H

TEMASEK JUNIOR COLLEGE

2022 JC2 PRELIMINARY EXAMINATION

Higher 2

TEMASEK JUNIOR COLLEGE

BIOLOGY **9744/01**

Paper 1 Multiple Choice **15 September 2022**

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).

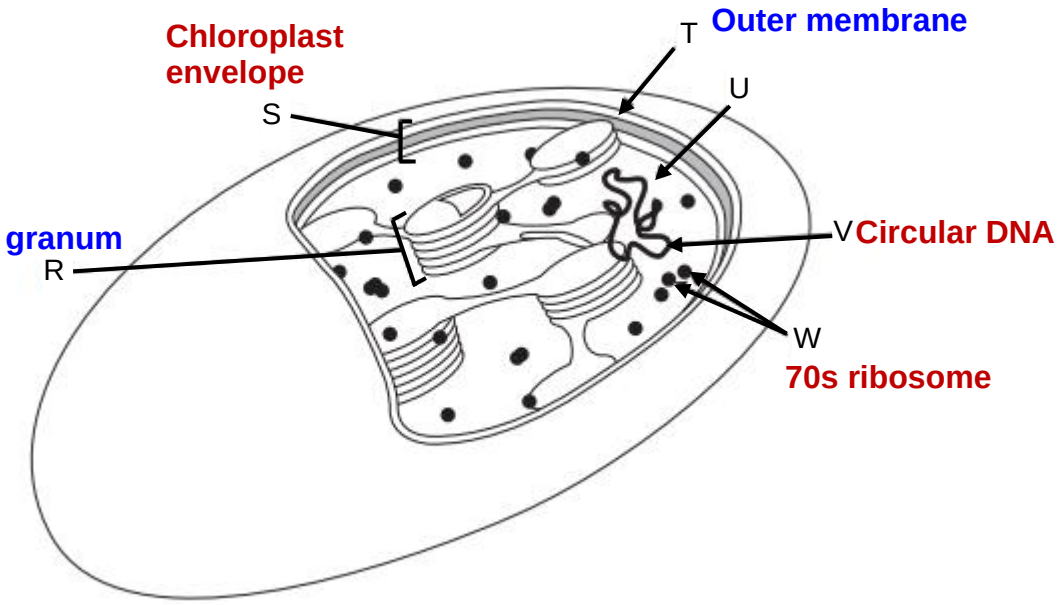
Write in soft pencil.
Do **NOT** use staples, paper clips, glue or correction fluid.

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 The diagram below shows the structures of a chloroplast, labelled R – W.



Which combination of two structures could be used as evidence for the bacterial origin of chloroplasts?

A U and R

B S and V

C U and W

D W and T

Based on the endosymbiont theory:
Photosynthesis Lect Notes p.34

Evidences supporting Endosymbiont Theory:

Strong evidences

1. Presence of **70S ribosomes** which are also found in bacteria / are less dense than the eukaryotic 80S ribosomes.

2. Presence of multiple **circular chromosomes/ DNA** which are different from/ smaller than the linear chromosome/ nuclear DNA in eukaryotes.

Other evidences

3. Presence of **double membrane**, suggesting that the ancient eukaryotic cell (outer membrane) engulfed the ancient prokaryotic cell (inner membrane).

4. The **composition** of the **inner mitochondrial membrane** (eg. presence of electron transport chain) is the similar to those found in the **cell surface** membrane of prokaryotes.

2 A decrease in some factors will increase the fluidity of the cell surface membrane.

Which pair of factors, when decreased, will increase the fluidity of the cell surface membrane?

	a **decrease** in
A	• distance between phospholipid molecules • proportion of short fatty acid chains INCORRECT: ↑ fluidity means ↑ distance between phospholipid molecules
B	• distance between phospholipid molecules • temperature
C	• proportion of phospholipids with saturated fatty acid chains • proportion of long fatty acid chains CORRECT: - **saturated f.a.** can be closely packed together - therefore ↓ saturated f.a. will ↑ fluidity - ↓ **long f.a chains** will ↓ hydrophobic interactions between phospholipids - this will ↑ fluidity
D	• proportion of phospholipids with unsaturated fatty acid chains • temperature

3 Equal sized potato pieces were placed into test-tubes containing equal volumes of different concentrations of sucrose solution and left for 30 minutes. All other variables were controlled.

After 30 minutes, the potato piece in one of the concentrations of sucrose solution had not changed in size.

What can be **concluded** from this result?

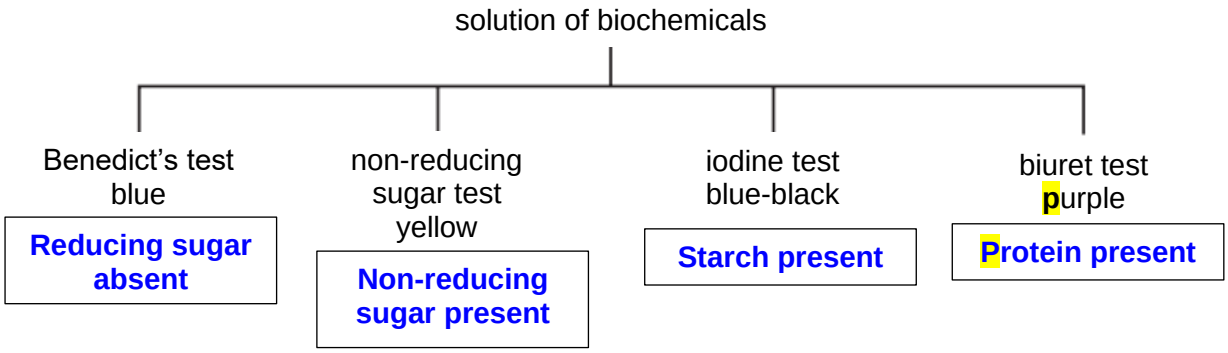
1 There is no net movement of water into or out of the potato.
TRUE: amount of water molecules moving in = moving out

2 The water potential of the potato is the same as the water potential of the sucrose solution.
TRUE: → no net movement of water

3 The concentration of sucrose in the potato is the same as the concentration of the sucrose solution.
FALSE: CANNOT be determine. Because ions and other sugars contribute to the water potential of the cell sap.

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

4 The diagram shows the results of a number of tests on a solution of biochemicals.



Which **substances** are **present** in the solution?

