RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Combined Mark Schemes And Report on the Units

January 2006

3881/7881/MS/R/06J

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REPORTS ON THE UNITS

Mark Scheme 2801
January 2006

Abbreviations, annotations and conventions used in the Mark Scheme	/	=	alternative and acceptable answers for the same marking point
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	AW	=	alternative wording
	A	=	accept
	ora	=	or reverse argument

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

1 (a) (i) mitochondrion **;** **A** mitochondria **1**

(ii) aerobic respiration **;**
ATP production **;** **A** provides ATP
energy release **;** **A** provides energy **R** produce / create / make / etc
AVP **;** e.g. Krebs cycle / regenerate NAD
oxidative phosphorylation
protein synthesis
lipid synthesis
oxidation of fats
ornithine / urea **,** cycle **2 max**

(iii) (energy / ATP needed) for **,** movement / wafting (of cilia) **;**
R flagellum / molecules **1**

(iv) *award two marks if correct answer (5) is given*
award one mark for calculation

5 **; ;**
if answer incorrect, allow 1 mark for
100 +/- 2 (mm) *or* 10 +/- 0.2 (cm) ÷ 20000 **2**

(b) low resolution **;** *ora*
(close) points not easily distinguished **;**
wavelength (of visible light) is too long **;**
max resolution of light microscope = **,** 200 nm / 0.2 μm **; A** anything close
no more detail visible than seen at **,** x1500 / x1000 **;**

A comparative statements
R reverse arguments for points 2 - 5 **2 max**

[Total : 8]

Question			Expected Answers	Marks
2	(a)		*do not credit if any incorrect answer included*	
		(i)	fox **;**	**1**
		(ii)	grass / clover / legume **;**	**1**
	(b)	(i)	nitrogen fixation / Haber (process) **;** **A** reduction	**1**
		(ii)	lightning **;** **A** oxidation / combines with oxygen **A** 'lightening' **R** thunderstorm / lighting	**1**
		(iii)	denitrifying **;** **A** correct e.g. (*Pseudomonas*) **R** *Nitrobacter / Nitrosomonas / Rhizobium*	**1**
		(iv)	fixes nitrogen / provides fixed nitrogen *or* $NH_4^{(+)}$ **;** **R** ammonia ref to**,** clover / legume / named legume **,** making **,** amino acids / polypeptides / protein **;** (plant has) no need to rely on (fixed) nitrogen compounds in soil **;** **R** *ref to fertilisers* free-living species provide **,** ammonium (ions) / fixed nitrogen **,** for nitrifying bacteria / nitrification **;**	**2 max**

[Total : 7]

Question			Expected Answers	Marks
3	**(a)**	**(i)**	endocytosis / phagocytosis **;** **A** bulk (transport) **R** pinocytosis / exocytosis	**1**
		(ii)	enzymes / named enzymes / lysins **;** acid / low pH **;** digestion **;** **A** breaking down breaking **,** peptide / glycosidic / ester **,** bond **;** **R** if in wrong context hydrolysis **;** soluble / named **,** products **;**	**3 max**
	(b)	**(i)**	not enough points plotted / experiment not carried out at enough (different) pH values **;** only 1 point between 3 + 4.3 / no points between 3.25 + 4.3 **;** don't know / uncertainty of **,** rate between those points / where peak should be / where optimum is **;** 3.25 reading might be anomalous **;** cannot draw **,** curve / line of best fit **;** rises to **,** 3 / 3.25 **,** and falls after 4.3 **;**	**2 max**
		(ii)	*note ~ enzyme is completely inactive at pH 7* loss of tertiary structure / loss of 3D structure / (enzyme) denatured **;** (change in pH/[H^+]) alters charge distribution on (enzyme) molecule **;** hydrogen / ionic **,** bonds affected **;** changes (shape of) active site **;** enzyme substrate complex cannot be formed / substrate not attracted to active site / substrate cannot bind to active site / AW **;**	**2 max**

Question		Expected Answers	Marks
3 (c)		*mark each section (E, S and C) to max shown*	
	<u>**E**</u>	***enzyme concentration ~***	
	1	reaction (rate) increases with increased enzyme **;** **A** high / low	
	2	more active sites available **;**	
	3	in excess substrate / as long as enough substrate (molecules available to occupy active site) **;**	
	4	(as reaction progresses) the rate will decrease as substrate **,** used up / becomes limiting **;** **R** plateau	**E (3 max)**
	<u>**S**</u>	***substrate concentration ~***	
	1	reaction (rate) increases with increased substrate **;** **A** high / low	
	2	more **,** molecules available to enter active site / ESC formed **;** **A** more successful collisions	
	3	reaches point where all active sites occupied **;**	
	4	no further increase in rate / reaches V_{max} **;** **A** plateau / levels off	
	5	enzyme conc. becomes limiting / unless add more enzyme **;**	**S (3 max)**
	<u>**C**</u>	***competitive inhibitor ~***	
	1	inhibitor has similar shape to substrate **;**	
	2	can **,** fit / occupy **,** active site **;**	
	3	for short time / temporary / reversible **;**	
	4	prevents / blocks **,** substrate from entering active site **;**	
	5	rate determined by relative concentrations **;**	
	6	little inhibition / rate little reduced **,** if substrate conc. > inhibitor conc. **;** *ora*	
	7	ref to chance of **,** substrate / inhibitor **,** entering active site **;**	
	8	effects can be reversed by increasing substrate conc. **;**	**C (5 max)**
		general points ~	
	10	drawing a suitable graph to illustrate point made with labelled axes **;**	
	11	ref to <u>optimum</u> (rate) **;**	**9 max**
		QWC ~ legible text with accurate punctuation, spelling and grammar	**1**

[Total : 18]

Question			Expected Answers	Marks
4	(a)		protein / polypeptide **,** with **,** carbohydrate (chain) / polysaccharide / sugar / glucose **;** (***R***) ***glycogen***	**1**
	(b)	(i)	(α) helix **;** **R** double helix	**1**
		(ii)	(β) pleat(ed) (sheet) **;**	**1**
	(c)		tertiary / 3^o **;**	**1**
	(d)	(i)	restriction (enzyme) / endonuclease **;** **A** named e.g.	**1**
		(ii)	(DNA) ligase **;**	**1**
	(e)		(rough) ER has ribosomes **;** **R** produces for **,** protein synthesis / translation **;** ER transports protein through cell **;** forms vesicles **;** for transport to / forming **,** Golgi **;** (in Golgi) modification of protein / glycosylation **;**	**2 max**

[Total : 8]

Question			Expected Answers	Marks
5	(a)		*look for shading in **A** on page 12* *do not credit if more than 1 chromosome shaded*	
			corresponding homologous chromosome correctly shaded on **A ;** *i.e. bottom one*	**1**
	(b)	*mark (i) and (ii) independently*		
		(i)	metaphase **;** **R** ref to metaphase I or II	**1**
		(ii)	(individual) chromosomes align at **,** metaphase plate / equator / centre (of cell) **;** join to **,** spindle / microtubules **;** by centromeres **;**	
			ref to bivalents / homologous pairs = max 1	**2 max**
	(c)		**C ;** **A ;**	**2**

[Total : 6]

Question			Expected Answers	Marks
6	(a)		solvent **;** liquid **;** **A** same dense **;** insulates **;** **A** keeps warm **R** protects / warms hydrogen **;** **A** H / weak **R** H^+ / H_2 surface tension / cohesion **;**	**6**
	(b)	(i)	**K ;**	**1**
		(ii)	(vacuole in cell **K**) has less water in it (than cell **L**) **;** *ora* (vacuole / cell **K**) has lost more water (than cell **L**) **;** *ora* lower, water potential / Ψ, outside cell **K ;** *ora*	**1**
		(iii)	(cell wall is) freely permeable / permeable to salt (solution) **;** **R** partially permeable	**1**
	(c)	(i)	- 1300 kPa **;** *credit if clearly indicated as candidate's choice*	**1**
		(ii)	arrow drawn from -800 to -950 **;** arrow drawn from -800 to -1000 **;** arrow drawn from -1000 to -1250 **;** *a continuous arrow from -800 to -1000 to -1250 = 2* *additional arrow(s) = -1 for <u>each</u> arrow that goes from low Ψ to high Ψ but do not award less than 0 for (c)(ii)*	**3**

[Total : 13]

Mark Scheme 2802
January 2006

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

1 (a)

		energy source / energy storage / component of, glycoprotein *or* glycolipid *or* DNA *or* RNA *or* ATP / AVP **;** e.g. function of glycoprotein such as cell membrane receptor *or* in vitreous humour / in synovial fluid **R** converted into energy **R** respiration on its own **R** energy on its own	
fat / fatty acid / lipid / triglyceride / oil / AW **;** **A** phospholipid			
		growth *or* repair *or* replacement / supply *or* source of *or* produce, amino acids / formation of, named protein *or* protein-containing tissue / AVP **;** **A** energy source **R** protein synthesis	
		(good) night vision / allows rods to function / prevents night blindness *or* xerophthalmia / make, rhodopsin *or* retinal *or* retinene / AVP **;** e.g. maintain epithelial cells / reduce risk of infection **R** helps vision, retinal pigments, retinol	
		absorption of calcium *or* phosphorus / use *or* deposition of, Ca *or* P, in bones *or* teeth / hardens bone *or* teeth / prevents, rickets *or* osteomalacia *or* osteoporosis / AVP **;** **A** reduce risk of, heart disease / cancer **R** strengthen / healthy, bone	**5**

(b) bar for pregnancy higher than normal **;**
bar for breast feeding higher than pregnancy (and normal) **;** **2**

(c) protein needed to allow fetus to, grow / develop **;** **A** baby
growth of mother's, cells / tissues **;**
used for growth of named tissue (maternal or fetal) **;**
e.g. placenta, umbilical cord, bone, muscle
for production of, milk / colostrum **; A** milk contains protein
after birth baby growing more quickly **;**
repair mother's tissues damaged during birth **;**
AVP **;** e.g. making antibodies for baby

A *ecf from answer to (b)* e.g. baby gets milk from other source, weaning (if breast feeding lower than pregnancy) **2 max**

[Total: 9]

2 **(a)** *mental*
Alzheimer's / schizophrenia / phobia / anorexia / depression / Parkinson's / Huntington's / CJD / AVP **;**

self-inflicted
alcoholism / cirrhosis / smoking addiction / drug addiction / lung cancer / obesity / CHD / anorexia / AVP **;** **R** unnamed cancer

inherited
sickle cell / haemophilia / cystic fibrosis **A** CF / diabetes / Huntington's / Down's syndrome / AVP **;** **3**

(b) **(i)** to find out where, rates are highest / people are most at risk **;**
to keep track of infection rates over time **;**
to see where, disease is likely to spread / epidemic most likely **;**
to help research (into how it is spread / into effectiveness of drugs) **;**
to allow organisations to provide aid where it is needed most **;**
to allow organisations to provide education (about disease) where it is needed most **;**

AVP **;** e.g. tourist industry **3 max**
e.g. limit potential spread by migration or imports

(ii) education on HIV/AIDS less effective in Africa **;**
sexual attitudes / number of partners **;**
availability of condoms **;** **R** general reference to contraceptives, not used / refused
poverty / poorer / less money **;**
sex industry **;**
less primary health care / less likely to be diagnosed **;**
AVP **;** e.g. ref. to unscreened or untreated blood
unsterilised needles or surgical apparatus
civil war / rape
no alternative to breast feeding
R access to drugs for treatment
R no vaccine
R ref to intravenous drug addiction **2 max**

(c) find person who is immune **;**
isolate gene that provides immunity **;**
identify protein (receptor) that provides immunity **;**
develop drug (to fit normal receptor) that provides immunity **;**

(gene used to) manufacture, drug, protein / antibody / immunoglobulin, giving immunity **;**
protein used as, vaccination / cure / AW **;**

gene therapy used in at risk groups / AW **;**

AVP **;**
AVP **;** **2 max**

[Total: 10]

Question			Expected Answers	Marks
3	(a)	(i)	phagocyte / macrophage / dendritic cell **;** **A** antigen presenting cell / APC **R** white blood cell / lymphocyte / neutrophil	**1**
		(ii)	bacteria in vacuole / phagosome **;** **A** lysosome bacterium, cut up / partly, digested / partly broken down / AW (so antigens still whole) **;** enzymes / lysins / lysozyme **;** AVP **;** e.g. hydrolysis / hydrolases	**2 max**
		(iii)	receptors / binding sites **;** on cell surface membrane (of T helper cell) **;** <u>complementary</u> to antigen **;** **R** matching **A** analogy to lock and key	**2 max**
		(iv)	<u>mitosis</u> **;** **R** cloning	**1**
		(v)	produced during, primary / first, immune response / exposure to antigen **;** remain in body **;** **A** blood / tissue fluid etc (memory cell or antibody) specific to antigen **;** produce secondary response **;** more quickly / no symptoms **;** divide / clone, to make plasma cells **;** (plasma cells) manufacture antibodies **;** more antibodies made / antibodies accumulate faster **;** gives long term immunity / immunological memory / AW **;**	**4 max**
	(b)		variable region binds to, antigen / pathogen **;** **A** antigen-binding site variable region specific to, antigen / pathogen **;** **A** antigen-binding site agglutinate pathogens / stick pathogens together **;** immobilise pathogens / attach to flagellum (of pathogen) **;** combine with pathogen to stop entry to cell **;** break wall of bacterium open / lysis **;** constant region, attracts phagocytes / makes it easier to engulf bacterium **;** AVP **;** e.g. ref to hinge region in context	**2 max**

[Total: 12]

Question		Expected Answers	Marks
4	(a)	*Mycobacterium tuberculosis / Mycobacterium bovis* **;** **A** *M. tuberculosis / M. bovis / Mycobacterium* **R** *Microbacterium / Myobacterium*	1
	(b)	many, air spaces / alveoli **;** large surface area **;** **R** ref to surface area to volume ratio thin wall of, alveolus / capillary **; A** one cell thick **R '**thin wall' on its own good blood supply / large capillary network **;** air passage / bronchiole **;** capillary close proximity to alveolus **;** **R** refs. to cilia, mucus, elasticity	**3 max**
	(c)	short of breath / breathless / less easy to inflate lungs *or* breathe **;** due to less surface area for gaseous exchange **;** less oxygenation of, blood / haemoglobin **; R** oxidation coughing due to irritation in lungs (alveoli filled with some substance) **;** coughing up blood **;** longer diffusion pathway **;** as alveoli walls thicker **;** AVP **;** e.g. destruction / loss of, alveoli and blood vessels AVP **;** weight loss chest pain when coughing	**2 max**
	(d)	opportunistic disease / immune system already weakened **;** long course of treatment not always completed **;** drug / antibiotic, resistance **; R** strand **R** mutation alone vaccine is less than 100% effective / no vaccine for mutated strains / more effective in some parts of world **;** symptomless carriers / dormant in body **;** lack of education about TB **;** overcrowding (in poorly ventilated accommodation) **;** Less Economically Developed Countries cannot afford, treatment / drugs / vaccines **;** **A** lack of access malnutrition **;** untreated milk / uncooked meat **;** breakdown of treatment programmes due to, war / civil unrest **;** migration of carriers / refugees / tourists / AW **;** AVP **;** e.g. link to HIV/AIDS AVP **;** ref badgers as carriers spitting / in sputum poverty, increased homelessness vaccine, refused / not wanted	**5 max**
			Total: 11]

Question		Expected Answers	Marks
5	**(a)**	(chronic) bronchitis **;** emphysema **;** COPD **;** heart disease **;** stroke **;** *two marks available for the following* lung / mouth / throat / breast / bladder / oesophagus / prostate other named cancer **;;** AVP **;** e.g. gangrene, erectile dysfunction AVP **;**	**2 max**

(b) *max 3 for each named component*

carbon monoxide (no mark)

c1 binds to haemoglobin / forms carboxyhaemoglobin **;**
c2 irreversibly / permanently **;** **A** greater affinity than for oxygen
c3 less effective oxygenation of haemoglobin **;** **R** oxidation
c4 shortage of breath **;**
c5 damages lining of arteries **;**
c6 AVP **;** max 3

nicotine (no mark)

n1 addictive **;**
n2 adrenaline released **;**
n3 increases heart rate **;**
n4 reduced circulation to extremities / vasoconstriction **; R** contract **A** narrow lumen
n5 sticky platelets **;**
n6 cause blood clotting / thrombosis **;**
n7 AVP **;** e.g. ref to effect on synapse / brain function max 3

tar (no mark)

t1 coats the (internal) surfaces of breathing system **;** **A** lungs
t2 reducing efficiency of exchange **;**
t3 irritation of mucous membranes **;**
t4 goblet cells stimulated / over secretion of mucus **;**
t5 inactivation of, cilia / ciliated epithelium **;** **A** destroys / damages **R** kills
t6 mucus not moved **;**
t7 coughing **;**
t8 carcinogenic / cancer-causing / causes mutations **;**
t9 causes emphysema / described **;** **R** ref to elastin damage alone
t10 AVP **;** e.g. ref to more infections / increased risk of chronic bronchitis max 3

may be awarded anywhere

AVP **;** strain on heart / heart disease
AVP **;** raised blood pressure / hypertension **8 max**

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

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

haemoglobin	carboxyhaemoglobin	affinity
oxygenation	addictive	adrenaline
vasoconstriction	lumen	platelets
thrombosis	mucous membranes	goblet cell
cilia	epithelium	carcinogenic
emphysema	bronchitis	hypertension

[Total: 11]

Question			Expected Answers	Marks
6	**(a)**	**(i)**	*award two marks if correct answer (0.55 – 0.65) is given* *incorrect answer (or no answer) but correct working = 1 mark* *ecf rules apply for 1 mark max* working **;** (marks on graph or calculation) 0.55 – 0.65 **;**	**2**
		(ii)	vital capacity **;**	**1**
	(b)	**(i)**	tidal volume increases / AW **;** **A** amplitude (of trace) increases rate of breathing increases / AW **;** **A** frequency (of trace) increases / wavelength gets shorter trace will fall more steeply / AW **;**	**2 max**
		(ii)	increased, heart / pulse rate **; R** blood pumped faster increased stroke volume **;** increased cardiac output **;** blood pressure rises **;** blood diverted to muscles / vasodilation in muscle **;** blood diverted away from digestive system / vasoconstriction in, digestive system / kidney **;** less (at first) / more (later on), blood to skin **;**	**2 max**

[Total: 7]

Mark Scheme 2803/01
January 2006

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Question			Expected Answers	Marks
1	**(a)**	**(i)**	6:1 **; ;** *working. 3.14 divided by 0.52*	**2**
		(ii)	ratio for B is smaller / decreased / AW **;** *ora* by two thirds / AW **;** volume increases more rapidly than area / AW **;** *ora* *ecf if wrong calculation in (a) (i)*	**2 max**
	(b)		*answers must relate to developing a transport system* diffusion not adequate / AW / *ora* **;** as not enough area (relative to volume) **;** *ora* distance too great / cells deep in body / AW **;** *ora* , **R** large unqualified mass flow system needed **;** transport / blood (vascular), systems, link, the parts of the body / named parts **;** e.g. of substance needing to be transported **; R** 'gases' / 'waste' / 'food' ref to activity / high metabolic rate, of mammals **;**	**3 max**
	(c)		alveoli lung villi gut small intestine **A** intestine capillary bed / capillaries / AW skin qualified e.g. elephant's ears cerebral cortex / brain kidney (tubule) liver AVP **;**	**1**

[Total: 8]

Question		Expected Answers	Marks
2	**(a)**	**C ;** **B ;** **G ;** **G ;** **C** / **D ;** **A** *if both put down* **B** / **C ;** **A** *if both put down*	**6**
	(b)	<u>cardiac</u> **;** <u>myogenic</u> **;** sinoatrial node / SAN **;** **A** pacemaker stop / prevent / AW **; R** delay atrio-ventricular node / AVN **;** bundle of His / Purkyne fibres *or* tissue **;**	**6**
	(c)	contractions / heart, not coordinated / irregular / AW **;** less / no blood, leaves heart / goes to lungs / goes to body **;** cells / (named) tissue(s) / (named) organ(s) / heart muscle, deprived of oxygen **;** ref to pressure **;** AVP **;** e.g. ref to lack of P/R/T on ECG	**2 max**

[Total: 14]

Question			Expected Answers	Marks
3	**(a)**		**G ;** **I ;**	**2**
	(b)	**(i)**	evap*ora*tion of water / water vapour lost (from plants) **;** <u>diffusion</u>, into atmosphere / out of leaf / down a water potential gradient / via stomata **;** **A** high to low water potential references *stop if / when candidate says transpiration is 'upward movement of water in plant'*	**2 max**
		(ii)	linked to gas exchange / AW **;** **A** refs to **both** oxygen and carbon dioxide unqualified carbon dioxide for photosynthesis **;** open stomata **;** large area **;** *can apply to leaf area or pore area* moist mesophyll to (relatively) dry air / water potential gradient / AW **;** AVP **;** e.g. ref to some cuticular transpiration inevitable / AW link open stomata to daytime when it is hottest / AW	**3 max**
		(iii)	hairs trap water vapour **; R** water unqualified / water particles **A** molecules reduces water potential gradient / stops wind removing vapour / more humid air around leaf **;** *ecf* for water so less transpiration / AW **;** AVP **;** e.g. ref reflective nature of hairs in context ref to need of xerophytes to conserve water in dry habitat	**2 max**
	(c)	**1**	in the xylem <u>vessels</u> **; A** tracheids	
		2	down a, water potential / Ψ, gradient **;** **R** *'*along*'* **A** refs to high to low water potential	
		3	most negative, at the leaf / in the atmosphere **;** *ora must refer to water potential*	
		4	transpiration sets up a gradient / AW **;** *any valid gradient*	
		5	(places) water (in xylem) under, tension / suction / negative pressure / pull / hydrostatic pressure gradient / AW **;**	
		6	cohesion **;**	
		7	description of cohesion **;**	
		8	ref to hydrogen bonding **;**	
		9	(continuous) water columns / AW **;**	
		10	<u>mass flow</u> **;**	
		11	root pressure, in context / described **;**	
		12	adhesion described / capillarity **;**	
			treat refs to osmosis and descriptions of passage through root as neutral	**6 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**
			[Total:	**16]**

Question			Expected Answers	Marks
4	(a)	(i)	Bohr **;**	**1**
		(ii)	(steep part) corresponds to pO_2 in, tissues / cells / organs **;** cells / tissues / organs, need (much) oxygen **;** change / drop, in pO_2 gives, large change / drop in saturation (of haemoglobin) / much release of oxygen / AW **;** **R** refs to increase in pO_2 data from Fig. 4.1 to support **;**	**2 max**
		(iii)	ref to (more), H ions / carbonic acid **;** **A** formula (forms) haemoglobinic acid **;** **A** HHb (haemoglobin), releases more <u>oxygen</u> / has lower affinity for <u>oxygen</u> / has lower saturation of <u>oxygen</u> **;** at a certain partial pressure of oxygen **;** data from Fig. 4.1 to support **;** *must be comparative* AVP **;** e.g. ref to effect of CO_2 on, brain / heart, related to oxygen delivery	**2 max**
	(b)		more heat (in exercising muscle) / increase in body temperature / AW **;** (as) respiration releases some energy as heat / AW **;** ATP to ADP releases some energy as heat / AW **;** (muscle) temperature rises, above normal body temperature / to 45 ^{o}C **;** (so) more oxygen release (from haemoglobin / RBCs) / AW **;**	**2 max**

[Total: 7]

Mark Scheme 2803/03
January 2006

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Planning Exercise

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

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

Practical Test

Pages 5 to 8 have the mark scheme for Questions 1 and 2 for the Practical Test.

AS Biology. Planning exercise

Checking Point	Descriptor	The candidate
A	P.1a	Plans a suitable procedure that involves 2 regimes and monitoring **one** physiological parameter**;** e.g. **resting** heart rate, **resting** blood pressure, recovery time over a period of time, vital capacity, VO_2 max
B	P.1a	Gives a prediction about the effect of the types of exercise regime chosen during training **;**
C	P.1b	Selects a suitable key piece of equipment **;** e.g. pulse meter / blood pressure monitor / spirometer / stop watch / peak flow meter
D	P.3a	Defines aerobic fitness **;** e.g. ref to oxygen supply / cardiovascular system
E	P.3a	Identifies at least 2 key factors to control or take account of, **one** to do with people, **one** to do with an aspect of training **;** e.g. age, gender, body mass, height, previous training, frequency of exercise, time of day for exercising / recording, training time
F	P.3b	Decides on appropriate number of measurements to take: minimum of **five** readings taken during the training period **;**
G	P.3b	Describes two appropriate training regimes to be carried out over a minimum of 4 weeks **;** e.g. cycling / rowing / swimming / muscle building exercises
H	P.5a	Uses appropriate scientific knowledge and understanding in developing a plan **;** e.g. explains nature of aerobic fitness / describes changes in muscle
I	P.5a	Uses results from preliminary work or previous practical work **;**
J	P.5a	Refers to a safety precaution **;** e.g. checking health status of subjects, supervision of training
*K**	*P.5b*	*Gives a clear account, logically presented with accurate use of scientific vocabulary (QWC)* ***;***
L	P.5b	Describes ways of obtaining reliable results by including replicates **;** e.g. uses ten or more people in the whole experiment
M	P.5b	Describes way(s) of testing aerobic fitness at intervals **;** e.g. testing resting heart rate / recovery time / lactate test / VO_2 max
N	P.5b	Explains how precise results could / would be obtained **;**
O	P.7a	Uses information from one **identified source ;** e.g. text book / web site / poster
P	P.7a	Shows how results are to be presented in the form of a table including units **for all relevant headings ;** *table must show results over time of the experiment or at beginning and end*
*Q**	*P.7a*	*Uses spelling, punctuation and grammar accurately (QWC)* ***;***
R	P.7b	Explains how data would be interpreted to find answer to the investigation **;** e.g. results plotted on a graph to compare improvement in chosen parameter, such as recovery time, over duration of investigation / stats test to test for significance / % change
S	P.7b	Comments on precision and/or reliability **;** e.g. use of matched pairs / measure more than one parameter
T	P.7b	Comments on problems in controlling variables / validity of investigation, e.g. using people with same initial level of fitness **;** **A** randomised

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

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

Question		Expected Answers	Marks
1	(a)	correct outline **;** (U or V shape overall) labelled circles to indicate regions of, blue / stain **; A** xylem / vascular bundle **R** if only called phloem circles in ridges **;**	**3**
	(b)	(dye in) water passes through **;** xylem / vascular bundle **;** ref to transpiration stream **;** AVP **;**	**2 max**
	(c)	two strips for each concentration **;** epidermis, identified / indicated, in each **;** curved with epidermis on inside in A and B **;** straighter in D than B **;** curved with epidermis on outside in E and F **/** straighter in F than in D **;**	**5**
	(d)	*mark (i) and (ii) together to max 6 – explanations must fit results in A and F* *distilled water* <u>cells</u>, have absorbed water / increased in volume **; A** movement of water into <u>cells</u> become (more) turgid **;** less / no, water absorbed by epidermal cells **;** **A** more water absorbed by, inner / parenchyma, cells ref to wax / cuticle / impermeable layer **; A** ref to other cells having thin walls epidermal cells cannot expand (as much) / create tension to produce curve / AW **;** *sucrose solution* <u>cells</u>, have lost water / decreased in volume / shrunk **;** **A** movement of water out of <u>cells</u> / <u>cells</u> absorb less water / no net movement in or out of <u>cells</u> less turgid / flaccid **; A** cells are plasmolysed / description therefore less pressure on the epidermis / AW **;** *explanation using water potential* water moves <u>down</u> water potential gradient **; A** descriptions 'from high Ψ to low Ψ' by osmosis **;** through, selectively / differentially / partially, permeable membrane **; R** semi *accept suitable explanation in terms of water potential if strips in F have not curved*	**6 max**

(e) petiole strips not left long enough / ora **;**
left for different lengths of time / cannot time each for exactly ten minutes **;**
water still moving, in / out, of cells **;**
petiole strips of different thickness **;**
tissues not fully immersed **;**
strips not cut to the same, length / width / surface area **; R** size
strips curved to different extents at the beginning **;**
some water evaporated before immersion **;**
this lowers water potential **;**
not all from the same (part of the) petiole **;**
difficult to draw exactly **;**

with respect to results

difficult to measure anything **; A** 'no numerical values taken'
possibly angle of curvature / AW **;**

carry out more, repeats / replicates **; A** suitable alternatives so long as 'more' or 3
calculate, average / mean **; A** ref to anomalous results
use intermediate solution(s) **;**
use a wider range of solutions **;**
continue to make drawings until there is no further change **;**
find solution at which no change = water potential of tissue **;**
observe cells under microscope for evidence of plasmolysis **;**
count plasmolysed cells to find solute potential **;**
use larger volumes of liquids to achieve total immersion / AW **;**
A ref to strips sticking together
weigh / change in mass **;**

AVP **;** e.g. use photographs **11 max**

(f) (i) axes correct with % change on vertical axis **;**
axes scaled appropriately **;**
axes titles and units **; A** % change
points plotted accurately **; R** if no negative % change shown on axis
joined by an appropriate line of best fit **;** **5**

(ii) intercept shown at 0% with appropriate annotation **;**
check for any comments on page 8 of scripts **1**

[Total: max 30]

Question			Expected Answers	Marks
2	(a)	(i)	cartilage **;**	**1**
		(ii)	*drawing*	
			5 to 7 lines **;** **R** if cells drawn inner / bottom, layer is thinnest **;**	**2**
		(iii)	*labels to correct position*	
			pseudostratified **;** epithelium **;** ciliated / cilia **;** mucous gland(s) **;** duct(s) **;** blood vessel / venule / arteriole / capillary **;** cartilage **;** elastic tissue / connective tissue **;** *either side of cartilage* AVP **;** e.g. basement membrane	
			R (smooth) muscle	**4 max**
			annotations with correct structure, accept ecf if in wrong position	
			(goblet cells / mucous glands) secrete mucus **;** ref to trap, bacteria / dust / AW **;** cilia (re)move mucus **;** **A** waft towards throat / away from alveoli / upwards **;** protects against infection **;** (cartilage) keeps trachea open **;** **A** maintains shape **R** support unqualified ref to, low resistance to air flow / good flow to alveoli *or* bronchioles **;** (blood vessels) supply oxygen / remove carbon dioxide / supply nutrients / AW **;** (connective tissue) ref to elastic to stretch (and recoil) **;** ref to firm to maintain shape **;** AVP **;** e.g. ref to basement membrane supporting epithelium	
			R ref to (smooth) muscle	**5 max**

(b)

max one mark per feature

feature	*artery*
lining of the lumen	crinkly lining / AW **;** elastic lamina / described **;** *accept* endothelium / squamous epithelium / described **;** single layer **;**
distribution of smooth muscle	beneath endothelium / elastic lamina **;** all around / AW **;** relatively thick / AW **;** in tunica media / middle layer **;**
tissues that are present, ***other*** *than smooth muscle*	fibrous / elastic / connective **;** **A** elastin / collagen **A** epithelium / endothelium **R** blood / blood vessel(s)

3

(c) *trachea*

widens / expands **;**
(smooth) muscle relaxes **;**
cartilage, further apart / AW **;**
reduced resistance to <u>air</u> flow / more <u>air</u> flows / greater <u>air</u> flow **;** **A** maximum <u>air</u> flow

2 max

artery

blood pressure increases **;**
(lumen) widens **;**
elastic tissue stretched more **;**
(smooth) muscle relaxes **;**
increased blood flow / decreased resistance **;** **A** ref to volume / speed
R if answer suggests artery pumps blood **2 max**

[Total: max 14]

Mark Scheme 2804
January 2006

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)
A - stroma **;** **A** ribosome
B - (outer/ inner) membrane / (chloroplast) envelope **; R** cell membrane
C - thylakoid / lamella **; A** lamellae
D - granum / granal stack **; A** grana **A** thylakoid stack **4**

(b) granum / thylakoid / lamella **;** **A** lamellae **R** the letter C **1**

(c) ATP **;**
reduced NADP / red NADP / NADP red / $NADPH_2$ / NADPH + H^+ **;** **A** NADPH
oxygen **;** **A** O_2

if only written on first, mark all the answers. Otherwise mark first answer on each line
treat water as a neutral answer **3**

