Skill building pack: Drawing

Drawing genetic diagrams

If we know the genotypes of organisms involved in a genetic cross, we can draw a **genetic diagram** to predict the possible genotypes or phenotypes of the offspring and the probability of each genotype or phenotype appearing in the offspring.

Consider a cross between two black mice. Both are heterozygous. Black coat colour is the dominant character whereas brown coat colour is recessive. We can follow the steps below to draw a clear genetic diagram to predict the possible outcomes of the cross.

Steps	Example of a genetic diagram
1 Define the symbols.	Let B be the allele for black coat colour and b be the allele for brown coat colour.
2 State the phenotypes and genotypes of the parents.	mouse 1: black coat colour; mouse 2: black coat colour parents: Bb × Bb
3 State the possible alleles in the gametes.	gametes: B, b, B, b
4 Work out the possible genotypes of the offspring. State their phenotypes.	F_1 genotypes: BB, Bb, Bb, bb phenotypes: black coat colour; brown coat colour ratio: 3 : 1

- Use a **capital letter** for the **dominant allele**, and the corresponding **small letter** for the **recessive allele**.
- Better choose a letter whose upper case and lower case are in different forms (e.g. B and b).
- If the allele is on the X chromosome, put the letter as a superscript of X, e.g. X^B.

- Write the dominant allele first.
- Label the genotypes '**parents**'.
- Write '×' between the genotypes to indicate a cross.

- Draw a circle around each possible allele in the gametes.
- Label the possible alleles '**gametes**'.

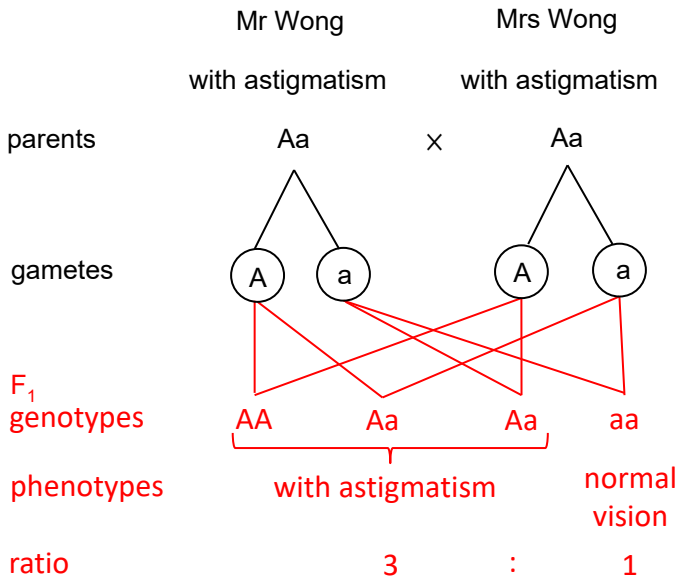
- Add **lines** for each possible combination.
- Label the genotype '$\mathbf{F_1}$'.
- Indicate the phenotypic ratio of the offspring.

Practice 1

Astigmatism is an eye defect. Heredity is one of its causes. This eye defect is controlled by a pair of alleles, which are not sex-linked. The allele for astigmatism is dominant while that for normal vision is recessive. Mr Wong and Mrs Wong are heterozygous for astigmatism and they are going to have a child.

Complete the following genetic diagram and find the probability of the child having normal vision.

Let A be the allele for astigmatism and a be the allele for normal vision.



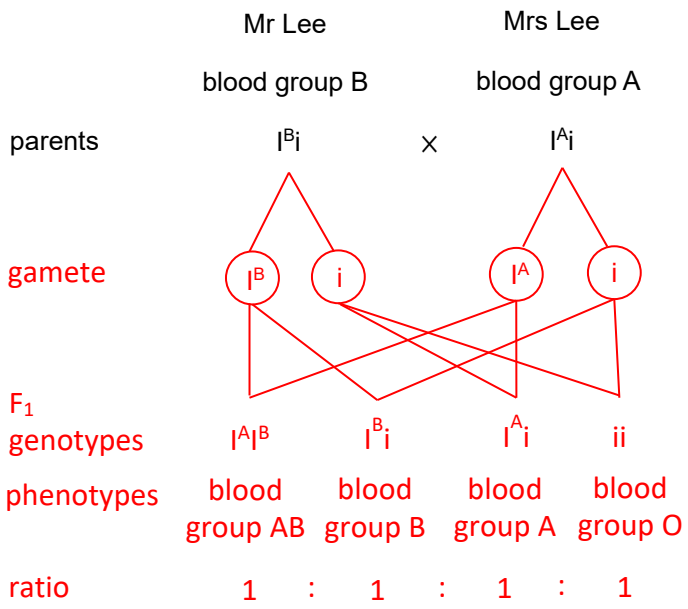
The probability of the child having normal vision is $\frac{1}{4}$ (or 25%).

