

## Exam Choice

2012 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	16	17	18	19	20
D	A	D	C	D	B	D	D	D	A	B	A	B	C	D	A	B	A	A	D

### Section I B

21.a.

Marking Guidelines	Marks
• Both answers correct	2
• One answer correct	1

Carbon dioxide – hydrogen carbonate ions  
Nitrogenous waste - urea

21.b.

Marking Guidelines	Marks
• Glomerulus indicated	1

22.a.

Marking Guidelines	Marks
• Correct answer given	1

$$\frac{339}{576} \times 100 = 58.9\%$$

22.b.

Marking Guidelines	Marks
• Correct type of graph (histogram)	3
• Axes: linear, labelled, with units	
• Accurate plot, correct use of space	
• 1-2 of the above	1-2

22.c.

Marking Guidelines	Marks
• Two important concerns about human health described and explained	4
• Two important concerns about human health described and one explained	3
• Two important concerns about human health described, but not explained OR	2
• One important concern described and explained	
• One important concern described, but not explained	1

Of great concern is the possibility of human to human transmission of H5N1. This apparently occurred in Thailand in 2005, but is so far rare. The great majority of human cases are thought to have been contracted from birds. Human to human transmission is of concern, as this is how an epidemic could develop. The fact that the virus has been found in wild migratory birds on all continents except Australia, and the fact that they may have infected poultry in Russia and Kazakhstan is of great concern also. This is a pattern of spread which conventional quarantine measures would be unable to control.

22.d.

Marking Guidelines	Marks
• Two measures justified	3
• One measures justified, or two measures outlined.	2
• One measure outlined.	1

Ban imports of live chicken from affected countries. This would minimise the risk of the virus coming in with these birds and being introduced to Australian chickens.

Survey visitors from overseas, to identify those who have been in contact with poultry over the previous few weeks. These people can be Quarantined or monitored until it is clear that they have not contracted the condition themselves. This will reduce the chance of the virus being introduced to the country by an infected human.

23.a.

Marking Guidelines	Marks
• Correct answer	1

Chimpanzee

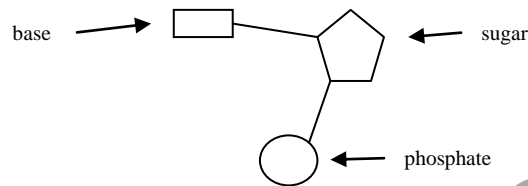
23.b.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Chemical similarity related to genetic similarity</li> <li>Explanation given in terms of mutation and time since divergence from a common ancestor.</li> <li>Similarity in protein or DNA related to closeness of evolutionary relationship.</li> </ul>	3
<ul style="list-style-type: none"> <li>Two of the above</li> </ul>	2
<ul style="list-style-type: none"> <li>One of the above</li> </ul>	1

The amino acid sequence of a protein is precisely determined by the base sequence of its gene. Differences between proteins in closely related animals reflect differences in their DNA. The longer the time since they diverged from a common ancestor, the more differences that would have accumulated due to mutation. Therefore the more similar their protein, the more closely related they are

24.a.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Components drawn in correct relationship to one another</li> <li>Correct labels used</li> </ul>	2
<ul style="list-style-type: none"> <li>One of the above</li> </ul>	1



24.b.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Three steps outlined in their correct sequence</li> </ul>	3
<ul style="list-style-type: none"> <li>1 – 2 of the above</li> </ul>	1-2

An enzyme 'unzips' the DNA molecule.

Free RNA nucleotides line up on their complementary bases on the template strand

These nucleotides join up to form a mRNA molecule.

The mRNA molecule leaves the nucleus via a nuclear pore and travels to a ribosome on the RER.

The ribosome moves along the mRNA molecule activating successive codons of three bases.

tRNA molecules, each carrying an amino acid specific to the sequence of bases in their anticodon line up on their complementary codons.

The amino acids detach from the tRNA molecules and join up to form a polypeptide.

