Exam Choice

2008 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	D	B	D	A	D	A	A	A	D	C	C	B	B	B

Section I B

16. a

Marking Guidelines	Marks
• Correctly identified nucleotide	1

16.b

Marking Guidelines	Marks
• Statement linking particular gene to particular polypeptide OR • Statement relating technological advance to advances in knowledge about proteins PLUS • Explanation that proteins consist of more than one polypeptide chain	2
• One of the above	1

Beadle and Tatum first showed the link between a specific gene and a particular enzyme. At the time it wasn't realised that most proteins actually consist of more than one polypeptide chain. Biochemical techniques showed this to be the case and hence the change to the theory.

17.a

Marking Guidelines	Marks
• Dissolved CO_2 correctly identified	1

Dissolved CO_2

17.b

Marking Guidelines	Marks
• Relative effects of both heavy and light exercise described	2
• Statement linking exercise to decrease in CO_2 bound to protein	1

Exercise causes the amount of CO_2 bound to protein to decrease in venous blood. The heavier the exercise, the more it decreases.

17.c

Marking Guidelines	Marks
• Statement identifying venous blood as slightly more acidic • Explanation that venous blood has higher conc. of CO_2 (no need to specify form) because it carries products of respiration. • Explanation that CO_2 when dissolved in water makes it more acidic/lowers pH	3
• 2 of the above	2
• 1 of the above	1

The venous blood is slightly more acidic than arterial blood and becomes more so with increasing exercise. This is because veins carry the CO_2 produced in respiration. HCO_3^- ions dissolve in water to make it more acidic.

18

Marking Guidelines	Marks
• Non infectious disease named. • Cause described and treatment/management described • Explanation given of how knowledge of cause helps in treatment/management.	3
• Non infectious disease named. • Cause described and treatment/management described	2
• Non infectious disease named and cause or treatment/management described.	1

Scurvy is an example of a non infectious disease caused by a deficiency of vitamin C. Once its cause was established it became possible to treat it effectively through administration of vitamin C to sufferers.

19.a

Marking Guidelines	Marks
• Example of homeostasis given • Way in which changes are detected described • Way in which change counteracted described	**3**
• 2 of the above	**2**
• 1 of the above	**1**

Example – temperature regulation
Changes detected by hypothalamus which monitors blood temp.
Changes counteracted by sweating (to lower temp back to normal) or by shivering (to raise temp back to normal).

19.b

Marking Guidelines	Marks
• Link made between stable internal environment and optimum conditions for enzyme function • Role of enzymes in metabolism outlined.	**2**
• One of the above	**1**

Metabolism is controlled by enzymes. For the metabolism to function properly the enzymes must function optimally. Enzymes only function optimally within very narrow ranges of such factors as temperature and pH. Homeostasis maintains these factors within these ranges, allowing enzymes, and therefore the metabolism, to function optimally.

20.a

Marking Guidelines	Marks
• Correct number given 7	**1**

20.b

Marking Guidelines	Marks
• Chimp named	**1**

20.c

Marking Guidelines	Marks
• Link made between biochemical make up and genetic make up. • Statement that genetic differences are due to mutations. • Link made between number of differences and time since divergence from common ancestor.	**3**
• 2 of the above	**2**
• 1 of the above OR • Statement linking biochemical similarities to degree of relatedness without mentioning genetics	**1**

The amino acid sequence of a protein like cytochrome C is determined precisely by the base sequence of the gene which codes for it. The possession of the same protein, and therefore the same gene, is strong evidence for a common ancestry. Any differences in amino acid sequence between 2 species reflect changes to the base sequence of the gene (mutations) which have occurred since the species diverged from their common ancestor. Since rates of mutation are believed to be relatively constant it can be inferred that the more amino acid differences between 2 species the greater the time since they diverged from a common ancestor and hence the less related they are.

21.

Marking Guidelines	Marks
• All 4 roles correctly outlined	**4**
• 1-3 correctly outlined	**1-3**

Antibodies – combine with antigens/pathogens and destroy them
B cells – clone to become plasma cells which manufacture antibodies
Helper T cells – sensitise B cells/Killer T cells to specific antigen
Killer T cells – Attack foreign cells/produce chemicals that attack foreign cells

22.

