Questions matter

Notes and guidance: Paper 3 essay Appendix 3

A-level Biology (7402)

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Appendix 3: Marked and annotated examples of student responses

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Extended Abstract

Student A

0 7 . 1 The importance of interactions between organisms and their environment. **[25 marks]**

Plan

- Taxis + Kinesis
- Receptor + nociceptor
- Nitrogen cycle
- ~~Coarse~~ Osmoregulation
- Natural selection
- Trichinella life cycle

Essay (The importance of interactions between organisms + environment)

One process which shows the importance of the interactions between organism and their environment is taxis. In taxis a motile organism moves either positively or negatively in response to a change in stimulus. An example of this is in the Anopheles mosquito which uses positive thermotaxis and ~~kinesis~~ chemotaxis to ~~decrease~~ locate a suitable warm-blooded organism to feed off. They

lay low in grass and detect trails of CO_2, as it is dense in air so it sinks, which leads them to respiring organisms. When they are approaching they use positive thermotaxis in response to a change in heat to locate their prey and use olfactoception to determine its suitability via specific fragrance molecules. Then This process is important because it allows them to find a suitable blood meal with a high concentration of plasma proteins which they use to develop ovum in order to reproduce. Only females need to find blood meals in this way and it allows for the propagation of their species as their food sources do not supply high enough concentrations of amino acids to produce eggs.

This student's first topic is 3.6.1.1 Survival and response. Overall, they have outlined what a taxis is at A-level depth and illustrated the importance of this taxis with a beyond specification example of the mosquito, again, at A-level depth. Note, there is no need to cover any other parts of topic 3.6.1.1, for example IAA, kineses or the simple reflex.

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Another process in which responses to changes in environment is important is the use of receptors to create a generator potential. Receptors detect a change in the external environment, such as an increase in pressure in Pacinian corpuscles. An increase in pressure leads to lamellae deforming and causing stretch-mediated Na+ channels to open which causes an influx of Na+ which, if it reaches threshold potential, causes the axon to depolarise and results in an action potential being

fired down the sensory neuron. The importance of this process is demonstrated in the detection and modulation of pain. When pressure or temperature are detected beyond tolerable limits, it results in the stimulation of nociception instead. Through a reflex arc, the body moves away from the stimulus subconsciously to prevent damage. However once the nociceptor action potential reaches the thalamus and primary somatosensory cortex we become consciously aware of the pain. This process is particularly important in the development as pain is a very effective teacher and the occurrence learns to avoid the painful stimulus and avoid damage. Once the stimulus is removed, the body releases endogenous opioids from the substantia gelatinosa which modulate the pain after the reason has been removed.

This student's second topic is 3.6.1.2 Receptors. They have correctly covered how the Pacinian corpuscle responds to a stimulus at A-level depth, and outlined the importance of this in terms of responding to pain. Their justification of the importance does go beyond the specification.

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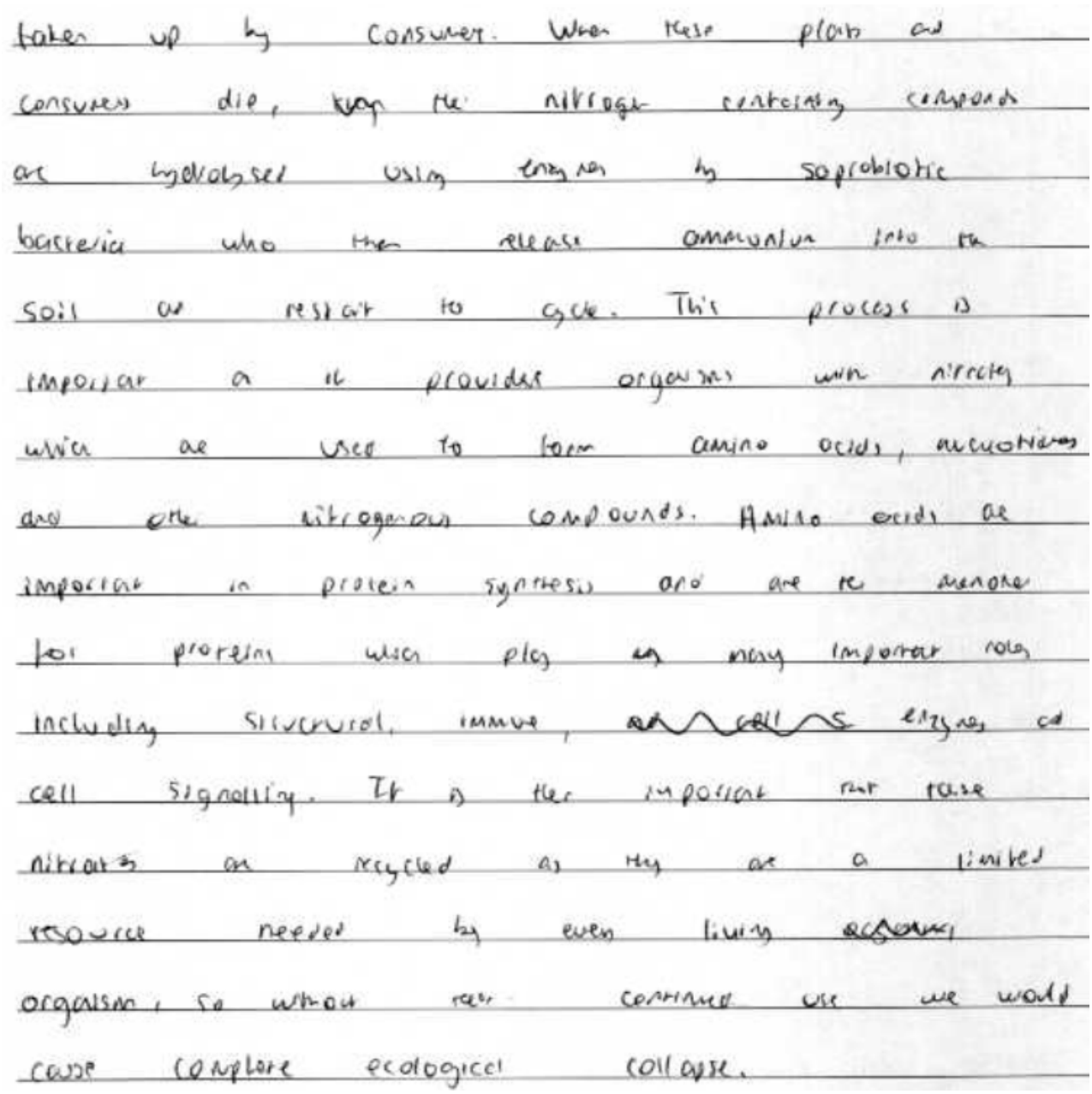
Another process which shows the importance of interactions between organisms and their environment is the Nitrogen cycle. Firstly the free-living nitrogen fixing bacteria use nitrogenase enzymes to fix atmospheric Nitrogen into useful ammonia compounds. These ammonium ions are then oxidised by Nitrobacter and Nitrosoma bacteria into nitrites and then nitrates. Plants then take these nitrates up from the soil and convert them to amino acids. The plants are then consumed and the nitrate in



taken up by consumers. When these plants and consumers die, the nitrogen containing compounds are hydrolysed using enzymes by saprobiotic bacteria who then release ammonium into the soil or restart to cycle. This process is important as it provides organisms with nitrates which are used to form amino acids, nucleotides and other nitrogenous compounds. Amino acids are important in protein synthesis and are the monomer for proteins which play so many important roles including structural, immune, cell signalling enzymes and cell signalling. It is therefore important that these nitrates are recycled as they are a limited resource needed by even living organisms, so without recycling continued use we would cause complete ecological collapse.

This student's third topic is 3.5.4 Nutrient cycles. There is a very concise, but correctly detailed description of aspects of the nitrogen cycle. It does not matter that they have not covered denitrification, there is sufficient AO1 detail provided. Knowing the names of enzymes and bacteria does not count as material beyond the specification. The importance, although a little weaker, is addressed at an acceptable level. It is important to note that responses to essay titles and topics relating to ecology can seem to be less detailed than other topics, for example, those based on biochemistry. What is important to note is that the responses cover what is expected on the specification.

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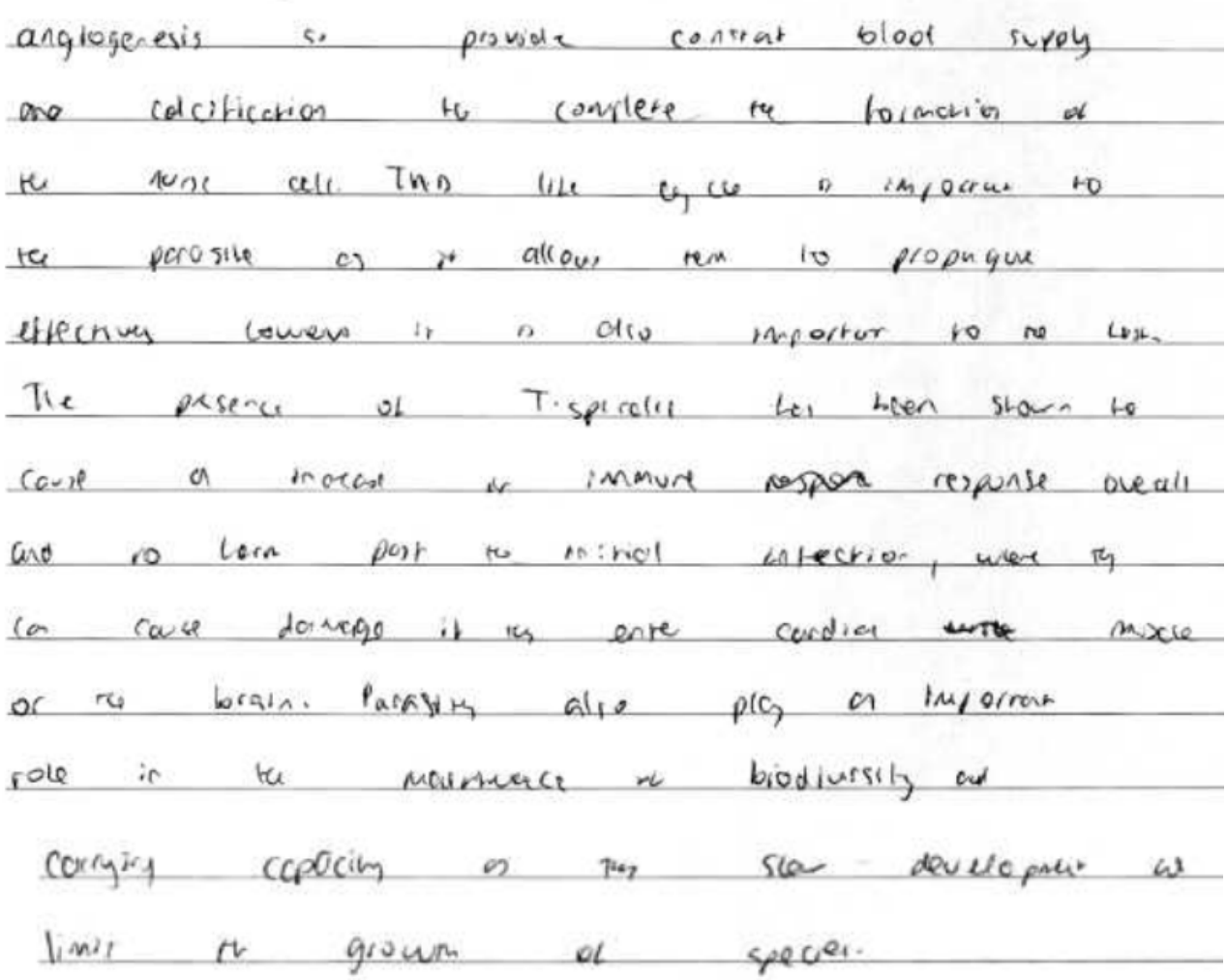
Another process in which ~~the~~ interaction with the environment is important is osmoregulation. In response to a decrease in blood water potential due to a change in external environment as the organism is not ingesting sufficient water, this change is detected by osmoreception in the hypothalamus and sends action potentials to the posterior pituitary which results in the secretion of ADH into the blood. ADH binds to receptors on the membrane of cells in the collecting duct. This causes a change in structure of a G protein which then activates adenylate cyclase. Adenylate cyclase form the second messenger cAMP from ATP. This leads to the activation of protein kinase A (PKA). This phosphorylates Aquaporins such as AQP2 and leads to them reacting with aquaporin interacting protein (AIP1 to form vesicles. These vesicles are then transported along the cytoskeleton by dynein and kinesin and are inserted in to apical membrane of the kidney's collecting duct. This results in more water being absorbed by osmosis and a increase in blood water potential. The careful maintenance of blood water potential

is a very important process because of the many
ways of water. A decrease in water potential leads
to cells becoming shrivelled or dehydrated to do
not have enough water to act as a metabolite
in processes such as hydrolysis. This leads to
a decrease in key functions of every tissue
damage. However if water potential rises too high it
can result in the osmotic lysis of cells
such as erythrocytes which prevents transport of
oxygen as a decrease in aerobic respiration.

