EUNOIA JUNIOR COLLEGE
JC1 Promotional Examinations 2021
General Certificate of Education Advanced Level
Higher 2

H2 Biology

Paper 1 Multiple Choice

9744/01

05 October 2021

1 hour

ANSWERS

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction tape/fluid.
Write your name, civics group and registration number on the Answer Sheet in the spaces provided.

There are **thirty** Multiple Choice Questions in this paper.

Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages.

1 Raffinose is a trisaccharide which can be degraded by enzymes. The results of two different enzymatic incubations are shown here:

enzyme used	products
sucrase	melibiose and fructose
galactosidase	galactose and sucrose

Which statements are consistent with the results shown above?

1 Raffinose is composed of two different monosaccharides. (False – from the table, besides fructose and galactose, we can derive that the other monosaccharide is glucose, as sucrose = fructose + glucose)

2 Melibiose is a dissaccharide. (True – from digestion by sucrose; melibiose is made up of glucose and galactose)

3 Acid hydrolysis of raffinose would yield glucose. (True – the high heat and acid would hydrolyse the glycosidic bond joining glucose and fructose in sucrose, yielding glucose as stated)

4 The products of raffinose digestion by sucrase and galactosidase will each yield an orange-red precipitate when heated with Benedict's reagent. (True – since both fructose and glucose will be released and these reducing sugars will give an orange-red ppt with Benedict's test).

A 1 and 3 only

B 2 and 4 only

C 2, 3 and 4 only

D 1, 2, 3 and 4

2 In triglyceride molecules, where are carbon-carbon double bonds located?

A between fatty acids and glycerol (the ester bond has a carbon-oxygen (C=O) double bond)

B within fatty acids and within glycerol (no carbon-carbon double bonds within glycerol)

C within fatty acids only (only the fatty acid chains have the carbon-carbon (C=C) double bonds)

D within glycerol only (no carbon-carbon double bonds)

3 Which correctly matches the functional and structural features of cellulose, collagen, glycogen and triglyceride?

		function	structure		
			fibrous	molecule held together by hydrogen bonds	branched chains
A	cellulose triglyceride	support energy source	✓ ×	✓ ×	× ×
B	collagen cellulose	strengthening support	✓ ✓	✓ × (only inter-chain)	× ✓ (x)
C	collagen glycogen	strengthening storage	✓ ×	✓ ×	✓ (x) ✓
D	glycogen triglyceride	storage energy source	× ×	✓ (x) ✓ (x)	✓ ×

key: ✓= true ✗= false

4 Which row about the structure of proteins is correct?

	primary structure	tertiary structure	quaternary structure
A	is the number (x) of amino acids present in a protein	is the result of cross bonding between all (x) the amino acids in the primary structure	is the polypeptides that link together to form a protein (maybe - unclear)
B	is the order of amino acids present in a protein encoded by DNA (maybe)	is the shape formed by folding of a polypeptide and held together by hydrogen bonds (not just hydrogen bonds)	contains two types of polypeptide that interact forming the shape of a protein (vague about 'two types of polypeptide')
C	is the result of translation of an mRNA molecule by a ribosome into a chain of amino acids (does not describe the structure!)	is the result of ionic and hydrogen bonds, disulfide bridges and hydrophobic interactions between amino acids (correct but missing reference to side chains of amino acids)	is formed by four polypeptides and an additional reactive group attached to the protein (not necessary must be four polypeptides and reactive group vague)
D	is the sequence of amino acids in a protein coded by an mRNA molecule	is formed as a result of interaction of the side chains of amino acids in the primary structure	is formed by the linking together of more than one polypeptide to form a protein

5 During the development of HIV, the polyprotein is hydrolysed by a HIV protease enzyme, producing several smaller peptides. This viral enzyme is the target of new anti-AIDS drugs.

Which feature is essential for the success of these drugs? (Specifically targeting HIV protease)

A A complex structure that inhibits many types of viral and non-viral enzymes. (Not good as the drug is not specific and may target the host's enzymes too!)

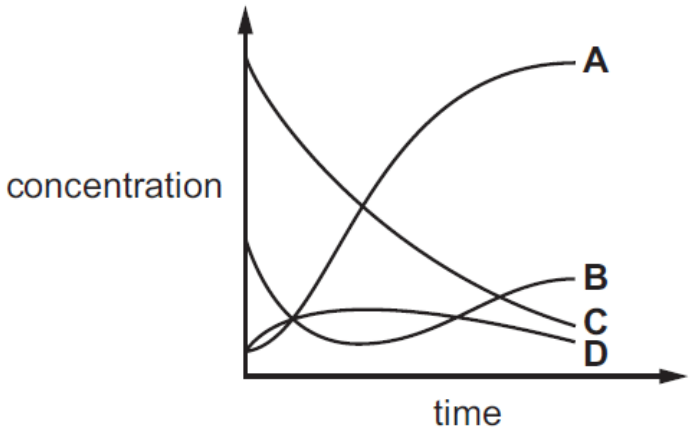
B A molecule containing a heavy metal atom that is a non-competitive inhibitor of enzymes. (Speculative that heavy metal atom is a non-competitive inhibitor of all enzymes! Even if true, still not specific and may target host's enzymes!)

