

**CAMBRIDGE**  
INTERNATIONAL EXAMINATIONS

**June 2003**

**GCE A AND AS LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 40**

**SYLLABUS/COMPONENT: 9700/01**

**BIOLOGY**  
**Paper 1 (Multiple Choice)**



<b>Page 1</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>A/AS LEVEL EXAMINATIONS – JUNE 2003</b>	<b>9700</b>	<b>1</b>

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	D	21	D
2	A	22	B
3	C	23	B
4	C	24	A
5	A	25	C
6	C	26	C
7	D	27	B
8	A	28	B
9	B	29	C
10	A	30	D
11	B	31	A
12	C	32	C
13	B	33	C
14	C	34	D
15	D	35	B
16	A	36	B
17	D	37	D
18	A	38	B
19	C	39	B
20	C	40	C

**TOTAL 40**

**CAMBRIDGE**  
INTERNATIONAL EXAMINATIONS

June 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9700/02

BIOLOGY  
Paper 2 (Theory 1)



<b>Page 1</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
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## KEY

a semi colon ;	indicates a separation of marking points
an oblique line /	indicates alternative wording or acceptable alternative
R	means reject
A	means accept
AW	means 'alternative wording'
underlined with a <u>straight line</u>	accept this word only, no alternative word is acceptable
<b>D</b>	represents quality mark(s) awarded for diagrams, as indicated on the Mark Scheme
<b>L</b>	represents mark(s) awarded for labels on diagrams, as indicated on the Mark Scheme
<b>Q</b>	represents quality of expression and is used for marks awarded on free-response questions

Page 2	Mark Scheme	Syllabus	Paper
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Question	Expected Answers	Marks
1 (a)	C, E, D, B;	1
(b)	centromeres have divided/duplicated; R. split R. replicated (sister) chromatids/(daughter) chromosomes pulled/moved/separate/migrate to (opposite) <u>poles</u> ; ref. to the spindle/microtubules/spindle fibres; R. fibres	max 2
(c)	replication/DNA synthesis; assembly of nucleotides/polynucleotide (chain) formed; (alongside) old/original/both strands, act as <u>template</u> ; by base/complementary pairing/ A-T <u>and</u> G-C; quantity of DNA doubles/two new double helices formed;	max 3
(d)	production of <u>genetically</u> identical cells/ <u>genetically</u> uniform cells/ identical DNA/maintains <u>genetic</u> stability/same number <u>and</u> kind of c-somes/no <u>genetic</u> variation;	1

[Total 7]

2 (a)

*Award one mark per column. No penalisation for complete lack of **all** crosses (or **all** ticks) unless mixture of x and ✓ missing as agreed*

statement	emphysema	tuberculosis	obesity	rickets	smallpox
eliminated by vaccination	x	x	x	x	✓
a worldwide infectious disease	x	✓	x	x	✓ or x
a form of malnutrition	x	x	✓	✓	x
a deficiency disease	x	x	x	✓	x
involves degeneration of lung tissue	✓	✓ or x	x	x	x

[Total 5]

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- 3 (a)** Correct letter order **on** Question Paper:
- A - nucleus;  
 C - mitochondria; B - RER;  
 D - Golgi apparatus;  
 E - cell surface membrane;
- max 4**
- R. process statements instead of letters*
- (b)** secrete/release/produce/make antibodies; **1**  
 A. immunoglobulins  
 R. memory cells unless linked to antibody production
- (c)** nucleus/nuclear envelope/nuclear membranes/nucleolus;  
 no cell wall;  
 have organelles/named visible organelles; (golgi/mitochondrion/  
 RER) R. more organelles  
 larger (cell);  
 fixed ribosomes/ribosomes attached to E.R./no free  
 ribosomes;
- max 2**
- [Total 7]**
- 4 (a)**
- (i)** shade in xylem; (complete xylem star must be shaded) **1**
- (ii)** shade in phloem; (A. shading of just one phloem group) **1**
- (b)** ref to bending/provide support/strength; R. lignin unqualified **1**  
 R. prevents collapsing
- (c)** osmosis/diffusion;  
down water potential gradient/from high/less negative to low/more  
 negative water potential/AW; (R. osmotic potential/conc. gradients/  
 less or more) through partially/selectively/differentially permeable  
 membrane; R. semi-permeable **max 2**
- (d)** transpiration pull/cohesion-tension/cohesion-adhesion/  
 mass flow in xylem;  
 into spongy mesophyll (cells);  
many cell walls/surfaces/large surface area; evaporation of water  
 (from damp walls); into (substomatal/intercellular) air spaces; diffusion  
 of water vapour/water as a gas/described; (e.g. movement of water  
vapour from high to low conc.) through stomata/cuticle (to air/  
 atmosphere); **max 4**
- (ignore ref. to apoplast, symplast, vacuolar pathways)
- [Total 9]**