25.a.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>3 biological characteristics and 3 disease examples given (6 correct pieces of information)</li> </ul>	3
<ul style="list-style-type: none"> <li>4-5 correct pieces of information</li> </ul>	2
<ul style="list-style-type: none"> <li>2-3 correct pieces of information</li> </ul>	1

Pathogen	Biological characteristic	Example of disease
Prion	Consist solely of protein	Mad cow disease
Bacterium	Prokaryotic – no distinct nucleus or membrane bound organelles	Tuberculosis
Protozoan	Eucaryotic – has a nucleus and membrane bound organelles	Malaria

25.b.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Role of two barriers found in respiratory system described.</li> </ul>	2
<ul style="list-style-type: none"> <li>Role of one barrier described OR two barriers named</li> </ul>	1

Mucus – traps pathogens and immobilises them so that they can be coughed out.

Cilia – push pathogens and other material trapped in mucus back out of respiratory tract.

25.c.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Evolution of resistant strains explained in terms of variation, differential survival and inheritance of resistance.</li> </ul>	2
<ul style="list-style-type: none"> <li>Two of the above</li> </ul>	1

There was variation in the ability of the bacteria of 30 yrs ago to resist the antibiotics of the day. Those that could resist survived and reproduced – passing on their resistance to their offspring. In this way they evolved to be resistant to the antibiotics.

26.a.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Role of active site outlined</li> <li>• Effect of blocking it explained</li> </ul>	2
<ul style="list-style-type: none"> <li>• One of the above</li> </ul>	1

Enzymes work by having an active site which binds precisely to their substrate molecule/s. A substance such as mercury blocking part of the active site would prevent it from binding to the substrate and catalysing the reaction.

26.b.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Any line showing enzyme activity decreasing with Hg conc.</li> </ul>	1

26.c.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Homeostasis outlined (explicitly or implicitly)</li> <li>• Link made between homeostasis and specificity of enzymes</li> </ul>	2
<ul style="list-style-type: none"> <li>• One of the above</li> </ul>	1

Homeostasis is the maintenance of a stable internal state. It is important for enzyme function as enzymes only function within narrow ranges of temperature and pH.

27.a.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Terms correctly distinguished.</li> </ul>	1

An infectious disease is one caused by a transmissible pathogen, while a non-infectious one is caused by some other agent.

27.b.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• All three features correctly described</li> </ul>	3
<ul style="list-style-type: none"> <li>• 1-2 features correct</li> </ul>	1-2

**Scurvy:** Cause: Deficiency in vitamin C. Effect: Non healing of wounds, old wounds reopen. Treatment/management: Ensure adequate supply of foods rich in vit. C. eg citrus.

28.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Feasible method incorporating:               <ul style="list-style-type: none"> <li>- Reasonable equipment</li> <li>- Range of salinities</li> <li>- Large numbers of plants (or multiple tests)</li> <li>- Adequate control of other named variables</li> <li>- Method of measuring plant growth/survival outlined</li> <li>- Management of data outlined</li> </ul> </li> </ul>	6
<ul style="list-style-type: none"> <li>• 1 – 5 of the above</li> </ul>	1-5

**Equipment:**

8000 wheat seeds, sand/vermiculite soil mix, salt, distilled water, electronic balance, large measuring cylinder, plant trays, overhead artificial light source.

**Independent variable:**

salinity of the water.

**Dependent variable:**

number of plants which survive to maturity

**Controlled variables:**

amount and type of soil, amount of sunlight, ambient temperature.

**Method:**

- Using the electronic balance to weigh out salt and the measuring cylinder to measure out water, prepare 8 different salt solutions. 0g/L, 2g/L 4g/L, 6g/L, 8g/L, 10g/L, 12g/L, 14g/L.
- Prepare 8 large planting trays, each with the same amount and mix of the soil mixture, and plant 1000 wheat seeds in each.
- Place all trays in a greenhouse under an artificial light source and a controlled ambient temperature. Ensure that they all receive the same light and temperature conditions throughout the test.
- Water each tray with one of the prepared salt solutions. Ensure that each tray receives the same amount of its solution throughout the test.
- Run the test until the plants either reach maturity or die. Then count the number of mature survivors in each tray.
- Calculate the survival rate for each tray as a %. Examine the data to see at which salinity there is a significant drop in survival rate.