C A protein that can act as a competitive inhibitor of protease enzymes. (Again not specific and could target host's enzymes!)

D A specific structure that inhibits only HIV protease.

6 The graphs show how the concentration of different components of an enzyme-catalysed reaction (e.g. substrate, active sites) changes with time. (Take note!)

Which graph represents enzymes with empty active sites? **B**



A – Concentration of empty active sites should not increase with time continuously.

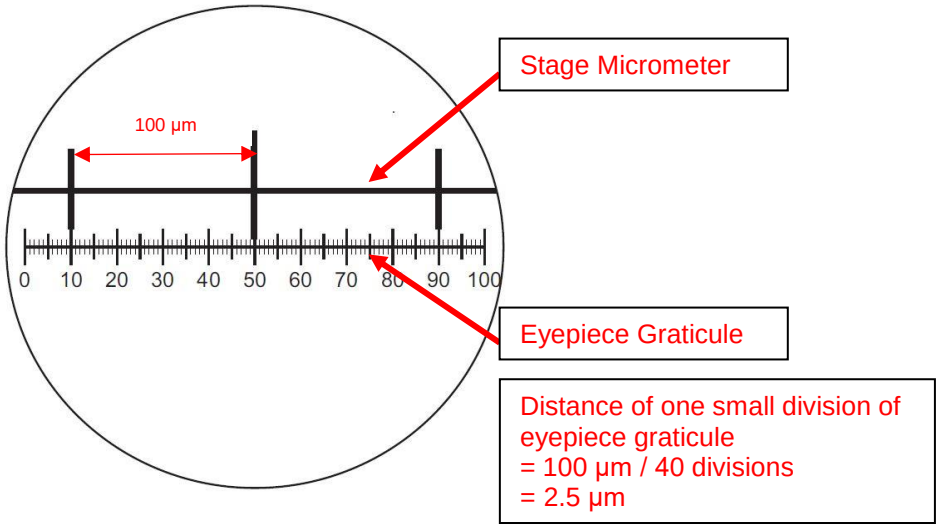
B – Concentration of empty active sites **decreases initially** as substrates bind to the empty active sites (and are converted to products). However, as more substrates are converted to products, concentration of substrate decreases over time, so more active sites become empty again. Hence, concentration of empty active sites **increases**.

C – (*see explanation for option B*)

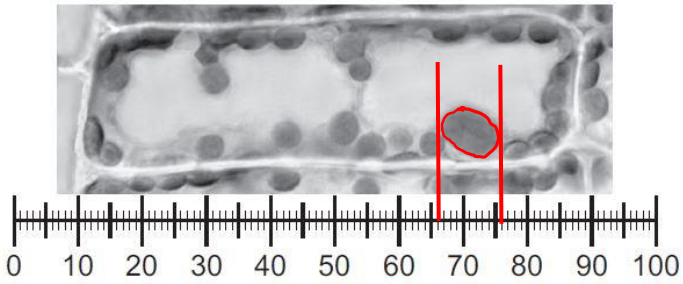
D – Concentration of empty active sites should not increase during the initial course of the reaction.

7 The diagram shows a stage micrometer scale viewed through an eyepiece containing a graticule.

Each small division of the stage micrometer scale is 0.1 mm. (100 µm)



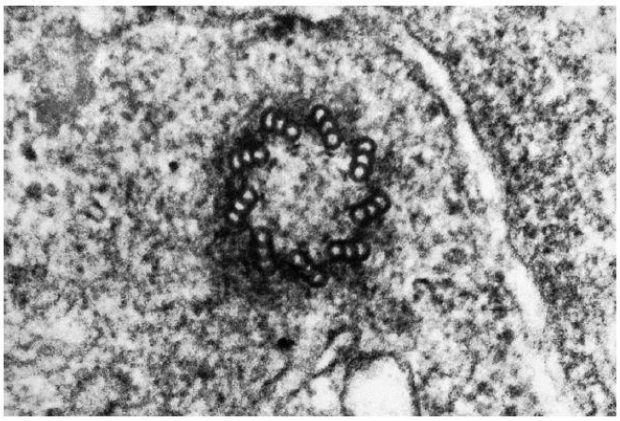
The stage micrometer scale is replaced by a slide of a plant cell. (Note position of eyepiece graticule as compared to previous diagram, its position has not changed, so the scale above it in the previous diagram must have been stage micrometer.)



What is the actual length of the nucleus in the plant cell?
(10 graticule units or 25 µm – option B)

A 8 µm **B** 25 µm **C** 200 µm **D** 0.8 mm

8 The electron micrograph shows a cell structure in a eukaryotic cell.



Structure shown is one of the pair of centrioles in an animal cell.

Pay attention to whether the question provides information on whether the cell is an animal cell or plant cell. If not, you have to infer based on the context of the question.

Which statement(s) about this cell structure is/are correct?

