TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

H2 BIOLOGY **9744/02**

Paper 2 Structured Questions

14 September 2023
2 hours

SUGGESTED ANSWERS

No	Oh dear, where did I go wrong? ☹	Affected Questions	I can improve by doing the following! ☺
1	I **don't understand** what the question wants from me.		• Identify topic(s) related to the question. • Analyse the preamble and/or diagram carefully. • Unpack the command term (e.g. explain, describe)
2	I don't know / can't remember the **conceptual facts**.		• Review my study techniques – what is effective and what is not? • Approach my tutor / peers for advice.
3	I did not give the **essential keywords** / wrong keyword.		• Reflect on why the missing words / phrases were essential in addressing the question.
4	My answers are **incomplete** / not of enough depth.		
5	I **misinterpreted** the questions / data, hence wrote the wrong answer / out-of-point answer		• Read the preamble carefully. • Paraphrase the question in my own words. • Unpack the command term (e.g. explain, describe)
6	I did not **contextualize my answers** to the question. That is, I did not make use of the information in the preamble / stimulus / figure.		• When the question revolves around a specific example, use the contextual information to craft the answers.
7	I did not **cite data** / I did not include the units for data / did not cite meaningful data for both axes.		• Cite complete data: both x & y axes, with units. • Examine the trend of the graph. If appropriate, divide the graph into ≥ 2 parts for meaningful citation of data.
8	I did not **organize my answers** properly, especially for comparison questions / essay questions.		• For comparison questions, ensure each sentence focuses on one feature. Use comparative words (e.g. but, whereas, while) • For essay questions, organise each major idea in a separate paragraph.
9	I did not manage to attempt the question due to **insufficient time.**		• Look through the whole paper and first attempt questions I am more confident in. • Be concise & succinct. Do not write excessively. • When I am stuck at a question, move on.
10	I was not able to **apply the conceptual facts** to this kind of 'suggest' questions.		• Identify topic(s) that the question is related to and draw links to the concept. • Examine any hint(s) / information in the preamble to suggest biologically sensible ideas.

QUESTION 1 [CELL/ TRANSPORT/ BIOMOLECULES]
The table below compares the features of typical eukaryotic and prokaryotic cells.

(a) Complete the table below by placing either a tick (✓), a cross (✗) or the words 'sometimes present' as appropriate in each empty box. **[KU1]** [3]

Features	Eukaryotic cell	Prokaryotic cell
nuclear envelope	✓	✗
cell wall	sometimes present	✓
chloroplast	sometimes present	✗
ribosomes	✓	✓
Golgi apparatus	✓	✗
flagellum	sometimes present	sometimes present
carries out respiration	✓	✓

Active transport and facilitated diffusion are two ways by which substances cross the cell surface membranes.

(b) State one similarity and one difference between active transport and facilitated diffusion. **[KU1]**

similarity [1]

- Both **require proteins/ transmembrane/ transport proteins**
- Both **transports hydrophilic molecules/ charged / polar**

Difference [1]

- Active transport **against concentration gradient** while facilitated diffusion **down a concentration gradient.**
- Active transport **requires energy / ATP** while facilitated diffusion **does not.**
- **Active transport uses a pump** while the other **uses carrier/channel**

Vitamins C and D are essential illness-fighting nutrients, which safeguard our health and boost immunity. They are therefore, taken into cells but take different routes across the cell surface membrane. Vitamin C is water-soluble while Vitamin D is lipid soluble.

(c) Explain how Vitamin C and D is transported across the cell surface membrane. **[HI2]** [3]

Vitamin C

- require **protein carriers** or **channel proteins** which **provide a hydrophilic passageway**
- Vitamin C is hydrophilic, hence**, cannot pass through hydrophobic fatty acid/ hydrocarbon of** phospholipid bilayer

Vitamin D

- Hydrophobic can **diffuse directly across the** phospholipid bilayer
- ..it can interact with **hydrophobic fatty acids via hydrophobic interactions**

A vitamin C drink is thought to contain glucose. Excess glucose consumed is stored as glycogen in muscles.

(d) Explain how the structure of glycogen is related to its role in living organisms. **[KU-2]** [3]

- [Structure] **α-1,4 glycosidic bond** between monomers angles at **109°** to form **helices** → [Property] form a **compact** structure so **more glucose can be stored per unit volume**.

- [Structure] **α-1,6 glycosidic bond** form **branch points** →
  [Property] greater number of free terminal ends for enzymes to bind, resulting in glycogen being **hydrolysed more quickly**.

- [Structure] **OH groups** forms bonds with other groups, hence, **unavailable for H bonding with water**→
- [Property] **insoluble** in water, can be **stored** in large quantities **without affecting the water potential of the cells.**

- [Function] **[compulsory]** Hence, good **energy storage** molecule.

[Total:11]

QUESTION 2 [ENZYMES]

(a) Enzymes speed up the rate of reaction by lowering the activation energy of the reaction. Most enzymes are specific to one reaction. **[KU1]**

Outline how enzymes lower the activation energy of a reaction. [2]

1. During catabolic reactions, an enzyme **stresses/strains the bonds** within substrates to slightly distort the substrate molecule bound to the active site.

2. During anabolic/catabolic reactions, an enzyme **maintains the precise orientation of the substrates** at the active site, such that these bonds are exposed to the catalytic residues.

3. During catabolic/anabolic reactions, an enzyme can **increase the substrate reactivity/** as the R groups on the enzyme can **change the charges of the substrate** / **alter the distribution of electrons within the bonds** of the substrate/cause other chemical changes.

4. Enzymes provide a **favourable microenvironment** for enzymatic reaction to take place.

A tyrosine kinase receptor (TKR) is a protein complex found in the cell surface membrane of mammalian cells.

TKR has two components involved in the process of cell signaling:

- a receptor for the signalling molecule (ligand)
- an enzyme that catalyses the transfer of a phosphate group from ATP to an intracellular protein.

Fig. 2.1 is a diagram to show how TKR is involved in cell signalling.

