2007 'A' Level
H2 Biology
Mark Scheme

PAPER 1 (MCQ)

1	**C**
2	**B**
3	**B**
4	**C**
5	**B**

6	**D**
7	**B**
8	**C**
9	**B**
10	**C**

11	**D**
12	**A**
13	**C**
14	**A**
15	**A**

16	**D**
17	**C**
18	**C**
19	**D**
20	**C**

21	**B**
22	**C**
23	**D**
24	**A**
25	**D**

26	**A**
27	**C**
28	**D**
29	**D**
30	**C**

31	**B**
32	**D**
33	**A**
34	**C**
35	**D**

36	**A**
37	**C**
38	**A**
39	**D**
40	**D**

PAPER 2 (CORE)

QUESTION 1

(a)

A – viral RNA
B – reverse transcriptase
C – capsid protein

(b)

1 host cell surface membrane surrounds virus particle / (viral) RNA and protein;
2 ref. synthesis of surface glycoprotein;
3 budding; *R exocytosis*

(c)

(i)

1 block protease active site so that substrate unable to bind;
2 viral polyprotein not cut / structural / enzyme protein not formed;
3 (newly formed) virus unable to infect further cells;

(ii)

1 similar shape to polyprotein / complementary shape to active site;
2 inhibitor not hydrolysed so remains in active site;

QUESTION 2

(a)

1 fluid refers to the phospholipids and proteins being free to move;
2 phospholipids also being able to move within a layer, transversely;
3 mosaic refers to the proteins embedded in the phospholipid bilayer, where they are scattered;

(b)

(i)

1 glucose is a polar molecule and ions are charged;
2 unable to pass through hydrophobic region within the membrane;
3 ref. to specificity of transport proteins;

(ii)
1 high levels of ATP close ATP-sensitive potassium channels;
2 build up of potassium ions inside cell;
3 depolarize membrane;

(iii)
1 insulin release involved exocytosis and therefore did not require a protein channel;
2 insulin is a protein;
3 too large to pass through membrane;
4 ref. to channel large enough to allow insulin through would allow other molecules through;

(c)
1 vesicles containing insulin move to cell surface membrane;
2 membrane of vesicle fuses with cell surface membrane;
3 vesicle contents emptied by exocytosis;

QUESTION 3
(a)
1 DNA strands separate by hydrogen bonds breaking;
2 both strands act as templates;
3 each new molecule of DNA contains one new and one original strand of DNA;

(b)
1 ref. to shape of active site of DNA polymerase;
2 needs 3'OH to initiate action of DNA polymease;
3 primers add only at 3';

(c)
1 DNA in bacteria occurs in a loop while human DNA is linear;
2 bacteria DNA is naked while human DNA is arranged in nucleosomes wrapped around histones;

3 ref. to introns only in human DNA;
4 ref. to telomeres only in human chromosomes;
5 ref. to centromeres only in human chromosomes;
6 ref. to operons only in bacteria;

(d)
(i)
1 much longer DNA molecule;
2 DNA packaging in nucleosomes with DNA wrapped around histones
3 more non-coding DNA in human chromosomes;

(ii)
1 multiple sites of replication (on each chromosome);

QUESTION 4

(a)

1 (inherited) change in DNA/nucleotide sequence/base sequence;
2 base substitution;
3 change in codon/triplet for amino acid/change in R group;
4 base addition/deletion;
5 ref. to frameshift or described;

(b)

1 (if addition/deletion resulting in) frameshift;
2 protein coded for no longer synthesized/non-functional;
3 (if substitution resulting in) amino acid changed;
4 change 3D/tertiary structure of protein/different R group;
5 ref. change in binding site *ref. to active site is neutral*

(c)

1 both copies of a tumor suppressor gene must be mutated (before a person will develop cancer);
2 ref. to effect of mutation being masked/ref. to normal allele being dominant/remaining functional copy of gene;
3 sufficient quantities of proteins synthesized to be effective;

(d)

1 specific shape of binding site of p53 protein;
2 corresponds to/complimentary to shape, part of DNA molecule;
3 different sequences of bases have different shapes;
4 ref. to major and minor grooves on DNA;

(e)

1 change in amino acid in region away from binding area;
2 may not affect shape or binding properties;
3 ref. idea some amino acids coded for by more than 1 codon/triplet of bases/ref. genetic code/some codons degenerate;
4 change in base/codon may not change amino acid/neutral;

QUESTION 5

(a)