1 ATP is synthesised in this cell structure. (False)

2 The cell structure is made of protein molecules. (True – centrioles contain microtubules which are made of tubulin subunits and tubulin is a protein)

3 The cell structure replicates during interphase of the cell cycle. (True – duplication of centrioles occurs in interphase, but note that centrioles are absent in the cells of higher plant and most fungi)

A 3 only **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

9 Which description of cell surface membrane permeability is correct?

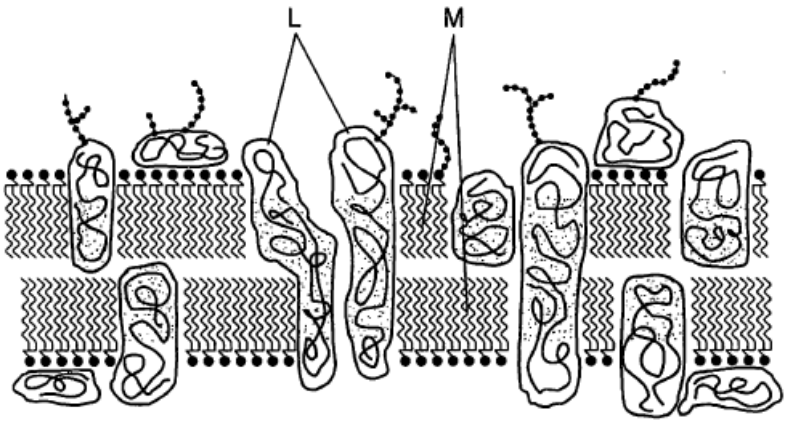
A An increase in the concentration of cholesterol molecules in the cell surface membrane can increase its permeability to hydrophilic substances. (False – should be decrease permeability instead as cholesterol is generally hydrophobic)

B Cell surface membrane permeability to large hydrophilic molecules is high and can be increased by membrane transport proteins involved in facilitated diffusion. (False – size of molecule may have a negative impact on membrane permeability either directly through membrane or via membrane transport proteins (e.g. Pore/channel of these proteins have limited width)

C The permeability of the cell surface membrane to ions increases as the proportion of saturated fatty acid chains in the phospholipids increases. (False – an increase in proportion of saturated fatty acid chains in the phospholipids will lead to closer packing (decrease membrane fluidity and permeability)

D Without the presence of carrier and channel membrane proteins, the cell surface membrane has a low permeability to large polar molecules. (True – by reading of option D statement for accuracy and by elimination of preceding three options)

10 The diagram below shows part of the cell surface membrane of an animal cell.



Which statement(s) correctly describe(s) the movements of molecules across this membrane?

1 Oxygen diffuses through molecules M. (small, non-polar oxygen molecules can pass through the phospholipid bilayer via simple diffusion)

2 Water may move through L via osmosis. (through aquaporin channels)

3 L has hydrophilic R groups that may allow facilitated transport of water. (yes)

4 Water may pass through M via osmosis. (very, very slow process but possible)

A 4 only

B 1 and 3 only

C 1, 2 and 3 only

D All of the above

11 When living pancreatic cells were placed in a solution of a red stain called neutral red, the cytoplasm became red. The cells were then removed from the solution of neutral red. (Living cells carry out processes like respiration, synthesis of biomolecules, cell division, etc.)

The red stain in the cytoplasm moved into vesicles, which were exported from the cell, eventually leaving the cell colourless. (Stain left the cells by transport process involving vesicles, likely exocytosis)

In another experiment, a respiratory inhibitor was placed into the solution and the cell remained colourless. (Respiration inhibited, no ATP synthesized, thus no active transport of stain INTO cell)

Which transport mechanism(s) could explain how the red stain entered and left the cells?

A active transport (accounts for entry but not exit of stain molecules)

B osmosis and exocytosis (osmosis could explain entry of water molecules, BUT not stain molecules)

C facilitated diffusion and endocytosis (facilitated diffusion and entry of stain molecules should not be affected by respiratory inhibitors as described above)

D active transport and exocytosis (best answer using the available information given)

12 The following statements describe various nucleic acids in eukaryotes.

1 a polynucleotide of variable length formed by a process which involves complementary base pairing (mRNA – its length depends on the gene size)

2 a small polynucleotide with a specific three-dimensional shape (tRNA – presence of intramolecular hydrogen bonds and folding give rise to its 3D conformation)

3 a large polynucleotide with a specific shape associated with proteins (ribosome = rRNA with ribosomal proteins)

4 a large polynucleotide with supercoiled sections associated with proteins (DNA with histones)

Which row correctly matches the description to the function of the nucleic acid?

	carrier of specific amino acids	catalyst of protein synthesis	carrier of coded information	long-term storage of coded information
A	2	4	3	1
B	3	2	4	1
C	2	3	1	4
D	1	3	2	4

Option A not possible because: DNA cannot catalyse protein synthesis, only peptidyl transferase enzyme (catalytic rRNA) in ribosome can catalyse peptide bond formation. Ribosomes do not carry coded genetic information, ribosomes translate coded genetic information in mRNA into proteins. mRNA is not a **long-term** storage for genetic information but DNA is.

Option B not possible because: rRNA does not carry specific amino acids, only tRNA can. tRNA does not have catalytic function. DNA for long-term storage of genetic information, not just carrier of coded information.

Option D not possible because: mRNA does not carry specific amino acids. tRNA does not carry coded genetic information.