This student's fourth topic is 3.6.4.3 Control of blood water potential. It could be argued that they are beyond the specification with their description of the effect of ADH on the cells of the collecting duct. They have given a few, concise examples of the importance of this interaction.

finally certain eukaryotic parasites use
changing interactions with their external
environment to modulate their life cycle. An
example of this is the Trichinella spiralis worm
is a nematode found in the meat of

species infected with it. When ingested, ~~herbivores~~
T. spiralis exists as a nurse cell complex
within muscle tissues. The outer layer of
this complex is completely resistant to pepsin so
is not opened in the stomach, but is now
resistant to trypsin so when it enters the small
intestine as there is a change in environment
it results in the breakdown of the outer
layer to release larvae into the small intestine,
here they quickly undergo 4 moults within the
epithelial cells to reach sexual maturity before
having a mate and releasing new larvae into
the intestine where they can then penetrate to
muscle tissues in the blood which is their final
destination. Here they again interact with their
environment by releasing enzymes which cause



This student's final topic is beyond the specification, relating to the interaction of a parasite and its environment, with the importance of this to the parasite outlined.

Overall, there are five topics. Each contains an appropriate depth of A-level content. A link to the theme is made within each topic. There are at least three examples that go beyond the specification. There are no significant errors and no irrelevant sections. This essay is extended abstract, at the very top of the level with a score of 25.

25 marks

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Student B

0 7 . 2 The importance of membranes in the functioning of cells.

[25 marks]

7.2 the importance of membranes in the functioning of cells:

- photosynthesis
- immunity (phagocytosis etc.)
- presynaptic + post synaptic neurones
- cells lining the PCT

} carried of membranes in cells.

Cell membranes are made up of a phospholipid bilayer. Phospolipids have a polar, hydrophillic phosphate head and non-polar, fatty acid tail which means only non-polar, lipid soluble substances that are small can diffuse across the cell membrane and into the cell.

This student starts with a short section on topic 3.2.3 Transport across cell membranes. This section is lacking detail, but has been taken to be more of an introduction.

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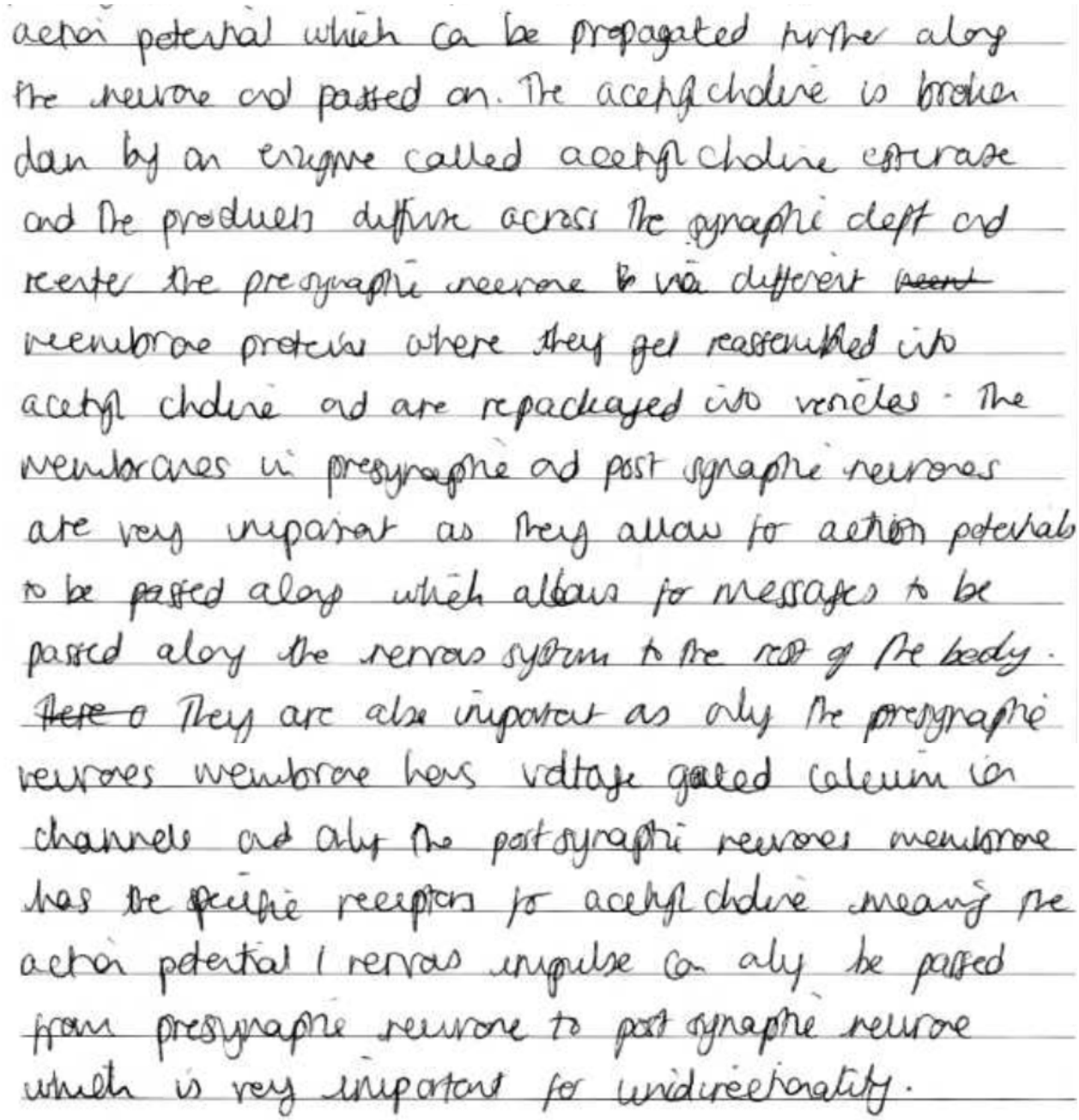
One way in which cell membranes are important is in immunity ~~with pathogens~~. In the ~~non-specific~~ non-specific immune response, chemicals released by a pathogen ~~attract~~ act as chemoattractants, drawing phagocytes towards it. This is positive chemotaxis. The phagocytes has many different but specific receptors embedded into its outer membrane which bind to the pathogen surface proteins (antigens). When the ~~phagocyte~~ phagocyte fuses with the pathogen, it forms a vesicle called a phagosome. Lysosomes migrate ~~to~~ towards the phagosome, and when they reach it, the release lysozymes which are hydrolytic enzymes which break down the pathogen. This is important as it kills the pathogen, preventing further replication and damage to the body. Once broken down, the phagocytes incorporates the antigens of the pathogen into its cell membrane, becoming an antigen presenting cell. This then meets a helper T-cell ~~that~~ which divides into more Helper T cells and killer T cells. It also stimulates specific B cells to divide which become antibody secreting plasma cells and B memory cells. B memory cells remain in the blood for a long time and if the body encounters the same pathogen, it stimulates a secondary immune response which is faster than the first one. The membrane of the antigen presenting cell is important as it allows for long-term immunity.

This student's second topic is 3.2.4 Cell recognition and the immune system. The AO1 content is at A-level depth, and the importance has been addressed at the correct A-level depth as well.

Neurones are also important in the presynaptic and post synaptic neurone - The presynaptic neurones membrane has calcium ion channels which are voltage gated in it - This means when an action potential arrives and the presynaptic neurone gets depolarised, calcium ion channels open - This allows Ca^{2+} ions to enter which cause vesicles filled with neurotransmitter to migrate towards the presynaptic neurones membrane (requires AO3). In cholinergic synapses, the neurotransmitter is acetylcholine and once the vesicle reaches the membrane, it releases acetylcholine which diffuses across the synaptic cleft, it binds to specific receptors on the post synaptic neurone and causes voltage gated sodium channels to open - This allows Na^+ ions to flow into the post synaptic neurone, depolarising it - This generates an



action potential which can be propagated further along the neurone and passed on. The acetylcholine is broken down by an enzyme called acetylcholine esterase and the products diffuse across the synaptic cleft and receptor the presynaptic neurone by via different ~~recept~~ membrane proteins where they get reassembled into acetylcholine and are repackaged into vesicles. The membranes in presynaptic and post synaptic neurones are very important as they allow for action potentials to be passed along which allows for messages to be passed along the nervous system to the rest of the body. ~~Here~~ They are also important as only the presynaptic neurones membrane has voltage gated calcium ion channels and only the postsynaptic neurones membrane has the specific receptors for acetylcholine meaning the action potential / nervous impulse can only be passed from presynaptic neurone to post synaptic neurone which is very important for unidirectionality.

This student's third topic is 3.6.2.2 Synaptic transmission. The AO1 content is at A-level depth, and the importance has also been addressed at the correct A-level depth.

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Membranes are also important in photosynthesis, in particular the light dependent reaction. The light dependent reaction occurs in the thylakoid membranes. First water is broken down into oxygen, protons and electrons. The oxygen is either used in the plant for respiration or diffuses out ~~of~~ of the plant via stomata in the leaf. ~~The~~ ~~Plant~~ The water is broken down by light energy in a process called photolysis. The light energy also raises electrons in photosystems to higher energy levels in a process called photoexcitation. Photosystems are clusters of pigments that absorb specific wavelengths of light. The electrons get excited and leave the photosystems in a process called photoionisation. The electrons enter the electron transport chain where the pass ~~from~~ from protein to protein, which are tightly packed together, in a series of redox reactions. The electrons travel down energy levels from protein to protein which releases energy which is then used to pump protons from the stroma, across the thylakoid membrane, into the ~~matrix~~ lumen of the thylakoid. Electrons lost from

photosystem 2 are replaced by the electrons released in the photolysis of water and electrons lost from photosystem 1 are replaced by electrons from photosystem 2. The electrons lost from photosystem 1 leave the electron transport chain and recombine with protons and NADP to form NADPH. There is a proton gradient across the thylakoid membrane as there a high concentration in the lumen of the thylakoid and low concentration in the stroma. The Protons move into the stroma, across the thylakoid membrane via a channel protein called ATP synthase (stalked particle) this provides energy for the phosphorylation of ADP to ATP. The protons combine with more electrons and NADP to form NADPH. This is very important as NADPH and ATP are required in the light independent reaction to reduce glycerate - 3- phosphate into triose phosphate. 5/6 of the triose phosphate is used to regenerate RuBP and 1/6 is used to create organic compounds such as glucose. This is very important as it can be used for respiration, to create ATP to make structural compounds like cellulose which supports and strengthens the plant cell wall or can be stored as starch. It is important to create ATP for cellular processes such as active transport.

This student's fourth topic is 3.5.1 Photosynthesis. The AO1 content is at A-level depth, and the importance has been addressed at the correct A-level depth too.

Another area where membranes are important is in the kidneys, in specific the proximal convoluted tubule of the nephron. It has sodium potassium pumps in the membrane facing the capillaries which actively pump 3 sodium ions out into the blood (and bring potassium ions into the epithelial cells) This creates a sodium ion gradient which is very important for selective reabsorption as it means Na^+ ions travel down their concentration gradient ~~out~~ into the epithelial cells and diffuse into the blood. Na^+ ions MUST enter the epithelial cells through specific co-transporter proteins which also means glucose and amino acids are brought into the epithelial cells. They also then diffuse into the blood. This is very important as it ensures the maximum reabsorption of mineral ions and other small compounds back into the blood stream from the filtrate where they would have been excreted

small enough to pass into the blood stream from the filtrate where they would have been excreted and gone to waste. Now they are reabsorbed the glucose can be used in respiration to make ATP and the amino acids can be used to create polypeptides, which can be enzymes or receptors. The cells of the PCT are adapted for selective reabsorption as they have lots of mitochondria for the sodium-potassium pump and their membranes have many co-transporter proteins.

This student's final topic is 3.6.4.3 Control of blood water potential. The AO1 content is at A-level depth, and the importance has been addressed at the correct A-level depth too.

Overall, there are five topics. The first was taken to be an introduction to the essay, and so whilst lacking detail, does not affect this essay being able to score in the Extended Abstract level. The remaining four topics all have AO1 detail at the correct level, and the theme has been addressed in these four topics at the correct level. There are no significant errors, nor irrelevant sections. There is no material beyond the specification, and so this essay is limited to a maximum score of 23.