A amylose, amylopectin and lipid

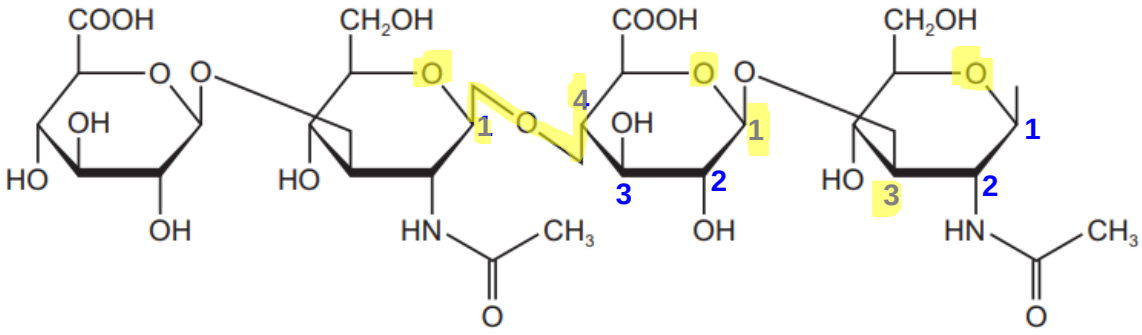
B glucose, starch and catalase

C sucrose, amylase and triglyceride

D sucrose, starch and catalase

sucrose – non-reducing sugar
catalase - protein

5 The diagram shows part of the chemical structure of a naturally occurring polysaccharide.



What **types of glycosidic bonds** are present?

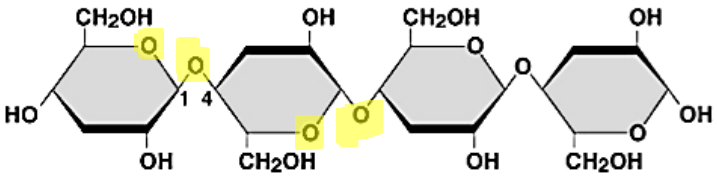
A α-1,3 and α-1,4

B α-1,4 and α-1,6

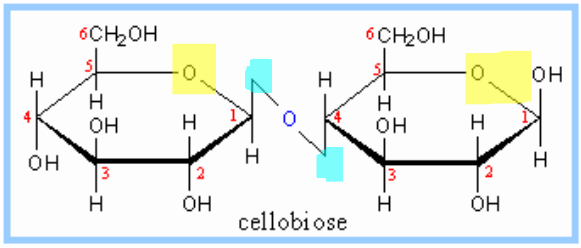
C β-1,3 and β-1,4

D β-1,4 and β-1,6

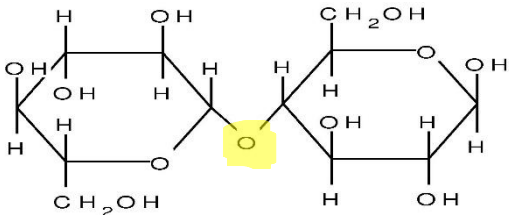
β(1-4) glycosidic (alternate glucose rotated)



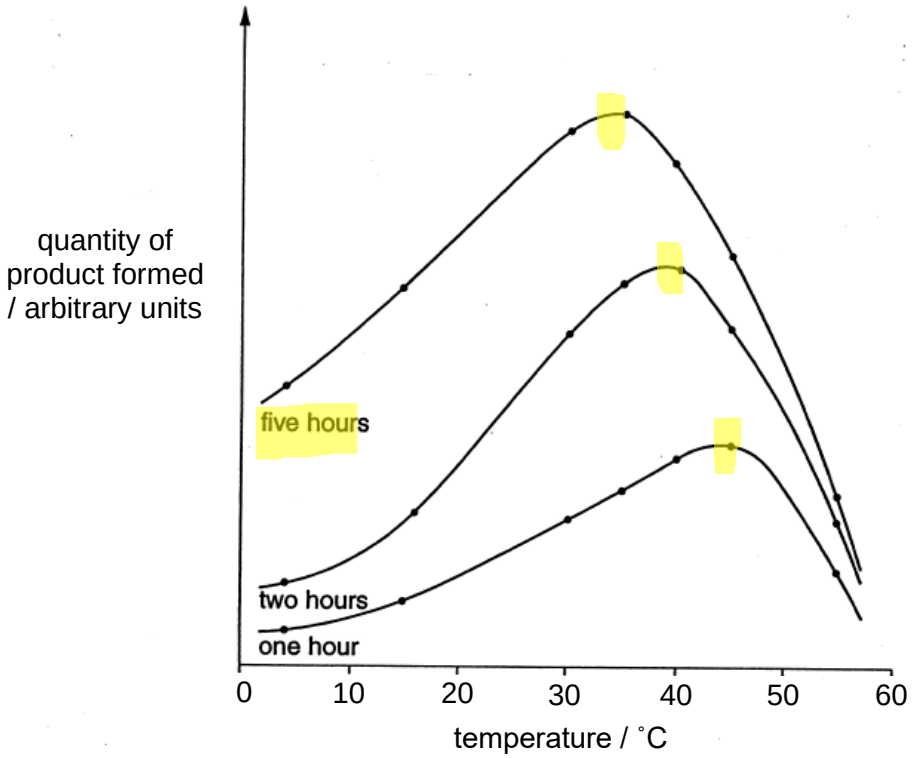
β(1-4) glycosidic (not rotated)

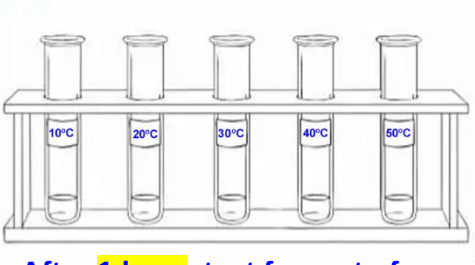


β(1-4) glycosidic (rotated)

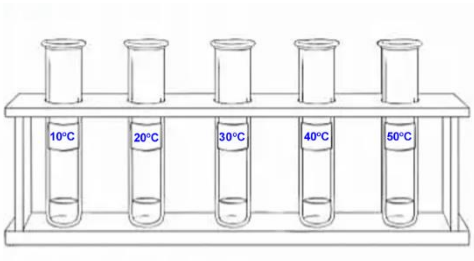


6 The graph shows the results of an experiment in which samples containing the same concentration of enzyme and substrate were kept at different temperatures for periods of one, two, and five hours. The quantities of product formed were then determined.

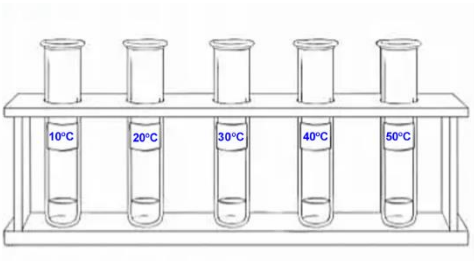




After 1 hour, test for amt of products in each tube



2 hours



5 hours

Note:
Leaving enzymes at a longer time at higher temp ⇒ more denatured

35°C instead of 45°C

Which of the following option **best explains** why the optimum temperature is lower if the quantity of product formed is measured after five hours rather than one hour?

A Tertiary bonds are not broken at higher temperatures.

B The enzyme has a range of optimum temperatures.

C A longer time at high temperature denatures enzyme.