RRPP
RRPp
RrPP
RrPp

(b)

parents	RRpp x rrPP;			
gametes	Rp x rp			
F1	RrPp;			
	RrPp x RrPp			
gametes	RP, Rp, rP, rp		RP, Rp, rP, rp;	
F2	walnut	rose	pea	single ;;
	RRPP	RRp	rrPP	rrpp
	RRPp x 2	Rrpp	rrPp	
	RrPp x 4	Rrpp	rrPp	
	Rrpp x 2			

(allow on Punnett square, all genotypes must be shown, correspond to correct phenotype)

(c)

RrPP x RRpp
RRPP x Rrpp
RRPP x RRpp

QUESTION 6

(a)

P nucleus / euchromatin / nucleoplasm / chromatin; **R:** heterochromatin
Q nuclear envelope;
R cell surface membrane;

(b)

1 site of cellular respiration / oxidative phosphorylation / aerobic respiration;
2 synthesis / production / release of ATP;
3 ref. specific use of ATP (e.g. active transport / vesicle transport / mitosis / macromolecule synthesis, incuding DNA replication, transcription and translation);
4 ref. ATP produced by mitochondria released into cytosol while ATP in chloroplasts not;

(c)

(i)

1 double membrane;
2 highly folded / large surface area of inner membrane;
3 presence of ETC / proton pumps;
4 ATP synthase;
5 70S ribosomes;
6 DNA loops;

(ii)

1 three membranes / double <u>outer</u> membrane in chloroplasts;
2 ref. position of stalked particles / chloroplasts "inside out"
3 starch grains;
4 stack of thylakoid membranes / grana;
5 ref. to thylakoids once;
6 no cristae in chloroplasts;
7 contain pigments / chlorophyll; **A**: other photosynthetic pigments

(d)

1 oxidative phosphorylation: final e^- (and H^+) acceptor / combines with e^- and H^+ to form water;
2 photophosphorylation: (waste) produce / from photolysis

QUESTION 7

(a) (dot correct answers then ticks bottom right of page)

animal ;
phylum ;
class ;
order ;
Dicrurus ;
species ;

6 correct = 4
5 correct = 3
4 correct = 2
3 correct = 1

(b)

1 ref. inherited variation/variation in alleles;
2 ref. natural selection;
3 differences in selection pressures in different habitats;
4 ref. to survive to pass on alleles;
5 geographical isolation / ref. allopatric;
6 idea that broadleaved woodland not continuous;
7 ref. islands;
8 prevents interbreeding / gene flow;
9 ref. to genetic drift/founder effect;

(c)

10 similar (morphological/anatomical/physiological) features;
11 capable of interbreeding;
12 to produce fertile offspring;

QUESTION 8

(a)

Cellulose

1 a polysaccharide;
2 (chain of) β/beta glucose;
3 1-4 links; (*glycosidic bonds not as important as linking bonds)*
4 ref. to microfibrils;
5 ref. to bundles of microfibrils/macrofibrils/fibres;

Collagen

1 a fibrous protein;
2 (chain of) amino acids;
3 ref. to peptide bonds;
4 ref. to each chain helical;
5 triple helix/tropocollagen;
6 ref. to role/presence of glycine;
7 ref. to staggered ends;

8 ref. to H bonds; A once in either

(b)

Glycogen

1 a polysaccharide;
2 (chain of) α/alpha glucose;
3 1-4 with (some) 1-6 links/branches;
4 insoluble;
5 (energy) store;
6 stored/produced in muscle/liver;

Glucagon

1 a globular protein;
2 (chain of) amino acids;
3 ref. to peptide bonds;
4 soluble in plasma;
5 produced by α/alpha cells in pancreas/islets of Langerhans;
6 a hormone/regulates/raises blood glucose;

(c)

1 ref. energy reserves;
2 ref. lipids buoyancy;
3 ref. lipids (thermal) insulation;
4 ref. lipids more energy per unit mass/higher calorific value;
5 ref. to metabolic water;
6 ref. protection;

QUESTION 9

(a)

1 length of DNA; (ref) a continuous piece/sequence
2 gene/ LacI, coding for repressor/inhibitor <u>protein</u>;
3 ref. to CAP (catabolic activator protein) binding site next to promoter;
4 <u>promoter</u> (gene);
5 RNA polymerase binding site;
6 ref. to operator;
7 binding site for repressor/inhibitor protein;
8 ref. to (3) <u>structural</u> gene;
9 Lac Z (galactosidase);
10 Lac Y (lactose permease);
11 Lac A (lactose transacetylase);
12 ref. to termination sequence; 8 max

(b)