Marking Guidelines	Marks
• The work of three different geneticists described • A sequence of development established by showing the dependence of the work of the later geneticists on the discoveries of their predecessors. OR • The work of three different geneticists described • One example of dependence discussed and one example of non-dependence on past work discussed	**5**
• The work of three different geneticists described • One example of dependence discussed or one example of non-dependence on past work discussed	**4**
• The work of three different geneticists described OR • The work of 2 different geneticists described • One example of dependence discussed or one example of non-dependence on past work discussed	**3**
• The work of 2 different geneticists described	**2**
• The work of one geneticist described	**1**

All advances in scientific knowledge build on work that has gone before.
Mendel's work showed the existence of units of inheritance, later called genes. He showed that these units exist in pairs in adults which separate in gamete formation.
Sutton sought to find the location of these units of inheritance, or genes. He observed meiosis in the testes of grasshoppers and observed the segregation of homologous chromosomes and the production of gametes with half the chromosome number of the adult cells. The fact that chromosomes occurred in pairs and separated at gamete formation in the same way that Mendel's factors did, led him to conclude that the genes were carried on the chromosomes. Sutton would not have reached this conclusion without Mendel's observations on the patterns of inheritance of his factors.
Morgan was trying to demonstrate Mendel's ratios using fruit flies. In one cross he obtained an F2 generation where all female flies were red eyed and ½ male flies were red eyed and ½ white eyed. Morgan proposed that the gene for eye colour must be carried on the X chromosome in fruit flies. He was the first to demonstrate and explain sex linked inheritance. He could not have reached that conclusion without the earlier work of Sutton identifying the chromosome as the site of the genes.

23.a

Marking Guidelines	Marks
• Cortex (outer region) marked with X	**1**

23.b

Marking Guidelines	Marks
• Two differences described. • Reason for each difference given	**4**
• Two differences described. • Reason for one difference given	**3**
• Two differences described. OR • One difference described and reason given	**2**
• One difference described	**1**

Artery has higher urea conc. than vein. This is because most urea is filtered out of the blood in the kidney and excreted.
Artery has higher O_2 level than vein. This is because respiring cells of kidney use O_2 for respiration.

24.

Marking Guidelines	Marks
• Feasible, step wise method • Independent and dependent variables recognised and adequately measured • Other variables controlled • Reliability ensured • Correct equipment used • Results illustrating effect of environment on phenotype described	**6**
• 1-5 of the above	**1-5**

Equipment.

A hydrangea plant
10 pots with potting mix and striking agent to allow cuttings to be grown
Soil alkaliniser (lime)
pH meter
green house

Method

- 10 cuttings were taken from a single hydrangea plant. (this controls the variable of genetic variation) (The use of 10 cuttings minimises the effect of chance results thus improving reliability)
- Each was potted separately in identical pots with identical potting mix (controlling these variables)
- The pH of the 10 pots was measured with the pH meter and found to be acidic (pH 6.0)
- Lime was added to 5 pots and the pH measured and found to be basic (pH 8.0) (pH is the independent variable)
- The cuttings were grown in the same greenhouse with identical conditions of sunlight, water and temperature until they all flowered.
- The colour of the flowers (dependent variable) was recorded.

Results

The flowers in the acidic soil were all blue and those in the basic soil were red.

25.

Marking Guidelines	Marks
• Role of microflora described • Explanation of how imbalance can occur • imbalance linked to a named disease	**4**
• Role of microflora described • Description of how imbalance can occur • imbalance linked to a named disease	**3**
• Two of above	**2**
• One of above	**1**

Humans have a large population of mutualistic bacteria living in the digestive tract, on the skin, inside the vagina and elsewhere. One of their useful functions is to exclude pathogens by out competing them for the resources present.
This balance can be disturbed in a number of ways – one of these is through over use of antibiotics which kills a large proportion of the bacteria. Pathogens are than able to establish themselves – for example the fungus Candida which causes thrush.

26.a

Marking Guidelines	Marks
• O_2 carrying function described • Adaptive nature explained	**2**
• O_2 carrying function described	**1**

Haemoglobin combines with oxygen to give oxyhaemoglobin and it is transported around the body in this way.
Haemoglobin gives a considerable adaptive advantage. Haemoglobin allows blood to carry 100 x the O_2 that it would be able to carry simply dissolved in water.