13 Which statement(s) about DNA polymerases and RNA polymerases is/are correct?

1 They read the DNA template in the 3' to 5' direction. (True - RNA polymerase reads DNA template during transcription and DNA polymerase reads DNA template during DNA replication for both leading and lagging strand synthesis)

2 They catalyse the formation of hydrogen bonds between complementary base pairs. (False – both DNA and RNA polymerases catalyse formation of phosphodiester bonds! Hydrogen bond formation does not need catalysis by an enzyme. Also notice that the formation of bonds is between complementary base pairs, not adjacent bases!)

3 They read the terminator sequence and stop adding nucleotides to nucleic acid chains. (False – Only true for RNA polymerase)

3 They bind to the same specific sequences to start their processes. (False – Origin of replication and promoter region for transcription have different sequences)

Notice all four statements started with the word 'THEY', referring to BOTH DNA and RNA polymerase!

A 1 and 3

B 2 and 3

C 1 only

D 4 only

14 The following steps describe a method to study the structure and localisation of protein kinase c in yeast cells. (Study structure and where protein kinase c is located at a point in time in yeast cells, basically to track synthesis of this protein)

- tRNAs with anticodon AAG were isolated and chemically modified to carry their specific fluorescent amino acids. (They will attach to mRNA codon UUA and carry the fluorescent amino acid to the ribosome)
- During translation, chemically modified amino-acyl tRNAs bind to the large ribosomal subunit. (The above modified tRNAs will bind to large ribosomal subunit during translation)
- Fluorescent amino acids are incorporated into the elongating polypeptide chain. (As stated)
- After translation, the polypeptide chain folds into its native conformation and the positions of the fluorescent amino acids can be detected and studied. (As stated, the fluorescence allows researchers to visually 'see' where the proteins synthesised using these chemically modified tRNAs and amino acids are located)

Which of the following describes a condition which will allow the above method to be carried out? (What is the best and most suitable situation that the above will work based on the description given and show the anticipated results?)

A Amino-acyl tRNA synthetase is specific to the fluorescent amino acid and chemically modified tRNA in order to form modified amino-acyl tRNA. (This is what a normal amino-acyl tRNA synthetase should have – catalytic site that is complementary to the specific amino acid and the specific tRNA molecule with specific anticodon! It just needs to now be specific to the modified substrates!)

B Peptidyl transferase is specific to the fluorescent amino acid and the elongating polypeptide chain in order to catalyse the formation of a peptide bond. (No mention above that peptidyl transferase needs to be modified and there did not seem to be any problems with elongation of polypeptide chain as described above. So probably this enzyme does not need a complementary active site specifically for fluorescent amino acids)

C The ribosome is specific to the mRNA sequence in order to synthesise protein kinase c. (Generic statement for any situation and not accurate as the ribosomes are not specific to any mRNA sequence anyway!)

D Chemically modified amino-acyl tRNA is specific to the P site of a large ribosomal subunit in order to add the fluorescent amino acid to the elongating polypeptide chain. (Same as C, the P site is not specific to these chemically modified amino-acyl tRNAs)

15 Below are descriptions of different gene mutations.

1 deletion toward the end of the code sequence (possible frameshift near to end of code sequence, not absolute as it could involve deletion of a complete codon!)

2 insertion in the middle of code sequence (possible frameshift for about half of the code sequence, not absolute because it could involve insertion of a complete codon!)

3 substitution close to the beginning of the code sequence (possible change in one codon)

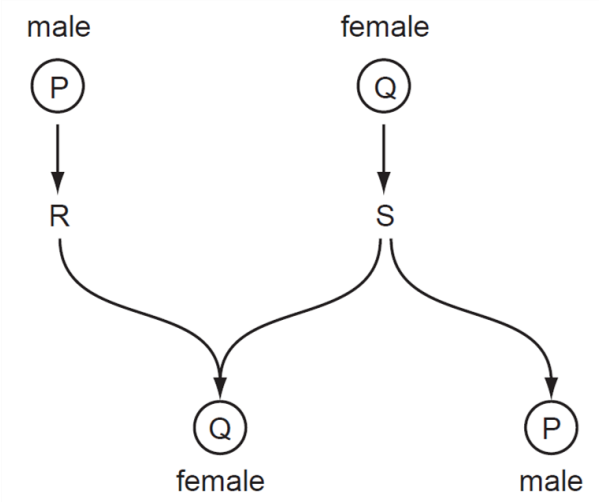
Which row correctly identifies the possible effects of these mutations on the synthesis of polypeptides?

	premature ending of a polypeptide	a non-functional polypeptide	a polypeptide with unchanged function	a polypeptide with a different function
A	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3
B	1, 2, 3	2 only (1 and 3 possible to lead to non-functional protein)	1, 3 only (2 possible as described above that insertion of an additional amino acid in the sequence may not change its function)	1, 2 only (3 likely possible to give this effect)
C	1, 3 only (2 also possible)	1, 2, 3	3 only (All three scenarios possible for this to happen)	1, 2, 3
D	2, 3 only (1 possible since a polypeptide with just one less amino acid at the end can be considered prematurely ended)	2, 3 only (1 possible since a polypeptide with one less amino acid at the end can lead to a non-functional protein if the interactions of missing R groups are very important for its conformation and function)	1, 2, 3	2, 3 only (1 possible since a polypeptide with either frameshift due to deletion of one base or deletion of a codon at the end of sequence lead to change of amino acid sequence and hence change to interaction of R groups changing conformation and function of protein)

