Exam Choice

2009 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
A	C	A	B	B	A	D	C	A	A	D	B	D	D	C

Section I B

16. a

Marking Guidelines	Marks
• Difference named and accounted for	2
• Difference named	1

Oxygen levels are higher at Y than X because the blood has just passed through the lungs and become oxygenated.

16.b

Marking Guidelines	Marks
• Metabolic waste named • Reason for removal given	2
• One of the above	1

CO_2 is a metabolic waste. It has to be removed as a build up will make the cell contents acidic and interfere with cell function.

17.

Marking Guidelines	Marks
• Two valid quarantine measures described and justified	3-4
• Two valid quarantine measures described	2
• Quarantine measures named	1

One important measure is the screening of people entering the country. They would need to be questioned about where they have been and examined for flu-like symptoms. This would allow quarantine officials to isolate any potential sufferers, reducing the risk of them spreading it to other members of the public. A second measure would be the issuing of face masks to any people who have cold or flu like symptoms. This would reduce the chance of their spreading the pathogen through droplet infection.

18.a.

Marking Guidelines	Marks
• Explanation given	2
• Correct statements made about chromosomal differences, but not linked in explanation	1

Females have 2X chromosomes, while males have an X and a Y. This means that women carry 2 alleles, and even if the recessive DMD allele is present it will be overridden by the dominant normal allele on the other X chromosome. Males, however have just one X chromosome. If it carries the DMD allele, then they will have the disease, as there is no dominant allele present to override it.

b.

Marking Guidelines	Marks
• Explanation given	2
• Some valid differences given but not sufficient as an explanation.	1

For a female to have a sex linked condition she must get one recessive allele from her mother and another from her father. This means that her father must suffer from the condition. While conditions such as colourblindness are not life threatening and men with the condition would be expected to survive to have children, this is very unlikely with DMD. Men with DMD die young and are normally significantly disabled by the age of 12. They are very unlikely therefore to have children and hence it is very unlikely for females to be born with the condition.

c.

Marking Guidelines	Marks
• Chance of Sue being a carrier correctly assessed • Chance of child having DMD if Sue is a carrier correctly assessed • Chance of child having DMD if Sue is not a carrier correctly assessed. • Assessment supported by punnet squares or logical reasoning.	3
• 3 of the above	2
• 2 of the above OR correct probability given with no supporting reasoning.	1

Mary must be heterozygous for the trait (X^NX^n), she must have obtained the recessive allele from her mother, as her father does not have the condition. The mother must therefore also be heterozygous meaning that there is a 50% chance that she passed the recessive allele to Sue, making her a carrier. If Sue is not a carrier there is 0% chance that the child will have DMD. If she is a carrier there is a 50% chance that the child will have the condition. Overall, the likelihood of the boy having DMD = 50% x 50% = 25%.

19.a

Marking Guidelines	Marks
• Genotype correctly stated	**1**

Aa Bb CC Dd

b.

Marking Guidelines	Marks
• Correct organ stated (testis or ovary)	**1**

Testis

c.

Marking Guidelines	Marks
• At least 3 drawings • Evidence of crossing over should be shown • Evidence of random segregation shown • Genotypes of gametes should be consistent with genotype of parent cell and with crossing over and random segregation illustrated.	**4**
• 3 of the above	**3**
• 2 of the above	**2**
• 1 of the above	**1**

20

Marking Guidelines	Marks
The answer can agree or disagree with the statement, but must contain • A case made for the benefits of antibiotics • A case made to illustrate the negative effects of antibiotics	**4**
• A case either for or against made	**3**
• Advantages or disadvantages of antibiotics stated without elaboration.	**2**
• 1 true fact about antibiotics given	**1**

The benefits of antibiotics still outweigh their disadvantages. Millions of people have been saved from bacterial diseases such as TB and septicaemia following injury, thanks to antibiotics. By any measure they have been one of the most significant advances in medical science. Since their discovery, however, some drawbacks in their use have become apparent. Particularly the tendency of bacteria to evolve resistant strains. This makes it necessary to continually develop new antibiotics as bacteria become resistant to old ones, and raises the possibility of the evolution of strains which it will not be possible to combat.