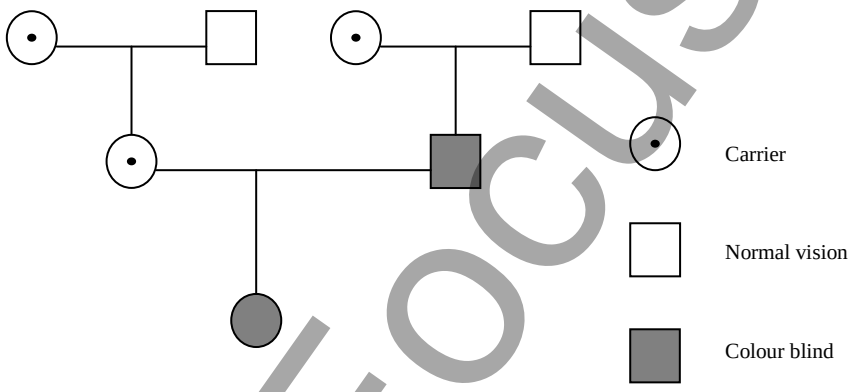
26.b

Marking Guidelines	Marks
• One reason given	**1**

Artificial blood is more useful as it doesn't need to be typed – it can be given to any recipient regardless of their blood type.

27.

Marking Guidelines	Marks
• Pedigree drawn using correct symbols OR with key • Girl's father identified as colour blind • Mother and both grandmothers identified as carriers	**3**
• 2 of the above	**2**
• 1 of the above	**1**



28.

Marking Guidelines	Marks
• Two developments (not necessarily those mentioned in question) described • Explanation of how each has improved human life expectancy • Assessment of contribution of each to human life expectancy	**7-8**
• Two developments (not necessarily those mentioned in question) described • Explanation of how each has improved human life expectancy	**5-6**
• Two developments described, explanation of how one has improved life expectancy	**3-4**
• One or two developments described	**1-2**

Modern medicine has greatly improved human life expectancy. Vaccination stimulates the immune system to develop an immunological memory against a dead or attenuated strain of a pathogen. World wide programs of vaccination have completely eliminated smallpox, almost eliminated polio and greatly reduced the incidence of many other once common diseases. These diseases were major killers of people of all ages, some such as polio and whooping cough particularly affected children. The great reduction in incidence of these diseases has greatly increased human life expectancy in previously affected areas.
Modern hygiene measures such as the provision of uncontaminated water supplies and the proper disposal of sewage are effective because they prevent people from coming into contact with disease causing pathogens. They break the faecal – oral transmission route. Contaminated water supplies in 3rd world countries lead to persistent diseases such as cholera, typhoid and other gastro intestinal conditions. These particularly affect children under five, resulting in high infant mortality. Modern hygiene measures have greatly decreased child death rates and in so doing have greatly increased human life expectancy.

Section II Options

Question 29 Communication

a.i.

Marking Guidelines	Marks
• Correct function given	**1**

The iris controls the amount of light which is allowed to enter the eye.

a.ii

Marking Guidelines	Marks
• Explanation in terms of stereoscopic vision, parallax (can be implied) and role of the brain	**3**
• 2 of the above	**2**
• 1 of the above	**1**

Humans have 2 eyes which each form a slightly different image of a given scene because of their different positions. This is called stereoscopic vision. Images of close objects show the greatest difference between eyes. This allows the brain to build a 3D image of the scene, allowing depth perception.

b.i

Marking Guidelines	Marks
• 1-3 correct functions given	**1-3**

A. Conversion of sound waves in air to vibrations of membrane.
B. Amplification of sound waves
C. Transfer of energy from ossicles to oval window of cochlea.

b ii

Marking Guidelines	Marks
• Suitable equipment used • Feasible method outlined • Results described • Relationship between wavelength, pitch and frequency outlined	**4**
• 1-3 of the above	**1-3**

A CRO was set up with an audio generator. Sounds of different frequency were generated and converted by the CRO into sine waves visible on the screen. Sounds of increasing frequency were generated and the wavelength of the waves on the screen was measured (from crest to crest). The change in pitch was assessed by ear. As the frequency increased, the pitch rose and the wavelength shortened.

c.

