

22 The gene that codes for protein R is 130 kb long.

Protein R is 220 kDa in mass.

The typical mass of an amino acid is 110 Da.

(1000 base pairs = 1 kb, 1000 Da = 1 kDa)

Which row is correct?

	approximate length of introns in this gene/ base pairs	approximate length of mRNA for this gene/ base pairs
A	6000	6000
B	6000	130 000
C	124 000	6000
D	124 000	130 000

25 The table shows some of the DNA triplet codes for some amino acids.

amino acid	DNA triplet code	amino acid	DNA triplet code
arginine	GCA	glycine	CCA
arginine	GCC	glycine	CCG
arginine	GCG	glycine	CCT
asparagine	TTA	lysine	TTC
asparagine	TTG	lysine	TTT
cysteine	ACA	proline	GGA
cysteine	ACG	proline	GGC
STOP	ATC	valine	CAC

The base sequence on the template DNA strand coding for part of a polypeptide is shown.

CCA TTC ACG GCG TTA GCA

Two mutations occur in this sequence during DNA replication.

Which mutated DNA would result in two different amino acids?

- A** CCA ATC ACG GCG TTG GCA
- B** CCA TTC ACA GCA TTA GCA
- C** CCA TTC ACG CCG TTA GCC
- D** CCA TTC ACG GCG TTC GGA

25 In a gene, the 20 common amino acids are each coded for by three bases in adjacent nucleotides.

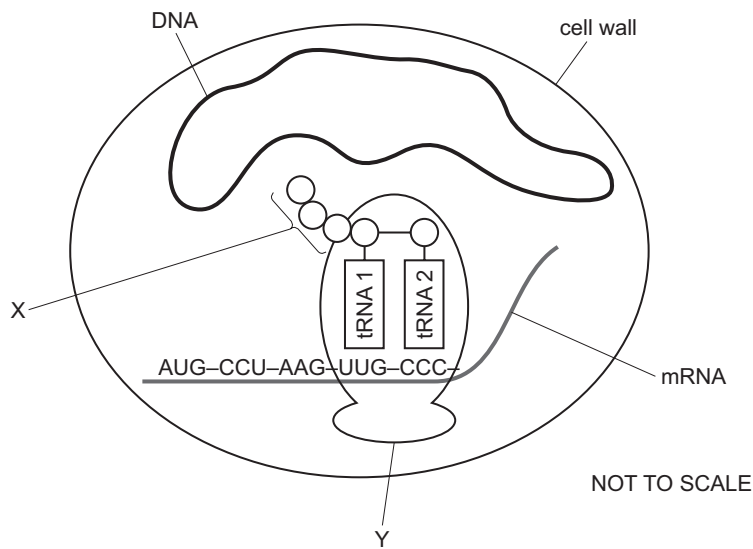
Why is there a difference between the number of amino acids and the number of possible triplet codes?

- A** 44 triplets have **no** functions.
- B** Some amino acids are coded for by more than one triplet.
- C** Some triplets have unknown functions.
- D** There are 44 'start' and 'stop' triplets.

26 How is a primary transcript modified to form mRNA?

- A** It becomes longer as exons are joined together.
- B** It becomes shorter as exons are removed.
- C** It becomes longer as introns are joined together.
- D** It becomes shorter as introns are removed.

27 The diagram shows protein synthesis in a prokaryote.



Which row is correct for molecule X, structure Y and the anticodon of tRNA 1?

	molecule X	structure Y	anticodon of tRNA 1
A	amino acid	80S ribosome	AAC
B	polypeptide	80S ribosome	UUG
C	polypeptide	70S ribosome	AAC
D	protein	70S ribosome	UUG

26 Which statement is correct for protein synthesis?

- A During translation, the strand of DNA used is the template strand.
- B mRNA is formed when introns are removed from the primary transcript.
- C The DNA primary transcript is modified by removing exons.
- D tRNA has codons which attach to anticodons on the mRNA.

27 A mutation occurred in this original DNA nucleotide sequence.

CTAG AATCCTCTCCC

After the mutation occurred, the new DNA nucleotide sequence coded for the amino acids Asp, Leu, Gly and Glu.

The table shows the amino acids that are coded for by each DNA triplet.

