

Exam Choice

2006 Biology Trial HSC examination. Marking Guidelines and model Answers.

Section I A Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	C	C	A	A	C	A	B	D	C	C	A	D	A	B

Section I B

16. a

Marking Guidelines	Marks
* Line which shows body temp. increasing as env. temp. does	1



16.b.

Marking Guidelines	Marks
* 2 ways of responding to either increase or decrease in temp.	2
* 1 way of responding to either increase or decrease in temp.	1

It could respond to an increase in temp. by moving into the shade. It could respond to a decrease in temp by seeking out warm rocks to lie on.

17a

Marking Guidelines	Marks
* 2 blood components named and medical uses given.	3
* 2 blood components named and one use given.	2
* 1 blood component named and its use given	1
OR	
* 2 components named.	

Red blood cells. – Given to patients suffering from anaemia.
Factor VIII – Given to patients with blood clotting problems eg. Haemophiliacs.

17.b.

Marking Guidelines	Marks
* One advantage given	1

Artificial blood does not need to be matched to the recipient – unlike real blood which needs to be typed and only given to a recipient with a compatible blood group.

18.a.

Marking Guidelines	Marks
* Correct axes (number smoked X, cancer incidence Y).	3
* Axes labelled and units indicated.	
* Axes linear	
* Correct plot	
* Curve of best fit	
* 4 of the above	2
* 3 of the above	1

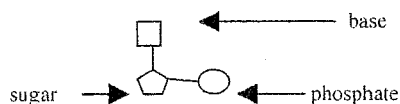
18.b.

Marking Guidelines	Marks
* Relationship between no. smoked and cancer incidence noted.	2
* Non – linear nature of the relationship noted.	
* Relationship between no. smoked and cancer incidence noted.	1

As the average number smoked per day increases the incidence of lung cancer also increases. The increase is exponential.

19

Marking Guidelines	Marks
* Base, sugar and phosphate correctly labelled	1



19.b.

Marking Guidelines	Marks
* Any 2 of the following steps: - 'unzipping' of DNA molecule - lining up of free RNA nucleotides - complementarity of bases - joining up of nucleotides to make mRNA molecule.	2
* One of the above steps.	1

Enzymes cause the DNA molecule to 'unzip' by breaking the H bonds between the bases. Free RNA nucleotides line up on their complementary bases on the DNA template strand. These nucleotides then join together to make the mRNA molecule.

20.a.

Marking Guidelines	Marks
* 3 important historical steps in sequence.	3
* 2 steps	2
* 1 step	1

Laveran noticed a suspected pathogen in the blood of malaria patients – but not in people who didn't have the disease.
Ross suspected mosquitoes as the vector and showed that the suspected pathogen was taken up by mosquitoes and reproduced in their intestines.
Grassi demonstrated that mosquitoes which had taken up the suspected pathogen could pass it on to previously uninfected humans, causing them to contract malaria.
Through their work these three researchers identified Plasmodium as the pathogen and the mosquito as the vector.

20.b.

Marking Guidelines	Marks
* Link made between mutations and changes in antigens on plasmodium * Explanation of how immunological memory is developed through vaccination * Explanation that if antigens change, they are not recognised by memory cells and 2ndry immune response is not triggered.	3-4
* 2 of the above Or * all 3 done less well	2
* 1 of the above Or * 2 done less well	1

As the production of the antigenic proteins on the membrane of Plasmodium is controlled by genes, genetic mutations will lead to changes in these proteins.
A vaccine works by stimulating the production of memory B cells and memory T cells in response to a non harmful form of a specific antigen. These will recognise the antigen in a subsequent infection, triggering the 2ndry immune response – causing the pathogen to be destroyed.
However, if the antigenic proteins of Plasmodium have changed they will not be recognised by the memory cells and there will be no 2ndry immune response. The vaccine will not protect against malaria.

21.