Marking Guidelines	Marks
• Description of sound perception in humans contrasted with that of another species. • Description of sight perception in humans contrasted with that of another species. • Differences accounted for in terms of structure and/or function • Adaptive value of all differences outlined	**6-7**
• Three of the above or all 4 done less well	**4-5**
• Two of the above	**2-3**
• One of the above	**1**

Humans see in colour, they possess three types of cones, each sensitive to a particular range of wavelengths. The input from these is interpreted by the brain to give our colour vision. Colour vision is advantageous to humans since we are active during the day, when colour is visible and light intensity is high enough for cones to work optimally.
Dogs, on the other hand, have far less effective colour vision, this is due to fewer cones and a higher number of rods. Rods work more effectively in low light conditions accounting for the superior night time vision of dogs. This is advantageous to dogs as it allows them to function as night time predators.

Humans can hear a range of frequencies from about 16 – 20,000 Hz. The range of hair cells in the cochlea allows them to do this. We hear particularly effectively in the range of frequencies used in human speech. The ability to communicate effectively is obviously advantageous. Bats can hear frequencies up to 80,000 Hz. They possess special hair cells which allow them to do this. This is highly adaptive since these very high frequencies are best for echo location.

d.i

Marking Guidelines	Marks
• One similarity in usefulness outlined • Ability of each to amplify sound and convert sound waves to electrical impulses contrasted	**3-4**
• One similarity and one difference in usefulness	**2**
• One of the above	**1**

Both technologies are useful in that they can improve hearing.
Hearing aids work by amplifying sound and making sure that it arrives at the round window at sufficient amplitude to be heard. They are useful for patients who have eardrum or ossicle damage, while the cochlear transplant will not help these patients.
Cochlear transplants work by receiving sound waves and converting them into electrical impulses which are transmitted to the auditory nerve. They are very useful for people with cochlear damage. Hearing aids are of no use in this situation.

d.ii

Marking Guidelines	Marks
• Explanation in terms of – Stimulus raising membrane potential Threshold potential All or nothing nature of response	3
• Two of the above	2
• One of the above	1

The membrane of the axon has a potential at rest of -70mV. A stimulus will cause sodium gates to open and sodium ions to rush in, raising this potential. If the potential is raised to -50mV, the threshold potential, then a full action potential is generated, if not, no action potential results. Therefore, stimuli which do not sufficiently raise the potential of the axon membrane do not generate an axon potential.

Question 30 Biotechnology.

a.i.

Marking Guidelines	Marks
• Aboriginal use of biotechnology outlined	1

Aborigines domesticated dingoes and practised selective breeding, selecting for the traits they valued.

a.ii

Marking Guidelines	Marks
• Species named • Changes to two characteristics described	3
• Species named • One change described.	2
• Species named	1

Modern chickens have been developed by artificial selection from wild jungle fowl of Asia. They have been selected for increased egg weight and earlier laying. They have also been selected for increased meat production.

b.i

Marking Guidelines	Marks
• Correct answer for both	1

X = sugar, Y = phosphate group

b.ii

Marking Guidelines	Marks
• Role of ribosome described • Role of tRNA as transporter of specific amino acids described • Complementarity of codon and anticodon described • Joining of amino acids described	4
• 1-3 of the above	1-3

The mRNA molecule travels from the nucleus to the rough endoplasmic reticulum where it binds to a ribosome. It moves along the ribosome exposing a codon of 3 bases at a time. Each time, a tRNA molecule with a complementary 3 base anticodon attaches to the mRNA molecule. There are a number of different transfer RNA molecules and each attaches to a specific amino acid. 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.iii

Marking Guidelines	Marks
• Outline of process of removal of gene from original species • Outline of process of insertion of gene into plasmid • Role of restriction enzymes and ligases outlined.	3
• Two of the above OR • All three less well done	2
• one of the above	1

Restriction enzymes target a particular base sequence in a DNA molecule and cut the molecule at that point. They leave a 'sticky end' at that point (ie not a straight cut). Ligases are enzymes which join sticky ends with complementary base sequences together. Both types of enzymes are essential in the process of making recombinant DNA.
The DNA of the 'donor' species is extracted and restriction enzymes are used to cut out the desired gene. The bacterial plasmids are then treated with the same restriction enzymes to ensure complementary sticky ends. The genes to be inserted are then added and ligase enzymes join them into the plasmids.

c.