29.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• All three changes correctly outlined</li> </ul>	3
<ul style="list-style-type: none"> <li>• 1-2 changes correct</li> </ul>	1-2

Lungs: O<sub>2</sub> level is increased,  
 Liver: urea level is increased.  
 Kidney: urea level is decreased

30.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>2 reproductive technologies outlined</li> <li>Links made between each technology and a possible societal or environmental consequence</li> <li>An evaluative judgement made about the extent of the consequences (at least one societal and one environmental consequence must be considered to gain full marks)</li> </ul>	6-7
<ul style="list-style-type: none"> <li>2 reproductive technologies outlined</li> <li>Links made between each technology and a possible societal or environmental consequence (at least one societal and one environmental consequence must be considered to gain 5 marks)</li> </ul>	4-5
<ul style="list-style-type: none"> <li>2 reproductive technologies outlined OR</li> <li>Societal or environmental consequences outlined without adequate linkage</li> </ul>	2-3
<ul style="list-style-type: none"> <li>One reproductive technology or societal or environmental consequence outlined</li> </ul>	1

One reproductive technology with the potential to change society and the environment is the production of transgenic species. For example, Bt crops such as Bt maize, Bt cotton and others are plants which have had a pesticide resistance gene from the bacterium *Bacillus thuringiensis* introduced into their genome. This has huge potential to cause change. These strains are owned by large agribusinesses, and so will be expensive and only be economic to produce for large scale farmers. This could have major effects on societies in developing countries where the produce of small scale farmers will become less competitive leading to increased poverty. One environmental consequence of Bt crops may be a reduction in the flow of pesticides into natural foodchains. Currently, large scale crop production requires large amounts of pesticides which run off into surrounding natural ecosystems, are passed along food chains and kill native organisms. Maybe the adoption of Bt crops will reduce the need for such pesticides and reduce the environmental impact. Another reproductive technology is cloning, a technology which has been practised through vegetative propagation in plants for many years. This technology allows genetically identical plants to be produced through taking cuttings, using vegetative structures or meristem culture. It allows good specimens to be reproduced without the wasteful variation obtained through sexual reproduction. This technology has already changed human society to a huge extent and will continue to do so. Cloned crops such as bananas are very productive, making it easier to produce food for the increasing human population.

Options.

Question 31 – Communication.

a.i.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Correct answer</li> </ul>	1

The iris controls the amount of light which enters the eye.

a.ii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Aspect of larynx structure described</li> <li>Link made between it and frequency of sound</li> <li>Link made between frequency and pitch.</li> </ul>	3
<ul style="list-style-type: none"> <li>1 – 2 of the above.</li> </ul>	1-2

The human larynx has two flaps of tissue over which air is passed when exhaling. The tension of these flaps can be controlled so as to cause them to vibrate with different frequencies (high tension – high frequency) As they vibrate they produce a sound with the same frequency. The higher the frequency of a sound, the higher its pitch.

b.i.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Role outlined (name of structure not required)</li> </ul>	1

It insulates the neurone from surrounding neurones.

b.ii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Receptor, or specific receptor named</li> </ul>	1

These dendrites would be attached to a receptor such as a rod or cone.

b.iii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Explanation in terms of ion movement and changes in potential</li> </ul>	3
<ul style="list-style-type: none"> <li>Poorer explanation</li> </ul>	1-2

Resting nerve fibre has higher [Na<sup>+</sup>] outside than in. [K<sup>+</sup>] is lower outside than in. At rest, membrane potential is –70 mV. The membrane is impermeable to Na<sup>+</sup>.

Stimulus causes membrane to become more permeable to Na<sup>+</sup> ions – they move into nerve cell causing polarity to be reversed. Polarity can only be reversed at nodes of Ranvier. Na<sup>+</sup> ions move from one to the next triggering the next action potential there – causing the ‘message’ (the reversal of polarity) to move along the axon. The action potential is quickly reversed by the Na<sup>+</sup> - K<sup>+</sup> pump restoring the membrane potential to its resting state.

b.iv

Marking Guidelines	Marks
• Answer incorporating roles of sensory input, brain and memory	3
• Poorer answer	1-2

Sensory input is received by the brain as action potentials move along sensory neurones. The brain registers the source and frequency of these inputs and formulates a response based both on this input and stored memory of similar events. The brain then sends out a response via the motor neurones.

