H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CLASS

BIOLOGY **9744/02**

Paper 2 Structured Questions **15 September 2025**

Candidates answer on the Question Paper.
No Additional Materials are required. **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name and CT on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do no use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions in the spaces provided on the Question Paper

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do no use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	10
2	8
3	10
4	10
5	11
6	10
7	10
8	10
9	10
10	6
11	5
Total	100

This document consists of **27** printed pages and **2** blank pages.

[Turn over

Answer **all** the questions in this section.

1 In the majority of cell types, ribosomes are the most common organelle. They are found in the cytoplasm of bacterial and eukaryotic cells. [2024 H1 A Levels]

(a) **(i)** List the **two** types of biomolecule that are found in ribosomes.

Protein, ribosomal RNA /ribonucleic acid

[1]

(ii) State one difference between the ribosomes found in the cytoplasm of bacteria and the ribosomes found in the cytoplasm of eukaryotes.

Bacteria have **70s ribosomes** whereas eukaryotes have **80s ribosomes.**

[1]

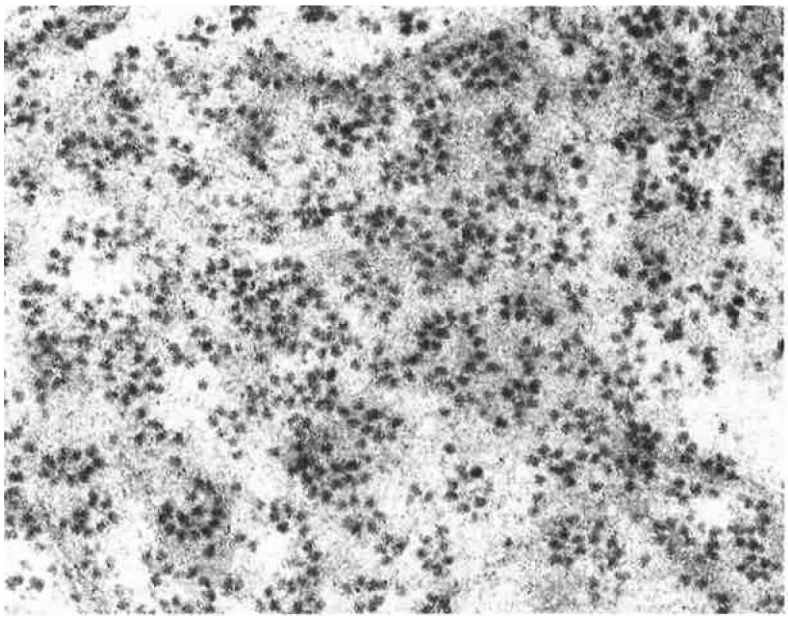
(iii) State **two** differences, **other** than differences in ribosomes, between typical bacterial cells and typical eukaryotic cells.

1. Bacterial cells have **peptidoglycan cell wall** whereas eukaryotes have **cellulose cell wall**.
2. Bacterial cells have **circular DNA** whereas eukaryotic DNA is **linear**
3. Bacterial cells **lack nucleus/membrane bound organelles** whereas eukaryotes **have**.

[2]

(b) Scientists have estimated the numbers of ribosomes found in cells.

Fig. 1.1 is an electronmicrograph showing ribosomes in a cell.



x67700

Fig. 1.1

(i) Suggest why it is difficult to use electronmicrographs, such as that shown in Fig. 1.1, to determine the total number of ribosomes in a cell.

1. **Too many** ribosomes to count which may cause **inaccuracy in counting**
2. **Difficult** to distinguish individual ribosomes as some are clustered together
3. Limited field of view capturing a small section of the cell, which may **not be a good representation of the ribosome density of the entire cell**.

[3]

(ii) Fig. 1.2 shows data for the number of ribosomes present in cells of different volumes.

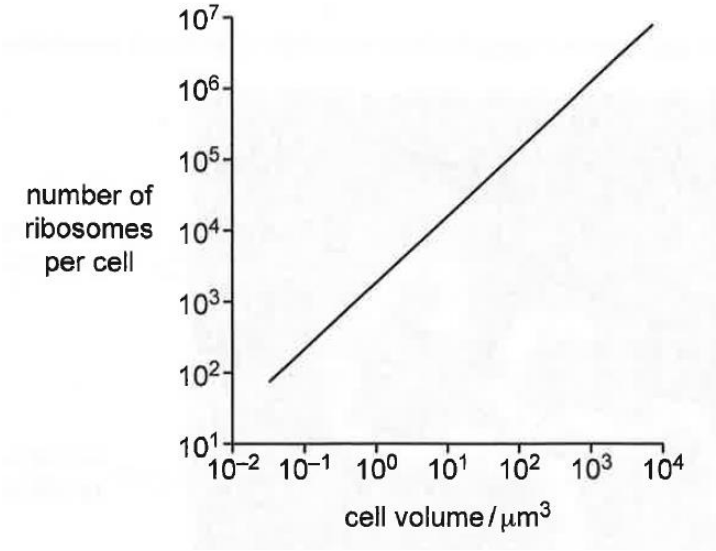


Fig.1.2

Describe **and** explain the relationship shown in Fig. 1.2.

1. [describe] As the cell volume **increases from $10^{-1.5}$ to $10^{3.9}$ μm^3**, number of ribosomes per cell increases from **$10^{1.9}$ to $10^{6.9}$**
   [explain]
2. The greater the volume of the cell, the more physical space to accommodate more ribosomes within the cell.
3. The greater the cell volume, the larger the cell size. Hence cell needs more ribosomes to **synthesize proteins** to carry out cellular activities for growth.

[3]

[Total: 10]

2 In 1953, James Watson and Francis Crick published details about the structure of DNA. They used experimental results from other scientists to help them work out the structure and then built a model of a section of a DNA molecule, using pieces of wire and metal, with clamp stands to hold the model in place. This is shown in Fig. 2.1.

Fig. 2.1

(a) Watson and Crick used results from work carried out by Erwin Chargaff. He found that the proportions of the bases A, T, C and G were different in different species, but within each species:

- the proportion of A was equal to the proportion of T
- the proportion of G was equal to the proportion of C.

(i) Name the bases A, T, G and C.

