Exam Choice

2011 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
C	B	A	B	A	A	C	D	A	B	D	B	A	C	C	B	B	D	C	D

Section I B

21.a.

Marking Guidelines	Marks
• Enantiostasis defined • Osmotic consequences of transition from fresh to salt water outlined • Consequences related to enantiostasis	**3**
• 1-2 of the above	**1-2**

Enantiostasis is the maintenance of metabolic and physiological functions in response to variations in the environment. Moving from fresh to salt water is a major change. In fresh water the eel would experience an uptake of water into the body by osmosis because of the high solute concentration of its tissues. In salt water the concentration gradient would be reversed and the eel would lose water to its environment. These very different conditions would make it hard to achieve enantiostasis.

21.b.

Marking Guidelines	Marks
• Mechanism fully outlined	**2**
• Some details of mechanism given	**1**

Some salt water fish maintain water balance by drinking sea water to replace water lost by osmosis, and then actively excreting the excess salts.

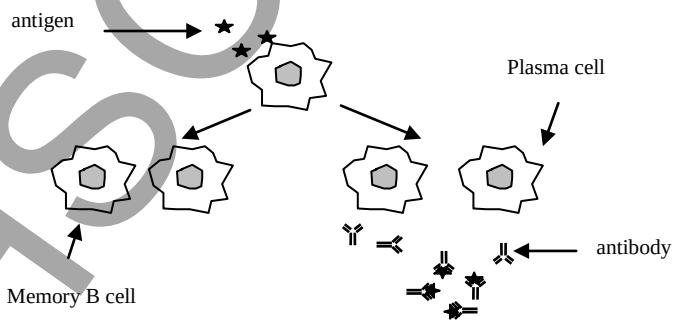
22.

Marking Guidelines	Marks
• 1-3 rows correct	**1-3**

	Biological Characteristic	Example of disease
Prion	Consists solely of protein – no nucleic acid	BSE/mad cow disease
Virus	Non cellular, consisting of nucleic acid inside a protein coat	rabies
Protozoan	Membrane bound organelles and a distinct nucleus	malaria

23.a.

Marking Guidelines	Marks
• 4 correct labels	**2**
• 2-3 correct labels	**1**



23.b.

Marking Guidelines	Marks
• 1-4 answers correct	**1-4**

1. Antigen transported to lymphocyte by macrophage.
2. B lymphocyte clones to make plasma cells.
3. Plasma cells produce antibodies specific to the antigen.
4. Antibodies combine with antigens to render them harmless.

24.a.

Marking Guidelines	Marks
• O_2 consumption related to metabolic rate • Need for high rate at low temps explained • Need for high rate at high temps explained.	**3**
• 2 of the above	**2**
• Relationship described OR 1 of the above	**1**

Endotherms have physiological mechanisms to maintain internal temperature within narrow limits. At low temps the body needs to generate heat through muscular activity – hence the higher O_2consumption. At high temps mechanisms to lower body temp such as panting and pumping blood to the extremities, are employed – these require muscular activity and increase O_2 consumption.

24.b.

Marking Guidelines	Marks
• Any line showing a rise with environmental temp.	**1**

25.a.

Marking Guidelines	Marks
• Description of check for relevance • Description of check for reliability	**2**
• One of the above	**1**

In assessing the relevance of the source – ie: does it contain information pertinent to the study. You would check that it is up to date. You would check that it addresses the subjects of HPV and or cervical cancer. To assess reliability you would check that the articles were in credible publications and that claims were referenced to credible sources and authors in other publications.

25.b.

Marking Guidelines	Marks
• Explanation linking repeated vaccinations and increased immunological memory • Mechanism of immunological memory outlined • Above linked to increased protection	**3**
• Two of the above	**2**
• One of the above OR Aspects of the immune response described.	**1**

The point of repeated vaccinations is to boost immunological memory through the production of extra memory B cells. The initial vaccination would have produced antibodies and memory B cells which would remain in the body ready to be activated. Subsequent vaccinations would trigger secondary immune response giving much greater levels of memory B cells and hence greater immunity.

