

**Core 1**

Hair colour in mice is controlled by a gene with two alleles. A homozygous black-haired mouse was bred with a homozygous brown-haired mouse. All the offspring were black-haired.

**(a) (i)** Explain what is meant by the terms *homozygous* and *recessive*.

*Homozygous* .....

.....

*Recessive* .....

.....[2]

**(ii)** Which is the dominant hair colour in mice?

.....[1]

**(b)** One of the heterozygous black-haired offspring was bred with a homozygous brown-haired mouse.

**(i)** Using the symbols **B** and **b** to represent the two alleles, draw a genetic diagram to show the outcome of this cross. [4]

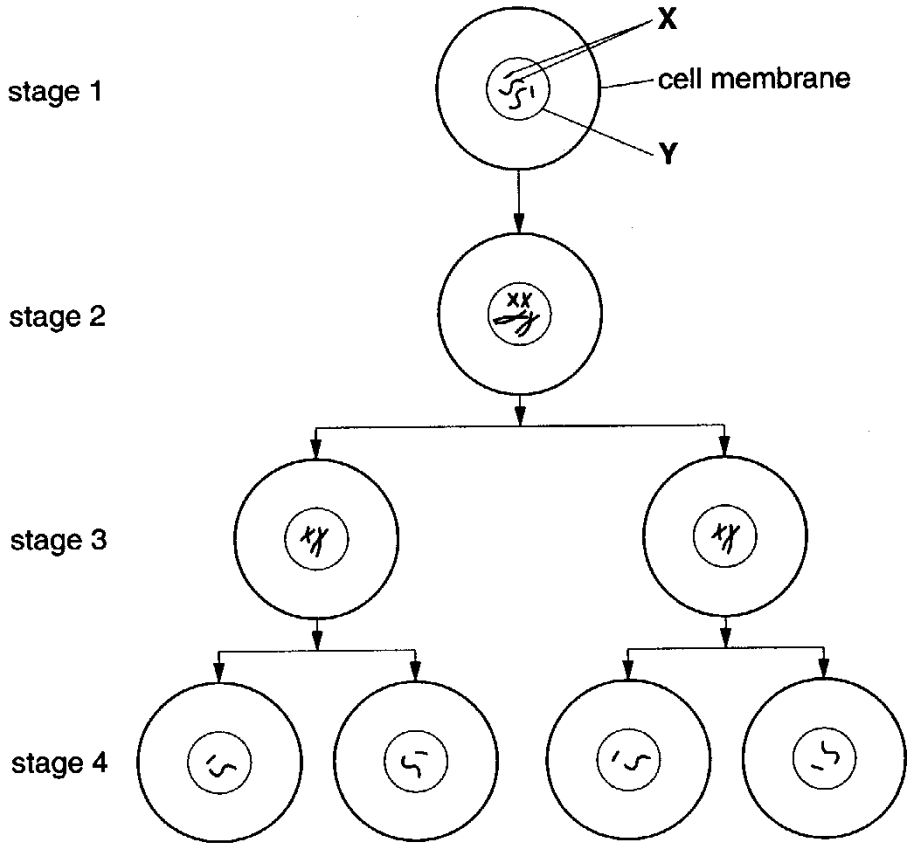
**(ii)** State the ratio of the phenotypes of the offspring.

.....[1]

[Total : 8]

**Core 2**

Fig. 1 shows, in outline, the stages of the division of a cell.



**Fig. 1**

**(a) (i)** Name the structures labelled X and Y.

X .....

Y .....

[2]

**(ii)** Identify, with a reason, the type of cell division shown in Fig. 1.

*Type of cell division* .....

*Reason* .....

.....

[2]

**(iii)** Name an organ in the body where this type of cell division occurs.

.....

[1]

**(b)** What process must occur if a cell in stage 4 is to form a cell similar to that shown in stage 1?

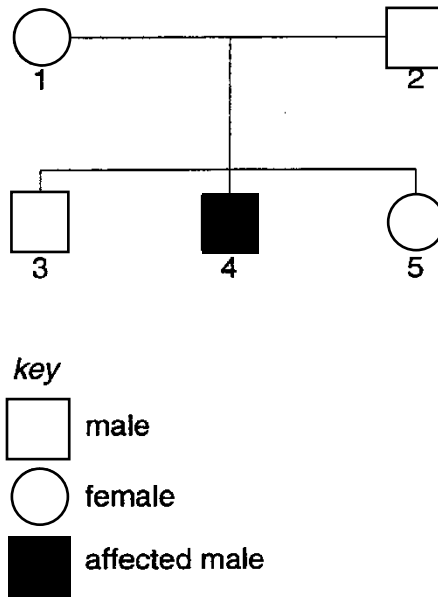
.....[1]

[Total : 6]

**Core 3**

Fig. 2 shows the inheritance of a condition in humans known as phenylketonuria (PKU).