A adenine T thymine

C cytosine G guanine

[2]

all correct = 2 marks one, two or three correct = 1 mark

(ii) Suggest **and** explain how Chargaff's findings helped Watson and Crick work out the structure of DNA.

1. **complementary base pairing** between…
2. **Adenine and Thymine**, **Guanine and Cytosine**
3. **hydrogen bonding** between base pairs/ holding two strands together
4. ***idea of*** fixed diameter at 2nm with two ring base pair with one ring base / purine with pyrimidine
5. **double helix** with two DNA strands/polynucleotides
6. two strands are **antiparallel**

[3]

(b) Phoebus Levene isolated the nucleotides of DNA and identified the carbohydrate component of each nucleotide.

State the name of this carbohydrate component.

Deoxyribose;

[1]

(c) Before the discovery of the structure of DNA as the molecule of inheritance, scientists thought that proteins were most likely to be the molecules that carried information.

Suggest how the structure of proteins made scientists think that these were the molecules that carried information.

1. proteins are made of **specific sequence** of amino acids
2. there are up to **20 different amino acids** in proteins
3. **different** proteins have **different** sequence of amino acids
4. ***idea that*** there is a **great variety** in protein structure

[2]

[Total: 8]

3 Leber Congenital Amaurosis (LCA) is an inherited eye disease. In LCA, the photoreceptor cells in the retina die at an early age. This causes impaired vision (reduced eyesight) in children, which can progress to blindness.

LCA10 is a different form of LCA caused by a recessive mutation in the *CEP290* gene. This gene codes for the protein CEP290, which is involved in the correct functioning of photoreceptor cells in the retina.

This mutation in *CEP290* occurs in the intron and causes an error to be made when the primary transcript is spliced to form messenger RNA (mRNA). The abnormal mRNA that is formed has an extra sequence of RNA nucleotides, known as exon X, between exon 26 and exon 27. Exon X contains a STOP codon.

Fig. 3.1 compares the effect of the mutation in CEP290 with the normal gene expression

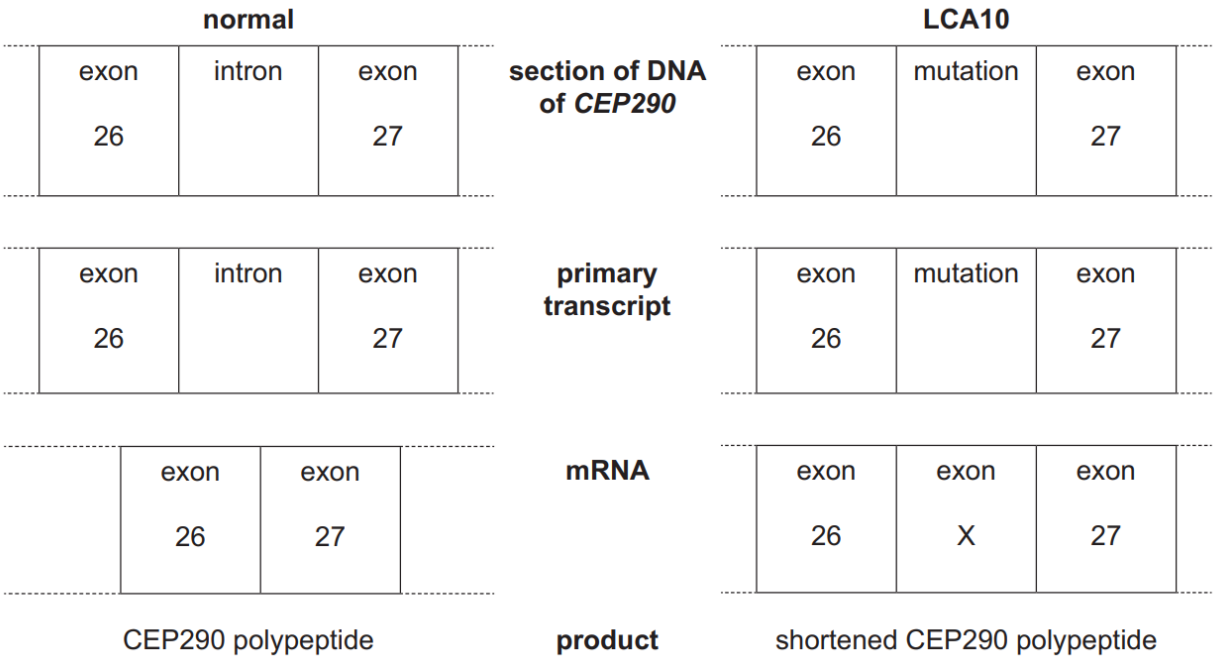


Fig. 3.1

CEP290 is a classic example of intronic mutation, changes in sequences that occur to non-coding DNA.

(a) Define what is non-coding DNA.

portions that do not encode protein or RNA

[1]

(b) Describe the structure **and** functions of another **two** types of non-coding DNA in eukaryotes.

including centromeres, telomeres, promoters, enhancers and silencers

[4]

In 2022, research was carried out into possible treatment of LCA10 using genetic technology.

A human clinical trial investigated a treatment of LCA10 using a short RNA nucleotide sequence known as Sepofarsen. Sepofarsen binds to the section of the primary transcript containing the CEP290 mutation.

(c) With reference to the above method, identify the level in which gene regulation is achieved **and** describe two other methods to regulate gene expression at this level and their respective functions.

1. Post-transcriptional level
2. Addition of **7-methylguanosine (7-MG) to the 5' end** of the pre-mRNA
3. Addition of stretch of adenine nucleotides at the 3' end of the pre-mRNA/ polyadenylation

Function of 5' GTP cap and 3' poly(A) tail

4. 5' GTP cap p**rotects the mRNA from degradation**
5. **3'** poly (A) tail **prolongs the half-life of mRNA** by buffering the mRNA against degradation
6. Both facilitates the **export of mature mRNA** from **nucleus to cytoplasm**
7. Promote translation initiation

[5]

[Total: 10]

Post transcriptional level; polyadenylation ; and 5' capping ;

4 **(a)** Fig. 4.1 shows photomicrographs of individual cells from the root tip of an onion, *Allium sp.*, at different times in the mitotic cell cycle.

