / AW **;** cells deep in the body **;** regions requiring materials separated by a distance / need to get materials to all parts / AW **;** diffusion too slow / AW **;** max 2 *activity* (mammals) more (metabolically) active / AW **;** need more materials / more rapid supply / more removal of wastes **;** *SA:V ratio* (mammals) surface area:volume ratio reduced / AW **;** diffusion alone not effective / AW **;** *must be linked to SA:V*	**4 max**
	(b)		*look at and credit any annotations on diagram* *if sequence gets lost do not award the marking points that follow and are directly linked, but give any general ones*	
		1	atrial systole / atria contract **;**	
		2	blood passes into ventricles **;**	
		3	veins / blood vessels, entering heart closed / AW **;**	
		4	atrioventricular / alternative names, valves open **;**	
		5	ventricular systole / ventricles contract **;**	
		6	blood to, the arteries / named arteries **;**	
		7	(via) open, semilunar / AW, valves **;**	
		8	atrioventricular valves shut to stop backflow **;**	
		9	relaxation / diastole, of ventricles (and atria) **;**	
		10	semilunar / AW, valves shut to stop backflow **;** *may be mentioned at X – only credit once*	
		11	ref to **X**,**Y** and **Z** **;** ***X*** *= 1-4* ***Y*** *= 5-8* ***Z*** *= 9-10*	**6 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 13]

Question			Expected Answers	Marks
4	(a)	(i)	*award two marks if correct answer (15) is given* 15 **;;** *ignore signs* *if answer incorrect give one mark for indication that 15.5* ***and*** *0.5 read off graph* *if 15 obtained by wrong calculation = 1*	**2**
		(ii)	qualified ref to distance from heart e.g. further **;** friction / resistance (to flow) **;** ref to increasing volume of e.g. capillaries**;** **A** surface area of capillaries idea of dissipation of energy in elastic recoil **;**	**2 max**
		(iii)	stop damage to, capillaries / arterioles / AW **;** **A** stops bursting ref to, lack of (much) elasticity in these vessels / thin walls / AW **;** ora for nature of artery wall *max one mark if only veins mentioned* slows flow rate **;** to allow (time for) exchange **;**	**2 max**
	(b)	(i)	C **;** **R** more than one letter i.e. a 'list'	**1**
		(ii)	*feature and role must match. Correct features are stand alone marks. Look at the given role to see if it informs the feature.* thin wall / single cell layer / AW **;** **R** membrane / thin cell wall **A** *statement which gives one cell thick, treating thin cell wall as neutral in this case* short pathway / ease of access to tissue fluid AW, rapid / easy, diffusion **;** smooth, (inner) surface / endothelium **;** **A** epithelium **R** refs to smooth muscle reduced friction / smooth flow / reduced turbulence / reduced resistance / AW **;** (small) gaps / pres / holes, between endothelial cells / in wall / AW **;** allows nutrients / named nutrients / fluid / AW, out, / (most) cells / proteins cannot pass **;** **R** refs to plasma **A** refs to, phagocytes / AW, passing narrow / small (diameter) / figure quoted / AW **;** idea of contact with many cells / short diffusion distance / rapid diffusion / reduced rate of flow qualified **;** large, total surface area / cross-sectional area **;** allows more exchange / slows flow for exchange / close to all the cells in the body**;** **R** easier / more efficient ideas unless qualified	**4 max**

[Total: 11]

RECOGNISING ACHIEVEMENT

Mark Scheme 2803/03
January 2005

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Planning Exercise

The mark scheme for the planning exercise is set out on page 4. The marking points **A** to **U** follow the coursework descriptors for Skill P.

Indicate on the plans where the marking points are met by using a tick and an appropriate letter. There are 14 marking points for aspects of the plan and two marks for quality of written communication (QWC).

Practical Test

Pages 27 to 30 have the mark scheme for Questions 1 and 2 for the Practical Test.

AS Biology. Planning exercise

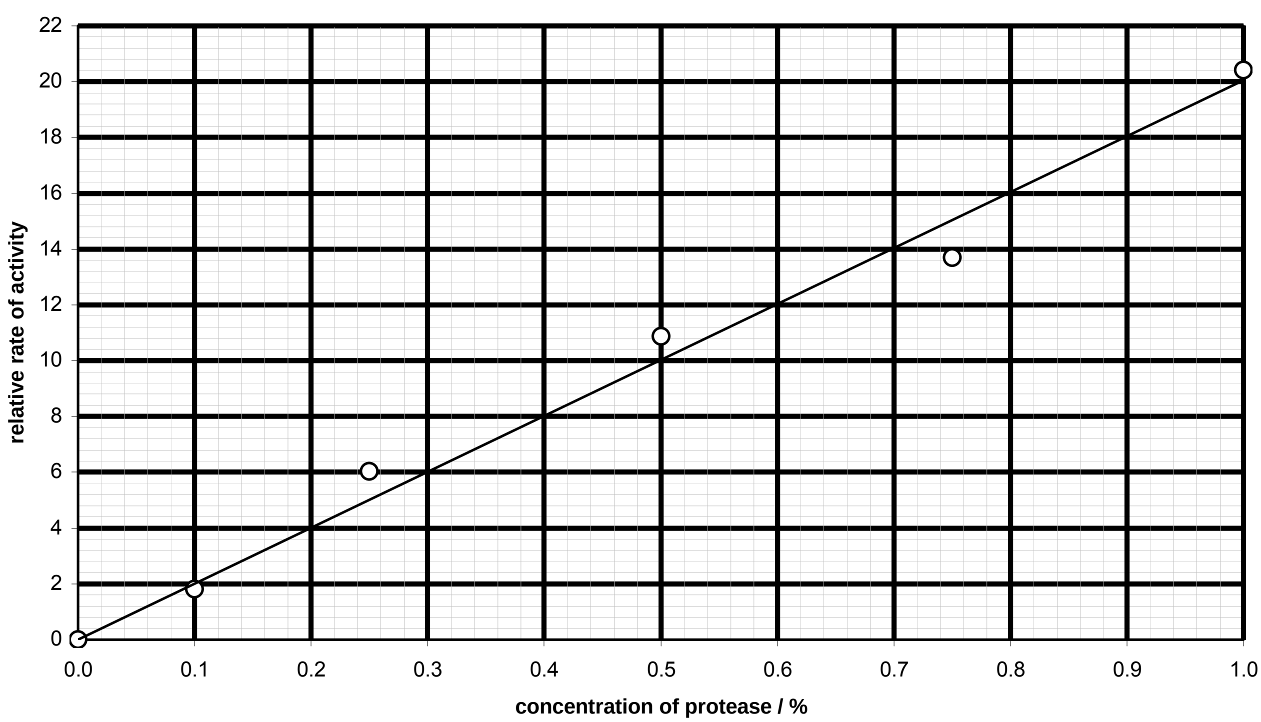
Checking Point	Descriptor	The candidate
A	P.1a	plans a suitable procedure that involves mixing different concentrations of urea with urease **and** repeating with thiourea**;**
B	P.1a	gives a prediction involving action of a competitive inhibitor, e.g. in the form of a graph**;** NOT simply rate increases as urea concentration increases
C	P.1b	selects suitable equipment and materials to include a way to follow the increase in pH / detect change in pH / measure volume of acid needed to neutralise NH_3**;**
D	P.3a	states that effect of competitive inhibitor is dependent on substrate concentration**;**
E	P.3a	identifies at least 2 key factors to control e.g. volumes, temperature, concentration of urease, concentration of thiourea, start pH, time for reaction**;**
F	P.3b	decides on appropriate number of measurements to take: minimum of **five** different concentrations of **urea**, which can include 0%**;**
G	P.3b	decides on an appropriate range of concentrations of urea, e.g. 0% to 1%**;** NOT higher than 1%
H	P.3b	describes ways of obtaining reliable results by including replicates, e.g. each concentration of urea repeated *at least* once**;**
I	P.5a	uses appropriate scientific knowledge and understanding in developing a plan **-** active site, competitive inhibition, complementary shapes**;**
J	P.5a	uses preliminary work, previous practical work or identified secondary source in developing a plan**;**
K	P.5a	gives a risk assessment or refers to a safety aspect, e.g. irritant nature of thiourea**;**
*L**	*P.5b*	*gives a clear account, logically presented with accurate use of scientific vocabulary (QWC);*
M	P.5b	describes way(s) of obtaining precise results, e.g. titrating to find ammonia concentration, recording time taken to reach a certain pH using pH probe (and data logger), using white background to see colour change**;**
N	P.7a	uses information from **at least two identified sources**, e.g. preliminary work / class practical / text book / web site**;**
O	P.7a	shows how results are to be presented in the form of a table including units for time, volumes, concentration, etc**; R** if units are in the body of the table
*P**	*P.7a*	*uses spelling, punctuation and grammar accurately (QWC);*
Q	P.7a	calculates a rate of reaction, e.g. if measures time to end point calculates 1/t *or* states that, enzyme should be denatured / reaction should be stopped**;**
R	P.7b	explains how data would be interpreted to find answer to the investigation, e.g. effect of increasing substrate concentration on the action of thiourea**;**
S	P.7b	justifies one way of obtaining precise results, e.g. justification of using burette**;**
T	P.7b	comments on validity e.g. problems with constant enzyme concentration using urease tablets or urease meal, keeping constant time for the reaction, ref to pH change during reaction, explains need to stop enzyme action (by denaturing)**;**
U	P.7b	explains how results would show that thiourea is a competitive inhibitor and not non-competitive**;**

Point mark up to **14** by placing letters A to U, **excluding L and P** in the margin at appropriate points.
Then award **1** mark for each of **L** and **P** (QWC). **Total: 16**

Specimen results for Q.1

tube	concentration of protease / %	time for milk to clear / seconds	relative rate of activity (/ s^{-1})
B	0	-	0
G	0.10	555	1.80
F	0.25	166	6.02
E	0.50	92	10.87
D	0.75	73	13.70
C	1.00	49	20.41

tube	concentration of protease / %	time for milk to clear / seconds	relative rate of activity (/ s^{-1})
A			
B	0	-	0
C	1.00	49	20.41
D	0.75	73	13.70
E	0.50	92	10.87
F	0.25	166	6.02
G	0.10	555	1.80



Question		Expected Answers	Marks
1	(a)	*table*	
		table format that includes protease concentration, time and rate **;** **R** if more than one table units (% and seconds) in headings **; R** in the body of the table correct trend **;** (C first etc) **A** no change in G/0.01% conversion to 1000/t carried out correctly **;** result and rate for B included (as 0% protease) **;**	**4**
	(b)	tube **A -** to show, end point / when reaction is complete / use as a standard **;** tube **B -** to show, no change without enzyme / enzyme needed **; A** ora for distilled water	**2**
	(c)	*graph*	
		axes labelled with numbers increasing **;** **B** included as 0 rate / line of best fit starts at 0,0 **;** *or at 0.1% if rate for G = 0* good scale with appropriate use of available space **;** variables correct with protease concentration on horizontal axis **;** all points plotted accurately **;** *if no change in G, then 0.1% has rate of 0* joined by an appropriate line of best fit **; R** if extrapolated beyond 1.0%	**5 max**
	(d)	increase in rate with increase in, protease / enzyme, concentration **;** ref to at least one figure (concentration and rate) from the graph **;** anomalous result(s) **;** any comment on shape of line **;** e.g. plateau / sigmoid / S-shape etc	**3 max**
	(e)	*increasing enzyme concentration - accept ora*	
		ref to more collisions **;** more enzyme-substrate complexes **;** more active sites are available **;**	
		(milk) protein is the substrate **;** is insoluble / gives cloudiness **;** peptide bonds are broken **;** hydrolysis **;** described **; A** addition of water to break (peptide) bond amino acids / peptides / small proteins **;** amino acids are soluble **;**	
		AVP **;** e.g. substrate is in excess enzyme is limiting factor ref to limiting factor if results show a plateau	**7 max**

(f) temperature is a control variable / all variables should be kept constant / temperature influences activity of enzymes **;**
if it changes then introduces another variable / idea **;**
higher temperature (**A** > 35 ^{o}C) , reaction occurs too fast to measure / ora **;**
high temperature (**A** > 40 ^{o}C) would cause denaturing **; R** if 'kills'
detail of denaturation **;** e.g. breaking of **named** bond(s) in enzyme / active site changes shape
35 ^{o}C is likely to be optimum (for protease) **; R** ref to 'body' temperature **2 max**

(g) name of enzyme **;**
formation of correct **named** product / disappearance of correct **named** substrate **;**
suitable method for detecting change **;** e.g.:
3

enzyme	substrate	method	product	method
catalase **R** 'catalyse'	hydrogen peroxide	loss in mass	oxygen	volume, e.g. measuring cylinder / gas burette / gas syringe **A** count bubbles / froth height
amylase	starch	iodine solution	maltose **A** sugar / glucose	Benedict's test
urease	(urea)	-	ammonia / ammonium	Universal indicator / named pH indicator / pH meter
sucrase	(sucrose)	-	reducing sugar / fructose / glucose	Benedict's test / Clinistix

(h) *limitations*

1 difficult to tell when cloudiness had disappeared **;**
2 protease solution not added at exactly the same time **;**
3 tubes removed from water bath so cooled down / temperature in tubes fluctuated **;**
4 difficult to keep water bath at constant temperature **;**
5 protease solution not warmed to 35 ^{o}C **;**
6 not wide enough range of protease concentrations / ora **;**
7 not enough intermediate concentrations / include intermediates within same range **;**
8 no repeats / no replicates / should carry out repeats **;**
9 check for / ref to, anomalous result(s) **;**
10 no means calculated / calculate means **; A** alternatives, e.g. plot lines for replicates

improvements

11 use a colorimeter to follow disappearance of cloudiness **;**
12 follow until reach, a set reading / pre-determined end point **; A** ref to seeing a **X**
13 do each tube separately **;**
14 use a thermostatically-controlled water bath **;**
15 constant stirring / use a magnetic stirrer **; A** ref to stirring / shaking / inverting etc

16 AVP **;** e.g. problem with use of syringe, pH not kept constant, use a buffer solution
17 AVP **;** use graduated pipette, ref to timers, use data logger **max 7**

[Total: max 28]

Question	Expected Answers	Marks
2	*mark (a) (i) and (ii) together*	
(a) (i)	*drawing*	
	1 clear, continuous lines **;**	
	2 nuclei shown **;**	
	3 cytoplasmic contents **;**	
	neutrophil	
	4 lobed nucleus **; R** if separate 'blobs'	
	monocyte	
	5 large (bean-shaped) nucleus with some cytoplasm **;**	
	lymphocyte	
	6 nucleus fills almost the whole of the cell **;**	
	basophil	
	7 (bi-)lobed / bean-shaped, nucleus **;**	
	or eosinophil	
	bi-lobed nucleus **;**	
(ii)	**8** dark blue / purple (nucleus) **;**	
	9 light blue / light purple / pink (cytoplasm) **; R** white	**7**
(b)	*neutrophil*	
	7 μm to 15 μm	
	monocyte	
	7 μm to 15 μm	
	lymphocyte	
	10 μm or less	
	basophil / eosinophil	
	7 μm to 15 μm	**2 max**
(c)	*neutrophil*	
	phagocytic / digests bacteria / AW **;**	
	monocyte	
	phagocytic / described / antigen presentation / becomes a macrophage / is immature macrophage **;**	
	lymphocyte	
	turns into a plasma cell / secretes antibodies **;**	
	or	
	kills cells infected with viruses / AW **;**	
	or	
	stimulates other cells during immune response **;**	
	or	
	secretes cytokines / AW **;**	
	basophil	
	releases histamine / releases heparin / involved in allergic responses **;**	
	eosinophils	
	attack parasites / involved in allergic responses **;**	**2 max**

(d) **(i)** *one mark for the name, max 2 for the description*

telophase **;** **1**

chromosomes, at opposite ends of the cell / have moved to the poles **;**
A chromatids
chromosomes 'uncoil' / AW **;**
nucleus / nuclear membrane, reappears / reforms **;**
cytokinesis / cytoplasmic division / cleavage / described **;**
ref to spindle disappearing **;**
AVP **;** **2 max**

(ii) greater resolution **; A** 'can see more detail' / any e.g. **1**

(iii) *treat 'see living cells' as neutral*
can follow changes / see movement of chromosomes / see cells dividing **;**
can see all the chromosomes (rather than those in the thin section) / idea **;**
can see many cells **;**
(slide) preparation is, easier / quicker **;**
can use stains (to give colours) **;**
ref to depth of field idea **;**
R cheaper / disadvantages of EM **2 max**

(iv) cell wall **;**
cell plate / AW **; A** ref to vesicles
no 'pinching in' **;**
no centrioles **;**
ref to small vacuoles **;** **R** large, central vacuole
R chloroplasts **1**

[Total: max 16]

RECOGNISING ACHIEVEMENT

Mark Scheme 2804
January 2005

Question		Expected Answers	Marks
1	(a)	produced in minute amounts **;** secreted into, blood / ductless gland **;** **R** excrete transported in blood **;** to target tissue (bone marrow) **; A** specific receptors / another part of body broken down in liver **;** many / some, hormones are proteins **; R** all hormones are proteins	**3 max**
	(b)	*one mark for each example and two marks for associated role* *max 3 for each PGR* abscisic acid / ABA **;** closure of stomata / stress hormone **;** inhibiting proton pump **;** prevent excessive water loss / related to dry conditions / reduce transpiration **;** *or* abscission of, leaves / fruits **;** details of abscission layer **;** (leaves are lost) in autumn / seeds dispersed **;** *or* promotes seed dormancy / inhibits germination **;** prevents production of enzymes **;** auxin / IAA **;** <u>apical dominance</u> **;** inhibition of lateral buds **;** shoots grow tall / AW **;** *or* tropisms **;** ref to cell elongation **;** shoot and/or root grows in advantageous direction **;** *or* ref to fruit drop / abscission **;** high concentration prevents / low concentration promotes **;** gibberellin / gibberellic acid / GA **;** germination of seeds **; A** embryo growth **R** ‘ seed grows’ stimulates release of, enzymes / named enzyme (from aleurone layer to endosperm) **;** *or* <u>stem / internode</u>, elongation **;** plant reaches normal height / AW **;** **A** ethene / cytokinins as examples with appropriate roles **A** applications of exogenous compounds e.g. weedkillers, rooting compounds	**6 max**
			[Total: 9]

Question			Expected Answers	Marks
2	**(a)**		more, chloroplasts / chlorophyll **;** large surface area (of chloroplasts) **;** to absorb more of the light / AW **;** to maximise (rate of) photosynthesis **;**	**2 max**
	(b)		*do not credit references to number of, or layers of, palisade cells* *assume answer is about shade leaf unless told otherwise* thinner (leaf) / fewer cells **;** thinner cuticle **;** shorter / smaller, palisade <u>cells</u> **;** more / larger, air spaces **; R** gaps fewer chloroplasts in palisade (cells) **;** fewer chloroplasts in spongy mesophyll (cells) **;** more, stomata / guard cells **;** less, vascular tissue / veins **;** AVP **;** e.g. correct ref to ratio between palisade and spongy tissue ref to staining	**2 max**
	(c)	**1**	closely packed to absorb more of incident light / idea **;**	
		2	columnar shape / arranged at right angles to surface of leaf, to reduce number of light absorbing cross walls **;**	
		3	large vacuole pushes chloroplasts to edge of cell **;**	
		4	chloroplasts on periphery of cell, short (diffusion) path for carbon dioxide **;**	
		5	chloroplasts on periphery of cell to absorb light **;**	
		6	large number of chloroplasts / much chlorophyll, to absorb light **;**	
		7	chloroplasts can move within cells to absorb as much light as possible **;**	
		8	chloroplasts can move to prevent damage (in high light intensity) **;**	
		9	cylindrical cells resulting in air spaces **;**	
		10	air spaces (between cells) to allow circulation of gases **;**	
		11	large surface area for, gas exchange / diffusion **;**	
		12	cell <u>walls</u> are thin, so short diffusion pathway / (greater) light penetration **;**	
		13	air spaces act as reservoir of carbon dioxide **;**	
		14	AVP **;**	
		15	AVP **;** e.g. non pigmented vacuole to allow light penetration ref to any chloroplast adaptation qualified.	
			R cells found near top of leaf	**7 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**
				[Total:12]

Question	Expected Answers	Marks
3 (a)	*mark each cross separately - 4 marks for each*	

in each cross - parental genotypes and gametes – 1 mark

F_1 *genotypes and correctly matching phenotypes – 1 mark*

F_2 *genotypes and correctly matching phenotypes – 1 mark*

correct ratio matching F_2 phenotypes – 1 mark

parental genotypes	- X^RX^R x X^rY		$X^r X^r$ x X^RY	
gametes	- X^R (X^R) X^r Y	;	X^r (X^r) X^R Y	;
F_1 genotypes	- X^RX^r (X^RX^r) X^RY (X^RY)		(X^RX^r) X^RX^r (X^rY) X^rY	
F_1 phenotypes	- red female and red males	;	red females and white males	;
(gametes	- X^R X^r X^R Y		X^r Y X^R X^r)	
F_2 genotypes	- X^RX^R X^RX^r X^RY X^rY		$X^r X^r$ X^RX^r X^RY X^rY	
F_2 phenotypes	- red eyed female (x 2) red eyed male white eyed male	;	white eyed female red eyed female red eyed male white eyed male	;
ratio	- 2: 1: 1	;	1: 1: 1: 1	;

accept heterozygous female in cross 1, but must select correct two flies from F_1 phenotypes

accept X^w as an alternative for white allele and penalise once if no key given

if r allele shown on Y chromosome penalise once **8**

(b) *one mark for suitable example of disease caused by mutation or a type of mutation*

e.g. sickle cell anaemia, phenylketonuria, haemophilia, Down's syndrome, cystic fibrosis, cancer, base substitution, base addition, base deletion, non disjunction **;**

three marks for description of phenotype

sickle cell anaemia
change in haemoglobin **;**
beta chain **;**
glutamic acid changed to valine **;**

haemoglobin less soluble **;**
tend to stick together **;**
form long fibres **;**
red cells become, sickle shaped / distorted **;**
block small capillaries **;**
less oxygen, carried / delivered to tissues **;**
lethargy / tiredness **;** **R** 'weak' on own
painful crisis / 'sickling' **;**
resistance to malaria **;**

PKU
no phenylalanine hydroxylase **;**
unable to form melanin **;** **A** dark pigment
lighter skin **;**
fairer hair **;**
phenylalanine accumulates **;**
brain damage in infants **;**
mentally retarded **;**

cancer
uncontrolled cell division **;**
tumour **;**
metastasis **;**
damage to healthy tissues / specific example **;**

haemophilia
no factor VIII **;**
blood slow to clot **;**
slow persistent bleeding **;**

Down's syndrome
broad flat face **;**
learning difficulties **;**
increased risk of infections **;**

cystic fibrosis
thick mucus in lungs **;**
small size **;**
poor digestion **;**

A other examples with suitable phenotypic features **4 max**

[Total: 12]

4	**(a)**	between different species **;**	**1**
	(b)	there are other, prey species / food **;**	**1**
	(c)	feed at different depths **;** feed on, different species / named species **;** ref to figures from table **;** little overlap in <u>niches</u> **;** relate to different size of, beaks / necks / birds **;**	**4 max**
	(d)	nesting sites / territories / other foods / nesting materials **;** *if list of resources mark first only*	**1**
			[Total: 7]

Question		**Expected Answers**	**Marks**
5	**(a)**	mutations occur randomly **;** variation in population **;** humans **;** select plants **;** higher yielding / larger ears / desirable characteristics / AW **;** cross plants with ideal features **;** take seeds from these plants **;** grow them **;** repeat over many generations **;** increase of allele frequency for desired characteristics **;**	**5 max**
	(b)	7,14, 21 **;** *all correct for one mark*	**1**
	(c)	*hybrids* parents have different, genotypes / chromosomes / named sets i.e. AB or ABD **;** chromosomes of hybrid are, non homologous / AW **; A** ora for emmer wheat **Q**, has odd number / 3 sets, of chromosomes **; A** 3 n **R** 3 chromosomes chromosomes unable to, pair up / form bivalent / AW **; A** ora for emmer wheat meiosis unable to take place **; A** ora for emmer wheat no gametes produced **; A** ora for emmer wheat *emmer wheat* each chromosome has made a copy of itself / ref to non disjunction **;**	**3 max**
	(d)	have different chromosome numbers **;** unable to form fertile offspring **;** different, genes / genomes **;** different <u>morphological (structural), physiological and biochemical</u> features **;** reproductively isolated **;**	**3 max**
	(e)	eutrophication **;** fertilisers, in run off / leached, into streams **;** algal bloom / growth of surface weeds **;** shading causes death of plants **;** growth of, bacterial / microbe, population **;** bacteria use up oxygen / increased BOD / less oxygen from photosynthesis **;** (growth of aerobic bacteria = 2 marks) low oxygen levels kills many (animal) species **; R** all species / (all) aquatic life anaerobic bacteria produce toxic hydrogen sulphide **;**	**4 max**

[Total: 16]

Question			Expected Answers	Marks
6	(a)	(i)	*award two marks if correct answer (180 000) is given* *award one mark for calculation – if answer incorrect* 125 x 60 x 24 **;** 180 000 **;**	**2**
		(ii)	*award two marks if correct answer (99-99.2) is given* *award one mark for calculation – if answer incorrect* *ecf applies if uses incorrect answer from (a)(i)* 180 000 – 1500 ÷ 180 000 x 100 **;** 99 – 99.2 **;**	**2**
	(b)	(i)	too large / greater RMM than 68 000 – 70000 / unable to pass through basement membrane **;**	**1**
		(ii)	reabsorbed **;** in, proximal convoluted tubule / pct **;**	**2**
		(iii)	water is reabsorbed (from filtrate) **;** (approximately half) urea remains in urine **;** *must be linked to first marking point* **R** all urea ref to reabsorption of other substances **;**	**2 max**
		(iv)	uric acid **;** creatinine **;** ammonium ions / ammonia **;** hormones / named hormone **;** AVP **;** e.g. bile pigments **R** creatine	**2 max**

(c)

1 osmoreceptors in hypothalamus **;**
2 (hypothalamus) detects low water potential of blood / AW **;**
3 (production) ADH **;**
4 by hypothalamus **;**
5 (ADH passes to and from) <u>posterior</u> pituitary **;**
6 released / transported, into blood **;**
7 acts on collecting ducts (of kidney) **;**
8 binds to receptor (in plasma membrane of collecting duct cells) **;**
9 activates (phosphorylase) enzyme **;**
10 causes vesicles with, water permeable channels / aquaporins **;**
11 to bind with plasma membrane **;**
12 increased permeability to water **;**
13 water reabsorbed by <u>osmosis</u> **;**
14 stimulation of thirst centre of brain / feel thirsty **;**
15 water potential of blood rises switching off ADH release **;**
16 AVP **;** e.g. ref to phosphorylase enzyme
ref to neurosecretory cells
ref to nerve impulses passing from hypothalamus to pituitary **7 max**

QWC – clear well organised using specialist terms ; **1**

award the QWC mark if four of the following are used in correct context

osmoreceptors	hypothalamus
pituitary gland	collecting duct
vesicles	phosphorylase
aquaporins	neurosecretion

[Total: 19]

Question			Expected Answers	Marks
7	(a)	(i)	<u>adenine</u> **;**	
		(ii)	<u>ribose</u> **;**	**2**
	(b)		✗ ✗ **;**	
			✓ ✗ **;**	
			✗ ✓ **;**	**3**
	(c)	(i)	chloroplast **;**	**1**
		(ii)	use of electron transport system / electron carriers / cytochromes **;**	
			release of energy **; R** produce / create, energy	
			moves / pumps, protons / H^+ **;** **R** H or hydrogen	
			across (energy transducing) membrane **;**	
			proton gradient / proton motive force / pH gradient **;**	
			ATP synthase / ATP synthetase / chemiosmotic channels **; A** ATPase	
			formation of ATP **;**	
			chemiosmosis **;**	**5 max**
	(d)		sodium and potassium pump **;**	
			potassium ions in and sodium ions out **;**	
			3 sodium ions for 2 potassium ions **;**	
			helps to, maintain / restore, resting potential **;**	
			synthesis of acetylcholine **;**	
			from choline and ethanoic acid **;**	
			recycling, of neurotransmitter **;**	
			synthesis of acetylcholine receptors **;**	
			movement of vesicles **;**	
			ref to active transport of calcium out of neurone **;**	**4 max**

[Total: 15]

Mark Scheme 2805/01
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme			
	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question			Expected Answers	Marks
1	(a)	(i)	(epithelial cells) secrete / AW, hormones **;** no duct / ductless **;** (secreted directly) into the blood **;** **R** into blood vessels good blood supply / AW **;** AVP **;** e.g. follicle walls one cell thick	**3 max**
		(ii)	thyroglobulin is a large molecule **;** insoluble **;** stored until needed / released as required / converted easily to T4 / AW **;** does not diffuse away / AW **;** *ora* AVP **;** e.g. thyroxine may activate secretory cells positive feedback may occur in secretory cells inactive / inert / example of inactivity	**2 max**
	(b)		secretory cells take up (small amount of) thyroglobulin **;** by pinocytosis **;** hydrolysed / AW (into thyroxine) **;** by, enzymes / proteases **;** diffuses, into blood / blood vessels / capillaries **;** attached to plasma proteins **;**	**4 max**
	(c)		*accept release / produce for secrete throughout* (hypothalamus) secretes thyrotrophin releasing, factor / hormone **;** **A** TRH stimulates anterior pituitary gland **;** to secrete, thyroid stimulating hormone / TSH **;** stimulates thyroid gland to release thyroxine **;** high level thyroxine inhibits, hypothalamus / anterior pituitary **;** reduce production of, TRH / TSH / TRF **;** ref to external factors on higher centres **;** negative feedback / homeostasis **;**	**5 max**

[Total: 14]