23 marks

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Relational

Student C

LDR, nitrogen cycle, succession

Either

0 7 . 1 The importance of interactions between organisms and their environment. **[25 marks]**

ADH, LDR, Synapses, Phagocytosis, epithelial cell, microvilli

Clostridial neurotoxin

Or

0 7 . 2 The importance of membranes in the functioning of cells. **[25 marks]**

The importance of membranes in the functioning of cells can be seen with a low water potential (Ψ). A low Ψ causes osmoreceptors in the hypothalamus ~~of cells~~ to shrink and produce ADH. Which is passed to the posterior pituitary gland secreted into capillaries and into the kidneys. ADH then makes the membrane of the collecting duct (CD) and Distal Convoluted Tube (DCT) more permeable to water and ah makes vesicle fuse with the membrane of the CD and DCT to form aquaporins. Water is now able to be reabsorbed into the blood via osmosis. Furthermore, in the nephron to, the descending limb membrane is permeable to water allowing water to be reabsorbed into the blood via osmosis. ~~But~~ However,

this is only made possible by the ascending limbs membrane which is impermeable to water but contains carrier proteins in its membrane allow the active transport of ions such as Na^+. This creates a low Ψ so water can leave the descending limb via osmosis. This is important for the functioning of cells as it means water is not lost in the urine but can go ~~to other~~ into the blood and into other cells. Where it can act as a metabolite and hydrolyse reactions such as ATP → ADP + Pi releasing energy for muscle contraction. Water can also act as a solvent and has a large latent heat of vaporisation so can provide a cooling effect. Hence the importance of water not being lost and it being in cells which is only possible due to the membranes of the CD, DCT, ascending and descending limb.

This student's first topic is 3.6.4.3 Control of blood water potential. Their AO1 content is of A-level standard. For their AO2 content, they give several examples of why water is important in the functioning of other cells which are lacking in detail. Ideally, this should be about the importance of the membrane of a nephron in the functioning of cells in the kidney. This is not given as an irrelevant section.

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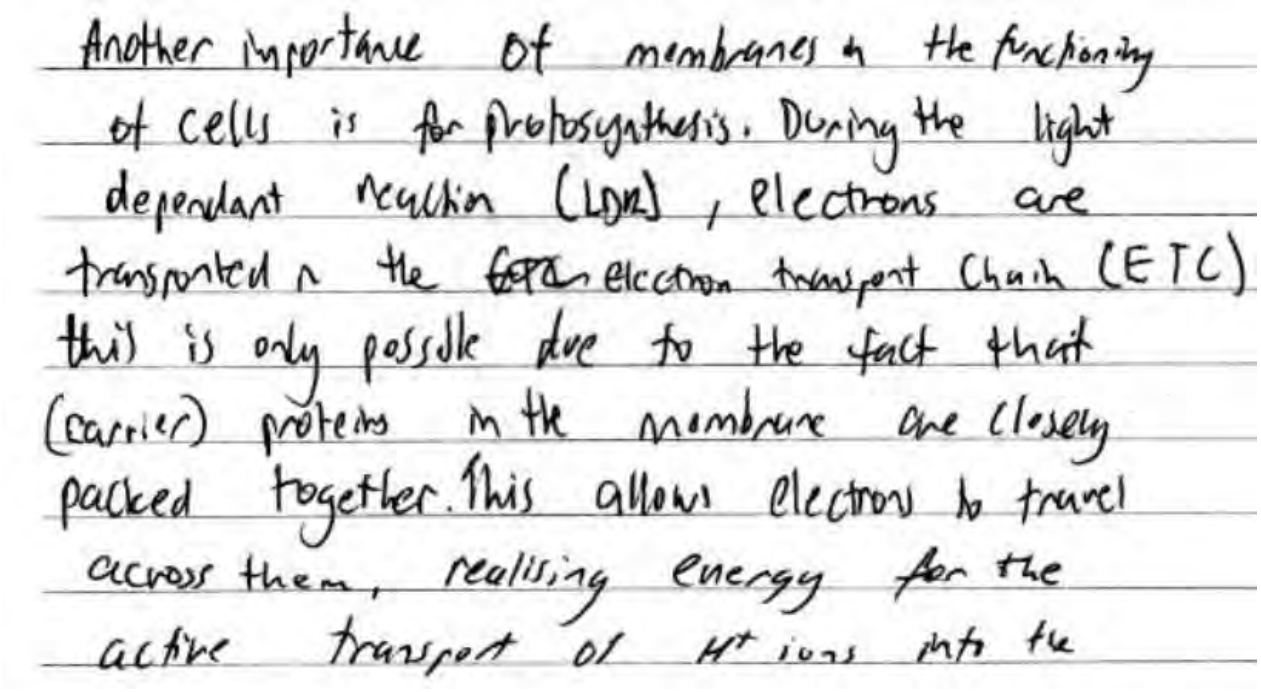
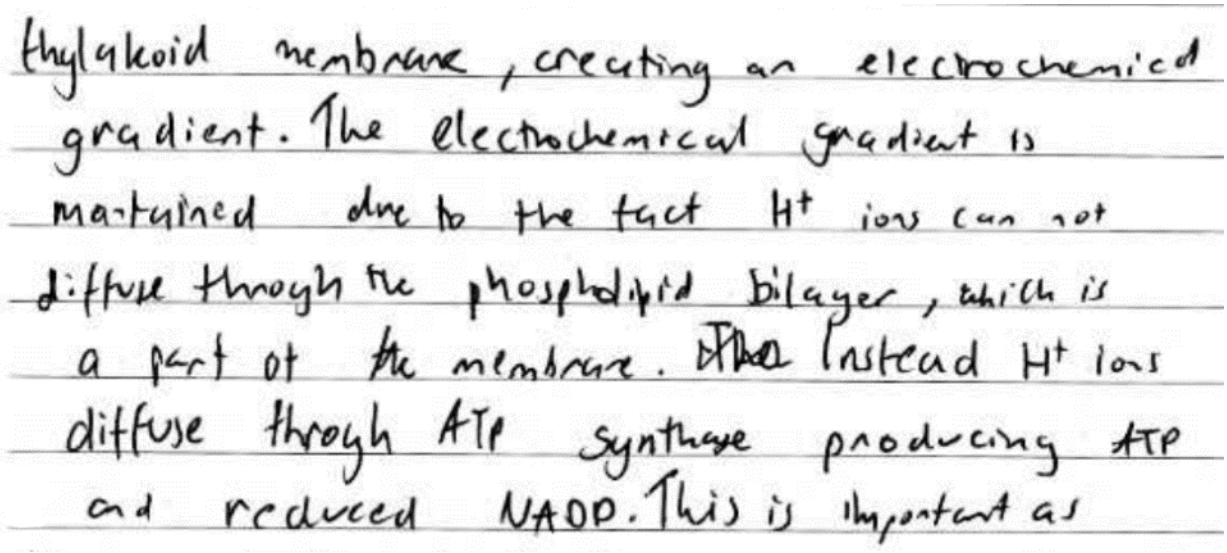


Another importance of membranes in the functioning of cells is for photosynthesis. During the light dependant reaction (LDR), electrons are transported in the ~~the~~ electron transport chain (ETC) this is only possible due to the fact that (carrier) proteins in the membrane are closely packed together. This allows electrons to travel across them, realising energy for the active transport of H^+ ions into the

Suggestion that electrons can only move from carrier to carrier due to close proximity of the carriers is not given as a significant error.

Protons are not moved by active transport; however, this is not a significant error, as it does not detract from what they are telling the examiner.



thylakoid membrane, creating an electrochemical gradient. The electrochemical gradient is maintained due to the fact H^+ ions can not diffuse through the phospholipid bilayer, which is a part of the membrane. ~~The~~ Instead H^+ ions diffuse through ATP synthase producing ATP and reduced NADP. This is important as

Student seems to be suggesting that reduced NADP is made by protons diffusing through ATP synthase. This is not a significant error.

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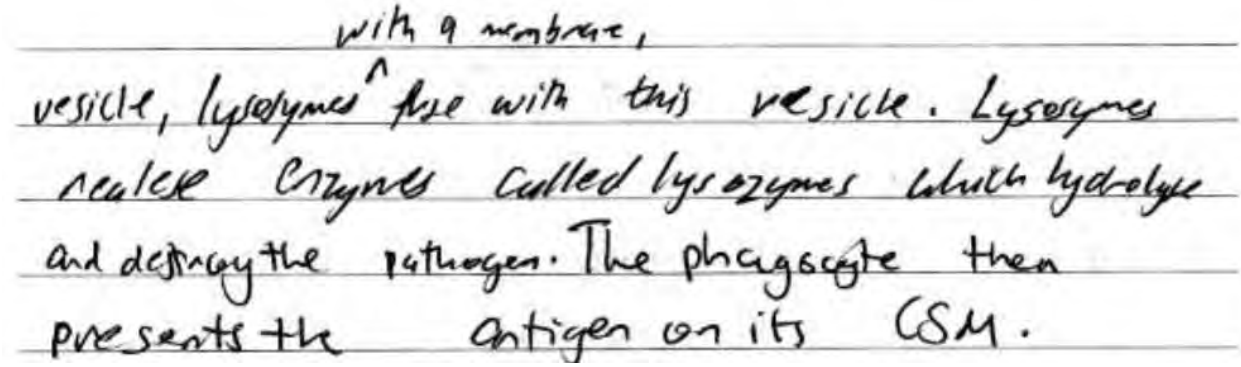
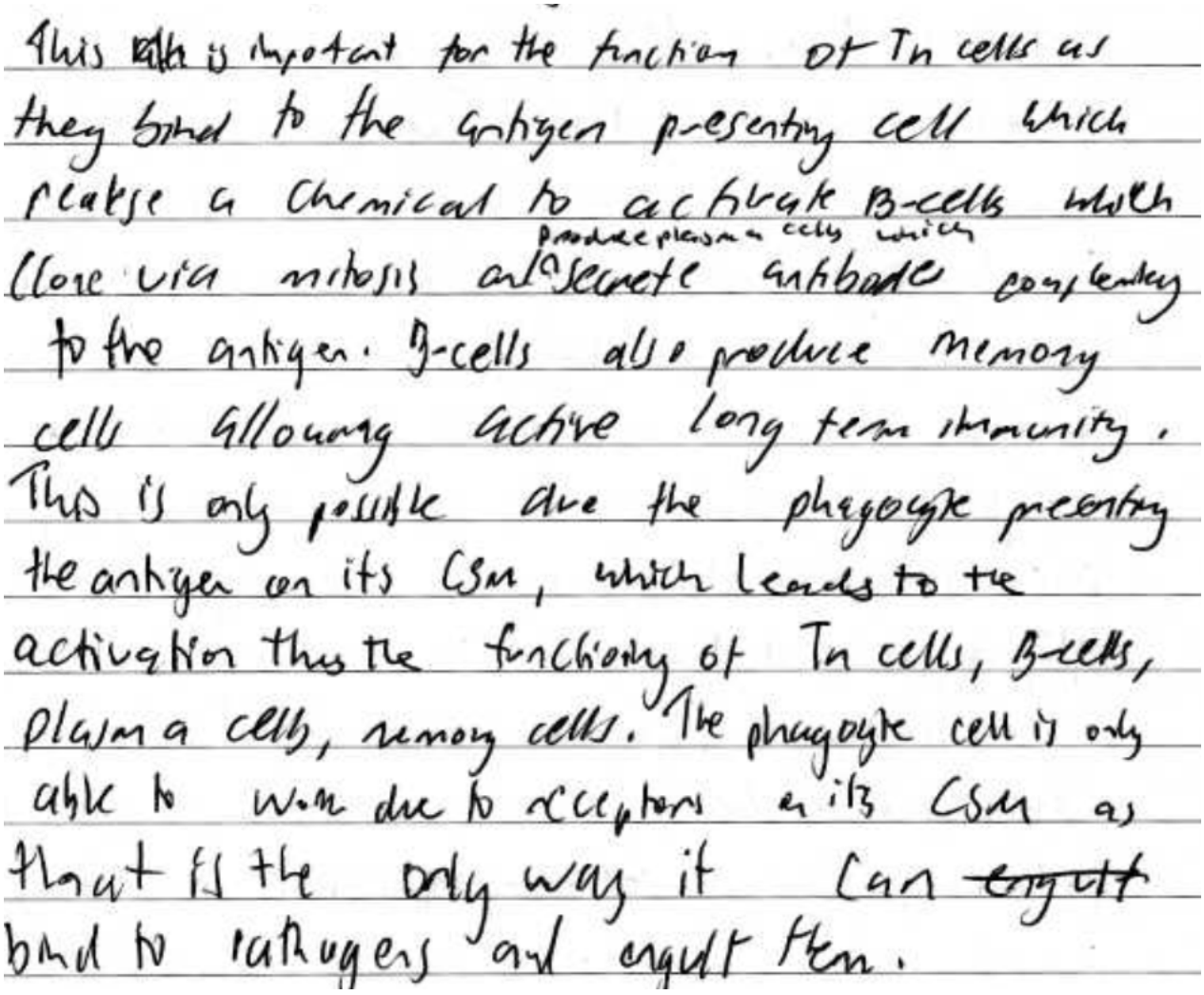
the products of the LDR are used to reduce GP into triose phosphate. The triose phosphate gives one of its carbons atom producing a hexose sugar, so after 6 cycles it leads to the production of a hexose sugar. This is important in the functioning cells as respiring cells need glucose (a hexose sugar) for glycolysis and for cells in the cell wall as they need cellulose a polymer of beta glucose. This is only made possible due to the membrane involvement in producing ATP and ~~reduced~~ NADPH in the LDR.

This student's second topic is 3.5.1 Photosynthesis. On the whole, the AO1 shows A-level detail, but there is some poor expression of ideas as indicated above. There is an attempt at AO2, and this shows some A-level detail.