Marking Guidelines	Marks
* Explanation needs to include the following: - allele for normal wings dominant - F1 gen. heterozygous - 3:1 ratio of phenotypes All of the above can be inferred from punnet square or other working	3
* 2 of the above	2
* 1 of the above	1

The allele for normal wings N must be dominant over that for vestigial wings n.
The original cross must have been between homozygous individuals. NN x nn, giving heterozygous offspring Nn.
A cross between two Nn parents would give the following

	N	n
N	NN	Nn
n	Nn	nn

This would give a 3 normal: 1 vestigial ratio – which is very close to the 93:29 obtained in the experiment.

22.a.

Marking Guidelines	Marks
* Correct variable stated	1

Genetic variation

22.b.

Marking Guidelines	Marks
* One other reasonable variable stated	1

Amount of sunlight received by the plants.

22.c.

Marking Guidelines	Marks
* Correct answer	1

To ensure that the results are reliable.

22.d.

Marking Guidelines	Marks
* Correct answer given	2
* Justification in terms of non heritability of environmentally caused variation.	
* Correct answer, incorrect justification.	1

There should be no appreciable difference between the two groups of plants. This is because the parents of both groups were genetically identical, the variation in their phenotypes was environmentally induced and therefore not inheritable.

23

Marking Guidelines	Marks
* Statement or inference that disease is caused by pathogens.	2-3
* Explanation of how hand washing can prevent transmission of flu pathogens	
Or	
* Contrary view put – with other mode of transmission of flu pathogens fully explained.	
* Statement or inference that disease is caused by pathogens.	1
Or	
* Discussion of a mode of pathogen transmission.	

People with colds or flu often sneeze or cough into their hands, infecting their hands with pathogens. If they subsequently handle food they could easily transmit the pathogen to another person. Washing hands thoroughly would remove the pathogens and decrease the chance of transmission.

24.

Marking Guidelines	Marks
* hypothesis stated	7
* suitable equipment listed	
* method in steps.	
* feasible method	
* one safety procedure described.	
* validity ensured (ie. independent and dependent variables measured correctly, other variables controlled,)	
* reliability ensured	
* 1 – 6 of the above	1-6

Hypothesis: The enzyme hydrogenase in lamb's liver works optimally at 37°C and progressively less well at temperatures above and below.

Equipment: Lamb's liver, water bath, boiling tubes, tubes, blender, thermometers, delivery tube, 500mL measuring cylinder, 10mL measuring cylinder, hydrogen peroxide, electronic balance.

Safety measure: Wear safety glasses to protect eyes against H₂O₂

Method:

- Puree the liver using the blender.
- Weigh out 15 portions of liver puree, 5g each and place each in a boiling tube.
- Prepare 5 water baths over a range of temperatures from 10°C to 70°C and place 3 tubes of liver in each and a bottle of hydrogen peroxide. (The temp. of the liver is the independent variable)
- Use the thermometers to monitor the temp. of the waterbaths. Allow the liver and the H₂O₂ to come to the same temperature as the waterbath.
- Add 10 mL of H₂O₂ to each boiling tube in turn, using the delivery tube to transfer the oxygen produced to the bucket where it is collected over water in the inverted 500mL measuring cylinder. Use the stopwatch to time how long it takes to produce 500mL of gas. (this is the dependent variable.)
- Average the results for each group of 3 tubes at the same temp. (This will help ensure reliability). And plot temperature (X axis) against time (Y axis).
- Variables such as the volume of H₂O₂, mass of liver, were controlled throughout – to help ensure validity.

25.

Marking Guidelines	Marks
* Crossing over named or described	4
* Implications of crossing over for genetic variation explained	
* Random segregation named or described	
* Implications of random segregation for genetic variation explained	
* 3 of the above	3
* 2 of the above	2
* 1 of the above	1

Genetic variation between gametes arises because of 2 processes which occur during meiosis.

- Random segregation is the process by which each pair of homologous chromosomes separates independently of every other pair at the end of the first part of meiosis. This is a random process ensuring that every gamete will get a different mixture of paternal and maternal chromosomes.
- Crossing over is the process by which adjacent chromatids exchange sections of DNA while grouped in homologous pairs. This ensures that new and different combinations of maternal and paternal alleles are passed on to the gametes.

26.

