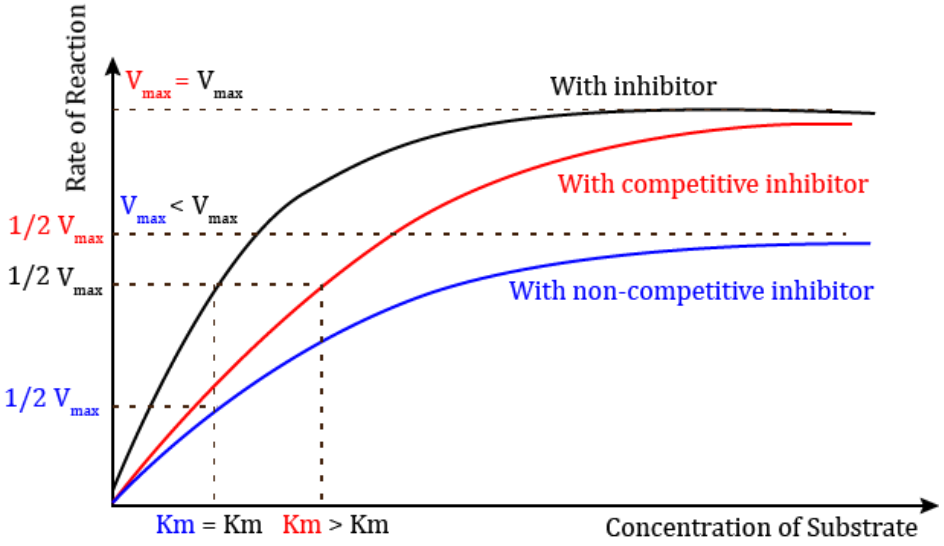
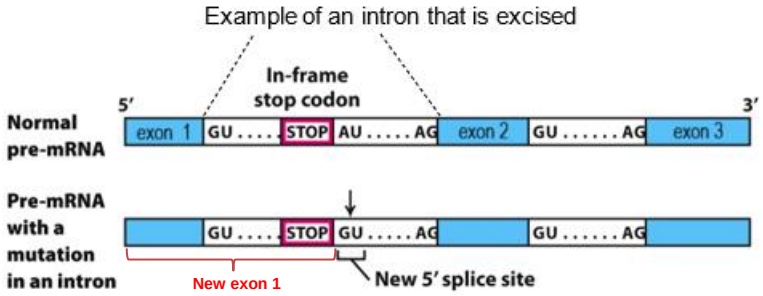
GCE A Level H2 Biology
9744 Biology November 2023

1.	**N23Q1**	B	Option A is wrong since the cell theory does not make reference to high temperature denaturing enzymes or killing cells. Option **C** is factually correct. The curvature of the swan neck indeed prevents air currents carrying any cells from passing into the nutrient media. However, this has no connection to cell theory. Option **D** statement is also factually accurate. However, you do not need to do this swan neck experiment to know that the statement in Option **D** is correct. Only Option B shows that all cells come from pre-existing cells, which is part of cell theory. The swan-neck experiment proved this, because as long as the swan neck is present, there is no way air current can introduce bacterial cells or spores from the external to the broth. There is no cell in the broth since it was previously heated, so no cells will grow. The top diagram contrasts with the bottom diagram, where once the swam neck "seal" is broken, pre-existing bacteria cells from outside can enter the broth and bacteria can divide to give even more bacteria – one central tenet of cell theory.
2.	**N23Q2**	A	Only statements 1 and 2 are correct, and the explanations are given below: 1: 70S ribosomes are found only in bacteria, mitochondria, and chloroplasts. 2: Prokaryotic DNA is not coiled around histone proteins, unlike eukaryotic DNA. 3: Cell wall is peptidoglycan, so it contains peptides, hence in addition to those named, there is also nitrogen. 4: Prokaryotes have free ribosomes, which are not attached to any membrane (phospholipids) in cytoplasm.
3.	**N23Q3**	D	Option **A**: Statement would have been correct if the second statement is "Binding of one oxygen molecules to a haemoglobin molecule causes a conformational change that makes binding of additional oxygen molecules easier." Option **B:** Statement would have been correct if the first statement is "Up to four molecules of oxygen can bind to four haem groups in a haemoglobin molecule." Option **C** incorrectly stated that there were four haem groups per subunit of haemoglobin.
4.	**N23Q4**	D	Statement 1 is wrong as for myeloid blood stem cells, genes that cause the cells to differentiate into cells other than certain blood cells cannot be switched on since myeloid blood stem cells are multipotent. Similarly, embryonic stem cells are pluripotent, so the genes that cause the cell to turn into cells of the placenta cannot be switched on. It is likely that some of their DNA is methylated to silence those genes, hence statement 4 is false. Statement 2 is wrong. Embryonic stem cell is pluripotent.
5.	**N23Q5**	D	Statement 4 is wrong so Option **C** is wrong. Students should note that radioactive threonine will only account for a small proportion of amino acids in each glycoprotein molecule. Students must also realise that radioactive glucose will account for a very large proportion of the monosaccharides that are incorporated into glycoproteins. Statement 1 is wrong because the peptide bonds are first formed in the RER, then glycosidic bond of the carbohydrate side chain will be attached to protein in the Golgi apparatus to form mucin as shown by the bottom graph where RER graph peak first before Golgi. Mucin formation is completed in the Golgi apparatus, so statement 3 is wrong.
6.	**N23Q6**	B	A is wrong as water is carried by the small vesicle to the contractile vacuole. B is correct as the small vesicles carry the water to contractile vacuole. If the membrane is permeable to water, water can also diffuse out and thus the small vesicles will not be able to serve its role