Moreover, the importance of membranes in the functioning of cells could be seen in phagocytosis. A pathogen enters the body and lysis of chemical signals which attract the phagocyte. The phagocyte has receptors on its cell surface membrane (CSM) which bind to the antigen on the pathogen. The phagocyte's membrane changes shape and surrounds the pathogen, allowing the phagocyte to engulf the pathogen. This forms a phagosome


with a membrane,
vesicle, lysosomes fuse with this vesicle. Lysosomes
release enzymes called lysozymes which hydrolyse
and destroy the pathogen. The phagocyte then
presents the antigen on its CSM.

The student has used 'CSM' to mean cell-surface membrane. This is not a specification abbreviation, but this is not penalised on the essay, as it can be understood what they meant.


This is important for the function of Th cells as
they bind to the antigen presenting cell which
release a chemical to activate B-cells which
clone via mitosis and produce plasma cells which secrete antibody complementary
to the antigen. B-cells also produce memory
cells allowing active long term immunity.
This is only possible due the phagocyte presenting
the antigen on its CSM, which leads to the
activation thus the functioning of Th cells, B-cells,
plasma cells, memory cells. The phagocyte cell is only
able to work due to receptors on its CSM as
that is the only way it can ~~bind~~
bind to pathogens and engulf them.

This student's third topic is 3.2.4 Cell recognition and the immune system. The AO1 content shows A-level detail, as does their attempt at the importance.

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Furthermore, the importance of membranes in the functioning of cells can be seen ~~with~~ in synapses. The presynaptic neurone (cell) is depolarised, so Ca^{2+} channels open and Ca^{2+} enter which signals a vesicle to fuse with ~~on~~ the presynaptic membrane. Neurotransmitters are then released from the presynaptic membrane and diffuse across the synaptic

This student states 'a vesicle,' whereas in reality this is multiple vesicles. This is not a significant error.

Cleft and bind to receptors on the post synaptic membrane. Na^{+} channels on the post synaptic membrane ~~bind~~ open and Na^{+} enters the post synaptic neurone (cell) causing it to depolarise and generate an action potential. Without membranes the post synaptic neurone (cell) would not be depolarised, and action potentials are vital in the transmission of signals across neurones and allowing rapid communication between parts of an organism. Without an action potential, organisms would not be able to respond to stimuli. This can be seen in bacterial infections as some release another Clostridial neurotoxin which inhibit

This student's fourth topic is 3.6.2.2 Synaptic transmission. Their AO1 content shows A-level detail, but some terminology used is not as strong, for example, the use of signals instead of impulses.

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neurotransmission and this neurotoxin is linked with tetanus. The way the Clostridial neurotoxin inhibits neurotransmission is by stopping the release of neurotransmitters from the presynaptic membrane so they do not bind to receptors on the post synaptic membrane, highlighting the importance of membranes to the function of cells. As in Tetanus the cells stop working due to no binding to the post synaptic membrane causing lockjaw.

This student's attempt at the importance of the membrane in the functioning of cells in a synapse starts in a weak way. They bring in clostridial neurotoxin to help develop their answer. This is beyond the specification; however, they only state that the action of the neurotoxin is to stop neurotransmitter being released, and this is not a sufficient description to constitute A-level standard. However, there is an attempt at AO2.

Finally the importance of membranes in the functioning of cells can be seen in the microvilli. The membrane of the microvilli is highly folded, contains transport proteins and enzymes. In the epithelial cell, Na^+ is actively transported out into blood through a carrier protein which is a part of the membrane. This creates a low concentration of Na^+

So Nat diffuses in from the lumen with glucose through a carrier (cotransport) protein, which is a part of the membrane. ~~With~~ Glucose diffuses out of epithelial cell through facilitated diffusion through a carrier protein which is apart of the membrane. Glucose is flow in blood which is important as it can go into cells and be used for glycolysis which ultimately produces ATP for processes such as muscle contraction. The membrane is highly folded giving it a large surface area meaning it contains lots of transport protein allowing the epithelial cell to function as it allows co-transport, active transport and facilitated diffusion. The membrane also contains membrane bound disaccharidases such as maltase, sucrase, lactase which break down disaccharides into glucose for example. Glucose is important in the ~~function~~ function of many cells as it can be stored as ~~glycogen~~ glycogen or carbohydrates but the main use is for respiration.

This student's final topic is 3.3.3 Digestion and absorption. There is sufficient AO1 material at A-level depth. However, their attempt at the importance is more about why glucose is important in the functioning of cells rather than the importance of the membrane in the functioning of epithelial cells, for example, that the channel proteins and carrier proteins within the membrane allow the transport of glucose into an epithelial cell, even against a concentration gradient.

Overall, there are five topics covered. Their AO1 is fundamentally correct A-level content but contains some points which are less detailed and less well expressed. There is an attempt at the theme in all topics, but this is less well developed in some of the areas. There are no significant errors and no irrelevant sections. This essay is Relational, at the top end and scores 20 marks. The less detailed areas and less developed AO2 prevent the essay from scoring in the Extended Abstract level.

20 marks

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Student D

0 7 . 2 The importance of membranes in the functioning of cells.

[25 marks]

The thylakoid membrane is made up of many membrane proteins that allow for electrons to move down the electron transport chain via a series of redox reactions releasing energy in chemiosmosis in the light dependent reaction. This energy that was released is used to actively transport H^+ ions from the stroma into the thylakoid membrane thus forming an electrochemical gradient. H^+ ions move down this gradient via stalked particles that from the thylakoid membrane to the stroma. These stalked particles have ATP synthase attached to them resulting in ATP synthesis once the H^+ ions have moved into stroma.

The protons are not actively transported, but this is not a significant error.

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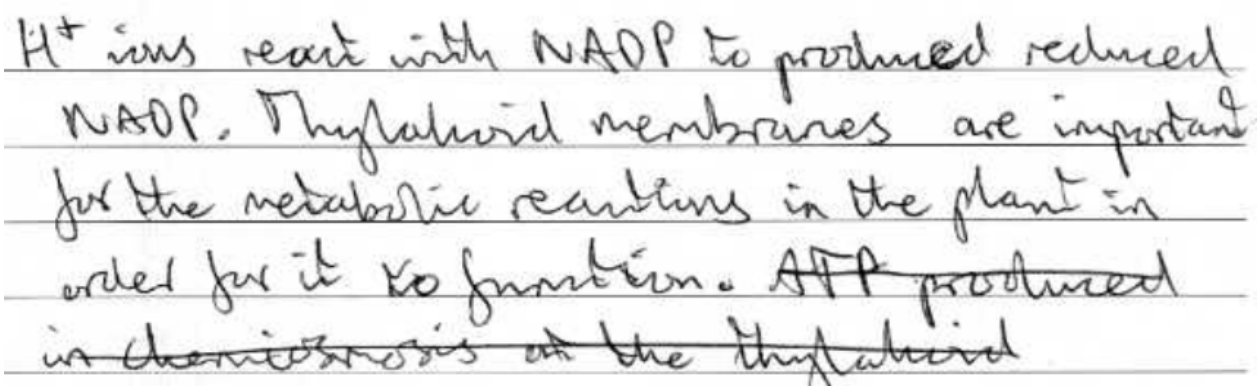
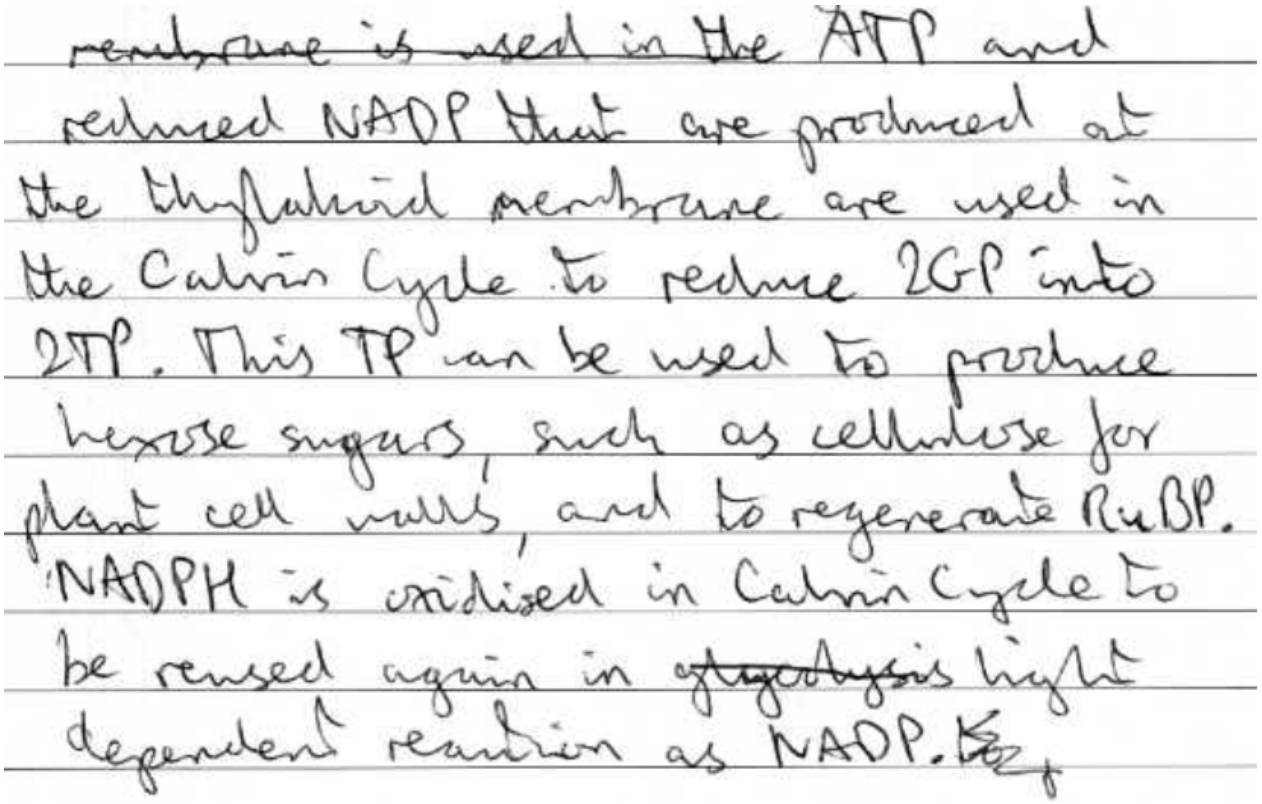


Protons reacting with NADP to produce reduced NADP is either a poor or incomplete understanding of reduction, but is not a significant error.



This student's first topic is 3.5.1 Photosynthesis. The AO1 content is of A-level standard, with a couple of sections with minor errors. The importance is addressed at the correct level.

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Epithelial cells lining the ileum have a lot of microvilli on their membranes. These folded membranes produce a large surface area for increased absorption. The membrane of the epithelial cells have a lot of co-transport proteins allowing for increased co-transport of glucose/amino acid and Na^+ ions. In co-transport, Na^+ is actively transported out of epithelial cell into the blood using ATP thus forming an electrochemical gradient. Na^+ concentration is higher in the epithelial cell than outside the cell lining of ileum so Na^+ and glucose are co-transported into the cell. Glucose then moves out of epithelial cell into the blood via facilitated diffusion. Microvilli allow for increased absorption of glucose due to their large number of co-transport proteins and large surface area. This means that more glucose and amino acids can be absorbed into the blood by co-transport. This means more glucose can be and amino acids can be

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transported to cells in the body. Glucose can be used in aerobic respiration to produce ATP so more energy can be released for metabolic reactions such as muscle contraction. Amino acids can be used to produce more membrane proteins and other proteins such as enzymes that can quicken rates of metabolic reactions in the body.

This student's second topic is 3.3.3 Digestion and absorption. The AO1 content is of A-level depth, however the importance is weaker, with little moving beyond GCSE level.

Presynaptic ~~membran~~ and postsynaptic membranes of neurones at a synapse allow for successful synaptic transmission of action potentials in the nervous system. Action potential reaches the presynaptic ~~membrane~~ membrane causing Ca^{2+} channels to open resulting in facilitated diffusion of Ca^{2+} into the presynaptic neurone. This causes synaptic vesicles containing neurotransmitter to fuse with the presynaptic membrane in order for neurotransmitter to diffuse across synaptic cleft. Neurotransmitter binds to receptors ~~on~~ on the postsynaptic

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membrane causing Na^+ channels on the membrane allowing for Na^+ to move into postsynaptic neuron via facilitated diffusion resulting in depolarisation of postsynaptic neuron. The postsynaptic and presynaptic membranes ensure the unidirectional movement of action potentials in synaptic transmission. This is because only the presynaptic neuron contains the neurotransmitter and only the postsynaptic neuron has receptors complementary in shape to neurotransmitter to activate

opening of Na^+ channels in postsynaptic neurone. This is important as if the unidirectional movement of action potentials ~~as~~ was not maintain in neurones not maintained by these features of the postsynaptic and presynaptic membranes, the action potential would not reach the effector and a response wouldn't be stimulated. This ensures that nervous responses are being carried out effectively and correctly To ensure survival of the organism when approached by stimuli.