c.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Two technologies described</li> <li>Each one’s role in ameliorating a hearing problem outlined.</li> <li>An assessment made about the effect of each technology on the lives of people receiving treatment.</li> </ul>	7
<ul style="list-style-type: none"> <li>Two technologies described</li> <li>Each one’s role in ameliorating a hearing problem outlined.</li> <li>An assessment made about the effect of one technology on the lives of people receiving treatment.</li> </ul>	6
<ul style="list-style-type: none"> <li>Two technologies described</li> <li>Each one’s role in ameliorating a hearing problem outlined. (no assessment of effect)</li> </ul>	5
<ul style="list-style-type: none"> <li>1-2 technologies described</li> <li>1-2 outlines of effect on hearing</li> </ul>	2-4
<ul style="list-style-type: none"> <li>1 technology described</li> </ul>	1

Hearing aids are electronic devices normally worn behind the ear. They receive sound waves, amplify them and deliver them into the ear. They help redress damage to the eardrum or the ossicles, ensuring that an adequate sound signal reaches the oval window. They can have a huge effect on the lives of people who wear them. Allowing them to take part in conversation more easily and therefore work in occupations where that is important, as well as be better integrated into their families. Hearing aids do not function as well as a healthy ear. They don’t discriminate between sounds well, leading to users complaining of background noise. This drawback partly offsets their usefulness. The cochlear implant or bionic ear is another technology in use. It has an external microphone which captures sound, and an electronic implant which converts sound frequencies into nervous impulses. It is a technology which is mainly designed to help people who are profoundly deaf due to a deficiency in the cochlea – where sound waves are normally converted into nervous impulses. It has had a huge impact on these people, allowing many of them to hear for the first time and therefore participate in employment and other interactions which would have been very difficult for them previously. The hearing it gives involves a smaller range of frequencies than normal hearing and takes a while to get used to, but it still brings about a great improvement to people’s lives.

d.i.

Marking Guidelines	Marks
• Answer incorporating role of rods and cones, their distribution in the retina and the effect of this on human vision.	3
• Poorer answer	1-2

There are two types of photoreceptor; rods and cones. Rods detect light and dark and they are sensitive to low light intensities. There are three types of cone in the human retina. Each one is sensitive mainly to a particular wavelength of light and the brain interprets the extent to which each type is stimulated as colour. Cones require higher light intensities than rods. Cones are mainly situated in the fovea centralis – the central part of our visual field. They are very densely packed and each synapses to its own sensory neurone. This means that we see in colour and that our central vision has high resolving power. Rods are mainly situated away from the fovea centralis, several synapse jointly to a single sensory neurone. This means that our peripheral vision is largely monochromatic and has less resolving power than our central vision. However, our peripheral vision functions better than our central vision in low light conditions.

d.ii.

Marking Guidelines	Marks
• Role of 2 eyes and brain in stereoscopic vision explained with an example given	3
• Poorer answer	1-2

Having two eyes is important to humans because it gives us depth and distance perception. Each eye produces a slightly different image and the visual cortex interprets these to determine distance. This is possible due to parallax. A distant object will appear in the same place in both images, while the closer to the person an object is the more different its position in the two images will be – allowing an assessment of distance to be made.

### Question 32 -- Biotechnology.

a.i.

Marking Guidelines	Marks
• Outline incorporating effect on DNA and reason for use.	2
• One of the above	1

Restriction enzymes are used to cut DNA. They do so at specific base sequences and leave characteristic 'sticky ends'. They are used both to cut a gene from a piece of DNA and to cut open a piece of DNA to allow a gene to be inserted.

a.ii.

Marking Guidelines	Marks
• Ancient aboriginal use described.	2
• Ancient aboriginal use named.	1

Aborigines practised selective breeding with dingoes. They selected the characteristics they desired to make them more useful to them.

b.i.

Marking Guidelines	Marks
• Explanation given	1

The water acts as an air lock preventing the entry of oxygen. This would cause the alcohol to turn to vinegar

b.ii.

Marking Guidelines	Marks
• Correct reactants and products.	2
• Correct reactants or products	1

Glucose → ethanol + carbon dioxide

b.iii.

Marking Guidelines	Marks
• Description of process	3
• Micro-organism and raw materials and products named.	
• Poorer answer	1-2

Citric acid is a product of industrial fermentation using the fungus *Aspergillus niger*. Fungal cells are maintained in a submerged culture in a stirred tank, provided with sugar, usually from corn or molasses. Calcium hydroxide is added to the resulting solution, causing calcium citrate to precipitate out. This is treated with sulfuric acid to yield citric acid.

c.

