

**H1**

ANDERSON JUNIOR COLLEGE  
HIGHER 1  
**JC2 MID YEAR COMMON TEST**

NAME

PDG





INDEX NUMBER


**BIOLOGY****8875/02**

Paper 2 Core Paper

**18 September 2015****Friday  
2 hours**

Additional Materials: Answer Paper

**READ THESE INSTRUCTIONS FIRST**

Write your name and PD group on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graph or rough working.

Do not use paper clips, highlighters, glue or correction fluid.

**Section A**Answer **all** questions.**Section B**Answer **all** questions

All working for numerical answers must be shown.

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

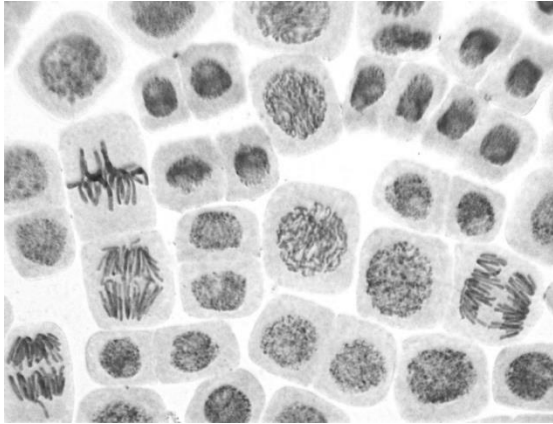
The number of marks is given in brackets [ ] at the end of each question or part question.

Calculators may be used

For Examiner's Use	
<b>PAPER 1</b>	
<b>1-30</b>	
	<b>30 marks</b>
<b>PAPER 2</b>	
<i>Section A</i>	<i>40 marks</i>
<b>1</b>	
<b>2</b>	
<b>3</b>	
<b>4</b>	
<i>Section B</i>	<i>20 marks</i>
<b>5</b>	
<b>PAPER 2</b>	
	<b>60 marks</b>
<b><u>TOTAL</u></b>	
	<b><u>90 marks</u></b>

### Section A

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

1	Fig. 1.1 below shows cells of an organism in various stages of mitosis.	
		
	Fig. 1.1	
(a)	On Fig. 1.1, use labels and label lines to indicate one cell in each of the following stages of mitosis.	[3]
	<div>Prophase</div> <div>Metaphase</div> <div>Anaphase</div>	
(b)	Explain how interphase ensures production of genetically identical daughter cells at the end of mitosis.	[2]
	<ul style="list-style-type: none"> <li>During S phase of interphase, semi-conservative DNA replication occurs;</li> <li>Double-armed chromosomes with genetically identical sister chromatids are formed;</li> <li>Such that genetically identical sister chromatids may be separated during anaphase to opposite poles, forming 2 genetically identical daughter cells.</li> </ul>	
	[any 2]	
(c)	Most chemotherapeutic drugs against cancer are inhibitors that interfere with the function of microtubules. However, these drugs do not specifically target cancer cells. They also interfere with the function of normal cells and cause severe side effects.	
	To overcome this challenge, scientists use microtubule inhibitor drugs that replace a fixed structural element with a flexible hinge that swings open or shut in response to blue light.	
(i)	Explain how interfering with the function of microtubules help to treat cancer.	[3]
	<ul style="list-style-type: none"> <li>Cancer is uncontrolled cell division;</li> <li>Cells will not be able to align chromosomes at metaphase plate</li> <li>Will not be able to pull genetically sister chromatids apart in anaphase;</li> </ul>	
	Preventing mitosis from completing and therefore prevent tumour formation;	
(ii)	State one function of microtubule in normal cells.	[1]
	<ul style="list-style-type: none"> <li>Aids in the movement of vesicles with the help of motor proteins;</li> <li>Helps to support the cell as cytoskeleton;</li> <li>Involved in cell movement;</li> </ul>	
	AVP/ any one	
(ii)	Suggest how light could cause structural changes in the drug.	[1]
	<ul style="list-style-type: none"> <li>Blue light changes the wavelength of light received by the cell/ energy received by the cell, causes R group interactions in the tertiary structure of drug to</li> </ul>	

change, causing conformational difference;