16 What are the conditions in a human cell just before the cell enters prophase? (Interphase completed, meaning S phase with doubling of DNA content and formation of sister chromatids completed)

	number of chromatids	number of molecules of DNA in nucleus	spindle present	nuclear envelope present
A	46 (S phase completed, so 92)	46	yes	no
B	92	46 (each sister chromatid is a DNA molecule so should be 92)	no	yes
C	46	92	yes	yes
D	92 (46 x 2)	92 (46 x 2)	no (no spindle prior to prophase)	yes (still present prior to prophase)

17 Sex determination in some insects, such as bees and wasps, is not controlled by sex chromosomes, but by ploidy level. Males are haploid, while females are diploid.



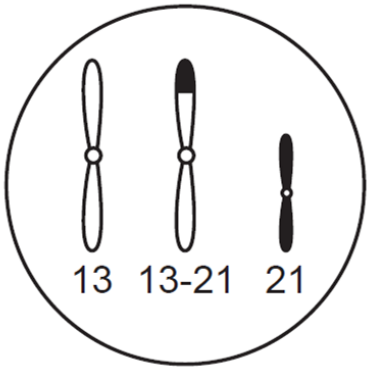
This was a relatively easy question as the clue that males are haploid and females are diploid would allow most candidates to narrow down the choice to option B. Males would produce gametes by mitosis instead of meiosis, while females would produce gametes by meiosis.

Which row correctly describes P, Q, R and S?

	P	**Q**	**R**	**S**
A	n	n	mitosis	mitosis
B	n	2n	mitosis	meiosis
C	2n	n	meiosis	meiosis
D	2n	2n	meiosis	mitosis

18 Down's syndrome can be caused by a trisomy of chromosome 21, but can also result from translocation of chromosome 21 onto chromosome 13, forming a single chromosome 13-21.

The diagram shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45. (This cell is already missing one chromosome 21).

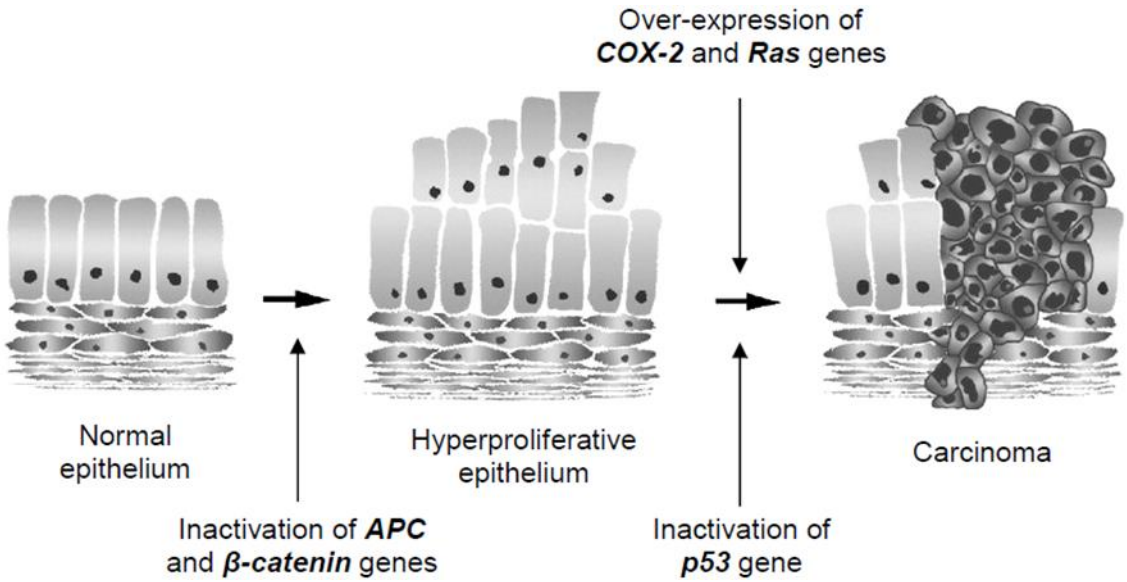


Which is not a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	embryo
A	13 and 21	2n = 46 normal phenotype
B	13-21	2n = 45 normal phenotype
C	13-21 and 21	2n = 46 Down's syndrome
D	13-21 and 21	2n = 47 Down's syndrome

NOTE: All chromosome permutations are possible except 2n = 47 because in this case, the Down's syndrome is not due to an extra *and separate* chromosome but due to translocation to an existing chromosome. So 2n should be either 45 or 46.

19 The diagram below illustrates the development of colorectal cancer.



Which of these statements can be inferred from this multistep model of carcinogenesis?

