Solutions

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

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

2.1

$q^2 = \frac{1}{10\,000}$, so $q = \frac{1}{100}$

carriers $= 2pq = 2 \times 0.99 \times 0.01$

≈ 0.02, about **1 in 50**

2.2

$1 \times \frac{1}{25} \times \frac{1}{4}$

$= \frac{1}{100}$

2.3

any three of: random mating; a large population; no selection; no migration; no new mutations

2.4

$q = 0.08$, the fraction of affected men

women $= q^2 = 0.0064$, about **0.6%**

3.1

(a) carriers $\approx 2q = \frac{1}{30}$, so $q = \frac{1}{60}$

(b) $q^2 = \frac{1}{3600}$

(c) $\frac{1}{30} \times \frac{1}{30} \times \frac{1}{4} = \frac{1}{3600}$

(d) founder effect: the small group that began the community had the allele; carrier couples can be found before pregnancy and offered choices such as prenatal or embryo testing

3.2

(a) $\frac{1}{8}$

(b) the cousin carries the same allele with chance $\frac{1}{8}$, so risk $= \frac{1}{8} \times \frac{1}{4} = \frac{1}{32}$

(c) unrelated: $\frac{1}{200} \times \frac{1}{4} = \frac{1}{800}$; $800 \div 32 =$ **25 times** higher

3.3

(a) $q^2 = 0.0025$, 1 in 400

(b) $2pq = 2 \times 0.95 \times 0.05 = 0.095$, about 1 in 10

(c) **250**

(d) carriers are protected from severe malaria, so they survive and have more children, keeping the allele common (heterozygote advantage)

(e) mating is not random; relatives share alleles, so more children get two copies (more homozygotes)

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