

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 1: BIOLOGICAL MOLECULES
DNA AND PROTEIN SYNTHESIS

SCORE

/183

PERCENTAGE

%

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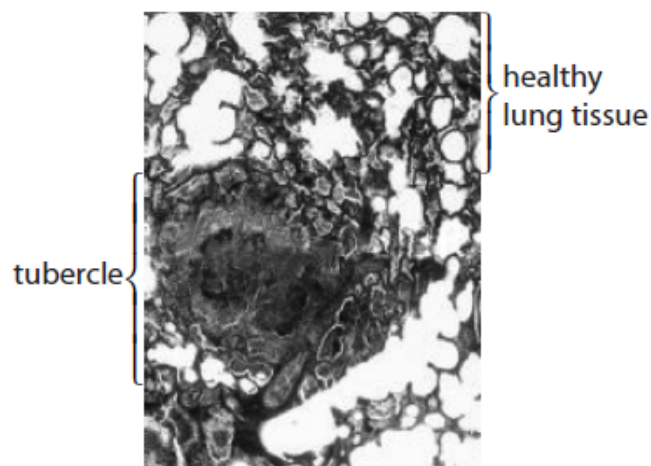
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Q1.

Infection of the lungs with *Mycobacterium tuberculosis* can result in a range of symptoms. These symptoms can include severe breathing problems, a persistent cough and coughing up blood.

The photograph below shows a tubercle in part of a lung infected with *Mycobacterium tuberculosis*, as seen using a light microscope.

A tubercle is a solid mass of dead tissue, macrophages and bacteria.



©John Burbidge/Science Photo Library

Magnification $\times 50$

Using the information in the photograph and your knowledge of gas exchange surfaces, suggest why this infection can result in these symptoms.

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Q2. The sequence of bases in DNA determines the sequence of amino acids in a polypeptide.

The table below shows the genetic code for each amino acid.

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

(a) The diagram below shows the DNA base sequence coding for part of a polypeptide.

A	T	G	G	G	C	A	T	T
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(i) Using the information in the table, state the order of amino acids for this part of the polypeptide.

(1)

(ii) Explain what is meant by the term **non-overlapping genetic code**.

(1)

(b) (i) Explain why there are **three** bases in each of the codes shown in the table.

(2)

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(ii) Suggest an advantage for most amino acids having more than one code. Give an explanation for your answer.

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(c) Explain the role of the base sequences TAA, TAG and TGA.

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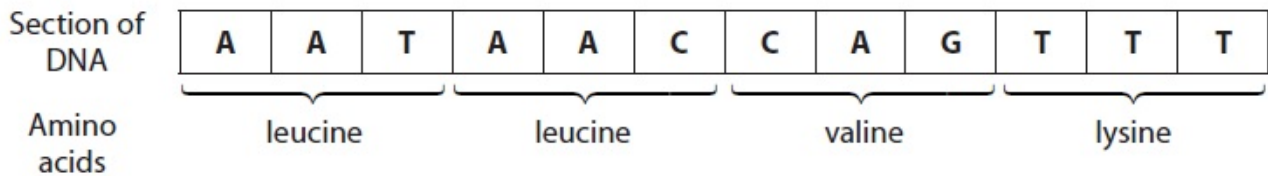
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(d) Explain how the amino acids are joined together in a polypeptide.

(3)

Q3. The diagram below shows the base sequence on a short section of DNA consisting of 12 mononucleotides. This base sequence contains the genetic code for a short section in the primary structure of a polypeptide.



(a) Name each of the bases represented by the letters, **A**, **C**, **G** and **T** in the diagram.

(1)

A.....

C.....

G.....

T.....

(b) Using the sequence shown in the diagram, explain the meaning of each of the following terms.

(i) Triplet code

(2)

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(ii) Non-overlapping

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(iii) Degenerate

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(1)

- *(d) Transcription of this section of DNA forms a complementary strand of mRNA.
Describe how translation of this mRNA synthesises part of a polypeptide molecule.

[illegible]

Q4.

Mitochondrial disorders may be caused by mutations in the genes coding for mitochondrial components. Some of these genes are found in mitochondrial DNA (mtDNA) and some are found in nuclear DNA.

Leigh syndrome is an example of a mitochondrial disorder. In this syndrome, a number of different proteins involved in respiration are affected.

These mutations may be inherited or may occur when DNA replicates.

Leigh syndrome can also be due to a mutation in the SURF1 gene.

This mutation results in a shortened protein.

Explain how a mutation can result in a shortened protein being produced.

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(Total for question = 2 marks)

Q5.

Many of the chemicals found in living organisms are polymers.

Which of the following molecules are all polymers?

(1)

☒ **A** polypeptides, nucleotides, starch

- ☐ **B** polypeptides, starch, lipids
- ☐ **C** proteins, carbohydrates, lipids
- ☐ **D** proteins, nucleic acids, starch

Q6.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

Transpiration moves water and mineral ions from the roots to the leaves of plants.

Which box in the table shows the mineral ions needed to make an amino acid and which box shows those needed to make DNA?

(2)

Molecule	Mineral ions needed to make the molecule			
	nitrate ions only	phosphate ions only	both nitrate and phosphate ions	neither nitrate nor phosphate ions
amino acid	☐	☐	☐	☐
DNA	☐	☐	☐	☐

(Total for question = 2 marks)

Q7.

During the development of active immunity, macrophages present antigens to T helper cells.

In an investigation into clonal selection, macrophages and T cells were isolated from two strains of guinea pig, strain 2 and strain 13.

The macrophages from each strain of guinea pig were exposed to an antigen and treated with mitomycin.

Mitomycin forms cross links between complementary strands of DNA.

These macrophages were then cultured with T cells from each of the strains of guinea pig for 72 hours.

Radioactive thymidine was included in the culture. This molecule will become incorporated into DNA during DNA replication instead of thymine.

The table shows the results of this investigation.

Source of macrophages	Level of radioactive thymidine incorporated into T cells / a.u.	
	T cells from strain 2 guinea pigs	T cells from strain 13 guinea pigs
strain 2	180	13
strain 13	17	59

(i) Explain why the macrophages were treated with mitomycin.

(3)

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(ii) Explain how radioactive thymidine becomes incorporated into the DNA.

(2)

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(iii) Analyse the data to explain the results of this investigation.

(4)

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(Total for question = 9 marks)

Q8.

Mitochondrial disorders may be caused by mutations in the genes coding for mitochondrial components. Some of these genes are found in mitochondrial DNA (mtDNA) and some are found in nuclear DNA.

Leigh syndrome is an example of a mitochondrial disorder. In this syndrome, a number of different proteins involved in respiration are affected.

These mutations may be inherited or may occur when DNA replicates.

Some people with Leigh syndrome have a mutation in the MT-ATP6 gene.
This gene codes for ATP synthase.

This is a point mutation at nucleotide 8993 that changes thymine to guanine.

(i) What type of mutation is this?

(1)

- ☐ **A** insertion
- ☐ **B** monosomy
- ☐ **C** substitution

☒ **D** translocation

(ii) Explain how this mutation could affect oxidative phosphorylation.

(3)

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(Total for question = 4 marks)

Q9.

A mutation of the *F2* gene causes thrombophilia, a condition that results in the production of excess prothrombin.

In this gene mutation, guanine is replaced with adenine.

(i) Name this type of mutation.

(1)

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(ii) People without this mutation have a 1 in 1000 risk of producing a blood clot in an artery.

The mutation increases this risk by 20 times.

State the probability of producing a blood clot for people with this mutation.

(1)

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(iii) Explain why thrombophilia increases the risk of producing a blood clot in an artery.

(3)

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(Total for question = 5 marks)

Q10.

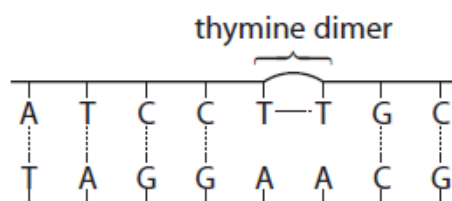
Ultraviolet (UV) radiation damages DNA and is used in microbiology to produce aseptic conditions.

The UV radiation changes the bonding found in DNA.

This change in bonding creates thymine dimers in which covalent bonds form between adjacent thymine nucleotides.

Thymine dimers bend the DNA backbone. This prevents replication of DNA.

The diagram shows the change in bonding caused by UV radiation.



Name the bonds that are lost when thymine dimers are formed.

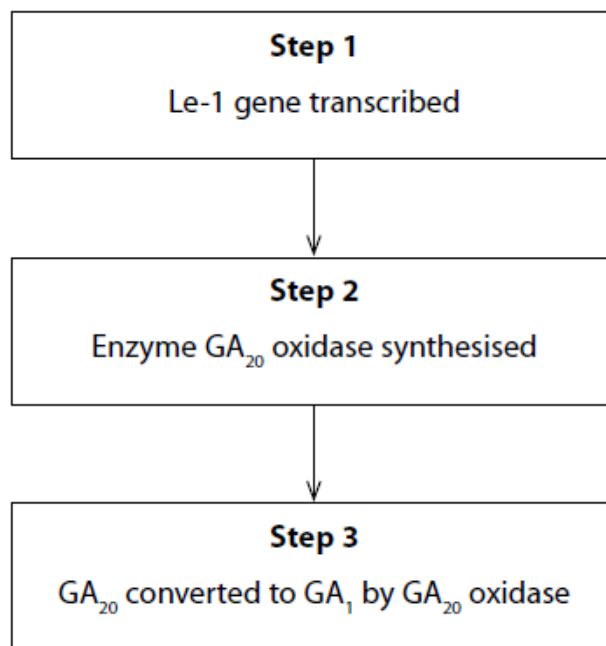
(1)

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Q11.

'DELLA' proteins normally prevent transcription factors from binding to important growth-stimulating genes in the cells of plant stems.

The diagram below shows part of the biochemical pathway leading to the synthesis of an active plant growth substance called gibberellin (GA_1). GA_1 reduces the effect of 'DELLA' proteins.