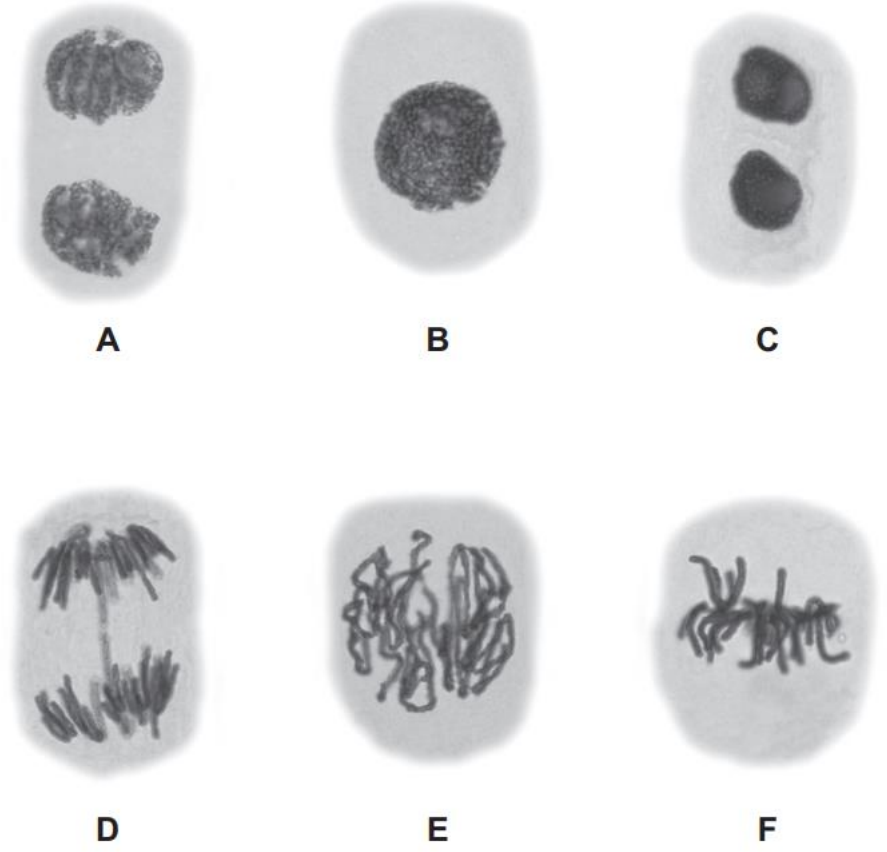


Fig. 4.1

(i) Place the letters representing the individual cells in the correct sequence of the mitotic cell cycle. The first letter has already been filled in.

B					

B, E,F,D,A,C

[2]

(ii) Describe the events that occur in cell **A**.

1. Telophase
2. **Nuclear envelopes reform** to form **two nuclei**.
3. Nucleolus **reappears**.
4. Chromosomes become **less condensed** to form **chromatin**.
5. Microtubules **disperse** by depolymerising.

[3]

(iii) Colchicine is a chemical used by scientists to study mitosis. This chemical inhibits the organisation of the microtubules in prophase of mitosis.

The cells shown in Fig. 4.1 had not been treated with colchicine.

Explain the evidence in Fig. 4.1 that shows the cells had not been treated with colchicine.

1. *Idea that* chromatids are attached to the spindle fibres which allows the chromosomes to align at the equator in cell F
2. *Idea that* sister chromatids have separated due to the shortening kinetochore spindle fibres *in* cell D

[2]

6(c)	*any* ***two*** *from:* (fully formed) spindle seen / spindle fibres, are visible ; *idea that* chromatids are attached to, the spindle fibres / (spindle) microtubules ; *idea that* chromosomes would have orientated at the equator (ready for anaphase) ; sister chromatids have separated (Fig. 6.1) because, spindle fibres have contracted / microtubules have disassembled / AW ; in anaphase so has, completed /AW, prophase / metaphase ;	**2**

(b) Complete Table 4.1 by stating the term that matches each of the descriptions.

Table. 4.1

term	description
Telomere	Region of DNA with repeated nucleotide sequences located at the ends of chromosomes
Centrioles	Organises microtubules to form the spindle in animal cells
Centromeres	Point of attachment between two sister chromatids

[3]

[Total: 10]

(b) Complete Table 6.1 by stating the term that matches each of the descriptions.

Table 6.1

term	description
	region of DNA with repeated nucleotide sequences located at the ends of chromosomes
	organises microtubules to form the spindle in animal cells
	point of attachment between two sister chromatids

[3]

5 A student crossed a tan-bodied *Drosophila* fly with a yellow-bodied *Drosophila* fly, expecting to get an F1 generation of all tan-bodied flies. Body colour for *Drosophila* flies are sex-linked. The tan-body allele (T) is known to be dominant over the yellow-body (t) allele. In *Drosophila*, the males are the heterogametic sex, possessing two different sex chromosomes, X and Y. The results from the cross are shown in Table 5.1.

Table 5.1

Phenotype of fly	Number of offspring
tan-bodied female	27
tan-bodied male	0
yellow-bodied female	0
yellow-bodied male	23

(a) (i) With reference to Table 5.1, describe crosses that can be carried out to determine if body colour is autosomal or sex-linked.

Do note that the offspring shown in Table 5.1 is a result of crossing yellow-bodied female with tan-bodied male.

1. ***Reciprocal cross****;
2. Mate tan-bodied female with yellow-bodied male and yellow-bodied female with tan-bodied male;
3. If offspring of both crosses shows the same phenotypic ratio / results , coat colour is autosomal inheritance;
   or

If offspring of both crosses show different phenotypic ratio, coat colour is sex linked;

[3]

(ii) Draw a genetic diagram to show how the results shown in Table 5.1 could have been produced.