(d)
1 light absorbed by, pigment / bacteriorhodopsin / protein **;**
2 ref to electron carriers / change in shape of bacteriorhodopsin **;**
3 energy released from electrons **; R** produced / created / made
4 protons into cell wall **;**
5 create, proton gradient / electrochemical gradient / pH gradient / proton motive force **;**
6 protons, diffuse / move down gradient **;**
7 through, ATP synth(et)ase complex / stalked particles **; A** ATPase
8 (ATP formed from) ADP + P(i) **;**
9 AVP **;** e.g. ref to chemiosmosis,
ref to energy transducing membrane,
ref to redox reactions. **4 max**

[Total: 12]

Question			Expected Answers	Marks
2	**(a)**		Animalia / animal **;** phylum **;** class **;** Panthera **;** species **;** **A** binomial name	**5**
	(b)	**(i)**	*apply ecf if candidate uses species rather than sub species* fewer <u>sub</u> species in 2004 / *ora* **;** originally 8 <u>sub</u> species in, 2004 there are 5 <u>sub</u> species / *ora* **;** originally ranges covered much bigger area / *ora* **;** populations more fragmented in 2004 / *ora* **;** any one named sub species that has disappeared **;** AVP **;** e.g. ref to biggest reduction of South China sub species	**2 max**
		(ii)	1. populations geographically isolated **;** 2. mutations **;** 3. new alleles arise **;** 4. no mixing of populations / reproductively isolated **;** 5. different selection pressures in different geographical locations **;** 6. example of this **;** e.g. coat colour and camouflage 7. beneficial alleles increase in frequency / ref to natural selection **;** 8. AVP **;** e.g. founder effect, genetic drift	**4 max**
		(iii)	1. geographically / reproductively, isolated **;** 2. but could, interbreed / mate / reproduce **;** 3. to produce fertile offspring **;** 4. ref to morphological, physiological, behavioural and biochemical features **;** *(need to name three of the four features for mark)* 5. occupy same ecological niche **;**	**2 max**
	(c)		23 ; 6-7 **;**	**2**
	(d)		tiger larger than leopard / *ora* **;** tigers require larger prey biomass / *ora* ;	**1 max**
	(e)	**1** **2** **3** **4** **5** **6** **7** **8** **9**	disease / pathogen / parasite **;** **A** pests hunting / illegal trade **;** **A** predators habitat destruction **;** **R** space on own, must be biologically qualified tourist activity / disturbance **;** decreased number of breeding females **;** **A** lack of mates limited gene pool / increased chance of harmful mutations **;** ref to competition **;** ref to carrying capacity **;** ref to global warming **;** **A** human influence / activities for 1 mark if points 2, 3 or 4 not given **A** lack of availability of water / AW	**2 max**

[Total: 18]

Question			Expected Answers	Marks
3	(a)	(i)	**A**, **B** and **E** **;**	**1**
		(ii)	*apply ora throughout* produced by, sexual reproduction / fusion of gametes / fertilisation **;** ref to random mating ***;*** *random fertilisation = 2 marks* contain chromosomes from two individuals / diploid organisms **;** more <u>alleles</u> **;**	**2 max**
		(iii)	**C** and **D** are haploid organisms **;** haploid cells have, one set of chromosomes / half the number of chromosomes **;** meiosis requires pairing of homologous chromosomes **;** ref to maintaining chromosome number when gametes fuse / gametes must be haploid **;**	**2 max**
	(b)		*marking points 1,6 and 9 must be linked to correct statements as to what is taking place in these stages to gain the mark.* **1** prophase 1 **;** **2** synapsis / homologous chromosomes pair up / bivalents form **;** **3** <u>crossing over</u> **;** **4** chiasma(ta) occur **;** **5** DNA / alleles, exchanged **;** **A** linked genes separated **;** **6** metaphase 1 **;** **7** <u>independent / random, assortment</u> **;** **8** bivalents line up on equator, independent of each other / randomly **;** **9** metaphase 2 **;** **10** independent assortment of <u>chromatids</u> **;** **11** <u>chromosome</u> mutation **;** **12** named example **;** e.g. non-disjunction **13** AVP **;** e.g. ref to non-sister / non-identical, chromatids.	**7 max**
			QWC – clear well organised using specialist terms ; *award the QWC mark if four of the following are used in correct context* prophase, metaphase, homologous, bivalent, chiasma, crossing over, independent assortment	**1**
	(c)		see table below	**4**

parent genotypes	baby blood group	
I^OI^O X (I^OI^O)	<u>O</u> **;**	*mark across each line in table*
I^AI^B X I^OI^O	<u>B</u> **;**	*if no marks gained mark down columns*
I^AI^O / I^AI^A X I^OI^O	<u>A</u> **;**	*max 2 marks if baby blood groups correct*
I^AI^B X I^AI^O / I^AI^A	<u>AB</u> **;**	

[Total: 17]

Question			Expected Answers	Marks
4	**(a)**		removal of, unwanted / toxic / waste, products **;** of metabolism **;**	**2**
	(b)		proteins / polypeptides **;** **R** amino acids **A** enzymes nucleic acids / DNA / RNA / polynucleotides **;**	**2**
	(c)	**(i)**	*award two marks if correct answer (568.18 / 568.2 / 568 / 570) is given* *evidence of 14.7 – 2.2 = 12.5 or 14.7/2.2 gains one calculation mark* 12.5/2.2 x 100 = 568.18 / 568.2 / 568 / 570 **; ;**	**2**
		(ii)	(more) proteins to amino acids **;** ref to deamination / removal of amino group **;** (more) ammonia formed **;** ref to ornithine cycle **;** (more) ammonia converted to urea **;**	**2 max**
	(d)		ammonia is, alkaline / highly toxic / *ora* **;** ammonia is more soluble / *ora* **;** large volumes of water to excrete it **;** would cause dehydration **;**	**2 max**
	(e)	**1** **2** **3** **4** **5** **6** **7** **8**	both filtered / AW **;** both small molecules / AW **; A** RMM close to 69 000 (all filtered) glucose reabsorbed **;** active uptake, carrier / cotransporter, proteins **;** (some) glucose used in, respiration / active processes, in kidney **;** some urea reabsorbed **;** by diffusion **;** ref to reabsorption in PCT **;** *apply once to either glucose or urea*	**5 max**

[Total: 15]

Question		Expected Answers	Marks
5 (a)		ADH / anti diuretic hormone **;** reduces blood sugar levels / correct mechanism to achieve this **;** increases blood sugar levels / correct mechanism to achieve this **;** ABA / abscisic acid **;** auxin / IAA **;**	**5**
(b)	**1**	ref to change in receptor **;**	
	2	creates, receptor potential / generator potential **;**	
	3	if greater than threshold value **;**	
	4	depolarisation / AW, (of axon / sensory / afferent, neurone) **;**	
	5	ref to action potential (*anywhere in answer*) **;**	
	6	ref to, myelin sheath / myelinated neurones **;**	
	7	saltatory conduction / AW **;**	
	8	ref to nodes of Ranvier **;**	
	9	synapse with, motor / effector / efferent, neurone **;**	
	10	ref to, calcium ions / calcium channels **;**	
	11	vesicles of neurotransmitter fuse with presynaptic membrane **;**	
	12	named neurotransmitter **;**	
	13	secretion / exocytosis (from presynaptic membrane) **; R** release	
	14	diffusion across synaptic cleft **;**	
	15	receptors on postsynaptic membrane **;**	
	16	depolarisation / AW, (of postsynaptic membrane / motor neurone) **;**	
	17	ref to, neuromuscular junction / motor end plate **;**	
	18	AVP **;** e.g. ion movement, refractory period voltage-gated channels	**8 max**
		QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

[Total: 14]

Question		Expected Answers	Marks
6	(a)	**A** ; **C** ; **C** ; **B** ;	**4**
	(b)	cytoplasm / cytosol **;**	**1**
	(c)	2 **;**	**1**
	(d)	conversion to, lactate / lactic acid **;** by addition of hydrogen **; A** pyruvate acting as hydrogen acceptor from reduced NAD **;** ref to lactate dehydrogenase **;** recycle NAD for glycolysis **;**	**3 max**
	(e)	ref to oxidative phosphorylation and ATP production **;** needs supply of hydrogen **;** to form reduced, NAD / FAD **;** lipids have more, hydrogen / hydrogen – carbon bonds **;** more acetyl coenzyme A generated / more 'turns' of Krebs cycle **;**	**2 max**
	(f)	dinitrophenol in body **;** ETC still functioning **;** <u>less</u> ATP formed in respiration **;** food not enough to meet metabolic demands of body / AW **;** had to respire, body tissues / food stores **;** AVP **;** e.g. heat production increasing metabolic rate	**3 max**

[Total: 14]

Mark Scheme 2805/01
January 2006

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	( )	=	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)**	**B** = stigma **;** **C** = anther **; A** stamen **D** = ovule **;**	**3**
		(ii)	smaller **;** less conspicuous / less colourful / green / no markings / dull / less bright / AW **;** absent **;**	**1 max**
	(b)	**(i)**	pollen mother cell **;** diploid (no. of chromosomes) **;** divides by meiosis **;** forms a <u>tetrad</u> **;** detail of meiosis **;** (resulting cells) haploid **;** formation, of cell wall / plate, described **;**	**3 max**
		(ii)	ref to thickness **;** ref to, waterproof / sporopollenin / resistant chemical **;** exine **;** sculptured / pits / surface features described **;** AVP **;** e.g. structure specific to, *Lilium* / each species	**2 max**

[Total: 9]

Question			Expected Answers	Marks
2	(a)	(i)	*award two marks if correct answer (6.2) is given* *allow one mark for ecf* *correct maths wrong measurement 1 mark only* $\frac{133 - 102}{5}$ **;** 6.2 **;**	**2**
		(ii)	(maximum) height less **;** growth spurt at puberty earlier / AW **;** maximum height reached earlier **;**	**1 max**
	(b)	(i)	absolute growth rate (curve) **;**	**1**
		(ii)	*award two marks if correct answer (20) is given* $\frac{1}{5} \times 100$ **;** 20 **;**	**2**
		(iii)	easier to measure because, babies do not stand / legs difficult to straighten / AW **;** more accurate **;** **R** reliable small changes detected / mass may increase without increase in height / AW **;** AVP **;** e.g. loss of mass may indicate health problems	**2 max**

(c) *accept letter abbreviations throughout*
***R** 'controls' except for BMR, but ecf if missed more than once*
***R** refs to GnRH*

G1	<u>anterior</u> pituitary **;**		
G2	secretes, human growth hormone / GH **;**		
G3	stimulates protein synthesis **;**		
G4	affects / causes growth in, all parts of body **;**		
G5	ref to (limb) bones **;**		
G6	ref to skeletal muscles **;**		
G7	increased rate of cell division **;**		
G8	AVP **;** e.g. with GH more use of lipids	5 max	
T9	<u>anterior</u> pituitary secretes TSH		
T10	stimulates thyroxine secretion **;**		
T11	from thyroid gland **;**		
T12	controls, basal metabolic rate / BMR **;**		
T13	switches on transcription of mRNA **;**		
T14	increased protein synthesis **;**		
T15	stimulates growth of skeletal system **;**		
T16	stimulates brain development **;**		
T17	ref to negative feedback / example of **;**		
T18	AVP **;** e.g. involvement of hypothalamus	5 max	**7 max**

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

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

anterior pituitary	transcription
(human) growth hormone	protein synthesis
TSH	basal metabolic rate

[Total: 16]

Question	Expected Answers	Marks

3 (a)

stage of oogenesis	cells produced
growth	primary oocyte **;**
meiosis I	secondary oocyte, (first) polar body **;**
meiosis II	ovum, (second) polar body **;** **R** egg

allow one mark for 2^{o}oocyte and ovum if in correct places if polar bodies not given
no mark for polar body on its own in rows 2 and 3 **3**

(b) *mitosis*
replacement / continuous production, of cells **;**
ref to large numbers of sperm **;**
genetically identical **;** 2 max

meiosis
haploid number of chromosomes / halves number / 2n $\rightarrow$ n **;**
maintains chromosome no. (after fertilisation) / AW **;**
ref to, crossing over / independent assortment **;**
generates / increases, variation **;**
ref to gender determination by X and Y chromosomes **;** 3 max **4 max**

(c) (i) corpus luteum, produces / secretes, progesterone **;**
levels (of progesterone) rise as it develops **;**
needed for implantation of embryo **;**
progesterone, maintains, endometrium / lining of uterus **; A** prevents menstruation
relaxes uterine muscle / prevents miscarriage **;**
ref to, FSH / LH / GnRH / prolactin, inhibition **;** **3 max**

(ii) blocked fallopian tubes **;**
low sperm count / less motile sperm / infertility in male partner / AW **;**
cervical mucus hostile to sperm **;**
intercourse not occurring at fertile time **;**
AVP **;** **2 max**

(d)
1 hypothalamus stimulated **;**
2 GnRH secreted **;**
3 stimulates <u>anterior</u> pituitary **;**
4 to secrete FSH **;**
5 causes follicle to, develop / secrete hormones **;**
6 secretes oestrogen **;**
7 oestrogen inhibits, FSH / GnRH **;**
8 higher levels / rapid rise, of oestrogen cause, FSH / LH, surge **;**
9 AVP **;** e.g. oestrogen secreted by theca **5 max**

[Total: 17]

Question			Expected Answers	Marks
4	(a)	(i)	produced by asexual reproduction ; one parent / no gamete formation ; <u>genetically</u> identical (to parent) ; produced by mitosis ;	2 max
		(ii)	keeps, desirable characteristics / high productivity / AW ; quicker / no germination time ; stronger / more likely to survive ; mass production / more produced ; disease free ;	2 max
		(iii)	induce seedless fruit ; increase fruit size ; improve fruit set ; avoid need for pollination ; AVP ; e.g. weedkiller / inhibits sprouting in potatoes / prevents premature fruit drop	2 max
		(iv)	large surface area ; absorbs water ; by osmosis / down a water potential gradient ; ions / named ion(s) ; ions pass through cell surface membrane ; protein, channels / carriers ; active transport ; help to prepare cuttings for transplanting to soil / AW ; AVP ;	4 max
	(b)		sucrose ; amino acids ; vitamins ; ions / named ions ; auxins ; cytokinins ; water ; agar ;	3 max
	(c)		labour intensive ; sterile conditions ; special equipment ; trained staff ; electricity / power, costs ; quality control of process ; AVP ; e.g. set up costs	3 max
	(d)		grafting / budding / described ; layering / described ;	1 max

[Total: 17]

Question			Expected Answers	Marks
5	**(a)**	**(i)**	(germination rate) increases between 6 ^{o}C and 32 ^{o}C **;** **A** figures within range slower increase between 25 ^{o}C and 32 ^{o}C **;** maximum at 32 ^{o}C **;** rapid decrease (between 32 ^{o}C and 42 ^{o}C) **;** correct ref to figures from y axis **;**	**2 max**
		(ii)	enzymes **;** break down / hydrolyse, food stores / e.g. of chemical **;** increases kinetic energy / lowers activation energy **;** more likely to collide with substrate **;** substrate in active site / enzyme substrate complex **;** more reactions **;** ref to optimum temperature **;** denaturation occurs at higher temperatures **;** bonds in protein structure broken / active site changes shape **;** substrate does not fit (active site) **;**	**4 max**
	(b)		germinates only if covered by, soil / growth medium **;** needs shady conditions for growth **;** AVP **;**	**1 max**
	(c)		*some marking points may come from equation or flow chart*	
		1	long nights / short days, needed for flowering **;**	
		2	photoperiodism **;**	
		3	phytochromes **;**	
		4	P_{FR} / $P_{730,}$ converted to, P_R / P_{660} **;**	
		5	slowly in darkness / AW **;**	
		6	or in far red light **;**	
		7	red light converts, P_R / P_{660} , to, P_{FR} / P_{730} **;**	
		8	more red light in, sunlight / daytime / *ora* **;**	
		9	end of, night / dark period, only P_R remains **;**	
		10	P_{FR} inhibits flowering **;**	
		11	reversible reaction / appropriate arrows on diagram **;**	
		12	small period of light during darkness prevents flowering ;	
		13	AVP **;**	**6 max**
			QWC – legible text with accurate spelling, grammar and punctuation ;	**1**

[Total: 14]

Question			Expected Answers	Marks
6	**(a)**	**(i)**	at 17 – 18 bones still, growing / developing / *ora* **;** more calcium being deposited in bone at 17-18 / *ora* **;** AVP **;**	**2**
		(ii)	*reason must relate to valid advice* *advice* increase protein **;** *reason* growth of fetal tissue / muscle / specific e.g. **;** *advice* increase B vitamins **;** *reason* aid energy release **;** *advice* vitamin C **;** *reason* aids iron absorption from gut **;** AVP **;** other valid advice AVP **;** reason relevant to advice	**2 max**
	(b)		*max 3 for naming the mechanisms* diffusion **;** high to low concentration / down gradient **;** passive / external energy not required **;** facilitated diffusion **;** ref to, carrier / channel, proteins **;** active transport **;** low to high concentration / against gradient **;** ATP / energy, required **;** pinocytosis **;** AVP **;** e.g. ref to adaptation of placental structure	**5 max**
	(c)	**(i)**	no, menstruation / blood loss **;** iron used from stores **;** better absorption from gut **;** AVP **;** e.g. advised to take more vitamin C so better absorption	**2 max**
		(ii)	1 less oxygen, crosses placenta / (from mother) to fetus **;** 2 less than 300 mg iron obtained by fetus **;** 3 <u>fetus</u> anaemic **;** 4 too little <u>fetal</u> haemoglobin produced **;** 5 less oxygen transported in red blood cells **;** 6 ref to effect on, respiration / energy release **;** 7 ref to specific need for energy **;** 8 slower growth *or* poor development of named, tissue / organ **;** 9 ref to effect on brain development **;** 10 less carbon dioxide removed **;** 11 AVP **;** e.g. cytochromes in electron transport chain **;**	**4 max**

(d) specific (antibodies) **;**
variable regions **;**
complementary shape **;**
to antigens on red blood cells **;**
attach to red blood cells **;**
agglutination **;**
AVP **;** e.g. ref to rhesus factor **2 max**

[Total: 17]

Mark Scheme 2805/02
January 2006

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)**	epistasis **;** dominant **;** correct ref to epistatic and hypostatic gene **;** ref to protein / enzyme / inhibitor, product of allele A **;** prevents, transcription / translation **;** inhibits, expression / gene action **;** blocks enzyme activity **;**	**3 max**
		(ii)	small number of phenotypes **;** distinct (phenotypic) classes **;** qualitative **;** two genes / AW **;** large effect **;** different genes have different effects **;** not environmental **;** AVP **;**	**3 max**
	(b)	**(i)**	emasculate /remove stamens from / male sterility gene in, seed parent **;** bag flowers, before / after, pollination **;** grow in isolation **;** transfer pollen by hand **;**	**2 max**
		(ii)	increase genetic contribution of that species / *ora* **;** keep (alleles of) background genes of that species **;** so that only A/a exchanged / AW **;** to see effect of A/a in other species **;**	**2 max**
		(iii)	to produce, homozygous recessive / aa / AW **;** so that, wanted allele / desired trait, expressed **;**	**1 max**

(c) pollinators can distinguish colour **;**
bees attracted to pink **;** [A refs to 'blue' or UV re pink]
swapping alleles reduces visits by normal pollinator **;**
swapping alleles attracts wrong pollinator **;**
selectively bred / aa / red *M lewisii*, decreases bumblebee visits**;**
but does not attract many hummingbirds **;**
selectively bred / Aa / pink *M. cardinalis*, attracts bumblebees**;**
and decreases hummingbird visits only slightly **;**
ref comparative figures **;**
colour important to bees **;**
colour not important to humming birds / some other feature important to humming birds **;**
AVP **;** **4 max**

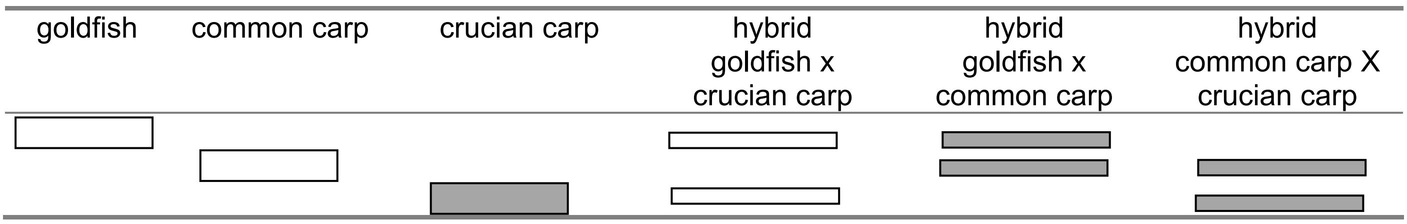
[Total: 15]

Question			Expected Answers	Marks
2	**(a)**		*max 5 for each section (1 to 10 and 11 to 18)*	
		1	need to choose parents whose desirable phenotype due to genotype **;**	
		2	rather than environment **;**	
		3	ref VP = VG + VE **;**	
		4	heritability is measure of proportion of phenotype due to genotype / AW **;**	
		5	1 all genetic - 0 all environmental **;**	
		6	higher heritability value can be selected for more successfully / *ora* **;**	
		7	values < 0.02 mean selective breeding will have little effect / *ora* **;**	
		8	pig e.g.s given can be selectively bred **;**	
		9	broad sense heritability = , proportion of total phenotypic variation due to genotype / V_G over V_P**;**	
		10	narrow sense heritability = variation due to additive effect of polygenes **;** *max 5*	
		11	progeny testing tests value of individual's genotype **;**	
		12	gives individual's value for selective breeding **;**	
		13	by looking at progeny from different matings **;**	
		14	mated with proven individuals **;**	
		15	average performance found **;**	
		16	important for sex-<u>limited</u> characters **;**	
		17	e.g. sex-limited character **;**	
		18	AVP **;** *max 5*	**8 max**
			QWC – clear, well-organised using specialist terms;	**1**
			award the QWC mark if four of the following are used in correct context *variation, variance, equations, broad sense, narrow sense, polygene, sex-limited*	
	(b)		more transcription by QQ genotype **;**	
			at both ages **;**	
			in both skeletal and cardiac muscle **;**	
			A *'throughout' / 'in all cases' for 1 mark of these 2*	
			much more in skeletal muscle / slightly more in cardiac muscle **;**	
			in QQ genotypes expression falls with age in both skeletal and cardiac muscle **;**	
			in qq genotypes expression rises with age in skeletal but falls in cardiac muscle **;**	
			use of comparative figures **;**	**4 max**
	(c)		changes shape of 'switch' **;**	
			alters binding of stimulating, hormone / chemical **;**	
			increased affinity for, RNA polymerase / enzyme **;**	
			prevents production of repressor **;**	
			allows RNA polymerase to bind **;**	
			comparison *lac* operon **;**	
			AVP **;**	**2 max**

[Total: 15]

Question			Expected Answers	Marks
3	(a)	1	gene bank **;**	
		2	ref to wild type **;**	
		3	maintain genetic diversity **;**	
		4	ref to, loss of alleles / genetic erosion **;**	
		5	may have appropriate trait for breeding **;**	
		6	for future use **;**	
		7	requirements of breeders change **;**	
		8	in case, climate change / different conditions **;**	
		9	ref to, temperature / global warming **;**	
		10	ref to, pH tolerance / acid rain **;**	
		11	as yet unknown traits may be useful **;**	
		12	in case other named change **;**	
		13	may lose trait if interbred **;**	
		14	may form part of, food web / community **;**	
		15	that cannot be replaced **;**	
		16	adapted for, habitat / niche **;**	
		17	hybrids less well adapted **;**	
		18	ref to extinction **;**	
		19	AVP **;** [*need to maintain population for leisure fishing*]	
		20	AVP **;**	**8 max**
			QWC – legible text with accurate spelling, punctuation and grammar;	**1**
	(b)	(i)	enzyme from bacterium **;** break down DNA of invading (bacterio)phages **;** ref to specific site of DNA **;** detail of site (4 - 6 bp / palindromic) **;** cut DNA **;** leaving blunt ends **;** or sticky ends **;**	**3 max**
		(ii)	*crucian carp* 1 (thick) band in correct position (*see diagram*) **;** *hybrid goldfish x common carp* 2 (thin) bands in correct position **;** *hybrid common carp x crucian carp* 2 (thin) bands in correct position **;**	**3**

[Total: 15]



Question			Expected Answers	Marks
4	(a)		mRNA and its complementary RNA bind together **;** hydrogen bonding **;** A to U and C to G **; R** 'T' double stranded RNA / duplex RNA **;** cannot bind to ribosome **;** tRNA cannot bind **;** cannot be translated / AW**;** ref to, RNA interference / RNAi **;**	**4 max**
	(b)	(i)	theobromine content, reduced / approximately halved **;** no significant difference between short and long lengths of RNA **;** caffeine content reduced **;** to half by short lengths of RNA **; A** figures to about a third by long lengths of RNA **; A** figures	**3 max**
		(ii)	(re caffeine) greater chance of pairing longer length with mRNA **;** AVP **;**	**1 max**
		(iii)	explant of meristematic / cambium / totipotent / pluripotent, cells / tissue **;** explant (surface) sterilised / sterile nutrient **;** appropriate hormone to stimulate, mitosis / division **;** <u>callus</u> formed **;** subdivided **;** appropriate hormone to stimulate differentiation **;** <u>plantlet</u> formed **;** hardening medium / sterile soil	**4 max**
		(iv)	<u>genetically</u> identical **;** genotype does not affect result **;** easily genetically engineered **;** plants derived from it identically genetically engineered / AW **;** large numbers easily obtained **;** early stages compact **;** so easily kept in identical conditions **;**	**3 max**

[Total: 15]

Question	Expected Answers	Marks
5 (a)	penetration of biofilm difficult **;** ref to diffusion of antibiotic **;** detail of diffusion **;** larger SA of separate bacteria / *ora* **;** does not reach all bacteria in film / *ora* **;** antibiotic trapped by film **;** detail of entrapment **;** dead bacteria in film form barrier **;** AVP **;** e.g. horizontal transmission / conjugation, easier in biofilm AVP **;**	**4 max**
(b)	both strains have identical sensitivity when in suspension **;** to all three antibiotics **;** both, less sensitive / more resistant, when in biofilms (*ora*) **;** strain 1 much, less sensitive / more resistant **;** comparative figures **;** C most effective / AW **;** B least effective / AW **;**	**4 max**
(c)	mutation **;** random / chance / pre-existing **;** detail of mutation **;** e.g. base substitution, addition, deletion ref to, selection / selective advantage **;** codes for different, glucan / biofilm **;** affects all three antibiotics **;** blocks antibiotic from reaching cells **;** binds antibiotics **;**	**4 max**
(d)	horizontal transmission **;** (copy of) plasmid **;** via conjugation **;** detail **;** conjugation tube / ‘R’ plasmid / single strand DNA transferred via transformation **;** transferred by (bacterio)phage **;**	**3 max**
		[Total: 15]

Question			Expected Answers	Marks
6	**(a)**	**(i)**	found, in / on, membrane **;** cell surface **;** antigen **;** recognition signal **;** self / not-self, marker **;** detail **;** (might act as) receptor **;**	**3 max**
		(ii)	glycoproteins = antigens **;** *do not give if awarded in (i)* not-self / foreign, tissue / cells **;** stimulate immune response **;** greater response with more, antigens / mismatches **;** ref comparative figures **;** <u>rejection</u> **;** ref to T cells **;** antibodies / receptors, bind with antigens **;** killer T / cytotoxic T, cells destroy transplant **;**	**4 max**
		(iii)	weakened due to, previous rejection / long term illness **;** so more likely to die **;** memory of any antigen in previous graft**;** memory cells become active quickly when antigen seen again **;** secondary response **;** quicker rejection **;** AVP **;**	**3 max**
	(b)	**(i)**	haplotype **;**	**1**
		(ii)	correct genotype **;**	**1**
		(iii)	0.25 / AW **;**	**1**
	(c)		HLA loci linked / on same chromosome / on chromosome 6 **;** tightly (linked) / close together / AW **;** rarely separated by crossing-over **;** inherited as, unit / haplotype **;** child receives one haplotype from each parent **;**	**2 max**
			[Total:	**15]**

Mark Scheme 2805/03
January 2006

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)	Winkler method / chemical method explained **;** further detail **;** e.g. chemicals used (Mn^{2+}), ref to titration repetitions / replicates / calculation of means **;** *or* use of probe **;** which has been calibrated repetitions / replicates / calculation of means **;**	**2 max**
(ii)	*award two marks if correct answer (95.45 / 95.5 / 96.0) is given* *award one mark for subtraction and/or calculation – if answer incorrect or not given* 5 – 110 = -105 $\frac{-105}{110}$ x 100 **;** *ecf for using incorrect figures* = 95.45 / 95.5 / 96.0 **;**	**2**
(b)	untreated sewage, provides / is a source of, <u>organic</u> , material / matter **;** results in a (large) increase in, decomposers / bacteria **;** which are <u>aerobic</u> **;** leads to a high BOD at B **;** and therefore a decrease in oxygen concentration between B and C **;** as organic matter is broken down / no input of sewage occurs, oxygen levels rise **;** data quote **;** e.g. B = 60% → C = 10% **R** if no units are given	**4 max**
(c)	a species whose, presence / absence **; A** ref to qualitative description or abundance **;** indicates a particular condition, e.g. BOD / oxygen saturation **;** such as, pollution / presence of pollutants **;** ref to correct use of data from Fig. 1.1 and/or Table 1.1 **;**	**3 max**
(d)	population has reached its <u>carrying capacity</u> **;** the maximum / total number, of organisms **;** which can be supported in that, environment / habitat **;** **A** number of new offspring produced / AW, is the same as number of deaths **;** AVP **;** e.g. competition, named resource AVP **;**	**3 max**

[Total: 14]

Question			Expected Answers	Marks
2	(a)		preservation of, organisms / environments **;** that are at risk from human activity **;** requires management **;** creation of new habitats **;** may need reclamation **;** conservation requires vigilance **;** resolving conflicts **; A** suitable alternatives	**2 max**
	(b)		use of pH, meter / probe **;** which has been calibrated **;** ref to data logging equipment **;** use of barium sulphate solution **;** use of Universal Indicator solution **;** compare with colour chart / AW **;** with repeats / averages **;**	**3 max**
	(c)	(i)	*assume answer is about intensive farming unless told otherwise* higher yields **;** higher costs involved **;** increased usage of pesticides **;** larger machinery used **;** less labour intensive **;** increased risk of disease from using larger number of cattle **;** (increased) use of antibiotics **;** AVP **;**	**2 max**
		(ii)	*accept answers that refer to N fixation in legumes* presence of, nitrogen-fixing bacteria / *Rhizobium* **;** which exist within root nodules **;** in a mutualistic relationship **;** presence of nitrogenase (enzyme) **;** converts nitrogen to, ammonium ions / amino acids **; R** ammonia (many) fertilisers provide N as, nitrate / ammonium **;** ref to nitrate required for plant growth **;**	**2 max**
	(d)	**1**	remove steep slopes / landscaping area / contouring **;**	
		2	addition of, lime / alkaline substance **;**	
		3	reason / neutralisation (of pyrite deposits) **;**	
		4	increased, soil quality / humus content **; A** add, topsoil / mulch	
		5	add grass mix **;**	
		6	ref to use of legumes **;**	
		7	planting (small), shrubs / trees **;**	
		8	ref to increased soil stability **;**	
		9	ref to secondary succession **;**	
		10	as a series of seres / seral stages **;**	
		11	ref to long length of time needed **;**	
		12	AVP **;** ref costs involved	**7max**
			QWC – clear, well organised using specialist terms *award the QWC mark if four of the following are used in correct context* *neutralisation, pyrites, humus, legumes, secondary succession, seres*	**1**

[Total: 17]

