GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Combined Mark Schemes And Report on the Units

June 2005

3881/7881/MS/R/05

OCR (Oxford, Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annersley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

CONTENTS

Advanced GCE Biology (7881)

Advanced Subsidiary GCE Biology (3881)

MARK SCHEMES ON THE UNITS

Advanced Subsidiary GCE Biology (3881)

Advanced GCE Biology (7881)

Reports on Units

Mark Scheme 2801
June 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** mitochondrion **;** **A** cristae / matrix **B** nuclear envelope / nuclear membrane **;** **A** nucleus **C** nucleolus **;** **A** heterochromatin **D** (cell) wall **;** **A** middle lamella	**4**
				[Total: 4]
2	**(a)**		*similar ~ allow valid similarities such as* same number **,** carbon / oxygen / hydrogen (atoms) / OH (groups) **;** **A** hexose same formula **;** **R** similar / molecule ring / ring with O (atom) in it **;** correct ref CH_2OH **;** contain C, H and O **;**	**1 max**
			different ~ assume candidate is writing about fructose unless told otherwise *allow valid differences such as* (fructose has) 5-membered ring / glucose has 6-membered ring **;** **R** pentose (*4 C in ring v. 5C in ring / furanose v. pyranose in glucose*) (in fructose) 2 CH_2OH side chains / 1 CH_2OH side chain in glucose **;** different angles between C atoms **;** ref alignment of H and OH groups (on carbon 3 / carbon 4) **;** (in fructose) carbon 1 not in ring / carbon 1 in ring in glucose **;**	**1 max**
	(b)	**(i)**	glycosidic **;** **NOT** *gl<u>u</u>cosidic*	**1**
		(ii)	**1** carbon positions 1 and 2 on glucose and fructose **;** **2** formation of **,** water / H_2O **,** from 2 OH groups (plus separation) **;** **3** oxygen bridge / – O – **,** shown **;**	**2 max**
	(c)	**(i)**	add / use **,** Benedict's (reagent) **;** heat **;** **NOT** use water bath alone (blue to) green / yellow / orange / brown / red (precipitate) **;**	**3**
		(ii)	hydrolysis **;** boil / heat **,** with (dilute) **,** acid / HCl **;** **A** (dil) NaOH (add) hydrolytic enzyme / sucrase / invertase **;**	**1 max**
				[Total: 9]

Question			Expected Answers	Marks
3	(a)		active site correctly labelled **;**	1
	(b)		**C ;**	1
	(c)		<u>shape</u> of active site **;** <u>complementary</u> **;** correct shape / correct molecule / correct substrate / **C ,** will **,** fit / form ESC **;** any other shape / any other molecule / any other substrate / **A** / **B** / **D** / **E ,** will not **;** *award 2 marks if candidate writes '<u>only</u> correct …..')*	3 max
	(d)		*look for points relating to the <u>substrate</u> changing shape* *ignore refs to enzyme changing shape* puts strain on the bonds in the substrate / bonds break more easily **;** **A** weakens bonds lowers activation energy **;** AVP **;** e.g. referring to anabolic reaction	1 max
				[Total: 6]
4	(a)	(i)	fructose **;**	1
		(ii)	glucose **;**	1
		(iii)	(passive) diffusion **;**	1
		(iv)	*ignore ref to, movement of sugars / solute potential* **1** surrounding solution higher concentration (of solutes) than cell contents **;** *ora* **2** cell has higher <u>water potential</u> **;** *ora* **3** water moves out of cell **;** **4** (so) volume decreases **;** **5** (water has moved) by osmosis **;** *only award in relation to water* **6** down <u>water potential</u> gradient / from high Ψ to low Ψ **;**	4 max
	(b)		active transport / facilitated diffusion / bulk transport / endocytosis / etc. **;** **A** using channel proteins, etc **NOT** osmosis	1
				[Total: 8]

Question			Expected Answers	Marks
5	(a)	(i)	niche **;**	**1**
		(ii)	population **;**	**1**
		(iii)	community **;**	**1**
	(b)	1	sun is the energy source (for the system) **;**	
		2	producers / (green) plants **,** trap / use / absorb (sun's energy) **;**	
		3	<u>photosynthesis</u> **;**	
		4	not all energy trapped <u>and</u> reason **;**	
		5	energy used for **,** plant metabolism / plant processes / e.g. **;** **A** respiration	
		6	so this energy not **,** passed on / available **,** to consumer **;**	
		7	(some energy) used for **,** growth / storage **;**	
		8	so this energy is **,** passed on / available **,** to consumer **;**	
		9	1^{o} consumer / herbivore **,** eats **,** producer / plant **;**	
		10	some producer **,** not edible / not accessible / e.g. **;**	
		11	some **,** not digested / egested / lost as faeces **;**	
		12	2^{o} consumer / carnivore / omnivore **,** eats **,** 1^{o} consumer / herbivore **;**	
		13	some parts of animal not edible / e.g. **;**	
		14	energy used by animal in moving (to feed) **;**	
		15	energy **,** used / lost **,** in **,** digestion / excretion / sweating / e.g. **;** **A** respiration	
		16	transfer / loss **,** to **,** decomposers / bacteria / fungi / saprotrophs **;**	
		17	energy lost as <u>heat</u> from respiration **;**	
		18	net productivity = gross productivity – respiration **;**	
		19	some ref to estimate of efficiency of transfer (a general statement) **;**	
		20	quote of (comparative) figures from diagram **;**	
		21	manipulation of figures to illustrate a point **;** **NOT** 6612 and 14198	
		22	AVP **;**	
		23	AVP **;** e.g. loss out of ecosystem another manipulation of figures available energy limiting length of chain	**max 9**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 13]

Question		Expected Answers	Marks
6	(a)	*mark first two answers unless neutral* *e.g. cell division / cell replication / produces identical cells* produces **,** genetically identical cells / clones **;** **A** same genes asexual reproduction **;** maintains **,** chromosome number / ploidy / AW **;** growth (of organism) **;** **NOT** 'of cells' replacement of cells / repair (of tissues) **;** **NOT** 'repair of cells'	**2 max**
	(b)	*ignore refs to early and late stages* **NOT** *ref to I and II*	
	(i)	telophase **;**	**1**
	(ii)	metaphase **;**	**1**
	(iii)	prophase **;**	**1**
	(iv)	anaphase **;**	**1**
	(v)	anaphase **;**	**1**
	(c) (i)	one set of (parental) chromosomes / one copy of each chromosome **;** **A** half the diploid number / half of 2n / one chromosome from each pair **NOT** half chromosomes / half the number number of chromosomes in a gamete **;** **A** 23 <u>chromosomes</u>	**1 max**
	(ii)	maintain / restore **,** same chromosome number / ploidy / 46 chromosomes / diploid number **;** ref to **,** fusion / fertilisation **;** prevents **,** doubling / increase **,** of the chromosome number (each generation) **;** **R** just 'too many' combining two (single) sets (will restore correct number) **;** not just n	**2 max**

[Total: 10]

Question			Expected Answers	Marks
7	(a)		cheaper **;** ref to compatibility / less chance of rejection / fewer side effects **;** stated ethical issue **;** e.g. don't need to kill animals / removes religious objections ref to contamination / easier to purify / ref to disease **;** consistent quality **;** more effective (as human in origin) **;** production level can meet demand / reliability of supply / faster production **;** *ignore greater production*	**2 max**
	(b)	(i)	glycoprotein **;**	**1**
		(ii)	(cell) recognition / antigen **;** attachment / receptor **;** **NOT** carrier holds enzymes **;** AVP **;** e.g. stabilises membrane in aqueous environment	**1 max**
	(c)	(i)	restriction (enzyme) / endonuclease **;**	**1**
		(ii)	*this may be answered in the context of inserting into a plasmid.* cut DNA with restriction enzyme **;** ref to sticky ends **;** <u>complementary</u> **;** base pairs / CCC and GGG / C pairing with G / alternative **;** (DNA) ligase / ligation **;** ref to bonding / AW **;** e.g. hydrogen *or* phosphodiester / sugar-phosphate AVP **;** e.g. add sticky ends to blunt ends cut both at the same place	**3 max**
		(iii)	codes for **,** protein / polypeptide / enzyme **;** **A** ref to, protein synthesis / transcription / translation (enzyme) catalyses / causes **,** condensation / formation of glycosidic bonds / reaction (between **,** mannose / sugars) **;**	**2**

[Total: 10]

Mark Scheme 2802
June 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)	*Vibrio cholerae / V. cholerae / Vibrio* **;**	1
	(b)	pass out of (infected) person in faeces / AW **;** contaminate water supply **;** water used to irrigate crops **;** **A** idea of contamination faeces / AW, used to fertilise crops **;** infected people handle, food / cooking utensils (without washing hands) **;** infection by mouth / drink contaminated water / eat contaminated food **;**	**max 3**
	(c)	lack of, education in / knowledge of, hygiene **;** poorer sanitation **;** lack of sewage treatment **;** raw sewage used to, irrigate / fertilise, crops **;** lack of water treatment / AW **;** unable to control outbreaks (due to lack of rehydration therapy) **;** AVP **;** e.g. qualified economic statement AVP **;** ref to natural disasters ref to, civil unrest / migrants	**max 3**

[Total: 7]

Question		Expected Answers	Marks
2	(a)	nicotine **;**	**1**
	(b)	*any two from*	
		carbon monoxide / CO **;** binds to haemoglobin / forms carboxyhamoglobin **;** Hb has greater affinity for CO / CO binds more strongly than oxygen **; A** irreversibly reduces oxygen carrying ability / amount of oxygen that can be carried **;** 3 max	
		tar **;** accumulates, in lung / on alveolar surface **;** increases, diffusion barrier / thickness of barrier between air and blood / AW **;** reduces rate of diffusion / gaseous exchange more difficult / AW **;** causes cancer / carcinogenic **;** paralyses / damages cilia **; R** kills cilia increases mucus production / AW **;** increases chance of infection **;** production of scar tissue **;** reduces elasticity of the airway / (oxidants) increase activity of elastase (emphysema) **;** 3 max	
		carcinogen **;** causes cancer **;** changes DNA / mutation **;** uncontrolled mitosis / no programmed cell death / no apoptosis **;** tumour **;** 3 max	
		AVPs 2 x 3 max e.g. arsenic **;** interferes with cytochromes in respiratory chain **;** prevents ATP production **;** replaces phosphate group in ATP **;**	
		benzpyrene **;** adheres to surfaces **;** cancer-causing **;**	
		A nicotine if not given in (a)	**5 max**

(c) **(i)** % heavy smokers rises from, professional / gp 1, to, unskilled manual workers / gp 6 / AW **;** **A** statements comparing groups 1 and 6

ref to figures used as a comparison **;** **2 max**

(ii) as % heavy smokers increases so does number of people suffering long-standing illness **;**

the relative increase in smoking is far greater than the relative increase in long-standing illness / not a proportional increase / AW **;**

use of figures to illustrate **;**

e.g. smoking increases more than 6 fold while long-standing illness increases less than 2 fold

smoking increases from 3% to 19% while long-standing illness increases from 290 to 420 (per 1000)

AVP **;** e.g. ref to anomalous point **2 max**

(iii) *qualified ref to*

medical services **;**
working environment **;**
living conditions **;**
income **;**
education (about diet / possible relief from long-term illness) **;**
diet **;**
work-related injury **;**
alcohol intake **;**
(work related) stress **;**
(aerobic) exercise **;** **2 max**

[Total: 12]

Question			Expected Answers	Marks
3	(a)	1	genetic, testing / screening **;**	
		2	for inherited disease / AW **;**	
		3	(test to see if) individual is carrier **;**	
		4	premarital testing / predict if (potential) offspring may inherit the disease **;**	
		5	antenatal testing **;**	
		6	ref to termination **;**	
		7	embryo selection (to ensure embryo healthy) **;** **R** selection of sex	
		8	(test for genes that contribute to) diseases that develop later in life **;**	
		9	those with genes given, advice to limit effects / counselling **;**	
		10	faster / earlier, diagnosis **;**	
		11	develop more, effective / efficient, drugs (to combat disease) **;**	
		12	drugs have direct effect, on genes / protein made from specific gene code **;**	
		13	gene therapy / correct the base sequence of faulty gene **;**	
		14	economic implications / AW **;**	
		15	AVP **;** e.g. ref. to method used / use of gene probes / biopsy	
		16	AVP **;** allows targeting of drug treatment	**4 max**
	(b)		anxiety about (future) health / may not want to know / AW **;**	
			many diseases we can test for have no treatments **;**	
			discrimination by employers **;**	
			discrimination by, insurance companies / banks **;**	
			reliability of tests in question **;** **A** false, positive / negative, result	
			example of disease given in context **;**	
			cost to, NHS / government **;**	
			rich people can benefit / poor will not benefit **;**	
			AVP **; ;** e.g. moral issues associated with embryo selection eugenics parents feelings towards child presence of allele may not cause disease / ref to multifactorial diseases ref to storage of data and freedom of information / invasion of privacy / question of paternity	
			R 'playing God' / cloning	**4 max**
				[Total: 8]

Question			Expected Answers	Marks
4	(a)		eating too much **;** high, fat / sugar / carbohydrate / alcohol (in diet) **;** energy intake greater than use **;** insufficient exercise **;** AVP **;** e.g. genetic predisposition underactive thyroid	**2 max**
	(b)		decrease in % underweight **;** decrease in % acceptable **;** increase in % overweight **;** large / great / dramatic / significant, increase in % obese **;** use of figs to illustrate one change **;**	**4 max**
	(c)	**1**	high level of saturated fat in diet ;	
		2	animal fat / red meat / dairy products ;	
		3	high cholesterol (in blood / body) ;	
		4	lack of, vitamin E / antioxidants ;	
		5	high salt in diet ;	
		6	obesity linked to, high blood pressure / hypertension ;	
		7	damage to artery, walls / endothelium ;	
		8	cholesterol transported in lipoproteins ;	
		9	cholesterol deposited in artery walls ;	
		10	in coronary arteries ;	
		11	atherosclerosis / atheroma ;	
		12	formation of, plaques / fatty streaks ;	
		13	hardening / loss of elasticity (of artery wall) ;	
		14	roughens lining / increases friction ;	
		15	clot formation / thrombosis / thrombus ;	
		16	narrows / restricts, lumen ;	
		17	reduced / restricted, blood flow / oxygen, to heart muscle ;	
		18	heart (muscle), under stress / works harder ;	
		19	angina / heart attack / myocardial infarction / heart failure / hypertrophy ; **R** CHD	
		20	AVP ; e.g. aneurism in aorta	
		21	AVP ; low density lipoproteins (LDL) associated with deposition high density lipoproteins (HDL) associated with less deposition	**7 max**
			QWC – clear well organised using specialist terms ;	**1**

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

saturated	coronary	cholesterol	lumen
vitamin E	atherosclerosis		antioxidants
blood pressure		plaque	hypertension
endothelium		thrombus	thrombosis
angina	myocardial infarction		atheroma
(low density / high density) lipoprotein			

[Total: 14]

Question			Expected Answers	Marks
5	(a)		122 ; **A** if not in box	**1**
	(b)	(i)	(pulse rate) increases **;** use of figures to demonstrate increase **;**	**2**
		(ii)	increased respiration **;** in muscles **;** requires more, oxygen / glucose **;** increased carbon dioxide production **;** carbon dioxide removed in blood **;** cardiac output must increase / AW **;** lactate, produced / transported to liver **;** **A** lactic acid	**3 max**
	(c)		**D ;** *max 3 for reasons* high resting pulse rate **;** heart rate / pulse rate, goes higher than others / very high **;** **A** pulse rate always high figures to demonstrate pulse rate point **;** blood pressure higher at rest **;** blood pressure, rises to higher than others / highest **;** **A** blood pressure always higher use of figures to demonstrate blood pressure point **;**	**4 max**
	(d)		fat more likely to, compress / constrict, blood vessels **;** atherosclerosis more likely **;** greater friction **;** (therefore) blood pressure higher **;** more weight means more work done (by muscles during exercise) **;** more oxygen needed (by respiring tissues) / more CO_2 needs to be removed **;**	**2 max**

[Total: 12]

Question			Expected Answers	Marks
6	(a)	(i)	**R ;**	**1**
		(ii)	**R** / binding site / variable region, has specific, amino acid sequence / primary protein structure **;** **R** / binding site / variable region, has specific shape **;** complementary to / matching (part of), antigen **A ;** **A** lock and key idea	**2 max**
	(b)	(i)	*award two marks if correct answer (17.2 / 17) is given* *award one mark for calculation – if answer incorrect or left at 82.8* 92/100 x 90 = 82.8 100 – 82.8 **;** 17.2 **;** **A** 17%	**2**
		(ii)	difficult to diagnose **;** not all / enough, of population vaccinated **;** **A** need 93-95% vaccination **A** ref to herd, vaccination / immunity poor response to vaccine / only 90-95% vaccinated people have protection **;** *ora* boosters needed / difficult to trace those who need boosters **;** *ora* migrants can (easily) bring measles into a community **;** AVP **;** e.g. length of time vaccination remains effective / *ora* AVP **;** measles mutates more frequently / *ora* people less worried about measles so don't get vaccinated / *ora* concerns about link of MMR to, side effects / autism	**2 max**

[Total: 7]

Mark Scheme 2803/01
June 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)	cut shoot under water **;** insert into apparatus under water / AW **;** full of water / no extra bubbles / no airlocks **;** *applies to plant / apparatus* cut shoot at a slant **;** dry off leaves / AW **;** ensure , air- / water- , tight joints / AW **;** use a , healthy / AW , shoot **:** allow time to acclimatise / AW **;** keep , condition(s) / named condition(s) , constant **;** measure per unit time / AW **;** shut screw clip **;** ref to scale **;** e.g. note where bubble is at start / keep ruler fixed **R** '*move bubble to end' ideas*	**4 max**
		(ii)	water uptake / AW **;** **R** water used	**1**
	(b)	(i)	103 **;** **R** decimals	**1**
		(ii)	***R*** *refs to water or water particles* **1** boundary layer / saturated air / water vapour / AW, around, leaf in still air / **A ;** **2** (which) fan / wind , removes / reduces **;** *ecf wrong ref to water* **3** ref steeper water potential gradient **;** **R** concentration gradient **4** (therefore) faster / greater / more / AW, evaporation / diffusion **;** *must be linked to above*	**3 max**
	(c)		set up in same, (environmental) condition(s) / named condition **;** calculate the rate per unit area of leaf / idea of getting same area of leaf in both **;** detail of how this could be done **;** e.g. draw round all leaves on graph paper replicates **;** both picked at same time / same degree of turgidity / AW **;** run for the same time / AW **;**	**2 max**

[Total: 11]

Question			Expected Answers	Marks
2	(a)	(i)	29 **;**	1
		(ii)	fetus gains oxygen from, maternal blood / mother / AW **;** across <u>placenta</u> **;** partial pressure / AW, of oxygen in placenta is low **;** 2-4 kPa **;** both in the fetal and maternal parts / AW **;** maternal haemoglobin releases oxygen **;** fetal haemoglobin has a high(er) affinity for oxygen **;** ref to maintaining diffusion gradient **;** oxygen needed for , respiration / energy release / AW **;** **R** energy production	**4 max**
	(b)		*accept answer written in terms of adult haemoglobin* affinity (of fetal haemoglobin) would be too high **;** would not release oxygen readily enough / AW **;** ref to idea that adult females will need difference with their fetuses in due course **;** ref to high partial pressure of oxygen in lungs allowing loading with Hb with lower affinity **;**	**2 max**

[Total: 7]

Question			Expected Answers	Marks
3	(a)	(i)	**A** = pulmonary artery **;** **B** = bicuspid valve **;** **A** atrioventricular / AV, valve *mark first on list* **R** 'arterio…'	2
		(ii)	arrows correctly positioned on left side only **;**	1
		(iii)	**1** wave of excitation / impulse / AW, stops **;** **2** at the AVN / no transmission to heart apex / AW **;** **3** no ventricular, contraction / systole **;** **4** fibrillation / described e.g. heartbeat, unco-ordinated / irregular / no rhythm **;** **5** blood not squeezed , upwards / out of ventricles / AW **;** **A** ref to pressure change **6** atrial contraction continues **;**	2 max
		(iv)	*credit answers written in context of what would happen if there was a hole* stops oxygenated and deoxygenated blood mixing **;** ensures, (fully) oxygenated blood gets to the body / deoxygenated blood to lungs **;** ref to possible drop in blood pressure if hole present **;** ref to allowing different pressures being maintained on each side / AW **;** AVP **;** e.g. prevention of rise in heart rate if two sides not separated	2 max
	(b)	**S1**	three named layers **;**	
		S2	(tunica intima / inner layer / AW) endothelium **;**	
		S3	(tunica intima / inner layer / AW)) squamous (epithelial) cells **;**	
		S4	(tunica media / middle layer / AW), thin / narrow / AW **;**	
		S5	(tunica media / middle layer / AW), muscle and elastic tissue **;** **R** large amounts *refs to collagen neutral*	
		S6	(tunica externa) collagen **;** **R** if muscle mentioned here	
		S7	valves **;**	
		S8	large / wide, lumen **;** ***max 4 S marks*** *credit S marks from labelled diagrams*	
		F9	smooth , endothelium / epithelium / lining / AW, reduces friction **;** **R** if smoothness related to muscle	
		F10	credit one reference to, thinness / strength , of wall withstanding low pressure **;**	
		F11	ref to thinness of wall to allow skeletal muscle to squeeze vein **;**	
		F12	valves to prevent backflow / AW **;**	
		F13	ref to, wide lumen / walls distending , to accommodate large volume of blood **;**	
		F14	detail of this e.g. relationship between large volume and slow flow rate **;** ***max 3 F marks***	6 max
			QWC – legible text with accurate spelling, punctuation and grammar ;	1
			[Total:	**14]**

Question		Expected Answers	Marks
4	(a)	water moves down a water potential gradient / AW **;** by osmosis **;** (ref to roots being below –50 kPa means) water will enter (the root) **;**	**2 max**
	(b)	*function must match adaptation, adaptation can stand alone* *assume answer is about water vapour unless clearly wrong e.g. water droplets* covered in hairs **;** reflect heat *or* water vapour, trapped / not blown away **;** thick, waxy layer / cuticle / AW **;** reduces loss (via the epidermis) / reflects heat **;** **R** no loss *if cuticle related to reflective nature, 'thick' not needed* small / AW , leaves **;** **A** no leaves (e.g. cacti) / needles / spines / spikes **R** thorns reduced surface area for loss / reduces number of stomata **;** **R** *ref to spines etc related to preventing consumption by herbivores* sunken stomata / AW **;** ***A*** *substomatal chamber hairs as an alternative here* water vapour, trapped / not blown away **;** rolling up of leaves / curled leaves **;** less surface area / stomata on inside *or* water vapour, trapped / not blown away **;** small air spaces in the mesophyll **;** quickly become fully saturated / reduced area for loss **;** stomata, shut in day / open at night / AW **;** day hotter / night cooler **;** AVP **;** e.g. reduced stomatal number plus reason AVP **;** timed leaf fall rosette of leaves close to ground	**4 max**
			[Total: 6]

Question		Expected Answers	Marks
5	(a)	diffusion / down a (concentration) gradient **;** dissolves in the water film / goes into solution / AW **;** crosses , cell(s) / named cell / cytoplasm / plasma / membrane(s) / wall of alveolus *or* capillary **;**	**2 max**
	(b)	*two from* biconcave / AW **;** large surface area to volume (ratio) **;** optimum oxygen uptake / fast diffusion **;** ora for oxygen release at tissues **max 2** for this feature small / about 7μm (diameter) / about same size as capillary / AW **;** all haemoglobin close to surface / fast diffusion / short diffusion path / capillaries can be small to get close to all tissues / (RBC) close to capillary wall for exchange / AW **;** no nucleus / no *or* few organelles **;** maximum space for, oxygen carriage / haemoglobin **;** elastic / flexible / pliable , membrane **;** allows them to go along capillaries **;**	**4 max**
	(c)	large nucleus / very little cytoplasm / non-granular cytoplasm / about the same size as red blood cells but with a nucleus **;** **A** from a diagram **R** nucleus unqualified / bean-shaped nucleus / lobed nucleus *only accept first answer if more than one feature listed,* ***BUT*** *'large' alone is not a feature, so* ***R*** *e.g. large bean-shaped nucleus*	**1**

[Total: 7]

Mark Scheme 2803/03
June 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

Planning Exercise

The mark scheme for the planning exercise is set out on the next page. 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

The mark scheme for Questions 1 and 2 for the Practical Test are on the pages following the mark scheme for the Planning Exercise.

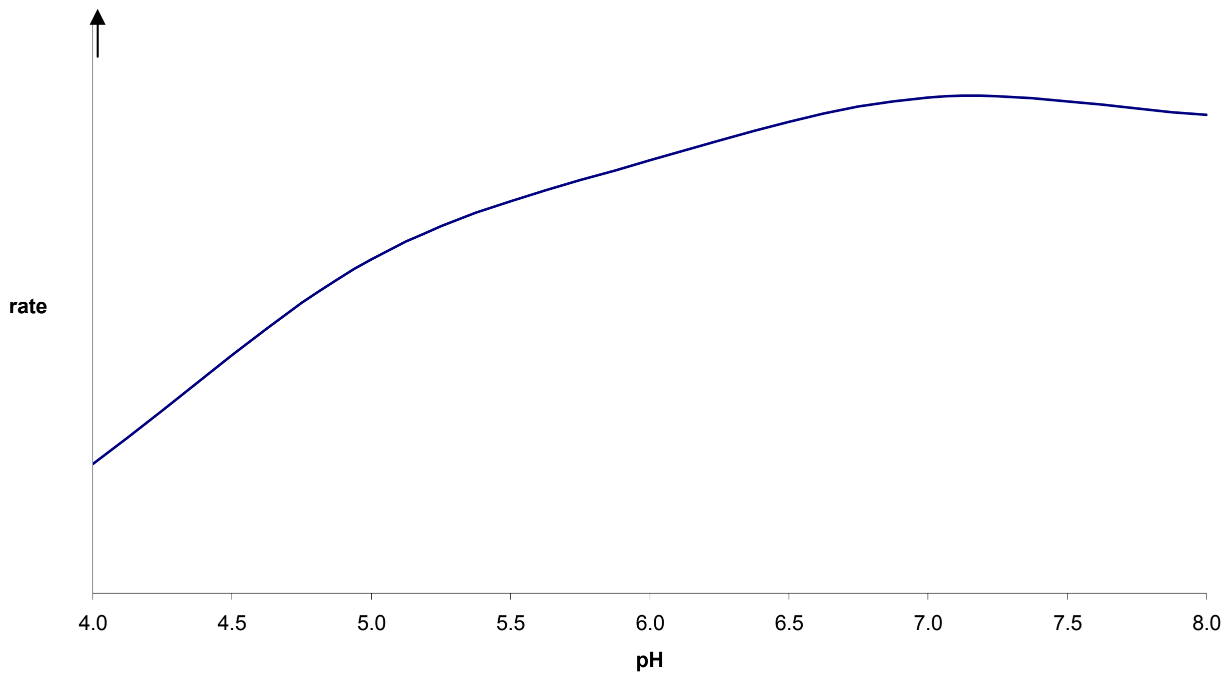
AS Biology. Planning exercise

Checking Point		The candidate
A	P.1a	plans a suitable procedure that involves growing plants in nutrient solutions containing varying concentrations of phosphate and carrying out squash preparations to observe mitosis **;**
B	P.1a	gives a prediction linking concentration of phosphate with number of cells in mitosis (may be a graph) **;**
C	P.1b	selects suitable equipment and materials to include named plant, microscope, named stain, slides and cover slips **;**
D	P.3a	states a role of phosphate in cells, e.g. for ATP / DNA / RNA / phospholipid **; R** nucleic acid
E	P.3a	identifies at least 2 key factors to control during growth, e.g. temperature, light intensity, age of plants, type of plant, nutrient medium, volumes, length of root, other ions / nutrients, time for growth **;**
F	P.3b	decides on appropriate number of measurements to take: minimum of **five** different phosphate concentrations (may include 0) **;**
G	P.3b	decides on an appropriate range of phosphate concentrations with at least one below 0.25 g dm^{-3} / 0.025% **; A** 0.1 mol dm^{-3}
H	P.3b	describes ways of obtaining reliable results by including replicates, e.g. at least three roots per solution **;**
I	P.5a	uses appropriate scientific knowledge and understanding in developing a plan, e.g. a **description** of at least one role of phosphate in cells which must be linked with mitosis / cell division (replication, RNA structure, DNA structure, ATP, phospholipids, cell membranes) **;**
J	P.5a	uses preliminary work, previous practical work or identified secondary source in developing a plan **;**
K	P.5a	gives a risk assessment and a safety precaution for **either** acid **or** stain **;**
*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. count the same number of cells from each sample, taking photographs, way to avoid counting same area twice, calculate % of cells dividing (mitotic index) **;**
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 with units for phosphate concentration and number / % of cells in mitosis **; A** from preliminary results
*P**	*P.7a*	*uses spelling, punctuation and grammar accurately (QWC) ;*
Q	P.7b	explains how data would be interpreted to find answer to the investigation, e.g. a correlation between phosphate concentration and number / % of dividing cells **; A** a graph
R	P.7b	comments on problems with precision, e.g. difficulty in locating dividing cells in squash preparations / difficulty in identifying cells in early and late stages of mitosis / preparation of solutions / preventing evaporation that would alter phosphate concentration **;**
S	P.7b	comments on problems with reliability, e.g. difficulty in sampling same region of root in each preparation **;**
T	P.7b	comments on validity, e.g. seeds, garlic cloves may store phosphate / need to vary phosphate concentration but keep concentration of the other ions constant **;**

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**

An example for Q.1(a) and (e)

pH	time taken for discs to rise / s		mean time taken for discs to rise / s
	first disc	second disc	
4	36.03	37.13	37.13
5	15.77	12.93	14.35
6	12.06	10.00	11.03
7	9.13	10.13	9.63
8	9.67	10.29	9.98



Question		Expected Answers	Marks
1	(a)	*table* table format with column/row headings – pH and time **;** pH in left hand column (ignore tube numbers) **;** units (seconds) in, column/row, heading(s) **; A** minutes **R** if in body of the table two sets of results given **;** means calculated **;**	5
	(b)	pattern / trend, described **; A** 'no trend' if supported by data in table data quote with pH and time **;** anomalous result(s) identified **;**	max 2
	(c)	hydrogen peroxide, decomposed / broken down, to form oxygen **;** (oxygen) bubbles collect, beneath the disc(s) / in the potato / AW **;** ref to, density / buoyancy **; A** 'float' **R** 'lighter'	3
	(d)	*accept ora for these points where appropriate* correct ref to optimum pH in context of results given **;** catalase functions, over wide range of pH / at all the pH values tested **;** ref to denaturation **;** e.g. of a pH in which, catalase / enzyme, is less active **;** pH increases, concentration of H^+ decreases **;** ionic / hydrogen, bonds break **; A** change in charge distribution between (amino acid), R groups / side chains **;** 3D / tertiary, structure disrupted **;** shape of active site changes **;** not complementary to substrate **; A** substrate does not fit (fewer) enzyme-substrate complexes formed **;**	max 6
	(e)	*sketch graph* *curve / line represents* ***rate*** *of reaction* axes labelled with pH and rate **;** pH on horizontal axis **;** *ignore what is on the vertical axis* use of pH values **;** line for <u>rate</u> corresponds with results from table **;** *for the last point assume pH goes from 4.0 to 8.0 if no values given* *if line starts at the origin assume that this is the lowest rate*	4

(f) *credit these points wherever given in the answer*

1 discs not all same thickness **; A** size / surface area
2 difficult, to time accurately / to judge when disc begins to 'flip' / AW **;**
3 not enough, repeats / replicates **; A** only one repeat
4 no controls, suitably qualified **;**
5 not at constant temperature / AW **;**
6 potato discs left in buffers for different lengths of time **;**
7 first disc breaks down hydrogen peroxide, so lower concentration for second disc **;**
8 problems with measuring volumes, described **;**
9 cross contamination described **;**
10 ref to, range / intermediate values, of pH **;**
11 AVP **;** *must be a criticism* **max 3**

(g) *improve*

1 use a control with, inert disc / boiled potato / water **;**
2 use fresh hydrogen peroxide for each disc **;**
3 leave discs in buffer solution for same length of time **;**
4 calculate rate as 1/t **;**
5 use a <u>thermostatically-</u>controlled water bath **;**
6 carry out more, repeats / replicates **;**
7 check pH with, pH meter / indicator **;**
8 use, homogenised / 'liquidised', potato **;**
9 filter / spin in a centrifuge / AW **;** (to make a solution of catalase)
10 measure, volume of, gas / oxygen **; A** count bubbles / mass *or* weight loss
11 per unit time **;**
12 detail of method / apparatus **;** e.g. gas syringe, syringe barrel, gas burette etc
13 ref to, age / part, of potato **;**
14 ref to way of cutting accurately **;**
15 use separate syringes / glass rods (for each solution) **;**
16 use graduated pipettes for measuring volumes **;**

extend

17 use wider range of pH / use pH > 8.0 **;**
18 use intermediate values of pH (between two highest readings) **;**

19 AVP **;** e.g. repeat with other types of potato, using same mass of potato
20 AVP **;** **max 7**

[Total: max 24]

Question			Expected Answers	Marks
2	(a)		area around the outside **;** *ignore skin which may have been left on* *accept shading alone or labels 'black' / 'starch'*	**1**
	(b)	(i)	*drawing* elongated cell **;** clear, continuous lines **;** starch grains of different sizes **;** at least one elongate **;** *labels* nucleus / nucleolus **;** cell wall **;** starch grain(s) **;** cytoplasm **;**	**max 5**
		(ii)	*annotations – if structure not labeled allow if in correct place* starch grains – blue / black / blue-black **;** **R** 'dark' **A** purple nucleus / cytoplasm / cell wall – yellow **;** **R** 'light' **A** brown / 'straw-coloured'	**2**
	(c)	(i)	*award two marks if correct answer is given and no working shown* $\frac{20\,000}{50}$ **;** (x) 400 **;** *allow one mark for ecf if length is given as 2 000 (x40) or 200 000 (x4000)*	**2**
		(ii)	higher / better / greater, resolution **;** **A** 'can see, starch grains / other named structure(s), in more detail' can see ultrastructure **;** gives 3D image **;**	**max 1**
	(d)	(i)	insoluble / no osmotic effect **;** energy reserve / used for respiration **;**	**max 1**
		(ii)	*accept ora for amylose* (many) branching points / branched polymer / AW **;** **A** 'it is branched' many 'ends' **;** easy to, add / remove, glucose units **;** **A** more points / places for enzyme to 'work on' more compact / AW **;**	**max 2**

mark (e) and (f) together to max 10

(e) and (f)

mix / stir **;**
leave to stand and decant liquid / filter and use filtrate **;**

add Benedict's solution **;**
boil / heat to 70°C or over **;**
in water bath / AW **;**
time ref **; A** between 1 and 10 minutes
wear, goggles / eye protection **;**

colour change / blue to green *or* yellow *or* red *or* orange **;**
precipitate / cloudiness / turbidity **;**

reducing sugars present **;**
qualified **;** e.g. glucose / other named reducing sugar / monosaccharide **;**
colour change explained **;** e.g. $Cu^{2+} \rightarrow Cu^{+}$ / Cu(II) to Cu(I) / copper ions reduced / CuO formed
final colour indicates concentration of reducing sugar / AW **;**
colour obtained related to stated concentration of reducing sugar **;** **max 10**

