

Mark Scheme (Results) Summer 2008

GCE

GCE SNAB Biology (6136/01)

GENERAL INFORMATION

The following symbols are used in the mark schemes for all questions:

Symbol	Meaning of symbol
; semi colon	Indicates the end of a marking point
eq	Indicates that credit should be given for other correct alternatives to a word or statement, as discussed in the Standardisation meeting
/ oblique	Words or phrases separated by an oblique are alternatives to each other
{ } curly brackets	Indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
() round brackets	Words inside round brackets are to aid understanding of the marking point but are not required to award the point
[] square brackets	Words inside square brackets are instructions or guidance for examiners

Crossed out work

If a candidate has crossed out an answer and written new text, the crossed out work can be ignored. If the candidate has crossed out work but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

Spelling and clarity

In general, an error made in an early part of a question is penalised when it occurs but not subsequently. The candidate is penalised once only and can gain credit in later parts of the question by correct reasoning from the earlier incorrect answer.

No marks are awarded specifically for quality of language in the written papers, except for the essays in the synoptic paper. Use of English is however taken into account as follows:

- the spelling of technical terms must be sufficiently correct for the answer to be unambiguous
e.g. for amylase, 'ammalase' is acceptable whereas 'amylose' is not
e.g. for glycogen, 'glicojen' is acceptable whereas 'glucagen' is not
e.g. for ileum, 'illeum' is acceptable whereas 'ilium' is not
e.g. for mitosis, 'mytosis' is acceptable whereas 'meitosis' is not
- candidates must make their meaning clear to the examiner to gain the mark.
- a correct statement that is contradicted by an incorrect statement in the same part of an answer gains no mark - irrelevant material should be ignored.

Question Number	Answer	Mark
1(a)	<ol style="list-style-type: none"> 1. huge numbers / population size / eq ; 2. illustrated with example from the text ; 3. variety in metabolism/diet/molecular differences / eq ; 4. illustrated with example from the text ; 5. wide habitat distribution / eq ; 6. illustrated with example from the text ; 7. more life under the earth than on it / eq ; 8. reference to "all bacteria swim in a single gene pool" / eq ; 9. explanation of single gene pool concept ; 10. specific example of how they have a major influence on many other living organisms e.g. oxygen production for respiration of other organisms ; 11. bacteria are unlikely to become extinct ; 	max (4)

Question Number	Answer	Mark
1(b)(i)	<ol style="list-style-type: none"> 1. {genetic / DNA}differences ; 2. molecular differences / lipids / peptidoglycan / eq ; 3. archaea are more different from bacteria than you and I are more different from a crab or spider / eq ; 	max (2)

Question Number	Answer	Mark
1(b)(ii)	<ol style="list-style-type: none"> 1. did not fit in with old way of classifying in terms of {gross morphological / visible} similarities and differences / Woese's system focuses on molecular characteristics / eq ; 2. suitable for microbiologists / less suitable for botanists and zoologists / too heavily weighted towards the microbial / eq ; 3. numerically distorted i.e. most identified species put into a small section of the classification system / eq ; 4. reference to alternative / updated classification systems; 	max (2)

Question Number	Answer	Mark
1(c)	<ol style="list-style-type: none"> 1. eukaryotes have a nucleus, prokaryotes do not ; 2. eukaryotes have {membrane bound organelles / named organelle}, prokaryotes do not ; 3. eukaryotes have larger ribosomes than prokaryotes ; 4. eukaryotic cells are much larger than prokaryotic cells ; 5. eukaryotic cells walls (if present) are made of cellulose (or chitin), prokaryotic cell walls are made of other materials (e.g. murein) ; 6. plasmids traditionally thought to be confined to prokaryotic cells ; 7. linear chromosomes in eukaryotes, circular DNA in prokaryotes / reference to histone proteins in eukaryotes, not prokaryotes / eq ; 	max (2)

Question Number	Answer	Mark
1(d)	<ol style="list-style-type: none"> 1. genes can spread between different {species / types / eq} of bacteria ; 2. through sexual reproduction / exchange of plasmids / conjugation ; 	(2)

Question Number	Answer	Mark
1(e)	<ol style="list-style-type: none"> 1. prostaglandins released ; 2. reset set point of hypothalamus / eq ; 3. produce fever / core temperature rises ; 4. histamine released ; 5. Inflammation / inflammatory response ; 6. {killer / cytotoxic} T cells {destroy infected cells / damage tissues} ; 7. clonal selection of white blood cells causes swollen {lymph nodes / glands} / eq ; 	max (3)