1 Cells whose *APC* and *β-catenin* genes are inactivated have lost contact inhibition. (True – note the additional layer of epithelium that is in the second figure above)

2 *APC* and *β-catenin* genes are most likely tumour suppressor genes. (True – the figure above referred to their 'inactivation' or possibly becoming 'non-functional' and thus hinting at possible loss of function mutation in tumour suppressor genes)

3 High levels of *Ras* protein are produced only when both copies of *Ras* gene are mutated. (False – *Ras* is a proto-oncogene, hence gain of function mutation can occur in one copy of the gene)

4 Two copies of normal *p53* alleles must be present to inhibit cell division. (False – both copies of p53 alleles must be mutated for p53 protein to LOSE its function)

5 Gain-of-function mutation in *COX-2* gene is one of the pre-requisites for the formation of carcinoma. (True – based on above diagram and the multi-step model of cancer)

A 1, 2 and 3

B 1, 2 and 5

C 2, 3 and 4

D 2, 3 and 5

20 Cancer cells may divide by far more divisions than other cells found in humans.

Which statements about cancer cells are correct?

1 They are able to synthesise the enzyme telomerase. (True – in this context of the question)
2 They have a mutation in the telomeres so DNA is not hydrolysed. (False – telomeres shorten due to the end-replication problem, their inability to shorten is not due to a mutation and has no bearing on cancer development)
3 They have DNA polymerase so they can replicate their DNA without telomere loss. (False - all cells have DNA polymerase and the end-replication problem cannot be overcome!)
4 They increase the number of copies of repeated DNA sequences in the telomeres. (True – with active telomerase, the number of copies of repeated DNA sequences in telomeres will increase)

A 1, 2 and 4

B 1 and 4

C 2 and 3

D 3 and 4

21 The protein retinoblastoma, RB, is a tumour suppressor protein encoded by a single gene on chromosome 13 of the human genome. (There is a corresponding allele on the other chromosome 13)

On which of the following would mutation most likely result in retinoblastoma cancer?

A One RB gene on each chromosome 13. (Both copies of the RB alleles are mutated)

B One RB gene on one chromosome 13. (Not likely as tumour suppressor gene mutation leading to cancer occurs in both genes)

C Two RB genes on each chromosome 13. (Incorrect – TWO RB genes on EACH chromosome contradicts the information given in the question!)

D One RB gene on one chromosome 13 and the other RB gene, by translocation, on one chromosome 6. (No information given that translocation would lead to cancer)

22 Which statement correctly describes a role of histone proteins?

A All eukaryotic genes are transcribed continuously because they are not packaged by histones. (False – all eukaryotic genes are associated with histones! Gene expression of eukaryotic genes is not just regulated by packaging by histones. Not all genes are expressed in a cell at a particular time anyway!)

B DNA must be selectively released from its histone packaging before transcription can occur in bacteria. (False - DNA is not associated with histones in bacteria!)

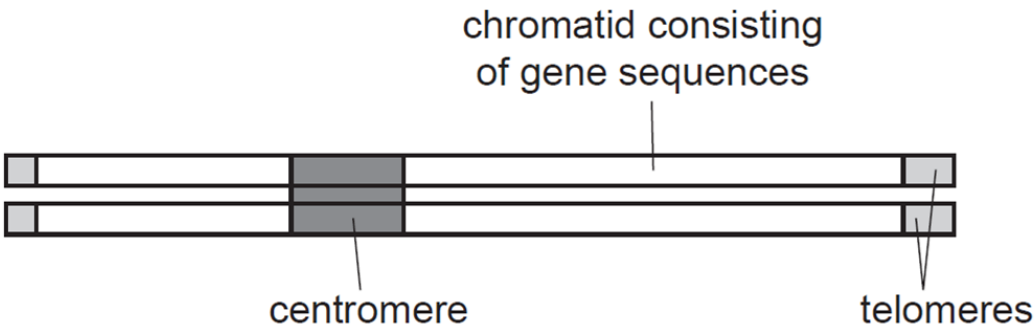
C Histones package prokaryote chromatin into the nucleosomes that form the bulk of the chromosome. (False - Note the word 'prokaryote' and the rest of the statement reference to histones)

D The organisation of DNA by histones in eukaryotes allows some gene control sequences to be thousands of base pairs away from the gene concerned. (True – reference to enhancer or silencer sequences that are far away if the DNA is uncoiled, but due to the coiling of DNA around histones, the histones (thus the sequences that coil around them) may be brought close to each other)

23 In order to replicate, the ends of a eukaryotic chromosome contain a special sequence of DNA called a telomere. Human telomeres consist of repeating TTAGGG sequences which extend from the ends of the chromosomal DNA.

When cells undergo mitotic division, some of these repeating sequences are lost. This results in a shortening of the telomeric DNA.

The diagram shows a eukaryotic chromosome.



What is a consequence of the loss of repeating DNA sequences from the telomeres?

A The cell will begin the synthesis of different proteins. (False - Telomeres are non-coding!)

B The cell will begin to differentiate as a result of the altered DNA. (False – same as above)

C The number of mitotic divisions the cell can make will be limited. (True)

D The production of mRNA will be reduced. (False – same option A – non-coding!)

24 The table shows a comparison between the genomes of a prokaryote and a eukaryote.

Feature	Prokaryote	Eukaryote
Genome length (base pairs)	4 640 000	12 068 000
Number of proteins	4 300	6 200
Proteins with roles in metabolism	650	650
Proteins with roles in energy release	240	175
Proteins with roles in protein synthesis	410	750

Which feature of eukaryotes accounts for the differences in the number of proteins with roles in protein synthesis?

