Mark schemes

Q1.

(a)   *Phytophthora*

1

(b)   the fungus can get oxygen from the air

1

(c)   the variety of species of organisms in the river

1

(d)   pesticide washed into river

> *allow spray drift*
> *allow reference to run-off*
> *allow carried by rainfall*

1

pesticide kills (some) organisms / plants / animals in river

1

(e)

	R	r
R	RR	Rr
r	Rr	rr

> *all 3 correct = 2 marks*
> *2 correct = 1 mark*
> *0 or 1 correct = 0 marks*

2

(f)   ring drawn around RR / rr in the diagram

> *allow around both RR and rr*

1

(g)   75%

> *percentage must match student's answer in the diagram*
> *allow 75% if no answer to question (e)*

1

(h)   no fusion of gametes
or
(asexual reproduction involves) mitosis

> *allow no fertilisation*

1

(so) offspring are genetically identical (to parent plant)

> *allow offspring are a clone*

allow offspring have same DNA
allow no mixing of genes / DNA
allow no mixing of genetic material allow all offspring inherit R

1

[11]

Q2.

(a) chromosome(s)

allow chromatid(s) / gene(s) / allele(s)

1

(b) sugar

allow deoxyribose
allow pentose
do not accept ribose

1

(c) base(s)

allow nitrogenous base(s)
allow adenine and cytosine and guanine and thymine

1

(d)
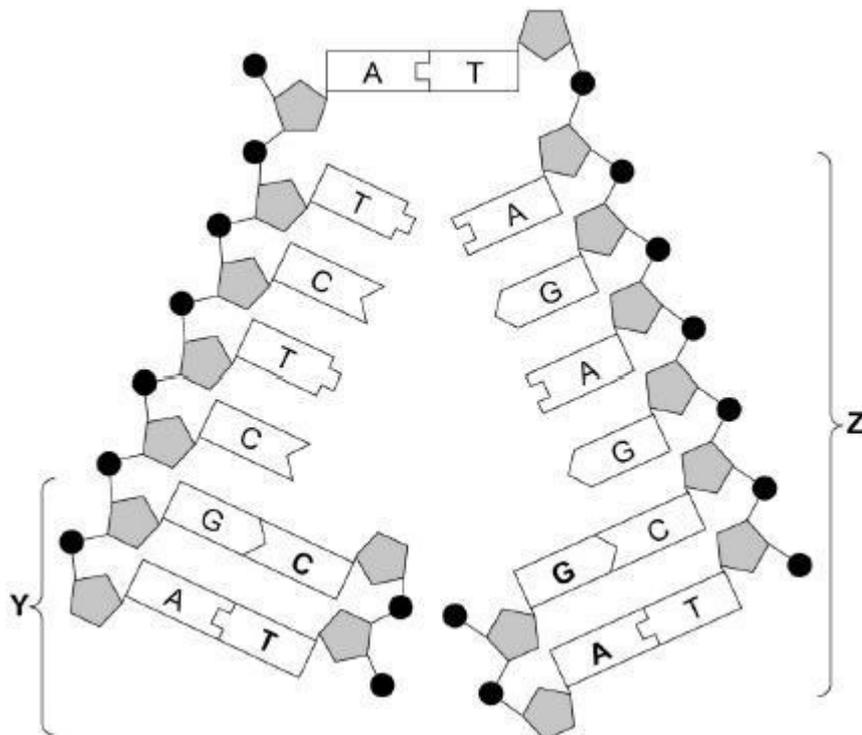
all four required for the mark

1

(e) replication

1

(f)   protein

allow polypeptide

1

(g) 3×10^{-12} grams

1

(h)   meiosis

1

[8]

Q3.