Page 4	Mark Scheme	Syllabus	Paper
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- 5 (a) (i) haem; R. incorrect spelling  
combines/binds with/carries/holds/takes up/transport oxygen; **2**
- (ii) soluble/polar/hydrophilic (on outside)/compact/spherical/curled/  
coiled/folded (into a ball)/metabolically active;  
4 polypeptides; **2**
- (b) iron needed for haem/haem contains iron;  
less haemoglobin (made); R. less RBCs  
less oxygen transported/supplied/delivered (to cells/tissues);  
less respiration/respiration rate decreased;  
R.respiration less efficient/effective **max 3**
- (c) muscle; A. cardiac/skeletal/involuntary muscle **1**  
R. named muscle, e.g. biceps muscle
- (d) (i) 90%;  
25%; A. within range 23-25% R. 23-26%, 22-25%  
(N.B. Both % need to be correct for one mark) **1**
- (ii) haemoglobin unloads/releases oxygen/dissociates,  
easily/readily/at higher ppO<sub>2</sub> (in tissues/cells);  
(whilst) myoglobin holds on to oxygen/is very stable/does  
not dissociate easily/has a higher affinity for oxygen;  
(so) providing a store/reservoir/reserve of oxygen;  
(so will not) release oxygen until the pp/conc./tension of oxygen  
is low/during strenuous exercise;  
so delaying anaerobic respiration; **max 3**
- (e) S-shaped curve to the right of **H**;  
(N.B. curve should be S-shaped, start at 0, plateau out at  
between 90-98% saturation, show 50% plus saturation at pp  
of 6kpa) **1**

**[Total 13]**

- 6 (a) *Two correct letters required for a mark for each column if list given;  
mark first 2 letters.*

Alcohol	Caffeine	Nicotine	Heroin
U	S	S	U
V	T	T	Y
Y	Z	W	W
Z		X	
		Z	

**4**

Page 5	Mark Scheme	Syllabus	Paper
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(b) decrease in response to drug/effect of drug becomes less (intense);  
 decrease in sensitivity of receptors/more receptors are made;  
 drug is metabolised/becomes part of body's metabolism; more  
 drug necessary to achieve the same effect/sensation/euphoria; **max 2**

(c) *award marks from any annotated diagrams*  
Either  
 inhibitor fits site other than active site/allosteric site; tertiary/3D  
 structure or shape changes/any two bonds mentioned break;  
 (ionic, van der Waals, hydrophobic, hydrogen, disulphide,  
 covalent)  
 active site changes shape;  
 substrate no longer fits/binds/active site no longer complementary  
 to substrate/E.S. complex not formed;

or  
 inhibitor fits permanently/irreversibly into active site;  
 substrate can no longer bind/substrate blocked/no E.S. complex  
 formed;  
 increasing substrate has no effect; **max 3**

Either mark scheme as appropriate – do not mix marking points from  
 both mark schemes

**[Total 9]**

**Total mark for paper = 50**



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**GCE A AND AS LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 25**

**SYLLABUS/COMPONENT: 9700/03**

**BIOLOGY  
Paper 3 (Practical 1)**

Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS – JUNE 2003	9700	3

Question	Expected Answers	Mark	Additional Guidance	
<b>1 (a) (i)-(iii)</b>	T1 > T2;	1		
	T1 results have increased;	1		
	35-40 means correct;	1		
	45-50 means correct;	1		
	<b>(b)</b>	Allow the yeast to get to the correct temperature;	1	
	Allow the gas to expand and vent/contract and suck back;	1		
	<b>(c)</b>	Correct ref. to results e.g. T1 higher;	1	REJECT unqualified rates of reaction. If T1 lower then ecf, i.e. accept correct ref. to table and denaturation i.e. max 2
	Increased kinetic energy of molecules/move faster;	1		
	More collisions;	1		
	Rate of diffusion of glucose into yeast;	1		
	<b>(d)</b>	Two from: Explanation of control, i.e. yeast or no yeast/enzyme; eliminate effects of gas expansion due to temp fluctuations; Number of bubbles produced by T2 deducted from totals for T1;	Max 2	IGNORE for better comparison/control/fair test
	<b>(e)</b>	Three from: Not alternate counting; Keep at constant temperature; Take more readings; Control pH; Measure volume of gas;	Max 3	Allow reduce volume of reagents if qualified
			<b>(15)</b>	
	<b>2 (a)</b>	Clear single lines (quality);	1	
		3 arms to drawing;	1	
Nuclei drawn;		1		
Red blood cells smaller than nuclei;		1		
Wall of alveoli not more than 3 diameters of nuclei;		1		
3 correct labels from: air space/alveolus; nucleus; cytoplasm; cell membrane; red blood cells; epi/endothelium; alveolus wall;		3		
		Max 6		

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- (b) 4 from:  
Procedure explained;  
Random sample;  
Repeat 3 or more times;  
Calculate means;  
Ratio calculated between 1:4 and  
1:20;

Max 4

**(10)**

**Paper Total 25**



**CAMBRIDGE**  
INTERNATIONAL EXAMINATIONS

**June 2003**

**GCE A LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 50**

**SYLLABUS/COMPONENT: 9700/04**

**BIOLOGY**  
**Paper 4 (Theory 2 (A2 Core))**



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS – JUNE 2003	9700	4

**1 (a)** top half of leaf/just below (upper) epidermis;  
packed (densely);  
long axis in line with incident light/AW;

**2 max**

**(b)** contain large numbers of chloroplasts/large amount of chlorophyll;  
large vacuole; (*only give if linked to next point*)  
chloroplasts (in cytoplasm) close to cell wall/cell membrane;  
short diffusion pathway;  
(cell) elongated/arranged to intercept (maximum) light;  
thin (cell) wall;  
ref. movement of chloroplasts;