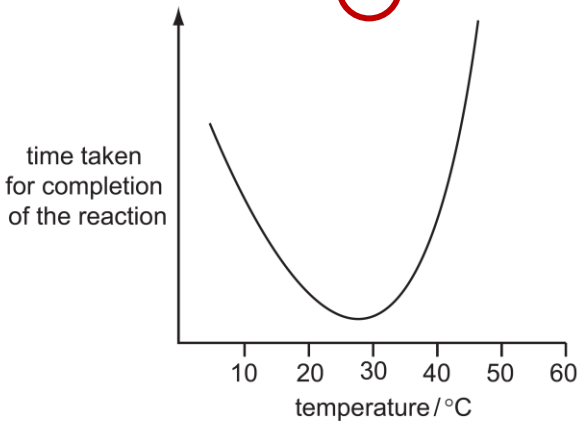
D The optimum temperature for the enzymes is 45˚C.

7 An enzyme is completely denatured at 50˚C. A fixed concentration of this enzyme is added to a fixed concentration of its substrate. The time taken for **completion** of the reaction is measured at different temperatures.

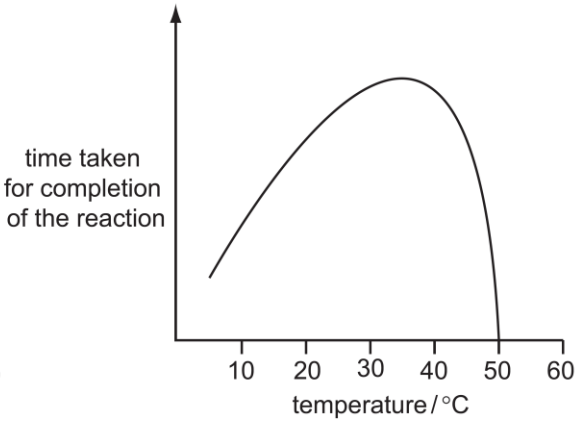
Which graph shows the results?

Note:
- **faster reaction ⇒ shorter time taken**
- **optimum temp ⇒ shortest time**
- **if enzymes are denatured ⇒ longest time taken**

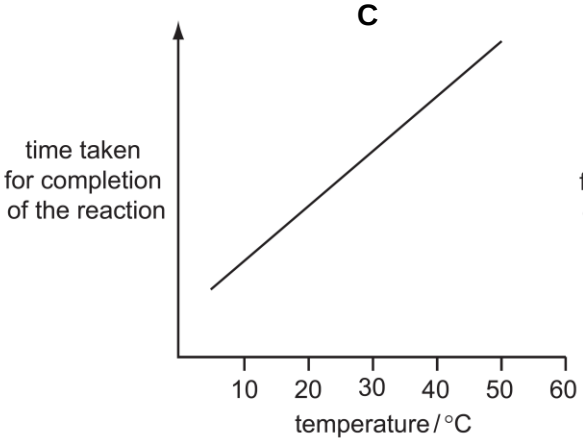
A



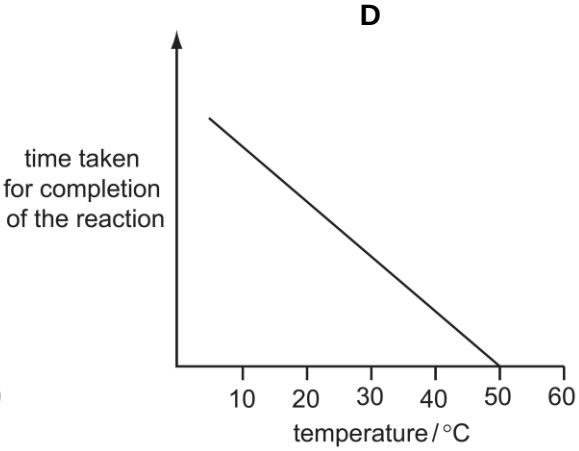
B



C



D



8 The rate of aerobic cellular respiration in a human cell may **increase** if the

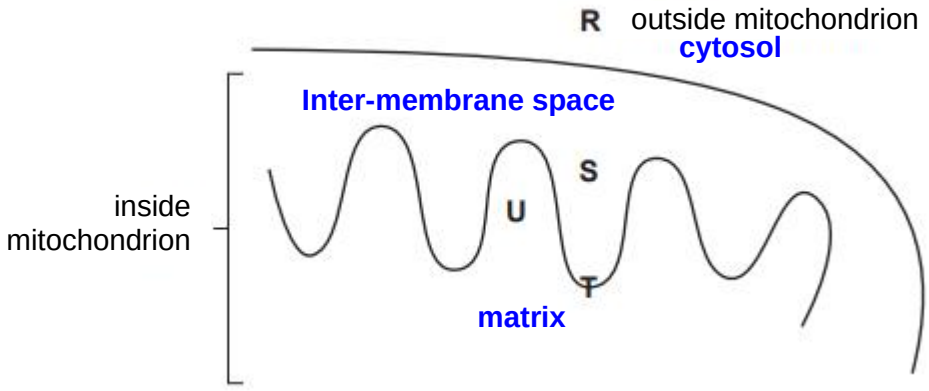
A temperature of the cell is lowered from 37˚C to 35˚C.

B oxygen concentration available to the mitochondria increases.
CORRECT: oxygen is the final electron acceptor

C carbon dioxide concentration in the cytosol of the cell increases.

D rate of facilitated diffusion of glucose into the cytosol of the cell decreases.
INCORRECT: glucose is the respiratory substrate ⇒ ↓ glucose will ↓ rate

9 The diagram below shows a section through a part of a mitochondrion.



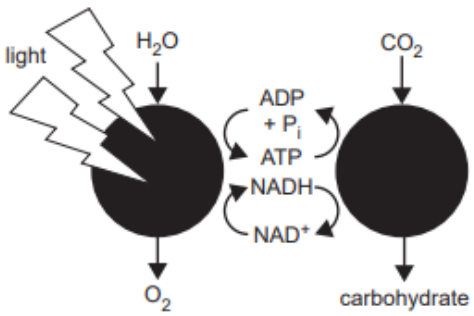
The **sites** of the pathways in **aerobic respiration** are

	glycolysis **in cytosol**	Krebs cycle **mitochondria matrix**	electron transport chain **inner mitochondrial membrane**
A	R	S	T
B	U	T	R
C	R	U	T
D	T	R	S

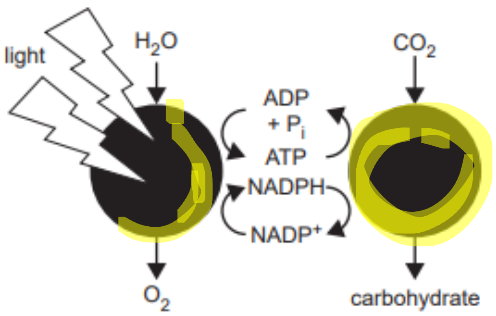
10 Which one of the following diagrams **correctly** represents the inputs and outputs of photosynthesis?

