GCSE
BIOLOGY

Topic Paper: 6.1 Genetic Inheritance
Part 1, 2 & 3 Mark Scheme

MARK SCHEME

90 Marks

M1. (a) **A** = Hh **B** = Hh

may not be in answer space

accept heterozygous or description

1

(allele for) polydactyly is dominant **or** polydactyly is H,

for marking points 1, 2 and 3 accept evidence in clearly labelled / annotated genetic diagram

1

cats with polydactyly have H

accept if polydactyly was recessive all offspring would have polydactyly

1

E or (some) offspring of **A** and **B**, does not have polydactyly,
so **A** and **B** must both have h

1

(b) (i) HH **and** Hh **or**
homozygous dominant **and** heterozygous

both required, in either order

allow description

1

(ii) any **one** from:

accept annotated genetic diagram to explain answer

polydactyly is dominant

parents are both Hh

if D is Hh all offspring could inherit H

1

[6]

M2. (a) both parents **Aa**

accept other upper and lower case letters without key or symbols with a key

allow shown as gametes in punnet square

1

aa in offspring correctly derived from parents /
aa correctly derived from the parents given

ignore other offspring / gametes for this mark parents do not have to be correct

1

offspring **aa** identified as having cystic fibrosis

*may be the only offspring shown **or** circled / highlighted / described*

1

(b) (i) any **one** from:

accept converse if clear eg if you (only) took one it might have cystic fibrosis / might not be fertilised

sure / greater chance of healthy / non-cystic fibrosis egg / embryo /child

accept some may have the allele

reference to suitable embryo is insufficient

greater chance of fertilisation

1

(ii) ***to gain 3 marks both advantages <u>and</u> disadvantages must be given***

advantages
any **two** from

ignore references to abortion unless qualified by later screening

greater / certain chance of having child / embryo without cystic fibrosis / healthy

child with cystic fibrosis difficult / expensive to bring up

cystic fibrosis (gene / allele) not passed on through generations

disadvantages
any **two** from:

operation dangers eg infection

ignore risk unqualified

ethical or religious issues linked to killing embryos

accept wrong / cruel to kill embryos accept right to life

(high) cost

possible damage to embryo (during testing for cystic fibrosis / during operation)

3

plus

conclusion

a statement that implies a valued, qualified judgement

eg it is right because the risk of infection is small

or
eg it is wrong because embryos are killed

***Note:** the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage has (already) been made*

*do **not** award the mark if the conclusion only states that advantages outweigh disadvantages*

1

[8]

M3. (a) Aa

*allow dominant **and** recessive*
allow heterozygous

1

(b) (i) gametes A, a **and** A, a

*max **1** if gametes are incorrect (eg in punnet square)*

1

correctly derived offspring from cross

allow ecf from their gametes

1

identification of round **and** wrinkled offspring

for this mark the phenotype of each different offspring genotype must be indicated

1

(ii) (due to) chance **or** expected ratio is only a probability

accept the idea of small numbers not representative
ignore anomaly / random / coincidence
*do **not** accept error*

1

(c) any **one** idea from:

genes / chromosomes / alleles / DNA not discovered / known about

*do **not** accept religious theme (ie confusion with Darwin's difficulties with the church)*

published in obscure journal / few scientists read his work

1

[6]

M4. (a) cystic fibrosis (allele / gene) recessive

allow an annotated genetic diagram

1

carrier has only one cystic fibrosis allele / gene

accept carrier is heterozygous
accept any symbol with key or
accept conventional use of symbols
penalise use of chromosome once only

1

(b) any **one** from:

Huntington's (allele / gene) dominant

(to have Huntington's) need only one Huntington's allele / gene

1

[3]

M5. (a) half / 50% sperm have X (chromosome)
or
half / 50% sperm have Y (chromosome)
penalise incorrect use of gene / allele once only

1

all eggs have X (chromosome)
*annotated genetic diagram could gain **2 marks***

1

(b) screening
ignore selection

1

(c) any **three** from:
*max **2** if only advantages **or** only disadvantages discussed*

advantages:(**max 2**)

(girl / children / women) don't / less likely to get / inherit (breast) cancer / this / the disease
*do **not** accept reference to allele alone for this point*

future generations get less cancer **or** less likely to have the allele

less expensive (for NHS) than treating cancer

disadvantages:(**max 2**)