25.c.

Marking Guidelines	Marks
• An aspect of the program justified from a positive point of view. • Justification given for viewing an aspect of the program in a negative light.	**3-4**
• A positive and negative aspect stated	**2**
• A positive or negative aspect stated.	**1**

The policy of vaccinating all girls makes sense from a public health point of view. This could potentially stop 70% of all cervical cancers and prevent a great amount of death and suffering and, ultimately, government expenditure on medical treatment. The decision not to provide free vaccination to boys, and therefore not vaccinate them, is hard to understand. Boys will represent a reservoir of HPV infection in the population. This policy won't wipe out HPV, it will only protect vaccinated girls, not unvaccinated ones.

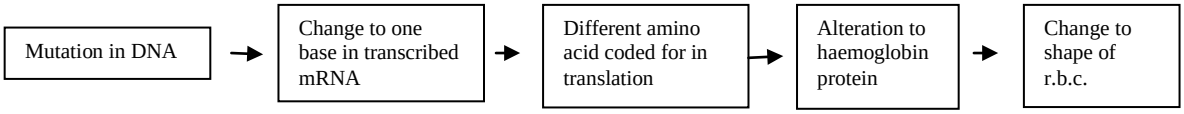
26.

Marking Guidelines	Marks
• Homeostasis defined • Metabolic activity linked to enzymes • Importance of narrow limits of factors such as temp, pH for enzyme activity explained.	**3**
• 1-2 of the above	**1-2**

Homeostasis is the maintenance of a constant internal state. It is essential for the maintenance of optimal metabolic activity as metabolism is controlled by a large number of enzymes. Enzymes are highly specific as far as factors such as temperature and pH are concerned. Therefore they will only function optimally if homeostasis is maintained.

27.a.

Marking Guidelines	Marks
• Flow diagram with at least five correctly sequenced steps	**3**
• 3-4 correctly sequenced steps	**1-2**



27.b.

Marking Guidelines	Marks
• Explanation of why the heterozygous state yields a different phenotype to the homozygous states. • Illustration of explanation with appropriate genotypes	**2-3**
• One of the above	**1**

In co-dominance neither allele is dominant over the other. If both are present, both are expressed leading to a phenotype different to either of the homozygous states. In this example, if the two alleles are H^N (normal) and H^S (sickle shaped), then the three phenotypes are produced by the following genotypes: H^NH^N normal red cells, H^NH^S mild sickling condition, H^SH^S severe sickling condition.

28.

Marking Guidelines	Marks
• Hypothesis proposed • Independent and dependent variables identified • Controlled variables identified • Suitable method of measuring independent and dependent variable • Feasible method with appropriate equipment. • Repeats or other method of ensuring sufficient data.	**6**
• 1-5 of the above	**1-5**

Hypothesis: As the pH of seawater decreases from its normal level, the hatching rate of brine shrimp eggs will decrease.

Independent variable: pH of seawater. Dependent variable: Hatching rate of brine shrimp eggs.

Controlled variables temperature of sea water
Salinity of sea water
Degree of aeration of seawater.
These variables must be controlled as they all have the potential to influence hatching rates of brine shrimp eggs.

Equipment:
3000 brine shrimp eggs
15 beakers
Stereomicroscope
4 L seawater
Drinking straw
pH probe

Method

- Place 250mL of seawater in each of the 15 beakers.
- Label them A,1-5, B 1-5 C 1-5.
- Determine the pH of beakers A1, B1 and C1. This is the pH of normal sea water, they will remain at this level.
- Use the drinking straw to blow exhaled air into the other beakers. Use the pH probe to ensure that a range of pH's is obtained, from normal seawater pH (beakers 1) progressively down to the lowest pH that can be made this way (beakers 5).
- Count out 15 batches of 200 eggs and place each batch in a beaker.
- After 3 days use the stereomicroscope to count the number of young brine shrimp in each beaker.
- Calculate the hatching rate as a percentage of the original 200 eggs and average the results from the 3 beakers at each pH. (3 beakers at each pH improves reliability of the result)
- Graph pH against hatching rate.