Marking Guidelines	Marks
• Two technologies described	6-7
• An assessment made about the effect of each technology on the lives of people.	
• Two technologies described	3-5
• An assessment made about the effect of one technology on the lives of people.	
• 1-2 technologies described	1-2

Recombinant DNA technology involves producing new combinations of DNA by artificial means. One example is the use of bacteria to produce chemicals which are useful to humans. Eg. The use of *E. coli* to produce human insulin. Restriction enzymes are used to extract the human insulin gene from human DNA. The same restriction enzymes are then used to open a bacterial plasmid with complementary 'sticky ends'. The insulin gene is spliced into the plasmid using ligase enzymes and is reintroduced to the *E. coli* which is then cultured and provided with the correct chemical ingredients to allow it to produce human insulin.

This technology has profoundly affected some people's lives. The production of human chemicals such as insulin, growth hormone, clotting factor etc. allows much more effective treatment of medical conditions without the problems of viral contamination or poor compatibility of animal sourced product. This allows sufferers of many diseases to function much more effectively as useful members of society.

Industrial fermentation is a technology which allows the production of huge quantities of chemicals such as citric acid and baker's yeast. It involves culturing a raw material such as sugar with a microorganism in large industrial vats and extracting the product. The mass production of baker's yeast in this way has a large effect on people's lives. It has allowed widespread production of inexpensive bread, providing the world's growing population with a healthy cheap and plentiful food.

d.i.

Marking Guidelines	Marks
• Description incorporating process of extracting and introducing DNA and naming species involved.	3
• Poorer answer	1-2

Bt potatoes are potatoes which include a gene for pesticide production taken from the bacterium *Bacillus thuringiensis*. This protects them from insect pests. The gene is extracted from the bacterium using restriction enzymes and has been introduced into the germ line cells of potatoes by using a gene gun. This is a device which shoots microparticles of gold or tungsten which carry the genes. The cell membranes are penetrated and the gene is incorporated into the DNA.

d.ii.

Marking Guidelines	Marks
• PCR, and its role in an application outlined.	3
• Poorer answer	1-2

The PCR can be used to synthesise large quantities of a DNA fragment without cloning it. It is used when only a small fragment of DNA is available, -eg at a crime scene.

This section of DNA is mixed with a selection of nucleotides and DNA polymerase from a heat tolerant bacterium. The mixture is heated, causing it to unzip and act as a template for the production of identical copies.

d.iii.

Marking Guidelines	Marks
• An ethical issue in gene technology outlined and reasons given for different views.	2
• One of the above.	1

Ethics is the consideration of rights and wrongs. Gene technology presents people with new questions that they have not had to consider before. Their views will reflect the different weightings they give to different factors. For example, the production of cloned embryonic stem cells is a biotechnology which holds out hope to sufferers of many diseases, such as diabetes and nerve damage. People's opinion about the ethics of this technology will depend upon the relative importance they attach to the rights of the sick people to have treatment, or the rights of the unborn embryos not to be used in that way.

**Question 33 – Genetics, the Code Broken?**

a.i

Marking Guidelines	Marks
• Correct example named	1

Human ABO blood groups.

a.ii

Marking Guidelines	Marks
• Description of each type given	3
• Effect of each on polypeptide produced outlined	
• Poorer answer	1-2

A base substitution mutation involves the changing of one base in a gene for another. Triplets of bases form the code for specific amino acids in the polypeptide produced by the gene. Therefore a change to one base may lead to a polypeptide with one different amino acid. This may affect the functioning of the polypeptide or it may have no effect at all on it. A frame shift mutation, on the other hand, involves the removal of a base, causing all the triplets 'downstream' of that point to shift along, changing every single one. This will lead to wholesale change in the amino acids produced and will have a much greater effect on the phenotype than a base substitution mutation would.

b.i.

Marking Guidelines	Marks
• Correct ratios determined	3
• Heterozygous genotypes shown for F1	
• Punnet square or similar correctly used	
• 1-2 of the above	1-2

The genotypes of the parents are

$$\begin{array}{cc} W & C \\ W & C \\ w & c \end{array}$$

The F1 generation will all be

$$\begin{array}{cc} W & C \\ w & c \end{array}$$

The cross between the F1 offspring

	W C	w c
W C	W C	w c
w c	W C	w c

Phenotype ratio =  
3 normal wings and body colour :  
1 vestigial wings and black body

b.ii.