(a) The Le-1 gene codes for the enzyme GA_{20} oxidase. A mutation of this gene forms a recessive allele which, when translated, leads to a single amino acid change in this enzyme. This change significantly reduces the activity of GA_{20} oxidase.

Explain how a single amino acid change can bring about a change in the structure and activity of GA_{20} oxidase.

(4)

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(b) (i) Explain why homozygous recessive plants will have short stems.

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(ii) An ecological survey of a stable population of one species of plant found that 36% had short stems.

Calculate the percentage of heterozygous individuals in this population.
Assume that there are only two alleles for this gene.

(4)

Answer

(Total for question = 12 marks)

Q12.

Antibiotics can affect bacteria.

The table describes the mode of action of four antibiotics.

Antibiotic	Mode of action
benzylpenicillin	disrupts peptidoglycan structure
streptomycin	binds to 70S ribosomes
ciprofloxacin	inhibits enzymes involved in prokaryotic DNA replication
rifamycin	inhibits prokaryotic RNA polymerase

Mutations in the DNA of bacteria can enable them to be resistant to antibiotics.

(i) A single bacterium can produce 2×10^{10} new cells per day by cell division.

The mean mutation rate in one day is 1 in 10 million new cells produced.

Calculate the mean number of bacteria with mutations that could be produced in one day from a single bacterium.

(2)

Answer

(ii) Explain how bacteria may become resistant to streptomycin if a mutation changes the primary structure of a protein.

(3)

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(Total for question = 5 marks)

Q13.

Antibiotics can affect bacteria.

The table describes the mode of action of four antibiotics.

Antibiotic	Mode of action
benzylpenicillin	disrupts peptidoglycan structure
streptomycin	binds to 70S ribosomes
ciprofloxacin	inhibits enzymes involved in prokaryotic DNA replication
rifamycin	inhibits prokaryotic RNA polymerase

Explain how rifamycin prevents the growth of bacteria.

(3)

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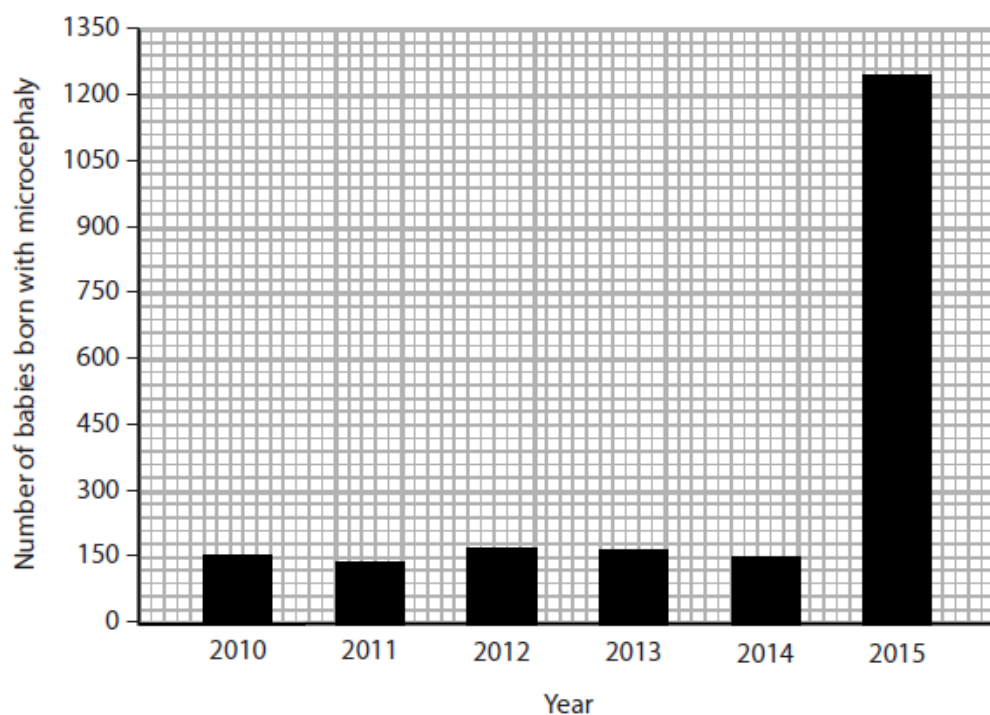
(Total for question = 3 marks)

Q14.

In February 2016, the World Health Organisation (WHO) declared a public health emergency because of the spread of the Zika virus.

The mild symptoms, such as joint pains, headaches and a slight temperature increase lasted only a few days. However, Zika virus has been linked to a birth defect called microcephaly.

The graph shows the number of babies born with microcephaly in Brazil from 2010 to 2015.



Scientists have discovered that the Zika virus genome is made of RNA.

This RNA codes for:

- capsid protein with 105 amino acids
- pre-membrane protein with 187 amino acids
- envelope protein with 505 amino acids
- seven nonstructural proteins

(i) State how many bases are needed to code for the capsid protein.

(1)

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(ii) Unlike human immunodeficiency virus (HIV), Zika is not a retrovirus.

Describe what happens to the Zika RNA once it is in the cell.

(2)

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(Total for question = 3 marks)

Q15.

The Ebola virus contains RNA that cannot be translated into protein directly.

First, RNA polymerase must produce a strand of RNA complementary to the viral RNA.

The diagram shows a section of the RNA contained in the Zaire Ebola virus.

A	A	A	A	A	A	C	A	C	A	C	A	G	G	U
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(i) Give the RNA strand that the RNA polymerase would make from this section of RNA.

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(1)

The table shows part of the genetic code.

RNA triplet	Amino acid	RNA triplet	Amino acid
AAA	Lysine	ACA	Threonine
AAG	Lysine	GGU	Glycine
CAU	Histidine	GGC	Glycine
CAC	Histidine	GUG	Valine
CCA	Proline	UGU	Cysteine
UUU	Phenylalanine	GGG	Glycine
UGG	Tryptophan	GUU	Valine

(ii) The genetic code was worked out by using radioactive synthetic RNA molecules and analysing the polypeptide produced.

The table shows some of the results obtained.

Synthetic RNA molecule	Amino acids incorporated into the polypeptide
contains only U	phenylalanine
contains only A	lysine
contains U and G in a 5:1 ratio	20% cysteine, 20% valine, 4% glycine, 5% tryptophan

Explain how these results give evidence for the genetic code.

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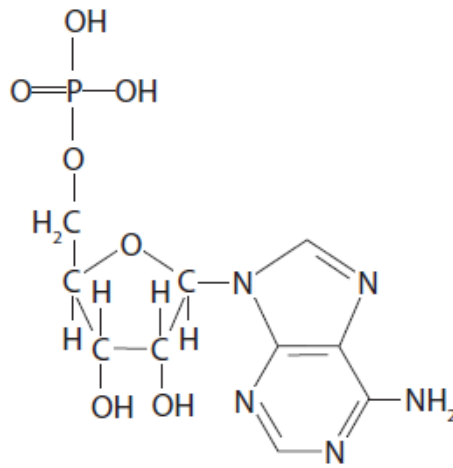
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Q16.

Many of the chemicals found in living organisms are polymers.

The diagram shows the structure of a monomer.

(1)



This monomer is found in

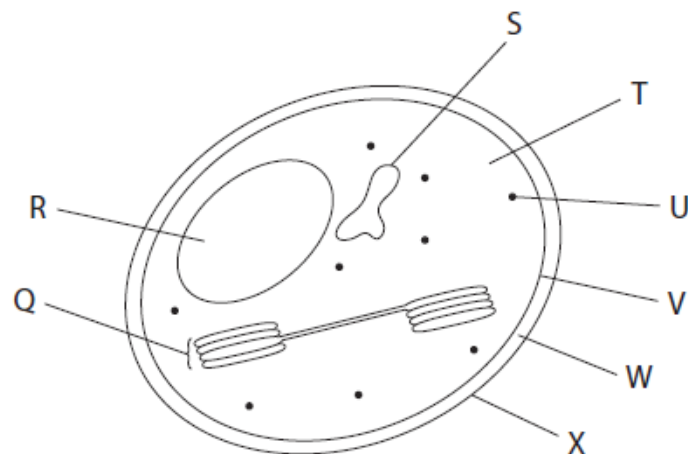
- ☒ **A** DNA
- ☒ **B** DNA polymerase
- ☒ **C** haemoglobin
- ☒ **D** mRNA

Q17.

The light-dependent stage and the light-independent stage of photosynthesis both take place in the chloroplast.

The rate of photosynthesis is affected by a number of different factors, including carbon dioxide concentration and temperature.

The diagram shows a chloroplast.



(i) Where does the light-dependent stage take place?

(1)

☐ **A** Q

☐ **B** T

☐ **C** V

☐ **D** X

(ii) The light-dependent stage produces hydrogen ions.

Where do these hydrogen ions accumulate?

(1)

☐ **A** Q

☐ **B** R

☐ **C** S

☐ **D** W

(iii) Where does translation take place?