(a)   mutation means less oxygen for (aerobic) respiration

allow haemoglobin or red blood cell carries oxygen for (aerobic) respiration

do not accept no oxygen for respiration

1

(b) $4 \div 17$

allow 4:13

1

0.235(29...)

allow 0.24 or 24%

allow ratio 1 : 3.25

1

(c)   father / 8's gametes correct: $H^A + H^A$

1

mother / 9's gametes correct: $H^A + H^S$

allow 1 mark for both sets of gametes if parents not identified

1

correct derivation of offspring genotypes:
H^AH^A H^AH^A H^AH^S H^AH^S

allow correctly derived offspring genotypes from incorrect parental gametes

1

correct phenotype for each derived genotype

1

0.25 / ¼ / 25% / 1 in 4 / 1:3

allow only a probability consistent with student's derivations

1

(d)   any three from:

points for:
- HH ^{s} do not get malaria

- HAH ^{s} survive sickle cell anaemia

points against:
- HAHA may die from malaria

- HSHS may become (severely) ill with sickle cell anaemia

- Judgement:
  if parents HAHS then some offspring survive both malaria and sickle cell anaemia
  or
  if parents HAHS then some offspring may become (severely) ill with malaria and some become (severely) ill with sickle cell anaemia

  to gain full marks both point(s) for and point(s) against must be given

3

[11]

Q4.

(a) 4 / four

1

(b) 23 / twenty three

do not accept 23 pairs

1

(c) a different form of a gene

1

(d) heterozygous

1

(e)

		Dd/dD
	dd	dd

allow 2 correct for 1 mark

2

(f) ring around any Dd

allow ecf from question (e)

1

(g) percentage must match answer given to questions (e) and (f)

if no answer in question (e) allow 50 %

1

(h) mutation / mutated

do not accept mutant

1

   (i)   any one from:
- to help them prepare
- to inform whether to consider having an abortion
- to find out if they have passed on the disorder

> *allow to see if the child / embryo has the disorder*
>
> *allow answers referring to genetic disorders, or specific example such as Dupuytren's / cystic fibrosis*

1

[10]

Q5.

   (a)   any two from:
- double

  > *allow two strands*

- helix

  > *allow twisted / spiral / coiled*

- long / thin

2

   (b)   bases

1

   (c)   protein

1

   (d)   nucleotide

1

   (e) $0.34 \times 6\,000$

1

      2040 (million nm)

1

   (f)   answer from question (e) correctly converted

> *if no answer to question (e), allow 2.04 (m)*

1

   (g)   any one of:
- to determine if the cancer is genetic (or caused by lifestyle factors)
- to inform / help treatment
- to allow embryo screening to ensure allele is not passed on
- to inform relatives if they have inherited (affected) gene / allele
- to detect cancer early or before symptoms show
- to understand cause of the cancer

1

[9]

Q6.

(a) many (joined) nucleotides or monomers

allow (long) molecule / chain made of repeating units

1

(b) phosphate

1

(phosphate attached to a) sugar

1

(which has 1 of 4) base(s) (attached to sugar)

ignore phosphorus
allow deoxyribose / pentose
allow 2 marks if position of sugar / phosphate / base is incorrect

1

(bases) are A, C, G   and T

allow bases are adenine, cytosine, guanine and thymine do not accept thiamine / adenosine
allow description of a pair of nucleotides

1

(c) 0.34 × 12 000 000 000

an incorrect answer for one step does not prevent allocation of marks for subsequent steps

1

4 080 000 000

1

$$\frac{4\ 080\ 000\ 000}{1\ 000\ 000\ 000}$$

allow conversion from nm to m at any point in the calculation

1

4.08 (m)

1

2.04 (m)
(divided by 2 due to base pairs)

allow division by 2 at any point in the calculation

1

(d) (non-coding parts) can switch genes on / off

1

[11]

Q7.
(a) any three from:
  • mitosis produces two (daughter) cells but meiosis produces four (daughter) cells

    answers must be comparative

  • one cell division in mitosis but two cell divisions in meiosis

  • mitosis produces cells with two of each chromosome, but meiosis produces cells with one of each chromosome

    allow mitosis produces diploid cells but meiosis produces haploid cells
    allow mitosis maintains the number of chromosomes or mass of DNA or mass of genetic material but meiosis halves the number / mass
    allow mitosis produces cells with 23 pairs or 46 chromosomes but meiosis produces cells with 23 chromosomes

  • mitosis produces genetically identical cells, but meiosis produced genetically different cells

    allow other correct differences between the processes of mitosis and meiosis

3

(b) any one from:
  • DNA doubles / copies / replicates (once)

    allow chromosomes or genetic material or genetic information double / replicate / are copied
  • increase in the number of mitochondria / ribosomes / sub-cellular structures

    ignore mitochondria / ribosomes are copied / duplicated

    allow chromosomes / chromatids pulled to side (of cell)
    allow other correct similarities between the processes of mitosis and meiosis