This condition affects the liver, causing it to produce toxins which can affect the mental health of the sufferer.



**Fig. 2**

(a) State, with an explanation, whether the allele for PKU is dominant or recessive.

.....  
.....  
.....[3]

(b) (i) Using the symbols **H** for the dominant allele and **h** for the recessive allele, state the genotypes of individuals 1 and 4.

Individual 1. ....  
Individual 4. ....[2]

(ii) What are the **two** possible genotypes of individual 3?

.....[1]

[Total: 6]

Alternative to Practical 1

Fig. 3 is a photograph of a flight feather of a bird.

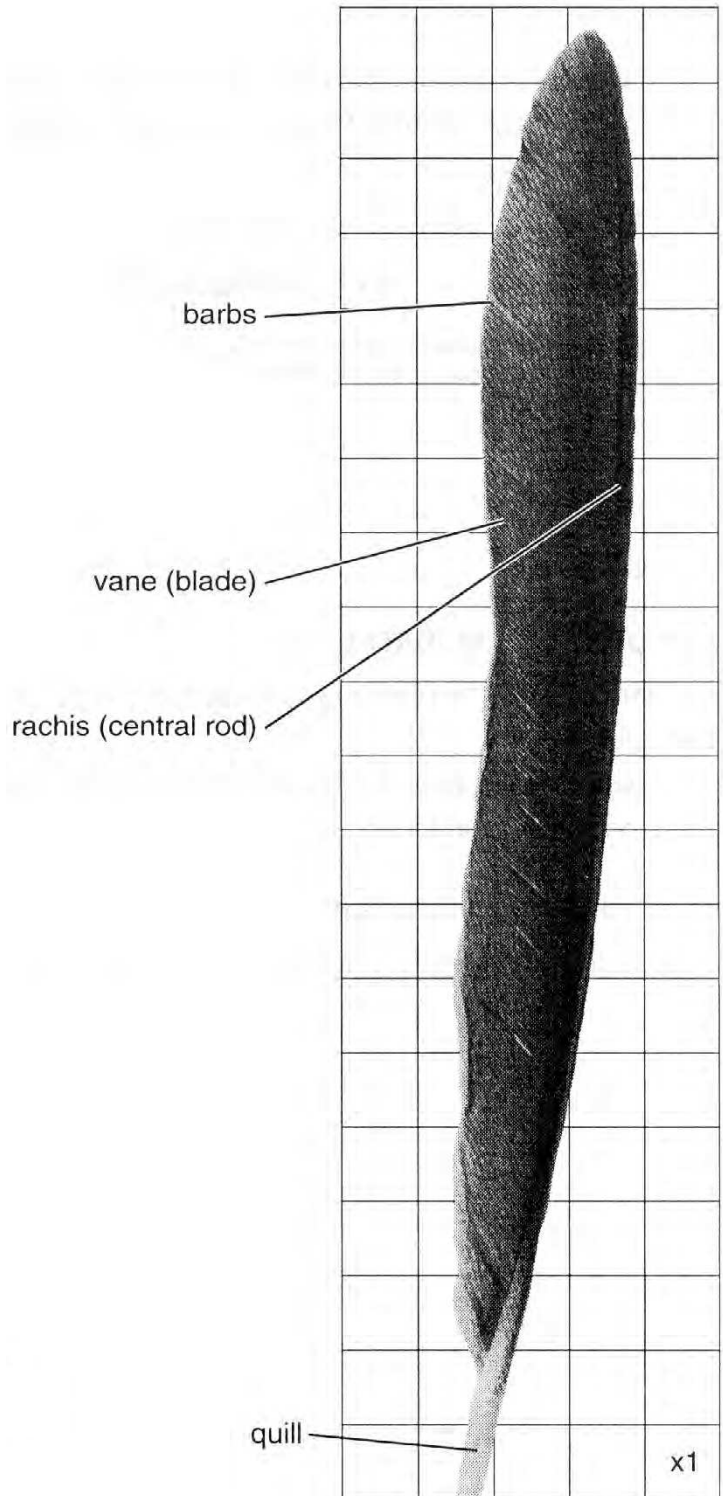


Fig. 3

- (a) Determine the surface area of the feather, excluding the quill.

