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TEMASEK JUNIOR COLLEGE

2023 JC2 PRELIMINARY EXAMINATION

Higher 2

TEMASEK JUNIOR COLLEGE

BIOLOGY **9744/01**

Paper 1 Multiple Choice **15 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, civics group and index number on the Multiple Choice Answer Sheet (MCAS).

Write in soft pencil.
Do **NOT** use staples, paper clips, glue or correction fluid.

There are **thirty** questions on 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.

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

1 Which statement regarding the cell theory is false?

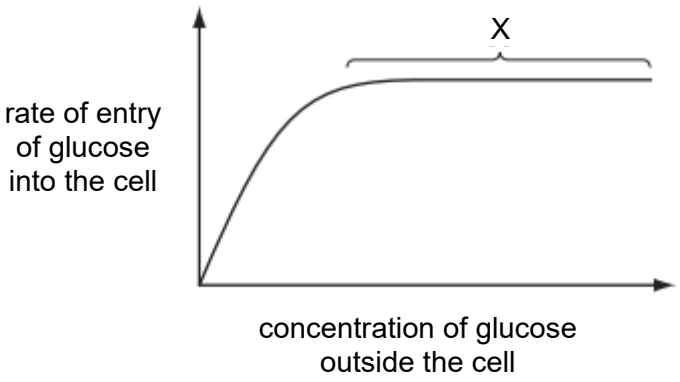
A All living organisms are made up of one or more cells.

B All cells must contain either DNA or RNA.

C The cell is the basic structural and functional unit of life.

D All cells arise from pre-existing cells.

2 The graph shows how the rate of entry of glucose into a cell changes as the concentration of glucose outside the cell changes.



What is the cause of the plateau at X?

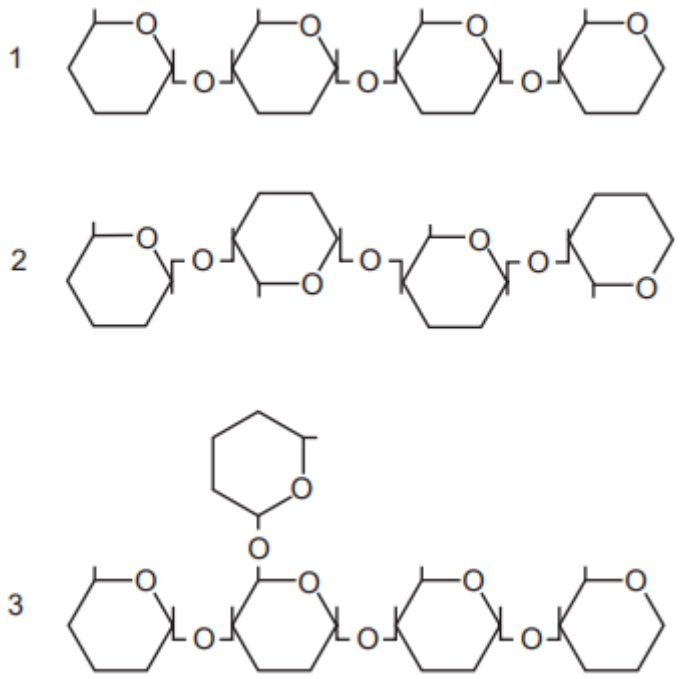
A All the carrier proteins are saturated with glucose.

B The carrier proteins are denatured and no longer able to function.

C The cell has used up its supply of ATP.

D The concentrations of glucose inside and outside the cell are equal.

3 Diagrams 1, 2 and 3 show the structural formulae of three polysaccharides.



What are the names of these polysaccharides?