1 lactose enters (bacterial) cell; *basal level of lac permease*
2 ref. to method of entry of lactose / qualified leaky membrane / small amount in;
3 allolactose / lactose binds to repressor protein;
4 results in a change in shape of repressor protein;
5 repressor protein no longer attached (to DNA);
6 exposes operator site;
7 allows RNA polymerase activity;
8 transcription (of genes coding for proteins required to utilise lactose);
9 leading to synthesis of proteins;
10 ref. named enzymes/proteins;

(c)

1 gene switching / majority of genes switched off / for regulation of gene expression;
2 so that bacterium only produces enzymes required;
3 <u>inefficient</u> / ref. waste of energy/resources **A converse**
4 ref. to selective advantage / disadvantage;
5 ref. group genes together for control;
6 ref. to bacteria able to use a <u>variety</u> of sugars/substrates

Paper 3 (Applications)

QUESTION 1

(a)

(i)

bacterium/bacteria;

ignore correct qualification (e.g.named)

(ii)

break phosphodiester bonds within polynucleotide strands/DNA;

(R) cut at, restriction site/gene

(iii)

protection; **allow ecf from (i)**

breaks down, foreign/viral/phage, DNA; 1 max

(b)

(i)

1 (BamHI + HindIII + EcoR1) all produce, sticky ends/cohensive ends/overhangs/staggered ends;

2 allows, cut DNA/gene, to be, joined/annealed/spliced, to another DNA;

ignore vector

3 using complementary basepairing;

4 AluI + HaeIII require additional procedure to add on, sticky ends/linker DNA/caps; ora 3 max

(ii)

1 5' represents end (of strand with nucleotide) with 'free' carbon 5 (on deoxyribose);

2 3' represents end (of strand with nucleotide) with 'free' carbon 3 (on deoxyribose);

3 5' has phosphate/ 3' has hydroxyl;

4 DNA strands are antiparallel;

(c)

(i)

genomic

1 DNA is broken (into fragments) using Restriction Enzyme(s);

Reject: treated

2 fagments/DNA, incorporated into <u>vector</u>;

3 X phage/plasmid/cosmid/BAC/YAC; (BAC: bacteria artificial chromosome, YAC: yeast artificial chromosome)

4 create, further copies/clones, of DNA;

cDNA

5 start with mRNA;

6 to DNA using Reverse Transcriptase;

7 make double-stranded using DNA polymerase;

4max for any section

(ii)

the cDNA Library

1 smaller/ more compact;
2 contains only, coding sections (of DNA)/ exons;
3 introns have been removed/ no junk DNA;
4 easier to find desired gene (DNA clone)/no need for gene probes;
5 contains genes that are being expressed/reflects proteins actually present (in cell);
6 genes are intact;
(R) not been cleaved

credit reverse statements for genomic library 3 max

QUESTION 2

(a)

Stage 1

1 denatures / H bonds broken;
2 (2) DNA strand separate;
3 by heating to 95^0C; * **A: 90 – 100^0C**

Stage 2

4 primer / oligonucleotides, bind / join to single (DNA) strands / 3' ends;
5 annealing;
6 by cooling to 54^0C; * **A: 30 – 65^0C**

Stage 3

7 new strands (of DNA) are synthesized by, TAQ / DNA polymerase;
8 starts at positions of primers / oligonucleotides;
9 by heating to 72^0C; * **A: 60 – 75^0C**

(b)

(i)

2^{26} / 67108864 **Look for 2^{26} first**

(ii)

1 (may only be) very small amount (of original DNA) to work with;
2 can, amplify / produce many copies / produce very large amounts of DNA / genetic material;
3 (large amounts) make analysis easier;

(c)

1 DNA sample / genome (removed from organism) ;
2 RFLP / Restriction Fragment Length Polymorphism;
3 (sample DNA) cut with restriction enzymes,
4 gel electrophoresis / described;
5 radioactive probe + X-ray film or ethidium bromide / stain + UV light (to locate bands position)

6 wild and captive populations have different genetic profiles;
7 genetic fingerprints of captive individuals obtained;
8 compare fingerprint / DNA, with that of organism being investigated;
9 if bred in captivity there will be a match in, banding / pattern; ora

Comments by examiner:

- Students were weak in identifying how genetic fingerprinting is used to verify what type of organism (wild / bred in captivity) as many elaborated too much on the
- Genetic Fingerprinting method.
- Restriction Enzymes are not just added to the mixture but also used to 'cut' DNA

QUESTION 3

(a)

(i)

1 derived from one parent/not a product of sexual reproduction ; (ignore asexual reproduction)
2 products of mitotic division;
3 genetically identical/share same DNA/same genotype/same genome/ same alleles; (R) same genes/similar

(ii)

