

## **2010 HSC Biology Sample Answers**

This document contains 'sample answers', or, in the case of some questions, 'answers could include'. These are developed by the examination committee for two purposes. The committee does this:

- (a) as part of the development of the examination paper to ensure the questions will effectively assess students' knowledge and skills, and
- (b) in order to provide some advice to the Supervisor of Marking about the nature and scope of the responses expected of students.

The 'sample answers' or similar advice are not intended to be exemplary or even complete answers or responses. As they are part of the examination committee's 'working document', they may contain typographical errors, omissions, or only some of the possible correct answers.

## Section I, Part B

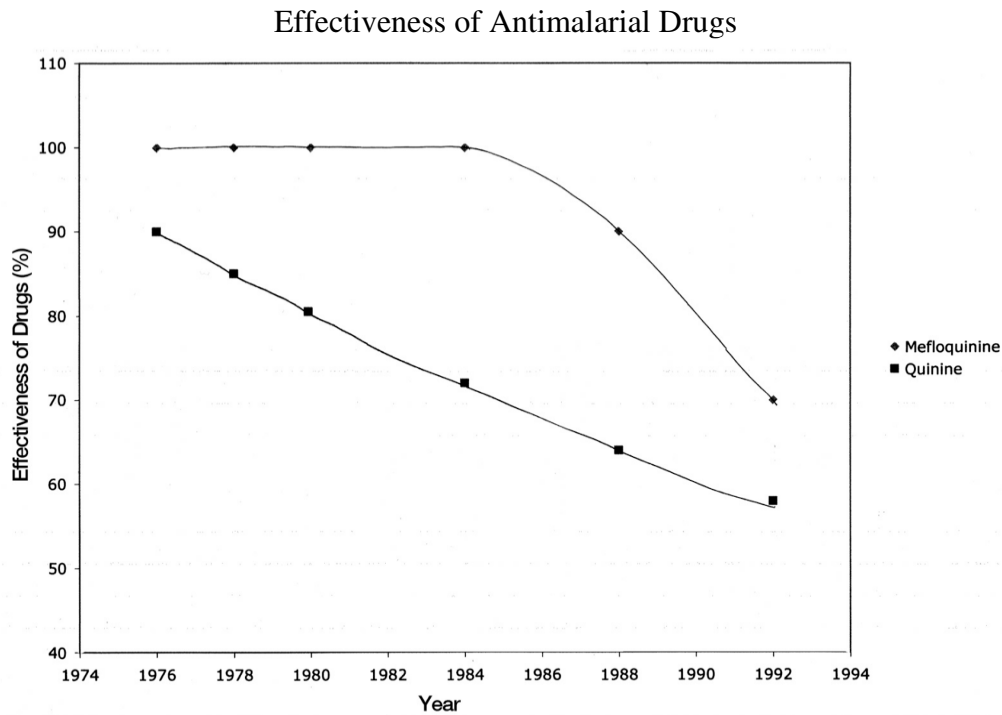
### Question 21

*Sample answer:*

	<i>Mendel's Monohybrid Cross</i>	<i>Mendel's Fruit Fly Experiments</i>																		
First Cross Parents Phenotype	tall × short	red eyed female × white eyed female																		
First Cross Parents Phenotype	TT × tt	$X^R X^R \times X^r Y$																		
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F <sub>1</sub> Phenotype	100% Tall	100% Red eye																		

**Question 22 (a)**

*Sample answer:*

**Question 22 (b)**

*Sample answer:*

Humans develop drugs to kill pathogens. The data show that the malaria pathogen becomes resistant to these drugs which become less effective with their use. This occurs because the drug is selecting for resistant pathogens and this reduces the biodiversity of the population.

**Question 23 (a)**

*Sample answer:*

A poodle and a Labrador were crossed to have the non-allergenic trait of the poodle with the gentle nature of the Labrador.

**Question 23 (b)**

*Sample answer:*

Bt cotton is an example of a transgenic species created by scientists. It provides a benefit to society as it reduces the need to spray cotton crops with insecticides. This saves people time and money. One disadvantage of this crop is that farmers have to buy the seeds each year and are dependent on large companies. An advantage to the environment is that Bt cotton reduces the use of insecticides, which benefits food chains and food webs. A disadvantage of Bt cotton is that it reduces biodiversity as it means large areas of crop are genetically identical.