Parental phenotypes yellow-bodied female X tan-bodied male
Parental genotypes (2n) X^tX^t X X^TY [1]

Meiosis

Gametes (n) X^t X^T Y [1]

		Gametes	
		X^T	Y
Gametes	X^t	X^TX^t tan-bodied female	X^tY yellow-bodied male

Offspring genotypes X^TX^t : X^tY

Offspring phenotypes tan female : yellow male
[1] for linking genotype to phenotype
Offspring phenotypic ratio 1 : 1

[3]

(b) The eye colour in *Drosophila* fly is determine by two genes, gene A/a and gene B/b. A homozygous wild type fly with brick-red eyes was crossed with a homozygous fly with white eyes. All the F_1 offspring were wild types with brick-red eyes. When the F_1 offspring were mated to each other, the F_2 generation was observed as follows:

Wildtype eyes (brick-red)	938
Scarlet eyes (bright red)	286
Brown eyes	315
White eyes	89

(i) The genotype for wildtype eyes have been filled in, in the table below. Suggest a suitable genotype for each of the remaining phenotypes.

Phenotype	Genotype
Wildtype eyes (brick-red)	A_B_
Scarlet eyes (bright red)	A_bb (Accept: aaB_)
Brown eyes	aaB_ (Accept: A_bb)
White eyes	aabb

[3]

(ii) A chi-squared test was carried out on the results of the second cross.

Phenotype	Observed number (O)	Expected number (E)	$\frac{(O-E)^2}{E}$
Wildtype eyes (brick-red)	938	915.75	0.54
Scarlet eyes (bright red)	286	305.25	1.21
Brown eyes	315	305.25	0.31
White eyes	89	101.75	1.60

The χ^2 test gave a value = 3.66, with 3 degrees of freedom.
Part of the critical values of the chi-squared distribution is shown below.

Distribution of χ^2

Degrees of freedom	**Probability, p**				
	0.10	**0.05**	**0.02**	**0.01**	**0.001**
1	2.71	3.84	5.41	6.64	10.83
2	4.61	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.35	16.27
4	7.78	9.49	11.67	13.28	18.47

Explain if the difference between the observed and expected is significant.

1. At df=3, χ^2 value 3.66 is **smaller** than the critical value 5.99 at 5% significance level OR Probability that the difference between observed and expected is due to chance is greater than 10%, p > 0.05
2. difference between expected and observed results is not significant and is due to chance

[2]
[Total: 11]

6 Adrenaline is a signal molecule that stimulates similar cellular responses from liver cells and adipose cells in a way similar to that of glucagon.

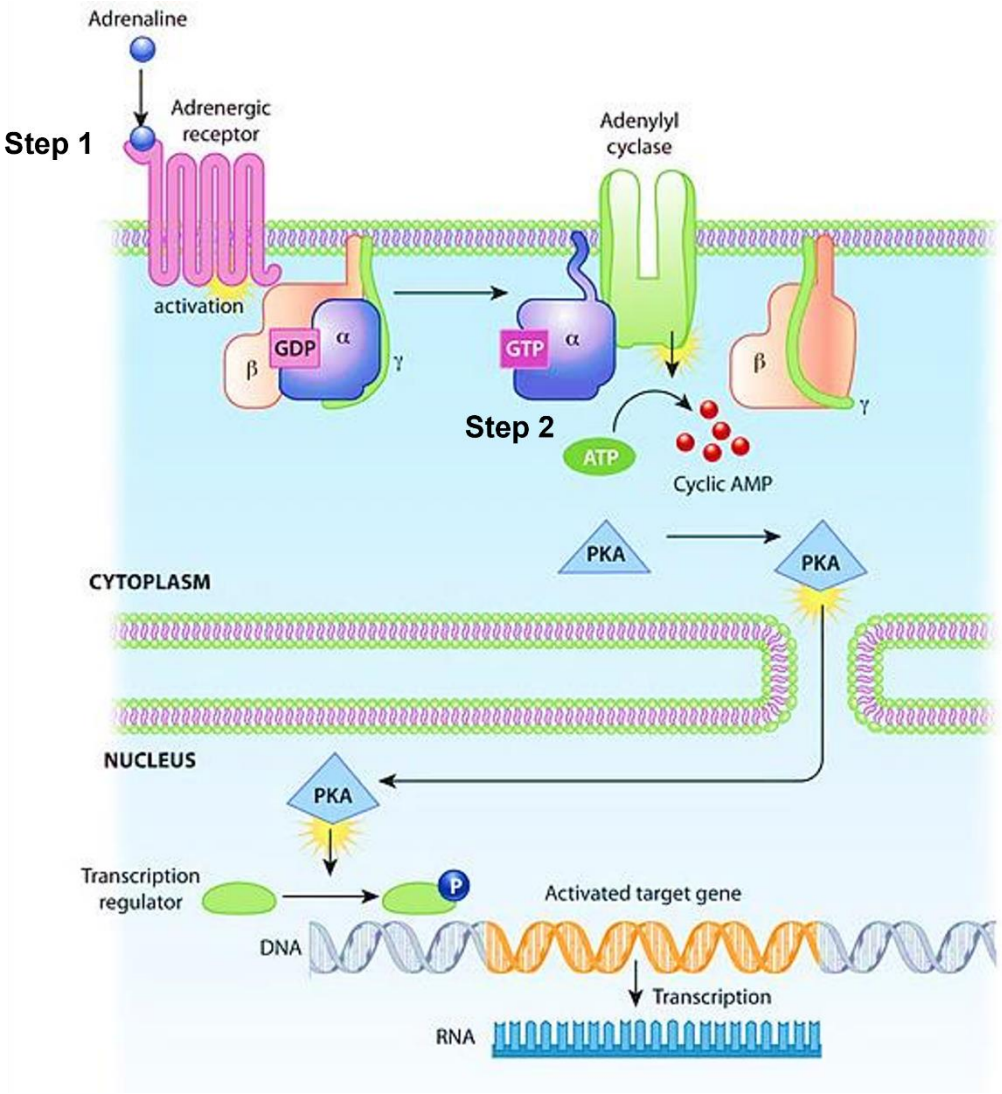


Fig. 6.1

(a) With reference to Fig. 6.1,

(i) describe the events occurring in **step 1** after the binding of adrenaline molecule to the adrenergic receptor.

1. Binding results in a **conformational change** of the receptor which **activates** the receptor
2. The activated receptor binds to an **inactive G protein** and **activates** it by **replacing GDP with GTP**
3. α subunit **dissociates** from the β and γ subunits, **moves along the plasma membrane** and binds with and **activates the adenylyl cyclase**

[2]

(ii) explain the significance of **step 2** that results in effective signal transduction.