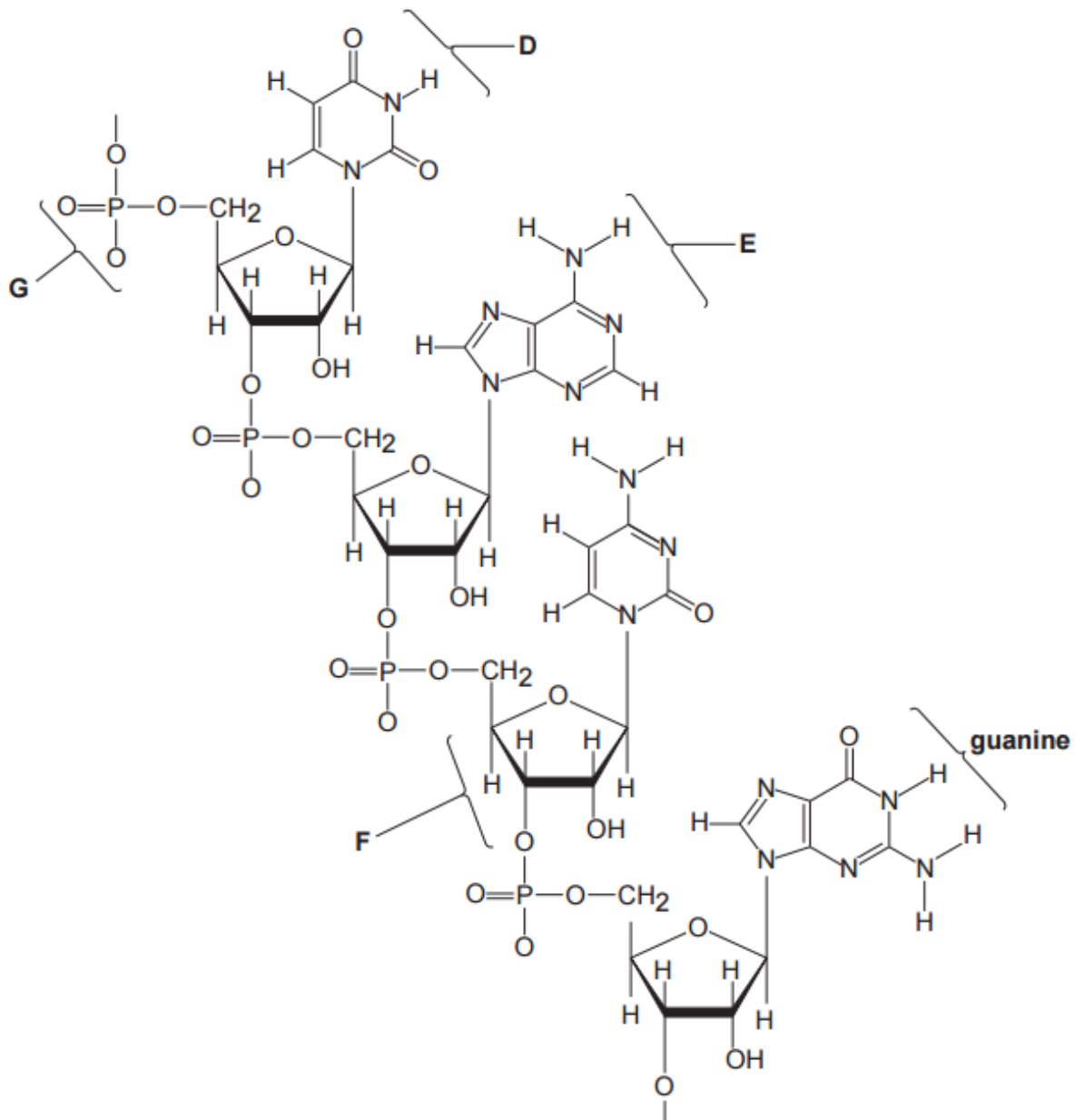
AVP

[Total: 10]

**2** A molecule of messenger RNA (mRNA) was produced during transcription of a gene.

**(a)**

Part of the template sequence of DNA was ATGC. Fig. 2.1 shows the part of the molecule of messenger RNA corresponding to that sequence of four bases.



**Fig. 2.1**

Name the parts of the mRNA molecule shown in Fig. 1.2 labelled D, E, F and G.