Question Number	Answer	Mark
1(f)	<ol style="list-style-type: none"> 1. rapid reproduction rate / quick generation time ; 2. large populations ; 3. large pool of mutations / lots of variation ; 4. strong selection pressure of antibiotics /eq ; 5. widespread use of antibiotics in farming ; 6. misuse of antibiotics / prescribed inappropriately / course not finished / eq ; 7. conjugation/bacterium can share plasmids / can pass antibiotic resistance genes from one bacterium to another (species) / eq ; 8. reference to antibiotic markers in genetic engineering ; 9. correct reference to hospital hygiene / compromised immune system of patients / intravenous procedures / eq ; 	max (4)

Question Number	Answer	Mark
1(g)	<ol style="list-style-type: none">1. may kill the host before they have a chance to infect other people / eq ;2. newly evolved strain so it has not yet become reduced in virulence ;3. reference to isolation of victims /eq ;	max (1)

Question Number	Answer	Mark
2(a)(i)	<ol style="list-style-type: none"> 1. main food chain: phytoplankton - <i>Calanus</i> - sand eel - herring /cod with arrows pointing showing direction of energy flow ; 2. trophic levels indicated correctly in any comprehensible way ; 3. inclusion of any two other organisms at correct trophic level with appropriate arrows ; 	(3)

Question Number	Answer	Mark
2(a)(ii)	<ol style="list-style-type: none"> 1. each cod eats many times its own mass of sandeels (in its life time) / eq ; 2. when {energy / nutrients / organic matter} passes from one trophic level to another only some is passed on / eq ; 3. energy loss through respiration / heat / faeces / not all potential prey get eaten ; 4. larger number of sandeels (than cod) / removal of cod by fishing ; 	max (2)

Question Number	Answer	Mark
2(b)(i)	<ol style="list-style-type: none"> 1. more light (intensity) ; 2. suitable wavelengths ; 3. more carbon dioxide dissolved in the water ; 4. more appropriate temperature ; 5. more minerals / eq ; 6. fewer zooplankton ; 	max (2)

Question Number	Answer	Mark
2(b)(ii)	production of ATP / DNA / nucleotides / phospholipids / membranes ;	(1)

Question Number	Answer	Mark
2(c)(i)	grams (organic) carbon per square metre ;	(1)

Question Number	Answer	Mark
2(c)(ii)	<ol style="list-style-type: none"> 1. there is a (weak) correlation between temperature and productivity ; 2. the increase / decrease in productivity starts earlier than the increase in temperature ; 3. appropriate reference to data to illustrate points made ; 4. increase in productivity is more gradual than the increase in temperature ; 5. reference to other variables that may affect productivity e.g. light intensity or day length ; 	max (3)

Question Number	Answer	Mark
2(c)(iii)	<ol style="list-style-type: none"> 1. productivity is limited by temperature (in May) ; 2. reference to grazing by {zooplankton / <i>Calanus</i>} (in July) ; 3. reference to another limiting factor e.g. reduced (solubility) of carbon dioxide, depletion of mineral ions, photoperiod ; 	max (2)

Question Number	Answer	Mark
2(d)	<ol style="list-style-type: none"> 1. less food available / more predation / eq ; 2. low temperature optimum of its enzymes / eq ; 3. life cycle out of seasonal synchrony with the species it feeds on / {reproductive / migratory} behaviour / eq; 4. increased respiration rate may increase food requirement/deplete stored food reserves more quickly; 5. lower oxygen concentration ; 	max (2)

Question Number	Answer	Mark
2(e)(i)	<ol style="list-style-type: none"> 1. herring stocks were in (steep) decline prior to {the ban / 1978} ; 2. but recovered <u>rapidly</u>/eq once fishing was controlled ; 3. use of figures e.g. recovered to over half of the 1963 level in less than ten years ; 4. meanwhile cod stocks (which were not controlled) remained low ; 	max (2)

Question Number	Answer	Mark
2(e)(ii)	<ol style="list-style-type: none"> 1. (mean) size of (adult) cod will get less /eq ; 2. cod may {mature/become sexually mature} earlier/at a smaller size ; 3. genes for smallness/early maturity passed on to the next generation /eq ; 4. example of change in behaviour ; 	max (2)

Question Number	Marking Grid	Mark
3		(20)