(1)

☐ **A** Q

☐ **B** R

☐ **C** S

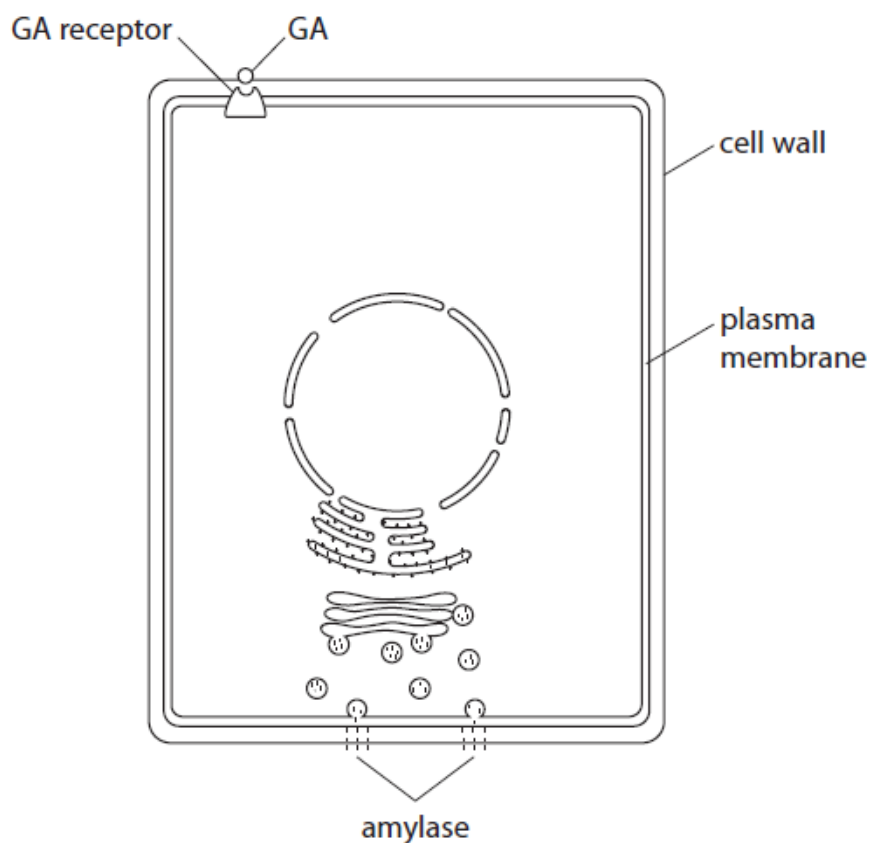
☐ **D** U

(Total for question = 3 marks)

Q18.

Gibberellin stimulates cells in the aleurone layer of cereal grains, such as barley, to produce the enzyme amylase.

The diagram shows a cell from the aleurone layer with some of the structures involved in the production of amylase.



Gibberellin binds to a protein receptor in the cell surface membrane and this stimulates transcription in the nucleus.

(i) Describe the process of transcription in the nucleus of this cell.

(2)

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(ii) Describe the processes occurring after transcription that result in the release of amylase from the cell shown in the diagram.

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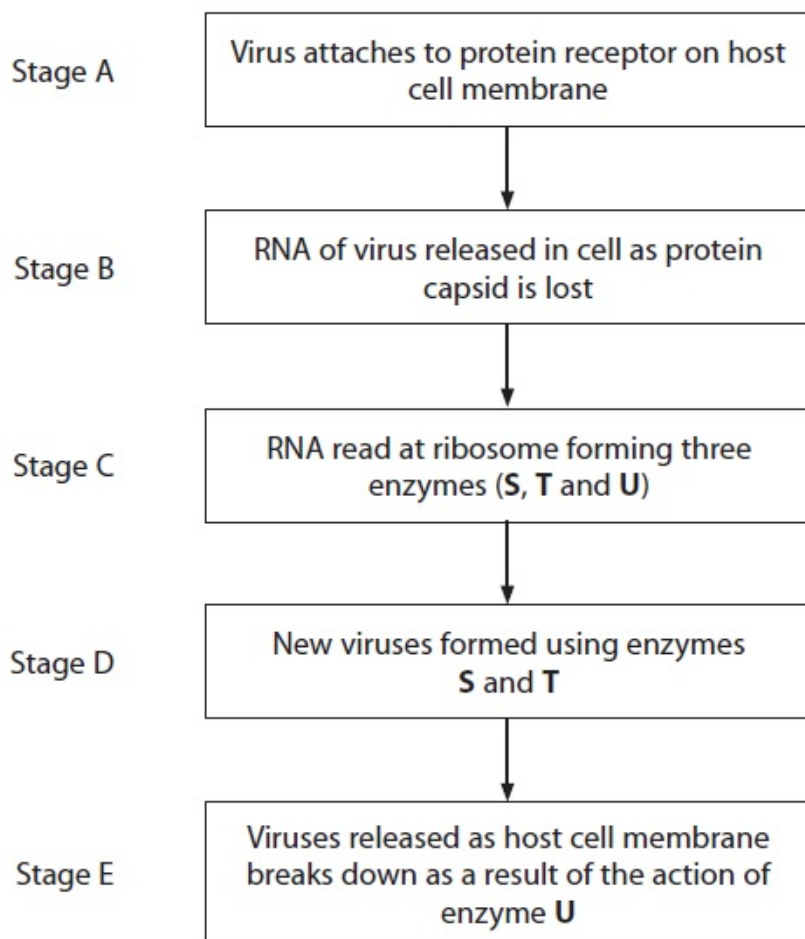
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(Total for question = 7 marks)

Q19. The common cold is a disease caused by a variety of viruses.

The flow diagram below describes how common cold viruses attack the cells on the inside of the nose.



(a) Common cold viruses infect only the cells inside the nose.

(i) Suggest why common cold viruses cannot infect cells if they land on unbroken skin.

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(ii) Suggest why common cold viruses cannot infect cells if they enter the blood through a cut in the skin.

(2)

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(b) Compare the action of the RNA in the common cold virus with that found in HIV.

(2)

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(c) At Stage C, three enzymes are formed.

(i) Suggest why two of these enzymes, **S** and **T**, are needed at Stage D.

(2)

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(ii) Suggest how enzyme **U** might catalyse the breakdown of the host cell membrane at Stage E.

(3)

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(Total for Question = 11 marks)

Q20.

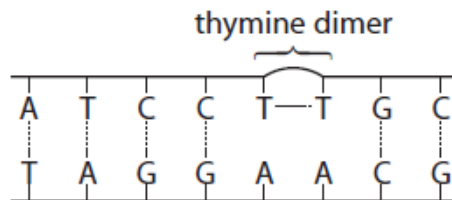
Ultraviolet (UV) radiation damages DNA and is used in microbiology to produce aseptic conditions.

The UV radiation changes the bonding found in DNA.

This change in bonding creates thymine dimers in which covalent bonds form between adjacent thymine nucleotides.

Thymine dimers bend the DNA backbone. This prevents replication of DNA.

The diagram shows the change in bonding caused by UV radiation.



Explain why preventing the replication of DNA produces aseptic conditions.

(2)

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(Total for question = 2 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	1. idea that the {alveoli / air sacs / lung / tissue } have been {replaced / destroyed / eq} (by the tubercle) ; 2. idea that the (tubercle / destroyed lung tissue) has reduced the (surface) area (of the lung) ; 3. breathing problems due to { gas exchange being reduced / less oxygen in blood / eq } ; 4. idea that the coughing is { due to irritation /to remove the dead tissue / eq} ; 5. blood coughed up is due to damage of (lung) blood vessels / eq ;	1 IGNORE blocks 4 ACCEPT tubercle 5 IGNORE idea that lung damage causes bleeding	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	{Met Gly Ile} / {methionine glycine isoleucine} ;	Not other abbreviations	(1)

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	idea that each {triplet is discrete / base is only used once in a triplet / eq} ;	Accept a description of how the code could be read if overlapping	(1)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. idea that each amino acid needs a code ; 2. idea that {using three bases give enough codes / using less bases does not give enough codes} ; 3. idea of three bases means there can be 64 {triplets / codes / combinations / eq} ;	Accept codons	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea that {effects of mutations are reduced / the amino acid may not be altered} ; 2. reference to the third base (being the one that can be changed with no effect) ; 3. no effect on (resulting) {polypeptide / protein} / eq ;	1. Accept description of effect Accept from a description of a specific example Accept always results in same amino acid Not similar amino acid 2 NB If mp 2 is awarded it will usually incorporate mp 1 as well = 2 marks	(2)

Question Number	Answer	Additional Guidance	Mark
(c)	1. reference to (TAA, TAG and TGA as) stop codons ; 2. occur at the end of the gene (on the DNA) / eq ; 3. reference to transcribed as mRNA / eq ;	1. Not codes, triplets	

	4. as AUU, AUC and ACU ; 5. idea that they are recognised by ribosome ; 6. idea that they signal the end of the polypeptide (chain) ; 7. reference to (during) translation ;	6. Accept stops the synthesis of the polypeptide / the polypeptide is finished	(4)
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Question Number	Answer	Additional Guidance	Mark
(d)	1. ref to peptide {bond / link} ; 2. between (amino group / NH_3 / NH_4^+) and {carboxyl group / COOH / COO^- } ; 3. ref to condensation (reaction) ; 4. idea of role of {tRNA / ribosome / enzymes / correctly named enzyme} in joining amino acids together ;	Accept mp 1 and 2 from correctly drawn and labelled diagram 2. NB formulae must be correct if only these are given 4. Accept e.g. hold the amino acids next to each other, ribosome contains enzyme	(3)

Q3.

Question Number	Answer	Additional Guidance	Mark
(a)	A = adenine C = cytosine G = guanine T = thymine ;	Accept reasonable phonetic spellings Not: adenosine cysteine glycine thiamine, thyosine, tyrosine	(1)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. idea that each amino acid is coded for by three {nucleotides / bases} ; 2. credit quoted example / idea that 12 {nucleotides / bases} code for 4 amino acids ;	Accept in context of RNA AAT / AAC = leucine, CAG = valine, TTT = lysine	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	- idea that each {triplet is discrete / each base is only used once in a triplet / eq } ; - idea that AAT + AAC + CAG + TTT gives 4 (distinct) {triplets / codes} ;	Accept a specific example eg the first T can only be used in code for first leucine Accept a description of how the code could be read if overlapping	(2)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	- idea that more than one code can be used for a {particular amino acid/ stop code} ; - AAT and AAC code for leucine ;	Accept more codes than are needed to code for all the amino acids (and stop code)	(2)

Question Number	Answer	Additional Guidance	Mark
(c)	B ;		(1)

Question Number	Answer	Additional Guidance	Mark
* (d)	QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence - reference to mRNA with sequence UUA UUG GUC AAA ; - idea that ribosome is involved ; - idea that each tRNA molecules is attached to one (specific) amino acid ; - credit example of tRNA anticodon with specific amino acid - reference to anticodons on tRNA {bind / link to / line up against / eq} codons on mRNA ; - credit a specific example (from this DNA) ; - idea of hydrogen bonds between bases (of tRNA and mRNA) ; - reference to formation of peptide {bonds / links} between (adjacent) amino acids ;	QWC emphasis is logical sequence NB The mps do not have to be given in this order necessarily Not tRNA carries amino acids AAU / AAC = leucine, CAG = valine, UUU = lysine Ignore complementary eg UUA codon and AAU anticodon Accept between codon and anticodon	(5)

Q4.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - the mutation may produce a stop codon (1) - therefore translation will stop {sooner / when the stop codon is reached} (1) Or {one / several} bases deleted (1) - therefore the mRNA is shorter (1)	Accept no more amino acids added to the peptide / peptide synthesis stops sooner	(2)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	D (proteins, nucleic acids, starch)		(1)

Q6.