Question			Expected Answers	Marks
2	(a)		fruit evolved to be eaten **;** fruit attracts, animals / birds / insects **;** so seeds are dispersed / ensures dispersal / described **;** inhibitors prevent seed germination / AW **;**	**2 max**
	(b)	**1**	provides, more energy / more ATP **;** **R** energy produced	
		2	for, synthesis of enzymes *or* breakdown of, starch / protein / other named e.g. **;**	
		3	no photosynthesis / chlorophyll not necessary / AW **;**	
		4	breakdown products used for, lycopene / suitable alternative **;**	
		5	lycopene / pigment / red colour, attracts birds / animals **;** **A** attractive to consumers	
		6	ethene synchronises ripening of all fruits in area / AW **;**	
		7	may be involved in lycopene synthesis **;**	
		8	sugar / sweetness, attracts, birds / animals **;** **A** attractive to consumers / AW	
		9	odour attracts, birds / animals **;** **A** attractive to consumers	
		10	polygalacturonase softens <u>cell walls</u> **;**	
		11	softening makes it easier to, eat / digest **;**	
		12	releases seeds **;**	**4 max**
	(c)	(i)	it would, digest / break down, the walls of the tomato during development / AW **;** AVP **;** e.g. does not contain gene for enzyme production	**1 max**
		(ii)	by <u>decomposers</u> / <u>bacteria</u> / <u>fungi</u> **;** AVP **;**	**1 max**
	(d)		*4 max for marking points 1 to 5*	
		1	fruit formed from ovary **;**	
		2	triggered by seed production **;**	
		3	ovary wall becomes <u>pericarp</u> **;**	
		4	modified to aid dispersal **;**	
		5	e.g. fleshy / sweet / brightly coloured / wings / explosive dehiscence / hard / AW **;** *4 max*	
		6	auxin / gibberellin **;**	
		7	produce seedless fruit **;**	
		8	without fertilisation **;**	
		9	<u>parthenocarpy ;</u>	
		10	improve fruit set **;**	
		11	increase fruit size **;**	
		12	gibberellin / cytokinin / ethene, controls, ripening / maturing / AW **;**	
		13	AVP **;** e.g. without ethene to delay ripening for transport	
		14	AVP **;**	**8 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 17]

Question			Expected Answers	Marks
3	(a)	1	only one parent needs to be introduced / (asexual is) more reliable / AW **;**	
		2	no wasted energy, producing gametes / finding a mate **;**	
		3	rapid reproduction / large numbers of offspring / outnumbers European species **;**	
		4	successful in same environment as parent **;**	
		5	quickly colonise new environment **;**	
		6	preserves successful combinations of alleles **;**	
		7	outcompete native species / competes vigorously / AW **;**	
		8	may introduce a, parasite / disease **;**	
		9	may mate with the European species **;**	
		10	hybrid sterility **;**	
		11	may prey on European species **;**	
		12	no natural predators **;**	
		13	AVP **;**	
		14	AVP **;** e.g. competitive exclusion / extinction / AW marbling as camouflage	**4 max**
	(b)	(i)	(vertical) hyphae **;** produce spores **;** by mitosis **;** haploid **;** in, conidiophores / sporangiophores **;** spores, small / light **;** dispersed by air currents **;** when, conidiophores / sporangiophores, burst **;** germinate / develop, on suitable, medium / substrate **;**	
			<u>yeast</u> buds **;** new individual buds from parent **;** breaks off **;** smaller than parent **;**	
			all genetically identical **;**	**4 max**

Question	Expected answers	
(ii)	enzymes ; secreted at tip of hypha ; proteases break down protein ; to amino acids ; lipase breaks down fat ; into fatty acids and glycerol ; AVP ; e.g. hydrolysis	4 max
(iii)	not autotrophic / cannot make own food ; no chlorophyll ; cannot photosynthesise / make organic compounds from CO_2 and H_2O ; AVP ; e.g. secrete enzymes external digestion	2 max

[Total: 14]

Question			Expected Answers		Marks
4	(a)		**A** primary spermatocyte **;** **B** spermatid **;**		2
	(b)	**1**	hypothalamus **;**		
		2	produces GnRH **;**		
		3	stimulates anterior pituitary **;**		
		4	to produce LH / ICSH **;**		
		5	stimulates, interstitial / Leydig cells **;**		
		6	(lock onto) specific receptors **;**		
		7	to produce testosterone **;**		
		8	from cholesterol **;**		
		9	stimulates, spermatogenesis / sperm production **;**		
		10	testosterone inhibits, GnRH / LH, production **;**		
		11	FSH stimulates Sertoli cells **;**		
		12	to develop sperm **;**		
		13	secretes, fluid / inhibin, into seminiferous tubules **;**		
		14	inhibin inhibits FSH **;**		
		15	AVP **;** e.g. ref to androgen binding protein	*max 7*	
			accurate references to position and sequence shown in Fig. 4.1		
		P1	sperm mature from the outside to the centre / AW **;**		
		P2	in close association with Sertoli cells / AW **;**		
		P3	germinal epithelium surrounds tubules **;**		
		P4	form primary spermatocytes **;**		
		P5	diploid **;**		
		P6	meiosis I **;**		
		P7	forms secondary spermatocyte **;**		
		P8	meiosis I I **;**		
		P9	forms four spermatids **;**	*max 5*	**8 max**
			QWC – clear, well-organised using scientific terms ; *award the QWC mark if three of the following are used in correct context* hypothalamus / interstitial / Leydig cells GnRH / testosterone anterior pituitary / cholesterol LH / ICSH / inhibin germinal epithelium		1
	(c)	(i)	*award two marks if correct answer to nearest 0.1 μm is given* *award one mark for ecf if incorrectly measured from Fig. 4.2* $\frac{10 \times 45 / 44 / 46}{30 / 31 / 32}$ **;** 15.0 / 14.5 / 14.1 / 14.7 / 14.2 / 13.8 / 15.3 / 14.8 / 14.4 **;**		2

(ii) chromatin **;**
chromosomes **;**
haploid set / half set / n / 23 **;**
DNA / genetic material / genetic information **;** **2 max**

(iii) release, ATP / energy **;** **R** produce energy
for propulsion of sperm / AW **;** **2**

(d) (i) *award two marks if correct answer is given (even if not in table)*
award one mark for giving correct calculation if answer incorrect

$\frac{31}{61}$ **;**

= 0.508 **;** **2**

(ii) (any) exposure increase proportion of female births **;**
exposure of mother has, little / no, effect **;**
exposure of father is, more / most, significant **;**
causes, decrease in male births / increase in female births **;**
comparative figures in support **;**
male, fetus harder to carry / prenatal mortality higher **;**
perinatal mortality higher in males **;**
small sample **;**
AVP **;** e.g. X sperm stronger **4 max**

[Total: 23]

Question		Expected Answers	Marks
5	(a)	sculptured outer wall will not match stigma surface / AW / ora **;** genetically incompatible / ora **;** AVP **;** e.g. further detail	**2 max**
	(b)	pollen tube grows from a pore in exine **;** grows down the style **;** chemotropism **;** chemicals secreted by the ovary **;** controlled by tube nucleus **;** tube enters ovule through micropyle **;** tip (bursts) releasing male gametes **;** AVP **;** e.g. detail of dispersal	**4 max**
	(c)	one male gamete fuses with the, female gamete / ovum / egg cell (nucleus) **;** to form the, zygote / embryo **;** diploid **;** restores chromosome number **;** increases variation **;** second male gamete fuses with the diploid nucleus **;** to form the triploid (endosperm) nucleus **;** (to form) endosperm / food store **;** AVP **;** e.g. ref to, evolution / natural selection	**5 max**
			[Total: 11]

Question			**Expected Answers**	**Marks**
6	**(a)**	**(i)**	a (permanent / irreversible) increase in dry mass **;**	**1**
		(ii)	name of a suitable parameter **;** *can be from equation* measure the parameter at the start **;** measure the parameter, at the end / after an interval **;** *plus one of the following* *EITHER* *subtract the parameter at start from parameter, at end / after an interval **;** *divide by parameter at start **;** *percentage **;** **OR* $\frac{\text{change in parameter}}{\text{parameter at start}} \times 100$ **;;;** **OR* $\frac{\text{absolute growth rate / change in parameter unit time}^{-1}}{\text{parameter at start}}$ **;;;**	**4 max**
	(b)		(**A** shows) higher protein through all three trimesters produces heavier birth weight / (**D** shows) lower protein in all three trimesters produces lower birth weight **;** figures stating differences **;** (**C** shows) a decrease in protein during second trimester has no significant effect **;** (**B** shows) low protein in the third trimester reduces calf weight more than in second **;** figures in support **;** *3 max* ref to need for statistical test / standard deviation is not given on graph **;** during third trimester rapid growth **;** more protein needed for growth **;** for, structural protein / metabolic protein / enzymes **;** second trimester is mainly development **;** differences could be due to, another effect / genetics / different fathers / environmental effect **;**	**4 max**

(c) cannot conduct this experiment on humans **;**
not ethical **;**
ignores the rights of the unborn child **;**
difficult to get a large enough sample **;**
inadequate controls / difficult to control human diet **;**
AVP **;** e.g. endanger health of, mother / child **2 max**

[Total: 11]

Mark Scheme 2805/02
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme			
	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question			Expected Answers	Marks
1	(a)	(i)	**AaBB** white **;** **aaBB** black **;** **Aabb** white **;** **aabb** brown **;**	**4**
		(ii)	(dominant) epistasis **;**	**1**
		(iii)	codes for inhibitor **;** protein **;** blocks transcription (of allele coding for pigment) **;** ref to regulator / promoter **;** blocks enzyme (producing pigment) **;** AVP **;** e.g. detail	**3 max**
	(b)	(i)	AaBb x AaBb / AaBb x Aabb **;** both must have A because they are white **;** *both must, have a / not be homozygous AA, because some kittens coloured **;** *both must have b to give brown kittens **;** • *'must be heterozygous at both loci' = 1 only* at least one / one or both, must have B to give black kittens **;** credit ref to Punnett square showing genotypes **;** credit ref to Punnett square showing phenotypes **;**	**5 max**
		(ii)	AaBb x AaBb 12 white : 3 black : 1 brown **;;** AaBb x Aabb 6 white : 1 black : 1 brown **;;**	**2 max**

[Total: 15]

Question			Expected Answers	Marks
2	(a)	(i)	gradual process / AW **;** to improve traits **;** to achieve homozygosity / AW **;** best in each generation interbred **;** ref to artificial selection **;** ref to, several traits involved / may be, additive / polygenic **;**	**2max**
		(ii)	ref mitosis **;** chromosomes replicated **;** failure of, spindle / cell division **;** colchicine / other method **;**	**2max**
		(iii)	self-pollination prevented **;** pollination by foreign pollen prevented **;** pollen transfer **;** practical detail **;**	**2 max**
		(iv)	3n **;** meiosis fails **;** ref to, synapsis / homologous pairs **;**	**2 max**
	(b)	(i)	sterile explant **;** sterile nutrient medium **;** ref to plant growth regulators **;** <u>callus</u> **;** subdivided **;** medium with different plant growth regulators **;** plantlets / embryoids **;** hardening medium / sterile soil **;** AVP **;** e.g. appropriate plant growth regulators	**5 max**
		(ii)	callus can be divided **;** large numbers of identical plants **;** **A** clone in short time **;** bulk up sterile hybrid **;** bulk up master hybrid lines **;** no need for making more 4n **;**	**2 max**

[Total: 15]

Question		Expected Answers	Marks
3	(a)	gives value of individual's genotype (for selective breeding) **;** male mated with different females **;** trait measured in progeny of different matings **;** average calculated **;** especially for, sex-limited traits / traits that appear in one sex only **;**	**3 max**
	(b)	**A** / 'marbling' **;** scale 0 - 1 **;** measure of genetic v. environmental contribution **;** high value most easily selected for **;** value <0.02 results in no selective breeding **;** ease of selection = 'marbling'>growth rate>subcutaneous fat>'rib eye' **;** all the traits / even 'rib eye', can be selected for **;**	**3 max**
	(c)	*continuous v. discontinuous* **1** no discrete classes v. discrete classes / AW **;** **2** vary between limits v. no intermediates **;** **3** quantitative v. qualitative **;** **4** plotted as normal distribution curve v. bar chart **;** **5** 3 or more genes v. one / few, genes **;** **6** <u>polygenes</u> (v. not so) **;** **7** many alleles v. few alleles **;** **8** different alleles have small v. large effects **;** **9** additive effects v. different effects **;** **10** large v. small environmental effect **;** **11** use of e.g. of continuous variation **;** **12** use of e.g. of discontinuous variation **;** **13** AVP **;**	**8 max**
		QWC - legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 15]

Question			Expected Answers	Marks
4	(a)		embryos from endangered species can be implanted in surrogates **;** different / related, species **;** e.g. **;** endangered species female can be superovulated **;** many times **;** not put at risk of pregnancy **;** embryos may be cloned **;**	**4 max**
	(b)	(i)	<u>control</u> **;** shows effect of, lipid removal but not freezing / lipid removal only **;**	**2**
		(ii)	allows development (to ball of cells) **;** in 31 - 64% of embryos **;** embryos with lipid, do not survive freeze-thawing / show no further development **;**	**2 max**
		(iii)	increases percentage that develop (to ball of cells) **;** 31% to 64% / doubles **;** larger surface area : volume ratio **;** freeze-thaw, quicker / more uniformly **;** so less damage **;** ref to size ice crystals **;** AVP **;**	**4 max**
	(c)		*three of following* **;;;** seed bank sperm bank eggs / ovarian tissue tissue culture zoo botanical garden field gene bank / growing crop rare breed / landrace	**3 max**

[Total: 15]

Question		Expected Answers	Marks
5	(a)	*ref to figures can only be awarded if data is manipulated – do not award for simply quoting the data from the table* increase in use of, GM crop / GE crop / Bt cotton **;** no / less, insecticide needed **;** reduced number of cases of pesticide poisoning **;** ref to figures (e.g. by x 4.4) **;** reduced cost (insecticide) **;** ref to figures (e.g. by 0.62 US$ kg^{-1} / x 1.38) **;** ref to limitations of survey **;** AVP **;** **A** reverse arguments	**4 max**
	(b)	mutation **;** random / chance / pre-existing **;** detail of mutation (gene / point / e.g.) **;** e.g. of how resistance achieved **;** <u>natural selection</u> **;** toxin, is selective agent / exerts selective pressure **;** resistants survive / susceptibles die **;** resistants pass mutation to offspring **;**	**5 max**
	(c)	wild sunflowers become resistant **;** because hybridise readily (ref to 40%) **;** become, weedier / more invasive **;** spread quickly because (50%) more seeds produced **;** pass resistance to other weeds **;** increased Bt toxin resistance in insects **;** ref to potential toxin (in seeds) **;** ref to potential effect on food chain **;** ref to potential effect on biodiversity **;** danger to certified ‘organic’ crops **;** ref to potential allergen in seeds **;** credit example **;** AVP **;** e.g. kill beneficial insects	**6 max**
			[Total: 15]

Question			Expected Answers	Marks
6	(a)		**1** MHC / HLA, system **;** **2** 6 loci / A,B,C,DP,DQ,DR **; A** 4 loci A to D **3** tightly linked / rarely separated by crossing-over**;** **4** chromosome 6 **;** **5** inherited as unit **;** **6** <u>haplotype</u> **;** **7** child inherits one haplotype from each parent **;** **8** code for cell surface (glyco)proteins **;** **9** = antigens **;** **10** each, locus / gene, has many alleles **;** **11** very large number of different combinations **;** **12** much more likely to find match in family / ora **;** **13** some antigens (B, DR) cause stronger reaction than others **;** **14** match prevents rejection / ora **;** **15** immune response **;** **16** detail, rejection / immune response / immunosuppression **;** **17** ref ABO antigens and antibodies **;**	**8 max**
			QWC – clear well organised using specialist terms ;	**1**
			award the QWC mark if the following are used in correct context MHC/HLA letters of loci haplotype antigen rejection linkage	
	(b)	(i)	ref to, rDNA / recombinant DNA **;** restriction enzyme(s) **;** cut DNA at specific site(s) **;** detail site(s) **;** ref to viral DNA and, human DNA / DNA of gene **;** ref to sticky ends **;** complementary binding **;** detail of binding **;** A = T / C $\underline{=}$ G / hydrogen bonds ligase to seal ‘nicks’ in (sugar-phosphate) backbone **;**	**4 max**
		(ii)	has effect when added to genome **;** not masked **;** no need to, remove / inactivate, recessive / mutant, allele **;**	**2 max**

[Total: 15]

Mark Scheme 2805/03
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit R = reject ( ) = words which are not essential to gain credit ___ = (underlining) key words which **<u>must</u>** be used to gain credit ecf = error carried forward AW = alternative wording A = accept ora = or reverse argument

Question	Expected Answers	Marks
1 (a)	increasing availability of phosphate increases growth of all three species **;** greatest effect on nettle **;** linear effect / increases proportionally / steadily / AW (on nettle) **;** slow increase / small increase, in growth of wavy hair grass **;** levels off at higher phosphate concentrations **;** high levels decrease growth of small scabious / ref to increase and then decrease in growth of small scabious **;** small scabious increases steeply / AW (at low phosphate concentrations) **;**	**4 max**
(b) (i)	fertilisers may help growth of some weed species **;** e.g. nettle **;** increase in competition with crops **;** interspecific **;** for light / ref to increased shading / overshadowing **;** space **;** water **;** minerals **;** **A** nutrients *2 max for abiotic factors*	**4 max**
(ii)	phosphate / nitrate (from fertilisers), is, washed / leached / runs off, from fields **;** high levels of, phosphate / nitrate / fertilisers, in ditches **;** more water available in ditches **;** no competition from crops **;**	**2 max**

(c) *inorganic fertilisers*

run-off / leached from fields (when it rains) **;**
cause algal blooms / AW **;**
ref to shading / decreased levels of photosynthesis **;**
increases decomposition **;**
which leads to an increased Biochemical Oxygen Demand / BOD **;**
oxygen levels reduced by <u>aerobic</u> bacteria **;**
organisms die due to lack of oxygen for <u>respiration</u> **;**
increases growth of some plant species **;**
leads to elimination of other species **;**

ref to eutrophication is neutral

4 max

herbicides

blown by wind away from fields / spray drift **;**
kill non-target species **;**
e.g. plant species at field margins / hedgerows / AW **;**
washed into bodies of water **;**
general effects on food chains / elimination of food source **;**
AVP **;**

3 max

[Total: 17]

Question			Expected Answers	Marks
2	(a)	(i)	trees are living organisms **;** renewable **;** ref to, growth / growing **;** timber is, of use to human beings / made into products **;**	**2 max**
		(ii)	harvested at levels which leave sufficient organisms **;** to grow / reproduce, and replenish what has been harvested **;** ref to, coppicing / replanting / afforestation **;** can be carried on indefinitely **;**	**2 max**
	(b)		*award two marks if correct answer (12.43%) is given* 3180 / 25 592 x 100 **;** = 12.43 % **;** **A** 12.425	**2**
	(c)	**1**	saves raw materials **;**	
		2	e.g. fewer trees felled to produce paper / decreases deforestation **;**	
		3	saves damage, to environment / habitats **;**	
		4	less need for landfill **;**	
		5	less pollution **;**	
		6	example **;** e.g. methane, carbon dioxide	
		7	reduces need for incineration **;**	
		8	saves, energy / fossil fuels, used in manufacture **;** *max 6*	
			pollution marks can be awarded for either ref landfill OR incineration	
		9	charge for waste disposal **;**	
		10	money back on bottles **;**	
		11	providing labels to use envelopes more than once **;**	
		12	(increased) collection / door-to-door service for goods to be recycled **;**	
		13	provision of <u>separate</u> bins to separate rubbish **;**	
		14	provision of more recycling, points / centres **; A** more convenient locations	
		15	education and information campaigns / increased public awareness **;** *max 6*	
		16	AVP **;** e.g. ref to figures, ref to greenhouse effect / global warning	
		17	AVP **;** ref to figures	**8 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**
				[Total: 15]

Question			Expected Answers	Marks
3	**(a)**		cyclamen mite / prey populations increase **;** when conditions are suitable / when predator numbers are low / no or few limiting factors **;** provides plenty of food for predator mites **;** which begin to increase <u>later</u> / time lag **;** cyclamen mites are then eaten by (increasing numbers of) predators **;** so both decline in numbers **;** cycle repeated **;** prey populations reach higher levels than predators **;**	**4 max**
	(b)	**(i)**	*start by looking at end of February* increases with appropriate time lag **;** decreases at spraying times (end of June / beginning of October) **;** final peak for predator numbers is the lowest **;**	**2 max**
		(ii)	less food available / less strawberry plants **;** low temperature / frost **;** other predators **;** disease / parasites **;** ref to parasitoids **;** AVP **;** **R** spraying idea	**2 max**
	(c)	**(i)**	biological (pest control) **;**	**1**
		(ii)	insecticides, are harmful to other organisms / may kill natural predators to the pest **;** reduces species diversity / disrupts food chains **;** many insecticides are, slow to biodegrade / long lasting **;** concentrate along food chains / bioaccumulate / bioconcentrate **;** stored in fat deposits of organisms **;** ref to effects on top carnivores **;** e.g. egg shell thinning poisonous to those applying them **;** **A** ref to humans / asthma sufferers pests can build up a resistance **;** ref to selection **;** run-off from land carries them into water supplies / causes pollution / poisons aquatic organisms **;** problems of residues in food **;** AVP **;** e.g. pesticides need to be used repeatedly	**5 max**
	(d)		crop rotation **;** intercropping **;** release of, irradiated / sterile, males of pest species **;** AVP **;** e.g. fly paper	**2 max**

[Total: 16]

Question			Expected Answers	Marks
4	(a)		trees felled for wood to, sell / export **;** cleared to provide land for agriculture **;** **A** cattle ranching to build, housing / villages **;** industrial development / mining / quarrying **;** building of roads **;**	**3 max**
	(b)	**1**	high, biodiversity / species diversity **;**	
		2	deforestation, causes extinction / reduces biodiversity **;**	
		3	decrease in, size of gene pool / genetic diversity **;**	
		4	act as carbon, reservoirs / sinks **; R** carbon fixation	
		5	remove carbon dioxide from atmosphere **;**	
		6	release of carbon dioxide when wood is burnt **;**	
		7	less photosynthesis also means less oxygen production **;**	
		8	transpiration contributes to atmospheric water content **;**	
		9	destruction of rainforests disrupts water cycle **;**	
		10	rainforests can be used to supply sustainable crops **;**	
		11	example of crop **;** e.g nuts / rubber / fruits / plant oils	
		12	drugs / other useful compounds (may await discovery), that only occur in rainforests **;**	
		13	soils are nutrient deficient and cannot sustain agriculture **;**	
		14	increased risk of soil erosion **;**	
		15	moral responsibility to conserve for later generations **;**	
		16	ref to, indigenous populations / tribes **;**	
		17	AVP **;** e.g. provision of habitats ref to Fig. 4.1	**8 max**
			QWC – clear, well organised using specialist terms ; *award the QWC mark if four of the following are used in correct context* biodiversity — transpiration deforestation — water cycle carbon, reservoirs / sinks — sustainable photosynthesis — nutrient deficient	**1**
	(c)		ban on import of wood from, tropical rain forests / unsustainable sources **;** introduce labelling system for wood **;** trade sanctions on countries that continue to remove rain forests **;** schemes / financial support, for setting up of sustainable use of rain forests **;** development of ecotourism **;** educate local population as to importance of rain forests **;** forest reserves established **;** AVP **;** AVP **;** e.g. debt relief fair trade schemes quotas	**3 max**

[Total: 15]

Question			Expected Answers	Marks
5	(a)		*advantages (max 2)*	
			can be used with any species (irrespective of size) **;** does not require to distinguish one individual from another **;** quick to assess **;** **R** simple	
			disadvantages	
			subjective / AW **;** dominant species may be over-estimated **;**	**3 max**
	(b)	(i)	line established, from shore to dune slack / from… to… **;** <u>quadrat</u> used **;** suitable size / actual size stated (minimum 0.25m^2) **;** **R** if no units given placed continuously / at specified intervals along line **;** key to identify species **;** abundance recorded in each quadrat **;** bare ground recorded **;**	**4 max**
		(ii)	**1** ACFOR scale converted to numerical scale **;** **2** reading at each site recorded (on graph paper) **;** **3** width of diagram related to ACFOR (maybe shown on diagram) **;** **4** points from each site joined together **;** **5** repeated for each species found present **;**	**3 max**
	(c)		use of, thermometer / probe **;** probe must be calibrated **;** pushed into, sand / soil, to same depth each time **;** repetitions at each sampling point **;**	**2 max**

(d) (i) a stage during the process of succession **;** **1**

(ii) sea couch / marram grass, grow in bare sand **;**
dune builds up / stabilised by grasses **;**
OR
colonisers established on bare, rock / soil **;**
example **;** (if not sand dunes)

ref to pioneer species **;**
organic matter builds up / humus content increases **;**
forming soil / depth of soil increases **;**
other species take over from grasses **;** **A** named example from Fig. 5.1
roots stabilise soil structure **;**
diversity of species increases **;**
climax eventually reached **;**
AVP **;**
AVP **;** e.g. reference to deflected succession,
growth of shrubs **4 max**

[Total: 17]

Question			Expected Answers	Marks
6	(a)		indicator (species) **;**	1
	(b)	(i)	release into, the environment / atmosphere / water / the land **;** (of) chemicals / energy / materials **;** as a result of human activity **;** remain for a long period of time / are persistent **;** damage / harm, to the environment / other species / ecosystems **;**	**2 max**
		(ii)	*air* burning of, fossil fuels / named example **;** releases, sulphur dioxide / carbon dioxide / nitrous oxides / soot / lead (from exhausts) / AW **;** release from, factories / industrial plants / vehicles **;** *water* release of, organic material / slurry / farm waste / sewage **;** leaching of inorganic fertilisers **;** release of, PCBs / hot water / heavy metals / AW **;** ref to named source **;**	**2 max**
		(iii)	appropriate sampling method **;** e.g. kick sampling / quadrats / timed searches how sample sites located **;** e.g. above and below source of pollution use of keys to identify species **;** repeats **;** measure, presence / absence **;** or abundance **;** how results might indicate pollution levels **;** ref to named, index / scale **;**	**5 max**
			[Total:	**10]**

Mark Scheme 2805/04
January 2005

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	( )	=	words which are not essential to gain credit
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	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question			Expected Answers	Marks
1	**(a)**	**(i)**	**A -** partially, permeable membrane **;** **A** selectively, semi, differentially **B -** biological recognition layer **;** **C -** transducer **;**	**3**
		(ii)	(only allows) glucose through membrane **;** by diffusion **;** immobilised enzyme **;** glucose oxidase **;** immobilised glucose oxidase = 2 marks glucose / substrate, binds to enzyme **;** **A** enzyme-substrate complex forms specific / complementary shape / AW **;** named product formed (gluconic acid / hydrogen peroxide) **;** reduces concentration of oxygen **;** ref to platinum oxygen electrode **;** transducer produces, electrical signal / current **;** ref to level related to glucose concentration **;**	**5 max**
		(iii)	*accept any three relevant comments* quantitative measurement of blood glucose **/** AW **;** rapid **;** accurate / sensitive **;** portable / can test anywhere / can test at home **;** using small volumes of blood **;** allows correct dose of insulin to be calculated **;** AVP **;;;** e.g. automated with mini-pump re-useable ref to cost no need to go to clinic / hospital	**3 max**
	(b)	**(i)**	<u>hybridoma</u> **;**	**1**
		(ii)	<u>B</u>, lymphocyte / cell **;** produce (specific) antibody **;** division limited **/** AW **;** myeloma, cell divides rapidly **;** and continuously **/** AW **;**	**3 max**

(c) **(i)** protein / glycoprotein on, the surface of virus / envelope **;**
antigen **;**
complementary shape / specific tertiary structure **;**
to, attach / bind, to (HIV) antibody **;**
AVP **;** e.g. ELISA technique
named protein
normally binds to receptors on host cells **3 max**

(ii) pregnancy test / test for HCG / identification of drugs / identification of cancers / drug delivery / tissue typing / blood typing / fertility test / passive vaccine / AVP **;**
R magic bullets unqualified **1 max**

[Total: 19]

Question	Expected Answers	Marks
2 **(a)**	heat milk **;** ref to temperature above 60 °C with a length of time **;** e.g. accept values given in yoghurt production - 85 to 95 °C for 15 to 30min, *or* older batch method 63 °C for 15 to 30 mins, *or* current method of 72 °C for 15 sec named method / ref to method **;** e.g. batch method / stirring sample, *or* HTST (high temperature short time) system / cooled rapidly, through pipes / thin stream between metal plates in heat exchanger max 2 kills pathogens **;** **A** bacteria / named example e.g. *M. bovis* / *E. coli* / *Brucella melitensis* **R** microorganisms / inactivates pathogens	**3 max**

(b) **1** haemocytometer / microscope slide, is gridded **;** **A** diagram of grid
2 use a clean, slide / cover slip **;**
3 breathe onto cover slip / cover slip moistened **;**
4 push cover slip horizontally onto the slide (and press down) **;**
5 'Newton's rings' / (6) rainbow patterns seen (when correctly in place) **;**
6 chamber is 0.1 mm deep **;**
7 idea of dilution / dilution described e.g. add 1 cm^3 to 9 cm^3 **;**
8 mix / agitate, culture / milk sample (before application) **;**
9 to, disperse cells / avoid clumping / give even distribution **;**
10 fill the chamber / description of method **;** e.g. Pasteur pipette / syringe with needle
11 add only enough to fill the, platform / chamber **;** **A** avoid running into grooves
12 allow to settle / leave five minutes **;**
13 ref to use of microscope **;** e.g. low to high power, focusing
14 magnification x 400 **;**
15 count number of cells in triple-lined squares **;**
16 selected sample squares at random / method of selecting squares to count **;**
e.g. count 4 corner and centre square
17 count using North-West / South–East rule **;** **A** description e.g. count as "in" those cells that lie on (or just touch) the top and left sides of middle line (of triple lines)
18 calculate the, number / density, of cells per (unit) volume **;**
19 ref to detail of computation **;** e.g. mean number, per square in 0.004mm^3 ,
multiply number in 5 squares by 5 to give number in 0.1 mm^3, multiply up by dilution factor
20 AVP **;** e.g. further detail of computation (if 19 is awarded)
ref to stain, further detail of method **R** explanations **9 max**

QWC – legible text with accurate spelling, punctuation and grammar ; **1**

(c) **(i)** (indicates number of) live / viable, bacteria **;**
A haemocytometer shows dead and alive **1**

(ii) colony / colonies **;** **R** bacteria
ref to different appearance of colony **;** e.g. shape, texture, colour **2**

(iii) takes too long / milk will go off while waiting for results **;** **1**

[Total: 17]