A	Breadth: maximum of 6 marks <i>These marks are to be awarded to the candidate if they successfully introduce the general area of Biology relevant to the essay title. If a relevant B point is awarded then the corresponding A point should also be awarded. Key ideas to look for are in bold type - the candidate need only show evidence that he or she realises that key idea is appropriate in the essay to gain a breadth (A) mark. Indicate A₁ to A₁₀ on the script as appropriate</i>	B	Depth: maximum of 8 marks <i>These marks are awarded to candidates for demonstrating an understanding of relevant A level biological detail expanding on the areas of biology introduced in A. This list is not exhaustive but is designed to give an idea of the type of response worthy of credit for a (B) mark. Allow a maximum of 4 B marks per corresponding A mark. Indicate B_{1a} to B_{10d} on the script as appropriate</i>
A1	Homeostasis	B1a	Good definition of what is meant by homeostasis i.e. maintenance of a constant internal environment or similar.
		B1b	Correct description of negative feedback.
		B1c	Description of a control mechanism with reference to at least 2 of the following: set point/norm value, detector/receptor, comparator/regulator, corrective mechanism/effector, control system, signal/nervous impulse/hormones.
		B1d/B1e	Credit up to two specific example of homeostatic mechanism not covered in another A/B point below.
A2	Neurones and the nervous system / reflexes	B2a	Correct outline description of the organisation of the nervous system into CNS and peripheral nervous system.
		B2b	Description of structure of a typical neurone.
		B2c	Description of how a resting potential is set up in a neurone.
		B2d	Description of an action potential and the nature of a nerve impulse.
		B2e	Description of saltatory conduction.

		B2f	Description of a reflex arc.
		B2g	Credit a specific examples of reflexes such as the pupil reflex.
		B2h	Explanation of purpose of reflexes e.g. fast, automatic and protective.
A3	Role of brain in control and coordination / synapses	B3a	Correct reference to at least two regions of the brain and their corresponding functions: e.g. thalamus for relaying sensory information, visual cortex for interpreting visual information etc.
		B3b	Role of hypothalamus in control of much of the endocrine system (via pituitary gland)
		B3c	Correct reference to role of the pituitary gland.
		B3d	Description of the role of the brain in either: learning, processing information, recall and memory, calculation, control of behaviour etc.
		B3e	Description of how information is passed at a synapse.
		B3f	Role of synapses in coordination of information e.g. temporal and spatial summation or inhibition.
		B3g	Description of how synapses can be directly affected by the internal environment e.g. chemical imbalances/drugs.
		B3h	Correct description of habituation and/or sensitisation.
A4	Receptors/sense organs	B4a	Provide examples of at least 2 types of receptor and what they detect e.g. mechanoreceptors, chemoreceptors, thermoreceptors, photoreceptors, baroreceptors, proprioceptors.
		B4b	Further specific detail of a receptor e.g. details of a rod photoreceptor in the retina.

A5	Autonomic nervous system	B5a	Role of parasympathetic nervous system described e.g. rest and digest described.
		B5b	Role of sympathetic nervous system described e.g. fight or flight described.
A6	Hormones/endocrine system	B6a	Outline description of the endocrine system as glands releasing hormones into the blood.
		B6b	Example of a specific hormone and its role in control and coordination e.g. adrenaline in fight or flight, or insulin/glucagons in blood glucose regulation.
A7	Control and co-ordination at level of the cells	B7a	Good example of control of cell cycle via cytokines etc.
		B7b	Consequence of loss of control of cell cycle.
		B7c	Description of role of tumour suppressor genes / eq.
		B7d	Example of control of metabolic pathway e.g. end point inhibition / lac operon.
		B7e	Outline description of control of gene expression.
		B7f	Further detail of control of transcription / translation e.g. selective splicing of mRNA, transcription factors / methylation etc.
A8	Response of body to infection / damage	B8a	Non-specific immune response described e.g. inflammatory response / fever.
		B8b	Clonal selection of relevant lymphocytes.
		B8c	Role of macrophages described / eq.
		B8d	Blood clotting described.

A9	Response to damage in external environment (not credited elsewhere) e.g. thermoregulation / uv light	B9a	Role of hypothalamus in thermoregulation.
		B9b	Correct description of 2 methods of increasing heat loss e.g. vasodilatation leading to more radiation, sweating - leading to more heat loss through evaporation.
		B9c	Correct description of two methods of conserving heat/ generating more heat e.g. vasoconstriction - less radiation, shivering - more heat generated from respiration.
		B9d	Outline description of melanin production in response to uv light exposure.
		B9e	Reference to role of MSH and MSH receptors - different sensitivities to uv light.
A10	Control of heart/breathing	B10a	Ventilation centre in medulla (oblongata).
		B10b	Chemoreceptors respond to {CO ₂ / pH / temperature} of the blood which change as a result of respiration.
		B10c	pH change explained by production and dissociation of carbonic acid/ production of lactic acid by anaerobic respiration. Stimulation of stretch receptors causes exhalation.
		B10d	Cardiac muscle is myogenic.
		B10e	SAN under influence of cardiovascular control centre in the medulla (oblongata).
		B10f	Specific correct ref. to sympathetic nerve/vagus nerve.
		B10g	Greater venous return causes greater stroke volume.