This student's third topic is 3.6.2.2 Synaptic transmission. The AO1 content is of A-level standard and the importance is addressed at the correct level.

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The membranes of phagocytes have many membrane receptors complementary to specific free antigens of pathogens allowing for phagocytes to bind and carry out the humoral response. Phagocyte binds to an specific antigen via its membrane receptors resulting in phagocyte engulfing antigen. Lysosome fuses with antigen forming a phagosome and lysozymes are released to hydrolyse the antigen - ~~and etc~~. This phagocyte presents the pathogen's antigens on its cell surface membrane therefore becoming an antigen presenting cell. T helper cells can now bind (using their own membrane receptors) to this antigen presenting cell and stimulate clonal selection of B cells. The cell either differentiates into B plasma cells or B memory cells. B plasma cells produce antibodies specific to antigen and B memory cells can differentiate into B plasma cells to secrete more antibodies. The humoral response is important as

This student refers mostly to the antigen throughout this topic, not the pathogen or antigen on the pathogen. Additionally, they state the antigen is hydrolysed by lysozymes, but later state the antigen is presented on the membrane of the phagocyte, which if it had been hydrolysed would not be possible. None of these ideas are significant errors, just poor expression.

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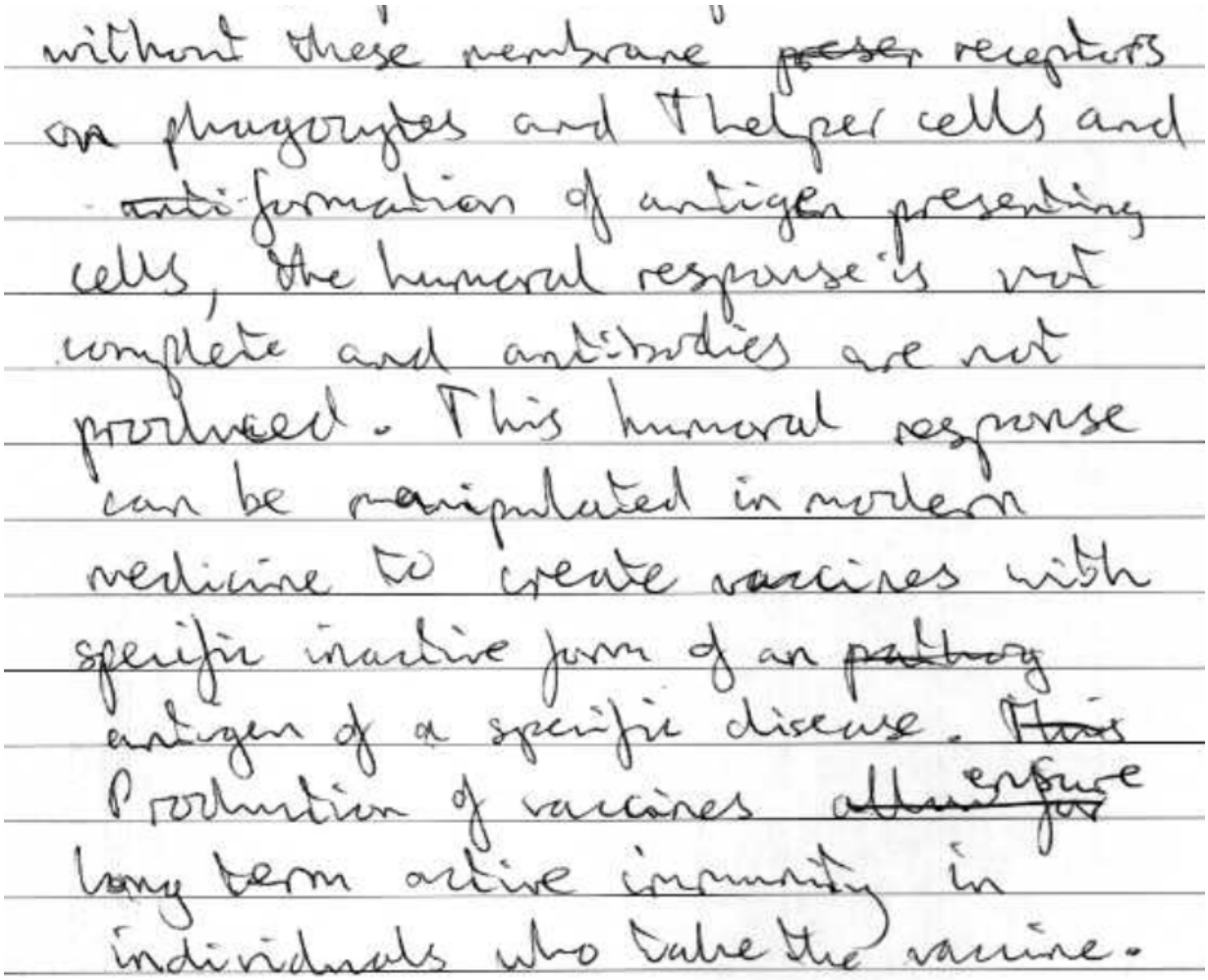

This student's final topic is 3.2.4 Cell recognition and the immune system. The AO1 content is of A-level standard, with some poorer expression. The importance is addressed at the correct level.

Overall, there are four topics. Two have good A-level content, and two have some poorer expression. Three of the topcis have the theme addressed at the correct level, and one is weak. There are no significant errors, nor irrelevant sections. This essay is in the Relational level. The poorer expression in two areas and weaker theme in one area prevent this from being at the very top of this level, with a score of 19.

19 marks

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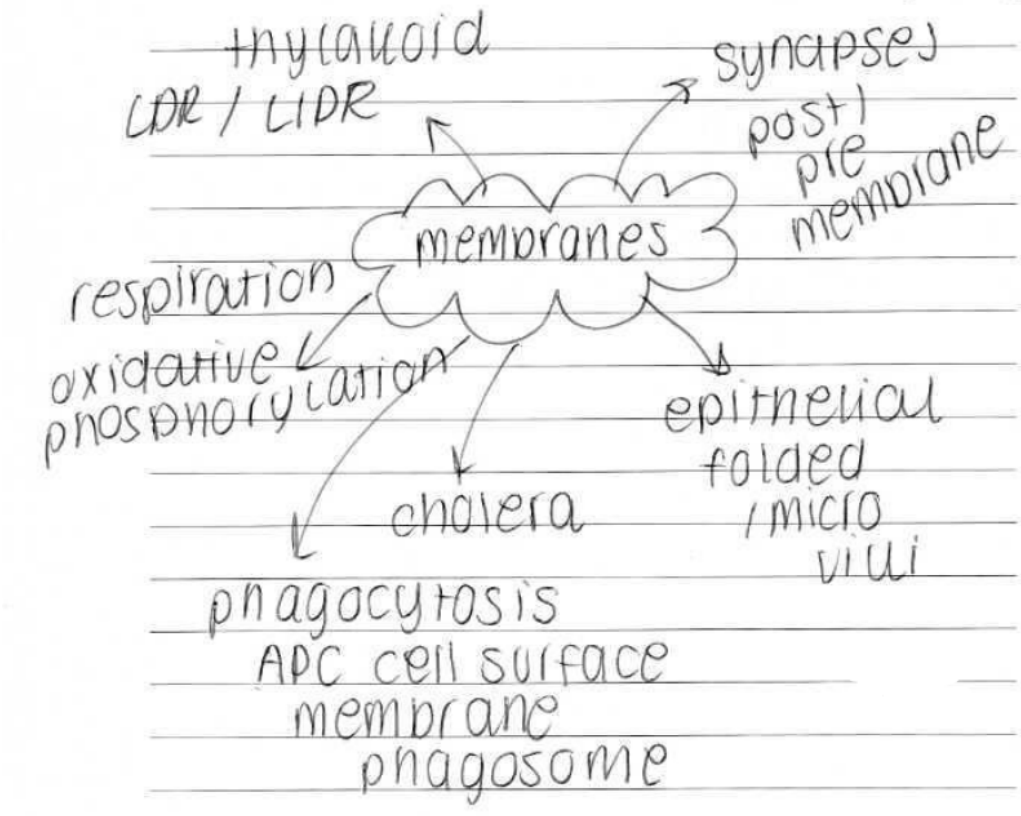
Multistructural

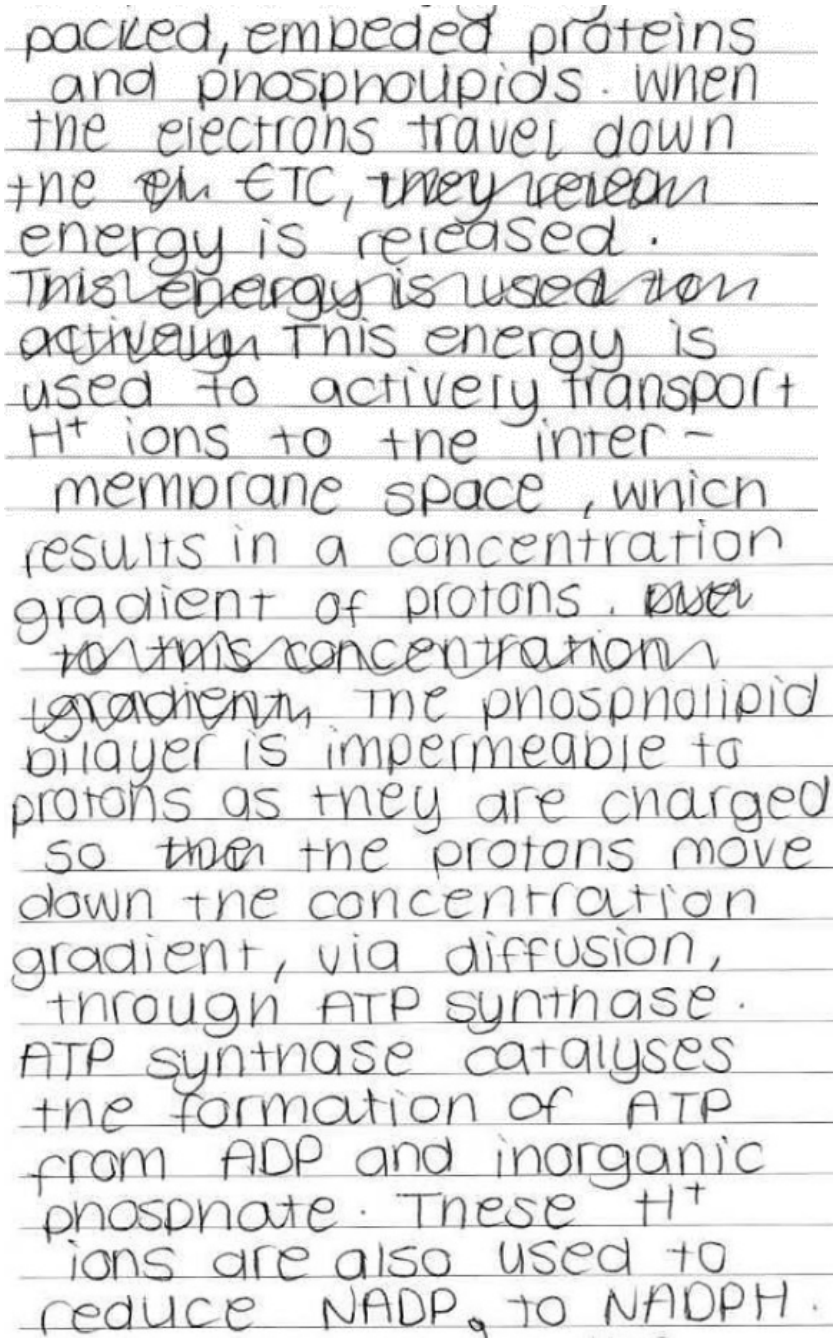
Student E

0 7 . 2 The importance of membranes in the functioning of cells.