Marking Guidelines	Marks
* One good advantage of each and contrasting disadvantage of the other stated	3
* Two good examples	
* One good advantage of one and contrasting disadvantage of the other stated	2
* Two good examples	
Or	
* One good advantage of each and contrasting disadvantage of the other stated with no examples	1
* One good advantage of one and contrasting disadvantage of the other stated	
Or	
* Two good examples	

	Urea	Uric acid
Advantage	Less energy needed to produce	Less water needed to excrete
Disadvantage	More water needed to excrete	More energy needed to produce
Example	human	goanna

27.a.

Marking Guidelines	Marks
* Definition of health stated or implied	2
* One problem with definition explained	
* One of the above	1

Health can be defined as a state of physical, emotional and mental wellbeing. The main difficulty with this definition is that is subjective. Every person has their own interpretation of what constitutes good or bad health.

27.b.

Marking Guidelines	Marks
* One method of checking reliability described	2
* One method of checking reliability stated..	1

The qualifications and background of the authors could be checked to see whether they have credibility in this field. A survey of other resources could be made to see whether these findings were supported elsewhere.

28.a.

Marking Guidelines	Marks
* Correct answer	1

Kidney

28.b.

Marking Guidelines	Marks
* One difference and one similarity stated	2
Or	
* Two differences stated	1
* One difference or similarity stated.	

The level of urea would be much lower in the blood leaving the machine than in the blood entering it. The absolute amount of glucose entering the machine would be the same as that leaving it. (although the concentration of glucose would depend on how much water has been removed or replaced)

29.

Marking Guidelines	Marks
* Definition of transgenic species given * 2 different named examples with an implication for society and an implication for the environment assessed for each.	5-6
* Definition of transgenic species given * 1 named example with an implication for society and an implication for the environment assessed. Or * 2 examples discussed less well	3-4
* Definition of transgenic species given And/Or * Information about a transgenic species given	1-2

Transgenic species are produced by inserting genetic material from one species into another.

One well known example is Bt plants. Genetic material from a bacterium has been inserted into a range of plants including cotton, maize and tomatoes. The effect of this is to greatly increase their resistance to insect pests. This has many potential impacts – environmentally it should significantly reduce the amounts of insecticides used to grow these plants – greatly reducing the impact of insecticides on native food chains. On the other hand, the economic advantage presented by these plants will likely lead to other strains not being planted, leading in turn to a reduction in genetic diversity over time. This technology should have positive impacts on society in that it should increase productivity and reduce the cost of food. On the other hand, the large companies controlling the technology will develop a greater influence over world food markets which may not benefit consumers.

One other example is genetically modified fish. These have genetic material inserted to make them grow faster and larger. One obvious positive implication for society is the provision of more food. One negative implication for the environment is the fact that when these fish escape into wild populations their large size makes them more successful at attracting mates – leading to genetic change in wild populations.

Section II Options.

30. Communication

a.i.

Marking Guidelines	Marks
* Correct answer	1

It focuses light onto the retina.

a.ii.

Marking Guidelines	Marks
* Cones named * sensitivity of different cones outlined * integration to give colour vision explained	3
* 2 of the above	2
* 1 of the above	1

Cones are responsible for colour vision and they come in three types. One type absorbs blue light best, another absorbs green best the other absorbs red best. Between them they cover all the visible wavelengths of light. Depending on the extent to which these cones are stimulated we perceive different colours. For example yellow light stimulates both the red and green sensitive cones and we perceive this as yellow.

b.i.

Marking Guidelines	Marks
* Both correct	2
* One correct	1

A – is the auditory region – it controls hearing

B – is the visual region – it controls sight.

b.ii.

Marking Guidelines	Marks
* a reason or example given to illustrate the importance of correct interpretation	2-3
* Some information about interpretation of signals given	1

Interpretation of sensory signals is performed by the cerebral cortex. This information is processed and analysed in the light of stored memory and a co-ordinated response which produced. The correct interpretation of this information can be essential to survival. Eg: A person observing an out of control vehicle coming towards them will process visual sensory signals in the visual cortex. This information will be processed along with stored knowledge about how cars move and a response will be generated to give the best chance of avoiding it.

b.iii.

Marking Guidelines	Marks
* Correct structure * At least one correct label	2
* One of the above	1

c.