21.a

Marking Guidelines	Marks
• Independent variable identified • Dependent variable identified • Variables to be controlled identified and some suitable controls proposed • Data to be collected specified • Feasible method with some equipment specified. • Sufficient data collected • Some consideration of how data would be used/processed/analysed	**5**
• 3-6 of the above	**1-4**

Equipment. 7000 coral trout larvae, 7 large aquaria, thermometers and thermostats, normal shelter and food requirements of coral trout (coral and food species)

Method.
- 7 large identical aquaria are set up, each with exactly the same sorts of corals and food species present. (controlled variables)
- Using the thermostats they are adjusted to 25, 26, 27, 28, 29, 30 and 31^{o}C respectively. (water temp is the independent variable) Thermometers are used to monitor water temp throughout the experiment.
- 1000 coral trout larvae are introduced to each aquarium and the numbers surviving are counted every 2 days for five weeks. (survival rate of coral trout, measured as the % surviving after 5 weeks is the dependent variable)
- After 5 weeks the survival rate, expressed as a % of the original number of fish is determined for each aquarium.
- A graph of temperature against survival rate can then be drawn.

b.

Marking Guidelines	Marks
• Answer incorporating variation, differential survival and reproduction, and inheritance of favourable characteristics	**3**
• 2 of the above	**2**
• 1 of the above	**1**

There would have been natural genetic variation in the ability of the fish to survive in hotter temperatures. As temperatures increased, any individuals which were better able to survive, survived and reproduced more successfully than the others, which died out. The offspring of these survivors inherited their tolerance of warmer water and the trait became widespread in the population.

22.a.

Marking Guidelines	Marks
• Drawing or description of the lock and key model • Link made to show how this makes enzymes substrate specific	**2**
• Drawing or description of model with no link made.	**1**

The lock and key model proposes that the active site of an enzyme can be thought of as having a unique shape which fits perfectly, and combines with, the shape of the substrate. For enzymes to catalyse a reaction they must combine with the substrate, so this model explains why enzymes are substrate specific. Their uniquely shaped active site will only combine with the one type of substrate.

b.

Marking Guidelines	Marks
• Description including both change in activity in response to temp, and denaturation (an annotated graph would be suitable)	**2**
• One of the above.	**1**

As temp increases so does enzyme activity, until the optimum temp is reached. Beyond this point, increases in temperature cause enzyme activity to decrease. At high temperatures the enzyme is irreversibly denatured.

23.

Marking Guidelines	Marks
• Two mechanisms described	**3**
• One mechanism described OR • Two barriers named	**2**
• One barrier named	**1**

The clotting mechanism prevents entry of pathogens into the bloodstream. Clotting proteins in the blood interact with platelets to form a mesh of fibres over a wound which traps blood cells and forms an impermeable scab.
Another mechanism is the action of cilia. Mucus traps pathogens inside the respiratory tract and they are then wafted by cilia back up the trachea until they can be swallowed and destroyed by stomach acid.

24.

Marking Guidelines	Marks
• Definition of homeostasis given • Action of aldosterone on the nephron outlined • Homeostatic role of aldosterone outlined	**3-4**
• 2 of the above	**2**
• 1 of the above	**1**

Homeostasis is the maintenance of a stable internal state within the body. Aldosterone has a role in maintaining salt balance within the blood and hence blood volume and pressure. Aldosterone is produced by the adrenal gland. It targets the cells of the nephron, causing them to actively move salts from the urinary filtrate back into the blood. Water then follows the salt by osmosis, raising blood volume and hence pressure. Secretion of aldosterone is stimulated by a drop in blood salt levels, so its secretion is an example of a negative feedback mechanism, restoring homeostasis.

25.

Marking Guidelines	Marks
• Survival implications of small population size addressed • Survival implications of low genetic diversity addressed in evolutionary terms.	**3-4**
• 1 of the above	**2**
• Statement of implications of either factor given without explanation.	**1**

A small population size makes the Wollemi pine susceptible to extinction, as a localised event such as a major bushfire could conceivably kill all the individuals. The larger the population, the greater the chance of some individuals surviving such an event. Low genetic diversity also has implications for long term survival, as in the event of major environmental change or disease there are unlikely to be individuals with genetic differences which allow them to survive. However, the fact that they have survived for a very long time already suggests that they are very well adapted to their environment, and provided there is no major change, they should continue to survive.