Products of light rxn:
- **ATP**
- **NADPH**

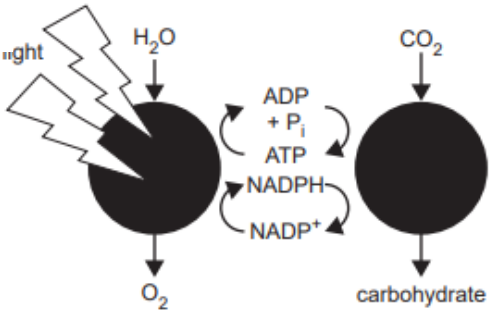
A



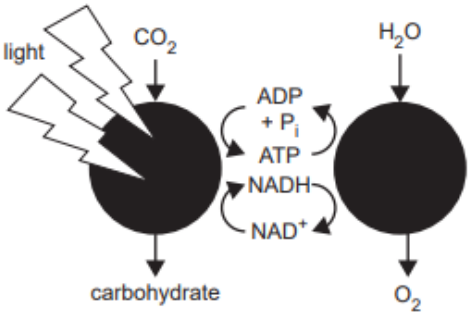
B



C



D



After DNA replication ⇒ each chromosome has a pair of sister chromatids

11 During prophase, a scientist stains the chromosomes of a diploid animal cell with a fluorescent dye to stain telomeres. This cell has 32 chromosomes.

How many telomeres will the scientist observe?

A 32 **B** 64 **C** 96 **D** 128

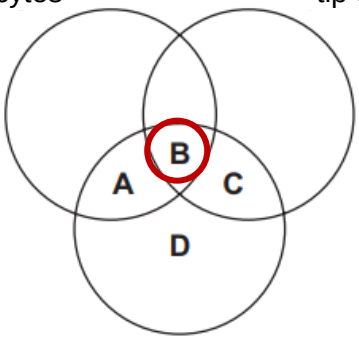
One chromosome with 4 telomeres

32 chromosomes = 32 X 4 = 128

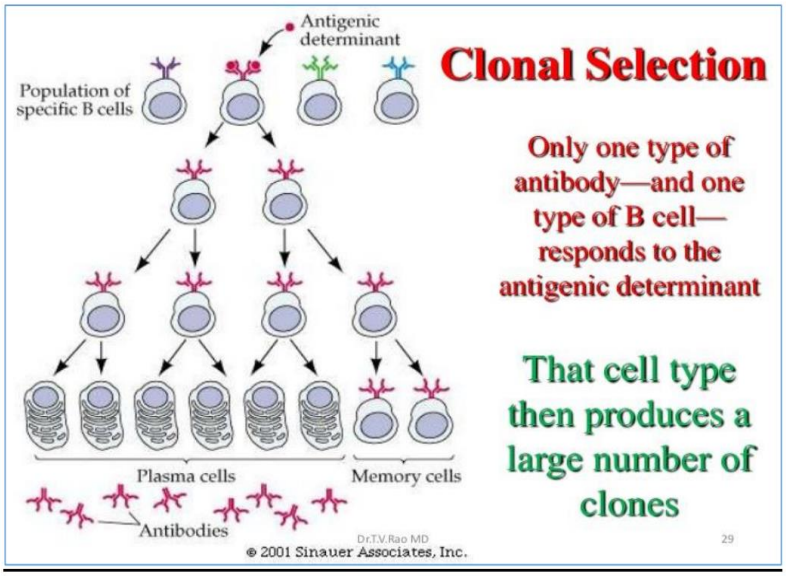
12 Which process(es) **involve(s) mitosis**?

clonal selection of T-lymphocytes

forming cells at the tip of a growing root



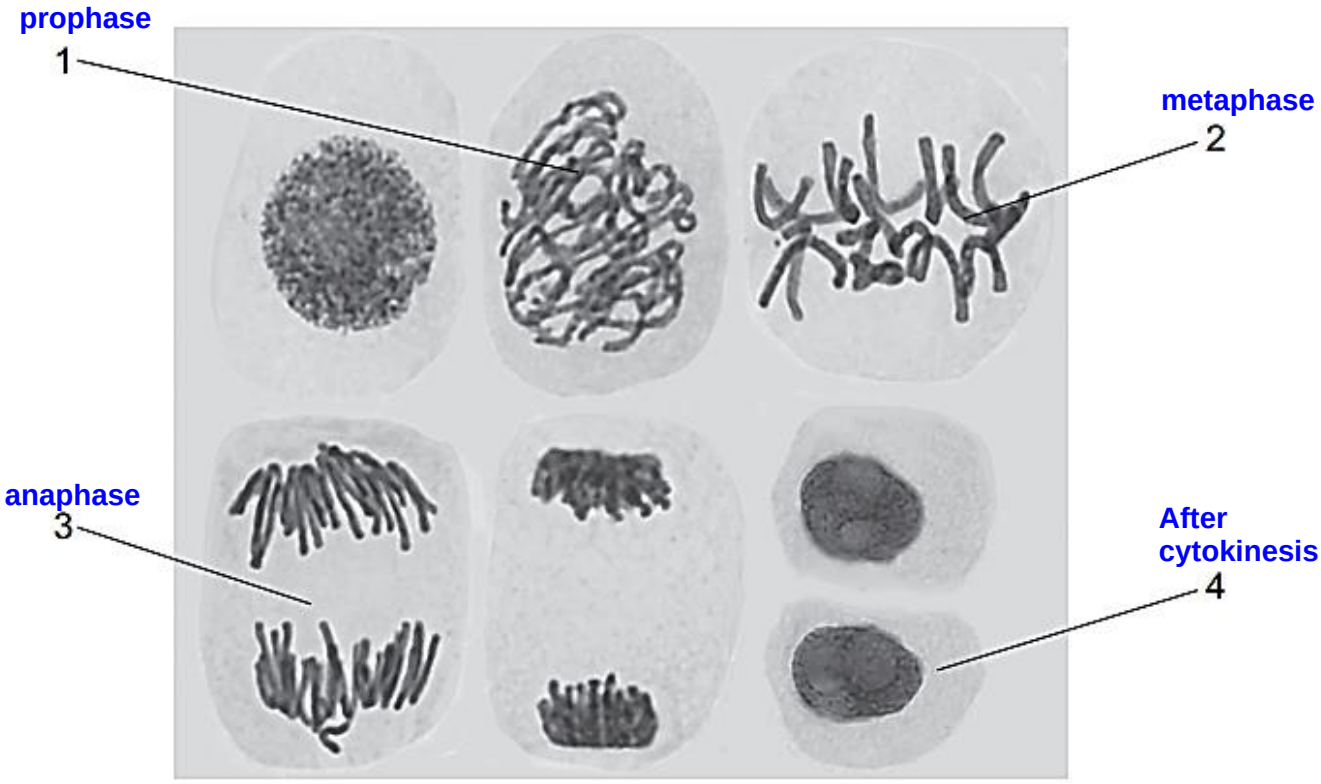
replacing skin cells damaged by an injury



13 A drug has been developed to treat certain types of cancer. It prevents mitosis by binding to the spindle. This prevents sister chromatids from being separated and moving to opposite poles of the cell.

⇒ **anaphase cannot take place**
⇒ **mitosis is arrested at metaphase**

The photomicrograph shows cells in different phases of mitosis.