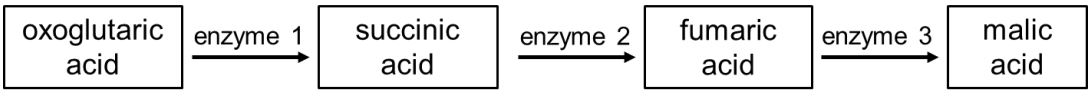
	1	2	3
A	amylose	cellulose	glycogen
B	amylose	glycogen	cellulose
C	cellulose	glycogen	amylose
D	glycogen	amylose	cellulose

4 Which statements about phospholipids and triglycerides are correct?

1 They both contain ester bonds.
2 They both have three fatty acid chains per molecule.
3 They both may have saturated and unsaturated fatty acid chains.
4 They are both used only as storage molecules.

A 1, 2 and 3 **B** 1 and 3 only **C** 2, 3 and 4 **D** 2 and 4 only

5 The four acids shown below form part of an enzyme-catalyzed sequence of reactions. The addition of malonic acid results in no change in the concentration of oxoglutaric acid, an accumulation of succinic acid, and a near absence of both fumaric acid and malic acid. Further addition of fumaric acid results in the formation of malic acid. What does this information indicate about malonic acid?



A It is an inhibitor of enzyme 2.

B It catalyses the formation of succinic acid.

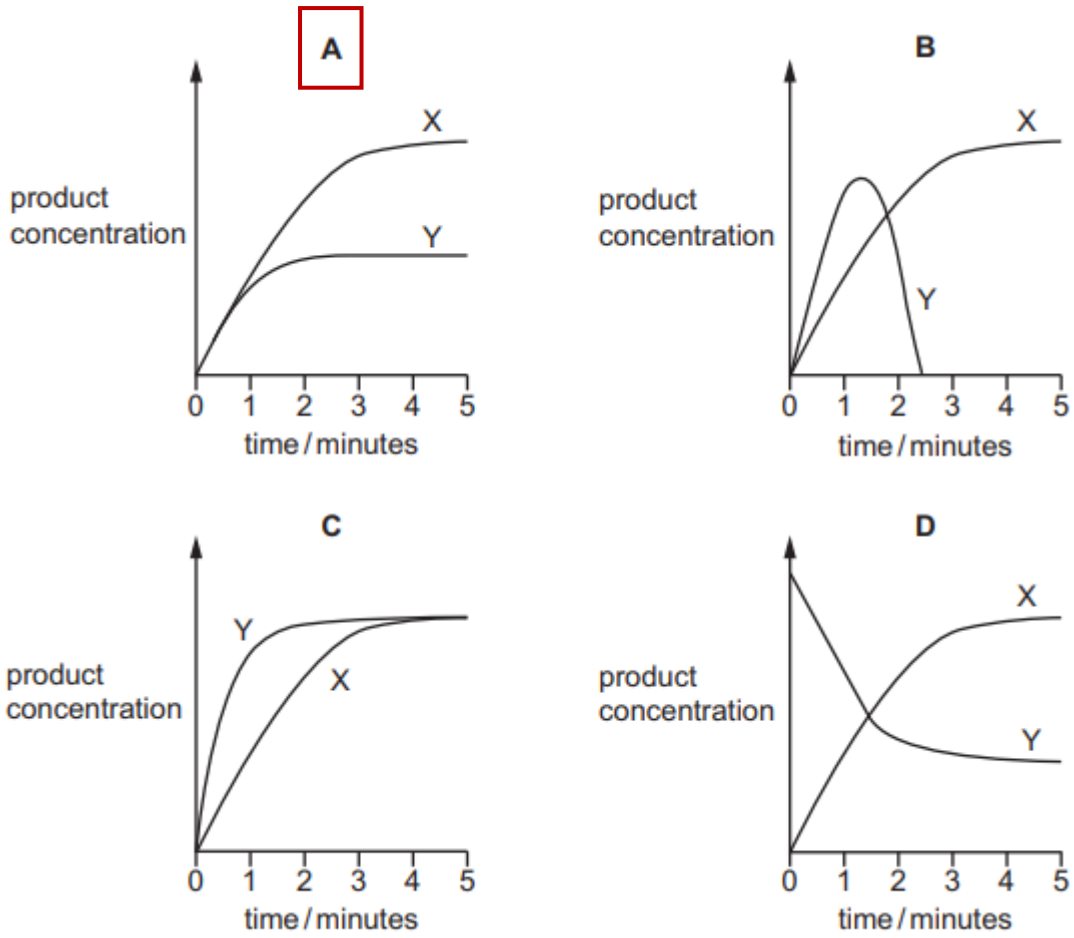
C It is an inhibitor of enzyme 1.