26.

Marking Guidelines	Marks
• Technology named and mode of action described • Role of the technology in medical care outlined with an example. • Assessment given of its importance	**3-4**
• 2 of the above	**2**
• 1 of the above	**1**

Pulse oximetry involves the placement of a monitor on the finger of the patient. The monitor emits and recaptures a combination of wave lengths of light. The wavelengths of light that haemoglobin will absorb is a function of its oxygen saturation. The monitor measures the wavelengths that are not absorbed, deduces those that are, and is calibrated to provide the corresponding oxygen saturation measurement. Pulse oximetry is a very important tool in modern medicine. It is used to monitor oxygen levels in premature babies and in people with respiratory diseases. In both of these cases it is important to know whether oxygen levels are sufficient so that supplementary oxygen can be given if necessary.

27.

Marking Guidelines	Marks
• Two examples of a development in knowledge about infectious disease or the body's response described. • Each of these clearly linked to the development of an effective treatment or control • An evaluation of the importance of the development in knowledge in bringing about the development in treatment or control given.	**7-8**
• Two examples of a development in knowledge about infectious disease or the body's response described. • Each of these clearly linked to the development of an effective treatment or control BUT no evaluation given OR • Two examples of a development in knowledge about infectious disease or the body's response described. • One evaluated and linked to the development of an effective treatment or control.	**5-6**
• Examples of a development in knowledge about infectious disease or the body's response outlined. • Examples of developments in treatment or control outlined, BUT links not made.	**3-4**
• Examples of developments in knowledge or treatment of disease outlined	**1-2**

Modern treatments and controls for infectious disease have only been developed because of vital advances in our knowledge about the nature of disease and the body's response to it. Pasteur developed the germ theory of disease through his investigations into the spoiling of wine. He extended his work into disease and showed that infectious disease is caused by pathogens. This knowledge was essential to surgeons and doctors who then adopted the practice of using disinfectants when treating wounds, thus dramatically reducing infection. Without this knowledge Fleming would not have seen the implications of his accidental experiment with penicillin mould and the development of antibiotics for the treatment of bacterial diseases would not have occurred.
MacFarlane Burnett and others studied the human immune system and developed our knowledge of the immune response. They showed that an antigen provokes the cloning of specific antibody producing cells, which then produce antibodies to combat the antigen. Memory cells produced at this time ensure that in the event of reinfection by the antigen a faster, more intense immune response occurs. Knowledge of this mechanism has been essential for the development of modern vaccines, which induce this immunological memory to protect patients against infection by the pathogen.

Section II Options.

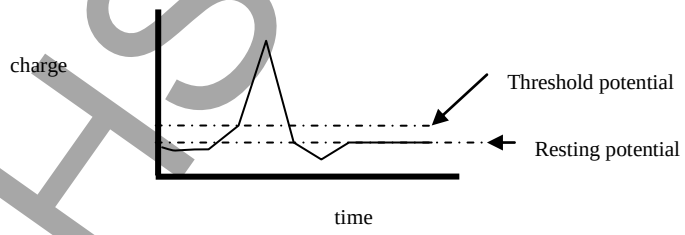
28. Communication.
a.i.

Marking Guidelines	Marks
• Receptor named	**1**

Rods and cones of the eye.

ii.

Marking Guidelines	Marks
• Accurate graph sketched (no need for labels, units etc.) • Threshold potential and resting potential either indicated on graph or described in answer • Explanation of how reversal of polarity has to exceed threshold potential to initiate AP.	**3**
• 2 of the above	**2**
• 1 of the above	**1**



Stimuli cause the polarity of the axon membrane to be reversed. This reversal must be greater than the threshold potential in order to produce an action potential. Weak stimuli that do not reach the TP will not produce an AP.

b.i.