Marking Guidelines	Marks
• Two biotechnologies described • Explanation of how each can be used to improve agricultural production • Assessment made of potential of each to do so	**6-7**
• Two biotechnologies described • Explanation of how each can be used to improve agricultural production	**4-5**
• Two biotechnologies described • Explanation of how one can be used to improve agricultural production	**3**
• One biotechnology described and use in agriculture explained OR • Two biotechnologies described	**2**
• One biotechnology described	**1**

One biotechnology with great potential in agriculture is genetic engineering. Genes from one species can be extracted from the DNA of that species using restriction enzymes and inserted into the DNA of the host organism using ligases. This has been used in agriculture to produce such GM crops as Bt cotton, Bt maize and others. Essentially a bacterial gene conferring resistance to insect pasts has been inserted into these plants and they are now insect resistant. Bt crops have enormous potential in agriculture. They are likely to become much more widespread as they increase productivity by protecting plants from insects and saving money on pesticides.
A second biotechnology is selective breeding. This is selecting individuals with desirable characteristics and using them to breed from. In this way organisms are produced with the characteristics desired by farmers. For example, cows with increased milk yields, sheep with better quality wool etc. This has been used already a great deal in agriculture and has great potential to improve production in the future. Selective breeding is constantly being practised by farmers. One current example is the selection of sheep without folds of skin around the backside. This will remove the need for 'mulesing' the cutting off of these flaps and will improve production by saving labour, reducing infection and suffering of the sheep.

d.i

Marking Guidelines	Marks
• Organism named • Products named	**2**
• One of the above	**1**

Yeast. Ethanol and carbon dioxide.

d.ii

Marking Guidelines	Marks
• Example described • Benefit outlined	**2**
• One of the above	**1**

Strain isolation mechanisms allow a particular strain of a microorganism to be separated from a larger population. One example of their use is in the separation of high yielding strains of penicillium mould from the larger population. The benefit of this was the greatly increased production of the antibiotic penicillin that was then possible.

d.iii

Marking Guidelines	Marks
• Opposing views outlined and justified • Views linked to background or beliefs of people	**2**
• One of the above	**1**

People have opposing views about such biotechnologies as GM foods. Some people support the technology as they believe it has potential to greatly increase food production – thus benefitting humanity. Others oppose it as they believe modified genes will move to wild populations and compromise plant populations in the long term.

Question 31 Genetics: The Code Broken?

a.i.

Marking Guidelines	Marks
• Germ line and somatic mutations distinguished between • Explanation of why germ line mutations affect species	**2**
• Germ line and somatic mutations distinguished between	**1**

Germ line mutations are those that occur in gametes or cells which give rise to gametes. These mutations are therefore inheritable and can affect the species more than somatic mutations which occur in body cells and cannot therefore be passed on.

a.ii

Marking Guidelines	Marks
• 3 steps outlined in process • At least one enzyme named in process	**3**
• 2 steps outlined	**2**
• Some details of the process given	**1**

In the event of a mutation the DNA can sometimes repair itself. This involves 3 steps.

- Removal of damaged section of DNA. Endonuclease enzyme opens DNA chain, exonuclease enzyme removes one nucleotide at a time from the end of the strand.
- Filling in the gap. New nucleotides fill the gap, lining up on the complimentary strand.
- Joining sections. Ligase enzyme joins the new nucleotides into the sugar-phosphate chain to complete the repair.

b.i

Marking Guidelines	Marks
• Correct explanation	**1**

It is diploid. Chromosomes are present in homologous pairs.

b.ii

Marking Guidelines	Marks
• Correct identification	**1**

It has three no. 21 chromosomes.

c.