1

(c) Dd / dD

    allow heterozygous

1

has D because has Dupuytren's and has d because child / person 6 is homozygous recessive or does not have Dupuytren's or is dd

    allow has D because has Dupuytren's and person 1 and person 2 both passed d to child / person 6

    allow has D because has Dupuytren's and cannot be homozygous / DD or all the children would have Dupuytren's

1

(d) male / person 7 gametes correct: D and d

1

female / person 8 gametes correct: d and d

*allow 1 mark for both sets of gametes
correct if parents not identified*

1

correct derivation of offspring genotypes:
Dd Dd dd dd

*allow correct derivation of offspring
genotypes from incorrect gametes*

1

offspring with Dupuytren's identified

*allow correct for genotypes stated in
mp3*

1

probability correct from the correct identification given

*allow probability correct from offspring
genotypes if identification not given*

1

(e) female(s) / person(s) 3 / 11 / 12 have Dupuytren's

allow some females have Dupuytren's

1

females don't have Y chromosome
or
Dupuytren's is passed from fathers / 1 / 7 to daughters / 3 / 12, (so is
not on the Y chromosome)

*allow only males have Y chromosomes
allow females are XX
allow Dupuytren's is passed from
mothers / 11 to children / 15, (so is not
on the Y chromosome)*

1

[13]

Q8.

(a) an allele expressed even if a person only has one copy of the allele

1

(b)

Woman

	e	e
E	Ee	**Ee**
e	**ee**	**ee**

Man

all 3 correct = 2 marks
1 or 2 correct = 1 mark

2

(c)   correct probability from Figure 1

if no answer in part(b) allow 0.5

1

(d)

Woman

	X	X
X	XX	XX
Y	XY	XY

Man

gametes = X + X and X + Y
allow in incorrect positions

1

X, X, X and Y in correct boxes

1

(e)

an answer matching the answer from part (c) × 0.5 scores 2 marks
if no answer in part (c), an answer of 0.25 / ¼ / 1 in 4 / 25% scores 2 marks

answer from part (c) × 0.5
if no answer in part(c) allow 0.5 × 0.5

1

answer to calculation in mp 1
if no answer in part(c) allow 0.25 / ¼ / 1 in 4 / 25%

1

[8]

Q9.

(a)   46

1

(b)   half the mass of the DNA in cell A

1

(c)   meiosis

1

(d)   mutation

1

(e)   any two from:
· different egg / sperm each time
· genes from two parents
· each gamete / egg / sperm has different alleles / genes / DNA / genetic information

   ignore different chromosomes
   ignore the children have different genes / alleles

2

(f)   8

1

(g)   40

   allow in range 39 to 41

1

(h)

   an answer of 80 scores 3 marks
   allow ecf from part (g) for 3 marks
   an answer of 0.08 scores 2 marks

$\dfrac{40}{500}$

   allow $\dfrac{\text{answer to part } \textbf{(g)}}{500}$

1

   × 1000

1

   80

   an answer from mp1 but not × 1000 scores 2 marks

1

(i)   embryo is (very) small

1

   (so) embryo not seen / felt
   or
   lost in normal menstrual flow

   ignore not noticed

1

[13]

Q10.

(a) chromosome(s)

allow gene(s) / allele(s)

1

(b) X = sugar

1

Y = nucleotide

1

Z = base

1

(c) double helix

1

(d) 3

1

(e) any two from:

allow descriptions or named examples
- diagnosis of inherited / genetic disorder

    allow research / understand genetic disorders
- gene therapy or treatment of inherited disorders
- understanding (human) evolution or understanding ethnic origins (of a person) or understanding ancestry
- tracing human migration patterns

    allow other examples – eg identification of criminals (1) paternity determination (1)

2

[8]

Q11.