29.

Marking Guidelines	Marks
• Explanation given in terms of variation, differential survival and inheritance of favourable traits.	**3**
• 1-2 of the above	**1**

There would be genetic variation in the fish population. Some would tend to breed at an earlier age than others. If the population was being heavily fished this would be a favourable variation. The sooner a fish reproduced, the better chance it would have to have offspring before it was caught. This favourable gene would be passed down to the offspring and would become more widespread in the population, since fish with it would leave more surviving offspring to the next generation.

30.

Marking Guidelines	Marks
• Details of at least two reproductive technologies and/or examples of genetic engineering given • Explanation given of how each could affect world food production. • Assessment of potential to solve world hunger given	**7-8**
• Two of the above, OR all three done less well	**4-6**
• One of the above, OR two done less well.	**1-3**

Reproductive technologies and genetic engineering do have the potential to greatly increase world food production and are already doing so. Artificial insemination allows the very best female farm animals to be inseminated with the sperm of the very best males. This has already led to the production of breeds of cattle with milk production and meat production far in excess of yields obtained in the past. Genetic engineering techniques have been used to produce transgenic species such as Bt corn. Bt crops carry bacterial genes from *Bacillus thuringiensis*, which protect them against insect pests. A large proportion of the world's crops are consumed by insect pests, so this development has the potential to greatly increase food production. Developments such as these are allowing the world to produce enough food to feed everyone, but the availability of food isn't the only factor affecting world hunger. Problems of distribution and of politics would have to be overcome for everyone to be fed.

Section 2: Options.

31. Communication

a.i.

Marking Guidelines	Marks
• Receptor named.	**1**

Rod

a.ii.

Marking Guidelines	Marks
• Need for two ears stated or inferred. • Difference in timing OR intensity mentioned • Role of brain in processing mentioned	**3**
• 1-2 of the above	**1-2**

Sound waves travelling from a source reach each ear at slightly differing times and with different intensities. The brain is able to correlate this data and infer the direction of the sound.

b.

Marking Guidelines	Marks
• Dog and human vision contrasted in terms of the implications of all four of the differences given	**5-6**
• Dog and human vision contrasted in terms of 1-3 of the differences given.	**2-4**
• A difference or similarity between dog and human vision stated.	**1**

The fields of view of the dog's eyes overlap much less than those of humans. This would allow the dog to view a much larger field of view overall (it would have a much larger peripheral vision), however it would have stereoscopic vision in a much smaller proportion of its field of view than humans do, meaning that it would only have depth perception in this small region. The larger number of rods in dogs would give them better night vision than humans – rods fire in much lower intensity light than cones. The possession of only two types of cone, compared to three in humans would mean that dogs have much poorer colour perception than humans. The lower density of cones in the central region of a dog's retina means that it would have a lower visual acuity. Ie. its vision has lower resolution than that of humans.

c.

Marking Guidelines	Marks
• One technology to address a hearing defect outlined • One technology to address a vision defect outlined. • Comparisons made in terms of: -mode of operation -limitations -impact on society	**5-7**
• Technologies outlined • Factors less well compared	**2-4**
• Some information given about a technology to address hearing or vision defects.	**1**