Practice 2

Mr Lee is of blood group B and Mrs Lee is of blood group A. Both are heterozygous. They are going to have a child.

Given that I^A represents the allele for producing antigen A on the surface of red blood cells, I^B represents the allele for producing antigen B on the surface of red blood cells and i represents the allele that does not lead to the production of any antigens on the surface of red blood cells.

Complete the following genetic diagram and find the possible blood groups of the child.



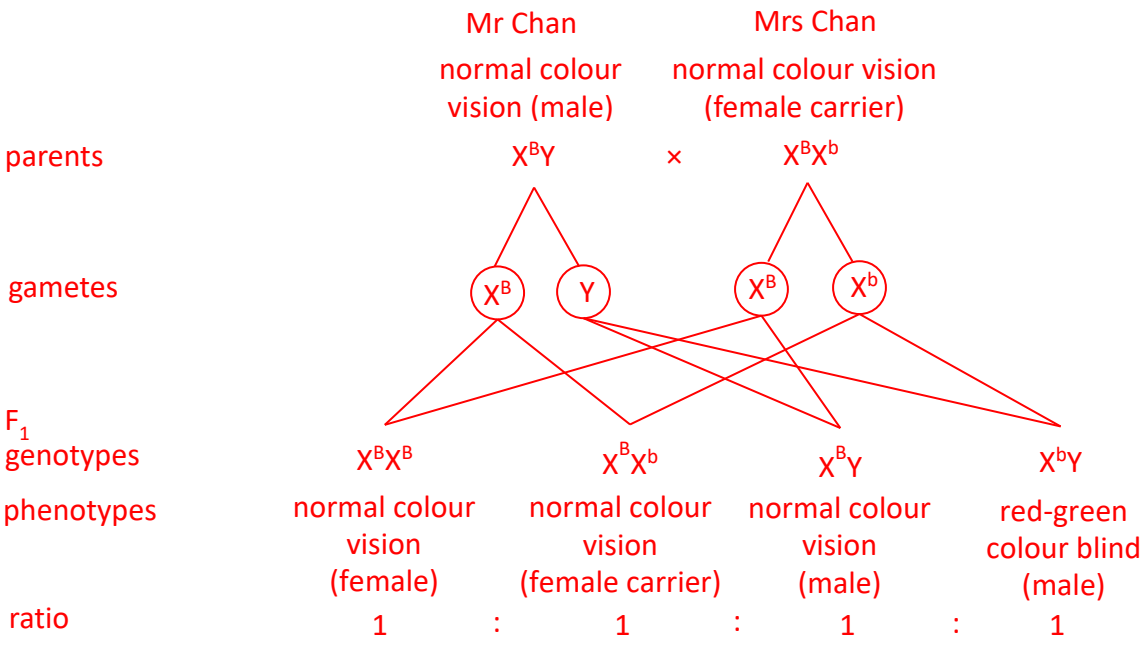
The child will have a 25% chance of being blood groups A, B, AB and O respectively.

Practice 3

Red-green colour blindness is caused by a recessive allele on the X chromosome. Mr Chan has normal colour vision while Mrs Chan is a carrier of the allele for red-green colour blindness. They are going to have a baby.

Using a genetic diagram, determine the probability of the baby being a red-green colour blind boy.

Let B be the allele for normal colour vision and b be the allele for red-green colour blindness.



The probability of the baby being a red-green colour blind boy is $\frac{1}{4}$ (or 25%).

