Solutions

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

2.1

- a structural gene codes for a (useful) protein such as an enzyme; a regulatory gene controls whether other genes are switched on

2.2

- an enzyme that is made only when it is needed (e.g. when its substrate is present)

3.1 B

- With no lactose, the repressor binds the operator and blocks transcription

3.2 B

- A transcription factor binds DNA and increases or decreases the rate of transcription

3.3

- when no lactose is present, the repressor binds the operator and blocks transcription, so no enzymes are made; when lactose is present, it binds the repressor and removes it from the operator; transcription can now occur, so the lactose-digesting enzymes are made

3.4

- gibberellin causes the breakdown of DELLA protein repressors; these normally block the transcription factors, so removing them lets the genes be transcribed/expressed

3.5

(a)

- A structural gene codes for a protein used by the cell — here *lacZ*, coding for β-galactosidase; a regulatory gene codes for a protein that controls the transcription of other genes — here *lacI*, coding for the repressor

(b)

- The regulatory gene is transcribed and the **repressor** protein is made; the repressor binds to the operator region; this blocks RNA polymerase from moving along the structural genes, so no mRNA and no enzyme are made

(c)

- Lactose acts as the **inducer**: it binds to the repressor and changes its shape so that it can no longer bind to the operator; RNA polymerase is then free to transcribe the structural genes and the enzymes are made. They are *inducible* because they are produced only when their substrate is present to switch them on

(d)

- Making enzymes costs amino acids and ATP, so producing them when there is no lactose to digest would be wasteful; the bacterium makes them only when they can be used, which gives it a selective advantage