Question 22 (Answer: **C**)

- The protein has $220\,000/110 = 2000$ amino acids.
- Three bases code for each, so the coding mRNA is about $2000 \times 3 = 6000$ bases.
- The gene is 130 000 base pairs, so roughly $130\,000 - 6000 = 124\,000$ of them are introns.

Question 25 (Answer: **D**)

- Use the table to translate the original sequence, then the mutated one.
- Compare the two amino acid sequences to see which triplet changed.
- The type of mutation follows from whether the reading frame shifted or a single base was swapped.

Question 25 (Answer: **B**)

- Three bases give $4^3 = 64$ possible triplets for only 20 amino acids.
- Most amino acids are coded for by more than one triplet – the code is degenerate.
- The spare triplets are not useless: three of them are stop signals.

Question 26 (Answer: **D**)

- The primary transcript contains both exons and introns.
- The introns are cut out and the exons are joined together.
- Removing material makes the molecule shorter, so mRNA is shorter than the primary transcript.

Question 27 (Answer: **C**)

- In a prokaryote there is no nucleus, so transcription and translation happen together in the cytoplasm.
- Prokaryotic ribosomes are 70S, not 80S.
- An anticodon is complementary to the codon, so read the first mRNA codon and pair each base.

Question 26 (Answer: **B**)

- The primary transcript has introns removed to leave the exons, giving mRNA.
- Transcription copies the *template* strand, but translation reads mRNA, not DNA – so A is wrong.
- Exons are kept, not removed, and it is tRNA that carries anticodons, not codons.

Question 27 (Answer: **A**)

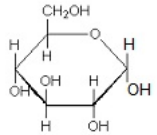
- Use the table to read the original sequence as triplets and translate it.
- Then translate the new amino acid sequence back into triplets.
- Comparing the two shows which single base changed and where.

Question 23 (Answer: **D**)

- An anticodon is complementary to the mRNA codon, and mRNA is itself complementary to the template DNA strand.
- So the anticodon matches the *coding* strand, except that U replaces T – statement 1 is wrong.
- There are more anticodons than amino acids because the code is degenerate, so statement 2 is wrong too.

Question 24 (Answer: **A**)

- The primary transcript contains both exons and introns.
- Splicing removes the introns.
- What is left, the mRNA, contains exons only.

3(a)	*any **three** from:* different sequence of, (DNA) nucleotides / bases **;R** RNA nucleotides code for / result in, different, polypeptides / proteins **;** **A** result in different sequences of amino acids **A** *LCT*, codes for / AW, lactase / enzyme, <u>and,</u> *MCM6*, codes for a different protein / involved in regulation have different numbers of, introns / exons **;** different, lengths / number of nucleotides / number of bases **;** *context is DNA* AVP **;** e.g. one may be continually expressed, the other switched on and off *MCM6* associated with different regulatory sequences
3(b)	statement showing relationship between transcribed strand and primary transcript **;** e.g. (transcribed strand is the) DNA (strand) / template (strand), used to form the primary transcript primary transcript is RNA (molecule first) formed from transcription of transcribed strand primary transcript is a complementary copy of the transcribed strand (but uracil replaces thymine) statement showing relationship between primary transcript and mRNA **;** e.g. primary transcript undergoes, gene / RNA, splicing, to form mRNA primary transcript undergoes modification to produce mRNA mRNA formed by removal of introns from primary transcript mRNA formed only from exons of primary transcript *one mark for a response that has correct ideas but does not show a direct relationship*
3(c)	base substitution / substitution (mutation) **; I** missense
3(d)	 *all correct for one mark – if deciding to leave out the H, then this must be for <u>all</u> C1 to C5 hydrogens – leaving out only the C5 H is zero marks*

3(e)(i)	*any **two** from:* *idea of* can, detect increase in / distinguish between, the intensity of colour (as products form) **;** can obtain quantitative results (for coloured product of ONPG) **;** **A** can provide numerical, values / readings / results / measurements **R** if stated that the results are wavelengths *ref. to* not subjective / AW **;** *idea of* not by-eye judgments / difficulty in describing different colour shades can obtain accurate, results / readings / values **;** **A** *idea of* greater accuracy in obtaining results *vague references to accuracy should be considered for ideas linked to 'not subjective'* can construct numerical graphs of results to compare curves of each (lactase) concentration **;** AW AVP **;** e.g. more sensitive to small colour changes at the beginning of the experiment not able to see initial reaction proceeding by eye *ref. to* use of a (prepared) calibration, curve / graph (to compare rates / product concentrations)

3(e)(ii)	*any **four** from:* *accept activity for percentage of maximum activity* **1** immobilised (overall) greater, productivity / yield / hydrolysis (of lactose in milk) **;** **I** activity **2** (process / immobilised) more tolerant to, temperature / pH, fluctuations / changes **;** AW **A** *idea that* can be used in processes covering a wide range of, temperature / pH **3** detail immobilised vs free lactase from Fig. 3.2 **;** e.g. (at temperatures) above optimum / higher than 38 / 39 °C, (immobilised) has a higher activity AW above optimum / higher than 38 / 39 °C, (partial / extent of) denaturation (for immobilised) is less at each temperature AW **A** higher than 40 °C *if accompanying context is correct* **R** if optimum stated as 35 °C **4** data from Fig. 3.2 to support **;** *any one comparison (units only for temperature required)* **5** detail immobilised vs free lactase from Fig. 3.3 **;** e.g. higher activity at all pHs except pH 6.5 and pH 7.0 higher activity, below pH 6.5 / above pH 7.0 free not active at pH 5.5 but immobilised active, at all pHs / for a wider pH range **6** data From Fig. 3.3 to support **;** **7** AVP **;;** e.g. can use a lower temperature / cheaper, for same quantity of product **8** more, heat stable / thermostable / stable at high temperatures **I** longer shelf-life **R** thermostatic better in alkaline pHs