Question			Expected Answers	Marks
3	(a)	(i)	penicillin **;** **A** other named antibiotic	1
		(ii)	(complex organic molecules) produced after / not produced during, the (log / rapid / main) growth phase **;** not essential for normal, cell growth / reproduction **;**	1 max
		(iii)	batch / fed batch **;**	1
			nutrients only added at start **;** short / rapid, growth phase **;** required product made, during stationary phase / late in life cycle **;** ora **R** death phase shortage / depletion of, nutrients / named nutrients **;** cell division / reproduction, no longer occurring **;** ref to addition of, glucose / lactose, at intervals (to avoid death of culture) **;**	2 max
	(b)	1	air pressure will push the medium into the culture vessel **;**	
		2	medium / nutrients, added to the culture at a constant rate **/** AW **;**	
		3	<u>algae / cells / *Chlorella*</u>, removed / harvested, from the sample port **;**	
		4	at the same rate / to match, the nutrients added **;**	
		5	so volume in fermenter remains constant **;**	
		6	removal of, waste / toxic products **;**	
		7	that could affect, growth / reproduction **;**	
		8	(cells kept in) exponential / log / rapid / main, growth phase **;**	
		9	algae are photosynthetic **;**	
		10	light <u>energy</u> required **;**	
		11	ref to use of fluorescent light to avoid overheating **;**	
		12	ref to monitoring temperature **;**	
		13	ref to optimum conditions **;** **A** ‘conditions for maximum growth’	
		14	air bubbles to mix culture with nutrients / AW **;**	
		15	air bubbles to allow algae to get sufficient light **;**	
		16	air bubbles provide oxygen for (aerobic) respiration **;**	
		17	and CO_2 for photosynthesis **;**	
		18	air flowing into the culture vessel flows out through an outflow tube **;**	
		19	preventing build-up of pressure **;**	
		20	AVP **;** e.g. sampling to check for mass of *Chlorella*	6 max

(c) difficulty maintaining a constant temperature **;**
difficulty maintaining a constant pH **;**
one mark for ref to difficulty of controlling environmental factors

heating / cooling, qualified **;**
foaming **;**
blocking of, inlet / outlet, tubes **;**
difficulties with, mixing / stirring **;**
contamination / keeping it sterile **;**
conditions need to be continuously monitored **;**
nutrient requirements may change **;**
AVP **;**
AVP **;** e.g. algal growth on glass
difficulties in providing sufficient light
errors lead to loss of several days production of *Chlorella* **4 max**

[Total: 15]

Question	Expected Answers	Marks
4 (a)	less insecticides used **thus** cost implications **;** less insecticides used **thus** fewer deaths of, beneficial / useful / other, insects or other organisms **;** less insecticides used **thus** lower environmental impact **;** protein within plant cells **thus** no danger to, humans / animals (of free *Bt* protein) **;** protein within plant cells **thus** specific to plant-eating insect **;** degrades rapidly **thus** no pollution of soil / low environmental impact **;** no bioaccumulation / does not build up in food chains / does not enter human food chain **;** AVP **;** e.g. less spoilage only pests are harmed, so safe if consumed by other organisms	**4 max**

(b)
1 identify / isolate, the gene **;**
2 restriction enzyme **;**
3 cuts out gene **;**
4 ref to 'sticky ends' **;**
5 ref to cloning **;**

either
6 plasmid vector **;**
7 <u>same</u> restriction enzyme used to, open / cleave, plasmid **;**
8 gene inserts by complementary base pairing **;**
9 ligase **;**
10 joins two pieces of DNA together / produces recombinant DNA **;**
11 bacteria used to transfer (recombinant) plasmids into plant cells **;**

or
6 ballistics **;**
7 (minute) gold / tungsten, pellets **;**
8 coated with, DNA / gene **;**
9 special gun used to fire **;**
10 pellets stopped by plate **;**
11 enough propulsive force for DNA to enter, plant tissue / nucleus **;**

allow other techniques to same number of mark points e.g. electroporation

12 use plant tissue culture **;**
13 ref to techniques **;** e.g. explant, protoplast culture, callus culture
14 use of, plant growth regulators / named plant growth regulator **;**

15 AVP **;**
16 AVP **;** e.g. ref to Ti plasmid / *Agrobacterium tumefaciens* / antibiotic resistance marker / calcium ions for transformation, new gene attached to the plants chromosome / transgenic plants produced / electrophoresis to isolate gene **8 max**

QWC – clear well organised, using specialist terms ; **1**

award the QWC mark if four of the following are used in correct context
restriction, endonuclease, sticky ends, cloning, vector, plasmid, complementary, recombinant, ligase, transformation, transgenic, explant, protoplast, callus, electrophoresis

(c)		ref to higher yield / faster growth **;** ref nitrogen fixation **;** resistance to herbicides **;** resistance to, disease / bacteria / fungi / viruses / pathogens **;** **A** disease-free resistance to extreme(s) of temperature **;** **A** frost resistance resistance to drought **;** tolerant to flooding **;** salt tolerance **;** improved shelf-life (after harvesting) **;** improved nutritional value **;** AVP **;** AVP **;** e.g. synthesis of vaccines improved texture after freezing growth on poor nutritional soils NOT insecticide resistance	**4 max**
			[Total: 17]

Question		**Expected Answers**	**Marks**
5 (a)		(stain with) crystal violet **;** (wash with) iodine solution **;** (clear with) alcohol or acetone **;** stains purple **;** A violet / blue	**4**
(b)		*mark (i) and (ii) together to max 2*	
	(i)	Gram-positive have thicker layer of, peptidoglycan / murein **;** ora	**1**
	(ii)	ref to, crystal violet-iodine complex / stain, removed, through thinner wall / from Gram-negative *or* not removed, through thicker wall / from Gram positive **;**	**1**
(c)	**(i)**	RNA(i) combines with mRNA **;** e.g. of base pairing (but not T) A-U / G-C **;** stops translation **;** ref to stops mRNA combining with ribosomes **;** stops protein synthesis **;**	**3 max**
	(ii)	chemicals / enzymes in, mouth / toothpaste / bacteria **;** denature / degrade, RNA **;** RNA not normally taken up by bacterial cells **;** short life of RNA **;** RNA not replicated in bacteria when bacteria reproduce **;** toothpaste in mouth only for short time **;** AVP **;** AVP **;** e.g. washed away by saliva	**2 max**
			[Total: 11]

Question			Expected Answers	Marks
6	(a)	(i)	amylase **;**	1
		(ii)	glycosidic **;** R glucosidic	1
		(iii)	alpha / α **;**	1
	(b)	(i)	encapsulation / trapped in alginate beads **;** adsorption *or* stuck onto, collagen / clays / resins **;** cross linkage *or* covalent / chemical bonding to, cellulose (fibres) **;** gel entrapment / trapped in silica gel **;** partially permeable membrane microspheres **;**	2 max
		(ii)	does not mix with / does not contaminate / stays separate from, the product **;** ref to, no / less / easier, downstream processing **;** recoverable / not lost during processing **;** reusable / cost effective **;** matrix stabilises / protects the enzyme **;** so activity not affected by changes in, temperature / pH *or* run at a high temperature / wider range of pH **;** longer, use / shelf-life **;** so suitable for continuous culture / cost effective / greater yield **;** AVP **;** *points can interchange if valid*	4 max
	(c)		not necessary to start with a pure enzyme **;** keeps the enzyme away from oxygen **;** more enzymes involved **;** cell produces enzymes **;** AVP **;** e.g. enzyme(s) may be, expensive / difficult to isolate simultaneous processes can occur	2 max

[Total: 11]

RECOGNISING ACHIEVEMENT

Mark Scheme 2805/05
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **<u>must</u>** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question			Expected Answers	Marks
1	(a)		**W** tarsal **;** **R** lines pointing to metatarsal **X** scapula **;** **Y** between 8^{th} and 19^{th} vertebra **;** **Z** shoulder / hip, joint **;**	**4**
	(b)	(i)	ref to, vertebrae / spinal column / axial skeleton / AW **; R** spinal cord four limbs / tetrapod **;** pentadactyl limb / five digits **;** one 'upper' limb bone plus two 'lower' limb bones **;** ribs attached to thoracic vertebrae **;** caudal vertebrae / coccyx / vestigial tail in humans **;** AVP **;** e.g. teeth correct ref to, pelvic and pectoral girdle / appendicular skeleton	**3 max**
		(ii)	diastema / described **;** long jaw **;** incisors in upper jaw only / no incisors in lower jaw **;** ref to horny pad **;** ref to specialised grinding teeth / AW **;**	**2 max**
	(c)		link between increased speed and increased oxygen consumption **;** link between increasing speed and increasing number of strides **;** data quote with correct units **;** <u>aerobic</u> respiration **;** (respiration linked to) ATP production **;** further detail **;** e.g. ref to oxidative phosphorylation energy / ATP, needed for <u>muscle</u> contraction **; R** 'energy for movement of legs' further detail **;** e.g. ref to ATP and cross bridge, formation / detachment	**5 max**

[Total: 14]

Question			Expected Answers		Marks
2	(a)	(i)	*automatic* requires no (conscious) thought / AW **;**		
		(ii)	*stereotyped* carried out by all individuals in a species / always carried out in same way / AW **;**		
		(iii)	*conditioned* (response) can be, modified / produced, following exposure to 'new' stimulus / AW **;**		**3**
	(b)		**A** any response, provided correct stimulus is given **;** **R** non-mammalian example **R** examples of conditioned reflexes		**1**
	(c)	**D1**	time spent in box decreases as number of trials increases / AW **;**		
		D2	greatest change in response occurs in first few trials **;**		
		D3	little / less, change in response time **;**		
		D4	between trials 6 and 20 **;**		
		D5	ref to supporting paired data **;**		
		D6	ref to 'fluctuations' **;**	*max 4*	
		E1	(at first) cat pulls, loop accidentally / AW **;**		
		E2	ref to trial and error **;**		
		E3	freedom is a, reward / reinforcer **;**		
		E4	associative learning **;**		
		E5	detail (of associative learning) **;**		
		E6	pulls loop sooner / AW **;**		
		E7	correct ref to acclimatisation period (when cat placed in box) / AW **;**		
		E8	AVP **;** e.g. other behaviours / inactivity, not, reinforced / rewarded	*max 5*	**7 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;		**1**
	(d)		no reward / punishment (of behaviour), in classical **;** ora one stimulus in operant / two stimuli in classical **;** AVP **;**		**2 max**

[Total: 14]

Question		Expected Answers		Marks
3	(a)	surface area **;** amylase **;** hydrolysis **;** trypsinogen **;** epithelial / exocrine / acinar **;** **A** acini maltase / sucrase / lactase / dipeptidase / aminopeptidase / exopeptidase / carboxypeptidase **;;** ***A** any 2 in any order*	 **R** carbohydrase **R** any ref to islets	**7**
	(b)	*allow in either section* ref to (release from), epithelial cells in / cells lining, duodenum **;** *secretin* release stimulated by acidic substances **;** stimulates release of, hydrogen carbonate / alkaline solution / bile **;** **R** enzymes from, pancreas / liver **;** *CCK* release stimulated by products of, fat / protein, digestion **;** stimulates release of, enzymes / named enzyme **;** from pancreas **;** stimulates gall bladder emptying **;** stimulates <u>smooth</u> muscle contraction **;**	 **R** alkaline fluid **R** liver *max 3*	**4 max**
	(c)	incomplete digestion **;** less surface area **;** less absorption **;** of <u>named</u> nutrient(s) **;** weight loss / stunted growth **;** malnutrition **;** breakdown / use up, of (named) energy stores **;** named deficiency disease **;** diarrhoea / rectal bleeding **;** wind / bloating / pain **;** AVP **;**		**5 max**

[Total: 16]

Question			Expected Answers	Marks
4	(a)	1	idea circular and radial muscles are antagonistic **;**	
		2	(drug) acts like noradrenaline / AW **;**	
		3	ref to sympathetic, neurones / nervous system **;**	
		4	radial muscle contracts **;**	
		5	(drug) blocks ACh / prevents ACh release / breaks down ACh **; A** acetylcholine	
		6	ref to parasympathetic, neurones / nervous system **;**	
		7	circular muscles, (in iris) relax / not stimulated to contract **;**	
		8	AVP **;** e.g. (neurotransmitter / drug) combines with receptors	**4 max**
	(b)		less damage to, cornea / eye **;** cornea heals faster **;** vision returns sooner **;** less chance of infection **;** **R** 'more side effects' or 'complications' less scar tissue **;** AVP **;** e.g. less need for antibiotics	**2 max**
	(c)	1	change in, nucleotide / base / triplet sequence **;**	
		2	transcription described **;**	
		3	translation described **;**	
		4	new / altered, amino acid sequence / primary structure **;**	
		5	new / different, R groups **;**	
		6	new bonds formed / position of bonds altered **;**	
		7	loss of / change in, secondary / tertiary structure **;**	
		8	crystallins, no longer globular (proteins) / become fibrous (proteins) **;**	**4 max**

(d) *macula degeneration*

1 image focused on fovea **;**
2 (fovea mainly) cones **;**
3 one cone to one, bipolar / ganglion, cell **;**
4 (cell, death / damage) deposits iodopsins **;**
5 (causes) loss in visual acuity (so reading difficult) **;**
6 rods in, remainder / periphery of, retina **;**
7 not affected so only central vision lost / peripheral vision unaffected **;**

max 4

retinitis pigmentosa

8 rods (mainly / only) in periphery **;**
9 several rods to each, bipolar / ganglion, cell **;**
10 (cell, death / damage) deposits rhodopsin **;**
11 loss of, retinal / synaptic, convergence **;**
12 ref to loss of summation (so difficult to see in dim light) **;**
13 cones not affected so only peripheral vision lost **;** *max 4*

14 AVP **;** e.g. loss of visual sensitivity in retinitis **6 max**

QWC – clear, well organised using specialist terms ; **1**
award the QWC mark if four of the following are used in correct context

iodopsin	convergence
rhodopsin	summation
rods	bipolar
cones	ganglion
acuity	

(e) ref to eye tests **;**
laser treatment **;**
reduce intake of, fat / saturated fat / cholesterol **;**
increase, activity / exercise **;**
lose weight / go on diet **;**
stop / reduce, smoking **;**
take antioxidants **;**
e.g. vitamin C / vitamin E / red wine / tomato (ketchup) / lycopene **;**
less salt **;**
less caffeine **;**
avoidance of ‘stress’ **;**
AVP **;** e.g. take aspirin **3 max**

[Total: 20]

Question			Expected Answers		Marks
5	(a)	(i)	noradrenaline / adrenaline / thyroxine / growth hormone / glucocorticosteroid **;** **R** steroid		1
		(ii)	insoluble **;** unreactive / stable / inert **;** cannot diffuse out of cell / AW **;** no effect on water potential **;** compact / branched **;** lots of glucose in small space / AW **;** easy to, convert to glucose / hydrolyse **;** lots of 'ends' for enzyme action **;**	 **R** lots of energy in small space	3 max
	(b)	1 2 3 4 5 6 7 8 9 10	increases activity of glycogen synthetase **;** slow initial effect / AW **;** ref to figures to show an increase **;** (overall effect) increases, production of glycogen / glycogenesis **;** **R** storage of glycogen lowers activity of glycogen phosphorylase **;** rapid effect **;** ref to figures to show a decrease **;** prevents / reduces, breakdown of glycogen / glycogenolysis **;** (glucose binds to) allosteric site / AW **;** (glucose acts as) inhibitor / activator **;**	**R** competitive inhibitor	5 max
	(c)		*either* deamination of amino acids / removal of NH_2 from amino acids **;** pyruvate / carbon skeleton / AW **;** triose phosphate / TP **;** condensation / increasing number of carbon atoms **;** *or* breakdown of, lipid / triglyceride **;** glycerol **;** triose phosphate / TP **;** condensation / increasing number of carbon atoms **;**		3 max

[Total: 12]

Question			Expected Answers		Marks
6	(a)		*cerebellum*		
			coordination of, (voluntary) movement / skeletal muscles **;** (control of) posture **;** (control of) balance **;** AVP **;**		**2 max**
			medulla oblongata		
			initiation / control of, breathing rate **;** control of heart rate **;** control of blood pressure **;** control of peristalsis (in alimentary canal) **;** AVP **;**	**R** initiation of heart rate	**2 max**
	(b)	(i)	build up of, tau / protein **;**		**1**
		(ii)	secretion of / high levels of, Aβ42 / beta amyloid 42 / abnormal Aβ**;**	**R** Aβ40	**1**
	(c)		similar shape to, acetylcholine / ACh **;** binds to / enters, active site **;** prevents ACh entry **;** competitive (inhibitor) **;** different shape to ACh **;** enters / binds, but not at active site **;** allosteric / indirect **;** change in, tertiary structure / shape of active site **;** non-competitive (inhibitor) **;**		**3 max**
	(d)		prevents ACh breakdown / increase ACh level **;** ACh binds to, proteins / receptors **;** on <u>post</u>-synaptic membrane **;** depolarisation / action potential / impulse (produced **;** activates memory circuit / AW **;**		**2 max**
	(e)		control group **;** given, placebo / tablet / injection / no drug **;** idea of 'double-blind' trial, i.e. neither patient nor doctor aware of which treatment each patient receives **;** random assignment of each patient to one group **;** similar severity of symptoms before trial **;** control of age **;** control of gender **;** control of diet **;** control of drug, dosage / administration **;** not taking any other, drug / medication **;** ref to suitable sample size **;** AVP **;**		**3 max**

[Total: 14]

OCR

RECOGNISING ACHIEVEMENT

Mark Scheme 2806/01
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
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	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **must** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Question **Expected Answers** **Marks**

1 (a) *accept reverse arguments*

(i) monozygotic (MZ) twins produced by, mitosis / mitotic division **;**
MZ twins have the same, DNA / genes / genotype / chromosomes **;** ora
egg / sperm / gametes, different because of meiosis **;**
independent assortment / crossing over / recombination, produces (genetically) different, gametes / eggs and sperm **;**
AVP **;** e.g. further relevant detail of, meiosis / cleavage / twinning

(ii) ref to, environment / upbringing / surroundings / lifestyle, influencing development / phenotype / characteristics **;**
example (diet / exercise / smoking habits / occupation) **;**
ref to different experiences in the uterus before birth **;**
AVP **;** e.g. further development of points above **4 max**

(b) unlikely to be due to chance (**A** not due to chance) / random error **;**
ref to null hypothesis or probability **;**
differences as great as those observed would be expected by chance less than once in 20 times / ref to 0.05 or 5% probability **;** **2 max**

(c) *accept*
- *any of these points as data quotes*
- *reverse arguments*
- *use of the terms identical, non-identical and fraternal*

mark the first 4 answers

1 monozygotic twins were less common (in this study) (than dizygotic) **;**
2 monozygotic twins more likely both to die of CHD (than dizygotic) **;**
3 female twins were more common than male twins **;**
4 males develop CHD more often than females **;**
5 about twice as often **;**
6 genes / inheritance / genetic factors, are involved in the development of CHD **;**
R genetics as the cause of CHD
7 AVP **;**
8 AVP **;** e.g. deduction from any of the above
other valid statements of fact based on the table **4**

(d) same-sex pairs more likely to have had similar environments **;**
example **;**
sex known to affect risk of developing CHD / males more likely to develop CHD **;**
ref to, sex chromosomes / XY difference / more genes on X **;**
males and females have different hormones **;**
as all the monozygotic pairs are the same sex, so should the dizygotic pairs **;**
one less, variable / factor, to 'take account of' / AW **;**
AVP **;** **1 max**

[Total: 11]

Question			Expected Answers	Marks
2	(a)	1	rate of respiration can equal rate of photosynthesis / CO_2 used = CO_2 produced / O_2 used = O_2 produced **;**	
		2	ref to compensation point **;**	
		3	mitochondria use oxygen **;**	
		4	chloroplasts produce oxygen **;**	
		5	mitochondria are always active / respiration continues independently of light **;**	
		6	chloroplasts are inactive in dark / photosynthesis does not take place without light **;**	
		7	oxygen released by, chloroplasts / photosynthesis, can be utilised by mitochondria / respiration **;**	
		8	at high light intensities, chloroplasts produce more oxygen than the mitochondria consume **;**	
		9	AVP **;** e.g. valid refs to CO_2 exchange	**4 max**
	(b)		phosphate ions are used to produce ATP **;** in oxidative phosphorylation / Krebs cycle / chemiosmosis / electron transport / ATP synth(et)ase **;** ATP leaves mitochondria **;**	**2 max**
	(c)		carrier protein / transport protein / transmembrane protein involved **;** **A** ref to a specific channel concentration of triose phosphate is higher in the chloroplast (than in the cytoplasm) **;** because it is a product of, photosynthesis / light independent reaction / Calvin cycle **;** triose phosphate moves, down concentration gradient / from high to low concentration **;** ATP not involved / no energy used **;**	**2 max**
	(d)		*ignore references to chloroplasts or mitochondria being cells, having cytoplasm and reference to free ribosomes* free / naked, DNA **;** **A** DNA not surrounded by, membrane / envelope have an inner folded membrane / AW **;** ribosomes, smaller than those in cytosol / similar in size to prokaryotic ribosomes **;** **A** ref to 70S and 80S circular DNA **;** **A** loop AVP **;** e.g. absence of introns ***R*** *absence of a nucleus from the chloroplast or mitochondrion* ***R*** *ref to membranous organelles as chloroplasts and mitochondria are these organelles*	**2 max**

[Total: 10]

Question			Expected Answers	Marks
3	(a)		*mark the first two answers* *both correct for one mark* sex / body mass / height / fitness / smoking habit / age / AVP **;** ***R** respiratory disease and ref to time for which the forced ventilation was carried out.*	**1**
	(b)		*no mark for stating whether supports or not* *accept suggestions of either positive or negative effect of the first attempt on the second* ref to male female imbalance in the two groups **;** for each student the time was always greater after forced ventilation **;** significant difference in the two groups / ref to group **B** having higher (mean) time, after forced ventilation **;** AVP **;** e.g. a data quote that supports or refutes ref to exceptional 115 value	**2 max**
	(c)		*mark (i) and (ii) together to max 4*	
		(i)	**A** increase in (blood) oxygen (concentration) **;** less / decrease in, (blood) carbon dioxide (concentration) **;** rise in pH **;** AVP **;** e.g. more oxyhaemoglobin formed larger, volume / mass, of CO_2 removed / O_2 absorbed (by blood)	
		(ii)	*note that the second marking point also implies the first* air in the, alveoli / lungs, more completely changed **;** concentration of oxygen in alveolar air increase **;** **A** reverse for carbon dioxide increase in concentration gradient between blood and air / increased diffusion rate **;** AVP **;** e.g. more alveoli are used / larger proportion of alveoli are used ref to, Hb dissociation curve / Bohr shift	**4 max**

(d) *award a max of **two** marks for factors that are regulated*

1 & 2 glucose (concentration) **A** blood sugar / temperature / lactate **A** lactic acid / pH / pressure / water potential **A** water content / salt content **; ;**

3 more glucose is used, for named process **;**
4 release of glucagon from, pancreas / islets of Langerhans / alpha cells **;**
5 less insulin, released from / produced by, pancreas / islets of Langerhans / beta cells **;**
6 conversion of glycogen to glucose **;**
7 further detail of blood glucose control mechanisms **;**
e.g. glucose enters blood from liver
8 ref to, <u>glycogenolysis</u> / <u>gluconeogenesis</u> **;**

9 vasodilation in skin / described **;**
10 allows blood to cool (as it passes through skin) / heat radiated **;**
11 reversing the temperature rise that occurs during exercise **;**
12 sweating / perspiration / ref to latent heat **;**

13 increased reabsorbtion of water by kidneys / decreased urine production **;**
14 ref to ADH **;**
15 further detail of osmoregulation **;**
16 increased, salt / sodium, reabsorbtion by kidneys **;**

17 lactic acid, reduces blood pH **;**
18 lactic acid removed by liver **;**
19 ref to a mechanism to restore blood pH **;** e.g. buffering *or* excretion of, H^+ / NH_4^+ / HCO_3^-
20 ref to chemoreceptors **;**

21 heart rate / stroke volume / cardiac output, increases **;**
22 this maintains and or increases blood pressure **;**
23 vasodilation / increased lumen of blood vessels, during exercise would otherwise result in a fall in pressure **;**
24 further detail of cardiovascular control mechanisms linked to homeostasis **;**

25 AVP **;**
26 AVP **;** e.g. haemoglobin dissociation curves / Bohr shift
explanation in terms of negative feedback

the AVPs must be awarded for further detail of different processes **7 max**

QWC – legible text with accurate spelling, punctuation and grammar ; **1**

[Total: 15]

Question			Expected Answers	Marks
4	(a)		1 : 2 :1 **;**	1
	(b)	1	ref to, codominant / equally dominant (alleles) **;** ***A** incomplete dominance but **R** genes as alternative to alleles*	
		2	appropriate symbols for two codominant alleles **;** eg G^1 and G^2 ***R** a capital and a lower case symbol or two different letters such as G and Y*	
		3	parent plant shown or stated to be heterozygous **; A** if it is explained that any sunny plant is heterozygous	
		4	gamete genotypes shown appropriately **;**	
		5	correct offspring genotypes **;**	
		6	the 'Sunny' / yellow-green, were heterozygous / genotype shown by diagram **;**	
		7	the dark green / the yellow, were homozygous / genotype shown by diagram **;**	5 max
	(c)	1	ref to randomness / chance (sampling) **;**	
		2	ref to random fertilisation **;**	
		3	totals are (quite) a large sample, pot **B** / single pot / six, is a small sample **;**	
		4	if (only) six seeds, there is a greater chance of departing from an expected ratio / AW **;**	
		5	probability of six seedlings all the same is ½ x ½ x ½ x ½ x ½ x ½ **;**	
		6	with, many seedlings / the totals, the deviations of the individual results cancel out **;**	
		7	some departure from an expected ratio is always likely / idea **;**	
		8	only the yellow number (33) deviates from the expected / 28 is half 56 **;**	
		9	chi squared test could be used **;**	
		10	AVP **;**	3 max
	(d)		*credit ora here* ***A** chloroplast as alternative to chlorophyll* yellow seedlings have, no / very little, chlorophyll **;** cannot photosynthesise **;** die when, energy reserve / carbohydrate (accept food), in seed is exhausted **;** dark green grow more because they have more chlorophyll (than the yellow-green) **;** so dark green have more, photosynthetic products / named product **;** ref to competition between the seedlings **;** ref to, selection / selective advantage **;**	3 max

[Total: 12]

Question		Expected Answers	Marks
5	(a)	dissolve / destroy, cell membranes (idea) **;**	1
	(b)	block the receptor / prevent ACh from binding **;** no longer able to stimulate post synaptic membrane **;** muscle fibres, not stimulated (by nerve fibres) / do not contract **; A** tetany idea AVP **;** e.g. ref to lack of synaptic transmission	**2 max**
	(c)	toxin acts too fast, for immunity / antitoxin to develop (idea) **;** human unlikely to have been, bitten before / exposed to toxin *or* antigen **;** one / a / few (immature), lymphocyte(s) / stem cell(s) (able to bind the toxin) **;** these must be stimulated to divide / ref to clonal selection *or* clonal expansion **;** mitosis takes too long **;** has no memory cells **;** AVP **;**	**2 max**
	(d)	more, antibody-secreting cells / B lymphocytes, produced **;** enough / more, antitoxin produced **;** (idea of good yield) faster / goes on for longer **;** <u>secondary response</u> **;** more mitosis (of antibody producing cells) **;** second injection of toxin would result in <u>clonal expansion</u> **;** ref <u>memory cells</u> **;** AVP **;** e.g. large dose would kill the horse	**3 max**
	(e)	*answers may be phrased in context of neurotoxin or haemolytic enzyme or both* toxin must bind to, receptor / enzyme **;** idea of specificity **;** heat would <u>denature</u> **;** change, secondary / tertiary, structure **;** ***A** change to β pleated sheet* AVP **;** e.g. ref to hydrogen bonds breaking **R** ref to peptide bonds breaking	**2 max**
	(f)	antibody / antitoxin, only remains in, blood / body, for short time **;** acquired immunity / passive immunity **;** person not themselves producing any antitoxin **;** no clonal selection **;** no memory cells **;** immune system will (soon) reject / destroy the (foreign) horse antibody **;** AVP **;** e.g. further detail explaining why immune system not stimulated different snakes have different toxins	**2 max**
			[Total: 12]

RECOGNISING ACHIEVEMENT

Mark Scheme 2806/03
January 2005

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
	;	=	separates marking points
	NOT	=	answers which are not worthy of credit
	R	=	reject
	( )	=	words which are not essential to gain credit
	___	=	(underlining) key words which **<u>must</u>** be used to gain credit
	ecf	=	error carried forward
	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

Planning Exercise

The mark scheme for the Planning Exercise is set out on page 97. The marking points **A** to **T** follow the coursework descriptors for Skill P.

Indicate on the plans where the marking points are met by using a tick and an appropriate letter. There are 14 marking points for aspects of the plan and two marks for quality of written communication (QWC).

Practical Test

Pages 98 to 100 have the mark scheme for Questions 1 and 2 for the Practical Test.

A2 Biology. Planning exercise

Checking Point	Descriptor	The candidate
A	P.1a	plans a suitable procedure that involves monitoring changes in colour of hydrogen carbonate indicator solution in response to different light intensities**;**
B	P.1a	gives a prediction that shade leaves have compensation points at lower light intensities than corresponding sun leaves / ora**;**
C	P.1b	selects suitable equipment and materials to include **-** tubes with bungs, lamp with different wattage bulbs or metre rule or light meter, stop clock**;**
D	P.3a	identifies at least 2 factors to control e.g. volume of indicator, amount (area) of leaf material, leaves from same plant, temperature, wavelength of light, time of illumination, leaves facing same way, **A** size of boiling tubes**;**
E	P.3a	states that light intensity influences rate of photosynthesis, but not respiration**;**
F	P.3b	decides on appropriate number of light intensities / distances, minimum of **four;**
G	P.3b	decides on an appropriate range of light intensities, e.g. 10, 20, 40 and 80 cm equivalent to light intensities of x, x/4, x/16 and x/32**; R** > 1 m
H	P.3b	describes way(s) of obtaining reliable results by e.g. excluding ambient light, using fresh leaves, using heat filter, using control tube without leaves, **A** replicates and calculating means**;**
I	P.5a	**uses** appropriate scientific knowledge and understanding in developing a plan, e.g. structure of leaves, relative positions of sun and shade leaves, inverse square law**;**
J	P.5a	**uses** results from preliminary work, previous practical work or identified secondary source in developing a plan**;**
K	P.5a	refers to a safety hazard and precaution e.g. heat from bulbs, electricity (and water), **A** ref to eye protection / glassware**;**
*L**	*P.5b*	*gives a clear account, logically presented with accurate use of scientific vocabulary (QWC)***;**
M	P.5b	describes way(s) of measuring light intensity e.g. use of inverse square law, use of calibration curve, use of light meter**;**
N	P.7a	**uses** information from at least **two** identified sources, e.g. preliminary work / class practicals / text books / web sites**;**
O	P.7a	shows how results from sun and shade leaves are to be presented in the form of a table**;**
*P**	*P.7a*	*uses spelling, punctuation and grammar accurately (QWC)***;**
Q	P.7b	**explains** how data would be interpreted to find the compensation points**;**
R	P.7b	comments on precision, e.g. repeating with narrower range of light intensities, precision of light meter**;**
S	P.7b	comments on reliability with reasoning, e.g. difficulty interpreting colour changes, use of colour comparator / control tube / colorimeter, use of CO_2 at high light intensities decreases rate of photosynthesis**;**
T	P.7b	relates results to biochemistry of, respiration / photosynthesis / photorespiration **A** productivity of plants**;**

Point mark up to **14** by placing letters A to T **excluding L and P**, in the margin at appropriate points.