D It reacts with fumaric acid.

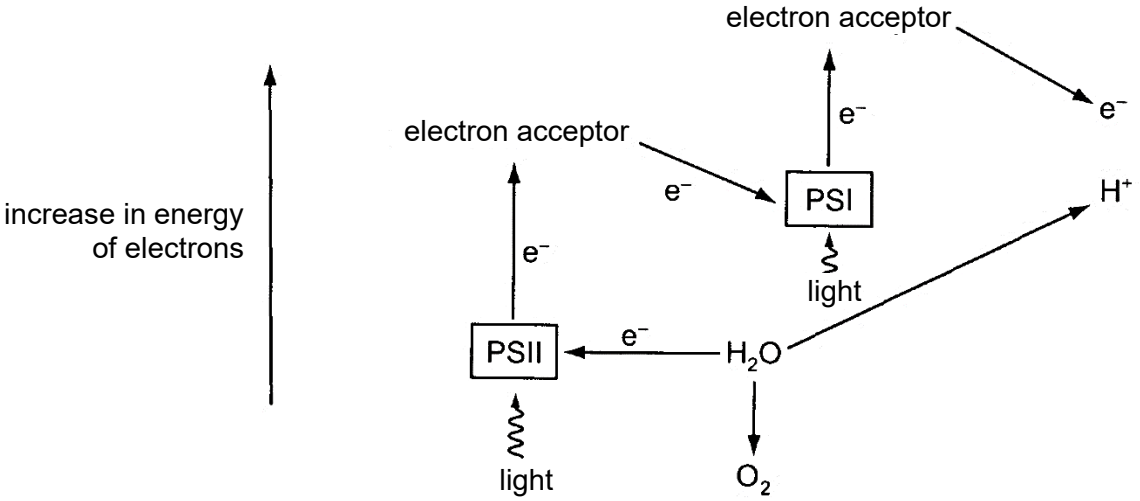
6 Two experiments, X and Y, were carried out using an enzyme from humans.

Experiment X was carried out at a constant temperature of 37°C while experiment Y was carried out a constant temperature of 80°C. All other factors were kept the same.

Which graph shows the results?



7 The diagram shows the path taken by electrons and the formation of hydrogen ions in the light-dependent stages of photosynthesis.



What are the electrons and hydrogen ions used to produce?

A ATP from ADP

B ATP from ADP and reduced NADP from NADP

C glycerate-3-phosphate from glyceraldehyde-3-phosphate

D reduced NADP from NADP

8 In light, Mg^{2+} ions move into the stroma. In the dark, the concentration of Mg^{2+} ions in the stroma is low.

In high Mg^{2+} concentrations, CO_2 and Mg^{2+} react with the active site of RuBP carboxylase (rubisco), making a carbamate group ($C0_2NH$) and making the rubisco active. In low Mg^{2+} concentrations the carbamate group dissociates making the rubisco inactive.

Inactive rubisco will bind tightly at its active site with any RuBP present, so that no rubisco catalysis can take place. An ATPase enzyme called rubisco activase, can, in high concentrations of Mg^{2+}, release the RuBP from the rubisco, producing a carbamate group and activating the rubisco.

Which statement is supported by these facts?

A Inactivated rubisco can be reactivated by NADPH made in the light-dependent reaction.

B Low concentrations of 3C compound in the stroma of the chloroplast deactivate rubisco.

C Rubisco without the carbamate group is inhibited by low concentrations of RuBP.

D The rate of carbon dioxide fixation increases when the carbamate group dissociates from rubisco.