Hearing aids are devices which address problems of the outer and middle ear. They amplify sound waves so that they reach the inner ear at sufficient amplitude for it to function correctly. Glasses address vision problems such as myopia and hyperopia. They refract the incoming light rays in a way that compensates for deficiencies in the lens or shape of the eye.
Hearing aids are electrical devices, they receive the sound waves and electronically amplify them, while glasses are not electrical, they don't amplify the light waves, merely redirect them.
Limitations of hearing aids include their poor ability to discriminate between sounds, they amplify background noise as well as speech, they can break down and they can be mislaid. Glasses only augment the refractive functions of the eye, they don't impair its ability to discriminate between objects, however, they too are easily broken or mislaid.
Both devices have had an enormous impact on society. A significant proportion of the workforce would be unable to do their jobs without the aid of glasses. A smaller, and generally older group are equally dependent on hearing aids for day to day functioning. Without these two devices many people would be forced into unemployment or jobs with little dependence on vision or hearing. This would greatly impact their lives and those of their families, it would also impose a huge burden on the rest of society to care for them.

d.i.

Marking Guidelines	Marks
• Explanation in terms of- -role of potential change across membrane -movement of ions -mechanism ensuring one-way flow of impulse	**3-4**
• Poorer explanation	**1-2**

A nervous impulse is a flow of charge along an axon.
When at rest there is a difference in potential across the membrane of the axon of the nerve cell. An impulse triggers the rapid movement into the cell of Na+ ions, reversing this potential. This reversal propagates along the axon, transmitting the impulse. The reversal is quickly counteracted by a flow of K+ ions out of the cell restoring the potential, but that part of the membrane is unable to sustain another reversal until the two sets of ions have returned to their original places. This takes a few microseconds, ensuring that an impulse cannot 'double back' on itself, making sure that it can only travel in one direction.

d.ii.

Marking Guidelines	Marks
• Difference outlined	1

A nerve cell is a single cell, while a nerve is a bundle of nerve cells.

d.iii.

Marking Guidelines	Marks
• Position of Organ of Corti outlined • Role of hair cells outlined • Arrangement of hair cells related to detection of different frequencies.	3
• 1-2 of the above	1-2

The organ of Corti is situated within the cochlea. It consists of a ribbon like structure running along the length of the cochlea, covered by hair cells. A hair cell is triggered by sound waves of a specific frequency in the fluid of the cochlea. On being stimulated, the hair cell generates a nervous impulse which travels along the auditory nerve to the brain and is perceived as a sound of that specific frequency. Hair cells are arranged along the organ of Corti in such a way that high frequency sounds trigger the hair cells closest to the oval window and low frequency sounds trigger those further away.

32. Biotechnology.

a.i.

Marking Guidelines	Marks
• Gas named	1

Carbon dioxide

a.ii.

Marking Guidelines	Marks
• Explanation of importance of strain isolation outlined • One example outlined	3
• One of the above, or both done less well	1-2

Strain isolation is the process of separating a strain of microorganism from a culture of multiple strains. It is important because it allows a strain which produces a desired product to be separated from strains which don't, so that that product can be produced in sufficient quantities. In the mid twentieth century it was important to separate antibiotic producing strains of *Penicillium* from those which didn't in order to produce commercial quantities of antibiotic. One method used is the 'dilution method'. The desired microorganism is extracted from a mixed plate of microorganisms and cultured. This is repeated until a pure strain is obtained.

b.i.

Marking Guidelines	Marks
• Role of rennin outlined • Feasible origin proposed	2
• One of the above	1

Cheese making involves the separation of milk into solid curds and liquid whey. The curds form the cheese. This requires addition of the enzyme rennin and probably first occurred accidentally when herdsmen carried milk in containers made from sheep stomachs.

b.ii.

Marking Guidelines	Marks
• Changes to two characteristics of a named species described	3
• Two changes named OR one change described	2
• One change named	1

Wheat was domesticated from wild strains found in the Middle East. Farmers selected and planted the grains from plants which had the characteristics they valued. This selection led to the development of plants whose seed clung to the stalk instead of blowing away in the wind, plants with high seed production and plants without seed husks.