Marking Guidelines	Marks
• Correct wave identified • justification	**2**
• correct wave identified	**1**

Wave B has the highest pitch. It shows more wavelengths than A in the same time – it is therefore of higher frequency. As frequency increases, pitch rises.

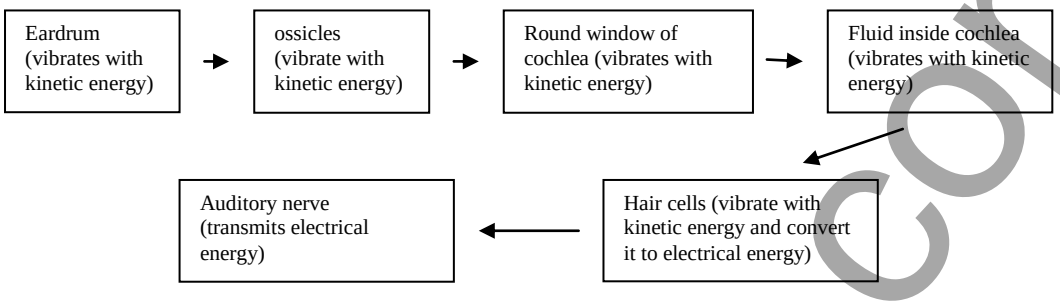
b.ii.

Marking Guidelines	Marks
• correct answer	**1**

As wavelength increases, frequency decreases.

b.iii.

Marking Guidelines	Marks
• At least 4 structures named in correct sequence • Energy types named • Conversion from kinetic to electrical indicated	**4**
• The above 3 done less well	**1-3**



c.

Marking Guidelines	Marks
• At least 2 vision defects described. • 2 technologies described (one relevant to each defect) • Explanation of how each technology restores normal vision. • A judgement made about one impact on society of restoring sight in visually impaired people.	**6-7**
• 3 of the above OR all 4 less well done	**4-5**
• 2 of the above OR 3 less well done	**2-3**
• 1 of the above OR 2 less well done	**1**

Cataracts develop in the lens of the eye making it opaque and impairing vision. One modern technology that can be used to combat cataracts is the insertion of intraocular lenses to replace the damaged ones. This restores normal vision because the intraocular lenses are transparent whilst the damaged lenses have become opaque.
Short sightedness is a condition where the lens is either too thin or too inflexible to focus on close objects. Corneal laser surgery is a technology that can correct this. 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.
These technologies have had a major impact on society by allowing people who would otherwise be unable to participate fully, to work and contribute to society.

d.i.

Marking Guidelines	Marks
• Safety measure named and justified	**1**

Hands carefully washed afterwards to prevent possible contamination of food with pathogens that may have been on eye tissue.

ii.

Marking Guidelines	Marks
• Structure of one feature described • Function of feature described • Structure related to function	**2**
• Structure and function both described, but not related	**1**

The lens is transparent and flexible. This allows its shape to be altered by the muscles of the eye, changing its refractive properties. This feature allows it to perform its function of fine focusing the image on the retina.

iii.

Marking Guidelines	Marks
• Cones named • Sensitivity to different colours explained • Integration of input to give other colours outlined • Role of brain in perception outlined	**4**
• One to three of the above	**1-3**

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. The brain allows us to perceive a colour depending on the extent to which the different types of cone are stimulated.

29. Biotechnology

a.i.

Marking Guidelines	Marks
• Suitable species named	**1**

Sheep.

ii.

Marking Guidelines	Marks
• 2 points for and/or against a named biotechnology on ethical grounds	**3**
• 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.

b.i.

Marking Guidelines	Marks
• New technology or knowledge outlined • Traditional use of biotechnology contrasted to new use • Role of new technology or knowledge in this change explained	**4**
• 2 of the above OR all 3 less well done	**2-3**
• 1 of the above	**1**

Fermentation has long been used in the production of wine. One example of how new knowledge has modified the old technology is the discovery by Pasteur of bacteria as the responsible agents for the spoiling of wine. Heating (pasteurisation) is now a part of the wine making process as it kills these bacteria.

ii.