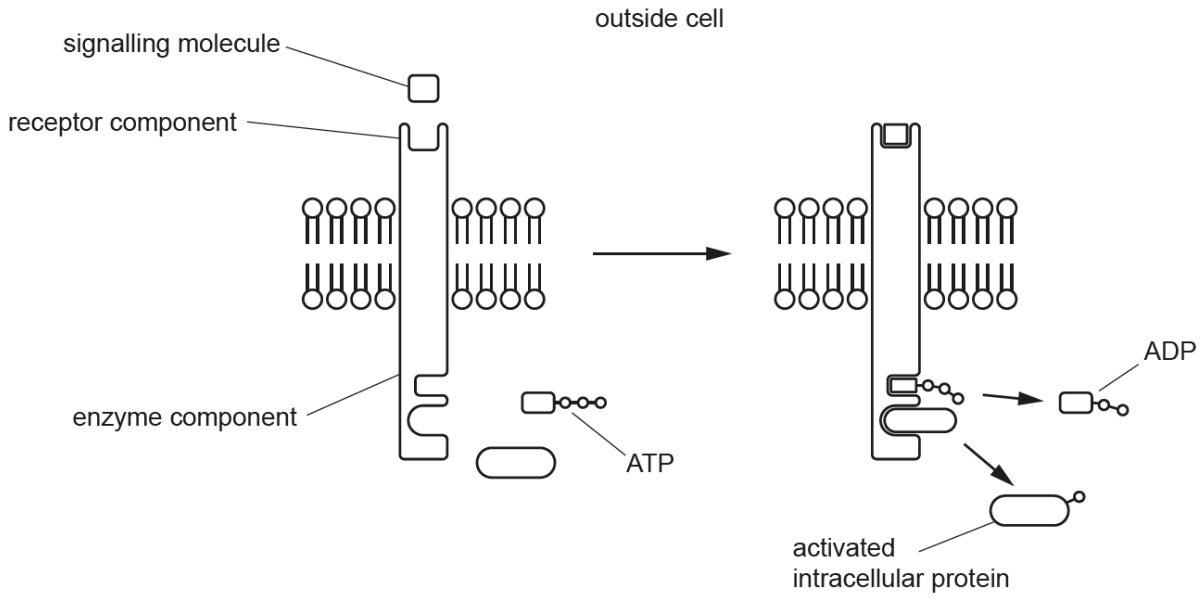


Fig. 2.1

(b) Describe how the signalling molecule shown in Fig. 2.1 is able to trigger a response inside the target cell. **[HI1]** [3]

- Signalling molecule is **complementary** in shape with and **binds** to the **extracellular domain** of the **receptor**.
- Binding induces a **conformational change** to the receptor protein.
- **ATP and intracellular protein** binds to the enzyme **active site**
- This results in the **phosphorylation and activation of the intracellular protein**, leading to a cellular response

(c) The drug GNF-5 is used in the treatment of some cancers. GNF-5 affects the activity of TKR by binding to the enzyme component of the complex.

Researchers investigated the effect of GNF-5 on the activity of TKR using different concentrations of ATP solution. In an experiment the activity of TKR was measured with no GNF-5 **and** with GNF-5.

The results are shown in Fig. 2.2.

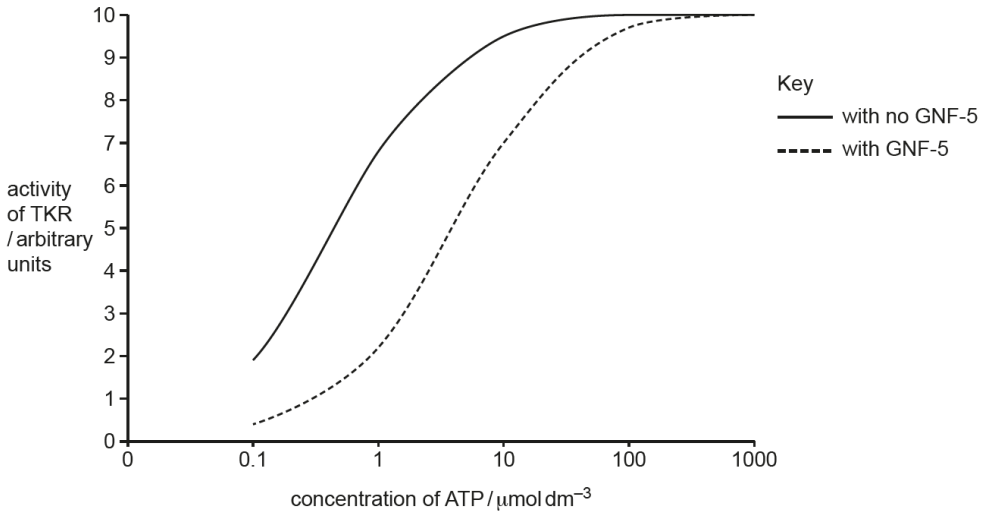


Fig. 2.2

Use Fig. 2.2 to provide evidence that GNF-5 acts as a competitive inhibitor. **[HI2]** [3]

1. At low(er) substrate concentration, activity of TKR is lowered with GNF-5.

[Cite data-compulsory]:

2. *Idea that it is lower* At **0.1 μmol dm^{-3} of ATP,** activity of TKR with no GNF-5 is **at 2a.u**., while with GNF-5, the activity **is lower at 0.5a.u**.

3. As substrate concentration increases, the effect of GNF-5 decreases. / As concentration of **ATP increases from 0.1 to ($10^{2.5}$) 316.2 μmol dm^{-3}**, the **differences** between TKR activity with and without GNF-5, **decreases from 1.3 a.u. to 0a.u.**

4. **Maximum rate of reaction / Vmax / Maximum TKR activity** is **achieved** with GNF-5.

(d) A mutation of the gene coding for TKR results in the change to the enzyme component of TKR. This altered form of TKR is known as T315L.

The effect of GNF-5 on the activity of T315L was also investigated.

The results of this investigation are shown in Fig. 2.3.