1 much larger numbers can be produced/mass production ;
2 requires less space;
3 (cultures) easy to transport/ref. air freight;
4 ensures new plants are disease-free;
5 genetic modifications possible;
6 not limited by seasons/external conditions/weather; (R) faster techniques

(b)

2,4-D

1 optimum peak/highest/described, is 0.3mg dm^{-3} with growth rate of 73/74;
2 idea that slight change from optimum is critical ;

Cytokinin

3 optimum peak/highest/described, is 8(.0)mg dm^{-3} with growth rate of 50;
4 not critical/large change from optimum to results in smallest decrease in growth (rate);

Thiamine

5 optimum peak/highest/described, is 1(.0)mgdm^{-3} with growth rate of 61/62;
6 marked effect/critical from 0.8mg mg dm^{-3};

7 2,4-D has highest growth rate/cytokinin has lowest growth rate;
8 cytokinin required at highest concentration / 2,4-D required at lowest concentration;
9 ref. qualified pattern of variation for one component;
10 use a mixture of all 3 at optimal levels;
11 idea of possible interaction between components;

Comments by examiner:

- Arbitrary units not required in this question but many not be true for all questions.
- Guide students to state the complete units in all questions wherever possible.
- Need to observe scale of graph
- Some form of comparison between graphs wanted by examiner though not very clearly stated in question

(c)

(i)

1 unable to fix nitrogen;
2 to produce, amino acids/proteins;
3 e.g. of required protein ; (e.g. enzymes/cytochrome/etc)
4 DNA/RNA/nucleic acid/nitrogenous base/named base/nucleotide;
5 ATP;
6 chlorophyll;

(ii)

1 ammonium nitrate contains more nitrogen;
2 may be, easier to assimilate/easier to absorb/more accessible, ammonium (ion rather than potassium ion);

QUESTION 4

(a)

SCID

1 more males affected (than females)
2 recessive|

3 (most common form is) sex-linked (X-chromosome)
4 mutation of IL2RG (interleukin-2 receptor gamma) gene (for gamma chain on lymphocyte receptor)

5 ADA (adenosine deaminase) deficiency
6 mutation of gene on chromosome 20

7 prevents formation of , lymphocytes / T cells / B cells
8 toxic metabolites not broken down so lymphocytes killed

9 so susceptible to opportunistic infections (award only if S7 and S8 awarded)
10 children usually die (if not treated)
11 pneumonia / PCP / meningitis / chicken pox / measles / other valid

Cystic fibrosis

1 autosomal / chromosome 7
2 recessive
3 mutation of, CFTR / CFTCR gene
4 deletion of, 3 base (pairs) / codon
5 CFTR / CRTCR, protein has lost phenylalanine

6 (channels) no longer able to transport chloride ions

7 causing thick mucus
8 resulting in stated problem in, lungs / pancreas / reproductive system
9 reduces life expectancy

(b)

1 gene therapy is a technique for introducing 'normal', allele/gene; *if "therapeutic" need to give further explanation*
2 new, allele/gene, generates, functional/correct, protein product; *accept specific example of protein product*
3 restores target cell to normal state / corrects function of cell / corrects phenotype;

Viral delivery systems

1 viruses are genetically engineered to carry 'normal' human gene;
2 adenoviruses/retroviruses/MMLV (for SCID);
3 virus releases genetic material into target cells;
4 in SCID the gene is inserted (by viruses) into, bone marrow cells / blood stem cells / lymphocytes, *ex vivo* / *in vitro*;
5 in cystic fibrosis the gene is inserted into cells within body;

Non-viral delivery systems

1 direct introduction of DNA into target cells (gene gun or other direct method e.g. micropipette);
2 creation of, lipid sphere / liposome, which carries DNA;
3 liposome can / use of electroporation to, pass through target cell membrane; *must be linked to pt 10*
4 link DNA to molecule that will bind to receptors in cell membrane;
5 DNA is engulfed by membrane;
6 possibility of introducing 47th chromosome into cells;

(c)

1 difficult to get DNA to integrate into target cell genome;
2 results can be short-lived / patients need to be treated on a frequent basis;
3 problem with controlling the activity of gene expression;
4 risk of stimulating immune / allergic response;
5 virus vector may, regain / develop, virulence;
6 incorrect insertion of gene may cause, named / described, problem to patient;
7 possible problem with finding vector for large gene;
8 many genetic diseases are a result of presence of many defective genes / multi-allelic / multigene conditions;
9 impossible to introduce many genes at the same time;
10 problem dealing with, dominant condition / non-dividing cells;
11 ref. problem with liposomes; (toxicity / less efficiency);