Question	Expected Answers	Marks
3 (a)	*any two of the following* refrigerators / fire extinguishers / aerosols sprays / solvents / cleaning agents / fast-food packaging **; ;**	**2 max**
(b)	loss increases / AW **; R** negative correlation 0% to -5.3% **; A** 5.5% **;** i.e. lost approx. 5.5% in 20 years **;** *accept two refs to the data to describe the pattern, e.g.* ref to % loss in early 1980s **;** *loss is approx. 0.5% a year* ref to % loss in 1990s **;** *loss is approx 0.2% a year*	**2 max**
(c)	intercepts UV, radiation / light **;** which damages <u>DNA</u> (in cells) / acts as a mutagen **; R** mutates cells increases mutation rates **;** increases occurrence of <u>skin</u> cancers **;** increases occurrence of cataracts **;** decreases metabolism of plants and animals **;** damages the immune system **;** leads to high mortality rates in, young fish / amphibians **;** photosynthetic rates decrease in phytoplankton **;**	**4 max**
(d)	*award marks for chemical equations* CFCs break down / ref to photochemical reaction **;** releases, free radicals / chlorine radicles / chlorine atoms / Cl· **;** reacts with ozone molecules **;** forms ClO· / chlorine monoxide **;** (ClO) reacts with an oxygen atom **;** releasing chlorine free radical **;** regeneration / reused idea **;** $CCl_3F \xrightarrow{uv} CCl_2F + Cl\cdot$ $Cl\cdot + O_3 \rightarrow ClO + O_2$ $ClO + O \rightarrow Cl\cdot + O_2$	**3 max**
(e)	protocols aim to lower CFC production **;** ref to data to support this statement **;** <u>combination</u> of protocols will work / one protocol not enough **;** ref to data to support this statement **;** ozone layer will repair itself over a period of time **;** ref to data to support this statement **;** AVP **;** e.g. CFCs persist in the atmosphere AVP **;**	**4 max**
	[Total:	**15]**

Question			Expected Answers		Marks
4	**(a)**		*features*		
		1	very large areas **;**		
		2	ref to data in table **;**		
		3	large number of, visitors / tourists **;**		
		4	ref to data in table **;**		
		5	hedgerows, provide large number of habitats **;**		
		6	and wildlife corridors **;**		
		7	and sources of food **;**		
		8	also provide nesting sites / migratory sites **;**		
		9	SSSIs / NNRs, provide protected areas for wildlife **;**		
		10	parks provide, education / amenities **;**		
		11	may have important geophysical features **;**		
		12	AVP **;** e.g. other use of data	*max 3*	
			management		
		13	restriction of access **;**		
		14	entrance fees charged **;**		
		15	park and ride schemes **;**		
		16	fencing off to protect areas of scientific interest **;**		
		17	adequate car parking facilities **;**		
		18	picnic sites **;**		
		19	litter bins **;**		
		20	maintenance of paths **;**		
		21	employment of, rangers / wardens **;**		
		22	AVP **;** e.g. visitor centres	*max 3*	**6 max**
	(b)		sites of, ecological / geological interest **;** local planning authorities / landowners must be informed of any activities **;** ref to protection from, English Nature / Countryside Council for Wales / Scottish National Heritage **;** government grants for management are available **;** AVP **;**		**2 max**
	(c)		difficulty in finding seeds initially **;** low numbers, therefore low genetic diversity **;** increased risk of disease / low resistance **;** difficult to replicate natural conditions in the lab **;** low germination rates / slow growth rates of young plants **;** difficulties in re-establishing the species **;** AVP **;** AVP **;**		**3 max**
	(d)		reduction in moisture content / dehydration **;** freezing (-20 ^{o}C) **;** **A** low temperatures growth of adult plants **;**		**2 max**

[Total: 13]

Question		Expected Answers	Marks
5	(a)	use of, identification key / chart **;** searched likely sites for lichens **;** e.g. walls, trees, roofs *idea of* standardisation of method at each sample site along transect **;** **A** use of quadrat **;** of suitable size **;** species recorded as, present / absent **;** ref to, repeats / repetitions (at each sample site) **;** AVP **;** e.g. timed search	**4 max**
	(b)	*description and explanation to be marked as a whole* qualitative description of change in number of species along transect **;** figures in support **;** few species nearest to city centre / ora **;** lichen species are indicator species of, sulphur dioxide levels / acid rain **;** use of data for SO_2 concentration **;** NE / 30-45 km along transect, lower number of lichen species **;** due to high [SO_2] compared to SW **;** data quote **;** ref to tolerant species **;** SW / 5-20 km along transect, higher number of lichen species **;** due to lower [SO_2] compare to NW **;** data quote **;** AVP **;** ref to zonation	**4 max**
	(c)	sulphur dioxide reacts with water to form sulphurous acid **;** sulphur dioxide (oxidised to form) sulphur trioxide **;** sulphur trioxide reacts with water **;** forms sulphuric acid **;** $SO_2 + H_2O \rightarrow H_2SO_3$ $H_2SO_3 \rightarrow H^+ + HSO_3^-$ $2\ SO_2 + O_2 \rightarrow 2SO_3$ / $SO_2 + O_3 \rightarrow SO_3 + O_2$ $SO_3 + H_2O \rightarrow H_2SO_4$ $H_2SO_4 \rightarrow H^+ + HSO_4^-$	**2 max**
	(d)	crown dieback **;** description **;** conifers / evergreens, particularly susceptible damage to stomatal mechanisms **;** decrease in photosynthetic rates **;** effect on transpiration rates **;** discolouration of leaves **;** root damage / effects on mineral uptake qualified **;** low pH leads to an increase in Al^{3+} ions in soil **;**	**3 max**

(e) *general*

1 use of capture-recapture technique / mark-release-recapture method **;**

2+3 description of method **; ;** e.g. catch initial sample, count sample / record number caught, marking, release, catch second sample

4 use of appropriate method / use of nets **;**
5 use of appropriate method for marking **;**
6 allow time for thorough mixing / 24 hours later **;**
7 record the number of <u>marked</u> individuals **;**
8 ref to Lincoln Index / correct equation **;**
9 AVP **;**
10 AVP **;** e.g. timed catches, ref to different species *max 5*

assumptions - minimum of 2

11 thorough mixing has taken place **;**
12 no, migration / emigration / immigration **;**
13 no, births / deaths **;**
14 marks have not rubbed off **;**
15 marks have not made fish more susceptible to predation / no change in behaviour **;** **7 max**

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

[Total: 21]

Question		Expected Answers	Marks
6	(a)	hunting / poaching / AW **;** habitat destruction **;** lack of food supply **;** ref to intraspecific competition / AW **;** ref to interspecific competition / AW **;** disease **;** predation (by other animals) **;**	**2 max**
	(b)	captive stress / atypical behaviour **;** altered breeding cycles **;** inability to mate due to foreign situation idea **;** compatibility of mate / AW **;** unknown habitat requirements / AW **;** dietary requirements **;** AVP **;**	**3 max**
	(c)	too tame **;** open to predation **;** unable to reintegrate back into population **;** difficulties in finding food **;** predators / poachers, still present in area **;** habitat, has changed / disappeared **;** AVP **;** e.g. behaviour has been altered AVP **;** resistance from local human population	**2 max**
	(d)	ref to, inbreeding / inbreeding depression **;** decrease in size of gene pool **;** inheritance of recessive, alleles / characteristics **; R** genes passed onto future generations **;** leads to a decrease in population numbers again **;** loss of certain alleles from the gene pool **; R** genes vulnerability to disease **;**	**3 max**
			[Total: 10]

Mark Scheme 2805/04
January 2006

Abbreviations, annotations and conventions used in the Mark Scheme			
	/	=	alternative and acceptable answers for the same marking point
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	R	=	reject
	( )	=	words which are not essential to gain credit
	____	=	(underlining) key words which **<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)**	*line is 3 cm / 30 mm* = x 30 000 **;** **A** x 29 300 – 30 700	**1**
		(ii)	*correct labels to each of the following structures* *ribosome* = **A ;** *cell wall* = **B ;** *plasmid* = **C ;** **A** *nuclear zone*	**3**
		(iii)	flagellum **;** **A** flagella *give label mark for any reasonably drawn exterior structure* drawn **through** wall into cell **;** **R** cilium	**2**
	(b)	**(i)**	*smear* to obtain thin / one cell thick, layer (for viewing) **;** to allow stain to permeate to (all) the cells **;** *heat fix* kill cells in life-like position **;** AW **R** kill cells unqualified cells / bacteria / sample, attached / stuck firmly / AW, to slide (for staining) **;**	**1 max**
		(ii)	*flooding with crystal violet* stains (all) cells, violet / purple **; R** ref to Gm+ only	**1**
		(iii)	*adding alcohol* decolourises Gram <u>negative</u> cells **;** AW e.g. washes out, Gram stain / crystal violet / crystal violet–iodine complex, from Gram –ve cells	**1**
		(iv)	*adding safranin* counterstain / stains Gram negative pink *or* red **;**	**1**
	(c)	**(i)**	(penicillin) secondary metabolite **;** produced at start of / during stationary phase / end of growth phase **; A** log phase ref to production (at maximum) when kept short of nutrients / nutrients depleting / factors limiting growth **;** continuous culture maintains in, log / rapid growth, phase **;**	**2 max**
		(ii)	to provide respiratory substrate / energy **;** **A** for respiration to maintain culture / keep culture alive / prevent (premature) death of culture **;** (limited) maintains in stationary phase / prevents rapid growth **;** AVP **;** **R** glucose as carbon source	**max 2**

[Total: 14]

Question			Expected Answers	Marks
2	(a)		*agar* to give more stability to the broth / prevent (mechanical) disturbance / AW **;** **A** thickens the broth **R** solidify *thioglycolate* to create, anoxic / anaerobic, conditions **; A** remove oxygen, qualified *resazurin* indicator of oxygen, presence / penetration (from broth surface) **;** **A** ref to indicating aerobic / anaerobic conditions	**3**
	(b)		ref to sterile / sterilising (equipment / broth) **;** disinfect surfaces **;** **A** alcohol if away from flame protective clothing / lab coat / goggles **;** spirit / Bunsen burner **;** flame neck of jar of broth culture / nutrient broth **;** lids, held / not placed on surfaces **;** *max 4 for aseptic techniques* idea of transfer, from broth culture to inoculate tube **;** use of named equipment e.g. pipette, inoculating / wire loop, stab wire **;** **A** syringe / mounted needle **R** needle unqualified *max 4 if inoculating agar plate*	**5 max**
	(c)	**1**	oxygen (only) present at surface **;**	
		2	(and) oxygen slightly below surface AW **;**	
		3	as shown by pink area **;** *ora*	
		4	different microorganisms display different oxygen requirements (for growth) **;**	
			organism D	
		5	grows only, at surface / slightly below surface **; A** grows only at top	
		6	<u>aerobic respiration</u> **;**	
		7	obligate / strict, aerobe **; A** strictly aerobic	
			organism E	
		8	growth, throughout the tube / with oxygen and without oxygen / in aerobic conditions and anaerobic conditions **;**	
		9	grows better, where oxygen available / in aerobic conditions **;** *idea of difference*	
		10	provides more energy for, growth / reproduction **;**	
		11	(capable of) aerobic and anaerobic respiration **; A** respire with and without oxygen	
		12	<u>facultative</u> (aerobe / anaerobe) **;**	
			organism F	
		13	growth only in anoxic / anaerobic conditions / no oxygen / sensitive to oxygen AW **;** **A** growth only at bottom *ora*	
		14	anaerobic respiration **;** **A** fermentation	
		15	strict / obligate, anaerobe **;**	
		16	AVP **;** e.g. entry of oxygen through cotton wool	
		17	AVP **;** diffusion of oxygen to just below the surface	**8 max**
			QWC – legible text with accurate spelling, punctuation and grammar ;	**1**

(d) *award 1 mark for each valid reason for the match of organism to location*

e.g. *vessel* **E** able to respire with and without oxygen / facultative anaerobe *or*
F anaerobic conditions (created in fermenter) **;**
skin surface **D** exposed to air therefore aerobic **;**
digester **F** anaerobic conditions in digester *or*
E initial aerobic, then anaerobic conditions **;** **3**

[Total: 20]

Question		Expected Answers	Marks
3	(a)	*benefits - any two valid* **; ;** *award 2 marks for first two acceptable (treat others as neutral)* e.g. improved, <u>alcohol / ethanol</u>, yield greater tolerance to alcohol faster fermentation rates / shorter fermentation time improved flavour ability to give same flavour with continuous fermentation ref to fermentation at lower temperatures **A** higher temperature only if qualified improved flocculation higher concentration of enzymes smaller cell size cheaper because enzymes don't need adding **R** ability to hydrolyse starch *hazards - any two valid* **; ;** *award 2 marks for first two acceptable (treat others as neutral)* mutation / increased mutation rates qualified e.g. spoilage ref to unknown transfer of other (dangerous), genetic material / genes ref to unforeseen effects if accidental transfer out of brewery **R** escape unqualified ref to possible effects on health / side effects ref to possible spread of antibiotic resistance (because of marker genes) flavour / taste, worse *accept ref to flavour once (a)* AVP **;** AVP **;**	**4**
	(b)	fewer gene copies per cell **;** more genes 'switched off' **;** lower levels of, transcription / translation **;** less enzyme, synthesised / produced **;** less enzyme secreted **;** less easily able to pass to outside (cell) **;** reduced catalytic powers / tertiary structure altered **;** AVP **;** e.g. ref to absence of, cofactor / coenzyme AVP **;**	**2 max**
	(c)	maltose / glucose **;**	**1**

(d) **(i)** type of starch **;**
<u>concentration</u> of, starch / suspension **;**
volume of, starch / suspension **;** **R** amount
ref to flow rate **;**
size of beads **;** **A** number / mass / volume, of beads in column **R** amount
temperature **;**
length / diameter, of column **;**
yeast concentration **;**
pH **;**
AVP **;** e.g. age of culture **3 max**

(ii) add Benedict's (reagent) and, boil / heat **;** **A** $CuSO_4$ in alkaline solution
different, densities / colours (of precipitates) formed **;** **A** turbidities
use of a colorimeter in correct context **;**
A filtering and weighing precipitate

OR
use of Clinistix / Diastix (strips) **;**
different colours obtained **;**
colour compared to chart **;**

accept other valid methods e.g. reference to use of biosensors **2 max**

(iii) *agree*
not all yeast cells successfully entrapped / AW **;**
(in product) yeast cells, respiring / metabolising / using sugar as an <u>energy</u> source **;**
(so) lower levels of sugar (in product) **;**

not agree
yeast cells, entrapped (in beads) / immobilised, so product not contaminated / yeast not present to affect product **;**
yeast cells unable to pass through, glass wool / filter **;**
only very low numbers of yeast cells (so unlikely to have great effect) **;** **2 max**

[Total: 14]

Question	**Expected Answers**	**Marks**
4	**G** = Protoctista **;**	
	H = Protoctista **;**	
	I = viruses **;**	
	J = fungi **;**	
	K = bacteria **;**	
	L = viruses **;**	6

[Total: 6]

Question			Expected Answers	Marks
5	**(a)**		antibody produced, by clone of / genetically identical, <u>hybridoma</u> cells **;** (antibody) all of same type / single type / same binding sites **;** ref to one ancestor / descendants of, B-lymphocyte / hybridoma cell **;** specific against one, antigen / receptor / epitope **;**	**2 max**
	(b)	**1**	inject mouse / immunise with, antigen / named antigen **; A** mammal **R** animal	
		2	(followed by) immune response / production of lymphocytes **;**	
		3	(kill mouse to) extract spleen and remove, splenocytes / lymphocytes **;**	
		4	one correct ref to <u>B-cells / B-lymphocytes</u> **;**	
		5	capable of producing antibody (against antigen) **;**	
		6	ref to specificity **;**	
		7	unable to grow indefinitely in tissue culture / AW **;**	
		8	one correct ref to require, myeloma / tumour, cell **; A** cancer cell	
		9	long-lived **; A** immortal / lives indefinitely	
		10	rapid growth / ability to replicate / carry out mitosis **;**	
		11	ref to fusion / hybridisation **;**	
		12	(to form) <u>hybridoma</u> cells **;**	
		13	obtain cell with genetic material of both **;**	
		14	capable of antibody secretion <u>and</u> survival in tissue culture / AW **;**	
		15	cells cloned in separate wells **;**	
		16	tested / screened, (at intervals) for antibody production **;**	
		17	AVP **;** e.g. leave mouse for 2-3 weeks **;** centrifugation of cells to obtain lymphocytes	
		18	AVP **;** e.g. fusogen / polyethylene glycol sub-culture desired cells	**8 max**
			QWC – clear well organised using specialist terms ; *award the QWC mark if four of the following are used in correct context* *lymphocyte / splenocyte, antigen, myeloma, hybridoma, hybridisation, fusogen / polyethylene glycol, clone / cloning, spleen, antibody*	**1**

(c) **(i)** *marking points may be taken from Fig. 5.1*
if Fig. 5.1 labelled incorrectly mark to max 3

constructed with, stainless steel / inert material AW **;**
inlet pipe for <u>sterile</u> air **;**
sparger / sparger described, provides (sterile) air for upward lift
(of culture and medium)
air / sparger provides oxygen for aerobic respiration **;**
exhaust / waste gases / CO_2, exit (at top) **;**
loss of gases makes culture heavier / more dense **;**
cells / culture, falls under gravity **;**
nutrients added (to falling cells) via inlet pipe **;**
heat exchanger, qualified **;**
outlet pipe to harvest products **;**
AVP **;** e.g. release of pressure **4 max**

(ii) absence of, paddles / stirrers **;**
creates, mechanical / shearing forces AW **;**
(hybridoma) cells delicate / easily damaged / no protective cell wall **;**
stop, producing / releasing, antibody **;**
AVP **;**
detail of AVP **;** e.g. accept reference to continuous versus batch fermenter, qualified **2 max**

(d) monoclonal antibody acts as (foreign) antigen **;**
(primary) immune response described **;**
e.g. B- / T-lymphocytes, sensitised / activated
clones of B- / T-cells produced AW
antibodies released / T-killer cells formed
takes time for response
R refs to immune response if not in context of treatment with monoclonal antibody
ref to specificity (B / T lymphocytes / antibodies) **;**

one-time treatment
no / few, antibodies / killer cells, present (therefore treatment effective) **;**
ora

prolonged treatment
ref to memory cells **;** **A** immunological memory
faster / rapid, (secondary) response **;**
A more antibodies produced in secondary response **3 max**

[Total: 20]

Question			Expected Answers	Marks
6	(a)	(i)	1. *raw milk* testing of milk at raw milk stage = **1 mark** 2. *heating* all main stages below in correct order = **3 marks** deduct 1 mark for each missing step 3. cooling 4. addition of starter culture 5. incubation sterilised fruit added = **1 mark** 6. cooling of product 7. storage any correct further detail = **1 mark**	**5 max**
		(ii)	**M** arrow to area of 6-7 above **;** **N** arrow to heating *(2)* above **;** **P** arrow to testing of milk **;**	**3**
	(b)		each creates conditions that, favour the other species / meet other's needs **;** both species benefit (from the association) AW **;** *Lactobacillus* / one (species), produces peptides (from proteins) **;** for growth of, *Streptococcus* / the other (species) **;** *Streptococcus* / the other (species), produces, methanoic acid / CO_2 **;** **A** formic acid for growth of, *Lactobacillus* / the first (species) **;** *allow growth once only* named bacteria e.g. *Lactobacillus (bulgaricus)* and *Streptococcus / Lactococcus (thermophilus)* **;**	**4 max**
	(c)		pH 4.4 – 4.6 **;** **A** pH 4.0 – 4.6 production of, lactic acid / methanoic acid **;**	**2**
	(d)		reduce time taken / less than 12 hours **;** *ora* (increased temperature) increases population growth rate **;** optimum temperature for population growth **;** ref to Q_{10} / doubling of reaction rate for each 10 °C rise in temperature **;** AVP **;** e.g. changed, flavour / taste AVP **;** **R** ref to enzymes / ES complexes	**2 max**
			[Total:	**16]**

Mark Scheme 2805/05
January 2006

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)**		**A** – sinusoid **;** **B** – (branch of) bile duct **;** **C** – (branch of hepatic) portal vein / HPV **;** **D** – (branch of) hepatic artery **;**	**4**
	(b)		emulsifies **;** breaks droplets into globules / AW **;** ref to increase in surface area **;** neutralises acid **;** AVP **;** e.g. globules 0.5 – 1.0 μm / ref to easier digestion by lipase	**3 max**
	(c)		bile pigments build up in blood **;** (pigments) do not enter gut / AW **;** AVP **;** e.g. bile, canaliculi / duct, blocked / gall stones	**2 max**
	(d)	**(i)**	reduction / oxidation / dehydrogenation / redox **;**	**1**
		(ii)	ethanal / acetaldehyde **;**	**1**
		(iii)	combines with CoA / forms acetyl CoA **;** combines with oxaloacetate / enters Krebs cycle **;** production of ATP **;** will be, dehydrogenated / decarboxylated **;** may be used to synthesise, fatty acids / ketones **;**	**3 max**
		(iv)	1. hepatocytes, die / destroyed / function inefficiently **;** 2. replaced by, fibrous tissue / fibres / collagen / connective tissue / scar tissue **;** 3. liver becomes, hard / nodular / shrunken **;** 4. named function not carried out efficiently e.g. gluconeogenesis **;** 5. named function not carried out efficiently e.g. deamination **;** 6. build up of ammonia **;** 7. blood bypasses sinusoids / AW **;** 8. irreversible / permanent **;** 9. AVP **;** e.g. correct ref to NAD	**5 max**

[Total: 19]

Question			Expected Answers	Marks
2	(a)	(i)	habituation / associative **;**	**1**
		(ii)	no threat **;** no waste of energy **;** less stress **;** AVP **;**	**2 max**
	(b)		1. hear sound of van / AW **;** 2. sound is stimulus **;** 3. ref to associate sound with food / AW **;** 4. conditioned response **;** 5. food acts as, reinforcer / reward **;** 6. ref to association centre (in brain) **;** 7. AVP **;**	**4 max**
	(c)		ref. faster / rapid / AW **;** AVP **;** e.g. survival	**1 max**
	(d)	(i)	relay / intermediate / internuncial / bipolar / connector **;**	**1**
		(ii)	**P** – receptor / named receptor **;** **R** – effector / named effector **;**	**2 max**

[Total: 11]

Question			Expected Answers	Marks
3	(a)	(i)	corpus callosum **;**	1
		(ii)	cerebellum **;** medulla (oblongata) **;** hypothalamus **;** cerebrum / cerebral cortex **;**	4
	(b)		acetylcholine – neurotransmitter / AW **;** acetylcholinesterase – breaks down ACh / enables repolarisation of post synaptic membrane **;**	2
	(c)	(i)	1. ACh at reduced level (in individuals with Alzheimer's) **;** *inhibitor* 2. binds to enzyme **;** 3. competitive / non-competitive (inhibition) **;** 4. ref. further detail **;** 5. ACh does not bind (to active site) **;** 6. ACh not broken down **;** 7. more ACh available (for receptor sites) / more action potentials generated **;**	4 max
		(ii)	keep brain active / AW **;** head protection / AW **;** ref to healthy lifestyle **;** AVP **;**	2 max

[Total: 13]

Question			Expected Answers		Marks
4	**(a)**	**(i)**	stimulus causes, increase in tension / twitch **;** fluctuation in tension / AW **;** overall increase in tension **;** AVP **;** e.g. ref to figs (must have time units)		**2 max**
		(ii)	state of constant, contraction / tension **;** **R** paralysed alone correct ref. to heart **;** difficulty in ingestion / jaw muscles fixed **;** rib / intercostal, muscles remain contracted **;** difficulty in, lung ventilation / breathing **;** AVP **;** e.g. fever / headache		**3 max**
	(b)	**1**	ATP produced **;**		
		2	Na^+ *or* K^+ pump / maintains concentration gradient / repolarisation **;**		
			transmission of impulses		
		3	acetylcholine / neurotransmitter formation **;**		
		4	vesicle formation **;**		
		5	movement of vesicles **;**		
		6	exocytosis / vesicles fuse with membrane **;**		
		7	ref. active transport (of ACh / Ca^{2+}) **;**		
		8	AVP **;** e.g. ref to microtubules / endocytosis	4 max	
			muscular contraction		
		9	ATP attaches to myosin head / ATPase **;**		
		10	hydrolysis of ATP / ATP $\rightarrow$ ADP + P **;**		
		11	myosin head tilts / shortening of sarcomere **;**		
		12	ATP / energy, required for detachment of myosin head **;**		
		13	from actin **;**		
		14	calcium pumps in <u>sarcoplasmic reticulum</u> **;**		
		15	synthesis of protein (for repair, growth) **;**		
		16	AVP **;**	5 max	**8 max**
			QWC – clear well organised using specialist terms ;		**1**
			award the QWC mark if four of the following are used in correct context acetylcholine, actin, myosin, sarcoplasmic reticulum, exocytosis, hydrolysis, repolarisation		
				[Total:	**14]**

Question			Expected Answers		Marks
5	(a)		*accept anywhere in mark scheme for part (a)*		
			1. low light intensity under water **;** 2. reason **;**		
		(i)	3. ref. good sensitivity **;** 4. rods respond (to low intensities) **;** 5. poor visual acuity **;** 6. cones less sensitive (in low intensities) **;** 7. no need for colour vision **;**	3 max	
		(ii)	8. improves efficiency of (rod) cells **;** 9. prevents absorption of light by choroid **;**		
		(iii)	10. more light enters eye **;**		
			11. ref. hunting / predation **;**	*accept anywhere for part (a)*	**6 max**
	(b)		1. ciliary muscles contract **;** 2. ref. circular **;** 3. release tension on suspensory ligaments **;** 4. lens, fatter / more convex / thicker **;** 5. ref. lens returns to original shape **;** 6. stronger lens / greater refraction **;**		**3 max**
	(c)	(i)	denaturing / denaturation **;**		**1**
		(ii)	plastic lens cannot change shape **;** fixed strength / AW **;** lens suitable for far vision **;** near vision needs strong converging lens (in spectacles) **;**		**3 max**
				[Total:	**13]**

Question		Expected Answers		Marks
6 (a)		***person A*** *description* 1. rises sharply (during meal) **;** 2. and up to 1 hour after / peaks at 1 hour after meal **;** 3. decreases steadily **;**		
		person B *description* 4. remains constant / AW **;**		
		5. comparative figs **;**	3 max	
		person A *explanation* 6. sight / smell / anticipation, of food **;** 7. impulses from brain **;** 8. ref to, parasympathetic nervous system / vagus nerve **;** 9. release / secretion, of gastrin **;** 10. by stomach mucosa **;** 11. also contact of food with, mucosa / stomach lining **;** 12. (local) reflex action (in stomach wall) **;**		
		13. AVP **;**	5 max	**6 max**
(b)	**1**	named e.g. **;** *accept 1,3 and 4 only if refer to carbohydrates*		
	2	anaerobic **;**		
	3	microbes **; A** e.g. of microbe		
	4	from, rumen / reticulum **;**		
	5	make amino acids **;**		
	6	from ruminant's food **;**		
	7	and from saliva **;**		
	8	(which contains) urea **;**		
	9	from deamination (of amino acids) **;**		
	10	in liver **;**		
	11	protein formed **;**		
	12	into omasum and abomasum **;**		
	13	proteases **;**		
	14	digest protein / microbes **;**		
	15	ref to protein from plant cells **;**		
	16	ref to internal nitrogen cycle **;**		
	17	AVP **;**		
	18	AVP **;**		**8 max**
		QWC – legible text with accurate spelling, punctuation and grammar ;		**1**

(c) (i) *award two marks if correct answer (49) is given*

$\frac{0.58 - 0.39}{0.39} \times 100$ **;**

49% **;** **2**

(ii) supplement / legume, had high nitrogen content **;**
wool fibres made of protein **;**
ref. nitrogen fixation / N2 → ammonium (ions / salts) **;**
further detail **;** e.g. ref. to amino acids
AVP **;** e.g. keratin **3 max**

[Total: 20]

Mark Scheme 2806/01
January 2006

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)
cholesterol not soluble (in water) **;**
lipids / cholesterol, hydrophobic / non-polar **;**
glucose is (very) soluble (in water) **;**
glucose is, hydrophilic / polar **;** **2 max**

(b)
low (TC:HDL) ratio = low risk **;** *ora*
low (resting systolic) blood pressure = low risk **;** *ora*
data quote **;**
AVP **;** e.g. if ratio is 3 high systolic pressure does not increase risk **3max**

(c)
***A** day 1 → 2 for rest → walk,* ***A** day 2 → 3 for walk → run*

pulse

1 rest to walk transition, has no (significant) effect / is anomaly **;**
2 rest / walk, to run transition increases pulse **;**
3 pulse data quote **;**
4 heart beats faster **;**
5 more O_2, supplied to / needed by, <u>muscles</u> **;**
6 for respiration **;**
7 to remove, more CO_2 / lactate / heat **;**

systolic pressure

8 rises as, exercise / level of activity, increases **; A** ref days
9 systolic pressure data quote **; R** if no units
10 heart beats more forcefully / greater stroke volume **;**

diastolic pressure

11 changes less than systolic **; A** relatively constant
12 because diastolic depends on elasticity of artery walls **;**

13 AVP **;** e.g. ref to aerobic (respiration), ref to cardiac output (qualified) **5 max**

[Total: 10]

Question			Expected Answers	Marks
2	**(a)**	**(i)**	higher, number / proportion / percentage / ratio / fraction, of mounds have thyme **;** (c.f. quadrats) *ora*	
			A figs, e.g. $^2/_3$ vs ½ , 2:1 vs 1:1, 36 vs. 24	**1**
		(ii)	*look for a statement and a reason*	
			use smaller quadrat **;** e.g. 50 cm x 50 cm for fair test **;** AW	
			use grid and random numbers **;** throwing keys biased **;** AW	
			estimate, percentage cover / abundance **; A** point (frame) quadrat may be single plants in some samples and many in others **;**	
			bigger study area / more data **;** (keep equal numbers mounds and quadrats) improves reliability / AW **;**	
			record other plants **;** could influence thyme **;**	
			measure / note, abiotic variables **; A** example explanation of how named variable affects thyme **;**	
			AVP **;** AVP **;**	**4 max**
	(b)		better drainage **;** finer soil **; A** looser more, nutrients / minerals / ions **; A** more fertile decay of, ants / prey / faeces **;** ants, eat / kill / drive away, animals that eat thyme **;** slopes of mound influence incident, light / sun (idea) **;** thyme, tolerates / grows well, when buried by growing mound **;** metabolism of ants warms soil **;** competing plants do not, thrive on / tolerate, the mounds **; A** less competition ants carry seeds of thyme **;** more wind on raised mounds **;** AVP **;** AVP **;**	**2 max**

(c)

1 named pioneer species **;**
2 ref to pioneer species change environment **;**
3 (as succession proceeds) stability increases **;**
4 example **;**
5 (as succession proceeds) nutrients increase **; A** more fertile
6 ref to leguminous plants increasing N **;**
7 ref to decay / nutrient cycle **;**
8 new species of plant can grow **; A** example
9 (pioneer) legumes outcompeted **; A** example
10 more food for herbivores / primary (1^{o}) consumers **; A** example
11 ref to specialised herbivores **; A** example
12 ref to specialised pollinators **; A** example
13 (more herbivores) more variety of food for next trophic level **; A** example
14 food webs more complex **;**

15 larger plants provide more, shelter / nest sites **;**
16 more microhabitats **; A** example
17 more spatial niches **; A** idea
18 AVP **;** e.g. pioneers outcompeted (qualified)
19 AVP **;** adaptation of pioneer **6 max**

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

[Total: 14]

Question			Expected Answers	Marks
3	(a)	(i)	steep increase, for the first 1 - 2 hours / till 2.2 - 3.8 (a.u) **;** **A** linear, steady became constant at, 3 hours / 4.3 (a.u) **;** *if no figs in description, e.g. 'rose then constant' award 1 mark max*	2
		(ii)	(increased as) enzyme working / rate of reaction high / reaction proceeding **;** (increased as) substrate converted into, drug / product **;** (levelled off / became constant, after the) enzyme, became inactive / was denatured**;** (levelled off / became constant) because product inhibits, reaction / enzyme **;** **R** references to enzyme or substrate being used up **R** T °C limiting	2
	(b)		pH **;** degree of mixing **;** enzyme concentration **;** AVP **;** e.g. ref to concentration of inhibitors	1 max
	(c)		*max of 2 marks for predicting **or** explaining*	
		P1	concentration of drug higher / AW **;**	
		P2	rate of reaction slower / AW **;**	
		P3	may not level off (in time scale shown on graph) **;**	
		P4	time taken to reach the maximum yield (approximately) doubles **;** (c.f. 15 °C)	
		E1	not denatured **;**	
		E2	adapted to 5 °C / optimum / body / usual, temperature **;**	
		E3	ref to Q_{10} of about 2 **;**	
		E4	ref to lower kinetic energy / AW **;**	
		E5	ref to E-S, collisions / complexes **;**	
			AVP **;** e.g. ref to active site	3 max
	(d)	(i)	(shaded amino acids) form the active site **;** substrate may not attach to the active site **;** enzyme-substrate complex may not be formed / AW **;**	1 max
		(ii)	44 and 66 not part of active site **;** hold, active site / 3° structure / 3D structure, in shape **;** **A** stop denaturing hydrogen bonds weak **;** easily broken by, vibration / heat **;** **A** pH disulphide bridge strong **;** not broken by heat **;**	2 max
	(e)		nucleotide / base/ DNA, sequence codes for, protein / amino acid, sequence **;** changes DNA **;** **A** change triplet makes different mRNA **;** **A** change codon transcription **;** different tRNAs line up **;** **A** change anticodon translation **;** different (amino acid sequence in), enzyme / protein / polypeptide **;**	2 max
			[Total:	**13]**

Question		Expected Answers	Marks
4 (a)		*any two of the following*	
		(monomer) not glucose **;** contains nitrogen **;** contains, sulphur **;** AVP **;** **R** ref to branching	**2 max**
(b)		amount of glycoprotein varies (in different cells) **;** (cells carry out) endocytosis to different extents **;** cells have different life spans / example **;** no time for polysaccharide to accumulate in short lived cells **;** number / role, of lysosomes not same in all cell types **;** AVP **;**	**1 max**
(c)		*with Hunter's syndrome, lysosomes / vesicles, might be*	
		larger **;** more numerous **;** have different shape **;** stain differently **;** AVP **;** e.g. granular cytoplasm	**1 max**
(d)	(i)	unaffected parents can have an affected child **;** *ora* e.g. 3, 4, 8 / 11, 12, 16, 17 **;**	**1 max**
	(ii)	only males affected **;** *ora* mothers pass it on **;** *ora* on the X chromosome **;** carrier women asymptomatic / dominant normal allele masks trait **;** 4 / 11 / 1 , could be carriers **;**	**2 max**
(e)		there are only 3 cases / too small a sample **;** mostly female line shown **;** AVP **;** e.g. pedigree of, 3 / 12, not known progeny of, 13 / 14 / 15, not known	**1 max**
(f)		drug must act in all cells **;** lysosomes are within cells **;** hard for drug to reach **;** if drug acts as enzyme, polysaccharide on cell membranes may be broken down **;** tissue mechanical support would break down **;** AVP **;** AVP **;** e.g. no animal model protein drug digested in gut rare condition (qualified), economic argument	**2 max**

[Total: 10]

Question			Expected Answers	Marks
5	(a)		avoid attracting a mate of a different species **;** *ora* ensure reproductive isolation **;**	**1 max**
	(b)	(i)	diffusion **;**	**1**
		(ii)	so that they do not receive oxygen constantly **;** there are mitochondria between them and the cell surface **;**	**1 max**
	(c)		mitochondria / aerobic respiration / oxidative phosphorylation, inhibited only briefly **;** oxygen concentration decreases again **;** preventing, action of luciferase / production of light **;** each flash short **;** *ora* e.g. so not continuously lit AVP **;**	**2 max**
	(d)		active transport **;** **A** e.g. Na^+/K^+ pump protein synthesis **;** synthesis of named substance **;** movement of organelles **;** phosphorylation of glucose **;** AVP **; ; ;** e.g. transcription, translation, anabolic reaction **R** respiration, DNA replication, chromosome movement, mitosis	**3 max**
	(e)		cells / membranes, damaged / disrupted **;** nitrous oxide released **;** mitochondria stop using oxygen **;** oxygen, allows light production / reaches light-producing organelles **;** in unlimited quantities / continuously, so light is brighter **;** respiration / oxidative phosphorylation, ceases **;** no more, ATP / $NADH_2$ **;** luciferin, synthesis / regeneration, stops **;** AVP **;**	**3 max**
	(f)		live bacteria, respire / produce ATP **;** *ora*	**1**
	(g)		mRNA (coding for luciferase) **;** **A** DNA	**1**

[Total: 13]

Mark Scheme 2806/03
January 2006

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

Planning Exercise

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

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

Practical Test

Pages 5 to 8 have the mark scheme for Questions 1 and 2 for the Practical Test.