Then award **1** mark for each of **L** and **P** (QWC). **Total: 16**

Question		Expected Answers	Marks
1	(a)	appropriate format (informative column headings) **;** table design (tube number/condition in first column, five additional columns) **;** records tube 1 as green throughout **; R** blue records tube 2 as blue-green throughout **;** records tube 3 as turning green after tube 4 **;** records tube 4 as turning green after tube 5 **;**	**6**
	(b)	*tube 1* to show dye changes colour / to show when dye in other tubes had changed colour **;** **A** to see if there is any colour change without dye *tube 2 to max 2* to show that light is necessary for colour change / AW **;** to show that light is necessary for, photolysis / splitting water / AW **;** ref to, H^+ / e^-, reducing the dye **;**	**3**
	(c)	tube, with reaction medium only / without leaf extract / AW **;** to show that leaf extract is necessary for colour change / AW **;**	**2**
	(d)	light intensity **;** temperature **;** CO_2, availability / concentration **;** ambient light **;** tubes set up at different times **;**	**2 max**
	(e)	*buffered* to, maintain pH / give a constant pH **;** same pH as, cell / sample **;** to maintain chloroplast activity / AW **;** *chilled* to reduce <u>enzyme</u> activity **;** homogenisation may have released (hydrolytic) enzymes (from lysosomes) **;**	**4 max**
	(f)	ref chlorophyll, absorbing / not absorbing, light **;** ref electrons / H^+, produced / not produced **;** ref to (H^+ / e^-), reducing / not reducing dye **;**	**3 max**
	(g)	*tube 3* **1** green filter only transmits green light / AW **;** **2** chlorophyll, reflects / does not absorb, green light **; R** only uses red and blue **3** does not emit (m)any, H^+ / e^- **;** *tube 4* **4** red filter only transmits red light / AW **;** **5** chlorophyll absorbs red light **;** **6** emits, more / some, H^+ / e^- **;** *tube 5* **7** exposed to, all / additional / optimum / wider range of, wavelengths / colours **;** **8** ref to effective blue wavelengths **;** **9** chlorophyll absorbs maximum amount of light **;** **10** emits, many H^+ / e^- (to reduce dye) **;**	**6 max**

(h) **(i)** chloroplasts lack, inner and outer membranes / envelopes **;**
thylakoids / grana / lamellae / internal membranes, exposed **; A** only have these
stroma, dissolved / lost **;**
no ribosomes **;**
no starch grains **;** **3 max**

(ii) dye does not have to pass through, membranes / envelope **;**
improves accessibility of thylakoids to dye / AW **;**
where light dependent stage takes place **;** **2 max**

[Total: 26 max]

Question			Expected Answers	Marks
2	(a)	(i)	*drawing quality* clear bold continuous lines **;** no chloroplasts or nuclei or vacuoles, i.e. no internal structure **;** no shading **;** cellulose walls shown as double lines **;** correct shape of guard cells **;** correct shape of epidermal cells **;**	**6**
		(ii)	no internal detail visible / only an imprint / AW **;**	**1**
	(b)		*either* *more stomata on shade leaf* to take up more CO_2 / allow more gas exchange / so CO_2 not limiting / only light limiting **;** to make more efficient use of low light intensities **;** *or* *more stomata on sun leaf* to take up more carbon dioxide / allow more gas exchange **;** to make more efficient use of high light intensities **;**	**2**
	(c)		2 x five counts made **;** suitable numbers recorded **;** means correctly calculated **; R** decimals	**3**
	(d)		*limitations* **1** five counts / one leaf, too small sample **;** **2** difficulty counting / may count same stoma twice **;** **3** different parts of same leaf may have different densities of stomata **;** **4** different, aged / sized, leaves may have different densities of stomata **;** **5** uncertainty distinguishing shade leaves from sun leaves **;**	**4 max**
			improvements **1** more counts / more leaves **;** **2** use photomicrographs for counting **;** **3** grow, plants / leaves, in different light intensities to provide leaves for counting **;** **4** calculate standard deviations **;** **5** use statistical test to see if difference is significant **; R** chi squared test **6** use other species **; R** other plants	**6**

[Total: 18 max]

RECOGNISING ACHIEVEMENT

REPORT ON THE UNITS
January 2005

Chief Examiner's Comments

In June 2004, GCE Biology was part of a pilot project that involved publishing the Report to Centres in the same document as the mark schemes for the examination papers taken in that session. The Report contained a new feature – the inclusion of *Teaching tips*. Both initiatives have met with an encouraging response from Centres so that they will now become standard practice.

The Examiners felt that all the papers performed in line with recent sessions and there were no real surprises as Centres and candidates have become acquainted with the style of papers. However, the Examiners did comment very favourably on several aspects that have improved noticeably in this session.

- Candidates appeared to be much better prepared for questions involving calculations. Many now realise that most papers have approximately two marks for calculations and these were often completed successfully.
- Clarity of expression has improved significantly.

This was the first session in which the descriptors for quality of written communication were printed on the examination papers. This seemed to help the candidates as more gained the mark for using specialist terms than in the past. The published mark schemes for this session include the lists of terms that were used by the examining teams. However, it should be pointed out that the descriptor is *not* just used for rewarding the inclusion of specialist terms. Answers that are poorly set out, incoherent and full of mistakes will not be awarded this quality mark however many technical terms are included. Although candidates paid careful attention to this descriptor in the extended answer questions, they were often not so careful over the use of technical terms elsewhere on their scripts. This suggests that Centres may need to adopt strategies to reinforce technical terms and their definitions.

The Examiners felt that many candidates lost marks by not paying careful attention to the command words in the questions. Many appear to be unsure about what to write in response to 'Describe' and 'Explain'. 'Comment' is a command word that is used occasionally and this often gives candidates difficulties as they are not really sure what to do. All the terms used in question papers are listed in a glossary in Appendix F of the specification. One use of mark schemes in teaching could be matching questions with answers to highlight the responses expected to the different command words.

Synoptic questions give candidates considerable difficulties. However, the performance of candidates entered for the first time for *Unifying Concepts in Biology* (2806/01) was much improved. The Examiners were impressed by the way candidates were able to apply their knowledge of immunity to the question on snake toxins (*Q.5*). Synoptic questions are set on the Option papers (2805). This session, these questions met with mixed success. A question on mutation on *Mammalian Physiology and Behaviour* (2805/05) proved to be particularly challenging (*Q.4 (c)*). *Q.4 (d)* on *Growth, Development and Reproduction* (2805/01) provides a useful exercise for all candidates on data analysis and responding to the 'comment on ….' instruction.

Many candidates entered for these Biology papers do not take Chemistry at AS or A2, therefore biochemistry may prove difficult for them. Questions on collagen and DNA in *Biology Foundation* (2801) were not answered well and candidates seemed reluctant to use the information given in the form of labels in diagrams (Fig. 2.1 and Fig. 4.1). In June 2004, a question on biochemistry in *Central Concepts* was answered very well. This time a question on aspects of respiration and photosynthesis (*Q.7*) was answered less well, possibly because it was targeted at the top of the ability range asking candidates to make comparisons between oxidative phosphorylation and photophosphorylation. It also asked them to make points about ATP that involved using information from Section 6 of the specification for 2804 on the nervous system.

A recurring theme of these reports is the poor performance of candidates on plant biology. Questions in *Transport* (2803/01) that tested knowledge of plant biology were not well answered. The three A2 core papers all had questions on aspects of photosynthesis. The Examiners felt that the candidate responses were unsatisfactory and that this area needs addressing. These three papers have some questions that together may help prepare candidates for future examinations.

- The Planning Exercise for the Practical Examination (2806/03) involved finding the light compensation point of sun and shade leaves.
- *Q.2* in *Central Concepts* (2804) included photomicrographs of transverse sections of sun and shade leaves of *Fagus sylvatica*.
- *Q.1* in the Practical Test involved the Hill Reaction using a leaf extract prepared from spinach leaves.
- *Q.2* in the Practical Test asked candidates to compare the stomatal densities of sun and shade leaves of ivy, *Hedera helix*.
- *Q.2* in *Unifying Concepts in Biology* (2806/01) asked about the relationships between mitochondria and chloroplasts.

One candidate listed a useful PowerPoint presentation on the responses of sun and shade leaves:

http://www.shef.ac.uk/aps/level3modules/aps325/shade1.pdf

Some of the slides may be useful to illustrate the principles covered by these questions.

Some candidates found it difficult to answer a question about the link reaction in respiration (*Q.7 (b)* on *Central Concepts*). This term is used in the text books endorsed by OCR and in various A level textbooks published by Cambridge University Press. However, it is not used universally and the reaction is often included in descriptions of the Krebs cycle without being given a separate name. The Examiners think that it is useful to call the reaction catalysed by pyruvate decarboxylase the 'link reaction' and its use has been rewarded on mark schemes in the past.

The use of statistics in biology is not a topic that is made explicitly anywhere in the core specification except in *Central Concepts*, which includes a learning outcome about the chi squared test. However, as a result of learning about the chi squared test, candidates should appreciate the meaning of the term *statistical significance* and be able to apply it in appropriate circumstances. *Q.1 (b)* in the *Unifying Concepts in Biology* paper suggests that this is not the case. In coursework, candidates should be encouraged to choose a suitable statistical test in their planning. This is unlikely to be the chi squared test. The use of statistical tests in analysing results provides a good opportunity to match descriptor A.5a that is concerned with *detailed processing*. The moderators are not concerned what type of statistical test is used so long as it is appropriate for the data collected and the type of investigation undertaken. Where candidates carry out whole investigations it is best for teachers to check that an appropriate statistical test has been included in the planning stage rather than being left until after data has been collected. However, it should be pointed out that there is no requirement for statistical tests to be used for A2 coursework. Other methods of processing are just as appropriate so long as they are more sophisticated than calculating percentages or means.

The report on coursework (see page 67) concentrates on some of the descriptors that continue to prove difficult to match. The advice given is just that – advice. There have been no changes made to the descriptors.

Graph drawing is a skill that is tested in coursework and in the Practical Test. Some of the graphs drawn in *Q.1* of the AS Practical Test were very poor. Teachers are always concerned about how their candidates should 'join up the points'. Should they join the points 'dot to dot' or use a curve/line of best fit? Judging by many of the graphs produced by the Year 13 candidates retaking the AS Practical Examination in this session that should be the least of their concerns. All sorts of basic errors were made that are highlighted in the report. OCR does not expect candidates *always* to join 'dot to dot' *or* to use lines of best fit. The advice given by the Institute of Biology should be followed. Often it is obvious that the data fall on a straight line or smooth curve, when a line of best fit or appropriate curve should be placed on the graph. Trend lines should show an even distribution of points on either side of the line along its whole length. Sometimes it is not possible to be sure if the line should be straight or a smooth curve, so adjacent points should be joined by straight ruled lines in order to represent the data with the minimum of assumptions. Lines should be finely drawn and should not contain kinks or breaks. When marking graphs on the Practical Examination, the Examiners will take into account the *expected* outcome of the investigation and the data collected by candidates. In the AS Practical Examination the candidates investigated the effect of enzyme concentration with substrate in excess. The expected outcome was a straight line relationship and unless there were very good reasons for doing otherwise, the Examiners looked for a straight line beginning at the origin or at the lowest concentration of enzyme used.

Centres are reminded that the Examiners set Practical Examinations for the January session as well as for the May/June session. These provide a resource that all Centres could use- especially *Q.1* on the Practical Test which is usually a simple practical exercise completed within about one hour. On the evidence of scripts seen this session, Centres preparing candidates for these examinations should pay great attention to questions on the Practical Tests that ask candidates to explain their results. These were very poorly answered in *Q.1 (f)* and *(g)* in the A2 paper and *Q.1 (e)* in the AS paper.

2801: Biology Foundation

General Comments

This paper provided a wide range of marks. The Examiners commented that it was pleasing to see a substantial proportion of candidates scoring well with clear, concise, well expressed and well thought out responses. Some candidates, however, experienced some difficulty in the way in which they expressed information. In some questions (notably *Q.2 (a)(iii)*, *Q.3 (a)(iii)* and *Q.4 (b)*) poorly expressed ideas resulted in answers that were ambiguous or biologically inaccurate. While the Examiners may well think that they know what the candidate *meant* to say, they only have the evidence of the written answer to make an assessment. Candidates should be encouraged to make every effort to write legibly, with attention being paid to the good use of grammar, punctuation and spelling. These communication skills are most useful in conveying the desired information for assessment.

Comments on Individual Questions

Q.1 *This was generally answered well. The parts of the cell were well known by the majority of candidates. Some clearly identified the structures from the drawing while others used the statement relating to the function as the main key to deciding upon their answers. Each 'box' was marked independently and candidates were not penalised if, for example, they correctly identified a structure when related to its function, but were unable to correctly identify it from the diagram, e.g. first line answer 'mitochondria E' = 1 mark for 'mitochondrion'. If no mark was awarded for the name or letter of the structure with the stated function, a mark could be awarded for correctly pairing the name and letter of a part of the cell, e.g. third line answer 'lysosome E' = 1 mark for linking structure to letter, even though it was on the wrong line. A common error was to give 'ribosome' in the second answer line with an incorrect letter but then to give 'rough ER' together with 'C' in the third answer line. As crediting the correct pairing would give credit for the same mark twice, in this situation a second mark was not awarded. Candidates seemed to be unaware of the singular term 'mitochondrion', the vast majority referring to 'mitochondria'. This was not penalised. ER was frequently not distinguished as being* rough *and the lysosome was often identified as a ribosome.*

Q.2 This question discriminated well.

(a) The majority of candidates experienced little problem with part *(i)*. A range of suggestions appeared in response to part *(ii)*. Most of these were amino acids, although some bases were suggested. Part *(iii)* proved to be a challenge for many candidates, especially those who find it difficult to express themselves clearly. The main difficulty was that of terminology. It had been hoped that the diagram and accompanying text would have helped them, but some candidates could only make inferences from the diagram and were unable to add anything of substance. It was frequently unclear whether a polypeptide chain, molecule or fibre was being referred to, despite the information supplied. Candidates could have used the terminology in the question to ensure that their answer was clear.

(b) This part of the question was generally well answered, as long as candidates had a reasonable grasp of the material. A frequent error was to transpose glycosidic and hydrogen bonds. Those who had not read the question carefully enough referred to polypeptide chains rather than a straight [chain] or a polysaccharide [chain].

Teaching tip

Candidates find it very difficult to apply what they have learnt about protein structure with respect to haemoglobin to the structure of collagen. It is worth emphasising the very different roles of the two proteins and giving the 'big picture' of the two proteins before dealing with the details. Another possibility is to follow the synthesis of collagen that occurs partly within the cell and partly in the extracellular matrix. This links well with other parts of the specification for this module:
5.1.5 *(e)* synthesis of polypeptides;
5.1.4 *(c)* exocytosis;
5.1.1 *(f)* tissues – with reference to basement membranes.

Q.3 *(a)* *Part (i)* was well answered by most candidates. The only problem arose with those candidates who simply stated 'thin' without qualification as this could refer to the cell wall or to the general shape of the root hair. Most candidates could supply a valid suggestion in part *(ii)*, but some did suggest osmosis. Again, most candidates recognised that water enters the root hair cell by osmosis. A significant number, however, explained this in terms of relative concentrations of water. Credit will be given for reference to water potential (not concentration) in questions such as this, as stated in the learning outcome (5.1.4 (c)). Those who knew and understood the material scored maximum marks. Some candidates misread the question and referred to the uptake of nitrate ions, while others described the passage of water through the plant rather than into it.

(b) Most candidates gave the correct response to the last box (**S**) and the second answer was frequently correct. Some confused, and therefore reversed, nitrification and denitrification. A minority of candidates scattered letters randomly in the boxes.

Q.4 *(a)* While many candidates gave the correct response to part *(i)*, common incorrect answers were 3, 20 and 64. Some candidates suggested very large numbers such as 140 000. These incorrect responses were, presumably a result of not reading the question with enough care. Able candidates could, in part *(ii)*, establish the presence of three suitable components of a DNA nucleotide. Candidates were expected to identify the pentose sugar as deoxyribose and the base as nitrogenous or to give a suitable example. The Examiners accepted an example of a base as the question asked for the components of a single nucleotide. Careless answers simply listed the possible bases, implying that each one was present, or just giving letters, which were not credited.

(b) This question discriminated well. Some answers were superb, stating the information in a clear and concise way. The Examiners credited clear statements that referred to nucleotides, molecules and polynucleotide strands. Terminology was loosely applied and answers that referred to 'half' the DNA

gained no marks as it was not clear what 'half' was being described. It was hoped that the diagram (Fig. 4.1) might have encouraged the description of the old and the new strand in each new DNA molecule produced. One way in which the original and new molecules might have been described could have been in terms of helices or, strictly speaking, double helices. Some weak answers were confused as they included references to RNA and transcription or parent and daughter cells.

Q.5 This question gave a good range of marks.

(a) The majority of candidates were able to state that cancer is the result of uncontrolled mitosis, leading to a tumour or mass of cells. Weaker responses indicated cell growth rather than division, the idea that you can 'catch' cancer or that it is a bacterium. References to mutation were sometimes confused, failing to indicate that this is a process that leads to the development of cancer and instead stating that 'cancer is a mutation'.

(b) Part *(i)* was only answered correctly by a minority of candidates. The most common incorrect answer was 10%, although many and varied answers were seen. Part *(ii)* produced many vague responses that failed to make sufficient use of the data and often simply repeated the information and response given in *(i)* (concerning smoking alone) or going into detail about how carcinogens produce cancer. Good answers noted that there was no increase in risk associated with an increase from 0 to 20 arbitrary units of radon exposure, but that the risk increased by a factor of 10 once exposure had increased to the 'threshold level'. Other valid statements were also credited, but they needed to be supported in a quantitative or semi-quantitative manner.

(c) Most candidates managed to supply two valid suggestions in this part of the question varying from the obvious, such as awareness and concern, to those that indicated deeper consideration, such as taking remedial steps to reduce the impact of radon in the home. There was some repetition of the same reason, in principle, being given both as an advantage and a disadvantage.

(d) The majority of candidates answered this part of the question with confidence and able candidates could easily score maximum marks. Some failed to grasp the fact that the question was asking about *chromosomes* and wasted time and effort in providing a full and detailed account of nuclear membranes, centrioles and spindle formation, which was not required. Weak responses were vague, often simply stating the names and order of the stages. Credit was given for identifying the labelled cells with the relevant events rather than simply with the name of the appropriate stage. Many apparently satisfactory accounts failed to gain the quality mark, which was awarded for the quality of the use and organisation of scientific terms. There was frequent confusion with chromatids, centromeres and exactly what was separating at anaphase. Some referred to pairing of chromosomes: homologous chromosomes often paired and chromatids were described as 'coming together' in order to pair up. Otherwise good accounts were often spoilt by the use of incorrect names for the stages. The Examiners appreciated some of the more inventive mnemonics that were written in the margins!

Q.6 This question provided a context for questions on enzymes.

(a) This part of the question elicited a vast range of suggestions, with little obvious pattern of error. The weakest responses simply restated information given in

the question, with no attempt to apply it. References to ER, which in this case was *smooth* ER, were often negated by comments on the production or transport of protein or enzymes. The idea that COX was 'waiting for the reactants to come through the membrane' was common; however, the recognition that phospholipid in the membrane might be a source of material for the reaction was not seen very often.

(b) The vast majority of candidates were able to make some sort of comment on the nature of ibuprofen and aspirin as competitive and non-competitive inhibitors respectively. All too often, however, the descriptions were reversed. Many simply ignored the information in the stem of the question which specifically stated that neither drug entered the active site of the enzyme. Weaker answers seemed to imply that COX was the substrate rather than the enzyme.

(c) Answers were generally good, with some very clear explanations. Weaker candidates found it difficult to concentrate on low temperatures, as stated in the question, and delivered the standard generalised response about the effect of temperature on enzyme action, with particular reference to optimum and high temperatures. Energy was referred to but this was rarely qualified as kinetic. Common misconceptions are that low temperatures denature (or even kill!) enzymes and that molecules are unable to move at all at low temperatures in the region of 5°C.

Teaching tip

Further information about COX inhibitors can be found at:
The aspirin foundation:
http://www.aspirin-foundation.com
and also at:
http://cti.itc.virginia.edu/~cmg/Demo/pdb/cycox/cycox_2.html

2802: Human Health and Disease

General Comments

The Examiners felt that this was a fair examination paper and that there was a very pleasing level of performance overall. All candidates had attempted every question and there was no evidence that candidates ran short of time. Some questions and part questions such as *Q.4 (b)* and *Q.5 (a)* were targeted at the top end of the range and challenged even the best candidates while others offered easily accessible marks to the weaker candidates. One or two questions were misinterpreted by a good proportion of candidates who did not read the question sufficiently carefully; this applies particularly to *Q.4 (b)* and *Q.6 (c)(iii)*.

The Examiners were certainly pleased to see a high level of attainment by the majority of candidates and some fairly good scores achieved even by weaker candidates. Few candidates scored less than 20 marks. Many candidates scored well on a range of questions and there were no areas of the specification covered in this examination paper that displayed any obvious weaknesses in the ways that Centres approach the teaching of this unit. Candidates should expect a range of stimulus material on this examination paper and can expect some of it to be unfamiliar as it used to test Assessment Objective 2. Centres are reminded that all parts of the specification can be tested and that candidates would be best advised not to prepare selectively on the assumption that particular topics will be tested.

The Examiners noted that poor spelling of general and technical terms was common on a significant number of scripts.

Comments on Individual Questions

Q.1 *(a)* Most candidates scored one or two marks here as an easy opener to the paper. There was a wide range of acceptable answers with the most candidates offering ‘physical’, ‘mental’ or ‘self inflicted’ diseases as their response.

(b) The majority of candidates scored marks on this relatively straightforward calculation. Only the weakest were unable to realise that a calculation of 85% of 47 kg was required. Some candidates calculated 85% of 55 kg which was the highest body mass recorded on the graph. Many candidates failed to round their answers to the nearest whole number indicating that they did not read the question carefully. The Examiners also noted that many candidates apparently did not have a calculator to use. In part *(ii)*, the menstrual cycle could be expected to stop as the body mass dropped below 40 kg. The Examiners decided to accept any point on the curve below 40 kg as the girl may not realise at what point in time the cycle actually stopped. If the body mass in part *(i)* had been miscalculated then the error was carried forward in the answer to part *(ii)*.

(c) Almost all candidates knew some of the signs and symptoms of anorexia with the most frequently quoted answers being ‘thin, brittle hair’, ‘fatigue’ or ‘tiredness’ and ‘muscle wasting’. Many candidates, who had obviously learnt this well, wrote far too much and listed a large number of signs and symptoms. This may have taken more time than necessary leaving them with less time in more difficult questions. Some candidates had an odd way of describing some signs and symptoms. The Examiners did not feel that

'eating her own organs' was worthy of credit! No credit was given for describing symptoms of bulimia.

Teaching tip

Candidates should be encouraged to consider the number of marks allocated for a part question. In their answer they should aim to provide that number of points and one or two more. No additional credit is given for demonstrating how much candidates know about a particular topic. This advice had obviously been followed by one candidate who even numbered the marking points in her response!

Q.2 *(a)* This question gave easy access to a number of marks and many pupils gained full credit in this relatively straightforward question. The teaching of the malarial life cycle is obviously well covered in most Centres. All but the weakest candidates knew the term *Plasmodium*. Many candidates knew the name of the mosquito but the spelling of *Anopheles* was very inconsistent. Most realised that the mosquito picks up the parasite by feeding on infected blood and that it then infects another person when it takes another blood meal. Fewer candidates knew that the mosquito is a vector and many called it a carrier. There were a number of possible answers to the alternative methods of transmission and most candidates could name one accurately. However, a simple statement 'mixing the blood' was considered too vague to be worthy of credit.

(b) All but the weakest candidates described accurately two ways in which the transmission cycle of malaria can be disrupted. The most commonly quoted answers were to 'drain standing water', 'use insecticides to kill mosquitoes' and 'sleep under nets'. All these were given credit but 'kill mosquitoes' and an unqualified reference to 'taking tablets' were not credited.

Q.3 *(a)* Most candidates were able to name rickets as the deficiency disease; however, 'bow-legged disease' was not considered to be sufficient. A surprising number of candidates displayed a lack of knowledge by suggesting scurvy.

(b) A good proportion of candidates realised that exposing the skin to sunlight was a way of reducing the effects of vitamin D deficiency. Commonly used incorrect answers included the need for some sort of regular exercise or corrective surgery. It was disappointing to see many references to vitamin supplements as a cure despite this being suggested in the stem of the question and candidates being asked to state **one other** way. The suggestion that children with this deficiency should 'stamp their feet to get the calcium down' was not awarded a mark.

(c) Only the better candidates could accurately define the term 'reference nutrient intake' as sufficient nutrient to supply the needs of the majority of the population. This is one of the dietary reference values (DRV) and refers to learning outcome (c) in Section 5.2.2 of the specification. Many candidates mentioned 'average intakes' or 'sufficient for certain groups of people'. The Examiners found it disappointing that so few candidates could answer this question correctly. This is an area in which more detailed teaching may help the candidates. However, in part *(ii)*, many candidates could state two functions of calcium in the body and most quoted 'strengthening bones' and 'stronger teeth'. The responses 'for healthy

bones' and 'for bone growth' were not considered sufficiently detailed. A reasonable proportion of candidates quoted 'to do with nervous transmission' which was not considered worthy of credit. The Examiners did, however, allow credit for correctly stating that calcium is involved in synaptic transmission.

(d) In part *(i)*, the table of data from a study in Nigeria was well understood and most candidates achieved some credit. The Examiners were pleased to see that middle ranking and better candidates achieved full credit and that most candidates quoted some figures from the table to back up their statements. In part *(ii)*, only the best candidates realised the importance of giving the groups a placebo. Few were able to explain clearly that giving a tablet as well as the vitamin D injection was so that the children did not realise that they were having a different (or less good) treatment. Many candidates suggested that the glucose in the placebo tablet was to 'boost energy levels' or to 'help take up the vitamin in the gut'. These statements were made despite the fact that candidates were told that placebos are expected to have no effect. Most candidates suggested in part *(iii)* that group 4 was 'included as a control'. However, the question stem clearly states this and it was given no credit as a response. All but the weakest candidates were able to extend their answer to suggest that group 4 was there for comparison, but few were able to state what was being compared or give a reason why such a comparison was desirable. The Examiners felt that candidates at this level should be able to understand and explain what a control is for and why it is needed in a well planned experiment.

Teaching tip

Candidates should be given copies of suitable questions and asked to read through the question carefully. They should then use a highlighter to pick out important words or phrases that will, of course, include all those given in bold type.

Q.4 *(a)* The term 'carcinogen' was accurately defined by the majority of candidates who were obviously used to using the term. However, a disappointingly large number of candidates were unable to define the term 'malignant'. Many appeared to think it meant 'harmless' or 'a cancer that does not grow'.

(b) This part question was either answered very well or very poorly, with little in between. Candidates were expected to link the name benzpyrene with the statement in the stem of the question that it is one of the most potent carcinogens. Unfortunately, this link was not made by a good proportion of the candidates and many went on to describe the general effects of tar on the epithelial tissue, cilia and mucus production. This type of answer was afforded no credit as the question referred specifically to 'substances such as benzpyrene'. The Examiners were looking for details of how a carcinogen can cause mutations in the genetic material which might then lead to a cancerous growth. Many candidates seemed to think that cancer causes *rapid* cell division rather than *uncontrolled* cell division. Only the more able candidates achieved full credit here.

(c) Most candidates could give two symptoms of lung cancer and the most frequently used responses were 'coughing up blood' and 'difficulty with breathing'.

(d) Again many candidates were able to give a good response to this question with most offering the use of X-rays as their response.

Q.5 *(a)* In what the Examiners thought should be a relatively straightforward question it was disappointing to find that very few candidates achieved full marks. Few candidates were able to recognise and name the smooth muscle (**X**) although many more were able to name the ciliated epithelium (**Y**). The Examiners decided to accept the response 'epithelium' as sufficient to gain credit. In part *(ii)*, very few candidates were able to recognise the structure **Z** as a blood vessel and of those that did many called it a capillary despite the presence of red blood cells, an endothelium and fibres in the wall. Answers ranged from 'mitochondria' or 'vacuole' (unacceptable) to venule (an acceptable answer).

(b) The majority of candidates did very well in this longer part question on the gaseous exchange system that offered candidates the opportunity to demonstrate the extent of their knowledge. Many candidates answered the question by describing the route taken by air as it enters the lungs and picked up marks along the way, rather than by offering a well structured answer in which the various tissues were clearly specified and functions given. The best candidates selected each tissue and gave concise details on where it was found and what it did in the gaseous exchange system. Some candidates confused the role of cilia with that of mucus. Care with the way answers are worded is important. Some described the ciliated epithelium as secreting mucus. Another common error, which has been seen in previous years, is the idea that cilia filter out dust and other particles from the air as it travels down the airways. There was also some confusion over the role of the smooth muscle that is able to alter the diameter of the airways to adapt for changing needs. However, some candidates described the smooth muscle relaxing to inhale and contracting to help expel air from the lungs – contraction would in fact have the opposite effect and would reduce the size of the airways slowing down the movement of the air as it is expelled by elastic recoil of the alveoli. Another erroneous idea that seems to be widely prevalent is that alveoli have a large surface area due to microvilli on their inner surface; some candidates even drew diagrams to illustrate the point!

