GENERAL
CERTIFICATE OF
EDUCATION

Biology and Biology (Human)

Advanced Extension Award
6811

Specimen Paper and
Mark Scheme

Qualification Available: Summer 2002

Special Features

- Designed to extend and stimulate the study of Advanced level Biology and Biology (Human)
- Free standing: does not require candidates to be entered for a particular Advanced level.
- Designed to be independent of individual Advanced level specifications.

AQA ASSESSMENT AND QUALIFICATIONS ALLIANCE
CEA Rewarding Learning
OCR
WJEC CBAC
Edexcel

GCE

General Certificate of Education

Specimen Assessment Material
Advanced Extension Award

BIOLOGY AND BIOLOGY (HUMAN)
Specimen Paper

In addition to this paper you will require:
- a 12 page answer book.
  You may use a calculator.

Time allowed: 3 hours

Instructions

- Use blue or black ink or ball-point pen.
- Write the Paper reference 6811 on the front cover of your answer book.
- Answer **all** questions in the answer book.
- This paper is divided into four sections, A, B, C and D. Answer **all** parts of the questions in Sections A and B. Answer **one** question from each of Sections C and D.
- Do all rough work in the answer book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 100.
- Each question carries 25 marks. Mark allocations for part-questions are given in the question paper.
- Quality of Written Communication will be assessed in your answers to Sections C and D. You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- Answers may be illustrated with diagrams provided that the diagrams explain or add to the written information.
- Graph paper is available on request.
- You are expected to use a calculator where appropriate.

Advice

- You are advised to spend about 45 minutes on each question. You may answer the questions in any order.
- Read each question carefully in sections C and D before making your choice. Before beginning your answer, plan out roughly what you intend to write.

Paper reference: 6811

SECTION A

Study the material below and answer **all** parts of the question.

1 One of the major functions of the plasma membrane is to act as a barrier. Because the membrane is such an effective barrier, the cell faces a problem – how to take up nutrients and get rid of waste products. Water is a small molecule so it is able to diffuse through the phospholipid bilayer to a limited extent. This means that all plasma membranes have a small but finite water permeability. But some cells have water permeabilities that are 100 to 1000 times higher than this basal level.

Observations such as this led scientists to suspect the existence of water channel proteins but the first of these was not isolated until 1988 and then quite by chance. At this time a group of biologists working in the USA was attempting to purify a protein from red blood cell membranes. The one they were interested in was the Rhesus antigen but their preparation was found to be contaminated with another protein of the same molecular mass. They investigated this second protein and ultimately determined its complete amino acid sequence. It was named CHIP28.

Given the amino acid sequence of a protein, molecular biologists can make predictions about its function. For example, in CHIP28 there are six regions containing hydrophobic amino acids. These span the membrane and cluster round a central pore. Proof of the function of CHIP28 came from an elegant series of experiments based on injecting mRNA coding for CHIP28 into immature egg cells taken from a frog. The injected cells were then transferred from their normal saline bathing solution and their behaviour compared with that of suitably treated controls.

Quite early on, it was noticed that CHIP28 had an amino acid sequence very similar to that of a number of other proteins. These included a membrane protein found in soya-bean root nodules, a glycerol transporter found in bacteria and a brain protein found in the fruit fly. Clearly this family of proteins is a very ancient one. Some of the amino acid sequences, particularly in the so-called B and E loops of these molecules, are the same in all these proteins. These "sequence homologies" between known members of this protein family have enabled molecular biologists to use the polymerase chain reaction (PCR) to search for related proteins in other tissues. In this way four more water channel proteins or aquaporins have been identified in mammals. Two of these, AQP1 and AQP2 have been linked to kidney function and are found in the membranes surrounding the lumen of the nephron. Another aquaporin, AQP4, is found in the plasma membranes of specialised neurones in the hypothalamus.

Aquaporins are also found in plants where they have a variety of functions. They are expressed in varying amounts in all the organ systems of the plant. For example γ-TIP is particularly plentiful in the elongation zone of root tips; α-TIP is specific to seeds and may be involved in the early stages of germination. Another member of this group, RD28 is expressed during times of drought and probably helps cells to maintain turgor.

Adapted from: Steward M. (1996) *Water Channels in the Cell Membrane*
Biological Sciences Review Vol 9 No 2

(a) Explain why biologists predict that the regions of CHIP28 containing hydrophobic amino acids span the plasma membrane (lines 15 - 16).