**3 max**

**(c)** contains photosystems/PS1 and PS2/chlorophyll and accessory pigments/  
reaction centres;  
maintain carriers/receptors in position;  
site of photophosphorylation/light reaction;  
site of ETC;  
ref. proton pumping/proton gradient;  
large surface area;  
produce ATP/ref. ATP synthase;  
produce reduced NADP;

**4 max**

**(d)** ref. to Rubisco;  
carbon dioxide combines with RuBP;  
driven/powered by ATP;  
and reduced NADP;  
forms PGA;

**2 max**

**Total: 11**

**2 (a)** provides energy;  
suitable examples;  
*e.g. muscle contraction, protein synthesis, DNA replication, cell movement, active transport*

**3**

**(b)** *substrate level phosphorylation*      cytoplasm (in glycolysis);  
matrix of mitochondria (in Krebs cycle);  
*oxidative phosphorylation*      inner membrane of mitochondria/cristae;

**2 max**

**(c)** oxidative phosphorylation more than substrate level phosphorylation;  
ref. to quantity, e.g. 32/34 vs. 4/6 per glucose;

**2**

Page 2	Mark Scheme	Syllabus	Paper
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- (d) requires proton gradient produced by ETC;  
with no oxygen ETC does not occur/no electron flow;  
NAD cannot be reformed/NADH cannot be oxidised;  
oxygen combines with electron/proton/oxygen final acceptor in ETC;
- 3 max**

**Total: 10**

- 3 (a) **A** vesicles containing transmitter/acetylcholine/synaptic vesicle;  
**B** presynaptic membrane;  
**C** synaptic cleft/gap;  
**D** post synaptic membrane;  
**E** receptor/protein/Na<sup>+</sup> gate;
- 5**

- (b) arrow pointing down;
- 1**

- (c) ref. low Ca<sup>2+</sup> in synaptic knob/high Ca<sup>2+</sup> outside knob;  
action potential/depolarization causes opening of Ca<sup>2+</sup> channels;  
Ca<sup>2+</sup> into synaptic knob;  
causes vesicles to move towards presynaptic membrane;  
causes vesicles to fuse with presynaptic membrane;  
vesicle contents/transmitter/exocytosis into synaptic cleft/gap;
- 3 max**

**Total: 9**

- 4 (a) metaphase;  
II; (*allow one mark for telophase and two marks for telophase 1*)
- 2**

- (b) ref. spindles/microtubules shorten contract/pull/breakdown;  
centromeres divide;  
chromatids (pulled) apart;  
to opposite poles;  
chromosomes unwind/AW;  
nuclear membrane reforms;  
ref. cytokinesis/cleavage;
- 4 max**

- (c) independent/random assortment;  
of homologous chromosomes;  
different combinations of parental chromosomes;  
crossing over/chiasmata;  
between chromatids of homologous chromosomes/non-sister chromatids;  
breaks up linkage groups/mixes alleles from parents; **R** genes  
ref. to non-identical/genetically different gametes;
- 4 max**

**Total: 10**

<b>Page 3</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
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- 5 (a)** phenotype is the feature/characteristic;  
 results from interaction of genotype and environment on organism/  
 environment may alter the appearance of an organism;  
 genotype unaffected by environment;  
 genetic characteristics inherited/passed on to offspring/ora/represents alleles  
 possessed;
- 2 max**
- (b)** artificial selection carried out by humans;  
 choose organisms with useful characteristics/benefit to humans;  
 natural selection carried out by environment;  
 ref. survival (to breed);  
 ref. evolution;
- 3 max**
- (c) (i)** length of DNA/sequence of bases/locus on a chromosome;  
 coding for a characteristic/protein/polypeptide/enzyme;
- 2**
- (ii)** alternative form of a gene;  
 determining contrasting characters/controls one form of a character;  
 occupies same locus;  
 ref. sequence of bases;  
 ref. dominance;
- 3 max**
- Total: 10**



**CAMBRIDGE**  
INTERNATIONAL EXAMINATIONS

**June 2003**

**GCE A LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 30**

**SYLLABUS/COMPONENT: 9700/05**

**BIOLOGY**  
**Paper 5 (Practical 2 (A2))**



Page 1	Mark Scheme	Syllabus	Paper
	A/AS LEVEL EXAMINATIONS – JUNE 2003	9700	5

Question	Expected Answers	Marks	Additional Guidance
1 (a) (i)	F1 does not change/ $\infty$ ;	1	
	F2 changes quickest/F3 2 <sup>nd</sup> to change;	1	
	(ii) Blue;	1	
	(iii) F1 renal vein (plasma); F2 urine; F3 renal artery (plasma);	Max 2	ENSURE ecf from (a) (i) 3 = 2    2 = 1
	1 mark for each correct explanation, i.e. F1 urea removed by kidney; F2 high concentration of urea; F3 low concentration of urea;	1 1 1	
(b)	Two from: start all three at same time; replication; means of more precise pH measurement	Max 2	
		(10)	
2 (a)	2 cells only drawn; columnar; cells tapering; brush border drawn by single line; large nuclei almost cell width; 3 correct labels from brush border; nucleus; nuclear membrane; cell membrane; cytoplasm; max 1	Max 4	3 correct labels = 1 mark
	(b) Both circular/oval/angular/NOT columnar; circular nucleus; Nucleus proportionately smaller than (a); Clear unbroken lines; 3 correct labels from: nucleus; nuclear membrane; chondrocyte; lacuna; intercellular matrix; cytoplasm; cell membrane; max 1	Max 4	3 correct labels = 1 mark