Teaching tip

Pupils should be given plenty of opportunities to study tissue plans either practically using prepared slides and microscopes or through the use of photomicrographs projected through a data projector. Collections of photomicrographs are readily available on CD-ROM or from the internet. Using a data projector has the added advantage that teachers can easily point out the position and features of various tissues.

Q.6 *(a)* Most candidates knew that an epidemic is the rapid spread of a disease to affect many people. However, a good proportion of candidates mentioned 'sudden outbreaks' with no mention of the rate of spread or the scale of the outbreak.

(b) A good number of candidates correctly stated that a worldwide epidemic is called a pandemic. Some weaker candidates rephrased the question and gave a textbook definition of pandemic. This was taken as another sign that these candidates had not read the question carefully.

(c) Part *(i)* was not well answered except by the very best candidates. The word artificial refers to the fact that the antigens have been artificially introduced into the body so that the immune system is activated. Common errors were to suggest that 'the disease was man-made' or to state that 'antibodies are injected'. This latter answer is, of course, producing passive immunity rather than active immunity. Questions on this section of the specification have often not been answered very well as it is one of the more demanding sections. The Examiners felt that many candidates were simply regurgitating answers from previous papers and actually had little or no understanding of the process. A lot of answers displayed incomplete or sometimes muddled recall of the steps in an immune response. However, many candidates still picked up enough marks to gain full credit. The majority of candidates gained their marks by mentioning the presence of antigens in the body that initiate an immune response. This produces memory cells, which provide a quicker response when the antigen reappears. Few candidates mentioned antigen presentation by macrophages and many were uncertain about which cells actually produce the antibodies. There were also fairly muddled references to B and T lymphocytes.

(d) A lot of candidates missed the point of this question and gave another, briefer answer to part *(c)(ii)* in describing how a vaccine could bring about immunity to an individual. However, better candidates spotted that this question was asking about an eradication programme and many suggested 'vaccinating many people to produce herd immunity which would stop the spread of the disease'.

Teaching tip

Ask pupils to construct a flow diagram of the events in an immune response. This can start with the entry of an antigen and follow a variety of pathways to production of antibodies, killer cells and memory cells.

2803/01: Transport

General Comments

The paper produced a full range of marks with many good scripts indicative of careful revision and the greater maturity that comes from many of the candidates tackling the topics for the second time. There still remains the problem that candidates seem less at ease with the questions on botanical topics; it is worth reiterating once again that approximately one third of the specification is botanical in flavour and this will generally be reflected in the papers. There were also some areas where the candidates seemed not to appreciate precisely what a particular question was looking for and perhaps simply described a situation when an explanation was needed. Spelling of biological terms still remains very varied. Candidates did not seem to have had any time problems.

The answer spaces in *Q.1 (b)*, *Q.3 (a)(ii)* and *Q.4 (b)(ii)* were divided to help candidates. However, the Examiners took linked ideas wherever they appeared within the whole answer space.

Comments on Individual Questions

Q.1 *(a)* The majority of candidates gained both marks here. Some drew the vascular tissue of the stem within the outline given. These candidates were awarded one mark if their drawing was labelled correctly so that they were not double penalised. There were a number that just drew two concentric circles and some showed xylem and phloem the wrong way round. Some lost a mark by having the xylem coming right out to the edge of the epidermis – in effect drawing a stele rather than the whole root.

(b) Most candidates were able to identify two valid features, such as lignin, pits or a lumen free of cytoplasm. Some of the explanations of the importance of the features were too vague; just describing lignin as strong is not enough. Some candidates thought that lignin stops vessels bursting rather than collapsing inwards under tension. Just to say that pits allow substances in and out is not enough; there needs to be some indication as to where the substances are going. Also, pits do not stop air bubbles forming; they allow an alternative route around them. A few thought that fibres and tracheids were features of xylem vessels.

(c) Many candidates muddled the source and sink in *(i)*. Roots can be sources, but there needs to be some qualification if they are to be given as such in this examination. A young leaf may be a sink, but again a qualification is essential. Just naming single cells, such as a mesophyll cell, was not accepted. In part *(ii)*, many candidates failed to refer to the diagram as asked in the question and thus tended to give a complete account of phloem transport rather than of mass flow. Many erroneously thought that mass flow was the diffusion of sugar from the source to the sink down a concentration gradient. Good answers got across the idea that water passes into the source by osmosis down a water potential gradient increasing the pressure and thus pushing the whole solution to the sink. Sadly these answers were few and far between. Some candidates even

gave answers on the cohesion tension mechanism in xylem.

(d) The two parts were marked together so that the Examiners looked for the evidence in either *(i)* or *(ii)*. Candidates who had understood and learnt this part of the specification had little trouble in gaining the marks, but clearly active transport in phloem remains a grey area for many. Most appreciated that energy or ATP was involved hence the presence of many mitochondria in the companion cell. The idea of protons being pumped out and then their return coupled with sucrose via co-transporter proteins was only seen in the best of responses. Credit was occasionally gained by mention of alternative active hypotheses.

Teaching tip

Proton pumping is such a unifying concept that teaching it as a general principle first and then giving some specific examples where it is involved in active mechanisms is worth trying. It may also be worth mentioning when covering learning outcome 5.1.4 (c) *in* Biology Foundation*.*

Q.2 This question was often well answered although the whole range from 0 to 5 marks was seen. Most candidates appreciated that iron was found in the haem group though 'hydrogen' and 'haemoglobin' both occurred on a number of occasions. It was also usual to find 4 as the number of oxygen molecules accepted by a molecule of haemoglobin though 8 was not uncommon and figures ranged from 1 to 'millions'. The Bohr shift or effect was usually given and this was usually spelt correctly unlike previous sessions, but 'dissociation curve' was seen on a number of occasions. Carbonic anhydrase was less often correct; there were a number of hybrid enzymes like 'carbamino hydrase' and quite a few blank spaces. Likewise haemoglobinic acid was often missed or put as carbamino haemoglobin.

Q.3 *(a)* Many candidates answered part *(i)* correctly. A common error was splitting up the circulatory system into oxygenated and deoxygenated rather than pulmonary and systemic (not systematic). In part *(ii)*, the Examiners were looking for two ideas from those related to size, surface area to volume or activity. With regard to size the distance between different parts of the body and the relatively slow rate of diffusion are important considerations. Where surface area to volume ratios are concerned there are those who think that the cat must have a larger one because it is bigger. It is important to talk about the ratio not just the area. As far as activity is concerned, the cat needs more materials and oxygen or needs them faster. The implication of 'more' or 'faster supply' was looked for.

Teaching tip

Surface area to volume ratio is another underlying principle in biological systems. Try giving some simple worksheets on basic mathematical models for students to do calculations to see how the ratio changes as 'organisms' increase in size. Or have 'bricks' of different sizes that can be measured so that ratios can be calculated.

written in proper sentences. Not all the biological terms were correctly spelt. This was particularly so in the case of systole and diastole. A common error was to have the atrioventricular valves closing before the ventricles contracted. It is important to get the sequence correct in descriptions of the cardiac cycle. The majority of candidates failed to notice the closure of the veins during atrial systole or if they did thought that they were semilunar valves. There was credit for clearly relating the stages to **X**, **Y** and **Z** on the diagram. Not all candidates accessed this mark.

Less sophisticated answers muddled semilunar and atrioventricular valves, had blood leaving the heart in veins or even had it flowing totally the wrong way. Those who used the terms bicuspid and tricuspid in place of atrioventricular valves sometimes had them related to the wrong chambers. Some candidates described the passage through one side and then the other. This was not penalised as such but it is better to describe both sides together. A number of candidates clearly did not read the question carefully and described the initiation and control of the heart beat even though this was specifically ruled out in the question. This just wasted valuable time and did not gain any marks

Teaching tip

Candidates could be advised to use the term atrioventricular valve(s) rather than referring to bicuspid or tricuspid.

Examination tip

Some useful advice for candidates.
In comparison questions always make it clear what you are writing about. For example, in this question, start the answer ‘in mammals the surface area to volume ratio is…………’ This will avoid confusion.

Q.4 *(a)* In part *(i)*, most candidates got 15 as the correct answer. Some read the graph as 16 and 1 and dropped the calculation mark. Others read a range of figures from the wrong part of the graph or divided 15.5 by 0.5. There was quite a bit of confusion in part *(ii)* over the parts of the system indicated by **B** to **D**. Some thought **B** was the heart and **D** the veins. A lot of candidates failed to answer the question and instead of explaining what brings about the drop in pressure, just described the graph (sometimes with detailed figures) or explained why a drop was useful (an answer to part *(iii)*). More careful reading of the question would have helped. Those who did try to explain the causes of the pressure drop were often confused. ‘Loss of oxygen’, ‘loss of nutrients’ and ‘less blood’ were all quoted. Distance from the heart was the most common correct response, but few mentioned the friction effect, the loss of energy in elastic recoil or the increased volume on entering the capillary bed. In *(iii)*, a number of candidates seemed to think that region **C** represented the veins (even if in part *(b)* it became capillaries or vice versa). The most common correct responses involved the prevention of bursting related to the thin nature of the capillary walls. Fewer candidates mentioned slowing the flow for exchange. Some thought that a high pressure in **C** would ‘wear out the heart’. If candidates thought that **C** represented the veins, then the Examiners gave a maximum of one mark if candidates gave appropriate responses.

(b) There were quite a few lists in *(i)* of two or more letters and discussions of what **C** was in part *(a)* did not always tally with the answer here. Candidates seem mostly to have realised in part *(ii)* that they were required to give structural features. ‘Thin cell wall’ with no indication that this meant one cell thick was a common error. Pores were seen as letting plasma out or related rather vaguely to ‘letting things in and out’. It is important that candidates distinguish between whole plasma and tissue fluid and state clearly what substances pass between them. The smooth nature of the endothelium was rarely mentioned; smooth muscle was as common! Not many got the idea that the total surface area of the capillaries was large. Overall, however, many candidates were successful in relating structure to function in this question.

2803/02: Experimental Skills (Coursework) – see page 67

2803/03: Practical Examination (AS)

General Comments

Where possible the Examiners like to set Practical Examination papers with a theme that runs through the Planning Exercise and both questions of the Practical Test. There were many points of similarity between the Planning Exercise and Q.1 of this Examination as both involved investigating the factors that influence enzyme activity. Q.2 however, was about white blood cells and mitosis. However, there is only a very tenuous link with white cells – perhaps the production of proteins, such as proteases in neutrophils and antibodies in lymphocytes.

The Examiners have decided that, whenever possible, they will ask Centres to obtain enzymes from the same supplier. In this case the protease used in Q.1 was Neutrase, a bacterial protease, supplied by the National Centre for Biotechnology in Reading. Centres who did not enter candidates for this examination but who wish to use this practical could trial it with trypsin to see if suitable results are obtained. If not, details for ordering Neutrase are given on page 6 of the instructions. Further details are available at http://www.ncbe.reading.ac.uk. But note that the NCBE recommends that Neutrase only works well with Marvel™. Centres have reported that the weakest concentration used did not work as well during the Test as it did during trials of the practical. There may be some loss of activity with storage.

The Planning Exercise for the January examination obviously poses problems for candidates. There may not be enough time to carry out preliminary practical work and as the numbers of candidates involved are likely to be small, Centres may not be able to devote as much time to this activity as in the summer examination session. Some of the plans seemed to reflect this. Marks were not as good as in June 2004 and this was possibly because of the more demanding nature of the exercise. Some Centres entered ten or more candidates and it was clear that they had gone to considerable trouble to give their candidates time in the laboratory to carry out preliminary work.

Most of the plans were concise and to the point, but some included far too much unnecessary material. Large chunks of information taken directly from web sites or from books will not gain any credit. It is not appropriate to include such information as an appendix to the plan.

The candidates did not appear to be pressed for time in the Practical Test, although there were some who wrote ‘no change’ for all the tubes in Q.1 and it was obvious that they had missed out some important part of the instructions. In these circumstances, supervisors may provide candidates with the results that they have obtained from their trial of the practical if candidates admit that they have not gained any results. This should be recorded in the Report on the back of the script. Results provided like this should be unformatted so that candidates may still gain marks for drawing up tables. Providing results when something goes wrong with the experiment allows these candidates to proceed through the rest of the test. There will usually be a few marks that such candidates will not be awarded.

The Planning Exercise

Planning Exercises always present new challenges. This one was no exception.

Candidates were asked to plan an investigation to measure the inhibitory effect of thiourea on the activity of urease at different concentrations of urea. Candidates were given enough information for them to work out that thiourea is a competitive inhibitor although few of them started their answers from this standpoint. Most of them found a web site that shows a demonstration experiment of the decomposition of urea by urease and the action of thiourea as a competitive inhibitor. This demonstration uses the indicator phenolphthalein. Some candidates did little more than copy the details of this demonstration totally ignoring the instruction given to them to use different concentrations of urea. These plans gained very few marks. Others *used* the information given in the demonstration[(1)] but planned a different method to measure the effect of the inhibitor.

It was expected that candidates would run a series of reactions with and without the inhibitor to show the effect of the inhibitor over a suitable range of concentrations of urea. Many missed this point failing to repeat their experiment *without* thiourea. If they did run a 'control' then this was only at one concentration of urea and not at all of them. As a result they missed checking point A, which is used to reward a suitable procedure. Checking points are identified in this report in brackets wherever they are discussed.

Many candidates gave lengthy accounts of all the factors that influence enzymes. This is not necessary. The Planning Exercise is not a piece of extended writing. Others concentrated on the action of inhibitors, making comparison between competitive and non-competitive inhibitors. The Examiners looked for statements about complementary shapes and active sites linked to the information about competitive inhibitors before awarding a mark (checking point I). Few related this information *specifically* to urease. They should have discovered that urease shows absolute specificity for its substrate so that thiourea, which is a very similar molecule, may occupy the active site, but is not hydrolysed. Some re-used this information at the end of their plans to explain how the results would confirm that thiourea is a competitive inhibitor and not a non-competitive inhibitor. They often did this with a graph and were awarded a mark (U).

Some candidates gave a prediction only in terms of the effect of increasing the substrate concentration. A simple statement that the pH would increase as the concentration of urea increases was not sufficient and a mark was not awarded. Predictions were sometimes accompanied by graphs, but these had to be explained to gain a mark *(b)*. A further mark was available for stating that the concentration of the *substrate* has an effect on the activity of the inhibitor *(d)*. Having given the *rate* of reaction on the prediction graph, few included in their plans a way in which this could be calculated. Many planned to record final pH without any reference to time. They would therefore be unlikely to find a difference between the results for 'with thiourea' and those 'without thiourea'.

The preliminary work was often employed to find an appropriate range of urea concentrations to use. Some used five dilutions between 0.1% and 1.0% and others used the 1% urea solution to make a serial ten-fold dilution (F and G). Others diluted 1% urea by a half and then continued diluting by the same factor to give five or more dilutions. Others varied the urease concentration or the ratio of thiourea to urea in the reaction mixtures. Candidates were awarded the relevant marking point (J) if they then made use of the information they had obtained. Sometimes candidates did not make it clear how they had used the preliminary experiment to make decisions about their plans.

Some candidates thought about ways in which they could obtain precise results. Many used universal indicator or phenolphthalein and explained how they would use a colour comparator or place the test-tubes on a white background to help decide on a suitable end point or to match a colour on a colour chart. Candidates reported meeting with varying success with pH meters, data loggers and appropriate software in their trial experiments. Many commented on being able to take more precise readings with the pH meter than by using an indicator that is more subjective as it relies on judgement. Some recognition of precision in results taking was rewarded (M); any further explanation also gained credit (S). Control variables were often missed by some candidates, while others wrote about these at great length. Candidates should be advised that they should identify the variables and make it clear that these are going to be controlled. Good plans include ways in which variables are to be controlled. Here, many dealt with temperature, concentrations and volumes *(e)*. Some stated that they would control the pH by adding a buffer solution. Others explained that this would not be appropriate given the nature of the exercise. Very few commented that urease may be influenced by the change in pH during the reaction (T). An effective way to set up investigations with urease is to add a small volume of 0.1 mol dm^{-3} ethanoic acid to the reaction mixture so that there is a significant change in pH.

Apparatus lists usually included all the relevant solutions and glassware. The Examiners awarded a mark if they found some way of detecting a change in pH or the quantity of ammonium carbonate produced *(c)*. Some candidates included extensive justification of every last piece of equipment. This is not necessary. Here many gained a mark for justifying the main piece of equipment, such as a pH meter or a burette, in terms of precision (S).

Very few missed the point about repeats *(h)*. It was good to see that many candidates realised that it is necessary to include replicates to check for reliability and identify anomalous results.

Safety statements were often researched and were quite extensive. The Examiners rewarded statements about the irritant nature of the substances used when they were followed by relevant safety precautions (K). Safety comments need to be specific. General statements about laboratory safety are not credited. Candidates should have access to the CLEAPSS Hazcards. Centres may like to know that there is an informative section in the Timstar catalogue devoted to hazard symbols and risk and safety phrases [(2)].

Plans do not end with the last instruction of the method. Candidates should explain how they are going to record their data and analyse it to find the answer to the question set. Tables varied between the sketchy and the exhaustive. The Examiners expected to find the independent variable (urea concentration) clearly identified with units in the appropriate headings (O). This mark was lost if units were given against each urea concentration. Some calculated a rate (Q) and a small number stated that this should be the initial rate and explained how their data would be used to determine this. Dividing the pH or the urea concentration by the time taken was not appropriate. Few went on to explain how they would interpret their results to show the effect of thiourea. Some illustrated this with drawing a sketch graph to show the expected rate of reaction at different concentrations of urea with and without the inhibitor (R).

Candidates are not expected to carry out their final plans, analyse the results and give limitations and improvements. If they realise that there are limitations to their plans then they should incorporate the improvements before writing their final draft.

Examiners are asked to reward logical, clearly written plans. This mark was given if the plan could be followed easily without continually having to re-read and flip back and forth from section to section (L). The great majority of plans are word processed and are therefore relatively free from spelling errors (P).

Many candidates give a bibliography at the end of their plans.

1 Decomposition of urea with urease. Web site prepared by Peter Kreusch, University of Regensburg.
2 Timstar Laboratory Suppliers, Ltd., Timstar House, Marshfield Bank, Crewe, Cheshire, CW2 8UY. Tel 01270 250459. Fax 01270 250601. e-mail: sales@timstar.co.uk. web site www.timstar.co.uk. Catalogue available on CD, which can be requested via their web site.

The sources of information included in such a bibliography can only be credited if they are indicated in the text of the plan as the Examiners wish to see where the information has been used. Many candidates omit to do this and do not gain a mark. Others use superscripts in their text, as has been done in this report, or use the footnote facility in Word or write in details of the source of information at the place where they have used it. All three of these methods are acceptable (N).

The Practical Test

Q.1 The candidates were supplied with a solution of milk powder and a 1% solution of a protease. They had to make dilutions of the protease and then make reaction mixtures with the milk powder. They had to time how long it took for the cloudiness to disappear.

Almost all candidates followed the instructions carefully and gained a good set of results. Many failed to get a clearing in tube G (0.1%), but this did not lose them any marks.

(a) Tables were not constructed very well. Only a few candidates gave the independent variable (protease concentration) in the left hand column. Many candidates just gave the letter of the tube - this is not enough. The Examiners used one mark to reward a table format with a minimum of three columns: protease concentration, time and rate. Most did the calculations correctly, but some simply wrote down the time in minutes and seconds from their stop watch or bench timer and then treated this as a decimal instead of converting to seconds.

Some candidates gave a table for tubes **A** and **B** and another table for tubes **C** to **G**. The Examiners did not penalise this ‘split table’, but they did not give a mark for the ‘table format’ where there were separate tables for the timings and the rates.

(b) This question should have been a bit more specific. Only good candidates realised the import of the word ‘purpose’ and stated that tube **A** was to give an indication of the end point.

(c) This needed a bit of thought. Tube **C** was the tube with the highest concentration of protease so needed to go at the far right hand side of the horizontal axis. Tube **B** was 0% protease and should have been included in the graph. Excellent graphs were seen with all the points on, or very close to, a straight line. However, every type of mistake was seen. There are too many to list all of them here. But here are a few.

- Tubes **C** to **G** were written at equal distances along the x axis without any reference to concentrations.
- Protease concentrations were given *decreasing* along the x axis.
- Inappropriate scaling was used so that the distance between 0.1 and 0.25 was the same as that between 0.25 and 0.5.
- Few included **B** or started their line at the origin.
- Some plotted time against rate, ignoring protease concentration altogether.

AS candidates should be able to present simple information such as this. This is clearly not the case and they need more practice at making and using graphs.

(d) Most of the candidates gave the general trend and some illustrated this with figures from the graph or table. A marking point was reserved for those who found little difference between the rates for **C** and **D** and therefore drew a plateau. This marking point was also used for any other comments about the shape of the line so long as it was supported by the graph. Few referred to anomalous results even when they had highlighted them on their graphs.

(e) Candidates clearly needed more prompting here. Many explained the pattern in terms of an increase in successful collisions, active sites and enzyme-substrate complexes. Few went on to explain that the protein in the milk was hydrolysed to peptides or amino acids and that this explains the loss of cloudiness. Pleasingly, some referred to limiting factors. Some wrote that the graph shows that enzyme concentration is the limiting factor as substrate is always in excess and that substrate concentration is not a limiting factor. However, many saw a big space and proceeded to explain that at high concentration there are *many* active sites, but at low concentration there are *few* active sites. Candidates should be advised that such repetition is unlikely to score many marks.

(f) Most candidates stated that 35 ^{o}C is likely to be the optimum temperature for the enzyme. However, some simply stated that this temperature is 'body temperature' and did not gain a mark. Other explanations included reference to high temperatures and denaturation. Some lost this mark by stating that denaturation will occur at temperatures higher *and lower* than 35 ^{o}C. Few explained that at lower temperatures the rate is likely to be so low that it would take a long time for the clearing to occur.

(g) This should have been an easy way to gain three marks. Some candidates referred to the reaction that they had investigated in the Planning Exercise. Others referred to amylase, catalase or lipase. Some had clearly done *Q.1* from the January 2003 paper and gave sucrase. To gain the second and third mark they had to state either the product that would appear during the reaction or the substrate that would disappear. The method had to be appropriate for the product or substrate concerned.

(h) 'No experiment is perfect. They never will be. Every experiment has its flaws including this one.' So saying a candidate began to demolish the method and suggest many improvements. Overall, the evaluation was answered very well indeed. There were often carefully thought out answers that showed a good understanding of the terms 'accuracy', 'precision' and 'reliability'.

Q.2 Candidates were supplied with a slide of mammalian blood and an electron micrograph of a dividing white blood cell.

(a) The drawings were much better than those seen in previous sessions. This was probably because candidates were drawing something simple and familiar. Some candidates missed the instruction to annotate their drawings with the colours of the structures that they had drawn. Few gave any cytoplasmic contents in neutrophils.

(b) Many candidates missed this instruction also - possibly because it did not have a dotted line. The mark scheme gives the range of sizes that were credited. Answers given in nanometers or millimetres were not acceptable!

(c) The question paper did not ask the candidates to identify the cells that they had drawn. This made it essential that the drawings were recognisable so that correct functions could be credited here. In general, this was the case and most drew and described neutrophils and lymphocytes. There were a few monocytes, basophils and eosinophils. Candidates are not expected to know about basophils and eosinophils, but credit was given if they did.

(d) *(i)* Many identified the stage of mitosis as telophase, although anaphase, prophase and metaphase were all seen. Descriptions usually included references to chromosomes arriving at the poles, the spindle, nuclear envelope and cytokinesis. The Examiners accepted ‘chromatids’ as an alternative to chromosomes. Candidates did well to recognise the stage of mitosis from an electron micrograph as it is unlikely that they would have seen this before. Not many candidates referred to resolution in answer to *(ii)*. The Examiners gave credit to answers that referred to being able to see more detail. Some candidates qualified this with reference to particular structures, such as ribosomes. Some referred to the detail of the mitochondria that can be seen in the EM. Responses to *(iii)* were not specific enough. ‘You can see living cells’ may be true but it does not answer the question. Most of the correct responses to *(iv)* identified cell walls. Others referred to the lack of centrioles. Some wrote that plant cells divide by meiosis rather than by mitosis.

2804: Central Concepts

General Comments

The performance of candidates this session closely mirrored that of June 2004. The Examiners were pleased to see an encouraging improvement in the following areas:

- clarity and accuracy of written English;
- ability to carry out simple calculations;
- using information provided in tables or diagrams.

Weaknesses still exist in identifying the response that Examiners are looking for when using the 'trigger words' *describe* and *explain*. Centres are advised to draw candidates' attention to the 'Glossary of Terms used in Question Papers', which appears as Appendix F in the specification. If the term *explain* appears in a question the examiners will be looking for biological reasoning and references to theory.

Teaching tip

Candidates need to understand that relating structure to function is an important concept in biology and questions on this core module often involve candidates making this link. When topics such as leaf anatomy, photosynthesis, kidney functioning and transmission of nerve impulses are being taught opportunities should be found for relating structure to function. Often this involves returning to topics from cellular biology covered during the AS course.

Comments on Individual Questions

Q.1 This question served well as a gentle introduction to the paper with nearly all candidates able to score marks in part (a). Part (b) proved more demanding and there was evidence that some Centres had not covered plant growth regulators with their candidates.

(a) Most candidates used information from the passage accurately. The most commonly used correct responses were:

- erythropoietin is carried in the bloodstream,
- it has an effect on a specific target organ
- it is effective in small amounts.

Some candidates incorrectly stated that *all* hormones are proteins. Few identified the fact that erythropoietin is broken down in the liver as a feature of hormones.

(b) This part proved more difficult with many candidates failing to describe the role of a named plant growth regulator accurately enough to gain credit. Auxin, abscisic acid (ABA) and gibberellic acid (GA) were the examples chosen by most candidates, but a significant minority referred to cytokinins and ethene.

Although gaining credit for correctly naming a plant growth regulator some found it hard to describe accurately a suitable role for these chemicals. In the answers that gained most credit apical dominance was linked with auxin, closure of stomata with ABA and mobilisation of food reserves in germination of seeds with GA.

> ***Teaching tip***
>
> *The Examiners suggest that the roles of plant growth regulators (PGRs) are taught in the context of how the responses they bring about are of benefit to plants. Taught in this way, candidates are more likely to develop a sounder grasp of this topic. There is a good summary of the roles of PGRs in Kimball's Biology Pages: http://users.rcn.com/jkimball.ma.ultranet/BiologyPages*

Q.2 This question proved far more demanding than expected. The Examiners felt that many Centres had glossed over this section of the photosynthesis topic concentrating mainly on the biochemistry of the process. A significant number of candidates showed little appreciation of leaf histology and it was clear that for many it had not been studied in a practical context. Many candidates found it difficult to distinguish between organ (leaf), tissue (palisade mesophyll) and organelle (chloroplast) even though it is clearly stated in learning outcome 5.4.2 (e) that: *'candidates should be able to describe the structure of a dicotyledonous leaf, a palisade cell and a chloroplast, and relate their structures to the process of photosynthesis'.*

(a) Candidates were expected to suggest why having more palisade tissue is of benefit to sun leaves. The Examiners were looking for the link to be made between a greater number of cells resulting in more chloroplasts, which in turn absorb more of the available light so maximising the rate of photosynthesis.

(b) This was the most successfully answered part of the question, with many candidates gaining full marks. Unfortunately, many candidates used the term chlorophyll when they meant chloroplast.

(c) Most candidates were able to describe the structure of palisade cells, but few went on to qualify the adaptations they mentioned and how they are of use in the process of photosynthesis. Failure to read the question carefully enough led to a significant number of candidates referring to the leaf rather than to palisade tissue and some focused solely on the adaptations of a chloroplast. The following adaptations gained credit if they were correctly qualified:

- cells closely packed;
- columnar shape;
- cells arranged at right angles to surface of leaf;
- large vacuole;
- many chloroplasts;
- chloroplasts move within the cell;
- air spaces between cells;
- thin cell walls.

Qualification of these adaptations needed reference to light absorption or gas exchange. Poor marks here were often the result of not answering the question rather than a lack of biological understanding.

> Teaching tip
>
> *The Examiners suggest that this topic is more successfully covered if candidates use prepared microscope slides and interpret both light microscope and electron microscope images found in text books and on the internet. Scanning electron micrographs of the internal structure of leaves are useful as are sections cut horizontally through the palisade mesophyll.*

Q.3 The solution to the problem on sex linkage was well within the grasp of the majority of candidates. The Examiners were pleased to see many excellent answers to part *(b)* on mutations and genetic diseases.

(a) Centres are becoming familiar with the layout of the page when solutions to genetic problems are required. The Examiners were pleased to see that most candidates used the symbols given in the stem of the question. Better candidates gained full marks, but common errors reported by Examiners included adding alleles to the Y chromosome and using the symbol ***w*** rather than ***r*** to indicate the white allele.

Cross 1 proved more demanding than cross 2. Candidates did not lose marks in cross 1 if the original red-eyed female was shown to be heterozygous for this trait rather than homozygous, so long as the candidate chose the correct F_1 flies to cross to produce the results given for the F_2 phenotypes. Many candidates sensibly used the blank half of page 7 to carry out rough work which allowed them to produce neat and easy to follow solutions on page 6.

Teaching tip

To ensure that candidates score well on genetics problems Centres should stress the following points:

- use symbols as given in the question;
- make a clear distinction between the X and Y chromosomes;
- use Punnett squares to work out results;
- link genotypes and phenotypes clearly and correctly.

(b) In this part almost all candidates gained the mark for naming a type of mutation or an example of a genetic disease caused by a mutation. There were a number of excellent descriptions of sickle cell anaemia, phenylketonuria and Down's syndrome that were awarded maximum marks. The Examiners credited a wide range of examples. The Examiners felt that it is important that teachers stress that it is the red blood cells that take on the sickle shaped appearance not the haemoglobin molecules as described by many candidates.

Q.4 *(a)* Nearly all candidates correctly stated that *interspecific competition* occurs between members of different species.

(b) A large number of candidates failed to read the data in the table carefully enough and stated that the reason for the figures for each bird not adding up to 100% was a result of other predators feeding on the prey. The correct answer was that both birds feed on other prey species that are not included in the table.

(c) When candidates are asked to refer to a table and /or figure they need to refer to the information provided and include it in their answers. Marks were awarded for quoting comparative data and also for linking the different sizes of the birds as shown in Fig. 4.1 to the different depths at which they feed. The Examiners reported that many candidates made excellent use of the data producing answers that made reference to the fact that the shag gained 82% of its prey by surface feeding and the cormorant only 1%. Similarly they stated

that the cormorant gains 59% of its prey by bottom feeding and the shag only 3%.