Marking Guidelines	Marks
• 3 events outlined in succession	**3**
• 1-2 events outlined	**1-2**

The earliest breads would have been simple flour and water 'flatcakes' cooked on hot rocks or similar. The earliest use of yeast was probably accidental – dough left in the air may have had yeast spores land on it. Archaeological evidence shows that ancient Egyptians had leavened bread, and by the time of Ancient Greece it was recorded that some groups added an extract from beer or wine, while others would keep a 'starter' from the previous day's bread.

c.

Marking Guidelines	Marks
• Two applications of biotechnology to medicine described • For each, an implication of either the process or product for society described and a judgement made	**6-7**
• Two applications described • One implication for society discussed	**4-5**
• Two applications described OR one described and an implication discussed	**2-3**
• One application described	**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.
Another application is the production of human insulin through recombinant DNA technology. The human insulin gene is inserted into a plasmid of a bacterium such as E. coli using restriction enzymes and ligases. The plasmid is reintroduced to the bacterium, which is cultured. This culture is then used to make human insulin. This has positive implications for society as it allows diabetics to live a healthier life. They now receive human insulin, rather than the biochemically different insulin taken from animals.

d.i.

Marking Guidelines	Marks
• Safety measure named and justified	**1**

Protective glasses were worn to protect the eyes from splashes of harmful chemicals.

ii.

Marking Guidelines	Marks
• One part of procedure outlined • Role in extraction process explained	**2**
• One of the above, OR both done less well	**1**

Fruit crushed and then gently stirred with detergent. The detergent breaks down membranes and releases the DNA from the cells.

iii.

Marking Guidelines	Marks
• Process outlined with at least 4 steps in correct sequence	**4**
• 1-3 steps outlined	**1-3**

Transcription. The DNA molecule 'unzips' and RNA nucleotides line up on their complementary bases on the template strand, to form a molecule of mRNA.
The mRNA travels out of the nucleus via a pore and along the endoplasmic reticulum until it reaches a ribosome.
Translation. The ribosome attaches to the mRNA molecule and moves along it, successively activating a triplet of bases on the mRNA molecule (codon). tRNA molecules, each attached to an amino acid which is specific to the triplet of bases they display (anticodon), are attracted to the ribosome and line up on their complementary triplets on the mRNA molecule.
The amino acids brought together in this way, join together by peptide bonds to form a polypeptide.
A group of polypeptides join together to make a protein.

30. Genetics: The Code Broken?

a.i.

Marking Guidelines	Marks
• Suitable species named	**1**

Sheep

ii.

Marking Guidelines	Marks
• Nature of transposons outlined • An example of their actions in a named species described	**2**
• One of the above	**1**

Transposons are sections of DNA which can move and insert themselves elsewhere in the chromosome. If they insert themselves into a gene, they can disrupt the function of that gene. In maize, purple corn kernels can sometimes develop a mottled appearance – owing to the fact that in some cells a transposon has inserted itself into the gene which codes for the protein which makes the kernels purple, disrupting its action and causing those cells to be white.

b.i.

Marking Guidelines	Marks
• Correct answer obtained	**2**
• Correct gametes identified, but incorrect answer	**1**

gametes	TR	Tr	tR	tr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	trRr	ttrr

3 tall round: 3 short round: 1 tall wrinkled: 1 short wrinkled

ii.

Marking Guidelines	Marks
• Different inheritance patterns of linked genes, compared to non linked ones outlined.	**2**
• Linkage defined	**1**

The way in which ABO and rhesus blood groups are inherited shows that they are on different chromosomes. If they were linked genes – on the same chromosomes, then they would not obey Mendel's Law of Independent Assortment. –Alleles would be inherited together.

iii.

Marking Guidelines	Marks
• Example of characteristic under polygenic control outlined • Pattern of distribution of phenotypes explained	**3**
• As above , but without the explanation	**2**
• Example named OR pattern of distribution described.	**1**

Human skin colour is a characteristic under polygenic control. It is controlled by at least 3 genes, each with 2 alleles – one coding for melanin production (dark skin) and the other for non production (light skin).
Seven different genotypes are possible – people can have 0,1,2,3,4,5 or 6 alleles for dark skin. Theoretically this gives rise to 7 different skin shades of increasing darkness. In practice, environmental factors blur the boundaries between these shades leading to continuous variation within humans from very light to very dark.

c.