Question Number	Answer				Additional Guidance	Mark
						(2)
	Molecule	Mineral ions used				
		nitrate ions only	phosphate ions only	both nitrate and phosphate ions	neither nitrate nor phosphate ions	
		amino acid	X	☐	☐	
		DNA	☐	☐	X	

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: - to prevent DNA {replication / unwinding / unzipping} (1) - so that macrophages could not {divide / carry out mitosis} (1) - so that any division could be attributed to the T cells only / radioactive thymidine incorporate into T cells only (1)	ACCEPT separating ACCEPT number of macrophages remains constant ACCEPT no thymidine incorporated into the macrophage	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: {complementary to / binds to / forms H bonds with} adenine (on the DNA) (1) - forming phosphodiester bonds (with adjacent nucleotides) (1)	ACCEPT formation of a sugar-phosphate backbone	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to four of the following: - most (radioactive) thymidine incorporated into T cells that were the same strain as the macrophages (1) - because these cells are dividing more (1) - because {the (MHC and CD4) receptors bind together better / antigen presentation improved} (1) - due to genetic compatibility (1) - strain 2 {macrophages are better antigen presenters / T cell proliferate faster than strain 13} (1)	ACCEPT converse throughout ACCEPT more T cells if antigen is presented by macrophages from same {strain / number} guinea pig description ACCEPT faster mitosis ACCEPT better recognition ACCEPT self-antigens ACCEPT antigen presentation is more effective	(4)

Q8.

Question Number	Answer	Mark
(i)	The only correct answer is C <i>A is not correct because an insertion adds an additional base</i> <i>B is not correct because monosomy is a chromosome mutation</i> <i>D is not correct because translocation is a chromosome mutation</i>	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: - it will change the {amino acid sequence / primary structure } of ATP synthase (1) - therefore the ATP synthase active site could be a different {structure / shape } so ADP cannot {bind / bind as well} (1) - therefore the {channel / ATP synthase} the wrong {structure / shape} so {hydrogen ions / protons} cannot {pass through / pass through as well} (1) - therefore { no / less} {ATP made / oxidative phosphorylation} (1)	Accept a stop codon could result changing the {length / shape / structure} of the protein	(3)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	substitution	Accept point mutation	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	1 in 50	Accept other correct probabilities e.g. 2% or 0.02	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: (excess prothrombin means) more thrombin (1) - therefore increased {conversion / catalysis} of fibrinogen to fibrin (1) - fibrin {is insoluble / traps blood cells / forms mesh / forms net} (1)	Accept if there is more fibrin it is more likely to clot	(3)

Q10.

Question Number	Answer	Additional Guidance	Mark
	H / hydrogen		(1)

Q11.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • {Active site changes shape / not correctly formed} and no longer an efficient 'fit' to substrate (1) • because if one amino acid is changed then these bonds cannot form (1) • because only certain amino acids (e.g. cysteine needed for S –S bonding) can form disulphide bridges/hydrogen bonds/ionic bonds (1) • and these bonds are important in the formation of a tertiary/3D protein structure (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: • (reduced activity of GA₂₀ oxidase means) less active GA₂₀ is produced (1) • therefore less GA₂₀ means more DELLA proteins present (1) • hence more DELLA proteins means fewer transcription factors binding to growth regulator genes (1) • therefore resulting in growth regulator genes not expressed / growth less because transcription factors needed for expression of genes (1)	Less DELLA protein broken down	(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(ii)	• equation $p^2 + 2pq + q^2 = 1$ (1) • $p^2 = 0.36$ so $p = 0.6$ (1) • $q = 0.4$ so $2pq = 2 \times 0.6 \times 0.4$ (1) • correct answer 48% (1)		(4)

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	• multiplication (1) • division (1)	2×10^{10} divisions per day $\times 10^{-7}$ mutations per division / $2 \times 10^{10} =$ 20 000 000 000 $\div 10\,000\,000 / = 2\,000 / 2 \times 10^3$ Correct answer gains full marks, with no working shown ALLOW one mark for 20 000 000 000 / $\div 10\,000\,000 / 10 \times 10^6 / 1 \times 10^7$	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • different {R groups / disulphide bonds / hydrogen bonds / ionic bonds} (1) • therefore different secondary / tertiary structure (1) • therefore different shaped ribosome (1) • therefore streptomycin cannot bind (to ribosome) (1)		(3)

Q13.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • {binds to / changes shape of} the {enzyme / active site / RNA polymerase} (1) • therefore {transcription / mRNA synthesis} prevented (1) • no {proteins / polypeptides / enzymes} can be made (1)		(3)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	315		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to the following: • used in translation to make (viral) protein (1) • more RNA is produced (1)		(2)

Q15.

Question Number	Acceptable Answer	Additional guidance	Mark															
(i)	<table><tr><td>U</td><td>U</td><td>U</td><td>U</td><td>U</td><td>U</td><td>G</td><td>U</td><td>G</td><td>U</td><td>G</td><td>U</td><td>C</td><td>C</td><td>A</td></tr></table>	U	U	U	U	U	U	G	U	G	U	G	U	C	C	A		(1)
U	U	U	U	U	U	G	U	G	U	G	U	C	C	A				

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: (1) - poly U gives only phenylalanine, poly A gives only lysine, therefore UUU codes for phenylalanine and AAA for lysine and therefore one triplet can only code for one amino acid (1) - in the mixture, more U is linked to higher % of cysteine and valine, therefore UGU and GUU are likely triplets - there are more combinations of U and G in a triplet than four, therefore one amino acid could have more than one code (1)		(3)

Q16.

Question Number	Acceptable Answer	Additional Guidance	Mark
	D (mRNA)		(1)

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is A B is incorrect because light-dependent stage takes place on thylakoid membrane and not in the stroma C is incorrect because light-dependent stage takes place on thylakoid membrane and not on the inner membrane D is incorrect because light-dependent stage takes place on thylakoid membrane and not on the outer membrane		(1) COMP
(ii)	The only correct answer is A B is incorrect because hydrogen ions accumulate inside the thylakoids and not in the starch grain C is incorrect because hydrogen ions accumulate inside the thylakoids and not in the DNA loop D is incorrect because hydrogen ions accumulate inside the thylakoids and not in the inner membrane space		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(iii)	The only correct answer is D A is incorrect because translation occurs on the ribosomes and not inside the thylakoids B is incorrect because translation occurs on the ribosomes and not in the starch grain C is incorrect because translation occurs on the ribosomes and not in the DNA loop		(1) COMP

Q18.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to two the following: • DNA strands separate (1) • antisense strand used as template (for mRNA) (1) • RNA polymerase synthesises mRNA (1)		(2)

Question Number	Answer	Additional guidance	Mark
(ii)	A description that makes reference to five of the following: - mRNA leaves through nuclear pores (1) {translation occurs at / mRNA travels to} ribosomes / rough endoplasmic reticulum (1) - codons (on mRNA) pair with anticodons on tRNA / tRNA brings amino acid (to the ribosome) (1) - peptide bonds form between amino acids (1) - amylase enters Golgi and is {modified / processed} / amylase {is packaged into vesicles / travels in vesicles} (1) - exocytosis releases {amylase / protein} (1)	Accept protein for amylase Accept description for exocytosis	(5)

Q19.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	{skin / epidermis} is a barrier / eq ; - reference to keratin ; - reference to lack of receptors (for the virus) ;	Accept prevents entry but not prevents infection NB keratin in skin forms a barrier = 2 marks Accept skin has different receptors	(2)

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	- idea that viruses only {infect / attach to / eq} {specific receptors / specific cells / host cells} ; - idea that receptors not present on {blood cells / endothelial cells / eq} ; - reference to {destruction / eq} of viruses by phagocytes ;	Accept white blood cells. neutrophils; PMN Ignore macrophages Not lymphocytes, T cells, plasma cells	(2)

Question Number	Answer	Additional Guidance	Mark
(b)	- reverse transcriptase (required) in HIV, no reverse transcriptase in cold virus ; - DNA formed (using RNA) in HIV, {no DNA formed / RNA used to make protein / translation} in cold virus ; - reference to {provirus / latency / delay in virus formation / eq} in HIV infection, {no provirus / lytic cycle / (immediate) formation of virus particles / eq} in cold virus ;	NB answers can be pieced together but candidates still have to state both parts of mark point	(2)

Question Number	Answer	Additional Guidance	Mark
(c)(i)	- to synthesise (common cold) RNA / eq ; - for amino acids to bind to tRNA / eq ; - to synthesise (common cold) protein (capsid) / eq ;	Accept translation	(2)

Question Number	Answer	Additional Guidance	Mark
(c)(ii)	- idea of enzyme affecting {molecules in membrane / proteins / (phospho)lipids / cholesterol} ; - enzyme breaks {bonds / named bonds / eq} ; - reference to {(by) hydrolysis / hydrolytic enzymes} ; - credit detail of enzyme action ; - reference to enzyme U as {protease / lipase / cholesterase} ;	eg lowers activation energy, binding of active site to substrate (cannot credit reference to catalyst, as in stem of question) Ignore lysosome	(3)

Q20.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: {bacteria / microbes} cannot {reproduce / undergo binary fission} (1) (because) complementary base pairing cannot occur (1) (because) mRNA synthesis prevented (1)	Accept bacteria cannot replicate / multiply Accept T cannot pair with A Accept no transcription occurs	(2)

Q1.