**Question 24**

*Sample answer:*

Independent Variable	Degree of opening of the window
Control	Window fully open OR window fully closed
Variables to be kept constant and justification for keeping each constant	Variable 1: Number of people in the room Justification: The number of people will alter the amount of available oxygen
	Variable 2: The activity of the people Justification: The more activity the lower the oxygen concentration
Technology used to measure oxygen saturation in blood	Pulse oximeter

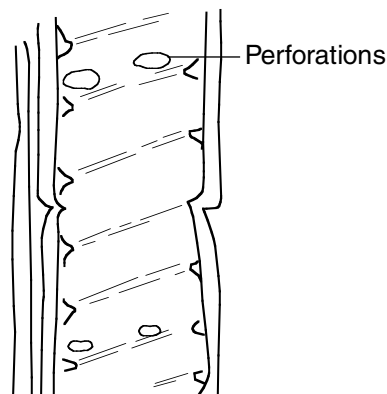
**Question 25 (a)**

*Sample answer:*

We used our own slides made by sectioning celery soaked in coloured dye. This enabled us to see xylem vessels.

**Question 25 (b)**

*Sample answer:*



Or other suitable alternatives.

**Question 26*****Sample answer:***

The data show that as the price of cigarettes increases, the number of cigarettes smoked per day and the incidence of lung cancer decrease. However, the data are limited to information about men aged 35–44 only. This is a limitation as the effect may not be the same for other groups in the population. Another problem is the relatively short period of 10 years of price increase data. Lung cancer takes a long time to develop so it is not possible to draw conclusions about the longer term. Therefore, the data alone do not justify increasing the price of cigarettes.

**Question 27 (a)*****Sample answer:***

- People with swine flu were spotted at the airport and then put into hospital and separated from others.
- New Zealand apples are not allowed to be brought into Australia because they have apple blight.

**Question 27 (b)*****Sample answer:***

Flu virus is spread by contact and airborne mechanisms. By isolating the person suspected of flu, it minimises contact with others thus preventing spread of the virus.

**Question 28 (a)*****Sample answer:***

An antigen

**Question 28(b)*****Sample answer:***

The model is highly effective as it shows the difference between the two types of cells. The two cells have different surface molecules (antigens) which means that the recipient will be able to recognise and attack the new organ with their immune system.

**Question 28(c)*****Sample answer:***

T killer cells recognise and bind to transplanted cells and release factors that kill them.

T helper cells produce growth factors that help other lymphatic cells, eg B cells to grow and produce factors (antibodies) that lead to killing transplanted cells.

**Question 29 (a)*****Sample answer:***

Activation or deactivation of genes leads to crop plants being better able to withstand high temperatures.

Locally adapted species may differ in their projected flowering times.

**Question 29 (b)*****Sample answer:***

The first two articles are relevant because they show a relationship between temperature increase and plant response. Article 3 has nothing to do with temperature change so is irrelevant.

- Information for Article 1 has been sourced from a web blog that is not a reliable source.
- Information for Article 2 has been obtained from a published scientific journal and can therefore be regarded as reliable.
- Information for Article 3 has been obtained from a user-modifiable web-based encyclopedia and as such is not reliable even though there are references from a scientific journal as it is modifiable by numerous individuals.

**Question 30*****Sample answer:***

In the New Zealand information, many practices of biology were undertaken to compile the data.

The observations of fauna in New Zealand represent an important practice in biological science. Making clear, dispassionate and unbiased observations, and recording such observations are intrinsic to science.

These observations validated the idea of convergent evolution in that birds in New Zealand, without competition from mammals, developed similar characteristics and were able to live in the same environments as mammals do elsewhere.

Practices in palaeontology of ageing fossils by radiometric dating or stratigraphy, describing fossils and comparing fossils, allows a history of fauna of New Zealand to be compiled, and history of islands [eg deducing from fossils found to be almost completely marine that New Zealand was covered by oceans].