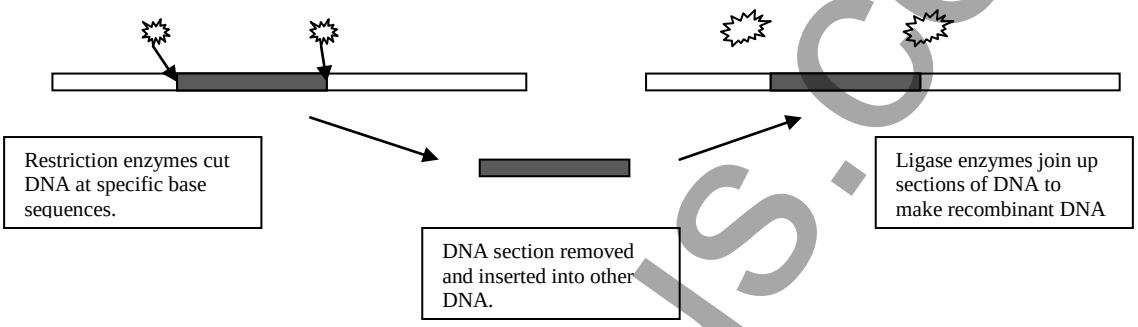
c.

Marking Guidelines	Marks
• Biotechnology used in agriculture outlined. • Biotechnology used to in medicine outlined • Comparisons made in terms of: -mode of operation -limitations -impact on society	5-7
• Technologies outlined • Factors less well compared	2-4
• Some information given about a biotechnology used in medicine or agriculture	1

The production of insulin through the use of recombinant DNA technology is an example of a use of biotechnology to combat disease in humans. The human insulin gene is spliced into the plasmid of E. coli. The bacteria are cultured, provided with the correct conditions and they produce human insulin which can then be used to treat diabetes. Recombinant DNA technology is also used in agriculture. An example is the extraction of the gene for insect resistance from the bacterium B thuringiensis and its insertion into the genome of plants such as cotton, rendering them immune to insect attack.
Production of insulin involves the insertion of the gene into a bacterial host, while in Bt crops the gene is inserted directly into the organism. Both techniques involve the insertion of a specific gene. The limitations of insulin synthesis in this way are few. It is less effective than natural insulin production by the patient themself as it is applied at set times and is present in the body in more varying concentrations than it would be naturally. The main limitation of Bt cotton is the fact that insects are evolving resistance to it. Both technologies have had a major impact on society. This method of insulin production has allowed diabetics to much better control their disease. Previously they relied on animal insulin, which was chemically different and less effective than human insulin. Bt crop technology has improved agricultural productivity, boosting cotton availability and lowering its cost.

d.i.

Marking Guidelines	Marks
• Suitable diagrams drawn • Role of restriction enzymes shown • Role of ligases shown	**3**
• 1-2 of the above.	**1-2**



d.ii.

Marking Guidelines	Marks
• Explanation that everyone's DNA is unique • Description of a method	**3**
• One of the above or both less well done.	**1-2**

Since everyone (except identical twins) has their own unique DNA, analysis of DNA at a crime scene can be used in identifying the perpetrator. One method is to take the DNA of a suspect and use it to make probes – molecules which combine to specific parts of their DNA. If these probes combine perfectly with the DNA from the crime scene then the suspect has been matched to the sample.

d.iii.

Marking Guidelines	Marks
• Nature of ethics described • One aspect of biotechnology related to issues of ethics.	**3**
• One of the above or both less well done.	**1-2**

Ethics concerns itself with whether things are wrong or right. Judgements of this can be made on the basis of whether or not the rights of people, or living things, have been impinged. Some people make these judgements on whether they believe religious principles or principles relating to a 'natural order of things' to have been transgressed as well. Since biotechnology involves the manipulation and changing of living organisms it stimulates much debate about the relative importance of the rights of the organisms concerned and those of humans who stand to benefit.

33. Genetics, The Code Broken.

a.i.