			C is wrong as potassium ion concentration gradient was set up by events in the membranes of the small vesicles and not the contractile vacuole D is wrong as movement of water across membrane is usually passive and active transport is the pumping of sodium and potassium ions instead by the sodium-potassium pump.
7.	**N23Q7**	A	Curve will shift to the right thus Km value increases as higher concentration of substrate is required for reaching ½ Vmax. As it is a competitive inhibitor, the inhibition can be overcome or Vmax can be achieved at high substrate concentration. 
8.	**N23Q8**	C	J and K are single stranded polynucleotides so eliminate options A and D. K shows catalytic activity as part of the multi-molecular complex thus it must be rRNA as peptidyl transferase in the ribosome.
9.	**N23Q9**	C	A and B are eliminated as the telomerase will extend the DNA strand from the 3' end. By comparing C and D, C has the correct complementary sequence of DNA to template RNA.
10.	**N23Q10**	A	A is correct as tail fiber is protein that attaches to bacterial cell wall. B is wrong as the enzyme lysozyme is located in the tail region. C is wrong as phages are non-enveloped/naked viruses. D is wrong tail fiber is not glycoprotein and entry of phage DNA is via injection and not endocytosis.
11.	**N23Q11**	B	In the information given, the lambda phage becomes lytic when the Cro protein is formed and remains in the lysogenic stage when the cI protein is present. So, when the host cell is damaged and a protease that digests cI becomes active, cI will no longer be present, transcription of *Cro* gene will be expressed, forming Cro protein and there will be a switch to the lytic cycle.
12.	**N23Q12**	D	The process shown is conjugation. Hence statement 1 is incorrect. During conjugation the F plasmid (i.e. genetic material) is transferred from the F^+ bacterial cell to the F^- bacterial cell via the sex pilus. Hence statements 2 and 3 are correct. There are no bacteriophages involved. Only two bacterial cells are involved in this process. Hence statement 4 is incorrect. Note: in this question Cambridge did not distinguish between the sex pilus and the cytoplasmic mating bridge. Do note that when writing answers for structured questions you should distinguish between the two structures.

13.	**N23Q13**	C	When mutations occur in introns, a new splice site can be created after a stop codon in its pre-mRNA. This can result in a new exon being created if splicing occurs at the new splice site, and hence a new gene being created. An example is shown below:  Remnants of retroviral DNA integrated into human germline DNA can give rise to new genes as these can be passed down to descendent over time. This question is **best done by elimination**. Promoters and telomeres can be first eliminated, leaving options C and D. Since remnants derived from viral infections is definitely an answer, option C must be the correct answer. **Fun Fact:** *HERVs, or human endogenous retroviruses, make up around 8% of the human genome, left behind as a result of infections that humanity's primate ancestors suffered millions of years ago. They became part of the human genome due to how they replicate. Like modern HIV, these ancient retroviruses had to insert their genetic material into their host's genome to replicate. Usually, this kind of viral genetic material isn't passed down from generation to generation. But some ancient retroviruses gained the ability to infect germ cells, such as egg or sperm, that do pass their DNA down to future generations. By targeting germ cells, these retroviruses became incorporated into human ancestral genomes over the course of millions of years and may have implications for how researchers screen and test for diseases today. Viruses insert their genomes into their hosts in the form of a provirus. There are around 30 different kinds of human endogenous retroviruses in people today, amounting to over 60,000 proviruses in the human genome.*
14.	**N23Q14**	A	A is correct as *lacZ* codes for beta-galactosidase that hydrolyses lactose to glucose and galactose. B is incorrect as *lacA* does not code for a repressor. *lac I* codes for a repressor. C is incorrect as lacY codes for a transport protein permease (that allows for lactose to enter the bacterial cell) and not a cell-signalling protein. D is incorrect as although *lacI* is a regulatory gene, it codes for a repressor and not a silencer.
15.	**N23Q15**	B	A is incorrect as coding regions are not lost as a person gets older. C is incorrect as the number of CAG repeats does not change over a person's lifetime. D is incorrect as younger people do not have more repeats than older people. Hence the answer is B. (Please do not misinterpret the graph. It does not show how the number of CAG repeat codons changes as people get older.)
16.	**N23Q16**	D	Centrioles and DNA replicate during the S phase of interphase.
17.	**N23Q17**	C	1 and 3 are necessary for metastasis whereby the cells of the tumour are about to spread to other parts of the body to form secondary tumours.