Page 2	Mark Scheme	Syllabus	Paper
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- (c) Two from:  
brush border: no brush border;  
columnar: angular or circular;  
nucleus oval: circular;  
cells side by side: cells scattered;  
no matrix: cells separated by matrix;      Max 2

(10)

- 3 (a) Three from:  
Ref to fan;  
Ref to support;  
Ref to under water;  
Ref to acclimatisation;  
Clip closed;  
Capillary tube contains water;  
Tight fit/no leaks;      Max 3

- (b) Two from:  
Light;  
Temperature;  
Humidity;      Max 2

- (c) Three from:  
Time measured;  
Scale read;  
Alter fan speed/change fan distance;  
Replication;  
Measure leaf area;  
Ref to reset apparatus qualified;  
Equilibrate if not given in (b);      Max 3

- (d)  $\pi r^2 h = 2$  marks;  
Or length X;      1  
Area of capillary;      1

(10)

**Paper Total 30**



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**GCE A LEVEL**

**MARK SCHEME**

**MAXIMUM MARK: 50**

**SYLLABUS/COMPONENT: 9700/06**

**BIOLOGY**  
**Paper 6 (Options (A2))**



Page 1	Mark Scheme	Syllabus	Paper
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### Option 1 – Biodiversity

- 1 (a)** (existence of many) different species;  
with (a wide range of) different, genes/alleles;  
(many) different, habitats/ecosystems; **max 2**
- (b)** has a very high, species diversity/biodiversity;  
is being lost rapidly;  
may be a carbon sink/ref. to global warming;  
loss may affect rainfall patterns;  
loss may affect, soil erosion/flooding; **max 3**
- (c) (i)** more variety of plants in system A than (B, C or) D;  
ref. to different levels of vegetation in original forest (canopy,  
understory);  
therefore greater variety of habitats for birds;  
greater variety of food sources for birds; ref. pesticides; **max 2**
- (ii)** more coffee trees grown in a (unit) area;  
no competition with other trees;  
better availability of light;  
loss of habitats for pests;  
increased use of fertilisers;  
increased use of pesticides; **max 2**
- (iii)** populations of pests (on coffee trees) can become very high in D;  
plentiful food source for them;  
fewer bird species to predate them/fewer predators; **max 2**
- (d)** nitrogen fixation;  
bacteria/*Rhizobium*/root nodules, provide nitrate/ammonium; **2**
- (e)** pay premium for coffee grown, in system A/in sustainable way;  
provide, grants/subsidies, to coffee farmers to use system A;  
encourage/educate/inform, consumers to encourage them to buy  
coffee grown in system A;  
find uses for the non-coffee trees in system A; **max 2**
- [Total 15]**
- 2 (a)** A operculum;  
B gill bar; **2**
- (b)** (each gill arch has) many (gill) filaments;  
each filament has many (gill) lamellae;  
which provides large surface area;  
distance between water and blood very small;  
filaments interlocked/packed closely, to slow water flow; **max 3**
- (c)** counter-current;  
partial pressure/concentration, of oxygen in blood always lower than in  
water next to it *or* always a diffusion gradient between water and  
blood;  
water progressively loses oxygen as it passes through the gills;

Page 2	Mark Scheme	Syllabus	Paper
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if both flowed in the same direction then blood could only become as saturated as outflowing water;  
 this arrangement takes more oxygen from the water;  
 increases length/surface area over which exchange occurs;

**max 3**

- (d) (i)** volume of, buccal cavity/mouth, increased;  
 by lowering, jaw/floor of mouth;  
 while operculum is closed;  
 this reduces pressure (below that of surrounding water) so water flows in;  
 mouth closed and, jaw/floor of mouth, raised;  
 increases pressure in mouth;  
 operculum open;  
 so water pushed out through the gills;

**max 4**

- (ii)** as swimming speed increases, rate of pumping increases;  
 because more oxygen required;  
 for (aerobic) respiration in (swimming) muscles;

rate of pumping, decreases/remains constant, between 0.4 and 0.6 ms<sup>-1</sup>;  
 stops completely at 0.75 ms<sup>-1</sup>/just before 0.8 ms<sup>-1</sup>;  
 because (only) ram ventilation used now/water flowing over gills as a result of swimming;

**max 3**

**[Total 15]**

- 3 (a) (i)** named virus + appropriate structure for it;  
 (core of) RNA/DNA/nucleic acid;  
 surrounded by, capsid/capsomeres;  
 (capsid contains) protein;  
 size between 10nm to 300nm;

detail for named virus;

*for example*

T<sub>2</sub> – tail fibres/baseplate/other

HIV – reverse transcriptase

herpes – envelope/lipoprotein covering

**6**

- (ii)** (*e.g. bacteriophage, adenovirus*)
- 1 cell recognition/interaction between viral protein and component of host cell membrane;
  - 2 virus/nucleic acid/DNA, enters cell;
  - 3 normal cell activities stopped;
  - 4 host cell DNA broken down (by viral enzymes);
  - 5 viral DNA used, for transcription/to form mRNA;
  - 6 viral proteins made;
  - 7 viral DNA replicates;
  - 8 new viruses assembled;
  - 9 viruses burst from cell/cell lysis;

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(e.g. HIV, other retrovirus)