1. An **activated adenylyl cyclase** catalyses the formation of **many cAMP** from **many ATP**
2. Thus **amplifying the signal** as may cAMP are produced by one adenylyl cyclase
3. cAMP is a ***second messenger***…
4. …that is small and can **diffuse** easily in the cytosol to **activate protein kinase A/ PKA**

[3]

(iii) describe the series of events that occur after the activation of protein kinase A that results in a cellular response.

1. Activated protein kinase A enters the nucleus through the **nuclear pore**
2. **Phosphorylates transcription regulators** resulting in a **activation**
3. Activated transcription regulator binds to specific regulatory DNA sequences (e.g., enhancers)…
4. …and recruits **RNA polymerase** / **promotes assembly of the transcription initiation complex**, resulting in **transcription of the target gene**.

[3]

(b) A mutation resulted in high concentration of cyclic AMP being produced in the liver cell.

Assuming that the adenylyl cyclase functions normally, explain how a mutation can lead to the observation above.

1. **Gain of function mutation** in the **gene** which codes for **adrenergic receptor**

2. Result in **hyperactive** receptor which **binds** to **adrenaline permanently/continuously** to trigger the signal pathway

OR

Result in **hyperactive** receptor which binds to and **activates G-protein permanently/continuously** to trigger the signal pathway

OR

3. **Gain of function mutation** in the **gene** which codes of **G-protein**.
4. Result in **hyperactive** G-proteins which binds to and **activates adenylyl cyclase permanently**.

[2]

[Total: 10]

7 The light-dependent stage of photosynthesis occurs within chloroplasts. In this stage, electrons are emitted from the special chlorophyll *a* molecules and passed to electron acceptors.

If a redox indicator, such as DCPIP, is added to a suspension of illuminated chloroplasts, electrons will be transferred to DCPIP, causing the colour of the DCPIP to change from blue to colourless.

A student investigated the effect of the wavelength of light (colour of light) on the rate of photosynthesis.

- DCPIP was added to three colorimeter tubes, each containing a suspension of chloroplasts. The chloroplast suspensions were kept in the dark until required.
- The colorimeter tubes were each exposed to light of a different colour: red, blue or green. The intensity of light was the same for all tubes, and each was exposed to light for four minutes. All other conditions were kept the same.
- The absorbance of each chloroplast suspension was measured at one-minute intervals using a colorimeter.

The results are shown in Fig. 7.1.

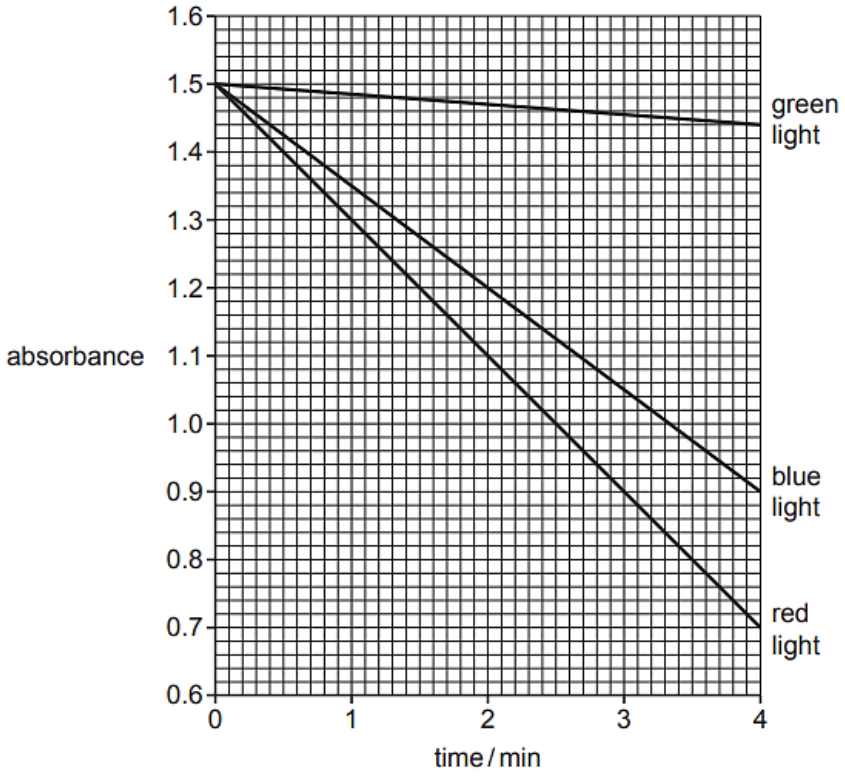


Fig. 7.1

(a) (i) Explain why the chloroplast suspensions were kept in the dark until required.

light not absorbed / stop photosynthesis / stop photoactivation / stop light dependent stage ;

[1]

(ii) Describe the results shown in Fig. 7.1.

any three from:

1 all decrease in absorbance (with time) ;

2 (all decrease) at constant rate ;

3 green, highest absorbance (throughout) /
absorbance stays fairly constant / smallest decrease in absorbance ;
ora red

4 smallest rate of decrease in green ; ora red

5 data quote – 2 colours compared to support mp1 or mp3 ;

	4 mins
green	1.44
blue	0.90
red	0.70

[3]

(iii) With reference to the light-dependent stage of photosynthesis, explain the differences between the results shown in Fig. 7.1 for red light and for green light.

any three from:

with red light ora green light

1 more, light / energy, absorbed (by chlorophyll) ;

2 (so) more, photoactivation / electrons emitted ;

3 more / faster rate of, electrons transferred to DCPIP ;

4 more / faster, decolourisation of DCPIP ;

[3]

(b) Changes in the atmospheric carbon dioxide concentration, light intensity and temperature can affect the rate of photosynthesis. These three factors directly affect different processes of photosynthesis.

Complete Table 7.1 using a tick (✓) to identify the processes that can be **directly** affected by each factor or a cross (✗) to identify the processes that are **not directly** affected by each factor.

Indirect effects where a change in the rate of one process affects the rate of a different process should **not** be considered.

A tick or a cross must be placed in the final column of every row.