A The DNA of eukaryote has histones. (Histones not involved in protein synthesis)

B The DNA of eukaryote has introns. (See below)

C The DNA of eukaryote has more base pairs. (Increase in number of base pairs only potentially increases the length of the gene and length of polypeptide chain, but not the proteins associated with protein synthesis)

D The DNA of eukaryote has less base pairs. (Incorrect with reference to prokaryote DNA)

- Due to the presence of introns, additional proteins are needed for excision of introns and splicing of exons. Hence, the number of proteins with roles in protein synthesis is higher in eukaryotes.

25 Hepatitis C virus (HCV) can only replicate by injecting its genome into human cells upon infection. HCV is a positive–sense RNA virus, i.e. its genomic material is RNA that can be used for translation immediately.

Which of the following are most likely **not** needed for HCV replication?

1 DNA–dependent RNA polymerase (no need since HCV is a RNA virus, no need to transcribe DNA into RNA)

2 Reverse transcriptase (maybe, if the replication cycle of HCV is similar to HIV's. However, by eliminating options B and D as ribosomes are needed for HCV replication, both remaining options A and C indicate that reverse transcriptase is not needed)

3 Ribosomes (MOST needed as viruses do not carry their own ribosomes!)

4 RNA–dependent RNA polymerase (needed to replicate its own genome! The virus uses its RNA as template (RNA-dependent) to synthesise new RNA genome (RNA polymerase)

A 1 and 2

B 1 and 3

C 1, 2 and 4

D 1, 3 and 4

26 Which of the following are valid comparisons between the replication cycles of lambda phage and HIV?

1 Both replication cycles involve uncoating to release viral genome into the cytoplasm.

(No - Lambda DNA is injected directly into host, no uncoating of genome required)

2 The protein involved in receptor binding for HIV is attached with short carbohydrate chains but not lambda phage. (Yes – general reference to glycoproteins, which both viruses use for attachment to host cell surface)

3 The synthesis of viral proteins in both viruses involves transcription of viral DNA and translation. (Yes – both processes required and lambda genome is DNA and for HIV, the integrated provirus is DNA!)

4 Both involve the insertion of viral DNA into host genome and may cause insertional mutagenesis leading to uncontrolled cell division. (First part of statement is correct: lambda phage is integrated into host genome as prophage while HIV is integrated into host genome as provirus. However, host bacteria do not undergo uncontrolled cell division due to dysregulation of cell cycle checkpoints)

5 The replication cycle of HIV involves enzymes not coded by the host genome but not lambda phage. (No – the replication cycle of HIV involves viral enzymes such as reverse transcriptase, integrase and HIV protease. The replication cycle of lambda phage also involves viral enzymes such as integrase and lysozyme.)

A 1 and 4

B 2 and 3

C 2, 4 and 5

D 1, 3 and 5

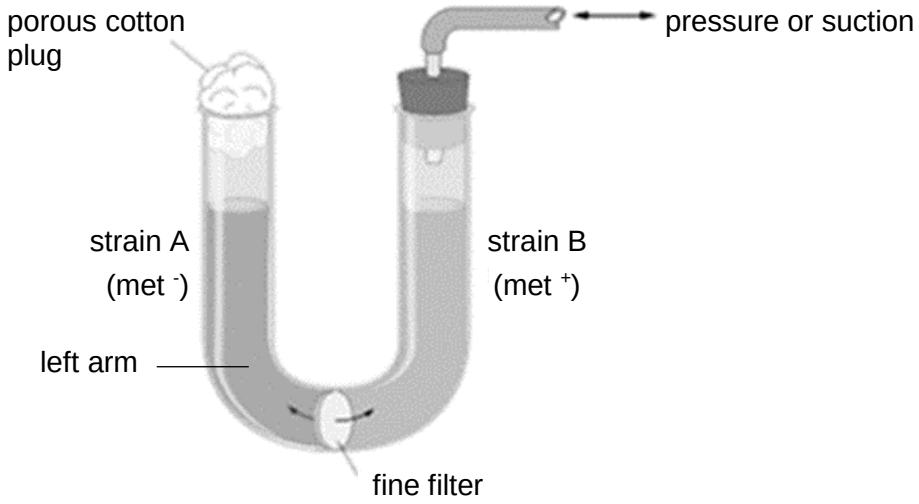
27 Which row correctly describes antigenic drift and antigenic shift?

	antigenic drift	antigenic shift
A	achieved by reassortment of gene segments	achieved by accumulation of mutations
B	new viral strain may infect hosts of the same species	new viral subtype may infect hosts in a different species
C	occurs less frequently	occurs more frequently

D	results in major antigenic change	results in minor antigenic change

Option A – description of antigenic drift and antigenic shift incorrect
Option B – correct descriptions
Option C – reverse occurrence more likely
Option D – reverse occurrence more likely

28 To investigate gene transfer by transduction between bacteria, two strains of the same bacterial species were each placed in different arms of a U-tube with a filter separating them.



met $^{+}$ is a wild-type gene that codes for the bacteria's normal ability to synthesise the essential amino acid, methionine.
met $^{-}$ indicates that the *met* $^{+}$ gene has been mutated.