		2nd base							
		A		G		T		C	
1st base	A	AAA	Phe	AGA	Ser	ATA	Tyr	ACA	Cys
		AAG	Phe	AGG	Ser	ATG	Tyr	ACG	Cys
		AAT	Leu	AGT	Ser	ATT	Stop	ACT	Stop
		AAC	Leu	AGC	Ser	ATC	Stop	ACC	Trp
	G	GAA	Leu	GGA	Pro	GTA	His	GCA	Arg
		GAG	Leu	GGG	Pro	GTG	His	GCG	Arg
		GAT	Leu	GGT	Pro	GTT	Gln	GCT	Arg
		GAC	Leu	GGC	Pro	GTC	Gln	GCC	Arg
	T	TAA	Ile	TGA	Thr	TTA	Asn	TCA	Ser
		TAG	Ile	TGG	Thr	TTG	Asn	TCG	Ser
		TAT	Ile	TGT	Thr	TTT	Lys	TCT	Arg
		TAC	Met	TGC	Thr	TTC	Lys	TCC	Arg
	C	CAA	Val	CGA	Ala	CTA	Asp	CCA	Gly
		CAG	Val	CGG	Ala	CTG	Asp	CCG	Gly
		CAT	Val	CGT	Ala	CTT	Glu	CCT	Gly
		CAC	Val	CGC	Ala	CTC	Glu	CCC	Gly

Which type of gene mutation occurred in the DNA nucleotide sequence?

- A deletion of one nucleotide
- B insertion of one nucleotide
- C insertion of two nucleotides
- D substitution of one nucleotide

23 Which statements about anticodons are correct?

- 1 The base sequence of an anticodon will always be the same as that of the corresponding triplet on the transcribed DNA strand.
- 2 There are 20 naturally occurring amino acids, so therefore there are only 20 anticodons as each anticodon is specific for only one amino acid.
- 3 The formation of hydrogen bonds between the bases of the anticodon with those of the complementary mRNA codon must occur before the new peptide bond can form.

- A 1, 2 and 3
- B 1 and 2 only
- C 1 and 3 only
- D 3 only

24 Part of a DNA molecule is transcribed to form an RNA molecule that is then modified.

Which row describes the RNA molecule before and after modification?

	before modification	after modification
A	contains exons and introns	contains exons only
B	contains exons and introns	contains introns only
C	contains exons only	contains introns only
D	contains introns only	contains exons only

3 The gene *LCT* codes for the enzyme lactase. In babies, lactase synthesis is necessary for digesting lactose, the sugar found in milk.

Another gene, *MCM6*, has introns that have a regulatory role in the expression of gene *LCT*. Gene *MCM6* codes for a protein that has **no** involvement in lactase synthesis.

As children get older, the *MCM6* introns are responsible for a decrease in lactase synthesis. This decrease in lactase synthesis is known as lactase non-persistence.

(a) *LCT* and *MCM6* are located on the same chromosome in humans.

Suggest differences between gene *LCT* and gene *MCM6*, **other than** their locations in different positions on the same chromosome.

[3]

(b) With reference to the process of lactase synthesis, explain the relationship between:

- a transcribed strand and a primary transcript
- a primary transcript and messenger RNA (mRNA).

[2]

(c) A mutation in a regulatory intron of *MCM6* allows lactase synthesis to continue. This is known as lactase persistence. In this mutation, the number of nucleotides in the intron remains the same, but one of the nucleotides is different to the original nucleotide.

State the type of mutation that is the cause of lactase persistence.

[1]

(d) Fig. 3.1 summarises the reaction catalysed by lactase.

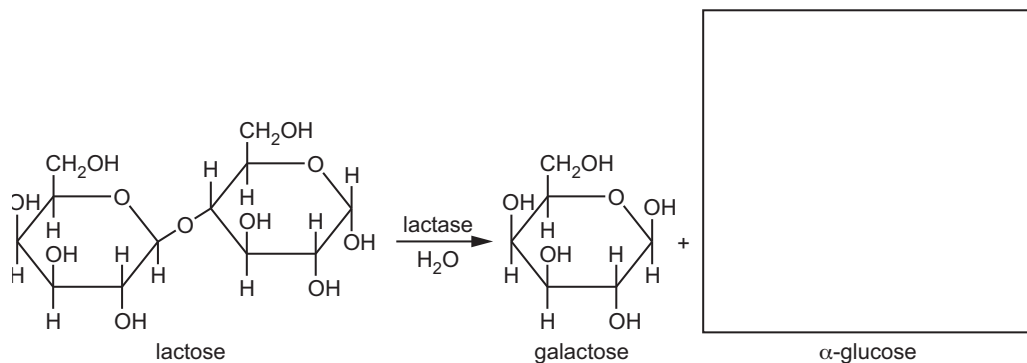


Fig. 3.1

Draw the ring structure of α -glucose in the box provided to complete Fig. 3.1. [1]

(e) Some people with lactase non-persistence may be lactose intolerant. They may have symptoms, such as abdominal pain, if their diet contains lactose.