(2 marks)

(b) Lines 17 to 20 refer to the experiments carried out to determine the function of CHIP28.

(i) Suggest an explanation for using immature eggs from a frog.

(3 marks)

(ii) Suggest how the function of CHIP28 could have been demonstrated by these experiments.

(3 marks)

(c) Explain the evidence for claiming that the family of proteins containing CHIP28 is a very ancient one.

(2 marks)

(d) The polymerase chain reaction is a method of producing a large number of copies of a piece of DNA. The key ingredients are DNA nucleotides, DNA polymerase (an enzyme which makes new DNA) and two primers. These primers are short polynucleotides which are complementary to two sites either side of the DNA you want to identify and copy. Heat is used to separate the two strands of the original DNA molecule and then the primers and DNA polymerase bring about the synthesis of complementary strands of DNA.

Describe how the polymerase chain reaction has enabled biologists to search for proteins related to CHIP28 in different tissues (lines 26 - 28).

(4 marks)

(e) (i) Suggest how aquaporins AQP1 and AQP2 may be linked with kidney function (lines 29 - 31).

(3 marks)

(ii) Describe the possible role of the aquaporin, AQP4, in the plasma membranes of neurones in the hypothalamus (lines 31 - 32).

(2 marks)

(f) (i) Discuss the potential of the protein RD28 in increasing crop yield.

(ii) What specific problems might result from genetically modifying crop plants to contain this protein?

(6 marks)

SECTION B

Study the material below and answer **all** parts of the question.

2 Although New Zealand is very similar in size to the United Kingdom, its isolated position means that it has a very different mammal fauna. Only five species of land mammal, two bats and three seals, are native to New Zealand. All the other mammal species found there have been introduced by humans, either deliberately or accidentally.

Table 1 compares the sizes of land-breeding mammals in New Zealand with sizes of land-breeding mammals in the United Kingdom.

Table 1

Mean body mass	<100g	100g - 1kg	1kg - 10 kg	>10kg	Total number of species
Number of New Zealand species	4	5	8	19	36
Number of UK species	29	12	7	15	63

(a) Comment on the data in *Table 1*. *(5 marks)*

The possum was introduced to New Zealand from Australia just over a hundred years ago. Since then it has spread widely and is now found all the way from the warmer north of the country to the colder south. *Table 2* shows the lengths of adult possums captured at a number of sites in New Zealand.

Table 2

Site	**Latitude**	**Number in sample**	**Total length/mm (mean ± standard deviation)**
Auckland(North New Zealand)	36º 37'	40	786*
Hawke's Bay	39º 43'	25	787 ± 59
Wairarapa	40º 54'	20	780 ± 47
Orongorongo Valley	41º 22'	60	789 ± 30
Nelson	41º 55'	62	831 ± 47
Westland (South New Zealand)	42º 45'	31	840 ± 37

* Standard deviation not known

(b) (i) To what extent do the data in *Table 2* support the view that body size increases with increasing latitude. *(3 marks)*

(ii) Suggest an evolutionary explanation for the trend in body length shown in the table. *(3 marks)*

(c) In Australia, where they are native, 8.3 % of adult possums do not have canine or premolar teeth in the upper jaw. The figure for the population in Wairarapa was 24.3%.

(i) The Wairarapa figures were described as being significantly different at the P 0.05 level from the Australian figures. Explain the meaning of this statement. *(2 marks)*

(ii) Assuming that the presence or absence of canine teeth has no selective advantage, suggest reasons for the difference in the percentage of possums without canine teeth. *(3 marks)*

There are four species of rats and mice in New Zealand. *Table 3* shows some of their features.

Table 3

Feature	Species			
	Kiore *Rattus exulans*	Black rat *R. rattus*	Brown rat *R. norvegicus*	House mouse *Mus musculus*
Adult body mass/g	60 – 80	120 – 160	200 – 300	15 – 20
Maximum head-body length/mm	180	225	250	115
Number of nipples	8	10 – 12	12	10 – 12
Gestation/days	19 – 21	20 – 22	21 – 24	19 – 21
Mean number of young per litter	5.7	5.9	7.1	5.7