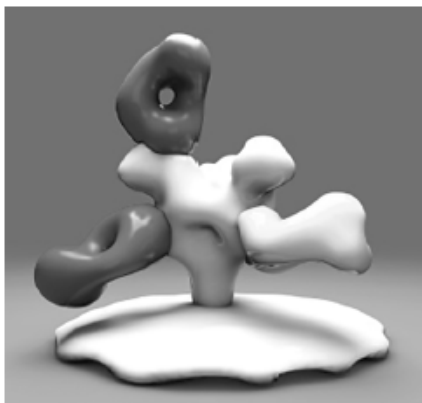
In 2014, the British nurse Will Pooley contracted Ebola. He was given the experimental drug Zmapp and he recovered.

Zmapp contains three monoclonal antibodies that bind to Ebola glycoprotein.

Changes to viral proteins are essential for fusion of the virus with the host cell membrane.

This process delivers the viral RNA into the cell cytoplasm.

The model shows how the three monoclonal antibodies bind to the Ebola glycoprotein.



(i) Analyse the information to explain the success of Zmapp in treating patients with Ebola.

(3)

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(ii) The rate of mutation in the Ebola virus is as fast as that of the influenza virus.

The Ebola genome codes for seven proteins, one of which is the glycoprotein.

Explain what effect a mutation may have on the effectiveness of Zmapp.

(2)

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Q2.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The photographs show a black cat and a Siamese cat.

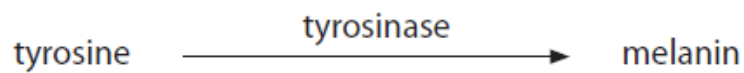


© Tim Macpherson, Cultura/Science photo library



© BSIP Laurent/Gluck/Science photo library

The pigment melanin causes the fur to turn black.
This pigment is produced by tyrosinase, an enzyme coded by the TYR gene.



(i) The diagram shows part of the DNA for the TYR gene.

A	C	C	C	C	A	A	G	G	C	T	C
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Complete the diagram to show the messenger RNA produced by the transcription of this DNA.

(1)

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(ii) Some amino acids have more than one codon.

Which term describes this property of the genetic code?

(1)

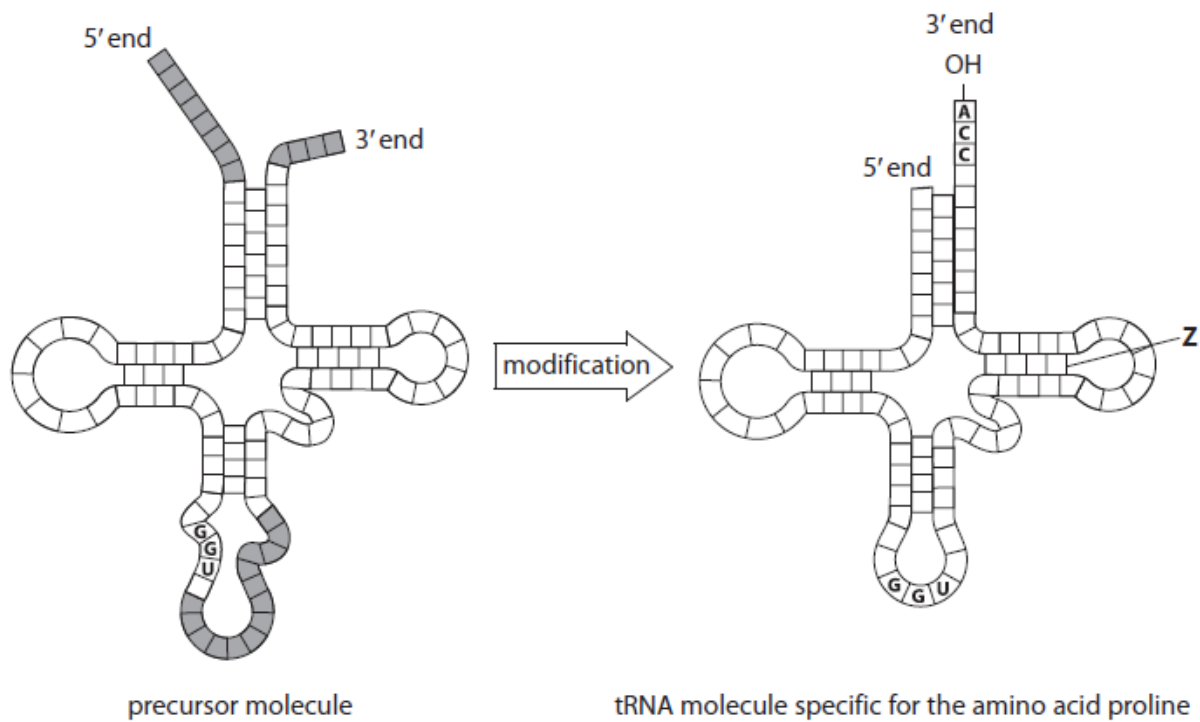
- ☐ **A** degenerate
- ☐ **B** non-overlapping
- ☐ **C** triplet code
- ☐ **D** universal

(Total for question = 2 marks)

Q3.

A molecule of tRNA is made from a precursor molecule that is modified. Modification includes splicing, trimming and attachment of new nucleotides.

The diagram shows a precursor molecule for a tRNA specific for the amino acid proline, and a tRNA molecule specific for the amino acid proline. Some of the bases are shown in each diagram.



(i) Which of the following base sequences is the mRNA code for proline?

(1)

- ☐ **A** A A T
- ☐ **B** C C A
- ☐ **C** C C T
- ☐ **D** C C U

(ii) Which of the following base sequences is the DNA code for proline?

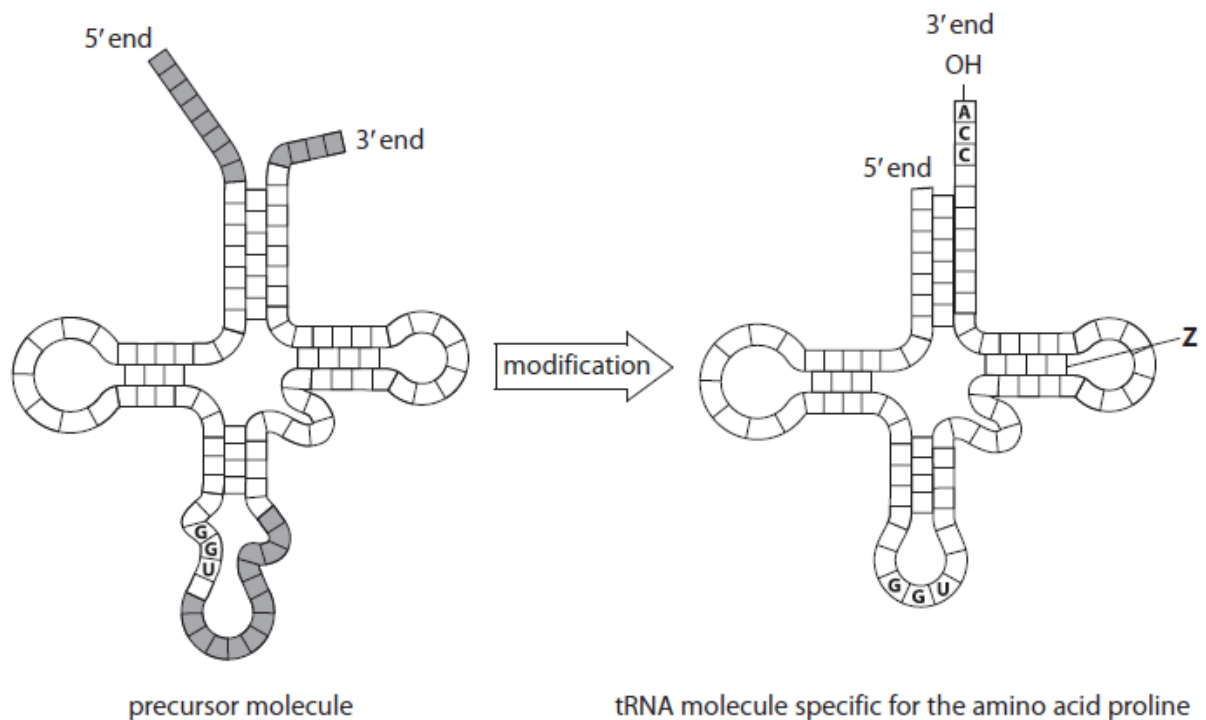
(1)

- ☐ **A** A C C
- ☐ **B** C C A
- ☐ **C** G G T
- ☐ **D** U G G

(Total for question = 2 marks)

A molecule of tRNA is made from a precursor molecule that is modified. Modification includes splicing, trimming and attachment of new nucleotides.

The diagram shows a precursor molecule for a tRNA specific for the amino acid proline, and a tRNA molecule specific for the amino acid proline. Some of the bases are shown in each diagram.



Which bond is labelled **Z**?

(1)

- ☐ **A** glycosidic
- ☐ **B** hydrogen
- ☐ **C** peptide
- ☐ **D** phosphodiester

(Total for question = 1 mark)

Q5.

Sickle cell anaemia is caused by a mutation in the β -globin gene which codes for part of haemoglobin.

The diagram shows the first 10 amino acids in this part of haemoglobin, in a healthy person and in a person with sickle cell anaemia.

Healthy person: val – his – leu – thr – pro – glu – glu – lys – ser – ala

Person with sickle cell anaemia: val – his – leu – thr – pro – val – glu – lys – ser – ala

Explain why the haemoglobin in a person with sickle cell anaemia will fold differently from the haemoglobin of a healthy person.