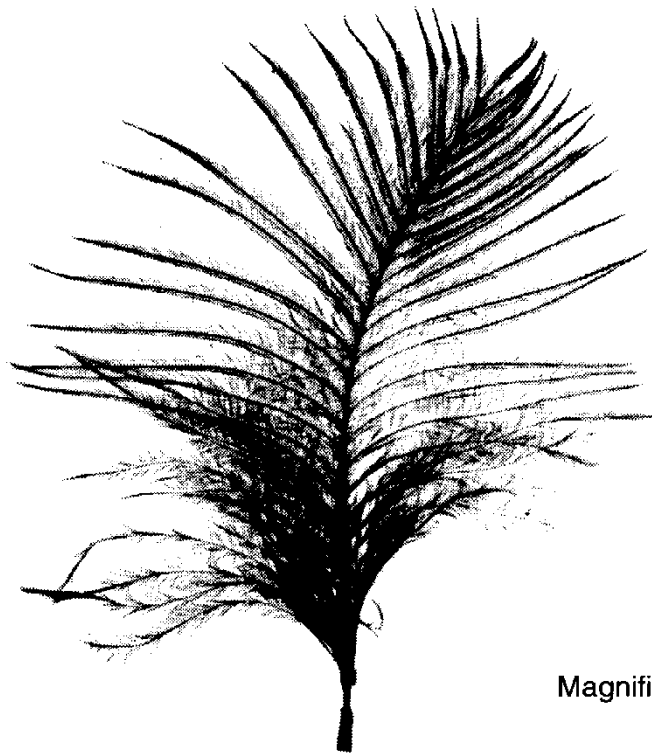
Show your working.

Surface area of feather .....cm<sup>2</sup>

[3]

Alternative to Practical 1

Fig. 4 is a photograph of a down feather. These feathers form a dense layer close to the skin surface of a bird.



Magnification x 4

Fig. 4

(b) Complete Table 1 to show **three visible** differences between the flight feather in Fig. 3 and the down feather in Fig. 4.

Table 1

	flight feather	down feather
1	..... .....	..... .....
2	..... .....	..... .....
3	..... .....	..... .....

[3]

**Alternative to Practical 1**

**(c) (i)** Suggest how the down feathers may be important especially to young birds in cold climates.

.....  
.....  
.....  
.....[2]

**(ii)** Using a beaker of hot water to represent a young bird, describe an experiment you could carry out to support your suggestion in **(c) (i)**.

.....  
.....  
.....  
.....  
.....[3]

[Total : 11]

**Extension 1**

Cystic fibrosis is an inherited disorder in humans in which an important protein is not produced. This protein is responsible for preventing the accumulation of thick and sticky mucus in the breathing tubes. The allele which causes cystic fibrosis is recessive to the normal allele (F).

**(a)** State the genotype of

**(i)** a carrier of cystic fibrosis; .....[1]

**(ii)** a sufferer of cystic fibrosis. ....[1]

**(b)** Draw a genetic diagram to show if it is possible for a man with a dominant pair of alleles and a woman who is a carrier to produce a baby with cystic fibrosis. Identify the phenotypes of the children.

[4]

**(c)** Suggest how the build up of sticky mucus would affect a sufferer of cystic fibrosis.

.....  
.....  
.....[2]

[Total : 8]

**Extension 2**

Some people suffer from sickle cell anaemia. They have abnormal red blood cells.

**(a) (i)** Describe the shape of a **normal** red blood cell.

.....  
.....[1]

**(ii)** State how the appearance of an abnormal red blood cell from a sufferer of sickle cell anaemia differs from a normal red blood cell.

.....  
.....[1]

**(iii)** What is the effect of sickle cell haemoglobin on the function of the red blood cell?

.....  
.....[1]

The allele for normal haemoglobin is represented by the symbol  $H^A$ . The allele for sickle cell haemoglobin is represented by the symbol  $H^S$ . The alleles are codominant.

**(b)** State the genotypes for

**(i)** a person with normal haemoglobin;

.....[1]

**(ii)** a heterozygous person;

.....[1]

**(iii)** a person with sickle cell anaemia.

.....[1]

**(c)** Which of the genotypes stated in **(b)** is likely to result in

**(i)** the greatest protection from malaria?

.....[1]

**(ii)** the greatest risk of an early death in a malaria-free country?

.....[1]

A man with sickle cell anaemia married a woman heterozygous for sickle cell.