Marking Guidelines	Marks
* 2 technologies described	5-7
* Evaluation of each made in terms of how well they can improve eyesight.	
* 1 technology described and evaluated Or	2-4
* Both discussed less well	
* Some information given about a technology.	1

One modern technology that has had a major impact in the third world is the insertion of interocular lenses to replace those damaged by cataracts. The damaged lens is surgically removed and the artificial one inserted. This greatly improves eyesight as the cataract in the original lens makes it opaque and the person becomes blind. This technology is enormously valuable as it effectively restores sight to people who were virtually blind.

Another technology is corneal laser surgery. This involves removing small layers of cornea to alter the refractive ability of the cornea so that an image can be focussed on the retina. The technique is highly effective, restoring normal eyesight to many people who otherwise would have to wear glasses.

d.i

Marking Guidelines	Marks
* 4 structures named in correct sequence	3
* 2 or 3 structures named	1-2

The vibrating of the eardrum causes the ossicles to vibrate and transmit the message to the oval window adjoining the inner ear. Vibrations of the oval window cause vibrations in the fluid of the inner ear. These vibrating fluids push against membranes in the inner ear which in turn exert pressure on the hair cells in the organ of Corti.

d.ii.

Marking Guidelines	Marks
* Relevant details of cochlea structure given	2
* Explanation of how this allows discrimination between frequencies	
* One of the above.	1

The basilar membrane within the cochlea consists of fibres of varying lengths. The different length fibres vibrate at different frequencies. A sound of a particular frequency will only cause particular fibres to vibrate – their associated hair cells will be stimulated and the sound will be perceived as that frequency.

d.iii.

Marking Guidelines	Marks
* Explanation of how a hearing aid can assist hearing	2
* Some aspects of hearing aid function given.	1

A hearing aid essentially amplifies the sound vibrations that are received. This is useful if the eardrum or the ossicles are damaged and unable to transmit the vibrations as efficiently. By amplifying the vibrations their transmission to the inner ear is helped.

Question 31 --- Biotechnology.

a.i.

Marking Guidelines	Marks
* Correct factor named	1

Temperature

a.ii.

Marking Guidelines	Marks
* role of tRNA as transporter of specific amino acids outlined	3
* complementarity of codon and anticodon described	
* combining of amino acids outlined	
* two of the above	2
* one of the above	1

There are a number of different transfer RNA molecules and each attaches to a specific amino acid. Each type of tRNA molecule has a characteristic triplet of bases called an anticodon. This anticodon corresponds to a complementary codon on the mRNA molecule. tRNA molecules line up on their complementary codons on the mRNA molecule and the amino acids they carry are joined together by peptide bonds to make a polypeptide whose sequence is determined precisely by the sequence of bases on the mRNA.

b.i.

Marking Guidelines	Marks
* Details of the process outlined	4-5
* Organism or tissues involved identified	
* Evaluation of efficiency	
* two of the above Or	2-3
* all three done less well	
* one of the above	1

The delivery of gene therapy through the use of nasal sprays is a significant development. It has great positive implications for human health. Sufferers from cystic fibrosis lack an allele which allows normal function of the lungs. By using nasal sprays to introduce viral vectors which carry the missing allele, these people can hopefully be treated. The missing gene will be taken up by some cells in the lungs of the sufferer causing them to function correctly and relieving the symptoms of the disease.

b.ii.

Marking Guidelines	Marks
* the process accurately outlined	2
* some details outlined	1

Whereas normal transcription involves the copying of a genetic code from DNA to RNA, reverse transcription operates the other way round. For example a retrovirus reverse transcribes its RNA code into the DNA of its host.

c.

Marking Guidelines	Marks
* Two technological changes described	5-7
* Effects of each explained.	
* One change described and its effect explained Or	2-4
* Both done less well	
* some details about a technological change given	1

Fermentation is an ancient biotechnology which uses microorganisms to produce particular products. Yeasts have long been used to make beer and wine. One technological advance that changed wine making was the discovery by Pasteur that bacteria were responsible for the 'spoilage' of wine and that they could be destroyed through heating. (Pasteurisation). This has greatly improved the productivity of win makers. Analytical techniques developed during the late C19 and early C20 allowing much more efficient monitoring and control of ethanol content and leading to improved quality and productivity.

d.i.