[Total: max 20]

Mark Scheme 2804
June 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)**		**S ;** **R ;** **S ;**	
			A – correct names instead of letters	**3**
	(b)		(carry genes for) production of m / t / r, RNA **; A** transcription **R** ribosomes (carry genes for) synthesis of (mitochondrial), proteins / polypeptides **;** (carry genes for) synthesis of (mitochondrial), enzymes / correctly named enzyme **;** ref to mitochondrial replication **;**	**max 1**
	(c)		FAD / NAD **; A** reduced FAD / reduced NAD / AW	**1**
	(d)	**1**	hydrogen split into protons and electrons **;**	
		2	flow of electrons / electrons pass along, ETC / cytochromes **;**	
		3	energy is released **; R** created / produced	
		4	protons pumped (into intermembranal space) **;**	
		5	sets up, electrochemical / proton, gradient **;**	
		6	protons diffuse (down concentration gradient) **;**	
		7	protons flow through <u>protein</u> channel **;**	
		8	site of ATP, synthase / synthetase **; A** ATPase / stalked particle	
		9	energy of proton gradient linked to ATP formation **;**	
		10	ref to chemiosmosis **;**	
		11	oxygen as final electron acceptor **;**	**max 5**
	(e)	**1**	no proton gradient set up **;**	
		2	no proton flow through, ATP synthase / ATP synthetase **; A** ATPase / stalked particle	
		3	no ATP formed **;**	
		4	no ATP for muscle contraction / description of muscle contraction **;**	
		5	cardiac muscle fails / intercostals muscles fail **; R** diaphragm fails	
		6	Krebs cycle stops **;**	
		7	only glycolysis occurs **;**	
		8	lactate poisoning / AW **; R** lactate build up and refs to pain and fatigue	
		9	AVP **;** e.g. 2 ATP (per mol of glucose) formed in glycolysis, no anaerobic respiration in cardiac muscle	**max 3**

[Total: 13]

Question			Expected Answers	Marks
2	(a)		chlorophyll a **;** **A** chlorophyll for one mark as an alternative to chl. a and b chlorophyll b **;** xanthophylls **;** carotenoids / carotene **;**	**2**
	(b)	(i)	thylakoid / lamella / granum **; A** membranes **R** inner membrane	**1**
		(ii)	*must be a comparative statement* different, reaction centre / form of chlorophyll a / absorption wavelengths / 700nm (PS1) and 680nm (PS2) / PS1 mainly on interganal lamellae and PS2 mainly on granal lamellae **;** **R** different pigments **A** cyclic photophosphorylation involves PS1 only **;** **A** PS1 not involved in photolysis / AW **;**	**max 1**
	(c)		ATP reduced NADP **;** **need both for one mark**	**1**
	(d)	**1**	occurs in stroma **;**	
		2	a series of enzyme-controlled reactions **;**	
		3	carbon dioxide fixed by RuBP **;**	
		4	carboxylation **;**	
		5	enzyme is Rubisco **;**	
		6	(unstable) 6C intermediate **;**	
		7	forms (2 molecules) of GP **;**	
		8	forms TP **;**	
		9	using ATP (linked to point 8) **;**	
		10	reduction step **;**	
		11	using reduced NADP **;**	
		12	ref to either ATP or NADP red coming from light dependent reaction **;**	
		13	(most of) TP regenerates RuBP **;**	
		14	rearrangement of carbons to form pentose sugars **;**	
		15	ATP required, for phosphorylation / ribulose phosphate to ribulose bisphosphate **;**	
		16	AVP **;** e.g. TP can be used to form, lipids / amino acids / hexose sugars / suitable named example	**max 7**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 13]

Question			Expected Answers	Marks
3	(a)		*parental genotypes* RrBb x Rrbb **;**	
			gametes RB Rb rB rb Rb rb **;**	
			offspring genotypes RRBb RrBb (RrBb) Rrbb RRbb (Rrbb) rrBb rrbb **;**	
			offspring phenotypes rough black rough white smooth black smooth white **;**	
			expected ratio 3 : 3 : 1 : 1 **;**	
			accept correct gametes, offspring genotypes and offspring phenotypes in Punnett square	
			use ecf except for ratio ***Reject*** *the ratio 6 : 6 : 2 : 2*	
			ratio not a stand alone mark – there must be some correct working to support it	**5**
	(b)	(i)	length of DNA **;** codes for a (specific), polypeptide / protein / RNA **;** found at a, locus / particular position on, a chromosome **;**	**2**
			variety / form of a gene **; R** type of gene **A** type of a gene	**1**
		(ii)	*assume the allele = coat colour allele*	
			(coat colour) gene / alleles, only on X chromosome **;** **A** no (coat colour), gene / allele, on Y chromosome male cats, XY / only have one X chromosome **;** (males have) only one (coat colour) <u>allele</u> / cannot have two (coat colour) <u>alleles</u> **;** need black and orange <u>alleles</u> for tortoiseshell colour **;**	**max 2**
	(c)		**1** ref to <u>operon</u> **;** **2** normally <u>repressor</u> substance bound to <u>operator</u> **;** **3** prevents RNA polymerase binding (at promoter) / prevents transcription **;** **4** lactose binds to <u>repressor</u> **;** **5** changes shape of protein molecule **;** **6** unable to bind (to operator) **;** **7** RNA polymerase binds (at promoter) / transcription occurs / genes switched on **;** **8** production of <u>lactose permease</u> **;** **9** production of <u>beta – galactosidase</u> **;**	**max 5**

[Total: 15]

Question			Expected Answers	Marks
4	(a)		ductless gland **;** secretes hormones **;** **R** excrete (directly) into blood **;**	**max 2**
	(b)	(i)	islets of Langerhans **;**	**1**
		(ii)	<u>glucagon</u> **;**	**1**
		(iii)	insulin **;**	**1**
		(iv)	negative feedback **;**	**1**
		(v)	binds to (glucagon) receptors **;** on cell surface membrane **;** activation of phosphorylase **;** stimulates breakdown of glycogen to glucose **;** <u>glycogenolysis</u> **;** use of fatty acids as main respiratory fuel **;** production of glucose from other molecules **;** <u>gluconeogenesis</u> **;** glucose released into blood **;** AVP **;** e.g. ref to cAMP	**max 5**
	(c)		insulin produced by, microorganisms / bacteria **;** cheaper source of insulin / more reliable supply / ref to large scale production **;** more rapid response / shorter duration of response **;** less chance of, immune / allergic, response **;** **R** reference to rejection better for people who have developed a tolerance for animal insulin / less needed **;** **R** immune acceptable to people who have ethical, moral or religious objections **;** **A** vegetarians no risk of, infection / contamination **;**	**max 3**

[Total: 14]

Question			Expected Answers	Marks
5	(a)		$R^R R^R$ - low, do not have enough vitamin K in diet / ref to figures **;**	
			R^RR^S - high, (warfarin resistant) and have enough vitamin K / ref to figures **;**	
			R^SR^S - low , will be killed by warfarin / ref to effects of warfarin **;**	
			If quote probabilities for survival less than 50% is low and over 50% is high	**3**
	(b)	(i)	mutation / named mutation **;** change in DNA base sequence **;**	**max 1**
		(ii)	variation within population **;** some individuals produce enzyme not susceptible to warfarin **;** these individuals survive / selective advantage **;** reproduce / breed **;** pass, resistance / advantageous <u>allele</u> , to offspring **; R** gene those without resistance die **;** ref to selective pressure of warfarin **;**	**max 5**
	(c)		does not directly involve humans **;** environment selects individuals that will reproduce **;**	**max 1**
	(d)		resistant allele / R^R , will decrease **and** , susceptible allele / R^S , will increase **;** R^RR^R at a disadvantage due to vitamin K requirements / R^SR^S at an advantage due to warfarin being removed **;** **A** frequencies of both alleles will stay the same **;** *must be linked to second statement* no longer any selective pressure / no directional selection **;**	**max 2**

[Total: 12]

Question			Expected Answers	Marks
6	(a)		thick axons transmit impulses quicker than thin ones / AW **;** myelinated fibres quicker than unmyelinated / AW **;** invertebrates have slower speed of impulse / *ora* **;** ref to one set of comparative figures from table **;**	**max 2**
	(b)	**1**	depolarisation of membrane **;**	
		2	sodium ions move into axoplasm **;**	
		3	sodium ions flow sideways inside axon **; A** move down axon	
		4	ref to local circuit **;**	
		5	towards, negatively charged region / region at resting potential **;**	
		6	sodium voltage gated channels open **;**	
		7	region behind local circuit not yet recovered / sodium voltage gated channels closed **;**	
		8	impulse moves in one direction along axon **;**	
		9	myelin sheath acts as (electrical) insulator **;**	
		10	ref to Schwann cell and myelin **;**	
		11	lack of sodium and potassium gates in myelinated regions **;**	
		12	ref to nodes of Ranvier **;**	
		13	depolarisation occurs at nodes only **;**	
		14	(therefore) longer local circuits **;**	
		15	jumps from one node to another **;**	
		16	saltatory conduction **;**	
		17	AVP **;** e.g. detail of why thicker axons have faster impulses i.e. less leakage of ions *or* offer less resistance	**max 7**
			QWC – clear well organised using specialist terms ; *award the QWC mark if four of the following are used in correct context* depolarisation, voltage gated channels node of Ranvier, local circuits saltatory, sodium ions or Na+	**1**
	(c)		following an action potential **;** need to, redistribute sodium and potassium ions / restore <u>resting potential</u> **;** sodium voltage gated channels are closed **;** (during which) another impulse cannot be, generated / conducted **;** ensures impulses separated **;** determines maximum frequency of impulse transmission **;** impulse passes in one direction only along axon **;** AVP **;** e.g. ref to absolute and relative refractory periods	**max 4**

[Total: 14]

Question			Expected Answers	Marks
7	(a)		**B ;** **C ;** **D ;** **A ;**	**4**
	(b)	(i)	*award two marks if correct answer (26.18 / 26.2 / 26) is given* 24 x 60 = 1440 ÷ 55 **;** 26.18 **; A** 26 / 26.2	**2**
		(ii)	less oxygen / *ora* **;** reduced amount of nutrients / *ora* **;** ref to pH / *ora* **;** competition from other bacteria / interspecific competition / *ora* **;** use of antibiotics **;** AVP **;** ref to intestinal enzymes or immune system **R** reference to temperature *treat toxins as neutral*	**max 3**

[Total: 9]

Mark Scheme 2805/01
June 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)	(i)	**A** funnel (of the oviduct / Fallopian tube) / fimbria **;** **B** bladder **;** **C** oviduct / Fallopian tube **;**	3
		(ii)	protects, the abdominal organs / named organ / fetus / uterus / AW **;** supports, uterus / fetus / abdominal organs / weight of body /AW **;**	1 max
	(b)	(i)	protects against infection **;** destroys, pathogens / bacteria / fungi / microbes **;** **A** antigens **R** germs / neutralise	1 max
		(ii)	continually replaced / AW **;** **A** stratified mucus, lubricates the vagina / reduces friction / makes smooth **;** to assist, intercourse / birth of baby **;** flat / thin **;** **R** one cell thick fit closely together **;** (rest on) basement membrane **;** AVP **;** e.g. folded surface to allow, entry of penis / passage of baby **R** elastic or stretches	3 max
	(c)	(i)	head too large for birth canal if delivery is delayed / AW **;** brain, not fully grown at birth / immature / AW **;** bones of skull, slide over each other / move / AW **;** need a long period of, parental care / education **;** AVP **;**	1 max
		(ii)	*cervix* cervix, dilates / ripens / relaxes / widens **;** ref to prostaglandins **;** *mark uterus to max 3* *uterus* (muscle) contractions **;** become, stronger / more frequent **;** due to, release oxytocin / increased sensitivity to oxytocin **;** positive feedback effect / described **;** push / force baby, down / out / through cervix / out of vagina **;** AVP **;**	4 max

[Total: 13]

Question			Expected Answers	Marks
2	(a)	(i)	tetrad ;	1
		(ii)	cells (of tetrad), separate / move apart ; **R** divide haploid / n / contain half set of chromosomes ; (each) forms exine ; of sporopollenin ; pollen grain (nucleus) divides by mitosis ; (forms) generative nucleus ; which divides to form two male gametes ; tube nucleus ; AVP ; e.g. ref to sculpturing or pit or intine	**4 max**
		(iii)	pollen sacs / anthers, dry ; split / dehiscence ; **R** burst at weak area in wall / AW ;	**2 max**
	(b)	(i)	**R** ref to colour or scent (insect takes) pollen of one flower to stigma of the other flower ; pin eyed <u>and</u> thrum eyed / heterostylic ; stigma of one in same position as anther of the other / AW ; insect picks up pollen on different parts of the body / ref to pollen picked up on named part of body ; in **Z**, stigma above pollen so cannot fall onto it ; self incompatible ; because of, structure of exine / growth inhibitors ; genetic incompatibility ;	**3 max**
		(ii)	prevents inbreeding / form of outbreeding ; <u>increases genetic</u>, variation / diversity ; utilises entire gene pool / 'shuffles' alleles of whole population / AW ; more evolutionary potential / natural selection possible / speciation / AW ; can withstand, environmental change / named change ; not all wiped out by disease ; recessive alleles less likely to be expressed / increase in heterozygosity / decrease in homozygosity ;	**3 max**

[Total: 13]

Question			Expected Answers	Marks
3	(a)	(i)	days 11-16 ; **A** days within the range two / three, days before ovulation and, two / three, days after **;** temperature rises at ovulation **;** due to progesterone **;** oocyte lives one day **;** **A** egg / ovum sperm can survive, two / three, days (after intercourse) **;**	**3 max**
		(ii)	temperature shows a natural variation / AW **;** temperature rise may be due to, illness / exercise **;** intercourse may have occurred / sperm may already be present, at ovulation **;** time of ovulation not known in advance **;**	**2 max**
		(iii)	take temperature at the same time each day **;** monitor for more than one cycle **;** fertility / narrow range, thermometer / take accurate measurements **;** advisable to use with another method / named **;** abstain, days 11 – 16 / before and after ovulation / AW **;**	**2 max**
	(b)	(i)	(the level rises) as the pill / hormones, are absorbed into the blood **;** (and declines as it is) destroyed by the liver / metabolised / lost in urine / excreted **;** pill taken each day **;** drops very low because, no pill / placebo, is taken **;**	**3 max**
		(ii)	*accept one day either side throughout* **1** days 17 – 22, concentration fairly constant, at 2 arbitrary units **;** **2** hormones / oestrogen / progesterone, from pill, inhibits FSH **;** **3** by negative feedback **;** **4** inhibits /slows, follicle, development / activity / secretion **;** **5** days 22 – 1, increase, from 2 – 5.2 / by 3, units **;** **6** inhibition / negative feedback, removed, when pill not taken **;** **7** FSH secreted **;** **8** stimulates, development / activity, of follicle **;** **9** secretes oestrogen **;** **10** days 1 – 5, secretion from follicle falls to, previous level / 2.4 units **;** **11** when pill starts again / AW, inhibition operates / AW **;** **12** AVP **;** e.g. minor fluctuations in concentration, caused by changing levels of hormones from pill	**5 max**

(c) **(i)** *mark (i) and (ii) together to max 5*

mark general points to max 2

1 vaccine promotes the formation of antibodies **;**
2 by B lymphocytes **;**
3 form antigen + antibody complexes **;**

mark HCG points to max 3

4 HCG destroyed **;**
5 HCG maintains corpus luteum / without HCG corpus luteum degenerates **;**
6 progesterone level drops **;**
7 endometrium sloughs off *or* menstruation / period, occurs **;**
8 AVP **;** e.g. not contraception, aborts fetus

(ii) *mark sperm points to max 3*

9 antibodies, cover / combine with / block / AW, protein (on sperm head) **;**
10 sperm cannot lock onto zona pellucida **;**
11 ref to, specific shape / complementary shapes (of protein and its receptor on zona pellucida) **;**
12 cannot digest path through zona pellucida **;** **A** no acrosome reaction in correct context
13 may not, lock onto / reach, oocyte membrane **;**
14 fertilisation cannot occur **;** **5 max**

(iii) vaccine causes formation of memory cells **;**
permanent immunity / AW **;**
not everyone responds to vaccines **;** **R** ref to side effects
could attack self antigens **;**
ref to ethics of destroying HCG **;**
AVP **;** e.g. may be irreversible / may be sterile
may only be specific to one type of sperm
not known how long contraceptive effect lasts **1 max**

[Total: 21]

Question		Expected Answers	Marks
4	(a)	shoot tip / root tip / apical bud / cambium / nodes between areas of growth **;**	1
	(b)	cells are, not differentiated / totipotent / can form all cell types **; R** unspecialised only need to insert the gene into one cell **;** throughout plant, cloned / all cells are genetically identical **;** easier with one cell **;** divides by <u>mitosis</u> **;** large nucleus **;** less cytoplasm **;** secretes, PGRs / named **;** AVP **;** e.g. DNA altered before, specialisation / gene switch	**3 max**
	(c)	*mark process to max 6* **P1** cells stop dividing **;** **P2** enlarge / elongate **;** **P3** water enters **;** **P4** by osmosis / down water potential gradient **;** **P5** vacuoles form **;** **P6** cellulose, stretches / increases area of cell walls **;** **P7** synthesise new materials / named **;** **P8** differentiate **;** **P9** cell becomes specialised **;** **P10** ref to gene switch on / off **;** **P11** ref to, PGR / named PGR **;** **P12** AVP **;** e.g. detail of protein synthesis *mark structure to max 3* **S13** cytoplasm round edge / <u>large central</u> vacuole **;** **S14** palisade columnar / AW **;** **S15** spongy irregular **;** **S16** chloroplasts form **;**	**7 max**
		QWC – clear, well-organised using scientific terms ; *award the QWC mark if three of the following are used in correct context* osmosis / named PGR water potential gradient / palisade cellulose / spongy differentiate / chloroplasts	1

[Total: 12]

Question			Expected Answers		Marks
5	(a)		imbalance / change in balance, of hormones **;** oestrogen <u>and</u> progesterone **;** decline at different rates **;** progesterone decreases **;** before menstruation **;**	**R** levels or concentrations **R** hormone deficiency	**3 max**
	(b)	(i)	degeneration / breakdown / may not mature / many may die / AW **;** (primordial) follicles, age / divide abnormally **;** monthly loss / AW **;** AVP **;** e.g. hormonal abnormality / pollution / smoking / named		**2 max**
		(ii)	*award two marks if correct answer (91) is given* *award one mark if not rounded up* 39874 – 3450 = 36424 $\frac{36424}{39874} \times 100$ **;** *OR* $\frac{3450}{39874} \times 100 = 8.7$ 100 – 8.7 **;** = 91 (%) **;;** *ecf = 1 max* *91.35 = 1 max*		**2 max**
	(c)		<u>follicles</u> less sensitive to FSH **;** less / no, follicle(s) matures, therefore, no / less, oestrogen **;** no ovulation therefore no progesterone **;** less / no, inhibition from, oestrogen / progesterone **;** FSH / LH, rises **;** by negative feedback **;** AVP **;** e.g. ref to involvement of hypothalamus and GnRH		**3 max**

(d) *mark symptoms to max 4*

- **S1** hot flushes / night sweats **;**
- **S2** dryness of, vagina / mouth / epithelia / membranes **;**
- **S3** depression / irritability / fatigue / mood swings **;**
- **S4** reduced, sex drive / libido **;**
- **S5** <u>osteoporosis</u> **;**
- **S6** increases risk of CHD **;** max 4

mark therapy to max 5

- **T7** HRT is mainly <u>oestrogen</u> / AW **;**
- **T8** oestrogen improves well being / mood / AW **;**
- **T9** pill / implant / injection / patch **;**
- **T11** reduces dryness of membranes **;**
- **T12** (this is) antagonistic to parathormone **;**
- **T13** which increases blood calcium **;**
- **T14** by removing it from bone **;**
- **T15** may be combined with progesterone **;**
- **T16** (to reduce) side effects, blood clotting / thrombosis / increased risk of stroke *or* heart disease
- **T17** AVP **;**
- **T18** AVP **;** max 5 **6 max**

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

[Total: 17]

Question			Expected Answers	Marks
6	(a)	(i)	asexual reproduction ; **R** divides asexually DNA replicates ; organelles replicate ; mitosis ; cell wall grows across / AW ; split into two / form mass of cells ; genetically identical / cloned ; AVP ; e.g. binary fission, fragmentation	**3 max**
		(ii)	too few grazers / described ; increase in temperature / AW ; increase in, intensity / duration, of light / AW ; good supply of, nutrients / named nutrient ; pollution by organic waste ; AVP ; e.g. excessive use of fertilisers	**2 max**
		(iii)	(increase in plants causes) increase in animals ; less light to lower levels results in less photosynthesis ; plants die (at lower layers) ; increase in organic material ; decomposed by, aerobic bacteria / micro-organisms ; correct ref to, increased oxygen consumption / increased BOD ; oxygen concentration decreases, causing death of, fish / other aquatic animals ; ref to anaerobic bacteria ; AVP ; e.g. eutrophication	**3 max**
	(b)		measured sample of lake water / stated volume ; randomly selected ; serial dilution / described ; replicates ; haemocytometer, total count ; measure release of oxygen as an indicator of viable count ; multiply count to take account of dilution ; repeat regularly over set time / AW ; plot, time versus count on graph ; rate calculated from tangent / AW ; calculate gradient (on graph) ; **A** calculation to show how to find rate AVP ; e.g. description of turbidity measurement	**6 max**

[Total: 14]

Mark Scheme 2805/02
June 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 - pink **;** aaBB - green **;**	**2**
		(ii)	(dominant) epistasis **;** ref to, epistatic / hypostatic, gene **;** ref to, promoter / gene switching **;** increased, transcription / expression **;** AVP **;** enzyme to alter pigment / change structure of pigment / make more pigment / complementary action	**max 3**
	(b)	**(i)**	*parents* (AaBb) red spines x (aabb) green spines **;** *gametes* AB Ab aB ab x ab **;** ***A** from Punnett square* *offspring* genotypes **; ;** *minus 1 for each of first two mistakes* phenotypes related to genotypes **;** ***A** key* *ratio* 1 red spines : 1 pink spines : 2 green spines **;**	**max 5**

gametes	*AB*	*Ab*	*aB*	*ab*
ab	*AaBb*	*Aabb*	*aaBb*	*aabb*
	red spines	*pink spines*	*green spines*	*green spines*

(ii)
many AaBb and aabb **;**
ref 1 : 1 ratio of these **;**
ref linkage **;**
ref parental types **;**

few Aabb and aaBb **;**
ref 1 : 1 ratio of these **;**
ref recombinants **;**
ref crossing over **;**

many red and green spined **;**
few / no, pink spined **;**
1 : 1 green : red / more green than red **;**
ref proportions depend on how close, loci / genes, are **;** **max 5**

[Total: 15]

2 (a)

1 prevent, self-pollination / unwanted pollination, of flowers **;**
2 detail of prevention **;**
3 cross-pollinate two varieties **; A** crossed / mated / hybridised
4 detail pollination **;**
5 isolate, plants / flowers **;**
6 collect seeds and sow **;**
7 in high salt concentration **;**
8 select plants, which survive / can tolerate, high concentration **;**
9 and have large, tasty tomatoes **;**
10 interbreed these plants **;**
11 repeat selection **;**
12 ref many generations **;**
13 cross with variety with large tomatoes to improve size **;**
14 cross with variety with good flavour to improve taste **;**
15 ref backcrossing with original variety for salt tolerance **;**
16 AVP **;** **max 8**
17 AVP **;**

e.g. ref background genes / hybrid vigour / heritability / effect on vigour / ref setting up pure-breeding initial lines

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

(b) (i)

active transport **;**
(energy from), ATP / respiration **;**
against concentration gradient **;**
ref binding site for ion / AW **;**
ref change of shape of protein **;** **max 3**

(ii)

GE quick(er) / SB slow(er) **;**
(tolerance) in one generation (v. many generations) **;**
ref one gene / rest of genome unaltered (v. hybridisation) **;**
background genes intact (v. need for backcrossing) **;**
different varieties engineered for different conditions **;**
no problem re interbreeding **;**
can select, transporter system / AW, / from, another species / named taxon **;**
can select, transporter system / AW, / for maximum efficiency **;**
AVP **;** **max 3**

[Total: 15]

Question			Expected Answers	Marks
3	(a)		loss of genetic, diversity / variation **;** **A** gene pool, reduced / eroded loss of <u>alleles</u> **;** increased homozygosity / decreased heterozygosity **;** increased expression / accumulation, of deleterious recessives **;** <u>inbreeding depression</u> **;** loss of, vigour / fertility / fitness **;**	**max 3**
	(b)		(selective) advantage / named (selective) advantage **;** behaviour favouring mating with non close relative **;** increased genetic variation (so more offspring survive) **;** hybrid vigour / increased heterozygosity / decreased homozygosity / reduced inbreeding depression **;** AVP **;** e.g. idea dominant male	**max 2**
	(c)	**1**	DNA extracted from cell sample / named cell sample **;**	
		2	cut by restriction enzyme(s) **;**	
		3	electrophoresis **;**	
		4	fragments placed in well at (cathode) end of gel **;**	
		5	ref to, agarose / polyacrylamide **;**	
		6	PD applied **;**	
		7	DNA negatively charged **;**	
		8	fragments travel to anode **;**	
		9	smaller / shorter, fragments travel further (ora) **;**	
		10	Southern blotting **;**	
		11	radioactive / ^{32}P / fluorescent, probe(s) **;**	
		12	single stranded **;**	
		13	ref single locus probe **;**	
		14	complementary binding **;**	
		15	autoradiograph / use of X ray film **; R** use of X rays	
		16	share pattern of bands **;**	
		17	ref VNTRs **;**	
		18	same, number of repeats / lengths, DNA move same distances **;**	**max 9**
		19	number of repeats / lengths / VNTRs, inherited **;**	
		20	AVP **;** e.g. scale from fragments of known size / PCR	
			QWC – clear well organised using specialist terms ;	**1**

award the QWC mark if three of the following are used in correct context
do not award if the sequence is seriously incorrect

restriction enzyme	electrophoresis
agarose	polyacrylamide
Southern blotting	autoradiograph
VNTRs	PCR

[Total: 15]

Question			Expected Answers	Marks
4	(a)		store of <u>alleles</u> **;** to maintain, genetic diversity / genetic variation / gene pool **;** to counteract, inbreeding / genetic erosion **;** to maintain traits for future use **;** (allele) for resistance to, 'new' / mutated, pathogen **;** for tolerance to environmental change **;** ref to, endangered species / rare breeds **;** for post-mortem use **;** AVP **;**	**max 4**
	(b)	(i)	1 ^{o}C min^{-1} **;**	**1**
		(ii)	ice crystals **;** grow in size **;** break membranes **;** when insufficient water withdrawn from cell **;** when freezing, not quick enough / not uniform **;**	**max 3**
		(iii)	not only need mitochondria **;** ref energy / ATP **;** some other essential component damaged **;** e.g. other essential component **;;** AVP **;**	**max 3**
	(c)		*advantages* two of following **;;** saves cost of male saves problems of keeping male access to range of males saves, cost / stress, of transport of male saves stress of mating speeds up selective breeding speeds up progeny testing quickly available sperm can be, genetically tested / sexed AVP *disadvantages* two of following **;;** damage of stored sperm overuse of one sire so (potential) inbreeding requires, vet / skill problem should sire have genetic defect cost AVP	**max 4**
				[Total: 15]

Question			Expected Answers	Marks
5	(a)	(i)	mutation **;** chance / random / preexisting **;** insecticide acts as selective, agent / pressure **;** susceptibles die / resistants survive **;** resistants pass, mutation / allele, to offspring **; A** gene	**max 3**
		(ii)	mosquito is vector **; A** carrier obligatory / AW **;** part of life cycle is in mosquito **;** not killed by insecticide **;**	**max 2**
	(b)	(i)	DNA from two different sources **;** combined / joined / AW **;**	**2**
		(ii)	restriction enzymes cut DNA **;** at specific sites **;** detail of sites **;** may give sticky ends **;** <u>complementary</u> sticky ends join **;** terminal transferase / enzyme, adds sticky ends **;** ligase joins, gaps / nicks **;**	**max 3**
	(c)	(i)	fewer genetically engineered mosquitoes pass parasites across midgut **; A** figures fewer g e mosquitoes have parasites in salivary glands **; A** figures fewer g e mosquitoes can infect (uninfected) mice **; A** figures *'less good as vectors' instead of all of first three points = 1 only* use of comparative figures **;**	**max 3**
		(ii)	*benefit* one of following **;** reduce use of, insecticide / drug safer than, insecticide / drug AVP	**max 1**
			hazard one of following **;** parasite may develop resistance gene may pass to other species AVP	**max 1**
			[Total:	**15]**

Question			Expected Answers	Marks
6	(a)	(i)	change in sequence of base pairs (in a DNA molecule) **;** unpredictable / AW **;** detail **;** e.g. addition / substitution / deletion / frame shift / small part of chromosome / may code for different protein / may code for no protein	**max 2**
		(ii)	recessive (allele) **;** autosomal / chromosome 7 **;** homozygote recessive = sufferer **;** heterozygote = carrier **;** correct statement re inheritance **;** e.g. both parents of sufferer must be carriers / 1 in 4 chance of sufferer from carrier parents	**max 3**
		(iii)	thick / dehydrated, mucus builds up in lungs **;** and gut **;** (bacterial) infections in lungs **;** scar / damage, lungs **;** mucus blocks secretion of digestive enzymes (from pancreas) **;** malnutrition / inadequate, digestion / absorption **;** mucus blocks sperm duct / males sterile **;**	**max 4**
		(iv)	large number of mutations **;** ref unrecognised / unknown, mutations **;** each test specific **;** DNA has different, code / base sequence **;** probe binds to complementary base sequence **;**	**max 2**
	(b)		mutation may give different, amino acid / primary structure **;** **A** ref stop codon some mutations alter, molecular shape / tertiary structure / binding **;** so unable to, accept / transport, HCO_3^- **;** unable to bind ATP **;** so increase in acidity / decrease in pH **;** effect on mucus **;** effect on enzyme(s) **;** ref pH optimum of enzyme(s) **;** poor digestion of, protein / lipid / starch **;** some mutations, give some transport / have less effect **;** $\geq$ 33% (of norm) allows normal digestive function / $\leq$ 6% (**A** very low) does not **;**	**max 4**

[Total: 15]

Mark Scheme 2805/03
June 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)	very high temperature **;** enzymes would denature **;** no water (vapour) present / no water in liquid state **;** consequences / effect on metabolism **;** consequence of high carbon dioxide concentrations **;** acidic atmosphere **;** lack of oxygen **;** lack of nitrogen fixation **;** ref to high pressure **;** ref to day length / increased day length **;** consequence to photosynthesis **;** synchronisation of life cycles / AW **;** ref to comparative data **;**	**max 4**
(b) (i)	volcanic eruptions release large quantities of, carbon dioxide / other greenhouse gases **;** *increase* in the layer / blanket of carbon dioxide / other named gases, around Venus**;** (allows) high energy / short wavelength, rays from the sun to enter Venus's atmosphere **;** (when these are) reflected / radiated, from the surface of the Venus **; R** heat energy they have lost energy **;** (and) the longer wavelength rays / infra-red rays, cannot escape through the blanket of gases **;** this causes global warming **;**	**max 5**

(ii) *carbon dioxide*

(increased) burning of fossil fuels **;**
deforestation **;**

methane

(increased) amount of decomposing, rubbish / waste **;**
increased numbers of cattle **;**
increased areas of rice paddy fields**;**
ref to landfill sites **;**
melting of permafrost **;**

nitrous oxides

increased, use of vehicles / air travel **;**

CFCs

aerosols **;**
refrigerators / cooling systems **;**
disposal of polystyrene **;** **max 3**

(iii) melting of polar ice caps **;**
thermal expansion of water **;**
expansion of water in oceans / rising sea levels **;**
flooding (of lowland / coastal areas) **;**
climatic changes / AW **;**
effects on biodiversity / distribution of (plant / animal) species **;**
(certain) pests / diseases, may thrive in warmer conditions **;**
e.g. malarial spread / ref to fungal diseases **;**
named effect on agriculture **;**
AVP **;** e.g. effect on Gulf Stream, effects on life cycles, increased levels of desertification **max 3**

[Total: 15]

Question			Expected Answers	Marks
2	(a)		*accept reverse arguments for all responses*	
			poorer drainage (of A) **;** higher water table (in A)**;** flooding (into A) **;** run-off from moor (into A) **;** clay soil (in A) / sandy soil (in B) **;**	**max 2**
	(b)	**1**	weigh sample of soil **;**	
		2	heat until constant mass **;**	
		3	calculation of percentage explained / use of <u>correct</u> formula **;**	
		4	ref to repetitions **;**	
		5	means / averages, calculated **;**	
		6	SD of means **;**	
			water	
		7	place sample in oven / incubator *or* heat to 60 - 110°C **;**	
		8	loss in mass = water in sample **;**	
			organic matter / mineral matter	
		9	place <u>dried</u> soil in oven **;**	
		10	heat strongly / burn **;**	
		11	loss in mass = organic matter **;**	
		12	mass remaining after above processes = mineral matter **;**	
			air	
		13	measure volume of a (soil) sample **;**	
		14	of core / undisturbed soil / AW **;**	
		15	add / place into, a <u>measured</u> volume of water **;**	
		16	total volume – (volume of soil + water) = volume of air **;**	
			marking points 1-6 are awarded <u>once only</u> for either the water <u>or</u> organic/mineral matter methods	**max 9**
			QWC – clear, well organised using scientific terms ;	**1**
			only award the QWC mark if answer is well structured and all four aspects are covered	
	(c)	(i)	anaerobic conditions encourage denitrifying bacteria **;** convert nitrate ions to (gaseous) nitrogen **;** reduces available nitrogen **;**	
			sundew does not rely on, soil nitrate / soil nitrogen **;** ref to, hydrolysis / digestion / use of enzymes, on insect proteins **;** releasing amino acids **;** ref to deamination **;** *max 3*	**max 4**