Marking Guidelines	Marks
• Human Genome Project described • Two potential impacts on society described • Assessment given of how the HGP could bring these about.	**6-7**
• Two of the above OR all three less well done	**4-5**
• One of the above OR Two less well done	**2-3**
• One of the above poorly done	**1**

The Human Genome Project is an international project which set out to map the human genome. Both in terms of the identification and location of all of our genes and the precise base sequence of each chromosome.
The 'first draft' of the human genome was obtained by 2003 and the knowledge obtained and soon to be obtained has many implications for society.
Knowledge of the location and base sequence of genes linked to diseases such as cystic fibrosis and types of cancer will allow screening of people for the possession of these genes. This will have major implications for society. It will allow people at risk of developing diseases

such as cancer to adopt life style changes and medical regimes to maximise their chance of survival. On the other hand, such screening might be used to deny people insurance cover or employment.
All people are genetically different and hence respond to medical drugs differently. Increased knowledge of the link between genetics and the response to medical treatments, which the HGP will reveal, should make it possible to treat people on the basis of their own genetic make up and hence more effectively.

d.i.

Marking Guidelines	Marks
• 1-2 aspects of the structure justified	**1-2**

The model was constructed using 4 different coloured beads to represent the bases. In this way the complementary pairing of the bases could be modelled. Pipecleaners were used to model the sugar – phosphate backbone of the model. Pipecleaners were chosen so that they could be bent to represent the helical shape of the molecule.

ii.

Marking Guidelines	Marks
• Example outlined • Explanation given of how this is evidence of evolutionary relationships	**2-3**
• Example given or general statement about why gene similarity reflects genetic relatedness.	**1**

The homeobox sequence of genes which controls development of the embryo in fruitflies, has been found, thanks to the use of genetic probes, throughout the animal kingdom. This is very strong evidence for the common ancestry of all animals, suggesting that they have all inherited these genes from a common ancestor.

iii.

Marking Guidelines	Marks
• Nature of gene cascades outlined • Description of their role in embryonic development • Importance of timing explained	**3**
• 1-2 of the above	**1-2**

Embryonic development in animals follows a precise pattern. For example, in humans limb development starts at the shoulder and moves down the arm.. This pattern of development is controlled by HOX genes which function as a gene cascade. Each gene in the cascade both stimulates an aspect of development and switches on the next gene in the cascade. The sequential timing of the expression of each gene is critical if the embryo is to develop correctly. Errors in timing lead to deformed embryos.

Question 31. The Human Story

a.i.

Marking Guidelines	Marks
• Fossil hominid named	**1**

Homo habilis

ii.

Marking Guidelines	Marks
• 1-2 major differences outlined	**1-2**

Members of the genus Homo have a much larger cranial capacity than their ancestors – suggesting larger brain size. They also have much smaller teeth.

b.i.

Marking Guidelines	Marks
• 2 differences or one difference and one similarity given • Mode of life of each related to structure.	**3-4**
• One of the above OR both done less well	**1-2**

The gorilla's foot has five toes like the human foot, but the big toe is opposable to the second toe. This is different to humans where the big toe is parallel to the other toes and not opposable. An opposable big toe is adaptive to the gorilla's way of life, allowing it to grasp branches and climb through trees. The human toe suits us to bipedalism as it helps to propel the body along.

ii.

Marking Guidelines	Marks
• Cultural development named • Evolutionary development outlined • Explanatory link made between the two.	**3**
• Cultural development named • Evolutionary development outlined	**2**
• Cultural development named OR evolutionary development outlined	**1**

One human cultural development that affected their subsequent evolution, was the development of co-operative hunting. Early humans worked in groups to hunt prey as it was more efficient. This created strong selective pressure for traits which improved the ability to communicate. Family groups which communicated better were more successful hunters, survived and reproduced more successfully and passed these traits on to their offspring. This would have been one of the factors which contributed to the eventual evolution of language and intelligence.

c.