(wrong / immoral to) reject / kill embryos
ignore wrong / immoral / religious argument unqualified

possible harm to embryo (that is implanted) / miscarriage
ignore reference to termination

possible harm to mother (due to operational procedure)
allow reference to needing hormone treatment

3

argued conclusion
*must refer to **both** advantages and disadvantages and must be at end of answer*

1

[7]

M6. (a) (i) DNA replication / copies of genetic material were made

'it' = a chromosome

allow chromosomes replicate / duplicate / are copied

ignore chromosomes divide / split / double

1

(ii) one copy of each (chromosome / chromatid / strand) to each offspring cell

ignore ref. to gametes and fertilisation

1

each offspring cell receives a complete set of / the same genetic material

allow 'so offspring (cells) are identical'

1

(b) (i) meiosis

allow mieosis as the only alternative spelling

1

(ii) Species A = 4 **and** Species B = 8

1

(iii) sum of A + B from (b)(ii) e.g. 12

1

(c) (i) similarities between chromosomes
or
similarities between flowers described

e.g. shape of petals / pattern on petals / colour / stamens

1

can breed / can sexually reproduce

allow can reproduce with each other / they can produce offspring

1

(ii) any **two** from:

offspring contain 3 copies of each gene / of each chromosome / odd number of each of the chromosomes

some chromosomes unable to pair (in meiosis)

(viable) gametes not formed / some gametes with extra / too many genes / chromosomes

or
some gametes with missing genes / chromosomes

2

[10]

M7. (a) (i) (alternative) forms / types of a / the same gene

1

(ii) only expressed if 2 copies inherited
or not expressed if other allele present

allow over ruled / over powered by the other allele

1

(b) (i) **Nn**

ignore heterozygous

1

(ii) genetic diagram including:

accept alternative symbols, if defined

gametes: **N** and **n** from <u>both</u> parents

accept alternative symbols if correct for answer to (b)(i)

1

correct derivation of offspring genotypes:
NN Nn Nn nn

allow if correct for candidate's parental genotypes / gametes

1

identification of **nn** as having cystic fibrosis

1

(c) **Argued evaluation**

any **four** from:

PGD <u>higher</u> financial cost

accept CVS <u>only</u> costs £600

PGD occurs before pregnancy / implantation

accept detected at <u>earlier</u> stage so less unethical / less trauma

PGD does not involve abortion so less trauma / less pain / ethical incidence of false positive / use of numbers so higher risk of destroying healthy embryo PGD higher

accept PGD has (surplus) embryos so some destroyed / unethical

PGD no chance of miscarriage whereas CVS does
or PGD less chance of miscarriage

4

[10]

M8. Marks should **not** be awarded for simply copying the information provided
A mark may be awarded for a comparison between treatments if the answer only involves copied information

any **four** from:

*For all **4** marks to be awarded, there must be at least 1 pro and 1 con*

embryo stem cells – examples of

pros

can treat a wide variety / lots of diseases / problems

many available / plentiful

using them better than wasting them

painless

cons

(possible) harm / death to embryo

(relatively) untested / unreliable / may not work
allow long term effects not known
***or** may be more risky*

embryo can't be 'asked' / 'embryo rights' idea

adult bone marrow stem cells – examples of

pros

no ethical issues (in collection) **or** permission given

quick recovery

(relatively) safe
allow does not kill (donor) / low risk

well tried / tested / know they work

cons

operation hazards eg infection

few types of cell / tissue produced **or** few diseases / problems treated

painful so may deter donors

4

Conclusion to evaluation:

A reasoned conclusion from the evidence

1

[5]

M9. (a) (i) meiosis

allow mieosis

1

(ii) testis / testes

allow testicle

1

(b) (i) 23

1

(ii) fuses / joins with cell D / with egg cell **or** used in fertilisation

allow fuse with another cell

1

prevents doubling of chromosome number / restores original no. / 46 / diploid no. / normal no. / full no.

accept 23 from each parent / from each gamete

1

[5]