(d) Nesting sites or nesting material were the most common correct answers given here.

One candidate was prompted to write out these lines by Christopher Isherwood.
The common cormorant (or shag)
Lays eggs inside a paper bag,
You follow the idea, no doubt?
It's to keep the lightning out.

But what these unobservant birds
Have never thought of, is that herds
Of wandering bears might come with buns
And steal the bags to hold the crumbs.

Unfortunately, the Examiners could not credit this offering, not even as an AVP. On reflection perhaps this poem can be used as a teaching aid – since the author did not realise that cormorants and shags belong to two different species.

Q.5 This question was about selection, a topic that candidates can find difficult to write about accurately.

(a) Some very imprecise descriptions of artificial selection were found. Often candidates stated that it is the chromosomes, genes or characteristics that are crossed, not the plants. Very long descriptions were given without mentioning human involvement. Most candidates seemed to appreciate the principles of the process and scored two or three marks. Few mentioned taking seeds from the offspring with the most desirable phenotypes and using these to produce the next generation. Also that this process should occur over many generations if the frequencies of the alleles for the desired characteristics are to increase significantly.

(b) This part was often correct, but a significant number of candidates simply copied the numbers directly from Fig. 4.1.

(c) This was the least well understood part of the question. Many candidates did not understand why **P** and **Q** were sterile. Pairs of chromosomes were often mentioned but the term 'homologous' was rarely seen. Although some candidates appreciated the idea that chromosomes could not pair up, few went on to say that meiosis would not be able to take place and that there would be no production of gametes.

(d) Most candidates realised that the 'wheats' had different chromosome numbers and that they would not be able to produce fertile offspring. The Examiners expected candidates to refer to the two species having different morphological, physiological and biochemical features for the third mark.

(e) Candidates scored very well on this part. Most understand the link between eutrophication of the water and the growth of algae. Many went on to say that algae prevent plants below the surface receiving enough light and so they die. The link between dead plant material and rapid growth of the bacterial population was not always made. Increase in the Biochemical Oxygen Demand (BOD) due to bacterial respiratory activity was well understood by

many.

Q.6 The Examiners felt that Centres had covered this topic thoroughly and many candidates showed an excellent understanding of the structure and functioning of the kidney.

(a) There was a marked improvement over previous sessions in the ability of candidates to carry out simple calculations. Far more candidates were able to work out the percentage figure in part *(ii)* than has been the case in similar calculations on previous papers. Even if the total volume of filtrate had been incorrectly stated in part *(i)*, candidates were able to gain full marks in *(ii)* when the Examiners used the error carried forward principle.

(b) The majority of candidates in part *(i)* correctly stated that the reason for proteins not entering the filtrate is that they are too large to pass through the basement membrane between the endothelium of the glomerulus and the epithelium of the renal capsule. There were many excellent answers to part *(ii)* stating that glucose is selectively reabsorbed in the proximal convoluted tubule. Some candidates lost a mark if they stated that this reabsorption occurs in either the loop of Henle or the distal convoluted tubule. Part *(iii)* proved to be more demanding and the Examiners were looking for candidates to realise that far more water is reabsorbed from the filtrate than urea as the filtrate passes from the renal capsule to the end of the collecting duct. Many candidates stated incorrectly that all the urea remained in the filtrate and the Examiners felt that Centres need to make it clear when covering this topic that almost half of the urea that passes out of the glomerulus diffuses from the filtrate back into the blood capillaries that surround the proximal convoluted tubule.

(c) This question was very similar to *Q.7 (b)* on the January 2002 paper. The Examiners were delighted to read answers of a significantly higher standard and there was strong evidence that this topic has been well covered by most Centres and that they had made good use of the old mark scheme to provide the framework for their teaching. There were many excellent accounts of the osmoreceptors in the hypothalamus linking with the neurosecretory cells that produce ADH. Some candidates failed to state that ADH is released into the bloodstream from the posterior pituitary gland. Candidates in the top half of the ability range were able to explain the action of ADH on the cells of collecting ducts in great detail, including the presence of specific receptors, a cascade of enzyme-controlled reactions and the fusion of vesicles with many water permeable channels to the cell membrane of the epithelial cells. Weaker candidates often described ADH as acting on the loop of Henle or the cell *walls* of the collecting duct rather than its cell membranes. In general though, the Examiners were pleased to read much accurate detail. The quality mark was awarded for producing a well-organised account using specialist terms. The Examiners were pleased to see a greater percentage of the candidates gaining this more demanding quality mark than in previous sessions.

Q.7 The Examiners were delighted to see many excellent answers to this question that was targeted towards the top end of the ability range. There were a few candidates who were clearly running out of time at this stage and sections were left blank.

(a) Many candidates correctly identified adenine and ribose. Common errors were adenosine for **X** and ribulose or pentose (without further qualification) for **Y**.

(b) The majority of candidates produced correct responses for Krebs cycle and the electron transport chain. Far fewer coped with the link reaction. Good candidates realised that no ATP is made in the link reaction, and that neither

substrate level phosphorylation nor oxidative phosphorylation occurs.

(c) A surprising number of candidates failed to state that the chloroplast is where photophosphorylation takes place. The most common incorrect response was the mitochondrion. In part *(ii)*, most knew that ATP was made in both processes and that electron carriers were involved. Far fewer appreciated the role of a proton gradient, ATP synthase and a membrane. When the term chemiosmosis appeared it was often in the wrong context. Weaker candidates stated that ATP was required for both processes.

The Examiners felt that candidates need to understand the role of the proton gradient in more detail to fully appreciate the mechanisms involved in both types of phosphorylation.

(d) Most identified the role of ATP in the Na / K pump. However, many candidates think this pump is involved in depolarisation and the opening of voltage-gated channels. Few candidates referred to synapses and the role of ATP in recycling the neurotransmitter, the movement of vesicles containing acetylcholine to the presynaptic membrane and the exocytosis of this chemical into the synaptic cleft.

2805/01: Growth, Development and Reproduction

General Comments

There were many papers of a high standard this session and it was clear that most candidates were well prepared. The great majority attempted all parts of all questions, and the extended answers were mainly answered well and in full. It was pleasing that the two calculations were completed correctly by a high number of candidates, an improvement on some recent sessions. Although many candidates could describe the data in Q.4 (d)(ii) and Q.6 (b), there were difficulties with interpretation. Candidates should be reminded to quote figures and explain their significance in order to access full marks.

Some synoptic references, such as the breakdown of protein and fats in *Q.3 (b)(ii)* was recognised, but it was disappointing to see how few candidates had the understanding of classification needed to answer *Q.3 (b)(iii)*. Other synoptic references were to endocrine glands in *Q.1* and to the significance of meiosis in sexual reproduction in *Q.5 (c)*.

Comments on Individual Questions

Q.1 *(a)* In part *(i)*, candidates were asked to relate the information about the structures in the drawing of some follicles in the thyroid gland to their knowledge of the functioning of endocrine glands. Many candidates were able to do this well, but others failed to make the connection, describing only what they could see. Many candidates were able to describe correctly the features of thyroglobulin molecules in part *(ii)*. A common error was to say that the molecules were small. Some candidates gave good answers explaining that thyroglobulin does not have an effect on the BMR.

(b) There were many clear and concise descriptions of the uptake and hydrolysis of thyroglobulin. However, candidates must realise that simply quoting from the stem that 'thyroglobulin is converted to thyroxine' will not gain credit. Further detail of the process is needed. Although a good number of candidates knew that thyroxine is carried in the plasma, few stated that it is attached to plasma proteins.

(c) Many candidates across the whole range scored highly in this part of the question. Credit was given for information given in flow diagrams, although most candidates who drew these had already given the correct information in writing. The main errors were caused by confusing the hormones and by not stating that it is the *anterior* pituitary gland that is involved.

Teaching tip

When studying drawings and diagrams, ask candidates to annotate them to show the features and functions of the different parts. This should help them to relate structure to function.

Q.2 *(a)* Surprisingly few candidates realised that the tomato fruit is adapted to be attractive to birds and other animals. Common errors were to say that the fruit protects the seeds, or even that it prevents them from being eaten. However, there were some good explanations of dispersal, with a few candidates describing the prevention of early seed germination by inhibitors in the fruit.

(b) Candidates who had referred to dispersal of seeds in *(a)* as well as others who had not, realised that many of the changes described related to this function. Although the function of ethene in causing ripening was frequently stated, credit was only given to the small number of candidates who realised that it causes other fruits to ripen, so coordinating the process. Some candidates referred to the *production* of energy through respiration – a statement that never gains credit.

(c) In part *(i)*, many candidates realised that a cellulose-digesting enzyme would break down cell walls and that its presence would break down the tomato fruit during development. Several candidates incorrectly thought that cellulose needed to be broken down and stated that the polygalacturonase would do this. Credit was given to those candidates who stated that the tomato does not contain the gene for production of a cellulose-digesting enzyme. There were many incorrect suggestions for the source of a cellulose-digesting enzyme in part *(ii)*. Many candidates suggested sources from within the plant, such as leaves or seeds, not realising that the enzyme would break down these structures. Very few candidates stated the source as bacteria. Several candidates did suggest the guts of animals as the source, but did not score the mark unless they stated that it is only in the gut of animals, such as ruminants, because of the presence of bacteria.

(d) There were some well written and high-scoring answers across the range. The majority of candidates scored the mark for the quality of spelling, grammar and punctuation. Unfortunately, despite the emphasis of *Q.2* being on fruit development, a large number of candidates spent time describing the development of the embryo and seed, which did not gain credit. In most cases candidates then scored marks by describing the development of the pericarp and its adaptations. The second part, on the commercial use of plant growth regulators, was clearly and accurately described by many candidates across the range.

Teaching tip

To emphasise the principle of energy conversion, discuss the different ways in which organisms take in energy. Then ask the candidates to work in groups to list ways in which energy is used in the processes of growth, development and reproduction. Examples that occurred in this paper were:

- synthesis of enzymes in tomato fruits;
- production of gametes by crayfish;
- movement of sperm.

Q.3 *(a)* There were 14 marking points for this four mark question, but very few scored the maximum mark. The information in the stem should have directed candidates to the fact that asexual reproduction in the American crayfish allows it to reproduce rapidly, colonise European fresh water rapidly and therefore compete strongly with the European species. Other ideas, such as American crayfish introducing disease or preying on the European species were also credited. There was some confusion between interspecific and intraspecific competition.

(b) Many candidates gave full descriptions of asexual reproduction using spores in part *(i)*. Candidates need to be clear that, after landing on a suitable medium, spores develop into fungi, rather than reproducing further. Credit was given for a description of budding, but this could only be credited with four marks if it was related specifically to yeast. A pleasing number of candidates recognised that part *(ii)* was synoptic and correctly described the hydrolysis of proteins and fats by enzymes. The best answers treated proteins and fats separately to avoid any confusion. Statements such as 'proteins and fats are broken down by lipases and proteases' did not gain credit. The main errors related to the breakdown products of lipids. Some candidates gave details of absorption, but this was not asked for in the question. Part *(iii)* was also synoptic and related to classification. Although some candidates gave full and correct answers, a disappointingly large number gave answers relating to asexual versus sexual reproduction or unicellular versus multicellular organisms.

Q.4 *(a)* This was a straightforward question asking for recall from a diagram that should be familiar to candidates. Many candidates scored two marks, but there were many errors, the main one being to label **B** as a secondary spermatocyte. These structures persist for such a short time that they are rarely observed and the Examiners credited only primary spermatocytes as the correct answer.

(b) This was a straightforward extended answer question that scored well, with some excellent descriptions of hormonal control. The main errors were in the description of the stages of spermatogenesis. The candidates were directed to make reference to Fig. 4.1, and the mark scheme was designed so that full marks could only be scored if this was done at least once. Therefore several otherwise excellent answers only scored seven marks rather than the maximum eight. The best candidates wrote very full answers that were clear and concise. The quality mark was given to candidates who wrote clearly and used at least three specified terms in the correct context. This was awarded to at least half the candidates.

Teaching tip

Use a flow diagram to show the cells produced in spermatogenesis and the processes occurring. Ask the candidates to suggest why growth or a type of nuclear division happens at a particular stage. For example, mitosis produces large numbers of cells and meiosis II reduces the chromosome number ready for fertilisation. Candidates could link the flow chart to a drawing of a cross section of the wall of the seminiferous tubule as in Fig. 4.1.

(c) Pleasingly, the calculation in *(i)* was carried out correctly by a large number of candidates across the range. A surprisingly large number of candidates

thought that **J** showed the acrosome in part *(ii)*; those that recognised it correctly as the nucleus generally gained both marks. Most candidates correctly described the function of K, the main error being, as in *Q.2 (b)*, reference to the production rather than release of energy.

(d) In part *(i)*, the second calculation in this paper was completed correctly by a large number of candidates. They were asked to write the answer in the table and this should have helped with the second part of the question. However, the two marks were given if the correct answer was elsewhere on the page. The data in the table showed the relationship between dioxin in the blood and the proportion of male births. Exposure decreased this proportion, but the main effect was when fathers were exposed. Candidates who understood and described this obtained three or four marks in part *(ii)*. Some candidates did not refer at all to proportions, and a few even referred to dioxin increasing the birth rate. Candidates should realise that at least one mark in data analysis questions is awarded for quoting figures often in a comparative fashion.

Q.5 This was a question about reproduction in flowering plants, based on an electron micrograph of the stigma of Morning Glory, *Ipomoea purpurea*.

(a) There were some correct references to the incompatibility of the shapes of the stigma surface and pollens from other species. However, a large number of candidates referred incorrectly to other mechanisms, such as those that favour cross-pollination between plants of the same species.

(b) Although this was a straightforward question, aimed at the full range of candidates, there were few full-scoring answers. Although most candidates were aware of the involvement of a pollen tube, few were able to explain in detail its route through the style to the ovule and the involvement of chemotropism.

(c) Many candidates clearly have a good understanding of double fertilisation. It is important to explain that the second male gamete fertilises a diploid nucleus to form a triploid nucleus, but some candidates missed this detail. Many candidates explained the significance of endosperm production, but few candidates were able to explain the significance of the production of the zygote with some rather vague references to survival of the species and passing on genes. Only a few good candidates referred to the restoration of the chromosome number and the increase in variation.

Q.6 *(a)* In part *(i)*, it was good to see that most candidates were able to define growth correctly. In part *(ii)*, candidates were asked to explain how they would determine the relative growth rate of a small mammal. Most candidates chose a suitable parameter. They then went on to describe the experimental method, showing understanding of the term *relative growth rate*. Credit was not given to candidates who suggested killing the animal to determine its dry mass.

(b) This data analysis question was not answered as well as the one in *Q.4 (d)(ii)*. Although many candidates were able to point out some differences between groups **A** to **D**, few went on to comment on these and explain the role of protein in the growth of the fetus. Again, it should be pointed out that credit was given for quoting comparative figures from the graph.

(c) This final question was answered well, with most candidates giving at least one reason for the lack of data. The most common answers were firstly that it would be difficult to control both the diet and other conditions and secondly that mothers would be reluctant to endanger the health of their babies.

Teaching tip

When candidates are analysing data, ask them to work in pairs. The first candidate should state or describe a pattern, difference or relationship. The second candidate should state whether he or she agrees with this and try to give a reasoned explanation. They should then change roles until the exercise is complete.

2805/02: Applications of Genetics

General Comments

A number of candidates had been very well prepared for this paper. Excellent answers were seen to all questions, with the stronger candidates showing both a good command of factual knowledge and an ability to apply that knowledge in unfamiliar situations. Inappropriate use of the terms *gene* and *allele* led to confusion in answers to some questions.

The majority of candidates attempted all parts of all questions, suggesting that the small number who left sections unanswered did so from lack of knowledge rather than lack of time. All questions allowed discrimination between candidates, with marks spread over a wide range.

Comments on Individual Questions

Q.1 Many candidates found this to be an approachable first question.

(a) In *(i)*, almost all candidates were able to state the correct phenotype for each of the genotypes given, although one candidate thought that genotype **Aabb** would result in ‘white fur with a hint of brown’. Pleasingly, very few candidates stated anything other than (dominant) *epistasis* in *(ii)*. Some candidates had difficulty with part *(iii)*, which was essentially a synoptic question. They described one gene inhibiting the other apparently directly, DNA to DNA. For one candidate, the alleles of one gene were different shapes, allowing one to bind to and block another gene. Only the stronger candidates permitted the inhibitory allele to code for a protein that then had a stated effect. Some candidates invoked complementary gene action.

(b) Most candidates were able to state correct genotypes for the white furred parents in the cross in *(i)*, although some were not able to give an explanation of why the particular parental genotypes had been chosen. There was a tendency to say that both parents *must* be heterozygous at both the **A**/**a** and **B**/**b** loci, when only one parent needs to contribute the **B** allele to give the offspring’s fur colours. In part *(ii)*, a large number of candidates arrived at the correct ratios of offspring phenotypes for the chosen parents and were careful to state both number and fur colour.

Teaching tip

Candidates should be encouraged to write genotypes conventionally, such as **AaBb** rather than **AbBa** or any other sequence and to use the terms *gene* and *allele* appropriately. The latter could be achieved by using a piece of text with a liberal sprinkling of ‘gene’ and ‘allele’. These terms could be removed and candidates asked to choose the most appropriate for each gap in the text.

Q.2 Despite the synoptic links with nuclear division, some candidates found parts of part *(a)* difficult.

(a) In part *(i)*, a pleasing number of candidates bred the best in each generation to improve the traits being selected for by increasing homozygosity. Only the strongest candidates referred to nuclear division and related the polyploidy to a failure of the spindle or of cell division in part *(ii)*. In part *(iii)*, most candidates prevented self-pollination by removal of stamens, transferred the required pollen by hand and prevented pollination by foreign pollen by bagging. There were, though, some unthinking references to 'pollinating the fruit', 'bagging the fruit', 'placing pollen onto stamens' and even to 'cutting off the stigmas and mixing the pollen of two flowers together'.

Although stronger candidates were clear that meiosis failed in the 3n hybrid, there were a significant number of candidates who thought that the sterile hybrid was 6n. Others thought that the sterility was the result of inbreeding depression.

(b) Appropriate procedures for cloning plants from tissue culture were well known by many candidates who scored all or most of the marks in part *(i)*. In part *(ii)*, a pleasing number of candidates were able to refer to the large number of genetically identical sterile hybrid plants that could be produced in a short time. Fewer considered that the 'master' hybrid lines could be bulked up, or that there is no need to change 2n to 4n.

Teaching tips

Remind candidates that not every plant to be cloned from tissue culture has a pseudobulb. Provide opportunities to show that a knowledge of mitosis and meiosis is crucial synoptic material for an Options paper in genetics.

Q.3 *(a)* For most candidates, progeny testing gave a measure of an individual's genotype for selective breeding. The strongest candidates wrote that an average value was calculated after measuring the trait in the offspring of a number of different matings. Weaker candidates seemed to think that it could be determined from the offspring of one mating.

(b) Almost all candidates correctly chose phenotypic trait **A** from the table given. Stronger candidates were able to explain that the values given were measures of the proportion of total phenotypic variation due to genetic effects and that therefore the trait with the highest value could most easily be selected for.

(c) This question was often done very well, with clear descriptions of continuous and discontinuous variation, together with an explanation of the genetic basis of the differences. Some of the many candidates who wrote separate blocks of text about each type of variation failed to complete their comparisons, and so lost marks.
The mark for quality of written communication was for a legible text with accurate spelling, punctuation and grammar. This was awarded to a majority of the candidates.

> *Teaching tip*
>
> Encourage candidates, when citing examples of continuous variation and probably thinking about people, not just to say 'height', with no organism stated. In some organisms, not least in the pea plants studied by Mendel, height is an example of discontinuous variation.

Q.4 Most candidates were able to make use of the information in the table to answer the questions, but a very small number confused ticks with crosses and thought that lipid had been removed from **C** and **E**.

(a) A large number of candidates were able to explain how superovulation of a female of the endangered species of mammal together with fertilisation *in vivo* or *in vitro*, could yield many embryos which could be implanted into surrogates, so that the endangered female was not put at risk in pregnancy or parturition. For some candidates, embryo transplantation and IVF were synonyms, resulting in unnecessary descriptions of IVF procedures.

(b) In part *(i)*, most candidates realised that group **A** formed the control group for the experiment, but not all realised that they showed the effect of lipid removal *without* freezing. In *(ii)*, the majority of candidates saw that lipid removal allowed development to a ball of cells after freezing and thawing, whereas embryos with lipid still present did not survive freezing and thawing. Most candidates also in saw in *(iii)* that freezing 8 cell embryos gave more success than freezing 2 or 4 cell embryos. The stronger candidates related this difference to differences in the surface area to volume ratios of the cells, saying that this affected the rate and the uniformity of freezing. A small number of confused candidates thought that the larger cells had larger surface area to volume ratios.

(c) Few candidates had any difficulty in listing three types of gene bank other than frozen mammalian embryos.

> Teaching tip
>
> Persuade candidates that the terms IVF and embryo transplantation are not synonyms, that embryos are not 'artificially inseminated' into surrogates and that mammalian embryos are not genetically identical to the mother (in the absence of a cloning procedure).

Q.5 The precision of explanations of the origin and spread of insecticide resistance in insects was not matched in discussions of the potential hazards of genetically engineering crop plants.

(a) A surprisingly large number of candidates made no reference to the findings of the survey that were in the text of the question, rather than in the table. Most candidates related the reduction in cases of insecticide poisoning in farmers and reduction in cost of cotton production to the decreased need for expensive insecticide. Some candidates, though, referred to increased resistance of the *farmers* to *Bt* toxin or increased resistance of the *cotton plants* to insecticide. The stronger candidates made use of the data in the table to calculate the percentage reduction in cases of poisoning or reduction in production cost per kilogram.

(b) There were many excellent answers invoking mutation and natural selection. Some candidates, plainly more familiar with antibiotic resistance in bacteria, passed resistance between insects horizontally by conjugation or allowed the insect to acquire resistance from a bacterium. Candidates should avoid reference to insects passing the 'gene' rather than the 'allele' for resistance to their offspring.

(c) Despite the specific information available in the question, weaker candidates wrote in very general terms about problems to food chains, to biodiversity or to organic crops without specifying what those problems might be. Unspecified plants became 'superweeds' and unknown plants or parts of plants were toxic or allergenic to unknown organisms. Stronger candidates referred to specific hazards in their discussion and gained marks accordingly.

Teaching tip

Encourage candidates to use all the relevant information they have been given in their answers. Remind candidates that the words 'resistant' and 'immune' are not synonyms, nor 'herbicide' and 'insecticide'. Encourage candidates to consider specific hazards of genetically engineering crop plants, rather than unspecified doom and gloom.

Q.6 Many candidates displayed a very good understanding of genetic compatibility in transplant surgery and of gene therapy.

(a) This question was often very well done. Errors which crept into otherwise good answers included that the linkage of the HLA loci increased the variety of tissue types in the population and that the HLA system coded for the ABO blood types. Surprisingly common, since immunity is synoptic material, was confusion between antibodies and antigens, with the latter being the active partners. In some answers which included discussion of the ABO blood types, there were a number of errors in descriptions of the A and B antigens and the anti-A and anti-B antibodies. Much confusion existed over universal recipients and universal donors.

The mark for quality of written communication was for a clear, well-organised answer making appropriate use of specialist terms, such as *MHC* or *HLA*, *loci A, B, C and D (DP, DQ, DR)*, *linkage*, *haplotype*, *antigen*, and *rejection*.

(b) In part *(i)*, many candidates showed a good recall of the use of restriction endonucleases, of sticky ends and of recombinant DNA, although in the answers of some candidates, the virus, rather than the viral DNA, was cut by a restriction enzyme. Sadly, DNA ligase appeared in many answers to catalyse the hydrogen bonding of complementary sticky ends. A significant number of the viruses genetically engineered in the answers appeared to be bacteria, with plasmids. Despite some confusion of wording, many candidates were able to explain in *(ii)* that one copy of the normal dominant allele would be expressed, without any need to inactivate or remove a mutant recessive allele.

Teaching tip

Refer back to the AS work on immunity when considering the significance of genetic compatibility in transplant surgery and revise the structure of the genomes of bacteria and viruses before starting on genetic engineering

2805/03: Environmental Biology

General Comments

Many candidates scored highly on this paper, but the candidates who did not mainly encountered problems with *Q.5* where practical ecological fieldwork was examined. Information presented with data was not well used. This was particularly evident in the long response item in *Q.2* on recycling.

Comments on Individual Questions

Q.1 The majority of candidates scored well on this question, with marks being lost mainly on part *(c)* where the effects on biodiversity of using inorganic fertilisers and herbicides were often poorly described and confused.

(a) This was a positive start to the paper for most candidates who were asked to *describe* the effect of increasing concentration of phosphate on the three plant species. Many candidates gave thorough descriptions of the effects of the phosphate thereby going beyond the maximum mark available. Credit was given for a general response that implied that all three species increased in growth. Further credit was awarded for more precise descriptions of individual dry mass increases. Many candidates referred to the proportional increase in dry mass of the nettle with increasing phosphate concentration. Few candidates, however, referred to the point that the greatest effect of increasing amounts of phosphate was on the nettles. Candidates referred to an increase and then a decrease of dry mass in small scabious and thus gained credit. Credit was also awarded for the slow increase in dry mass of wavy hair grass with a further mark available for a plateau effect at high levels of phosphate. Very few candidates pointed out the steep increase in dry mass of small scabious at low concentrations of phosphate.

(b) Part *(i)* provided the opportunity for candidates to make synoptic links to *Central Concepts* in terms of competition for resources and how this competition, for example for sunlight, decreased the crop yield. The majority of candidates correctly referred to an increase in weed growth that naturally led them towards a competition for resources. Credit was given for up to two factors which were being competed for. Very few candidates referred to interspecific competition. Candidates should be reminded that the term minerals is better than 'nutrients' at this level. The majority of candidates scored both marks for part *(ii)* where references to leaching or run-off from the fields were complemented by reference to high levels of fertilisers existing in the ditches thus increasing nettle growth. Very few candidates made reference to the point that there would be little competition from the crops in the ditches, failing to link parts *(i)* and *(ii)* together.

(c) Items referring to the problems of inorganic fertiliser usage can be found in this module and in *Central Concepts*. The majority of candidates began their answers with reference to run-off or leaching of fertilisers into lakes, thus causing an algal bloom. However, the sequence of events that followed the algal bloom was often incorrect. Photosynthesis and aerobic respiration are terms that A2 candidates should be aiming to use in this type of question. Only a few candidates gave accurate descriptions of events

including references to decreased levels of photosynthesis, leading to an increase in dead organic matter that is decomposed by aerobic bacteria. Responses should then infer that a lack of oxygen or an increased BOD would lead to the death of organisms that respire aerobically.

Herbicides were often referred to as being non-specific thus gaining credit, but little reference was made to spray drift or how herbicides become non-specific in terms of the manner in which they are spread. Many candidates confused herbicides with pesticides and made non-creditworthy responses referring to bioaccumulation and egg-shell thinning in birds of prey. Food chains are disrupted, but only due to a food source which has been eliminated by the herbicide. Very few candidates gained full marks for this part as a whole.

Q.2 Overall, this question was well answered by most candidates. Most marks were gained in part *(c)* which involved a long response item based on recycling and its benefits to the environment.

(a) This part of the question was disappointingly answered by a majority of candidates. A biological resource is a resource that is living or is growing. The resources part of the term gained credit when candidates implied that products could be made from timber. Responses to this term were often simply rearrangements of the question stem. Very few candidates made reference to a biological resource being renewable. The term sustainable production had synoptic links to the Populations and Interactions section in *Central Concepts*, but many candidates failed to gain the two marks available. Sustainable is a term that is used in this module with reference to fish populations. Candidates often gained credit for references to replanting or afforestation, but many failed to gain the second mark for the idea that the number left after harvesting should replenish the population.

(b) This was a simple calculation where a percentage rate of household waste recycling was required. However, many candidates left their answers to 3 or 4 decimal places. The figure for 1996/7 was given to 2 decimal points and candidates should use other figures in tables as a guide when giving their answers to question such as this.

(c) This long response item was well answered by the majority of candidates. Very few candidates failed to gain the quality mark that was awarded for spelling, punctuation and grammar as well as for legibility. The majority of candidates split their responses into two clear sections.

- The importance of recycling – many candidates gave thorough descriptions of increased use of landfill sites and its resultant pollutant effects. Credit was also given for candidates who stated that less fossil fuel would be burnt or less incineration would occur in general. Saving raw materials and decreasing deforestation also gained credit. A maximum of six marks were awarded for this section.
- How can local authorities increase levels of recycling taking place? The vast majority of candidates made references to increasing public awareness in various ways thus gaining credit. Many answers referred to increased collection services or the provision of more accessible recycling points.

Overall, the majority of marks were awarded for the importance of recycling rather than the second section, although most candidates aimed to give balanced responses which was encouraging.

Q.3 The predator-prey relationship relies a great deal on synoptic knowledge and understanding. It was pleasing to see many candidates using their ideas and transferring them into this module.

(a) The descriptions and explanations of the predator-prey relationship were well answered by the majority of candidates, with many gaining the four marks available for this part. The most common responses included candidates referring to increasing prey populations providing adequate food supplies to the predator. Very few candidates, however, referred to the time lag idea that is indicative of this type of relationship. Creditworthy responses included a decrease in both populations being caused by overfeeding and thus a lack of food for the predator population. Candidates often commented upon repetition of the cycle. A minority of candidates failed to indicate in their responses that the prey population always reached higher numbers than the predator population.

(b) There were a variety of ways in which candidates could gain the two marks that were available for part *(i)*. The most common method of gaining maximum marks was indicating a peak of predator population after the prey and before the second spraying. However, many candidates did not indicate a drop in predator population when the spray was actually applied and simply redrew the pattern seen in Fig. 3.1. A third mark was available for candidates who realised that continued spraying would decrease the predator numbers with time. Part *(ii)* required candidates to suggest reasons other than spraying or resistance to the spray for the gradual decrease in cyclamen mites. Again, good synoptic responses included a lack of food supply, presence of other predators or disease occurring within the population.

(c) Only a very small minority of candidates did not realise that this was an example of biological pest control. Part *(ii)* provided an opportunity for candidates to explain the overuse of insecticides and the problems that could then occur in the environment. Many candidates offered excellent answers here, which included references to bioaccumulation, non-specificity of insecticide, resistance of target species or residues being left on food causing concerns for consumers. Candidates who did not score highly on the part referred to overuse of fertilisers and eutrophication. Some candidates were confused over the effects of excess fertilisers and insecticides on the environment.