A2 Biology. Planning exercise

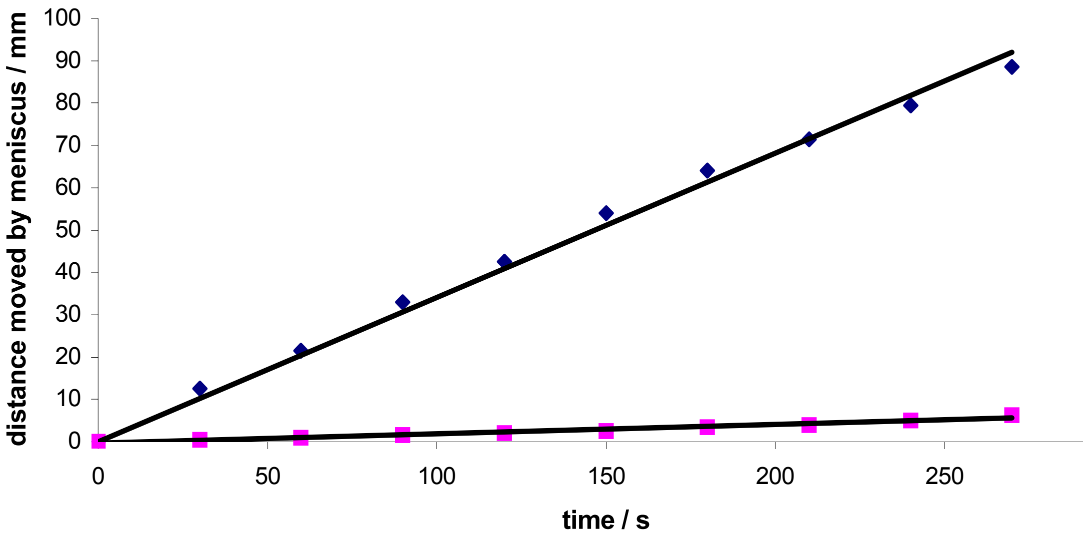
Checking Point	Descriptor	The candidate
A	P.1a	plans a procedure that involves mixing yeast suspension with each sugar solution separately and measuring rate **;**
B	P.1a	gives a prediction about the effect of concentration **and** different monosaccharides **;**
C	P.1b	chooses suitable materials and equipment to measure respiration rates, e.g. measuring volumes / TTC / methylene blue / lime water, etc. **; R** counting bubbles
D	P.3a	uses appropriate knowledge and understanding, ref to effect of substrate concentration on reaction rate **;**
E	P.3a	identifies at least **two** key factors to control or take account of, e.g. temperature / volumes of yeast suspension / volumes of all sugar solutions / concentration of yeast suspension / concentration of all sugar solutions / time **;**
F	P.3b	decides on an appropriate range of measurements (minimum of **five** different concentrations, **A** 0%) with each sugar **;**
G	P.3b	decides on number of measurements to make, (minimum of **three** at each concentration) **;**
H	P. 5a	uses appropriate knowledge and understanding of enzymes, e.g. structure of monosaccharides / uptake into yeast cells **;**
I	P.5a	**uses** information / results from preliminary work or previous practical work **;**
J	P.5a	refers to safety aspect (hazard and precaution), e.g. assembling glassware / allergy to yeast / TTC / NaOH **;**
K	P.5b	describes a way of producing precise results, e.g. agitating yeast suspension and sugar sols before mixing / measuring volumes to nearest 0.5 cm^3 or 1.0 cm^3 / consistent end points **;**
*L**	*P.5b*	*gives a clear account, logically presented with accurate use of scientific vocabulary (QWC)* **;**
M	P.7a	**uses** information from identified secondary source **;**
N	P7a	**uses** appropriate scientific knowledge and understanding, e.g. sources of CO_2 / H in respiration **;**
O	P.7a	shows how data are to be presented as a table, name and concentration of sugar **and** distance moved by meniscus / volume of gas produced / time taken for indicator to change **;**
P	P.7a	shows how rates would be calculated, e.g. d/t / 1000/t / gradients from (time course) graph **;**
Q	P.7a	explains/shows how data are to be illustrated on **one** graph i.e. all four sugars on one graph: x axis = concentration of sugar(s), y axis = rate **;**
*R**	*P.7a*	*uses spelling, punctuation and grammar correctly (QWC)* ***;***
S	P.7b	states that rates will be compared quantitatively, e.g. glucose respired twice as fast as sorbose at five minutes / calculates ratios , use of stats to test significance **;**
T	P.7b	comments on using initial rates as being more valid / sugars used up over time / aerobic becoming anaerobic / need for control without sugar **;**
U	P.7b	comments on constraints, e.g. number of yeast cells in suspension / air leaks / judging end points / sugar in yeast / alcohol poisoning / osmotic effects / **A** reassembling apparatus **;**

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**

Example of expected results for Q.1 (a)

time / s	distance moved by meniscus / mm	
	with soda lime	without soda lime
0	0.0	0.0
30	12.5	0.5
60	21.5	1.0
90	33.0	1.5
120	42.5	2.0
150	54.0	2.5
180	64.0	3.5
210	71.5	4.0
240	79.5	5.0
270	88.5	6.3

Example of graph for Q.1 (b)



Calculations

r = 0.2 mm
r^2 = 0.04
πr^2 = 0.125

volume of oxygen used up after 270 s = 88.5 x 0.125 = 11.06 mm^3

volume of carbon dioxide produced after 270 s = (88.5 – 6.3) x 0.125 = 10.28 mm^3

RQ = $\dfrac{10.28}{11.06}$ = 0.93

Question			Expected Answers	Marks
1	(a)		results in the form of a table **;** informative column headings **;** time, distance with soda lime, distance without soda lime appropriate units not in body of table **;** results for both conditions **; R** if mean for both conditions included results with soda lime greater than without soda lime **;**	**5**
	(b)		axes round right way (x axis = time, y axis = distance moved) **;** axes labelled (time and distance) **;** axes scaled <u>with units</u> in ascending order starting at zero **;** makes good use of / uses more than half of, available space **;** points accurately plotted to include zero plot **;** two curves drawn and identified (one with soda lime, one without) **;** points joined, clearly / neatly, by straight lines (unless conform to line of best fit) **;**	**5 max**
	(c)		shows working i.e. $3.14 \times (0.2)^2 \times l$ / $3.14 \times 0.04 \times l$, where l is correct **;** calculates volume of oxygen (used up) correctly to nearest mm^3 **;** subtracts distance moved in absence of soda lime from distance moved in presence of soda lime **;** calculates volume of carbon dioxide (produced) correctly to nearest mm^3 **;**	**4**
	(d)		shows / uses, CO_2 produced over O_2 used up to calculate RQ **;** ecf calculates RQ correctly **;** ecf calculates RQ <u>correctly</u> to be between 0.6 and 1.1 **;**	**3**
	(e)	(i)	uses lipid initially **;** uses increasing amounts of carbohydrate subsequently **; R** uses less lipid **;** as leaves photosynthesise **;** aerobic throughout **;** AVP **;** e.g. lipid converted to carbohydrate	**4 max**
		(ii)	lipids contain high(er) proportion of, C and/or H / C–H bonds (than C–O bonds) **;** more CO_2 and H_2O *formed* **;** on oxidation **;** (therefore) lipid releases, more / twice as much, energy (as carbohydrates) **;** per unit mass **;** A volume seeds dispersed **;** have smaller mass **; A** size	**4 max**
	(f)		syringe <u>with soda lime only</u> **; A** no seeds **;** boiled seeds / inert material **;** boiled seeds / inert material, with same mass / volume / number as seeds **;** at same time / simultaneously **;** for same length of time **;** suitable comment on need for control **;** e.g. to compensate for atmospheric CO_2 in apparatus / atmospheric temp / pressure changes subtract / add, any movement of meniscus in control from experimental results **;**	**6**

(g) *limitations* **A** *ora*

inconsistency measuring distance due to shape of / moving meniscus **;**
use of ruler qualified e.g. can only measure to nearest 0.5 mm / percentage error / thickness of line (on ruler or pen) **;**
meniscus sticking in capillary tube **;**
connections not airtight **;**
capillary tube too short **;**
fall off in rate CO_2 absorbed by soda lime **;**
variations in, temperature (affecting volume of air in apparatus / rate of respiration / enzymes) **;**
variations in atmospheric pressure (affecting position / movement of meniscus) **;**
no repeats / anomalies not identified / no means calculated **;**
AVP **;** e.g. seeds not germinated for same length of time
AVP **;** seeds from different batches **4 max**

[Total: 28 max]

Question	Expected Answers	Marks
2 (a)	*drawing*	
	clear continuous lines **;** correct proportions - radicle at least twice length of seed **;** correct size, no smaller than actual size **;**	**3**
	correct distribution shown by annotations	
	white (at root cap) **;** red just above root cap / root tip **;** pink further up **;** some pink on hypocotyls and/or cotyledon **;**	**4**

(b) (i)

feature	explanation
thin walls / squamous epithelium / high density of alveoli / capillaries **;**	to minimise diffusion distance **;** **R** to make diffusion 'easier' / efficient / quicker etc.
capillaries / blood vessels **;**	to maximise volume of gases exchanged / to maintain diffusion gradient **;**
large S.A. / high density of alveoli **;**	to maximise volume of gases exchanged / rate of gas exchange **;**

AVP **;** e.g. bronchioles to bring air to maintain diffusion gradient
cartilage to keep airways open to maintain diffusion gradient **6**

(ii) alveoli cut in section / seen in one plane **;**
sections pass through different, levels / planes / positions **;**
A annotated drawing **2**

(c) fewer alveoli **;**
damaged / ruptured walls / alveoli **;** **R** cell walls / membranes
thinner walls / less prominent nuclei **;**
fewer capillaries / blood vessels **;** **R** "blood supply"
larger air spaces **;** **R** "gaps"
less surface area **;**
AVP **;** no bronchioles visible / greater variation in size of air spaces **3 max**

(d) NAD / FAD, not limiting rate of respiration **;**
more dehydrogenases **;**
more electron carriers **;**
more cristae **;**
higher rate of respiration (per unit mass of tissue) **;** **A** glycolysis / link reaction / Krebs cycle / oxidative phosphorylation / ETC **R** more "active"
AVP **;** e.g. to compensate for reduced oxygen availability **3 max**

[Total : 16 max]

Report on the Units

January 2006

Chief Examiner's Comments

This examination session continued the trends reported in previous sessions. The number of candidates taking the AS and A2 core papers continues to increase.

The Principal Examiners have reported on the performance of the question papers and included some *Teaching tips*, as they have done since June 2004. The feedback from centres about these teaching tips has been very positive. Centres new to the specification may find these teaching tips to be extremely useful as examples of activities that they can do with their candidates and as sources of further information. The *Teaching tips* also emphasise the points that Examiners insist on when marking scripts. In these reports, several Examiners remind us that candidates do not gain any reward for imprecise or inaccurate statements such as 'mitochondria produce energy'.

The Examiners would like to point out that the examinations are not set on the contents of the text books that have been endorsed by OCR. Sometimes teachers refer to '*The* text book'. There is no such thing. OCR has now endorsed four books for the GCE specification, but the Examiners always set their papers on the learning outcomes of the specification itself. Of course, they consult the endorsed text books when discussing questions and constructing mark schemes, but they are also aware that teachers and candidates may use a range of other text books and sources of material. The Examiners are always grateful to hear about different interpretations of topics on the learning outcomes in the specification. Teachers are asked to contact the Subject Officer in Cambridge about any differences in interpretation that they find in the many and varied sources that they use.

The Examiners are very grateful to the person who commented that according to the International Codes for Nomenclature the scientific name of any taxon of higher rank than the species group is one word that begins with an upper-case letter. The table at the beginning of *Q.4* on *Central Concepts* should have read 'Carnivora' rather than 'carnivora'. OCR apologises for this lapse in scientific correctness.

The Examiners for *Human Health and Disease* (2802) are somewhat concerned about the way they have awarded marks for the names of the pathogens in Section 5.2.5 of the specification. In this session, as in earlier sessions, they have allowed *M. tuberculosis* and *M. bovis*. As reported below, they feel that they should now insist on the full generic names when these are required as in questions like *Q.4 (a)* in this session's paper. So, in future they will only award a mark for naming the pathogens as follows:

cholera	*Vibrio cholerae*
malaria	*Plasmodium falciparum / malariae / ovale*
TB	*Mycobacterium tuberculosis / bovis*

In each case they will be happy to award a mark for the generic name alone.

Mathematical matters

1. Reading from graphs. Candidates often have problems reading figures from graphs. In *Q.2* of *Central Concepts* (2804), there was a simple graph, but some multiplied the numbers they extracted from the graph by 100 showing that they did not understand the vertical axis. The label on this axis read 'per 100 km^2'. Similarly, information was not extracted very well from Fig. 4.1 on *Mammalian Physiology and Behaviour* (2805/05).

2. Using graphs to extract information for calculations. In *Q.6 (a)(i)* in *Human Health and*

Disease (2802), candidates were asked to find the mean tidal volume from a spirometer trace. Very few were able to do this.

3. Calculations were, on the whole, poorly done. In several places, candidates were asked to calculate percentage increases, for example in *Q.4 (c)(i)* of *Central Concepts* (2804). Very few candidates were able to calculate this properly. Calculations given in the specification, such as those in *Growth, Development and Reproduction* (2805/01), are usually done well as in the examination this session. But perhaps this was because these candidates knew that calculations were in learning outcomes and had practised many of them!

In *Q.1* of the A2 Practical Test, candidates were expected to calculate the volume of oxygen absorbed and the volume of carbon dioxide produced by respiring seeds. Many did not calculate the radius of the bore of the glass tubing before calculating the respective volumes in spite of being given the full equation to use.
.
The relevant A2 boundary performance descriptions (as prepared by QCA) for A/B and E/U state:
A/B: carry out accurately most of the calculations specified for A level; apply the principles of statistical analysis when directed.
E/U: carry out some steps within calculations.

This indicates that the Examiners will continue to set calculations as they are a requirement of the assessment. Candidates obviously need to be drilled in the appropriate methodology for the calculations that they will meet.

Synoptic Assessment

Questions with a synoptic element continued to cause much concern. It is, perhaps, too early for candidates who are only half way through their A2 course to be suitably prepared and confident enough to approach these questions in the A2 papers. Also for those candidates in Year 14 repeating A2 examinations, it may be 18 to 24 months since they first encountered AS material. They may not have revisited it much in the intervening period. Several reports advise centres to continually remind candidates of synoptic material from *Biology Foundation* (2801) as this material is so central to the rest of the course. This is particularly true of the following sections in 2801: Cell Biology, Biochemistry and Genetic Control of Protein Structure and Function. The report for *Unifying Concepts in Biology* (2806/01) makes this point several times. It was felt that there was a great deal of material on that paper for the candidates to read and assimilate. It was quite clear that many did not read the material at the beginning of *Q.5* on fireflies and some did not study the diagram on the insert. This was evident in answers to *Q.5 (b)(ii)*. The Examiners on this paper commented how few candidates appreciated the importance of animals in succession. Very few candidates made comments on animals. Perhaps this is something that is not stressed in the teaching of succession in *Central Concepts* (2804). Candidates could look at the changes in factors such as biodiversity, niches, biomass and production in a succession and draw sketch graphs to summarise these.

Command words

The command words used in Biology examination papers are carefully defined in the glossary in Appendix F of the specification. One word that always gives problems is ‘outline’. This was particularly true in *Q.5 (b)* of *Central Concepts* (2804). Here candidates should give an overview, not write all they know about a particular topic. Asking candidates to write down the main points that they would use in answer to outline questions is a good teaching strategy to use to reinforce this point.

Annotating the question papers

Occasionally, the Examiners find scripts that have been annotated quite fully by the candidates. Often this takes the form of highlighting passages of text. Less often there are lines ruled on graphs or calculations carried out at the sides of data tables. The Examiners would like to see more of this engagement with the information on the question papers. It shows that candidates have read through and/or analysed the information carefully. Candidates are more likely to score marks if they have done this.

Water potential

Questions on water potential appeared in *Biology Foundation* (2801), *Transport* (2803/01) and the AS Practical Examination (2803/03). The terminology for water relations in plants that students should use is that given in the Institute of Biology handbook and in all modern textbooks. Some confusion exists about the relationship between water potential and solute potential. This is particularly true of the coursework submitted by some candidates. It is worth repeating some advice given in an earlier report (June 2001).

Water potential. When pieces of plant tissue are immersed in different concentrations of a bathing solution, they may gain or lose water. The effect is measured by recording changes in length or changes in mass. By plotting the results on a graph, it is possible to estimate the water potential of the tissue. This is done by finding the water potential when there is no net gain or loss of water and the tissue remains in equilibrium with the surrounding bathing solution. Often this is estimated by taking an intercept on a graph.

Solute potential. The method that is usually followed to find the solute potential is sometimes known as limiting plasmolysis. Here a tissue is immersed in different concentrations of a bathing solution and the cells observed under a microscope. This works well with tissue peels from onion or rhubarb. The number of plasmolysed cells can be counted. The water potential at which 50% of the cells are plasmolysed is taken as the point when the average cell is at incipient plasmolysis. The cell membrane is just touching the cell wall, but it is not pushing against it. The pressure potential therefore is 0 kPa. At this point the water potential of the cell is equal to the solute potential.

The water potential of plant tissue is a function of the solute potential of the cell contents and the pressure potential:

$$\psi = \psi_s + \psi_p$$

The water potential will be a negative figure, because cells taken from a plant are likely to be partially turgid, but not fully turgid. When placed into distilled water, the cells absorb some water to become fully turgid. As this happens, the pressure potential increases so that the water potential becomes 0 kPa after a certain period of time has elapsed.

Finding the water potential by the change in mass method or the change in length method indicates the overall water potential of the tissue; it does not indicate the solute potential. The cells in the plant tissues that are used for this method (usually potato or a root vegetable) are partially turgid when they are immersed in the bathing solutions. This means that when the tissue is placed into the bathing solution there is a pressure potential that counteracts the solute potential. Further investigation is needed to find the solute potential.

It is unlikely that candidates will have sufficient time to undertake investigations using *both* methods described above during their AS course. However, this does mean that teachers should emphasise the difference between water potential and solute potential and consult the

Institute of Biology booklet *Biological Nomenclature: Standard terms and expressions used in the teaching of biology*. 3rd Edition, 2000, Edited by Alan Cadogan. ISBN 0-900490-36-5.

Practical work

Teachers often comment that there is little time within the course to do much practical work. The Examiners would like to remind all teachers of the specification that the Practical Examinations form a very useful resource for practical work. In this session the following exercises were set.

AS Practical Examination
A Planning Exercise on fitness based on *Human Health and Disease*. An osmosis exercise using strips of epidermis cut from celery petioles (as dandelions are not available in January!). A microscopy exercise using a slide of TS trachea and photomicrographs of a muscular artery.

A2 Practical Examination
A Planning Exercise looking at how yeast uses four different monosaccharides. Candidates also had to investigate how the effect of increasing concentrations of these monosaccharides influenced respiration in yeast. Investigating respiration in mung beans using simple respirometers made from syringes and capillary tubing. Looking at the distribution of mitochondria in germinating mung beans and comparing healthy lung tissue visible in a slide with a photomicrograph of tissue showing emphysema.

All of these questions could be used in schemes of work to reinforce different parts of the specification.

Teachers entering candidates for the practical examinations should trial *Q.1* and *Q.2* of the Practical Test before the date of the examination and obtain a sample set of results. In the General Instructions to centres that accompanies the Practical Test, the following advice is given:

‘Candidates should be informed that, if they find themselves in real difficulty, they may ask the Supervisor for assistance but the extent of this assistance will be reported to the Examiner, who may make a deduction of marks. If the Supervisor becomes aware that a candidate is having difficulty, then the Supervisor is expected to give the minimum amount of help required to enable the candidate to obtain a set of results from the apparatus. A note of the type of help given should be made on the Report Form on the last page of the candidate’s script. **Under no circumstances should help be given to candidates with the presentation or analysis of experimental data.**’

Teachers are reminded that they should use the Report Form at the back of the Practical Test to report any problems that arise in the examination. They are also encouraged to give as much information as they can to the Examiner, so that candidates are not disadvantaged. As ever, the Examiners were very grateful for the comments that were recorded and for the results that accompanied the scripts for the two examinations this session.

Planning Exercises are often concise. Candidates appear to know that there is nothing to be gained by writing about background theory at great length. However, few are able to show how they have used the theory that they think is relevant. This is also a problem with coursework. Perhaps this is an area that needs attention as many candidates are good at finding appropriate, relevant material but not so good at using it to inform their planning.

The two practical examinations provide resources that centres may like to use not only for preparing their candidates for these examinations, but also as ready-made class practicals.

It is clear from reading scripts that candidates have problems with understanding the effect of enzyme concentration and substrate concentration on the rate of enzyme-catalysed reactions. There are a number of questions that have been set on this topic in recent practical examinations, notably in the AS Practical Tests in January 2003 and in January 2005.

2801: Biology Foundation

General Comments

This paper produced a wide range of marks.

It was noticeable that some questions, such as *Q.3 (c)*, which were expected to be reasonably accessible by weaker candidates proved to be more difficult, mainly because the candidates presented information imprecisely and the facts presented in this way were often misleading. Some candidates, therefore, did not perform as well as they might have expected or as their level of knowledge and understanding might suggest.

Another feature that was evident in this paper was that some candidates had obviously not read some of the questions carefully enough, homing in on key words rather than looking to see exactly what was required. The importance of reading very carefully both the information supplied and the question cannot be over-emphasised.

Even able candidates experienced some problems with data interpretation. It is possible that some tried to evaluate the data by thinking back to a similar question. This could explain why some candidates referred to temperature rather than pH in *Q.3 (b)(i)*.

Comments on Individual Questions

Q.1 This question was designed as an easy introduction to the paper. As such, it worked quite well although imprecise expression resulted in some candidates losing marks.

(a) The vast majority of candidates were able to correctly identify the organelle as a mitochondrion in *(i)*. Candidates were expected to qualify the function as 'aerobic respiration' rather than simply 'respiration', although able candidates were able to score full marks by referring to release of energy, production of ATP and other functions, such as lipid synthesis. Energy *production* was not credited. The Examiners were looking for the function of movement in part *(iii)*. Some candidates referred to movement of cilia, others to movement of mucus. Weak responses tried to link its presence in the airways to the process of respiration, presumably confusing breathing and respiration. Others wrote in vague terms about the cell requiring energy for its functions. Many candidates were able to score at least one mark in *(iv)*. A few lost a mark by failing to give their answer to the nearest micrometre while others appeared to be giving answers in other units, judging by the multiplication to various powers of 10 that were seen.

(b) This part of the question was targeted as a high level response, so vague statements such as 'the image was blurry' did not score unless a clear explanation followed. Many referred to the poor resolving power of the light microscope, while better responses gave a quantitative value or referred to the wavelength of light.

Teaching tip

Impress on candidates the idea that energy is not 'made', 'produced' or 'created' during respiration. It is released for energy-requiring processes. Perhaps candidates can be encouraged to write a series of statements about cells using the word 'energy'; the whole class can then assess these. This would be a way of highlighting the importance of using the correct language. For a start here is a statement taken from a recent newspaper article about longevity: '…mitochondria. These tiny structures help create energy in our cells.'

Remind candidates to take a ruler and calculator into the examination ~ they will probably need them!

Q.2 The nitrogen cycle is a topic with which many candidates experience difficulty. Those who understood the material were able to score marks relatively easily, but many were obviously very confused. This tends to be evident when this topic is examined in this way.

(a) Most candidates could correctly identify fox and grass or clover. It was pleasing to note that very few candidates suggested organisms that did not appear on Fig. 2.1. A significant number, however, suggested rabbit as a secondary consumer and a smaller minority suggested nitrogen-containing compounds from the figure.

(b) This part of the question proved more difficult for the weaker candidates who were confused between terms and processes. The Examiners were looking for lightning rather than rain or thunderstorms in *(ii)*. A considerable number gave an example in response to *(iii)*, although in many cases this was *Rhizobium* rather than the more appropriate *Pseudomonas*. Part *(iv)* was the most demanding part of the question, as it specifically requested information about the importance of *Rhizobium* in the nitrogen cycle rather than 'write all you know about *Rhizobium*'. Quite a lot of irrelevant information was therefore supplied in many answers. Candidates were expected to refer to nitrogen fixation, supplying leguminous plants with a source of nitrogen for amino acid or protein synthesis, allowing the leguminous plant to survive without having to rely on sources of nitrogen from the soil and (in the case of free-living bacteria) supplying ammonium ions that could then be acted upon by other bacteria to be made available to other plants. Some who mentioned nitrogen fixation then contradicted themselves by stating that this process converted nitrate ions into atmospheric nitrogen. Many suggest that the bacterium had a role in death and decay.

Teaching tip

There is a good article on nitrogen fixation and the nitrogen cycle at:
http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm#Top

Q.3 *(a)* Part *(i)* was generally well answered, most candidates stating either endocytosis or phagocytosis. Weak candidates tended to suggest active transport or diffusion.
By accepting 'break down' as an alternative to 'digestion', most candidates were able to score at least one mark in *(ii)*. Good responses referred to enzymes, hydrolysis and amino acids or soluble end products.

(b) Part *(i)* proved to be very challenging to all candidates. Many candidates adopted one or other of these answers:

- referring to optimum temperature,
- stating that not every enzyme has the same optimum pH,
- relating the data to variations in conditions during the experiment.

Candidates obviously found difficulty in looking at the data critically and analysing it in the best way. It was not uncommon to see a simple statement 'because student B gave a range' with no further explanation.

Responses to *(ii)* were better and able candidates were able to score maximum marks with ease. Common errors were to state that pH 7 is alkaline rather than neutral and to imply that enzyme activity was reduced in alkaline conditions rather than totally stopped by pH 7.

(c) It was unfortunate that some candidates lost marks because of poor and incomplete expression of otherwise relevant information. For example, ‘enzyme concentration increases the rate of reaction’ did not score as there was no indication that this was as a result of *increased* enzyme concentration. Increasing substrate concentration was better expressed and more thoroughly understood than increasing enzyme concentration, with good explanations of reaching a point at which the rate does not increase despite increasing substrate concentration. A significant number of candidates stated that an increased substrate concentration resulted in a decrease in the rate of reaction.

There was some confusion with competitive and non-competitive inhibitors; many candidates supplying information on both and letting the Examiner extract the relevant marks. The Examiners were looking for a clear statement that the inhibitor enters the active site of the enzyme, thus preventing the substrate from entering the active site. ‘The inhibitor and substrate compete for the active site’ is not only too vague but also uses one of the terms that is being described. When the shape of the inhibitor is being described, candidates should refer to its similarity to the shape of the substrate or part of the molecule having the same shape rather than stating that the inhibitor is the same shape as the substrate. There was also some confusion as to whether the competitive inhibitors were temporary or permanent

Candidates who had read the question carefully and had good knowledge were able to score six marks or more quite easily. Weaker responses tended to try and combine all three factors together and consequently resulted in muddled descriptions, meaning that it was not always possible to decide which factor was being described. As in previous sessions, it is evident that some candidates are not clear whether the active site is situated on the enzyme, substrate or inhibitor. Some candidates answered this question without once mentioning the active site. As this is the key point of interaction between the substrate and the enzyme, candidates would be expected to refer to it in order to gain credit rather than simply stating, for example, that ‘the substrate will collide with the enzyme’.

Teaching tip

To demonstrate competitive inhibition, use a large pencil sharpener that has a built-in sharpenings collector. This will represent the enzyme. The pencil (substrate) fits into the sharpener (active site) and sharpens (performs a reaction). A pen/biro (inhibitor) fits into the sharpener (active site) but will not sharpen (does nothing). While the pen (inhibitor) is in the active site, the pencil (substrate) cannot enter. When the pen (inhibitor) occupies the sharpener (active site), it does not change the shape of the whole sharpener (enzyme). As the pen (inhibitor) can be removed from the sharpener (active site) the effect is not permanent.

This report gives some ideas for practical work that could be included here to help with understanding of the effects of substrate and enzyme concentration. See the Chief Examiner’s report

Q.4 *(a)* The term was well understood by many candidates but a common error was to state that it was a protein with ‘a glycogen attached’ or a protein that had glycosidic bonds.