- 1 cell recognition/interaction between viral protein and component of host cell membrane;
- 2 RNA and reverse transcriptase enter cell;
- 3 viral DNA made using viral RNA as template;
- 4 viral DNA incorporated into host DNA;
- 5 viral DNA used, for transcription/to form mRNA;
- 6 viral proteins made;
- 7 viral DNA used to produce RNA component of virus;
- 8 new viruses assembled;
- 9 viruses burst from cell/cell lysis;

**max 7**

- (iii) virus acellular/bacterium is a cell;  
virus, has no cell surface membrane *or* may have envelope/bacterium (always) has cell surface membrane;  
virus has no cell wall/bacterium does;  
virus is (much) smaller than bacterium;  
virus has either DNA or RNA/bacterium has both;  
viral, DNA/RNA, may be single stranded *or* is linear/bacterial DNA is double-stranded *or* circular;  
virus has no ribosomes/bacterium does;  
virus does not, respire/feed/grow/excrete/have metabolic reactions, (while outside host cell);  
virus can only reproduce inside host cell;

**max 7**

**[Total 20]**

- (b) (i) *Absence of features can be implied*  
chordates have notochord (at some stage), arthropods do not;  
chordates have, gill/pharyngeal, slits (at some stage), arthropods do not;  
chordates have hollow nerve cord, arthropods have solid nerve cord;  
chordates have dorsal nerve cord, arthropods have ventral nerve cord;  
chordates have closed blood system, arthropods have, open system/haemocoel;  
chordates have endoskeleton, arthropods have exoskeleton;  
chordates have postanal tail, arthropods do not;

**max 6**

- (ii) three body layers;  
ectoderm on outside, mesoderm, endoderm on inside;  
coelom is cavity; within mesoderm;  
somatic mesoderm on outside and splanchnic mesoderm inside;  
coelom is filled with fluid;  
coelom is lined by peritoneum (in vertebrates);  
mesentery connects, peritoneum/the two layers of mesoderm;

**max 7**



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(iii) isolates muscles of gut from muscles of body wall;  
which provides advantages in, locomotion/digestion;

provides space for development of organs; example; (not heart or lungs)  
can provide specialised cavities (such as pleural/pericardial/abdominal);  
within which fluid composition can be regulated;

(fluid within coelom) can act as a hydrostatic skeleton;  
by providing incompressible material against which muscles can act;  
detail of role of coelom in annelid locomotion;

(fluid within it) can be used as a transport system;  
fluid moved by cilia;  
provides fluid for excretion (of metabolic waste);

(in e.g. annelids) provides a site for gamete maturation;  
and for embryo development;

**max 7**

**[Total 20]**

<b>Page 5</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
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### Option 2 – Biotechnology

- 1 (a)** use of living organisms/biological agents/animals/plants/cells/  
microorganisms;  
to, produce useful products/produce foods/produce medicines/  
produce chemicals/process other materials/treat waste;  
in fermenter/culture vessel/AW; **max 2**
- (b)** ref. availability of information;  
ref. public knowledge/understanding/awareness (of information);  
ref. complexity of issues;  
ref. actual/potential benefits importance;  
ref. actual/potential risks;  
ref. perceptions of benefit/risk;  
ref. political/commercial pressures;  
ref. misinformation/AW; **max 4**
- (c) (i)** initial levels, normal higher than GM/ora;  
normal has a more rapid rise from 0-4 days/ora;  
normal reaches much higher level at 4/8 days/ora;  
normal stays same level from (approx.) 4-8 days/while GM rises  
slightly;  
normal drops again after 7/8 days/GM continues to rise after 7/8 days; **max 3**
- (ii)** idea of – start later;  
idea of – happen slower; **2**
- (iii)** not ripe/green when picked;  
long shelf life/AW;  
will not over-ripen;  
do not ripen too quickly;  
do not become squashy/firmer;  
AVP; **max 2**
- (iv)** ref. moral principles/personal choice/values of society/AW;  
ref. to actual/potential/perceived advantages/named advantage;  
ref. to actual/potential/perceived risks/hazards/named risk/hazard;  
AVP. **max 2**
- [15]**

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- 2 (a) (i)** stimulates immune system;  
without causing (severe) infection;  
made from, killed organisms/fragments of organisms;  
made from, weakened/attenuated organism;  
with antigens; **max 3**
- (ii)** attenuated/weakened organism can survive attenuation/still have  
ability to cause disease;  
or regain pathogenicity/regain ability to cause disease;  
very rare/AW;  
ref. allergy to vaccine/hypersensitivity;  
ref. side effects;  
named side effect linked to appropriate vaccine;  
chance of serious injury or death;  
but chance of dying of disease much greater; **max 4**
- (iii)** virus grown in living cells;  
e.g. animal/named animal/hen embryo;  
attenuated/weakened;  
by, treatment with chemicals/high temperatures/alien conditions for  
growth/AW;  
subcultured many times/AW;  
ref. harvest;  
ref. purification; **max 4**
- (b) (i)** vaccination/immunisation;  
for (almost) all children;  
detail (e.g. type of vaccine/introduced before 1980);
- OR
- better treatment;  
details (e.g. isolation/antibiotics); **max 2**
- (ii)** better vaccine/AW;  
more people vaccinated/AW;  
better antibiotics/treatment;  
cheaper antibiotics/treatment;  
better public awareness;  
AVP. **max 2**
- [15]**