**(d)** Using a genetic diagram, predict the possible percentage of their children that would suffer from sickle cell anaemia.

Percentage ..... [5]

[Total : 13]



## Extension 2

A man with sickle cell anaemia married a woman heterozygous for sickle cell.

- (d) Using a genetic diagram, predict the possible percentage of their children that would suffer from sickle cell anaemia.

Percentage ..... [5]

[Total : 13]

## Core 1

a(i) homozygous – both alleles present are the same / individual received the same allele from both parents / gametes

recessive – an allele which is only exhibited when present in the homozygous state / when the dominant allele is not present / masked by dominant allele, not gene

(ii) black

b(i) up to 4 points are scored for the following

use of capital B for dominant (black) allele / lower case b for recessive allele  
correct genotypes for both parents (Bb, bb)  
gametes correctly displayed (B, b and b, b or b)  
correct genotypes of offspring (Bb,bb)  
correct phenotypes identified (for all offspring)

(ii) correct ratio predicted (1:1 or 1 in 2 or 50%, 50%)

## Core 2

- a(i) X – chromosomes  
Y – nucleus / nuclear membrane
- (ii) meiosis – four nuclei are produced / number of chromosomes / genetic material is halved / new nuclei haploid
- (iii) ovary / testis / gonad
- b fertilisation / fusion of sperm and ovum / gametes / formation of zygote

### Core 3

a        recessive

4 has inherited PKU from parents (or alternative wording)  
as it is not apparent in 1 or 2 / neither parent shows it / if dominant a  
parent would show it / have PKU

b(i)    1 – Hh

4 – hh

(ii)    HH and Hh

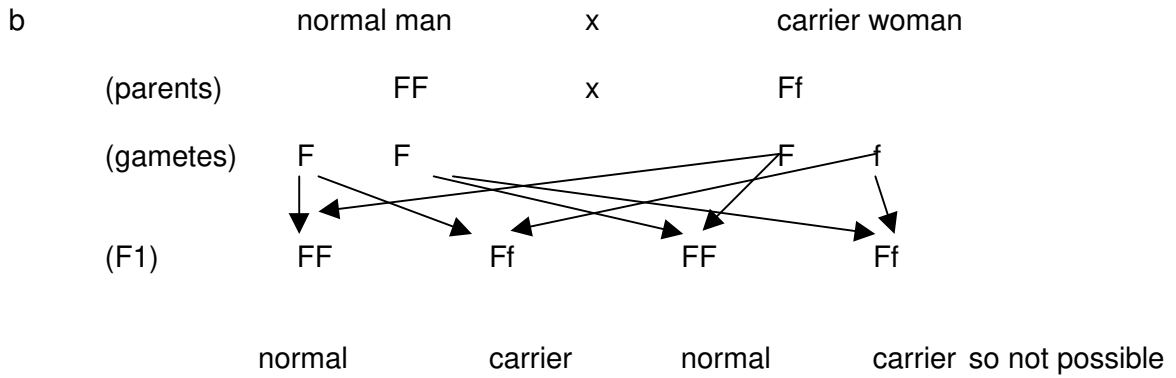
## Alternative to Practical 1

- a working includes
  - squares to be marked on the feather
  - breakdown of rows into sub-totals / tally grids
  - total to be in the range 25 – 30 cm<sup>2</sup>
  
- b three visible differences to include references to shape, area, appearance of barb or blade, appearance of rachis (central rod), size or shape of quill
  
- c(i) insulation / traps air / keeps it warm / stops heat escaping / traps heat  
maintains body temperature / homiothermy / warm blooded  
reference to young birds do not fly or less active so generate less heat / large surface area to volume ratio / no regulation of body temperature / not able to keep temperature the same
  
- (ii) any three of these within the context of a fair test
  - uses several feathers or any insulation to wrap around a body / glassware
  - use of thermometer to follow cooling recorded at intervals
  - comparison of apparatus with and without any covering or with flight feathers

**Extension 1**

a(i) Ff

(ii) ff



- c any two of these
- reference to trachea / bronchi / bronchioles / alveoli blocked or congested
  - makes gaseous exchange more difficult
  - reference to lack of energy / respiration impaired
  - reference to being more susceptible to infections
  - reference to digestion affected

**Extension 2**

- a(i) biconcave disc
- (ii) reference to sickle / crescent shaped
- (iii) able to carry / absorb less oxygen

b(i)  $H^A H^A$

(ii)  $H^A H^S$

(iii)  $H^S H^S$

c(i)  $H^S H^S$

(ii)  $H^S H^S$