(4)

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Q6.

In flowering plants, pollen grains grow pollen tubes that are involved in fertilisation, producing a zygote and endosperm.

A scientist investigated the effects of chemical A and chemical B on pollen tube growth.

Chemical A prevents transcription.

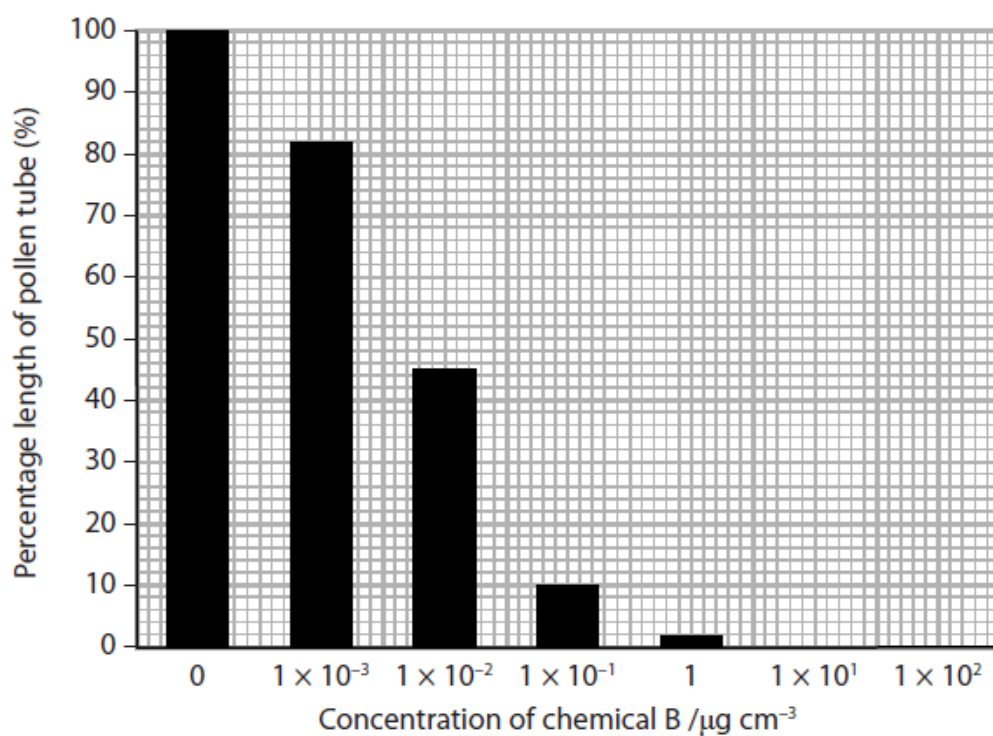
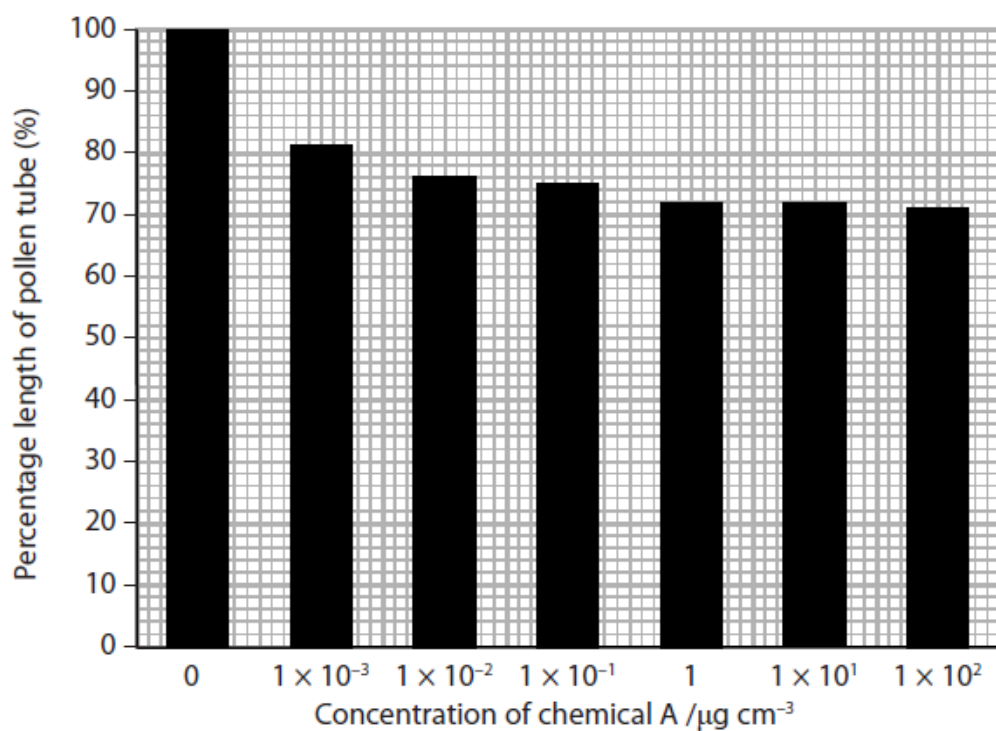
Chemical B prevents translation.

Pollen grains were treated with different concentrations of these two chemicals.

The lengths of the pollen tubes they produced were compared with a control group of pollen grains.

The lengths of the pollen tubes were measured and expressed as a percentage of the control group.

The results are shown in the graphs.



(i) The mean length of the pollen tubes in the control group was 7.5 mm.

Calculate the mean length of the pollen tubes after adding $0.010 \mu\text{g cm}^{-3}$ of chemical A.

(2)

Answer

(ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth.

(4)

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(Total for question = 6 marks)

Q7.

Leukaemia is a type of cancer involving abnormal white blood cells.

In 2015, scientists announced that 1 in 5 people aged 90 or over had mutations linked to leukaemia.

The current UK population is about 64 million, of which 0.8% are aged 90 or over.

(i) Calculate how many people aged 90 or over could have these mutations.

(2)

Answer

(ii) Patients with leukaemia were given injections of radioactive thymidine so that the growth rate of the leukaemia cells could be measured.

Thymidine is a molecule containing thymine and deoxyribose.

Analyse this information to explain how the radioactive thymidine could give an indication of the growth rate of the leukaemia cells.

(2)

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Q8.

Prothrombin is involved in the blood clotting process.

The *F2* gene codes for the synthesis of prothrombin.

This gene is located from base pair 46 719 191 to base pair 46 739 504 on chromosome 11.

Determine the number of codons in this gene.

(1)

Answer

(Total for question = 1 mark)

Q9.

The HIV virus contains an enzyme called reverse transcriptase. This enzyme uses the viral RNA as a template to synthesise a single strand of complementary DNA in the host cell.

(i) A sequence of bases in a section of RNA from HIV is UCCCCAGCG.

Which of the following shows the correct sequence of bases in the single strand of complementary DNA made using reverse transcriptase?

(1)

- ☐ **A** UCCCCAGCG
- ☐ **B** AGGGGTCGC
- ☐ **C** AGGGGUCGC
- ☐ **D** TCCCCTCGC

(ii) Describe how other enzymes convert the complementary single strand of DNA into a double strand of DNA in the host cell.

(2)

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(Total for question = 3 marks)

Q10.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

The nucleic acids, DNA and mRNA, are polymers.

The table shows some components that may be found in a molecule of these nucleic acids.

For each component, put **one** ☐ cross in the appropriate box, in each row, to show where these components can be found.

(4)

Component	Component found in a molecule of			
	both DNA and mRNA	DNA but not mRNA	mRNA but not DNA	neither DNA nor mRNA
Adenine	☐	☐	☐	☐
Hydrogen bonds	☐	☐	☐	☐
Pentose sugar	☐	☐	☐	☐
Uracil	☐	☐	☐	☐

(Total for question = 4 marks)

Q11.

As a result of the destruction of many habitats, the numbers of some species of animals are now so low that they may not be able to survive.

The white rhinoceros, *Ceratotherium simum*, is an example of a mammal that is threatened with extinction.



White rhino
Magnification $\times 0.02$

In southern Africa, many reserves have been set up to protect habitats and animals. These areas are governed by special legislation and monitored by wardens.

(a) Suggest why many scientists consider that the use of protected reserves is likely to be more successful for the conservation of some animals than captive breeding programmes in zoos.

(3)

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*(b) The illegal killing of white rhinoceros (poaching), to obtain their horns, is a serious problem in many of the reserves in southern Africa. When the body of a white rhinoceros is discovered, determination of the time of death is an important part of the police investigation to catch the poachers.

After several days, body temperature and rigor mortis cannot be used to determine the time of death.

Suggest how the time of death of a white rhinoceros could be determined if it is discovered several days after being killed.

(5)

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(Total for question = 8 marks)

Q12.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

(i) Which bonds join the nucleotides in a single strand of DNA?

(1)

☒ **A** peptide

- ☐ **B** disulfide
- ☐ **C** glycosidic
- ☐ **D** phosphodiester

(ii) Describe how the process of DNA replication produces two identical DNA molecules.