			2 is not necessary and 4 does not give rise to a tumour (should be gain in function mutation of a protooncogene.
18.	**N23Q18**	C	Plant P (cyanogenic) maybe AABb or AaBB (can't be AaBb as only 9/16 offspring will be cyanogenic). Plant Q (non cyanogenic) is aabb. Option A is wrong as all non cyanogenic offspring (Aabb or aaBb) are homozygous at one gene and heterozygous at other. Option B is wrong as the only 2 genotypes are cyanogenic and non cyanogenic. Option C is correct as the offspring are: AaBb, Aabb or aaBb. Option D is wrong. If Plant P is heterozygous AaBb, then all offspring will be cyanogenic.
19.	**N23Q19**	A	Male parent is aabb. Female parent is Aa since can get offspring with aa and Aa genotype. Short striped offspring is AaBb (since it must get b from male parent). Female parent is therefore BB or Bb. By elimination, best answer is A
20.	**N23Q20**	B	To calculate chi-square, one will need the observed and expected numbers of each phenotype (expected numbers can be derived from expected ratio because the total number of offspring can be calculated by summing up the observed numbers). One also needs the statistical table to make reference to the *p* value. $$\chi^2 = \sum \frac{(O-E)^2}{E}$$
21.	**N23Q21**	D	A - As ambient temperature increases, the rate of all enzyme dependent reactions will increase including the Calvin cycle reactions. Hence rate of carbohydrate synthesis should increase. B- From 620 nm to 660 nm, light absorbance decreases with decreasing temperature. This is untrue as light absorbance is still higher at 11°C compared to 38°C. C – Not true as the light absorbance is greater at lower temperatures and hence total amount of light reflected will be less. D – At all temperatures, the pattern of the graph is same across all wavelengths of light.
22.	**N23Q22**	D	When the graph plateaus (at 1), the rate of photosynthesis does not increase with increasing light intensity. This means that it is limited by some other factor other than light intensity. At very high light intensities, chlorophyll bleaching can occur and temperatures may be higher leading to enzyme denaturation. This can cause rate of photosynthesis to decrease.
23.	**N23Q23**	B	3C → 2C → 1C (pyruvate (3C) undergoes oxidative decarboxylation to form acetyl coA (2C) and CO_2 (1C). 2C → 6C → 1C (acetyl coA (2C) combines with oxaloacetate to form citrate (6C) which is undergoes oxidation by dehydrogenation to form α-ketoglutarate and CO_2 (1C)
24.	**N23Q24**	B	1- Insulin receptor is an RTK, 2- Ligand should be insulin and not glucagon, 3- glucose transporters allow uptake of glucose, 4- process is facilitated diffusion and hence involves movement of glucose down a concentration gradient.
25.	**N23Q25**	C	1- heterozygous rats are resistant to warfarin and hence will always have a selective advantage when warfarin is used. 2- heterozygous rats are selected for but they will not keep increasing in frequency with every generation.

			3- since heterozygous rats have an advantage over homozygous R^R and homozygous R^S rats (heterozygote advantage), they are selected for. When 2 heterozygous rats cross, all 3 genotypes are possible in the offspring. 4- R^S allele will not be eliminated from the population as they can remain in heterozygous individuals are not expressed in the phenotype. So R^S allele is able to exist in the population (heterozygote protection).
26.	**N23Q26**	C	2 and 3 involve speciation which will contribute to macro evolution. Those who selected option D (3 only) had not appreciated the significance of a new species evolving that had not existed before.
27.	**N23Q27**	B	There is no mention of phylogenetic relationship which will include evolutionary relationship,
28.	**N23Q28**	D	Only memory cells are associated with adaptive immunity; the rest can occur in innate immunity
29.	**N23Q29**	B	Many candidates selected option **A**. Candidates selecting option **A** had not considered that an inert bacterial population would be able to continually stimulate an immune response without developing into a significant threat to health, or that rapid destruction of an infection that can rapidly progress to a serious disease is preferable to allowing time for a strong immune response to develop (4)
30.	**N23Q30**	A	1. Rising sea level will affect the habitat of sea turtles 2. Increase air temperature will bring the temperature higher than temperate seas 3. Changes in ocean currents affect migration pathways which will cause problems for turtles to find breeding areas 4. Heavy rainfall will erode away sandy beaches where turtles breed All the above (1,2,3,4) will contribute to decline in sea turtle population