9 Cyanide is a poison that blocks the passage of electrons along the electron transport chain.

Assuming that all other conditions are optimal, which one of the following options would see an effect on ATP synthesis with the addition of cyanide?

A Chloroplast suspension illuminated by light.

B Cytoplasm lacking in organelles incubated with lactate.

C Cytoplasm lacking in organelles incubated with pyruvate.

D Mitochondria suspension incubated with fructose 1,6 bisphosphate.

10 Methotrexate is a drug used to treat cancer. It can act as an enzyme inhibitor preventing the synthesis of nucleotides containing thymine.

Cells treated with methotrexate are not able to complete the cell cycle.

A cell entering telophase is treated with methotrexate.

Which stage of the cell cycle will be affected by the action of methotrexate?

A anaphase

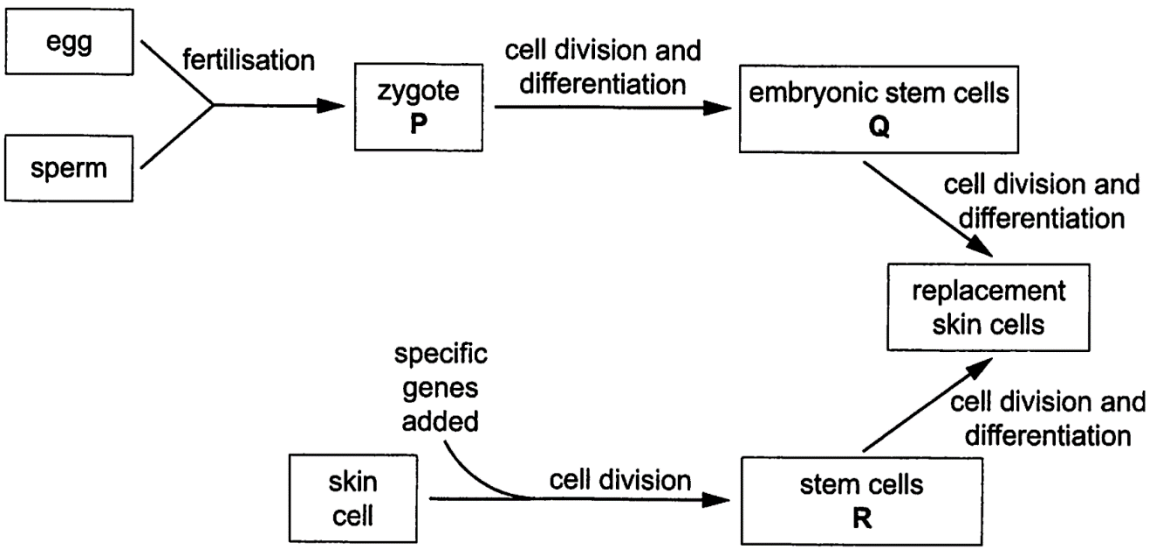
B interphase

C metaphase

D prophase

11 Stem cells can be used to replace cells in damaged tissues, such as skin.

The diagram shows two ways in which replacement skin cells can be produced.



Which row correctly describes the stem cells **P**, **Q** and **R**?

	P	Q	R
A	pluripotent	multipotent	totipotent
B	pluripotent	induced pluripotent	induced pluripotent
C	totipotent	pluripotent	induced pluripotent
D	totipotent	totipotent	totipotent

12 In eukaryotic cells, nucleic acids are found in organelles other than the nucleus.

Which of the following is correct?

	chloroplast	endoplasmic reticulum	ribosome	mitochondrion
A	DNA and RNA		RNA	DNA and RNA
B	DNA		DNA	DNA and RNA
C	DNA and RNA	RNA		DNA
D		RNA	DNA and RNA	RNA

13 Telomerase is an enzyme that adds nucleotides to telomeres.

Which statement about telomerase is correct?

A A high concentration of telomerase in a cell damages genes during DNA replication.

B A high concentration of telomerase in cancerous cells limits the rate of tumour growth.