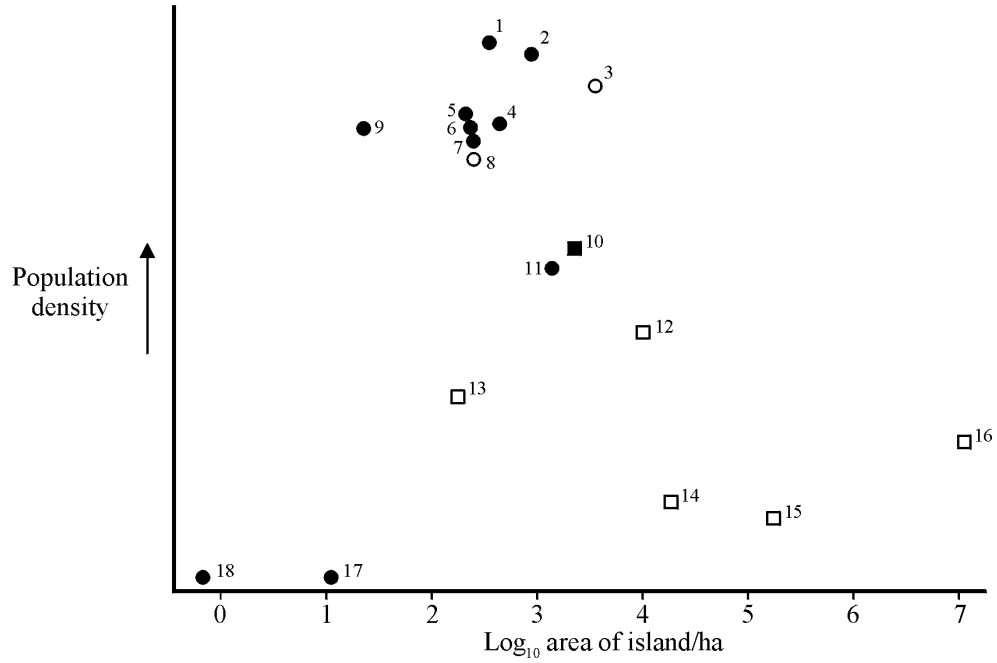
The kiore is a rat which in New Zealand is confined to islands. In one series of studies, snap traps were used to monitor the populations of kiore on a number of islands. These traps killed the animals that were caught.

(d) (i) Describe briefly how snap traps might be used to compare the size of kiore populations on different islands. *(2 marks)*

(ii) Evaluate the method you have suggested, discussing the main sources of error. *(3 marks)*

(e) The results of this study are shown in the graph in *Figure 1* on page 6.

Figure 1



Key

Squares indicate islands with other species of rats and mice as well as kiore
Circles indicate islands with no other species of rats and mice, only kiore

Solid symbols indicate cats are present
Open symbols indicate cats are absent

Numbers refer to individual islands

Suggest explanations for these results. *(4 marks)*

SECTION C

Answer **one** question from this section

In addition to the biological content of your answer, marks will be awarded for your ability to:

- select appropriate and relevant material from different areas of your biological knowledge and apply this to the topic concerned;
- organise and present information clearly and logically, using appropriate scientific terminology

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3 Membranes are found both in and around cells. How do cell membranes differ from each other in their structure and function?

4 Describe the ways in which human activities affect the transfer of energy in ecosystems.

5 Explain what is meant by homeostasis. To what extent to organisms other than mammals show homeostasis.

SECTION D

Answer **one** question from this section.

In addition to the biological content of your essay, marks will be awarded for your ability to:

- develop and support a general argument with appropriate biological information;
- organise and present information clearly and logically, using appropriate scientific terminology.

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6 Discuss the view that increasing the concentration of carbon dioxide in the atmosphere will lead to an increase in the yield of crop plants.

7 The measures recently adopted to control foot and mouth disease included extensive closure of footpaths and open land, and the slaughter of animals. As a biologist, discuss whether or not you would expect these measures to be effective.

8 Some medical conditions can be treated by transplanting a healthy organ into the affected person. Xenotransplants are transplants taken from other species of organisms. What are the arguments for and against using xenotransplants as a way of overcoming the current shortage of human organs available for transplant.

