

AS91157 Demonstrate understanding of genetic variation and change

Punnett Squares

(2014, 1)

DIHYBRID INHERITANCE

In pumpkins or squash (*Cucurbita pepo*), white skin colour (W) is dominant to yellow skin colour (w) and disk-shape (D) is dominant to sphere-shape (d).



The genes controlling colour and shape in pumpkins are located on different pairs of homologous chromosomes.

A pumpkin homozygous for white skin colour and disk shape is crossed with a pumpkin homozygous for yellow skin colour and round shape. All the next generation pumpkins (F1) have the same genotype.

- (a) Describe the **genotype** of the F1 generation.
- (b) Two of these F1 pumpkins are crossed to produce the F2 generation.

Use the Punnett square to show the **gametes** and all the expected **genotypes** of all the possible F2 offspring.

(c) Give the **phenotype ratio** for the cross completed in part (b) AND describe the appearance of each phenotype.

(d) Discuss how crossing over and linked genes affect genetic variation in a population.

In your discussion:

- describe what linked genes are
- describe the process of crossing over, including when it occurs
- explain the effect of crossing over on linked genes
- compare and contrast how both linked genes, and crossing over, affect genetic variation in a population.

You may draw diagrams to support your answer.

(2013, 1)

DIHYBRID INHERITANCE

In the sweet pea plant, *Lathyrus odoratus*, the allele for purple (P) flower colour is dominant over the allele for red (p) flower colour. A second gene determines the shape of the pollen. Long (L) pollen is dominant over round (l) pollen.



(a) A purple, long-pollen plant, PPLL is crossed with a red, round-pollen, ppll plant.

Give the genotype of the F1 generation,

Two F1 generation plants were crossed to produce the F2 generation plants.

(b) Use the Punnett square to show the gametes and the expected genotypes of all the possible F2 offspring from these two F1 plants.

Demonstrate understanding of genetic variation and change.

- (c) Give the expected phenotype ratio for the cross you have completed.
- (d) When biologists crossed the F1 plants to produce F2 offspring, their observed phenotype ratio was different from the expected phenotype ratio in (c).

	Observed phenotype ratio
Purple, long (PpLl)	12
Purple, round (Ppll)	1
Red, long (ppLl)	1
Red, round (ppll)	1

They concluded that the gene for colour and the gene for pollen shape were not independently assorting as expected, therefore the genes must be linked.

Discuss why the **expected phenotype** ratio you calculated is different from the **observed ratio** the biologists actually observed.

In your answer:

- describe **linkage**
- explain why linked genes do not assort independently
- explain how crossing over produces recombinants
- discuss how crossing over resulted in the low occurrence of purple, round pollen and red, long-pollen phenotypes.

The following questions were collated from the expired Level 2 AS 90459 Describe genetic variation and change but are still useful for the new AS91157

(2011:2)

In a particular breed of sheep, wool colour is determined by two pairs of genes: natural / domesticated and black / brown.

‘Natural’ sheep that have never been domesticated show a pattern of coloured wool on their heads and necks (collars) and white wool on their bodies. Most domesticated sheep show a solid colour throughout. The natural pattern (N) is dominant to the domesticated (n). Black (B) is dominant to brown (b).

A male sheep (ram) and a female sheep (ewe) that breed over several seasons produce offspring that show a 9:3:3:1 phenotypic ratio.

- (a) State the genotypes of the male and female sheep, and use the Punnett square below to determine the phenotype of their offspring.

Male genotype _____ Female genotype _____

- (b) Describe the phenotype of the individuals for the given ratio 9:3:3:1.

9 = _____ 3 = _____
3 = _____ 1 = _____

- (c) A breeder of this type of sheep wants to establish a flock (group of sheep) that all have the ‘**natural**’ wool pattern with a **brown** collar.

Discuss why the male and female sheep used in part (a) are not a suitable starting point for establishing this new flock, and how the breeder could determine which of his sheep were suitable.

In your answer you should refer to:

- the crosses that would have to be carried out
- the genotypes of the ram (male sheep) and ewe (female sheep) that would establish the flock that the breeder wants.