C The low concentration of telomerase in stem cells means that these cells can divide an unlimited number of times.

D The low concentration of telomerase in body cells means that these cells can divide a limited number of times.

14 A bacterial circular DNA molecule is 2 600 150 base pairs long. 26% of these bases are adenine.

How many cytosine bases would be in the DNA molecule?

A 624 036 **B** 676 039 **C** 1 248 072 **D** 1 352 078

15 The table shows a comparison of some aspects of the genomes and protein-coding genes of the prokaryote bacterium, *Escherichia coli* and the eukaryote fungus *Saccharomyces cerevisiae*.

	E. coli	*S. cerevisiae*
Genome length / base pairs	4 640 000	12 068 000
Number of protein-coding genes	4300	5800
Proteins with roles in:		
Metabolism	650	650
Energy release / storage	240	175
Membrane transport	280	250
Transcription	240	400
Translation	180	350
Cell structure	180	250

What could **not** account for the differences in the number of protein-coding genes?

A Many catabolic pathways for using carbon compounds in prokaryotes.

B The presence of introns in the DNA of eukaryotes.

C The presence of membrane-bound organelles in eukaryotes.

D The use of histones to package DNA in eukaryotes.

Examiner's comments:
A slightly higher proportion of the candidates incorrectly chose option A. However, the question discriminated well as the majority of those choosing the incorrect option were low scoring candidates, while the majority of those choosing the correct option were high scoring candidates. Options C and D were also chosen by about a third of the candidates. The only option that could not account for differences in protein coding genes is option B as introns are present in protein coding genes but are not translated.

16 How is translation controlled in eukaryotes?

A by activation of the protein by folding or cleavage after it is formed

B by differential removal of introns enabling a gene to code for more than one protein

C by protein factors that bind to specific sequences in the mRNA

D by the production of RNA from the non-coding strand of the DNA

17 The table identifies the condition associated with a variety of ploidy changes.

chromosome number	condition name
monosomy 5	Cri du chat syndrome
trisomy 21	Down syndrome
trisomy 23	Klinefelter syndrome
monosomy 23	Turner syndrome

For a person who has 45 chromosomes (2n – 1) due to an autosomal condition, which condition do they have?

A Cri du chat syndrome

B Down syndrome

C Klinefelter syndrome

D Turner syndrome

18 Mutation of the BRCA1 gene is responsible for many hereditary breast cancers. Inactivation of a 'genome caretaker' gene such as BRCA1 results in an increased mutation rate of 'gatekeeper' genes such as the gene coding for the protein p53. Protein p53 promotes cell death when a cell has changes in its DNA and the mutation prevents this function.

Which combination of alleles is most likely to result in the development of breast cancer?

	type of gene	
	genome caretaker	**gatekeeper**
A	one normal and one mutated allele	one normal and one mutated allele
B	two normal alleles	two normal alleles
C	two mutated alleles	two normal alleles
D	two mutated alleles	two mutated alleles