Marking Guidelines	Marks
• Understanding of mechanism of evolution explained or implicit in answer • Potential of increased mobility to affect evolution assessed. • Potential of modern medicine to affect evolution assessed.	**6-7**
• 2 of the above OR all three less well done.	**4-5**
• 1 of the above OR two less well done	**2-3**
• 1 done poorly	**1**

An evolutionary change is a change in the frequency of alleles within a population. It occurs as a result of natural selection giving a survival or reproductive advantage to individuals who carry a particular allele.
Increased population mobility has the affect of homogenising human genetic make up. Previously, through natural selection, isolated populations developed allele frequencies and therefore characteristics that were unique to them – leading to the racial diversity of the human species. Nowadays, increased mobility is breaking down any reproductive barriers that might have existed and leading to a much greater mixing of genes. People will become more alike.
Modern medicine is affecting evolution by removing selecting agents from the human population. Five hundred years ago only about 50% of children lived to adulthood. Pathogens and the harsh conditions were strong selecting agents for resistance to disease and a resilient metabolism – only people with these characteristics survived and reproduced. Modern medicine, in reducing these selecting agents, has increased the frequency of alleles that predispose us to disease. Over time, modern medicine might be expected to increase the frequency of deleterious alleles and lead to more people with congenital health problems.

d.i.

Marking Guidelines	Marks
• One difference described	**1**

The great apes have a diploid number of 48 compared to the human 46 – they have an extra pair of chromosomes.

ii.

Marking Guidelines	Marks
• Link between molecule under investigation and gene outlined or implied. • Concept of mutation occurring at a regular rate outlined or implied. • Link made between the degree of difference between molecules and the time since divergence.	**3**
• 1-2 of the above	**1-2**

Biologists can use certain biological molecules as biological clocks. The extent to which the molecule is different between two species is a reflection of how long ago they diverged from a common ancestor. Typically this molecule is a protein like cytochrome c. The cytochrome c of closely related species differs by only a few amino acids, but that of a more distant species would differ by more. The amino acid structure of the protein directly reflects the base sequence of the gene which codes for it. Amino acid differences between proteins reflect base sequence differences in their genes. These differences come about through mutation, and if such mutations are assumed to occur at the same rate, then it follows that the more differences there are, the longer ago the two species diverged.

iii.

Marking Guidelines	Marks
• Polymorphism defined • Human example described • Explanation of its origin given in terms of selective advantages of different forms.	**3-4**
• 1-2 of the above	**1-2**

Polymorphism is the existence at the same place and time of two or more distinct forms of a species. One example is human ABO blood groups. These are determined by multiple alleles of the same gene and people can be one of 4 different blood groups, A, B, AB or O.
It is suggested that in the past each blood group gave a selective advantage, presumably through increased survival of particular diseases, and that the alleles remain in the population today because of the relative selective advantage of each phenotype.

Question 32. Biochemistry.

a.i.

Marking Guidelines	Marks
• Correct answer	**1**

Water

ii.

Marking Guidelines	Marks
• Statement that it doesn't require light to proceed • Explanation that the energy that drives it comes from the light reaction.	**2**
• Statement that it doesn't require light to proceed	**1**

The Calvin cycle is a part of photosynthesis that has been shown to proceed without the presence of light. The energy required to drive it comes in the form of ATP from the light reaction.

b.i.

Marking Guidelines	Marks
• The work of at least two scientists outlined. • Explanation given of how the discoveries of one of them was dependent on the work of the other.	**3-4**
• Work of two scientists outlined, links not made.	**2**
• The work of one scientist outlined	**1**

Emmerson and Arnold were interested in the relationship between the amount of light energy, the amount of chlorophyll present and the amount of oxygen produced in the light reaction. They exposed algal cells to flashes of light and determined that only one O_2 molecule was generated by every 2400 molecules of chlorophyll, suggesting that not all chlorophyll molecules are photochemically active.
Gaffron and Wahl set out to provide an explanation for the findings of Emmerson and Arnold. They showed that chlorophyll molecules act as an 'antenna complex', collecting light energy and transferring their energy to a 'reaction centre' where the light reaction occurs.
Gaffron and Wahl's work was dependent on the earlier work of Emmerson and Arnold. Without E & A showing that only a small proportion of chlorophyll molecules actually perform the light reaction G and W would not have had a starting point for their research.

ii.