Which **stages of mitosis** will be **able to occur** in a cell which is entering prophase when treated with this drug?

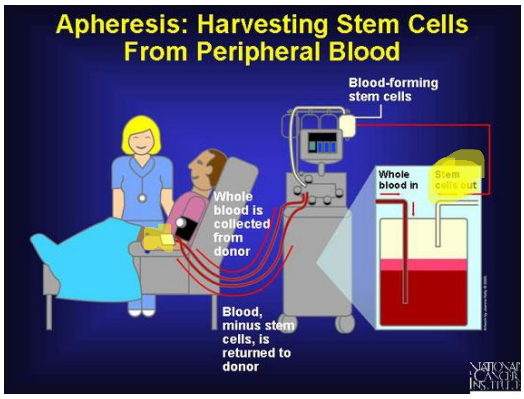
A 1 and 2 **B** 2 and 3 **C** 2 only **D** 3 and 4

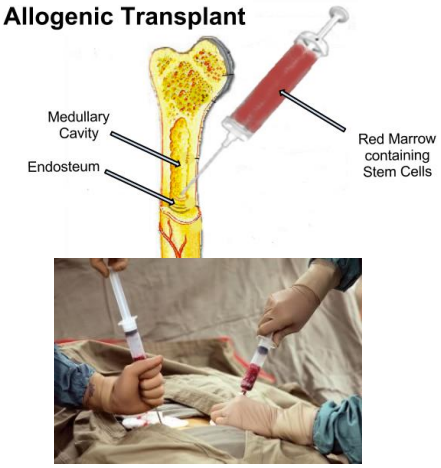
14 Hematopoietic stem cell (HSC) gene therapy can potentially cure a variety of human hematopoietic diseases, such as sickle cell disease. HSCs remain among the most promising target cells for gene therapy, where normal genes are introduced into HSCs before transferring them back into the patient to correct genetic disorders.

Which of the following statement regarding the usefulness of HSCs is **not** true?

A They have the ability to self-renew, hence repeated administrations of gene therapy can be reduced.
TRUE: HSCs can divide by mitosis → some daughter cells remain as HSC

B They can easily be removed from the blood, bone marrow or umbilical cord.
TRUE: all blood stem cells can easily be removed via



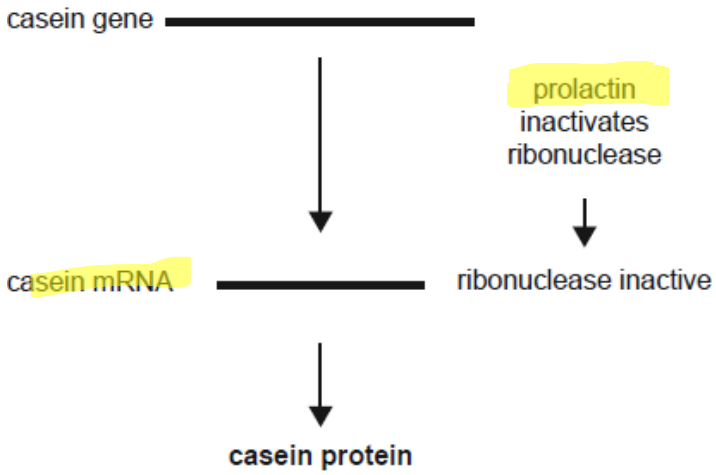


C Usage of HSCs can avoid potential ethical issues as opposed to using embryonic stem cells.
TRUE: embryos are not killed

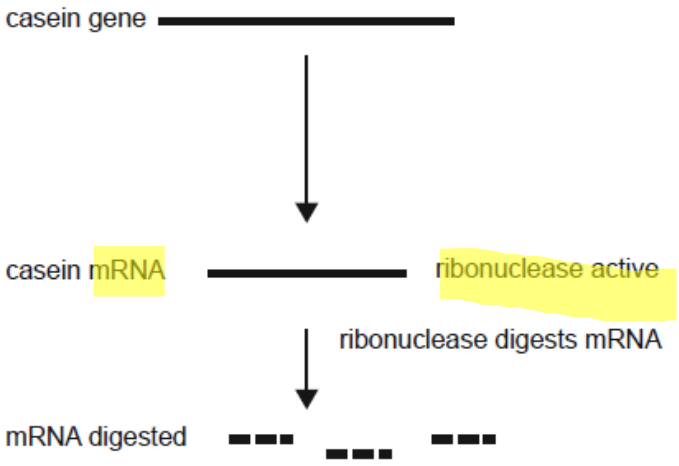
D They are capable of developing into any type of cell or tissue except those that form a placenta or an embryo.
NOT TRUE: HSCs can ONLY differentiate to form myeloid and lymphoid stem cells

15 Casein is a major protein found in mammalian milk.

When the mammals are producing milk, the pathway for the production of casein can be represented in the diagram below.



When the mammals are not producing milk, the pathway can be represented in the diagram below.



Which one of the **following conclusions** can be **made** from the information above?

A Ribonuclease has the effect of turning on the casein gene.
FALSE: Ribonuclease digest mRNA NOT involved at transcription stage

B Casein is a repressor protein for milk production in mammals.
FALSE: Casein is NOT involved at transcription stage

C The hormone prolactin allows for the expression of the casein gene.
TRUE:
- **prolactin inactivates ribonuclease**
- **⇒ mRNA to be translated to form functional gene product**
- **⇒ gene is expressed**

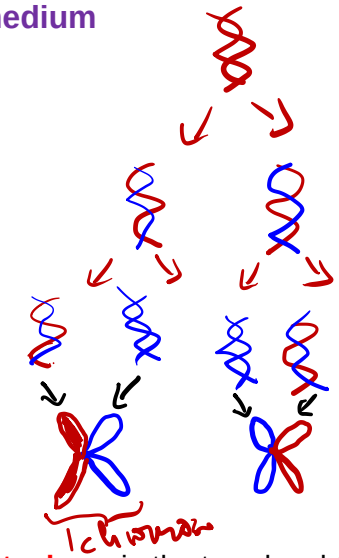
D Mammals produce milk only in the absence of the hormone prolactin.
FALSE: prolactin MUST be present during milk production

16 The following experiment was carried out.

1 Haploid cells, containing three chromosomes each, were grown in a medium containing **radioactive thymine**, so that all the DNA was labelled.