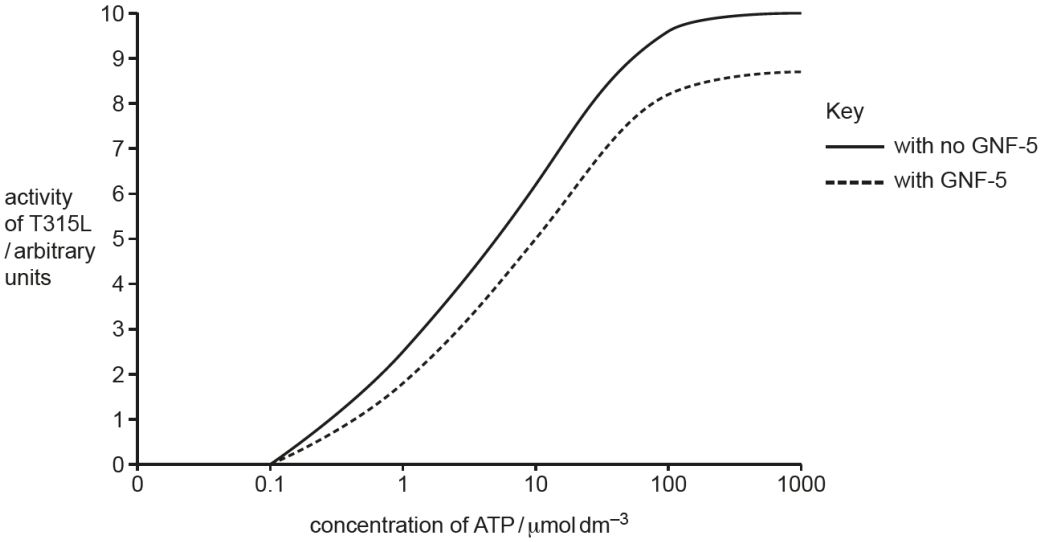


Fig. 2.3

Use Fig. 2.2 **and** Fig. 2.3 to

(i) State how the activity of T315L differs from TKR when **no** GNF-5 was present.**[HI2]** [1]

- T315L has **no activity** at **0.1 μmol dm^{-3} (ATP)**, while **activity of TKR is at 2 a.u.**
- **Maximum rate** of reaction is reach for T315L at a **higher** **ATP concentration** of **100 μmol dm^{-3}** while TKR reach maximum at (accept range$10^{1.5-1.9}$) **31.6 - 79.4 μmol dm^{-3}** of ATP.

(ii) Explain why the effect of GNF-5 on T315L differs from the effect of GNF-5 on TKR.**[HI2]** [2]

- With GNF-5 inhibitor, **activity of T315L does not reach maximum / Vmax not reach**.
- GNF-5 acts as **non-competitive inhibitor of T315L** while GNF-5 acts as competitive inhibitor of TKR.
- GNF-5 has **less effect** on the activity of T315L at **low concentrations**.
  [Accept: data citation as comparison]

[Total: 11]

QUESTION 3 [CELL CYCLE]

Fig. 3.1 shows a pair of homologous chromosome in one stage of meiosis.

The letters **G** to **M** represent the dominant alleles of seven genes and the letters **g** to **m** represent the recessive alleles of the same seven genes.

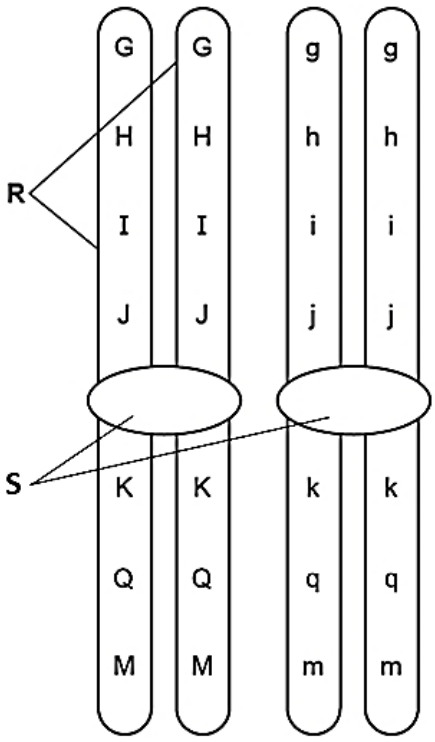


Fig. 3.1

(a) (i) Name the structures labelled **R** and **S** on Fig. 3.1. **[HI1]** [2]

R sister chromatids

S centromere

(ii) State **three** features visible on Fig. 3.1 that identify the chromosomes as a homologous pair. **[HI1]** [3]

- have **same genes** (G to M) **at the same loci** / **position** on a chromosome/ **same gene loci**
- same position of, **S** / centromere;
- same length **[Reject: same number of genes]**

(iii) Fig. 3.2 shows the same two chromosomes a little later in the same stage of meiosis. Crossing over is starting to occur at point **T**.

Fig. 3.3 shows an outline of the same two chromosomes after crossing over has occurred. Complete Fig. 3.3 by writing in the letters of the alleles along both chromosomes. Take care to clearly show the difference between letters representing dominant alleles and letters representing recessive alleles. **[HI1]** [2]

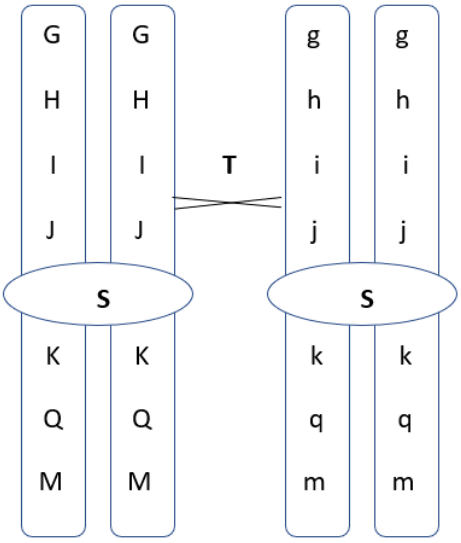


Fig. 3.2

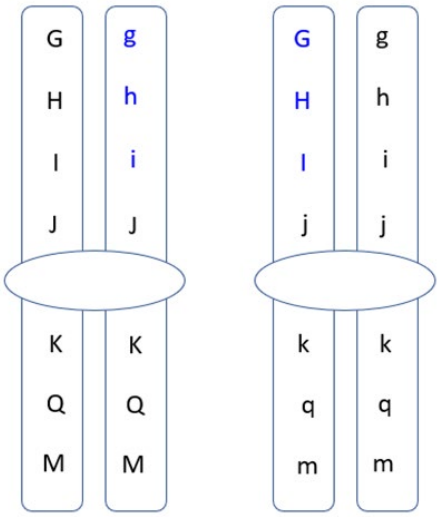


Fig. 3.3

(b) State the stage in meiosis in which crossing over occurs. **[KU1]** [1]

Prophase 1

(c) Crossing over results in genetic variation.
Explain how random assortment of homologous chromosomes also results in genetic variation. **[KU2]** [2]

- homologous chromosomes / bivalents, **align independently of each other**; at the equator / metaphase plate;
- *idea that* this leads to **different combinations of chromosomes** in the daughter cells**;**
- results in **new combinations of alleles**.