The history of fauna and geologic events validates Charles Darwin's theory of evolution in that populations of birds, which began as migratory/occasional visitors, gradually changed into permanent endemic species.

Divergent evolution is validated as new unique species develop from migratory species.

The data also validates Stephen J Gould's punctuated equilibrium theory in that the diversification of bird species happened very quickly in the space of only 2 million years.

## Section II

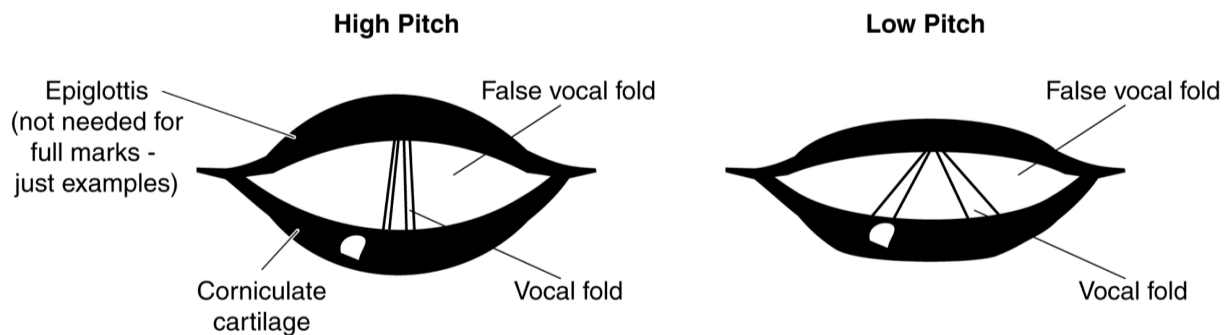
### Question 31 (a)

*Sample answer/Answers could include:*

<i>Organism</i>	<i>Structure</i>
Insects	Tympanal discs on legs
Fish	Lateral line system on body
Mammals	Organ of corti in ear

### Question 31 (b)

*Sample answer:*



### Question 31 (c) (i)

*Sample answer:*

Cones

### Question 31 (c) (ii)

*Sample answer:*

The cones in the fovea are less pyramidal shaped (they look similar to rods). This is so that each cone takes up less space, allowing a higher density of cones in a smaller area.

### Question 31 (c) (iii)

*Sample answer:*

Rhodopsin is the molecule that rod cells use to detect light. Part of the molecule changes shape when stimulated by light. This results in a signal being produced, which is sent to the brain.

**Question 31 (d) (i)**
**Sample answer:**

Area X processes sensory information received from the eyes. This animal may be blind, which means they are not able to send information to X. Another possible cause is damage to area X as a result of the fall. This may mean that action potentials cannot be passed from the optic nerve to the sight centre at X or cannot be transmitted from X.

**Question 31 (d) (ii)**
**Sample answer:**

The animal will not be able to see. This will result in a lack of coordination. It will move more slowly and bump into things.

**Question 31 (e)**
**Sample answer:**

<i>Technology</i>	<i>Understanding of the Eye/Ear</i>	<i>Evaluation of the effect of our understanding on the development of the technology</i>
3D Movie	<p>In 2D-style movies, the eye receives stimulus from the light coming from the screen. The light stimulates photoreceptors that send electrochemical signals to the brain. These signals are sent via neurons through the optic nerve to the brain. The visual cortex (in the occipital lobe) of the brain interprets these signals. Since the light coming from the screen is emanating from the same distance (though slightly different angles), the brain correctly interprets the images as 2D</p> <p>In 3D movies, the same process occurs, however, 2 different images from the screen are produced, and each image passes through a different eye (due to the glasses). Thus, each eye sees a slightly different image that is designed to cause the brain to interpret the combination of signals and produce a 3D image.</p>	<p>Before we understood depth perception, we were unable to produce technology that would alter our sensation of depth. However, now that we understand how the brain interprets depth (differences in the angles of the image that are produced on the retina of each eye) we can use this information to create new technologies. This can be applied across a range of technologies, not just movies, such as TVs, home theatre systems. Thus, our increased understanding has had a large effect on technology and consequently for society.</p>
Surround sound systems	<p>In older-style movies, sound is produced from one speaker or location within a room. The vibrations from the speaker travel to the pinna, vibrate the tympanic membrane and ear ossicles</p>	<p>Before we understood how the ear was able to locate the origin of sounds, we were unable to produce technology that would alter our sensation of this. However, now that we understand how</p>