(i) Lactase supplements (tablets) can be taken before milk or milk-based products are consumed to avoid symptoms of lactose intolerance.

A student compared the activity of two different concentrations of a lactase supplement using an artificial substrate, ONPG, instead of lactose.

A solution of ONPG is colourless, but the hydrolysis of ONPG by lactase releases a coloured product.

The student planned to follow the progress of the reaction for each concentration of lactase using a colorimeter.

Explain why the student chose to use a colorimeter to follow the progress of the reaction for each concentration of lactase.

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[2]

(ii) The lactose in milk can be hydrolysed using immobilised lactase or using lactase free in solution (free lactase). This results in milk and milk products that do not contain lactose and so are suitable for lactose-intolerant people.

Scientists carried out an investigation to compare the activity of lactase immobilised in very small magnetic beads (magnetic microspheres) with free lactase, at different temperatures and at different pH values.

Fig. 3.2 shows the activity of immobilised lactase and the activity of free lactase at 5 different temperatures.

Fig. 3.3 shows the activity of immobilised lactase and the activity of free lactase at 8 different pH values.

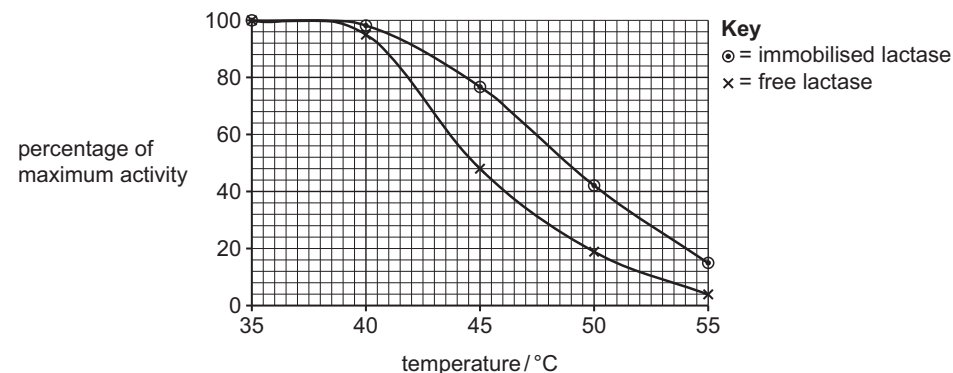


Fig. 3.2

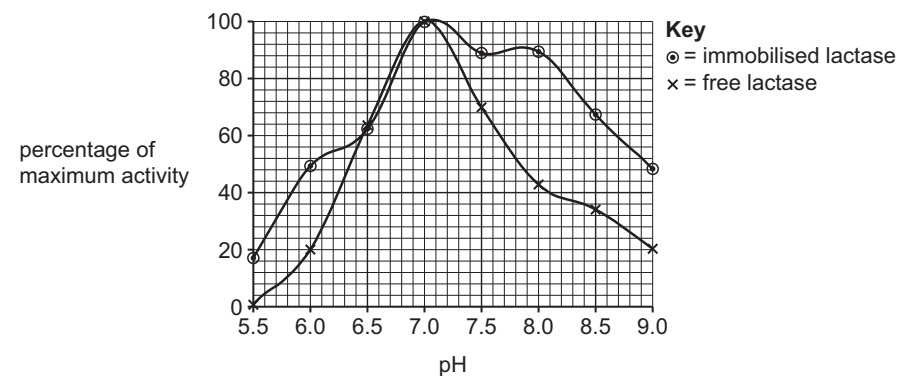


Fig. 3.3

One advantage of using magnetic microspheres with immobilised lactase is that they can be easily recovered using an electric field and reused.

With reference to Fig. 3.2 and Fig. 3.3, explain why the results indicate that there are **other** advantages in using immobilised lactase instead of free lactase to produce lactose-free products.

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[Total: 13]