		(ii)	Reduces amount of air in soil **;** roots starved of oxygen **;** respiration becomes anaerobic **;** insufficient energy released **;** not able to absorb (enough), ions / named ion **;** via active transport **;**	**max 3**
				[Total: 19]

Question			**Expected Answers**	**Marks**
3	**(a)**		set out a grid in each area *or* site / description of how the grid is established **;** use random numbers **;** how generated **;** e.g. random number tables / use of calculator to give co-ordinates **;** at that point / co-ordinate, measure nearest plant **;** repeat (14 times) **;**	**max 4**
	(b)	**(i)**	total heights **;** divided by the number of plants (in the sample) **;** provides an average height for the sample **;**	**max 2**
		(ii)	measure of, variability / spread of heights (in sample) **; R** range sum of differences from the mean **;** 68% of values lie within mean $\pm$ 1 S.D. **;** 95% of values lie within mean $\pm$ 2 S.D. **;**	**max 2**
	(c)		greater spread from mean in site **B** / *ora* **; R** range height of plants in site **B** is more variable / *ora* **;**	**max 1**
	(d)	**(i)**	that there is no <u>significant difference</u> **;** between the mean height in site **A** and the mean height in site **B ; A** results any difference is entirely due to chance **;**	**max 2**
		(ii)	there is a <u>significant difference</u> between the means at the two sites **;** the <u>difference</u> is due to something other than chance **;** reject the null hypothesis **;** with 28 degrees of freedom**;** at the 5% confidence level **; A** $p<0.05$ / <0.01 / <0.001 the critical t value is, 2.05 / 2.76 / 3.67 **;** calculated value, exceeds / is much higher than, this **;** assuming the sample shows a normal distribution **;**	**max 4**
				[Total: 15]

Question			Expected Answers		Marks
4	(a)		(existence of many) different species **;** with (a wide range of) different, genes / alleles **;** live / co-exist, in (many different), habitats / ecosystems **; A** environment		**max 2**
	(b)		*ecological*		
		1	prevents disruption of food, chains / webs **;**		
		2	maintenance of, ecosystems / habitats **;**		
		3	interdependence of species / AW **;**		
		4+5	credit two good examples **; ;** e.g. dispersal of seeds, pollination		
		6	AVP **;**	*max 3*	
			economic		
		7	importance of gene pool **;**		
		8	some species, may be of use in the future / not yet discovered **;**		
		9	for medicinal purposes **;**		
		10	example **;**		
		11	fishing / agricultural / silvicultural, purposes **;**		
		12	could be crossed with existing agricultural, species / strains **;**		
		13	to improve yield **;**		
		14	increase hardiness **;**		
		15	increase, disease / pest resistance **;**		
		16	tourism **;**		
		17	AVP **;**	*max 4*	
			ethical		
		18	reduction in biodiversity is a result of human activity, so have a moral responsibility to try to put things right / AW **;**		
		19	for future generations **;**		
		20	AVP **;**		**max 8**
			QWC – legible text with accurate spelling, punctuation and grammar ;		**1**
	(c)		purchase of land **;** setting up, nature reserves / bird reserves / nesting sites **;** managing of such reserves / full time wardens **;** recruiting / training, volunteers **;** education / raising public awareness **;** through advertising / national campaigns **;** giving talks / lectures **;** publishing magazines **;** bird / wildlife, surveys **;** selling products **;** e.g. nest boxes, bird feeders lobbying Members of Parliament **; R** Government monitoring any activities which might harm, wildlife / habitats **;** prosecuting, egg collectors / dealers in endangered species **;** AVP **;** e.g. rehabilitation of injured wildlife, captive breeding and release programmes		**max 4**
				[Total:	**15]**

Question			Expected Answers	Marks
5	(a)		*accept reverse arguments if responses are referring to cereal plants*	
			both have root nodules **;** with *Rhizobium* bacteria **;** which are nitrogen-fixing **;** convert nitrogen (gas), to nitrate ions / ammonium compounds **; A** NO_3^- / NH_4^+ **R** ammonia / NH_3 plants convert these to amino acids **;** which are used to make protein **;** high levels of proteins stored in seeds **;**	**max 4**
	(b)		organic manure of variable composition **;** (manure) difficult, to control amount applied / to apply evenly **;** (manure too) bulky **;** (manure) needs heavy machinery to apply on farms **;** more labour intensive **;** lower yield / more land required **;** (products have) shorter shelf lives / more blemishes **;** (products have) higher prices in shops **;** more problems, with pests / diseases, in or on the produce **;**	**max 3**
	(c)	(i)	intercropping **;**	**1**
		(ii)	different crops (species) may be harvested at different times so land is always under cultivation **;** reduces soil erosion (in long term) **;** some (species of crops) may offer, protection / support / shelter, to other species **;** predators of pests of one crop (species) may live on other crop (species) **;** different crop species have different mineral requirements **;** which helps to maintain soil fertility **;** ref to legumes **;** nitrogen fixation **;** increases, nitrogen / nitrate, in the soil (for other crop species) **;**	**max 5**
			[Total:	**13]**

Question			Expected Answers	Marks
6	(a)		*award two marks if correct answer (9 600 – 10 4 00) is given* *incorrect answer but correct working = 1 mark* *ecf rules apply for 1 mark max* diameter of oocyst in photo = 50 mm / 5 cm / 50 000 μm **;** **A** +/- 2mm magnification = 50 000 / 5 **;** **A** 48 000 – 52 000 / 5 = x 10 000 **;** **A** 9 600 – 10 400	**max 2**
	(b)	(i)	nucleus **;** membrane-bound organelles / named organelle **;** named eukaryotic feature **;**	**max 1**
		(ii)	disease-causing / AW **;**	**1**
	(c)	(i)	chlorine **;** ultra-violet light **;** ozone **;**	**max 2**
		(ii)	faeces from infected, cattle / sheep **;** contain oocysts **;** rainwater, washes / AW, these from fields **;** into reservoirs **;** water treatment ineffective / oocysts resistant **;** oocysts enter domestic water supply **;** human error **;**	**max 3**
	(d)		those infected with HIV / immuno-compromised **;** old people / elderly **;** infants / babies **;** **R** children pregnant women **;** AVP **;** e.g. people recovering from surgical procedures	**max 2**
	(e)		pesticides **;** lead / heavy metals **;** nitrate **;** PCBs / PBBs **;** AVP **;** e.g. chlorine, fluoride	**max 2**
			[Total:	**13]**

Mark Scheme 2805/04
June 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)**	**(i)**	attached to an insoluble material / AW **;**	**1**
		(ii)	(micro)encapsulation / (trapped) in alginate beads **;** adsorption / stuck onto, e.g. collagen / clays / resin / (porous) glass **;** cross linkage *or* covalent / chemical bonding to, e.g. cellulose / collagen fibres **;** gel entrapment / trapped inside gel e.g. silica (lattice / matrix) **;** partially permeable membrane (polymer) microspheres **;**	**max 2**
		(iii)	urine can be processed / no problem of removing urine / AW **;** pure / drinkable / useable, water produced **; A** water recycled space saving / less water needs to be taken into space **;** payload limit / weight reduction / AW **;** no need to take more enzymes into space / enzymes reusable **; A** enzymes recoverable no problem in separating enzyme from products / product not contaminated **;** ref to longer shelf-life of enzyme **;** AVP **;** e.g. larger surface area of enzyme exposed, more stable at extremes, ref to ease of use (of bioreactor)	**max 3**
	(b)	**(i)**	adding / using, <u>water</u> **;** breaking, bond / ester bond (in molecule) **; A** breakdown into smaller molecules	**2**
		(ii)	matrix, protects / stabilises, (immobilised) enzyme / lipase **;** *allow once* so will function, at optimal rate / more efficiently (than soluble), at higher temperature / 45 ^{o}C **; A** greater activity / AW ref to soluble lipase begins to denature (reducing activity) **;** *ora* continues to work, at optimal rate / more efficiently, at <u>lower</u> pH **;** ref to presence of fatty acids changing pH **;** ref to ionic bonds breaking (in soluble lipase) **;** *ora* AVP **;** e.g. ref to industrial uses, ref to effect on R groups	**max 4**

[Total: 12]

Question		Expected Answers	Marks
2	(a)	*aseptic techniques* ***to max 4***	
	1	<u>sterile</u>, Petri dish / pipette / agar **;** **A** <u>sterile</u> inoculating loop	
	2	lift lid of dish, slightly / away at angle **;** AW	
	3	flame, neck of jar / bottle of, culture / (molten) agar **;**	
	4	ref to disinfectant **;** e.g. discard pots, surfaces cleaned	
	5	AVP other aseptic technique **;** e.g. flamed forceps, use of spirit burner / Bunsen burner	
		method to make seeded plates	
		max 1 if ref to inoculate but inappropriate method to create lawn	
	7	molten agar poured into plate (and set) / use prepared plate **;**	
	6	ref to inoculating **;** e.g. add bacterial sample to surface using pipette	
	8	ref to making lawn **;** e.g. spread with glass / disposable spreader / (sterile) swab	
		or	
	6	ref to inoculating **;** e.g. add bacterial sample to molten (cooled) agar	
	7	mix contents **;**	
	8	pour plate (and set) **;**	
		or	
	6	add bacterial sample to dish using pipette **;**	
	7	(then) molten agar poured in **;**	
	8	swirl plate (gently) to mix (and allow to set) **;**	
		method to add deodorant	
		max 1 if deodorant added by e.g. one streak / drops (must be method to give comparison)	
	9	dip filter paper disc into deodorant **;**	
	10	repeat with other deodorant **;**	
	11	place onto surface of agar **;**	
		or	
	9	punch holes / make wells in agar **;**	
	10	add deodorant to well **;**	
	11	repeat with other deodorant **;**	
		incubation and results	
	12	(partially) seal dish with, tape / parafilm **;**	
	13	incubate at 20 – 30 ^{o}C **;** **R** 37 ^{o}C	
	14	for 2-5 days **;**	
	15	measure / compare size of, zone of inhibition **;** AW	
	16	larger zone more effective deodorant **;** **R** ref. to colonies	
	17	ref to replicates **;**	
	18	ref to variables controlled **;** e.g. size of, discs / wells *and* volume of organism / agar	
	19	AVP **;**	
	20	AVP **;** e.g. further detail of, technique / procedure detail of measuring, diameter / area (Vernier) calipers tracing onto acetate	**max 8**
		QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

(b) **(i)** increased sweat (in hot conditions) **;**
releasing more antibacterial substances **;**
bacteria divide more in hot conditions / AW **;** **R** bacteria grow more
bacteria destroyed / growth inhibited **;**
(potential) pathogens prevented from infecting / AW **;** **max 2**

(ii) bacterial <u>cell wall</u> contains, murein / peptidoglycan **;**
plant cells have cellulose cell walls **;** **max 2**
animal cells no cell wall **;**

[Total: 13]

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

3 (a)

structural feature	*virus*	*bacteria*
outer coating	envelope / protein / capsid / capsomeres	peptidoglycan / murein / lipopolysaccharide / capsule / slime layer **;**
cytoplasm	none	present **;**
nuclear material	*DNA or RNA*	DNA **;** **A** chromosome

3

(b) **A** - RNA **;**
B – glycoprotein (spikes) / protein (spikes) / gp 120 / antigen **;**
C – reverse transcriptase **;** **3**

(c)
1 viral recognition (of host cell) **;**
2 ref to named host cell **;** e.g. T (helper) lymphocyte / cell , CD4 cell , macrophage , monocyte , Langerhans cell (skin) , glial cell, dendritic cell (CNS)
3 virus, adsorbs onto / attaches to / binds to, receptors (on membrane) **;**
4 ref to entry into host cell **;** e.g. fusion envelope with host cell surface membrane / taken in by endocytosis **R** injected
5 nucleocapsid in cell / AW **;**
6 uncoating / capsomeres disassembled **;** AW
7 (viral) DNA synthesised using reverse transcriptase **;**
8 enters nucleus **;**
9 integrates into (host) chromosome / DNA **;** AW
10 (known as) provirus **;**
11 lysogenic / latent (phase) **;** **A** dormant *must be in context*
12 (progresses to) lytic cycle **;** *must be in context*
13 (new) viral RNA synthesised **;**
14 ref to other named viral components synthesised **;** e.g. capsomeres, enzymes, spikes
15 host cell machinery used / AW **;**
16 assembly (of new viruses) / AW **;**
17 leave cell by budding / enclosed in cell membrane / AW **;**
18 AVP **;**
19 AVP **;** e.g. specificity of recognition and binding to host cell receptors
CD4 receptor, DNA polymerase used to make viral double stranded DNA
latent infection in macrophages have newly made viruses in vacuoles
provirus activated to initiate lytic cycle
transcription of viral DNA to make viral RNA
translation to make viral proteins **max 8**

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

award the QWC mark if four of the following are used in correct context
named host cell, fusion, receptors, endocytosis, nucleocapsid, capsid, capsomere, uncoating, reverse transcriptase, provirus, budding, polymerase, lysogenic / latent, lytic, transcription, translation

(d) *marking points can be taken from a labelled diagram*

binary fission **;**
bacterial DNA / chromosome, attaches to, plasma membrane **; A** mesosome
DNA replication **;**
semi-conservative (replication) **;**
ref to viral replication as host DNA replicates **;**
cell elongation **;**
growth between attachment points pushes, DNA / chromosomes, apart **;**
cross wall / septum, forms **;**
two daughter cells formed / AW **;** **max 4**

[Total: 19]

Question		Expected Answers	Marks
4	(a)	odd number of sets of chromosomes / AW **;** homologous pairs not formed **;** **A** ref to difficulties in pairing during meiosis **;** *allow point if reference made to causing problems during meiosis* does not form seeds **;**	**max 2**
	(b)	ref to, sterile conditions / aseptic techniques **;** (small) piece of plant tissue removed **;** **A** take cuttings ref to named tissue **;** e.g. meristem, axillary / (apical) buds explant **;** *or* leaf removed **;** enzymes / cellulases / pectinases, to remove cell wall **;** protoplasts formed **;** growth on nutrient medium **;** plant growth regulators / named growth regulator **;** **R** hormones rooting **;** incubation in light **;** plantlets **;** subdivide **;** handling, medium / sterile soil **;** AVP **;** AVP **;** e.g. remove wax from leaves callus culture / mass of undifferentiated cells forms ref. auxin to cytokinin ratio Murashige and Skoog (M & S) medium further detail of culture method / aseptic technique	**max 5**

(c) *max 4 for either*

advantages
many plants **;**
genetically identical **;**
(so) all have desired, characteristics / genotypes / phenotypes **;**
no need for (artificial) selection **;**
can be obtained in short space of time / AW **;**
easy to, transport / store **;** **A** ref to space saving
easy to genetically engineer **;**
disease / virus, free **;**

disadvantages
genetically identical, qualified in terms of disadvantage **;**
susceptible to disease **;**
loss in genetic diversity (as cloned plants are grown exclusively) **;**
farmers have to buy plants from suppliers / AW **;**
ref to economic problems for developing countries **;** e.g. start up costs
patented property **;**

AVP **;**
AVP **;** e.g. no quarantine required, ref. to cost qualified, not labour intensive (advantages), genetically unstable (disadvantage) **max 5**

[Total: 12]

Question			Expected Answers		Marks
5	(a)	(i)	temperature **;** concentration of, substrate / sugars / carbohydrates **;** concentration of yeast **;** pH / carbon dioxide concentration **;** oxygen availability **;** concentration of, alcohol / ethanol / toxic waste **;** AVP **;**	**R** volumes / amounts **R** volume / amount	**max 3**
		(ii)	carbon dioxide **;**	**A** CO_2	**1**
	(b)	(i)	*one mark for slow, fast, slow / nothing* initial gas production slow, ref to time **;** rapid rate, ref to time **;** little gas production, ref to time **;** ref to actual volumes **;** any rate calculated **;**		**max 4**
		(ii)	ref to (aerobic / anaerobic) respiration **;** *slow gas production* transport of glucose into yeast cells takes time **; A** absorbed / taken up by yeast detail **;** e.g. ref to carriers *rapid rate of respiration* high substrate concentration in yeast cells **;** *rate slows* substrate runs out **;** or other factor(s) / named factor, affect the rate **;** AVP **;** e.g. increase in number of yeast cells increases rate of respiration, qualified ref to time taken for adjustment to conditions (in slow production)		**max 4**
	(c)		*slower rate of respiration* enzymes(s) to, metabolise / hydrolyse / digest / breakdown, maltose not present **;** genes switched on **;** time for enzymes to be synthesised **;** ref to, membrane transport / ease of passing through membrane **;** AVP **;** e.g. facilitated diffusion		**max 2**

[Total: 14]

Question			Expected Answers	Marks
6	(a)		provides oxygen for <u>aerobic</u> respiration **;** any detail, e.g. oxidative phosphorylation **;** sterile to prevent contamination **;** mixes fungus with substrate / prevents settling / bubbles help stirring / AW **;**	**2**
	(b)	(i)	carbon – glucose / lactose **;** nitrogen – amino acids / nitrate ions / ammonium ions / yeast extract **;** **A** corn steep liquor for either but not both	**2**
		(ii)	water is for, cooling / removing excess heat **;** maintains, constant / optimum, temperature **;** respiration produces heat **;** which would, denature enzymes / kill cells **;** heat also produced by, stirrer / motor **;**	**max 3**
		(iii)	will affect, enzyme action / metabolic rate **; A** denature enzymes addition of, buffer / acid / alkali / base **;**	**2**
	(c)	(i)	96 hours **;**	**1**
		(ii)	**X** includes, rapid / exponential / main, growth phase **;** *ora* when primary products are made / penicillin is a secondary metabolic product **;** excess of nutrients in **X** *or* penicillin produced when nutrients, limited / depleted **;**	**3**
	(d)		filter (to remove fungus) **;** fungus washed (to remove penicillin) **;** continuous countercurrent / chemical extraction **;** concentration **;** addition of potassium ions **;** precipitate crystals / (potassium) salts **;** solvents used to purify penicillin **;** AVP **;** e.g. dried, some are chemically modified, 99.5% pure	**max 3**
	(e)		can genetically engineer microorganisms **;** ref to risk of infection **;** e.g. CJD with GH avoids problem with, side effects / allergic effects **; A** ref. to immune response large amount of product **;** grow microorganisms in small, area / volume **; A** less space required can be cultured anywhere in world **;** ethical advantages, qualified **;** ref to cost qualified **;** e.g. *insulin* uses cheaper feedstock (than for rearing pigs) AVP **;** AVP **;** e.g. high replication / growth rate extraction of GH from brains slow process	**max 4**

[Total: 20]

Mark Scheme 2805/05
June 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)	(cortex is group of), specialised / similar / same, cells / neurones **;** performing, similar / same / named, function **;** brain is made of, more than one / different tissue(s) **;** carrying out more than one function / AW **;**	**max 3**
	(b)	large(r) surface area **;** idea of more cells / neurones (in given space) **;** idea of more 'processing power' / AW **;**	**max 2**
	(c)	'shock absorber' / mechanical protection **;** **R** protection unqualified removes (excess) heat / cools the brain **;** supplies oxygen **;** supplies (named) nutrient **;** removes, (named) waste / carbon dioxide **;** ref to osmoregulation **;** AVP **;** (e.g. ref to macrophages or white blood cells)	**max 2**
	(d)	planning a task **;**	**1**
	(e)	*accept 'white and grey matter' for neurones throughout* **1** idea of largest, loss of neurones / damage, in **rear** of brain **;** **2** explains poor understanding of words / poor memory of objects **;** **3** (some / less) damage / loss of neurones, in **middle** (region) **;** **4** affecting motor control **;** **5** (but) not affecting hearing **;** **6** no damage / increase in neurones, in **front** (region) **;** **7** speech (production) unaffected **;** **8** ref to paired figures / manipulated figures **;**	**max 4**
			[Total: 12]

Question			Expected Answers	Marks
2	(a)		**X** = oxyntic / parietal **;**	
			Y = chief / peptic **;** **A** zymogen	
			lipase / mucus / water / (Castle's) intrinsic factor / HCO_3^- **;**	**3**
	(b)	(i)	<u>aerobic</u> respiration / supply ATP / supply energy **;** **R** produce energy (for) active transport / pumping **;** of hydrogen ions / protons **;** exocytosis **;**	**max 2**
		(ii)	modification / processing / idea of change in structure, of protein **;** packaging / making vesicles **;** of, pepsinogen / inactive enzyme / precursor **;** **R** protein or pepsin	**max 2**
	(c)	1	impulses along, parasympathetic / motor, neurone / axon **;** **A** vagus	
		2	vesicles move towards membrane **;**	
		3	release of acetylcholine **;**	
		4	(causes) release of gastrin (from G cell) **;**	
		5	gastrin, enters capillary / carried in blood / AW **;**	
		6	gastrin binds to receptors on E cell **;**	
		7	(causes) histamine release **;**	
		8	histamine / gastrin, binds to receptors on, cell **X** / oxyntic cell / parietal cell **;**	
		9	<u>exocytosis</u> of, ACh / gastrin / histamine **;**	
		10	<u>diffusion</u> between cells of, histamine / gastrin / ACh **;**	**max 5**
	(d)		idea of complementary shape **;** bind to / blocks, (histamine) receptors / histamine binding site **;** less / no, secretion of HCl **;**	**max 2**
	(e)		*endopeptidase* breaks / hydrolyses, peptide bond **;** within, polypeptide / protein **;** **A** 'breaks up into smaller pieces' *hydrolysis* breaking of, suitable named bond **;** using / adding, water **;**	**max 3**
				[Total: 17]

3 (a) **M** = neural spine / neural process **;**
attachment of, ligaments / muscles **;** **R** articulates

N = neural canal / neural channel / foramen **;**
protects / allows passage of, spinal cord **;** **R** spine **4**

(b) support greater, load / weight **;** *comparative statement* **1**

(c) **T** correctly labelled **;**
A correctly labelled **;** **2**

(d) *C1 to C14 to max 5*

C1 osteoarthritis affects cartilage **;**
C2 osteoporosis affects bone **;**

C3 osteoarthritis due to 'wear and tear' on joints **;** **A** ref to 'load bearing'
C4 vigorous use / overuse, of joints **;**
C5 ref to, sport / dance / lifting job **;** **A** relevant activity
C6 more cartilage breakdown than replacement **;**
C7 less, collagen / glycoprotein **;**

C8 osteoporosis due to loss of bone, mass / density **;**
C9 idea of <u>osteoclasts</u> more active than <u>osteoblasts</u> **;**

C10 loss of calcium phosphate / demineralisation **;**
C11 ref to, menopause / low oestrogen **;**
C12 diet low in, calcium / vitamin D **;**
C13 bone density less than 648 mg cm^{-3} **;**
C14 AVP **;** e.g. smoking / steroid use

S1 to S6 to max 3

S1 pain during movement in osteoarthritis **;**
S2 reduced mobility (of joint / limb) **;**
S3 inflammation of joint **;**

S4 (increased chance of) fractures in osteoporosis **;**
S5 immobility **;**
S6 pain qualified **;** e.g. sciatica **;**
S7 AVP **;** **max 7**

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

[Total: 15]

Question			Expected Answers	Marks
4	(a)		ref parasympathetic NS / AW **;** sympathetic NS less active / AW **;** more impulses in vagus nerve / less impulses in accelerator nerve **;** more acetylcholine / less noradrenaline **;** effect on SAN **;**	**max 3**
	(b)		*any two of* fibrinogen **;** **R** fibrin prothrombin **;** **R** thrombin albumin **;** **A** albumen (named) globulin **;** **R** immunoglobulin or antibodies AVP **;** e.g. transferrin	**max 2**
	(c)		*similarities*	
		1	production of urea **;**	
		2	urea transported in blood **;**	
		3	urea filtered from blood **;**	
		4	synthesis of proteins from amino acids **;**	
			differences (assume refs are to brown bears unless otherwise stated)	
		5	amino acids synthesised from ammonia **;**	
		6	<u>all</u> urea reabsorbed **;**	
		7	from kidney <u>and</u> bladder **;**	
		8	urea converted to ammonia by <u>bacteria</u> **;**	
		9	AVP **;** e.g. (humans) less tolerant to high ammonia (in blood)	**max 5**
	(d)		component of cell membranes / AW **;** ref to, mechanical stability / impermeability / fluidity **;** *ignore* rigidity production of, steroid hormone / named hormone **;** production of vitamin D **;** production of bile salts **;**	**max 3**
	(e)		increases high density lipoproteins (HDLs) **;** reduces low density lipoproteins (LDL) **;** prevents, deposition of cholesterol / plaques / atherosclerosis **;**	**max 2**
				[Total: 15]

Question			Expected Answers	Marks
5	(a)		ulna **;**	1
	(b)		rapid / almost immediate / AW **;** automatic / no conscious thought / does not involve brain **;** (co-ordinated by) spinal cord / (only) three neurones involved **;** no learning / innate / instinctive / AW **;**	**max 3**
	(c)	1	depolarisation of spindle **;**	
		2	generator / receptor, potential **;**	
		3	ref to threshold **;**	
		4	action potential / impulse **;**	
		5	sensory neurone **;**	
		6	synapse with, relay / intermediate, neurone **;**	
		7	exocytosis of, neurotransmitter / ACh **;** A description of exocytosis	
		8	diffusion (of neurotransmitter / ACh) across cleft **;**	
		9	action potential in motor neurone **;**	
		10	to, end plate / neuromuscular junction **;**	
		11	binding of transmitter to receptors (on sarcolemma) **;**	
		12	depolarisation of sarcolemma / AW **;**	
		13	spreads down T-tubules **;** **A** T-tubes	
		14	calcium ions released from, sarcoplasmic reticulum / SER / cisternae **;**	
		15	calcium ions bind to troponin **;**	
		16	tropomyosin moves **;**	
		17	exposes myosin binding site (on actin) **;**	
		18	ref to, sliding filaments / cross-bridges / ratchet mechanism **;**	
		19	AVP **;** e.g. sarcomere shortens / ATPase involved	**max 8**
			QWC – clear well organised, using specialist terms ;	1
			award the QWC mark if four of the following are used in correct context depolarisation T-tubules threshold sarcoplasmic reticulum synapse troponin sarcolemma tropomyosin	
	(d)	1	proteins needed for repair / AW **;**	
		2	more transcription of, DNA / genes **;**	
		3	more translation **;**	
		4	protein synthesis **;**	
		5	named protein **;** e.g. actin / myosin / troponin / tropomyosin	
			ignore all refs to muscle contraction	
		6	more aerobic respiration **;**	
		7	so more, energy released / ATP produced **;**	
		8	(energy required for) condensation / anabolic, reactions **;**	
		9	(energy required for) formation of peptide bonds **;**	
		10	(energy required for) formation of extra mRNA **;**	**max 5**
				[Total: 18]

Question			Expected Answers	Marks
6	(a)		**X** = tympanum / tympanic membrane / eardrum **;** passes vibrations to, ossicles / malleus / hammer **;** **Y** = Eustachian, tube / canal **;** equalises pressure (on either side of tympanum) **;**	**4**
	(b)		prevent damage to ossicles **;** prevent damage to, cochlea / organ of Corti / sensory hair cells **;**	**2**
	(c)	(i)	**1** little difference / similar results, up to 1,000 (Hz) **;** **R** no difference **2** no, loss of hearing / increase in volume of test sounds, for person **A ;** **3** increasing, hearing loss / volume of test sounds, for person **B** (above 1,000Hz) **;** **4** large, hearing loss / increase in volume of test sound, for person **C** at <u>4,000</u> (Hz) **;** **5** quote fig(s) with both units **;**	**max 3**
		(ii)	loud / damaging, sound was of, one frequency / 4 000 Hz **;** (causes) damage to / loss of, stereocilia / hair cells **;** in (only) one region **;** of, basilar membrane / organ of Corti / hair cells **;**	**max 2**
		(iii)	(testing) apparatus **;** background noise / no background noise **;** time of day **;** same number of tests at each frequency **;** same range of frequencies **;** AVP **;** e.g. alertness of patient **R** gender, age	**max 2**
				[Total: 13]

Mark Scheme 2806/01
June 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

Expected Answers **Marks**

1 (a) *2 marks for the correct answer*

$\frac{46\ \text{mm}\ +/-1}{20\ 000}$ **;**

answer 2(μm) **;** *accept error carried forward if answer is a whole number* **max 2**

(b) (i) Golgi (apparatus) / dictyosome **;**
modifies proteins **; A** collects / processes
adds, carbohydrate / sugars / polysaccharide **;**
A makes glycoproteins / glycosylation
(packages into) vesicles (for export) / lysosomes **;** **max 3**

(ii) vesicles fuse with, cell membrane **/** plasmalemma **;**
ref to exocytosis **; A** reverse pinocytosis
cell wall permeable **;**
reference to spaces between cellulose microfibrils **;**
AVP **;** e.g. reference to enzymes
breaking up / disrupting, cell wall **max 2**

(iii) respiration **;**
(protein / glycoprotein) synthesis / exocytosis **;**
requires, energy / ATP **; A** active
(mitochondria) release energy / produce ATP **;**
R produce / make / create, energy **max 2**

[Total: 9]

Question			Expected Answers	Marks
2	(a)	(i)	*penalise lack of units once in answer* increase in, elongation / length, with auxin concentration up to, 1.4 / 1.8, μmol dm^{-3} **;** peak / maximum, at 1.4 μmol dm^{-3} **;** decrease between 1.4 and 1.8 μmol dm^{-3} **;** data quote with any 2 points **;** linear / directly proportional, before <u>1.2</u> *or* linear inversely proportional after <u>1.5</u> **;** **R** length decreases	**max 3**
		(ii)	*mark first three factors* temperature **;** age of stems **;** light, <u>intensity</u> / wavelength **;** concentration of dissolved, ions / salts **;** (concentration of) other named growth substance **;** AVP **;;;** e.g. pH, genotype (of plant), concentration of named metabolite (e.g. glucose / amino acids), O_2 concentration, CO_2 concentration **R** 'amount of'	**max 3**
	(b)		<u>cell</u>, enlargement / elongation **;** **R** stem enzyme synthesis **;** vacuolation **;** increase in plasticity of cell walls **;** (cell) wall softened by, H^+ / lowered pH **;** high concentration of auxin causes inhibition of growth **;** AVP **;** e.g. cell division, mitosis, replication, cytokinesis, increase in number of cells **R** ref to uptake of nutrients	**max 2**
	(c)		*assume answer is about plant growth substances unless stated otherwise* *treat refs to target, cells / tissue(s) and external stimuli as neutral* growth substances produced by, dividing cells / meristems **;** *ora* hormones produced by, islets of Langerhans / alpha cells / beta cells / <u>endocrine</u> gland / pancreas growth substances move, in phloem / in xylem / from cell to cell **;** *ora* hormones / named hormone(s), move in blood growth substances usually produce a permanent change in the plant **;** *ora* hormones produce reversible change in blood sugar (GS) not homeostatic / no negative feedback **;** *ora* for hormones **R** positive feedback **A** description of negative feedback (GS) not protein / not polypeptide **;** *ora* insulin / glucagon, are proteins AVP **;**	**max 2**
			[Total:	**10]**

Question			Expected Answers	Marks
3	**(a)**		*accept any three correct statements based on the data;;; for example* populations of, mites / springtails, much greater / more than twice the number, in the climax forest than before trees established *ora* number of species of springtail greatest in the climax community *ora* small difference in numbers / no significant difference, between areas with young trees and areas with mature trees there were always (many) more mites than springtails in the sample	**max 3**
	(b)		<u>succession</u> **;**	**1**
	(c)	**1**	consumers have alternative sources of food **;** *ora*	
		2	change in numbers of one species has less effect on another trophic level **;**	
		3	ref competition **;**	
		4	regulation of population size **;**	
		5	food / energy, exploited efficiently / AW **;** **R** general ref to energy flow	
		6	interlinking food chains **;**	
		7	role of named organisms in recycling / recycling of C *or* N *or* Fe *or* P **;**	
		8	food available throughout the year / AW **;**	
		9	niche / idea **;**	
		10	example(s) of any of the points 1 to 9 **;**	**max 3**
	(d)		no trees to, take up / absorb / use, nitrate **;** decomposition of, organic matter / named plant part **;** **R** animal nitrate soluble (in water) **;** leaching / run off **;** detail of any stage in protein to nitrate **;** **R** ref to 'nitrogen' at any point	**max 2**

(e) *all points refer to strip felling but accept reverse argument*

1 uncut strip acts as, reservoir / refuge **;**
2 faster regeneration (of trees) **;**
3 species less likely to become extinct / maintains biodiversity **;**
4 does not disturb, food webs / habitats / ecosystems **;** **A** conserves / maintains
5 ref to, nest sites / breeding sites / territories / migration channels **;**
6 creates new habitats (on margins) **;**

7 soil less likely to dry out (with strip felling) / AW **;**
8 soil erosion / mud slides, less likely **; A** refs to, surface run off / gullies
9 ref to roots of trees binding soil **; R** 'trees protect soils'
10 ref to flooding **;**
11 ref to, nutrient / mineral / C / N / Fe / P, cycles **; R** refs to, CO_2 / global warming
12 ref to, nutrient leaching / eutrophication **;**

13 less change to microclimate / more humid beneath the trees **;**

14 ref to, amenity / aesthetics **;**

15 ref to sustainability **;**
16 ref to cost **;**
17 larger total area of forest may be exploited or disturbed **;**
18 more, roads / access, needed than if one (compact) area exploited **;**
19 ref to, pollution / noise / hunters / AW **;**
20 AVP **;** e.g. damage, wastage, not all timber used, prolonged disturbance,
21 AVP **;** labour intensive, niches preserved, quality of timber, ref to fertiliser **max 6**

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

[Total: 16]

Question			Expected Answers	Marks
4	(a)		ref limiting factor **;** not carbon dioxide **;** named factor e.g. light / temperature / limited number of chloroplasts **; R** water photosynthesis at maximum rate **;** explanation of effect of named factor e.g. ref to enzyme action **;**	**max 2**
	(b)		ref respiration **;** production of carbon dioxide **; R** release (at low concentrations, CO_2 was) diffusing / moving down a concentration gradient **;** respiration faster than photosynthesis / AW **;** AVP **;** e.g. below compensation point	**max 2**
	(c)		control of variables / light is a variable **; R** 'fair test' unqualified	**1**
	(d)		*accept ora here* maintenance of water supply **;** xylem / vascular bundles, intact **;** water required for, photosynthesis / turgor **; A** water prevents wilting stomata might close if the leaf detached **;** leaves site of photosynthesis **;** AVP **;** e.g. ABA, water stress, sugar transport	**max 2**
	(e)	**1**	one similarity between barley and sugar cane **;**	
		2	one difference between barley and sugar cane **;**	
		3	temperature ref between or within species **;**	
		4	CO_2 concentration ref between or within species **; A** ppm for concentration	
		5	data quote comparison with units **;**	
		6	ref to habitat **;** e.g. tropics, named country, biomes (biological zones), climate	
		7	ref to biochemistry **;** e.g. C4 / C3, different enzymes	
		8	ref to enzymes **;**	
		9	AVP **;** e.g. ref compensation point	**max 5**
			[Total:	**12]**

Question		Expected Answers	Marks
5	(a)	AATCCC / adenine adenine thymine cytosine cytosine cytosine **;** (first 6)	**1**
	(b)	does not result in the synthesis of (messenger) RNA **;** not transcribed **;** does not code for, protein / polypeptide / amino acid sequence / AW **;** **R** amino acid	**max 2**
	(c)	more, cell division / generations of cells / mitosis / replication **;** loss of, telomere / DNA / nucleotides / part of chromosome, at each replication **;** **R** loss of bases	**max 1**
	(d)	(bacterial / prokaryote) DNA is, circular / loop / not linear **;** **A** no chromosome(s)	**1**
	(e)	provides sites for binding **;** ref to, spindle fibres / microtubules **;** ref to genes being spaced out along chromosome **;** places to break and rejoin (during meiotic division) **;** **A** chiasmata formation function may not yet have been discovered **;** 'junk' implies no, function / purpose **;** *ora* AVP **;** e.g. raw material for, evolution / natural selection, required for, cell division / mitosis / meiosis	**max 2**
	(f)	straight line sloping up from left to right **;** (does not need to start at origin)	**1**
	(g)	ATP / NAD / NADP / RNA / phospholipid / GP / TP / RuBP / ADP / RUP / AMP / cAMP/ phosphocreatine / AVP **;** **R** DNA	**1**
	(h)	*penalise ref to nitrate once only in answer* increase, uptake / absorption **;** promotes / increased / more, growth of, (aquatic) plants / algae **;** **A** algal bloom more food for herbivores **;** species that need low phosphate concentration may be adversely effected **;** less light penetrating water / ref to plants or algae blocking light **;** less photosynthesis in submerged plants **;** plants die (in context) **;** increase in, decomposers / bacteria **;** eutrophication **;** ref to (bacteria) use O_2 / aerobic respiration / depletion of O_2 / raises BOD **;** ref to death of, animals / named animals / named group of animals, linked to O_2 **;** AVP **;** e.g. effect on humans, decrease in biodiversity	**max 4**
		[Total:	**13]**

Mark Scheme 2806/03
June 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

Planning Exercise

The mark scheme for the planning exercise is set out on the next page. 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

The mark scheme for Questions 1 and 2 for the Practical Test are on the pages following the mark scheme for the Planning Exercise.