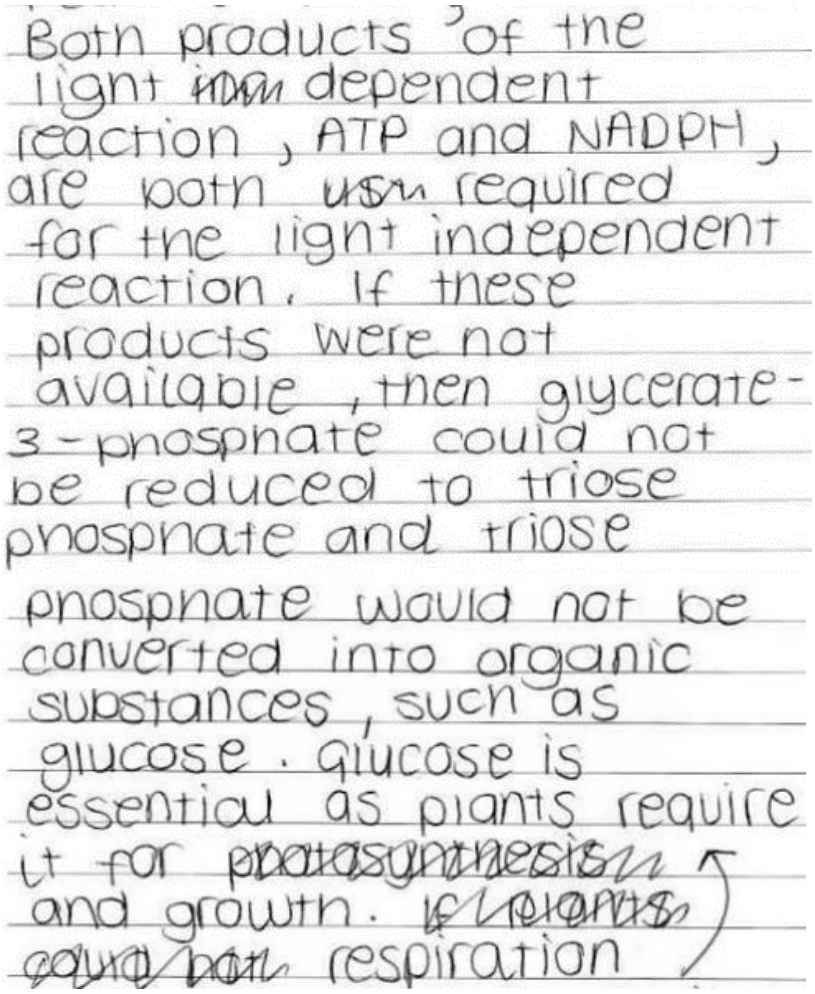
[25 marks]



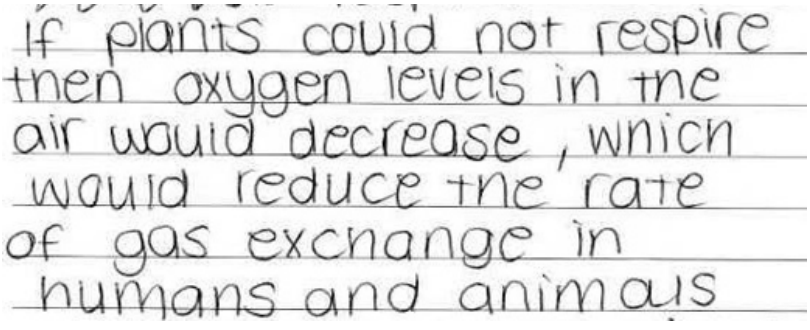
During the light dependent reaction of photosynthesis, which occurs in the thylakoid membrane of the chloroplast. chlorophyll absorbs light energy of a specific wavelength, causing electrons in chlorophyll to excite to higher energy levels. The electrons are released from chlorophyll, leaving it with a positive charge, and travel down the electron transport chain, via. The electron transport chain is a membrane composed of tightly


packed, embeded proteins and phospholipids. When the electrons travel down the ETC, they release energy is released. This energy is used to actively transport H+ ions to the inter-membrane space, which results in a concentration gradient of protons. Due to this concentration gradient the phospholipid bilayer is impermeable to protons as they are charged so then the protons move down the concentration gradient, via diffusion, through ATP synthase. ATP synthase catalyses the formation of ATP from ADP and inorganic phosphate. These H+ ions are also used to reduce NADP, to NADPH.

Hydrogen ions being used to reduce NADP is just poor expression, and is not a significant error.


Both products of the light dependent reaction, ATP and NADPH, are both required for the light independent reaction. If these products were not available, then glycerate-3-phosphate could not be reduced to triose phosphate and triose phosphate would not be converted into organic substances, such as glucose. Glucose is essential as plants require it for photosynthesis and growth. If plants could not respiration

This student's first topic is 3.5.1 Photosynthesis. Their AO1 content contains correct A-level depth content, as does their AO2 attempt at the importance. This is where the student should have stopped and moved onto their next topic.


If plants could not respire then oxygen levels in the air would decrease, which would reduce the rate of gas exchange in humans and animals

The student here is telling the examiner that respiration increases oxygen levels in the air. This is a significant error.

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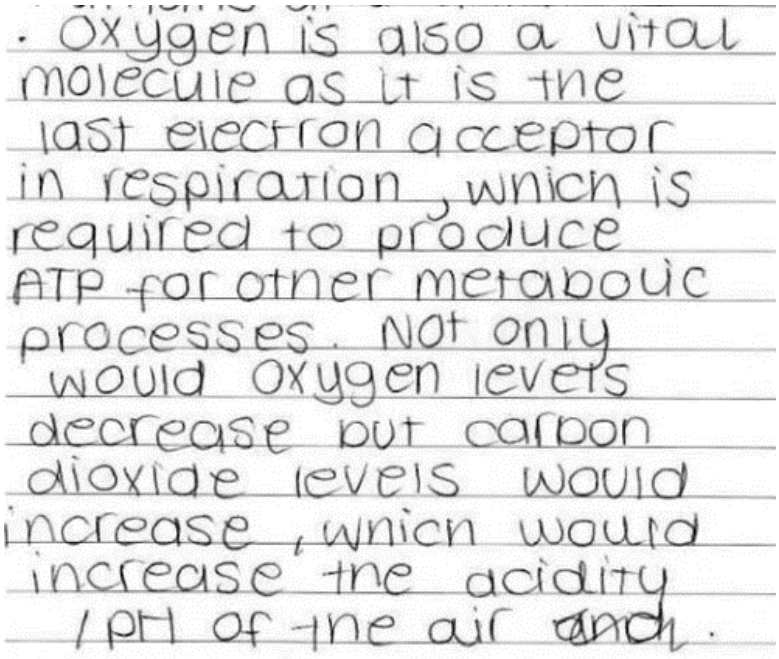
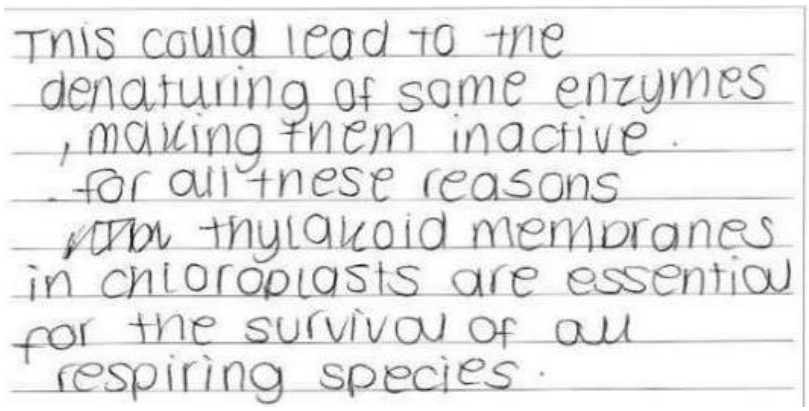
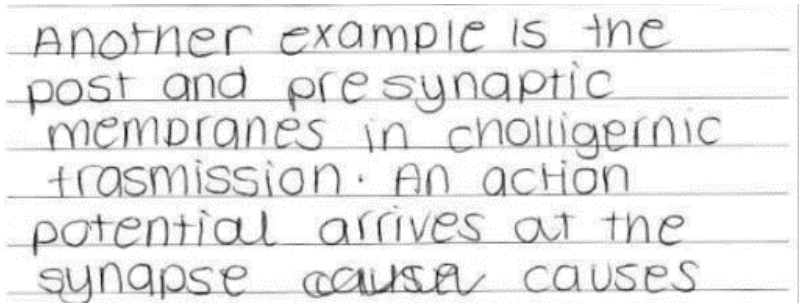

. Oxygen is also a vital molecule as it is the last electron acceptor in respiration, which is required to produce ATP for other metabolic processes. Not only would oxygen levels decrease but carbon dioxide levels would increase, which would increase the acidity / pH of the air and.

This section is not relevant to the title, being about the importance of oxygen, and not related to the importance of membranes in the functioning of cells.

There is a contradiction here, stating both acidity and pH increase, however, there is a significant error for stating that an increase in the pH of air could denature enzymes.


This could lead to the denaturing of some enzymes, making them inactive. For all these reasons thylakoid membranes in chloroplasts are essential for the survival of all respiring species.


Another example is the post and presynaptic membranes in cholligernic trasmission. An action potential arrives at the synapse cause causes

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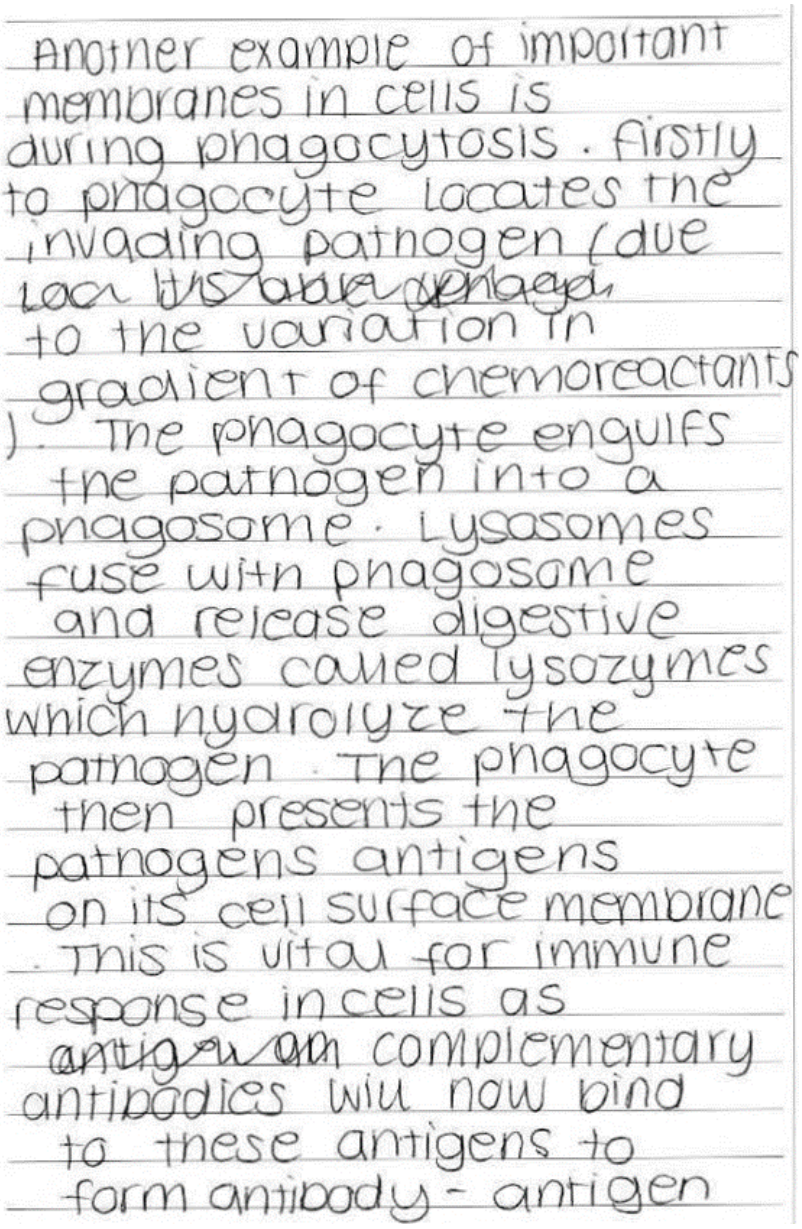
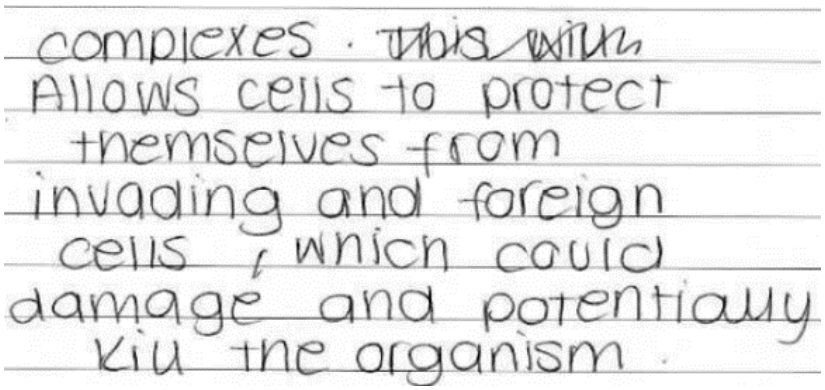
Ca^{2+} ion channels on the presynaptic membrane to open. Ca^{2+} ions diffuse in → this influx of Ca^{2+} ions causes vesicles containing acetylcholine to fuse with the presynaptic membrane. Acetylcholine is released and diffuses across the synaptic cleft. Acetylcholine then binds to specific Na^+ ion channel receptors on the post synaptic membrane. This causes the Na^+ ion channels to open and Na^+ ions diffuse in. If enough Na^+ ions diffuse in then the membrane will depolarise and if a threshold is reached → another action potential is generated. The location of the specific protein channels and receptors on the post and presynaptic membranes allow for a unidirectional impulse. This is important in the functioning of cells as it allows for a fast trasmission across nerves and neuromuscular junctions. Without synapses organisms would not be able to quickly respond to dangerous stimuli and protect themselves from harm.