(b) This part of the question was generally well answered. Candidates were expected

to use the terms 'helix' and 'pleated', although 'double helix' was not credited.

(c) Mostly answered correctly.

(d) This part of the question proved to be more taxing, although many candidates were able to suggest a restriction enzyme in *(i)*. Care should be taken, however, as 'restrictive' or other variants were not credited. Part *(ii)* asked for the name of the enzyme that is used to insert the gene for Factor VIII into the genome of the hamster. Ligase was the expected answer, although see some further comments on this question in the *Teaching tip* below.

(e) The key to this part of the question was the involvement of ER in the production of Factor VIII. Those who had read the question carefully and saw the focus of the question were able to relate this to the presence of ribosomes, protein synthesis, transport of protein and formation of the Golgi apparatus. Some tried to relate it to the function of the ovary cells themselves.

Teaching tip

There is a very useful tutorial on DNA, protein synthesis and recombinant DNA technology at:
www.biological.com/abouthaemophilia_recombinant.cfm
Look at the sections 'About Haemophilia' and 'Research and Development'.

In the process described by Bayer the human gene that was the subject of this question was inserted into the plasmid vector - pAIVIL 3p.8c1 – this subsequently became incorporated into a chromosome of the hamster cell line. The cell line used was derived from kidney cells, but other companies use cell lines derived from ovary cells. The gene is incorporated indirectly via a plasmid and ligase is used to seal the sugar-phosphate backbone rather than to 'insert the gene'. 'Insertion' occurs by base pairing. Also the gene is inserted into the plasmid rather than into a hamster chromosome. As a result, the question is perhaps somewhat ambiguous.

Q.5 *(a)* Nearly all candidates selected the correct chromosome to shade, although some failed to shade a chromosome at all or shaded an incorrect chromosome, sometimes in a different nucleus, even though nucleus **A** was clearly stated in the question.

(b) The vast majority of candidates correctly identified metaphase and the descriptions in *(ii)* were generally good. A common error was to state that chromosomes align along the equator of the *nucleus*. A few referred to chromosomes pairing at the equator, but otherwise there was little evidence of confusion with meiosis.

(c) This was poorly answered, although it was targeted as a high level response. Candidates not only had to decide on the number of chromosomes but also whether one or two of each chromosome should be present. Candidates commonly reversed the sequence.

Teaching tip

Human karyotypes for teaching purposes are available at:
http://worms.zoology.wisc.edu/zooweb/Phelps/karyotype.html

Models of chromosomes can be made with coloured pipe cleaners. These are good for modelling the stages of mitosis and meiosis. These can be purchased from craft shops or from educational suppliers, such as Kent County Supplies. They can be cut to different sizes to model chromosomes from specific organisms, such as *Vicia faba* and *Crocus balansae*. It is quite a good idea to find a species with a small number of chromosomes (not 46!). Some species of muntjac deer have small diploid numbers of chromosomes.

Pipe cleaner chromosomes can also be used to model the cytological evidence for segregation of alleles and independent assortment. Small sticky labels can be attached to the 'chromosomes' at the appropriate loci and be labelled with the alleles concerned. Candidates can be asked to criticise these models. It is not really possible to model the centromere properly. They cannot be used to show replication and crossing over means destroying some or all of the pipe cleaners!

Q.6 *(a)* This part of the question was generally answered well. 'Solvent' was frequently confused with 'solute'. Candidates should distinguish between a layer of ice insulating the water beneath rather than stating incorrectly that the layer warms or protects the water beneath. They should also take care in using the term 'tensile strength' as it does not have the same meaning as 'surface tension' or 'cohesion', which were the answers credited.

(b) Candidates found this difficult, partly it is suspected because of confusion with the term 'plasmolysis'. It has been observed in previous sessions that some candidates confuse plasmolysis and turgidity. Consequently, the most common incorrect answer to *(i)* was given as **J**. **S** was favoured by a few candidates, even though this was a letter labelling the diagram, rather than any of the letters used to identify the three diagrams **J** to **L**.

Many candidates appeared not to have read the question thoroughly in *(ii)*. The question referred to the difference between **K** and **L**, so a comparative answer was required. So, 'K lost water by osmosis' did not score but 'K lost more water' was credited. A few suggested incorrectly that *all* the water had left **K**. Only a small number of responses offered a correct explanation in terms of a lower water potential outside **K** (than outside **L**).

In part *(iii)*, as the salt solution had passed through the cell wall, the wall must (at the very least) be permeable to salt. Any indication to this effect was credited as long as there was no confusion with cell membranes. Consequently, answers referring to 'membranes', 'semi-permeable' or 'selectively permeable' were rejected.

(c) A surprising number of candidates gave the incorrect answer of $\Psi = 0$ in *(i)*. Even those who correctly indicated $\Psi = -1300$ were often unable to show water moving from a higher water potential to a lower one in *(ii)*. In many cases, the concepts of both negative numbers and water potential were understood, resulting in three arrows drawn correctly between touching cells. A number of candidates, however, reversed the arrows or added arrows between non-touching cells. In some cases arrows were drawn both from high to low and low to high water potential, showing a complete misunderstanding of the concept of water potential gradients. It was interesting to note that some candidates managed to show the correct movement on one side of the cell with a water potential of –800 kPa but not on the other side, resulting in one or two marks being awarded.

Teaching tip

The specification makes it clear that candidates will not have to carry out any calculations on water potential. However, they should be aware of water potential gradients and be able to handle numerical information such as that given in this question.

2802: Human Health and Disease

General Comments

Overall the Examiners were pleased with the general level of knowledge displayed by many candidates sitting this paper. The majority of questions were answered well with a good level of detail. However, significant numbers of candidates lost marks because of a failure to express themselves clearly. Possibly answers were made deliberately vague because these candidates did not know the material sufficiently well. An answer for *Q.3* which apparently read: 'antiques can be destroyed by woodworm' may be true, but was very difficult to decipher as a relevant answer to the question. The Examiners noted an increasing use of bullet points in responses. This often meant that the candidate was well focused and scored well; however, if the bullet points are reduced to one word or short phrases it can be difficult for the Examiner to know if the point is correct and in context. If they are using bullet points, candidates should ensure that their responses are complete and detailed.

Comments on Individual Questions

Q.1 *(a)* Candidates were asked to complete a table giving details about the functions of certain components of a healthy diet. Most candidates were able to provide at least three correct responses; however, few candidates could accurately distinguish between the roles of vitamin A and vitamin D. Many provided answers that were not sufficiently specific such as 'vitamin A is used in the retina' or 'vitamin D helps bones grow'. The Examiners were disappointed that more candidates were not able to achieve full marks in this relatively simple recall task at the start of the examination paper.

(b) Almost all candidates achieved one mark by showing that a woman needs more protein when she is pregnant compared to normally. However, the majority of candidates then suggested that she would need less protein when breast feeding her baby.

(c) The misconception that a breast feeding mother would need less protein than a pregnant woman was often backed up with statements suggesting that the baby does not grow as quickly after birth as in the nine months before birth! Better candidates provided good answers that indicated the need for protein to allow the fetus to grow and develop and that after birth the protein was used to make milk which provided the baby with antibodies and the building blocks needed for more rapid growth.

Teaching tip

The functions of various components in the diet are often taught at key stages 3 and 4. At AS level this topic can be used as an opportunity for independent study. Pupils can be provided with a blank proforma in which the column titles are given as 'component of diet', 'sources', 'functions in body', etc. The pupils can then conduct their own research to complete the table.

Q.2 *(a)* The majority of candidates achieved credit here with three correct responses. A wide range of examples was used and it is clear that centres are teaching this part of the specification well and possibly that candidates are learning their examples from their own wider reading and research.

(b) In part *(i)*, many good responses were seen for a relatively familiar question taken

directly from the specification. Many candidates were able to describe how information about the prevalence of a disease could be used to highlight where prevalence is highest. They then suggested that these are the areas where aid and education should be directed. Better candidates also suggested that this information could be used to guide research into ways of combating the disease. In part *(ii)*, most candidates gained credit for suggesting that people in Sub-Saharan Africa are poorer than those in Europe and cannot afford to use condoms or do not use them for a variety of reasons including a lack of knowledge about how HIV is spread. A significant number of candidates lost credit here because their answers were not very specific, for example 'lack of education' was felt to be too vague and could have applied to any disease.

(c) In this part of the question the Examiners were looking for candidates to apply what they know about the Human Genome Project to a specific example and suggest how the HGP could be used to help reduce the spread of HIV. It is possible to identify people who are immune to the virus and, through the information gained from the HGP, to show how their genotype is different from that of most other people. This information about the genes may lead to the development of drugs to block receptors on T helper cells that are used by HIV. This use of a specific drug should then prevent the virus from entering the cells. The Examiners were willing to credit any suitable response that showed an application to the HIV virus. Unfortunately, very few candidates were able to spot a link and many gave generic answers about being able to develop specific drugs or carrying out some form of gene therapy. However, these answers were not applied to the example of HIV and were not given credit. A worrying number of responses referred to 'the gene that causes AIDS' as if candidates believed this to be an inherited disease. It must be made clear in teaching this topic that mothers who pass HIV to their children at birth or through breast milk are not passing on an inherited disease. Of equal concern was the number of candidates who obviously read the last line of the question and responded with stock answers about distributing and using condoms or not sharing needles.

Teaching tip

Some companies and research institutes foster links with schools and colleges. They can provide resources and visiting speakers and they also run open days and organised visits. Science Learning Centres also have links with such institutions and provide courses to bring current research and development into the classroom. Further details are available from:
www.sciencelearningcentres.org.uk
www.abpi.org.uk
www.biochemistry.org

The Human Genome Project is a difficult topic to teach and perhaps lends itself as a topic to be covered as individual research followed by discussion or debate.

Two useful places to start:
www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml
www.sanger.ac.uk/HGP/

Influenza viruses have some surface antigens that are shaped a little like mushrooms and toblerone chocolates. Teachers can demonstrate the presence of surface antigens using a large grapefruit (or similar) with miniature toblerones and button mushrooms attached using cocktail sticks. Antigenic shift and drift can be demonstrated by altering the positions and proportions of the 'antigens' on different grapefruit. This model could be extended to demonstrate clonal selection of T or B cells by using smaller fruit with plasticene 'surface antigens' as the pathogen and a grapefruit with complementary shaped receptors on its surface as the T or B cell. Pupils could be asked to make these models themselves which would allow teachers to assess their understanding.

Q.3 In this question, the processes involved in an immune response were separated out in order to test candidates' knowledge of this relatively complex topic in more detail. Responses to this question tended to be centre specific. Generally all the candidates from a centre did well or they did not. Few candidates displayed a good knowledge of topic specific vocabulary and terms such as 'immunological memory', 'complementary', 'variable region' and 'constant region' were seldom seen.

(a) In part *(i)*, most candidates knew that the cell involved in stage 1 of the process is a macrophage. General terms such as white blood cell or lymphocyte were not accepted. Many candidates realised in part *(ii)* that the phagocytic cell must use enzymes to cut up the bacterium leaving the antigens whole so that they can be transferred to the cell surface membrane for presentation. Some candidates described the digestion of the antigens and others were clearly confused and gave a description of T cell selection – even though this was asked for in part *(iii)*. In part *(iii)* better candidates gave good responses describing the receptors on the surface membranes of the T helper cells that are complementary to the antigens. However, many responses were rather more vague. Some candidates came close with statements about the T helper cells being specific without revealing how that specificity is achieved. The majority of candidates knew that mitosis was involved at stage 5 of the process. However, some weaker candidates may have been unsure and this was revealed in answers like 'meitosis'.

The importance and role of B memory cells is well known by the majority of candidates and most scored well in part *(v)*. There is still, however, some confusion over the difference between antigens and antibodies, while the role of plasma cells is often omitted.

(b) Here, answers were either very vague or very well constructed with plenty of detail. Candidates gained credit for responses that described antibodies immobilising pathogens or causing agglutination. The best candidates described the roles of the variable and constant regions of an antibody attaching to the antigens of a pathogen and then attracting a phagocyte.

Teaching tip

Devise and play a game of bingo using subject specific terms – the teacher can read out definitions and the students can cross out the correct word if it is on their grid.

Q.4 *(a)* Most candidates knew the full name of *Mycobacterium tuberculosis.* There were, however, a number who misspelled the name as '*Microbacterium*' or as *'Myobacterium'*. The Examiners gave credit for the accepted abbreviation '*M. tuberculosis*'. This does, however, give rise to a possible inconsistency in that those candidates who spell the name incorrectly are penalised while those who do not attempt the spelling gain credit. The Examiners advise centres that such names should be spelt out in full.

(b) Many candidates were able to state three features of the lung that permit efficient gaseous exchange; a common error was to reel off a list of features of which some were visible in the photomicrograph and others were not. No credit was given for stating features that were not visible in Fig. 4.1. Some candidates failed to read the question properly and listed features of the diseased lung that would hinder efficient exchange.

(c) A wide range of effects was given credit here and most candidates gained full marks. There was, however, frequent confusion between the effects of tuberculosis on the person with the disease and the effects of smoking or bronchitis. The most common responses concentrated on the idea that the person with tuberculosis would have difficulty with breathing and may be coughing up blood. Better candidates were able to relate what they saw in the photomicrograph (Fig. 4.2) to effects on the person. These candidates described destruction of the alveoli and blood vessels leading to reduced surface area for gaseous exchange. This question may have been more discriminating if it had been allocated more marks.

(d) The majority of candidates gained some or full credit here. This is a question that has been used as a longer answer in the past and there are a large number of points that can be given to gain credit. Commonly, candidates described

- ease of spread via droplets in overcrowded living quarters,
- a long incubation or a dormant phase allowing people with no symptoms to spread the disease,
- ineffective vaccines and development of drug resistance.

There remain a number of misconceptions, such as vaccines being given only to those people who are infected and the bacterium becoming 'resistant to the vaccine'. Another common error was the statement that the 'bacterium becomes immune to the antibiotics', this response suggests that the candidate does not have a good grasp of the meaning of immunity.

Teaching tip

In this question an insert was provided showing photomicrographs of a healthy lung and one with damage due to tuberculosis infection. Candidates are not expected to write responses on these inserts and centres may choose to save them for use as future teaching aids. There was an insert in the A2 Practical Examination of a section of lung showing the effects of emphysema. The photomicrograph used is available at:
http://www-medlib.med.utah.edu/WebPath/ORGAN.html#2
and reached by going to the section entitled Pulmonary Pathology.

Q.5 *(a)* With so many diseases now being attributed to smoking it was of no surprise to the Examiners that most candidates gained full marks here. The majority of responses listed emphysema and lung cancer or bronchitis. Some candidates lost credit as they stated 'cancer' without specifying where the cancer was found.

(b) As a longer response this question was generally very well answered and it is clear that centres are teaching this topic very well and in sufficient detail. Many candidates knew the appropriate scientific terms and used them effectively to gain the quality mark. In the majority of responses candidates separated out the three compounds and listed the effects of each one before going on to the next. This made their responses clear, logically laid out and easy to follow. The less well organised candidates jumbled up their answers so that it was not always easy to be certain which compound had caused which effect. If effects were attributed to the incorrect compound then the candidate lost credit. The effects of each component were well known and many candidates scored well above the maximum number of marks. Some candidates seem to believe that tar lines the arteries causing atherosclerosis and blood clots. A significant number of others attributed the effects of tar to carbon monoxide and stated that carbon monoxide causes lung cancer and inactivates the cilia.

Teaching tip

Students can compile a poster showing the human body with annotations covering the effects of each component of smoke – these can be colour coded to help link the effects to the component.

Q.6 In a question that contains a simple spirometer trace, the Examiners were surprised by the number of candidates whose responses suggested that they had never seen a similar trace or been asked to perform any analysis of such a trace.

(a) The Examiners were shocked by the small number of candidates who were able to gain full marks here. The Examiners did not expect measuring the mean tidal volume to be a task beyond all but the very best candidates at AS level. The majority of candidates came up with an answer between 3.10 and 3.50 dm^3. This suggests that these candidates were simply taking readings off the vertical axis and not actually measuring anything at all. Some better candidates took measurements but measured along the line of the trace rather than making a vertical measurement, these candidates achieved an answer that was too high. Even those candidates who measured accurately did not all achieve full marks as they expressed their answer to too many or too few decimal places.

In part *(ii)*, many candidates were able to state the measurement marked as **X** which was the vital capacity. Some erroneously called it the 'VO_2 max' or 'the maximum tidal volume'.

(b) A lot of candidates were able to give the simple response that the Examiners were expecting: 'the frequency of breathing will increase' and 'the tidal volume will increase'. However, a good proportion of candidates were possibly misled by the wording of the question and attempted to describe changes to the trace in the way that its waveform would change. Responses like 'the wavelength would decrease' and 'the amplitude would increase' were often not worded very clearly but were given credit.

Some candidates failed to read the question carefully or did not understand the meaning of ‘cardiovascular system’. These candidates gave perfectly accurate descriptions of what may happen to the breathing system which, unfortunately, gained no credit. The majority of candidates who did read carefully gained one or two marks for ‘increasing heart rate’ or ‘increasing stroke volume’. The best candidates were also able to describe vasodilation in muscles and vasoconstriction in the gut to ensure that blood is directed to the muscles where it is needed most.

Teaching tip

Using a spirometer in class is an excellent way to demonstrate how a trace is drawn and how it can be analysed. It is also a good opportunity to bring ICT into the classroom as it is relatively straightforward to connect a spirometer to a data logger using an appropriate sensor.

2803/01: Transport

General Comments

The paper produced a good range of marks and there seemed no evidence that the candidates were in any problem with time allocation. It was good to see that the more plant orientated section did not produce significantly lower scores than the other parts. This has not always been the case. The spelling of biological terms remains varied and it would be beneficial if centres continue to stress its importance. It is also important that candidates use the mark allocation as a guide to the number of points that the Examiners will be looking for in a response.

Comments on Individual Questions

Q.1 The aim of this question was to test some of the basic principles that underpin this module. There was evidence that candidates appreciated some of these ideas.

(a) Most candidates got the calculation correct in part *(i)*. A few had the ratio the wrong way round, but some incorrect answers were awarded the calculation mark. This underlines the importance of including a calculation in all such responses. In part *(ii)*, there was again a large number who stated that the ratio decreased as the spheres got larger. To get the second mark the candidates were expected to show some ability to manipulate the figures by indicating that the change was by two thirds or to explain the change in terms of the volume increasing by a factor of three whilst the area only increased by a factor of two. A significant minority became confused and thought that when the ratio decreased in the larger sphere, the surface area of that sphere actually decreased too.

(b) Many candidates had a good grasp of this idea and were able to relate the need to develop a transport system to the decreased surface area to volume ratio meaning that the area and distance for diffusion would make that mechanism ineffective. Weaker responses described mammals as having a large surface area to volume ratio so diffusion was suitable. Some failed to relate their answer to transport systems and discussed organs inside the mammal that had a large surface area.

(c) This was usually answered correctly. Lungs and alveoli were the usual responses.

Teaching tip

Always start this section with some simple mathematical models (cubes or spheres) to get the candidates confident at handling the mathematical concepts. Then apply the ideas to living organisms.

Q.2 This question proved to be a little more taxing for the candidates than expected. Applying knowledge in slightly different circumstances seems to have caught some out.

(a) Fewer candidates than expected scored all the marks here. Atrio-ventricular valve opening and semilunar valve closing were often correct. Atrio-ventricular valve closing was often given as **C** not **G**. The ventricle starting to contract was often given as **H** not **G**. Both the atrium and the ventricle relaxing was usually correctly recognised as **C** or **D**, but the minimum blood volume in the ventricle was often given as **D** (lowest pressure value) not **B** or **C**.

(b) Although there were a number of totally correct responses to the paragraph completion, there were a number of common errors. Myogenic often appeared in both the first two spaces. The SAN and AVN were sometimes inverted. The nodes sometimes became valves. 'Atrio' became 'arterio' – a different biological connotation and not credited. The band of fibres between the atria and ventricles stops the wave of activity. Many thought it passed it on or only delayed it or controlled it. Purkyne fibres sometimes appeared in the gap appropriate to the AVN.

(c) Most candidates got one mark for the general idea that the heart beat was uncoordinated. Many were then able to follow this through to the idea that less blood would reach the body and thus less oxygen would reach cells, tissues or organs.

Teaching tip

When teaching the cardiac cycle practice using graphs of pressure data alongside the factual accounts of the events in the cycle so that candidates become confident at applying their basic knowledge of the cycle to actual graphical data.

Examination Tip

When doing a paragraph completion exercise ensure that candidates read through the completed paragraph to ensure that it makes sense – this can eliminate some basic errors.

Q.3 It was good to see that candidates seemed more confident than has been the case on this area of the specification. That being said, it is important to stress again that answers on this area should be written in terms of water potential.

(a) There were many correct responses (**G** and **I**). Some candidates inverted the two. **F** was the most common incorrect response to either.

(b) *(i)* The definition of transpiration should include the evaporation of water from the aerial surfaces of plants and its diffusion down a water potential gradient into the atmosphere, mainly via the stomata. It is ***not*** the uptake and movement of water in the plant as has been stressed in previous reports. The Examiners stopped marking when this was mentioned in answers. This cost some candidates marks. Good answers to *(ii)* related the inevitability of transpiration to

- the large surface area inside the mesophyll of leaves,
- the need for open stomata for gas exchange so that carbon dioxide could be taken in for photosynthesis,
- the water potential gradient that exists between the mesophyll and the atmosphere.

Poor answers simply talked about transpiration pulling water up the plant.
It was encouraging in *(iii)* to see increasing numbers of candidates realising that xerophytic modifications do not stop transpiration just reduce it. In this particular question the key idea is that the hairs trap water vapour (not just water) thus reducing the water potential gradient and thus reducing transpiration. This is essential in the dry habitat where xerophytes grow. The hairs do not increase the area for water absorption as quite a number of candidates suggested.

(c) The extended writing answer produced many good answers and the quality mark was usually awarded. However, too many candidates wasted time by giving details of uptake and movement across the root via apoplast and symplast pathways. Common omissions were to talk of xylem rather than xylem *vessels* and confuse cohesion and adhesion. Water cannot move by the cohesion-tension theory (or any other theory); it is important to explain what the theory suggests as a mechanism. See the teaching tip below.

Teaching tip

Start teaching water movement in the xylem vessels from the top as that is where the majority of the force to move water is generated. Water moves *up* the xylem *down* a potential gradient. Transpiration from the mesophyll sets up this gradient which places water in xylem vessels under a tension. Vessels are completely water filled so the tension combined with the cohesive and adhesive properties of water move water up as a complete column (mass flow). Only when candidates are clear on this mechanism would it seem appropriate to deal with root pressure.

Q.4 This proved a difficult question for many of the candidates.

(a) *(i)* Most were able to name the Bohr effect. Some just called it a sigmoid curve. Part *(ii)* proved a mystery to many. The steep part of **both** curves corresponds to the partial pressure of oxygen in the tissues that need oxygen. Thus a small drop in partial pressure of oxygen in the tissues will give much unloading of oxygen from the haemoglobin. The majority of candidates either talked about how the curve was produced in terms of loading oxygen, or thought that the steep part was at the lungs or explained the Bohr effect. In part *(iii)*, the Bohr effect was better understood, but the key is that it results in **more** oxygen being unloaded at any given partial pressure. There was also scope for explaining how the effect works in terms of production of carbonic acid or hydrogen ions leading to the formation of haemoglobinic acid.

(b) Candidates found this difficult. They did not spot that the temperature effect was similar to the Bohr effect in terms of increasing the oxygen release. Some were able to suggest that exercise would produce the heat to raise muscle temperature, but few indicated that some of the energy in respiration comes off as heat.

Teaching tip

The curves are called oxygen dissociation curves for a good reason and should always be taught in terms of oxygen dissociation rather than oxygen association. Always work from right to left across the graph i.e. from lungs (the area with the highest oxygen partial pressure) to tissues (the areas with the lowest oxygen partial pressure). Encourage candidates to annotate a copy of a curve with the key areas and events.

2803/03: Practical Examination

General Comments

The examination as a whole tested material from all three AS modules as well as aspects of experimental design. The theme for the examination was movement. The Planning Exercise for this examination took the candidates out of the laboratory and into the gymnasium, sports hall or fitness suite. Some of the candidates obviously enjoyed carrying out the Planning Exercise and there were many interesting accounts of preliminary work that were used to inform the final plan.

The Practical Test was, perhaps, more demanding than some recent papers. Although concerns were raised about the time required to complete the exercises, almost all candidates attempted answers to all the questions and there were few comments on the Report Forms about shortage of time. In fact some finished with 15 minutes to spare. The drawing required in *Q.2 (a)* was not a detailed high power drawing, so did not require much time with the microscope. In part (b), candidates had to look at two photographs so did not require to use the microscope.

Most candidates produced word processed plans, which the Examiners always appreciate. Candidates who write their plans by hand should be advised that these must be written on one side of the paper only. While some information can be usefully included in tables, these should not be used for almost everything as a way of avoiding the limit on words! Most plans were within the word limit.

Candidates should sign the declaration on page 2 of the Planning Exercise and their teacher should sign the declaration on the front cover. There were quite a few instances where signatures were missing.

Centres are reminded that they may retain any inserts included with the Practical Test unless the candidates have written on them. If that is the case, then the insert should be attached firmly to the rest of the script.

Some centres asked why the instructions told them to use methylene blue in preparing the celery for *Q.1* of the Practical Test. Many technicians suggested that blue food dye works much better. And so it does! Anyone using this practical with students is recommended to use blue food dye (or presumably any colour) instead of methylene blue. Eosin also works well.

In the Report on the Planning Exercise, checking points are referred to by the appropriate letter. The report should be read alongside the mark scheme.

Planning Exercise

Most candidates appeared to have set about this Planning Exercise with some enthusiasm! Many found suitable information about training regimes and testing for aerobic fitness in school or college PE departments or on suitable web sites. Some quoted fitness trainers as one of their sources of information. The Examiners were often impressed by the preliminary work that had been carried out and the way in which this had been used to devise the plan. Some candidates stated that a pilot investigation should be carried out, but gave no further details. Others stated what the pilot investigation should be, for example finding a suitable number of participants with the same level of fitness. However, this does not get awarded the checking point (**l**) because candidates have to *show* evidence of preliminary work and state how this has been used in their planning.

Some candidates reproduced much of the material that they found within their plans, or attached to the end as an appendix. This is not necessary. However, candidates should show how they have made use of the material they find and give a reference to the source in the text. There are a number of ways of doing this – by a letter or number that refers to a bibliography or using the footnote facility in Word. Many did not score the checking point for this (**O**) because there was no reference *in the text*. There was no need to print out information from web sites and include all of this as an appendix.

Many candidates discussed the nature of VO_2 max and based their plans on assessing improvement in this parameter. Some wanted to use sophisticated apparatus to do this, but others explained that measuring pulse rates would achieve the same purpose. Shuttle runs, bleep tests and step tests were used to assess improvement in aerobic fitness. Unfortunately, some candidates decided to use these tests as their training regimes, which was not thought to be appropriate. However, the Examiners managed to apply the mark scheme to these plans although some checking points were somewhat more difficult to apply. Some candidates misread the instructions and planned to compare 'training' with 'no training'. Many explained the physiology behind VO_2 max and aerobic fitness. There was no need to do this in great detail, just enough to explain the theory behind the plan (**H**). However, this was an aspect that some candidates ignored. Others wrote at great length often copying information from a text or web site. This information should be put in the candidate's own words and it should be linked to some aspect of the plan. Most did this by referring to the effect of fitness on the body systems, such as the gas exchange system and the circulatory system. This linked well to *Q.2* of the Practical Test.

The Examiners applied the usual 'rules' about Planning Exercises to this example. This means that the usual checking points for reliability, precision, number and range were adapted for this context.

Some candidates realised that in the absence of a ready supply of identical twins that they would have to use a relatively large sample of people. The Examiners considered ten people to be the minimum for this (**L**). There was often much discussion of the need to have people of similar age, initial fitness, etc. This point (**E**) was awarded if there was also some control over the two training regimes, for example that participants trained for the same length of time or on the same number of days each week. The Examiners also thought that there should be a definite time for the investigation so looked for a minimum of four weeks (**G**). Although many decided to assess aerobic fitness at the beginning and at the end of the training period, there were many more that realised that they should measure parameters, such as resting heart rate, recovery time or blood pressure at intervals throughout and thus scored **F** if they made five such assessments. Many did this by assessing their chosen parameters at the end of each week or at the time of each training session. In many cases the Examiners had to look hard for this checking point and perhaps candidates should be encouraged always to think about this aspect. Many more than usual gained the checking point for validity (**T** in this case). They did this by commenting on the need to have participants in the study who had the same initial level of fitness. **T** was not awarded for simply making a statement. It was awarded for some discussion and/or explanation.

The Examiners were surprised that some candidates did not include a prediction. Some candidates simply stated that the aerobic fitness of all the participants would increase. This was not awarded checking point **B**. Others chose very different training regimes, stated something about them and then decided that one would be better at improving aerobic fitness. The null hypothesis was found occasionally and this was awarded this point. Some did not define aerobic fitness and so did not gain **D**. The training regimes were usually appropriate. In some cases they were described in great detail! However, some were clearly inappropriate. Five minutes on a treadmill was definitely not considered sufficient.

Very few candidates considered the precision of their measurements (**N**). As many were recording pulse rates, it was expected that they would refer to issues to do with timing using a stop watch or refer to the reasons for using a pulse meter or heart rate monitor. Many described how to take blood pressure measurements, but few stated how the results were obtained or referred to precision.

Candidates are always expected to show how they will collect the data from their investigations (**P**). The Examiners looked for tables that showed how data would be collected throughout the investigation. Often in these tables the headings lacked units. Some only gave tables to show how data from one individual assessment of aerobic fitness would be presented. Many explained how they would interpret their results (**R**). Some stated that they would calculate percentage changes; some used a statistical test, such as the t test. However, the majority stated that they would draw a graph although often the axes were not labelled clearly and so lost the mark.

Teaching tip

Candidates would benefit from being given a check list of points that correspond to the descriptors for Skill P. Such a check list is given below. However, the letter ascribed to each descriptor below may change from session to session depending on the precise nature of the planning exercise.

1. Plans a suitable procedure.

2. Gives a prediction.

3. Selects suitable equipment and materials.

4. Identifies key factors to control.

5. Decides on appropriate number of measurements to take.

6. Decides on an appropriate range of measurements.

7. Describes appropriate AS level scientific knowledge and understanding.

8. Uses information from at least one identified source, e.g. preliminary work, previous practical work or secondary sources in developing a plan.

9. Refers to a safety aspect, (hazard and precaution).

10. *Gives a clear account logically presented with accurate use of scientific vocabulary.*

11. Describes ways of obtaining precise results.

12. Describes ways of obtaining accurate results.

13. Uses information from at least two identified sources, e.g. preliminary work, previous practical work or secondary sources in developing a plan.

14. Shows how data is to be presented in a table or graph correctly formatted.

15. Links plan throughout to scientific knowledge and understanding.

16. *Uses spelling, punctuation and grammar accurately.*

17. Explains how data would be interpreted to find the answer to the investigation.

18. Comments on precision and accuracy by evaluating sources of error

19. Comments on validity by commenting on constraints in method controlling variables / evaluating effects of uncontrolled variables

Practical Test

Q.1 This exercise was about osmosis. The majority of candidates performed well on the practical aspects, and most were able to use their knowledge of water potential in giving an explanation. This aspect (analysis) was much better than in previous practical examinations. Some of the points of evaluation credited on previous examinations were not easy to apply to this particular investigation, but many candidates made sensible suggestions although they often spent too long writing this out in lengthy prose and often repeated themselves.

In this exercise, the candidates had to cut narrow strips from the edge of the petiole of celery and immerse them in different concentrations of sucrose. While these were immersed, they had to make a cross section of a piece of celery that had been standing in some water dyed with methylene blue.

(a) A very simple outline drawing was all that was required here. Some candidates did not observe the position of the vascular bundles very clearly. They should have placed these immediately behind the ridges on the outer edge of the petiole.

(b) There were many descriptions of the cross section. Some candidates thought that water was transported in the phloem.

(c) Almost all candidates showed that the epidermal strips curved appropriately in distilled water with the epidermis on the inside of the strip. In the dilute solutions, the strips remained fairly straight. Some candidates showed the strips curving in the opposite direction in 0.5 mol dm^{-3} sucrose solution. If this did not happen, then the Examiners were able to apply the mark scheme by looking for **F** being straighter than **D**. Some candidates drew what appeared to be very thick sections and it was not surprising that these did not show any bending at all. A few candidates omitted to include an ‘E’ on each of their drawings.