[2]

Answer:

D – uracil ; E – adenine ; F – ribose ; G – phosphate

**(b)** The amount of DNA and RNA bases are measured as shown in Fig. 2.2.

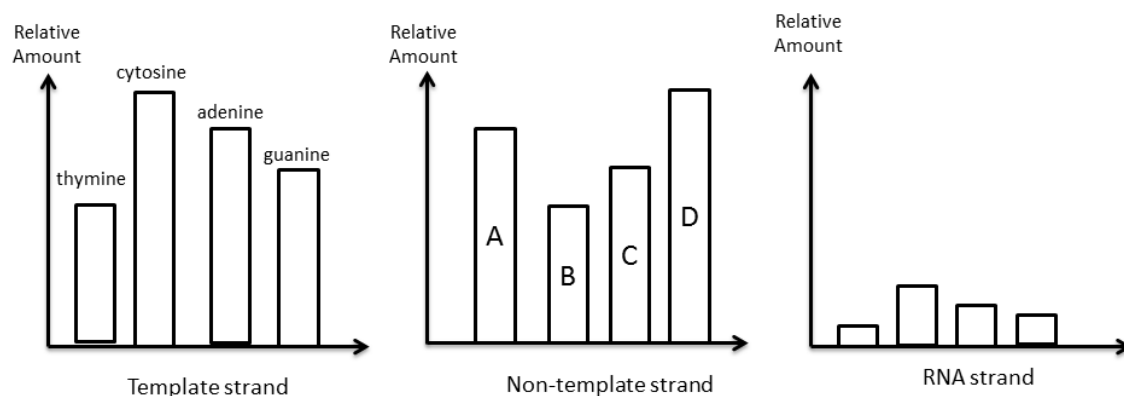


Fig. 2.2

(i) Name the bases A, B, C, and D

A: thymine  
B: adenine  
C: cytosine  
D: guanine

[2]

(ii) Explain why there are fewer bases for RNA strand.

**Answer:**

- A gene is transcribed to give mRNA;
- Reference to gene occupies only a section of DNA template;
- Reference to DNA containing many non-coding sequences besides gene'

[2]

(c) Describe 2 features that make DNA a good information storage molecule.