(a) same kingdom + phylum + class + order
or
same order
or
they have the top four groups the same

allow both Poales

1

(b) Rr / rR

do not accept RR or rr
ignore heterozygous
do not accept homozygous

1

(c) Ccᵂ

1

(d)

allow R and W throughout

allow own symbols if defined

parental genotypes / gametes correct for both parents:
CR CW CR CW / CR and CW

1

genotypes of offspring correctly derived in a Punnett square:
$C^R C^R$ $C^R C^W$ $C^W C^W$
allow correctly derived genotypes from incorrect gametes

1

correct identification of phenotypes from their cross:
CRCR = red
CRCW = pink
CWCW = white
allow colours correctly identified from different offspring, only if pink and other colour(s) are given

1

(e)   answer correctly derived from part (d) to match stated phenotypes
allow 50(%) if no offspring given in part (d)
allow to match genotypes if no phenotypes given

1

(f)   *(several groups)*
so many / several plants can be produced
allow each (group) will give a new plant

1

(nutrients)
for making protein / amino acids or for making chlorophyll or for providing   energy or for respiration
allow other examples
do not accept making energy
ignore for growth

1

(add hormones)
so differentiation occurs or so roots / shoots develop
allow for the formation of different tissues / organs / named
allow to stimulate cell division

1

(sterile conditions)
to prevent growth / entry of microorganisms / named type or prevent decay / disease
ignore to kill microorganisms
ignore contamination unqualified

1

(temperature = 20 °C)
so optimum / good growth

> *allow reference to enzymes working well*
> *ignore enzymes not denatured*
> *ignore reference to pathogens / microorganisms*

1

(g)   (all new plants have been) produced by asexual reproduction / mitosis or produced without (fusion of) gametes

> *ignore produced from one parent*

1

(so) all are genetically identical / clones or all are CRCW / heterozygous

> *allow all are the same genotype / alleles / genes / DNA*

1

[14]

Q12.

(a)   nucleus

1

(b)   gene(s)

> *allow allele(s)*

1

(c)   copying of chromosomes

1

(d)   mitochondria

1

(e)   60 – 45
or
120 – 105

1

15 (minutes)

1

> *an answer of 15 (minutes) scores 2 marks*

(f)   C

1

(g)   8

1

(h)   to repair tissues

1

[9]

Q13.

(a) Gregor Mendel

1

(b) DNA

1

(c) when the dominant allele is not present

1

(d) tt

allow homozygous recessive

1

(e)

	T	t
T	TT	Tt
t	Tt	tt

all 3 correct = 2 marks
2 correct = 1 mark
0 or 1 correct = 0 marks
allow tT for Tt

2

(f) circle drawn around either TT or tt on Figure 2
allow circles drawn round both

1

(g) correct ratio from part (e) e.g. 3 : 1
allow multiples of stated ratio
allow 3 : 1 if no answer to part(e)

1

[8]

Q14.

(a)

	statement is true for		
	mitosis only	meiosis only	both mitosis and meiosis
all cells produced are genetically identical	✓		

in humans, at the end of cell division each cell contains 23 chromosomes		√	
involves DNA replication			√

3 correct = 2 marks
2 correct = 1 mark
0 or 1 correct = 0 marks

2

(b) any two from:

ignore references to one parent only

- many offspring produced
- takes less time

allow asexual is faster

- (more) energy efficient
- genetically identical offspring

allow offspring are clones

- successful traits propagated / maintained / passed on (due to offspring being genetically identical)
- no transfer of gametes or seed dispersal

allow no vulnerable embryo stage
allow no need for animals

- not wasteful of flowers / pollen / seeds
- colonisation of local area

must imply local area

2

(c) genetic variation (in offspring)

1

(so) better adapted survive

allow reference to natural selection or survival of the fittest

1

(and) colonise new areas by seed dispersal
or
can escape adverse event in original area (by living in new area)

must imply new area

1

many offspring so higher probability some will survive

1

allow bluebell example described (max 3 if not bluebell)

[8]

Q15.

(a) 3.7

1

(b) 2

1

(c) (different combinations of alleles cause) many / 22 values

allow continuous variation

or
in-between values

or

large range of values

or

allow there are not only 3 values if 3 is given in part (b)

there are not only two values

1

(d) different protein made

allow change in shape (of enzyme) or change in 3-D structure
ignore denature

1

active site changed

1

so substrate does not fit / bind

allow description of substrate
allow cannot form E-S complex
ignore lock and key description

1

(e) produces (some) offspring with high-fat milk
or
not all offspring have low-fat milk

ignore reference to alleles

1

(f) takes less time (to obtain results)
or
more offspring at the same time

allow other sensible suggestion − e.g. allows screening or allow cow 7 to continue to produce eggs or avoid injury to cow 7 during mating or giving birth