END OF QUESTIONS

BIOLOGY

ADVANCED EXTENSION

SPECIMEN MARK SCHEME

SECTION A

1 (a) In this position associate with hydrophobic part of phospholipids;
Avoiding contact with water; 2

(b) (i) Possibility that meiosis has not taken place;
Therefore genetically identical at this stage;
Likely to be no variation in proteins expressed which act as aquaporins;

or

Frog's eggs laid in fresh water;
Which would have a higher water potential than cytoplasm/Water likely to enter by osmosis;
At maturity changes in membrane may restrict entry of water; 3

(iii) Transferred to dilute/more concentrated saline and change in volume/diameer recorded in given time;
Compared with control;
Involving injecting eggs with equal volume of water/mRNA-free solution; 3

(c) Found in a wide range of organisms;
Bacteria are so different from eukaryotic/other organisms mentioned that they are likely to have diverged long ago; 2

(d) DNA from tissue will need to be extracted and cut into manageable lengths;
Primers based on DNA sequence coding for sequence homologies added;
PCR will then produce large amounts of DNA containing these sequences;
If this is present, then tissue likely to produce one of these proteins;
Detection of gene however does not detect that protein is being produced;
4 max

(e) (i) Allow water to be removed from nephron rapidly;
Two types suggest that they may function in different ways;
Possible that one of these types found in collecting duct linked to ADH;
ADH secretion associated with an increase in number of these aquaporins/controls their opening; 3 max

(ii) These are possibly cells which secrete ADH;
Aquaporins will enable them to respond rapidly to a change in the osmotic concentration of the blood; 2

(f) More marginal land could be cultivated;
Likely to be necessary as a result of climatic change stemming from global warming/increased population pressure;
Limiting wilting and therefore providing greater surface for interception;
Of light; Therefore plants able to make this protein can photosynthesise for longer in dry conditions;
Gene could be spread to related weeds in pollen;
Making these weeds better able to compete;
Also potential problems associated with using (specified) marker genes; 6 max

SECTION B

2 (a) Smaller number of species in New Zealand reflects larger distance from nearest land mass and difficulty in colonisation;
Greater percentage/proportion of larger species;
Supported by appropriate quantitative evidence;
Larger species regarded as useful for hunting/meat etc;
Smaller species tending to be commensal; and few of these adapted to living in close proximity to humans; 5 max

(b) (i) Limited significance as differences in mean are small compared with large standard deviation;
May (in some cases) reflect sample size;
Some anomalies in trend, e.g. Auckland;
Size has other dimensions as well as length; 3 max

(ii) Ancestors/Australian possums showing genetic variation in terms of length;
Larger possums with smaller surface area/volume ratio/more subcutaneous fat and better able to survive colder conditions;
Differential survival, reproduction and passing on of alleles; 3

(c) (i) Less than 5 %/1 in 20 probability;
Of results being due to chance; 2

(ii) Could be an environmental/nutritional factor;
Affecting tooth development;
Presence or absence of canine teeth is determined genetically;
Founder effect/large proportion of introduced possums have relevant alleles;
Loss of teeth linked to valid explanation; 3 max

(d) (i) Method based on random sampling;
And producing an index related for example to number of traps set/trap nights; 2

(ii) Allow one mark for each valid point related to method suggested.
For example:
Needs a large sample which might affect future population size;

Different habitats are likely to support different populations;
Males/females/young/adults may have different chance of being caught, thus producing a seasonal effect; 3 max

(e) Small islands have a low population density of kiore, possibly as they do not support enough food/suitable habitats;
Density higher on islands not inhabited by cats which are probably significant predators;
Density also higher on islands not inhabited by other mice and rats;
Likely to compete as black and brown rats larger in size;
Comment on breeding rates of kiore and black and brown rats;
Comment on limited nature of data in some categories; 4 max

SECTIONS C and D

General principles for marking questions in these sections

Four skill areas will be marked: Biological content (C)
Scope of knowledge (S)
Relevance (R)
Quality of written communication (Q)

These skill areas will be marked independently of each other. Providing that there is sufficient evidence and the subject content is relevant to the question answered, it is possible for candidates to obtain maximum credit for skill areas S, R and Q even if they gain few marks for the biological content.

The following descriptors will form the basis for marking

Biological content (maximum 16 marks)

Mark	Descriptor
16	Material accurate and of a high standard throughout, reflecting a comprehensive understanding of the principles involved, and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, a significant amount of the content involves material which indicates greater depth of study
14	
12	Some minor errors which detract from the overall accuracy. Content reflects understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, occasional significant references to material which indicates a greater depth of study.
10	
8	Generally accurate and free from fundamental errors. Content reflects understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. No significant reference to material which indicates a greater depth of study.
6	
4	Material largely superficial and either fails to reflect understanding of the principles involved or fails to show a knowledge of factual detail in keeping with a programme of A-level study. If greater depth of knowledge is demonstrated, then there are a number of fundamental inaccuracies. No indication of material which indicates a greater depth of study.
2	
0	Material superficial and inaccurate seldom reflecting the depth expected from a programme of A-level study.