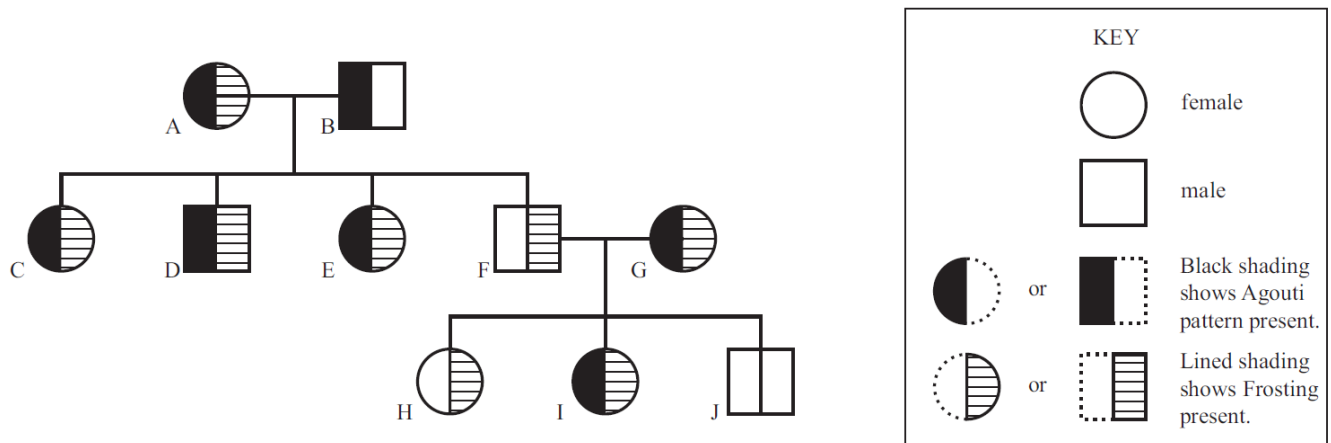
(2010:2)

Pygmy goats have different coat colours and patterns.

An Agouti coat pattern has white hairs mixed between coloured hairs. Agouti (**A**) pattern is dominant to full colour (**a**).

Another pattern, Frosting, is where there are white hairs on the tips of the ears. Frosting (**F**) is dominant to non-frosting (**f**).

Use the information provided in the pedigree chart below to answer the following questions.



- Determine the genotypes of the individuals B and G.
- Explain why the genotype of 'H' cannot be determined from the information given in the pedigree chart.
- Discuss **why** it would be necessary to carry out a test cross to determine the genotype of 'I', and **how** this would be carried out.

You may draw Punnett squares to help explain your answer.

(2009:1)

A new plant variety is established that shows variation in both the pattern of the veins and the lobe shape of the leaves. The genes controlling these features are located on different pairs of homologous chromosomes.

R = allele for regular patterned veins r = allele for irregular patterned veins

D = allele for deep lobes d = allele for shallow lobes

A plant with leaves that are regular and shallow, **RRdd**, is crossed with a plant with leaves that are irregular and deep, **rrDD**.

- Give the genotype of the F_1 generation.

Two of these F_1 plants are then crossed to produce the F_2 generation.

- Use the Punnett square to show the gametes and the **genotypes** of all the possible F_2 offspring from these two F_1 plants.

- (c) Give the phenotype ratio for the cross you have completed. Include a description of the appearance.

The phenotype ratio in this cross is quite different from the genotype ratio.

- (d) **Explain** why genotype and phenotype ratios can sometimes be different. Use examples from parts (b) and (c) above to support your answer.
- (e) **Discuss** how a test cross can be used to **establish** true breeding plants with regular patterned veins, and deep lobes on the leaves.

(2008:2)

In pea plants, two commonly studied features are the colour and the shape of the seeds. The genes controlling these features are located on different pairs of homologous chromosomes.

R = allele for round seeds

r = allele for wrinkled seeds

Y = allele for yellow seeds

y = allele for green seeds

- (a) Use the Punnett square to show the gametes and the **genotypes** of all the possible offspring from these two F₁ plants. Make sure you write your letters clearly

- (b) State the appearance of the offspring AND give the phenotypic ratio for the cross you have completed:
- (c) A plant breeder wants to establish a population of pea plants that are **pure-breeding** for **wrinkled** and **yellow** seeds. The breeder has a stock of pea seeds of unknown genotypes that are all **round** and **yellow**.

Discuss the **genetics** involved in establishing the desired pure-breeding population from the stock seeds. Support your answer with the possible genotypes of the plants involved, using the letters for the alleles given in part (a).

(2007:1)

- (a) Define the term **mutation**.

Drosophila melanogaster, the common fruit fly, is used in genetic experiments. A normal population of *Drosophila* consists of flies with long wings and grey bodies. Many mutant forms are found naturally in a population, and one such example is a fly with short wings and a black body.