19 Which feature occurs only in the reproductive cycle of the influenza virus, and not in HIV?

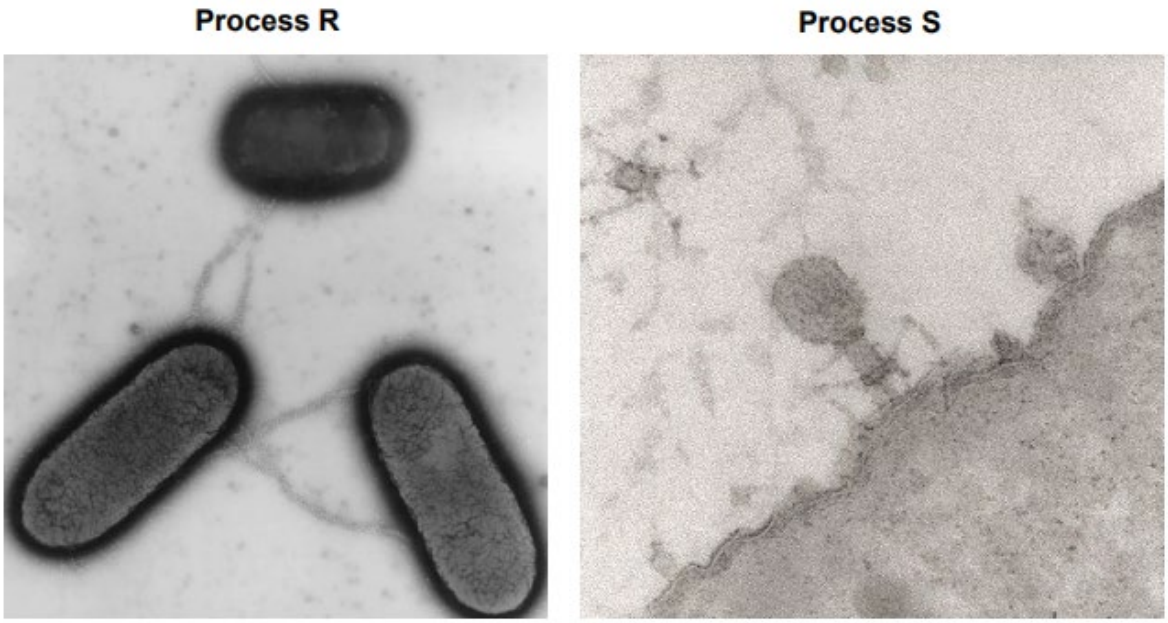
A Host cell DNA is destroyed by lytic enzymes.

B Reverse transcriptase synthesizes viral DNA.

C Viral RNA acts as template for viral DNA synthesis.

D Viruses enter the host cell by endocytosis.

20 The photomicrograph below shows two different processes of genetic transfer in bacteria.



A series of statements concerning the two processes is shown below.

1 Any gene on the bacterial chromosome can be transferred.

2 Only bacteria with a specific plasmid can act as donors.

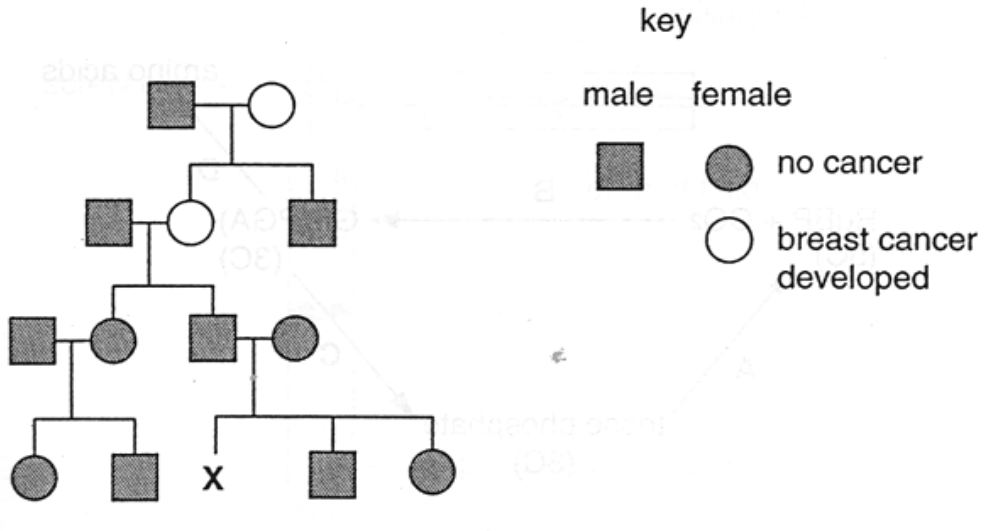
3 Physical contact between the donor and recipient bacterium is necessary.

4 The donor bacterium is lysed during the process.

Which row shows the correct statements for the corresponding process?

	Process R	Process S
A	1 and 2	3 and 4
B	1 and 4	2 and 3
C	2 and 3	1 and 4
D	3 and 4	1 and 2

21 The diagram shows the inheritance of a form of breast cancer associated with the presence of just one allele of the autosomal gene BRCA3.