(d) The majority of candidates often offered crop rotation and intercropping as creditworthy responses. A minority of candidates referred to the release of sterilised males. Many candidates gave herbicides and pesticides as answers, which are clearly incorrect in the context.

Teaching tip

None of the candidates referred to parasitoids in their answers although this term appears in the mark scheme for this question. In a parasitic relationship, the parasite and host live together with little or no damage to the host organism. The parasite takes enough nutrients to live on and reproduce without draining the host's reserves or killing it. In a parasitoid relationship, the host is usually killed after the full development of the parasitoid. This type of relationship seems to occur only in organisms that have fast reproduction rates, such as insect or mites. Perhaps the best known example of a parasitoid used in biological control is *Encarsia formosa* that is used to control whitefly in glasshouses. For more information about biological control and *E. formosa* in particular see:

The Microbial World at http://helios.bto.ed.ac.uk/
and
www.anbp.org
www.biowise-biocontrol.co.uk
www.greengardener.co.uk

The mention of the film *Alien* may help an understanding of the principle……

Q.4 This question provided an opportunity for candidates to describe and explain the importance of rainforests. Many candidates gained good marks in parts *(a)* and *(b)*, but many lost marks for vague responses in part *(c)*.

(a) This is a standard question relating to rainforest destruction and many candidates gained three marks. Many referred to clearance for farming, road or buildings. However, some candidates suggested more than three reasons and at times failed to gain credit, where one response negated another. Candidates should refrain from saying that rainforests are simply destroyed for timber. A more suitable reason is that trees are felled for export or for producing other products. It must be noted that building houses and building roads were treated as separate answers thereby gaining two marks.

(b) Some candidates produced very good answers and gained full marks. Candidates were asked to describe the important features of tropical rainforest and explain why their disappearance is of concern. The majority of candidates offered creditworthy points including high biodiversity and the fact that deforestation could cause the extinction of species. Good candidates also referred to the size of the gene pool in the rainforest and linked this to possible medicinal cures for illnesses. Many candidates indicated that carbon dioxide was removed from the atmosphere by rainforests but many referred to the formation of carbon *dioxide* sinks rather than to carbon sinks or reservoirs. Oxygen production was often commented upon but failed to gain credit unless linked to photosynthesis. Transpiration rates and effects on the water cycle were also included in good answers. The majority of candidates realised the importance of crops and fruits in the rainforest, but better candidates dealt with the beneficial effects of sustainable harvesting of these products. The quality mark was awarded for the correct inclusion of up to four specialist terms.

(c) This was the most disappointing part of the question. The three marks available for this item were for international measures that can be taken to halt the decline of rainforest. Many answers referred to individual or national measures for halting rainforest destruction and therefore did not gain credit. Good candidates referred to trade sanctions or schemes for sustainable uses of the rainforest, while others mentioned the promotion of ecotourism and the provision of quotas for deforestation. This is a specific learning outcome for this specification and candidates need to be directed towards suitable strategies.

Q.5 Questions on practical fieldwork in this module are set regularly, but many candidates were not at all confident in their responses in this question.

(a) This part was marked as a whole with a maximum of two advantages being credited. It was common for candidates to gain one or two marks here, though it was only on rare occasions that three marks were awarded. Candidates who explained that there would be inter-observer differences often included the idea of subjectivity. Some candidates made reference to the disadvantage of overestimating dominant species that may be present quadrats. The main advantage given by candidates was that the technique was quick to assess. The fact that it is a simple technique was not credited.

(b) Part *(i)* was often the better answered here. The majority of candidates were fairly familiar with the idea of an interrupted belt transect. Better candidates indicated that a suitably sized quadrat should be used. Many candidates failed to give a clear indication as to which direction the transect should run, i.e. from seashore to dune slack. The use of identification keys was rarely given. The derivation of kite diagrams is a stated learning outcome in this module, but it was surprising to see how few candidates knew how they would be constructed from raw data. Most candidates gained one mark for the idea of the width of the kite diagram relating to increasing abundance. However, the majority of candidates did not gain any further credit as they failed to mention that readings at each site would be taken and these points joined up. The Examiners felt that candidates who did gain maximum marks using a diagram did so more by luck than understanding!

(c) The vast majority of candidates gained at least one mark in this part for referring to a thermometer or probe, but only better candidates gained maximum marks for reference to calibration of the probe or placing the thermometer at the same depth into the soil each time. It was very worrying to find a significant number of candidates who did not know how to measure temperature.

(d) Candidates should refrain from using the term 'level' when describing a sere. Many candidates did not explain that a sere (or seral stage) is a stage in a succession. Part *(ii)* relied on candidates applying some synoptic ideas from *Central Concepts*. Many candidates however, failed to gain the maximum four marks available. Good, precise answers were not common. Good answers explained how soil developed in both nutrient content and depth through succession while allowing species diversity to increase as succession progressed. Many candidates referred to a climax community being formed at the end of succession. Credit was awarded for candidates who referred to deflected succession in the right context, but many candidates confused secondary succession with primary or even deflected succession.

Q.6 This question was generally well answered by candidates, but far too many marks were lost in *(b)(iii)* where chemical methods for measuring levels of pollution were explained rather than the biological methods asked for.

(a) Almost all candidates gave *indicator* as the correct name given to species used to ascertain pollution levels.

(b) Many candidates seemed to struggle with the meaning of the term pollution at this level. Many answers were vague and implied what a pollutant was rather than explaining that pollution damaged the environment and was a result of human activity. Too many candidates referred to ‘substance’ rather than using more accurate terms such as ‘chemicals’ or ‘energy’. Part *(ii)* also revealed poor understanding where terms and definitions are concerned. A majority of candidates failed to refer to *inorganic* fertilisers as a water pollutant, but many gave sewage or slurry as creditworthy responses. Candidates referring to air pollution usually scored maximum marks by making references to the burning of fossil fuels and the release of carbon dioxide or nitrous oxides. In part *(iii)*, candidates divided into those who gave detailed answers about measuring BOD and those who gave a *biological* method as asked by the question. Unfortunately, determining BOD is clearly a chemical method and gained no marks. Candidates who described sampling techniques, such as kick sampling, and the use of keys to identify species gained good marks. Better candidates made excellent references to the Trent Biotic Index and also gave examples of indicator species and how they are used to indicate levels of pollution.

Teaching tip

A simple introduction to three methods of assessing water quality can be found at:

http://schools.ceh.ac.uk/advanced/freshpoll/pf-freshpoll3.htm

2805/04: Microbiology and Biotechnology

General Comments

Generally, candidates were prepared well for this examination, many demonstrating a very thorough knowledge of the topics covered and some producing excellent answers throughout. However, the synoptic elements, tested in all questions in this paper, were answered less well and it was evident that many were unable to recall their knowledge of common AS topics, such as biological molecules. Where candidates were expected to apply their knowledge, many did not appear to have read carefully enough the question or the information in the ‘stem’ of the question and were then unable to get their ideas organised to answer in the right context. Additionally, many candidates need to practise the skill of reading their answers while referring back continually to the original question. There was no evidence that more time was required to complete the paper. The vast majority of candidates were able to score marks on each question and overall marks were spread across the range.

> *Teaching tip*
>
> At the end of each teaching topic, get candidates to revisit their notes and to use the AS and A2 *Central Concepts* specifications to highlight any possible links. This maintains their familiarity with the specification and is also good preparation for *Unifying Concepts in Biology* (2806/01).

Comments on Individual Questions

Q.1 This was a high scoring question, with most candidates taking the opportunity to demonstrate their knowledge of biotechnology in medicine and allowing many to obtain maximum marks.

(a) In part *(i),* complete labels of the parts of the biosensors were required and this meant that a few candidates lost marks because they referred to a membrane rather than a partially permeable membrane. Some described **B** as ‘immobilised enzymes’, but the label line did not point to these. Although credited, many candidates used ‘selectively permeable’ or ‘semi-permeable’ membrane rather than the preferred term. In part *(ii)*, there were some very full and well written answers, with candidates stating the name of the enzyme and the products of the reaction. However, some candidates answered in general terms, indicating only the principles involved in biosensors. Good accounts were still able to score well. Part *(iii)* was very well answered with a wide range of thoughtful suggestions, although time was wasted by some candidates who repeated how the biosensor worked or who compared the biosensor with using Benedict’s solution to test for reducing sugars.

(b) Part *(i),* the hybridoma cell, was well known. The Examiners only awarded the mark if the term was spelt correctly. This was not a problem except for a few candidates. In part *(ii)*, candidates who achieved maximum marks gave the desirable features that each of the two cells brought to the fusion, rather than simply describe the features of the hybridoma cell. The latter answers

left Examiners to guess if the candidate knew which feature came from which donor cell and invariably lost marks. In addition, a good number of candidates failed to note that the lymphocytes were the source of the antibody and some wrote about lymphocytes being unable to divide 'inside cells'. Surprisingly few candidates remarked about the ability of myeloma cells to divide continuously.

(c) Part *(i)* gave candidates the opportunity to draw from their knowledge of the structure of the HIV virus as well as use information from *Biology Foundation* (tertiary structure of proteins) and *Human Health and Disease* (antigens, antibody structure and function). Although there were some excellent answers, the majority of candidates either described the structure of the virus, many omitting the envelope, or described bacteriophage lambda with its life cycle. The exact location of the glycoproteins of HIV was often not well described and although the Examiners did allow 'found on the cell membrane', better answers correctly referred to the envelope. Part *(ii)* was well answered by almost all candidates. The term 'magic bullets' is now used in a variety of contexts and those candidates who gave this answer with an acceptable example were credited.

Q.2 This was mainly a question about techniques used in microbiology. Many candidates appear to have spent a lot of time on this question, making full use of the space provided in parts *(a)* and *(b)*, but not always to good effect. For those that did score well, part *(c)* often posed the most difficulties. Despite the information given at the start of the question, a few candidates continually referred to *Salmonella* as a virus.

(a) Almost all candidates realised that milk should be heated during pasteurisation and they stated that this would kill the bacteria or pathogens. It was felt that 'microorganisms' being killed was too vague, given the information that candidates were given in the 'stem' of the question. Many candidates went on to give temperatures ranging from as low as 30 ^{o}C to over 100 ^{o}C. Fewer realised the importance of heating for a length of time. These candidates correctly quoted figures from milk handling (using pasteurised milk in cheese making) or yogurt making. All reasonable temperatures with a length of time were credited. A handful of candidates described the filtration of milk as a method of pasteurising, presumably by incorrectly using Fig. 2.1 or using their knowledge of microfiltration of milk. A few wrote about immobilised enzymes and the production of lactose-free milk. Candidates were not expected to know the details of pasteurisation in milk factories, but those that demonstrated this extra knowledge were credited. As there were two parts to this question, 'outline' **and** 'explain', a maximum of two marks was awarded for the outline of pasteurisation.

(b) Overall, this extended question enabled most candidates to write with sufficient care to be awarded the quality mark. High marks for this question were achieved by candidates across the entire ability range and often reflected the degree of learning that had been given to this topic. High quality answers were clear and sequential in setting up the haemocytometer for use and did not need to include long accounts of all the steps involved in ten-fold (or decimal) serial dilution or of aspects of aseptic technique. Those candidates who wrote at length about dilution technique often forgot to give details on how to set up the haemocytometer correctly. Many placed on the cover slip *after* adding the sample of milk and did not seem to understand the significance of requiring an exact volume in the chamber. The addition of the cover slip was also described as if the candidate was preparing a

normal slide rather than pushing it on from the side. Few candidates noted the importance of using clean haemocytometers and cover slips, or that the sample needed to be mixed before addition to the haemocytometer. The choice of sample squares to use, or descriptions of triple-lined squares and how to avoid counting cells twice were very often unclear or vague. A number of candidates failed to note or describe the haemocytometer grid and very few made any reference to the correct use of the microscope. In poorer answers, there was confusion between ‘grids’ and ‘triple-lined squares’, ‘counting colonies’ instead of ‘cells’, and poor descriptions of the counting technique. Comments such as ‘count as in those only in the top and left of the square’ did not gain credit. In giving details of computation, not all candidates were aware of the exact dimensions involved and some thought that counts gave numbers in an area rather than a unit volume. Where they had used an example and had shown a calculation, involving volume, some then incorrectly used the wrong units, for example, mm^2 rather than mm^3. Some candidates suggested multiplying the count by the volume of the triple-lined square.

(c) Part *(i)* was usually well answered, but in parts *(ii)* and *(iii)* candidates struggled to obtain marks. The question in part *(ii)* was intended for candidates to use their experience in dilution plating and streak plating to realise that *colonies* are formed on agar plates. A number of candidates referred to differences in shape or Gram staining that could be seen between individual bacteria down the microscope. Only some candidates in part *(iii)* realised that the time delay involved in dilution plating would not be of benefit in a milk factory and some incorrectly thought that the term ‘dilution plating’ meant that the milk would be made ‘weaker’.

Teaching tip

It is possible to use the free demonstration version of the computer program: Bacterial Growth 3 from Scotcal to show how to count bacteria using a haemocytometer. The demonstration version can be downloaded from the Scotcal web site: www.scotcal.com.

There is a haemocytometer simulation in the Resources section on the Biology4all web site:

www.biology4all.com/resources_library/resources_library.asp

Q.3 This question, although based mainly on large scale production, enabled candidates who could use their knowledge of protoctists and photosynthesis to earn some marks.

(a) All parts of this question were generally well answered. A few candidates stated *Penicillium* instead of penicillin in part *(i)*. A named antibiotic or other secondary metabolite was required for this question, even though the general idea of 'antibiotic' was allowed. Credit was given to the fact that secondary metabolites were produced in the stationary phase in part *(iii)*, but the Examiners were looking for more than this for part *(ii)*, where candidates needed to be clear that they were mainly produced after the rapid or main growth phase. Sadly, all marks were lost in part *(iii)* where candidates described the benefits of continuous fermentation.

(b) By using Fig. 3.1, most candidates were able to earn themselves some marks, but only the more able candidates were able to apply the principles behind continuous fermentation to answer the question fully. As a result, 'product' removal from the sample port was not sufficient to gain a mark as the candidates had been informed that the aim of the fermentation was the production of algae. Candidates were not required to know that *Chlorella* was photosynthetic, as the light source and the information that *Chlorella* was an alga was thought to be sufficient to point candidates in the right direction. Surprisingly few answers included references to photosynthesis, the requirement of light *energy* and the usefulness of carbon dioxide in the process. Generally carbon dioxide was only described as a 'waste gas' that left via the air outflow and often the light was considered to be a source of heat. The fact that the continuous culture maintained the exponential growth phase was well expressed by candidates, but rarely did candidates realise that the constant rate of addition of nutrients needed to be balanced by the same constant removal rate in order to maintain a constant volume in the fermenter.

(c) This was answered well by most candidates, with many able to apply their knowledge to good effect. There were some candidates who stated that large scale production may have a detrimental effect to the 'taste'. Those candidates who answered the question directly and wrote about the 'problems' of scaling up were more likely to score full marks than those that gave solutions without referring to the problem. Only one mark was awarded if candidates referred to the difficulty in maintaining environmental factors at a constant level, whereas noting the difficulties of maintaining a constant pH and temperature gained a mark for each point.

Q.4 This question turned out to be quite demanding for the candidates, who did not always interpret the questions in the manner intended. Nevertheless, many obtained very good marks for this question.

(a) The most common error in answering this part was for candidates to simply quote from or restate the information in the stem without extending their ideas further. The Examiners were looking for answers that would note a point given in the stem of the question and then elaborate further with a clear advantage. For example, stating that other insects would not be affected, only gained a mark if it was linked to the fact that less insecticide would need to be used with the protected plants, or that as the toxin was inside plant cells, it would not affect the insects unless they ate the plant as well. Similarly 'there is less damage to the environment' would not be sufficient unless it was explained that, for example, the protein degraded

rapidly following plant death, or that less insecticides need to be used.

(b) This proved to be a difficult question to answer completely, but one that allowed candidates to score maximum marks if they had a good understanding of genetic engineering from *Biology Foundation* or from the genetic manipulation of crop plants covered in this option. Only the most able candidates were able to deal successfully and expertly with all the stages involved in the production of *Bt*-protected cotton plants and these candidates were able to gain almost all the points considered by the Examiners. The depth of information that these candidates displayed was very impressive, with detailed accounts of gene probes and electrophoresis, disarming of the Ti plasmid and plant tissue culture techniques. Fairly common errors were to use reverse transcriptase in addition to a restriction endonuclease and use DNA ligase to allow base pairing. Many candidates extracted plasmids and/or the desired gene from *protected cotton plants* and ignored totally the information given to them at the start that the gene was found in a bacterium. Various methods other than the use of *Agrobacterium* were given by candidates to introduce the gene and these could all be credited where they were clear and correct in their descriptions. Vague answers included plasmids entering ‘plants’ rather than plant cells and *Agrobacterium* giving cotton plants crown gall disease as well the desired gene. Some answers switched half way to engineering herbicide-resistance into the crop plant. A good number of candidates stopped after making the recombinant plasmid and did not go on to write about any aspect of plant culture. The mark allocated to the use of scientific terms was usually awarded, but in a number of cases answers were too confused to be able to give credit.

(c) This question enabled many candidates to score well if they stated improvements that are already in use or are being researched. The mark scheme has a lengthy list of these. Some ideas were not credited if they were vague and offered no further explanation, for example ‘bigger leaves’ or ‘stronger stems’.

Teaching tip

The three main examples of genetic manipulation that candidates learn during their two-year course can be used in a summary to show how some of the enzymes are used to obtain a desired gene:

- humulin production: using *reverse transcriptase* with pancreatic β cell mRNA;
- Human Growth Hormone: using knowledge of the amino acid sequence, genetic code and *DNA polymerase* to synthesise the gene
- crop plants and, for example, coding for resistance to herbicide: using *restriction endonucleases* to cut out the gene with the desired characteristic from another plant or another type organism.

Q.5 This proved to be a question of 'two halves', with parts *(a)* and *(b)* scoring extremely well and *(c)* being very challenging to all but the most able candidates.

(a) This was a straightforward question that was answered very clearly by most candidates, who had obviously practised the technique. The question did not ask about the identification of Gram-negative bacteria and although most candidates included this in their answer, it did not affect their overall mark. Some candidates did not use crystal violet or one of the other chemicals; some identified the correct chemicals, but used them in the wrong sequence. These candidates only gained two or three marks overall. For example, leaving out the use of alcohol could not enable them to gain the mark for Gram-positive bacteria being stained purple as both cell types would be this colour if the alcohol was not used.

(b) Both parts of this question were considered together in the award of the two marks. This was well answered. Those candidates who lost a mark failed to mention murein or peptidoglycan or wrote about the lipopolysaccharide membrane of Gram-negative bacteria.

(c) Only a few candidates were able to use their knowledge and understanding of the genetic control of protein synthesis from *Biology Foundation* to help them in their answer to part *(i)*. Generally, candidates were way off the mark and a whole range of incorrect explanations appeared. Some candidates thought that RNAi binding to mRNA would produce DNA, hence leading to a different gene and different protein product. A number of candidates used reverse transcriptase in their answer. It was sometimes difficult for the Examiners to understand the strands of thought that led to the answers given. Part *(ii)* was rarely answered correctly. Some left the whole of part *(c)* blank. Maybe candidates would have been helped by having a diagram to illustrate the text in the stem of the question.

Q.6 This was a question that tended to score fairly well. Marks were lost either with a lack of AS level biochemical knowledge in part *(a)* or with a lack of depth or precision in answering part *(b)*, rather than a lack of understanding.

(a) This question was a quick way to earn three marks for those candidates who had maintained their AS knowledge. In addition, part *(i)* may have been covered by those candidates who used immobilised amylase to hydrolyse starch to maltose as an example for learning outcome 5.8.6 (c). It was surprising how many candidates thought enzyme **P** was 'starchase' and an even greater number who incorrectly named 'hydrogen' as the bond for part *(ii)* and β glucose in part *(iii)*.

(b) Candidates were well informed for this question. In part *(i)*, correct ways of immobilising enzymes were also followed with concise examples, for example 'encapsulation, with enzyme trapped in alginate beads'. The Examiners were looking for the generally accepted term for ways of immobilising or a brief description. Candidates who simply stated 'cellulose fibres', 'alginate beads' or 'insoluble matrix' did not gain credit. Although not penalised where it was clear what the candidate meant, there were quite a few who wrote about 'absorption' rather than 'adsorption' onto an insoluble matrix. In part *(ii)* there were many different combinations that candidates could use to gain full marks and generally, they were successful in explaining advantages clearly. Many were guided by the mark allocation for this question and made a statement that was followed up by an obvious

advantage. Those candidates who did well on this question usually gained good marks for *Q.4 (a)*.

(c) Although this question enabled candidates to gain two marks using a general knowledge of the advantages of immobilising whole cells, there were many candidates who used the information given to apply their knowledge, writing about providing anoxic conditions for the enzyme and using several enzymes in the whole processes involving nitrogen fixation.

Teaching tip

There are two useful articles in Biological Sciences Review, Volume 15, Number 1, September 2002:

- haemocytometers and dilution plating, page 14 (for *Q.2*)
- genetic manipulation of plants, page 10 (for *Q.4*)

Biological Sciences Review is published by Philip Allan. See:
http://www.biomed2.man.ac.uk/bsr/revweb.html
and
http://www.philipallan.co.uk/

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of the appropriate difficulty and there was no evidence that candidates could not complete the paper in the time available. Most candidates attempted all of the questions, there being few blank pages. Many weaker candidates appeared to have difficulty with *Q.2* and *Q.4*. There was a greater emphasis on data manipulation than in some more recent papers. However, it was pleasing to see that most candidates have been trained to use figures appropriately and include relevant units when analysing the data.

Comments on Individual Questions

Q.1 This question proved to be quite successful for candidates of all abilities.

(a) Most candidates were able to label the scapula (**X**) and a thoracic vertebra (**Y**) correctly, although some were less precise with their label for **Y**, which extended to a rib. They were less able to identify a ball and socket joint (some indicated a hinge joint) and may candidates lost the mark for **W** by indicating either metatarsals or carpals/metacarpals.

(b) Most candidates stated that both kangaroos and humans possess pentadactyl limbs or expressed this in terms of five digits. Many commented on the presence of vertebrae or a spinal column being common to both, although surprisingly few mentioned the fact that both were tetrapods. References to one upper limb bone and two lower bones were seen less often, although some candidates mentioned the '1 to 2 to 5' structure of each limb. Few appreciated that the ribs are attached to thoracic vertebrae or that the caudal vertebrae are vestigial in humans although there were some references to the coccyx. In *(ii)*, the majority of candidates mentioned the presence of a diastema, or described it, and some recognised that incisors were only found on the upper jaw. However, some failed to look at the photograph and reverted to their knowledge of cows or sheep, stating that the incisors were found only on the lower jaw. References to the horny pad were credited unless the candidate identified it as being on the upper jaw. Many candidates were credited for describing the role of the molars and premolars in the grinding of plant material.

(c) A large number of candidates seemed to ignore the first graph here altogether; they went directly to a discussion of the second graph. A mark was almost always awarded for the link between the increase in speed of the treadmill and the increase in oxygen consumption. The majority of candidates gave correct paired data quotes and understood that ATP would be produced during respiration (although *aerobic* respiration was not always stated) and that ATP was necessary for muscle contraction. However, vague references to muscles working harder were not credited. Further detail, such as reference to oxidative phosphorylation, was hardly ever seen. Some candidates went into detail about the mechanisms involved in increasing oxygen supply to the muscles (such as increased ventilation and heart rate) rather than concentrating on its use within the muscle cells.

Teaching tip

Provide students with some complete skeletons of different species, together with photographs and/or drawings, and ask them to make observations about similarities and differences. The observation could be recorded in a table.

Examination tip

A sharp pencil or a fine pen should be used along with a ruler to ensure accuracy when answering questions like *Q.1 (a)*.

Q.2 Although many candidates were able to score well, some responses were not always sufficiently precise enough and this question proved to be a reasonable discriminator.

(a) Most candidates gained a mark for a correct explanation of an automatic reflex, described in a number of ways, such as innate, requiring no conscious thought, involuntary, etc. Stereotyped behaviour proved to be slightly more difficult, although most candidates recognised that it was either carried out by all individuals of a species, or the response was always the same for a particular stimulus. Some candidates found it difficult to define a conditioned reflex although many explained a suitable example, which was credited.

(b) A correct stimulus and response were given on most scripts. However, some vague stimuli, such as 'temperature', were given without suitable qualification for the given response, so a mark was not awarded.

(c) The vast majority of candidates stated that the time spent in the box decreased with the number of trials. Many then qualified their statement with suitable figures. Relatively few candidates went on to give more detailed descriptions of the data. Only a very few candidates stated that the greatest change occurred in the first few trials. Most recognised that the loop was initially pulled accidentally and appreciated the connection between pulling the loop and escape. Some neglected to state that escape or freedom was the 'reward' or 'reinforcer'. Surprisingly few references to 'trial and error' or 'associative learning' were seen although stronger candidates mentioned both. Many candidates scored at least four or five marks although maximum marks were not awarded as frequently as expected. Nevertheless, most candidates achieved the quality mark for spelling, punctuation and grammar.

(d) In general, candidates rarely managed to get both marks available for this part. Many recognised that operant conditioning involved a reward or punishment, but few appreciated that classical conditioning requires two stimuli while operant conditioning requires only one. Nevertheless, some good points were made allowing the AVP to be awarded.

Teaching tip

Ask students to research experiments on learning behaviour in mammals on the Internet as an extension to the classical work of Kohler, Pavlov and Skinner.
The Association for the Study of Animal Behaviour has some useful resources available on its web site. See:
http://asab.icapb.ed.ac.uk/
Another useful site to begin such a search is the site that supports the BBC series *Life of Mammals*:
http://www.bbc.co.uk/nature/animals/mammals/

Q.3 This question showed that many candidates had a good knowledge of digestion and its control. It was accessible to the full ability range.

(a) Most candidates were awarded the first three marks, although some did not know that trypsinogen is the inactive form of trypsin. Some suggested chymotrypsin or even pepsin. Many were also not sure as to which cells would secrete this enzyme. Many candidates gave correct examples of enzymes, which would be embedded in the cell surface membrane of the villi, although amylase was frequently stated, as was protease.

(b) Good candidates gave comprehensive answers concerning the effects of secretin and cholecystokinin (CCK) on digestive secretions and the stimuli, which would elicit their secretion, often achieving full marks easily. Less able candidates identified that both secretin and CCK would stimulate the release of pancreatic juice but were unable to describe the relevant components. Several imprecise references to the release of bile from the gall bladder were seen.

(c) Even the weakest candidates were able to achieve some marks for this part, most commonly for appreciating that a loss of villi would result in a reduction in surface area. Many then linked this fact to reduced absorption and some gave valid examples of what would not be absorbed so effectively. Most candidates understood that weight loss and malnutrition would be a consequence of coeliac disease although many stated that a deficiency disease would arise without giving a specific example. References to diarrhoea or wind, bloating or pain were rarely seen.

Teaching tip

Using different coloured cards can enhance the teaching of digestion. For example, red cards could have names of parts of the digestive system, blue could have enzymes, green could have substrates and yellow have products. The cards could be shuffled and students would then be required to set them out as a flow chart in the correct sequence.

Q.4 This was by far the best discriminator on the whole paper, although full marks were rarely awarded.

(a) Good candidates correctly stated the effect of the drug. They referred either to stimulation of the sympathetic nervous system (SNS) and noradrenaline release, or inhibition of the parasympathetic nervous system (PNS), and the effects on the radial or circular muscles. Weaker candidates failed to read the question and simply gave an account of the control of pupil size without relating their answer to the action of the eye drops. There were also some confused responses regarding the role of the SNS and PNS in the dilation of the pupil. Some candidates stated that the drops obscured light entering the eye and therefore the pupil dilated to let more light in and others thought that they would have an effect on the rod and cone cells. There were also incorrect references to the 'role' of the ciliary muscles in the dilation of the pupil.

(b) Most candidates managed to gain at least one mark for suggesting why ultrasound would be less likely to cause complications, predominantly for stating 'less damage', 'faster healing' or 'less infection'. However, references to surgical ineptitude and damage were not credited. Some candidates did not read the stem of the question carefully and believed that ultrasound required no invasive treatment at all.

(c) This synoptic section was badly answered. Only rarely did candidates manage to score more than one mark – most frequently awarded for recognising that the base sequence of the gene would change, although this was often expressed in terms of the type of mutation – deletion, addition or substitution. No correct references to either transcription or translation were seen. Very good candidates realised that the primary structure and therefore the secondary and tertiary structures would change and some went on to qualify their statements by mentioning that bonds would be changed because of different R groups. Some candidates lost marks by stating that the base sequence or amino acid sequence would be 'wrong', which gained no credit.

(d) Again, only the best candidates scored full marks and were awarded the quality mark for correct use of scientific terms. Most candidates appreciated that the cones would be affected in macula degeneration and many stated that the image is focused on the fovea although few commented on the one-to-one connection between cones and bipolar cells and between bipolar cells and ganglion cells. Some understood that visual acuity would be reduced; they expressed this in a number of ways, such as stating that there would be a lower resolution or a reduction in sharpness of the image. References to iodopsin being deposited were rare.

For retinitis pigmentosa, the most commonly awarded mark was for stating that the rod cells would be affected, although occasionally this mark was withheld because the candidate had neglected to identify where the rods would be found. Better candidates also made the link between the sensitivity of rods to low light intensity and therefore the reduced vision in dim light. Rarely did candidates mention that rhodopsin would be deposited or that several rod cells synapse with one bipolar cell. No correct references to loss of either convergence or summation were seen.

(e) This part was the best answered of the whole question with candidates frequently obtaining full marks for describing the advice that doctors would give to people showing early signs of macula degeneration. A reduction in saturated fat or cholesterol intake was the most common response although 'increased exercise' and 'giving up smoking' also featured highly. Far fewer candidates commented on the reduction of salt or caffeine, or that aspirin could be taken. The other marking points were hardly seen at all.

> *Teaching tip*
>
> *A useful website on the treatment of cataracts is:*
>
> *www.stlukeseye.com/Conditions/Cataracts.asp*

Q.5 Despite a potential for confusion between similarly named processes this question was quite well answered.

