2024 Bi H2 Q2

Section: DNA and the Genome

Topic: Mutations

Question Summary

The MSTN gene encodes myostatin, a negative regulator of muscle growth. A mutation in the MSTN sequence is shown for two cattle breeds; you must identify the mutation type, explain its effect on the protein, relate it to muscle mass, and compare pregnancy length and birth mass between beef and dairy breeds.

Worked Solution

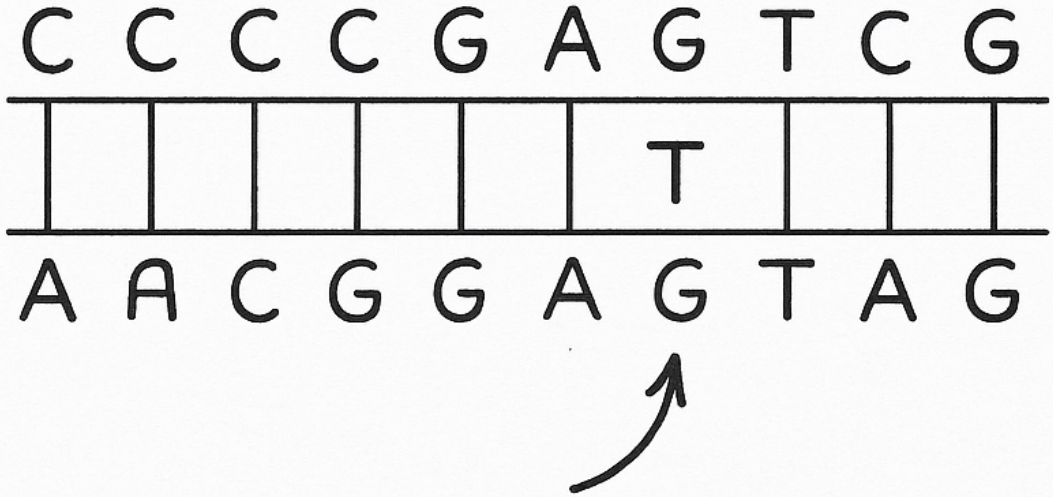
• (a)(i) The change is a **base deletion** (single-nucleotide deletion).
• (a)(ii) A deletion causes a **frameshift**, altering all downstream codons; this is likely to produce a non-functional myostatin protein with a major change in amino-acid sequence and/or a premature stop.
• (b) Myostatin normally *inhibits* muscle growth. If the MSTN protein is non-functional, the inhibition is reduced, so muscle growth increases — hence breed B shows increased muscle mass.
• (c) Comparison: Dairy breeds have a **shorter** average pregnancy length (≈275–280 days) than beef breeds (≈284–285 days), but a **higher** average birth mass (≈36.9–38.2 kg in dairy vs ≈34.6–35.3 kg in beef).

Final Answer

■ (a)(i) Base deletion (frameshift) | (a)(ii) Frameshift changes downstream codons → major change/non-functional protein
■ (b) Reduced myostatin inhibition → increased muscle growth
■ (c) Dairy: shorter pregnancy but higher birth mass than beef

Revision Tips

• Single-nucleotide **deletions/insertions** often cause frameshifts with large effects; substitutions may be silent, missense or nonsense.
• **Myostatin** is a negative regulator: loss of function increases muscle mass.
• When comparing data in tables, state the trend for each group (higher/lower; longer/shorter) with approximate values.



substitution mutation

one base replaced

may change amino acid