**Answer:**

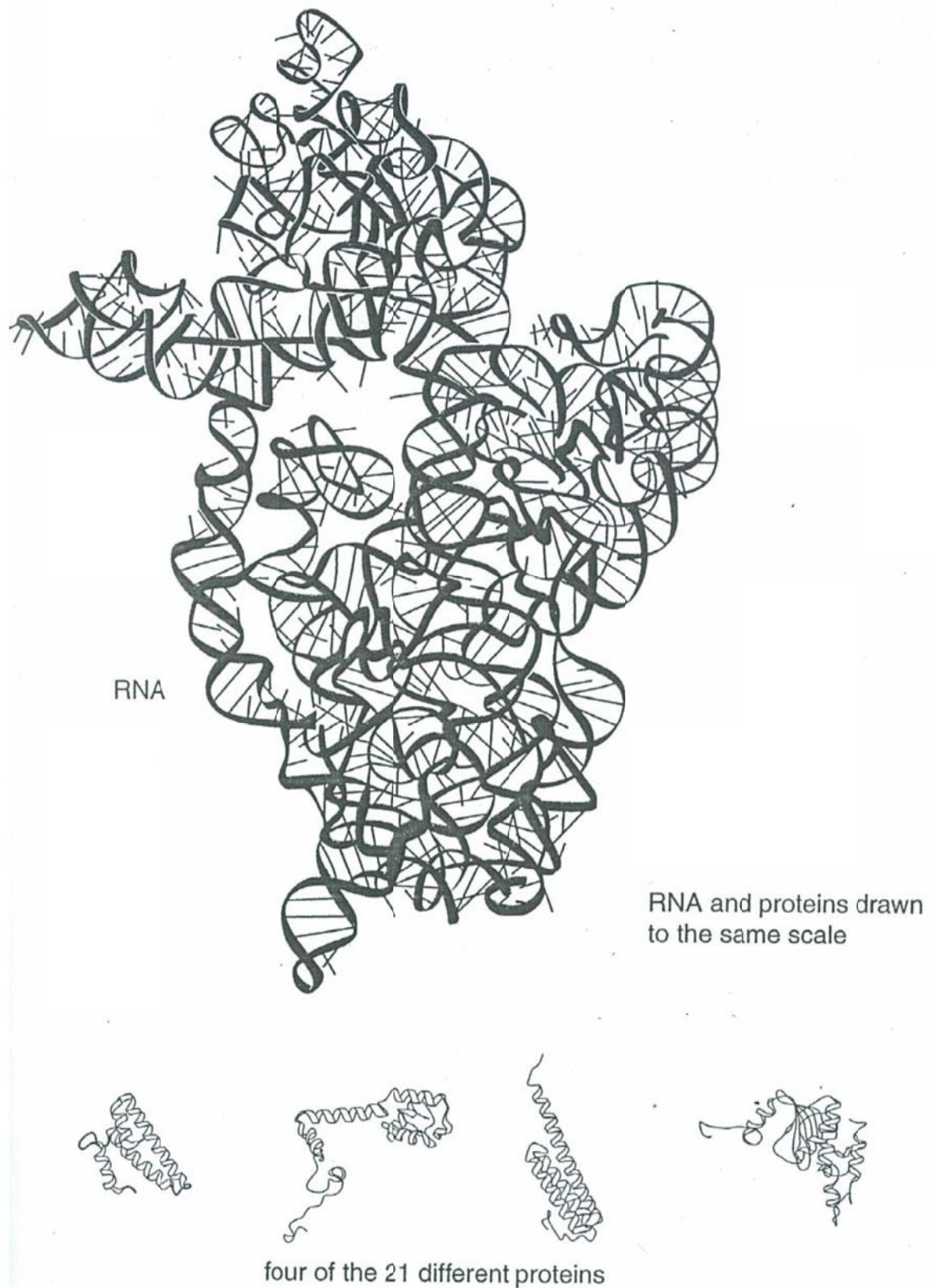
**(Any two with reasoning)**

- Four different bases: genes are made of base sequence);
- Two antiparallel strands: Both can be used as template;
- Supercoiling: Making DNA compact;
- Can accept: Phosphodiester bonds and hydrogen bonds make DNA molecule stable;

(Tested in Nov 2011 H2 Biology Paper 1 Q7)

[2]

Fig. 2.3 shows the molecule of RNA and four of the twenty one protein molecules that make up the small subunit of a ribosome. The individual molecules are shown separated so they can be seen clearly.



**Fig. 2.3**

- (d)** Describe in what ways the helical structures that are shown in Fig. 2.3 in both RNA and protein molecules differ.

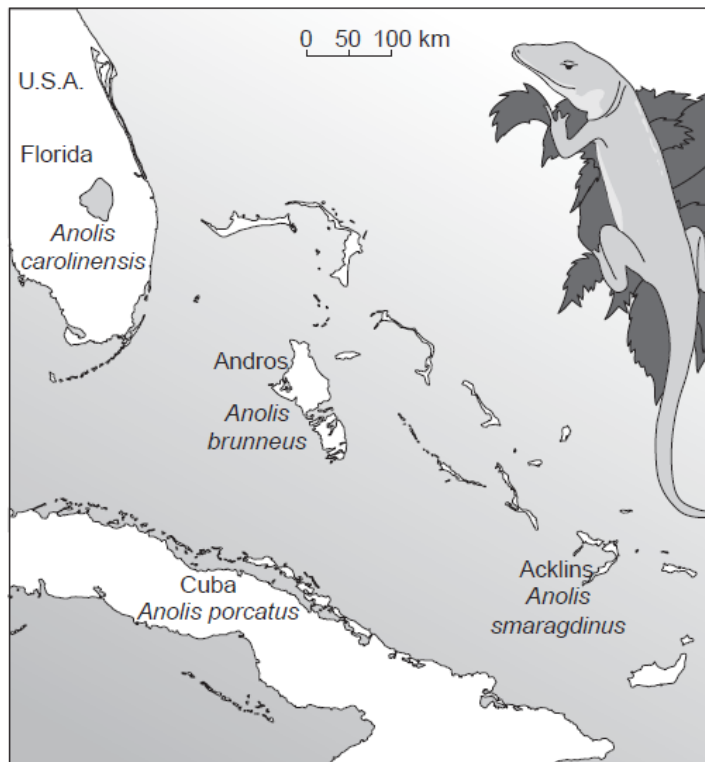
Answers:  
(Any 2)

- RNA helical structures are bigger than protein helical structure
- RNA folds back upon itself to create regions of double helixes, while protein molecules show alpha helices;

		<ul style="list-style-type: none"> <li>RNA helices are maintained by hydrogen bonds formed between <u>complementary base pairs</u> (A=U; G≡C); while protein helices are maintained by hydrogen bonds formed between the <u>C=O</u> and <u>N-H</u> of peptide backbone;</li> </ul>	[2]
			[Total: 10]

- 3 There are many species of the Anole lizards throughout the Caribbean and the surrounding mainland. Each species is found only on one island or a small group of islands, apart from *Anolis carolinensis* which is found in mainland Florida.