A2 Biology. Planning exercise

Checking Point		The candidate
A	P.1a	plans a suitable procedure that involves measuring species abundance / distribution in a specific habitat and water content of soil**;**
B	P.1a	gives a prediction about abundance / distribution of two **named** plant species**;**
C	P.1b	selects suitable equipment and materials to include quadrat (point or frame), tape / rule, balance, drying oven / incubator**;**
D	P.3a	chooses species frequency / species density / percentage cover, to determine abundance / distribution**;**
E	P.3a	identifies at least two key factors to control, **one** for field e.g. size of quadrat, time of sampling, depth of soil, volume of soil, **one** for lab e.g. drying time, drying temperature**;**
F	P.3b	decides on appropriate number of measurements to take - minimum of **ten** different quadrats**;**
G	P.3b	decides on an appropriate way to sample whole habitat, e.g. using (belt) transect / random numbers to generate co-ordinates**;**
H	P.3b	describes ways of obtaining reliable results, e.g. soil sample from every quadrat / at least 3 transects / at least 3 soil samples from different habitats**;**
I	P.5a	uses appropriate scientific knowledge and understanding in developing a plan, e.g. distinguishing features of chosen plants, shows percentage dry mass calculations**;**
J	P.5a	uses results from preliminary work, previous practical work or uses a relevant, identified secondary source in developing a plan**;**
K	P.5a	identifies one hazard and an appropriate precaution, e.g. avoiding infection, avoiding burns by wearing gloves, anything appropriate for fieldwork**;**
*L**	*P.5b*	*gives a clear account, logically presented with accurate use of scientific vocabulary (uses capital letter for generic name, small letter for specific name) (QWC)***;**
M	P.5b	describes way(s) of obtaining precise results, e.g. use of keys, drying soil to constant mass, use of desiccator**;**
N	P.7a	uses information from at least **two** relevant identified sources, e.g. preliminary work / class practical / text book / web site**;**
O	P.7a	shows how results are to be presented in **one** table with data from field and with percentage water content**;**
P	P.7a	shows how both sets of data are to be presented graphically to enable a comparison to be made, e.g. bar charts / kite diagrams / scatter graphs**;**
Q	P.7a	comments on an adaptation of **named** plant(s) to water content of soil, e.g. buttercups in wet soil with aerenchyma**;**
*R**	*P.7a*	*uses spelling, punctuation and grammar accurately (QWC)***;**
S	P.7b	explains how data would be analysed, i.e. correlates species distribution / abundance data with water content data, e.g. suitable statistical test, such as correlation coefficient, Spearman's rank**;**
T	P.7b	comments on precision and/or reliability with **justification**, e.g. use gridded quadrat, strategy for plants half in quadrat, soil prevented from drying before placing in oven**;**
U	P 7b	comments on validity, e.g. influence of other environmental factors**;**

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

Question		Expected Answers	Marks
1		colour of filtered potato extract - brown red / AW ; **R** no change / colourless	1
		pH **A** = 3 ± 1 ; pH **B** = 9 ± 1 ;	2
(a)		records results in the form of a table ; informative, column / row, headings ; identity of tube in first, column / row ; time with unit heading ; **R** if units in body of table time taken for **C** shortest ; no starch in **D** ;	**5 max**
(b)		starch absent ; crushing ruptures, cells / cell walls ; **A** releases cell contents starch / grains / amyloplasts, too large to pass through filter paper ;	**2 max**
(c)		*in **A** or **B*** not optimum pH / enzymes only work within narrow pH range ; ref to acid making basic side chains +ve / bases making acidic side chains –ve ; ref to, attraction / repulsion, between side chains ; *in **A**, **B** or **D*** disruption of, H-bonds / ionic bonds ; tertiary structure changed ; active site distorted ; substrate no longer fits ; enzyme denatured ; *in any tube that produced starch (ora in tube that did not produce starch)* enzyme catalyses ; formation of glycosidic bonds ; with elimination of phosphate groups ; forming / synthesising, starch ;	**8 max**
(d)	**(i)**	glucose phosphate / phosphate group attached to glucose ;	1
	(ii)	ATP ;	1
(e)		concentration of P_i in extract very low ; concentration of glucose phosphate very high ; enzyme catalyses reversible reaction ; concentration of P_i in plants (100x) higher than glucose phosphate ;	4
(f)		glucose phosphate not an enzyme ; **R** tube contained just glucose phosphate glucose phosphate present in all tubes ; but starch not produced in **D** ;	**2 max**

(g) *limitations*

1 unknown concentration of enzyme in extract **;**
2 different volumes in tubes **A**, **B** and **C**/**D** **;**
3 different concentrations in tubes **A**, **B** and **C**/**D** **;**
4 pHs estimated **;**
5 only two pHs estimated / pH of **C** and **D** not estimated **;**
6 pH not estimated after addition of glucose phosphate **;**
7 temperature not controlled **;**
8 optimum temperature not used **;**
9 judging colour changes of iodine solution **;**
10 ref to drop size **;**
11 cross contamination **;**
12 sampling intervals too infrequent **; R** ref to regular intervals
13 not possible to take samples simultaneously **;**
14 no repeats / should be repeated **;**
15 ref to no control with just plant extract **;**
16 AVP **;** e.g. no buffer solution used

improvements to give more accurate and reliable results

17 make up, equal / same, volumes with (distilled) water **;**
18 use pH, meter / probe **;**
19 use colorimeter **;**
20 use of standard in colorimeter to define end point **;**
21 ref to calibrating colorimeter to measure concentration of starch **;**
22 calculate rate 1/t **;**
23 two or more repeats **;**
24 correct ref to anomalies in context of repeats **;**
25 calculate means **;**
26 AVP **;** e.g. thermostatically-controlled water bath **8 max**

[Total: 28 max]

Question			Expected Answers	Marks
2	(a)		*drawing quality* clear continuous lines not too, faint / bold **;** no shading **;** proportions correct **;** no cells **;**	**4**
			labels xylem **;** phloem **;** sclerenchyma **; A** fibres parenchyma **; A** cortex epidermis **; R** upper / lower epidermis aerenchyma / chlorenchyma **; A** photosynthetic <u>tissue</u>	**6**
	(b)	(i) & (ii)	counts squares / calculates area, 1600 - 2400 squares / 64 - 96 cm^2 **;** records no of squares / area of vascular tissues **;** correct method for calculating percentage **;** percentage of stem that is vascular tissue calculated as between 5 and 20% **;** percentage that is phloem calculated as less than half area of vascular tissue **;** *ecf*	**5**
		(iii)	*drawing quality* draws minimum of three sieve tubes and three companion cells **; R** circles walls of sieve tube elements angular **;** companion cells have contents **; A** annotation size of companion cells $^1/_4$ to $^1/_3$ size of sieve tubes **;** no spaces between cells **;** cell walls double lines **;**	**5 max**

[Total: 16 max]

Report on the Units
June 2005

Chief Examiner's Comments

General comments

The general impression gained by the Senior Examining team was that the standard at AS remained remarkably stable, but that candidates had shown significant improvements at A2 over past years. The improvement mentioned in the January 2005 *Report for the Units* was maintained. Performance, particularly at the top end, continues to improve. This is most noticeable in *Central Concepts* (2804)*,* the A2 core module, but also in *Unifying Concepts in Biology* (2806/01 - the synoptic paper) and some of the Options (2805). In general, the outcomes from the different units and components are very stable over time. The Examiners set papers that conform to the established pattern and candidates realise how they will be tested. This session saw a continuation of the trend towards the Practical Examinations and away from coursework.

These reports, as ever, discuss the more challenging questions, catalogue the problems faced by candidates and highlight the weaknesses exposed. However, it should be reported at the start that candidates generally appear to be confident about topics that are clearly delimited by the specification and which have been the subject of questions on earlier papers. They appear more ill at ease with questions that test Assessment Objective 2 (Application of Knowledge and Understanding, Analysis, Synthesis and Evaluation) and Assessment Objective 4 (Synthesis of Knowledge, Understanding and Skills) especially in the Options (2805). These are areas where candidates clearly need more guidance and practice.

The reports highlight aspects of examination technique that candidates should consider. They also contain *teaching tips* and *examination tips* based on the questions set in this session. The reports on the two Practical Examinations also contain some *practical tips* as well.

Some centres encountered a most regrettable problem with *Q.1* of the A2 Practical Examination. Centres were asked to prepare an enzyme extract from potatoes. The difficulties of doing this on a large scale in advance of the examination had not been anticipated and it proved difficult for some centres to provide a reliable extract. As a result some candidates did not gain the expected results and were understandably distressed. Centres should be reassured that OCR and its examining team went to great lengths to make sure that candidates were not disadvantaged by the difficulties they experienced. There is an outline of the steps taken in these comments and a full report on the practical examination at the end of this document. For all Practical Examinations, centres should trial the procedures well in advance of the practicals and contact OCR if they encounter difficulties. If, during practical examinations, centres encounter problems that prevent candidates gaining expected results, the trial results obtained by teachers and technicians may be given out to candidates (in a non tabulated form) to enable them to continue with the question. Centres must ensure that OCR is informed of all circumstances and that the Report Form on the back of the first candidate's script is completed.

Examination techniques

Often examination papers contain questions without dotted answer lines. These may involve labelling a diagram (*Q.3 (a)* on *Biology Foundation* (2801)), completing a table (*Q.5 (a)* on *Human Health and Disease* (2802) and *Q.1 (b)* on *Transport* (2803/01)) or adding arrows to a diagram (*Q.3 (c)(ii)* on *Transport* (2803/01)). Candidates often miss these questions. They could be advised to put a tick by each question or part question as they are answered.

In at least two papers, candidates were asked to list factors that should be controlled in an investigation. Some candidates repeated factors that they had already been given in the question or gave those that were being changed as the independent variable. An example of this is *Q.2 (a)(ii)* in the synoptic paper (*Unifying Concepts in Biology* – 2806/01). The reports include other examples of questions where candidates did not read the information given to them carefully enough.

Quality of expression
A worrying issue that has emerged over the past few months is the difficulty experienced by candidates in expressing their ideas using accurate English with appropriate technical terms. Teachers comment that their students often know, understand and explain certain topics in class, but they find it difficult to put their ideas into writing using appropriate scientific terminology. The Examiners inevitably report the same finding. There are some suggestions about how to help students improve their written answers in these reports.

Some examples of poor expression that were noted this session:
'*to add water*' as a definition of hydrolysis
'*organisms in food webs eat one another*'
…they are 'out of sync'….
'*…at amnion (room) temperature*.'
'*one sperm could be used by different females*'
'*o-zone*' for ozone and '*a sexual*' for asexual
'*production of energy*'

The word '*amount'* gave difficulties. To quote the report on the synoptic paper:

'*Amount is not acceptable at AS/A level to describe mass, volume or concentration*.'

In some cases it is clear what is meant, but in *Q.2 (a)(ii)* on 2806/01 it was not: the '*amount of the auxin solution*' could refer to the **volume** (correct response) or to the **concentration** (incorrect). Amount is a word best avoided in these circumstances. Another example of this is *Q.5 (a)* on *Microbiology and Biotechnology* (2805/04).

Mercifully the Examiners did not find much text (or should that be 'txt'?) language.

Calculations
Calculations continue to remain problematic for many candidates. Most papers have at least one question which involves a calculation. The types of calculations are quite predictable, but are often poorly done. For instance, some candidates found calculating magnifications and actual sizes difficult. There were examples of these in *Q.2 (c)* of the AS Practical Examination and in *Q.6* of *Environmental Biology* (2805/03). It is worth noting, though, that there are signs of improvement in the way that calculations are tackled.

The instruction '*present your answer to the nearest whole number*' has appeared in a number of questions. Candidates have lost marks by not following this instruction.

Sometimes candidates are presented with data and asked to '*describe'* or '*comment'*. Mark schemes often give credit for comparative data quotes. Calculations, such as rates, gradients and percentage changes are often good ways of matching these points. For example, there was an energy flow diagram in *Q.5 (b)* of *Biology Foundation* (2801). There were marks for data quotes, but there was also a mark for manipulating the data; candidates could calculate ecological efficiency - the percentage energy transfer between trophic levels. Some candidates made very good use of the data in this question – an encouraging sign. This question would form the basis of a good class exercise, important since some Examiners feel that energy flow is a topic neglected at AS.

Statistics
Statistical tests were mentioned in the *Report for the Units* for January 2005 (see page 103). While chi squared is the only test that all candidates are required to know, many make use of others in their coursework. The *t*-test (which is part of the specification for *Environmental Biology* (2805/03) is commonly used. *Q.3* on the *Environmental Biology* paper is based on some field work and the *t*-test. This would be a useful resource to use when preparing candidates for field work or to show them how to use the *t*-test. Perhaps a good idea would be to contrast this test with the chi squared test as used in other questions, particularly those from past papers for *Applications of Genetics* (2805/02) – see for example *Q.1* January 2004.

Drawings, photographs and diagrams
The Examiners were disappointed with the standard of drawing on the AS Practical Examination. Partly, this may be due to the unfamiliar nature of the material that they were asked to draw (banana cells). Marking of these drawings cannot be by impression only as it is too subjective and cannot be standardised across a team of Examiners. However, it has been pointed out that the objective mark schemes used by Examiners tend to give credit to some very poor drawings. The drawings in *Q.2* of the A2 Practical Examination were much better. With AS, one has to remember that candidates will have had limited opportunities to practise their drawings skills. Centres should try to find time in an already crowded course for some exercises to practise these skills. An important skill is drawing low power plans; the *teaching tip* at the end of these reports suggests a way to help students do this.

It is good to see candidates using their own digital images in their Planning Exercises and coursework. Some have taken their own photographs and included them in their reports. This is to be encouraged if the photographs are helpful in conveying important information, and add quality to the reports. It is often useful to have some photographs to illustrate field work reports, for example. This helps the reader picture the habitat under study and the organisms being investigated. They are often a useful reminder for candidates who may be writing their reports several weeks (or months) after collecting the data.

Photomicrographs and electron micrographs were used in several examination papers. When these are included as inserts, centres are free to retain them and use them. It was clear from answers to *Q.1* of *Biology Foundation* (2801) that AS candidates need some practice with transmission electron micrographs of cells. Photographs are in the following papers:

root cell	(TEM)	*Q.1 Biology Foundation* (2801)
potato cell with starch grains	(SEM)	*Q.2 AS Practical Test* (2803/03)
tetrad from an anther of *Lilium*	(PM)	*Q.2 Growth, Development and Reproduction* (2805/01)
Cryptosporidium	(SEM)	*Q.6 Environmental Biology* (2805/03)
root cap cell	(TEM)	*Q.1 Unifying Concepts in Biology* (2806/01)

An excellent diagram showing the control of secretion in the stomach appeared in *Q.2* of *Mammalian Physiology and Behaviour* (2805/05). Candidates used it to describe the sequence of events depicted. Not a difficult exercise, but one that matched the Assessment Objective: '*translate, from one form into another, data presented as continuous prose, or in tables, diagrams, drawings and graphs*'. This question (*Q.2 (c)*) is an exercise that could be used with all candidates to practise this skill.

Data response
AS candidates tended not to gain marks available for quoting data in questions based on graphs or tables. A2 candidates were often much better at this. Candidates should realise that instructions, such as '*Describe… …shown in Fig. X.x*' or '*With reference to Fig. X.x,*

describe…' or '*Use the information in Fig. X.x to describe...*' are open invitations to describe trends and patterns and illustrate these with figures taken from graphs or tables. Perhaps the most complex question like this was *Q.4 (e)* on the synoptic paper (2806/01). Many candidates gave accurate data quotes, but equally many did not. Very few made use of the graph (Fig. 4.2, which was on an insert) by ruling lines on it to help them identify the patterns and quote figures accurately. Many were poor at stating the exact concentration of carbon dioxide at which the rate of carbon dioxide uptake reached its maximum value. Some ideas for practising analysis of information in graphs are given in the teaching tips in the report for that paper. The Options papers provide useful material for developing the skills that are tested in the synoptic paper and in *Central Concepts* (2804). It is well worth investigating these to find useful resources.

Candidates often do not seem to realise the importance of the solidus (forward slash) in separating what is being measured from its unit. Often candidates lift the solidus as well as the figure and unit when giving data quotes, for example:

10 / g cm^{-2} *instead of* 10 g cm^{-2}
100 / cases per 100 000 *instead of* 100 cases per 100 000.

Candidates should use the solidus in any tables and graphs that they prepare for their coursework or in the Practical Examination. Brackets should not be used. Further information about this is in the Institute of Biology booklet *Biological Nomenclature* and in the OCR publication: *Teacher Support: Coursework Guidance* available from the OCR website.

Biochemistry
Biochemistry is a topic that many biology candidates find difficult. Be that as it may, protein structure and function and nuclear biochemistry are topics that recur throughout the course and make appearances in the A2 papers. Some AS candidates were not able to express themselves very well when it came to describing the idea of specificity – especially when they were not rewarded by using the term 'specific' as it was in the question. Two questions that could be used together in revision for the AS papers are:

Q.2 (b) from *Biology Foundation* (2801) – enzymes, substrates, active sites, complementary shapes.
Q.6 (b)(ii) from *Human Health and Disease* (2802) – antibodies, antigens, variable regions, complementary shapes.

In the synoptic paper, candidates confused DNA structure with protein structure. This highlights the need to revisit these important topics during the A2 course.

Experimental and Investigative skills
Coursework
The Principal Moderator's report at the end of this document contains some very useful clarification of the coursework descriptors that continue to give problems and are often the reason for adjustments to marks. OCR runs a very useful Coursework Consultancy service. Centres requiring help and advice with coursework are recommended to make use of this free service; details are available from the Subject Officer. Centres who wish to receive more information on the work submitted for moderation may also like to use this service. The Moderators' reports are often detailed, but the limited space means that they may not give as much help and advice as centres would like. Centres changing the tasks that they use for coursework are advised to use this service too. It is well worth checking that a proposed task will give access to all the descriptors, particularly the synoptic descriptors at A2.

The Examiners and Moderators have been concerned that the A/B grade boundary for A2 coursework has been set too high at 50 (out of a maximum mark of 60). After full consideration this grade boundary has been lowered to 48 so that it is now in line with the similar boundary for AS coursework. However, centres are advised to use this as a guide only. Marks given by teachers can be moderated up or down (and yes, marks do go up). Also the mark for coursework is added to the mark for another component (*Transport* in 2803 and *Unifying Concepts in Biology* in 2806) so is not very significant on its own.

Practical Examinations

The AS Practical gave no significant problems, although there was a regrettable omission in the Instructions. The procedure for making the citrate-phosphate buffer did not state that the masses indicated were for the *hydrated* forms of citric acid and disodium hydrogen phosphate. OCR apologises for this omission; the report for the practical includes the correct procedure for making this buffer solution. Some centres reported that they needed to provide a large quantity of apparatus for the Practical Test. This is something that will be considered when designing future tasks.

About a quarter of the centres that entered candidates for the A2 practical examination experienced problems with *Q.1*. The potato extract was prepared as a source of the enzyme starch phosphorylase. In the practical, candidates should have discovered that it catalyses the synthesis of starch from glucose-1-phosphate. This is counter to their usual experience of enzymes, such as amylase and catalase, which are catabolic in action. It was very unfortunate that there were problems in centres, because the question worked well at discriminating between those who read the information at the beginning of the question and appreciated the subtlety of what was happening and those that followed the well worn path of 'enzymes break down substances'.

The original intention was that candidates should prepare the extract themselves so that it would be fresh. However, it was suggested during trialling that this would take them too long so was dropped. The report on the question ends with some tips on how to prepare the extract if centres wish to use this question as a class exercise. It is highly recommended, as is *Q.1* from the January A2 Practical Examination for the same reason: it prompts plenty of discussion and may reveal some serious weaknesses in candidates' understanding of an important A2 topic (learning outcome 5.4.2 (d)) and the role of enzymes within cells. (The latter topic was the subject of the extended answer question in the synoptic paper (2806/01) in January 2004. It was not very well answered as candidates missed the words 'within cells'.) This practical question also makes the point that candidates should read very carefully the information provided at the beginning and turn back to it when answering the questions, particularly the ones that ask for explanations.

OCR received many comments from centres that experienced problems with *Q.1* of this practical. Care was taken by OCR to make sure that candidates were not disadvantaged. The Examiners revised the mark scheme thoroughly in view of the problems encountered, applying the error carried forward rule. A team of Senior Examiners scrutinised marked scripts from centres where there had been problems. They checked candidates' results tables to see if the mark scheme had coped with the results obtained and the interpretation of those results. Where applicable, a scaling or a Special Consideration tariff was applied to candidates' marks.

The Examiners would appreciate it if centres entering candidates for the Practical Examination would attach Plans and Tests together with treasury tags (not string) and put the Test **on the front**. Plans and Tests should not be sent separately. Centres should check that candidate details are entered on both the Test *and* the Plan. The coversheet for the Plan should be signed by the candidate *and* by the teacher.

Some centres have reported problems receiving the Planning Exercises in time for candidates to make a prompt start to this activity. As from the next session, OCR will post the Planning Exercises on its web site. For the January session this will be done in November, for the May session in March.

Study beyond the specification
While performance on the examinations improves, few candidates seem to show much evidence of further reading or study beyond the specification in their answers. Admittedly there are few chances to show evidence of this further study in papers that have to follow the specification and the Assessment Objectives very closely. However, there were some opportunities to show evidence of wider reading in the synoptic paper (as recorded in the report on that paper), but little was seen by the Examiners. It is a shame that few A level biology students take the Advanced Extension Award (AEA). It is taken by about 600 candidates each year. Candidates who have spent time preparing for the synoptic paper definitely have the skills to tackle the AEA so long as they have also done some wider reading and perhaps are also taking General Studies. The AEA paper contains two essay questions which are marked against several descriptors; the experience of preparing for General Studies would be useful. (Details of the Biology AEA are on the AQA web site at www.aqa.org.uk/qual/aea/biol.html)

Some centres make use of the Biology Olympiad to challenge their best students. (Details of the Biology Olympiad together with specimen papers are at www.iob.org) The four students who represented Britain at the 16th International Biology Olympiad held in Beijing this year come from schools that follow the OCR Biology specification.

E-communities
Centres might like to consider encouraging their technicians to subscribe to the e-mail discussion group SCITECH, run by the University of Central Lancashire. This is a useful way for technicians to share good practice, swap tips and provide mutual support. Further details are at:
www.biology4all.com/scitech.asp

Teachers preparing candidates for this specification may like to subscribe to the OCR Biology e-community which is one of several networks run by OCR to allow '*subject specialists to share their knowledge, views and ideas*'. Further details are at:
http://community.ocr.org.uk/lists/listinfo/biology-a

A number of teachers already subscribe, but there are few contributions. It is hoped that more will join and make use of this forum to exchange ideas for teaching and learning A level Biology. Perhaps there could be some contributions on the issues raised in these reports?
Subscription to both these e-communities is free.

INSET
The INSET team will be presenting the following courses during the Autumn Term 2005.

A Beginner's Guide to teaching and assessing A2.
A Beginner's Guide to teaching and assessing AS.
Delivering and Assessing AS and A2 Coursework.
Teaching practical skills at AS and A2.

The Beginner's Guides will be repeated in the Spring Term 2006. Although courses with these titles have been offered before, they have been thoroughly revised and new material will be used. A new course to provide information for NQTs is being offered in May 2006.

Full details are on the OCR web site and can be found by following the links from the Home Page to AS/A Sciences, AS/A Biology and then to Training.

2801: Biology Foundation

General Comments

Those candidates who had been well prepared and approached the paper logically, providing clear answers, were able to score well. It was pleasing to note that, despite some challenging questions, many candidates performed well on this paper. Candidates should, however, make every effort to produce clear and legible answers. Poor expression often led to vague statements and cost marks as the Examiners were looking for precise answers. Often candidates wrote in such a way that they displayed a variety of misconceptions notably referring to 'water concentration' in *Q.4*.

Candidates should be reminded that they are expected to apply their knowledge of topics and concepts to unfamiliar situations. Candidates should be given practise at identifying these questions and advised to read the information provided carefully for help with writing their answers.

Comments on Individual Questions

Q.1 This should have been a reasonably easy starter question. Some candidates demonstrated that they were relatively unfamiliar with using electron micrographs, simply suggesting any structure that might be present in a plant cell. As it was a plant cell, some were unable to resist the temptation to suggest a large number of 'plant only' labels, the only one that was appropriate being the cell wall. Chloroplast was the most common incorrect answer for **A**. Careful spelling was needed for **C**, as the line clearly pointed to the nucleolus: 'hybrid' words such as 'nucleous' did not score. The most common incorrect identification for **D** was cell membrane.

Q.2 This was a question that contained information that the candidates could usefully employ in applying their knowledge of carbohydrates.

(a) This should have been a straightforward question, the candidates being asked to use their powers of observation to identify a similarity and a difference between the two molecules. Many scored at least one mark, but confusion arose with inappropriate use of terms, such as molecules and elements, when referring to groups and atoms. A common error was to describe fructose as a pentose rather than a 5-membered ring.

(b) Most candidates correctly answered *(i)*. Clarity was expected in the answers to *(ii)*. The two molecules had been drawn with the correct orientation to form the disaccharide and some candidates made good use of it to demonstrate the removal of a water molecule. Correct identification of the OH groups as the source of the water and the isolation and removal of two hydrogen atoms and one oxygen atom were expected. Some ingenious methods of joining the two molecules were seen, the bridging component being given as OH, H_2O or H.

(c) The lack of heating after adding Benedicts solution was the most common fault here. The use of a water bath does not automatically imply heating unless some reference to heat, warming or boiling is also made. Some candidates suggested using biuret solution or iodine solution. Suitable colour changes were normally given. In *(ii),* there was some confusion evident between condensation and hydrolysis. This part of the question was not as well answered. Some candidates thought that simply adding water would break the bond - an ambiguous statement that was not credited unless hydrolysis was also stated to put it into context. Others

neglected to boil with the dilute acid while others continued the procedure including references to cooling and neutralising that were not required.

Q.3 *(a)* A significant number of candidates failed to answer this part of the question, with no label attempted. This was not restricted to the weaker candidates. When the question was attempted, there were very few incorrect answers seen.

(b) The vast majority of candidates answered this correctly.

(c) Candidates did not seem confident to answer this question without using the term 'specific'. As this was part of the phrase that they were asked to explain, credit was not given. It was hoped that the diagram would encourage them to refer to the shape of the active site and the complementary or matching shape of the substrate. Candidates who referred to the active site and the substrate having the *same* shape did not gain credit as the active site is shown as concave and the substrate as convex in Fig. 3.1. Some candidates made good use of the diagram, indicating which substrates did or did not fit.

(d) Candidates found this difficult; this was as expected since the question was targeted at the higher grades. Few related the information to the idea that the bonds within the substrate would be under strain or that activation energy would be lowered. Many comments referred to the idea that the enzyme could fit around the substrate, which was not the point of the question. All too often, the question was restated or a simple statement that the reaction would be faster was made. The Examiners consider that candidates should understand the 'lock and key' principle at GCSE and be prepared to discuss induced fit idea at AS.

Examination tip

Encourage candidates to check the marks in the square brackets to make sure that they have answered each part question. This is to ensure that they do not neglect a part question that does not have an answer line.

Q.4 Candidates generally scored poorly on this question. The main problem seemed to be that they did not read the information carefully enough.

(a) Candidates were told that the artificial membrane was not permeable to disaccharides and these disaccharides were named. Despite this, many candidates ignored the information and concentrated entirely on the relative concentrations inside and outside the 'cell'. Consequently two sugars were suggested in both *(i)* and *(ii)*, which was not credited. It was disappointing to see so many candidates stating that sugars crossed the membrane by osmosis in *(iii)*. Part *(iv)* did not score well. Few realised that a change in volume would be brought about by the passage of water through the membrane, referring solely to the movement of sugars. Those who did realise that water was involved normally scored reasonably well, although some failed to make use of the information in the diagram relating to the concentrations of the sugars inside and outside the 'cell'. These candidates tended to present a hypothetical account, giving alternative water movement into or out of the 'cell'. They either did not realise where the higher water potential occurred or did not want to commit themselves. Some candidates appear to have progressed little beyond the concept of 'concentration of water'. At AS, candidates are expected to answer in terms of water potential. Some confusion arose with the use of the term solute potential. Some candidates mistakenly suggested that an

increase in solute concentration caused an increase in solute potential. However, some very clear concise accounts were seen that easily scored the maximum marks.

(b) Many candidates correctly selected an active method of transport to gain the mark. Some, however, had not realised that, being inanimate, the membrane in the experiment was unable to carry out active processes and suggested diffusion or osmosis.

Teaching tip

Fig. 4.1 could be adapted in a large number of different ways and used to test understanding of diffusion and osmosis. For example, different substances could be added inside and outside the 'cell' and the concentrations could be changed. Adapted in a variety of ways the diagram could be used alongside a practical on osmosis, such as that in *Q.1* of the January 2004 AS Practical Test.

Q.5 *(a)* This part of the question was generally answered well, although some candidates were obviously simply trying any term that they could remember. This is a shame, as questions of this type will invariably appear on question papers. The alternative way of testing this material from Section 5.1.7 of the specification is to ask candidates to supply definitions in their own words. Much more demanding.

(b) This question discriminated well, with most candidates prepared to have a reasonable attempt at answering it. Those who approached it logically, using the information in Fig. 5.1 to help them, generally scored well. Credit was given for both quoting the data and for manipulating it, such as adding, subtracting or calculating percentages. It was pleasing to see that many candidates provided percentages, but some were estimates that in many cases were fairly inaccurate.

Despite the assistance given, some candidates wrote in very general terms, repeating the points made for each stage of the food chain. Many candidates failed to state units when quoting figures and, while it was tolerated on this occasion, they should always be encouraged to include units. While many recognised the sun as the source of energy for the ecosystem, this was not always well expressed. A surprising number failed to mention how the sunlight would be used or to consider how it might be lost before being incorporated into the plant. More able candidates expressed this well and continued to write concisely, easily scoring maximum marks.

Energy losses by respiration were frequently not attributed to a particular trophic level and while decay was often mentioned, no mention was made of the transfer of energy to decomposers. Candidates were expected to state that the major source of heat loss is respiration in order to gain credit. Transfer of energy between the trophic levels was dealt with in a vague way; a significant number of candidates failed to state that the material was eaten or digested. The use of the term 'loss' was also used indiscriminately. A common statement was that 'energy is lost in growth', whereas this is this energy that is made available to the organisms in the next trophic level. This was often recognised in good answers. Better candidates often considered the parts of organisms that could not be eaten or digested for various reasons. Most candidates were awarded the quality mark.

Teaching tip

Candidates could use Fig. 5.1 to calculate the percentage energy transfers between trophic levels.

Q.6 *(a)* Mitotic cell division does not allow for 'growth of cells' or 'repair of cells'. These statements were not credited.
Some candidates clarified their statements by referring to replacing cells. Even so, it was not always clear from the answers whether candidates were referring to cells, tissues or a mixture of the two. To ensure consistency in applying the mark scheme, the following procedure was applied:
'*growth and repair*' scored 2 marks;
'*growth and repair of cells*' scored 1 mark for growth;
'*growth of cells and repair*' scored 1 mark for repair;
'*growth of cells. Repair of cells*' scored 0 marks;
'*growth / repair of cells*' scored 0 marks.

This allowed the Examiners to give the benefit of the doubt to candidates. Good candidates easily scored maximum marks although some missed the marking point about forming *genetically* identical cells by omitting the word 'genetically'. References to clones were seen, as was the mention of asexual reproduction, but not as often as might have been expected. There seems to be an increasing tendency for candidates to write 'asexual' as 'a sexual' (two words) which could, of course, convey a completely different meaning.

(b) Some candidates gave numbers or initial letters when answering this section and some interesting spelling was also seen. The majority of candidates, however, managed to score reasonably well if they had a basic knowledge of the process.