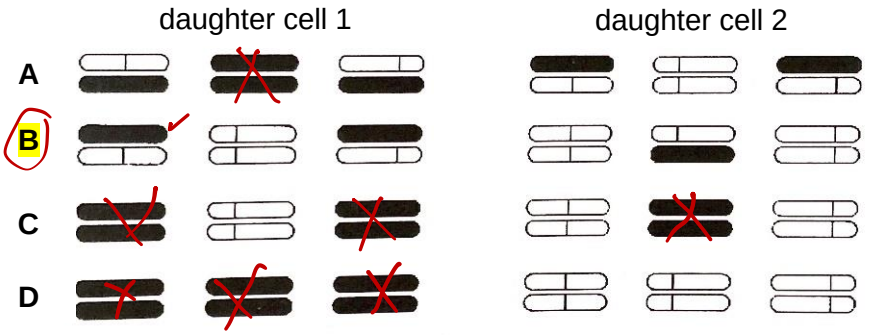
2 Cells in early interphase were then transferred to a medium where the available **thymine** was **not radioactive**.
Note: BEFORE DNA replication

3 A single cell was immediately isolated and allowed to divide once. When the two daughter cells reached the next metaphase they were fixed and their three chromosomes were inspected for radioactivity.
Note: DNA replication TWICE in non-radioactive medium



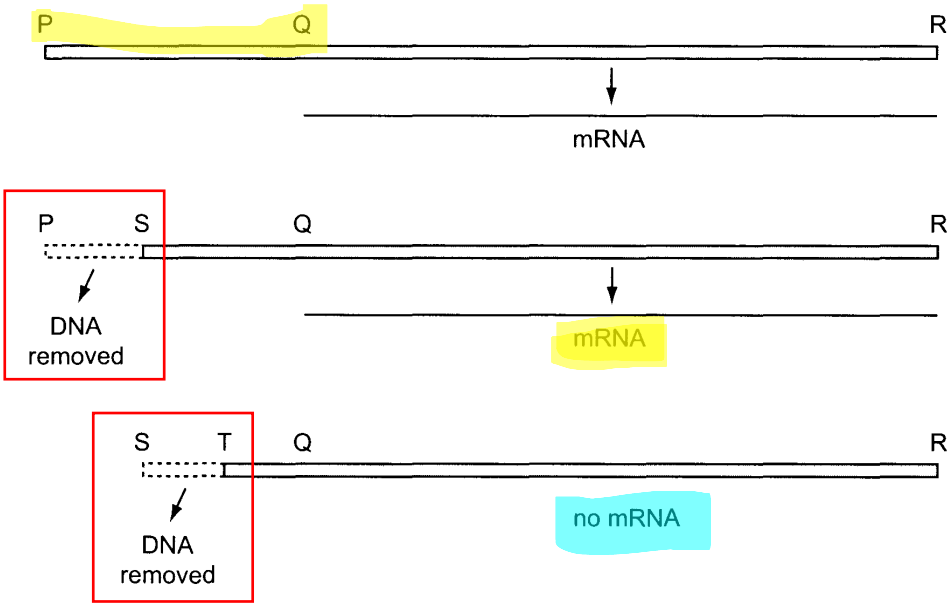
Which diagram represents the **distribution** of **radioactivity at metaphase** in the two daughter cells?

key = normal chromatid = radioactive chromatid



Note:
- At most ONLY ONE chromatid can be radioactive.

17 A length of DNA contains a non-coding region, PQ and a coding region, QR. The effect on the coding region of removing parts of the non-coding region was investigated. The results of removing firstly the length of DNA, PS and then ST are shown in the diagrams.



Which **conclusions** may be **deduced** from these results?

A Removal of any DNA from the non-coding region affects transcription.
NOT TRUE: removal of P – S region → transcription can take place

B The beginning of the promoter region is between P and S.
NOT TRUE: removal of P – S region → transcription can take place

C The beginning of the promoter region is between S and T.
TRUE: removal of S – T region → NO transcription

D The non-coding region has no role in transcription.

18 Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β-globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the coding strand of DNA for both the HbA (normal) and HbS (sickle cell) β-globin allleles.

HbA CTGACTCCTGAGGAGAAGTCT

HbS CTGACTCCTGTGGAGAAGTCT

Mutation in the HbS allele result in the production of an altered version of the β-globin polypeptide.

Which statements are **correct**?

1 Only one amino acid coded for after the mutation will differ from those in the HbA protein.
CORRECT: glutamate → valine

2 mRNA transcribed from the HbS allele will contain the codon CAC instead of the codon CTC.
INCORRECT:
Thymine is not found in mRNA
HbA: GAG → transcribed → CUC codon on mRNA
HbS: GTG → transcribed → CAC codon on mRNA

3 A tRNA molecule with the anticodon GUG will hydrogen bond to the atlered codon on mRNA.
CORRECT:
HbS: CAC codon on mRNA will base-pair with GUG anticodon on tRNA

4 The ribosome will be unable to continue translation of the HbS mRNA after the altered codon.
INCORRECT: glutamate → valine

A 1, 2 and 3 only

B 2 and 3 only

C 1 and 3 only

D 1, 2, 3 and 4

19 A gene codes for the production of a protein, p53, that binds to damaged DNA during interphase and prevents its replication. A carcinogen in cigarette smoke mutates this gene.

Which **statement explains** why this **mutation** may **cause cancer**?

A Lack of p53 allows cells to undergo mitosis.
INCORRECT: undergoing mitosis does not imply that cancer will develop

B Lack of p53 allows cells with damaged DNA to replicate.
CORRECT:
- **If proto-oncogene or tumour suppressor gene is mutated, the mutation will be pass to daughter cells**
- **Lack of p53 allows different mutations to accumulate in a single cell → may cause cancer**

C The carcinogen in cigarette smoke increases the rate of cell division.
INCORRECT:
- **carcinogen increases the chance of a cell becoming cancerous**
- **e.g. results in mutation or affects checkpoints**
- **carcinogen does not directly cause increase in rate**

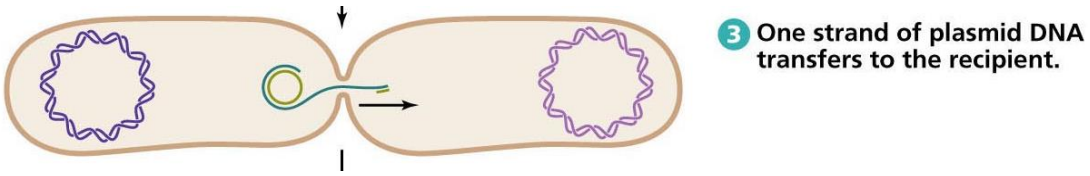
D The p53 causes uncontrolled cell division.
INCORRECT: this is NOT the direct role of p53

20 Which **statement correctly** describes the transfer of DNA from one bacterium to another?

1 Both chromosomal and non-chromosomal DNA are transferred to daughter cells via binary fission.
CORRECT:
- **DNA replication of bacterial chromosome and plasmid always take place before binary fission**
- **All daughter cells are genetically identical to parent cell and to each other**

2 Bacteriophages transfers DNA from one bacterium to another during specialized transduction.
CORRECT:
- **Specific genes are transferred**

3 Single strand of F plasmid transferred from one bacterium to another during conjugation.
CORRECT:



4 Bacterial cell takes up foreign DNA from culture medium during generalized transduction.
INCORRECT: it should be transformation

