3.2 Inheritance and evolution

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **inheritance, variation and evolution** 、 : DNA, genes and alleles, genetic crosses and family pedigrees, sex determination, mitosis and meiosis, mutation, and natural selection.

You must be able to:

- use the terms gene, allele, dominant, recessive, homozygous and heterozygous
- complete a genetic cross and give probabilities and ratios
- interpret a family pedigree
- explain natural selection and antibiotic resistance

1 Key knowledge and worked examples

Genes and inheritance

idea	rule
gene	a section of DNA that codes for a protein
allele	one form of a gene, e.g. F or f
dominant / recessive	a dominant allele shows when one copy is present; a recessive allele shows only with two copies
homozygous / heterozygous	two identical alleles (FF or ff) / two different alleles (Ff)
genotype / phenotype	the alleles present / the feature that shows
natural selection	variation; competition; the best adapted survive and reproduce; they pass on their alleles

Worked example 1: a cross. Two heterozygous pea plants, $Tt \times Tt$ (T = tall). Find the ratio of tall to short.

1. Known: each parent gives T or t.
2. Rule: list all offspring: TT, Tt, Tt, tt.
3. Numbers: 3 tall, 1 short.
4. Result: 3 : 1 (a probability of 0.25 for short).

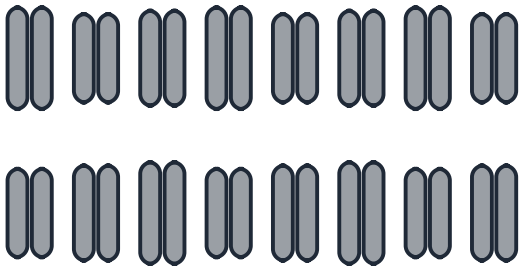
Worked example 2: expected numbers. A cross gives a 3 : 1 ratio and 240 seeds. How many are expected to show the recessive feature?

1. Known: 1 in every 4.
2. Rule: total × fraction.
3. Numbers: $240 \times \frac{1}{4}$.
4. Result: 60 **seeds**.

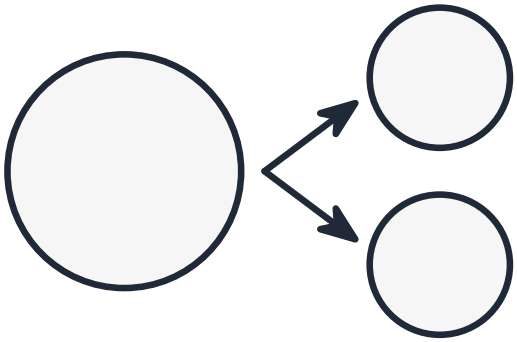
Answer shapes: show the parents' gametes and a Punnett square before you give a ratio.

2 Practice

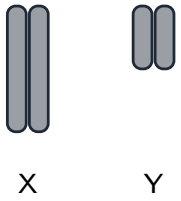
2.1 State the number of chromosomes in a human body cell and in a human egg cell. [2]



2.2 Give **two** differences between mitosis and meiosis. [2]



2.3 Explain why there is a 50% chance that a baby will be a boy. [2]

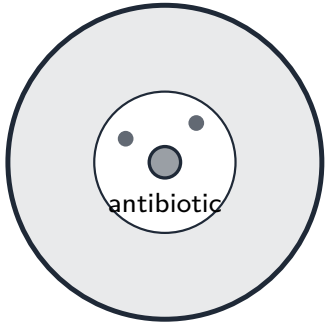


2.4 Define the term mutation, and give **one** factor that makes mutations more likely. [2]

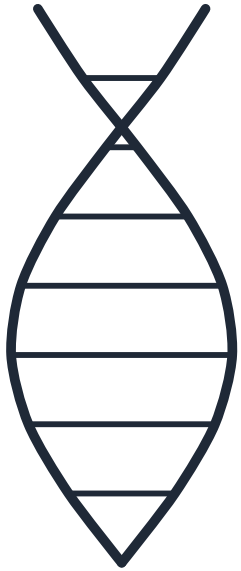


3 Exam-style questions

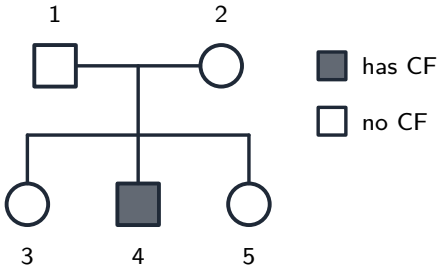
3.1 Explain how a population of bacteria becomes resistant to an antibiotic. [3]



3.2 Describe the structure of DNA. [3]



3.3 Cystic fibrosis (CF) is caused by a recessive allele, f. The dominant allele is F. The family pedigree is shown.



(a) Give the genotypes of parents 1 and 2, and explain how you know. [3]

(b) Draw a Punnett square for parents 1 and 2, and give the probability that their next child will have CF. [4]

(c) In one country, 1 person in 25 carries the CF allele. Calculate the number of carriers expected in a town of 50 000 people. [3]

(d) Children 3, 4 and 5 have the same parents but are all different. Explain how meiosis and fertilisation produce this variation. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- body cell: 46
- egg cell: 23

2.2

Any two (1 mark each):

- mitosis gives two cells; meiosis gives four
- mitosis cells are diploid; meiosis cells are haploid
- mitosis cells are identical; meiosis cells are genetically different
- mitosis is for growth and repair; meiosis makes gametes

2.3

- the mother's eggs all carry an X; half the father's sperm carry X and half carry Y
- so half the zygotes are XY (boy) and half XX (girl)

2.4

- a rare, random change in the DNA (genetic material)
- ionising radiation (or certain chemicals, e.g. in tobacco smoke)

3.1

- a random mutation gives some bacteria resistance
- the antibiotic kills the bacteria that are not resistant; the resistant ones survive
- the resistant bacteria reproduce and pass on the allele, so resistance becomes common

3.2

- two strands twisted into a double helix
- the strands are joined by pairs of bases
- A pairs with T and C pairs with G

3.3

(a) both Ff; child 4 has CF, so is ff and got one f from each parent; the parents do not have CF, so each also has an F

(b) gametes F, f from each parent; offspring FF, Ff, Ff, ff; ff is 1 in 4; probability **0.25** or 25%

(c) $\frac{1}{25}$ of the town; $50\,000 \div 25 = \mathbf{2000}$

(d) points to include:

- each parent has two alleles of every gene, one on each chromosome of a pair (K)
- in meiosis the chromosome pairs separate, so each gamete gets only one of each pair (K)
- the chromosomes are shared out randomly, so each gamete has a different mix of alleles (An)
- fertilisation is random: any sperm can fuse with any egg (K)
- so each zygote gets a new combination of alleles from the two parents (An)
- this explains why child 4 has CF (ff) while 3 and 5 do not (App)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.