Marking Guidelines	Marks
* one ancient use outlined	1

Aborigines domesticated dingos and practised selective breeding to enhance the characteristics they valued.

d.ii.

Marking Guidelines	Marks
* Two events outlined	2
* One event outlined	1

Yeasts are naturally occurring fungi and their first uses in fermentation occurred in prehistory. Most likely the events that led to their use in making alcohol would have been the discovery that stored grain fermented and also the discovery that fruit fermented if left uneaten.

d.iii.

Marking Guidelines	Marks
* 2 points for and /or against a biotechnology on ethical grounds.	3-4
* some ethical points stated	1-2

Cloning is an example of a biotechnology which has stimulated ethical debate. Cloning has been suggested as a way of saving species from extinction. One could argue that this was ethically justified since humans brought about the near extinction and have a duty to try to redress it. On the other hand you could argue that this was not justified ethically because the large amount of money involved would be better spent on conserving whole environments – whose inhabitants also have the right to survive.

Question 32 --- Genetics: The Code Broken?

a.i.

Marking Guidelines	Marks
* correct answer	1

A change in the genetic make up of an organism.

a.ii.

Marking Guidelines	Marks
* Both processes outlined.	3-4
* Consequences of each outlined	
* Process and consequence of one outlined Or	2
* Both done less well	
* One process or consequence outlined	1

A base substitution mutation involves the replacement of one base in a sequence by another. The consequence of this will be that one triplet has changed. The new triplet may code for a different amino acid leading to the production of a different protein.

A frame shift mutation involves the deletion of a base from a sequence, meaning that every triplet from that point on has changed. This means that every amino acid from that point on will be different, or more likely, that one of the triplets will be a nonsense codon – leading to a break in the protein.

b.i.

Marking Guidelines	Marks
* Correct genotypes given for both linked and non – linked genes	2
* Correct genotype given for one of the above	1

If genes are linked AbC and aBC

If not linked ABC, aBC AbC and abC

b.ii.

Marking Guidelines	Marks
* Outline of what researchers looked for.	3-4
* Explanation of significance of this	
* Explanation of relationship between distance apart on chromosome and frequency of separation.	
* Two of the above Or	2
* All 3 less well done	
* One of the above	1

They would perform cross breeding experiments and observe the inheritance of linked genes. Alleles of linked genes should be inherited together because they are on the same chromosome. Occasionally, however, these alleles are separated due to crossing over. The researchers proposed that genes that were further apart on the chromosome would be separated more often than those close together. By comparing the frequencies with which pairs of genes were separated by crossing over the researchers were able to draw chromosome maps.

c.

Marking Guidelines	Marks
* Outline of what gene therapy is	5-7
* Description of its use to manage a named disease.	
* Evaluation of its effectiveness	
* Two of the above Or	2-4
* All 3 less well done	
* One of the above	1

Gene therapy is the process by which the sufferer of a disease is given copies of a gene which he or she lacks in the hope that it will help to manage their disease. One example of this is in the treatment of cystic fibrosis. Sufferers are double recessive for a defective allele and are unable to make a protein which assists in lung function. Over time their lungs become clogged and fibrous. Copies of the gene which these people lack have been inserted into a viral vector which the sufferer then inhales in an aerosol. The hope is that the virus will insert the gene into enough of the cells lining the lungs to help correct the problem. So far results have been mixed and this technique isn't yet right for managing cystic fibrosis. More success has been had with other diseases though such as SCID and gene therapy obviously has potential as a tool for disease management in the future.

d.i.

