Unit 3 · Genetics

ANSWER KEY · FOR TEACHERS

Full marks 40

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

K · 4

1. chromatid
2. centromere
3. kinetochores
4. telomeres
5. satellite
6. locus
7. allele
8. genotype

Each carries 0.5 mark.

2 Label the diagram

K · 2

1. kinetochore
2. chromatid
3. centromere (primary constriction)
4. long arm (q)

Each carries 0.5 mark.

3 Multiple choice

i. **b.** centromere — K · 1

The **centromere** (primary constriction) joins the sister chromatids until anaphase, when they are pulled apart.

ii. **d.** telocentric — U · 1

Humans have metacentric, submetacentric and acrocentric chromosomes, but **no telocentric** ones; the house mouse's chromosomes are nearly all of that kind.

iii. **b.** William Bateson — K · 1

Bateson named the subject in 1905. Johannsen named the gene (1909); Mendel worked out its first rules; Morgan placed a gene on a chromosome.

iv. **b.** locus — K · 1

A gene's place is its **locus**. An allele is one form of a gene, and the kinetochore and centromere are parts of the chromosome.

v. **b.** Sutton and Boveri — K · 1

Sutton and Boveri (1902–1903) saw that chromosomes behave as Mendel's factors do. Watson and Crick found DNA's structure (1953); Tjio and Levan counted 46 human chromosomes (1956).

4 Match the columns

K · 3

1. metacentric → **c.** arm ratio 1 to 1.7, V-shaped
2. submetacentric → **a.** arm ratio 1.7 to 3, L-shaped
3. acrocentric → **d.** arm ratio over 3, J-shaped
4. telocentric → **g.** no short arm, I-shaped
5. autosome → **f.** carries genes for the body's characters
6. sex chromosome → **b.** decides the sex of the individual

Each carries 0.5 mark.

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5 Very short answers

a. MARKING SCHEME — K · 1

✓ Mendel.

b. MARKING SCHEME — U · 1

✓ 22.

c. MARKING SCHEME — U · 1

✓ 44 + XX and 44 + XY.

6 Short answers

a. MARKING SCHEME — U · 2

✓ At metaphase they are at their most tightly coiled, short, thick and clearly visible.

✓ They line up in one plane in the middle of the cell, so they can be counted (in a nondividing nucleus the chromatin is only a tangled network).

b. MARKING SCHEME — U · 2

✓ The zygote gets one set from the sperm and one from the egg, so each chromosome has a homologous partner.

✓ All body cells are made from the zygote by mitosis, which copies the chromosomes exactly.

c. MARKING SCHEME — U · 2

✓ A gene is a segment of DNA; a chromosome is a whole DNA molecule with its proteins, carrying many genes.

✓ A gene can't be seen under a light microscope; a chromosome can, at cell division.

d. MARKING SCHEME — A · 2

✓ Environmental variation.

✓ Not inherited, because it changed his body and not his genes.

7 Long answer

ANSWER — U · 4

1. A gene is a segment of the DNA of a chromosome; a chromosome is one long DNA molecule with its proteins.
2. Each chromosome carries many genes (hundreds to thousands), arranged in a line, each at its own fixed place, its locus.
3. Chromosomes come in homologous pairs, one from each parent, and the two of a pair carry the same genes at the same loci, so genes too come in pairs; the two may be the same allele or different ones.
4. When gametes form, the two chromosomes of each pair separate, taking their genes with them, so each gamete gets one gene of each pair; at fertilization the pairs are made again.

MARKING SCHEME

✓ A gene is a segment of the DNA of a chromosome, which is one long DNA molecule with its proteins.

✓ A chromosome carries many genes in a line, each at its own locus.

✓ Homologous chromosomes carry the same genes at the same loci, so genes come in pairs.

✓ When gametes form, the chromosomes of each pair separate, taking their genes; fertilization makes the pairs again.

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8 Working it out

a. ANSWER A · 3

$$p + 2.5p = 7\ \mu\text{m} \quad \text{so} \quad 3.5p = 7\ \mu\text{m}, \quad p = 2\ \mu\text{m}$$

Long arm $q = 2.5 \times 2 = 5\ \mu\text{m}$.
The arms are 2 µm and 5 µm. An arm ratio of 2.5 lies between 1.7 and 3, so it is **submetacentric**, L-shaped at anaphase.

MARKING SCHEME
- ✓ $p + 2.5p = 7$, so $p = 2\ \mu\text{m}$.
- ✓ $q = 5\ \mu\text{m}$.
- ✓ Submetacentric.

b. ANSWER A · 2

$p = 5.5\ \mu\text{m}$, $q = 12 - 5.5 = 6.5\ \mu\text{m}$.

$$\text{arm ratio} = \frac{6.5}{5.5} = 1.18$$

Less than 1.7, so it is **metacentric** (the arms are nearly equal), V-shaped at anaphase.

MARKING SCHEME
- ✓ Arm ratio $= 6.5 \div 5.5 = 1.18$.
- ✓ Less than 1.7: metacentric.

c. ANSWER A · 3

Autosomes in a body cell $= 78 - 2 =$ **76** (38 pairs).
A sperm is haploid: $78 \div 2 =$ **39** chromosomes, which are 38 autosomes and **one sex chromosome, X or Y**.

MARKING SCHEME
- ✓ $78 - 2 = 76$ autosomes.
- ✓ A sperm has 39 chromosomes.
- ✓ These are 38 autosomes and one sex chromosome, X or Y.

9 Think

ANSWER HA · 3

The cell still has **46 chromosomes**. Each has been copied into two sister chromatids held by one centromere, so there are $46 \times 2 =$ **92 chromatids** and **46 centromeres**.

MARKING SCHEME
- ✓ 46 chromosomes: each is still one chromosome, now copied.
- ✓ 92 chromatids, two to each chromosome.
- ✓ 46 centromeres, one holding each pair of sister chromatids.

10 Activity: Hang a clay chromosome

(not marked)

WHAT STUDENTS SHOULD FIND

Arms 6 and 6 cm, ratio 1, metacentric, V. Arms 4 and 8 cm, ratio 2, submetacentric, L. Arms 2 and 10 cm, ratio 5, acrocentric, J. No short arm, telocentric, a straight rod, I. With the same length for all four, it is the arm ratio, not the size, that tells the types apart.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	14	13	10	3	**40**

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