(c) The diploid number of chromosomes of this organism is ten.

In the absence of crossing over or mutation, state the number of genetically unique kinds of gametes that might be formed by one individual. **[KU1]** [1]

Formula = 2^n, where n represents the number of chromosomes in one haploid set.
In this example, diploid number (2n) = 10, therefore n = 5.
Number of genetically unique gametes = 2^5 = **32**

[Total:11]

QUESTION 4 [TRANSFORMATION OF ENERGY]

Fig. 4.1 is an electron micrograph of part of a chloroplast.

Fig. 4.1

(a) Using ruled label lines and the letters **X, Y** and **Z**, identify a structure in Fig. 4.1: **[HI1]**

(i) that contains Rubisco – X **(stroma)**

(ii) where photoactivation takes place – Y **(thylakoid membrane/grana)** [2]

(b) State where in a chloroplast circular DNA may be located. **[KU1]** [1]

stroma

(c) Describe the similarities between ATP production in mitochondria and chloroplasts **and** suggest why these similarities exist. **[KU2]** [4]

[Similarities] – at least 1

- **Electron transport chain** is involved
- When electrons are passed along electron carriers of progressively lower energy levels, **energy is released for active transport of protons / H+**
- **proton gradient across membrane** generated,
- occurs in the respective membranes (**inner mitochondrial membrane** and **thylakoid membrane)**
- When **H+ diffuse through stalked particles / ATP synthase** complex, energy is released, to **form ATP**

[Why these similarities exist] – at least 1

- mitochondria and chloroplasts are theorized to be ancestral prokaryotes which were engulfed by larger eukaryotic cells.
- and became **symbiotic** with the eukaryotic host / **endosymbiosis.**

Fig. 4.2 shows a raccoon.

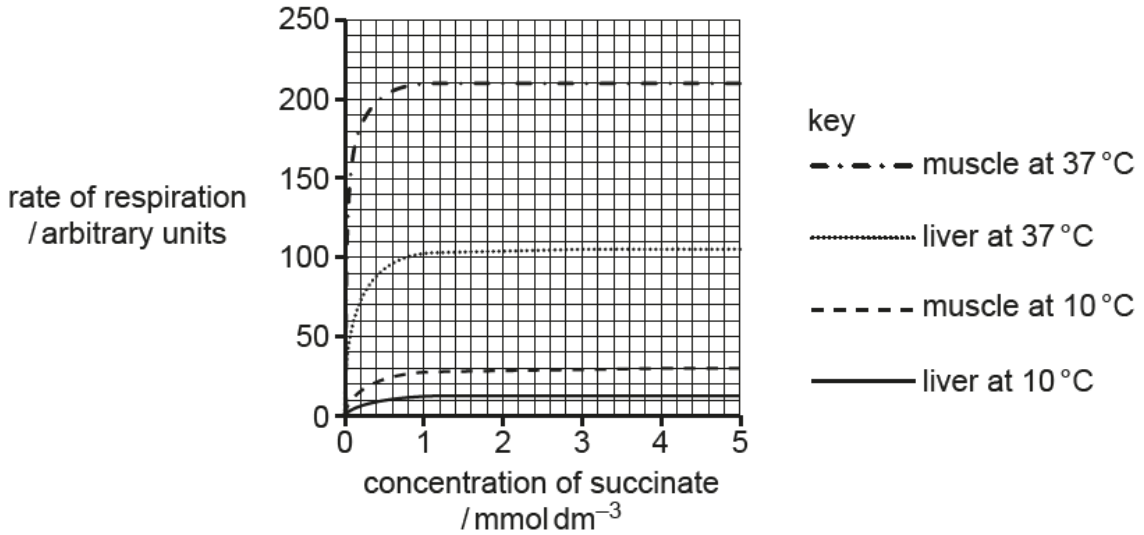
Fig. 4.2

In the winter, the raccoon curls into a spherical shape underground and sleeps for long periods. During this time, the raccoon switches between two states:

- torpor, when the body temperature is maintained at 10°C
- euthermia, when the body temperature is maintained at 37°C.

Scientists used the activity of succinate dehydrogenase to investigate the rate of respiration in the mitochondria of raccoons. Mitochondria were extracted from liver and muscle samples of raccoons. The rate of respiration was measured at different concentrations of succinate and at temperatures that corresponded to torpor (10°C) and euthermia (37°C).

The results are shown in Fig. 4.3.



(c) (i) Compare the effect of temperature **and** cell type on rate of respiration. **[HI3]** [3]

- In both cell types, **rate of respiration is higher at 37 °C than at 10 °C**
- **liver (105 vs 13 a.u.)** and **muscle (210 vs 30 a.u.);**
- At both temperatures, **rate of respiration is higher in muscle than in liver**
- At 10ºC, **(muscle 30 a.u. vs liver 13a.u.)** / At 37ºC, **(muscle 210 a.u. vs liver 105a.u.)**
- Extent of **effect on liver is greater than on muscles**. **(muscles 7 times more** vs **liver 8 times more)**

[cite data-compulsory]

(ii) Suggest reasons for the difference in the rates of respiration between liver and muscle cells. **[HI2]** [2]

muscles have higher rate of respiration because:

- more mitochondria
- so as to **synthesise more ATP / energy**;
- for **muscle contraction**/ **movement** / **locomotion**

[any 2]

[Total:12]

QUESTION 5 [INHERITANCE]

A piebald fur dog is one that has white spotted pattern and is often associated with deafness.

Pure bred brown fur dogs with normal hearing were crossed with pure bred piebald, deaf dogs. All F1 generation were brown fur dogs with normal hearing. The F1 generation were then inbred and gave offspring with the following observed numbers and phenotypes as shown in Table 5.1 below.