Fig. 3.1 shows the distribution of four species of anole lizards.



**Fig. 3.1**

An investigation using DNA analysis was carried out to establish the relationships between the four lizard species, using DNA analysis. The base sequences of a region of mitochondrial DNA from the four species were compared. The percentage differences in base sequences are shown in Table 3.1.

**Table 3.1**

	<i>A. brunneus</i>		<i>A. smaragdinus</i>	
<i>A. brunneus</i>			<i>A. smaragdinus</i>	
<i>A. smaragdinus</i>	12.1			<i>A. carolinensis</i>
<i>A. carolinensis</i>	16.7	15.0		
<i>A. porcatius</i>	11.3	8.9	13.2	

- (a) The researchers put forth the hypothesis that *A. brunneus*, *A. smaragdinus* and *A. carolinensis* all originated from *A. porcatius* in three separate events.

Explain how the results in Table 3.1 support the hypothesis.

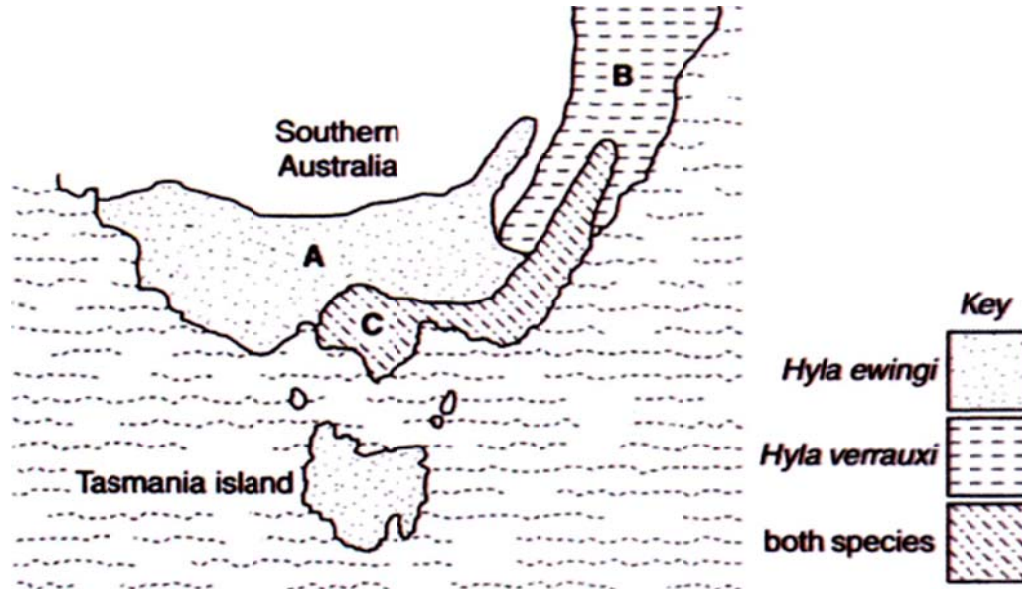
- Each species is more closely related to *A. porcatius* than to each other;
- G.S : C carolinensis have smaller nucleotide differences with *A. porcatius* than with the other species;
- QF: *A. brunneus* only has 11.3 differences with *A. porcatius* but 16.7 differences with *A. carolinensis* and 12.1 differences with *A. smaragdinus*
- QF : *A. smaragdinus* has only 8.9 differences with *A. porcatius* but 15.0 differences with *A. carolinensis*.



5. QF : *A. carolinensis* has only 13.2 differences with *A. porcatus*.
6. The 1<sup>st</sup> separation event resulted in *A. carolinensis*, 2<sup>nd</sup> separation event resulted in *A. brunneus* and 3<sup>rd</sup> separation event resulted in *A. smaragdinus*.

[3]

Besides lizards, frog species are also frequently studied. **Fig. 3.2** shows the distribution of the tree frogs in Southern Australia.

