# Unit 3 · Genetics

**ANSWER KEY · FOR TEACHERS**

Full marks 47

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. dihybrid
2. test
3. purines
4. phosphodiester
5. N-glycosidic
6. antiparallel
7. anticodon
8. hemizygous

K · 4

Each carries 0.5 mark.

## 2 Complete the checkerboard

**MARKING SCHEME** A · 3

✓ 1 RrYy and 2 RRyy.
✓ 3 RrYY and 4 rrYy.
✓ 5 Rryy and 6 rryy.

## 3 Multiple choice

**i.** **b.** 9 K · 1

Each gene gives three genotypes (RR, Rr, rr and YY, Yy, yy), and $3 \times 3 = \mathbf{9}$. There are 16 boxes, but several boxes hold the same genotype; there are 4 phenotypes.

**ii.** **c.** cytosine K · 1

**Cytosine**, like thymine and uracil, has one ring: a pyrimidine. Adenine and guanine have two rings: purines.

**iii.** **b.** tRNA K · 1

**Transfer RNA** carries an amino acid on its CCA end and matches it to the codon by its anticodon.

**iv.** **b.** all carriers with normal vision U · 1

Every daughter gets her father's only X, which carries the allele, and a normal X from her mother: a carrier with normal vision.

**v.** **b.** holandric genes K · 1

Y-linked genes are **holandric**, passed only from father to son. Pseudoautosomal genes are in the parts the X and Y share.

## 4 Very short answers

**a.** **MARKING SCHEME** K · 1

✓ 1 : 1 : 1 : 1.

**b.** **MARKING SCHEME** K · 1

✓ Three.

**c.** **MARKING SCHEME** K · 1

✓ Uracil (U).

**d.** **MARKING SCHEME** U · 1

✓ He gives his son his Y, not his X.



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## 5 Short answers

**a.** MARKING SCHEME U · 2

- ✓ The alleles for shape and for color separate independently, so the $F_1$ also makes the gametes Ry and rY.
- ✓ These give round green and wrinkled yellow seeds, which neither grandparent had.

**b.** MARKING SCHEME U · 2

- ✓ The strands separate, and each old strand is the template for a new one.
- ✓ Each daughter molecule has one old and one new strand.

**c.** MARKING SCHEME U · 2

- ✓ A man has one X, so a single recessive allele affects him.
- ✓ A woman needs two; with one she is only a carrier, and two are much less likely than one.

**d.** MARKING SCHEME U · 2

- ✓ Any one difference, e.g. DNA's sugar is deoxyribose; RNA's is ribose.
- ✓ Any second difference, e.g. DNA has T and two strands; RNA has U and usually one strand.

**e.** MARKING SCHEME U · 2

- ✓ mRNA carries a gene's code from the DNA to the ribosome, as the template for a protein.
- ✓ rRNA builds the ribosome and joins the amino acids into a chain.

## 6 Long answers

**a.** MARKING SCHEME U · 4

- ✓ Two polynucleotide strands in a right-handed double helix; each nucleotide is a phosphate, deoxyribose and a base.
- ✓ Sugar–phosphate backbone outside; bases inside.
- ✓ A with T by two hydrogen bonds, G with C by three; the strands antiparallel.
- ✓ About 2 nm wide, 0.34 nm per base pair, about 10 base pairs (3.4 nm) a turn.

**b.** ANSWER U · 4

**Sex-linked inheritance** is the inheritance of characters whose genes lie on the sex chromosomes.

1. **X-linked genes:** on the part of the X with no partner on the Y. Women have two copies, men one. Examples: color blindness, hemophilia.
2. **Y-linked (holandric) genes:** on the part of the Y with no partner on the X. They pass only from father to every son. Example: SRY, the gene that makes an embryo male.
3. **XY-linked (incompletely sex-linked) genes:** in the pseudoautosomal regions shared by the X and Y, where they cross over; inherited almost like autosomal genes. Example: SHOX, needed for the growth of the arm and leg bones.