(a) In Table 5.1,

- indicate the expected number of progeny of the F2 phenotypes if the genes assorted independently.
- complete the rest of Table 5.1 to calculate the chi-squared value. **[HI1]** [4]

Table 5.1

Phenotypes	Number of F2 progeny		$(O - E)^2$	$\frac{(O - E)^2}{E}$ (2 d.p.)
	Observed (O)	Expected (E)		
Brown fur, normal hearing	30	**36**	**36**	**1.00**
Piebald fur, deaf	24	**12**	**144**	**12.00**
Brown fur, deaf	7	**12**	**25**	**2.08**
Piebald fur, normal hearing	3	**4**	**1**	**0.25**

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

= **15.33**

(b) The critical chi-squared value for these results at a probability of p = 0.05 is 7.81.

State what can be concluded about the inheritance from the chi-squared value you have calculated in **(a)(ii)**. **[HI2]** [3]

- the value of $\chi^2 = 15.33$ **is larger than the critical value of 7.81 at 5% significance level**
- i.e. **The probability that the deviation from expected ratio is due to chance is less than 5%. That is, p < 0.05.**
- **[Contextualize]** Thus, **deviation of observed numbers of 30:24:7:3 from the expected ratio of 9:3:3:1** is **significant and is not due to chance**.

OR

The observed numbers of 30:24:7:3 do not conform to expected ratio of 9:3:3:1 and is not due to chance.

(c) Explain the difference between the expected and observed number in the F2 progeny.**[KU-2]**[4]

- When the two genes are on different chromosomes, **independent assortment and segregation** results in the expected ratio of 9:3:3:1.
- The significant deviation of the actual results from the expected ratio shows that the two genes could possibly be **linked**.
- During **crossing over**, exchange of corresponding gene loci gives rise to a relatively **smaller numbers of recombinant gametes**.
- The recombinant gametes in turn give rise to relatively **smaller number of individuals with non-parental phenotypes**.

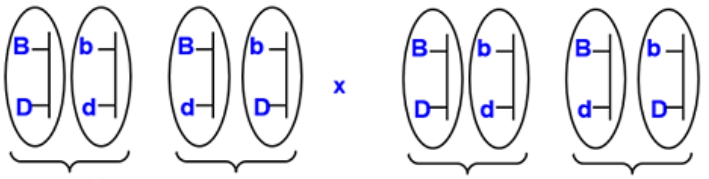
(d) Draw a genetic diagram to show the results of a cross between the F1 generation.

Use the symbols **B** and **b** to represent alleles for fur colour and **D** and **d** to represent the alleles for hearing. **[HI2]** [4]

B represents the dominant allele for brown fur
b represents the recessive allele for piebald fur
D represents the dominant allele for normal hearing
d represents the recessive allele for deafness

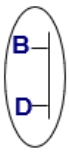
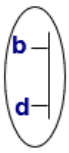
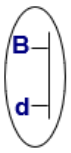
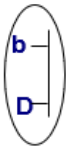
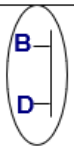
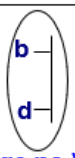
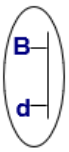
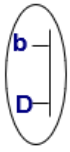
Selfing F_1: Brown fur, Normal hearing x Brown fur, Normal hearing

F_1 genotype:  [1]

Gametes:  [1]

Non-recombinant gametes (large no.) | Recombinant gametes (small no.) | Non-recombinant gametes (large no.) | Recombinant gametes (small no.)

F_2 genotypes and phenotypes:

	 (Large no.)	 (Large no.)	 (small no.)	 (small no.)
 (Large no.)	Brown fur, normal hearing	Brown fur, normal hearing	Brown fur, normal hearing	Brown fur, normal hearing
 (Large no.)	 Brown fur, normal hearing	Piebald, deaf	Brown fur, deaf	Piebald, normal hearing
 (Small no.)	Brown fur, normal hearing	Brown fur, deaf	Brown fur, deaf	Brown fur, normal hearing
 (Small no.)	 Brown fur, normal hearing	Piebald, normal hearing	Brown fur, normal hearing	Piebald, normal hearing

[1]

F_2 phenotypes:	Brown fur, Normal hearing	Piebald, deaf	Brown fur, deaf	Piebald, Normal hearing	
	Non-recombinant phenotypes (large numbers)		Recombinant phenotypes (small numbers)		
Observed no.	30 :	24	7 :	3	[1]

The observed numbers approximate the theoretical ratio.

[Total:15]

QUESTION 6 [OCPG]

The *lac* operon is a section of DNA present in the genome of *Escherichia coli*. The structural genes of the *lac* operon are only fully expressed when the bacteria is exposed to high lactose concentrations.

Fig. 6.1 is a diagram showing the *lac* operon and a nearby region of the *E. coli* genome.

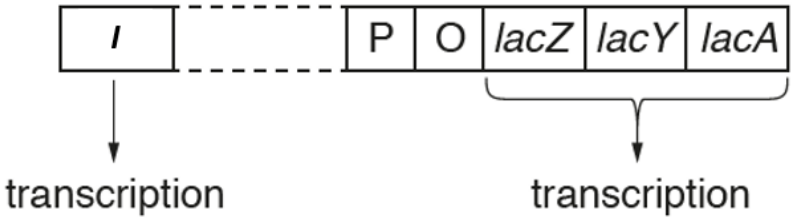


Fig. 6.1

(a) With reference to Fig. 6.1, complete Table 6.1 to identify two structural genes and its products. **[HI1]** [2]

Table 6.1

structural gene	name of the gene product
lac Z	**β-galactosidase**
lac Y	**permease**
lac A	**transacetylase**

[any 2]

(b) Gene *I* is transcribed all the time to produce its protein. This is known as constitutive expression.

Explain why Gene *I* is constitutively expressed. **[HI2]** [3]

- Gene *I* **continuously** codes for an **active repressor** protein which binds to the **operator**…
- …and **blocks RNA polymerase from binding to the promoter of *lac* operon.** This **prevents mRNA synthesis**
- Ensure that the cell **does not waste energy / resources** synthesizing unneeded enzymes in the **absence of lactose.**

In an investigation into the growth of *E. coli*, a sample of the bacterium was grown in a medium that contained limited concentrations of glucose and lactose. The population size of *E. coli* was measured at regular intervals.