What is the probability that woman **X** inherits the BRCA3 allele associated with breast cancer?

A 0.00 **B** 0.25 **C** 0.50 **D** 1.00

22 The coat colour of Norwegian cattle is mainly determined by the distribution of two pigments: red and black. Both pigments are produced by the action of the enzyme tyrosinase in cells called melanocytes. A low level of activity of the enzyme leads to the production of red pigment, whilst a high activity allows only black pigment production. The activity of tyrosinase is increased by the melanocyte stimulating hormone (MSH), which binds to a MSH receptor. The receptor is coded for by the **E** gene locus, which has two alleles, **E** and **e**. No receptor is produced by the recessive allele **e**.

The dominant allele of a second gene, the **A** locus, codes for a protein which binds to and blocks the MSH receptors, thus preventing stimulation of tyrosinase activity in a melanocyte.

Which of the following statements about the two genes and their effects in the colouration of Norwegian cattle is true?

A Allele A is completely epistatic to allele a and allele E is completely epistatic to allele e.

B Cattle with the genotype AAEE have red coats.

C Cattle with black coats must have the genotype aaEe only.

D Cattle with the genotypes aaEE, aaEe and Aaee will have high tyrosinase activity.

23 The genes for flower colour and pollen grain shape are linked in sweet pea plants. Sweet pea plants homozygous for white flower colour and long pollen grains were crossed with plants homozygous for red flower colour and round pollen grains. The F_1 generation all had red flower colour and long pollen grains. The F_2 generation obtained by selfing the F_1 generation gave a phenotype different from the Mendelian ratio of 9:3:3:1.

Assuming there were 112 plants in the F_2 generation, which is the only row that shows a possible outcome of this cross, given the linkage between flower colour and pollen grain shape?

key:
O = Observed numbers
M = Mendelian numbers

	red flowers, long pollen grains		red flowers, round pollen grains		white flowers, long pollen grains		white flowers, round pollen grains	
	O	M	O	M	O	M	O	M
A	56	63	14	21	28	21	14	7
B	56	63	28	21	28	21	0	7
C	70	63	14	21	14	21	14	7
D	70	63	28	21	14	21	0	7

24 Which statement about Southern blot is correct?

A The intensity of the fluorescence signal generated is proportional to the amount of target DNA present.

B The nucleotide sequence on a strand of the target DNA can be used to synthesise a probe to identify the target DNA.

C DNA must be heated to 96°C to allow the strands to separate, so that DNA probe can hybridise to the target DNA.

D A DNA stain must be added to visualise the DNA fragments on the agarose gel, to allow for dark image to develop on the X-ray film.

25 A small group of dingoes migrated to a new area and established a population. After several generation, the new population showed a different genetic composition from the original population. This is an example of