<i>Technology</i>	<i>Understanding of the Eye/Ear</i>	<i>Evaluation of the effect of our understanding on the development of the technology</i>
	<p>and allow the hair cells in the Organ of Corti (in the cochlea) to detect the vibration and convert the signal into an electrochemical signal. This is sent via neurons in the auditory nerve to the auditory cortex (in the temporal lobe) of the brain. The brain interprets the sounds from each ear and compares them. It calculates the time lag between the 2 signals and can use this to locate the source of the sound. It also notes if one sound is louder in one ear than the other or if there is a sound shadow (absence of sound in one ear due to the head blocking the incoming sound waves). These methods allow the brain to pinpoint the single source of the sound. This is quite unrealistic, as we live in a 3D world where sounds can come from any direction.</p> <p>In surround sound cinemas, speakers are located all around the cinema (but pointing towards the audience members), so that particular sounds are produced from different areas of the cinema. When the brain interprets these signals, it detects the different locations, producing a more realistic feeling like you are at the centre of the action.</p>	<p>sound shadows and sound detection time lags work, we can use this information to create new technologies. This can be applied across a range of technologies, not just movies, such as TVs, home theatre systems. Thus, our increased understanding has had a large effect on technology and consequently for society.</p>

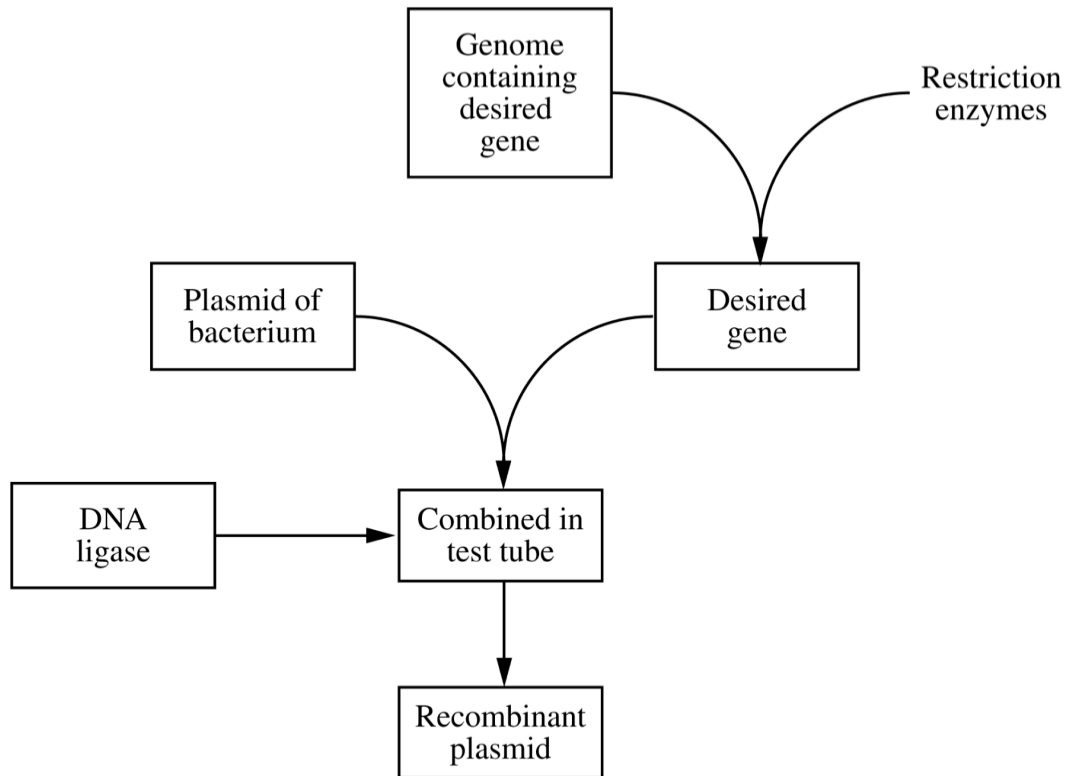
### Question 32 (a)

*Sample answer:*

Process	Beer Brewing
Microorganism	Yeast
Product	Alcohol

**Question 32 (b)**

*Sample answer:*

**Question 32 (c) (i)**

*Sample answer:*

The farmer used selective breeding to increase the lifespan of the animals.