Bacteria with normal wild-type genes can synthesise all the essential amino acids even if grown on a minimal medium (with no essential amino acids). (They have the normal genes coding for enzymes in the respective amino acid synthesis pathways. If bacteria have a mutated gene for one of the enzymes they will not be able to synthesise that amino acid and will not survive on minimal medium and thus no growth seen on the medium)

Liquid may be transferred between the arms of the tube by the application of pressure or suction, but particles that are larger than the filter pore size would not be able to pass through the fine filter.

type of particle	size
bacteria	1 – 10μm
bacteriophages	0.025 – 0.2μm

After several hours of incubation, bacterial cells from the left arm of the tube are grown on a separate minimal medium.

Which pair of experimental results best shows that transduction was most likely the process responsible for gene transfer between strains A and B?

(Only viruses must be involved, bacteria cannot pass through)

	filter pore size	growth of colonies on minimal medium	
A	5μm (both bacteria and virus can pass through)	yes (growth possible as conjugation and transduction possible)	Pair does not meet question requirement
	0.1μm (only virus can pass through)	yes (correct)	
B	5μm (both bacteria and virus can pass through)	no (growth possible as conjugation and transduction possible)	Pair does not meet question requirement
	0.1μm (only virus can pass through)	no (should have growth)	
C	0.45μm (only virus can pass through)	yes (correct)	Pair does not meet question requirement
	0.02μm (virus cannot pass through)	yes (should have NO growth)	
D	0.45μm (only virus can pass through)	yes (correct)	Pair meet question requirement
	0.02μm (virus cannot pass through)	no (correct)	

29 In the gene regulation of the *lac* operon, which event takes place in the absence of lactose?

A Regulator protein prevents binding of RNA polymerase so no mRNA is produced.

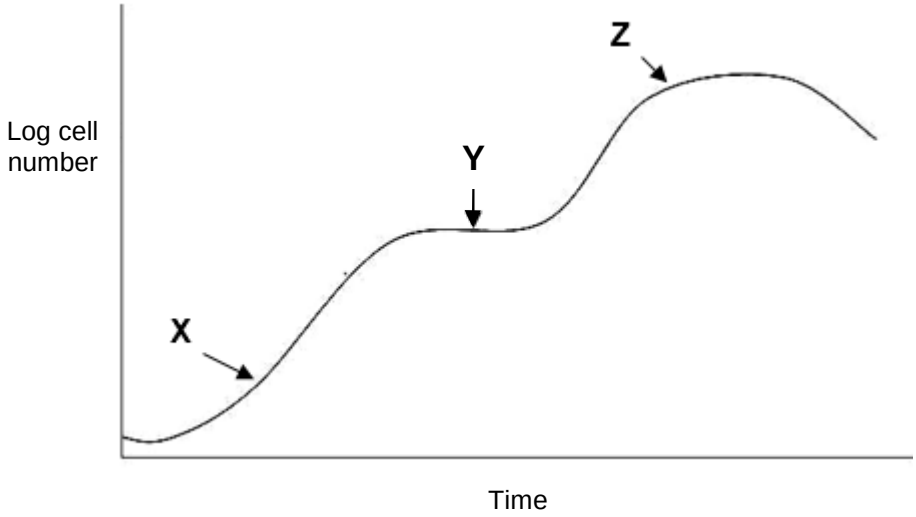
B Regulator protein binds to lactose. (Regulator protein binds to operator sequence, not lactose)

C Regulator protein binds to DNA polymerase. (Regulator protein binds to operator sequence, not DNA polymerase!)

D Regulator protein binds to mRNA. (Regulator protein binds to operator sequence, not mRNA)

Regulator protein in this question refers to lac repressor, which is coded for by the regulatory gene *lac I*.

30 *E. coli* bacteria are grown in a culture of nutrients, which includes glucose and lactose as the main source of carbon-based nutrient. The following growth curve is obtained.



Which row is correct?

	CAP activated	high amounts of *lac* polycistronic mRNA	repressor inactivated
A	X only	X and Y only	Y and Z only
B	Y only	X and Y only	X, Y and Z
C	Y and Z only	Z only	Y and Z only
D	Y and Z only	Y and Z only	X, Y and Z

CAP is activated at both Y and Z because glucose is already depleted (cAMP levels are high).

At Y and Z, the lac operon would be activated, leading to large amounts of *lac* polycistronic mRNA.

Repressor is inactivated at X, Y and Z because as lactose is present, it can still be converted to allolactose that can bind to repressor at X. However, at X, glucose is still the main respiratory substrate and the level of *lac* operon expression is still low.

– End of Paper –

JC1 PROMO 2021
H2 BIOLOGY PAPER 1
ANSWER KEY

Qn	1	2	3	4	5
Ans	C	C	A	D	D
Qn	6	7	8	9	10
Ans	B	B	D	D	D
Qn	11	12	13	14	15
Ans	D	C	C	A	A
Qn	16	17	18	19	20
Ans	D	B	D	B	B
Qn	21	22	23	24	25
Ans	A	D	C	B	A
Qn	26	27	28	29	30
Ans	B	B	D	A	D