Sex determination

4.6.1.8 · Inheritance, variation and evolution · revision notes

Human body cells have 23 pairs of chromosomes, and one pair decides sex: XX is female and XY is male. You need to draw a genetic cross to show how sex is inherited and explain why the chance of a boy or a girl is always 0.5.

Key facts

- Human body cells: 23 pairs of chromosomes
- Female = XX; male = XY
- XX × XY → XX, XX, XY, XY → 1 : 1 female : male
- 22 pairs control characteristics only; 1 pair are the sex chromosomes
- Eggs: all X. Sperm: half X, half Y
- Probability of a boy (or a girl) = 0.5 for every child

Notes

Chromosomes and sex

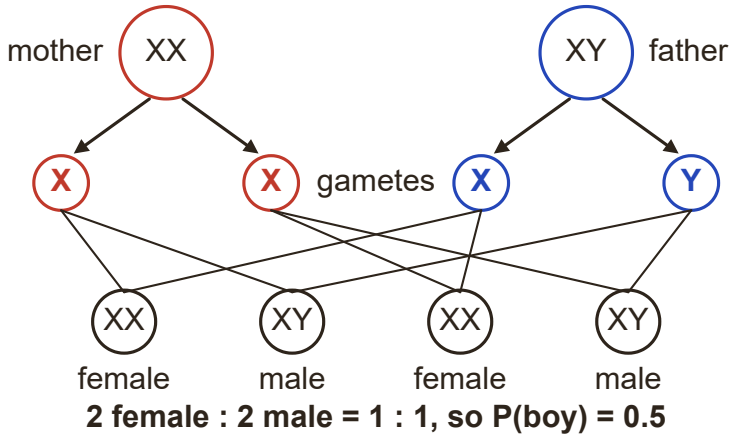
- Ordinary human body cells contain **23 pairs** of chromosomes (46 in total).
- **22 pairs** control characteristics only.
- **One pair** carries the genes that determine sex. These are the **sex chromosomes**.
- In **females** the sex chromosomes are the same: **XX**.
- In **males** the sex chromosomes are different: **XY**.

Gametes

- A gamete has one chromosome from each pair, so it has one sex chromosome.
- All **egg cells** contain an **X** chromosome.
- Half of all **sperm cells** contain an **X** chromosome and half contain a **Y** chromosome.

The genetic cross

- Put the mother's gametes (X and X) along one side of a Punnett square and the father's gametes (X and Y) along the other.
- The offspring are XX, XX, XY and XY: 2 female and 2 male, a ratio of 1 : 1.



The father's sperm (X or Y) decides the sex of the baby.

- So the probability of a boy is 0.5 (50%), and the probability of a girl is also 0.5.
- The probability is 0.5 for every child, however many boys or girls a family already has.
- The sex of the baby depends on whether the egg is fertilised by a sperm carrying an X or a Y chromosome.

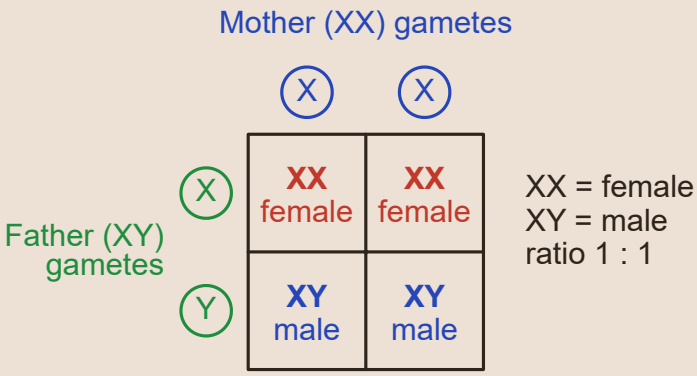
How to answer each type of question

Complete a genetic cross to show sex inheritance 2 to 3 marks **Grade 5**

1. Mother's gametes: X and X. Father's gametes: X and Y.
2. Fill in the four boxes.
3. Label XX as female and XY as male.

Example. Complete a Punnett square to show how sex is inherited in humans. Label each offspring as male or female. [3 marks]

Model answer.



Correct gametes: X and X from the mother, X and Y from the father (1). Offspring XX, XX, XY, XY (1). XX labelled female and XY labelled male (1).

Give a probability or ratio

1 to 2 marks | Grade 5

1. From the cross, 2 of the 4 boxes are male.
2. Probability = 0.5, 50% or ½; ratio 1 : 1.
3. Each fertilisation is a separate event, so earlier children make no difference.

Example. A couple have three daughters. They are expecting a fourth child.
What is the probability that the fourth child will be a boy? Explain your answer. [2 marks]

Model answer. 0.5 / 50% / ½ (1). Half of the father's sperm carry a Y chromosome and each fertilisation is a separate event, so the earlier children do not affect the chance (1).

Explain how sex is determined

2 marks | Grade 7

1. Give the sex chromosomes: XX female, XY male.
2. Eggs all carry X; sperm carry X or Y.
3. So the sex depends on which type of sperm fertilises the egg.

Example. Explain why the sex of a baby is determined by the sperm and not by the egg. [2 marks]

Model answer. All egg cells contain an X chromosome (1). A sperm cell can contain either an X or a Y chromosome, so the sperm decides whether the baby is XX (female) or XY (male) (1).

Don’t lose marks

- Saying human body cells have 23 chromosomes (that is a gamete) or 46 pairs. Body cells have 23 pairs (46 chromosomes).
- Putting a Y in the mother's gametes. Only males have a Y chromosome.
- Thinking a family with several girls is 'due' a boy. The probability is still 0.5.
- Saying only males have sex chromosomes. Both sexes have a pair; they are XX or XY.

More tips

Memory tricks

- Y is for guY: the Y chromosome makes a male.
- Mum can only give an X; Dad gives an X or a Y, so the sperm decides.
- The sex cross always gives 1 : 1, so any 'boy or girl' probability is 0.5.

Exam technique

- Draw the Punnett square neatly and label the gametes; each part carries marks.
- In 'explain' questions, link the chromosomes to the gametes (eggs X; sperm X or Y), not just 'it is random'.
- Give probabilities as 0.5, 50%, ½ or '1 in 2', not as a ratio.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State the number of chromosome pairs

Ordinary human body cells contain 23 pairs of chromosomes.

Grade 4

Give the sex chromosomes of each sex

Females are XX; males are XY.

Grade 5

State what the other 22 pairs do

22 pairs control characteristics only; one pair carries the genes that determine sex.

Grade 5

Draw a genetic cross for sex

XX × XY in a Punnett square gives XX, XX, XY, XY.

Grade 5

Explain the 0.5 chance of a boy

All eggs carry an X chromosome and half of sperm carry X, half carry Y.

Grade 7

Explain why the sperm determines sex

Eggs always carry X, so the sex depends on whether the sperm carries an X or a Y.

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