Fig. 6.2 shows the population growth curve obtained for this investigation.

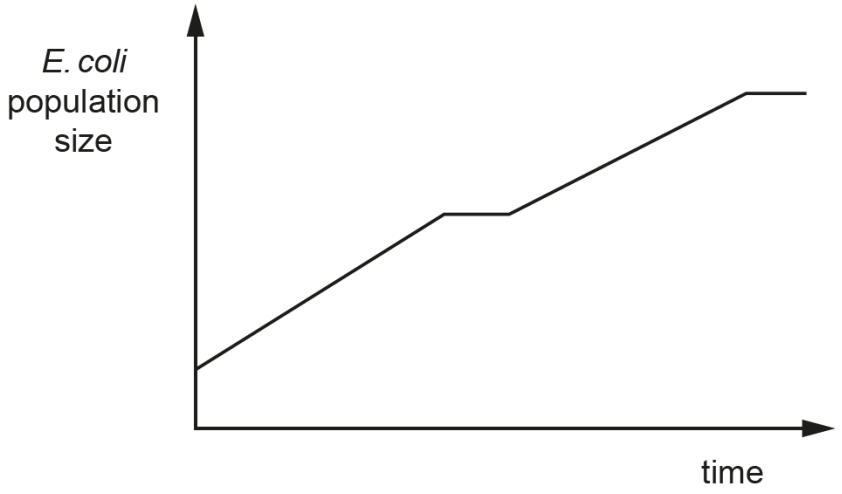


Fig. 6.2

(c) Describe and suggest explanations for the population growth curve shown in Fig. 6.2. **[HI2]** [4]

[Description] – 1m

1. As **time increases**, the *E. coli* population size **increases**, **remain constant** for a short duration before **increasing** and **remaining constant** again.

[Explanation] -3m

2. At the start, glucose is used as a **respiratory substrate** to provide energy for cells to divide by **binary fission**.

3. **Glucose is used in preference to lactose** by the bacterial cells.

4. After glucose has been used up, **time is needed** for the **induction of *lac* operon** /to **produce β-galactosidase** before lactose can be metabolized.

5. Lactose is now **hydrolysed / broken down into glucose and galactose** to be used as respiratory substrate.

6. As more **lactose is being used up**, there is no more respiratory substrate available for bacteria to undergo binary fission, hence E. coli population size remains constant.

[Total:10]

QUESTION 7 [BIOLOGICAL EVOLUTION]

Fig. 7.1 shows the evolutionary relationship, constructed based on the DNA sequence data, of three species of *Urena* plants and the corresponding timescale.

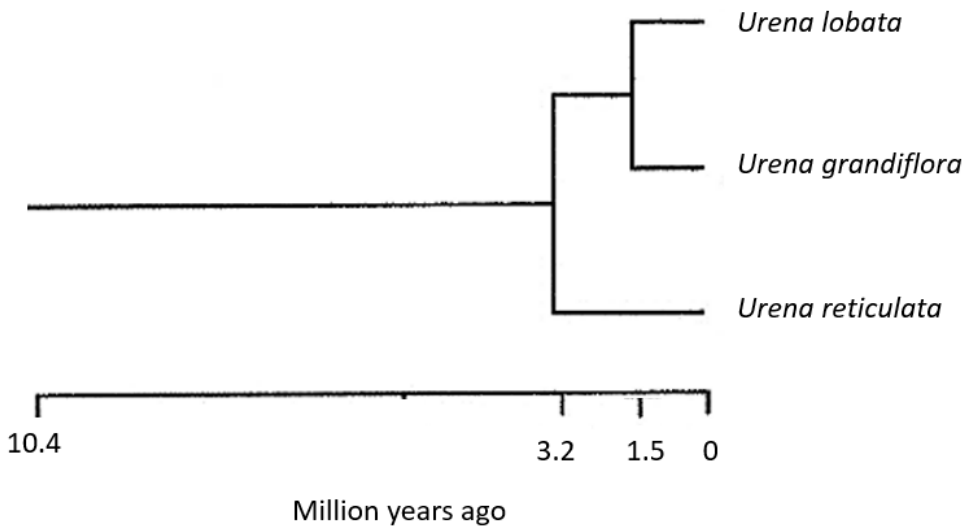


Fig. 7.1

(a) (i) Name the type of diagram used to represent the above evolutionary relationship. **[KU1]** [1]

- Phylogenetic tree.

(ii) Describe the evolutionary relationship between the three species above. [2]

- U. lobata and U. grandiflora are **more closely related** as they diverged from a common ancestor **1.5million years ago.**
- U. reticulata is **more distantly related** to the other two species as they diverged from a common ancestor **3.2 million years ago**.
  [overall minus 1m if lacking data citation]

Table 7.1 shows the Linnaean taxonomy of *Urena lobata*.

(b) Complete Table 7.1 to show the classification of *Urena lobata*. **[KU-1]** [2]

Table 7.1

Kingdom	**Plantae**
Phylum	Tracheophytes
Class	Magnoliopsida
Order	Malvales
Family	Malvacea
Genus	***Urena***
Species	***Urena lobata***

(c) Describe one advantage of using DNA sequence data in determining evolutionary relationships. **[KU1]** [1]

- It is **objective**. **Homologous** nucleotide sequences / sequences of amino acids of homologous proteins are compared
- It is **quantitative** / quantifiable and can be subjected to statistical analysis
- Similarity in DNA sequences **reflect common ancestry** as **DNA is inherited** / passed down from previous generations of organism / ancestral organism.
- As DNA is being compared, it takes into consideration **changes in non-coding sequences** (which are not expressed in phenotype). Hence more complete comparison.
- As DNA is being compared, it takes into account **silent mutation**.
- Can be used to compare species that are **anatomically indistinguishable**.
- Can be used to assess relationship between species that share few morphological similarities

(d) *Urena lobata is a* wind-pollinated plant species which is an iron tolerant form abundant on land near an iron ore mine. Figure 7.2 is a profile of the area around the iron mine showing where samples were taken for a study.