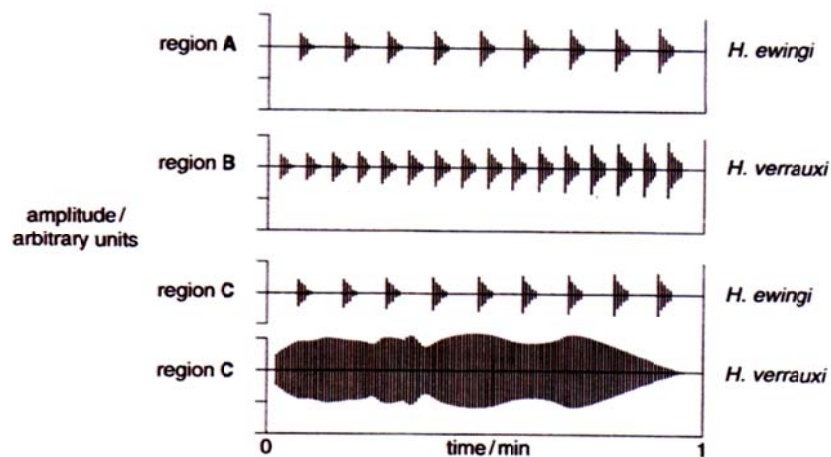


**Fig. 3.2**

*Hyla ewingi* and *Hyla verrauxi* are two closely related species of tree frogs from southern Australia. Research from breeding studies and DNA sequence data has shown that they have weak genetic incompatibility.

Male frogs attract females of the same species for mating by their pulsing call. The pulse rate of the male calls of the two species is almost identical. However, when both species coexist within the same region, the calls of *H. ewingi* are quite different than those of *H. verrauxi*.

**Fig. 3.3** shows the calls of *H. ewingi* and *H. verrauxi* from three regions, **A**, **B** and **C**. The male advertisement calls were recorded and played back electronically to produce the pattern shown.



**Fig. 3.3**



	Some female frogs of the species <i>H. verreauxi</i> were transferred from region <b>B</b> to region <b>C</b> . Observations showed that they were not attracted by the calls of the males in region <b>C</b> .	
(b)	Suggest why this is so.	
	<ol style="list-style-type: none"> <li>1. The male advertisement calls by <i>H. verreauxi</i> in region C are no longer pulsatile / discontinuous / more continuous without any interval in C;</li> <li>2. Amplitude of the sound waves also differ / Sound intensity of male call in region B is from soft to loud compared to loud to soft in C;</li> </ol>	[2]
(c)	Explain how the process of natural selection could have led to the different male advertisement call in <i>H. verreauxi</i> in region <b>C</b> .	
	<ol style="list-style-type: none"> <li>1. <u>Variation</u> in male advertisement calls present in population of <i>Hyla</i> frogs in region C;</li> <li>2. Selection pressure is the competition for mates that exists between these two species;</li> <li>3. Successful male mates with female <i>H. verreauxi</i> tree frogs and reproduces more offspring with similar male advertisement call /</li> <li>4. Those <i>H. verreauxi</i> males who fail to mate with another female will diminish in numbers after several generations;</li> <li>5. These genes that code for such male advertisement calls are passed down to the next generation / inherited;</li> </ol>	[3]
(d)	It was suspected that <i>H. ewingi</i> and <i>H. verreauxi</i> have evolved from a common ancestor. Explain how this phenomenon could have arisen.	
	<ol style="list-style-type: none"> <li>1. Population of the ancestor of <i>H. ewingi</i> and <i>H. verreauxi</i> are isolated into two sub-populations + Ref to geographical / physiological / behavioral isolation;</li> <li>2. Thus no gene flow between sub-populations and over time (and space) evolved into separate species;</li> </ol>	[2]
		<b>[Total: 10]</b>

- 4 Golden Rice™ is a genetically modified form of rice that produces relatively large amounts of  $\beta$  carotene in the endosperm.  $\beta$  carotene is metabolised in the human body to produce Vitamin A.

Fig 4.1 shows the metabolic pathway by which  $\beta$  carotene is synthesised in plants, and the enzymes that catalyse each step of the pathway.