Marking Guidelines	Marks
• Outline of what gene therapy is • Description of its use to manage a named disease. • Assessment of its potential impact	**5-7**
• Two of the above OR • All 3 less well done	**2-4**
• 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
• Parent genotypes correctly identified • Cross performed correctly • Correct phenotype ratios	**3**
• 1-2 of the above	**1-2**

RrTt x rrTt

Gametes RT, Rt, rT, rt, rT, rt

	rT	rt
RT	RrTT	RrTt
Rt	RrTt	Rrtt
rT	rrTT	rrTt
rt	rrTt	rrtt

Phenotype ratio. 3 tall round: 3 tall wrinkled: 1 short round: 1 short wrinkled.

d.ii

Marking Guidelines	Marks
• Explanation in terms of Linked genes Non independent assortment of alleles	**2**
• 1 of the above	**1**

If the genes were on the same chromosome they would be linked at meiosis. They would not sort out independently of each others and not obey Mendel's Law of Independent Assortment. Therefore they would not give the same phenotype ratio.

e.i

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

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.

e.ii

Marking Guidelines	Marks
• Def^{n} of polygenic inheritance • Process explained using human example	3
• Def^{n} of polygenic inheritance • Human example stated	2
• One of the above	1

Polygenic inheritance occurs where a trait is determined by more than one gene. An example is skin colour in humans. There are thought to be 3 genes, each at different loci. Each one has 2 alleles, one coding for melanin (dark skin) the other coding for non production of melanin (light skin). The human population therefore shows a wide range of variation from very white (all six alleles coding for non production) to very black (all six alleles coding for production) with the whole range of variation in between.

Question 32 --- The Human Story

a.i

Marking Guidelines	Marks
• 2 features named	2
• 1 feature named	1

Opposable thumb and forefinger, large brain.

a.ii

Marking Guidelines	Marks
• Phenotypic variation described • Variation linked to environment or geography	2
• Phenotypic variation described	1

Skin colour shows a clinal gradation. Human populations living close to the equator have very dark skin which becomes progressively lighter in populations which are further North until populations in high latitudes have very light skin.

b.i

Marking Guidelines	Marks
• 2 differences identified	2
• 1 difference identified	1

A. afarensis has prominent brow ridges, modern humans don't. *A. afarensis* has a much smaller cranial capacity than modern humans.

b.ii

Marking Guidelines	Marks
• Implication of difference to both species outlined.	2
• Implication of difference to 1 species outlined.	1

A. afarensis smaller cranial capacity reflects its smaller brain. It had no complex tool culture nor did it have a language. Modern humans have much larger brain reflecting their much more complex society. They have a language and a very sophisticated tool culture – requiring much greater brain power.

b.iii

Marking Guidelines	Marks
• Two implications for human evolution assessed.	3
• 1 implication assessed OR • 2 implications outlined	2
• 1 implication outlined	1

Helplessness of young and long juvenile stage have several important implications for human evolution. Firstly, humans have fewer young compared to other primates and therefore give more parental care. This has been very significant as it has encouraged the evolution of intelligence and memory – young humans have the opportunity to learn from adults. Those who do it most successfully survive and reproduce. This has also helped to lead to evolution of language – the more effectively closely related individuals can communicate the better they can help each other survive and reproduce.

c.

Marking Guidelines	Marks
• Two points for and/or against the proposition put forward • Each point argued correctly from a Darwinian point of view • Human evolution defined in terms of changes in gene frequency, or definition implied.	**5-7**
• Two of the above	**3-4**
• One of the above	**1-2**

Modern Science and technology have certainly changed the course of human evolution but they haven't put an end to it. Natural Selection still operates. Human evolution can be regarded as any change in gene frequencies, and natural selection is the process by which individuals with favourable characteristics survive and reproduce more successfully, thus increasing the frequency of their genes in the population. Modern medicine has the potential to have a large effect on human evolution. Genes predisposing people to diseases such as haemophilia, appendicitis etc were strongly selected against in the past and maintained at low frequencies. These conditions no longer kill people or stop them from reproducing. Their frequency will increase in the population. Any genes which impair fertility were also formerly strongly selected against, but today with IVF and other fertility treatments, people with these conditions will reproduce, the genes will be passed on and infertility will become much more common in the population.

d.i

Marking Guidelines	Marks
• Description of process in DNA-DNA hybridisation. • Explanation of how results can be interpreted	**3**
• Description of process and description of results	**2**
• Aspects of process given	**1**

In DNA-DNA hybridisation the DNA of two species is taken and heated to break the H bonds between the strands and break the double stranded molecules into single stranded ones. The single strands of the 2 species are then mixed, cooled and allowed to rejoin. The extent to which they rejoin is an indication of how similar their DNA is, as rejoining requires complimentary bases.