(a) In part *(i)*, adrenaline was the only correct hormone named of those given in the mark scheme. Weak candidates repeated the stem of the question and stated glucagon. In part *(ii)*, most candidates gained at least two marks, frequently three, for a comprehensive description of the properties of glycogen. Almost all marking points were seen, in various combinations, although the fact that glycogen has many 'ends' for enzyme action was rarely commented on.

(b) Generally, candidates either understood the question and interpreted the data correctly, thereby scoring well, or went off at a complete tangent. Many references to blood glucose concentration and its regulation by insulin and glucagon were seen. Some candidates misread the table and thought that the liver cells were subjected to increasing concentrations of glucose. No references to the possible inhibitory or activating effects of glucose on enzyme activity were seen.

(c) Both pathways for gluconeogenesis were seen although most candidates elected to describe the deamination of amino acids and the subsequent conversion of the carbon skeleton into pyruvate, although the triose phosphate step was occasionally omitted. Candidates who chose the route from triglycerides rarely scored all three marks, either for not converting glycerol to triose phosphate or converting it to pyruvate.

> ***Teaching tip***
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> Some candidates tend to repeat themselves when analysing data from a graph such as in *Q.5 (b)*. It may be appropriate for them to practise answers by writing numbered or bulleted points.

Q.6 This question proved to be quite successful for candidates of all abilities. The Examiners noted that the candidates' knowledge and understanding of Alzheimer's disease was sound in most cases.

(a) Most candidates appreciated the role of the cerebellum and medulla oblongata and easily gained full marks for each. However, some confused the two, or confused the cerebellum with the cerebrum. Some also failed to appreciate that the cerebellum does not initiate skeletal muscle contraction but refines it.

(b) Many candidates stated that the tangles would arise as a result of the deposition of tau protein although there were vague references to fibrous deposits or neurones themselves becoming tangled. The cause of plaques was less well understood and although candidates appreciated that they would be linked to the build up of beta amyloid, they neglected to mention that it be would the abnormal form. Quite often the answers to tangles and plaques were swapped and so could not be given any credit.

(c) The mechanisms by which the drug might inhibit acetylcholinesterase were not always well expressed although the better candidates were awarded full marks for good descriptions of both competitive and non-competitive inhibition. Some referred to the active site as the binding site or receptor site.

(d) Only the good candidates were awarded both marks for this part. Some mistakenly thought that the drug would allow more acetylcholine to be released rather than prevent its breakdown. Few correct references to the activation of memory circuits were seen, candidates often repeating the question by stating that they would be formed. However, some appreciated that impulses or action potentials would be generated in the postsynaptic neurone.

(e) This part was generally well answered with the vast majority of candidates scoring at least one mark, many scoring two or all three. Most recognised that there should be a control group and the administration of a placebo was often mentioned. Many also appreciated the factors, which should also be controlled, such as diet, age and gender and frequently went on to state that no other medication should be taken. Weaker candidates suggested that the drug should also be given to patients not suffering from Alzheimer's as a control or that patients should simply be 'carefully monitored'.

Teaching tip

Quite often questions relating to human diseases in this option paper start with the word 'suggest'. Candidates should be encouraged to be more confident in attempting to provide relevant answers. The Examiners will frequently allow some latitude in the responses to these questions.

Teaching tip

Although this paper had several references to human biology and human diseases, everyone should be reminded that it is an option on *mammalian* physiology and behaviour.

The BBC web site provides support materials for David Attenborough's series *Life of Mammals*.

http://www.bbc.co.uk/nature/animals/mammals

For those interested in CPD, there is an Open University short course linked to the series. Details at:

http://www3.open.ac.uk/courses/bin/p12.dll?C02S182

2806/01: Unifying Concepts in Biology

General Comments

Population biology and ecology were not strongly represented in this paper, which also did not have a complex graph to interpret. Candidates have found these areas difficult in the past. The standard seen in the work of some large Centres was extremely pleasing, the candidates showing a good general understanding of Biology and answering the questions clearly and precisely. Other large Centres had entered many candidates who seemed to have had little practice at tackling questions designed to test assessment objective AO 4 – synthesis of knowledge, understanding and skills. This synthesis may not have developed after four terms of advanced level study, even though teachers will have been striving to develop it from the start of the AS programme.

Questions which required the understanding of an investigation and the interpretation and evaluation of data, tended to be more poorly answered than those which required the bringing together of ideas from different parts of the specification. There seemed to be fewer candidates who left large sections blank and the fluency of expression in answers seemed to have improved.

Teaching tip

'Comment on' is one of the terms listed in Appendix F of the specification as a term likely to be found in OCR science examination papers. It is often appropriate in testing AO4 and teachers should perhaps use it in tests or homeworks more often.

Candidates would be able to answer questions of this type more easily if they were given tables of data and asked to discuss in small groups, firstly, what biological principles each table had been selected to illustrate and secondly to prepare a list of comments and conclusions. Ability to conclude and evaluate is also tested in the coursework (2806/02) and the practical exam (2806/03).

Comments on Individual Questions

Q.1 This question was designed to test understanding of the fundamentally important principle that development is influenced by environmental and genetic factors. It also tested the comprehension of numerical data.

(a) Perhaps because this was the first question and candidates had not settled down to their task, there was much restatement of the information provided but little by way of explanation. In part *(i)*, most candidates were able to state that monozygotic twins have the same chromosomes, genes or DNA but it was extremely rare to find correct references to meiosis or mitosis. They needed to focus more on why dizygotic twins are genetically different.
Many weaker candidates did not understand the term phenotype and proceeded to contradict the answer they had already given. Most understood that environment was important for development and they tended to give diet as an example. A small minority of able candidates suggested that different alleles of the same gene might be expressed in each of the twins, while weaker candidates often imagined that alleles might change by mutation of by random assortment or crossing over, during the development of each monozygotic twin. Mutation is far too uncommon to be used as an explanation for variation between most individuals.

(b) This proved extremely difficult for most candidates. They tended to use the words statistical and significant very freely in their answers, which therefore became circular. The Examiners were expecting them to refer to chance or probability but few did so. A good answer was: 'The differences between the monozygotic and the dizygotic twins might have been just chance. This is the null hypothesis and there is less than 0.05 probability of this chance happening.'

(c) There were many conclusions that were valid and many candidates were able to get full marks. Careless errors in which monozygotic was misread for dizygotic or vice-versa were not uncommon and there was repetition of the same conclusion using different wording.

(d) This proved very straightforward. Most candidates referred to sex chromosome differences or to the higher incidence of CHD in males. The most thoughtful pointed out that monozygotic twins must be of the same sex, so should be compared only with same sex dizygotic pairs. It was very pleasing to see that even the weakest candidates were giving specific reasons rather than making bland statements about fair tests.

Q.2 This question was designed to explore understanding of the overall processes of respiration and photosynthesis and the interaction of these processes in plant metabolism. Candidates were required to use information from the flow diagram in Fig. 2.1. They found it very accessible so that few gained less than half marks and maximum marks were not uncommon.

(a) Even though the question asked about oxygen concentration, many candidates approached their answer almost solely with reference to carbon dioxide. These candidates disadvantaged themselves, but were able to gain at least two of the available four marks. Many were familiar with the term compensation point. They were expected to refer to respiration *and* photosynthesis, processes not directly referred to in Fig. 2.1 or in the accompanying information given. Weaker candidates tended to launch into irrelevant accounts of limiting factors.

(b) Almost all candidates were able to state that inorganic phosphate is used in the mitochondria to make ATP. They often failed to give further detail or to mention that the ATP leaves the mitochondria, so missed the second mark.

(c) This was extremely well answered. Most candidates were very familiar with important principles of transport across membranes and many would have scored three marks if more than two had been available.

(d) Cell structure underpins much of Biology and the Examiners had expected this to be a straightforward question; however, it was common for the stronger candidates to score zero and this item did not discriminate well. It was disturbing to find that many candidates believed that chloroplasts and mitochondria have a wall or even 'a wall as well as a membrane'. Few seemed to understand that chloroplasts and mitochondria are organelles and it was common for them to be called 'cells'. The Examiners would have preferred candidates to refer to circular DNA instead of DNA in the form of a 'loop', but they accepted the latter term.

> Teaching tip
>
> Both mitochondria and chloroplasts are membrane-bound cytoplasmic organelles. Learners become confused by the word cytoplasm since it is used to mean everything apart from the nucleus and also as shorthand for the cytoplasmic matrix or cytosol. Teachers might try getting classes to prepare a table that compares and contrasts chloroplast stroma, mitochondrial matrix and cytoplasm. Stronger candidates could research the nature of the cytoskeleton, especially if they are going to study *Mammalian Physiology and Behaviour* as this will help support the study of the ultrastructure of striated muscle.

Q.3 Candidates were required to understand and evaluate an investigation and to relate this investigation to their knowledge and understanding of human gas exchange. The parts relating to the investigation led into an extended writing item, in which ideas on the transport system studied in AS, were linked to homeostasis, studied at A2. It was striking that the questions relating to the investigation were often poorly answered whilst the extended writing was usually quite well done, even by weaker candidates.

(a) This was intended to be an easy start, but it was also intended to get the candidates thinking along lines that would help them in part *(b)*. The Examiners are sure that most teachers encourage learners to look at a series of part questions as a whole so that candidates avoid repetition and misunderstanding. Candidates who can see where a question is leading are at a considerable advantage.

(b) Even though many had already pointed out that groups **A** and **B** *should* have had equal numbers of males and females, only a minority stated that the actual gender imbalance made conclusions about the importance of the sequence in which the breath holding trials took place problematic. Most decided that the sequence was important and quoted data to support this conclusion, gaining full marks.

(c) In *(i)*, most referred to an increase in blood oxygen concentration or to an increase in the percentage saturation of haemoglobin. Very few referred to a decrease in blood carbon dioxide. Very many candidates gave extensive answers that suggested vasodilation of blood vessels and increased blood flow, which were not relevant. A substantial proportion of candidates ignored the fact that the question was about the effect of forced pulmonary ventilation and launched into an account of the effect of exercise on the cardiovascular system. In part *(ii)*, it was rare to see an answer that showed understanding of tidal flow of air in the lungs. Stronger candidates realised when they reached this part of the question that carbon dioxide exchange was important. They gained marks by explaining that concentration gradients between alveolar air and blood would be *greater* - a concentration gradient is there without forced ventilation. They rarely referred directly to alveoli. A majority assumed that cardiac output would increase during and after forced pulmonary ventilation, though no evidence for this was available in the account of the investigation.

(d) Most candidates wrote well-structured and logical answers of the required length. It was rare for them to lose the quality of written communication mark. Weaker candidates often gained a substantial proportion of their total for the paper on this extended answer, whilst stronger candidates usually scored well over the allocated maximum mark.

Up to two marks were available just for identifying variables which would change as a result of prolonged exercise. A candidate could gain most of the available marks for explaining how any one of these variables was maintained at a relatively constant level during the exercise. Most concentrated on temperature, glucose concentration, water potential or pH. Stronger candidates were able to give concise accounts of two of these whilst mentioning one or more of the others.

Candidates often gained credit by mentioning an increase in heart rate, but it was rarely clear how this related to homeostasis. Teachers might in future wish to extend the understanding of candidates that, as cardiac output increases, it is important that there is a corresponding overall increase in vasodilation, so that blood pressure remains within safe limits.

Q.4 Candidates were asked to show that they could apply their understanding of Mendelian genetics to real data and that they understood the role of chance in such investigations.

(a) Some candidates failed to read the instruction to give the ratio to the nearest whole number. A minority of candidates obviously spent a long time calculating but sometimes had no idea of what is meant by a ratio. Candidates who were familiar with genetic principles had clearly been taught to look out for a 1:2:1 ratio and could, as intended, supply this by inspecting the numbers.

(b) This was very clearly and logically answered by most candidates and maximum marks were common. Many candidates gained the mark allocated for choosing correct symbols for codominant alleles and pleasingly few confused genes and alleles. One of the seven marking points was for the use of appropriate symbols for codominant alleles. Candidates could still gain full marks if, as many did, they used symbols appropriate for a dominant and a recessive allele. Almost all candidates used a clear genetic diagram but most failed to write in phenotypes as well as genotypes, wasting time by writing out the phenotypes separately. The Examiners really felt that standards were rising as they marked this part question as the answers were clearly laid out.

(c) It was rare for three marks to be awarded. Some weak candidates forgot the information given at the start of the question and suggested that the six yellow-green seedlings in pot **B** were an F_1. As is common when a genetic analysis is beyond them, they often explained the results as the result of mutation. Stronger candidates were able to explain that six seedlings is a small sample, so that chance may have a big influence. They found it much more difficult to explain that chance effects are unlikely to have a proportionately large effect on a big sample, such as the class data in Table 4.2. Many suggested that the results should be accepted as valid just because they conformed to a 1:2:1 ratio.

(d) Many candidates, including some who had shown little understanding of the genetics, were able to explain very clearly that yellow seedlings would not have chlorophyll so would die whilst dark green plants would be able to store more photosynthetic product in bright light than yellow-green ones. Candidates who failed to connect green with chlorophyll found it difficult to score, though they could pick up a mark if they referred correctly to competition. Explanations in terms of nutrient deficiency were not uncommon even though the candidates were told that all the plants were in the same soil.

Teaching tip

Seed segregating in the way illustrated in this question will give results in about two weeks from sowing and students enjoy looking after their own pot of seedlings. There are also several mutant strains of Rapid Cycling Brassicas that can be used.
Further details available from:
http://www-saps.plantsci.cam.ac.uk/
http://www.philipharris.co.uk/teaching.htm
http://www.blades-bio.co.uk/

Q.5 This question brought together ideas about proteins (enzymes and antibodies), the immune system and the nervous system. It required candidates to show comprehension of a short piece of prose. There were very pleasing responses, with few candidates scoring under half marks and full marks not uncommon.

(a) This was targeted at less able candidates. In some Centres most scored the mark but in some large Centres it seemed that candidates had completely forgotten all they knew about the role of phospholipids. Answers were often poorly and vaguely expressed. It would have been good to see clear references to the 'cell surface membrane' or 'the plasma membrane'. Many candidates seemed unclear about the difference between cells and tissues.

(b) Weaker candidates were clearly confused about the difference between acetylcholine and its receptors and between presynaptic and postsynaptic events. Only the strongest candidates scored both marks. It was fairly easy to gain one mark for stating, or strongly implying, that synaptic transmission would be prevented.

(c) A detailed recall of the mechanisms of the immune response was not expected. There were seven marking points available for a maximum of two marks. Candidates almost all remembered and had understood the concept of immunological memory and were able to link this to the rapid action of the snake venom as described in the first paragraph of the passage. Many candidates showed a very good recall of the immune response.

(d) Candidates understood the idea of a small, slow primary response and a large, quick secondary response and were able to link this with memory cells, often achieving full marks.

(e) A disturbing number of candidates believe that peptide bonds are broken when a protein denatures. Most were able to gain a mark for using the term denature and to gain an additional mark with further detail.

(f) This was really well answered. Candidates understood the concept of passive immunity and were often able to use the term. They also frequently referred to the elimination of the horse antitoxin by the human immune system and to memory cells.

Teaching tip

Learners are encouraged to read and to bring different concepts into focus by comprehension exercises of this kind, which can be done, both individually for homework or in small groups.

2803/02 and 2806/02: Experimental Skills (Coursework)

General Comments

The work presented for moderation fell into two categories:

- resubmission of coursework by small numbers of candidates
- submission of work for first moderation by complete groups of candidates.

The latter was generally of good quality and compared favourably with previous sessions, being well marked and annotated. The work offered for a second time seemed to have changed very little and scored much the same. It is accepted that entering a single candidate may pay dividends when a Centre has had scores adjusted at the previous moderation. However, it seemed that the reasons for adjustment had often not been addressed and the single candidate suffered the same adjustment as before. If a candidate is going to receive an improved score then the following should be addressed:

- Resubmitted material must have been reworked preferably by candidates producing new or extra results, which are then analysed and evaluated.
- The work should be marked again taking into account the comments on the moderator's report to the Centre at the previous moderation.

The interpretation of a number of descriptors is still a cause for concern. An attempt is made below to present an explanation of these descriptors. Centres should not interpret this amplification as in any way a modification to the specification. Centres are advised to make use of the coursework consultancy service if they are unsure about any aspects of organising and marking coursework. Details are available on the OCR web site, www.ocr.org.uk, by following these links:

AS/A level GCE + Sciences > AS/A level GCE Biology > Publications and Materials > Coursework Enquiry Form (there are separate forms for AS and A2).

There is no charge for the coursework consultancy service.

P.3b Decides on a suitable number and range of observations and/or measurements to be made. Repeats are needed for reliability to be assessed, so at least three replicates should be planned for. If this plan is to be implemented and the results analysed, it should be noted that the calculation of a mean is less reliable with data taken from less than three readings. Three readings will also aid the identification of anomalous results for use in skill E. A range of five in the independent variable is expected, but the exact number depends on the context of the investigation and the independent variable studied. If in doubt the Centre should contact OCR and make use of the coursework consultancy service. In the case of ecology it can be appropriate to study a range of two, for example when studying an exposed shore and a sheltered shore. However, Centres should endeavour to set tasks where a range of five is possible.

P.5bi Describes a strategy, including choice of equipment, which takes into account the need to produce precise and reliable evidence. Candidates are required to give a detailed description of the strategy, including apparatus and variables. One way to test whether this descriptor is met is to ask the question 'could this method be followed by another student?' The strategy should enable data to be collected to the same degree of precision and reliability.

P.7b Justifies the strategy developed, including the choice of equipment, in terms of the need for precision and reliability. Candidates should explain why the choices in the apparatus and strategy planned have been made in order to give precision and reliability in the results. For example, in a gas collection experiment, a reason for choosing a gas syringe rather than an upturned measuring cylinder would be to give more precise readings. How the key variable(s) will be controlled will show how reliability can be improved.

I.5bii Records observations and/or measurements in an appropriate format. All **raw** data should be displayed in a single table to allow a comparison to be made of the independent variable range and the replicates. The independent variable should be in the first column. Appropriate SI units should be used for both the independent and dependent variables in the row and column heading(s). Units should not appear in the body of the table.

A.3a Processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques. **Processed** data should be presented in an appropriate format. For most investigations this is likely to be a line graph. The processed data, e.g. means and/or percentages, should be presented in a suitable and correct graphical format that allows further data to be extracted. In some cases it is not possible to present data as a graph. In such cases, candidates should present the details of their calculations and this may be used to match this descriptor. At A2, details of the stages of a chi squared test or other statistical test might meet this descriptor. A hand drawn graph remains the best way to match this descriptor.

Some candidates use Excel to prepare their graphs. The report for June 2004 gives further information about the way in which these should be presented to match this descriptor (see pages 76 and 77 of the Report for the Units - June 2004).

A.7a (part) ….with due regard to …..the use of significant figures… With respect to significant figures the general convention is that the mean should be expressed with the same number of significant figures as the total for the data, i.e. the mean should be given to one more decimal place than the original data. However, this assumes the data set is small (n < 100) and that the data is recorded to a consistent precision. If different measurements have different numbers of significant figures then the final result should contain the same number of significant figures as the measurement with the smallest number of significant figures. If candidates calculate standard deviations, then the same rule applies. Results should be recorded in a table to the same number of significant figures. This applies to the individual columns or rows of data as appropriate.

E.3bi Comments on the accuracy of the observations and/or measurements. Accuracy is an assessment of how close the obtained value is to the true value. There are various ways in which this descriptor can be achieved. Some examples are:

- calculating and commenting on percentage error;
- commenting on the accuracy for piece(s) of apparatus;
- commenting on how the trend line compares to the theoretical trend line.

E.5ai Indicates the significant limitations of the experimental procedures and/or strategy. Whilst level 3 might be the identification of all the limitations (problems in the method) in the procedure, level 5 is a clear indication which limitation(s) caused the greatest impact on the data. Simply ranking the limitations can do this, but other techniques may be used.

E.5bi Comments on the reliability of the evidence. Candidates should consider the spread of results that they have. Some show this by including range bars or error bars on their graphs. There are a variety of ways in which they may comment on the reliability of their evidence.

- Considering the closeness of replicates to the mean.
- Considering the size of range bars or error bars on graphs.
- Calculating variance, standard deviation, standard error or 95% confidence intervals.

Any of these can be used by candidates to assess reliability and will achieve a match with the descriptor.

E.5bii Evaluates the main sources of error. Candidates must explain what impact the main error(s) (inaccuracy in the numbers), has/have on the data. For example, they may decide that the main errors have meant that all the results are slightly lower than they should be.

E.7b Assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn. The candidates should comment concisely on their data stating if it is accurate, precise and reliable enough to be confident in their conclusion, with reference to their prediction and/or expected results.

P.5bii and **A.5bii** Produces a clear account and uses specialist vocabulary appropriately. Centres should consider whether their candidates have used terminology appropriate for the topic investigated. When candidates investigate osmosis they should use the appropriate water potential terminology. Terms such as water potential, solute potential, pressure potential and water potential gradient should be used. In this case, the specification refers to the terminology for plant water relationships given in Biological Nomenclature published by the Institute of Biology.

Centres should note that the mark descriptors within a skill area have been written to be hierarchical. An intermediate mark may be awarded when the work of a candidate exceeds the requirements of a defined mark level but does not meet the requirements of the next higher defined mark level sufficiently to justify its award. Thus, an intermediate mark could be awarded if the work meets half of the sub-descriptors at the higher defined mark level. For example to award level 4 for Planning all the sub-descriptors must be fully met for levels 1 and 3 plus, either all of the sub-descriptors for P5a, or all of the sub descriptors for P5b, or 50% of the sub-descriptors from each of P5a and P5b, e.g. P5ai, P5aiii, P5bii.

2806/03: Experimental Skills (Practical Examination)

General Comments

Photosynthesis and the differences between sun and shade leaves provided the link between the tasks in this paper. There were few reported problems and candidates do not appear to have been unduly short of time. The general standard of responses suggests that candidates found the tasks demanding. Centres are reminded that candidates may have their planning exercises during the practical test and in this instance this may have helped with answering *Q.2 (b)* in the Practical Test in particular.

Comments on Individual Questions

Planning Exercise

This Planning Exercise required candidates to find out and compare the compensation points of shade leaves and sun leaves. The majority of candidates rightly planned an investigation in which sun and shade leaves were introduced into test tubes containing hydrogen carbonate indicator solution. Following insertion of a bung, the tubes were then exposed to a suitable range of light intensities, usually by being placed at known distances from a light source. Light intensity could be measured in arbitrary units using $1/d^2$, where d = distance from the light source. This could be quantified in lux using a light meter. Any colour change in the indicator could be quantified using a colorimeter. A graph of colour change plotted against light intensity would, by means of intercepts, give the light intensity at which there was no colour change (shown by the arrow on the graph in Fig.1). These intercepts would be the light compensation points for the two types of leaf. Fig. 1 shows what some candidates included in their plans to show how they would interpret their results to answer the question set (checking point Q). Once variables were controlled (e.g. the use of a water-filled heat shield to control temperature), precautions to ensure reliability taken, and hazards identified, a clearly written account would generally score well. A significant minority of candidates was convinced that they should time how long it takes for the indicator to turn colour; they failed to appreciate the need to find the light intensity at which the indicator did *not* change colour.

Some candidates gave full accounts of their preliminary work prior to giving full descriptions of their plans. This is unnecessary. There is a mark for stating *how* the preliminary work has influenced the plan. If this mark point is not awarded for stating how preliminary work helped to inform the plan, then it may be awarded for stating how a quoted source has influenced it (see checking point J in the mark scheme for this Planning Exercise). Candidates should note that the word preliminary is an adjective and not a noun. Spell checkers failed to spot some interesting comments. Candidates often waited for five 'minuets' before taking readings.

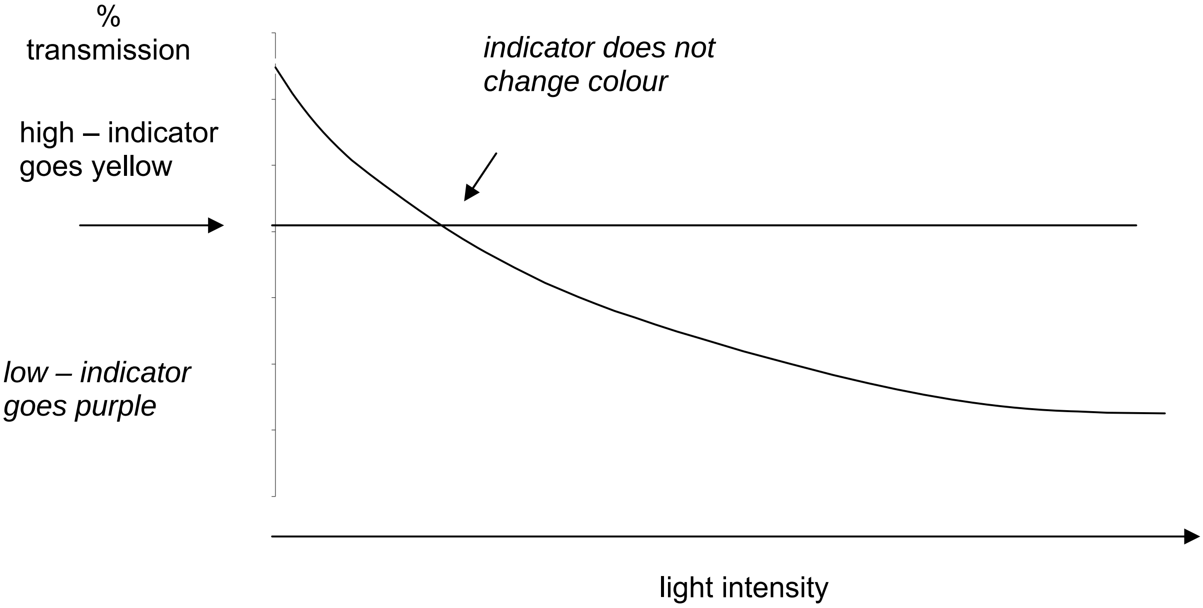

Fig. 1

Practical Test

Q.1 *(a)* This question asked candidates to investigate the effects of different wavelengths of light on the rate of the light dependent reaction of photosynthesis using 2,6-dichlorophenolindophenol (DCPIP) as an artificial hydrogen acceptor. The majority of candidates provided clearly tabulated results that conformed to those expected and, deservedly, most candidates scored highly.

(b) This question was mostly well answered. Most candidates realised that tube 1 was a control to confirm that the dye was necessary for a colour change and that the tube could be used to gauge when the dye had changed colour in the remaining tubes. Rather fewer appreciated that the purpose of the foil-wrapped tube 2 was to show that light was necessary for the colour change.

(c) Even fewer candidates appreciated the need for a tube with just the dye to show that the leaf extract was also required for the colour change.

(d) This was well answered with most candidates including light intensity, realising perhaps that to change the colour or wavelength of light without changing its intensity required something a little more sophisticated than a piece of coloured plastic. In the light of the planning exercise, most candidates also realised that temperature was not controlled.

(e) A significant number did poorly here, either overlooking the significance of buffering and chilling the extract before it was used, or perhaps simply overlooking the synoptic element to this paper. Candidates were expected to refer to maintaining a constant pH (buffering) and to the reduction in enzyme activity. They also gained a mark if they referred to the activity of lysosomal enzymes.

(f) Most candidates answered this straightforward question correctly.

(g) This question discriminated well with a surprising number of candidates neither appreciating which colours/wavelengths the filters transmitted nor which the pigments absorbed. Quite a few thought that the green filter reflected green light so reducing the light available to the chlorophyll. They thought that chlorophyll normally absorbs green light.

(h) Many candidates did not pick up on the reference to water potentials (despite the photographic evidence of the result); this again introduced a synoptic element that candidates missed. An alarming number of those who realised that the chloroplast envelope had disappeared referred to the loss of the cell membrane or cell wall.

Teaching tip

Candidates could be set the task of comparing electron micrographs of intact chloroplasts and the electron micrograph of lysed chloroplasts used in *Q.1* of this Practical Test. A suitable image of lysed chloroplasts is available at:

http://aer2.sbc.edu.hk/~bio/pic4web/cell%20biology/lysed%20chloroplast.jpg

and also in Taylor, D.J., Green, N.P.O. and Stout, G.W. (1997) *Biological Science 1 and 2.* 3rd Edition. Cambridge. CUP. Page 222.

Q.2 This question returned to the idea of sun and shade leaves. Candidates made imprints of the lower surface of sun and shade leaves of ivy, *Hedera helix*.

(a) The drawings of the imprints varied in quality. The technique of using nail varnish painted over the leaf surface for showing stomata is reasonably foolproof. Candidates were rewarded if they gave clean lines without any shading. Good candidates made accurate drawings of what they observed. However, the technique does not allow nuclei or chloroplasts to be observed but these were present in a number of drawings.

(b) Since candidates were to suggest which type of leaf had a greater stomatal density, either alternative was acceptable and marks were given for justifying their answer. However, according to Lowson's Botany (1) 'In general the distribution of stomata . . . is greater where the light intensity is less', but this assumes water conservation is not a problem. Ivy, being an evergreen, may have problems with conservation of water and this may be an influencing factor.

(c) Nearly all candidates made two sets of five counts and calculated a mean.

(d) Though no one candidate identified all the marking points on the mark scheme they were considered by the candidates as a whole. A number dwelt on the limitations introduced by gathering leaves in a woodland habitat so perhaps the word procedure should have been highlighted in the question.

1. Simon E., Dormer K. and Hartshorne J (1977) *Lowson's Botany*. 15th edition. London. University Tutorial Press. Page 151.

Advanced Subsidiary GCE Biology (3881)

Advanced GCE Biology (7881)

January 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	Total Number of Candidates
2801	Raw	60	49	43	38	33	28	0	17378
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	47	42	38	34	30	0	6036
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	95	84	73	63	53	0	887
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	95	84	73	63	53	0	1267
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	91	81	72	63	54	0	923
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	64	56	48	41	34	0	10479
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	67	59	51	43	36	0	175
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	69	60	52	44	36	0	50
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	64	59	54	49	44	0	238
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	67	60	53	47	41	0	216
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	63	57	51	45	39	0	379
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	93	83	73	63	54	0	1051
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	93	83	73	63	54	0	77
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	81	73	65	58	51	0	267
	UMS	120	96	84	72	60	48	0	

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

•	Maximum Mark	A	B	C	D	E	U
3881	300	240	210	180	150	120	0
7881	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

•	A	B	C	D	E	U	Total Number of Candidates
3881	16.0	33.6	55.0	76.0	94.6	100.0	1012
7881	14.5	48.7	75.1	90.7	97.4	100.0	221

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