技巧提升教材：繪圖

繪畫遺傳圖解

如果我們知道涉及雜交的生物的基因型，我們便可以繪畫**遺傳圖解**，預測後代中可能出現的基因型或表現型，以及各種基因型或表現型出現的機會率。

下表將以兩隻黑色老鼠的雜交作為例子，顯示怎樣繪畫遺傳圖解，以預測雜交的可能結果。雜交的兩隻老鼠都是雜合的，黑色毛皮是顯性性狀，棕色毛皮則是隱性性狀。

步 驟	遺傳圖解的例子
1 定義符號。	假設 B 代表黑色毛皮的等位基因，b 代表棕色毛皮的等位基因。
2 列出親本的表現型和基因型。	老鼠 1 黑色毛皮　　老鼠 2 黑色毛皮 親代　Bb　×　Bb
3 寫出可能在配子中出現的等位基因。	配子　B　b　B　b
4 寫出後代可能出現的基因型，並列出表現型。	F_1 代基因型　BB　Bb　Bb　bb 表現型　黑色毛皮　棕色毛皮 比例　3 : 1

- 用**大寫英文字母**代表**顯性等位基因**，用相應的**小寫英文字母**代表**隱性等位基因**。
- 盡量選擇大小寫字形不同的字母（如 B 和 b），以免混淆。
- 如果等位基因位於 X 染色體，把英文字母寫成 X 的上標，例如 X^B。

- 要先寫顯性等位基因。
- 把基因型標記為「**親代**」。
- 在兩個親本的基因型中間畫上「×」，代表雜交。

- 用圓圈**圈起**每個可能在配子中出現的等位基因。
- 把可能在配子中出現的等位基因標記為「**配子**」。

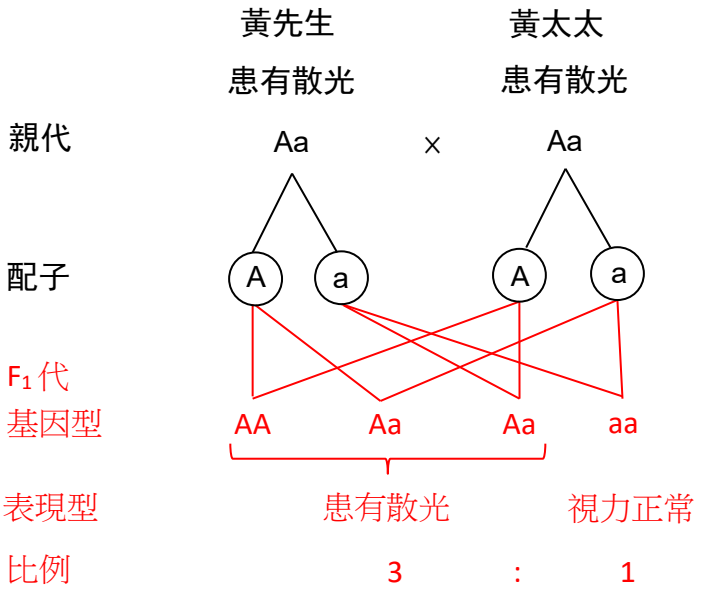
- 加上**連線**，顯示可能出現的等位基因組合。
- 把基因型標記為「F_1 代」。
- 寫出後代的表現型比例。

練習 1

散光是常見的眼睛毛病，而遺傳是導致散光的其中一個原因。散光由一對等位基因控制，這對等位基因並非性連鎖。導致散光的等位基因屬顯性，導致正常視力的等位基因則屬隱性。黃先生和黃太太都是患有散光的雜合子，他們準備生育一名孩子。