(c) Part *(i)* probably looked fairly straightforward. Many candidates, however, did not realise the subtlety in the distinction between a simple 'half the number of chromosomes' and 'one of each type of chromosome' or 'half the diploid number'. The Examiners were looking for the clear idea that the term refers to one set of chromosomes rather than 'half the number' without further clarification. Some candidates implied that each chromosome was itself halved or that the haploid cell contained two sets of chromosomes while others gave responses that focussed on DNA or genes or had nothing whatsoever to do with the topic. Candidates should be encouraged to be as precise as possible when dealing with the terms haploid and diploid. The emphasis in part *(ii)* was on the haploid state rather than on the contribution of meiosis to genetic variation, which is dealt with in *Central Concepts* (2804). Consequently, answers that referred to the restoration of the diploid number after fertilisation were credited. Vague answers referred to the danger of too many chromosomes, while the idea of doubling in each successive generation was a more precise way of expressing the idea.

Teaching tips

Make sure that candidates understand the difference between growth, repair and replacement in tissues and *growth of cells*. They should make this clear when answering questions involving mitosis.

There are several tutorials and a self test on the cell cycle and mitosis on the Biology Project web site:
www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/main.html

Q.7 This question proved to be a good discriminator, as candidates with a high level of knowledge and good examination skills performed well.

(a) Fewer candidates than expected were able to score full marks in this section. Many repeated the stem of the question, indicating that growth hormone could be produced in large quantities. Further qualification, such as the idea that supply could meet demand or that it could be produced quickly, was required. Some general statements were seen concerning the benefits to the individual of using growth hormone while others seemed to think that the cells were used as a treatment rather than their product.

(b) The most common error in *(i)* was to suggest that the protein depicted in Fig. 7.1 was a carrier protein. More able candidates were able to suggest a suitable function for the glycoprotein in *(ii)*. Marks were lost by those who described the transport of substances across the membrane and by those who described the glycoprotein as a receptor *cell*. Good descriptions of how the glycoprotein would stabilise the membrane in an aqueous environment were seen; however, it was clear that candidates need to be careful to avoid possible confusion with the role of cholesterol in the membrane when referring to stability or fluidity.

(c) A significant proportion of candidates named a restriction enzyme or endonuclease in *(i)*, but some mentioned any enzyme that might be involved in genetic engineering. Reverse transcriptase featured in many responses, but was not accepted. The more ingenious answers included ‘cuttase’, ‘snipase’, ‘stripase’, ‘healase’ and ‘scissorase’. Most candidates realised that sticky ends needed to be applied to both the gene and the DNA in order to join them in *(ii)*. Some good, clear accounts were seen, but also some that were vague or concentrated on the uptake of the recombinant DNA by the bacteria, which was not what had been asked. A significant proportion of candidates found the whole question difficult and did not even attempt the questions. Part *(iii)* was not answered well and proved particularly tricky. Only the most able candidates realised that the gene coded for a protein, such as an enzyme, that might assist in the joining of the mannose units to one another to form a chain. Many thought that mannose units were amino acids while others simply restated the phrasing in the question rather than concentrating on what might happen between the sugars. All too frequently candidates thought that size was the problem and that the roundworm had to produce small chains because it was such a small organism. As this question was targeted at the higher grades, this was not surprising.

Teaching tip

Further information about human growth hormone and genetic engineering may be found at:
http://news.bbc.co.uk/2/hi/health/medical_notes/98757.stm
www.abernathyclinic.com/ArticleHGH.htm
www.biologymad.com/GeneticEngineering/GeneticEngineering.htm

2802: Human Health and Disease

General Comments

This paper tested candidates' ability to select, organise and present relevant material fairly thoroughly. It included questions on topics that should have been very familiar and tables of data which candidates had to interpret and describe. The Examiners were pleased to see a high level of biological knowledge and attainment by many candidates. However, the Examiners were dismayed by the difficulties many candidates had in expressing themselves clearly. The standard of written English was disappointing and often meant that candidates failed to gain credit because they had not explained their point with sufficient clarity or had presented two opposing arguments in the same sentence.

The majority of candidates made good attempts at all the questions and there was no evidence that candidates were left short of time. Those questions, such as *Q.5*, which were targeted at the lower end of the mark range, were very well answered and many candidates scored close to full marks. Other questions, such as *Q.3* and *Q.6*, covered topics that are often less well understood; here only the better candidates scored well. Centres should remember, while teaching this unit, that candidates should be thoroughly prepared for all the learning outcomes listed in the specification. Certain areas of the specification are complex and lend themselves to questions targeted at the higher end of the range, but can also be treated in a way that candidates throughout the ability range can gain credit. An example of this is in *Q.3 (b)* where even weaker candidates can gain credit for suitable arguments that are well presented.

Candidates should expect a range of stimulus material on this examination paper and can expect some of it to be unfamiliar as it is used to test Assessment Objective 2. Centres can help candidates prepare for these by using past papers and mark schemes but should stress the need to read the question carefully before attempting an answer.

Comments on Individual Questions

Q.1 *(a)* Answers ranged from 'virus'(!) to '*Microbacterium cholerus*'. However, the majority of candidates had a good idea what the bacterium causing cholera is called but relatively few were able to spell it correctly as *Vibrio cholerae*.

(b) Most candidates knew that cholera is transmitted in water contaminated by the faeces of an infected person and that the bacteria must be ingested to infect a new person. However, weaker candidates described infection by means of inhaling water droplets or sharing needles and even the best candidates struggled to present a succinct answer describing the bacterium leaving the body in the faeces, which contaminate water that is later used for drinking or preparing food.

(c) Almost all candidates knew some of the reasons why cholera is more likely to spread in less developed countries. Most frequently given correct responses included 'lack of water treatment' and 'lack of sewage treatment' along with 'poor sanitation'. Many candidates suggested 'cramped living conditions' which was not awarded credit as this is a factor in diseases passed by droplet infection. It is not an appropriate response if water supplies are treated and sewage is properly disposed of.

Q.2 *(a)* Almost all candidates were able to identify correctly the compound nicotine as the addictive element in cigarette smoke.

(b) The majority of candidates were able to achieve full marks here. The most commonly used responses focused on carbon monoxide binding irreversibly with haemoglobin to reduce its oxygen carrying capacity, and tar which stops the cilia working and contains carcinogens. Better candidates also gave further detail of how carcinogens affect the cells lining the airways. Credit was also given to candidates who described tar lining the airways or alveoli and reducing gaseous exchange due to a thicker diffusion barrier, but credit was not given for the idea of tar reducing the surface area for diffusion. A significant number of candidates wrote about tar 'clogging' the airways and even 'clogging' the arteries; this sort of terminology is not accurate and is not suitable at this level.

(c) This was targeted at AO2 and was less well answered particularly by candidates who were not sufficiently precise in their responses. In part *(i)*, most candidates spotted that the percentage of smokers increases from socio-economic group 1 to group 6. However, some candidates wrote about 'higher' and 'lower' classes and it was unclear whether they meant 'higher group number' or the more professional end of the scale. Other candidates referred to numbers of smokers in each socio-economic group; this is inaccurate as Fig. 2.1 does not include the number of people in each group. Many candidates failed to quote figures from the graph to illustrate the relationship that they described. In part *(ii)*, the Examiners hoped that candidates would spot that as the percentage of smokers increases so does the proportion of people with long standing illness and that this is not a proportional increase. Many candidates had apparently spotted these two points but tied themselves in knots attempting to describe what they had identified. A common error was to read from the same axis for both sets of figures. Weaker candidates also used the similarity in the heights of the bars in groups 4 to 6 as evidence of a link, but the difference in heights in groups 1 to 3 was taken as evidence of no link. The Examiners were pleased to see that many candidates did make note of an anomaly between groups 2 and 3. Part *(iii)* was well answered although the responses were often a little vague. One word answers such as 'stress' or 'environment' were not sufficient to gain credit, but the majority of candidates gained one or two marks here.

Q.3 *(a)* Targeted at the top end of the mark range this question certainly proved to be a good discriminator. Good candidates often gave points beyond the maximum mark, while weaker candidates struggled to gain even a single mark. The best candidates wrote about:

- identifying carriers;
- predicting the chances of offspring inheriting the disease;
- antenatal testing and possible termination;
- diagnosing earlier with advice given to those with genes for diseases that develop later in life;
- developing more effective drugs which have fewer side effects and may have a direct effect upon the gene.

With plenty of possible marking points it was disappointing to see a relatively large proportion of candidates floundering with answers that, at best, suggested something to do with gene therapy. However, it was noted that answers were often centre specific and, in particular, certain misconceptions were centre specific – the idea of removing faulty genes or even removing chromosome 22 were alarmingly frequent.

(b) Many candidates did better here with answers that suggested discrimination by employers and insurance companies and potential anxiety for people who are

identified as being at risk of developing a genetic disease. However, weaker candidates were led into writing about designer babies, giving a tirade against the 'big brother state' and stating that man should not be playing God or interfering with nature. Some candidates seemed to believe that genetic screening could cause mutations.

Teaching tips

This topic can be approached quite successfully with small group discussions. Students may be given some suitable background information and press cuttings to stimulate discussion about the advantages and disadvantages of the human genome project. Each group can make a list and compare with others. Or they could be provided with a set of appropriate statements and be asked to rank them in some way.

The Wellcome Foundation provides an excellent website with many subsections:
www.wellcome.ac.uk/en/genome/

Students would be well advised to keep up with the news – in the months leading up to the examination there were many news items referring to such issues as embryo selection, stem cells and tissue donation which may well have helped with their understanding. (This also applies to question 6 with the reports of measles epidemics amongst 18 to 25 year olds as a result of refusal to use the MMR vaccine because of its possible link to autism.)

Q.4 *(a)* The majority of candidates gained full credit for answers indicating that eating too much and not exercising enough can cause obesity.

(b) Again, the majority of candidates achieved good marks here as the trends were easy to spot and describe. Few noticed that the proportional increase in obesity was far greater than in any other category; also few used figures from the table to illustrate the points that they made.

(c) The Examiners were very pleased to see that almost all candidates were able to gain some credit in this extended answer question. Even weaker candidates tended to gain three or four marks while better candidates easily achieved full marks. The level of knowledge regarding the effects of diet on the heart and circulation was very good. The full range of marking points were regularly observed in candidates' responses, some of which were very detailed and used specialist terms widely and effectively. There were some common errors, such as vague descriptions of fats or cholesterol 'building up' in the arteries with no reference to the wall of the artery or damage to the endothelium. Another common problem is to describe the reduced size of arteries due to atherosclerosis without specifying that it is the size of the *lumen* that is reduced. Again, there were many references to arteries getting 'clogged up'.

Teaching tip

Model the structure of an artery using a roll of paper towel. The cardboard roll is the endothelium and the layers of paper represent the tunica media. Add a layer of card outside as the tunica externa. Students should compare this model with a diagram of the artery in TS. The effect of atherosclerosis can be modelled by inserting some plasticene or 'blu-tack' under the endothelium between the card and paper layers.

There is a short animation showing atherosclerosis at:
www.atenmedicalart.com/anim/athero.htm#

Q.5 *(a)* The majority of candidates were able to calculate the mean and complete the table. A significant minority missed this part of the question – most likely because they did not read the question carefully before answering.

(b) In part *(i)*, almost all candidates noted that as intensity of exercise increases so does the pulse rate. Some candidates went on to explain why this happened although this was not asked. Many candidates lost a mark by not illustrating their response with a data quote including units. In part *(ii)*, many candidates noted that muscles respire and need oxygen to do so; however, a good proportion of candidates failed to relate this to the question by pointing out that as intensity of exercise increases the respiration rate must rise and therefore more oxygen is needed and the cardiac output must increase to supply this requirement.

(c) Most candidates successfully identified student **D** as the overweight student in the test. The majority of candidates also gave suitable reasons for their choice using the information in Table 5.1. In addition, better candidates used the information in Table 5.2 about blood pressures and gained full marks. Most candidates achieved three or four marks in this part and it is clear that this part of the specification is well understood by the majority of candidates.

(d) Most candidates responded in terms of atherosclerosis reducing the size of the lumen of arteries leading to increase in blood pressure. This response gained credit; however, the Examiners were hoping that candidates might 'think outside the box' a little more. Atherosclerosis is unlikely to have a big effect in young students – even if they are overweight. The Examiners were hoping to see that candidates would follow the line of the whole question and use part *(d)* to explain the effects seen in part *(c)*. Since the overweight student is carrying more mass his/her muscles would be working harder to carry out more work, this would lead to greater demand for oxygen and so to an increased heart rate. The extra fat can compress blood vessels and so lead to higher blood pressure.

Examination tips

Give candidates practice at answering complete past papers. Suggest that they look for the number of marks awarded for the part questions which are found in square brackets. Candidates could then tick this bracket once they have made a response.

Candidates should be given a list of words commonly used in examination questions, such as '*describe'* and '*explain'* along with a brief statement about what each word means in the context of an examination question. Matching questions with mark schemes from different papers is another way of making this point.

Q.6 *(a)* Most candidates correctly identified **R** as the position of the variable region of the antibody in Fig. 6.1. In part *(ii)*, far fewer candidates were able to explain why an antibody will only bind to a particular antigen. Most gave a vague response such as 'only A will fit'. However, as candidates were asked to *explain*, the Examiners were looking for information about why the receptor site had a particular shape and that the antigen must be complementary to that shape in order to fit. Better candidates did achieve full marks, but the Examiners were disappointed to see how few candidates could manage this. A common error was to describe the whole antibody as having a specific shape rather than referring to the binding site or simply saying the variable region is specific without stating that it is the *shape* that is specific. Many candidates confused antibodies and receptor sites with enzymes and active sites.

(b) In part *(i)*, the Examiners were pleased to see that perhaps half the candidates were able to complete this calculation correctly. However, a good number were able to calculate the proportion of children who would be protected as 82.8%, but then omitted to subtract this figure from 100 to achieve the correct answer of 17.2%. Unfortunately, a lot of candidates appeared to have little idea about how to approach this calculation and attempted calculating 8% of 90 or 10% of 92. Part *(ii)* was generally quite well answered and almost all candidates gained one or two marks. The most common response was along the lines of measles having many strains or mutating so that one vaccine was insufficient. However, many candidates referred to pathogens becoming 'immune to vaccines'.

Teaching tips

The structure of antibodies should be treated in a similar way to that of proteins and enzymes. At the beginning of this topic it is a good idea to recap protein structure stressing that a particular amino acid sequence will lead to a particular shape of receptor site, active site or variable region giving the specificity that is so important.

Students could be set the task of comparing and contrasting the symptoms, treatment and eradication of various diseases in the form of a table. This information is well described in text books and selecting information to put in a table is a valuable skill to be learnt.

2803/01: Transport

General Comments

The whole range of marks was used and there were many good scripts in the top part of the range where candidates had clearly been well taught on the ideas tested and were able to express them. There was no evidence of time shortage. There was little evidence that candidates did not understand the rubric, though some failed to put the arrows on the heart in *Q.3 (a)(ii)*.

Some candidates did not have a calculator and this showed in *Q.1 (b)*. As in previous papers, it was sometimes the more plant-orientated questions that sometimes let candidates down. Likewise, the need to relate structure clearly to function, which is a recurrent theme in the paper, was tackled with varying degrees of success. At the top end there were excellent and lucid accounts, but in the weaker scripts it was difficult for the Examiners to unpick the answers.

Comments on Individual Questions

Q.1 *(a)* Although there were many good accounts of the way in which a potometer should be set up in *(i)*, it was clear that some candidates had never used one or perhaps even seen one demonstrated. The specification makes it clear that they need to know this sort of experimental detail. The mark scheme contained many points worthy of credit that could be applied to various types of potometers. One problem was rather vague references to the start of the scale rather than specifying that a precise starting point should be noted. In the same vein there were a number of rather general references to 'making everything airtight' which seemed to suggest sealing the end of the capillary tube. In part *(ii)*, most candidates realised that uptake of water was what was measured. Some thought it was uptake and use or just use. Some said it was transpiration despite the information given in the question.

(b) The absence of a calculator meant that some did not get the correct figure in *(i)*, whilst others failed to read the rubric and did not give the answer to the nearest whole number. It should be stressed to candidates that transpiration should be considered in terms of loss of water vapour down water potential gradients. Although there were many good answers in *(ii)* there was also a lot of muddled expression in place of logical sequencing. The wind created by the fan blows away water vapour, not water or water droplets. This steepens the water potential gradient and thus more water evaporates and more water vapour diffuses out of the stomata. Just to say that the wind causes more evaporation without explaining why did not get a mark, but weaker responses tended to leave it at that.

(c) Most candidates realised that to get a fair comparison both species would need to be in the same environmental conditions. Fewer were able to express the idea that there should be some attempt to use the same surface area or calculate the rate of water uptake or loss per unit area of leaf.

Teaching tips

- Make sure that all candidates have used a potometer or at least seen the apparatus demonstrated.
- If a piece of apparatus is illustrated in a question encourage candidates to indicate on the diagram such things as the joint that they would ensure is to be made airtight. Annotations on illustrations (graphs, diagrams, drawings, photographs, etc) may well help to clarify answers. Candidates should also draw the attention of the Examiners to these annotations.

A method for setting up and using a potometer is available on the Science and Plants for Schools (SAPS) web site at:
www-saps.plantsci.cam.ac.uk/worksheets/scotland/poto.htm

Q.2 This question posed the most problems to the candidates and only the best scored more than one or two marks.

(a) At this level it is expected that candidates can read graphs accurately. The line on Fig. 2.1 crossed between 30% and 32% and thus the difference could be estimated as 29%, which was the only answer credited for part *(i)*. Not however 29.3%. Many answers to part *(ii)* revealed a fundamental lack of understanding of the concept of dissociation curves. Some thought it was the Bohr effect. Many did not refer to fetal haemoglobin, but only talked in terms of the fetus having a higher affinity. Many thought the fetus needs more oxygen than the mother. A number wrote in terms of blood passing from the mother to the fetus. There were many answers couched in terms of the fetus ‘pulling oxygen off the mother’. Many candidates confused the ideas of affinity and saturation instead of making it clear that at given partial pressures the differences in saturation were due to the differences in affinity, not ‘infinity’ as one candidate wrote. It is important that candidates realise that at the placenta where oxygen exchange occurs the partial pressure of oxygen is low. At this low partial pressure the maternal haemoglobin gives up its oxygen, which is thus free to diffuse across the placenta to the fetal system where it can be picked up by fetal haemoglobin with its higher affinity. This maintains a gradient across the placenta. Very few went on to say why the oxygen was needed for the survival of the fetus.

(b) There were also many weak responses here. Candidates were asked to suggest why fetal haemoglobin is replaced by adult haemoglobin. A common misconception was that fetal haemoglobin would provide the baby with too much oxygen. One candidate thought it would allow the mother to have all her oxygen to recover from birth. Some candidates had the idea that if the baby was female it would need the difference in due course if she had a child. But not many developed the general idea that the affinity would be too high in active life and so not enough oxygen would be given up.

Teaching tips

- Never explain the oxygen uptake at the placenta in terms of the fetus ‘stealing’ oxygen from the mother.
- Start this topic by getting across the idea that the fetus obtains oxygen from its mother across the placenta as it needs oxygen for respiration. Then go on to the details.

Q.3 *(a)* Many candidates got both labels correct in part *(i)*, although occasionally the answers were the wrong way round. The most common errors were **A** being identified as the pulmonary vein or aorta and **B** the tricuspid valve or semi-lunar valve. The pathway through the heart was usually well known in *(ii)*. A few labelled the right side, both sides or had the blood entering the ventricles and leaving via the atria. Some also missed this question. In part *(iii)*, many knew what the Purkyne tissue did in some detail. A few simply stated its function without even hinting that these events would not occur if it was damaged. Some weaker candidates thought that it was a blood vessel or formed the septum and wrote about heart muscle being deprived of oxygen or the whole heart collapsing. Good candidates were able to talk in terms of the wave of excitation (or in one case 'wave of exultation') stopping at the AVN. Weaker answers referred to 'messages', 'pulses' or electronic signals' and did not gain any credit. Part *(iv)* was also well answered; most candidates were able to say that it stops oxygenated and deoxygenated blood from mixing and thus ensures that the body receives suitably oxygenated blood.

(b) There were many good answers although only the best were able to give a clear account of the structural nature of the three layers of the vein wall and then relate this to the functions. The most common point was about the presence of valves to stop backflow. There was a tendency to write an account that compared veins with arteries. This was not specifically required, but often picked up marks along the way. Common errors were to mention smooth muscle as reducing friction, to have muscle in the tunica externa, to consider that a thin wall *maintained* a low pressure or to mention thin walls in the context of substances leaving or entering the vein.

Teaching tip

When starting to teach about arteries and veins, begin by stating that both have a three-layered wall and then indicate the tissues that are present in each layer. Make sure that students do not confuse smooth muscle with the smooth inner lining of blood vessels.

Q.4 *(a)* Most candidates knew that having a water potential of lower than –50 kPa in the roots would allow water uptake by osmosis. Despite the term water potential being used in the question some candidates persisted in describing osmosis in terms of concentration gradients.

(b) There were some excellent descriptions of xerophytic features clearly matching each feature to its role in reducing water loss. Some candidates failed to read the question carefully and wrote about roots for uptake or fleshy stems for storage. Candidates should be reminded that the presence of a cuticle is not a xerophytic feature – it is a *thick* cuticle that is important. Also they should know that this thick cuticle does not stop all evaporative loss through the cuticle, it only reduces it. Other areas where a lack of precision cost the candidates marks included:

- not making clear that shutting the stomata in the day reduced loss as this was the hottest time;
- failing to indicate that hairs, sunken stomata or rolling of leaves all trap water vapour in some way;
- mentioning a reduction in stomatal number without making it clear that

stomata are the main region of transpirational loss.

'*Thorns to prevent animals eating the leaves*' was not considered a valid response in the context of the question.

Q.5 *(a)* Most candidates knew that gases moved by diffusion and would pass through various cells, but a few thought that the movement was by osmosis. Comparatively few however mentioned that the oxygen would have to dissolve in water at some stage in the process.

(b) Lack of precision in the description was the main problem here; cells were seen as concave rather than biconcave and the cell rather than the membrane was described as flexible. The biconcave shape was often stated as giving a larger surface area; this was not accepted – the key idea is the increased surface area to volume ratio. Good responses linked this to increased uptake of oxygen which was what the Examiners were looking for; weaker responses just said something like 'more area for diffusion' and did not score the marks. The lack of a nucleus or other organelles linked to more oxygen carrying capacity was well understood. Some candidates failed to read the question and talked about the presence of haemoglobin.

(c) Whilst many candidates knew that lymphocytes have a large nucleus, a surprisingly large number thought it was a lobed nucleus or just stated '*a nucleus'*. A number thought that antigens would be visible on the surface under a light microscope.

Teaching tip

Surface area to volume ratio is an idea underpinning much of the specification. At the end of the teaching period get the students to summarise all the topics where it is relevant.

2803/02: Experimental Skills (Coursework) **- see page 158**

2803/03: Experimental Skills (AS Practical Examination)

General Comments

The impression of the Examiners was that this was an appropriate test that drew on different aspects of 2801. ‘Plant cells’ was the general ‘theme’ running through the paper. On this occasion there was not such a strong link between the Planning Exercise and the content of the Practical Test. In previous sessions, candidates have found that the information they researched for their Plans has helped them in answering *Q.1* or *Q.2* (usually *Q.1*). The obvious link would have required candidates to observe prepared slides of mitosis in *Q.2*, but it is now impossible to provide these slides for the large number of candidates now taking this examination in the summer session. Making a temporary preparation of banana cells seemed an appropriate exercise and one that some teachers had not come across before. Of course, it was hoped that candidates would make temporary preparations of root tips to show mitotic figures in their preliminary work for the Plan and so be aware of the practical procedures involved in making such preparations.

The Examiners felt that it was harder to gain very high marks on this paper in comparison to the last two summer sessions as there were fewer scripts where it was necessary to ‘round down’ the mark to the maximum given for each question. However, it was pleasing to find that fewer candidates were scoring low marks. In fact 90% of candidates gained over 24 marks on the paper. A mark of 24 is the ‘design threshold’ for setting the E grade boundary. It did seem as if candidates in many centres have been trained in the requirements of this examination and that they applied this training to the presentation of their Plans and to the way they organised their practical work in the Test. There were many well structured and carefully researched plans.

One general area that needs attention is labelling of axes on graphs and writing headings for tables. It was often the case that candidates omitted the substance or process that was recorded. For example, ‘% concentration’ or ‘concentration of solution’ are not sufficiently informative.

The Examiners are always very grateful for the comments supplied by teachers about the examination and also for the results supplied with the scripts. Judging from the comments included in the script packages, the Test seemed to present few problems. Timing certainly was not an issue with little evidence of candidates failing to complete the tasks set. There were comments concerning the amount of equipment needed for candidates. This posed problems especially for large centres and is an issue that the Examiners will consider in designing future practical tasks.

The Examiners would prefer candidates to follow the instructions about writing in blue or black ink. Red and green ink are not appropriate. Pencils should not be used for answers to questions although of course they should be used for graphs, drawings and ruling up tables.

Centres have reported problems receiving the Planning Exercises in time for candidates to make a prompt start on this activity. As from the next session, OCR will post the Planning Exercises on its web site. For the January session this will be done in November, for the May session in March.

Comments on Individual Questions

Planning Exercise

Many candidates presented word processed plans. This makes the marking process much easier especially if they use sub headings and leave a wide margin on the right hand side of the page. Some candidates appear to value style over content and include elaborate drawings or diagrams and many digital images from the web that often add little of any merit.

Teachers are advised to read this report in conjunction with the mark scheme. The letters that appear here refer to the checking points (**A** to **T**). In the Planning Exercise, candidates were asked to find out if the phosphate concentration of a nutrient medium had any influence on the number of cells undergoing mitosis in root tips. This involved candidates in choosing a suitable range of nutrient solutions, growing cloves of garlic or broad bean seedlings using hydroponics and then making root tip squashes. Almost all candidates found a suitable procedure for making root tip squashes. A common source was Student worksheet 17 from Science and Plants for Schools (SAPS) to be found at:

www-saps.plantsci.cam.ac.uk/worksheets/ssheets/ssheet17.htm

However, candidates often found it more difficult to prepare suitable solutions for growing the material. The reason for this appeared to be that candidates did not know how the nutrient solutions given to them for their preliminary work had been prepared; they did not research such solutions as Knop's, Sachs' or Hoagland's to discover how to make a range of solutions with varying phosphate concentration (**G**).

It was clear that some centres are well practised in administering the Planning Exercise and many laboratories and prep rooms were full of trays of garlic, and/or broad beans, onions or other suitable plant. Candidates have clearly been taught to follow the expected marking criteria in developing their plans and as a result many scored highly on this exercise. Plans are now more focused and there is much less background material than in previous years. On the other hand, candidates from some centres are not picking up marks because of omissions; in particular making predictions (**B**), stating what variables should be controlled (**E**), planning for repeats (**H**), tabulating expected results (**O**) and interpreting them (**Q**). Fewer candidates scored full marks than in June 2004, often because they did not show how they would prepare their nutrient solutions (**G**). Almost invariably plans included references to preparing different concentrations of phosphate solutions, but in many cases the chosen method did not specify concentrations expressed in g dm^{-3} or mol dm^{-3}. Often the concentrations were expressed as a percentage, but did not make it clear that they were dilutions of the Sachs' solution provided. Some centres provided the recipe from the instructions and candidates used this but did not state the volume of water to use. Better answers referred to mixing Sachs' complete solution and Sachs' solution deficient in phosphate in appropriate mixtures to give at least five different concentrations (**F**). Less creditworthy responses included serial dilutions of phosphate deficient Sachs' solution.

Where predictions were included they often concentrated on the *rate* of mitosis rather than the number of cells undergoing mitosis as asked by the question (**B**). There were also vague references to root growth being enhanced by higher phosphate concentrations.

Candidates often make mistakes drawing tables and graphs. To gain a mark for an outline table, candidates had to indicate the range of their phosphate concentration using the appropriate unit. Many wrote the unit all the way down the appropriate column or omitted it completely. The Examiners looked for evidence that candidates would count a set number of cells or calculate a mitotic index and show evidence of this in their table (**O**). Some candidates plotted the phosphate concentration on the wrong axis. Some only plotted number of cells rather than percentage of cells undergoing mitosis or the mitotic index. Candidates did not have to draw the axes for their graph, although this is always a safe way to gain a mark. Some described the graph that they would draw. They should know that in this case they must make clear what is being plotted and on which axis. 'I will plot phosphate concentration against percentage of cells showing mitosis' does not gain a mark, but 'I will plot percentage of cells showing mitosis against phosphate concentration' does as it follows the accepted convention. 'Phosphate concentration will be plotted on the x axis and percentage of cells showing mitosis on the y axis' is obviously also acceptable (**Q**).

The variables that could have had an effect on the growth of the cloves or seedlings were often not mentioned. Variables such as light intensity, temperature, the concentrations of other ions and volumes of solutions were often not discussed.

However, it was pleasing to see so many references to calculating the mitotic index (**M**). Candidates often showed the importance of precision from the instruments used for measuring solutions and occasionally explained how they would take results from the microscope. Some referred to using 'grids' similar to the haemocytometer. One candidate drew such a grid over an imaginary squash preparation to show how results could be obtained randomly.

Many gave unnecessary detail of the stages in mitosis (often accompanied by drawings or downloads). They very rarely said how they would use these images. It was perfectly acceptable to state that they would be used in helping to identify the stages of mitosis in their preparations. They could have incorporated these into their preliminary work. Interphase is not a stage in mitosis. Some candidates gave many details about the role of phosphate in plants, but they failed to make the link between these and the effects of a phosphate deficiency on mitosis and the object of the exercise! Some thought that RNA and DNA are *nucleotides*.

Many candidates did not gain the safety mark (**K**). To gain this mark candidates have to give a risk and an appropriate safety precaution. Many stated that it is necessary to wear goggles, but did not explain that the stain and/or hydrochloric acid are corrosive or irritants. Candidates may be directed to appropriate safety literature, such as the CLEAPSS Hazcards. General lab instructions ('tie your hair back') and actions to take when an accident occurs ('wash out your eyes with cold water') are not credited.

Many candidates managed to gain **J** from adapting previous practical work or an identified source, such as the SAPS student sheet. It was good to see that centres do not feel that they need to do preliminary work on every occasion, although many candidates clearly benefited here if only because they had to make a temporary preparation to show stages of mitosis. The Examiners consider good quality plans to be informed by preliminary practical work. But to gain a mark (**J**), candidates must describe what they have decided to do as a result of carrying out their preliminary practical. Quite a number stated that preliminary work needed to be carried out without showing any evidence of having done any!

Candidates included full bibliographies in their plans but failed to include references within the body of the text as to where the sources listed had been used; as a consequence they were not awarded the mark for 'identified secondary sources' (**N**). Some made very explicit references in the text, such as 'The basic details of the staining method used were obtained from ref X' or 'I found details of Sachs' water culture solution in ref Y and I have modified the solution as follows….'

Checking points **R**, **S** and **T** did not feature highly on scripts; however, there were some references to the storage of phosphate in the seed or clove and this prompted some discussion of validity (**T**). This was also awarded to those who appreciated that it was necessary to control the concentrations of the other ions in the nutrient medium, so that the only variable was the phosphate concentration. It was also awarded to those who considered the need to use genetically identical material. Candidates in general do not consider or criticise their plans and discuss the issues of precision, reliability and validity.

The phrase ‘fair test’ should be outlawed by this time in a student’s career.

Omissions included forgetting to mention a microscope anywhere in their plan. Some did not do a squash preparation at all and some cut the roots off their plants and placed them in the nutrient solutions. The latter prevented them scoring **A**.

Many candidates recognised the need for at least three repeats, although this was sometimes justified on the grounds of ‘greater accuracy’ rather than better reliability. It would appear that this is a distinction that some candidates at this level find hard to grasp.

Teaching tip

Recipes for Knop’s solution and Sachs’ solution (including all the deficiencies) are given on CLEAPSS recipe card No. 73.

If garlic is used for this exercise it is best to place the cloves over containers of nutrient solution and leave them completely undisturbed until the roots are harvested. It is best to harvest the roots at mid day. If the roots cannot be used immediately, then they may be kept in a preservative. This is prepared by mixing 3 parts of absolute alcohol to 1 part of glacial ethanoic acid (acetic acid), which should be freshly mixed before use.

It is a good idea to incorporate this procedure into a scheme of work as it gives candidates the opportunity to make a temporary preparation – something that they are likely to be asked to do in the AS practical. Also the best preparations tend to be made by the least academic students! Something which provides them with some encouragement.

Practical Test

Q.1 There was quite a wide variation in the results obtained for this exercise. Some found that the optimum pH was between 6 and 8 and others finding that the optimum pH may be beyond pH 8. The ‘text book’ result is pH 7.6, but the Examiners were not expecting any particular result other than an increase in rate as the pH increased. In January 2005, there was a mark for an expected trend. Here there was not. The Examiners used the results provided by the candidates when marking *(b)*, *(d)* and *(e)*.

(a) Almost all candidates were able to collect some results and present them in a table. Some centres provided specimen results for individual candidates who would have had difficulty in answering part *(d)* with their own results. However, the results were not given in the format as required by the mark scheme and therefore it was felt that the candidates were not advantaged or disadvantaged. Almost all constructed an appropriate table and many calculated the means for their results. Some even calculated rates as 1/t – something that is now becoming very familiar as a result of questions on previous examinations.

(b) Most candidates were able to score one mark for describing the trend or pattern, but few quoted data in support and even fewer made references to anomalous results that were often clearly visible in their tables. Many made a valid comment about the time for the second disc being longer than that for the first at all or most of the pH values used. This was rewarded as an alternative to a description of the trend, but should have been a marking point in its own right.

(c) Even with the decomposition of hydrogen peroxide given in the stem of the question, surprisingly a significant number of candidates failed to link the enzyme to the potato. The majority did not appreciate the idea that the oxygen bubbles became trapped in the potato tissue or provided buoyancy. Some thought the gas was hydrogen. There were also suggestions from some that changes in water potential and osmotic influences were involved.

(d) This question proved to be a discriminator as weaker candidates simply described their results and offered no explanation. Some attempted to explain in terms of optimum pH and how the active site might be affected. Details concerning tertiary structure and hydrogen/ionic bonds being broken were seen less frequently and few candidates scored maximum marks. Answers tended to be centre-based. Some centres had obviously trained their candidates in identifying the 'explain' questions in these practical tests.

(e) The more able candidates plotted *rate* against pH and scored well. Weaker candidates used 'time' for the vertical axis and did not! Some extended the pH range beyond that used. Others drew conventional, symmetrical, graphs that were not supported by the data collected. Many candidates calculated the rate as 1/t and gave exceptionally accurate graphs when only a sketch was required.

(f) Some confused 'criticisms' for 'improvements' and were not able to be credited for their answers. However, most scored marks for referring to inaccuracies in cutting the slices, problems with timing, contamination and the lower substrate concentration for the second disc. All as expected!