Table 7.1

factor	process	✓ or ✗
carbon dioxide concentration	Calvin cycle	✓
	photophosphorylation	✗
light intensity	Calvin cycle	✗
	photophosphorylation	✓
temperature	Calvin cycle	✓
	photophosphorylation	✓

[3]
[Total: 10]

8 Fig. 8.1 shows the reproductive cycle of Human Immunodeficiency Virus (HIV).

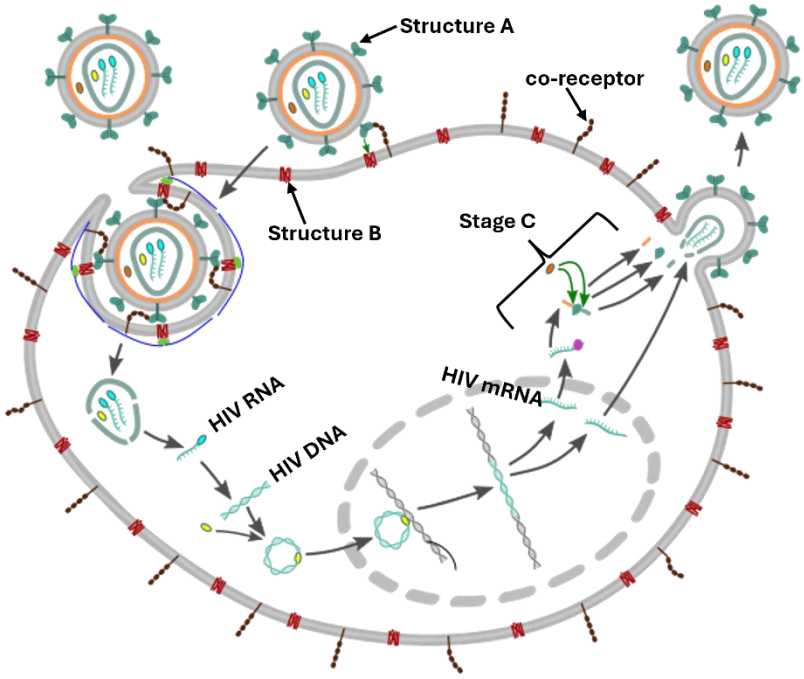


Fig. 8.1

(a) Name structures **A** and **B**.

A: gp120

B: CD4 receptor

[2]

(b) Describe the events occurring in Stage **C** leading to the formation of Structure **A** on the host cell surface membrane.

1. The viral mRNA serves as template for **translation** into **viral polyprotein** by **host ribosomes** on **rER**
2. **ER vesicles** containing viral protein **bud off** **rER** and **fuse** with **cis face** of **Golgi apparatus.**
3. **biochemical modification** of viral protein in rER/GA
4. **Cleavage of polyprotein by protease** to functional viral proteins, such as gp120
5. **Golgi vesicles** with viral glycoprotein **embedded** onto the membrane…
6. … **bud off** from **trans face** of **Golgi apparatus** and transport to the plasma membrane of the host cell.
7. Membrane of Golgi vesicle **fuses** with the host cell surface membrane and the viral glycoproteins are incorporated into the host cell surface membrane.

[4]

(c) Explain why enveloped viruses such as HIV will not exit their host cells the same way as the T4 bacteriophage.

- **Enveloped viruses** exit host cells through **budding** (*reject: exocytosis*) so as to **obtain their viral envelope from the host cell surface membrane**
- **T4 bacteriophages** are **not** enveloped viruses hence exit the host cell through **lysis**

[2]

(d) Besides the structures shown in Fig. 8.1, state two other components of the viral envelope.

1. Cholesterol
2. Channel proteins / carrier proteins / transport proteins
3. Glycolipids

[2]

[Total: 10]

9 *Spea multiplicata* is one of several species of American spadefoot toad.

(a) Young spadefoot toads are called tadpoles and live in water in ponds.

S. multiplicata tadpoles show three different phenotypes due to genetic variation. The three phenotypes are: detritus feeder, intermediate and carnivore.

Detritus feeders are small, and carnivores are large. Intermediates vary in size between the two extremes.

A detritus feeder and a carnivore are shown in Fig. 9.1.

Fig. 9.1

Detritus feeders:
- eat detritus (small pieces of dead organic matter) and algae (photosynthetic protoctists)
- have smooth mouthparts, small jaw muscles and long intestines.

Intermediates:
- can eat all available food (detritus, algae and fairy shrimps)
- have teeth-like mouthparts, medium-sized jaw muscles and medium-sized intestines.

Carnivores:
- eat fairy shrimps and other small animals
- have teeth-like mouthparts, large jaw muscles and short intestines.

Scientists counted the number of each type of tadpole in two different ponds: pond 1 and pond 2.

(i) In pond 1, the scientists observed:

- a high density of tadpoles
- a low abundance of food
- that most of the tadpoles they counted were either detritus feeders or carnivores, with very few intermediates present.

Describe and suggest explanations of natural selection that appears to be acting in pond 1.

1. Disruptive selection
2. Extremes / carnivores and detritus feeders are selected for and are able to survive and reproduce and intermediates are selected against
3. High competition which causes intermediates to be outcompeted for not getting detritus/algae and shrimps/small animals
4. Lack of food is the selection pressure
5. AVP

[2]

Question	Answer	Marks
7(a)(i)	*any **three** from:* **1** disruptive / diversifying (selection) ; **2** extremes / carnivores and detritus feeders, survive / are selected for **and** intermediates, die / are selected against ; **3** high / intense, competition ; **4** intermediates, outcompeted for / don't get enough, detritus / algae, and, (fairy) shrimp / small animals ; **5** lack of / limited, food is selection pressure ; **6** AVP ;	**3**

(ii) In pond 2, the scientists observed:

- a low density of tadpoles
- sufficient food availability for all tadpoles
- that most of the tadpoles they counted were intermediates, with fewer detritus feeders or carnivores.

Describe and suggest explanations of natural selection that appears to be acting in pond 2.