(d) Most candidates were able to apply their knowledge of osmosis and water potential to the explanations required here. Inevitably, there were quite a few references to ‘water concentration’ and ‘semi-permeable membranes’: neither gained credit. Many candidates did not use the phrase ‘water potential gradient’. This would have made their explanations much more concise and saved them time.

(e) The evaluations were often very good. Candidates seem to perform better if they think in terms of a number of different aspects of the method and the results rather than concentrating on just two or three. Short comments are all that are required for each point of evaluation. Candidates should know that there are approximately 14 marks devoted to evaluation on these Practical Tests.

(f) Candidates clearly found this exercise more demanding than was intended. Part of the exercise was to select the appropriate information to draw the graph. There was a mark for giving percentage change on the vertical axis of the graph and concentration of salt or water potential on the horizontal axis. However, if candidates plotted any other pair of variables, then they could gain the rest of the marks. Those that plotted concentration against water potential (or vice versa) were not able to answer part *(ii)*. There were many excellent answers to part *(ii)* that were annotated clearly on the graph and explained.

Very worrying was the large number of graphs that were not scaled correctly. This point was raised in the report on the examination taken in January 2005.

Q.2 Some problems were reported with the slide of TS trachea. In some cases the cartilage did not form a complete C-shape as indicated in Fig. 2.1. However, teachers reported that they instructed their candidates which part of the section to use in answering part *(a)*. The Examiners were grateful for this information. Teachers using their centre's own slides for this exercise should be aware of this.

(a) Most identified cartilage in Fig. 2.1. Some thought it was smooth muscle. The drawings varied considerably in quality. Candidates were expected to note the different thicknesses of the tissues and indicate this in the plan drawing. It was not necessary to draw cells or to put in any shading. Nor was it necessary to draw the whole section as seen in the slide. Making low power plans is obviously an area that needs some attention. Good candidates spotted blood vessels and mucous glands so added these. Labels and annotations also varied in quality, but almost all the points on the extensive mark scheme were seen. The candidates should not have seen any smooth muscle in their slides, although many indicated this.

(b) Most candidates gained full marks for the table. Some, however, did not read the instructions carefully and gave accounts of function that were not required. There is no such thing as 'rough muscle'. Some candidates knew the names of the different layers and could give some detailed information.

(c) This question prompted some excellent descriptions of changes in the trachea and the artery. However, some candidates discussed the changes that happen in an artery at any time, not during exercise. Rather worrying were the references to cilia in the artery and cartilage in the artery. Some candidates wrote about the movement of oxygen in the trachea, rather than the movement of air. In the artery, the smooth muscle was described as 'contracting' or 'pulsating' to help move blood along.

Teaching tip

Fig. 2.2 has two photomicrographs of a muscular artery. This topic was last asked in January 2002. The question asked candidates to compare three slides which were cross sections of a muscular artery, an elastic artery and a vein. This was quite a demanding exercise and one that might have worked better with a slide and two photomicrographs. If teachers wish to use this question and do not have access to the appropriate slides, they can use Fig. 4.1 and some material from web sites such as The Histology Learning System:
www.bu.edu/histology/m/index.htm

2804: Central Concepts

General Comments

The paper provided an opportunity for candidates to score marks across the ability range. The Examiners were pleased to see an encouraging improvement in the following areas:

- clarity and accuracy of written English,
- ability to carry out simple genetics problems,
- the use of correct biological terminology.

Overall candidates showed good knowledge with understanding on many of the questions. However, they were less secure when having to apply biological principles and concepts in solving problems in unfamiliar situations. This matches Assessment Objective 2 (a). Very few candidates were able to complete the calculation in *Q.4 (c)* successfully.

Comments on Individual Questions

Q.1 This proved to be an appropriate question to start the paper and it was generally well answered. Candidates demonstrated sound knowledge of photosynthesis.

(a) Most candidates identified the labels on the electronmicrograph of a chloroplast correctly. However, a significant number thought the chloroplast was a cell and stated that label **A** was cytoplasm and label **B** the cell membrane. Label **B** proved the most demanding, but the Examiners were happy to accept inner membrane, outer membrane or chloroplast envelope.

(b) The Examiners were looking for thylakoid, lamella or granum. Most candidates answered this question successfully.

(c) A large number of candidates scored full marks on this section. The most common error was to state reduced NAD rather than reduced NADP.

(d) This section tested candidates' understanding of photophosphorylation in an unfamiliar context. In general, the candidates made good use of the information in the diagram to explain the mechanism in terms of setting up a proton gradient and using the energy of this gradient to phosphorylate ADP as the protons diffuse through the ATP synthase complex. Many candidates correctly referred to chemiosmosis and the fact that the cell membrane is acting as an energy transducing membrane.

Teaching tip

When electrons move through a series of carriers in a membrane, or protons diffuse across a membrane, energy is released. It is not 'produced' or 'created'.

Q.2 Candidates tended to score well on this question.

(a) Most candidates scored three or more marks. The most common mistakes were Kingdom Mammalia rather than Animalia and 'feline', 'cat', 'Homo' or 'tigris' stated as the genus. The full binomial name of the tiger was given in the stem of the question. Many candidates did not realise that the first part of the binomial is the

genus of the organism.

(b) *(i)* Many candidates missed out on scoring both marks in this section by referring to *numbers* of tigers in their descriptions rather than how the overall distribution has changed in the last one hundred years. Most marks were gained for reduction of area covered and the disappearance of the Caspian (and other) sub-species.
(ii) Many candidates scored three marks for reference to geographical separation of the different populations, the fact that they are subjected to different selection pressures and that over time natural selection occurs. The fourth mark could be gained by reference to mutations or the fact that new alleles arise. Credit was also given to answers that mentioned the founder effect or genetic drift.
(iii) This was very well answered with most candidates explaining the difference between sub-species and species in terms of whether reproduction can take place and whether the offspring are fertile.

(c) A surprisingly large minority of candidates failed to read the graph correctly. Weaker candidates failed to understand the label *cats per 100* km^2 and thought that they had to multiply the figure read off the graph by 100.

(d) There were very few problems with this section. The majority of candidates correctly stated that tigers are bigger.

(e) The Examiners credited references to disease, hunting, habitat destruction, limited gene pool, competition for resources other than food, and climate change due to global warming.

Teaching tip

Centres should make candidates aware that in natural selection it is *allele* frequencies that change and not *gene* frequencies.

Q.3 Part *(a)* seemed to present the most problems to candidates; many were able to score high marks on parts *(b)* and *(c)*, but very few on part *(a).*

(a) Many candidates assumed in *(i)* that there was only one stage with diploid individuals (usually **A**) and therefore failed to score. Surprisingly few candidates picked up on the idea of random fertilisation or random fusion of gametes in *(ii)*. Many stated details of the causes of variation during meiosis, such as crossing-over and independent assortment. Some stated that because individual **A** has two parents it has more genes or chromosomes, rather than more alleles. In part *(iii)*, most candidates recognised that individuals **C** and **D** were haploid but did not make clear that mitosis maintains the chromosome number whereas meiosis results in a reduction in that number.

(b) Responses to this question were dominated by descriptive accounts of the stages of meiosis with incidental references to features resulting in variation. Features such as ‘Independent assortment’, ‘crossing over’ and ‘homologous chromosomes’ were referred to in many answers although only the better candidates were able to make the links clear. Candidates who mentioned mutations usually referred to gene mutations rather than chromosome mutations and therefore missed the mark. Many candidates were unable to distinguish between chromatid and chromosome.

Weaker candidates were unable to distinguish between meiosis I and meiosis II. The quality mark was readily accessible as many candidates could list four terms from the seven available.

(e) Although it was clear that most candidates understood the genetics of human blood groups, marks were lost by failing to complete the table correctly. The most common mistake was to use only one allele for each genotype rather than two.

Teaching tip

When describing the stages of meiosis candidates are advised to state whether they are referring to the first or second division. Candidates should be reminded that independent assortment takes place in both metaphase I and metaphase II. In metaphase I it is the independent assortment of chromosomes, and in metaphase II it is the independent assortment of chromatids.

Q.4 This question caused the most difficulties of any on the paper.

(a) The Examiners were looking for candidates to refer to the removal of the toxic products of *metabolism*.

(b) Many candidates correctly stated proteins, but few referred to nucleic acids. Unfortunately there were many references to amino acids that did not gain the mark as the question asked for macromolecules.

(c) The calculation of percentage increase in part *(i)* was beyond the capabilities of most candidates. However, many gained one mark for calculating the difference in mass as 12.5 g. In part *(ii)*, the Examiners looked for candidates to state that with more amino acids there will be increased levels of deamination resulting in more ammonia. The ammonia is converted to urea in the ornithine cycle. Many candidates simply stated that proteins are converted to urea.

(d) Many candidates realised that urea is less toxic than ammonia. Few referred to the fact that ammonia requires large amounts of water to dilute it to a level where it is non toxic and that terrestrial animals cannot afford to lose this amount of water.

(e) The Examiners were disappointed by the poor standard of answers to this question. Few realised that the drop in the concentration of glucose as the blood passes through the kidney is due to the kidney cells using the glucose in respiration. In addition, few realised that some of the urea diffuses back into the blood in the proximal convoluted tubule and elsewhere. Many candidates ignored the data and simply stated that all the urea is lost in the urine.

Teaching tip

Candidates should be encouraged to calculate percentage change in the following way:
(final value – original value) / original value x 100

Candidates should be reminded that urea that is absorbed into the tissue fluid in the medulla from the collecting duct, diffuses into the ascending limb of the loops. This keeps the urea within the medullary tissue where it has a role in lowering the water potential and so helps to concentrate urine.

Q.5 This proved to be a very approachable question. Candidates across the ability range wrote at length and scored well.

(a) The Examiners were often able to award maximum marks on this section. ADH was correctly identified as the hormone controlling water permeability in the collecting ducts by all. Marks were lost for both insulin and glucagon by not specifying the respective roles they play in controlling blood glucose concentrations. Some candidates confused glycogen with glucagon. No marks were awarded for answers with hybrid spelling. The Examiners saw many incorrect spellings of abscisic acid and in general it was felt that candidates might be better to stick to writing ABA.

(b) This section was either done extremely well with vast amounts of very detailed knowledge on both the transmission of the nerve impulse, action potentials and synaptic transmission, or extremely badly with only the sketchiest of ideas expressed in vague terms. Problems were caused when candidates failed to realise that an *outline* of the entire process was required and not a detailed account of the development of the action potential.

Teaching tip

Centres should stress to candidates to refer to sodium and potassium *ions* when describing the events associated with the action potential. In addition, candidates should be able to differentiate between voltage-gated channels and ligand-gated channels.

When describing synaptic transmission candidates should always refer to the presynaptic and postsynaptic membranes.

Q.6 This was a demanding question to complete the paper. There were many good answers correctly describing the reactions involved in glycolysis and the lactate pathway. Candidates were less successful in explaining why fats have a greater energy value per unit mass or what happens when oxidation is uncoupled from phosphorylation.

(a) Many candidates gained full marks on this section. The most common error was to state that dehydrogenation occurred in stage **B** rather than in stage **C**.

(b) Nearly all candidates correctly stated that the site of glycolysis is in the cytoplasm.

(c) Most candidates correctly stated two as the net gain of ATP molecules in glycolysis, but a significant number incorrectly stated four. Presumably they had not seen **net gain** in the stem of the question.

(d) Weaker candidates were confused between the lactate and ethanol pathways and their answers were often a hybrid of the two. It was often incorrectly stated that carbon dioxide was released as pyruvate is converted to lactate. There were many references to lactose rather than lactate. There were a considerable number of candidates who incorrectly stated that NAD is reduced when pyruvate is converted to lactate and that the pyruvate is dehydrogenated.

(e) This section was not so well answered. Many candidates simply referred to fats having more calories. There were vague references to 'more bonds' being present without reference to more C-H bonds. It was perfectly acceptable to say that fats contain more hydrogen. Only a few candidates made the link between more

hydrogen, a greater number of reduced NAD and FAD molecules, and how these feed into the chemiosmotic process of oxidative phosphorylation generating more ATP.

(f) Very few candidates realised that the electron transport chain would still function. Most candidates did not appreciate that some ATP would be generated through substrate level phosphorylation in glycolysis and Krebs cycle. Marks were gained by candidates who stated that food stores would be used to generate ATP and that there would be no excess food to build up these stores again.

Teaching tip

In questions such as *Q.6 (d)* where the candidate's knowledge of a biochemical pathway is being tested it is quite acceptable for the candidate to write out the pathway as a flow diagram as part of their answer. Many candidates who followed this approach gained full marks.

2805/01: Growth, Development and Reproduction

General Comments

There were many papers of a high standard with candidates well prepared. Legibility was generally good, with very few scripts being difficult to read. The majority of candidates attempted all parts of all questions. The two calculations were completed correctly by a high number of candidates. When interpreting data, although the majority of candidates quoted figures, some still failed to do this, so were unable to gain marks.

In this paper, there were synoptic references to hormonal control, nuclear division, water uptake by plants, enzymes and antibodies. These were tackled with varying degrees of success, and will be referred to in the comments on the relevant questions.

Comments on Individual Questions

Q.1 This question was intended as a gentle introduction, with most candidates obtaining high marks.

(a) *(i)* There were few problems naming **B** and **C**. Some weaker candidates were less sure about **D**, naming it incorrectly as ovary, ovum or embryo sac.
(ii) All candidates who correctly identified **A** as a petal went on to give relevant comments. However, a few candidates across the range referred to stamens, leaves or sepals.

(b) *(i)* The tetrad was recognised and the majority of candidates described its development from a pollen mother cell clearly and concisely. The main error was in referring to division by mitosis. Some candidates went on to describe how the tetrad continues to develop, thus wasting time in giving irrelevant information.
(ii) Most candidates correctly described features of the exine. A few candidates incorrectly referred to features of seeds, rather than pollen grains.

Teaching tip

Compare diagrams and specimens of flowers from a range of species, to ensure that the parts can be recognised in contexts other than textbook illustrations. Discuss the various adaptations for wind and insect pollination. Candidates could then go on to design their 'ideal flower' for attracting insects.

Q.2 This was quite a straightforward question on growth, and should have been accessible to all candidates. However, some responses to *(c)* were disappointing.

(a) *(i)* The calculation was generally well done. Candidates could obtain one mark if they took incorrect figures from the graph, but used them in the correct way. This emphasises the need for working to be shown.
(ii) The majority of candidates gave a correct answer. One or two candidates gave answers such as 'the female growth spurt is at a different time'. This is not specific enough to gain credit.

(b) *(i)* The data in the table would clearly produce an absolute growth rate curve. Relatively few candidates gave this correctly, and no other responses were accepted.
(ii) This calculation was carried out less well. Percentage calculations always seem

to cause difficulties, even to some of the best candidates.
(iii) There were some very interesting and thoughtful responses, including those that suggested that measuring mass could give early indications of malnutrition or obesity.

(c) Credit was given for references to human growth hormone and thyroxine. There were some excellent responses with detailed descriptions of the effects of these hormones. It is correct for candidates to refer to '*control* of basal metabolic rate' by thyroxine, but the word *control* should be avoided in relation to processes such as protein synthesis and transcription. Candidates should be encouraged to use words that describe the specific effects. For example, HGH *stimulates* protein synthesis and *increases the rate* of cell division. Some weaker candidates gave very vague descriptions of hormone control, without any reference to named hormones, or wrote about the effect of hormones during, rather than before, puberty. Most candidates with five or above marks obtained the quality mark.

Teaching tip

Produce a diary of someone's life, from birth to old age, in terms of the hormones affecting their growth and development at different stages. Small groups could each take on one stage of life and report back to the others. The stages and the hormones involved could also be summarised as a timeline.

Q.3 It was pleasing to read some very clear responses relating to hormones involved in the menstrual cycle. Details of gametogenesis were less well known.

(a) Responses to this question were disappointing. Large numbers of candidates were unclear about the cells produced at different stages in oogenesis.

(b) This question required a response related to the *importance* of mitosis and meiosis, not simply a description of the cells produced. Many candidates understood the importance of meiosis in reducing the chromosome number, but only a few referred to genetic variation. Fewer candidates than expected were able to relate mitosis to the production of the large numbers of spermatozoa needed, despite referring to a low sperm count in *(c)(ii)* as a reason for infertility.

(c) *(i)* This was generally answered well, indicating a good understanding of the role of progesterone in maintaining the endometrium for implantation. Incorrect responses included references to the uterus wall.
(ii) Most candidates recognised that male infertility would be a possible reason. Responses suggesting that there were problems with the woman's menstrual cycle were not credited, as candidates had been told that this was normal. This question referred to a failure to become pregnant, so responses referring to early miscarriage were not credited.

(d) There were some excellent responses, indicating a good understanding by many candidates. The best candidates were able to explain the different effects on FSH and LH, depending on the levels of oestrogen secreted. However, candidates who gave a straightforward description of negative feedback, referring correctly to the hormones and endocrine glands involved, were easily able to obtain full marks. When referring to the pituitary gland, candidates should always state the name of the relevant lobe in order to gain credit.

Teaching tip

List some of the processes in which mitosis occurs. These could include: gametogenesis, asexual reproduction, division of the generative nucleus and growth of endosperm. In each case discuss why it is important for mitosis to occur. What would happen in each case if the numbers of cells failed to increase, or if genetic variation occurred?

This may also be a suitable place to revise the mitotic cell cycle from *Biology Foundation* (2801). Also mitosis may be compared with binary fission in bacteria.

Q.4 This question was accessible and answered well by a wide range of candidates.

(a) *(i)* Although the majority of candidates explained that clones were genetically identical to the parent, most felt that they had said enough, with few obtaining a second mark by stating the process involved (yet another example of the importance of mitosis), or by making it clear that only one parent was involved.
(ii) All the possible answers shown on the mark scheme were seen. However, it was not enough to restate that clones are genetically identical without putting this into the context of the desirable characteristics being passed on from the chosen parent.
(iii) This question asked about commercial uses, which are very specific. There were many very vague references to auxins increasing growth or plant maturation.
(iv) It was pleasing to see how many candidates realised the synoptic nature of this question and explained how the large surface area provided by root hairs helps in the uptake of water and ions. Some candidates moved too far from the original question by describing the functions of water to the plant and this did not gain them credit.

(b) Many candidates correctly listed three constituents. Specific details were required and credit was not given for ‘nutrients’, ‘sugars’ or ‘growth hormones’. A few candidates had misread the question and wrote about conditions rather than constituents.

(c) There were many excellent responses, showing good understanding of the financial implications of the commercial process.

(d) Almost every candidate obtained this mark.

Q.5 It was pleasing to see the topic of photoperiodism, often considered difficult by candidates tackled so well.

(a) *(i)* Candidates who took figures from the graph to illustrate their answers easily obtained two marks. It was easy to read figures precisely from this graph, and only correct figures were accepted. Statements such as ‘the germination rate increased’ are not enough for credit and must relate to a range. Most candidates seem to be aware of this, but some do need to be reminded.
(ii) As in the previous question candidates used synoptic material, this time on enzymes, to good effect. A majority referred to optimum temperature and denaturation, with the best responses also including references to reaction rate and the structure of the active site. The weakest responses described the pattern, but did not explain this in biological terms.

(b) About half the candidates gained credit here by recognising that germination would

be more likely to occur in covered or shady locations. Many responses were more related to temperature than light, so did not gain credit.

(c) It was encouraging to see this topic tackled well. Many candidates in the top third of the range gained full marks easily, and it was common to see at least four marks obtained. Marking points could be obtained from an equation, though most candidates who provided one usually gave the information in writing as well. Candidates who obtained very low marks usually did so for one of two reasons: some confused the two forms of phytochrome; others made statements such as 'far red light changes to red light at night', without any reference to phytochromes at all. Most responses were legible and well written, with the majority obtaining the quality mark.

Teaching tip

Kimball's Biology has some useful pages on photoperiodism:
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Photoperiodism.html

Q.6 Responses to this question were very varied but it was rare to see full marks obtained.

(a) *(i)* A surprisingly large number of candidates recognised that the 17 to 18 year olds would still be growing themselves, but did not refer specifically to bone development. Even candidates who wrote about bone growth were not able to expand on this in order to obtain the second mark.
(ii) There were very many correct responses, with the most popular being references to folic acid, protein and alcohol. 'Do not smoke' is not dietary advice.

(b) A maximum of three marks was given for stating the names of transport methods with a large majority obtaining at least two of these. To obtain full marks, candidates needed to give more detail of these methods with one mark being available for a description of an adaptation of the placenta. The best candidates easily obtained these additional marks.

(c) *(i)* This question asked candidates to state how a healthy pregnant woman is able to provide 300 mg of iron to her fetus without taking extra iron in her diet. The most common correct response referred to the cessation of menstruation. Few but the best candidates knew that iron absorption from the gut is increased during pregnancy. There were many references to iron already being present in the body, but a specific reference to iron stores was needed to gain credit. Weak responses included references to fetuses not needing extra iron, indicating that candidates had not read the stem of the question.
(ii) Most candidates obtained at least two marks, most often by stating that a fetus is less able to obtain oxygen and is therefore likely to have slow growth. By relating back to the stem, the best candidates were able to work out that an anaemic mother may not be able to supply sufficient iron to her fetus for production of fetal haemoglobin, with consequences for oxygen transport, respiration and energy release. As the question asked for consequences for the fetus, credit was not given for references to the effects of anaemia on the mother.

(d) This final question needed candidates to draw on synoptic information on antibodies. Although correct references to the Rhesus factor gained credit, knowledge of this was not necessary to gain marks. Some candidates were aware that antigens are present on the surface of red blood cells, somehow causing the

antibodies to attach, but it was disappointing that no candidates gave any detail on the importance of antibody structure in relation to this function.

Teaching tip

There are many sources of advice on diet for pregnant women including leaflets obtainable from medical centres. Try the informative websites, www.nutrition.org.uk and http://www.food.gov.uk

2805/02: Applications of Genetics

General Comments

Some candidates had been well prepared for this paper and showed a pleasing command of the topics tested and an ability to apply their knowledge in unfamiliar situations. Good answers were seen to all questions, but maximum marks on questions were rare and a smaller proportion of candidates than usual produced clear, unambiguous answers. Technical terms were mostly used appropriately, although the Quality of Written Communication (QWC) mark for the use and organisation of scientific terms was awarded only rarely. Candidates should be reminded of the differences between the terms *gene* and *allele*, *homologous* and *homozygous* and *transcription* and *translation*.

A small number of candidates did not complete the last question, but the majority attempted all parts of all questions. All questions showed discrimination between candidates, with marks spread over a wide range. Not for the first time, those sections of questions that included synoptic material (33% of the marks) were answered less well than those relating only to this option. The material on this paper from the AS specification, namely nucleic acids, protein synthesis and immunity, were particularly poorly answered.

Comments on Individual Questions

Q.1 In general, candidates found this to be an approachable first question. Much good use was made of the information provided.

(a) *(i)* Many candidates recognised that this was dominant epistasis, and a number were able to go on to identify the epistatic and hypostatic genes. Stronger candidates suggested a mechanism for the inhibition of carotenoid production.
(ii) A pleasing number of candidates stated that this flower colour had distinct phenotypic classes, was qualitative and controlled by two genes with different, large effects.

(b) *(i)* Most candidates were on familiar ground here, although some attempted to bag just the stamens and there was some confusion between *stamens* and *stigmas*.
(ii) Stronger candidates were able to propose that this was to increase the genetic contribution of the species concerned, some referring to the species' background genes.
(iii) A large number of candidates mentioned homozygosity, but only the stronger candidates stated that it was a way of getting plants with red (**aa**) flowers.

(c) Some very good answers were seen here, with appropriate references to the data provided. Many candidates realised that swapping the alleles reduced the number of visits by the normal pollinator and that colour appeared to be more important to bumblebees than to humming birds.

Teaching tips

- Persuade candidates that gene and allele are not synonyms.
- Ensure candidates have a good understanding of flower structure before starting on plant selective breeding.
- Remind candidates that information given in a question is there for a purpose.

Q.2 Although many candidates were familiar with heritability and progeny testing, the explanations of their importance in a selective breeding programme were often couched in non-technical language.

(a) Full marks on this question were rarely seen, often because the candidates wrote largely about either heritability or progeny testing, leaving the second to a final sentence. The quality mark for use and organisation of scientific terms was awarded only occasionally, with most candidates using no other terms than the two given in the question, not even referring to phenotypic variation. Occasional attempts to stress the importance of progeny testing for *sex-limited* traits foundered because the traits were described as *sex-linked*. A number of candidates made good use, in their answers, of the examples from selective breeding of pigs.

(b) Most candidates were able to compare the differing transcriptions by the **QQ** and **qq** genotypes and made suitable use of comparative figures, although a few candidates assumed that the data given could be read as mass of muscle produced by the two types of pig.

(c) Despite the emboldening of *non-coding* in the stem of the question, the majority of candidates plunged straight into a change in triplet code meaning a different amino acid in a polypeptide, with consequent change in tertiary structure. It was pleasing to see that this is so well known by so many candidates, but irrelevant here. Only the strongest candidates suggested changes in the regulation of protein synthesis.

Teaching tips

This question prompted several suggestions.

1. Point out to candidates that they are unlikely to get full marks for considering only one of two items in a question.
2. Candidates should always make use of comparative figures when asked to compare data from a table or graph.
3. Stress the importance of reading the stem of the question. An item in bold type is likely to be important.
4. Revise transcription, translation and the regulation of protein synthesis before starting on this module.

Q.3 Some candidates failed to spot that they were being asked about a wildtype gene bank.

(a) Those candidates who realised that a population of crucian carp that had not interbred with other species was needed as a gene bank for future use immediately accessed a number of marks. However, full marks in this section were not common. A few candidates focused on the carp's ability to live in a range of temperatures, but seemed to think that the ability to live at 1 ^oC was more unusual in a British fish than the ability to live at 38 ^oC. References to the use of this trait in case of possible temperature rise or global warming were very rare. There was considerable *inbreeding* between species and *interbreeding* of one species, making it difficult to see whether or not the candidate was referring to hybrid offspring.

(b) *(i)* Most candidates were on very firm ground here. Maximum marks were common.
(ii) Most candidates were able to draw bands in the correct positions.

Teaching tip

Point out to candidates that it is possible to use bullet points to organise an answer, even in a question that carries the Quality of Written Communication (QWC) mark for the quality of spelling, punctuation and grammar, provided that the bullet points are full sentences.
Distinguish between *inbreeding* and *interbreeding*.

Q.4 An alarming number of candidates were confused about transcription and translation.

(a) The stronger candidates saw that the two RNAs would bind together to give double-stranded RNA which was incapable of attaching to a ribosome or to tRNAs. A large number of candidates said that binding the two RNAs would prevent transcription. Some said that both RNAs would give rise to proteins, or that the RNAs would produce DNA.

(b) (i) On the whole, candidates were able to gain marks by describing the data given in the graph. A few were confused by the label of the vertical axis, referring to fresh mass of cells, rather than to theobromine or caffeine contents.
(ii) Stronger candidates suggested that the two lengths of complementary RNA bound differently with the mRNA.
(iii) Most candidates were familiar with the procedure of cloning plants from tissue culture. The explants were rarely described as meristematic or cambial, or as being pluripotent or totipotent, but enough other correct information emerged to give many candidates full marks.
(iv) Some candidates, who correctly saw that the plants would be genetically identical, found it hard to explain how this was of benefit to the experiment. Others realised that large numbers of plants could be produced quickly. Very few candidates considered both points.

Teaching tips

- Revise the nucleic acids, transcription and translation before starting this module.
- Persuade candidates always to make use of the data given in a graph. For example, when one value is half another they should say so.

Q.5 Some candidates had confused ideas about the structure of bacterial cells.

(a) Very few candidates pictured the antibiotic diffusing into a biofilm of bacteria and the possibility that it might not reach all the cells, or be trapped by the material of the film. Almost all candidates said that since the bacteria were held together by the film, then transfer of a resistance allele by conjugation would be easier than when in suspension. This idea, although unlikely, was credited.

(b) Many candidates made good comparisons of the sensitivities of the two strains of bacteria to antibiotics, quoting appropriate values. A few candidates thought that an increased sensitivity was shown by a larger value.

(c) A majority of candidates suggested that the difference in sensitivity between the two bacterial strains arose from a chance mutation, which was then selected for.

Details of mutations were rare. Some candidates forgot about the structure of a prokaryotic cell and talked of chromosomes and dominant and recessive mutations. Only the strongest candidates suggested that the mutation might affect the structure or composition of the biofilm.

(d) The question asks about transfer to a different species of bacterium, but many candidates plunged into vertical transmission. There was much confusion, even among candidates who were describing conjugation, in whether this was horizontal or vertical transmission. The word *conjugulate* (sic) was used by candidates from more than one centre.

Teaching tip

Revise bacterial cell structure before embarking on bacterial resistance.
Distinguish between vertical and horizontal transmission.

Q.6 Many marks were lost from confusion over various aspects of the immune system, including mistaking antigens for antibodies.

(a) *(i)* Relatively few candidates were able to write that glycoproteins were antigens displayed on the outer surface of cells and distinguishing self from non-self.
One candidate thought that the HLA system determined the ABO blood groups.
(ii) A number of candidates failed to notice the instruction *explain* in the stem of the question and merely described the differences shown in the graph. Few candidates made reference to an immune response and no candidate gave any detail about what such a response might be. A few answers included the words *rejection* and *foreign*.
(iii) Only a few candidates gave the impression that they had encountered the idea of memory cells or a secondary response when studying immunity for AS.

(b) *(i)* The majority of candidates were able to name a haplotype, although not all could spell it correctly.
(ii) A few candidates failed to keep paternal and maternal haplotypes intact and introduced crossing over.
(iii) A significant number of candidates opted for a probability of 0.5.

(c) Candidates were much more confident of the answer to this question, compared with the last time it appeared on a paper. Plainly candidates could have written at greater length on this topic.

Teaching tip

Revise immunity before introducing the HLA system. Persuade candidates that it is preferable to write a probability as, for example, 0.25, rather than 25% or 1 in 4.

2805/03: Environmental Biology

General Comments

Overall the candidates performed quite well on the paper. Candidates were able to answer parts of each question set and there was not one area that was poorly attempted. Both the extended answer questions were answered in detail and it was pleasing see many candidates using a plan and a clear structure in tackling these. Candidates from many different centres highlighted and annotated the question stems and graphs to aid in their answers. Many candidates, however, lost marks on several questions by failing to explain their answers. This was because they either did not use the data provided in the stem of the questions or they failed to understand the actual data which needed to be interpreted first before answering the question. The data referring to biological oxygen demand (*Q.1*), the international agreements on CFC production (*Q.3*) and sulphur dioxide concentration and lichens (*Q.5*) had to be understood thoroughly before candidates began to attempt their answers. It appeared that many did not study the data carefully and this resulted in these candidates failing to explain the information clearly. However, some did annotate the graphs or rule lines to help their understanding and the quality of their answers was very much better.

Teaching tip

There were several questions in this paper on freshwater pollution and atmospheric pollution. A useful source book for teachers and candidates is the Royal Society of Chemistry publication:
Harrison, R.M. (editor). *Pollution: causes, effects and control*. 2001. 4th Edition.
ISBN 0 854 04621 6
Another useful book to support this module is:
Hayward, G. *Applied Ecology*. 1992. Nelson Thornes. ISBN 0 174 48187 X

Many candidates confuse the various forms of pollution with their effects. A good way to start the section on pollution is to draw up a table listing the various forms of atmospheric pollution and giving details of such things as sources, chemical changes that occur in the atmosphere, and environmental effects. It was clear from answers to this paper that candidates confuse the effects of CFCs, SO_2, CO_2, NO_x and CH_4.

Comments on Individual Questions

Q.1 *(a)* *(i)* This question was well done by most candidates. The majority of responses involved using calibrated oxygen probes as a method for measuring the oxygen saturation of the water. Many of the better candidates included the need for repeats and calibration within the method. Few candidates chose the Winkler method to measure oxygen saturation. Those who chose this method managed to describe the chemical method accurately.