MARKING SCHEME

- ✓ Sex-linked inheritance: the inheritance of characters whose genes lie on the sex chromosomes.
- ✓ X-linked: part of the X with no partner on the Y; color blindness or hemophilia.
- ✓ Y-linked (holandric): part of the Y with no partner on the X; SRY.
- ✓ XY-linked: the pseudoautosomal regions shared by both; SHOX.

## 7 Numerical problems

**a.** ANSWER A · 3

a. Tall white is 3 in 16: $\frac{3}{16} \times 800 = \mathbf{150\ plants}$.

b. Dwarf white (ttpp) is 1 in 16: $\frac{1}{16} \times 800 = \mathbf{50\ plants}$.

c. Pure for both genes: TTPP, TTpp, ttPP and ttpp, 4 boxes in 16: $\frac{4}{16} \times 800 = \mathbf{200\ plants}$.

MARKING SCHEME

- ✓ $3/16 \times 800 = 150$ tall with white flowers.
- ✓ $1/16 \times 800 = 50$ dwarf with white flowers.
- ✓ $4/16 \times 800 = 200$ pure for both.


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**b.** ANSWER A · 2

6.8 μm = 6,800 nm.

$$\text{base pairs} = \frac{6800\ \text{nm}}{0.34\ \text{nm}} = 20{,}000$$

Turns = 20,000 ÷ 10 = **2,000**. It has **20,000 base pairs** and **2,000 turns**.

MARKING SCHEME

✓ 6,800 nm ÷ 0.34 nm = 20,000 base pairs.

✓ 20,000 ÷ 10 = 2,000 turns.

**c.** ANSWER A · 2

$$2x + 3(500 - x) = 1300 \quad \Rightarrow \quad 1500 - x = 1300 \quad \Rightarrow \quad x = 200$$

**200 A–T pairs and 300 G–C pairs.** Check: 200 × 2 + 300 × 3 = 400 + 900 = 1,300.

MARKING SCHEME

✓ 2x + 3(500 − x) = 1300.

✓ 200 A–T pairs and 300 G–C pairs.

**d.** ANSWER A · 3

a. Her father gave her his $X^c$; her vision is normal, so she is a carrier, $X^cX$. The man is $X^cY$.

b. Their children are $X^cX^c$, a color-blind daughter; $X^cX$, a carrier daughter; $X^cY$, a color-blind son; and XY, a normal son. **Half the sons** and **half the daughters** are expected to be color-blind.

MARKING SCHEME

✓ The woman is $X^cX$ and the man $X^cY$.

✓ The checkerboard of their children drawn correctly.

✓ Half the sons and half the daughters are color-blind.

## 8 Think

ANSWER HA · 3

The double recessive parent (rryy) gives only r and y.

- **Shape:** all 101 seeds are round, so the plant gave R every time: it is **RR**.
- **Color:** 52 yellow : 49 green ≈ 1 : 1, so it gave Y and y equally: it is **Yy**.

The plant is **RRYy**. Check: RRYy makes the gametes RY and Ry equally, which with ry give RrYy (round yellow) and Rryy (round green), 1 : 1.

MARKING SCHEME

✓ All the seeds are round, so the plant gave R every time: RR.

✓ Yellow and green about 1 : 1, so it gave Y and y equally: Yy.

✓ The plant is RRYy.

## 9 Activity: Mendel's dihybrid cross with beans (Practical 7)

(not marked)

WHAT STUDENTS SHOULD FIND

Expected out of 64: 36, 12, 12 and 4. Real counts wander: a count of 36 can easily come out from about 30 to 42, and the wrinkled green count from 1 to 8. Adding the whole class's results brings the ratio closer to 9 : 3 : 3 : 1.

| Marks by level | Knowledge | Understanding | Application | Higher ability | Total |
|---|---|---|---|---|---|
| **Marks** | 11 | 20 | 13 | 3 | **47** |



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