Marking Guidelines	Marks
* correct genotypes of parents	4
* correct gamete genotypes	
* correct offspring genotypes	
* correct phenotype ratio	
* Three of the above	3
* Two of the above	2
* One of the above	1

Phenotypes of parents

Genotypes

Gametes

A+ $I_A i$ $I_A D, I_A d, iD, id$	x $I_A i$ $I_A d, I_B d$	AB- $I_A I_B dd$
	$I_A d$	$I_B d$
	$I_A I_A Dd$	$I_A I_B Dd$
	$I_A I_A dd$	$I_A I_B dd$
	iD	$iB iD$
	id	$iB id$

2 A +ve. : 2 A -ve. : 1 AB +ve : 1 AB -ve : 1 B +ve : 1 B -ve.

d.ii

Marking Guidelines	Marks
• Nature of gene cascades described	3
• Role of gene cascades in embryonic development outlined.	
• One of the above OR	1-2
• Both less well done	

Gene cascades are sequences of genes that are switched on one after the other. As each gene is switched on to perform its function the substance it produces also switches on the next gene in the sequence. Different parts of the embryo develop in a particular order and this is thought to be controlled by gene cascades. For example, the parts of the human arm develop in a precise sequence, each stage controlled by different genes. As each stage is complete the next set of genes is switched on and the next stage begins.

Question 32 --- The Human Story

a.i

Marking Guidelines	Marks
* correct answer	1

Humans possess mammary glands to suckle young.

a.ii.

Marking Guidelines	Marks
* Explanation of adaptive value of each	3
* Explanation of adaptive value of one	2
* Description of one	1

Stereoscopic vision allows depth perception – this is essential when moving through trees since it allows the animal to accurately judge the distance of branches. An opposable thumb allows the animal to grip, which is essential for holding on to branches.

b.i.

Marking Guidelines	Marks
* contrasting feature stated for both human and chimp	2
* feature of one given without contrasting feature of the other	1

The chimp has 24 pairs of chromosomes while the human has 23 pairs.

b.ii.

Marking Guidelines	Marks
* Significance of differences in amino acid sequence explained	3
* This difference related to primate evolutionary relationships	
* One of the above Or	2
* Both less well done	
* One of the above done less well	1

Any differences in the amino acid sequence of primate haemoglobin reflect genetic differences. (Since the DNA codes for the precise amino acid sequence). Genetic differences arise through mutation which is assumed to occur at a constant rate over time. Therefore the greater the genetic difference between two species the longer the time since they shared a common ancestor. Comparison of primate haemoglobin shows great similarity between humans and great apes, but less similarity between humans and other monkeys. Confirming a closer evolutionary relationship with the great apes.

b.iii.

Marking Guidelines	Marks
* Explanation of maternal inheritance of mitochondria	2-3
* Link between variation in mtDNA and time explained	
* One of the above	1

Mitochondria are inherited along a maternal line. This means that there is no mixing of DNA as occurs with nuclear DNA. The only variation that occurs to mtDNA arises through mutation. Since mutation occurs at a constant rate the difference in mitochondrial DNA between two individuals is a reflection of the length of time since they shared a common maternal ancestor. This allows mtDNA to be used as a molecular clock. Species and races that have more recently diverged will have the most similar mtDNA.

c.

Marking Guidelines	Marks
• Two medical technologies described	5-7
• Possible effect of each on human evolution explained	
• Potential of each assessed	
• Two technologies described but potential not assessed	3-4
• One technology described OR	1-2
• Two named	

Modern medical advances such as the development of vaccines have the potential to effect human evolution. Diseases such as smallpox and diphtheria would have been strong selecting agents. Genes conferring an increased chance of surviving these diseases would have been strongly selected for and would have had high frequencies in the population. With this selecting pressure removed the frequency of these genes will decrease and the population as a whole would be more susceptible to these diseases should vaccination cease at some time in the future.

Assisted reproductive technologies such as IVF are becoming more and more widespread. Previously, any gene that compromised fertility was strongly selected against and would have been present in very low frequencies in the population. These genes are now less strongly selected against and will increase in the population. This will mean that in future generations fertility problems will be much more common.

d.i.

Marking Guidelines	Marks
* Two differences described	2
* One difference described	1

Homo habilis had a less protruding jaw than the Australopithecines. It also had a more arched foot than the Australopithecines.

d.ii.

Marking Guidelines	Marks
* Two differences described	2
* One difference described	1

Homo habilis had a much smaller brain capacity than modern humans. It also lacked the pointed chin of modern humans.

d.iii.