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- 3 (a) (i)** hydroponics;  
 plant roots grown in/in contact with water;  
 not usually submerged;  
 will tolerate almost freezing;
- aeroponics;  
 misting plant roots/AW;  
 ref. cycles/continuous;  
 run off collected/reused;
- ref. nutrient solution;  
 grown indoors/AW;  
 use virus tested cuttings AW;  
 ref. artificial light;  
 soil based media must be washed off/clean plants;  
 ref. optimum temperature (15°-18° C);  
 ref. effects of low temperatures (e.g. flowers liable to split/weaker flower stems/slower growth);  
 ref. effect of higher temperatures (e.g. denaturation of enzymes);  
 requires Na<sup>+</sup>/Ca<sup>2+</sup> levels to be high to establish plants;
- N supplied as, nitrate/not ammonium salts;  
 ref. pH around 6/below 7;  
 ref. low humidity/need for ventilation;  
 AVP (e.g. CaNO<sub>4</sub> requirements decrease during flowering/wider spacing between cuttings reduces disease);

**max 8**

- (ii)** (indoor culture so)  
 not ruined by pests/easier pest control;  
 no pesticides;  
 no bad weather/AW;  
 can be grown in adverse climates/AW;  
 avoids poor soil/variability of soil;  
 no weeds/no herbicides needed;  
 avoids, poor drainage of soils/over watering/AW;  
 higher oxygen levels around roots/AW;  
 can be grown out of season/any time of year/when profit is biggest/AW;  
 grown where land is in short supply/maximises land use/AW;  
 ref. potential for lower labour costs;  
 AVP (e.g. can easily supply more carbon dioxide/maximise photosynthesis/optmise conditions);

**max 6**

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(iii) *Callus culture:*

named specific example of source;  
 aseptic transfer;  
 ref. sterile medium/conditions;  
 with named plant growth regulator;  
 ref. cell division/mitosis;  
 including cells that may not normally divide;  
 each (callus/sample/cell) capable of forming a new plant;  
 genetically identical to/clone of;  
 the source material/each other;  
 section cut;  
 detail (e.g. from suitable part of plant, e.g. hypocotyl/surface sterilised);  
 (callus is) mass of undifferentiated cells/aggregate of cells;  
 solid medium;  
 detail (e.g. agar);  
 use (e.g. propagation);  
 detail (e.g. of cheap/virus free/GM/ cloned plants;  
 AVP;  
 AVP;

*Suspension culture:*

named specific example of source;  
 aseptic transfer;  
 ref. sterile medium/conditions;  
 with named plant growth regulator;  
 ref. cell division/mitosis;  
 including cells that may not normally divide;  
 each (callus/sample/cell) capable of forming a new plant;  
 genetically identical to/clone of;  
 the source material/each other;  
 separation/dispersal of cells;  
 detail (e.g. gentle shaking/cellulase);  
 (culture of) single cells/small clumps of cells;  
 liquid medium;  
 detail (e.g. medium is entirely synthetic/complex);  
 use (e.g. production);  
 detail (e.g. of metabolites/GM proteins/AW;  
 AVP;  
 AVP;

*Protoplast culture:*

named specific example of source;  
 aseptic transfer;  
 ref. sterile medium/conditions;  
 with named plant growth regulator;  
 ref. cell division/mitosis;  
 including cells that may not normally divide;  
 each (callus/sample/cell) capable of forming a new plant;  
 genetically identical to/clone of;  
 the source material/each other;  
 cell walls removed;

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detail (e.g. by enzyme action/cellulases/pectinases);  
 (culture of) single/naked cells;  
 liquid medium  
 detail (e.g. with same water potential as cells);  
 use (e.g. physiology/genetic investigation/making hybrids  
 detail (e.g. ref. specific investigation heterokaryon);  
 AVP;  
 AVP;

max 6

[20]

**(b) (i)** uses *Saccharomyces*;  
*cerevisiae/carlsbergensis*;  
 malting barley;  
 under moist conditions/soaked;  
 causes germination of grain;  
 enzymes/amylases hydrolyse starch;  
 dry in kiln;  
 crush dried grain/milling/grist;  
 mashing/mix crush grain with water;  
 allow further breakdown of starch;  
 add hops;  
 for flavour;  
 and sterilise wort;  
 add yeast;  
 fermentation;  
 produce CO<sub>2</sub> and alcohol;

grapes;  
 crushed;  
 to extract sugars;  
 etc. for wine;

max 8

**(ii)** new strains of yeast;  
 by genetic engineering/named process;  
 improved yield/tolerate higher alcohol content;  
 top and bottom fermenters;  
 add amylases/gibberellins;  
 reduces time to convert starch to sugars;  
 produce low carbohydrate beers;  
 unmalted barley and amylases/glucanases/proteases replace malt;  
 marking points for wine;

max 6

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- (iii) use *Fusarium*;  
grown on flour waste/named medium;  
other nutrient sources, e.g. glucose/minerals/ammonia;  
continuous aseptic culture;  
air lift fermenter;  
heat exchanger;  
mycelium harvested;  
centrifuged;  
water content reduced;  
RNA reduced;  
by ribonucleases/heating to 60-70°C;  
pressed/processed;  
flavour added;  
colour added;  
high protein content;  
no cholesterol.

max 6

[20]

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### Option 3 – Growth, Development and Reproduction

