Solutions

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

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

2.1

substitution: one base is replaced by another; deletion: a base is removed, shifting the reading frame

2.2

a substitution changes only one codon, and may not change the amino acid (degenerate code); a deletion shifts the reading frame (frameshift); every codon after it changes, so many amino acids change / an early stop codon appears

2.3

it is a somatic mutation, not in a germ-line cell / gamete, so it is not passed to offspring; if it affects a gene that controls cell division; the cell can divide uncontrollably, forming a tumour / cancer

2.4

a guide RNA is made to match the target DNA sequence; Cas9 is guided to that sequence and cuts the DNA; the cell repairs the cut, which can disable the gene or insert a new sequence

2.5

they code for vital functions, e.g. histones / ribosomal RNA; most mutations in them are harmful; so individuals with those mutations die / do not reproduce, and natural selection removes them

3.1

(a) Met–Phe–Ala–Lys

(b) ATG TTT GAA AA…: codons AUG UUU GAA A…; Met–Phe–Glu: every codon after the deletion changes, so Ala and Lys are lost: a frameshift

(c) UAA is a stop codon; translation stops early, so the protein is shorter and probably does not work

(d) any one: X-rays / gamma rays / UV light / chemicals in tobacco smoke

3.2

(a) the more cigarettes per day, the higher the risk (positive correlation)

(b) tobacco smoke contains mutagens / carcinogens; these cause mutations in the DNA of lung cells; mutations in genes that control cell division make cells divide uncontrollably, forming a tumour

(c) mutation creates new alleles; this gives the genetic variation on which natural selection acts