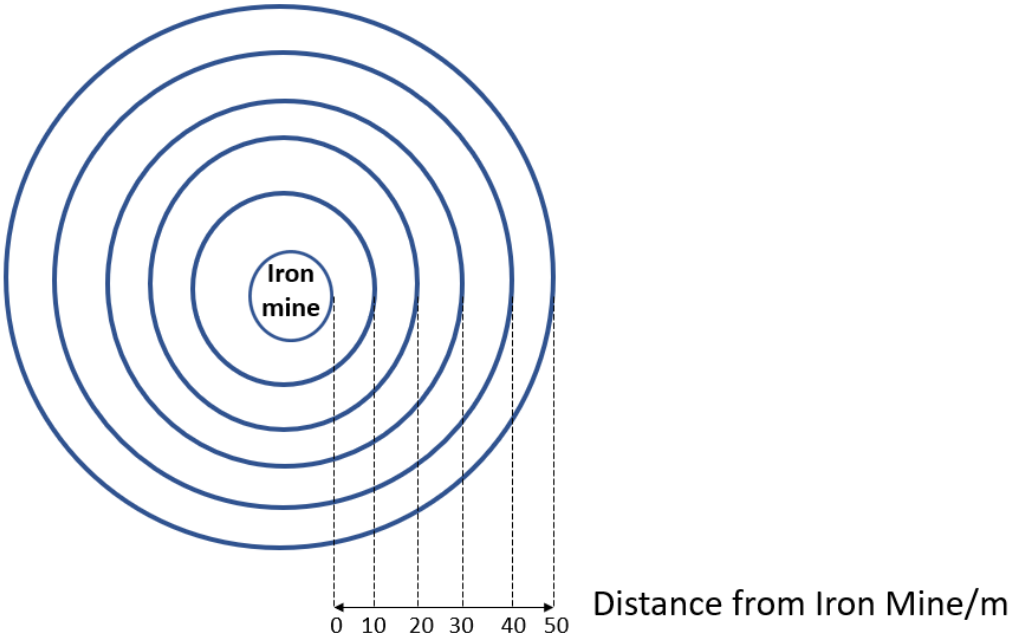


Fig. 7.2

Seeds were collected from plants at 10 metre intervals from the iron mine and germinated in laboratory. The seedlings were planted in a medium containing all the minerals required for healthy growth. Batch **A** was watered with solution containing diluted concentrations of iron while Batch **B** was watered with distilled water. After two weeks, the mean height of each batch of seedlings were recorded. Table 7.2 shows the results.

Table 7.2

Distance from mine where seeds were collected/ m	Mean height of seedlings/cm	
	Batch **A**	Batch **B**
10	3.9	4.0
20	3.8	4.1
30	3.7	4.8
40	3.8	4.9
50	3.7	4.9

(i) Describe the results shown in Table 7.2. **[HI2]** [3]

Batch A

- All seedlings have **little variation** in height **(3.7-3.9cm)** – **[cite data - compulsory]**

Batch B

- Seedlings closer to mine /10-20m from the mine are **shorter (4.0 & 4.1cm)** while those from 30m away are **taller (4.8 & 4.9cm)** / as distance from mine **increases from 10 to 40m, mean height increases (4.0 to 4.9cm)** and **remain constant at 4.9cm from 40-50m**

General

- Batch A seedlings are **shorter** than Batch B **(3.7- 3.9cm vs 4.0- 4.9cm)**

In Batch **A**, it is observed that seedlings collected closer to the mine has greater survival rates after two weeks while those taken further away from the mine died.

(ii) Explain why seedlings collected closer to the mine grow more successfully. **[HI2]** [2]

- Land closer to the mine has **high iron content** which acts as a selection pressure.
- Plants that survived closer to the iron mine would **have alleles resistant to iron ore**,
- hence, it will **survive and reproduce** to pass on advantageous alleles to **fertile and viable offsprings.**

(iii) Suggest why some iron tolerant plants can be found 50m or more away from the mine area. **[HI3]** [1]

- They are probably **wind pollinated / dispersed by wind**

  Or

- Land there probably **contaminated with iron ore** too hence, **plants with iron ore resistant alleles would have survived** there too.

[Total:12]

QUESTION 8 [IMMUNITY]
AIDS is caused by a virus that infects and kills helper T cells.

(a) State the name of the virus that leads to AIDS. **[KU1]** [1]

Human immunodeficiency virus [Reject abbreviation, spelling MUST be correct]

(b) Describe the consequences of the lack of helper T cells on the functioning of the immune system. **[HI2]** [4]

- **No helper T cells** to bind to **antigen displayed on class II MHC** in antigen presenting cells (e.g. dendritic cells).
- Hence, **no helper T cells activated** to **release cytokines** to..
- …trigger the **proliferation** of more helper T cells specific to a particular epitope.
- … activate B cells to **proliferate** and **differentiate** into **plasma cells** and **memory B cells**.
- …**activate** $CD8^+$ **cytotoxic T cells**.

(c) State **one** way in which this virus can be transmitted from person to person.**[KU1]** [1]

- re-using/sharing of needles
- Unprotected sexual intercourse
- Blood transfusion / mixing of blood contaminated with virus
- Across placenta
- Breastfeeding

(d) Suggest why antibiotics are prescribed to patients with AIDS, despite the fact that antibiotics have no effect on viruses. **[HI3]** [2]

- Protect patient with AIDS from **bacterial infection / opportunistic infections** *[look out for bacteria in subsequent points]*
- *Idea that* Bactericidal / kill bacteria / Bacteriostatic / prevent bacterial growth / prevent bacterial replication
- E.g. Tuberculosis or pneumonia or name of bacteria

(e) Currently, there is no drug that effectively eliminates the virus that causes AIDS. Explain why this is so. **[HI3]** [2]

- **Reverse transcriptase** has **no proof-reading** and is **error prone**
- HIV genome **undergoes mutation** frequently/rapidly,
- Hence, **changes the structure of the glycoprotein / viral protein.**

[Total:10]

QUESTION 9 [CLIMATE CHANGE]
A large number of different mammal species living in North America were weighed and the mean mass of each mammal species was calculated.

Fig. 9.1 shows the relationship between the mean mass of different mammal species and the mean annual temperature of the habitat in which they normally live.