1

(g) male gametes correct: d (and d)

1

female gametes correct: D and d

1

allow 1 mark if gametes are correct but gender not identified

correct derivation of offspring genotypes from given gametes

allow 2 × 2 or 2 × 1 derivation

1

Dd identified as low-fat and dd identified as high-fat in offspring

if DD offspring are produced, must also identify as low-fat

1

(h)   find female with low(est) fat in milk and high(est) milk yield

allow choose from 7, 9, 12, 13 which has the highest yield

1

find male whose female offspring have high(est) milk yield and low(est) fat in milk

allow choose from 16 or 18 whose female offspring has the highest yield

1

or

find female with lowest fat in milk
or cow 13 (1)*

**or
allow female with high(est) milk yield*

find male whose female offspring have high(est) milk yield (1)*

**or
allow male whose female offspring have lowest fat in milk / male 16*

cross the best (for both features) female with the best male

1

select best offspring (for both features) from each generation and repeat for several generations

1

[16]

Q16.

(a)   46

1

(b)   23

allow ecf from 2.1 – ie half of answer given in 2.1

1

(c)   egg

1

sperm

1

ovary

1

meiosis

1

fertilisation

1

correct order only
correct spelling only

	X	Y
X	XX	XY
X	XX	XY
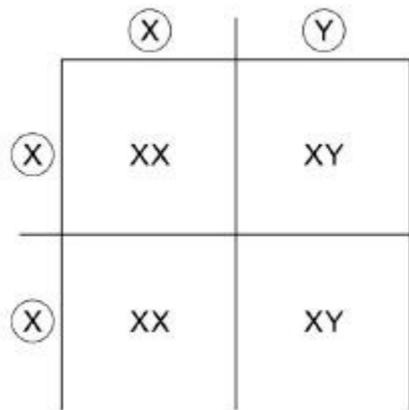
(d)

all 4 correct = 2 marks
2 or 3 correct = 1 mark
0 or 1 correct = 0 marks
ignore correct / incorrect identification of male and female offspring

2

(e)   1 in 2

1

(f)   any two from:

- multiple genes determine appearance
  allow several / many genes determine appearance

- different combinations of alleles
  allow description of combinations of alleles' allow genes for alleles

- different environmental effects
  allow example e.g. eat different diets

- from different egg / sperm

2

[12]

Q17.

(a) red blood cell

1

(b) 44

1

(c) retina

1

(d) 7 and 8 / the parents
do not have A (allele)
or only have a (allele) or are aa

allow converse – if parents had an A (allele) they would have Stickler syndrome

1

so children cannot inherit A
or can only inherit a

or

the parents show the recessive characteristic

so must be homozygous
(recessive)
or must be aa
or parents cannot have A

1

(e) parental genotypes:
12 = Aa and 18 = aa
or parental gametes:
12 = A + a and 18 = a + a

1

derivation of offspring genotypes
allow ecf

1

identification of Aa offspring as Stickler

1

probability = 0.25 / $\frac{1}{4}$ / 1 in 4 / 25% / 1:3
*allow ecf – e.g. 0.5 if 12 = AA
do not accept 3:1 do
not accept 1:4*

1

[9]

Q18.

(a) A

1

(b)
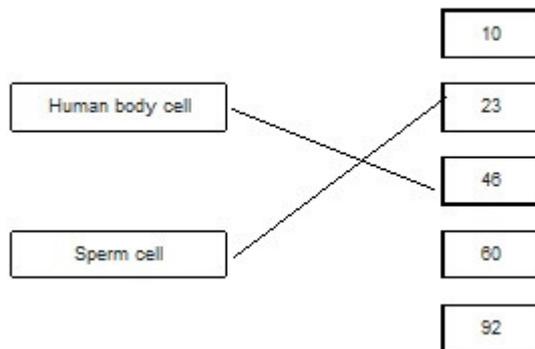
2

(c)   one x circled under mother

accept if clearly indicated choice even if not circled

1

(d)   XY

*allow YX*

1

(e)   50 (%)

1

[6]

Q19.