M10. (a) changes code /sequences of bases

or

sequence of amino acids is different

1

the enzyme has different / wrong shape / structure

allow the active site is changed

1

so substrate will not fit into enzyme / will not join to enzyme

1

(b) (i) 46

allow 23 pairs

1

(ii) also inherited (from mother) normal chromosome 15 / normal allele / normal gene / boy is heterozygous / **Hh**

allow the boy is a carrier

1

(allele for) this disorder is recessive

or

the normal allele would give a working enzyme

ignore converse

1

(iii) genetic diagram including:

Parental gametes:

H and **h** from both parents

accept alternative symbols, if defined

1

derivation of offspring genotypes:

HH Hh Hh hh

allow alternative if correct for student's parental genotypes / gametes

1

identification of **hh** (having the disorder) if 1 in 4

1

[9]

M11. (a) both parents **Aa**

*accept other upper and lower case letter without key **or** symbols with a key*

allow as gametes shown in Punnett square

1

aa in offspring correctly derived from parents
or
aa correctly derived from the parents given

ignore other offspring / gametes

for this mark parents do not have to be correct

1

offspring **aa** identified as having cystic fibrosis

*may be the only offspring shown **or** circled / highlighted / described*

1

(b) (i) any **one** from:

accept converse if clear, eg if you (only) took one it might have cystic fibrosis / might not be fertilised

(more) sure / greater chance of healthy / non-cystic fibrosis egg / embryo / child

accept some may have the allele

reference to 'suitable / good embryo' is insufficient

greater chance of fertilisation

1

(ii) **advantages**

to gain 3 marks both advantage(s) and disadvantage(s) must be given

max 3

any **two** from:

ignore references to abortion unless qualified by later screening

greater / certain chance of having child / embryo without cystic fibrosis / healthy

child with cystic fibrosis difficult / expensive to bring up

cystic fibrosis (gene / allele) not passed on to future generations

disadvantages

any **two** from:

operation dangers / named eg infection
ignore risk unqualified

ethical or religious issues linked with killing embryos
accept wrong / cruel to embryos accept right to life argument
ignore embryos are destroyed

(high) cost of procedure

possible damage to embryo (during testing for cystic fibrosis / operation)

plus

conclusion

a statement that implies a qualified value judgement
eg it is right because the child will (probably) not have cystic fibrosis even though it is expensive
or
eg it is wrong because embryos are killed despite a greater chance of having a healthy baby

***note**: the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage is made*

*do **not** award the mark if the conclusion only states that advantages outweigh the disadvantages*

1

(c) any **three** from:

osmosis / diffusion

*do **not** accept movement of ions / solution by osmosis / diffusion*

more concentrated solution outside cell / in mucus

assume concentration is concentration of solute unless answer indicates otherwise or accept correct description of 'water concentration'

water moves from dilute to more concentrated solution

allow correct references to movement of water in relation to concentration gradient

partially permeable membrane (of cell)

allow semi / selectively permeable

3

[11]

M12. (a) (i) allele expressed even when other allele present **or** expressed if just one copy of allele is present **or** expressed if heterozygous

if present other allele not expressed

1

(ii) 2 affected parents have unaffected child **or 1** and **2** → **5** / **6**

or if recessive all of **1** and **2**'s children would have CADASIL

1

(iii) heterozygous – has unaffected children **or** because if homozygous all children would have CADASIL

1

(b) genetic diagram including:

accept alternative symbols, if defined

1

correct gametes:

D and **d**
and d (and **d**)

ignore 7 / 8 or male / female

1

derivation of offspring genotypes:

Dd Dd dd dd

*allow just **Dd dd** if ½-diagram*
allow ecf if correct for student's gametes

1

identification **of Dd** as CADASIL
or dd as unaffected

allow ecf if correct for student's gametes

1

correct probability: 0.5 / ½ / 1 in 2 / 50% / 1 : 1

1

(c) (i) stem cells can differentiate **or** are undifferentiated / unspecialised

1

can form blood <u>vessel</u> cells / brain cells

or

stem cells can divide

1

(ii) ethical argument - eg no risk of damage to embryo or adult can give consent for removal of cells **or** adult can re-grow skin

more ethical qualified

ignore religion unqualified

or

if from a relative then less chance of rejection **or** if from self then no chance of rejection

or

skin cells more accessible

1

[10]