A11	Osmoregulation/excretion	B11a	Description of role of liver in wide range of roles e.g. urea production for excretion.
		B11b	Outline description of role of kidney in osmoregulation.
		B11c	Role of kidney in excretion
		B11d	Role of kidney in control of pH/salt/blood pressure
A12	Behavioural responses	B12	Outline of a correct description of a behavioural response to help survival in a suitable context e.g. hide to avoid predator, adjust clothing worn/diet to survive in different environment.

UNPACKING THE QUESTION - MAXIMUM OF 6 MARKS

C1 A good comparison has been made between the nervous and endocrine systems.

C2 The essay clearly conveys that the systems described work closely together and rarely in isolation.

C3 Importance of thermoregulation described i.e. clear consequences of lack of regulation hypo or hyperthermia described - e.g. consequence on enzyme action and metabolism due to temperature change.

C4 Importance of cardiac output/ ventilation rate linked clearly to supplying muscle cells with oxygen/removing waste for respiration so we can respond to danger and move faster.

C5 Linked point to C4 but description also includes role of adrenaline and sympathetic nervous system.

C6 Importance of the reflex described for B3b clearly described together with consequence of the reflexes not working e.g. damage to retina if pupil does not constrict in bright light.

C7 Importance of osmoregulation or excretion well described with consequences of lack of excretion of CO₂, urea, imbalance of water/salt levels etc described.

C8 Example of consequence of a hormone not working correctly e.g. lack of insulin leading to diabetes mellitus and consequent potential problems described.

C9 Example of damage to brain and the effect it can have on a person - ultimately if your brain doesn't work you die.

C10 Good description given to explain how a human can survive in a particular environment / hazardous situation because of the way he/she can respond to the situation - probably combining physiological and behavioural responses.

C11 Explanation that complex brain has enabled complex behavioural responses and social learning, / detailed communication / tool use etc which made possible cultural and technological evolution so that we can manipulate our environment to help survival / eq.

C12 Description that human populations have shown evolutionary adaptations to survive in their environments e.g. melanin levels in skin, surface area to volume ratio due to body shape, etc.

C13 Description of effects of drugs or disease on control and coordination and the potential consequences for the body.

D: Coherence, clarity and expression of the answer - maximum of 4 marks

This strand will award students for **style** of their answer and is quite distinct from mentioning the big ideas (C). It isn't *what* candidates say but *how* they say it.

Level	Mark	Descriptor
Level 5	4	A truly synoptic essay which links together information from different parts of the specification in a coherent and logical style (introduction, conclusion, good use of paragraphs and well illustrated by examples). Good spelling, punctuation, grammar and sound use of technical terminology.
Level 4	3	Good logical structure with good spelling, punctuation, grammar and sound use of technical terminology, but tends to be a collection of information which, although relevant, tends to be disjointed and only partly attempts to synthesise information.
Level 3	2	A reasonably coherent account that includes satisfactory spelling, punctuation and grammar, which tends to be disjointed. A collection of information with little or no attempt to link ideas together.
Level 2	1	Some relevant information is presented in an intelligible way using correctly formulated simple sentences.
Level 1		The use of English is not adequate to convey scientific information beyond naming a list of examples. A candidate who has scored some marks (particularly in strand A) for mentioning some relevant points may nevertheless fail to score marks in strand D if he or she fails to form simple sentences.