d.ii

Marking Guidelines	Marks
• Both theories outlined • Evidence for each theory outlined • Explanation given for superiority of evidence favouring Out of Africa theory	**4**
• Both theories outlined and evidence for each theory outlined	**3**
• One theory outlined and evidence described OR two theories outlined	**2**
• One theory outlined	**1**

The Out of Africa Theory proposes that modern humans evolved in Africa and then spread out across the world about 100.000 years ago. The best evidence for this is mitochondrial DNA evidence which shows far greater diversity in African populations than in others. This suggests that African populations are much older – they have had time for mDNA to undergo more mutations. The small diversity in other populations suggests that they are relatively young and that they each originated from a small group of 'founder' individuals.
The theory of regional continuity proposes that ancient populations of ancestral human species such as *Homo erectus* lived in various parts of the world and that modern humans evolved independently in each area from *H. erectus*. The best evidence for this is the discovery of *H. erectus* fossils in many parts of the world, including Africa, China and Java. The Out of Africa Theory is favoured because there is no other way of explaining the mDNA evidence. The fossil evidence can be explained by saying that these *H. erectus* populations outside of Africa were not the ancestors of the human populations of these areas, they died out completely before the humans arrived.

Question 33 --- Biochemistry

a.i

Marking Guidelines	Marks
• Isotope identified	**1**

Oxygen 18

a.ii

Marking Guidelines	Marks
• Outline of what a biochemical pathway is • Explanation of why it is hard to study biochemical pathways • Outline of how radioactive isotopes help	**3**
• 1-2 of the above	**1-2**

Biochemical pathways are the chains of reactions by which particular reactants are converted into products. They involve many different enzyme mediated reactions and many intermediate compounds. They are hard to study because they generally occur inside cells, small amounts of compound are involved and it is hard to know whether chemicals detected in a specimen are the products of the pathway under investigation or some other pathway. If a radioactive isotope is used it becomes much easier to study the pathway. Radioactive molecules must be part of the pathway and parts of the plant which are radioactive must be sites of the pathway.

b.i.

Marking Guidelines	Marks
• Role of both molecules outlined	**2**
• Role of one molecule outlined	**1**

ADP in the light reaction acts as an energy vehicle. Its role is to take up the energy from light. It picks up energy in the form of a high energy bond when it conbines with an inorganic phosphate group to make ATP.
NADP acts as a vehicle for hydrogen. It combines with hydrogen from the breakdown of water during the light reaction to make NADPH.

b.ii

Marking Guidelines	Marks
• Position of each process identified • Explanation for why they are located there	3
• Position of each process identified	2
• Position of one process identified	1

The chlorophyll and accessory pigments which capture light are located on the thylakoid membrane. The Calvin cycle takes place in the stroma. The photosystem reactions which use the light energy to split water and release electrons are also on the thylakoid membrane. These electrons are used to make NADPH for the Calvin cycle in the nearby stroma.

b.iii

Marking Guidelines	Marks
• Description of technique including how intermediate compounds were determined	3
• Outline of technique	2
• Reference to chromotography	1

Calvin grew the alga Chlorella in a flat glass vessel. He exposed it to CO_2 labelled with radioactive ^{14}C. He then extracted samples of the algae at regular intervals and killed them using boiling alcohol to arrest the biochemical pathways. He separated the molecules present using paper chromatography and then identified which were radioactive and therefore products or intermediate products of the pathway.

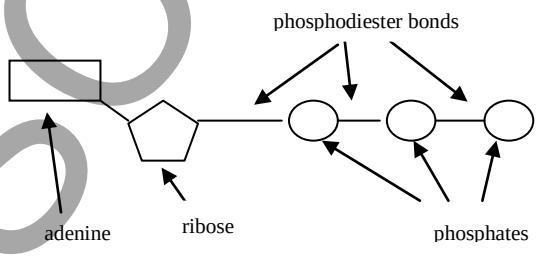
c.