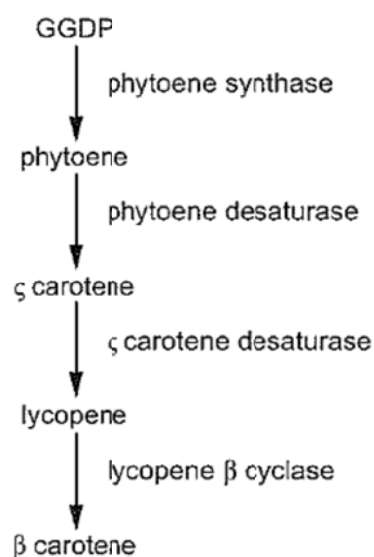


Fig. 4.1

The first types of Golden Rice™ contained a phytoene synthase gene, *psy*, from daffodils and a gene *crtl*, which produced the two desaturase enzymes, from the bacterium *Erwinia uredovora*.

It was found that the first types of Golden Rice™ produced only a very low mass of  $\beta$  carotene per gram of rice. Research continued to try to increase this.

Measurements of the quantities of intermediates in this metabolic pathway in rice endosperm showed that there was always a large amount of GGDP present, and that no phytoene accumulated in the tissues.

- (a) Explain how this suggests it was **not** enzymes produced by the *crtl* gene that were limiting the production of  $\beta$  carotene.

(desaturases, are not limiting production because) phytoene does not accumulate ; (no marks for stating this alone)  
 (so) **desaturases** are, functioning normally / **converting phytoene to other compounds** ;  
 GGDP, present in large amounts / accumulates / remains high ; (no marks for stating this alone)  
 (so) **phytoene synthase is, limiting** / reducing conversion to phytoene ;

[2]

- (b) Investigations were carried out to see if *psy* genes taken from species other than daffodils would enable rice endosperm to produce greater quantities of  $\beta$  carotene than the first types of Golden Rice<sup>TM</sup>.

- *Psy* genes were isolated from the DNA of maize, tomatoes, peppers and daffodils. The genes were inserted into different plasmids.
- The promoter *Ubi1*, and *crtI* genes from *E. uredovora*, were also inserted into all of the plasmids.
- The four types of genetically modified plasmids were then inserted into different cultures of rice cells.
- The quantity of  $\beta$  carotene produced by these rice cells was measured.

The results are shown in Table 4.1.

**Table 4.1**

Source of <i>psy</i> gene	Total $\beta$ carotene content of rice cells/ arbitrary units
Maize	14
Pepper	4
Tomato	6
daffodil	1

- (i) Explain why a promoter was inserted into the plasmids.

1. (promoter required) to ensure expression of the (introduced) genes / AW ;
2. (suitable promoter) might not be present in the rice cells ;
3. (suitable promoter) might not be in the correct position relative to the introduced genes ;

[2]

- (ii) With reference to Table 4.1, evaluate the effectiveness of the various *psy* genes in increasing the carotenoid content of the maize calluses.

- *psy* gene from maize is the most effective, followed by tomato, pepper, and daffodil;
- *data*: total  $\beta$  carotene content of rice cells is 14au for maize, 6au for tomato, 4au pepper, only 1au for daffodil (minimum quote highest and lowest)

[2]

- (iii) Explain whether or not these results support the hypothesis that the *psy* gene, not the *crtI* gene, was limiting the production of  $\beta$  carotene in genetically modified rice.

- yes (no mark)
1. all rice cells contain the same *crtI* genes ;
  2. only difference was the source of the *psy* genes ;
  3. if *crtI* limiting there would be no difference in the carotene in each group ;

[2]

- (c) The original choice of a *psy* gene from daffodils was made because daffodils produce large amounts of  $\beta$  carotene in their yellow petals, and because they are monocotyledonous plants, like rice.

Suggest explanations for the much lower production of  $\beta$  carotene in rice containing the *psy* gene from daffodils than in rice containing the *psy* gene from maize.

1. different base sequences (in the *psy* genes from different sources) ;
2. so different amino acid sequences, in the enzyme / in phytoene synthase ;
3. so different tertiary structure ;
4. could affect interaction with other components, e.g. cofactors ;

5. AVP ; e.g. refs to different protein synthesising machinery in the cells  
ignore refs to active site and ability to bind with GGDP – must be able to do that as it does it in daffodils

[2]

[Total: 10]

### Section B

Answer **all** questions.

Write your answers on the separate answer paper provided.

Your answer should be illustrated by large, clearly labeled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in section (a), (b) etc., as indicated in the question.