(g) There were some very good answers to this evaluation exercise. Candidates suggested increasing the range of the buffers being investigated as well using intermediate values of pH. Almost all suggested 'more repeats' and many realised the problems with failing to keep the discs in the buffer solutions for the same length of time. The more astute candidates described methods of collecting oxygen through downward displacement as being more accurate. Here were also quite complex modifications to the apparatus suggested, such as using light or pressure sensors to determine when the discs lifted from the bottom of the tubes.

One candidate wrote: 'the potato discs did not have enough time to collaborate in the buffers'. A good example of a candidate not having the vocabulary to express a good idea!

Teaching tips

This practical exercise could be used to train candidates in the requirements of evaluation. They could carry out the practical (perhaps with a wider range of pH) and then identify a set of criticisms, improvements and extensions. This information could be presented in tabular form or with a set of subheadings (e.g. reliability, accuracy, precision, validity, etc) or as a set of bullet points.

Q.2 It was clear that a number of candidates did not understand the instruction to annotate the drawing that they made in *(b)*.

(a) A variety of ways of indicating starch distribution were seen, but almost all scored a mark here.

(b) Some candidates completed a drawing of a starch grain rather than a cell and thus had difficulty in adding labels. Drawings of cells were generally poor, but the mark scheme enabled most to score some points. Line quality in particular was poor: starch grains were often drawn as incomplete 'blobs'. Many omitted labelling and/or colours after staining. Some wrote 'pale', 'dark' or 'colourless' – none of these are colours. Having said this, there were some excellent well observed drawings. These were a credit to the candidates considering that there is no way they could have practised these unlike the prepared sections that have been set in previous tests. Cell membranes cannot be seen at this resolution.

(c) The calculation resulted in maximum marks for about half the candidates; some confused the units and ended up with x 4000. Candidates should be advised to measure in millimeters, not centimetres.

(d) Most candidates gained a mark for *(i)*, but they did not if they stated that starch is a *food* store. It was pleasing to see that many candidates appreciated the molecular structure of amylopectin (from 2801) although not so many picked up the two marking points for part *(ii)*. Some thought amylose was an enzyme, others that amylopectin is a sugar.

(e) The Examiners marked parts *(i)* and *(ii)* together.

Candidates were presented with the reagent needed to carry out this test so should have scored well on this question. Most described the procedure and the positive result stating clearly the sequence of colour changes that could be observed. However, full marks for this section were rarely seen. All appreciated the need to heat the reagent with the banana (pulp or filtrate), but did not state 'boil' or 'use a temperature over 70ºC'. Only the best candidates referred to the nature of the reduction reaction and hardly anyone referred to 'wearing goggles' as the appropriate safety procedure. A few did discuss the semi-quantitative aspect of this test and stated what their result showed in terms of quantity of reducing sugar. Some even explained how to test for non-reducing sugars in the banana although this was not asked by the question.

The candidates were provided with a filter funnel and filter paper, but there were not many references to them on the scripts. Indeed one centre made the comment that in their trials it took approximately 15 minutes to filter the pulp to obtain sufficient filtrate to carry out the Benedict's test; clearly this time was not available in the examination. This was not evident during trialling. In fact it was not necessary to filter; judging from their scripts most candidates gained good results and described them well.

***Teaching tip*s**

- Making a temporary preparation of banana cells, as here, and staining them with iodine solution would make a suitable practical activity to support Section 5.1.1 of *Biology Foundation.*
- The staminal hairs from *Tradescantia* flowers are also excellent material for studying cell structure especially as it is possible to see strands of cytoplasm across the vacuole and cytoplasmic streaming. Further details are available at:
- www.uq.edu.au/_School_Science_Lessons/UNBiology1.html#2.1.1
- Cotyledons of mung beans also have good starch grains.
- Cross sections of banana may also be stained with 2.5% silver nitrate solution to locate areas with reducing sugars.

Practical tip

Making citrate-phosphate buffer solutions.

Prepare stock solutions of:
0.2 mol dm^{-3} disodium hydrogen phosphate-12-water ($Na_2HPO_4.12H_2O$), and
0.1 mol dm^{-3} citric acid monohydrate ($C(OH)(COOH)(CH_2.COOH)_2.H_2O$) as follows:

0.2 mol dm^{-3} disodium hydrogen phosphate-12-water ($Na_2HPO_4.12H_2O$) is prepared by dissolving 71.63 g in distilled water and making up to 1 dm^3.

0.1 mol dm^{-3} citric acid is prepared by dissolving 21.01 g of citric acid monohydrate in distilled water and making up to 1 dm^3.

The buffer solutions should be made up using the volumes of 0.1 mol dm^{-3} citric acid and 0.2 mol dm^{-3} disodium hydrogen phosphate (Na_2HPO_4) shown below.

pH	volume of 0.2 mol dm^{-3} disodium hydrogen phosphate-12-water / cm^3	volume of 0.1 mol dm^{-3} citric acid monohydrate / cm^3
2.2	2.00	98.00
3.0	20.55	79.45
4.0	38.55	61.45
5.0	51.50	48.50
6.0	63.15	36.85
7.0	82.35	17.65
8.0	97.25	2.75

The pH should be checked with a pH meter and adjusted (if necessary) by adding one or other of the two solutions.

Formula weights:
disodium hydrogen phosphate ($Na_2HPO_4.12H_2O$) = 358.14
citric acid monohydrate ($C(OH)(COOH)(CH_2.COOH)_2.H_2O$) = 210.14

For the recipe to make a Universal Buffer Solution see: CLEAPSS Recipe Card No. 14.
Also see Appendix 2 of the CLEAPSS Guidance Leaflet R35

2804: Central Concepts

General Comments

The Examiners reported a pleasing improvement in standard particularly at the top end of the ability range. This was partly due to both the long answer questions being very approachable and evidence that centres are making good use of mark schemes from previous sessions to focus their teaching. Candidates appear to be spending more time reading the stem of the question before making their response. There was less confusion between the command words 'describe' and 'explain' and it was pleasing to see the majority of candidates making appropriate responses.

Comments on Individual Questions

Q.1 The Examiners were pleased to see many excellent attempts at this demanding question on respiration. Candidates appear to be well prepared on the biochemistry associated with this topic.

(a) The sites of the Krebs cycle and oxidative phosphorylation were well understood, but candidates were not as confident about identifying the site of decarboxylation within the mitochondrion. The Examiners hoped that candidates would link decarboxylation with the Krebs cycle and that this would allow them to produce the correct response.

(b) The Examiners were looking for a reference to the production of messenger RNA or synthesis of proteins. A general reference to the role of DNA in mitochondrial replication was also acceptable.

(c) Nearly all candidates successfully named either NAD or FAD as a hydrogen carrier involved in the Krebs cycle.

(d) The Examiners were pleased to see candidates making good use of the information in Fig. 1.2 to help them answer this section of the question. The fact that the hydrogen from NAD / FAD is split into protons and electrons was well understood as was the fact that electrons then enter the electron transport chain (ETC). Good candidates understood that energy is released as the electrons pass from one carrier to another and that this energy is used to pump protons across the inner mitochondrial membrane, setting up a proton gradient. Some candidates stated incorrectly that the energy released from the movement of electrons from one carrier to the next is *directly* used to form ATP. There were many correct references to chemiosmosis, the proton motive force and the ATP synthetase enzyme complex.

(e) This section proved more demanding. Candidates were able to state that no ATP would be formed through oxidative phosphorylation but few linked this to the inability to set up a proton gradient. Without this gradient there would be no flow of protons through the ATP synthetase complex and chemiosmosis will not occur. The Examiners were looking for candidates to refer to ATP being required for muscle contraction. Reference to the failure of cardiac muscle or intercostal muscles was given credit as was the toxic nature of lactate that would build up as glycolysis proceeds to generate a small amount of ATP.

Teaching tip
Centres need to make candidates aware of the following:

- The role of energy released from the ETC in pumping protons across the inner mitochondrial membrane.
- The setting up of a proton gradient.
- Protons flow back through special protein complexes in the membrane known as ATP synthetase or ATP synthase. The term 'stalked particle' is also acceptable, but the Examiners would prefer not to see ATPase in this context.

Q.2 There were many excellent answers to this question. The Examiners are encouraged by the general level of understanding of the processes occurring in photosynthesis.

(a) The most common correct responses were chlorophyll and carotenoids. Candidates were given credit for chlorophyll a and chlorophyll b, but not alpha or beta chlorophyll. In contrast to most sections of the paper this was an area where the spelling was poor.

(b) There were few problems with part *(i)*. Many candidates were able to recall significant details, e.g. 'thylakoid membrane in granum'. Occasional confusion with cristae occurred in weaker scripts. Most candidates answered *(ii)* with reference to the different absorption peaks shown by the two photosystems. However, a significant number failed to gain the mark due to their answer not being comparative. The response 'absorbs at 700 nm' failed to gain the mark. Candidates needed to also refer to photosystem II having an absorption peak at 680 nm. A few candidates mentioned cyclic photophosphorylation or photolysis, but some of these candidates failed to pick up marks due to lack of comparison.

(c) ATP seemed a straightforward response, but quite a few candidates missed out on the mark due to mistakes with reduced NADP. 'Reduced NAD' and 'hydrogen' were common errors here. Weaker candidates gave oxygen, glucose or carbon dioxide.

(d) Many candidates achieved full marks here with many scoring well in excess of the seven content marks available. Answers were, invariably, well organised and accurate reflecting thorough learning. Common misconceptions included:

- reduced NAD instead of reduced NADP;
- reference to ATP formation rather than its utilisation;
- references to carbon dioxide as a product of the light dependent stage;
- the use of ATP and reduced NADP in the formation of GP rather than TP.

Very few candidates appeared to understand the role of ATP in the recycling of ribulose bisphosphate.

The quality mark was awarded in the vast majority of cases. If not, it was usually because too little had been written. It is pleasing to see candidates' use of spelling, punctuation and grammar continuing to improve. The Examiners did not see any flow diagrams here.

Teaching tip

Centres need to make candidates aware of the following.

- To write a fully comparative answer whenever a question asks for differences.
- The role of ATP in the regeneration of ribulose bisphosphate.
- That reduced NADP and not reduced NAD is produced in the light dependent stage of photosynthesis and used in the Calvin cycle.

Q.3 The Examiners were surprised to see the genetics problem causing significant difficulties for many candidates. However, the definitions of terms used in genetics were better than in previous sessions as was knowledge of the lac operon in bacteria.

(a) Most candidates correctly predicted the parental genotypes, although some mixed the alleles by writing RBrb, for example, which often led to later confusion. From thereon a number of common errors were observed by the Examiners:
- failure to recognise that each gamete requires a pair of letters;
- lack of clarity when writing letter groupings in the gametes;
- offspring genotypes linked incorrectly to offspring phenotypes;
- a ratio of 6:6:2:2 rather than 3:3:1:1.

(b) The Examiners were pleased to see candidates taking note of previous mark schemes and producing faultless definitions in part *(i)*. The most common mistake was for candidates to state that genes code for characteristics rather than polypeptides. Many candidates gained both marks. Poorer answers were characterised by a failure to differentiate between gene and allele. In some cases the ‘tortoiseshell allele’ was used in some scripts.

(c) There were many excellent responses to the question and it was quite common to see all nine marking points in a single answer. Weaker answers revealed confusion between the promoter and operator sections of the lac operon.

Examination tip

Tips for candidates completing genetics questions:
- link offspring genotypes carefully to phenotypes;
- make good use of the blank pages on the paper to carry out rough working before producing a solution in the spaces provided;
- always use the symbols given in the stem of the question;
- in dihybrid crosses always write the alleles in this form – **AaBb**, and not as **aAbB** or **ABab**.

Teaching tip

For those interested in finding out much more about feline genetics and trying their own breeding programme (albeit a simulation) go to:
www.tenset.co.uk/catgen/index.html
where you will find free feline genetics software. For dog-lovers, free canine genetics

software is available at the same web site.
To achieve some differentiation, good students could be asked to find out why there are only a few documented cases of tortoiseshell male cats. Answers at:
www.messybeast.com/mosaicism.htm
and
http://ourworld.compuserve.com/homepages/L_P_swepston/mosaic.htm

Q.4 The Examiners were pleased to report that candidates made good use of the information in Fig. 4.1 and most have a good grasp of the homeostatic control of blood glucose levels.

(a) Most candidates were able to define the term endocrine gland. A common error was for candidates to use the term excretion rather than secretion.

(b) In part *(i)*, the endocrine tissue was often incorrectly identified as the pancreas rather than the islets of Langerhans. The spelling of glucagon in part *(ii)* had to be correct to gain the mark to avoid confusion with glycogen. Insulin was correctly named as the hormone produced by the beta cells in part *(iii)* and the majority of candidates identified the dotted line as representing negative feedback in part *(iv)*. Part *(v)* proved to be far more demanding. The Examiners were looking for a reference to glucagon binding to receptors on the cell surface membrane of the hepatocytes. Activation of a phosphorylase enzyme occurs which promotes the breakdown of glycogen to glucose. The production of glucose from other sources and the use of fatty acids rather than glucose as the main respiratory fuel both gained credit. The Examiners were pleased to see many candidates correctly using the terms glycogenolysis and gluconeogenesis.

(c) The Examiners were able to credit a wide range of responses. However, they were looking for candidates to state that there is less chance of an immune response with genetically engineered insulin rather than simply referring to the fact it is less likely to be rejected. Some candidates incorrectly referred to people developing an immunity to animal insulin rather than developing a tolerance.

Teaching tip

Centres should make it very clear to candidates that correct spelling is crucial in answers dealing with glucose, glycogen and glucagon.

Q.5 This question proved to be a good discriminator, but also allowed many candidates to access over half the marks.

(a) Unfortunately not all candidates read the information carefully enough. A few muddled the terms ‘resistant’ and ‘susceptible’ and so lost two marks. Some candidates lost marks by not referring to the vitamin K requirements of the rats with different genotypes. Some candidates used words other than high or low to indicate the chances of surviving to maturity. In most cases they were acceptable alternatives but candidates would be well advised to use the terms given in the stem of the question. In this case they just had to indicate whether the chances of survival are **high** or **low**.

(b) Most candidates correctly stated mutation in *(i)*. Candidates and centres are becoming familiar with the type of question in Part *(ii)*. However, a significant number of candidates stated that ‘warfarin caused the mutation’. Most candidates correctly described selective advantage and stated that these rats survive to breed and pass on alleles. Many candidates referred to genes being passed on rather than alleles.

(c) This was not well answered. Many candidates simply repeated that this was natural selection without stating why. Correct answers generally mentioned the fact that it is the environment that determines which individuals survive.

(d) Weaker answers referred to the frequency of rats rather than alleles. Even if the correct description of the likely change in allele frequencies was given, very few candidates used the information on vitamin K requirements to gain the second mark.

Teaching tip

Centres should ensure that candidates are very clear about the difference between genes and alleles and the way in which natural selection changes allele frequencies. They need to be able to use this knowledge to interpret unfamiliar examples as in this question. Examples other than the Peppered Moth and antibiotic resistance in bacteria should be studied.

Q.6 *(a)* Most candidates were able to spot the trends in the data given in Table 6.1. The most common answer was the ‘myelinated faster and non-myelinated slower’ point. Those who lost marks were trying to compare across the two variables, e.g. myelinated and larger diameter having the highest speed for a particular animal. A surprisingly small number of candidates included comparative data from the table to illustrate their answer.

(b) Many candidates wrote in great detail about the events involved in an 'action potential' rather than how it is propagated along a neurone. However, these candidates still gained some credit as the mark scheme allowed candidates to pick up marks by discussing the insulating nature of the myelin sheath, the presence of nodes of Ranvier and the action potential ‘jumping’ from node to node. Very few understood or commented on how local circuits are set up. Weaker candidates tended to describe transmission of impulses across a synapse.

(c) Very few candidates scored full marks on this section. Candidates seemed able to outline the importance of the refractory period in the one way transmission of nerve impulses and the separation of nerve impulses. However, they were unable to give accurate explanations as to what was taking place in terms of sodium and potassium ions.

Teaching tip

Candidates need to be clear about the events taking place during depolarisation and repolarisation. They should always refer to sodium and potassium ions in their answers and they should be aware of the difference between the sodium – potassium pump and voltage gated channels.

Q.7 *(a)* Almost all candidates achieved full marks. Bacterial population growth is well understood.

(b) Most candidates found the calculation in *(i)* to be straightforward. The most common errors were:

- rounding up incorrectly;
- inverting the equation and dividing by 56 generations rather than 55.

The error carried forward principle allowed candidates to gain one mark even if they used incorrect figures in their working. Relatively few candidates achieved full marks for part *(ii)*. Many answers given were far too general, e.g. 'conditions in intestine are not so good for growth'. The most common correct responses were references to the presence of digestive enzymes, sub-optimal pH and the gut having low nutrient levels.

Teaching tip

Candidates should practise different types of calculations, such as:

- means;
- percentages;
- percentage changes (increases and decreases);
- rates;
- generation times (as in *Q.7*);
- ratios (as in *Q.3*).

There are now many past paper questions to provide a bank of these.

2805/01: Growth, Development and Reproduction

General Comments

The entries for this paper covered a wide range of abilities, with a few excellent candidates scoring almost full marks. However, weaker candidates failed to obtain marks for reasons such as failure to use correct terminology or misreading instructions in questions. The better candidates had a good understanding of both plant and human topics. Weaker candidates often had a poor understanding of plant reproduction. Several candidates, who did quite well on the rest of the paper, failed to gain many marks on *Q.3*, particularly in the sections involving interpretation of graphs. Synoptic topics included cell structure (*Q.1 (b)*), immunity (*Q.3 (c)*) and genetic control (*Q.4 (b)*). The standard of spelling, punctuation and grammar was generally good. A small number of papers were extremely difficult to read.

Comments on Individual Questions

Q.1 *(a)* Most candidates were able to name the structures in *(i)* correctly, with the main error being to name **B** as the uterus, indicating that some candidates had not studied the diagram sufficiently. Most candidates gave a correct function for the pelvis in *(ii)*, although a few thought that it could stretch to accommodate the fetus, or contract during birth. Candidates should note that such statements as ‘the pelvis supports’ or ‘the pelvis protects’ are not enough to gain credit.

(b) Although most candidates correctly identified the role of the acidic mucus in preventing infection in *(i)*, a few incorrectly referred to destruction of alkaline sperm. There were some excellent descriptions of the features of squamous epithelium in *(ii)*, with several candidates describing how the folds in its structure enable it to enlarge in area. Common misconceptions were that the tissue is elastic or contains cilia.

(c) In part *(i)*, very few candidates were able to relate to the development of the baby and there were many references to damage caused during birth. The best candidates described the overlapping of the bones of the skull during birth.
Many answers referred very generally to the size of the fetus, rather than focusing on the size of the head. Candidates across the range gave answers showing good understanding of the role of oxytocin in part *(ii)*. A number of candidates did not read the question fully and gave accurate and detailed explanations of the role of the cervix and uterus during pregnancy.

Q.2 *(a)* Many candidates correctly named structure **X** as the tetrad in part *(i)*. Incorrect answers included ‘pollen mother cell’. It was pleasing that many candidates were awarded full marks for part *(ii)*. A fair number of candidates first described how the tetrad is *produced*, which was not relevant to the answer, but then continued to obtain three or four marks. Common errors were to say that:

- the cells of tetrad are diploid and divide by meiosis;
- each pollen grain divides into four gametes;
- a degenerative nucleus is formed.

The majority of candidates correctly described dehiscence in part *(iii)*. There was occasional confusion with wind dispersal of seeds.

(b) It was disappointing that few candidates, even those who were familiar with this example and described the flowers as pin-eyed and thrum-eyed, failed to

describe the significance of the different relative positions of anthers and stigma in the two flowers for pollination by insects in part *(i)*. A mark was available for a definition of cross-pollination and a good number of candidates gained this mark but no others. Many candidates incorrectly made the assumption that the anthers and stigma were maturing at different times and described protandry and protogyny. Credit was not given for references to large petals, bright colours or landing platforms. These certainly attract insects for pollination, but not necessarily cross-pollination. Many candidates were very familiar with the advantages of cross-pollination and gave accurate descriptions, easily gaining the three marks for part *(ii)*. Cross-pollination does not prevent certain alleles from being inherited, as several candidates thought, but it does make different combinations of alleles more likely. There was also some confusion with dispersal of seed.

Teaching tip

This is an example of a good answer to Q.2 *(a)(ii)*.

'The tetrad splits apart (1 mark) forming four individual pollen grains. They contain sporopollenin (1) in their outer layer or exine (1) which is often pitted (1). The haploid nucleus (1) divides by mitosis (1) to form a pollen tube nucleus (1) and a generative nucleus (1) which divides again to form two male gametes (1).'

A good description of cross pollination in *Primula vulgaris,* as well as other links to pollination can be found at:

www.offwell.freeuk.com/primrose.htm

Q.3 *(a)* Most candidates explained the link between temperature rise and ovulation in *(i)* and the better candidates linked this to progesterone. However, a number of candidates did not identify the 'at risk' days correctly, being distracted by the smaller peaks in temperature. In part *(ii)*, most candidates were able to give possible alternative causes of temperature rise, but the other reasons were rarely given. A few good candidates were able to explain that intercourse could have occurred just before the temperature rise, when the woman was not aware that she was about to ovulate. In *(iii)*, a good number of candidates explained when intercourse should be avoided and that the temperature should be taken at the same time each day. Others did not make the link between this part of the question and the previous information in the question, writing more generally about contraception and sexually transmitted infections.

(b) Part *(i)* asked the candidates to explain the changes in concentration of hormones from the combined pill. Very few were able to explain the daily absorption and metabolism of the hormones. Large numbers of candidates quoted data at length, or explained the effects on the hormones from the ovarian follicle. Part *(ii)* asked the candidates to describe *and* explain, and up to three marks could be gained from accurate data quotes using information from both axes. The best candidates showed a good understanding of the effect of hormones from the pill on the ovarian follicle, gaining marks easily. It was essential for candidates to be clear which hormones they were writing about; some failed to gain the marks because of a lack of clarity.

(c) Candidates could obtain marks in parts *(i)* and *(ii)* by applying their understanding of immunity, but few obtained these. However, the better candidates obtained full marks, showing understanding of fertilisation and the role of HCG in early pregnancy. Weaker candidates apparently confused HCG with GnRH. Others incorrectly assumed that the proteins referred to in *(ii)* were those within the acrosome or those involved in capacitation. In *(iii)*, very many candidates realised that vaccination would probably be long term and might cause sterility.

Teaching tip

When studying questions including graphs or other data, discuss the difference between the terms '*describe*' and '*explain*'. Go through the list of command words, found in Appendix F of the specification, and discuss what is expected for each one in the context of this Option.

Q.4 *(a)* Most candidates identified a place where meristematic cells are found in flowering plants.

(b) The tendency here was for candidates to write what they knew about meristematic cells, but not to consider their application to genetic modification. A few very good candidates realised that if one cell is modified and then divides by mitosis, all the cells produced will be genetically identical and therefore contain the modification.

(c) It was pleasing to see so many answers in which candidates obtained at least five marks. The majority of marks were for the process of development, which was well understood. It was less common for the Examiners to give the marks related to the structure of mesophyll cells, probably because this was synoptic material. Weaker candidates gained three or four marks, but then wrote about cells other than mesophyll cells. Less than half the candidates gained the quality mark, mainly because they did not include at least three of the required scientific terms.

Q.5 *(a)* The best candidates described the imbalance between oestrogen and progesterone as their levels fall at different rates just before menstruation. Candidates who failed to gain marks wrote about symptoms of PMT, hormone levels before ovulation or an increase in oestrogen and progesterone.

(b) Part *(i)* was generally answered well. A few candidates did not read the question fully and described effects in menopausal women. A good number of candidates obtained both marks for the calculation in *(ii)*, but some gained only one, as they did not give the answer to the nearest whole number.

(c) Answers gaining full marks were not often seen. Many candidates realised that a relationship between oestrogen and FSH was involved, and gave some correct information about these hormones. However, this was often out of context. Those candidates who realised that there is a decrease in sensitivity of the follicles to FSH were more likely to gain the other marks.

(d) This was a very accessible question allowing candidates across the whole ability range to gain some marks by describing some of the symptoms of the menopause and describing the administration of HRT. A pleasing number of candidates were able to describe the effects on parathormone, often gaining a further three marks. The weakest candidates just described the cessation of periods and loss of fertility, without giving any other relevant information. Most candidates gained the quality mark for their spelling, punctuation and grammar.

Teaching tip

Draw flow charts to show:

- effects of hormones on ovarian follicles in the menstrual cycle;
- effects of hormones on ovarian follicles after the menopause.

Compare and discuss the differences between the two.

Q.6 *(a)* There were many good answers to part *(i)* from candidates across the ability range, who all had a good understanding of asexual reproduction and the processes involved. In part *(ii)*, most candidates gained at least one of the marks, but a few just referred to temperature or sunlight, without explaining that it is the *increase* in temperature and light intensity during the summer that increase the chances of an algal bloom. In part *(iii)*, many candidates were aware of the generalities of the process but rather unclear about the details. A common misconception was that the algae themselves, rather than aerobic bacteria, use up increasing amounts of oxygen from the water. Some confusion between photosynthesis and respiration was apparent.

(b) Answers gaining five or six marks were unusual. Many methods, such as measuring the surface area of algal cover, measurement of dry mass and agar plating were often suggested, but did not gain marks. However, candidates could gain marks for describing experimental techniques such as measurement of volumes, random sampling and regular repeats of sampling. There were a few clear descriptions of the use of a haemocytometer to measure total cell count. Although many candidates suggested that a graph could be plotted, they did not state what data should be used. Some candidates had not read the question and described the features of a sigmoid growth curve.

2805/02: Applications of Genetics

General Comments

Many candidates had been very well prepared for this paper and showed a good knowledge and understanding of the topics tested and an ability to apply that knowledge when faced with unfamiliar data. Technical terms were mostly used appropriately, but candidates should be reminded of the differences between the terms gene and allele, homologous and homozygous and chiasma and crossing-over.

The majority of candidates attempted all parts of all questions, suggesting that the minority 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. The unfortunate typographical error in *Q.6*, in which epithelial cells appear as 'epithetical' did not appear to put any candidate at a disadvantage.

Not for the first time, some of the questions including synoptic material (one third of the marks) were answered less well than those relating only to this Option. There is always likely to be a high probability of questions requiring a knowledge of genetic control of protein structure (Section 5.1.5 from *Biology Foundation* (2801)) in this Option. However, other topics appear: this time, active transport, mitochondria and the transmission of malaria. Candidates should be alerted to this.

Comments on Individual Questions

Q.1 *(a)* Most candidates were able to ascribe the correct phenotypes to the genotypes given in part *(i)*. Although many candidates recognised the interaction as epistasis, few gave an answer related to increased expression in part *(ii)*. Only the stronger candidates were able to suggest how a pink colour might be increased to red, for example by increased transcription of a relevant enzyme. Weaker candidates allowed allele **B** at one locus to inhibit allele **A** at the other locus, tending to decrease the colour intensity.

(b) Although many candidates scored full marks in *(i)*, some failed to note the instructions to show the phenotypes of the parent plants or to relate the genotypes of the offspring to their phenotypes. Supposedly phenotypic ratios were often given without mention of the phenotypes. A minority of candidates were unable to derive the correct gametes from the parental genotypes given, putting **A**/**a** and **B**/**b** alleles into individual gametes. Some candidates tried to fit their answer to a 9 : 3 : 3 : 1 ratio. Candidates' attention should be drawn to the advisability of laying out genetic diagrams according to the conventions in the Institute of Biology's *Biological Nomenclature*.

In part *(ii)*, a pleasing number of candidates were able to describe the effect of linkage, with and without crossing-over, on the phenotypic ratio. The stronger candidates easily scored full marks on this section. Candidates should be encouraged to distinguish between the process of *crossing-over* and a *chiasma*. Pink spines became pink stems or pink flowers by the end of this question.

Teaching tip

Candidates should be encouraged to encircle gametes to avoid any confusion about which symbols are, or are not included in a particular gamete. Punnett squares should be used, with gametes in the sequence **AB**, **Ab**, **aB** and **ab** and unlinked genotypes written conventionally: **AaBb** and not **aAbB**. Linked genotypes should have brackets: **(AB)(ab)**. The homozygous genotype **aabb** produces one type of gamete. Candidates should be discouraged from writing out a Punnett square involving four identical gametes from this parent. Such candidates commonly stated that there was a phenotypic ratio of 4 red-spined plants : 4 pink : 8 green.

Q.2 *(a)* Excellent descriptions of selective breeding programmes were seen, with many candidates able to apply their knowledge of breeding other plants to the tomatoes. Weaker candidates assumed that once the two varieties (often said to be different species) were interbred, all the offspring would have all the desirable traits, leaving selection out of their breeding programmes. Some candidates only selected the desired phenotypes when setting up initial breeding lines. Some candidates, in describing how their plants might be pollinated confused stamens and stigmas. Few candidates appreciated that seeds need to be collected and sown to obtain new plants. A small number of candidates failed to note the instruction to describe a programme for selectively breeding the plants and plunged into a description of genetic engineering, limiting the marks that could be awarded. The mark for the quality of spelling, punctuation and grammar was awarded to a majority of the candidates.

(b) Part *(i)*. A pleasing number of candidates were on familiar territory in this synoptic question, invoking active transport moving ions against a concentration gradient with the necessary energy from ATP. The stronger candidates described shape changes of the protein. In part *(ii)*, most candidates claimed as an advantage for genetic engineering that it was quicker than selective breeding, often referring to the number of generations needed in selective breeding. Stronger candidates noted that the bulk of the genome was unaffected by genetic engineering, in particular that alleles of background genes could be left undisturbed. A few candidates were aware that the inserted gene could be from another species.

Teaching tip

- Point out to candidates that it is possible to use bullet points, without sacrificing the quality of expression mark, in an answer that requires a clear sequence of events provided that each point is a full sentence.
- Convince candidates that the terms *inbreeding* and *interbreeding* are not synonyms.
- A question that asks for the advantages of one procedure over another requires the candidate to make some comparisons, not simply to produce a list from one point of view.

Q.3 *(a)* Many candidates were thoroughly familiar with the possible effects of inbreeding in a small population, although there was much confusion between *genes* and *alleles*.

(b) Some candidates struggled to produce two distinctly different reasons for the increase in population numbers after the arrival of a single immigrant male wolf, but the many convincing suggestions ranged from increased genetic variation via some selective advantage to behaviour favouring mating with a wolf that was not a close relative.

(c) This question was often very well done, with a large number of candidates scoring full marks. A very common error involved X-raying the gel or the Southern blot. Examples of errors include 'X-rays are used to darken the bands' and 'X-ray light is shone underneath the nylon sheet causing shadows on a clear film'. Other errors were making the DNA single stranded and treating it with a radioactive probe before electrophoresis.

The mark for the quality and use of scientific terms required a clear description of the procedure with appropriate use of terms, such as *restriction enzyme*, *electrophoresis*, *agarose gel*, *Southern blotting*, *autoradiograph* or *variable number tandem repeats (VNTRs)*. For one candidate: 'VNTRs do not code for anything and are there to fill the gaps between the genes'. The quality mark was not awarded if the sequence was incorrect. For example, if denaturing was carried out before cutting then the quality mark was not awarded.

A small number of candidates confused this topic with HLA haplotypes and a few described the process of karyotyping. Confusion between the banding pattern of chromosomes and the bands of a genetic fingerprint was also seen.

Teaching tip

Remind candidates that writing a statement such as 'the distance moved by the DNA fragment depends on its length' does not tell the reader that smaller fragments move further in a given time than larger fragments.
Be particularly careful about the use of 'X-ray film' in autoradiography. Candidates who wrote 'use X rays' did not gain marking point 15.

Q.4 *(a)* This question was answered very well by a large number of candidates. Some weaker candidates failed to read the question carefully and answered only in terms of the use of human sperm in artificial insemination or in *in vitro* fertilisation.

(b) In part *(i)*, an alarming number of candidates quoted a temperature (^{o}C) rather than a rate (^{o}C min^{-1}). In part *(ii)*, stronger candidates realised that the danger to sperm when frozen and thawed comes from ice crystals growing in size and breaking intracellular membranes. Weaker candidates tended not to answer the question: 'how?' Part *(iii)* challenged the weaker candidates. A reasonably common suggestion was that the sperm needed not only mitochondria but another essential component, such as a tail, for movement. Often there was no link with the need for mitochondrial action in motility. Some sperm, alarmingly, were multicellular with tissues. Some candidates thought that there were two different types of sperm, with mitochondria and with motility.

(c) This was generally answered well, although some candidates did not actually write what they, presumably, intended: 'one sperm can be used by different females' and 'one sperm may be over-used and cause inbreeding depression'.

Some candidates strayed away from the artificial insemination of the question into the realms of embryo transplantation and in one case cows were 'inseminated by an embryo'. 'Ethical issues' was often listed as a disadvantage, but did not gain any marks without further explanation.

Teaching tips

Remind candidates that when using figures from a graph to quote in full the units given on the axis. Units follow the solidus, e.g. rate of cooling / $^{o}C\ min^{-1}$ - the unit is $^{o}C\ min^{-1}$. Make sure that candidates realise that AI, IVF and embryo transplantation are different procedures.

Q.5 *(a)* Part *(i)* was often answered very well, but some candidates described horizontal transmission of resistance in the mosquitoes. A significant number of candidates thought that the presence of insecticide caused a mutation for resistance. Only a minority of candidates allowed their resistant mosquitoes correctly to pass an *allele* for resistance to the offspring. Some candidates misleadingly 'selected out' resistant mosquitoes in the presence of insecticide.
In part *(ii)*, very few candidates were able to recall their AS knowledge of the spread of malaria and refer to the mosquito as a vector. Common answers involved the use of insecticide leading to more resistance, rather than the basic reason for using insecticide.

(b) A number of candidates found it difficult to explain what is meant by recombinant DNA in part *(i)*. 'DNA that has been fragmented and then recombined' does not indicate that the DNA is from different sources, nor explains the word 'recombinant'. Part *(ii)* was answered very well by many candidates and full marks were easily gained by many from their knowledge of restriction enzymes. Errors that crept into answers mostly involved other enzymes, including the erroneous use of DNA polymerase (rather than transferase) to create sticky ends or to catalyse the bonding of sticky ends, for which no enzyme is needed.

(c) Stronger candidates found it easy to score full marks in *(i)* by using the data in Table 5.1. A number of weaker candidates threw marks away by claiming that the figures were percentages of malarial parasites rather than the actual percentages of mosquitoes. Some candidates overlooked both the mosquitoes and the percentages in the headings so that 10 individual uninfected mice became infected. A few candidates associated the 'vector' in the question with bacterial plasmids. In part *(ii)*, stronger candidates recognised that this method of controlling the spread of malaria could reduce the use of insecticides, but that there would be a danger of the malarial parasite becoming resistant to the effect of the gene. 'Fewer cases of malaria' was not rewarded as a benefit. Weaker candidates contented themselves with unspecific 'unforeseen effects' or 'mutation leading to undesired effects' in an unspecified organism as the hazard. Cost may be a disadvantage, but it is not a hazard.