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

A haploid cell has a single set of chromosomes (n) ie. a gamete. A diploid cell has two sets of chromosomes (2n) ie. a body cell.

a.ii.

Marking Guidelines	Marks
• Genotypes of parents correctly expressed • Gametes correctly expressed • Genotypes of offspring correctly expressed • Phenotypes of offspring correctly expressed.	**4**
• 1-3 of the above	**1-3**

Parents **male** Group A rhesus +ve **female** Group B rhesus -ve

Genotypes I^AiDd I^Bidd

Gametes I^AD, I^Ad, iD, id I^Bd, id

	I^Bd	**id**
I^AD	**I^AI^BDd**	**I^AiDd**
I^Ad	**I^AI^Bdd**	**I^Aidd**
iD	**I^BiDd**	**iiDd**
id	**I^Bidd**	**iidd**

Genotypes of offspring

Offspring phenotypes. 1 AB +ve : 1 AB –ve : 1 A +ve : 1 A –ve : 1 B +ve : 1 B –ve : 1 O +ve : 1 O –ve.

b.i.

Marking Guidelines	**Marks**
• Nature of gene cascades described • Role of gene cascades in embryonic development outlined.	**3-4**
• 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.

b.ii.

Marking Guidelines	**Marks**
• Explanation of how homeotic gene similarities can relate to common ancestry • Link between extent of similarity and closeness of evolutionary relationship explained	**3**
• One of the above, or both less well done.	**1-2**

Comparison of homeotic gene sequences can reveal evolutionary relationships between groups. Groups that share a relatively recent common ancestor have the same homeotic gene sequences. The extent to which these sequences differ reflect the time since two groups diverged, since rates of mutation are thought to be constant. Therefore, the more similar the homeotic gene sequences of two groups, the closer their evolutionary relationship.

c.

Marking Guidelines	**Marks**
• Gene cloning outlined. • Whole animal cloning outlined • Comparisons made in terms of: -process -limitations -impact on society	**5-7**
• Technologies outlined • Factors less well compared	**2-4**
• Some information given about a gene or whole animal cloning.	**1**

Gene cloning is a technique used to make many copies of a particular gene, whole animal cloning makes copies of the whole animal.

One method of gene cloning is to cut the gene from the DNA using restriction enzymes, splice it into a bacterial plasmid, reinsert the plasmid into the bacterium and then culture the bacterium, producing multiple copies of the gene. One method of whole animal cloning is to take the nucleus of a cell from the organism to be cloned, insert it into an enucleated egg cell, implant it into a surrogate mother and allow it to develop into an animal – a clone of the original. The processes are different in that gene cloning involves the use of restriction enzymes to extract specific genes while whole animal cloning involves using the whole nucleus. They are similar in that they both require a host cell. The main limitations of gene cloning relate to concerns about the genetically altered hosts spreading un-natural gene combinations to wild populations. The main limitations of whole animal cloning relate to the low success rate of the process and the shortened life span of the organisms produced by it. Gene cloning has had a major impact on society. It allows production of many substances important to medicine such as insulin. Whole animal cloning has had little impact on society so far, but has great potential. The cloning of genetically superior agricultural species could greatly improve productivity.

d.i.

Marking Guidelines	**Marks**
• Distinction between somatic and germ line cells made • Evolutionary implications of somatic and germ line mutations explained.	**2**
• One of the above	**1**

Somatic cells are body cells. Any mutation in a body cell has no potential to be inherited and hence has no effect on future evolution of the species. Germ line cells are cells which give rise to gametes. A mutation in a germ line cell is therefore heritable. It provides genetic variation on which natural selection can act and therefore has the potential to contribute to the future evolution of a species.

d.ii

Marking Guidelines	Marks
• Technique of gene therapy outlined. • Use to treat a named disease described.	**3-4**
• One of the above, or both done less well.	**1-2**

Gene therapy involves treating a disease caused by a single defect, by inserting copies of the functioning allele of that gene into the person. An example is in the treatment of cystic fibrosis. Sufferers lack the ability to make an enzyme which facilitates the correct function of the lining of the lungs. The gene therapy involves using an adenovirus as a vector for the functioning gene. It is inhaled in a spray, it infects cells in the lining of the lung and inserts the gene, allowing those cells to make the requisite enzyme.