Normal
(long wings, grey body)



Mutant
(short wings, black body)



A homozygous normal male with the genotype **WWGG**, is crossed with a homozygous mutant female with the genotype **wwgg**. The offspring of this cross all have the same genotype as each other.

Two of these F₁ offspring are then bred together to produce the F₂ generation.

- (b) Use the Punnett square to show the gametes and the **genotypes** of all the possible F₂ offspring from these two F₁ flies.

- (c) Give the **phenotypic** ratio for the F₂ offspring in part (b) above.

(2006:2)

Budgies are small birds kept as pets. There are many colourful varieties.

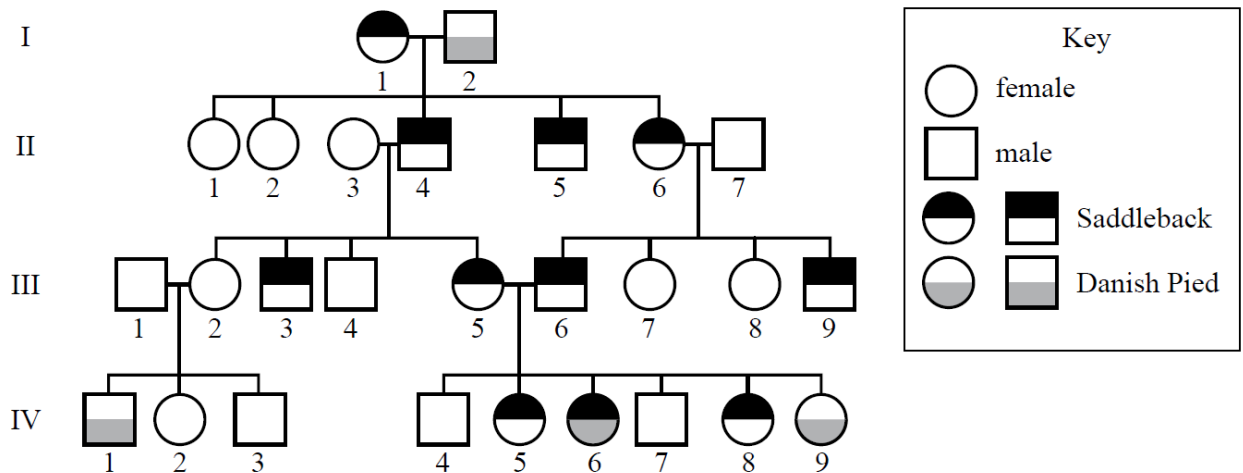
The *Spangle* (A) colour pattern was first seen in 1974 and is caused by a dominant allele. The recessive allele is *Saddleback* (a).

The *Dutch Pied* (D) variation appeared in 1934. The recessive allele is *Danish Pied* (d).

- (a) Describe how these new variations have arisen.
- (b) Determine the genotype **and** phenotype of the possible offspring from a mating of a pure breeding *Spangle* / *Danish Pied* budgie with a pure breeding *Saddleback* / *Dutch Pied* budgie.
- You may use a Punnett square to help you.

The pedigree below shows the pattern of transmission of alleles from the mating of a *Saddleback* (a) and *Danish Pied* (d). Saddleback individuals are indicated by a solid upper half of the symbol: those showing Danish Pied are indicated by a shaded lower half.

GENERATION



- (c) (i) What is the **genotype** of I-2?
- (ii) Explain your answer to (i) above.
- (d) A breeder has a *Spangled* / *Danish Pied* budgie. Discuss which individual in the cross on the previous page could be used to determine the genotype of this budgie.

(2005:2)

Some dogs bark when working, others are silent. The barker (B) allele is dominant to the silent (b) allele.

Tail shape is also controlled by a single gene. The allele for normal tail (T) is dominant to the allele for twisted tail (t).

A farmer has a litter of pups from a true breeding male dog, silent and with a normal tail, and a true breeding female dog, a barker with a twisted tail.

- (a) Describe the genotype and the phenotype of the pups from these two dogs.

One of the female pups from the litter is mated with a dog heterozygous for both genes.

(b) Use a punnet square to work out the **genotypes** of all the possible offspring from these two dogs.

(c) Give the **phenotypic** ratio for the offspring in part (b) above.

(d) A farmer is considering using another barker dog with a normal tail for breeding.

Discuss how he could determine the **genotype** of this dog and establish a true breeding group of normal tailed dogs.

Answers will be found for Level 2 AS 90459 at

<http://www.nzqa.govt.nz/qualifications-standards/qualifications/ncea/subjects/biology/expired-standards/>