Teaching tips

- When asked to 'use the data', candidates should not merely quote the figures given, but also manipulate them.
- Distinguish carefully between 'recombination' as a result of crossing-over between non-sister chromatids of homologous chromosomes and the joining of DNA from different sources in genetic engineering.
- Distinguish the various uses of the term 'vector'.
- Avoid using 'selected out' when meaning 'selected for' or simply 'selected'.
- Avoid references to immunity when talking of resistance to insecticide in insects.

Q.6 *(a)* In part *(i)*, a surprisingly large number of candidates could not clearly explain what is meant by a gene mutation, introducing changed sequences of amino acids into their answer in ways that suggested the DNA was made up of amino acids. In part *(ii)*, a few candidates confused cystic fibrosis with Down's syndrome or Huntington's disease, but the majority of candidates answered this question well. Errors included 'a carrier has a 1 in 4 chance of passing on the allele' when actually meaning a 1 in 2 chance of passing on the allele, or that two carriers have a 1 in 4 chance of producing a child with CF. A few candidates wrote that CF is inherited in the same way as anything else - via the gametes to the zygote. This was not considered to be worthy of marks.
The symptoms of CF were generally well known in part *(iii)*. Some weaker candidates, describing dehydrated mucus and infections, forgot to say that they were talking about the lungs. Part *(iv)* proved challenging. Fairly common answers were that one cannot detect either a recessive mutation or a silent mutation, that a gene mutation is too small to be seen and that the mutation occurred after the screening. Other misconceptions included that the wrong cells were tested since only the lung and gut cells would have the mutation and that in heterozygotes the mutation is hidden from the test. Stronger candidates realised that there is a large number of possible mutations and that each test is specific.

(b) A surprising number of candidates confined themselves to saying that 33% or more of normal HCO_3^- transport resulted in normal digestive functioning, whilst 6% or less did not. Only the strongest candidates associated these mutations with a change in molecular shape affecting transport, resulting in a change in pH such that enzymes were affected. For a few candidates the change in pH was the cause rather than the effect of the change in HCO_3^- transport.

Teaching tip

Discuss gene mutations as unpredictable changes in the sequence of base-pairs in a DNA molecule and provide a suitable range of examples drawing on case studies including those from this Option and sickle cell anaemia from *Central Concepts* (2804).

2805/03: Environmental Biology

General Comments

This paper seemed to produce a lower range of marks than was seen in the January session. Some candidates scored very highly displaying a thorough understanding of both Environmental Biology and the synoptic elements as well. Centres and candidates should be reminded that knowledge and understanding from AS and *Central Concepts* (2804) are examined within this paper. Again, it appeared that there are some candidates taking this Option who have not carried out much, if any, practical field work. This was certainly the opinion of the Examiners after marking *Q.2* and *Q.3*.

Comments on Individual Questions

Q.1 This question focused on the greenhouse effect and the consequences of global warming. Table 1.1 contained data about Earth and Venus. Most candidates scored well on this question except in part *(b) (i)*, where the majority of candidates seemed insecure regarding their knowledge of the greenhouse effect.

(a) This part of the question was intended to give candidates a relatively straightforward start to the paper using the table of information and introductory text. Candidates who scored well made references to very high temperatures and how they would denature enzymes. Many candidates referred to longer day lengths and the effects that this could have on photosynthetic organisms. Candidates who did not score well only made vague references to high carbon dioxide levels, failing to explain possible consequences of this. The Examiners looked for lack of water or oxygen as appropriate responses among many others.

(b) Part *(i)* was very poorly answered by the majority of candidates who gave some very disappointing responses when trying to describe the pattern of events that enhance the greenhouse effect. This is a very well outlined sequence that candidates should be familiar with. Many candidates referred to heat or light entering the atmosphere of Venus and not short wavelength or high energy rays. These candidates rarely referred to infra-red or longer wavelength rays being unable to escape the blanket of greenhouse gases. Part *(ii)* was generally well answered by candidates with numerous references to burning fossil fuels, deforestation and the use of aerosols being responsible for increasing the concentrations of greenhouse gases in the atmosphere. Candidates should aim to refer to *increases* in human activities, e.g. an increased use of vehicles. Part *(iii)* was well answered by candidates with many referring to polar ice caps melting and sea levels rising which then lead to flooding. Candidates who made reference to effects on biodiversity or suggested effects on climate change also gained credit.

Teaching tip

The learning outcomes relating to the greenhouse effect and global warming can easily be summarised using flow diagrams to highlight the relevant points.

Q.2 Overall, this question was poorly answered by candidates, partly due to a lack of practical knowledge regarding soil analyses and secondly due to candidates who failed to discuss some synoptic ideas questioned in part *(c)*.

(a) Many candidates failed to gain marks in this section. Candidates rarely explained that site **A** had poorer drainage or that flooding from the river occurred into **A**. Very few candidates referred to run-off from the moorland area or gave a comparative comment regarding the soil types at **A** and **B**.

(b) Unfortunately, it was clearly evident to the Examiners that the majority of candidates had not experienced the practical aspects that this section examined, namely analysis of soil samples. The candidates were asked to describe *and* explain how the soil samples were analysed to obtain results for mineral matter, water, air and organic matter as shown in the pie charts. Some candidates gave good descriptions as to how to measure water content of the samples, with credit being awarded for heating at suitable temperatures until constant mass was achieved. Inaccurate reference to equations used for percentage calculations lost candidates straightforward marks. Candidates' attempts at describing how to measure the air in a soil sample were very poor. There were few references made to *measured* volumes of soil or water in the method. Organic content methods were described reasonably well by candidates who had carried out this procedure practically, with good references to the burning of dry soil samples and the calculation required. Credit was also given to candidates who made reference to carrying out repeat samples and therefore being able to calculate means for the results. Candidates in their responses far too frequently omitted a method to obtain results for the mineral matter. In fact, this is the simplest figure to obtain after having carried out the other measurements.

Many candidates gave irrelevant details regarding testing pH or oxygen levels of the soil and thus failed to gain the quality of written communication mark. The quality mark was awarded for good organisation and coverage of all four items shown in the pie charts.

(c) Parts *(i)* and *(ii)* gave candidates the opportunity to display an understanding of concepts met in Section 5.1.7 of *Biology Foundation* (2801) and Section 5.4.3 of *Central Concepts* (2804). Unfortunately in *(i)*, many candidates failed to transfer their ideas into this different situation. Very few candidates referred to the idea that the anaerobic conditions created by the very wet soils actually encourage denitrifying bacteria to convert nitrate ions into gaseous nitrogen, thus lowering the nitrogen content of the soil. Some candidates made reference to the fact that sundew is a carnivorous plant and could therefore obtain its nitrogen from sources other that the soil. Inaccurate use of key terms failed to gain credit for a simple reference to digestion or hydrolysis of insect proteins that thereby released amino acids for use by the sundew. Part *(ii)* aimed to examine the links between anaerobic conditions created by the very wet conditions and the subsequent lack of energy not available for active transport of ions into the roots of the plants. Unfortunately, many candidates made references to changes in water potential gradients, effects on osmosis or even a general lack of support for the roots themselves.

Teaching tip

Candidates may be encouraged to make links with other parts of the specification using spider diagrams or other forms of presentation. There are many different examples of ways of organising this sort of information at:

www.enchantedlearning.com/graphicorganizers

Q.3 The marks in this question ranged from 0 to 15, thus showing how this question polarised the candidates' responses. It was pleasing however to note that all candidates did make some attempt to answer this question based on practical work from Section 5.7.1 of this Option. It was clearly evident to the Examiners that candidates find the application of statistics and the interpretation of results very demanding.

(a) Candidates tended not to gain full or high marks here with some candidates clearly appearing not to have done the field work that produces this type of data. Some candidates included in their responses information from field study work which was clearly not relevant in this situation, e.g. choice of quadrat size and methods for estimating percentage cover. Comparatively few candidates explained that random numbers should be used or how to derive them electronically or otherwise. The idea of a grid being set up and coordinates being used were also not well described by the majority of candidates. A few candidates mentioned that measurements need to be repeated even though this was clearly evident from the table of results.

(b) Parts *(i)* and *(ii)* both relied on candidates making reference to Table 3.1 in their explanations. Many candidates failed to do this. In order for candidates to gain both marks available for part *(i)*, reference should have been made to *total heights* not just sets of data. It was this looseness of terminology that lost candidates the marks available. Part *(ii)* asked candidates to explain the meaning of the term standard deviation. Good candidates referred to variability or spread of data in the sample. However, the majority of candidates included the term *range* in their responses that is incorrect from a statistical point of view. Some candidates chose to write the standard deviation equation without explaining what it meant. A very small minority of candidates referred to the percentages of the sample lying within one (or two) SDs of the mean.

(c) If part *(b) (ii)* was answered well then part *(c)* was also answered correctly by candidates. The most common error in this section and the previous one was the use of the term *range* which centres should encourage their candidates not to use in this context.

(d) In part *(i)*, many candidates gained at least one mark, with better candidates using the term *significant difference* accurately. Some candidates gained their mark for a reference to differences in data sets occurring by chance. In part *(ii)*, most candidates calculated the degrees of freedom as 28, although 14 was a common error. Using this information, many candidates read off an accurate value for *t* at the appropriate level of significance. It was pleasing to see that many candidates appreciated the level of significance to be 0.05. However, many candidates then accepted the null hypothesis or stated that the results were due to chance when in fact there clearly is a significant difference. No candidates made reference to the sample having to show a normal distribution for a statistical analysis to have value in this context.

Q.4 Overall, *Q.4* performed reasonably well, with the majority of candidates offering some good responses, especially for the extended answer question. Part *(c)* allowed candidates to discuss their understanding of the role of the RSPB and other similar organisations.

(a) Many candidates attempted to rewrite the term biodiversity, e.g. the diversity of biological organisms. This naturally failed to gain any credit. The Examiners were looking for good references to *different* species that *co-exist* in an ecosystem rather than an *area*. Again, candidates lost easy marks by poor use of ecological terms.

(b) This proved to be far more mark yielding than *Q.2 (b)*. Candidates were asked to outline the *ecological*, *economic* and *ethical* reasons behind biodiversity initiatives. Many candidates answered this item in a structured fashion with clear references to all three reasons. A minority of candidates seemed to confuse the three terms however. The Examiners were wary of the fact that candidates attempted to simply twist the introductory text in order to gain credit here. The ethical reasons behind maintaining biodiversity were well answered with many references being made to the importance to future generations. The quality of written communication mark was often awarded. Candidates and centres should be reminded, however, that the Examiners usually look for at least 10 lines of legible text before they consider awarding this mark.

(c) The activities of the RSPB are well documented in the recommended texts for this Option, but many candidates seemed unaware of these activities. Vague references to maintenance or reclamation of land were often not justified and therefore did not gain any credit. More accurate points, such as purchasing land, setting up and then managing reserves with trained volunteers were not often seen by the Examiners. The mark scheme for this question gives a fairly comprehensive list of suitable activities for centres and candidates to use in future.

Q.5 This was generally well answered by the majority of candidates who displayed some excellent subject knowledge in terms of organic farming and the benefits of intercropping as a technique to increase crop yields. Candidates also had a secure understanding of the role of nitrogen fixation and protein yields in crops.

(a) This was very well answered by candidates who gave accurate descriptions of nitrogen-fixing bacteria in root nodules, with many giving *Rhizobium* as an example. However, the fourth mark proved slightly more elusive for the majority of candidates. A reference to nitrogen being converted into nitrate ions or conversion of amino acids into proteins would have gained credit.

(b) Many candidates had a good understanding of the disadvantages of organic farming with references being made to labour intensive methods, lower yields, and shorter shelf life of the products. It was pleasing to see such a varied range of acceptable answers here.

(c) The vast majority of candidates gave *intercropping* as the correct answer in part *(i)*. Part *(ii)* asked candidates to explain some of the benefits of intercropping. Many good answers referred to reduction in soil erosion, protection of crop species by the other crop in terms of shelter. A large majority of candidates indicated that growing legumes in fields would increase the nitrogen content of the soils for non-leguminous crop plants. Many candidates scored well here.

Q.6 This question provided some opportunities for assessing the synoptic aspects of the Option. The Examiners saw many high quality answers on water treatment, but were disappointed with answers to the synoptic elements.

(a) The calculation required candidates to measure the image of the oocyst and convert the answer into micrometres and then divide by the actual size (5 μm). This proved difficult for many who may have forgotten the appropriate technique from *Biology Foundation* (2801).

(b) Parts *(i)* and *(ii)* also relied on candidates using their biological understanding from elsewhere in the course. It was disappointing to find that candidates could not recall the features of a eukaryote and simply gave features of a bacterium that were clearly not required. Part *(ii)* was again disappointingly answered with many candidates failing to gain credit. References to disease or illness were key words that the Examiners were looking for in order to award the mark available.

(c) In part *(i)*, many candidates knew that chlorine was an effective method of water disinfection that gained one mark. However, very few candidates followed this up with reference to the use of either ozone or ultra-violet light. Far too many candidates referred to simple filtering systems or even boiling the water.
Part *(ii)* specifically asked candidates to use the information in Fig. 6.2 to suggest the reasons why the water supplies became contaminated. However, it was again disappointing to find that many candidates chose to ignore this advice and therefore gave answers that did not answer the question. The Examiners were looking for references to material from infected cattle faeces being washed or leached into reservoirs in order to gain credit. The idea of oocysts being resistant to water treatments was often poorly described.

(d) This was well answered by candidates who made good references to the elderly or people with weakened immune systems as more susceptible to infection than others. The Examiners were looking for specific references to babies or infants rather than children in general.

(e) Many candidates gave nitrates or heavy metals as correct responses. Alternative acceptable answers included PCBs or pesticides. This part was generally well answered by the majority of candidates.

2805/04: Microbiology and Biotechnology

General Comments

There were a number of candidates who were very well prepared for this paper and scored very highly, displaying both excellent knowledge and understanding of the Option as well as the synoptic content. There were also some very good examples of extended writing where candidates included most of the Examiners' mark points in their answers. The majority of candidates attempted all parts of every question, although there were some who left blanks for some parts including the extended answers. Even with these candidates, there was no evidence that more time was required to complete the paper. In questions that required candidates to read information carefully and then make use of it to answer, there was considerable evidence of a lack of careful thought and planning and sadly many cases where the question had been misread. The consequences of this in *Q.4 (b)(i)* and *(ii)* and *Q.5 (b)(i)* and *(ii)* proved to be costly for some.

Generally, the synoptic elements of the paper were less obvious and candidates who knew about genetic engineering techniques or bacterial population growth mistakenly used this information to answer the parts of *Q.4* and *Q.5* mentioned above.

There were a number of instances where candidates had continued to answer on extra sheets of paper or the blank pages without alerting the attention of the Examiner. Moreover, some had completed a number of questions on the additional paper and had not identified their continuation answers with appropriate question numbers and letters. Candidates should also be advised that the number of marks and lines allocated to answering a question are generally good pointers to the amount to write. Although it is appreciated that candidates are working to a time limit, the Examiners experienced great difficulty interpreting the writing of a good number of candidates.

Comments on Individual Questions

Q.1 This was a question that expected candidates to apply their knowledge of immobilised enzymes as well as use synoptic information. For many, only part *(a)* proved to be accessible, with some repeating the advantages given in *(a)(ii)* to answer *(b)(ii)*.

(a) Parts *(i)* and *(ii)* have been asked previously and were intended to be a fairly easy introduction. Indeed, many candidates correctly gave a definition for *(i),* but it was disappointing that a good number wrote about the enzyme being 'unable to move', or who gave one of the methods for immobilising enzymes and then went on to repeat this method in *(ii)*. Correct answers for *(ii)* were given by the majority of candidates, but for some there was a lack of understanding and some methods were compilations of various techniques. The most common correct answer was 'trapped in alginate beads', which may indicate that many have carried out the immobilised enzyme experiment and gained their best understanding from their practical experience. The best answers in *(iii)* were from those who had assimilated the information and suggested *practical* advantages of using the bioreactor in a *space ship*, rather than just stating three advantages of using immobilised enzymes.

(b) The synoptic element of *(i)* was fairly well understood, with most candidates correctly writing about the use of water and many going on to give information about the breaking of bonds. It was disappointing that a number thought that

glycosidic bonds were involved and some wrote about condensation reactions. In *(ii)*, candidates who achieved maximum marks were those that used the information given rather than repeat the advantages of immobilisation used in part *(a)*. Few candidates linked the production of fatty acids to a lowering of pH and advantage of using immobilised lipase.

Teaching tip

Candidates should appreciate that there is usually little flexibility when they are asked to give a definition or explain what is meant by a term. To help with defining and using terms they could create their own glossary of relevant terms at the end of each topic. Many may find it useful to learn main cue points rather than sentences. For example: *immobilised enzyme*: attachment, inert, insoluble, support.

The following web site gives some further information about ‘water recovery’ in space:
www.msfc.nasa.gov/news/news/releases/1997/97-065.html

Q.2 This was a question that required candidates to apply their synoptic knowledge of antibiotics from *Human Health and Disease* (2802) and their knowledge of microbiological techniques and safe working practices. Almost all candidates gained the quality mark for part *(a)*. However, it should be noted that many were close to losing this mark with incorrect spellings or poor grammar and punctuation.

(a) This extended question proved to be very confusing for many candidates, who seemed unable to sort out the unfamiliar information given in the introduction and formulate a clear design for an investigation. However, there were some excellent answers, with full sequential accounts and relevant examples of aseptic practice (which could gain half the available marks). Although there is no requirement to carry out an investigation of this nature, it was evident that some centres have carried out disc diffusion experiments and this was well remembered, with only the weaker candidates inadvertently referring to using antibiotics or giving incomplete descriptions. The Examiners were looking for good practical planning, such as the use of replicates and controlled variables, and this occurred only in the minority of answers. References to incubation at 37^{o}C did not score as the question required candidates to devise a plan that *they* could carry out safely. Similarly, vague or very short incubation times ‘a few days’, or ‘12 / 24 hours’ did not earn marks.

The Examiners had to work carefully through many answers to pick out relevant mark points. Some candidates grew bacteria and sprayed with deodorant to check for reduction in smells. Others took swabs of sweat from various parts of the body and implied that this was the bacterial culture or the antibacterial substance. Some took swabs of underarms sprayed with different deodorants, while some planned investigations that used deodorants (sometimes added to molten agar) or bacteria but not *both*. Some of the bacterial sources suggested were clearly unsafe. Better candidates gave valid accounts of a method to create a lawn of bacteria, introduce the deodorants and then describe results that could be measured to give a comparison of antibacterial effectiveness. At the other extreme there were descriptions of streak plating, ten-fold dilution, haemocytometry, dilution plating, colony counting and turbidimetry. However, where good aseptic techniques were noted, candidates could gain marks. Very few answers incorporated the safe disposal of equipment into disinfectant discard pots. Most candidates who wrote about the use of alcohol to sterilise work surfaces also wrote about Bunsen burner flames and did not emphasise the importance of safe practice, i.e. the possible close association of a flammable liquid and a naked flame. Some candidates incubated bacteria and subsequently exposed or contaminated the culture by adding the deodorant. The Examiners came across numerous other examples of unsafe practice. Learning outcome *(c)* in 5.8.2 of the specification is about safe working in microbiology.

(b) Part *(i)* was often well answered, with many scoring full marks. However, there were a surprising number of poorer answers that ignored the idea of antibacterial substances and wrote that sweat ‘prevents entry of bacteria into pores’ or ‘stops flies from being attracted’. Weaker responses that acknowledged the antibacterial properties then referred to ‘killing fungi’ or ‘getting rid of diseases like eczema’ or thought that killing bacteria would stop the smell. Part *(ii)* proved to be a straightforward way to gain two marks for candidates of all abilities from some centres, although it was disappointing that murein was frequently spelt incorrectly. For other centres, the quality of answer varied and it was not uncommon for the Examiners to come across candidates who thought that ‘animal cells had cell walls’ or that ‘the animal cell membrane was thick and tough’ or ‘plant cell walls were made of protein’. Some candidates gave a description that referred to receptors and resembled T-killer cell action.

Teaching tip

Candidates should be encouraged to *(a)* write their own risk assessments before carrying out microbiology practicals or *(b)* select appropriate hazards and precautions from a list of safety comments. If there is easy access to shared use of an information and learning technology (ILT) site (for example, *Blackboard*), the relevant risk assessments could be selected from a master list. This will serve as useful consolidation for the coursework or practical examination as well as make them more responsible for their own safety.

Q.3 This question was intended to give candidates the opportunity to use their knowledge and understanding of the *Microbiology* section and it was pleasing that there were many high scores. Surprisingly, there were more problems with parts *(a)* and *(b)* than with the last two parts.

(a) This proved to be harder than anticipated, with most candidates only able to score one or two marks and many leaving blanks. Knowledge of viral structural features was poorer than for bacteria, which accounted for lost marks. There were a number of candidates who thought that viruses had cytoplasm and there were also some who listed contents of the cytoplasm. The mark for *nuclear material* was often lost by only stating one type of nucleic acid. Those that answered ‘RNA’ for the virus column may have mistakenly looked ahead to part *(b)* and answered for the HIV virus only. The Examiners only credited ‘DNA or RNA’ as the correct answer. Incorrect references to ‘single stranded / double stranded’ were overlooked by the Examiners. This is clearly an area where the majority of candidates showed gaps in their knowledge.

(b) As with part *(a)*, a good many candidates failed to score full marks. Structure **A** was usually correctly identified. Incorrect answers for Structure **B** included ‘capsomere’, ‘receptor’ and ‘stalked particle’. Answers for structure **C** included various named enzymes including ‘RNA transcriptase’ (another term for RNA polymerase) and, more worryingly, ‘plasmid’, ’nucleus’, ‘ribosome’ and ‘vacuole’.

(c) Generally, candidates made a very good attempt at this straightforward extended question and many were able to gain full marks, with a few giving outstanding accounts and demonstrating detailed knowledge of the HIV life cycle. Only the very best answers gained the quality mark for the use of at least four of the specialist terms, which was disappointing. Candidates did not always remember to name the host cell but those that did were correct, although a few incorrectly named B lymphocytes as a host cell. Most realised that the virus binds to host cell receptors and a handful described the recognition of the viral gp 120 glycoprotein antigen to the CD4 receptor. Generally, there was a lack of knowledge of the uncoating of the nucleocapsid following entry and also the release of new viral particles by budding to gain their envelope, with most candidates simply describing host cell lysis. There was good knowledge of the role of reverse transcriptase and the mechanisms leading to latency and many were able to gain an AVP mark for stating that HIV was a retrovirus. For those that scored less well, the most common errors were to give superfluous information on HIV transmission or to confuse the life cycle with bacteriophage lambda. Consequently, RNA was 'injected' into host cells and the 'phage' DNA incorporated into the host bacterial genome.

(d) This was usually very well understood and answered, with some full accounts and clear diagrams, although 'bacteria dividing by mitosis' did creep into a number of answers.

Teaching tip

Candidates could gain experience of dealing with unfamiliar material by labelling and annotating diagrams, photographs and electron micrographs of the same microorganism / virus that have come from different sources. Alternatively, candidates could be asked to draw their own versions of diagrams of a microorganism and swap them around for others to label.

Q.4 This was not a popular question with candidates and was often the least well answered. However, it did prove to be a good differentiator and stronger candidates were able to gain almost full marks. The information given in the introduction to the question was intended to lead candidates from a synoptic element from *Central Concepts* (2804) through to plant tissue culture - a topic on this Option.

(a) Part *(a)* attracted poor quality answers: 'the hybrid is sterile because it has an unusual number of chromosomes', 'difficulties in two varieties breeding', 'from two species so produce infertile offspring', were fairly common. Odd numbers of chromosomes rather that an odd number of chromosome *sets* was also given frequently. Roughly half the candidates gained one mark in realising that meiosis was involved but they showed little understanding of the mechanics of the problems created by triploidy. The sequence of events of meiosis seemed to have been forgotten by some candidates, who thought that pairing of homologous chromosomes occurred at metaphase (a mere handful referred to pairing at prophase I). Mitosis also made an appearance in some answers. Only the most able provided answers that demonstrated good understanding and although others did gain two marks, this was mainly due to the Examiners giving some candidates the benefit of the doubt. Once again, spelling mistakes were in abundance: 'pairing', 'homologous', 'meiosis' and 'chromosomes' were all victims.

(b) A significant number of candidates seemed determined to disregard the reference to tissue culture and incorrectly concentrated on cloning to give, in many cases, very good accounts of the genetic improvement of crop plants. Where possible, the Examiners found correct marking points to award. Most candidates who started on the right track achieved two or more marks. Although the mark scheme catered for those who gave consideration to the variety of possible methods of plant tissue culture that could be adopted, the most able candidates chose one method to present and gave full flowing accounts, with the inclusion of appropriate scientific terminology. Given the acceptance of more than one valid approach, it was not unusual for candidates to be able to score full marks.

(c) This question, which asked about using plant tissue culture technique to *clone plants*, proved to be more demanding for candidates than intended, with fewer candidates scoring above three marks. There was usually an emphasis on the advantages rather than on disadvantages and references to desirable characteristics, speed and quantity of production, overcoming quarantine and transport problem were frequently given. 'Virus free' was less common and may have incorrectly caused some conflict with the disadvantage of being 'susceptible to disease'. Valid comments on social and economical implications were credited, but were rarely made; where cost was mentioned, it had to be a reasoned argument to score rather than 'makes it cheaper'. Those candidates who had taken the wrong route on part *(b)*, continued with accounts of the benefits and hazards of genetic engineering. Many candidates tried to tailor their answers to watermelons; candidates were not good at realising that the question had moved on from this specific example to the general principle.

Teaching tip

Word lists for each topic taught will help candidates to remember specialist terms as well as their correct spellings. Individual words printed on car, laminated and backed with self-adhesive Velcro could be stuck onto fixed or mobile notice boards – easy to remove at the end of a topic and replaced with the next set. Or candidates could be given assignments to write extended answers that must include specific words. These can be of varying difficulty depending on the number of words in the list and should aid understanding as well as improve the quality of extended writing.

Q.5 This question was based on the fermentation of sugars by yeast cells and had a large synoptic element, drawing on strands from *Central Concepts* (2804) and *Biology Foundation* (2801). The lengthy introduction included diagrams to illustrate the main stages and was intended to leave candidates in no doubt as to the nature of the investigation. However, by the time the majority of candidates had turned the page and had seen the shape of the curve of the graph, they had switched to 'bacterial population growth curve' mode and were on course to lose marks. Part *(a)* was aimed at all candidates and the outcome was successful, with almost all being able to gain at least three out of the total four marks. Parts *(b)* and *(c)*, however, were particularly challenging and only a handful of the most academic candidates were able to think on cellular or molecular levels and gain maximum marks.

(a) This was very well answered, with marks only being lost because of a lack of precision, for example 'type of nutrients'. *Amount* of sugar or yeast was rejected as Examiners had no way of knowing if this referred to concentration (which

could score) or volumes (which was in the introduction). A number of candidates made reference to oxygen and this was considered acceptable as there was no indication that conditions in the fermentation tubes were completely anaerobic.

(b) The Examiners accepted a range of figures for time in *(i)*, treating as neutral references to the phases of bacterial population growth where possible. It was pleasing that most candidates used figures from the graph to help them in their answers and many could gain at least three marks. However, some forgot to give units or gave seconds instead of minutes and forfeited one or two marks. Many candidates seem to refer to any rapid increase as 'exponential' and seemed to forget that they have probably come across this term when the y axis is $\log_{10}$ numbers rather than volume of gas / cm^3. Although the question asked candidates to describe the results obtained with glucose, quite a few candidates decided to compare the results for glucose and maltose and very rarely gained more than one mark. Part *(ii)* was intended to be an invitation where candidates could consider the transport of glucose across membranes and the effect of its concentration in cells on respiration. However, only a minority realised this and may have then gained a few marks accidentally by continuing with explanations of the population growth curve. Many thought that yeast cells would need to synthesise new enzymes to respire glucose. Those that had compared maltose and glucose were rarely able to score marks unless they referred to 'respiration' at some point (to gain one mark). Indeed only a minority of candidates mentioned respiration.

(c) This was not well answered by most candidates. There was a range of answers given that used biochemically incorrect information about the two sugars. Maltose is considered in this specification (brewing) as well as at AS. It was hoped that candidates would realise that maltose is a disaccharide and glucose a monosaccharide. This should have led some to consider how uptake of the sugars into the cell from the external medium may differ. Some candidates who realised that enzymes needed to be synthesised did not always make it clear that these were for maltose and that this would explain the time delay. Time needed to breakdown maltose was not credited as an AVP unless candidates gave more details, for example hydrolysis into its component glucose molecules.

Q.6 This was a very accessible final question that tended to score fairly well.

(a) Almost all candidates gained at least one of the two marks, with the idea of 'sterile' preventing contamination being the most common answer. It was disappointing that many candidates only attempted to give one reason even though they could see an allocation of two marks. Very few candidates seemed to realise that the air provided *oxygen* for *aerobic* respiration but more were able to write about the air playing a role in the mixing of the nutrients.

(b) Generally, candidates were well prepared and many gained maximum marks for all sections of part *(b)*, which was pleasing. In *(iii)*, some candidates did not read the question carefully and described how probes monitored the pH. There were also some candidates that referred to the 'denaturing' of organisms.

(c) In *(i)*, 96 hours was usually given to gain the mark, although 44 hours (the start of penicillin production) and 144 hours were also frequently incorrectly stated. Presumably those that gave 144 hours used the curve for penicillin production

and had marked the time when the curve was beginning to plateau. In *(ii)*, most candidates correctly wrote about the production of secondary metabolites, but some incorrectly gave explanations for the lag phase of population growth.

(d) This was the most demanding part of *Q.6* and was well understood by the most able and best-prepared candidates. In addition, some centres had covered downstream processing and their candidates could also gain marks. The Examiners were not looking for any great detail when awarding marks, but did expect candidates to understand that the penicillin product needed to be separated from the fungus and that it then had to be purified in some way.

(e) Most candidates scored at least three marks for part *(e)* and this was usually well understood. References to cost were unlikely to gain a mark unless qualified logically and clearly. Some candidates wrote at length about one or two reasons, for example in giving descriptions of genetic engineering and this was not the intention of the question.

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of appropriate difficulty and most candidates attempted each section of every question. There was no evidence of misinterpretation of the rubric and candidates had sufficient time to give full responses to each question. There appeared to be slightly more emphasis on using information provided by either text or diagrams than in previous papers, with less requirement for candidates to use their knowledge in order to interpret new situations.

As in previous sessions, it was clear that some candidates had not read the question fully before formulating their answers, occasionally ignoring the directions given. Sufficient space was provided for candidates to write their responses and only rarely did candidates require extra sheets of paper.

The most discriminatory questions were *Q.2 (b)*, *Q.4 (c)*, *Q.5 (c)* and *Q.5 (d)*; the least discriminatory were *Q.1 (e)* and *Q.3 (d)*.

Comments on Individual Questions

Q.1 *(a)* While many candidates were awarded full marks on this synoptic section, it was evident that some were unable to remember the definition of either a tissue or an organ and apply it to the cerebral cortex and the brain. Some candidates commented that a tissue was a collection of cells omitting the fact that the cells or neurones should be ‘similar’ or ‘specialised’, although they recognised that it would perform a particular function. Some made the mistake of stating that an organ would have one function rather than several, although most appreciated that it would consist of different tissues.

(b) Most candidates understood that the folding of the cortex would increase the surface area although few went on to explain the significance. Some referred to ‘more neurones’ or ‘more axons’, but not to the increasing processing power. A common answer was a reference to ‘more synapses’ but this was not given credit, as it could have been the result of other factors, such as increased learning.

(c) This section was generally well answered with the majority of candidates stating two or more correct functions of the cerebrospinal fluid.

(d) The vast majority of candidates identified the function of the cerebrum as ‘planning a task’.

(e) Some candidates neglected to describe the effects of hydrocephalus on each area, often grouping the middle and rear regions together. Few appreciated that the greatest damage or loss of neurones occurred in the rear region. Nevertheless, most recognised that there was an increase in the total percentage of white and grey matter in the front region and went on to comment that there would be normal speech production as a result. Some failed to link the given features with the appropriate areas, resulting in somewhat vague statements. However, most candidates scored at least one mark and many were awarded the maximum available.

Q.2 *(a)* The majority of candidates correctly identified cells **X** and **Y** and gave a suitable component of gastric juice not shown in Fig. 2.1.

(b) In *(i)*, most candidates were able to link the increased number of mitochondria in cell **X** with ATP production or, less often, aerobic respiration, but references to the *production* of energy were not credited. Relatively few then went on to state why ATP would be necessary although some references to active transport and/or exocytosis were seen. Hardly any candidates mentioned the use of ATP in proton pumping. The role of the Golgi body in *(ii)* was frequently less well described. Good candidates appreciated that it was important in the formation of vesicles which would contain pepsinogen (for exocytosis). Some commented that the Golgi body modified or processed proteins, although there were occasionally irrelevant statements concerning lipid.

(c) Candidates who had studied Fig. 2.1 carefully achieved maximum marks for the sequence of events leading to the release of hydrochloric acid very easily. Common errors included the secretion of vesicles, rather than their contents, and inaccurate statements, such as acetylcholine or hormones being 'received' or 'picked up' by receptors. Nevertheless, even the weakest candidates managed to score at least two or three marks.

(d) Again, the majority of candidates were awarded full marks for recognising that the antihistamine would bind to the histamine receptor, blocking histamine and reducing or preventing the release of hydrochloric acid. Occasionally, a mark was lost for stating that the antihistamine would act as a competitive inhibitor, binding to the active site rather than to the receptor.

(e) Many candidates gained credit for understanding that the endopeptidase would break bonds within the protein molecule producing shorter (poly)peptide chains; however, some candidates failed to state that the peptide bond would be hydrolysed. Most candidates appreciated that hydrolysis reactions involve the addition of a molecule of water across a bond; many went on to give an example of the bond that would be broken. Weaker candidates described condensation reactions.

Q.3 *(a)* Weaker candidates often incorrectly named **M** and **N**, although the functions were understood by most. Some believed that the neural spine allowed articulation of the vertebrae with each other or was to prevent over-extension of the spine. Others stated that the neural canal was important to protect spinal nerves, rather than the spinal cord itself.

(b) The majority of candidates appreciated the significance of the larger centrum in lumbar vertebrae although a few failed to make their statement comparative and some commented that there would be greater muscle attachment.

(c) Generally, the transverse process was correctly identified while the location of the articular process was less well known. Some candidates labelled the thoracic vertebra rather than the lumbar, as instructed, but were not penalised.