(ii) This question was correctly attempted by most candidates and an answer of between 95.45 and 96 was acceptable. It was pleasing to see that most candidates showed the calculation for the percentage decrease and this is to be encouraged. Many candidates who failed to get the correct answer were still awarded one mark for an earlier correct component of the calculation. This should be stressed to future candidates.

(b) Most candidates failed to explain the importance of organic matter and the information provided in Fig.1.1 and Table 1.1 relating this to bacterial decomposition and a decrease in oxygen saturation. This appeared to be because they did not see the word *explain* in the question and they tended simply to describe the data. They

did not explain that the contents of the untreated sewage was leading to the changes in BOD and oxygen saturation as a result of aerobic bacterial action. Simple descriptions were given to this question and it was clear that few candidates fully understood the difference between BOD and oxygen saturation and how these factors are linked.

(c) Answers to this question were generally well done but many candidates failed to use any reference to Table 1.1 or Fig. 1.1. In fact there were some good answers to part (b) here! However, many were able to give good answers to the question as they knew about indicator species.

(d) This part of *Q.1* was well attempted by all candidates with most using the term carrying capacity in their answer. Most candidates explained why the numbers of mayflies would not increase beyond the maximum found at sampling point **F**.

Teaching tip

Candidates could be encouraged to link Biological Oxygen Demand with sewage treatments and with intensive farming. There is a useful search facility on the website for the course: Environmental Challenges of Farm Management run by the University of Reading.
www.ecifm.rdg.ac.uk
This also has several good links that would enable this area of study to be investigated fully.
Candidates may also be directed to:
http://waterontheweb.org/under/waterquality/oxygen.html
and the Environment Agency's web site:
http://www.environment-agency.gov.uk
The example used in the question came from data relating to the Isle of Wight. There is a brief account of the effect of intensive farming on a river in Devon in James Lovelock's new book: *The Revenge of Gaia.* 2006. Allen Lane. ISBN: 0 713 99914 4. Required reading for teachers of this module.

Q.2 *(a)* Most responses regarding an explanation of dynamic conservation were very poorly answered. Very few candidates explained that this type of conservation occurs in areas that are primarily at risk from human activity and so require management. The key element to this question is the emphasis on the possible creation of new habitats and the possible need for reclamation.

(b) Descriptions of various methods for the measurement of pH were detailed and most candidates scored highly here. Many candidates correctly described using barium sulphate as a flocculating agent and using Universal Indicator and a chart to identify the pH. Several candidates described a method using litmus paper that is not acceptable as a suitable method. Candidates mentioned the use of calibrated probes to measure the pH and it is important that these are calibrated using buffer solutions of known pH.

(c) *(i)* Most candidates were able to outline various ways that intensive and extensive agriculture differ. Many candidates stated incorrectly that intercropping was a feature

of intensive agriculture. Intercropping is defined as the practice of cultivating an additional crop in the spaces available between the main crop. It is a practice often associated with sustainable agriculture and organic farming. It is therefore not a valid answer for this question.

(ii) This question provided many good structured answers from candidates. Most were able to explain that fertilisers provide nitrogen in the form of nitrate (and/or ammonium) and a subsequent decrease in application would occur by altering crop plants to fix their own nitrogen. Very few candidates described the presence of a nitrogenase enzyme that these GM plants would need to be able to fix atmospheric nitrogen. The Examiners allowed candidates to gain marks by referring to the role of *Rhizobium* in leguminous plants.

(d) The first extended answer question in the paper was generally well done by most candidates and there were some good descriptions of how a thriving plant community could be established on a spoil heap of coal mine waste. Many candidates showed a clear and sequential structure in their responses and there were good descriptions of levelling or contouring the site, liming and improving the soil composition and structure. Sowing grasses and legumes also featured. Unfortunately, many candidates were too general in their responses and were not awarded the mark for use of technical terms. Many candidates failed to include details on the pH of the soil and why crushed limestone would need to be added. One of the primary features of reclaimed land from coal mines is the presence of many acidic iron compounds. These are neutralised or the soil may be removed.

Teaching tip

Many candidates attempted to explain how land reclamation could be aided by the use of tolerant grass species that help to stabilise the soil and start the process of succession. This is an area that could be explored further especially with links to selection in *Central Concepts* (2804).
A useful review article on this topic (with plenty of data and case study material) is at:

www.rsc.org/images/is001003_tcm18-26093.pdf

Much of the original work on heavy metal tolerance was carried out at the University of Liverpool under the supervision of Professor A.D. Bradshaw. His book in the *Studies in Biology* series is a useful source of information and data:

Bradshaw, A.D. and McNeilly, T. *Evolution and Pollution*. 1981. Edward Arnold.
ISBN 0-713-12818-6

Q.3 *(a)* Most candidates received full marks for this question and identified the most commonly recognised sources of CFCs. One candidate suggested that plastics were a source of CFC. Plastics do not contain CFCs, but there are a few types of plastic that use CFCs in their production or they are produced as by products. One such is polyurethane.

(b) Candidates had problems understanding the information in Fig. 3.1. For example, the graph does not show that ‘in the year 1980 the mean percentage of ozone was 0%…and this steadily fell to -5%’. Some made good use of the data stating that the rate of ozone loss has not been constant. During the 1980s the loss was about 0.5% a year, but by the 1990s this was 0.2% a year. Candidates who drew lines on the graph found it easy to extract such information.

(c) Most candidates scored high marks for this question. Very few candidates described the potential harmful effects of UV on organisms other than humans such as increased mortality rates in fish and amphibians or the deleterious effects on phytoplankton. Several candidates linked UV radiation with global warming.

(d) Candidates showed a good understanding of the photochemical reaction between UV and CFCs and the production of chlorine free radicals. Many candidates provided equations to describe the reactions of chlorine monoxide (ClO) and ozone (O_3) that were accurate and aided in the completion of a good answer. There was clear evidence that candidates had learnt this material thoroughly.

(e) This question was interesting in that candidates needed to read carefully and fully understand the information on the graph before attempting the question. Many candidates did not see the lines on the graph as projected outcomes and answered the question as if we were currently in the year 2100. There were many examples of good practice, however; most candidates used the data to substantiate their arguments.

Teaching tip

Fig. 3.1 and Fig. 3.2 would be useful teaching tools when discussing the topic of CFCs and the effective use of legislation to limit pollution. Candidates are expected to understand how legislation may help to limit the effects of pollution and this graph offers much scope for discussing and describing how a combined multi-national approach to tackling an environmental problem can work.

Q.4 *(a)* Very few candidates achieved full marks for this long answer question. Candidates were expected to describe features of National Parks and outline some management issues. The Examiners awarded a maximum of three marks for each section. Many candidates gave either three features or three management issues: very few dealt with both aspects fully. There were many good descriptions of management issues in National Parks with many candidates showing a good level of understanding of issues specific to a particular park. These responses suggested specific case studies had been taught and those candidates were clearly at an advantage over others. Very few candidates stated that the management of National Parks restricts access to the public as a way of protecting parts of the park.

(b) Most candidates explained reasons for protecting SSSIs, but very few candidates stated how these sites are protected. Several candidates cited English Nature as a protective body but, not surprisingly, there was no mention of the Countryside Council for Wales or the Scottish National Heritage. All three bodies have useful web sites that could be used in teaching the topic of SSSIs. It is important that candidates appreciate the importance of landowners in the management of these sites and the role of partnerships with conservation bodies.

(c) This question was poorly answered and few candidates linked the information in the stem of the question to the concept of low genetic diversity and its associated problems. As these orchids grow slowly, are hard to find and have low rates of germination conserving a viable population will be problematic and so the effects of a limited gene pool would become evident. This is a key concept that the candidates need to grasp as it is revisited in other aspects of the Environmental Biology specification.

(d) Most candidates answered this question well although it should be specified that simply keeping seeds at a low temperature is insufficient. The seeds are first dried and then frozen. Certain seeds need a period of cooling to stimulate germination. If the seeds are kept at temperatures that might fluctuate then the process of storage might in effect cause them to germinate and this would defeat the object for collection. Some candidates confused the term ‘seed bank’ with ‘gene bank’ and suggested ‘field gene banks’ as an answer.

Teaching tips

This question provides some good stimulus material to develop the teaching of threatened species and the importance and influence of legislation The Royal Botanic Gardens at Kew (http://www.rbgkew.org.uk) has some excellent resources available to help students understand in more detail the genetic problems of dwindling biological resources. It is important with such examples as the Lady’s Slipper Orchid to stress the importance of reducing the gene pool and the likelihood of an increase risk of disease and lowering of resistance. This area is closely linked to an understanding from *Central Concepts* (2804).

Details of the Millennium Seed Bank at Wakehurst Place are available at:
www.rbgkew.org.uk/msbp

Details of SSSIs in England, Wales and Scotland can be found at:
www.english-nature.org.uk/special/sssi/
www.ccw.gov.uk/Images_Client/Reports/report%20final%207.pdf
www.snh.org.uk/about/ab-pa01.asp

Q.5 *(a)* Most candidates answered this question well although very few suggested the use of an identification key. Certain lichens are quite similar in appearance and as the experiment was only looking at counts of numbers of species, some method of identification would have been essential. The majority of the candidates’ responses involved the use of quadrats, but very few commented on the size of this measuring grid. Few realised the need to standardise the sampling procedure at each site along the transect. The award of marks for the use of a quadrat, that might not in reality be used, was to recognise this aspect.

(b) This question, which asked candidates to describe and explain the data from the transect, was poorly attempted. Most candidates provided a qualitative response to the question. If data was given it was not uncommon to find the wrong axes used. For example, many quoted the number of lichen species with decimal places. A common error was to assume that because the city centre showed higher levels of pollution the lichen species were all eliminated. Several candidates referred to the tolerance levels of lichen and it was good to see references to acid rain and indicator species. Many lichens cannot tolerate sulphur dioxide and different species of lichen have different threshold levels before death occurs. This means that that it is possible to quantify the approximate level of pollution by studying which species are present and which are absent.

(c) This question asked candidates to explain the formation of acid rain with reference to the flow chart. This confused many candidates. Most missed the point that sulphur dioxide is converted to sulphurous acid and is also oxidised to sulphur trioxide, which in turn forms sulphuric acid. This oxidation is an important step in the formation of acid rain.

(d) Most candidates received high marks for this question and there were a few excellent descriptions of the effects of acid rain and ion exchange on the soil and the subsequent effects upon the plants. Most candidates described crown dieback and there were many accurate descriptions referring to the effects on coniferous forests.

(e) The second extended answer question was much better attempted than the previous one and candidates scored highly here. Many described the use of the capture-recapture technique in detail and many explained the assumptions made in using this technique. Candidates explained and described the use of the Lincoln Index correctly and many gave an example of how an estimate of the population size could be calculated. This was a useful addition to the answer. There were many interesting methods suggested for marking the fish; the general agreement was that tagging would be the most appropriate. Most candidates did not describe how the fish would be caught or state the length of time before recapture. The Examiners considered the use of a trawler in the River Wye somewhat impractical!

Teaching tip

Responses to the formation of acid rain were poorly done.
The Environment Agency web site has some useful material on this topic:
www.environment-agency.gov.uk

Q.6 *(a)* Most candidates received full marks for this question and many cited poaching and habitat destruction as the possible causes for such a decline. There were very few references to inter- and intraspecific competition as possible causes for population decline.

(b) Candidates gained high marks for this question and several produced detailed accounts of why breeding in captivity can be so unsuccessful. Candidates described the problems with altered breeding cycles and inappropriate habitats as well as the possible negative effects of inbreeding. Several candidates still discussed interbreeding which is breeding between different, albeit closely related, species. The term is related to hybrids and sometimes it is used incorrecty to mean inbreeding.

(c) Most candidates described two problems encountered when reintroducing captive bred individuals into the wild. Many of the responses involved the concept that the animals would be too tame as a result of captivity and so reintroduction would create problems due to the animals not being able to find food or avoid predators and poachers.

(d) There were many very detailed answers to this question and most candidates were able to link the small gene pool with vulnerability to disease. Several candidates discussed interbreeding (sic) and the passing on of recessive *genes*. Candidates should refer to recessive *alleles*. It is the presence of two recessive alleles that is likely to cause a genetic disease to be seen in organisms with low genetic diversity.

Teaching tip

The question uses a good example to highlight the problems encountered with introduction of captive bred animals into their native habitat. Jersey Zoo provides some excellent information sheets for students to research this topic further. For further details see:
www.durrellwildlife.org/index.cfm?a=21

Another species worth considering is the golden lion tamarin (GLT), *Leontopithecus rosalia.*
A good source of information about captive bred Golden Lion Tamarins is:
http://nationalzoo.si.edu/ConservationAndScience/EndangeredSpecies/GLTProgram/

2805/04: Microbiology and Biotechnology

General Comments

The majority of candidates were well prepared for this option unit, displaying a good knowledge and understanding of the topics covered in Microbiology and Biotechnology. This was particularly evident in the quality of the extended answers. However, only those candidates who were able to draw from their knowledge of relevant topics in the AS specification and in *Central Concepts* (2804) were able to obtain higher marks; at this early stage of the A2 course, only a few candidates were able to demonstrate fully their abilities to use *ideas* and *skills* in new contexts. There were a significant number of candidates who were unable to perform the simple magnification calculation. There were also some instances where candidates did not read the question or question instruction carefully enough and lost valuable marks. Candidates should be encouraged to read through each question at least twice before answering. In addition, there were surprisingly few candidates that had made use of a highlighter pen or some other method to help them organise their thoughts. All questions appeared to be accessible to candidates and the candidates with lower scores appeared to be unprepared for the examination rather than displaying a lack of understanding. There was no evidence to suggest that candidates were short of time.

Comments on Individual Questions

Q.1 This question was intended to allow candidates the time to settle into the examination with a range of questions that (i) tested relatively straightforward sections of the module together with some synoptic elements, and (ii) encouraged candidates to think about different practical and theoretical topics that have been examined before. Many candidates were able to score well gaining 10 or more out of the 14 marks, but it was disappointing that many were unable to reach half marks. This was because of a lack of AS knowledge in part *(a)* and/or poor explanations in part *(b).*

(a) Part *(i)*, covered by *Biology Foundation* (2801), proved to be particularly difficult, with about only half of all candidates obtaining the correct answer and other answers ranging from x 3 to x 90,000 to x 3,333333. Some did not read the question, which asked for the magnification, and gave the actual length of the bacterium. Others used the formula:

magnification = image length / actual length

but did not remember to ensure that the units were the same, measuring the scale bar length in cm or mm for the image length and using µm as the actual length. A few candidates arrived at the correct answer, but took the longer route of calculating the actual size of the bacterium and then determining the magnification.

Parts *(ii)* and *(iii)* gave a range of marks, with many gaining four out of five marks, only losing the final mark for a poor drawing of the flagellum. Again, a lack of knowledge of the function of the structures was evident for some candidates and in these cases the mesosome was usually incorrectly labelled with one of the three letters! Structure **A**, the ribosome, was often attached to the plasmid. Structure **C**, carrying advantageous genes, was allowed if candidates had labelled the plasmid or the nuclear zone/circular DNA. Candidates were not asked to identify features **A**, **B** and **C**; marks were lost by those few candidates who did this without assigning the correct letter. In addition, there were some who wrote the letters in the diagram without using label lines as instructed. Part *(iii)* was usually well known, with the most common incorrect answer being ‘pilus’ or ‘pili’. Although there were a few excellent drawings of the flagellum that showed it penetrating the cell wall and ending in the basal body. These drawings were awarded the full two marks; the majority of candidates did not show the flagellum passing into the cell and were given the benefit of the doubt for their poor quality diagrams and awarded one mark. Parts *(ii)* and *(iii)* contained synoptic elements from *Biology Foundation* (2801).

(b) Most candidates seemed to have had practical experience of carrying out a Gram staining exercise and were usually able to explain why a heat fixed smear was prepared and why safranin or carbol fuschin was added. There were fewer clear explanations for the use of crystal violet and for alcohol. A number thought that the initial flooding with the Gram stain would only stain the Gram *positive* cells purple or violet and did not appreciate that at this stage *all* cells would take up the stain. Similarly, the use of the alcohol to decolourise the Gram *negative* cells was not usually well stated.

(c) Part *(i)*, which has been well tested in previous sessions, was very well answered by almost all candidates. However, for the majority, the same answers that were given in part *(i)* were used in *(ii)* and only the minority of candidates seemed to understand the principles behind the fed-batch culture method compared to the batch culture. A number of candidates demonstrated confusion between the actual organism *Penicillium* and the product penicillin, which lost them marks.

Teaching tip

Candidates should expect to be asked to construct or complete simple diagrams, including adding labels or annotations. To prepare for this, candidates could be given a set of diagrams at various stages of construction to complete. The final product with full annotations would also serve as the learning notes required for the examination. Microorganism diagrams could also be used to practise magnification and scaling calculations.

Q.2 This question proved to be accessible to candidates of all abilities and it was not uncommon for candidates to score 18 or 19 out of the possible 20 marks. The question was also a good example of how marks could be lost by candidates not proof-reading their answers to check for obvious mistakes, as in part *(c)*, or to check for missing details, as in part *(b)*. Candidates may have found it easier to answer part *(b)* in a bullet-point format.

(a) All but a few candidates found it difficult to suggest why a *small* amount of agar was added to the tubes of broth. Although the introduction clearly stated that the tubes contained *nutrient* broth the most common answer given by candidates was that agar was the source of nutrients. Reasons for the other two additions to the tubes, thioglycolate and resazurin, were usually able to gain marks although weaker candidates simply repeated the information given in the text. There were some that thought that the statement in the question that thioglycolate *reduces the oxygen dissolved in the broth to water* meant that the oxygen was still present in the broth but the *levels* of oxygen were reduced or that the point of adding thioglycolate was to provide water. Some candidates thought that adding resazurin was to determine if the microorganisms were producing oxygen.

(b) For this question, there was flexibility in the mark scheme to allow for the different approaches that may have been employed to inoculate a medium. Generally, candidates were able to gain three or four marks for their knowledge of aseptic technique. The Examiners were looking for a clear description of a *transfer* from the microorganism culture to the tube (of broth or agar) and good answers used the

correct terminology, details of the equipment used and the appropriate aseptic technique. Some accounts failed to mention either the removal of the organism or the actual inoculation or used 'skewers', 'sticks' or 'spikes' to perform the stab. A number of answers removed microorganism **D** from an agar slope rather than a broth culture and there were some answers that gave an account of streak plating. Details of incubation were not required but were often given. The use of alcohol to sterilise surfaces is only considered safe if there are no naked flames in the vicinity and some candidates did not make this clear. In addition, the use of disinfectant, which is harmful to human tissue, to clean hands was mentioned on a number of occasions.

(c) This extended question enabled many candidates to gain all the available marks yet surprisingly only the very best accounts included synoptic references to diffusion of oxygen (*Biology Foundation*) to penetrate the upper surface of the tube and to aerobic and anaerobic respiration (*Central Concepts*). Very few candidates gave the general conclusion that different microorganisms exhibited different oxygen requirements, which was worthy of a mark. Most answers correctly identified the areas of the tube where growth was occurring and named the type of organism according to its oxygen requirement, but a significant number failed to mention 'growth' and used only terms like 'survive' and 'prefer' and 'are present'. There were answers that wrote about 'pink' and 'colourless' areas without identifying that these were areas with oxygen present or absent. There was an assumption made by some candidates that the microorganisms were bacteria and some counted 'colonies' in each tube. A few candidates thought that in tube **F** the microorganisms had died and 'sunk' to the bottom and some assumed that the microorganisms were motile and had 'moved' to the areas they preferred. Similarly some concluded that the distribution could be attributed to mass, so that 'heavy' bacteria went down to the bottom of the tube while others 'floated' on top or that it was a method to separate live microorganisms from dead ones. A wide range of incorrect spellings of 'facultative' were seen. The quality mark was awarded to the majority of candidates.

(d) Most candidates were able to gain the full three marks for this question. The best explanations wrote about the actual processes and oxygen conditions occurring in the locations and linked these to the microorganism oxygen requirements. A number of candidates had not read the question and suggested named organisms rather than give the letters, **D**, **E**, or **F** which sadly lost them all three marks.

Teaching tip

This module, with practical procedures and biotechnological processes, lends itself to questions that may ask for descriptions of stages together with reasons and/or explanations, as in part *(c)* above and also in the question on Gram staining (*Q.1 (b)*) and in *Q.5 (b)* (production of monoclonal antibodies). A possible strategy for candidates may be to prepare their learning notes for these procedures and processes in the form of a two column table. The first column will contain the procedures and the second an explanation of each procedure. Alternatively, candidates may construct a flow chart of a process with the main stages in boxes in one colour and explanations or reasons underneath each box in a different colour.

Candidates could be asked to perform comparison investigations inoculating nutrient broth or nutrient agar and then inoculating sterile water or sterile agar in order to consolidate their understanding of the importance of the added nutrients that are in the basic media. This exercise could develop into the teaching of synthetic and complex media.

Q.3 This question, which required the use of knowledge and understanding from different topics within the module in addition to synoptic elements, proved to be fairly searching for many candidates.

(a) In this question, the Examiners were looking for answers that clearly outlined potential benefits and hazards of using genetically modified yeasts to brew beer and the mark scheme shows that there were many points that would have been acceptable. However, the majority of answers were too vague to gain the marks and some answers outlined benefits and hazards of using GM crop plants.

(b) This proved to be a difficult question for most candidates and those that did score usually gained one mark for the simple suggestion that less enzyme may have been synthesised. Candidates should be reminded that text that appears at the start of a question may well have information that will enable them to deduce answers in subsections that appear later. The introduction to *Q.3* clearly stated that researchers had 'been successful in producing a recombinant strain of *S. cerevisiae*' and that glucoamylase was 'an extracellular digestive enzyme'. This would have negated ideas that *S. cerevisiae* had not been successful in taking up the gene coding for glucoamylase or that starch was unable to enter the cell in order to be broken down.

(c) The majority of candidates were able to gain this mark.

(d) Part *(i)* was well answered. Candidates should be encouraged to use the terms 'volume' and 'concentration' (e.g. of starch) rather than 'amount'. Some candidates had not understood that whole yeast cells were entrapped within the alginate beads and made reference to 'enzyme'. Part *(ii)* was intended to allow candidates to give a practical description of the reducing sugar test to measure concentrations and for many candidates it was a relatively straightforward two marks to gain. However, a statement to 'use the Benedict's test' and/or a description of a positive result would not have been sufficient to score marks. For this, the Examiners were looking for an understanding that there would be differences in the colour and density of the precipitates obtained. A general lack of knowledge of biochemical tests was evident in many answers, where biuret (various spellings) reagent or iodine solution was used to test for the reducing sugars. There was a wide range of answers for part *(iii)*. Candidates were able to gain marks for any valid ideas agreeing and/or disagreeing with the concerns and there were a number of well-argued answers putting forward both viewpoints. Other candidates were clearly very confused and wrote about starch as the product or enzymes in the product or the fact that heating with Benedict's would kill the yeast to prevent it affecting the results.

Teaching tip

The potential implications of biotechnology and gene manipulation in food production and in medicine are learning outcomes in this module. For each topic within these areas, candidates should be encouraged to research the potential benefits and hazards. The production of humulin, Factor VIII and the Human Genome Project are synoptic elements that could be included in this research.

Q.4 Many candidates were able to gain all the marks for this question, which indicated a good knowledge of the main features of the four groups. The *least* well-known answer was microorganism **G**, with the incorrect choice of 'fungi' being given almost as frequently as the correct answer, 'Protoctista'.

Teaching tip

Asking candidates to produce questions for their peers to answer is a useful learning exercise for a whole group. The construction of tables such as Table 4.1 and the production of dichotomous keys without the microorganisms identified are examples of worksheets that candidates could prepare. This would also result in a range of differentiated material being made available.

Q.5 Most candidates were able to gain at least half marks for this question, mainly as a result of high scores in the extended answer. There were a number of excellent scores, with these candidates being adept at dealing with different topics within the unit as well as showing a good understanding of the immune response from *Human Health and Disease* (2802).

(a) Many candidates struggled to produce explanations that were worthy of credit, despite going on to produce good answers for part *(b)*. The antibody was frequently confused with a lymphocyte or was stated as being a product of a B lymphocyte rather than a hybridoma cell. Very few realised that the antibody-producing hybridoma cells were descendants or clones of an original ancestor cell. However, most candidates were able to gain one mark by stating either that the monoclonal antibody was specific against one antigen or that the antibodies were all of one type.

(b) Overall, there were some detailed and well-written accounts of the production of monoclonal antibody and many candidates gained all the available marks, including the quality mark for use of scientific terminology and good organisation. Some candidates displayed an impressive knowledge and understanding of the process and covered the majority of the marking points. A few candidates were confused with the production of insulin or human growth hormone and wrote about extracting genes and genetic modification, while others extracted only antibodies from the mouse spleen to fuse with the myeloma cell.

(c) Generally, in part *(i)*, the majority of candidates were able to write correctly about four features of the airlift fermenter, usually gaining marks for the heat exchanger, nutrient inlet, sterile air inlet, product out, waste gases out. There were fewer accounts providing details of how the culture and medium flowed round the fermenter. Some good written accounts were hindered by incorrect annotations on Fig. 5.1. Poorer quality answers incorrectly assumed that the heat exchanger was to provide heat or to sterilise antibodies and some attempted to use knowledge of other fermenter types and included reference to motors and cooling water jackets. In part *(ii)*, fewer than half the candidates understood that the stirrers or paddles would damage the cells or hyphae. Although no reference had been made in the text to the production of monoclonal antibodies by continuous fermentation, many candidates made that assumption and gave answers that compared batch to continuous fermentation. This was only allowed where there were clear differences in the fermenters, for example continuous fermenters designed to allow a steady, continuous input of nutrients rather than the batch design of nutrients in at the start of the process. References to production of secondary versus primary metabolites or growth phases did not gain marks.

(d) The candidates who had a good knowledge and understanding of the immune response, covered in *Human Health and Disease* (2802), produced clear and well explained accounts for this question. Other responses showed that the understanding was almost there, but the terminology was not sufficiently scientific to gain marks. For example, the monoclonal antibody was described as being 'a foreign invader' which the body would 'fight against' and 'remember it' and then 'kill it' when it 'invades' again. There was also a significant number of candidates who had not understood the question and who thought that the monoclonal antibody was given to stay in the body and act against future invading pathogens or that the body would become weaker and weaker in acting against it.

Teaching tip

The Medical Research Council (www.mrc.ac.uk) has produced an informative publication: 'Monoclonal Antibodies - research in focus' available electronically. From the home page click on publications and then follow the link to electronic publications. This publication also has links to useful websites.

Q.6 Most candidates were able to score highly for this question.

(a) In part *(i)*, candidates were asked to complete a flow chart using the information given and this was well done by most candidates, many of whom included additional information. The Examiners also saw some very poor attempts where insufficient attention was paid to using correctly the information given or where the flow chart appeared to wander in all directions. In addition, some candidates appeared to make very little use of the information and produced their own version of yogurt production. The arrow leading rightwards from the 'raw milk' box was often left 'floating' and no reference was made to the testing of milk. In part *(ii)*, candidates were usually able to assign at least two of the letters to the correct stage, but many failed to use arrows as instructed and may have lost a mark if this then involved 'guesswork' for the Examiner.

(b) There were very few correct explanations of the term 'mutualistic', covered in Biology *Foundation* (2801), although many candidates could gain all four marks using their detailed knowledge of the beneficial relationship between *Lactobacillus* and *Streptococcus*.

(c) The majority of candidates were able to score at least one mark for this question, generally for stating that lactic acid or methanoic acid was produced. To gain the final mark, candidates were expected to give an actual pH value rather than simply to state that the pH would decrease or give a range (for example, pH 4 to 6). A considerable number of candidates correctly identified the presence of the acid but gave a pH nearer to neutral or even slightly alkaline.

(d) Most candidates were able to suggest that the incubation process would reduce in time and some correctly deduced that the time would approximately halve. It was therefore disappointing that these candidates did not link this halving with the 10 ^{o}C rise in temperature and only wrote generally about the effect of temperature on enzymes and substrates. A good proportion of candidates assumed that the yogurt would not be produced as bacteria would be killed at this temperature (owing to enzymes denaturing), even though the question stated that some producers like to incubate the yogurt at the higher temperature.

Teaching tip

Students can use 100 cm^3 McCartney jars to make yogurt: 5 cm^3 plain yogurt mixed with 50 cm^3 of milk, incubated overnight in a thermostatically-controlled water bath or incubator. Hand held pH meters will fit into the jars to measure the 'start' and 'end' pH. The decrease in pH can also be recorded using universal indicator paper. The change in pH over time could be followed with a pH probe and a data logger. See for example:
http://www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/PRACBIOTECH/PDF/yogsub.pdf

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of appropriate difficulty and most candidates attempted each section of every question. They had sufficient time to give full responses to each question. There was more emphasis on requiring candidates to use their knowledge in order to interpret new situations than in previous years. This was highlighted by *Q.4 (b)* and *Q.6 (b)*, the two extended answer questions. As usual careful reading of information given in the questions would have avoided some elementary errors made by some candidates.

Comments on Individual Questions

Q.1 *(a)* This should have been a fairly gentle start to the paper and good candidates scored all four marks but weaker ones scored less than two. Common mistakes were to state bile canaliculus instead of bile duct for **B**, and there was some confusion between the hepatic portal vein and the hepatic artery.

(b) Most candidates were able to describe the role of bile in the digestion of lipids, scoring maximum marks very easily. Even weaker candidates recognised that the function of bile was to emulsify lipids although some referred to large *molecules* being broken down into smaller ones. Overall, all available marking points were seen in responses.

(c) This question was poorly answered. Many candidates erroneously suggested that urea would not be broken down, thereby giving rise to jaundice. While some understood that bile pigments would not enter the gut in the bile, this was often poorly expressed. Nevertheless, many appreciated that bilirubin would accumulate in the bloodstream, giving rise to the symptoms. There were few references to gall stones or a blocked bile duct.

(d) *(i)* Those who recalled material from *Central Concepts* were more likely to answer this correctly. Hydrolysis was the most frequent incorrect answer.
(ii) Most candidates correctly stated ethanal (occasionally acetaldehyde).
(iii) Some candidates made the mistake of describing the pathway they had already been given in the figure. Better candidates understood that ethanoate would be converted into acetyl CoA and then enter the Krebs cycle although frequently the first step was omitted. Many appreciated that ATP would be generated during the cycle. There were some references to ethanoate being converted into acetoacetate although very few mentioned that ethanoate could be used for fatty acid synthesis.
(iv) This question often elicited rather vague answers from the weaker candidates who made references to hepatocytes being damaged by excess alcohol without the qualification that they would either die or function inefficiently. Good candidates stated the effect on the hepatocytes then recognised that they would be replaced by scar or connective tissue. Loss of lobule structure was not credited although more detail, such as the liver becoming hard or nodular, gained a mark. Good candidates gave considerable detail as to the various functions that would be impaired. A few recognised that these changes would be permanent or irreparable.

Teaching tip

A useful website to help in the understanding of cirrhosis is www.britishlivertrust.org.uk

Q.2 *(a)* *(i)* It was pleasing to note that many candidates stated that the type of behaviour exhibited by the lambs in response to repeated use of the umbrella was habituation. However, a variety of incorrect responses, such as classical conditioning or operant conditioning were seen.
(ii) Most candidates commented that the lambs would cease to be afraid of the non-threatening stimulus and many understood that either less time or less energy would then be wasted. Some also mentioned that the lambs would experience less stress, often expressed in terms of a reduction in adrenaline secretion.

(b) This section was generally well answered and many gained marks for commenting that the lambs were exhibiting classical conditioning as they learned to associate the sound of the van with the arrival of food. Some appreciated that the sound of the van was the conditioned stimulus although weaker candidates failed to mention the importance of the sound and simply stated that the appearance of the van itself would elicit the response. Few mentioned that the food acted as a reward or reinforcer and references to association centres in the brain were rare.

(c) The vast majority of candidates achieved a mark for stating that an advantage of a reflex action is the speed at which it occurs. Others recognised its importance in survival or protection against danger.

(d) *(i)* It was rare for a candidate to be unable to give a correct example of neurone **Q**, particularly as it has many different names.
(ii) While many candidates named **P** and **R** as the receptor and effector respectively, a common error was to state 'cell' which was penalised once. Correct references to an effector (muscle or gland) were credited.