- 1 (a) (i) A plasma membrane/cell surface membrane  
 B acrosome  
 C nucleus  
 D mitochondrion *half marks rounded up;* **2**
- (ii) A allows attachment to receptors in zona pellucida;  
 fuses with oocyte membrane; **max 1**
- B enzyme digests path between follicle cells;  
 enzyme digests zona pellucida; **max 1**
- (b) (i) *fresh/not frozen* maximum/peak/80% at 24 hours;  
 at 24h 80% v. 26%;
- frozen* highest/c. 58% at 0 hours and falls with time;  
 after 48h fresh still penetrate 40% of oocytes v. frozen only 10%;  
 A any valid figures of comparison **max 2**
- (ii) need time for capacitation;  
 removal of, glycoprotein/plasma protein;  
 accounts for increase in ability to penetrate oocytes between 0 and 24 hours;  
 decrease in ability 24-48 hours from lack of, nutrients/energy; **max 3**
- (iii) non-lethal/slight, damage;  
 during, freezing/thawing;  
 alters membrane/speeds up capacitation;  
 ref. to capacitation having already occurred;  
 during time delay between ejaculation and freezing; **max 2**
- (c) increase in, enzyme/nitric oxide synthase, activity in sperm;  
 on contact with zona pellucida;  
 enzyme active after sperm penetrates oocyte;  
 results in increase in nitric oxide concentration in oocyte;  
 leads to increase in calcium ion concentration in oocyte; **max 4**
- Total: 15**
- 2 (a) *Any three of the following:*
- petals, absent/small/inconspicuous/green/dull-coloured;  
 stamens, flexible filament/hang outside flower/anthers versatile;  
 stigma, feathery/hangs outside flower;  
 pollen, much/small/light/smooth (non-sticky);  
*no credit for structures that are not present such as 'no nectary'* **max 3**



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- (b) (pericarp) becomes, more fleshy/other possible change;  
growth/swells;  
colour change;  
increase in, attractants/sugars/scent; max 3
- (c) *needs knowledge of:*  
undifferentiated/meristematic, cells in, cutting/other propagule;  
stimulated by plant growth substances/plant growth regulators;  
auxin/cytokinin;  
form adventitious roots;  
ref. tissue culture; max 3
- (d) asexual reproduction;  
genetically identical/clone;  
original susceptible so all susceptible to same pathogen;  
only change via mutation; max 3
- (e) meiosis fails;  
in pollen mother cell/embryo sac mother cell;  
problem, in synapsis/when homologous chromosomes pair;  
in prophase 1;  
crossing over between, three chromosomes/six chromatids,  
results in tangle; max 3
- Total: 15**
- 3 (a) (i) *absolute growth rate:* also called actual growth rate;  
measure of how rate of growth varies with time;  
plot of increase in parameter in unit time against time;  
e.g. kg per year plotted against year/( $dm/dt$ ) against ( $t$ )/other e.g.;  
useful for showing, when growth is most rapid/how rate changes with time;
- relative growth rate:* also called specific growth rate;  
takes into account existing growth;  
absolute growth rate divided by parameter;  
e.g. change in mass in one year divided by mass at beginning of year ( $dm/dt$ .  
 $1/m$ );  
shows growth rate relative to size of organism; max 6
- (ii) suitable example; (*that will allow for samples over time*)  
large number of organisms;  
in identical conditions;  
e.g. of condition (e.g. temperature/water supply/humidity/nutrients);  
second e.g. of condition;  
samples taken at regular intervals;  
randomly;  
organism separated from medium;  
dried in oven/other suitable conditions;  
cooled in desiccator;  
repeat to constant mass;  
average dry mass; max 8

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- (iii) problem of allometry;  
single dimension may not reflect growth in different dimension;  
e.g. may be long but thin/other e.g.;  
problem instars;
- fresh mass/wet mass easily altered;  
(plants) by water supply/transpiration/environmental conditions;  
(animals) by, ingestion/egestion/excretion;  
such gains/losses not true growth;

**max 6**

**Total: 20**

- (b) (i) link between nervous system and endocrine system;  
stimulates pituitary gland;  
to release specific hormones;  
via releasing factors;  
small peptides;  
travel in, blood/portal vessels;  
e.g. GnRF for pituitary to release, FSH/LH;  
e.g. TRH for pituitary to release TSH;  
involved in negative feedback;  
e.g. negative feedback; (oestrogen/progesterone/thyroxine)

**max 6**

- (ii) anterior lobe;  
growth hormone (GH)/somatotrophin, from anterior lobe;  
ref. somatomedin from liver;  
stimulates protein synthesis;  
important for growth of, long bones/arms and legs;  
TSH from anterior lobe;  
stimulates thyroxine secretion;  
FSH from anterior pituitary;  
stimulates development of ovarian follicle;  
stimulates secretion of oestrogen;  
ref. secondary sexual characteristics in female;  
stimulates spermatogenesis;  
LH (ICSH) from anterior pituitary;  
stimulates ovulation;  
stimulates formation of corpus luteum;  
stimulates secretion of progesterone;  
stimulates secretion of testosterone;  
ref. secondary sexual characteristics in male;  
FSH and LH control menstrual cycle;

**max 8**

- (iii) secretes, thyroxine/T<sub>4</sub>;  
secretes, triiodothyronine/T<sub>3</sub>;  
target = respiring cells/increase in respiration rate;  
controls, basal metabolic rate/BMR;  
switches on transcription;  
stimulates protein synthesis;  
stimulates brain development;  
stimulates growth;  
especially of skeleton;  
ref. temperature regulation;