A 1 and 2 only

B 2 and 3 only

C 1, 2 and 3

D 1, 3 and 4

21 Viral reproduction cycle takes place over many stages. Some of statements describe the stages involved.

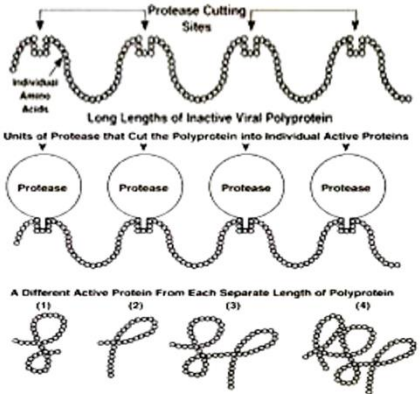
1 It has haemagglutinin and gp40 glycoprotein spikes to recognize and bind to the host cell.
INCORRECT: HIV does NOT have haemagglutinin

2 The virus carries reverse transcriptase, integrase and protease for its reproductive cycle.
CORRECT: HIV carries these 3 enzymes

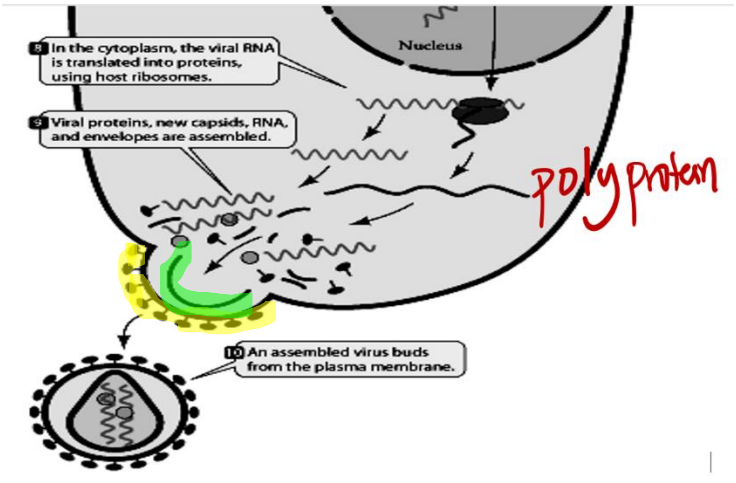
3 Since the genetic material of HIV is RNA, the RNA-dependent RNA polymerase is needed during replication of viral genome.
INCORRECT:
- **HIV RNA → DNA via reverse transcription in host cell**
- **DNA inserted into host cell DNA**
- **Inserted DNA → transcribed → HIV mRNA (using host RNA polymerase)**

4 After translation, a polyprotein is formed which must be hydrolysed by HIV protease to form functional proteins.
CORRECT:

- **HIV protease** catalyses the **hydrolysis** of the **inactive** polyprotein **chain** into individual **functional proteins** that are required for viral assembly and activity (**Fig. 3.19**).



5 Viral glycoproteins must be incorporated into the host cell membrane.
CORRECT:



6 The virus exits the host cell via exocytosis.
INCORRECT: it is via BUDDING

Which statements refer to the **reproductive cycle of HIV**?

A 1, 2, 3 and 6

B 2, 3, 4 and 6

C 2, 3 and 5 only

D 2, 4 and 5 only

22 A trial breeding programme between Nepalese yaks and a breed of British cattle called the Dexter was carried out to develop a hybrid that was hardy, easy to handle, produced good quality meat and high milk yield.

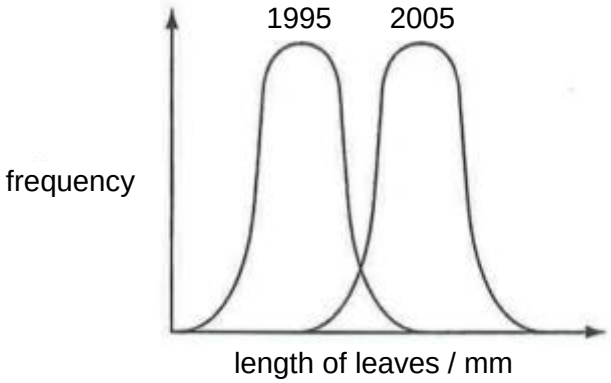
The table below shows the relative strengths of the alleles of each gene for the relevant characteristics.

characteristic	Dexter	Yak	hybrid
aggression	low	high	low
intelligence	low	high	high
hardiness	low	high	high
meat quality	high	low	high
milk yield	high	low	high

Which combination shows the **animals with** the **alleles** for the **desired characteristics**?

	aggression **NOT desired**	Intelligence **Desired**	Hardiness **Desired**	meat quality **Desired**	milk yield **Desired**
A	Dexter	Dexter	Dexter	Yak	Yak
B	Dexter	Yak	Yak	Dexter	Dexter
C	Yak	Dexter	Dexter	Dexter	Dexter
D	Yak	Dexter	Dexter	Dexter	Yak

23 The graph shows the results of data collected by measuring the leaf length of the same hybrid of coffee plants grown in 1995 and 2005.



range of phenotype ⇒ continuous variation

What **explains** the **difference in leaf length** of the coffee plants?

A continuous variation and a genetic factor
INCORRECT: all the plants were of the same hybrid ⇒ genetically similar

B continuous variation and an environmental factor
CORRECT: environment has a major effect on continuous variation

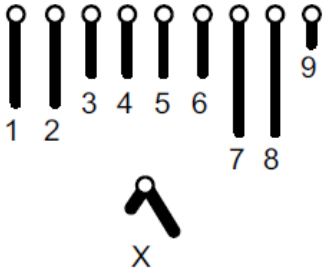
C discontinuous variation and a genetic factor

D discontinuous variation and an environmental factor

24 In some Australian insects, new species have arisen through changes that occurred to chromosomes in an ancestral species. Such changes may involve the joining together of chromosomes, the loss of whole or parts of chromosomes, and rearrangement of the genetic material within chromosomes.

One ancestral species has the following haploid set of chromosomes.

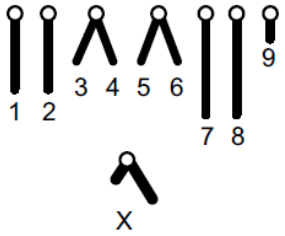
ancestral species



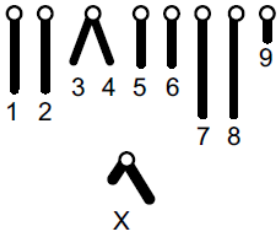
As the changes in chromosomes accumulate, a number of different species can result from a single ancestral species.

Three species that have evolved from the ancestral species shown above have the haploid sets of chromosomes shown below.

species Z

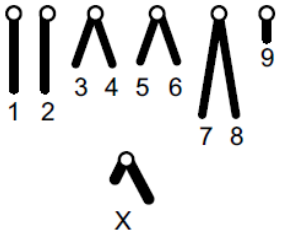


species G



Most similar to ancestral

species M



Least similar to ancestral

The **most likely order** of **evolution** of these species is

A ancestral species, species Z, species G, species M.