(4)

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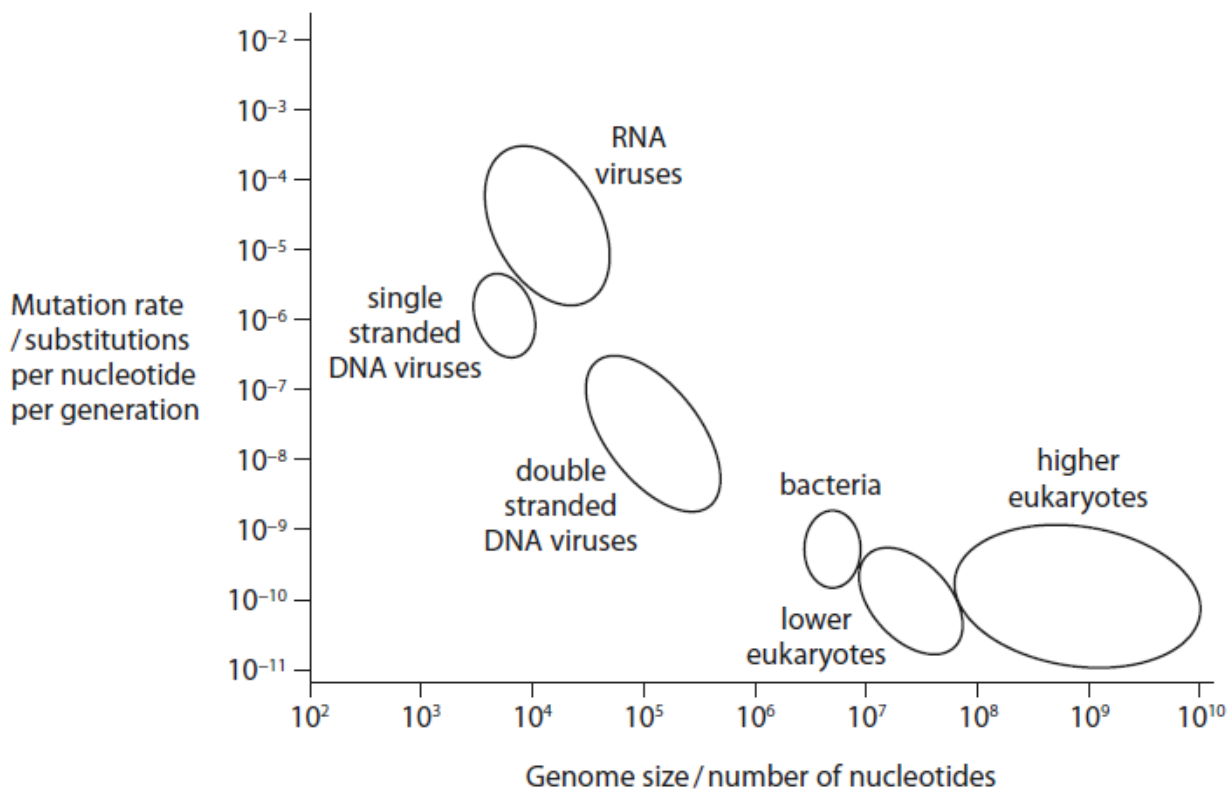
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(Total for question = 5 marks)

Q13.

The graph shows the relationship between genome size and mutation rates of organisms.



(i) Analyse the graph to determine the approximate mutation rate for tobacco mosaic virus (TMV).

(2)

Answer

(ii) Comment on the relationship between genome size and mutation rate of the organisms shown in the graph.

(3)

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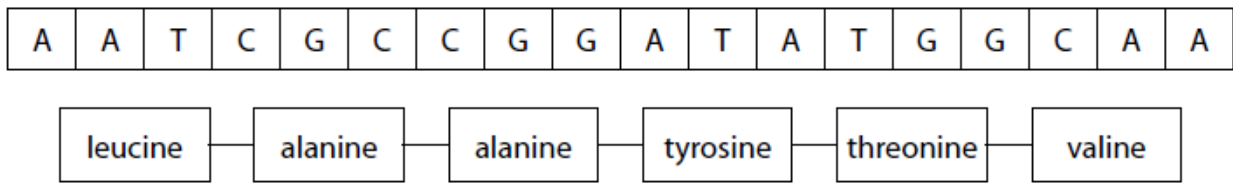
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(Total for question = 5 marks)

Q14.

The diagram below shows the order of bases in a section of DNA that codes for part of a polypeptide chain.



(i) Give the sequence of bases in the mRNA that codes for the amino acid leucine.

(1)

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(ii) Explain how this length of DNA will code for this sequence of amino acids.

(3)

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*(iii) Discuss the possible consequences for this sequence of amino acids if a point mutation occurred in this section of DNA.

(6)

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(Total for question = 10 marks)

Q15.

Enzymes are polymers. A mutation in DNA can lead to a change in the primary structure of an enzyme.

Explain why a mutation might lead to a change in the activity of an enzyme.

(4)

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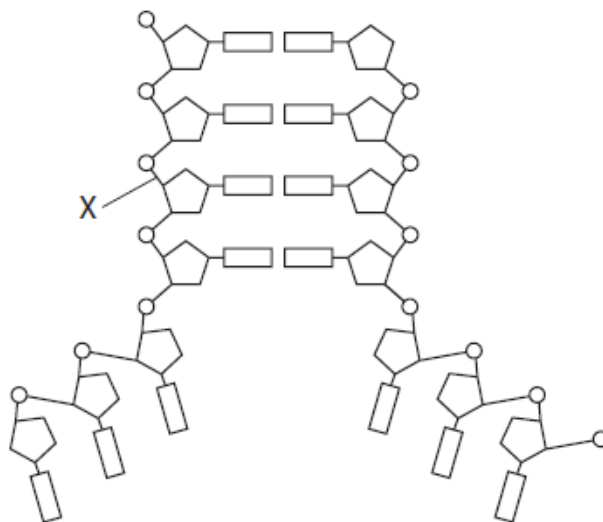
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Q16.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows DNA replication.



Which of the following is the name of the bond labelled X on the diagram?

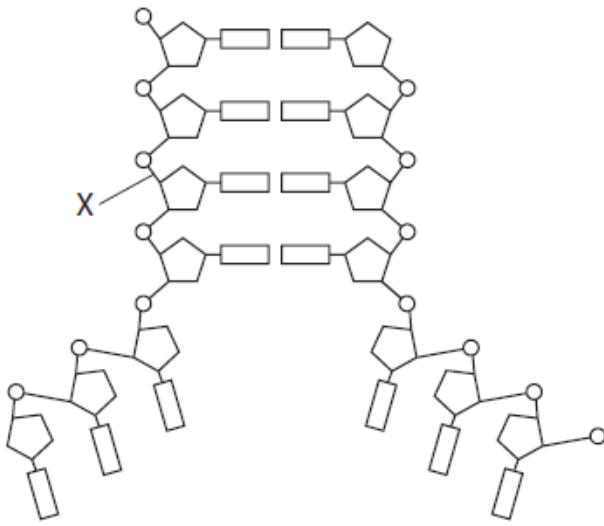
(1)

- ☐ **A** ester
- ☐ **B** glycosidic
- ☐ **C** hydrogen
- ☐ **D** phosphodiester

(Total for question = 1 mark)

Q17.

The diagram shows DNA replication.



Describe the roles of three named enzymes involved in DNA replication.

(3)

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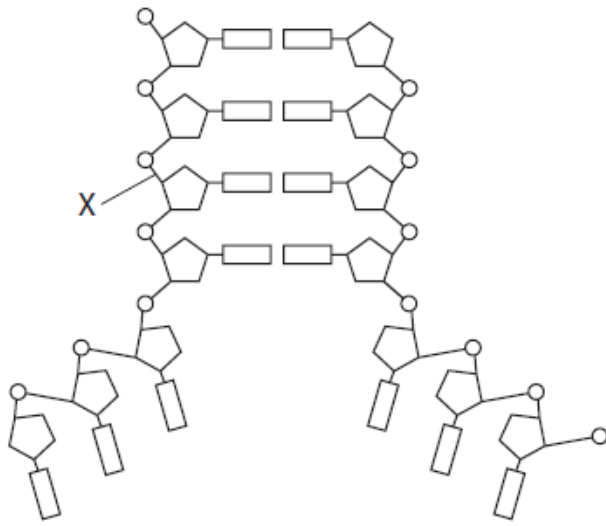
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(Total for question = 3 marks)

Q18.

The diagram shows DNA replication.



A section of double-stranded DNA has a total number of 10 000 nucleotides.

Adenine makes up 35% of the nucleotides in this section of double-stranded DNA.

Calculate the total number of cytosine nucleotides found in this section of DNA.

(2)

Answer

(Total for question = 2 marks)

Q19.

Some antibiotics work by inhibiting the production of ribosomes in bacteria.

The structure of ribosomes in bacteria is similar to the structure of ribosomes in mitochondria.

(i) Describe the structure of a ribosome.

(2)

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(ii) Describe the role of ribosomes in protein synthesis.

(2)

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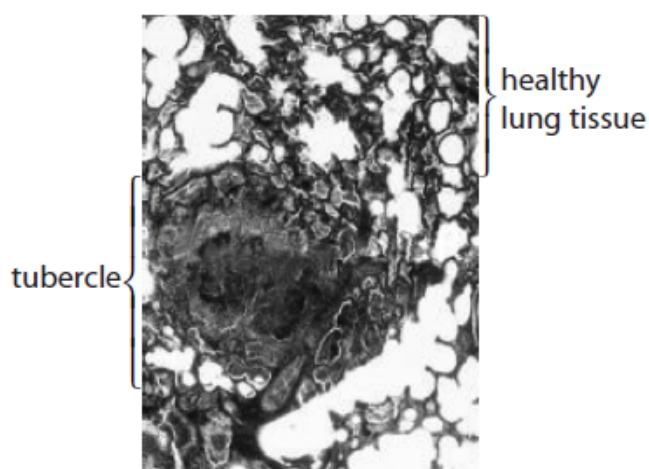
(Total for question = 4 marks)

Q20.

Infection of the lungs with *Mycobacterium tuberculosis* can result in a range of symptoms. These symptoms can include severe breathing problems, a persistent cough and coughing up blood.

The photograph below shows a tubercle in part of a lung infected with *Mycobacterium tuberculosis*, as seen using a light microscope.

A tubercle is a solid mass of dead tissue, macrophages and bacteria.



©John Burbidge/Science Photo Library

Magnification $\times 50$

Using the information in the photograph and your knowledge of gas exchange surfaces, suggest why this infection can result in these symptoms.