(d) Most candidates gave detailed and accurate responses to the differences in causes and symptoms of osteoarthritis and osteoporosis, achieving the maximum marks available. Only rarely were the two diseases confused. The majority of candidates were awarded the quality mark for correct spelling, punctuation and grammar.

Q.4 *(a)* The vast majority of candidates inadequately explained the role of the autonomic nervous system in achieving a decrease in the resting heart rate. While most recognised that this would be brought about by the parasympathetic nervous system, few candidates went on to score any further marks. The effect of the PNS on the sino-atrial node was rarely stated correctly although better candidates understood that there would be an increased rate of firing. Some commented that impulses would be transmitted down the vagus nerve, resulting in the release of acetylcholine, although there were very few comparative references required by the mark scheme. A minority of candidates stated that sympathetic activity would be reduced. On the whole, candidates struggled with this part and full marks were hardly ever awarded.

(b) Most candidates were able to name two plasma proteins synthesised by the liver although weaker candidates gave unacceptable responses, such as pancreatic hormones or enzymes.

(c) This was a very good discriminator, as only the most able candidates were able to score the five marks available, despite the fact that much of the information had been presented to them in the preceding text. Weaker candidates failed to use this material, despite being directed to do so in the stem of the question. Instead they concentrated on their own knowledge of the metabolism of nitrogenous compounds in humans, giving details of deamination and the ornithine cycle, neither of which was relevant. Furthermore, some candidates neglected to put their responses under the appropriate headings of 'similarities' and 'differences', thereby losing marks for otherwise correct statements.

Most candidates appreciated that humans and bears use amino acids in the synthesis of proteins and many stated that urea would be produced in both mammals. There were fewer references to either the transport of urea in the bloodstream or to the filtration of urea. With regard to the differences, a number of vague statements were seen, such as the conversion of urea to ammonia without mention of the role of bacteria in this process or precisely where reabsorption of urea would take place. Better candidates understood that amino acids could be synthesised from ammonia in bears although some believed that this would also take place in humans.

(d) The importance of cholesterol in mammalian metabolism was frequently well explained, with good candidates easily scoring maximum marks. However, weaker candidates were unable to recall the role of cholesterol in the plasma membrane or its significance in the synthesis of bile salts, vitamin D or steroid hormones. Responses concerning the synthesis of high or low density lipoproteins were not credited.

(e) Most candidates suggested that the protective substance would prevent the deposition of cholesterol in the arteries, alternatively expressed as the prevention of atheromas, atherosclerosis or plaques. There were relatively few references to the reduction of LDLs or enhanced HDL production. Some candidates suggested that HDLs would remove cholesterol / plaques, etc. although this was not credited as candidates had been informed that the plasma cholesterol concentration 'rises to twice the concentration found in normally active bears…. brown bears do not suffer any of the cardiovascular diseases associated with high cholesterol in humans.' The implication was that despite the high cholesterol concentration, no adverse effects were apparent, due to the

presence of the protective substance.

Q.5 *(a)* Naming the bone **F** proved to be difficult even for good candidates, presumably because they confused the brachialis with the biceps and assumed that both muscles had the same insertion. Every long bone in both the upper and lower limb was seen, as well as hybrids such as ‘fibia’ and ‘tibula’. Weak candidates simply stated ‘elbow’. Choices, such as ‘radius / ulna’ were not credited.

(b) Surprisingly few candidates were awarded full marks for an explanation as to why the response shown in Fig. 5.1 was a reflex, although a question of a very similar nature has featured in several of the preceding examination papers. Most candidates recognised that the reflex would not involve the brain, expressed in a variety of different ways, although there were fewer references to the involvement of just the spinal cord or only the three neurones shown in Fig. 5.1. Many commented that the response would be rapid or immediate, but statements that the reflex was instinctive or innate were rare.

(c) Candidates were either well prepared for this section, scoring maximum marks fairly quickly, or gave vague responses involving the actions of antagonistic muscles in returning the forearm to its previous position following the additional load. The idea that the muscle spindle is the receptor of a sensory neurone was often poorly understood, with some candidates believing that there would be a synapse between the receptor and that neurone. Nevertheless, once candidates had overcome this initial hurdle, the sequence of events thereafter was often well described. Some responses started with the arrival of the impulse at the neuromuscular junction, although there were still sufficient marking points available for candidates to accrue the maximum marks available for a detailed answer.

As in *Q.2 (d)*, a common error was the exocytosis or diffusion of ‘vesicles’, rather than the neurotransmitter. Furthermore, some candidates confused the movement of calcium ions with sodium ions at the neuromuscular junction, stating that the former would cause the depolarisation of the sarcolemma.
The quality mark was not always awarded, even if candidates had used the requisite number of technical terms, because the events were sometimes erratic in their sequence or a number or inaccuracies were present in the description.

(d) The comparative nature of the two parts of this question was not always appreciated by candidates although many were able to gain at least two marks for understanding that the increased mRNA concentration allowed protein synthesis to take place in order to repair damaged muscle fibres. Good candidates went on to name the proteins that might be synthesised. However, the idea of *more* transcription of the genes involved or *more* translation of the mRNA was hardly ever mentioned. Weaker candidates confused the increased mRNA with mitosis (or, very occasionally, meiosis) to replace damaged cells.

The significance of the higher rate of oxygen consumption was rarely answered well. While candidates commented that oxygen was needed for respiration, there were relatively few references to *aerobic* respiration and even fewer to the fact that *more* aerobic respiration would take place. Similarly, the *increased* provision of energy or ATP synthesis was not described. Of the five marks available, most candidates failed to gain more than three and weak candidates rarely scored at all.

Q.6 *(a)* Structure **X** was correctly named by most although its role was often poorly expressed, weaker candidates stating that it would transmit sound waves to the ossicles or that it would simply vibrate.

There were many varied spellings of Eustachian tube for structure **Y**. Only those that were phonetically close were accepted. 'Eucharitian', for example, was not accepted. Again, the role of the Eustachian tube was not always accurately described. References to equalising the air pressure between the inner and outer ear were rejected, as were those concerning the draining of fluid from the middle ear or the escape of sound waves from the round window. A slight majority of candidates correctly stated that its function was to equalise the air pressure on either side of the tympanic membrane.

(b) Regrettably, candidates were required to state *one* advantage of the contraction of the muscles attached to the ossicles when loud sounds were detected although two marks were available for this section. The mark scheme was subsequently altered to reflect this and any reasonable responses concerning the prevention of damage to the ossicles and a named structure in the inner ear were credited.

(c) Candidates who studied the graph carefully and appreciated its significance easily gained maximum marks in *(i)*. However, while weaker ones commented that person **A**'s hearing remained fairly constant over the frequencies tested, thereby gaining a mark, they then went on to state that **B**'s hearing increased with increasing frequency and **C**'s hearing peaked at 4000 Hz. Nevertheless, correct references to figures (with units) were credited.

The reason for the hearing loss shown by person **C** was well explained by good candidates in *(ii)* although some failed to recognise that the damage would have been caused by *loud* volumes of noise at that particular frequency and simply commented that person **C** had frequently heard sound at that frequency. While many recognised that hair cells would be damaged, few appreciated that it would only be hair cells in one particular area of the cochlea, and suggested that different hair cells responded to sounds of different frequencies without relating this to their position on the basilar membrane in the inner ear.

Most candidates managed to make two suggestions as to the factors that should be controlled when carrying out hearing tests in answer to *(iii)*. Many commented that the apparatus used should be the same and that there should be no background noise; some mentioned the use of the same range of frequencies. References to gender or age were not credited, although statements concerning the physical condition of the subject under test, such as presence of earwax, or whether the person had a cold, thus impairing hearing ability, were awarded a mark. Overall, the majority of candidates scored at least one mark here.

2806/01: Unifying Concepts in Biology

General Comments

Overall the response of candidates to the paper was pleasing. It appeared to be accessible to most, with some very good scores obtained and very few truly poor scores. The range of marks was 0 to 58, with only about 5% of the entry scoring 20 or less. Most candidates showed a sound knowledge and understanding of the units and topics being examined as well as a confidence in handling complex data. Generally they were able to express themselves clearly and accurately and gave well structured extended explanations. The standard of written English was, on the whole, good. It was clear that many candidates had been very well prepared for the paper, and that the efforts made by teachers to drill candidates in writing and interpretation had paid off.

On the negative side, many candidates do not read the questions carefully, do not heed the instructions and do not take account of the mark allocations. This resulted in marks being needlessly thrown away in some sections of the paper. It is clear that candidates still need to be drilled in the correct use of scientific terminology at the appropriate level. For example, the word ‘amount’ is not acceptable at A level to describe mass, volume or concentration. Candidates do not distinguish between ‘optimum’ and ‘maximum’, using the words as if they were synonymous. At A level, the term ‘fair test’ is not acceptable, and candidates should be able to use the terms 'control' and 'variables' correctly. In ecology it is too easy to use vague terms as used by the mass media, but words like ‘thrive’ or expressions such as ‘survive better than’ are inappropriate in scientific work. Most candidates now quote data, but many still do not give full and/or correct units: they must be encouraged to do so. Candidates must also appreciate that the x axis of a graph is not always time, so that words like ‘faster’ and ‘slower’ or expressions like ‘takes less / more time than….’ are entirely inappropriate in cases such as Fig. 4.2 (see comments on *Q.4 (e)*). All data should be taken into account when conclusions are being drawn. In general, it is better to keep conclusions drawn from data as clear and simple as possible: candidates who try to be too clever and look for obscure conclusions usually shoot themselves in the feet! Candidates should not be afraid of stating the obvious and should not go beyond interpretations that are supported by the data.

Weaker candidates have difficulty in expressing themselves clearly and concisely and should be encouraged to draft answers before they write or to use bullet points. Of course, in extended answers full sentences should be used. *Q.4 (e)* is a good case, where candidates tended to repeat themselves and/or to omit facts that they had been instructed to cover. Candidates who made it clear that they were making differences and similarities tended to score well.

Comments on Individual Questions

Q.1 This was intended as an easy starter that should have generated high marks: it was, but did not. It revealed some major fundamental flaws in knowledge and understanding; it showed that thorough revision of cell structure and trans-membrane transport is essential when preparing for this paper.

(a) Many candidates did not know the formula to calculate the dimensions of the organelle. Many multiplied by 20 000, rather than dividing. About 75% of candidates ignored the instruction to give the answer to the nearest micrometre, thus instantly losing a mark. It was clear that many had no idea of the sizes of organelles, and many gave answers that were ludicrously of the wrong order of magnitude, such as 0.00000023 micrometres.

(b) In part *(i)*, many candidates were unable to identify the Golgi body, giving endoplasmic reticulum instead. Many believed that the Golgi body makes proteins rather than modifies them. Many were unable to relate the Golgi to glycoprotein synthesis. Part *(ii)* was extremely badly answered. Few gave the correct responses - exocytosis and fusion of vesicles with the cell membrane; many described active transport, carrier proteins or facilitated diffusion. A worrying number thought osmosis was involved. Many fused their vesicles with the cell wall. It is clear that this section is poorly understood and needs careful revision. Most scored well on part *(iii)*, giving good explanations, but many described energy 'being produced': this is never acceptable.

Q.2 This question revealed some serious weaknesses in some candidates. Many scored well in the data description part, only to go to pieces later through lack of knowledge.

(a) In *(i)*, many candidates failed to read the y axis label carefully, so described a 'decrease' in length instead of a reduced increase. Many failed to point out the obvious peak at 1.4 μmol dm^{-3} or described it as 'optimum'. Many failed to quote units fully and/or accurately. In *(ii)*, many weaker candidates quoted factors that had already been controlled, such as time, were imprecise (e.g. 'light' rather than 'light intensity') or used the unacceptable word 'amount' instead of volume or concentration.

(b) This revealed candidates' lack of knowledge and understanding of the effects of auxins on cells. They were confused by the use of the word 'stem' in the question and described apical dominance and the inhibition of lateral buds. Re-reading the preamble to the question would have made it clear that the stems were far too short to have any lateral bud development. Candidates clearly find this topic difficult, and a careful review of how it is taught might be valuable.

(c) Most candidates answered this in terms of hormone action, which was perfectly acceptable, but marred their answers by vagueness; for example they wrote 'glands' rather than 'endocrine glands', or biologically incorrect descriptions, such as 'exocrine glands'.

Teaching tip

Ask students to prepare a list of statements about the information shown in Fig. 2.1. Collect these in and display them or put them on a hand out or use them to prepare a set of cards. Ask groups of students to assess the statements and see whether they match the information in the graph or not. For example:

- as the concentration of auxin increases so does the mean length of the shoots;
- at high concentration of auxin the shoots decrease in length;
- the optimum length is achieved at 1.4 μmol dm^{-3}.

They could also be set the task of calculating the final mean lengths of the shoot sections.
A similar exercise could be carried out on Fig. 4.2 from this paper.

Q.3 Many candidates were able to score very good marks on this question, but it also revealed a very poor understanding of the nature of food webs.

(a) Candidates were given credit for any three correct deductions based on the data, but many failed to score all three marks for a number of reasons. Many ignored the data for the climax forest and based their conclusions only on the three stages of tree development: all data should be used to draw conclusions. Many used vague wording which was not scientific: words like 'thrive' are meaningless in this context and should be avoided. Many gave conclusions that could not be supported by the data: 'survive better' was a commonly used expression. Remarkably few candidates quoted figures in a comparative way.

(b) Many realised this was an example of succession, but others struggled to find an answer. Common errors were 'biodiversity', 'natural selection' and 'evolution'.

(c) Candidates found this section very difficult and few scored good marks. Most ignored the words 'food web' and described what happens in food chains. They had little concept of how webs result in stability. Many thought that energy can be recycled. Only the best candidates described competition, population regulation and alternative food sources.

(d) This question was well understood and well answered. Candidates should beware of writing 'nitrogen' when they mean nitrate.

(e) This was intended to allow candidates to display either a deep knowledge of one aspect of forestry practice, a broad knowledge of many aspects, or a combination of both, and the mark scheme was accordingly very flexible. Many candidates fulfilled these expectations well and there were some good, wide-ranging responses. Good candidates included biological, ecological, financial, aesthetic, practical and edaphic factors in well constructed responses. The standard of English was much improved compared to previous years. Less able candidates tended to repeat themselves or go off at tangents describing global warming, climate change or the effects on oxygen and/or carbon dioxide concentrations in the atmosphere.

Q.4 This question showed up some worrying fundamental errors in biological knowledge and understanding, also an inability to write explanations at A level standard using correct A level terminology.

(a) Many candidates gave good answers showing a clear grasp of the concept of limiting factors. Some were confused, believing that carbon dioxide became the limiting factor. Surprisingly few recognised that photosynthesis was at its maximum for those conditions. The best candidates were able to give internal, physiological reasons, such as the enzyme rubisco being fully saturated.

(b) This revealed some major misconceptions about plant physiology. A worrying number of candidates thought that photosynthesis and respiration are mutually exclusive processes, that photosynthesis releases carbon dioxide while respiration uses it, that respiration only occurs at night or that plants do not respire at all. Although compensation point is not in the specification as such, some candidates knew about it and used it to good effect in their answers.

(c) The term '*fair test*' alone and unqualified is not acceptable at AS/A level. Candidates should refer to controlling variables. Many scored marks by describing the potential consequences of not using the same light intensity, but others returned to describe limiting factors that was not an acceptable response.

(d) Most only scored one mark here, failing to state the obvious facts that photosynthesis occurs in the leaves and that water, derived from the roots via an intact stem, is needed for photosynthesis.

(e) Many candidates scored maximum marks here simply by doing what the question asked them to do and quoting, accurately, two sets of data. The most common errors were to omit to comment on the similarities, to repeat several differences, to omit to comment on the effects of carbon dioxide concentration and to omit data quotes with correct, full and accurate units. Few if any candidates annotated Fig. 4.2 to clarify their minds before writing. Many failed to distinguish between carbon dioxide release and uptake, so writing confusedly and losing marks. Many took time to be the x axis, so described rates of uptake in terms of time. Many used the word 'optimum' when they meant 'maximum' to describe the plateaux of the four lines on Fig. 4.2. Highlighting the key instruction words in the question and the use of bullet points in the answer would be ways to avoid unnecessary loss of marks in this type of question. Marks were available in this section for candidates to show their wider knowledge and understanding of the biological principles behind the data: sadly, few mentioned C3 or C4 metabolism, geographical distribution or different enzymes in the plants. It is to be regretted that candidates do not appear to be encouraged to think 'out of the box' or to show their breadth of knowledge and understanding. Is the age of reading more widely beyond the confines of the specification and specified textbooks dead and gone? It is to be regretted if that is true.

Teaching tips

This question could be used with some of the questions set in January 2005 to reinforce the ideas about respiration and photosynthesis in plants and the effects of limiting factors. The questions are:

- Planning Exercise for the A2 Practical Examination (2806/03/PLAN)
- *Q.2* in *Central Concepts* (2804)
- *Q.1* in the Practical Test for the A2 Practical Examination (2806/03/TEST)
- *Q.2* in *Unifying Concepts in Biology* (2806/01)

Also see the *Report on the Units* for January 2005 for a discussion of these questions.

Students could be given the introductory information about this investigation and the graph (Fig. 4.2). They could then be asked to write a series of statements that *describe* the results shown in the graph and another series to *explain* them. All this could be done without the actual questions ((a) to (e)) that were set. They could also be encouraged to annotate the graph and rule lines on it to make accurate data quotes. Running a ruler along the graph (from left to right) may help them to spot that the x axis is ***not*** time!

Q.5 This threw up some frightening gaps in knowledge and understanding about DNA, but it also allowed many candidates to demonstrate a very good understanding of eutrophication in a slightly different context from that of nitrate ions.

(a) Most candidates scored this mark. A few repeated TTAGGG and some substituted U for T so that their sequence read AAUCCC.

(b) This section was very poorly answered. Many candidates equated non-coding DNA with stop sequences or 'genetic full stops'. A very common mistake is to state that a DNA sequence codes for an amino acid or, worse, for amino acid synthesis. Many candidates ignored the mark allocation for this part, so automatically losing a mark. An answer like '*non-coding sequences are not transcribed, so no mRNA is made and no protein is synthesised*' is not difficult to give and would have scored maximum marks.

(c) Most candidates used the information intelligently to get the correct answer.

(d) This was very poorly answered. The required response was that bacterial DNA is circular or is not in the form of a chromosome. Most candidates described the lack of a nucleus, naked DNA or the lack of mitosis or meiosis in bacteria. More seriously, many thought that bacteria have single stranded DNA or that it is not a double helix.

(e) This was also badly answered and again candidates ignored the mark allocation. Most were able to explain the misleading implications of the word 'junk', but they were unable or unwilling to go on to make some alternative suggestions. It is clear that time spent revising biochemistry, especially DNA-related topics would be time well spent in preparation for this paper.

(f) About half the candidates drew a negative correlation line. A few drew a curve in spite of the instruction.

(g) Most gave a correct chemical. A few gave 'cell membrane'. Some gave 'glucose' or 'lipid'.

(h) There were some excellent, detailed and extended accounts of eutrophication. Candidates understood the principles and could apply them to phosphate instead of nitrate. The alternative answer dealing with the effects on plant growth and its consequences for the rest of the river food chain was seldom if ever given. A worrying number of candidates thought that plants use up the oxygen, or that anaerobic bacteria do so. Some candidates were side-tracked into describing the well-known effect of phosphates on nettle growth, ignoring the instruction '*on a river community*'. Some could not believe a simple response was required and tried to describe the effects in terms of natural selection and evolution, completely ignoring the time-scale implications.

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

General comments

Script Annotations
The standard of mark sheets and tick sheets provided by centres and the annotations on the scripts continues to improve; a considerable number of centres communicate with their Moderators very effectively by providing clear annotations that cross refer to mark sheets. This is very gratifying and contributes significantly towards successful moderation. Centres with inexperienced staff are encouraged to attend INSET training if at all possible to discover how to set and mark appropriately.

Internal Moderation
We would encourage centres to provide a brief outline of the internal moderation process that was carried out within the centre.

Good investigations
The most popular areas include osmosis and enzymes for AS whilst respiration is the leader for A2, though there are large numbers of original alternatives. Great care should be taken to ensure that the synoptic descriptors can be matched when choosing an A2 investigation. An example would be with photosynthesis where the effect of temperature works well, but the effect of different light intensities or wavelengths often fails to meet the level 7 synoptic criteria. The reader should refer to the *Report for the Units* for June 2004 for a review of ecology investigations. Some excellent microbiology work has been seen again this year; centres are reminded that module specific techniques, such as serial dilutions and aseptic technique, are valid aspects of scientific knowledge and understanding (SKU) for skill P, but not for skill A.

Poor investigations
There are still some centres setting invertebrate physiology investigations to represent human heart function or the effects of exercise or drugs. It is difficult to understand why more clear-cut osmosis or enzyme investigations are rejected in favour of these. At A2, the task must be taken from the appropriate module specification or it will not match the synoptic descriptors and so will not be eligible for high marks in skills P and A.

Descriptors that can cause difficulty
Listed below are a number of descriptors that continue to present some centres with difficulty in interpretation. The inclusion of the column headed ‘Additional Clarification’ does not represent a change to the descriptors, merely a different wording to improve clarity or give examples. When marking work, centres should always use the generic descriptors as published in the specification. Centres may find that their Moderators’ reports contain some of this additional clarification.

	Generic Descriptor	Additional Clarification
3.b	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 3 replicates should be **planned for**. A **range** of 5 in the independent variable is expected, but the exact number depends on the context of the investigation and the independent variable studied. Centres will remember that at GCSE it is usual to adopt the 5x3 pattern when marking coursework; why would it be less in a higher demand specification?
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 method, including reference to apparatus and variables, which allow it to be repeated (and data to be collected with the same degree of precision and accuracy) by another student.
P.5bii	Produces a clear account and uses specialist vocabulary appropriately.	Terminology used by candidates with respect to water potential should be **as stated in the specification** i.e. water potential, solute potential, pressure potential, water potential gradient.
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 of the apparatus and in the method **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. Discussion of how the key variable(s) will be controlled is also important here. Where a candidate planned to make dilutions/concentrations of particular solutions, details of how this would be achieved should be included.
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 with SI units for both the dependent and independent variable in the appropriate row/column heading(s).
A.3a	Processes and presents evidence gathered from experimental work including, where appropriate, the use of	A3a is for the presentation of **processed** data, e.g. percentages, in a suitable and correct graphical format **that allows further data to be extracted**.

	appropriate graphical and/or numerical techniques.	Most candidates match this descriptor using a hand drawn graph. Care must be taken to make sure that computer generated graphs can be **used** rather than being merely a 'picture' of the data. More details can be found in the *Report for the Units* from June 2004. In some cases the presentation of the details of calculations in processing may be used to match this descriptor. At A2, details of the stages in the calculation of χ^2 or other statistical processes might meet this descriptor if a suitable graph cannot be drawn. Centres should take care not to permit summary layouts of simplistic calculations.
A.5bii	Produces a clear account and uses specialist vocabulary appropriately.	Terminology used by candidates with respect to water potential should be **as stated in the specification** i.e. water potential, solute potential, water potential gradient.
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. This can be achieved by the calculation of percentage error, commenting on the stated accuracy of pieces of apparatus, or commenting on how a plotted trend line compares to a theoretical trend line.
E.5ai	Indicates the significant limitations of the experimental procedures and/or strategy.	Whilst level 3 requires identification of all the limitations (problems in the method) in the procedure, level 5 is a clear **indication** which limitation(s) cause the **greatest** impact on the data collected. Simply ranking the limitations can achieve this descriptor, but other techniques may be used. Centres should note that it is not acceptable for the teacher's annotations to highlight this; candidates must **clearly** demonstrate this skill for themselves; ephemeral evidence is not acceptable.
E.5bi	Comments on the reliability of the evidence.	Considering the closeness to the mean, variance, size of range bars, percentage error, standard deviation or standard error are all ways in which candidates may assess reliability.
E.5bii	Evaluates the main sources of error.	Candidates must explain what impact the main error(s) (inaccuracy in the numbers), has on the data and how it is affected, e.g. if measurements (raw or processed) are over or

		underestimates of the 'true' values. As with E5ai, centres should note that it is **not** acceptable for the teacher's annotations to highlight this; candidates must **clearly** demonstrate this skill for themselves; ephemeral evidence is not acceptable.
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 the data collected stating if it is accurate, precise and reliable enough to allow them to be confident in their conclusion, with reference to their prediction/expected results.

Much has been said in favour of the use of writing frames in past reports and examples of tables for Skills P and E have been included. The b strand of Skill E continues to present difficulty to many candidates, particularly the weaker ones. It is suggested that specific headings be provided, though care should be taken to avoid unfair leading. Some suggestions are: -
"*Anomalous results and their causes*"
"*Are my data readings accurate?*"
"*How reliable is the evidence that supports my conclusions?*"

Intermediate marks

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 level 1 and 3 plus either all of the sub-descriptors for P.5a, **or**, all of the sub descriptors for P.5b, **or** 50% of the sub-descriptors from P.5a or P.5b (e.g. P.5ai, P.5aiii, P.5bii).

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 students calculate standard deviation, 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.

Centres wanting further help with coursework should contact the Subject Officer at OCR and make use of the Coursework Consultancy Service. Moderators often suggest this as a way of receiving detailed feedback on work submitted for moderation. This service is free.

2806/03: Experimental Skills (A2 Practical Examination)

General Comments

There was an oversight in the instructions accompanying this summer's practical for which OCR expresses regret and apologises to centres and to candidates for the distress it caused. The potato extract for *Q.1* needed to be freshly prepared and yet in large centres in particular this was not often possible. It was also clear that extracts prepared from certain types of potato were better than others. Up to a quarter of centres were affected. However, adjustments to the mark scheme were made allowing all candidates to score highly. Paradoxically, *Q.1* appears to have worked well more because candidates seemed unfamiliar with the idea that an enzyme could catalyse a reversible reaction. Very many candidates wrote that the enzyme *broke down* glucose phosphate to starch and phosphate suggesting that these candidates thought only in terms of enzymes catalysing catabolic reactions and did not appreciate the difference between anabolic and catabolic reactions. This in spite of the information provided at the beginning of the question.

The theme for this paper was adaptation allied to perennation and storage. The Planning Exercise and *Q.2* did not generate problems and candidates generally did very well in these tasks.

The need for discretion prior to the practical test is pressing. A number of entries posted in internet chat-rooms suggested that this discretion may not always be exercised and a few centres commented on how this undermined their own efforts to maintain security.

Centres have reported problems receiving the Planning Exercises in time for candidates to make a prompt start on this activity. As from the next session, OCR will post the Planning Exercises on its web site. For the January session this will be done in November, for the May session in March.

Comments on Individual Questions

Planning Exercise

This was a straightforward piece of fieldwork, which it was felt was long overdue on the practical examination. Some candidates referred to previous practical work that they had carried out earlier in their course. This was most encouraging. Candidates need to be reminded that previous practical work may be quoted (if relevant) and *used* to inform the planning. This exercise also gave centres the opportunity for their candidates to do some field work: something which they might not otherwise have much time to do. Most candidates chose to plan how to investigate the distribution and abundance of two of the buttercup species suggested by using an interrupted belt transect placed perpendicular to a water course. Some candidates presented their quadrat size as 0.5 m^2 instead of 0.5 x 0.5 m = 0.25 m^2. Though species density could have been determined, most candidates chose to estimate the percentage cover of the two species in each quadrat. Most then suggested removing a sample of soil (often more than one) from each quadrat. In determining the water content of soil many neglected to describe the need at some point to find the mass of the container. Most candidates then demonstrated succinctly how they would tabulate their results, but a few candidates included several pages of blank tables. There were a number of good graphs and/or kite diagrams to demonstrate both how the results would be illustrated and how the distribution and abundance would be expected to vary with the water content of the soil.

Good candidates identified strategies to ensure reliability (repeatability) in a number of ways, such as:

- being consistent about counting plants that overlapped the edges of the quadrat;
- ensuring that soil samples did not dry out while being transferred from field to laboratory;
- removing soil samples at a fixed depth beneath the surface which was less liable to be influenced by prevailing weather.

The best candidates commented that any number of abiotic and biotic factors in addition to water content would affect the distribution and abundance of the two chosen species and that unless these are monitored also, the validity of the conclusion that might be drawn from carrying out the submitted plan would be undermined by these other variables.

It was pleasing that most plans were much more concise than has been the case in the past with candidates not describing preliminary work at length but simply referring to it and how it influenced the proposed plan in the same way that they might refer to any other secondary source. However, references to secondary sources should be cited in the text and ideally page numbers should be given in a full reference.

Candidates who failed to present species names in the correct way (e.g. *ranunculus bulbosus* instead of *Ranunculus bulbosus*) were not awarded the first quality of written communication mark. A few who wrote rambling accounts that did not follow a logical pattern also lost this mark. Many are not alert to the difference between an adjective and a noun so that usually soil was '*dryer'* and variables were '*dependant'*, but amongst the many quadrants that escaped the spell checker was the candidate who wanted to use a '*tarred balance*' and the candidate who wisely took precautions to avoid catching Vile disease.

Practical Test

Q.1 Initially, the candidates had to identify that the iodine solution retained it colour when added to the potato extract and that the pH of solutions **A** and **B** were acidic and basic respectively.

(a) Candidates recorded their results in a table in which it was anticipated that starch would become apparent in tube **C** before tubes **A** and **B** and that no starch would be visible in tube **D**. Assuming the format of the table of results was acceptable, the most that any candidate could lose as a result of a faulty extract was one mark.

(b) Most candidates commented on the absence of starch from the plant extract. referring back to the initial test with iodine solution and the failure to produce a blue-black colour. Despite being cued (twice) that the extract had been filtered, few thought that this might be because starch grains are too large to be collected in the filtrate.

(c) By adding marks for an explanation of what did (or did not) happen in *any* tube, virtually all of the marks for this question were accessible to all candidates. However, explanations were often simple with little attention to what should be routine descriptions of the effects of pH and boiling on enzymes. The Examiners applied the *error carried forward* rule and in centres where there had been problems with this practical a team of Senior Examiners scrutinised the marked scripts to make sure that candidates had not been disadvantaged.

(d) Most candidates answered this question correctly, appreciating that any ATP in the extract would soon be exhausted and that it was the nature of the glucose-phosphate bond that was providing the energy for starch synthesis *in vitro* whereas ATP would do so *in vivo.*

(e) Many candidates did not appreciate the crucial point of the reaction being reversed. Good candidates who read the preface to the question carefully had little difficulty in spotting why starch was synthesised.

(f) This question proved taxing to all but the best candidates who commented that glucose phosphate is not a protein or an enzyme liable to be denatured, that it was present in all tubes including **D** and yet this tube did not produce starch.

(g) In past sessions candidates have found evaluation exercises challenging, but most did well identifying the difficulty in interpreting colour changes and the lack of repetition as major limitations. Consequently, the use of a colorimeter and the opportunity to calculate mean times and identify anomalies were often suggested as improvements. Indeed many of the limitations and improvements on the mark scheme were identified by many of the candidates and the impression was that centres had trained their candidates well to be critical of procedures and constructive in suggesting improvements.

Practical tip

Centres that use this practical in preparing their candidates or as a class exercise may like to take note of the following points and add them to the Instructions.

- Use Desiree potatoes if possible (do not use new potatoes).
- Use medium-sized potatoes, not small and certainly not large potatoes.
- Do not over-filter the extract.
- Allow students to make their own extract if this is possible. The extract should be as fresh as possible.
- Trial the procedure first.

The method can also be modified to investigate the effect of adding phosphate to the reaction mixture to find the effect on the synthesis of starch. It is also possible to add starch to the reaction mixture and see that it is broken down if sufficient phosphate is present. *In vivo*, starch phosphorylase catalyses the breakdown of starch. *In vitro*, it will catalyse the synthesis of starch as well – as this practical exercise set out to demonstrate.

Q.2 *(a)* Though a significant number of candidates included cells in their drawings, most candidates appreciated that a low power plan excludes individual cells and identifies different tissues. Paying attention to the proportion of those tissues is a skill many had not mastered as they drew vascular bundles from memory. Most candidates identified most tissues correctly though a surprising number identified upper epidermis, palisade mesophyll and spongy mesophyll.

(b) Despite poor presentation, this task was often accomplished quite impressively with a careful and methodical approach. The vascular tissue takes up about 10% of the stem but a generous margin either side was allowed depending on whether the hollow centre of the stem had been included. The percentage would be higher if the space was not included.

Good candidates drew three sieve tubes and three companion cells, noticed that the walls of sieve tubes are angular, that companion cells have visible contents and are smaller and that there are no spaces between cells. A handful of candidates proffered textbook drawings of phloem in L.S.

Teaching tips

Teaching microscope skills can be a problem. Especially at AS when there is so much to do. A substitute may be recommended:

Source materials are easily downloaded from web sites. There are many web sites that have histological images – both plant and animal.

A graphic can be copied from a web site and inserted into a Word document as a .jpeg image. This is then printed on acetate as an overhead projector transparency.

A very feint copy of the graphic can be printed to give the candidates. This is done as follows:

- open a new Word document
- go to View,
- go to Header and Footer
- click on Show/Hide Document Text
- add the graphic
- open the format picture dialog box and click on Color and scroll down to Watermark, click OK
- organise the position of the image and its size on the page
- print the document.

You should then have two matching documents. The OHT is a clear image that can be projected onto a white board; alternatively, the image can be projected with a data projector. Candidates can be given the printed version and can use this to trace a plan drawing of the tissues.

This is an easy way to show how a low power tissue map relates to the cell detail that can be seen through the microscope.

Candidates could be given several copies of the feint version to use for annotating and revision.

BioScope

Another aid to microscopy is *BioScope*. There is a demonstration of this at

www.cambridge-hitachi.com/products/secondary/bioscope/demo.htm

Advanced Subsidiary GCE Biology (3881)
Advanced GCE Biology (7881)
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	Total Number of Candidates
2801	Raw	60	47	42	37	32	27	0	18365
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	46	41	37	33	29	0	25788
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	95	84	73	62	51	0	13741
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	95	84	73	62	51	0	895
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	94	83	73	63	53	0	10805
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	68	59	51	43	35	0	10501
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	58	51	44	37	31	0	2241
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	67	60	53	46	39	0	1378
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	59	53	47	41	35	0	1014
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	62	54	46	39	32	0	1156
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	65	58	51	44	38	0	9024
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	90	81	72	63	55	0	8445
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	92	82	73	64	55	0	297
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	87	79	71	63	55	0	5789
	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	15.9	33.9	53.6	71.3	85.7	100.0	18847
7881	24.6	46.8	67.8	84.8	95.7	100.0	15133

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Information Bureau

(General Qualifications)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: helpdesk@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance
programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

INVESTOR IN PEOPLE