34. The Human Story.

a.i.

Marking Guidelines	Marks
• Example described	**1**

The gradual change in skin colour, from dark near the equator to very light in Northern Europe.

a.ii.

Marking Guidelines	Marks
• Definition of clinal gradation, stated or implied. • Variation in physical characteristic linked to environmental gradient.	**3**
• One of the above, or both less well done.	**1-2**

A clinal gradation is a continuous change in a feature corresponding to an environmental gradient. In the example of human skin colour, dark skin colouration is found in equatorial regions where there is a distinct survival advantage in having high levels of melanin to protect against skin cancer. Natural selection maintains dark skin in this area. In far Northern Europe, where the intensity of the sun is much less, natural selection has led to the evolution of very light skin, as it maximises vitamin D production. At points in between these two extremes skin colour reflects the competing influences of these two selecting agents, resulting in a gradation of skin colours from very dark at the equator, to very light in the far North.

b.i.

Marking Guidelines	Marks
• One feature identified	**1**

Large, forward facing eyes.

b.ii.

Marking Guidelines	Marks
• Explanation of what DNA sequencing means. • Explanation of how it can indicate evolutionary relationships.	**3-4**
• One of the above, or both less well done.	**1-2**

Using a technique such as the polymerase chain reaction, it is possible to determine the sequence of genes on a chromosome, or the sequence of bases within a particular gene. Since mutations are assumed to occur at a fairly constant rate, the more similar the DNA of two species, the more recently they must have diverged from a common ancestor, and therefore the more closely they are related. In the example here, DNA sequencing of the fruit bat would have revealed much greater similarity with microbats than with primates, confirming its original classification.

c.

Marking Guidelines	Marks
• Potential of two factors to influence human evolution explained • Implications of each for the population assessed.	**5-7**
• One of the above, or both less well done.	**2-4**
• Some information about human evolution given	**1**

Assisted reproductive technologies are becoming more and more widespread, for example, IVF. Previously, any gene that compromised fertility was strongly selected against and would have been present in very low frequencies in the population. These genes are now less strongly selected against and will increase in the population. This will mean that in future generations fertility problems will be much more common.
Easily available world travel is another factor which has the potential to influence human evolution. Human races evolved as a result of reproductive isolation of populations who were subject to different sets of selective pressures acting on the gene pools that each population had. The distinctive variation that we see between races of people was only made possible by this isolation. Increased travel is removing this reproductive isolation. Gene pools are no longer separated, over time we can expect a much greater homogenization of the human race.

d.i.

Marking Guidelines	Marks
• Evidence outlined • At least two fossil hominids referred to.	**3**
• The above done less well	**1-2**

Fossil evidence of *Australopithecus africanus*, considered to be a human ancestor, shows, from the shape of the spine, the position of the foramen magnum and the shape of the knees that it was bipedal, it had an upright stance. However its brain was small compared to members of the genus *Homo*. *H. erectus*, also considered to be a human ancestor, although a much more recent one than *A. africanus*, has a much larger brain capacity, comparable to that of modern humans. This supports the theory that upright stance evolved before large brain size in humans.

d.ii.

Marking Guidelines	Marks
• Links made between upright stance and selecting pressure for brain capacity	3
• Potential of upright stance or large brain capacity described without making links between them.	1-2

An upright stance freed the hands of the early hominids and left them free to pick up rocks and sticks to help them hunt or modify objects. There would have been strong selecting pressure for abilities relating to the manipulation and modification of these tools to make them more useful and these abilities would be brain functions. In this way natural selection would have led to larger brains.

d.iii.