**Question 32 (c) (ii)**

*Sample answer:*

This is a useful biotechnology because the numbers or percentage of early deaths in subsequent generations decreases.

$$\text{eg } \frac{27}{53} \longrightarrow \frac{10}{62}$$

This has occurred because brown offspring have better survival rates. Longer survival leads to surviving to breeding age. Beneficial characteristics are transmitted to the next generation.

**Question 32 (d) (i)*****Sample answer:***

mRNA has the signal in codons for the amino acids that make a protein. If that signal is destroyed in part by RNA interference, then these amino acids will not be translated from the mRNA.

**Question 32 (d) (ii)*****Sample answer:***

Recombinant DNA technology is used to produce insulin for diabetics. The relevant cDNA is produced by reverse transcribing RNA. This cDNA codes for the protein insulin. The cDNA is then spliced into the DNA of a bacterium. The incorporated DNA is transcribed to mRNA and translated using tRNA. The result is the protein insulin.

**Question 32 (e)*****Sample answer:***

New biotechnologies are revolutionising the way we live. The development of genetically modified crops has bolstered the agricultural industry and the aim of this revolution is to eliminate world hunger. The generation of GM crops has eliminated the necessity for the use of pesticides, which has significant societal impact as these chemicals will not enter the digestive tract of animals and humans thereby reducing the risk posed by such, sometimes toxic/carcinogenic substances. Additionally, the selection and propagation of larger, better and more nutritious products also has a significant impact on society in the realm of health and disease.

However, there are several concerns pertaining to the use of GM crops. The potential for ‘contamination’ of surrounding native species is high on the list of serious concerns. Evidence now exists that in certain ‘test’ regions this ‘contamination’ is inevitable. Societal acceptance of GM crops is also of concern. In both developed and developing countries, the perception of GM crops is still widely debated and not accepted.

Acceptance in both these societies is not a given luxury. A significantly wider education program will be required throughout the world in order for the wide use of GM crops. Despite this education, there will be sceptics among the educated. Additionally, it will be difficult, if not impossible to educate society as a whole, especially rural consumers and farmers.

The identification of DNA cloning and the ability to manipulate DNA has opened a new door into the field of human disease and therapy. The ability to regulate genes, to select ‘desired’ genes and to manipulate them has provided scientists with a remarkable tool that is enabling the discovery of new methods aimed at curing life-threatening diseases. A recent use of this technology was the specific selection and implementation of an embryo that did not express a gene linked to a familiar breast cancer. Genetic technologies are enabling the creation of ‘designer babies’ where, like GM crops, babies with the most desired characteristics and genetic profile can be chosen.

The ethical implications of these technologies are immense. Although it is now feasible to clone an entire human, similar to ‘Dolly’ the sheep, societal pressures and moral issues have thus far prevented the creation of ‘designer’ or ‘cloned’ humans. The selection and mixing of

genes to create the 'ideal' human will pose a significant threat to humans. Human beings, unlike animals, are much more complex (debatable) entities with feelings/emotions, thought processes and higher order functioning, and it is unknown what effect previously independent genes might have when combined.

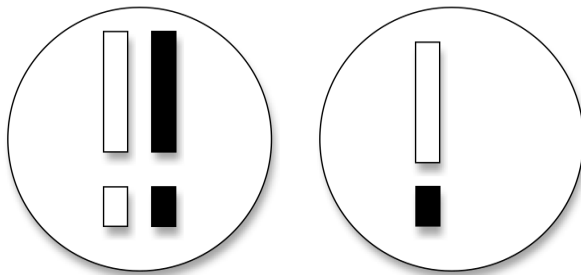
### Question 33 (a)

*Sample answer:*

<i>Mutation</i>	<i>Effect on chromosome number</i>
Trisomy	Organism has three of one type of chromosome
Polyploidy	Organism has three or more complete sets of chromosomes
Base substitution	No change in chromosome number

### Question 33 (b)

*Sample answer:*



Diploid cell with 4 chromosomes

Possible Haploid cell with 2 chromosomes

### Question 33 (c) (i)

*Sample answer:*

I predict that the genes for both traits are recessive.