Marking Guidelines	Marks
• Explanation based on relationship of frequency of unlinking (crossing over) to distance apart of linked genes	3
• Poorer answer	1-2

In a large number of crosses involving linked genes of the type seen here, a certain small percentage of the offspring will be recombinant types. I.e. they will have normal wings and black body or vestigial wings and normal body. This can only happen as a result of crossing over occurring at a point in between the two gene loci. The further apart the two genes are the more frequent such crossings over are likely to be. Therefore, researchers were able to produce linkage maps of the relative positions of genes based on the relative frequencies at which they were separated by crossing over.

c.

Marking Guidelines	Marks
• Two technologies described	6-7
• An assessment made about the effect of each technology on the lives of people with health problems.	
• Two technologies described	3-5
• An assessment made about the effect of one technology on the lives of people with health problems.	
• 1-2 technologies described	1-2

Recombinant DNA technology involves producing new combinations of DNA by artificial means. One example is the use of bacteria to produce chemicals which are useful to humans. Eg. The use of E. coli to produce human insulin. Restriction enzymes are used to extract the human insulin gene from human DNA. The same restriction enzymes are then used to open a bacterial plasmid with complementary 'sticky ends'. The insulin gene is spliced into the plasmid using ligase enzymes and is reintroduced to the E. coli which is then cultured and provided with the correct chemical ingredients to allow it to produce human insulin.

This technology has profoundly affected some people's lives. The production of human chemicals such as insulin, growth hormone, clotting factor etc. allows much more effective treatment of medical conditions without the problems of viral contamination or poor compatibility of animal sourced product.

The delivery of gene therapy through the use of nasal sprays is another 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. At the present time this technology has had limited effect on the health of people; further refinement of techniques is required.

d.i.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>HGP outlined, 2 benefits outlined, 2 limitations outlined. Some balancing of the points provided</li> </ul>	3-4
<ul style="list-style-type: none"> <li>Poorer answer</li> </ul>	1-2

The HGP is a project, now completed, to map the human genome. Both in terms of the position of all the genes and their base sequences. There are many benefits that can flow from this. Through sequencing individual genes it becomes possible to devise genetic tests to detect the presence of deleterious alleles. This allows early treatment of conditions or therapeutic abortion if required. The HGP should also allow more targeted medical treatments. Not everyone responds to a treatment in the same way. By gaining an understanding of the genetic basis of this variation it should become possible to identify which treatment is best for a particular person based upon their individual genetics. There are limitations, however. Firstly, variation between humans is a product of genetics and environment. The HGP won't be able to help explain environmentally caused variation. Also, genes rarely act alone. They normally interact with others to bring about very sophisticated outcomes. While the HGP can tell us about the genes present it doesn't tell us how they interact. In conclusion, while the HGP will not answer all the questions about the genetic basis of individual difference, it does have the potential to reveal a great deal.

d.ii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Nature of gene homology outlined and related to common ancestry. Relationship to evolutionary relationships made.</li> </ul>	3-4
<ul style="list-style-type: none"> <li>Poorer answer</li> </ul>	1-2

Gene homologues are genes possessed in common by different species. The only feasible explanation for the possession of homologous genes is inheritance of them from a common ancestor. The extent to which the genes of two species are homologous is a reflection of how recently they diverged from a common ancestor and hence the closeness of their evolutionary relationship.

#### Question 34 – The Human Story.

a.i.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Two features given</li> </ul>	1

Hair, possession of mammary glands.

a.ii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Table constructed with column and row headings.</li> <li>At least 2 differences and/or similarities described</li> </ul>	3
<ul style="list-style-type: none"> <li>1-2 of the above</li> </ul>	1-2

Feature	Homo habilis	Homo sapiens
Cranial capacity	Approx 600 mL	Approx 1300 mL
Tool use	Stone flakes used as meat scrapers, probably not for defence or hunting	Sophisticated use of whole range of materials as tools for all purposes.
Height	1.3 m	1.7 m

b.i.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Comparison made of the relative lengths of these stages</li> <li>Actual numbers used in comparison</li> <li>Explanation given in terms of parental care</li> </ul>	3
<ul style="list-style-type: none"> <li>Poorer answer</li> </ul>	1-2

Human females spend 30% of their lives as dependents and the same amount as reproductive adults, a ratio of 1:1. The other animals spend comparatively much less as dependents, 1:2.5 for chimpanzees and even less for the others. This is a reflection of the need for parental care in humans. Humans are born in a much more helpless state than other primates. Also, as the primates with by far the most complex culture (language etc.), they need a much greater dependent time to learn the skills they need.

b.ii.