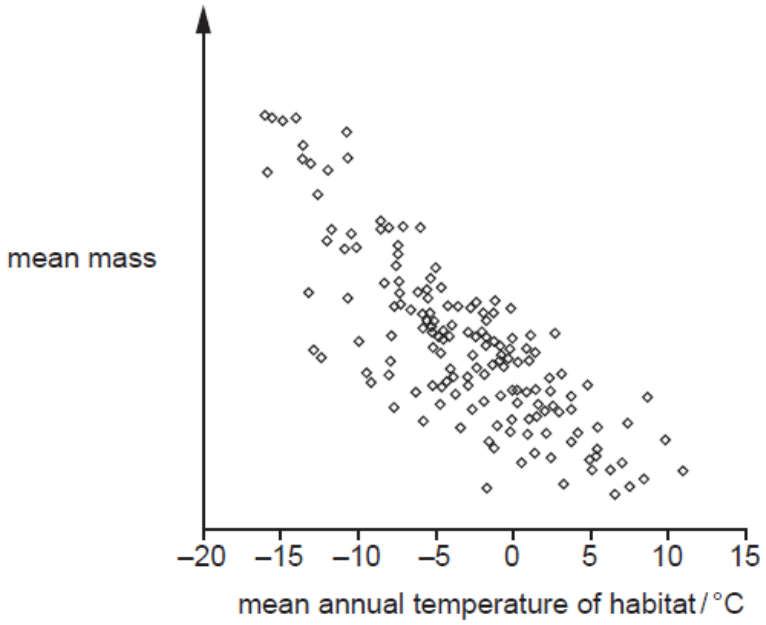


Fig. 9.1

(a) Account for the relationship between the mean mass of mammal species and the mean annual temperature of their habitat shown in Fig. 9.1. **[HI2]** [3]

[Describe]

- **[cite data - compulsory]** As mean annual temperature **increases from -15°C to 11°C**, the **mean mass of mammal species decreases**.

[Explain]

- At **lower temperatures**, mean mass is higher as **mammals store more fats / thicker fur** as **insulation**.
- These fats are also **energy reserve**, as in (extreme) low temperature, e.g. northern ends of N. America regions, food sources are scarce.
- There's considerable **variation in mean mass** at all temperatures. E.g. at 0°C, mammals can have different mean mass.
- This could be due to **differences** in **behaviour** / **activities carried out** / **fur thickness** / **stored fats** / **shapes of mammals**, which **affects heat loss**.

The mean annual temperature across the world is increasing. The global average surface temperature rose by 0.6 to 0.9°C. Global warming is the term used to describe the rapid increase in Earth's average surface temperature over the past century primarily due to the release of greenhouse gases, such as carbon dioxide.

Fig. 9.2 shows the average concentration of carbon dioxide in the atmosphere every 10 years from 1965 to 2015.

The concentration is in parts per million (ppm).

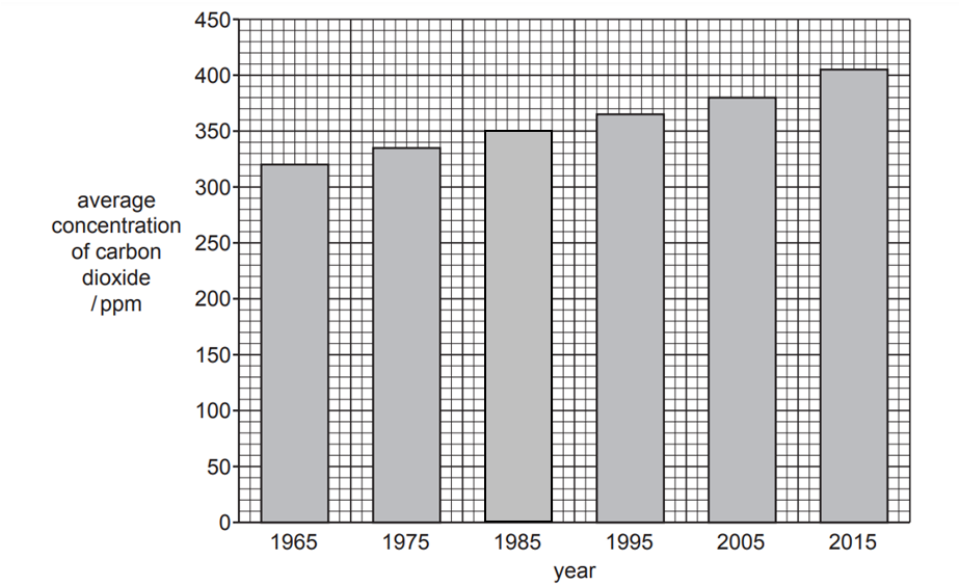


Fig. 9.2

(b) State which 10-year period experienced the greatest increase in concentration of carbon dioxide. **[HI1]** [1]

- **Between 2005 – 2015**

(c) State a reason for the increase in average concentration of carbon dioxide over the years. **[KU1]** [1]

- **Anthropogenic activities**/ Give **an example of a human activity (i.e. burning of fossil fuels, deforestation, food choices) that releases CO_2**

  [Reject human activities]

Scientists study many biotic and abiotic factors that may have been influenced by global warming. Global warming is putting pressure on the different mammal species both on land and in the ocean. Warmer temperatures have already shifted the growing season in many parts of the globe. Spring is arriving earlier in both hemispheres, causing the growing season in parts of the Northern Hemisphere becoming two weeks longer in the second half of the 20th century.

Therefore, migrating animals, have to start seeking food sources earlier. Furthermore, the shift in seasons may already be causing the life cycles of pollinators, like bees, to be out of sync with flowering plants and trees. This mismatch can limit the ability of both pollinators and plants to survive and reproduce, which would reduce food availability throughout the food chain.

(d) Define biotic factor. **[KU1]** [1]

Biotic factor refers to **living organisms in an ecosystem** such as animals, birds, plants, fungi, and other similar organism.

(e) Describe how global warming has impacted **other** biotic factors. **[KU2]** [3]

- Warmer sea, coral reefs expel photosynthetic zooxhanthellae, leading to coral bleaching

[Reject: Higher acidity in the ocean]

- ***Ref to.*** increased prevalence of parasites and spread of infectious diseases
- ***Ref to.*** changes in plant distributions / range of animals /AVP
- ***Ref to.*** Reduced crop yield/ livestock productivity due to heat waves/ AVP
- ***Ref to.*** Loss of habitats leading to loss of biodiversity / extinction of certain species

[Total:9]

☺ END OF PAPER 2 ☺