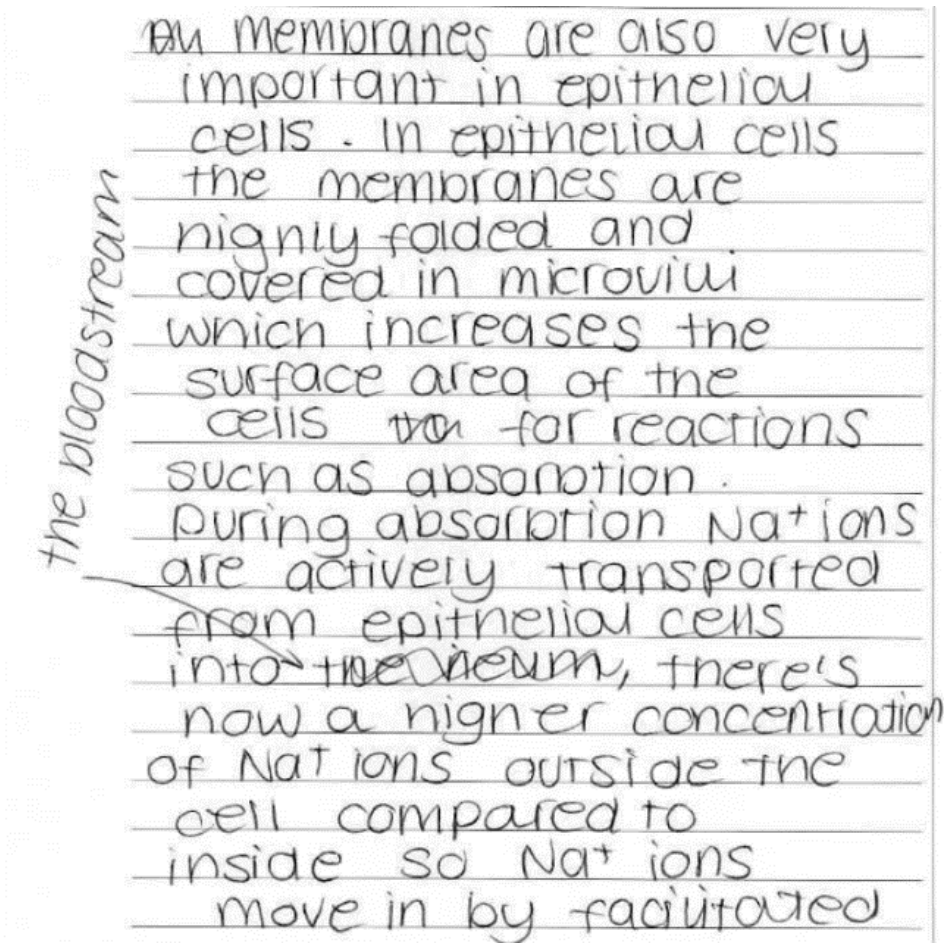
This student's second topic is 3.6.2.2 Synaptic transmission. Their AO1 content shows correct A-level depth. However, their AO2 content in the last sentence of this page is weaker, and is not explicitly about the importance of the synaptic membranes.

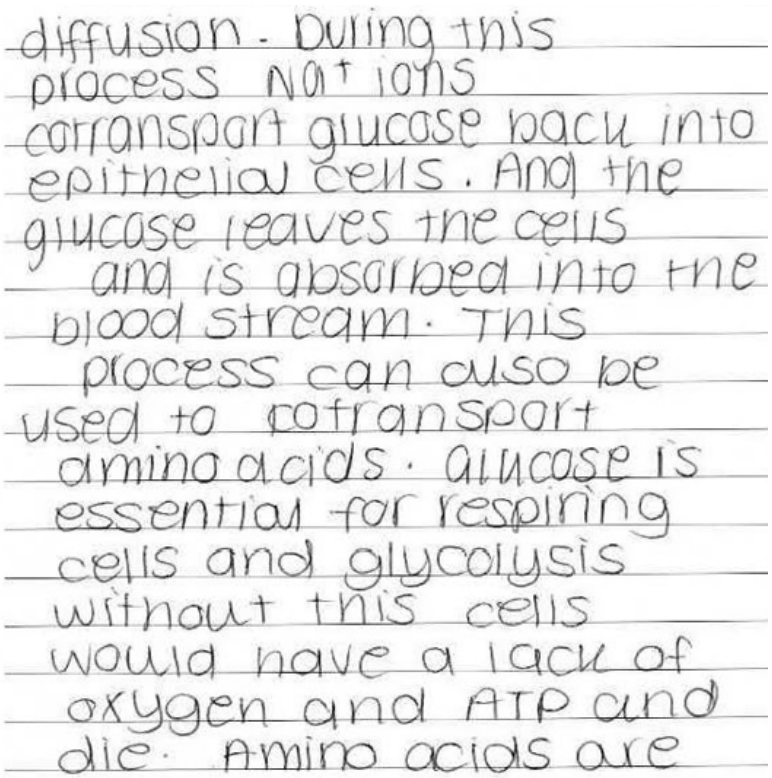


another example of important membranes in cells is during phagocytosis. firstly to phagocyte locates the invading pathogen (due to the variation in gradient of chemoreactants). The phagocyte engulfs the pathogen into a phagosome. Lysosomes fuse with phagosome and release digestive enzymes called lysozymes which hydrolyze the pathogen. The phagocyte then presents the pathogens antigens on its cell surface membrane. This is vital for immune response in cells as complementary antibodies will now bind to these antigens to form antibody-antigen

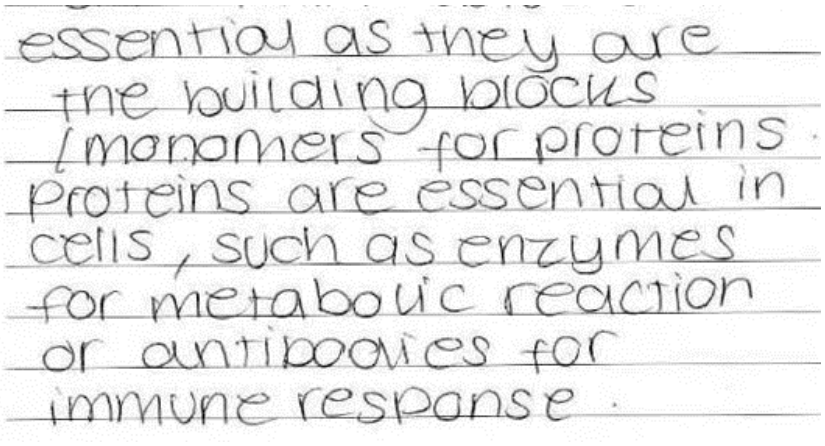

complexes. This with
Allows cells to protect
themselves from
invading and foreign
cells, which could
damage and potentially
kill the organism.

This student's third topic is 3.2.4 Cell recognition and the immune system. Their AO1 content shows correct A-level depth. However, their AO2 content is weak, being at GCSE level.


Membranes are also very
important in epithelial
cells. In epithelial cells
the membranes are
highly folded and
covered in microvilli
which increases the
surface area of the
cells for reactions
such as absorption.
During absorption Na^+ ions
are actively transported
from epithelial cells
into the ileum, there's
now a higher concentration
of Na^+ ions outside the
cell compared to
inside so Na^+ ions
move in by facilitated
the bloodstream


diffusion. During this process Na^+ ions cotransport glucose back into epithelial cells. And the glucose leaves the cells and is absorbed into the blood stream. This process can also be used to cotransport amino acids. glucose is essential for respiring cells and glycolysis without this cells would have a lack of oxygen and ATP and die. Amino acids are

This student is suggesting that glucose is needed to provide respiring cells with oxygen. This is a significant error.


essential as they are the building blocks (monomers for proteins. Proteins are essential in cells, such as enzymes for metabolic reaction or antibodies for immune response.

This student's third topic is 3.3.3 Digestion and absorption. Their AO1 content is lacking in some A-level detail, and their attempt at AO2 is GCSE level.

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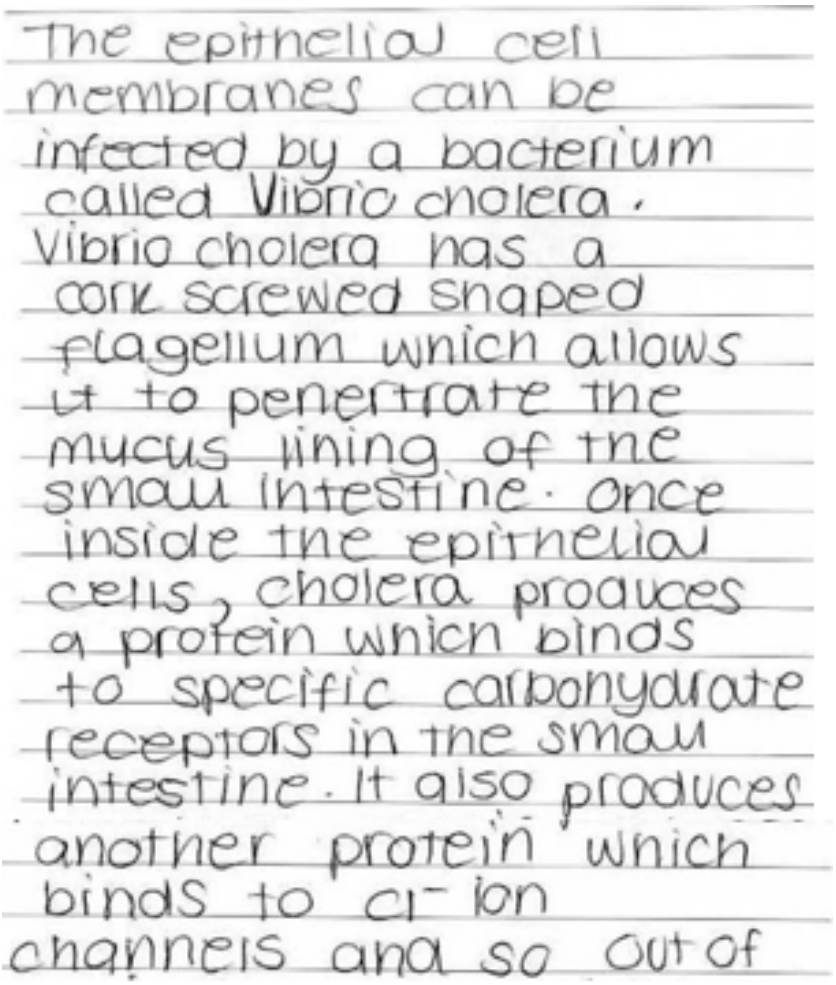
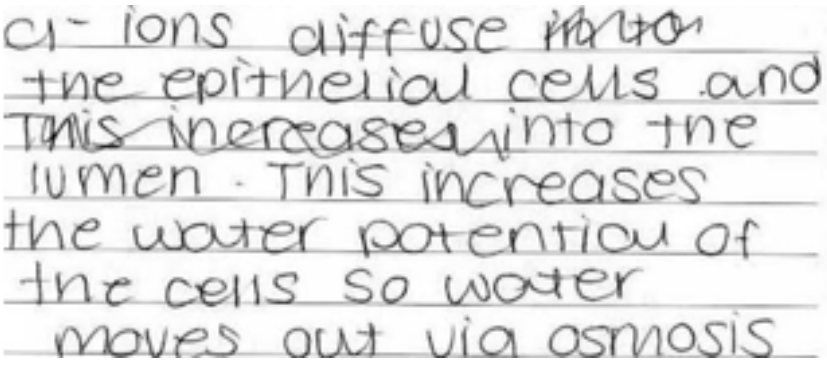

The epithelial cell membranes can be infected by a bacterium called Vibrio cholera. Vibrio cholera has a cork screwed shaped flagellum which allows it to penetrate the mucus lining of the small intestine. once inside the epithelial cells, cholera produces a protein which binds to specific carbohydrate receptors in the small intestine. It also produces another protein which binds to Cl^- ion channels and so out of

This student makes an attempt at beyond specification material with topic 3.2.3 Transport across cell membranes, and cholera. However, their description contains errors.

1. The carbohydrate receptors they refer to are gangliosides, which are lipids.
2. The 'another protein' they refer to, is cyclic AMP, which is not a protein.

Their section of AO2 on this topic is weaker, but does contain some A-level detail.