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>Feasible suggestion</li> </ul>	1



Older, post reproductive females can play an important role in providing parental care to their children and grandchildren. The other primates require less parental care and therefore there is less evolutionary advantage in surviving so long beyond reproductive age.

**b.iii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Link made between upright stance and use of hands</li> <li>• Link made between hand use and brain function</li> <li>• Assessment made.</li> </ul>	3
<ul style="list-style-type: none"> <li>• Poorer answer</li> </ul>	1-2

When human ancestors developed an upright stance it freed their hands from use in locomotion. There was great evolutionary advantage in making more and more sophisticated tools and this selected for hand eye co-ordination and the associated brain function. These brain functions are amongst those associated with intelligence. The development of an upright stance is thought to have been an essential step in the evolution of human intelligence.

**c.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Requirements for future evolution outlined.</li> <li>• Two technologies outlined and the way in which each could bring about an evolutionary change explained.</li> <li>• An assessment made of the extent to which this might happen</li> </ul>	6-7
<ul style="list-style-type: none"> <li>• Two of the above OR</li> <li>• All three done less well.</li> </ul>	4-5
<ul style="list-style-type: none"> <li>• One of the above or 2 done less well</li> </ul>	1-3

For a technology to cause an evolutionary change in humans it would have to bring about a change in gene frequencies. It could do this either by affecting the survival rate of certain variants or by affecting their reproductive success. Modern fertility techniques such as in-vitro fertilisation can cause an evolutionary change by reducing the selective pressure against genes which cause infertility and increasing their frequency in the population. As IVF and similar technologies become more widespread in their use it is very likely that the average fertility of humans will decline as a result. Vaccination against deadly diseases such as whooping cough will weaken the selective advantage of genes conferring an ability to survive these diseases. The frequency of genes giving no such protection will increase and over time it is highly likely that the population will become much more vulnerable to these pathogens if unvaccinated.

**d.i.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Explanation of what a clinal gradation is</li> <li>• Explanation of how it can evolve accounting for regional variation.</li> </ul>	3
<ul style="list-style-type: none"> <li>• Poorer answer</li> </ul>	1-2

A clinal gradation is a gradual change in a phenotypic characteristic along a geographic or ecological gradient. An example is the change from the deep black skin of people living near the equator, through the whole range of shades to the white skin of people living in Scandinavia. This is thought to have evolved through the action of two competing selecting pressures. Black skin is thought to evolved in response to the skin cancer giving properties of bright equatorial sunlight. Melanin confers some protection. As people move away from the equator not only does this selecting agent become less strong, another comes into play. In Northern latitudes there is a shortage of the UV rays which make vitamin D in the skin. This exerts a strong selective pressure for melanin free skin to maximise UV absorption.

**d.ii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Out of Africa model contrasted with regional continuity</li> <li>• Evidence for Out of Africa model explained.</li> </ul>	3-4
<ul style="list-style-type: none"> <li>• Poorer answer</li> </ul>	1-2

There are two main theories to explain the current distribution of the different races. The 'regional continuity' theory suggests that primitive human ancestors left Africa a very long time ago and that each group then evolved into the present day races. The 'Out of Africa' theory suggests that successive waves of hominids have dispersed from Africa and each one has displaced the populations living in the lands it moved into. Mitochondrial DNA studies provide convincing evidence for the 'Out of Africa' model. mDNA follows a maternal line and is not subject to meiosis. Therefore it remains unchanged from generation to generation unless subject to mutation. As mutation rates can be assumed to be constant the amount of diversity of mDNA in a race or population is a good measure of how long it has existed. mDNA studies reveal much greater diversity in African mDNA, confirming Africa as the home of humans, and very little diversity in other races, confirming their very recent origins.