Note: Only marks 0, 4, 8 etc are described. This limits the number of categories and improves consistency of marking. Marks intermediate between descriptors may be awarded.

Scope of knowledge (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most if not all areas that might realistically be covered in the relevant parts of an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to treatment at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect
0	Material mostly irrelevant

Relevance (maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly related to the title. Allowance should be made for judicious use of introductory material.
2	Material generally selected in support of the title but some of the main content of the essay is of marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant
0	Material entirely irrelevant or too limited in quantity to judge

Quality of written communication (maximum 3 marks)

Mark	Descriptor
3	Material is organised and presented clearly and logically. Technical terminology has been used effectively and accurately throughout.
2	Most of the material is organised and presented clearly and logically. Technical terminology has usually been used effectively and accurately.
1	The essay generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

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Sample Answers to
Sections C and D

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ADVANCED EXTENSION AWARDS

BIOLOGY AND BIOLOGY (HUMAN)

1 INTRODUCTION

Candidates are offered a choice of essays in Sections C and D of the paper. Although to a certain extent the marks gained by a candidate in any examination which involves options will depend on question choice, it is important that the final mark genuinely reflects the quality of the work offered. As such, the mark scheme offered must make equal demands of candidates, whatever their choice of question. As well as this, candidates entering for the Advanced Extension Award are likely to have been prepared for one from a number of different A-level specifications and their courses may have emphasised different aspects of biology. The essays which form half the total number of marks available on this paper, are designed to test a number of objectives in addition to the ability to demonstrate knowledge with understanding. Because of this, a mark scheme is required which will credit other skills as well as the ability to recall items of factual information.

2 THE MARK SCHEME FOR THE ESSAYS

Four skill areas will be marked:

Biological content (C)
Scope of knowledge (S)
Relevance (R)
Quality of written communication (Q)

These skills will be given different weightings with a total of 16 marks for biological content and 3 marks each for the remaining skill areas.

These skill areas will be marked independently of each other. Providing that there is sufficient evidence and the subject content is relevant to the question answered, it is possible for candidates to obtain maximum credit for skill areas S, R and Q even if they gain few marks for the biological content.

The following descriptors will form the basis for marking:

Biological content (maximum 16 marks)

- It should be noted that only marks 0, 2, 4 etc are awarded. This serves to limits the number of categories and improves consistency of marking.

- Marks intermediate between descriptors may be awarded for work which is of an intermediate quality.

- A maximum of 16 marks is available for a piece of work which matches the relevant descriptors and has been completed in approximately 45 minutes. For many candidates this probably reflects around 3 - 4 sides of hand-written script. Examiners are careful to avoid awarding maximum credit only to those who write at inordinate length.

- Credit may be given for information offered as part of a plan, where this information adds to the quality of the essay. Such plans will never result in candidates being penalised.

Mark	Descriptor
16	Material accurate and of a high standard throughout, reflecting a comprehensive understanding of the principles involved, and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, a significant amount of the content involves material which indicates greater depth of study.
14	
12	Some minor errors which detract from the overall accuracy. Content reflects understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, occasional significant references to material which indicates a greater depth of study.
10	
8	Generally accurate and free from fundamental errors. Content reflects understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. No significant reference to material which indicates a greater depth of study.
6	
4	Material largely superficial and either fails to reflect understanding of the principles involved or fails to show a knowledge of factual detail in keeping with a programme of A-level study. If greater depth of knowledge is demonstrated, then there are a number of fundamental inaccuracies. No indication of material which indicates a greater depth of study.
2	
0	Material superficial and inaccurate seldom reflecting the depth expected from a programme of A-level study.

Scope of knowledge (maximum 3 marks)

- This skill rewards candidates for their ability to select and draw on material from different parts of the specification.

- Credit may be also be given in this section for information offered as part of a plan, where this information adds to the quality of the essay. Again, such plans will never detract from the candidate's mark.

Mark	Descriptor
3	A balanced account making reference to most if not all areas that might realistically be covered in the relevant parts of an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to treatment at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect.
0	Material mostly irrelevant.

Relevance (maximum 3 marks)

- This skill rewards candidates for the ability to select relevant material with which to illustrate their answers. Material which is clearly irrelevant will result not only in a low mark for this section but will limit the mark that is awarded for scientific content.

- The examiners accept that candidates may feel it necessary to explore topics in rather greater breadth in setting the scene as part of an introduction. Allowance will be made for such material. The emphasis throughout the marking of this skill will be the award of credit rather than the penalising of occasional lapses.