**Question 33 (c) (ii)**

*Sample answer:*

Not linked

Aatt × AaTt

	AT	At	aT	at
At	AATt	AAtt	AaTt	Aatt
at	AaTt	Aatt	aaTt	aatt

Linked

$\frac{At}{at} \times \frac{AT}{at}$

	AT	at
At	<u>AT</u> At	<u>At</u> at
at	<u>AT</u> at	<u>at</u> <u>at</u>

Key: A – Normal vision  
 a – Vision defect  
 T – Normal limb  
 t – Limb defect

∴ Phenotypes if not linked

3	3	1	1
Normal vision Normal limbs	Normal vision Defect limbs	Defect vision Normal limbs	Defect vision Defect limbs

∴ Phenotypes if linked

2	1	1
Normal vision Normal limbs	Normal vision Defect limbs	Defect vision Defect limbs

**Question 33 (d) (i)****Sample answer:**

In order to construct linkage maps, crossbreeding experiments are carried out. Individuals with different alleles of the linked genes in question are crossbred. The phenotypes of the offspring are carefully observed and recorded. The frequency of phenotype shows which linked genes are separated and provide the relative position of linked genes on a chromosome.

**Question 33 (d) (ii)****Sample answer:**

- Linkage maps provide the relative position of linked genes, not the actual position
- Linkage maps do not provide the base sequence of a gene
- Some genes are not easily ‘observed’ in the phenotype
- Many genes do not have an obvious ‘faulty/disease version that assists in mapping
- You cannot carry out crossbreeding experiments on humans (not ethical and slow breeding time)

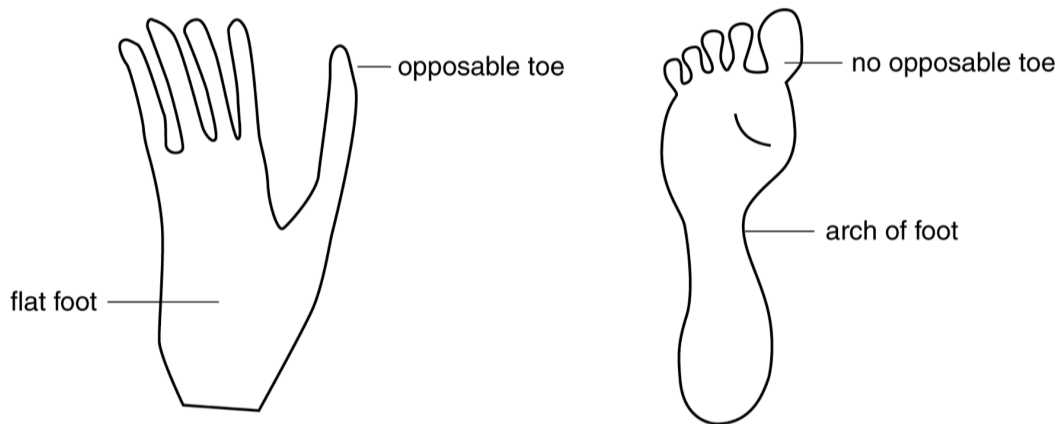
**Question 33 (e)****Sample answer:**

Gene cascades are when the expression of one gene leads to the expression of the next gene. This is very important normally in such things as limb development. Currently, it is important in causing stem cells to develop in a particular direction. Because we now understand how gene cascades occur, we can use this knowledge to produce new technologies such as artificial organs. However, this is a very expensive technology and is not available to most of the world.

