Unit 8 · Mendelian Genetics

ANSWER KEY · FOR TEACHERS

Full marks 32

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

1 Key words

1. alleles
2. locus
3. homozygous
4. genotype
5. phenotype
6. emasculation
7. incomplete dominance
8. codominance

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. tall, TT
2. F_1 selfed: Tt × Tt
3. 3 tall : 1 dwarf
4. dwarf, tt
5. all tall, Tt
6. tt dwarf

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **b.** it is heterozygous; its genotype is Tt and its phenotype is tall — K · 1

Tt is the **genotype** (the alleles), and it has two different alleles, so the plant is **heterozygous**. Its **phenotype** (what it looks like) is tall, because T is dominant. It isn't pure-breeding: half its gametes carry t, so some of its offspring can be dwarf.

ii. **c.** TP, Tp, tP and tp — U · 1

Each gamete gets **one allele of each gene** (segregation), and which allele of the first gene goes with which of the second is a matter of chance (independent assortment): so **TP, Tp, tP and tp**, a quarter each. A gamete never carries two alleles of the same gene, so Tt or TT can't be gametes.

iii. **b.** 1/3 — U · 1

The F_2 is 1 TT : 2 Tt : 1 tt. Of the **three** tall plants in every four, only **one** is TT: so 1/3 of the tall plants breed true, and 2/3 are hybrids. (A quarter of **all** the F_2 plants are TT, a tempting wrong answer.) Mendel tested this by selfing tall F_2 plants: about a third gave only tall offspring.

iv. **c.** pink × pink — A · 1

Rr × Rr gives 1 RR (red) : 2 Rr (pink) : 1 rr (white). Red × pink gives 1 red : 1 pink, pink × white gives 1 pink : 1 white, and red × white gives all pink.

v. **c.** codominance — A · 1

The calf shows **both** parents' characters, each in full (whole red hairs and whole white hairs), not a color in between: that is **codominance**. (If every hair were pink, it would be incomplete dominance.)

4 Short answers

a. MARKING SCHEME — K · 2

- ✓ Alleles stay unmixed in the hybrid but separate in gamete formation, one to each gamete.
- ✓ So each gamete is pure (one allele, unblended).

b. MARKING SCHEME — U · 2

- ✓ Two correct reasons (e.g. contrasting characters, self-pollinating).
- ✓ Two more (e.g. short life cycle, many seeds).

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c. MARKING SCHEME A · 2

- ✓ Both parents Bb.
- ✓ Punnett square giving bb in 1 of 4 (25 %).

d. MARKING SCHEME U · 3

- ✓ Peas: F_1 all tall; F_2 3 : 1 (genotypes 1 : 2 : 1).
- ✓ Mirabilis: F_1 pink; F_2 1 red : 2 pink : 1 white, phenotypes = genotypes.
- ✓ Pure parents reappear, so the alleles don't blend.

5 Numerical problem

ANSWER A · 4

P: RRYY × rryy; F_1: all **RrYy**, round yellow, making RY, Ry, rY, ry in equal numbers. The F_2 (16 boxes) is 9 : 3 : 3 : 1.

- round yellow 9/16 × 640 = **360**; round green 3/16 × 640 = **120**; wrinkled yellow **120**; wrinkled green 1/16 × 640 = **40**.
- RRYY is 1 box in 16: 640 ÷ 16 = **40**.

MARKING SCHEME

- ✓ F_1 RrYy and its four kinds of gamete.
- ✓ F_2 ratio 9 : 3 : 3 : 1.
- ✓ 360 : 120 : 120 : 40.
- ✓ 40 RRYY.

6 Long answer

ANSWER U · 4

Law: when two or more pairs of contrasting characters are inherited together, each pair is inherited **independently** of the others: alleles of different genes go into gametes at random.
Cross pure **tall purple** (TTPP) with **dwarf white** (ttpp): the F_1 is all **TtPp**, tall purple.
Each F_1 plant makes **four kinds of gametes** in equal numbers, **TP, Tp, tP, tp**, and selfing gives 4 × 4 = 16 combinations.
F_2: **9 tall purple : 3 tall white : 3 dwarf purple : 1 dwarf white**. Tall white and dwarf purple are **new combinations**, and each pair alone still gives 3 : 1 (12 : 4), so the two pairs were sorted independently.

MARKING SCHEME

- ✓ Statement: each pair of characters inherited independently.
- ✓ P TTPP × ttpp; F_1 TtPp.
- ✓ Four kinds of gametes, 16 combinations.
- ✓ F_2 9 : 3 : 3 : 1, with new combinations.

7 Think

ANSWER HA · 3

Cross the tall plant with a **dwarf (tt)** plant (a test cross: the dwarf can give only t).
If the tall plant is **TT**, every gamete carries T, so **all offspring are tall** (Tt).
If it is **Tt**, half its gametes carry t, so about **half the offspring are dwarf** (1 tall : 1 dwarf). Even one dwarf offspring shows it is Tt.

MARKING SCHEME

- ✓ Cross it with a dwarf (tt) plant.
- ✓ All tall offspring: the plant is TT.
- ✓ About half dwarf (1 : 1): the plant is Tt.

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8 Activity: Mendel's ratios with coins

(not marked)

WHAT STUDENTS SHOULD FIND

Your own 40 tosses rarely give exactly 30 : 10 (27 : 13 or 32 : 8 is normal). The class's totals come closer to **3 : 1**, because chance evens out only in large numbers, which is why Mendel counted thousands of plants.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	10	11	8	3	**32**

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