Marking Guidelines	Marks
* Statement about small amount of evidence or incompleteness of evidence	2
* Statement about evidence being capable of different interpretation	
* One of the above	1

There is only a small amount of human fossil evidence and many gaps which have to be inferred. Different anthropologists have placed differing interpretations on some of the evidence, meaning that they haven't all made the same inferences.

Question 33 --- Biochemistry

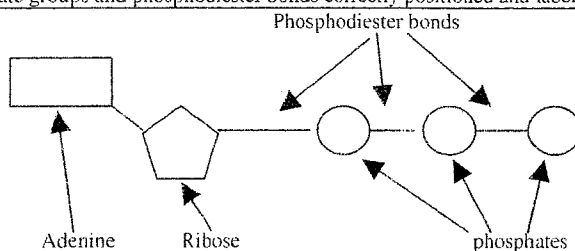
a.i.

Marking Guidelines	Marks
* correct answer	1

Mitochondrion

a.ii.

Marking Guidelines	Marks
* adenine, ribose, phosphate groups and phosphodiester bonds correctly positioned and labelled.	1-3



b.i.

Marking Guidelines	Marks
* description of his experiment	2
* statement of his finding	
* One of the above	1

Priestley showed that a plant could 'restore the air' in a closed container. Air which could not support combustion or a mouse could be 'restored' by a plant to a point where it would. What he called 'dephlogistised air' was later called oxygen.

b.ii.

Marking Guidelines	Marks
* feasible method	5
* method of measuring rate of photosynthesis explained	
* variables controlled	
* reliability ensured	
* justification of each of the above	
* The above less well done	1-4

- A piece of pond weed *Elodea* was taken and placed in a funnel with a water-filled measuring cylinder inverted above it.
- This was all placed in a tank of water.
- The inverted measuring cylinder was to collect the oxygen produced. The rate of photosynthesis was measured as the volume of O_2 produced per hour.
- The apparatus was assembled in a dark room and subjected to different intensities of light controlled and measured by a dimmer switch. A dark room was chosen to prevent other light interfering with the experiment.
- The experiment was repeated 3 times at each light intensity to ensure reliability.
- Other variables which might affect photosynthetic rate, such as temperature were controlled throughout the experiment.

c.

Marking Guidelines	Marks
* Two possible benefits outlined	5-7
* Both of the above linked to areas of research into photosynthesis	
* An assessment made of these benefits	2-4
* Two of the above Or	
* All 3 less well done	
* Some information about research into photosynthesis.	1

One major potential benefit of research into photosynthesis is the possibility of using photosynthesis to sequester CO_2 . Photosynthesis does this naturally but with increasing levels of CO_2 in the atmosphere it becomes vitally important to learn more about how this process occurs and how higher CO_2 levels will themselves affect photosynthesis. A better understanding of the role of plants in controlling CO_2 levels will be of great importance when planning to deal with global warming. Another major benefit that should come from study of photosynthesis is increased crop yield. The world's population is steadily increasing and food production needs to be increased. A better understanding of the precise conditions required to maximise photosynthesis in particular plants will allow correct strains to be chosen to maximise production in particular areas.

d.i.

Marking Guidelines	Marks
* Size and shape of chloroplasts of named angiosperm outlined	3-4
* Size and shape of chloroplasts of named angiosperm outlined	
* Comparison made	1-2
* Information about angiosperm and algal chloroplasts given	

The angiosperm *Tradescantia* has ovoid chloroplasts situated mainly in the mesophyll cells. They are larger than those of the alga *Ulva*, whose chloroplasts are more spherical and situated in all tissues except the holdfast. *Tradescantia* chloroplasts are about $5\mu m$ in diameter while those of *Ulva* are about $1\mu m$.

d.ii.

Marking Guidelines	Marks
* location identified	3
* structure outlined	
* adaptive nature of structure explained	
* Two of the above	2
* One of the above	1

Thylakoids form part of the grana in the chloroplast where they are stacked on top of each other. They are flattened hollow disks with gives them a large surface area to volume ratio. The thylakoids are the site of the light reaction and this shape maximises light absorption.