1. Stabilising selection
2. Extremes / carnivores and detritus feeders are selected against and intermediates are selected for
3. low competition
4. intermediates able to eat all/wide range of food
5. greater variety in the diet improves the growth and development of intermediate tadpoles

[2]

Question	Answer	Marks
7(a)(ii)	*any **three** from:* **1** stabilising (selection) ; **2** extremes / carnivores and detritus feeders, die / are selected against / are not selected for, **and** intermediates, survive / are selected for ; **3** low / less / prevents, competition ; **4** intermediates can eat, both types / all / a wider range, of food ; **5** greater variety in the diet improves the growth and development of (intermediate) tadpoles ;	**3**

(iii) State the type of variation shown by the intestine length of *S. multiplicata* tadpoles and list the factors that lead to this type of variation.

1. **Continuous variation**
2. The intestine length is controlled by **multiple genes**
3. The **additive effect of each gene** give rise to a range of phenotypic variation
4. **Environment** also affect the phenotypes

[2]

(iv) A student suggested that the variation in *S. multiplicata* tadpoles could lead to sympatric speciation in some populations.

Outline the feature of **one** concept of species and its limitation.

1. biological, ecological, morphological, genetic and phylogenetic concepts
2. And its accompanying limitation from lecture notes

[2]

(b) Fig. 9.2 shows the evolutionary relationships between three species of American spadefoot toad.

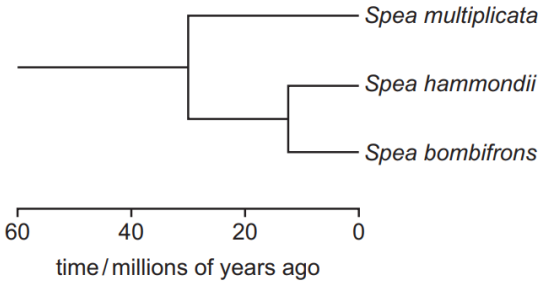


Fig. 9.2

Explain how analysis of DNA allowed the evolutionary relationships shown in Fig. 9.2 to be determined.

1. **Align the homologous DNA sequences** and **compare the similarities and differences** in nucleotides
2. **The fewer** the nucleotide differences, **the more closely related** the populations are, the **more recently they have diverged** from a common ancestor
   Or
   S. hammondii and *S. bombifrons* have **fewer genetic difference** and hence are **more closely related** and the **more recently they have diverged** from a common ancestor

[2]

[Total: 10]

7(b)	*any* ***three*** *from*: **1** *ref. to* DNA sequence (for all / three species) ; **2** find / count, nucleotide / base, differences / similarities ; **3** fewer differences means, more closely related / less time since divergence / less time to common ancestor ; **4** bioinformatics / database / software / BLAST ; **5** *S. hammondii* and *S. bombifrons,* have the fewest genetic differences / are the most genetically similar ;	**3**

10 Fig. 10.1 shows a process that occurs naturally in a B cell.

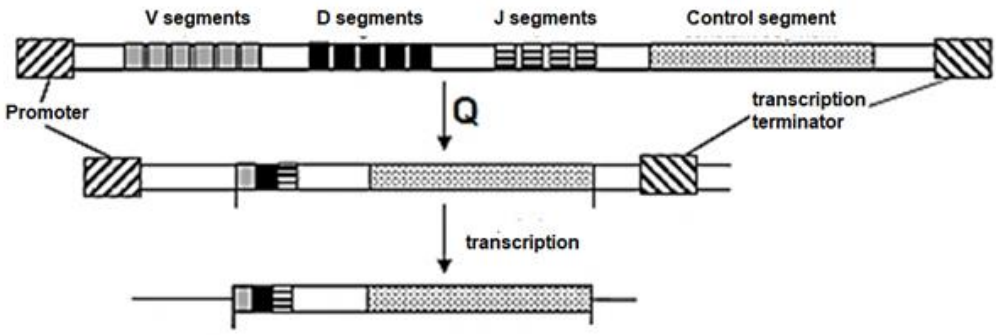


Fig. 10.1

(a) State precisely where the process shown in Fig. 10.1 occurs in the human body.

bone marrow ;

[1]

(b) Explain why Process Q is essential to maintaining the health of an individual.

Q is somatic recombination;

Random assembly of different combinations of V, D, J gene segments (in immunoglobulin heavy chain) enables the diversifying of antigen-binding specificities of B cell receptors;

Idea of creating repertoire of receptors that can recognise any potential pathogen → protection against external threats;

[3]

(c) Besides the location, describe two differences between process Q and class switching.

Process Q	Class switching
Occurs during maturation process of B cell/ in developing B cells	Occurs after activation of B cell (by cytokines from helper T cell)/ in activated B cells
Involves changes to variable region/ antigen binding site	Involves changes to constant region
result in changes to antigen binding specificities	result in changes to effector function

[2]
[Total: 6]

11 The two-spot ladybird, *Adalia bipunctata*, is a species of small, flying beetle that is found in northern Europe and other parts of the world. The wings of these beetles are covered by two tough structures known as elytra, as shown in Fig. 11.1.

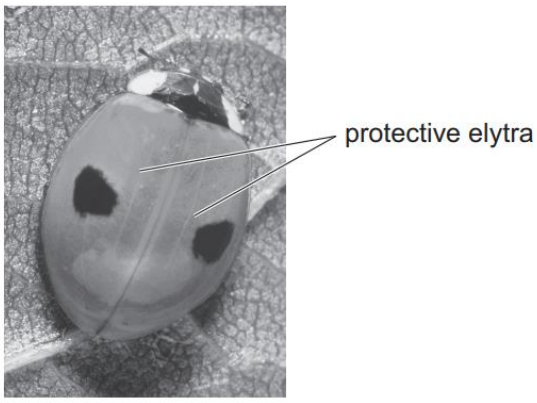


Fig. 11.1

The elytra of *A. bipunctata* show phenotypic variation. The three most common morphs (forms) found in northern Europe are known as typica (**T**), quadrimaculata (**Q**) and sexpustulata (**S**).

- The typica morph, shown in Fig. 11.1, is mostly red with two black spots and is described as non-melanic.
- The other two morphs are described as melanic as they are mainly black with some red.
- The distribution of the colours in these three morphs is shown in Fig. 11.2.