### Question 35 – Biochemistry

**a.i.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Isotope named</li> </ul>	1

Carbon 14

**a.ii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• 1-3 developments described</li> </ul>	1-3

Zeiss lenses were so precisely made they would have allowed him to observe structures to the limits of the resolving power of a light microscope. This would have improved the precision of his observations.  
 Lacassagne's autoradiographic methods which allowed accumulating radioisotopes to be viewed would have allowed him to deduce photosynthetic pathways by using oxygen 18.  
 Zernicke's phase contrast microscope allowed people to view unstained, living cells. This would have allowed him to observe bacteria migrating to the site of photosynthesis.

**b.i.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Role of ATP outlined</li> <li>• Nature of phosphodiester bonds and their role explained</li> </ul>	3
<ul style="list-style-type: none"> <li>• Poorer answer</li> </ul>	1-2

ATP is the 'energy currency' of the cell. It travels around the cell and releases energy where it is needed. The phosphodiester bond allows it to do this. It is a very high energy bond. The breakdown of a molecule of ATP to ADP and iP breaks one phosphodiester bond and releases a large amount of energy.

**b.ii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• At least 3 important points about ATP synthesis outlined</li> </ul>	3
<ul style="list-style-type: none"> <li>• 1-2 points outlined</li> </ul>	1-2

ATP synthesis is membrane based. Protons are unable to passively move across the thylakoid membrane and so they build up inside thylakoid during the light reaction. The movement of protons back into the stroma through protein channels drives the synthesis of ATP by the enzyme ATP synthase. This process is called photophosphorylation.

**c.**

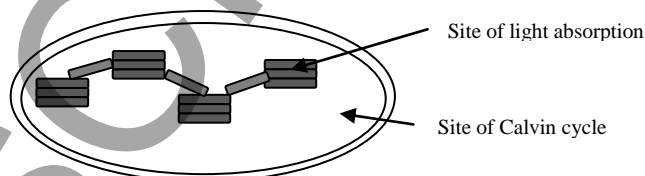
Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Description of 2 uses of photosynthesis to produce renewable resources</li> <li>• Assessment of potential of each to reduce use of non renewable resources.</li> </ul>	6-7
<ul style="list-style-type: none"> <li>• Three of the above or all 4 less well done</li> </ul>	4-5
<ul style="list-style-type: none"> <li>• Descriptions of use of photosynthesis in production of 2 renewable resources.</li> </ul>	2-3
<ul style="list-style-type: none"> <li>• Description of use of photosynthesis in production of one renewable resource</li> </ul>	1

We are very heavily reliant on non-renewable resources such as oil as our source of fuel for transport and the chemical feedstock for plastics. Photosynthesis can be harnessed to grow sugar cane or corn which can be refined to produce ethanol, a renewable biofuel. Ethanol is a good fuel and can also be used as a feedstock for plastic manufacture, but the cost of its production and the relatively small amount that can be produced compared to the amount of oil used every year means that it will not make a significant reduction in our use of oil if current use patterns continue.

Photosynthesis can also be harnessed through growing trees for wood. In many developing countries wood is still an important fuel. Wood, a renewable resource, could be burnt to generate electricity, replacing coal, a non-renewable resource. Reliance on wood to provide very modest amounts of energy in developing countries has led to major deforestation, and its potential to replace coal is very small. The rate at which trees grow is way too small for wood to be a realistic substitute for coal.

**d.i.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Good representation, both sites correctly labelled.</li> </ul>	3
<ul style="list-style-type: none"> <li>• 1-2 of the above.</li> </ul>	1-2



**d.ii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Chromatography outlined and evaluation made of its use in photosynthesis studies</li> </ul>	3
<ul style="list-style-type: none"> <li>• Poorer answer</li> </ul>	1-2

Chromatography is the process by which different substances are separated by virtue of their different adsorptive properties to a particular substance. It was used to separate the chlorophylls and xanthophylls in plants and was essential for this purpose.

**d.iii.**

Marking Guidelines	Marks
<ul style="list-style-type: none"> <li>• Difference outlined, Significance explained</li> </ul>	2
<ul style="list-style-type: none"> <li>• 1 of the above.</li> </ul>	1

Photosystem I has chlorophylls which absorb red light of wavelength 700nm. It provides NADP+ which accepts the H and an electron from the split of water performed by photosystem II. System II absorbs red light of 680nm. It splits the water. The significance of the difference is that the electron transfer between the 2 systems drives ATP synthesis.