Mark	Descriptor
3	All material presented is clearly related to the title. Allowance should be made for judicious use of introductory material.
2	Material generally selected in support of the title but some of the main content of the essay is of marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

Quality of written communication (maximum 3 marks)

- The emphasis in marking this skill will be to reward those aspects of the quality of written communication to which reference is made in the assessment objectives. As such the emphasis will be on the appropriate use of technical terminology and clear and logical presentation rather than spelling, punctuation and grammar.

- Centres are reminded that special consideration should be requested for candidates whose ability to communicate effectively is affected by illness or other circumstances.

Mark	Descriptor
3	Material is organised and presented clearly and logically. Technical terminology has been used effectively and accurately throughout.
2	Most of the material is organised and presented clearly and logically. Technical terminology has usually been used effectively and accurately.
1	The essay generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge

3 EXEMPLAR MATERIAL

Question 1

Membranes are found both in and around cells. How do cell membranes differ from each other in their structure and function?

ESSAY A

Membranes vary dramatically between those found on the outside of cells compared to those found containing the contents of organelles within the cell, although there are similarities in both structure and function.

The phospholipid bilayer that surrounds the cell basically controls what enters and leaves that particular cell, therefore it acts like a barrier. The fluid mosaic model proposes that it isn't static but constantly moving and changing shape with various features that have made it ideal for the function that it has. The phospholipid contains a hydrophobic tail and a hydrophilic head. When placed in water, bathed in the liquids our body is ultimately made up of, the phospholipid arranges itself according, with the tails facing inwards away from water, with the hydrophilic heads facing outwards. Within this structure, various adaptations have occurred enabling the different functions of the membrane to be carried out. Protein pores are present, thus meaning easy exchange of molecules that are too large to just diffuse through the membrane, such as Na^+ ions. Molecules such as oxygen, water and carbon dioxide have no problems diffusing through the bilayer, however. Receptors are also present within the membrane allowing chemical "messages" to be received and transmitted, with the chemical adrenaline being the best example.

Within the cell, there are many different membranes for many different organelles, some having similar structures and functions to that of the external membrane, although some have completely differing structures and functions compared to the previously mentioned.

The nucleus is surrounded by a double-enveloped membrane, not surprisingly called the nuclear membrane. This too is made of phospholipids arranged in a similar fashion to that of the external membrane, although nuclear pores are present, allowing exchange of nucleus information, such as mRNA, efficiently. Mitochondria also have this same double envelope, although this is often folded inwards to form cristae. This increases the surface area of the mitochondrion, as the inner membrane aids the function of this organelle, which is the "powerhouse" of the cell, converting ATP acquired during respiration to energy.

The most striking difference between internal and external membranes is the endoplasmic reticulum. This is layers of membrane folded in flattened like sacs

which form the transport network of the cell, which is the cytoplasm. This membrane can be encrusted with ribosomes (RER), which is a striking difference between this and the external membrane. The function is also different in comparison with the external cellular membrane. The RER provides the site of protein synthesis in the cell - a vital aspect of the workings of the cell.

The structure and function, in summary, between internal and external membranes is similar but also differs. The phospholipid bilayer on the external membrane provides a barrier to exchanging materials, a vital function, therefore has many pores and receptors. The cell membrane compared to the internal membranes is relatively large. The nuclear envelope is also double-membraned with pores, similar to those present in the cell membrane, to allow exchange, although no pores are present in the mitochondrial membrane , which is also folded internally. The main difference in function between internal and external membranes is in ER, whose membranes provide transport and protein synthesis, unlike the external cell membrane. With smooth ER being the site for toxin synthesis, the structures, especially also the functions of cellular membranes can vary dramatically.

Overall marks

C	**6**
S	**2**
R	**3**
Q	**2**
Total	**13**

Biological content (C)
Apart from a fairly basic error concerning the role of mitochondria in converting ATP acquired during respiration to energy this essay is generally accurate and free from errors.
Its content also reflects understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study and there is no significant reference to material which indicates a greater depth of study. All this seems to indicate that we should be looking at around 8 marks. However, given the rather superficial nature of some of the contents, particularly those referring to the functions of some of the cell organelles, the best mark may lie between the descriptors at 6.

Scope of knowledge (S)
The descriptor for two marks - A number of aspects covered but a lack of balance. Some topics essential to treatment at this level not covered. - matches the quality of the work best. Although consideration is given to a reasonable range of cell organelles, the emphasis is largely on function and there are few references to structure.