完成以下遺傳圖解，找出他們孩子的視力屬正常的機會率。

假設 A 代表導致散光的等位基因，a 代表導致正常視力的等位基因。



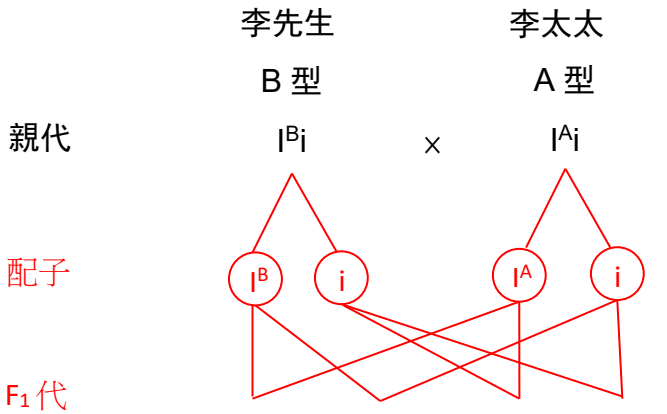
孩子的視力屬正常的機會率是 $\frac{1}{4}$（或 25%）。

練習 2

李先生的血型是 B 型，而李太太的血型是 A 型，兩人在血型上都是雜合的。他們準備生育一名孩子。

已知 I^A 代表導致紅血細胞表面產生抗原 A 的等位基因，I^B 代表導致紅血細胞表面產生抗原 B 的等位基因，而 i 代表導致紅血細胞表面不會產生任何抗原的等位基因。

完成以下遺傳圖解，找出孩子可能的血型。



F_1 代

基因型	I^AI^B	I^Bi	I^Ai	ii
表現型	AB 型	B 型	A 型	O 型

比例　1 : 1 : 1 : 1

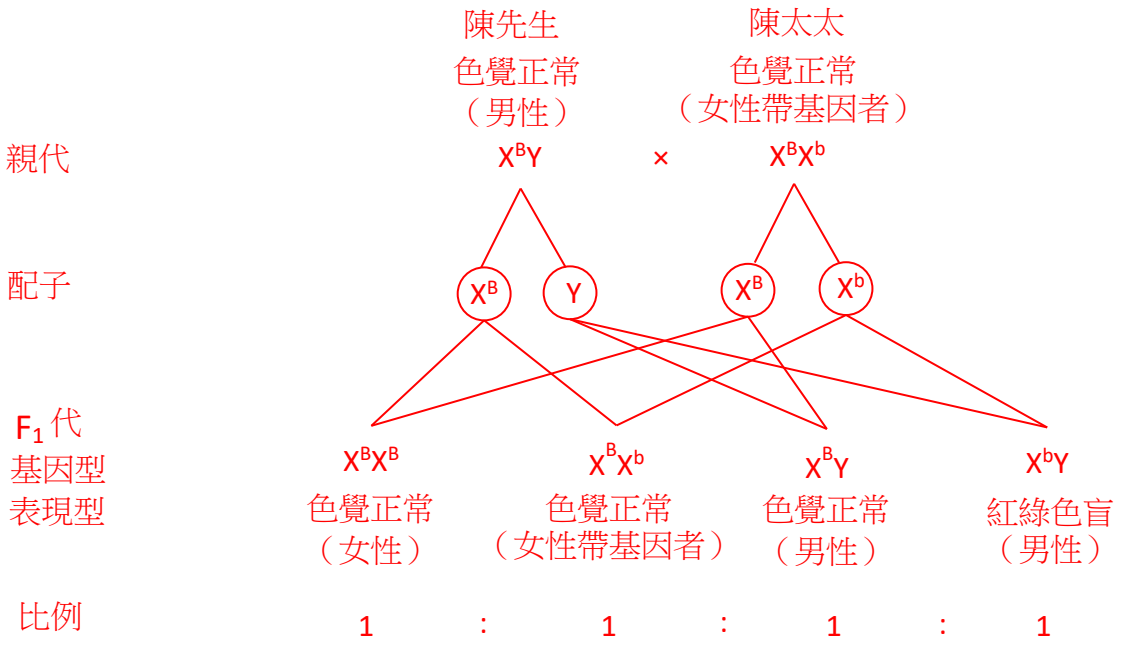
孩子的血型可能是 A 型、B 型、AB 型或 O 型，而每種血型的機會率都是 $\frac{1}{4}$（或 25%）。

練習 3

紅綠色盲是一種由 X 染色體上的隱性等位基因引起的遺傳病。陳先生色覺正常，而陳太太是紅綠色盲等位基因的帶基因者。他們準備生育一名孩子。

利用遺傳圖解，預測誕下患上紅綠色盲男嬰的機會率。

假設 B 代表色覺正常的等位基因，b 代表紅綠色盲的等位基因。



誕下患上紅綠色盲男嬰的機會率是 $\frac{1}{4}$（或 25%）。