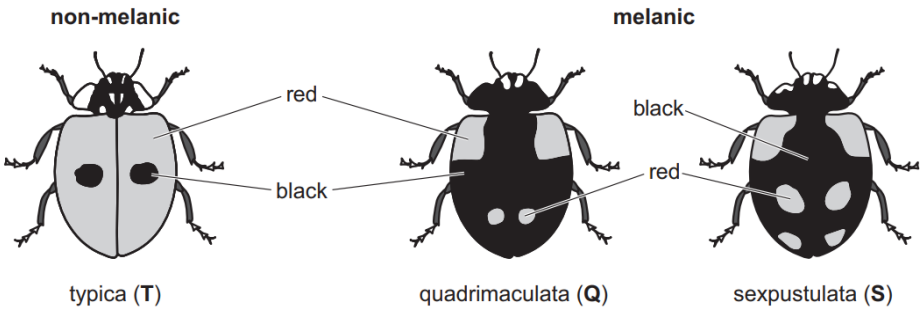


Fig. 11.2

Environmental temperature is one of many different selection pressures that could be acting on populations of *A. bipunctata*. The melanic phenotypes, morphs **Q** and **S**, are considered to be better adapted to the climate in northern Europe as they absorb heat energy more readily than the non-melanic phenotype, morph **T**.

25

Scientists investigated the effect of temperature on the body temperature of the two different phenotypes.

- The four individuals used in the investigation were collected while they were hibernating (inactive) during winter and were kept outdoors for six weeks before the investigation.
- The individuals were weighed and arranged into pairs, each with approximately the same mass.
- A temperature sensor was fixed to the lower (ventral) surface of each individual.
- The temperature of each individual was recorded for 9 minutes. During that time, a heat-emitting lamp positioned directly above the individuals was switched on at 30s and switched off at 5 minutes.

The results are shown in Fig. 11.3.

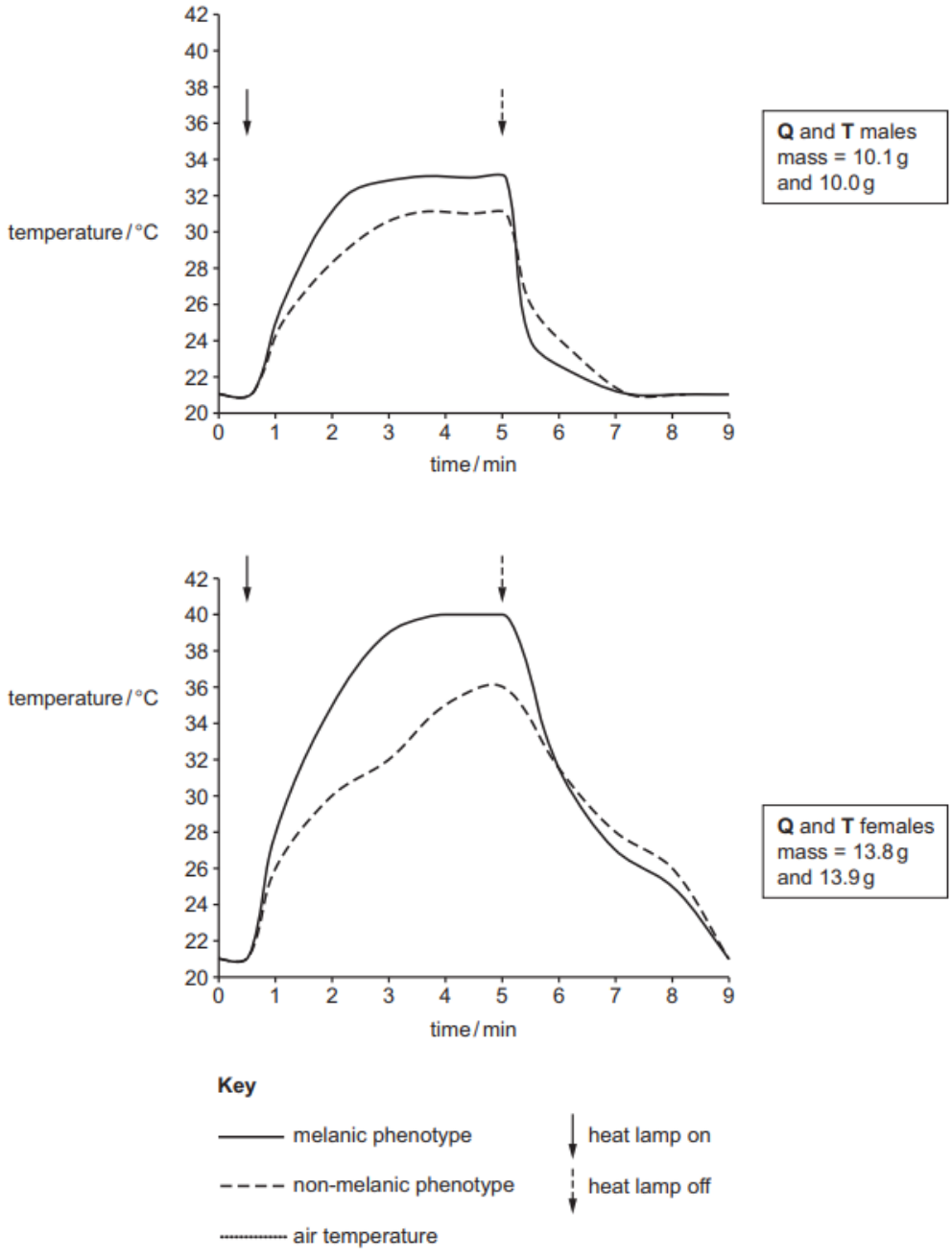


Fig. 11.3

(a) The researchers concluded that melanic morphs warm up more quickly than non-melanic morphs. Explain how the information shown in Fig. 11.3 supports this conclusion.

Line for melanic phenotype is steeper (than non-melanic phenotype) ;
Quote with data

[1]

(b) Explain how global warming might affect the population and distribution of these ladybirds.

1. Melanic will be selected against as global temp increases as they gain heat more easily.
2. More females than males as males has lower tolerance to higher temp ;
3. Melanic will migrate northward further up Europe due to lower temp

[3]

(c) Suggest why female ladybirds are heavier in mass when compared to the male ladybirds.

- Males are smaller to be agile in finding mates ; requires less resources ;
- Females needs to store more energy/resources to produce eggs

[1]

[Total: 5]