Relevance (R)
It is difficult to fault this in terms of relevance. The answer is confined to aspects of the structure and function of membranes and as such it should gain the maximum mark.

Quality of written communication (Q)
The best descriptor is probably that for two marks. The last paragraph is somewhat repetitive and lacks fluency. Such technical terminology as is used is generally used effectively and accurately.

ESSAY B

Structure and function are frequently explored in A-level Biology. Linking these topics is appropriate to the discussion of structures such as cell membranes as well as individual cells or organs. Cell membranes have a number of different functions. There are straightforward mechanical aspects. The membrane to some extent has a protective role and it also provides a degree of support to the cytosol. The plasma membrane isolates a cell to some extent from its immediate environment It regulates the passage of substances into and out of the cytoplasm. In addition to this the protein and carbohydrate molecules which it contains enable recognition between cells. Enzyme-controlled reactions are also catalysed on its surface. Inside the cell are many other membranes. In eukaryotic cells, many of these membranes surround such organelles as mitochondria, chloroplasts and nuclei and have a variety of different functions. These include the support of enzymes and the compartmentalisation of the cell so that different metabolic pathways are localised in the cell. I shall look at some of these different functions in rather more detail.

Before we can discuss this aspect of membrane function in detail we need to look at some aspects of the basic structure of the plasma membrane. All membranes are based on a phospholipid bilayer. This results from the association of the hydrophobic hydrocarbon "tails" of the fatty acids which make up the phospholipids. Associated with the phospholipid bilayer are proteins which may penetrate the membrane or be associated with one or other of its surfaces. Other molecules are also found. Cholesterol, found in animal cell membranes is thought to reduce the fluidity of the membrane by reducing the sideways movement of the phospholipids. Interestingly, in membranes where limited permeability is important, such as those forming the myelin sheath round the axons of nerve cells, there is a relatively high concentration of cholesterol.

To return to function. Small molecules and those that are lipid soluble are able to pass directly through the membrane, possibly moving between the phospholipids. Other substances require the aid of proteins. I will consider one of these proteins here. Water can diffuse through a plasma membrane down a water potential gradient but this process is slow. It has been found that in many cells passage of water is much faster than this mechanism would allow. We will consider as an example those cells in the hypothalamus which are responsible for detecting changes in the water potential of the blood. They have specialised proteins in their membranes called aquaporins. Aquaporins have a number of hydrophobic domains in their polypeptide sequences which enable them to form pores in the membranes of hypothalamus cells which speed the entry of water, enabling a rapid response to dehydration.

Another example of a cell membrane with a specialised protein - in this case part of a cell - are those sections of a cell membrane responsible for taking up cholesterol. Cholesterol is absorbed by the cell in the form of LDLs (low-density lipoproteins) LDLs are taken in by endocytosis. Protein molecules in the lipid layer surrounding the LDL latch onto specialised protein receptors in the cell. These receptors are associated with other proteins in which enable vesicles to form. So parts of plasma membranes differ from each other in structure and function.

Membranes found within cells have a wide range of functions as well. One of the most important of these is that they allow for compartmentalisation. Take as an example, the lysosomes. These organelles play an important part in breaking down molecules in the cell once they have gone beyond their "sell-by date" They contain a wide range of hydrolases and clearly if they were free in the cytoplasm, cell structures would be very much at risk. The membranes surrounding lysosomes are resistant to the action of these hydrolases and therefore protect the cell contents.

An advantage of having enzymes on membranes in organelles is that they increase the probability of an enzyme colliding with its substrate in that they restrict substrate movement to two dimensions rather than three dimensions that would be the case if the enzymes was free in the cytoplasm. It is also possible to assemble enzyme systems in this way so that the various enzymes responsible for a complete pathway are close together as a fundamental part of the membrane.

Membranes are also of vital importance in mitochondria and chloroplasts where they allow for an electron-driven proton gradient to be established. It is the movement of protons down this gradient which is responsible for the transfer of energy in the formation of ATP. The various carrier molecules and enzymes necessary form an integral pert of the structure of the membrane
So what we can see from the examples that I have discussed is that when we write about membranes, structure really is related to function.

Overall marks

C	**16**
S	**3**
R	**3**
Q	**2**
Total	**24**

Biological content (C)
The key here is not only is the material accurate and reflecting a comprehensive understanding of the principles involved but a significant amount of the content involves material which indicates greater depth of study. Worth commenting on are the references to aquaporins, cholesterol and compartmentalisation in particular. This is worth maximum credit for this section.