Marking Guidelines	Marks
• Meaning of cultural development explained or implied. • Role of language explained.	3
• One of the above, or both less well done.	1-2

Cultural developments are changes in the way people live or organise their society. They encompass changes in technology. Language allows precise communication between people of concrete and abstract ideas. The development of language greatly accelerated the process of cultural development as it allowed people to learn of technologies and ideas without seeing them first hand.

34. Biochemistry.

a.i.

Marking Guidelines	Marks
• Technique named	1

Centrifugation.

a.ii.

Marking Guidelines	Marks
• Englemann's experiment described • Link made between his results and his development of action spectrum.	3
• One of the above, or both done less well.	1-2

Englemann illuminated some filamentous green algae by passing white light through a prism and allowing the different colours of the spectrum to fall on different parts of the algae. He introduced a bacterium into the dish which he knew required oxygen to thrive. He then observed which areas of the dish the bacteria grew well in. Good bacterial growth meant high O_2 availability, which in turn meant photosynthesis must be happening. He found that photosynthesis occurred strongly in blue and red light, but hardly at all in green light.

b.i.

Marking Guidelines	Marks
• Nature of bonds described • Role of bonds described	2
• One of the above	1

The phosphodiester bonds are high energy bonds. Their function is to transport energy within the cell and make it available where needed.

b.ii.

Marking Guidelines	Marks
• Process described in detail	3
• Process described less well	1-2

ATP synthesis is a process mediated by the enzyme ATP synthase.

$$ADP + iP \xrightarrow{\textbf{ATP synthase}} ATP$$

This reaction is driven by the energy from protons moving down an electrochemical gradient across a membrane. Such as within the mitochondrion or chloroplast.

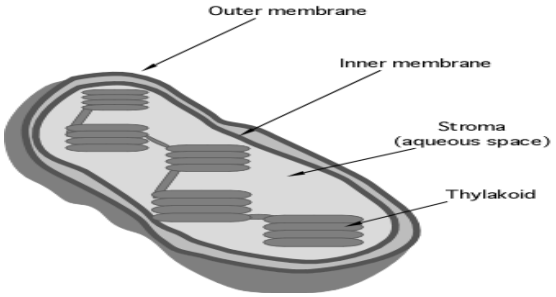
(c)

Marking Guidelines	Marks
• Role of radioactive tracers outlined • Use of tracers in two aspects of photosynthesis outlined. • Evaluation made of their contribution to knowledge.	5-7
• 1-2 of the above	2-4
• Some information given about one of the above	1

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.
This use of radioactive isotopes was critical to our understanding of the Calvin cycle.
Ruben used radioactive ^{18}O to trace the fate of oxygen in the light reaction of photosynthesis. He gave plants water tagged with ^{18}O and showed that the O_2 they released was radioactive, while the carbohydrates they produced were not. This was important in proving the previously supposed role of water in the light reaction.

d.i.

Marking Guidelines	Marks
• Good drawing • 4 good labels	**3**
• Poorer drawing, fewer labels.	**1-2**



d.ii.

Marking Guidelines	Marks
• 2 structures or substances named. • Role of each outlined	**3**
• One of the above, or both done less well.	**1-2**

Starch granules. These are storage structures, they store carbohydrate made during photosynthesis.
DNA. Chloroplast DNA codes for the production of various proteins used in photosystems I and II as well as proteins involved in ATP synthesis.

d.iii.

Marking Guidelines	Marks
• Algal and terrestrial angiosperm chloroplasts compared in terms of: -size -shape -distribution	**3**
• 1-2 of the above.	**1-2**

Algal chloroplasts like those in *Spyrogyra* are spiral and about 6 μm long, while those of terrestrial angiosperms are disc shaped and about 3 x 6 μm in size. Algal chloroplasts are found throughout every cell, while terrestrial angiosperm chloroplasts are found in specialised photosynthetic tissues such as palisade mesophyll