The example above shows a new use for cloning technology where only one gene is inserted into an organism for the purpose of generating a pharmaceutical product such as insulin. Because we understand how to use gene cloning, the example above shows that we can now use it to insert many hundreds of genes for the purpose of creating a whole new organism. This could be useful for developing life forms that can live in adverse environments and perhaps be able to remediate contaminated environments. However, this may also lead to organisms which damage the environment or cause disease because these new organisms could become mutated.

**Question 34 (a)****Sample answer:**

<i>Classification</i>	<i>Feature</i>
Animal	No cell wall
Chordate	Back bone
Mammal	Mammary glands

**Question 34 (b)***Sample answer:***Question 34 (c) (i)***Sample answer:*

Nuclear DNA is inherited from both parents where mitochondrial DNA is only inherited from the mother.

**Question 34 (c) (ii)***Sample answer:*

Analysis of mitochondrial DNA is more important to evolutionary biology. This is because there is a faster rate of mutation, so mutation can be used to quantify time in smaller increments. There is no recombination of genes for fertilisation (where a gene complement is added from another individual) — so any gene changes can be assumed to be from mutation. The rate of mutation is linear, so mitochondrial DNA can be used as a molecular clock to age fossils. Time of divergence of fossils from each other can be estimated.

**Question 34 (d) (i)**
**Sample answer:**

<i>Collection method</i>	<i>Justification</i>
Use of adult skulls only	Allow for valid comparisons by eliminating inconsistencies due to juvenile skulls
Data used from scientific journals	Data reliable
Averaging data for each site	Ameliorating outlier effects
A large number of sites used	- Check for reliability - Multiple sites for some hominins

<i>Presentation method</i>	<i>Justification</i>
Graph	Easy to read and see trends
Scatter gram type	Multiple value for same data due to overlapping times for different sites
2 axes	Able to see relationships between time and cranial capacity

**Question 34 (d) (ii)**
**Sample answer:**

A could be *Australopithicus afarensis* (Africanus did not appear till around 3mill ya) cranial capacity small.

B *Homo erectus* (1mya with large skull capacity — larger than A robustus which overlapped in time). *Homo sapiens* — not till 500 000 ya.

**Question 34 (e)**
**Sample answer:**

The increased development in brain size and cranial capacity as well as more upright stance has enabled humans to develop many technologies that may affect cultural development of humans. This is not the case for primates, who, because of their physical characteristics and limited intellectual development have shown only limited cultural development.

Some examples are that humans have developed transportation technologies. It has meant increased population mobility with bigger mixing of gene pools, which will allow more variety in the gene pool and allows a better chance for some individuals to survive if there were a major change in environment. Similarly, modern medicine has allowed many individuals to survive and pass on their genes who would normally have died eg diabetics. However, modern medicine has meant that humans have not evolved to protect against viruses and bacteria. Instead, we have been using drugs such as vaccinations and antibiotics to kill these. This means that it is more likely that humans may be wiped out by a superbug. In summary, by preventing natural evolution, we may become at risk. By contrast, primates are subject to evolving their immune system to provide natural protection against infections. They also care for sick members of their families. This cultural development will support survival and evolution of primates who show this social feature compared to primates who do not.



Primates, like humans, have used social groups to increase their chances of survival and thus the inheritance of their genes. This has led to tribal arrangements where the community works together to protect and obtain land and food supplies. Those with more complex social arrangements have been more successful and so have survived better. With primates, social evolution has been limited to the local environment with some introduction of new ideas from neighbouring tribes. The advanced intellect of humans has allowed wide communication beyond the local area and so their social structures have developed well beyond tribal arrangements. However, this has made us reliant on technology and if the technology fails, our social systems may not allow us to survive. This is not the case for primates, who do not rely on technology for survival.