**max 6**

**Total: 20**

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### Option 4 – Applications of Genetics

- 1 (a) reduces genetic diversity;  
alleles lost;  
increases homozygosity/decreases heterozygosity;  
accumulation of deleterious recessive alleles; **max 3**
- (b) (i) 1430-1500; **1**
- (ii) neither A nor B can self-pollinate;  
stigma not receptive when own pollen released;  
stigma not in appropriate position when own pollen released;  
neither can be pollinated by another plant of the same phenotype;  
because behaviour synchronous;  
A pollinates B in morning and B pollinates A in afternoon; **max 4**
- (c) (i)  $\eta = 1$ ; **1**
- (ii) probability =  $> 0.1$ ; **1**
- (iii) difference from expectation is not significant;  
because  $>$  than 0.05/1 in 20;  
ratio of phenotypes is 1 : 1;  
observed difference due to chance; **max 2**
- (iv) unambiguous symbols identified;  
Aa;  
aa;  
[A correct answer based on co – dominant situation] **max 3**
- Total: 15**
- 2 (a) (i) thick/dehydrated, mucus builds up in lungs;  
and gut;  
bacterial infections in lungs;  
scar/damage, lungs;  
mucus blocks secretion of digestive enzymes (from pancreas)/  
impaired digestion;  
infertility; **max 3**
- (ii) recessive allele;  
autosomal/chromosome 7;  
homozygote recessive = sufferer;  
heterozygote = carrier;  
correct statement re inheritance;  
[e.g. 1 in 4 chance from 2 carrier parents] **max 3**
- (iii) large number of different mutations;  
each test specific;  
DNA has different, code/base sequence;  
probe binds to specific/complementary sequence; **max 2**

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- (b) (i) study of ion transport through cell membrane;  
if no CFTR/protein (produced and put into cell membrane) then no transport; **2**
- (ii) inability to transport  $\text{HCO}_3^-$ ;  
change in transport ratio;  
transport ratio < 0.1 : 1.0;  
increase in acidity/decrease in pH;  
ref. effect on mucus; **max 3**
- (iii) poor digestion of protein;  
lipid;  
starch;  
malnutrition;  
ref. to effect on production of, insulin/glucagon; **max 2**
- Total: 15**
- 3 (a) (i) to alter phenotype of domesticated animals or plants;  
trait of, use/value, to man.
- Allow following examples of use:*  
quantitative agricultural plant improvement;  
quantitative agricultural animal improvement;  
qualitative agricultural improvement (plant or animal);  
ornamental example in plants;  
ornamental example in animals;  
other example; (i.e. sporting, etc.) **max 6**
- (ii) plant without resistance crossed with resistant plant;  
offspring 1 seeds sown;  
offspring 1 plants challenged by disease/AW;  
resistant offspring 1 interbred;  
selection and interbreeding continued for many generations;  
resistant offspring 1 backcrossed to parent;  
for background genes;  
for traits other than resistance;  
selection and backcrossing continued for many generations;  
resistant parent, same species/primary (or secondary) gene pool;  
resistant parent, different species/tertiary gene pool;  
practical detail 1;  
practical detail 2; [male sterility/removal of anthers/bagging/pollination]  
gene bank/landrace/wild species; **max 8**
- (iii) orthodox seeds;  
seeds dehydrated;  
stored at  $-20^\circ\text{C}$ ;  
storage life doubled by  $5^\circ\text{C}$  (A approx.) reduction in temperature;  
storage life doubled by 2% (A approx.) reduction in humidity;  
germination tests every 5 years;  
recommended threshold value = 85% germination;  
then seeds grown and fresh seed collected;  
recalcitrant seeds cannot be dried and frozen; **max 6**
- Total: 20**

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- (b) (i) *linkage*  
 2 or more genes on same chromosome;  
 do not assort independently in meiosis;  
 inherited together;  
 number of linkage groups = number of pairs of homologous chromosomes/haploid number of chromosomes;  
 genes closer together less likely to be separated by crossing-over;
- crossing-over*  
 prophase meiosis I;  
 during synapsis;  
 chromatids of a bivalent break;  
 rejoin with non-sister chromatid;  
 exchange between paternal and maternal chromatids;  
 of alleles;  
 diagram;  
 ref. chiasma;  
 ref. cross over value; [max 5 on c-o]  
 genes closer together less likely to be separated by crossing over; **max 8**
- (ii) six loci; [A 4 loci]  
 A, B, C, DP, DQ, DR; [A A, B, C, D]  
 tightly linked/rarely separated by crossing over;  
 inherited as a unit;  
haplotype;  
 chromosome 6;  
 very large number of alleles;  
 hence very many different combinations in the population;  
 child receives one haplotype from mother and one from father;  
 probability of two siblings sharing one haplotype = 0.5;  
 probability of two siblings with identical haplotypes = 0.25; **max 6**
- (iii) HLA loci code for (glyco)proteins;  
 at cell surface/in plasma membrane;  
 recognition markers/self or not-self markers;  
 act as antigens;  
 transplant from unmatched donor rejected;  
 ref. immune system/immune reaction;  
 detail of immune system; [antibodies/T cells]  
 some HLA antigens induce a greater reaction than others;  
 ref. immunosuppression;  
 ref. ABO groups;  
 red cell antigens and plasma antibodies;  
 detail ABO mismatch;  
 ref. 'universal donor'/'universal recipient'; **max 6**

**Total: 20**