(a)
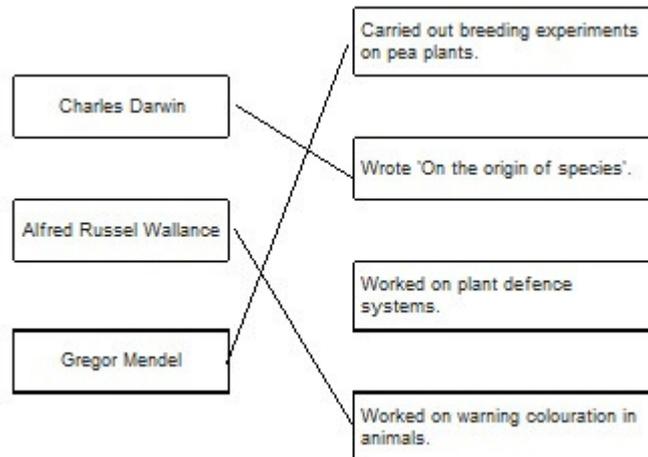
3

(b)   a gene

allow allele

1

(c)   4

1

(d)   correct derivation of children's genotypes

1

identification of children with cystic fibrosis (dd)

1

0.25

> *allow ecf*
> *allow ¼ / 25% / 1 in 4 / 1:3*
>
> *do not accept 1:4*

1

(e)   heterozygous

1

[9]

Q20.

(a)   phosphate

> *allow PO3− 4*
>
> *do not allow P*

1

(b)   A / adenine and T / thymine
and
C / cytosine and G / guanine

> *do not allow U / uracil*

1

(c)   (mutation) changes from C to T DNA code
or
there is a change in the three bases / triplet from CAG to TAG

1

(mutation) changes the amino acid

1

(this could) change the protein

1

(so it) forms a different shape / changed active site

> *accept different tertiary structure*

1

(therefore) the enzyme no longer fits the substrate / carbohydrate

1

(d)   mother / woman's gametes correct: A   a

1

father / man's gametes correct: a   a

1

correct derivation of offspring

> *ecf*

1

identification of child with syndrome H or genotype aa

1

0.5

ecf
allow 50% / 1 / 2 / 1 in 2 / 1:1

do not accept 1:2

1

[12]

Q21.

(a) When the dominant allele is not present.

1

(b) (i) Bb

1

Woman
Brown hair

	B	b
b		bb
b	Bb	bb

Person 3
Red hair

(ii)

3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks
allow bB for Bb

2

(iii) 1 in 2
allow ecf from part ii

1

[5]

Q22.

(a) testis / testes
allow testicle(s)

1

(b) (i) B = 13.2
C = 6.6 =
E 3.3

all 3 correct = 2 marks
2 or 1 correct = 1 mark

*If no marks awarded allow ecf for C and E based
on answer to B
ie C = ½ B and E = ½ C for one mark*

2

    (ii)   6.6

allow twice answer for cell E in part bi

1

    (iii)   mitosis

correct spelling only

1

(c)   (i)   any two from:
- cells that are able to divide
- undifferentiated cells / not specialised
- can become other types of cells / tissues or become specialised /differentiated

allow pluripotent

2

    (ii)   4-day embryo is a (potential) human life

or

destroying/damaging (potential) human life

*allow cord would have been discarded anyway
ignore reference to miscarriage
allow cannot give consent*

1

    (iii)   perfect tissue match or hard to find suitable donors

*allow same/matching antigens
allow no danger of rejection
allow no need to take immunosuppressant drugs
(for life)
ignore genetically identical or same DNA*

1

    (iv)   stem cells have same faulty gene / allele / DNA / chromosomes

*allow genetically identical
ignore cells have the same genetic disorder*

1

[10]

Q23.
(a)   (i) man has (inherited) polydactyly (PD) allele (from mother)

1

man has (inherited) other / normal / recessive allele from father

1

because father does not have PD allele or if father had it father would have had PD or father only has normal allele or father is homozygous recessive

1

allow gene for allele

(ii) 0.5 / ½ / 1 in 2 / 1:1 / 50%
do not allow 1:2 or 50/50
allow 50:50

1

(b) parental phenotypes: both brown

1

parental genotypes: both Bb

1

gametes: B   b   and   B   b

1

allow only on gametes answer line
allow ecf from genotypes

offspring genotypes: BB   (2)Bb bb
allow ecf from gametes

1

offspring phenotypes correctly assigned to genotypes:
BB & Bb = brown   bb = red
do not penalise confusion of 'phenotypes' & 'genotypes' here

1

[9]