Teaching tip

A very useful video that highlights many of the topics tested in the question is 'Stimulus Response' produced by the Association for the Study of Animal Behaviour. It is available from the Association (http://asab.nottingham.ac.uk/pubs/videos.php) and also from Compassion in World Farming (www.ciwf.org.uk/publications).

Q.3 *(a)* *(i)* The corpus callosum was identified correctly by the vast majority of candidates who had carefully analysed the figure.
(ii) The most common error in this section was to confuse the hypothalamus with the medulla oblongata and only rarely were other parts of the brain named.

(b) Many candidates were able to state that acetylcholine is a neurotransmitter or, alternatively, give a correct description of its actions. Good candidates understood the role of acetylcholinesterase although some made the mistake of stating that it would inhibit acetylcholine rather than break it down.

(c) *(i)* A surprising number of candidates failed to read the question carefully and embarked upon a detailed account of abnormal beta amyloid production and the build up of tau protein in Alzheimer's disease. Some candidates erroneously linked acetylcholinesterase with the synthesis of either beta amyloid or tau protein. Good candidates recognised the synoptic element of this question and gave a comprehensive description of the effect of inhibitors on enzyme action and went on to state that there would be less breakdown of acetylcholine so there would be

more present in the synapse. Relatively few commented that there is less acetylcholine in Alzheimer's disease.
(ii) Only the weakest of candidates failed to score on this section. Most appreciated that an increased level of brain activity, expressed in a number of ways, would serve to reduce the risk of developing Alzheimer's disease. Many commented on the importance of a healthy lifestyle, such as a balanced diet or regular exercise. Some stated that blows to the head should be avoided.

Teaching tip

A good website for information on Alzheimer's disease is www.alzheimers.org.uk

Q.4 *(a)* *(i)* Most candidates recognised that a stimulus would cause an increase in muscle tension. Some went on to state that the tension would decrease (or the muscle would relax) between stimuli. Stronger candidates commented that an increase in the frequency of stimuli would increase tension even further or result in an overall increase in tension. References to figures were often somewhat vague although better candidates gained a mark for accurately giving values from the graph.
(ii) Correct references to a constant state of muscle contraction were frequently seen although its significance was not always explained. Nevertheless, good candidates gave descriptions of how the heart might be prevented from pumping or described the effect of constant contraction on ventilation movements. Some candidates suggested that digestion might cease, which was not credited, although mention of peristalsis being impaired was awarded a mark.

(b) A common fault was to give a detailed description of neurochemical transmission followed by a comprehensive account of muscle contraction without stating which processes required energy. This showed that they had either not read the question carefully enough or that they had difficulty in applying their knowledge in this new situation. However, most candidates gained a mark for understanding that ATP is synthesised by the mitochondria. Good candidates were more selective in their response and identified those events which required energy and only these candidates were usually awarded the quality mark for mention of the required number of specialist terms in the correct context.

Teaching tip

Part *(b)* of this question relies on a sequence being remembered accurately. The various stages could be written on cards. The cards could be shuffled and then students would need to arrange them in the correct order.

Q.5 *(a)* Although it was obvious to most candidates that there would be a reduction in light intensity underwater they frequently failed to get a mark by stating that it was dark under the water rather than commenting on it being dim or there being less light than on the surface. Very few went on to *explain* why there would be less light.

(i) Many candidates understood that rods respond to low light intensity or only function in dim light and many also understood that the increased number of rods would lead to increased sensitivity in dim conditions. However, few recognised that there would be a reduction in visual acuity. Some mentioned that colour vision would be unnecessary although references to cones being less sensitive to the prevailing light conditions were rare.

(ii) Good candidates understood that the reflection of light would allow more rods to be stimulated although some simply repeated the stem of the question, stating that light would be reflected back onto the retina without describing its significance. Good candidates stated that the tapetum lucidum would prevent the absorption of light by the choroid. Many incorrectly mentioned that the eyes of a seal would act like a torch, due the light being reflected back out, and this would help the seal to see where it was going!

(iii) The vast majority of candidates appreciated that an increase in pupil size would allow more light into the eye. Some candidates commented, either in this section or preceding ones, that the adaptations would allow the seal to see its prey or predators more clearly.

(b) This was a straightforward question, which enabled most candidates to score full marks. Most appreciated that the ciliary muscle would contract during near vision although some made the mistake of stating that the suspensory ligaments would relax, rather than the tension on them would be reduced. Most also understood that the lens would become more convex as a result although the subsequent effect on refraction of light rays was not always clearly expressed.

(c) *(i)* Although many candidates correctly stated denaturing, or variations of it, some incorrect answers just repeated coagulation or mentioned deamination.

(ii) A common answer stated that the plastic lens would be less flexible or could change as easily which was not credited. Good candidates understood that the lens would not be able to change shape at all although only a few commented that the lens was only suitable for distant vision. There were vague references to spectacles bending or refracting the light although better candidates understood that the spectacle lens would strongly converge the light rays.

Teaching tip

The best way to reinforce this part of the specification, particularly parts *(b)* and *(c)*, is to repeat experiments with ray boxes and different lenses. This will have been taught maybe four years before in science lessons and some practical revision of this topic would be useful.

Q.6 *(a)* A common error here was to describe the curve of the graph for **A** without sufficient qualification, such as the gastrin concentration increasing *sharply* or decreasing *gradually*. Often the description was not accompanied by any explanation, as directed by the question, resulting in a maximum of three marks out of a possible six. Most offered an acceptable comment about **B**. Unfortunately very few candidates scored the mark for using figures as they failed to use both units. Good candidates gave a comprehensive explanation of mechanisms involved in the release of gastrin.

(b) As in *Q.4 (b)*, a significant number of candidates did not read the question carefully enough and gave a detailed account of carbohydrate digestion rather than explaining how the *ruminant* would be able to obtain sufficient amino acids for its growth and metabolism. Those candidates who had understood what was asked of them often scored maximum marks with ease. A worrying minority of candidates chose the rabbit as a ruminant and explained in detail how this 'ruminant' ate its faeces.

(c) *(i)* Despite the fact that there is usually a question involving a calculation, and that it often asks for a percentage increase, it was disappointing to note that very few were able to score two marks.
(ii) The key to this question was the mention of legumes. This should have elicited responses concerning nitrogen fixation, amino acid formation and thus protein production. Unfortunately, only a minority were able to make the connection and even fewer were able to state that wool is made of protein.

Teaching tip

A good way of responding to questions like part (a) is to give several graphs to candidates and ask them to write statements that are appropriate to 'describe' and 'explain'. These can then be collected and assessed.

2806/01: Unifying Concepts

General Comments

Candidates displayed good knowledge and understanding on *Q.1*, *Q.2* and *Q.3*. Many also showed good comprehension of the unfamiliar material in *Q.5* and performed well. The combination of biochemistry and a pedigree diagram in *Q.4* proved extremely challenging, however. Candidates generally showed competence in dealing with concepts at the ecological and physiological levels, but many showed a lack of basic knowledge and understanding of cytology and biochemistry. This may reflect a lack of time in preparing for this paper in January, meaning that revision of *Biology Foundation* (2801) was insufficient. As the name suggests, the material in the Foundation module underpins all the rest of the Biology in the specification, and familiarity with it is crucial to success on this synoptic paper.

Comments on Individual Questions

Q.1 Candidates of all abilities scored well on this question and seemed confident with the context provided by health and physiology. Some candidates lost marks through not quoting data or units fully, but in general understanding of this material was good.

(a) Candidates scored two or zero in general. They either recalled the basic biochemical fact about differing solubilities of lipids and sugars, or they were lost for an answer and talked vaguely about cholesterol blocking blood vessels, or how the substances move through cell membranes. A common mistake was to talk about the relative sizes of the molecules without going on to comment about solubility or the polar and non-polar nature of the molecules.

(b) Most candidates gained two or three marks here. They interpreted the general trends correctly for two marks and earned a third mark for a full data quote (x and y coordinates plus the risk percentage) with units given. A few weaker candidates misinterpreted the graph and made the incorrect statement 'As TC:HDL ratio increases so does systolic blood pressure'.

(c) Again there was scope here for the majority of candidates to display their knowledge and understanding to advantage. Most scored at least three marks from the extensive list of mark points. Weaker candidates recalled information without relating it to the data given, as in making the general statement that pulse rate increases with exercise. They failed to notice that in the table pulse rate decreased on day two. Some candidates indeed were so confident about what they expected the data to show that they stated that pulse rate increased from 61 to 58 beats per minute!

Candidates need to be made aware of the requirement to give units when quoting data from a table, graph, diagram or piece of text. A problem that led to candidates missing out on a mark here was the use of a vague term like 'cells', 'tissues' or 'the body' as requiring more oxygen during exercise, rather than the muscles specifically. Similarly some candidates wrote about 'the circulatory system' when clearly they meant the heart. Candidates are keen to relate changes in blood flow to the need for oxygen, but few talked about the need to remove waste products of respiration.

Teaching tip

Candidates should be encouraged to give units when quoting data from a table or graph.
If the instruction reads 'Using the data …' they need to tailor their answer to the data and to refer to it. Simply giving memorised information in this situation is unlikely to yield full marks.

Q.2 It was apparent that candidates who had done practical fieldwork displayed their familiarity with the techniques and species to advantage in this question. Most candidates made a good attempt at the question as the ecological context was readily understandable.

(a) Most candidates scored a mark in part *(i)*. At the weaker end there was a failure to understand the table and which comparison (ant mounds versus grassland quadrats) was relevant. Some candidates compared the two columns in the table rather than the two rows. A proportion of candidates had trouble putting into words the numerical evidence from the table and made wrong statements about what the figures actually measured and showed. Candidates should be encouraged to read the introductory explanation part of the question carefully. In *(ii)*, plenty of candidates made sensible suggestions that earned credit, the most common being a method to make the selection of random points more random, and the idea that more data should be collected. Candidates followed up with suitable reasons, such as to

- avoid bias,
- improve reliability,
- enable an average to be taken.

A common suggestion that was not appropriate here was to take a line or belt transect. Candidates used terms such as reliability and accuracy interchangeably and need to learn the meanings of these. They also need to understand concepts such as bias, fairness and validity.

When a question asks for improvements to an experimental method it is likely that there are some glaring errors in the method given. Few candidates spotted the discrepancy between the surface area of the ant mounds and the area covered by a 1 m^2 quadrat. Some of those that did suggested using the larger quadrat on the ant mound, rather than reducing the size of quadrats for use on the grassland.

(b) Most candidates came up with reasonable ideas, generally along the lines of ant mounds providing more nutrients and a finer tilth of soil. A common error was to argue that because ants did not themselves eat thyme this meant being near ants was beneficial to thyme. In itself this is a neutral point. The idea that ants may prey on or drive off herbivores that do feed on thyme was creditworthy.

(c) This extended answer provided scope for well-prepared candidates to score full marks, but there was a rump of disappointing answers that only offered one or two creditworthy statements on the topic of succession. Only a tiny minority of candidates extended their answer to include animals. Most answers dealt with succession of plant species related to changing abiotic factors. Very few went on to explain that different species of plants provide food and microhabitats for particular insects and other animals. Few explained how diversity of plant life allows diversity of niches for primary consumers with benefits further up the food web to secondary consumers and so on. Candidates referred to nitrogen fixation, but few related this to leguminous plants or to a named legume. Candidates who mentioned that when pioneer plants die they add humus to the soil could have gained extra marks if they had followed this line of reasoning and written about the decay process and conversion to soil nutrients.

Teaching tips

Concepts like reliability, accuracy, fairness, validity and bias in experimental design and analysis of data should be explained and differentiated between.

Ecological work may focus on plants as their abundance and distribution is easier to ascertain. However, discussion should be made of the links between plant diversity and associated animal species in the context of the whole food web.

Teachers who use sand dune succession when teaching *Central Concepts* might like to supplement the information about plants that their students collect with details of the animal species. The following may be helpful:
www.countrysideinfo.co.uk/successn/primary2.htm
www.ehsni.gov.uk/pubs/publications/NH009.pdf
However, the ‘Sands of Time’ website that deals with the sand dunes on the Sefton Coast in the North West has no information about animals!

Q.3 Enzyme questions are a familiar area for most candidates and the cohort performed well, though there was discrimination between the top candidates and those with less well-developed skills and understanding, particularly on parts (a) and *(e)*.

(a) This was a standard question requiring description of a graph. Many candidates did well, but a few still seem uncertain of what is required. Candidates need to differentiate between the significant areas of the curve. Here these were the linear increase phase and the plateau. Candidates should quote data (with units) to identify the segment of the graph they are describing. Again part *(ii)* was a standard question requiring explanation based on biological principles of the pattern previously described. Ideally an answer here accounts for the rising phase of the graph and for the plateau. Many candidates made correct statements about both features of the pattern, though in many cases basic knowledge of enzymes, such as enzyme and substrates colliding to generate products, and denaturing was not applied. Some candidates talked about limiting factors causing the plateau. Often, despite the information in bold type that there was a ‘large excess of substrate’, candidates thought the substrate ran out and became limiting. Some also thought the enzyme ran out.

(b) Most candidates earned credit by saying pH or concentration of enzyme.

(c) This was well answered with most candidates making one or two predictions, for example 'greater product concentration would be achieved but at a slower rate', and adding at least one explanatory comment, such as 'enzyme not denatured at this temperature', or stating that 'this temperature mimics the natural habitat of the worm'. A common mistake was for candidates to assume that because this temperature was the optimum it must cause the reaction to go faster. It seems there is confusion between the words optimum and maximum.

(d) The vast majority correctly identified in *(i)* that this was the active site. In *(ii)*, candidates were generally successful in contrasting the superior strength of disulphide bonds at high temperature with that of hydrogen bonds. Some described the effect of this on the whole enzyme with statements such as 'preventing denaturing' or 'loss of tertiary structure at high temperature'.

(e) This part question discriminated well between candidates who scored the higher marks on the paper overall and candidates who did less well. Only the better candidates seemed to be able to recall and state clearly the central dogma of molecular biology explaining the relationship between DNA, mRNA and protein primary structure via the mechanisms of transcription and translation. Weaker candidates did not identify what type of nucleotides (those of DNA or mRNA) they were discussing and made vague and general statements, or erroneous ones such as that DNA, mRNA or nucleotide sequences 'produce' amino acids or that amino acid sequence determines nucleotide sequence. It is noted that poor understanding of this central relationship was also shown in last June's paper and tends to be a recurring problem.

Teaching tip

Data quotes from graphs should include units. Where time is measured candidates should double-check that they have read the units correctly and have not written minutes or days where the unit is actually hours.

Candidates could be encouraged to use a ruler in interpreting a graph. Placed against the slope this helps to identify the point at which a linear increase stops being linear (as when the rate of increase begins to slow down). A ruler is also helpful to read off x and y coordinates with accuracy.

The basics of protein synthesis and the relationship between genes and proteins should be reinforced wherever possible, for example in the contexts of different genes, proteins and enzymes as they appear in the teaching of the specification.

Q.4 This question proved beyond the scope of large numbers of candidates. This underlines the need to revisit *Biology Foundation* (2801) before sitting this paper.

(a) This question required the candidates to compare the diagram pictured in Fig. 4.1 with their recall of the structure of the subunit of cellulose, β-glucose. Simply observing that the molecule pictured was not glucose earned a mark, as did the observation that the sugar unit in Fig. 4.1 contained sulphur and nitrogen atoms.

Surprisingly few candidates came up with these simple statements. A frequent error was to refer to branching – usually, the incorrect claim that cellulose is a branching polysaccharide, or to state that cellulose is a polymer of α-glucose. Candidates appeared to be somewhat panic-stricken by the biochemistry and tried to recall anything they knew about cellulose, for example the hydrogen bonding to form fibrils. Recall of random facts without relating their knowledge to the question or gleaning information from the diagram lost many candidates marks here.

(b) Few candidates came up with a reasonable suggestion. Some suggested that the amount of glycoprotein varies in different tissues, and that the extent to which different cells carry out endocytosis varies.

(c) Slightly more candidates made a reasonable suggestion, the most common being that there would be more lysosomes, and that the lysosomes (or vesicles) would be larger in size. A disturbing number of candidates thought that polysaccharide chains would be visible under the electron microscope.

(d) In part *(i)*, many candidates scored a mark, realising that unaffected parents were producing an affected child, or giving the numbers of such parents and children from the pedigree diagram of Hunter's syndrome. Many candidates did not appear to have a clear notion of what sex linkage was in part *(ii)*. However, many candidates scored a mark for observing that only males suffer from Hunter's syndrome in the diagram or that no females have the syndrome. Better candidates went on to identify the X chromosome as the possible site of the gene, or to identify mothers or numbered individuals as the carriers who passed on the allele. Some candidates thought that if males were affected the gene was likely to be carried on the Y chromosome.

(e) Few candidates scored. The obvious answer is that the diagram provides insufficient data to be sure. Many candidates criticised the data by stating that genotypes need to be included to be certain.

(f) The most common mistake here was to ignore the word 'drug' in the question. Explanations were given that involved gene therapy and the difficulties associated with it. Some candidates considered the development of a drug realised that getting a drug to act inside lysosomes in cells would be very difficult. Others commented on possible side effects, based on the information they had read on page 12 of the paper. A few used general common sense and commented on the economic and logistical problems of developing a drug for a very rare disease.

Teaching tip

Candidates need to be encouraged to read and study the material provided thoroughly. This is particularly important in this paper, where extra time is allocated so that candidates have time to assimilate the quantity of new information provided. Candidates cannot expect to perform well if they rely purely on recall of facts. Their knowledge has to be integrated with the information and context given. They should be encouraged to look for clues in the material provided.

Further details about Hunter's syndrome can be found at:
www.patient.co.uk/showdoc/40001392/
www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=309900
www.mpssociety.co.uk/index.htm

Details of the family of glycoproteins referred to in this question may be found at:

www.med.unibs.it/~marchesi/glycans.html
There is also a useful summary of compounds found in the extracellular matrix (ECM) at:
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/E/ECM.html

A suitable exercise to prepare candidates for the synoptic paper is to look at pedigree analysis. There is a tutorial at:
www.usd.edu/med/som/genetics/curriculum/2CINHER3.htm

Q.5 Candidates picked up marks on this question, but many would have done better if they had paid attention to basic aspects of examination technique such as studying the information given in the introductory text and diagram and in the part questions with more care.

(a) Most candidates realised that the characteristic flashing attracted mates of the correct species.

(b) Most candidates correctly named diffusion as the process by which oxygen reached the light-producing organelles in part *(i)*. It seemed that few candidates studied the large diagram provided on an insert to deduce the correct answer to part *(ii)*. Those who did examine the diagram realised that the arrangement prevented oxygen reaching the light-producing organelles constantly, since the oxygen was intercepted and used by the mitochondria.

(c) Many candidates made a reasonable suggestion. Most focused on the necessity of aerobic respiration not being inhibited all the time since this would deprive the cell of ATP and prevent other essential processes from happening, perhaps leading to death of the cell. Some candidates followed the line of reasoning that if the effects of nitrous oxide were not temporary the light would be on constantly and that this would render the communication ineffective, would be a waste of energy in daytime or could attract predators. Candidates did not on the whole make use of information provided on page 16 which would have scored marks had they explained events in a stepwise fashion.

(d) Active transport was the most common creditworthy answer here. Other good answers were protein synthesis, anabolic reactions and movement of organelles. Some candidates ignored the information that these cells do not divide and talked about ATP being required for DNA replication or mitosis. Candidates who scored few or no marks here were either being very vague ('movement') or gave standard responses to the uses of ATP without relating their answers to the particular situation given.

(e) Many candidates gave a coherent explanation and scored two or three marks. The most popular reasoning was that oxygen was suddenly available and allowed the production of light but that this ceased when ATP ran out.

(f) Most candidates scored this mark. For those that did not, the reason was often that they were discussing bacteria without stating whether they were alive or dead. A clear statement that only the live bacteria respire or produce ATP was needed (or the reverse argument). Some candidates thought that live bacteria produce oxygen.

(g) Surprisingly few stated DNA or mRNA here. Since the question required the name of a substance, the words 'gene' or 'chromatin' were not acceptable. Most candidates, however, did not appear to understand what gene technology was or to realise that luciferase is a protein enzyme, and they named substances from the text such as luciferin, oxyluciferin or nitrous oxide.

Teaching tip

Again candidates should be encouraged to read the text carefully, perhaps highlighting or underlining key points as they read. If a diagram is provided they must assume it is important and again should study it closely before embarking on answering the questions. They should also go back to the information or diagram to double check their understanding.

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

General Comments

As with previous January entries the work presented for moderation fell into two categories:

- a comparatively large number of centres submitted work done by one or several candidates;
- a few centres entered complete cohorts for first assessment.

The latter was generally of good quality and compared favourably with previous sessions, being well marked and annotated. The work offered for a second time seemed to have changed very little and scored much the same. It is accepted that entering a single candidate may pay dividends when a centre has had marks adjusted at the last session. However, it seemed that the reasons for adjustment had often not been addressed and the mark of the single candidate was adjusted in the same way. To show an improved score, resubmitted material must have been reworked, preferably by the candidate producing new results, and then marked again. The person marking the coursework should take into account the comments on the moderator's report from the previous session.

A major cause of adjustment remains the lack of structure to some candidates' work. The use of writing frames to reduce repetition and omission makes the task of presenting work in writing much more straightforward and more representative of candidates' abilities. Even the best students sometimes fall into the trap of submitting large quantities of text where digression causes confusion in the writer's mind and masks detail essential to the task. This is particularly true of Skill P (planning) where P7aii, and P7b may be lost and in Skill A (analysis) A5bi, A7ai and A7bi often suffer a similar fate. Some suggested writing frames are shown below.

Apparatus list

Item	Quantity	Concentration and volume

The two tables below could also be used to guide candidates, without unfair assistance, in fulfilling parts of P1a, P5b and P7b.

Table to show how concentrations of working solutions will be made.

End concentration	Volume of ………	Volume of …….

Table to show reasons for choice of apparatus.

Item	What it is used for	Reason for choice

Skills P3a and P7b might be more clearly stated if candidates used a table such as that below. These aspects do not have to be written in continuous prose.

Table to show the variables that must be controlled.

Variable	Why it must be controlled	How it will be controlled

Skill E (evaluating) is said to be the more difficult and therefore discriminating part of the coursework assessment. Centres that have adopted the writing frame shown below have had some startling improvements in overall standard of work.

Table to show some possible effects of limitations in the methods.

Limitation [E3a]	Error that may have resulted from the limitation	Rank order of limitation **with qualification** [E5ai]	Suggested improvement [E5aii]	Justification of improvement [E7a]

Centres should be aware that some candidates are confused by the words limitation, accuracy and reliability. This can go unnoticed in the script and credit may be given inadvertently.

Statistical analysis is a useful skill and enhances work at this level, particularly at A2. Some candidates spend a good deal of time developing conclusions based on the outcomes of the statistical methods that they employ. Candidates who rely only on deductions made from the results of statistical tests will not score at A5b or A7b. This is because A5bi and A7bi require relevant scientific knowledge and understanding; deductions based on the outcome of statistical tests often do not match those descriptors. Candidates should draw full conclusions using the statistical test(s) to inform those conclusions. They should also explain exactly what they mean in terms of probability and chance, as well as accepting or rejecting the null hypothesis that they have used.

The moderators felt that candidates from some tutorial colleges were at a disadvantage as their work often did not show a good match to the descriptors. These candidates could benefit from more guidance; it was felt that their teachers would be best advised to use the Coursework Consultancy Service or attend one of the INSET meetings during autumn 2006. Details are on the OCR web site: www.ocr.org.uk
The Biology section of the web site can be reached by using the qualification finder on the home page and scrolling down to find:
AS/A Level GCE *and* Sciences.

2806/03: Practical Examination

General Comments

The barely disguised theme of respiration lay behind this January's practical examination. The range of marks was more limited than usual because candidates did not seem to be sufficiently confident or familiar with respiratory quotients and so whereas planning exercises showed the usual range of marks and *Q.2* was often very well answered, candidates' marks for *Q.1* were disappointing.

The theory underlying a simple respirometer should be familiar to candidates. In the presence of soda lime, the movement of a meniscus towards the specimen is a measure of the amount of oxygen used up. In the absence of soda lime any movement of the meniscus is the sum of both the oxygen used up and the carbon dioxide produced. If the movement is towards the specimen, more oxygen is being used up than carbon dioxide produced but if the movement is away from the specimen, more carbon dioxide is being produced than oxygen used up.

The expected results were that in the presence of soda lime, the meniscus would move towards the mung beans, but in the absence of soda lime it would not move much towards the beans. If the candidates found that this happened it might have been due to handling the syringe so warming the contents, which as they cooled contributed to the movement of the meniscus.

Comments on Individual Questions

Planning Exercise

Candidates were asked to plan an investigation to find out the effect of different concentrations of four different monosaccharides on the rate of respiration in yeast. There are two basic strategies. One is to record the volume of carbon dioxide produced using an upturned measuring cylinder or a burette (not 'biurette') or use a gas syringe. The other is to use a redox indicator such as triphenyl tetrazolium chloride (TTC) turning pink or methylene blue turning colourless. All techniques were described and the mark scheme rewarded all these strategies.

A common mistake was to write everything about monosaccharides, enzymes and respiration and not identify or select material that was pertinent to the planned investigation. Sometimes none of it was used in the planned investigation. One candidate wrote 1800 words over eight pages and scored nothing.

Predictions should have been, and often were, informed by reference either to the structure of the different monosaccharides or to the different pathways by which they enter glycolysis (not 'glycolosis'). Many candidates put down any structure that they could find so that there were straight line and ring forms (both α and β) in plan view and in elevation invalidating any meaningful comparison. The better candidates took the trouble to write down four straight line formulae or four ring structures either all α or all β. It was hardly surprising that there were few references to pyran or furan structures. A worrying number thought that fructose, and indeed all ketoses, were non-reducing sugars.

A number of candidates thought that yeast only respired anaerobically. It is of course a facultative anaerobe. Thus, it generally respires aerobically but if suspensions are made up using boiled, cooled water with a layer of paraffin oil on the surface, conditions may then be sufficiently anaerobic to guarantee respiration will be the same. Reassuringly few candidates thought yeast was an enzyme, but many referred to a yeast *solution* rather than to a yeast *suspension*.

Lists of apparatus are welcome, but should include all major pieces of equipment. Often lists of apparatus were token and sometimes did not include a clock or stopwatch or bench timer that was crucial for determining rates. The better candidates specified volumes and concentrations where appropriate. However, reluctance to rinse apparatus let alone wash it up, or thinking on an industrial scale, does not excuse the candidate who specified 1000 syringes, 1000 beakers and 20 dm^3 of each monosaccharide solution. The majority rightly chose a range of five or more different concentrations, but this quite often included 100% glucose which at 100 grams 100 cm^{-3} might be sufficiently dense to fall through the bottom of the test tube.

Unless using sodium hydroxide or TTC, there were few real hazards and candidates were generally rewarded for saying so. Quite a number who identified a hazard also identified the treatment necessary following an injury whereas it would be more instructive to know the precaution necessary to avoid being admitted to the nearest hospital in the first place.

The last hurdle was what to do with the data that the planned investigation would generate and candidates should be encouraged to think harder about precisely what the table of results and any graph that illustrates them should look like. A minor cosmetic point, but it was noticeable that a number of candidates' tables ran over page breaks.

Amongst the gems that escaped the spell checker were the 'calculated syringes' and the 'hydrostatic water bath'. Eyebrows were raised when an Examiner found a candidate using a 'serial killer' technique for diluting sugar solutions; other examples included the candidate whose 'private' entered the link reaction and the candidate who attached her delivery tube to a 'conical flash'. Finally some might think that much is enforced by OCR, but not (yet) the textbooks.

Teaching tip

A useful book to have in the departmental library is:
Rockett, B and Sutton, R. *Chemistry for biologists at advanced level*. 1996. John Murray.
ISBN 0 7195 7146 4

Practical Test

Q.1 *(a)* Results were adequately recorded in tables, but these varied from the immaculate to the barely legible. Candidates are expected to take a little care over the presentation of their results. For a small number of candidates the meniscus moved towards the syringe *more* in the absence of soda lime. If this genuinely occurred (e.g. due to a leak when using soda lime) and was not due to a mistake by the candidate (e.g. mixing up the two results when recording them), the supervisor can supply specimen results, but not in tabulated form. This highlights the need for supervisors to be vigilant and the need to have such results available.

(b) Graphs were generally well executed but a small number of candidates sacrificed marks by carelessness. As with tables, taking a certain amount of trouble over presentation is expected.

(c) The single most common error was that having obtained good results, candidates did not use the radius 0.2 mm but used the diameter 0.4 mm in their calculation of volumes. Using $\pi r^2 l$ to calculate volumes should be routine in practical work, such as when using potometers. Only the better candidates appreciated the need to subtract the result without soda lime from the result with soda lime to measure carbon dioxide produced.

(d) The majority knew what calculation to perform and had they carried out both steps in *(c)* they would have obtained respectable values for the respiratory quotient.

(e) In part *(i)*, many candidates thought that a higher respiratory quotient meant a faster rate of respiration rather than a shift from lipid towards carbohydrate metabolism. Many candidates did not think synoptically in *(ii)* and so did not comment on the higher energy content of lipid.

(f) Identifying a control experiment was problematic for many. Good candidates appreciated the need for a syringe with soda lime but without seeds and with an inert material, such as glass beads, instead. They rightly reported that this would show that mung beans were responsible for the movement of the meniscus in the experiment. Only a small minority thought further, realising that any movement would then be due to pressure or temperature changes. If such movements were towards the syringe, they would have to be subtracted from the results or, if away from the syringe, they would have to be added to the results.

(g) Four limitations were rarely identified. Amongst them were the inability to:
- control temperature,
- check for leaks,
- carry out repeats,
- measure the position of the (moving) meniscus accurately.

Teaching tip

This practical exercise could be used in conjunction with questions that have been set on the respiratory quotient in *Central Concepts* (2804). See for example:
2804 January 2004, *Q.1* and 2804 January 2003, *Q.7*.
The Lab Bench exercise on cell respiration at The Biology Place is also a useful resource for practical work using respirometers:
www.phschool.com/science/biology_place/labbench/lab5/intro.html

Q.2 *(a)* Diagrams of seedlings were generally acceptable and adequately annotated. Very close inspection of the root tip usually reveals that the root cap is not stained but this was rarely observed.

(b) Those who remembered adaptations of lungs for gaseous exchange had little

difficulty identifying in *(i)* thin or squamous epithelium, large surface areas and capillaries as visible features. However, an alarming number casually referred to alveolar cell walls and alveolar membranes instead of just alveolar walls.
In part *(ii)*, good candidates appreciated that cutting a spherical structure at different levels produces sections of different sizes.

(c) Most candidates did very well identifying differences between healthy lung tissue on the slide and diseased tissue on the photomicrograph.

(d) An explanation for the fact that cells with more mitochondria stain more intensely with TTC did not elicit the expected response. This was that there would be more respiratory enzymes, including dehydrogenases, more cristae and hence a higher rate of respiration in these cells.

Teaching tip

Centres that wish to use this question, can find the photomicrograph of emphysema at:
www-medlib.med.utah.edu/WebPath/ORGAN.html#2
by exploring the section called Pulmonary Pathology.
Other suitable photomicrographs can be found on web sites that provide histology or pathology slides. Examples are:
http://medicine.uchc.edu/curriculum_pub/swp/LisaStoll/cp4.html
http://www.path.utah.edu/casepath/PM%20Cases/PMCase6/PMCase6Part2.htm

Advanced GCE (Biology) (3881/7881)
January 2006 Assessment Session

Unit/Option Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	Number of candidates
2801	Raw	60	44	39	34	29	24	0	19330
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	46	41	37	33	29	0	6655
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	92	81	70	60	50	0	763
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	92	81	70	60	50	0	1197
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	89	79	69	60	51	0	998
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	66	58	50	42	35	0	11031
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	67	59	52	45	38	0	149
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	64	56	49	42	35	0	56
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	63	56	50	44	38	0	210
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	67	61	55	49	43	0	255
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	64	56	49	42	35	0	431
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	89	80	71	62	53	0	1244
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	89	80	71	62	53	0	47
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	85	77	69	62	55	0	530
	UMS	120	96	84	72	60	48	0	

1.

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	ii)	C	D	E	U	Total Number of Candidates
3881	14.6	34.4	55.2	78.6	94.8	100.0	893
7881	13.7	41.1	75.3	90.4	97.9	100.0	174

For a description of how UMS marks are calculated see:

http://www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication.

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