Scope of knowledge (S)
This section is also worth full credit. The introduction is necessarily an overview but considers a considerable number of aspects of structure and function. A selection of aspects have then been developed in detail. Given the time available, the candidate has established a nice balance of depth and breadth.

Relevance (R)
Clearly relevant throughout.

Quality of written communication (Q)
Obviously written in haste but quality has not been sacrificed for quantity. The style is fluent and technical terminology is used is accurately - the penultimate paragraph is worth reading in this respect.

Question 2

Some medical conditions can be treated by transplanting a healthy organ into the affected person. Xenotransplants are transplants taken from other species of organisms. What are the arguments for and against using xenotransplants as a way of overcoming the current shortage of human organs available for transplant?

Essay C

Xenotransplantation being the transplantation of organs or cells between species is by no means a new idea. Doctors have been attempting cross species transplants since as early as the 17th century but had little success. The earliest successful xenotransplant was in 1963 when a patient survived nine months with a chimpanzee kidney.

The beneficial sides of xenotransplantation are simple. Many people die every day waiting for organ transplants. There is a huge demand for organ transplants and we cannot easily meet this without embarking on unethical approaches such as paying people in the third world to give a kidney. If xenotransplantation became acceptable we could set up supplies of organs in organ farms so that anyone who needed a new organ could get one easily and not have to wait until a suitable organ became available.

Human bodies can distinguish self and non-self. If foreign cells are found in the body, they are assumed to be pathogens and are fought and destroyed by the body's immune system. To overcome this people are given immunosuppressant drugs which dampen down the immune system and prevent rejection. This solution, however sets up a new problem. The body cannot now defend itself against bacteria and viruses. So the patient could die from something which would not normally be lethal. This is one strong argument against xenotransplantation. The more different an organ, the stronger the immunosuppressant drugs that have to be used and the longer they will have to be used for.

Another problem is that transplanting an organ could introduce a disease into the body. The possibility of introducing new killer viruses really does exist. Normally a virus only affects one species but if we transplant a kidney from a pig to a human, the cells in the transplanted kidney could be carrying a virus in its DNA. This virus could mutate and affect the human concerned, possibly spreading rapidly from person to person One example of this is the PERV (porcine endogenic retrovirus). This virus has, over many generations, become part of a pig's DNA. It appears to be quite harmless. When introduced to humans though, it is impossible to predict what might happen. This sort of situation has already arisen with AIDS. AIDS is caused by HIV. A person with AIDS shows a number of symptoms. These include initial fever and a general rash and then the virus lays quiet. It has gone on, however, quietly doing its sinister work and eventually, the patient will die of full-blown AIDS. We think

that AIDS comes from monkeys, possibly chimpanzees. Scientists now have a theory that the chimpanzee virus contaminated polio vaccines and enabled the virus to escape into humans.

Apart from scientific worries about transplanting an organ from one person to another there are also ethical considerations. Are we right to breed animals in conditions that have to be kept so sterile that even the young piglets have to be born by Caesarean rather than letting them pick up bacteria and viruses from thmeir environment? Is it right to use an animal just for a single organ when if, for example, the person was a smoker, the illness from which he suffered might have been his fault anyway? How would you feel if you knew that the new heart inside you came from an animal such as a pig? These are all questions which we must answer before xenotransplantation becomes a real possibility. It is even possible with the current research on stem cells, that we will never need to develop the possibility of xenotransplantation any further.

Overall marks

C	**8**
S	**3**
R	**2**
Q	**1**
Total	**14**

Biological content (C)
The candidate has obviously constructed an argument and has made a genuine attempt to support this with suitable biology. The overall account however, is very superficial - note, for example the material on the functioning of the immune system. A mark of 8 has been awarded reflecting a compromise between the superficiality which would suggest 4 marks and the fact that some material does reflect the greater depth of study which would led to the award of a higher mark. The ethical material posed relevant points.

Scope of knowledge (S)
This section is just worth full credit. There has been an attempt to address both sides of the argument and consider both biological and ethical issues.

Relevance (R)
Most of this is relevant but it wanders from the theme in introducing the material about HIV and the development of AIDS. Fits the descriptor for 2 rather better than that for 3.

Quality of written communication (Q)
Although the account was readable and the argument was presented logically, the style tended to become somewhat journalistic. Technical language was also notable by its absence. As such, a mark of 1 is probably most appropriate.