

Solutions

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

2.1

- any two: identical to human insulin; never in short supply; fewer allergic reactions; no risk of animal-borne infection; no ethical objection from using animals

2.2

- any one: breast cancer (BRCA1/BRCA2); Huntington's disease; cystic fibrosis

3.1 B

- Gene therapy adds a working copy of the gene to the patient's cells

3.2 B

- Engineered bacteria make insulin identical to human insulin, in unlimited supply

3.3

(a)

- it lets the person know their risk before symptoms appear, so they can make informed choices about treatment, monitoring or having children

(b)

- e.g. results could be misused by insurers/employers, or cause anxiety / there is no cure for Huntington's

3.4

- a working copy of the faulty gene is inserted into the child's cells; the cells then make the missing protein, restoring immune function

3.5

(a)

- The mRNA for insulin is taken from human pancreatic cells and **reverse transcriptase** is used to make a complementary DNA copy of the gene; alternatively the gene is cut from the genome with a **restriction endonuclease**, which leaves sticky ends; a **plasmid** vector is cut with the same enzyme so its sticky ends are complementary; the gene and plasmid are joined by **DNA ligase**; the recombinant plasmid is then taken up by the bacterium, for example after treatment with calcium ions and heat shock

(b)

- Only a small proportion of bacteria take up the plasmid, so the transformed cells must be identified. A marker gene — for antibiotic resistance or for a fluorescent protein — is carried on the same plasmid; growing the culture on a medium containing that antibiotic, or under UV light, leaves only the transformed bacteria visible or alive

(c)

- It is identical to human insulin, so it works exactly as the body's own does and is far less likely to cause an allergic reaction; it can be produced in unlimited quantity by fermentation, and is acceptable to people whose religion or beliefs forbid animal products

(d)

- **Genetic screening** tests a person, embryo or fetus for alleles causing a genetic condition — it identifies risk but changes nothing; a concern is that the results could be used by insurers or employers to discriminate, or could pressure a couple's reproductive decision. **Gene therapy** inserts a working allele into a patient's cells to treat the condition; somatic therapy affects only that patient, but germ-line therapy would change every future generation, with consequences that cannot be predicted or consented to