Marking Guidelines	Marks
• One relevant piece of technology described • Scientist named • Explanation of how it could have helped the scientist given	**3**
• 1-2 of the above	**1-2**

Van Niel's work would have benefitted greatly from radioactive tracing technology. This works by using molecules that have been 'tagged' with radioisotopes such as ^{18}O or ^{14}C. The fate of these tagged atoms can then be traced through the compounds that they are incorporated into and biochemical pathways can be deduced. Van Niel proposed that the oxygen produced during photosynthesis came from the water rather than the CO_2. He based this idea on his observations of the fate of sulphur in sulphur bacteria. If he could have tagged water with ^{18}O he could have justified his conclusions much more easily.

c.

Marking Guidelines	Marks
• Justification of research in terms of potential to reduce fossil fuel use. • Description of use of photosynthesis to reduce fossil fuel use. • Justification of research in terms of potential to reduce atmospheric CO_2. • Description of use of photosynthesis to reduce atmospheric CO_2.	**6-7**
• Three of the above or all 4 less well done	**4-5**
• Descriptions of use of photosynthesis to reduce atmospheric CO2 and reduce fossil fuel use.	**2-3**
• Descriptions of use of photosynthesis to reduce atmospheric CO2 or reduce fossil fuel use.	**1**

It is very important to continue research into the process of photosynthesis to try to reduce fossil fuel use. This use of fossil fuels is driving the conversion of geological carbon into atmospheric carbon and is the main cause of global warming. Crops such as corn and sugar cane, grown through photosynthesis, can be used to make ethanol which can be used as a fuel instead of fossil fuel products. Currently, the potential of such biofuels to significantly reduce fossil fuel use is greatly limited. The demand for fuels is simply too great. Research into improving the efficiency of photosynthesis as a means of producing biofuels more efficiently is obviously an important part of trying to solve this problem.
Another possible application of photosynthesis in tackling atmospheric CO_2 build up is to use it to sequester carbon and remove it from the atmosphere. This carbon would then be locked up in the tissues of plants and could potentially be returned to geological carbon through fossilisation. Research into the use of photosynthesis as a means of sequestering carbon and thereby reducing atmospheric CO_2 levels is vital if we are to continue to use fossil fuels.

d.i.

Marking Guidelines	Marks
• Safety measure named and justified.	**1**

Care taken to extinguish all flame to avoid igniting the highly flammable ethanol solvent used in the extraction process.

ii.

Marking Guidelines	Marks
• Difference in function of the two photosystems outlined. • Significance of difference explained.	**3**
• Difference in function of the two photosystems outlined.	**2**
• Aspects of the function of a photosystem outlined.	**1**

Photosystem I absorbs red light of 700 nm. It is not involved in O_2 production, it provides $NADP^+$ which accepts an electron from water and the H atom from Photosystem II. This forms NADPH which is later involved in photophosphorylation.
Photosystem II absorbs red light of 680 nm. It splits water, producing O_2 and providing electrons to photosystem I.
The significance of this difference is that combined, the 2 systems produce more oxygen than the sum of that produced at the 2 individual wavelengths. This is called the Emerson enhancement effect.

iii.

Marking Guidelines	Marks
• Outline of what a biochemical pathway is, given or implied. • Description of how radioisotopes can be used. • The use of a radioisotope in tracing a named pathway outlined	**3-4**
• 1-2 of the above	**1-2**

Radioisotopes are isotopes of an element which emit a type of radiation. This allows them to be detected using Geiger counters or other suitable equipment. An example of their use in tracing a biochemical pathway is the use of ^{14}C in tracing the Calvin cycle. The CO_2 to be used in the process is 'tagged' with ^{14}C. Once the photosynthesising plants were supplied with the tagged CO_2, samples of the plant were plunged into boiling alcohol every few seconds. This arrested the process of photosynthesis. It was then possible to analyse each sample. Any compound containing the ^{14}C must be part of the biochemical pathway, and the sequence of the pathway could be deduced from the order in which the samples were plunged into alcohol.