Note that the maximum total mark which can be awarded is 20

Question Number	Marking Grid	Mark
4		(20)

	<p>Breadth: maximum of 6 marks <i>These marks are to be awarded to the candidate if they successfully introduce the general area of Biology relevant to the essay title. If a relevant B point is awarded then the corresponding A point should also be awarded. Key ideas to look for are in bold type - the candidate need only show evidence that he or she realises that key idea is appropriate in the essay to gain a breadth (A) mark. Indicate A₁ to A₁₀ on the script as appropriate</i></p>		<p>Depth: maximum of 8 marks These marks are awarded to candidates for demonstrating an understanding of relevant A level biological detail expanding on the areas of biology introduced in A. This list is not exhaustive but is designed to give an idea of the type of response worthy of credit for a (B) mark. Allow a maximum of 4 B marks per corresponding A mark. Indicate B_{1a} to B_{10d} on the script as appropriate</p>
A1	Embryo screening/PIGD	<p>B1a</p> <p>Clear description of selecting cells from an early embryo - i.e. context must be pre-implantation - <i>in vitro</i> as part of IVF.</p> <p>B1b</p> <p>Use of restriction enzymes to cut the DNA [<i>may be credited in context of A1, A2, A3 or A5 but not more than once</i>]</p> <p>B1c</p> <p>Outline correct description of gel electrophoresis and southern blotting [<i>may be credited in context of A1, A2, A3 or A5 but not more than once</i>]</p> <p>B1d</p> <p>Description of use of gene probe - complementary bases and labelled {radioactive/fluorescent} [<i>may be credited in context of A1, A2, A3 or A5 but not more than once</i>]</p> <p>B1e</p> <p>Example of a specific context and disease in which IVF and embryo screening would be worthwhile.</p>	
A2	Prenatal/foetal screening	<p>B2a</p> <p>{Amniocentesis/chorionic villus sampling/CVS} to obtain the cells from the foetus.</p> <p>B2b B2c B2d</p> <p>See B1b See B1c See B1d</p> <p>B2e</p> <p>Risk of miscarriage as a result of the techniques used to obtain the cells.</p>	

		B2f	Improved genetic screening of foetus for informed decisions re. Abortions/ preparation/ peace of mind.
		B2g	Example of specific disease in which prenatal screening may be used e.g. cystic fibrosis - <i>[must be different to any context awarded in B1e]</i>
A3	Adult screening	B3a	Clear use described e.g. to identify carriers/ early detection of genetic abnormalities in adults so that they can receive early treatment or make informed decisions about having children e.g. Huntingdon's Chorea
		B3b	See B1b
		B3c	See B1c
		B3d	See B1d
		B3e	Describe suitable source of cells e.g. cheek swab.
		B3f	Clear description of benefits / drawbacks of knowledge of predisposition e.g. can adjust lifestyle to reduce risks.
A4	Gene therapy	B4a	Normal allele inserted into a target cell by means of a suitable vector.
		B4b	Name/description of a suitable vector e.g. liposome, virus [not gene gun for human gene therapy used to insert a normal allele]
		B4c	Method of delivery of a vector to the cells e.g. nebuliser, direct injection into extracted stem cells.
		B4d	Outline description of transcription and translation of the new added gene resulting in the production of the functional protein and hopefully recovering lost function - relieve symptoms etc.
		B4e	Treatment needs to be repeated as somatic gene therapy is not a cure and the treated cells will die and need to be replaced.
		B4f	Can use gene therapy to modify stem cells to provide cure/replacement tissue - e.g. to cure SCID.

A5	Genetic fingerprinting	B5a	Measuring genetic diversity within a population
		B5b B5c B5d	See B1b See B1c See B1d
		B5e	Outline description of PCR to obtain enough DNA to carry out analysis. <i>[may also be credited in other contexts]</i>
		B5f	One other application of genetic fingerprinting discussed in context e.g. paternity testing/identifying a body/criminal, etc.
A6	Genetically modified organisms containing human genes	B6a	Plants, animals and bacteria may have a human gene inserted into them to produce a useful protein.
		B6b	Specific example provided e.g. bacteria to produce human insulin, factor 8 in milk/boar's semen/vaccines in plants like bananas.
		B6c	Modify animal cells so they are more similar to human cells for transplantation e.g. pigs hearts for xenotransplantation due to lack of human hearts available.
		B6d	Use of antibiotic marker genes
		B6e	Outline description of method for getting gene into the organism e.g. produce protoplasts and use gene gun/ <i>Agrobacterium</i> <i>[do not credit same technique as used for B4b if already credited.]</i>
A7	Understanding inherited diseases	B7a	If you find a gene associated with a specific inherited disorder you may be able to determine what protein it makes/ role it has in the cell and therefore explain how the mutation causes the disorder/eq