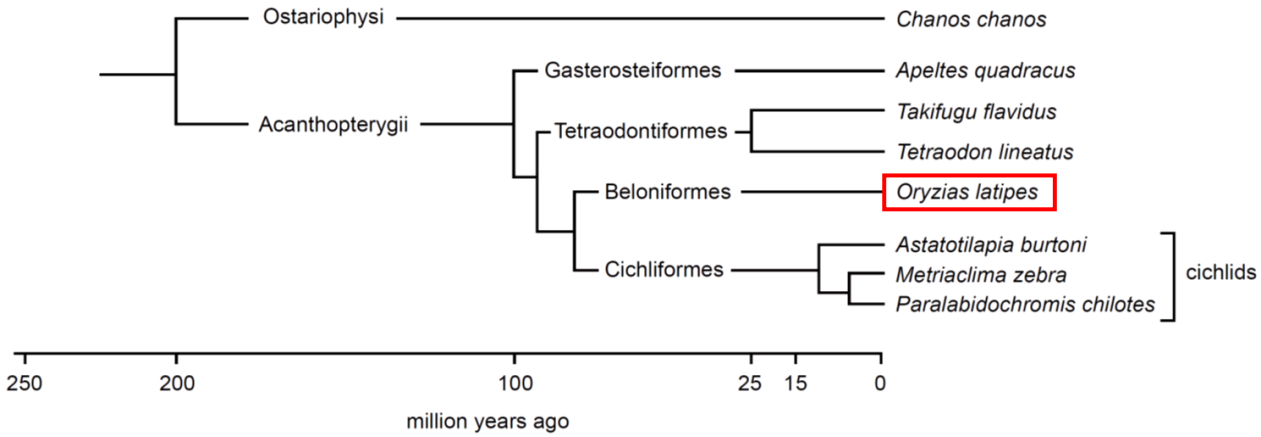
B ancestral species, species G, species M, species Z.

C ancestral species, species M, species G, species Z.

D ancestral species, species G, species Z, species M.

Note:
- The species which **matches** the **most** with the ancestral species – is the 1st to evolve

25 Consider the following phylogenetic tree, which summarises the evolutionary relationships between certain fish species.



Which statements are **incorrect**?

1 *O. latipes* is more closely related to *A. burtoni* than to *A. guadracus*.
CORRECT:
- *O. latipes* share a recent common ancestor with *A burtoni*
- *O. latipes* share a very distant common ancestor with *A. guadracus*.

2 Cichlids diverged to form three distinct species 100 million years ago.
INCORRECT: less than 15 million years ago
1. *A. burtoni*
2. *M. zebra*
3. *P. chilotes*

3 *C. chanos* was the last species to diverge from the most distant common ancestor.
INCORRECT:
- the most distant common ancestor ALSO diverged to form many more species e.g. *A. guadracus*; T. flavidus, etc

4 Gasterosteiformes, Beloniformes and Cichliformes share a common ancestor.
CORRECT: Acanthopterygii

5 *T. flavidus* and *T. lineatus* diverged to form two distinct species 25 million years ago.
CORRECT: refer to time scale

A 1 and 2 only

B 2 and 3 only

C 2, 3 and 4

D 1, 3 and 5

26 Growth hormone (GH) is a peptide hormone that is made by cells in the pituitary gland. GH is released into the blood. Liver cells respond to GH by secreting another hormone called insulin-like growth factor (IGF-1). IGF-1 stimulates muscle cells to increase in size and bone cells to produce mineralised bone.

The **secretion of IGF-1** by liver cells and **increasing in size** of **muscle cells** can be considered

A ligand-receptor interaction

B cellular response

C signal transduction

D phosphorylation cascade

27 When a blood vessel is cut, platelets release a protein called platelet-derived growth factor that causes skin cells to divide and repair the cut. Once the platelet-derived growth factor interacts with the receptor, a series of events take place.

Which pair of events are in the **correct sequence**?

A Signal amplification followed by change of shape of receptor on skin cell.
INCORRECT: change of shape of receptor comes 1st

B Cellular response followed by signal amplification.
INCORRECT: signal amplification comes 1st

C Signal transduction followed by signal amplification.
CORRECT: signal amplification can take place along any part of signal transduction

D Signal transduction followed by change of shape of receptor on skin cell.
INCORRECT: change of shape of receptor comes 1st

28 The statements refer to the disease tuberculosis (TB).

1 The pathogen lives inside human cells so is not accessible to the immune system.
INCORRECT: antibiotics is not released by our immune system

2 The bacterial pathogen reproduces slowly.
CORRECT: bacteria reproduces slowly inside the granuloma

M. tuberculosis reproduces very slowly (20 hours every generation), thus the incubation period is between 4 to 12 weeks.

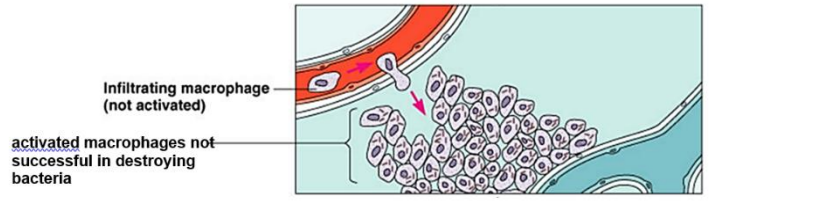


Fig. 6: *M. tuberculosis* can survive and multiply inside macrophages and more macrophages are brought into infected alveolus.

3 The pathogen is not very sensitive to antibiotics.
CORRECT: some forms of TB are resistant to certain antibiotics

Which **explains why antibiotic treatment** for TB **takes** a **long time**?

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

29 Four ways of being immune are

1 having memory cells after an infection
Active immunity – primary immune response has taken place → memory cells
Natural immunity – due to infection

2 having memory cells after being injected with dead bacteria
Active immunity – primary immune response has taken place → memory cells
Artificial immunity – due to injection (dead bacteria)

3 being injected with antibodies
Artificial immunity – due to injection
Passive immunity – antibodies was not produced by the body

4 receiving antibodies from breast milk
Passive immunity – antibodies was not produced by the body
Natural immunity – because antibodies was given via milk NOT injection

Which row in the table **correctly** shows the **type of immunity**?

	natural active	artificial active	natural passive	artificial passive
A	1	2	3	4
B	1	2	4	3
C	2	1	3	4
D	2	1	4	3

30 Malaria is a disease caused by a group of unicellular eukaryotes. These eukaryotes carry out part of their life cycle in the human body and part of their life cycle in the female *Anopheles* mosquito.

Which **factors** would **increase** the **global distribution** of **malaria**?

1 A fall in annual rainfall
FALSE: this reduces water bodies for mosquitoes to lay eggs

2 An increase in the use of antibiotics
FALSE: antibotics is NOT used to treat malaria

3 A rise in global air temperatures
TRUE: mosquitoes now can survive in areas which were previously too cold

4 Increasing use of land for farming (e.g. water-logged soil for rice)
TRUE: water-logged soil → provides body of water for mosquitoes to lay eggs

A 1, 2 and 3

B 1 and 2 only

C 2, 3 and 4

D 3 and 4 only

- End of Paper 1 –