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Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An explanation that makes reference to the following: - the three antibodies in Zmapp each bind to a specific part of the viral glycoprotein (1) - therefore the protein cannot change shape and fuse the cell membrane (1) - therefore Ebola RNA cannot enter the cell and the virus cannot replicate (1)		(3)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: - if mutation causes a change in the shape of the glycoprotein, Zmapp may not bind and will not be effective (1) - if mutation occurs in one of the other genes, the shape of the glycoprotein will not be affected and Zmapp will still be effective (1)		(2)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	UGG GGU UCC GAG		1

Question Number	Answer	Mark
(ii)	The only correct answer is A degenerate <i>B is incorrect because non-overlapping refers to discrete reading frames</i> <i>C is incorrect because it simply refers to three bases</i> <i>D is incorrect because it refers to the same code in all organisms</i>	1

Q3.

Question Number	Answer	Mark
(i)	The only correct answer is B <i>A is not correct because G binds to C and U to A</i> <i>C is not correct because G binds to C and U to A</i> <i>D is not correct because G binds to C and U to A</i>	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is C <i>A is not correct because C binds to G and A binds to T on DNA</i> <i>B is not correct because C binds to G and A binds to T on DNA</i> <i>D is not correct because C binds to G and A binds to T on DNA</i>	(1)

Q4.

Question Number	Answer	Mark
	The only correct answer is B <i>A is not correct because glycosidic bonds join monosaccharides together</i> <i>C is not correct because peptide bonds join amino acids together</i> <i>D is not correct because phosphodiester bonds join adjacent mononucleotides together</i>	(1)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - substitution of val for glu, which has a different { R / residual } group (1) - val (R-group) has no positive charge (1) - therefore ionic bond lost (1) - therefore tertiary structure changes (1)	Allow glu has a positive charge	(4)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	- reading from graph at 1×10^{-2} - reading multiplied by 7.5 and divided by 100	<u>Example of calculation:</u> 76 % $76 \div 100 \times 7.5 \text{ mm} = \underline{5.7 \text{ mm}}$ Accept 5700 μm TE for wrong reading from graph A Correct answer gains full marks 5.7 with no units = maximum 1 mark	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to four of the following: • {chemical A / stopping transcription} has {less effect / smaller reduction} on pollen tube growth (1) • growth levels off when chemical A increases and growth {falls steeply / drops to zero} when chemical B increases (1) • mRNA is already present (1) • (pollen tube) growth requires production of new proteins / enzymes (1)	Accept converse for chemical B / stopping translation Accept correct mathematical comparison e.g. overall chemical A causes a 29% drop and chemical B causes a 100 % drop Accept transcription occurred before chemical A added Accept pollen tube cannot grow without synthesis of new proteins	(4)

Q7.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An explanation that makes reference to the following: - correct calculation of UK population 90 and over (1) - correct calculation of number of people with mutations (1)	<u>Example of calculation</u> 0.8% of 64 million = $(0.8 \div 100) \times 64\,000$ $000 = 512\,000$ 1 in 5 of 512 000 = 102 400 Correct answer with no working gains full marks	(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: - radioactive { thymine / thymidine / deoxyribose } is used in DNA synthesis (1) - therefore daughter cells having radioactive DNA gives a measure of growth rate (1)		(2)

Q8.

Question Number	Answer	Additional Guidance	Mark
	6771		(1)

Q9.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	B		(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	A description that makes reference to the following: - DNA polymerase to join nucleotides / bases / formation of phosphodiester bonds (1) - ligase to join DNA sections (1)		(2)

Q10.

Question Number	Answer				Additional Guidance	Mark
		Component found in a molecule of				
	Component	both DNA and mRNA	DNA but not mRNA	mRNA but not DNA	neither DNA nor mRNA	
	Adenine	X	☐	☐	☐	
	Hydrogen bonds	☐	X	☐	☐	
	Pentose sugar	X	☐	☐	☐	
	Uracil	☐	☐	X	☐	

Q11.

Question Number	Answer	Additional guidance	Mark
(a)	1. idea of less {stress / trauma / discomfort / depressed / eq} (for the animals) ; 2. idea that animals are more likely to breed in natural environment ; 3. idea that animals may require large areas ; 4. idea that problems of releasing animals back into the wild is avoided eg habituation ; 5. idea that {disease is less likely / disease will not wipe out population} ; 6. idea of allowing (natural) {interspecific relationships / communities} to exist ; 7. idea of allowing (natural) {intraspecific relationships / family / social / eq} {structure/ behaviour} ; 8. (because) large numbers of animals needed / wider gene pool / eq ; 9. idea that (natural) {diet / food / eq} available ;	Accept converse argument throughout 6. Accept reference to maintaining their niche	(3)

Question Number	Answer	Additional guidance	Mark
*(b)	(QWC– Spelling of technical terms (<i>in italics</i>) must be correct) 1. reference to <i>succession</i> ; 2. reference to (<i>forensic</i>) <i>entomology</i> ; 3. example of {insect / eq} e.g. <i>fly</i>, <i>beetle</i>, <i>wasp</i> ; 4. idea that the {types / <i>species</i> / life cycle stages} (of insects) are used ; 5. reference to {<i>decomposition</i> / <i>decay</i> / eq} ; 6. idea that there are different stages of {<i>decomposition</i> / <i>decay</i> / eq} ; 7. detail of {<i>decomposition</i> / <i>decay</i> / eq} e.g. production of <i>gases</i>, <i>liquefaction</i> of <i>tissue</i>, <i>bloating</i>, <i>discolouration</i> ; 8. reference to rate of {<i>succession</i> / <i>insect development</i> / <i>decomposition</i>} influenced by {external factor / appropriate named factor} ; 9. idea that insect and decomposition information is used to determine time of death ;	Penalise spelling once 1. Accept in context of either insects or decomposition 3. Named insect must be spelt correctly 6. Accept if 2 or more stages listed 8. Named <i>factor</i> must be spelt correctly	(5)

Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	D phosphodiester <i>A is incorrect because peptide bonds are found in proteins</i> <i>B is incorrect because disulfide bonds are found in proteins</i> <i>C is incorrect because glycosidic bonds are found in carbohydrates</i>		1
(ii)	A description that makes reference to four of: - hydrogen bonds between nucleotides broken by DNA helicase (1) - complementary nucleotides bind (1) - because {hydrogen bonds} will only form between cytosine and guanine and adenine and thymine (1) - phosphodiester bonds are formed by DNA polymerase (1) (the leading strand is synthesised continuously but lagging strand required) DNA ligase to join fragments (on lagging strand) (1)	Allow unzipped by helicase	4

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	<i>An answer that makes reference to:</i> - correct indication of selection of RNA virus (for TMV) (1) - correct use of graph to identify intercept between 0.000001 and 0.0005 (1)	Allow correct use of standard form e.g. 10^{-4} Allow ecf for correct use of y axis with wrong selection of virus type correct answer gets both marks	2
(ii)	<i>An answer that makes reference to three from:</i> - as genome size increases, mutation rate decreases (1) - RNA / ss DNA / ss nucleic acid has a higher mutation than ds DNA (1) - because it is single stranded template so does not produce copies with complementary bases / is less stable (1) - viruses have a higher mutation rate than bacteria / eukaryotes (1)	Allow converse / allow correlation Allow eukaryotes have lowest mutation rates Allow RNA viruses have highest mutation rates	3

Q14.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	UUA		(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: 18 bases code for six amino acids (1) plus any two from: - because genetic code is made up of triplets of bases (1) - because the code is degenerate, some amino acids can have more than one code (1) - because of non-overlapping code (1)		(3)

Question Number	Indicative content	
*(iii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Frame shift effect due to addition / deletion • Replace amino acid due to substitution • No effect on amino acids due to substitution • Degeneracy of code due to substitution • Shorter due to stop codon • Consequence for protein structure explained	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed, which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed, which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Q15.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • (a mutation results in) a different sequence of amino acids (1) • therefore different R groups / side chains (1) • resulting in changes to { ionic / hydrogen bonding / disulphide bridges } (1) • change in shape of active site causing a change in enzyme activity (1)		(4)

Q16.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is: D phosphodiester <i>A is incorrect as this bond is found in lipids</i> <i>B is incorrect as this bond is found in carbohydrates</i> <i>C is incorrect as this bond pair bonds nucleotides</i>		1 comp

Q17.

Question Number	Answer	Additional Guidance	Mark
1(b)	A description that makes reference to the following points: • {DNA polymerase} {joins the sugar phosphate backbone (between nucleotides) / forms phosphodiester bonds / joins adjacent nucleotides} (1) • DNA {ligase} {joins fragments of DNA / short pieces of DNA / Okazaki fragments} (1) • DNA {helicase} {breaks hydrogen bonds / unzips double helix / separates strands} (1)	Accept {RNA primase} makes {RNA to start replication of DNA}	3 expert

Q18.

Question Number	Answer	Additional Guidance	Mark
	A calculation that <u>makes reference</u> to the following points: • correct calculation of percentage cytosine (1) • correct calculation of number of nucleotides (1)	15 % cytosine 15 % of 10 000 = 1500 Correct answer with no working gains full marks One mark for 15 %	2 grad

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: - composed of protein and RNA (1) (arranged in) two {(sub) units / parts} (1)	ACCEPT large and small subunit / 60S and 40Ssubunit / 50S and 30S subunit	(2)
(ii)	An answer that makes reference to two of the following: - translation (1) - to hold the tRNA on the mRNA (1) - whilst peptide bonds form to join (adjacent) amino acids together(1)		(2)

Q20.

Question Number	Answer	Additional Guidance	Mark
	1. idea that the {alveoli / air sacs / lung / tissue } have been {replaced / destroyed / eq} (by the tubercle) ; 2. idea that the (tubercle / destroyed lung tissue) has reduced the (surface) area (of the lung) ; 3. breathing problems due to { gas exchange being reduced / less oxygen in blood / eq } ; 4. idea that the coughing is { due to irritation /to remove the dead tissue / eq} ; 5. blood coughed up is due to damage of (lung) blood vessels / eq ;	1 IGNORE blocks 4 ACCEPT tubercle 5 IGNORE idea that lung damage causes bleeding	(4)