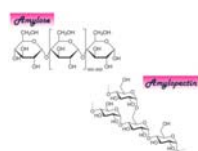
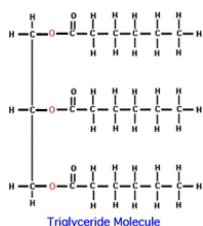
**5 (a)** Compare triglyceride and starch as a storage molecule.

[8]

#### Similarities

- Both have high percentage of hydrocarbons [not just hydrogen or carbon atoms] and hence stores energy;;
- Both are macromolecules formed through condensation reactions [accept both formation results in loss of water/ production of water; R! polymer as triglyceride is not a polymer];;
- Both are compact [triglyceride consists of non-polar hydrocarbon chains and is dehydrated and can be packed compactly while starch consists of two compact forms – amylose and amylopectin];;
- Both are insoluble and therefore do not affect water potential of cells;;

Feature	Triglyceride	Starch
Basic units	Triglyceride is made up of 1 glycerol and 3 fatty acid chains;	Starch is made up of repeating units of $\alpha$ glucose;
Type of Bonds	bonds linking up the monomers are ester linkages;	bonds linking up the monomers are glycosidic linkages;
Type of biomolecule	Triglyceride is not a polymer;	Starch is a polymer of glucose;
As energy store	<p>Higher/ twice amount of energy stored/ superior long term energy store; (g for g, stores twice the amt of en compared to CHO)</p> <p>Due to greater number of carbon atoms/ more C-H bonds for the same mass;</p> <p>→ lesser amount of fats needs to be stored for the same amount of energy;</p> <p>A! more compact per unit mass; due to little association of –CH groups with water/ minimal hydration;</p>	<p>Lower/ 2X less energy stored;</p> <p>Due to more –OH groups and so less carbon atoms/ less C-H bonds for the same mass;</p> <p>→ more starch molecules need to be stored for the same amount of energy;</p> <p>A! less compact per unit mass; due to association of polar –OH groups on surface associating with water;</p>



Starch



(b)	Compare between the movement of insulin and glucose across the cell surface membrane. Explain the differences in their movement.	[6]								
	<table><tr><td>Insulin</td><td>Glucose</td></tr><tr><td>Moves by exocytosis</td><td>Moves by facilitated diffusion</td></tr><tr><td>Secretory vesicle containing insulin fuses with CSM to release insulin;</td><td>Moves through GLUT receptors/ transmembrane receptors via hydrophilic channel</td></tr><tr><td>Uses ATP</td><td>Does not require ATP</td></tr></table> <ul style="list-style-type: none"><li>Glucose is small and polar;</li><li>Cannot pass through hydrophobic core of the phospholipid bilayer;</li><li>Insulin is too large to pass through phospholipid bilayer;</li><li>Will not allow membrane to regulate movement of substances a membrane channel for insulin would be too large;</li></ul>	Insulin	Glucose	Moves by exocytosis	Moves by facilitated diffusion	Secretory vesicle containing insulin fuses with CSM to release insulin;	Moves through GLUT receptors/ transmembrane receptors via hydrophilic channel	Uses ATP	Does not require ATP	
Insulin	Glucose									
Moves by exocytosis	Moves by facilitated diffusion									
Secretory vesicle containing insulin fuses with CSM to release insulin;	Moves through GLUT receptors/ transmembrane receptors via hydrophilic channel									
Uses ATP	Does not require ATP									
(c)	State the similarities between ATP production in mitochondria and chloroplasts and suggest why these similarities exist.	[6]								
	<p><b>Part 1: State the similarities between ATP production in mitochondria and chloroplasts</b></p> <ul style="list-style-type: none"><li>Both process take place on membranes: inner mitochondria membrane and thylakoid membrane in chloroplast</li><li>flow of / passing electrons down electron transport chain / involves movement of electrons from 1 electron carrier to another</li><li>generation of electrochemical / proton gradient across membrane using energy from ETC</li><li>diffusion of protons through stalk particles/ATP synthase / ATP synthetase produces proton motive force to drive phosphorylation of ADP</li></ul> <p><b>Part 2: Suggest why these similarities exist</b></p> <ul style="list-style-type: none"><li>both mitochondria and chloroplasts evolved from prokaryotes</li><li>endosymbiotic theory/ describe endosymbiotic theory: mitochondria and chloroplasts were formerly small prokaryotes living within larger cells</li></ul>									
		[Total: 20]								