Marking Guidelines	Marks
• Description of use of photosynthesis in production of biofuels • Assessment of potential to decrease green house gas production. • Description of use of photosynthesis to produce renewable resources • Assessment of potential to reduce use of non renewable resources.	6-7
• Three of the above or all 4 less well done	4-5
• Descriptions of use of photosynthesis in production of biofuels and renewable resources.	2-3
• Description of use of photosynthesis in production of biofuels or renewable resources	1

Greenhouse gas production is mainly associated with the burning of fossil fuels. The rate at which CO_2 is released into the atmosphere is far greater than the rate at which CO_2 is being converted back into some form of geological carbon, hence the build up of CO_2 as a greenhouse gas. If biofuel, such as ethanol, produced from sugar cane or some other plant, was used, then the rate at which CO_2 is released to the atmosphere could be balanced by the rate at which it is taken up by the plants and used in photosynthesis. The process could be 'carbon neutral'. This use of photosynthesis has the potential to reduce greenhouse gas production but not by a very large proportion. The amount of fossil fuel used today couldn't possibly be completely replaced by biofuel, it wouldn't be possible to grow enough plants. By the same token photosynthesis only has limited potential to reduce the use of non renewable resources. Ethanol produced indirectly by photosynthesis in plants could be used as a chemical feedstock in the plastics industry and reduce its reliance on non renewable oil. Again, the huge amount of oil used in this way and the limits to the amount of land that could be used to grow the plants needed, means that only a small part of the non-renewable resource could be saved.

d.i

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



d.ii

Marking Guidelines	Marks
• Possession of phosphodiester bonds linked to function of molecule.	1-2

The molecule contains 3 phosphodiester bonds. These bonds are capable of storing large amounts of energy. The splitting of one of these bonds releases energy for use in cell processes.

d.iii

Marking Guidelines	Marks
• Role in Calvin cycle described	1

ATP provides the energy which drives the Calvin cycle.

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Mapping Grid

Question No.	Marks	Syllabus Ref.	Outcomes (H-)	Target Performance Band(s)
PART A				
1	1	9.2.3	6	4
2	1	9.2.2	6	3
3	1	9.2.1	8	4
4	1	9.2.2	6	2
5	1	9.2.3	6	4
6	1	9.2.2	14	5
7	1	9.3.3	9	5
8	1	9.3.5	9	4
9	1	9.3.1	10	4
10	1	9.4.3	7	3
11	1	9.4.6	14	5
12	1	9.4.4	4, 6	4
13	1	9.4.4	6	2
14	1	9.4.7	4	3
15	1	9.4.5	6	2
16	3	9.3.4	1, 9	2-5
17	6	9.2.2	6, 14	2-6
18	3	9.4.6	3	2-5
19	5	9.2.1	6	2-5
20	5	9.3.1	5, 10, 12, 14	2-6
21	4	9.4.5	6	2-4
22	5	9.4.3, 9.4.4	1, 2, 5, 9	3-6
23	5	9.2.3	6	2-4
24	6	9.3.3	2, 10, 11, 15	2-5
25	4	9.4.4	6	3-5
26	3	9.2.2	5, 6	3-5
27	3	9.3.2, 9.3.3	9, 13, 14	3-6
28	8	9.4.7	3, 4, 13	3-6

OPTIONS

		Marks	Syllabus Ref.	Outcomes (H-)	Target Performance Band(s)
29	a	4	9.5.2, 9.5.3	6	2-4
	b	7	9.5.5, 9.5.6	6, 11, 14	2-5
	c	7	9.5.4, 9.5.6	6, 8	3-6
	d	7	9.5.6, 9.5.7	3, 4, 6	3-6
30	a	4	9.6.1	1, 3	2-4
	b	8	9.6.4, 9.6.5	3, 6	2-5
	c	7	9.6.6	3, 8	3-6
	d	6	9.6.3, 9.6.7	3, 5, 6	3-6
31	a	5	9.7.6	9	2-4
	b	2	9.7.6	9, 14	2-3
	c	7	9.7.5	3, 4, 5, 9, 13	2-5
	d	5	9.7.3	9, 13	3-6
	e	6	9.7.2, 9.7.8	9	3-6
32	a	4	9.8.1	10	2-4
	b	7	9.8.3, 9.8.5	10, 14	2-5
	c	7	9.8.6	4, 10, 13	3-6
	d	7	9.8.2, 9.8.3	1, 10	3-6
33	a	4	9.9.5	3, 6	2-4
	b	8	9.9.4	1, 6	2-5
	c	7	9.9.1	3, 4, 5	3-6
	d	6	9.9.6, 9.9.7	6, 13	3-6