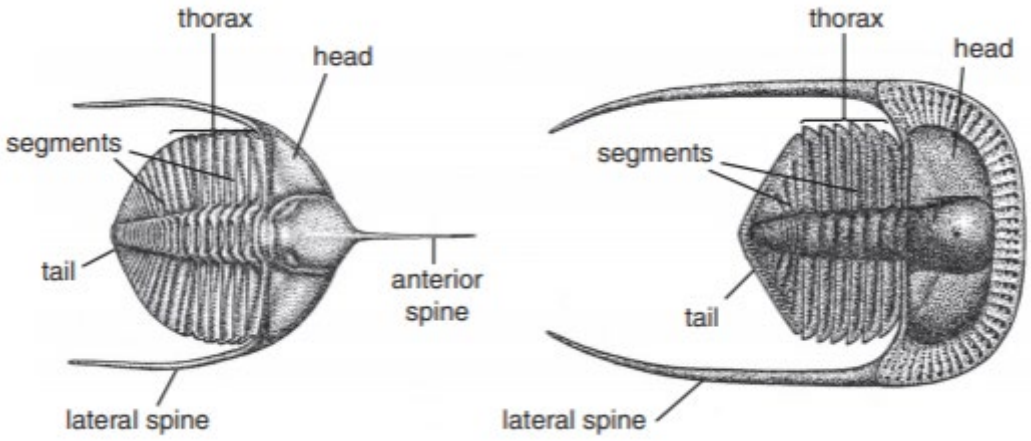
A microevolution and gene flow

B macroevolution and gene flow

C microevolution and genetic drift

D macroevolution and genetic drift

26 The fossils of two trilobites are shown below. Trilobites are a group of arthropods that became extinct about 240 million years ago. Fossil A is 20 million years older than fossil B.



fossil A **fossil B**

Which of the following is correct?

	features that suggest fossils A and B are related	features that suggest fossils A and B are **not** from the same species
A	Similar in size	Head of fossil A is more rounded that that of fossil B
B	There are 3 parts to the body – the head, thorax and tail	Organism that gave rise to fossil A can protect itself through its anterior spine
C	Presence of spines	Lateral spines in Fossil A is shorter and thicker than that in Fossil B
D	Segmented thorax and presence of spines from both sides of the head	Anterior spine is present in Fossil A only

27 Many signal transduction pathways use second messengers to

A transport a signal through the plasma membrane.

B bind to an intracellular receptor to form a complex.

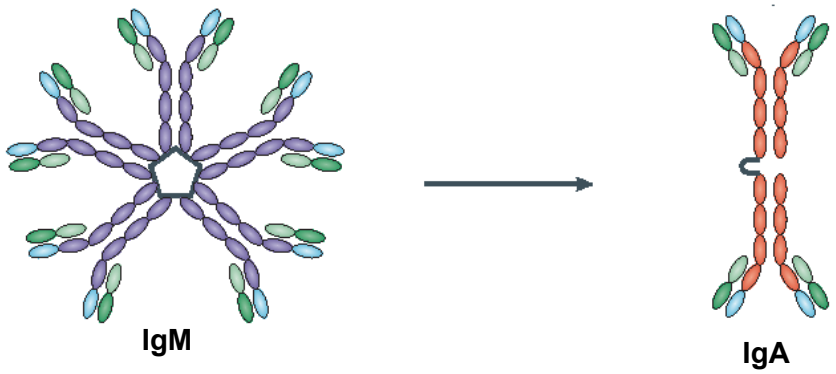
C relay a signal throughout the cytoplasm.

D amplify the message by phosphorylating proteins.

28 Which row shows how penicillin kills bacteria?

	process inhibited by penicillin	effect on bacteria
A	formation of peptidoglycan cross-links	water enters and bacteria burst
B	breakdown of peptidoglycan cross-links	water enters and bacteria burst
C	formation of peptidoglycan cross-links	water leaves and bacteria dehydrate
D	breakdown of peptidoglycan cross-links	water leaves and bacteria dehydrate

29 Which row correctly explains how antibody diversity is generated in the diagram?



	mechanism	description
A	class switching	results from alternative splicing of gene segments coding for the constant region of the heavy chain
B	class switching	results from deletion-recombination of gene segments coding for constant region of the heavy chain
C	somatic recombination	results from alternative splicing of gene segments coding for the variable region of the heavy and light chains
D	somatic recombination	results from recombination of gene segments coding for the variable region of the heavy and light chains

30 The habitat of sea turtles is shallow coastal water in warm and temperate seas. Sea turtles migrate to breeding areas to lay their eggs on sandy beaches. The nest temperature has a strong influence on the sex of the offspring. Colder temperatures result in a higher proportion of males and warmer temperatures result in a higher proportion of females.

Which effects of climate change could contribute to declines in populations of sea turtles?

1 increased melting of glaciers causing a rise in sea level

2 increased air temperature causing more heating of the Earth's surface

3 changes in ocean currents modifying migration pathways

4 heavy rainfall causing flooding of land and coastal erosion

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 2 only

D 3 and 4 only

- End of Paper 1 –

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