A8	Development of new medicines	B8a	If you identify the gene causing a disease you may be able to manufacture a protein/medicine that will replace the lost protein/ inhibit a malfunctioning protein / enzyme
		B8b	May use antisense drugs (RNA/complementary DNA) as new medicines to switch off malfunctioning genes e.g. oncogenes causing cancer.
A9	Understanding development/cell differentiation.	B9a	Cell development/differentiation is controlled by gene switching.
		B9b	Describe the role of transcription factors in the initiation of transcription for gene expression.
		B9c	Describe one other method of gene switching e.g. the lac operon, methylation, supercoiling.
		B9d	Description of cancer as a disease of the genes causing uncontrolled cell division, therefore the more we know about the genes controlling cell division the more likely we will be able to find a cure for cancer.
		B9e	Reference to ability to manipulate stem cells.
A10	Understanding mental health disorders	B10a	Many mental health disorders are multifactorial, including the involvement of one or more genes.
		B10b	Specific example provided e.g. Alzheimers linked to APOE genes.
A11	Understanding Human evolution/ancestry	B11a	Can trace migration patterns/ ancestry through the genes
		B11b	Y chromosome only inherited from father to son (often with the surname) helps determine family trees and ethnic origins/eq. /Mitochondrial DNA only inherited from mother through the egg.
		B11c	Tracing patterns of mutations and mutation rates helps show migration patterns, evidence for evolution of modern humans in Africa and subsequent migration across the world.
		B11d	Comparing genes/DNA sequences provides evidence for evolutionary relationships with other organisms/eq.

A12	Specific wider/ethical issues/dangers	B12a	Rights of the embryo/ foetus to life (reference to source of stem cells).
		B12b	Eugenics - selection according to genotype
		B12c	Gene therapy may cause further mutations - could cause cancer/eq
		B12d	Viruses used as vectors for gene therapy may become infectious and cause damage/disease.
		B12e	Suitable reference to insurance issues.

UNPACKING THE QUESTION - MAXIMUM OF 6 MARKS

C1 Results of genetic screening need to be handled with sensitivity and counselling should be provided.

C2 Discussion about whether the testing (esp embryo testing) is worth the cost/ hassle etc e.g. IVF is expensive and fairly unreliable and uncomfortable, but is it worth it in order to reduce the need for a possible abortion if they waited for a foetal screen rather than an embryo screen? Better not to know arguments e.g. some people prefer not to know if they have incurable conditions/ stress with positive result for presence of a particular allele.

C3 data protection issues / insurance issues e.g. high premiums if you inform the insurance company of a higher risk, but you will defraud them if you know you are likely to die prematurely but take out an extra large health/life insurance policy based on knowledge you withhold from the insurance company.

C4 Thin end of the wedge arguments (*Current applications are acceptable*) but might lead to greater pressure for designer babies/eugenics - misuse of the new technology or 'and why not?' e.g. arguments discussion of positive and negative issues surrounding designer babies (*recognising the argument but countering it*).

C5 information about the human genome is ethically/morally neutral, it is the applications you use the information for that may generate ethical/moral dilemmas.

C6 difficulties in policing genetic research legislation: *recognises that if this type of research continues there will need to be safeguards but these will be difficult to police and this throws the whole business into question/if we ban some types of research in the UK other it will merely move overseas to (less scrupulous) countries.*

C7 clear distinction provided between somatic gene therapy (legal treatment but not a cure) and germ line gene therapy (could cure/ prevent but illegal as dangerous and issues to do with future generations not being able to provide consent).

C8 DNA finger printing - only the guilty need fear - or a civil liberties time bomb?

C9 obtaining the DNA sequence is only the beginning, further research needed to identify the genes and understand what they do - Bioinformatics.

C10 Issues regarding patenting - who owns the DNA sequence? Can it restrict other research opportunities due to price? / eq.

C11 good discussion about some of the potential hazards of genetically modifying plants/animals e.g. super weeds, spread of antibiotic resistance/ new allergies etc.

C12 credit discussion of a further ethical issue e.g. is it worth the cost in comparison to trying to find an effective treatment for HIV/Malaria etc? Do the rights of one person to have a treatment outweigh a potential (but small) risk of a negative outcome for a wider population e.g. a transgenic pig heart may save a life, but there is a small risk that a new viral disease could be introduced to the human population (e.g. reactivate a dormant porcine retrovirus because it is now contained within a human host and may combine with an infectious human virus).

C13 It would be unethical to ignore potential for good in GM technology: the dangers and the need for regulation need to be recognised but the medical / environmental / agricultural opportunities to alleviate human suffering/save the planet/feed the hungry is such that it would be ethically wrong not to pursue it/to try to ban it.

D: Coherence, clarity and expression of the answer - maximum of 4 marks

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Note

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