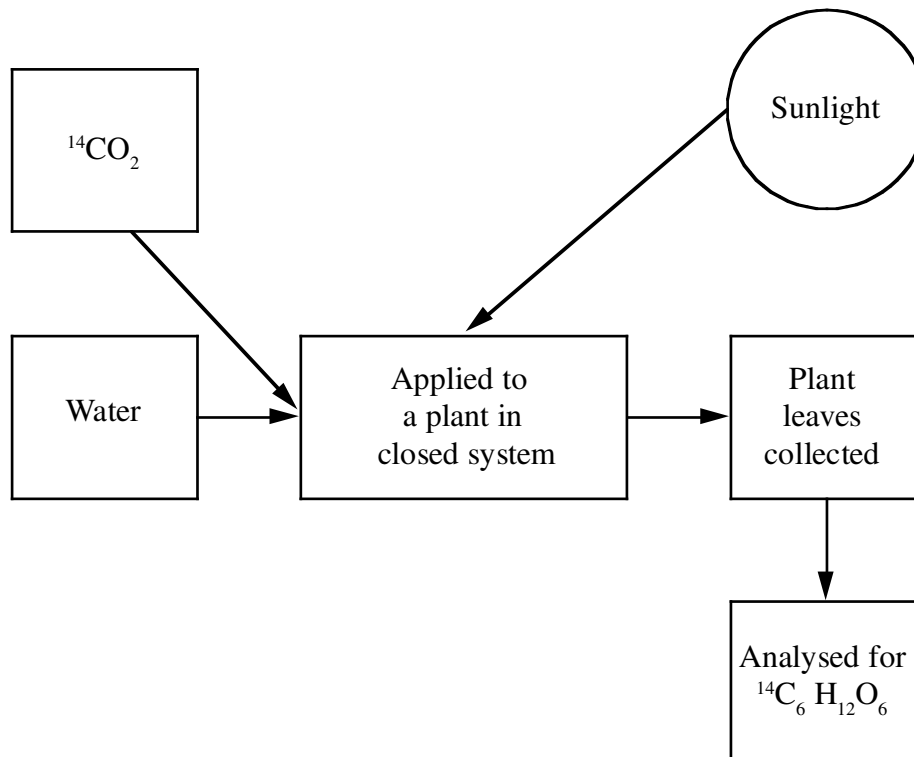
### Question 35 (a)

*Sample answer:*

<i>Scientist</i>	<i>Contribution</i>
Stephen Hales	Showed that plants grow by taking something from the air
Ingen-Housz	Showed that plants grown in light produce oxygen
Priestley	Put plants in a space with a candle and showed that these produced O <sub>2</sub> to keep it burning

### Question 35(b)

*Sample answer:*



**Question 35 (c) (i)****Sample answer:**

X = wavelength

Y = amount of light absorbed

**Question 35 (c) (ii)****Sample answer:**

Chromatography allows different plant pigments to be separated because they have different properties. The separated pigments can then be analysed using a colorimeter and the absorption spectrum of pigments can then be identified. This information can be used to explain the action spectrum of pigments in non-green-leafed plants.

**Question 35 (d)****Sample answer:**

The observations of 1772 are not related to the light and dark reaction other than identifying that plants restore oxygen to the atmosphere. It does not say anything about carbon dioxide.

The observations of 1905 show that both adequate light and CO<sub>2</sub> levels are needed to give maximal uptake of CO<sub>2</sub>. This hints at separate reactions taking place between CO<sub>2</sub> uptake (dark reaction) and O<sub>2</sub> production (light reaction).

The observations of 1939 indicate that oxygen synthesis and CO<sub>2</sub> uptake are separate processes and that the reducing agent is something other than CO<sub>2</sub>.

**Question 35 (e)****Sample answer:**

Carbon dioxide is one of the greenhouse gases that is of great concern. Through photosynthesis, plants remove carbon dioxide from the atmosphere and convert it to carbon-based molecules eg carbohydrates. This process is separate from oxygen production. Therefore, it would be ideal to develop plants which show greater ability to fix carbon dioxide.

Knowing the enzymes involved in fixing carbon dioxide means that it could be possible to develop artificial enzyme arrays that carry out the Calvin Cycle using other elements besides photosystems as the electron donors. In this way carbon dioxide can still be the electron acceptor. The effectiveness of these methods could be tested using radioactive tracers.

Alternatively, since plants have different abilities to photosynthesise due to their size, shape and distribution of their chloroplasts, we could use current technologies to genetically engineer plants, which are more efficient at photosynthesis. Theoretically, it may also be possible to enable animals to photosynthesise. These new plants or animals could be mass produced and used in new technologies to help reduce the levels of CO<sub>2</sub> in the atmosphere.