Cl^- ions diffuse into the epithelial cells and This increases into the lumen. This increases the water potential of the cells so water moves out via osmosis

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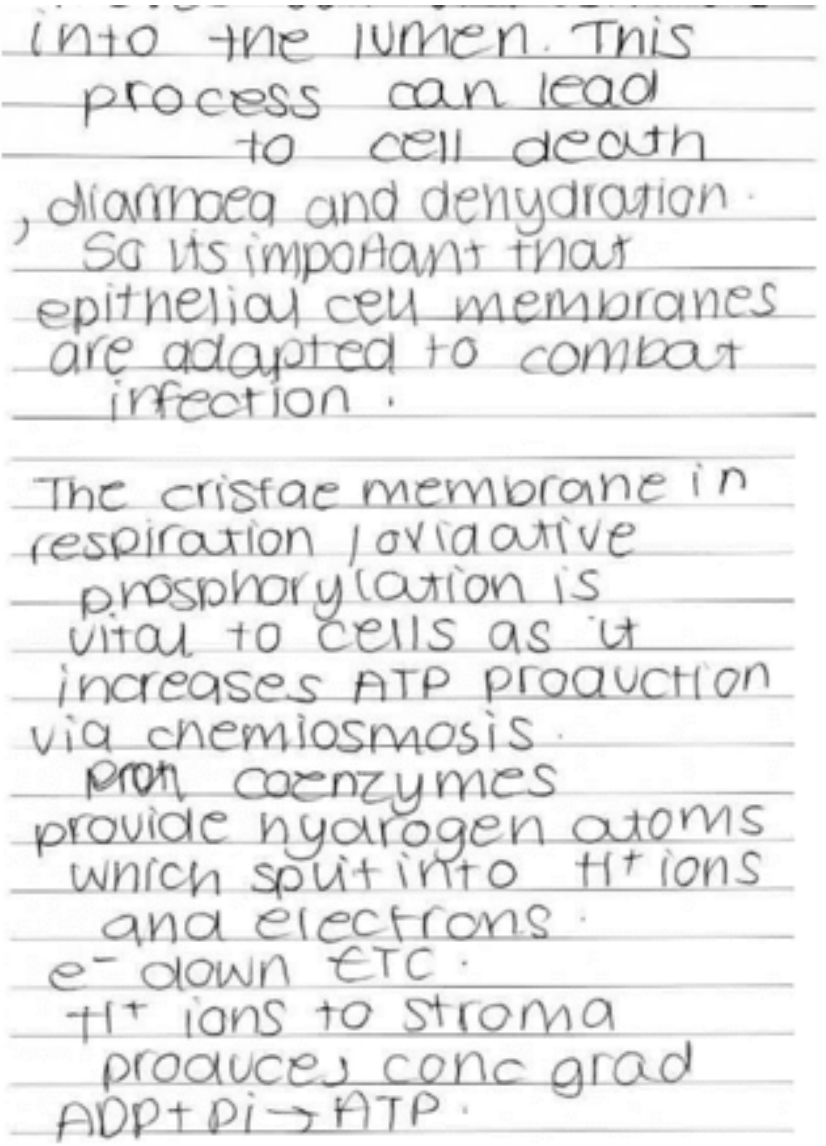
into the lumen. This process can lead to cell death, diarrhoea and dehydration. So its important that epithelial cell membranes are adapted to combat infection.

The cristae membrane in respiration / oxidative phosphorylation is vital to cells as it increases ATP production via chemiosmosis. Coenzymes provide hydrogen atoms which split into H^+ ions and electrons. e^- down ETC. H^+ ions to stroma produces conc grad ADP + Pi → ATP.

This student's final topic is 3.5.2 Respiration; however, there is no creditworthy A-level material, with this section being weak and confused. It appears that they were running out of time. The comment at the end about the stroma was ignored and is not a significant error.

Overall, the first four topics show A level content, one with good importance, the rest with weak importance. There is an attempt at beyond specification material but it is weak with significant errors. Their final topic is weak and confused. There are four significant errors. This essay is in the Multistructural level, but the number of errors prevent this from being at the top of this level, and so it scores 14.

14 marks

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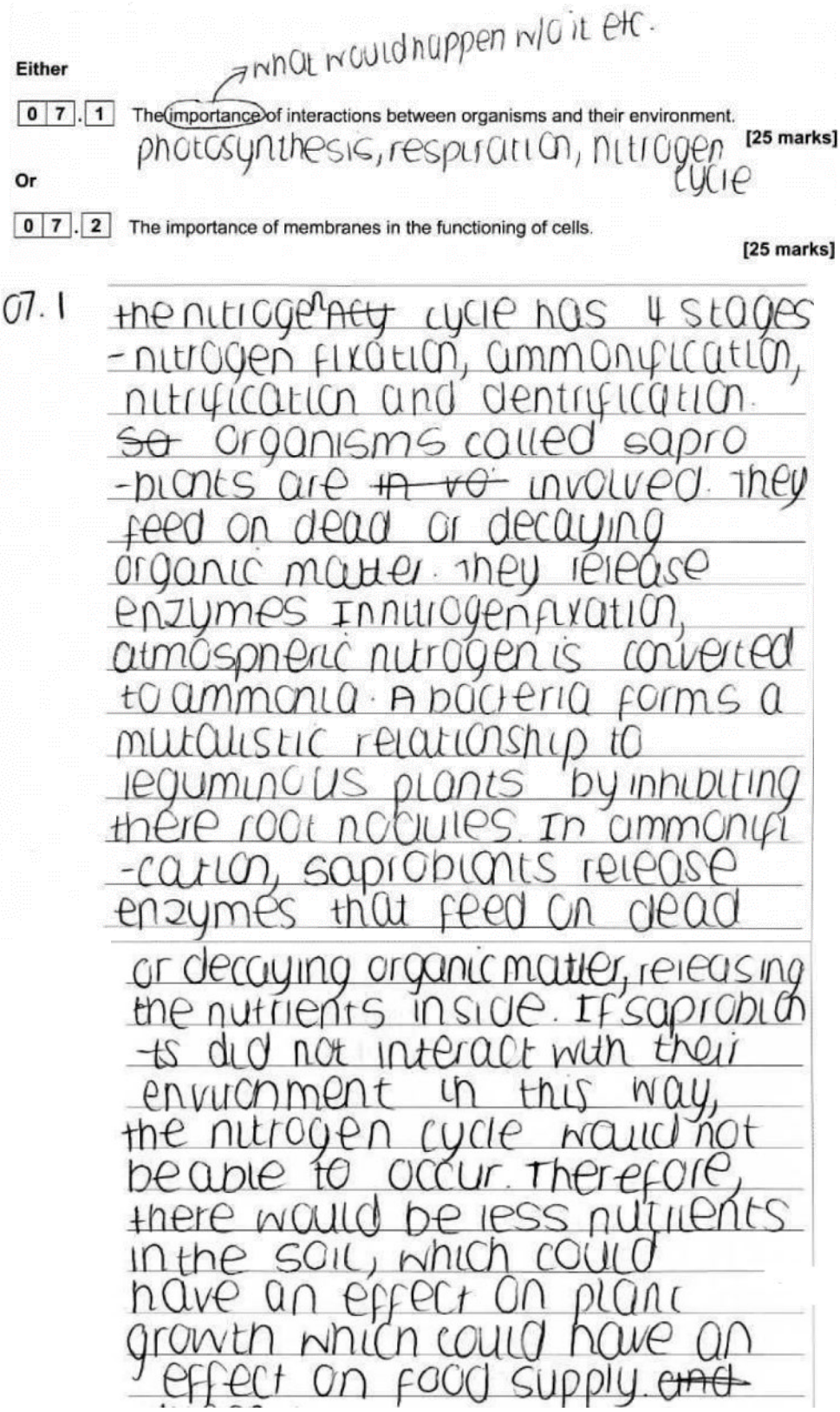
Student F



Either

07.1 The importance of interactions between organisms and their environment. [25 marks]

what would happen w/o it etc.

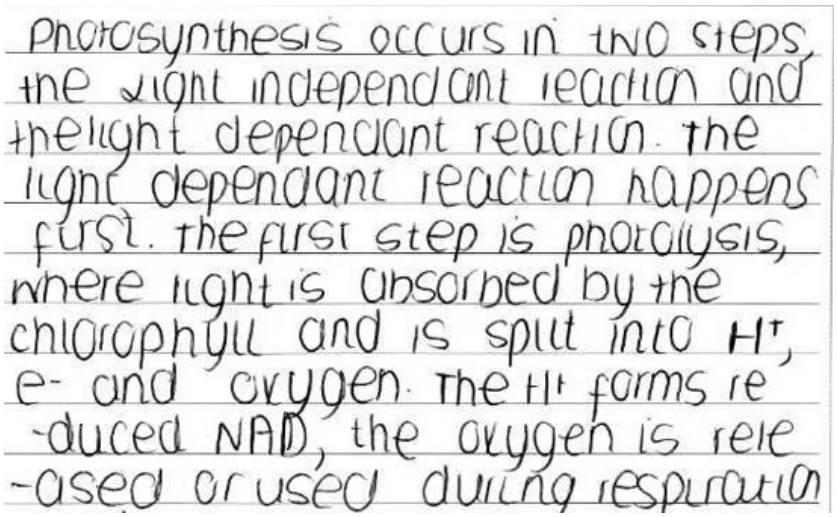
photosynthesis, respiration, nitrogen cycle

Or

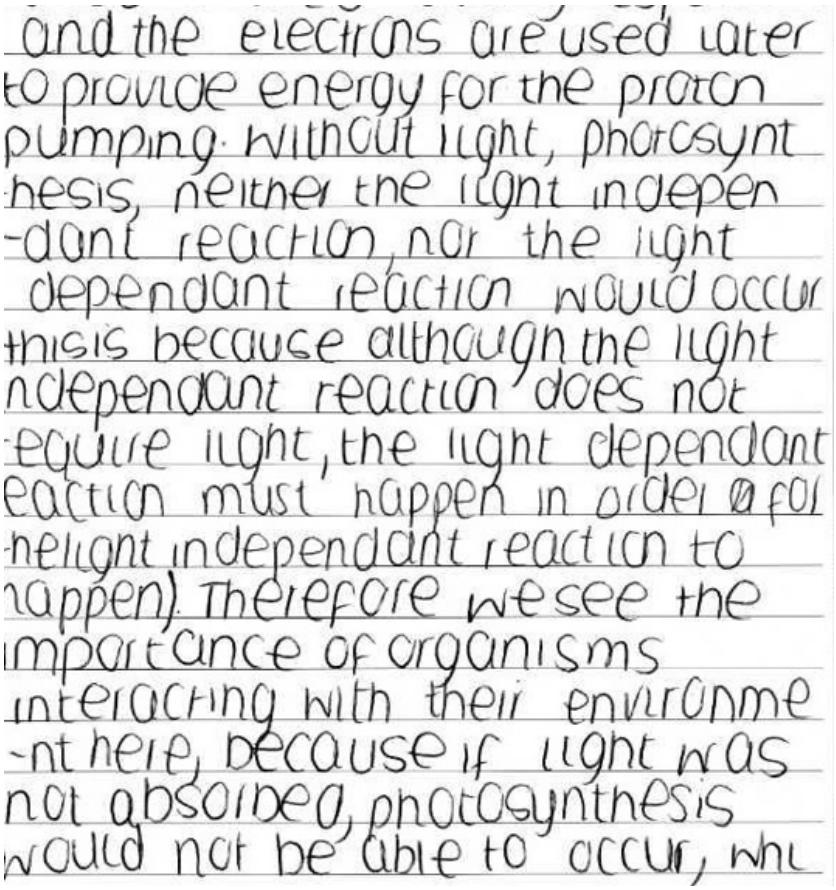
07.2 The importance of membranes in the functioning of cells. [25 marks]

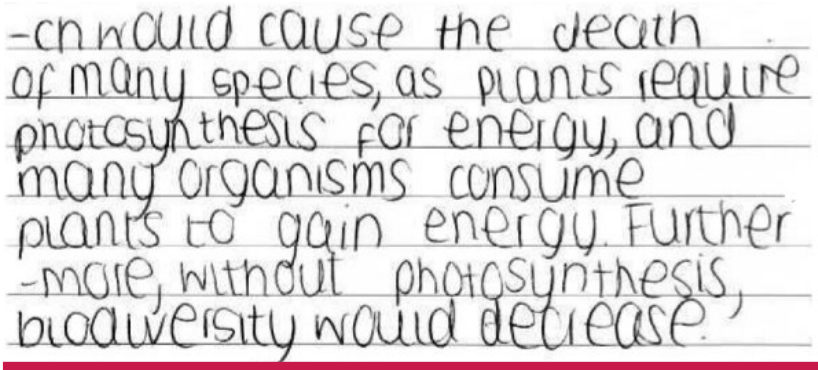
07.1 the nitrogen ~~acty~~ cycle has 4 stages - nitrogen fixation, ammonification, nitrification and dentrification. ~~so~~ organisms called sapro - plants are ~~in vo~~ involved. they feed on dead or decaying organic matter. they release enzymes In nitrogen fixation, atmospheric nitrogen is converted to ammonia. A bacteria forms a mutualistic relationship to leguminous plants by inhabiting there root nodules. In ammonifi - cation, saprobionts release enzymes that feed on dead or decaying organic matter, releasing the nutrients inside. If saprobion - ts did not interact with their environment in this way, the nitrogen cycle would not be able to occur. Therefore, there would be less nutrients in the soil, which could have an effect on plant growth which could have an effect on food supply. ~~and~~

This student's first topic is 3.5.4 Nutrient Cycles. There is only superficial A-level AO1 content, and the attempt at the importance is not beyond GCSE level.

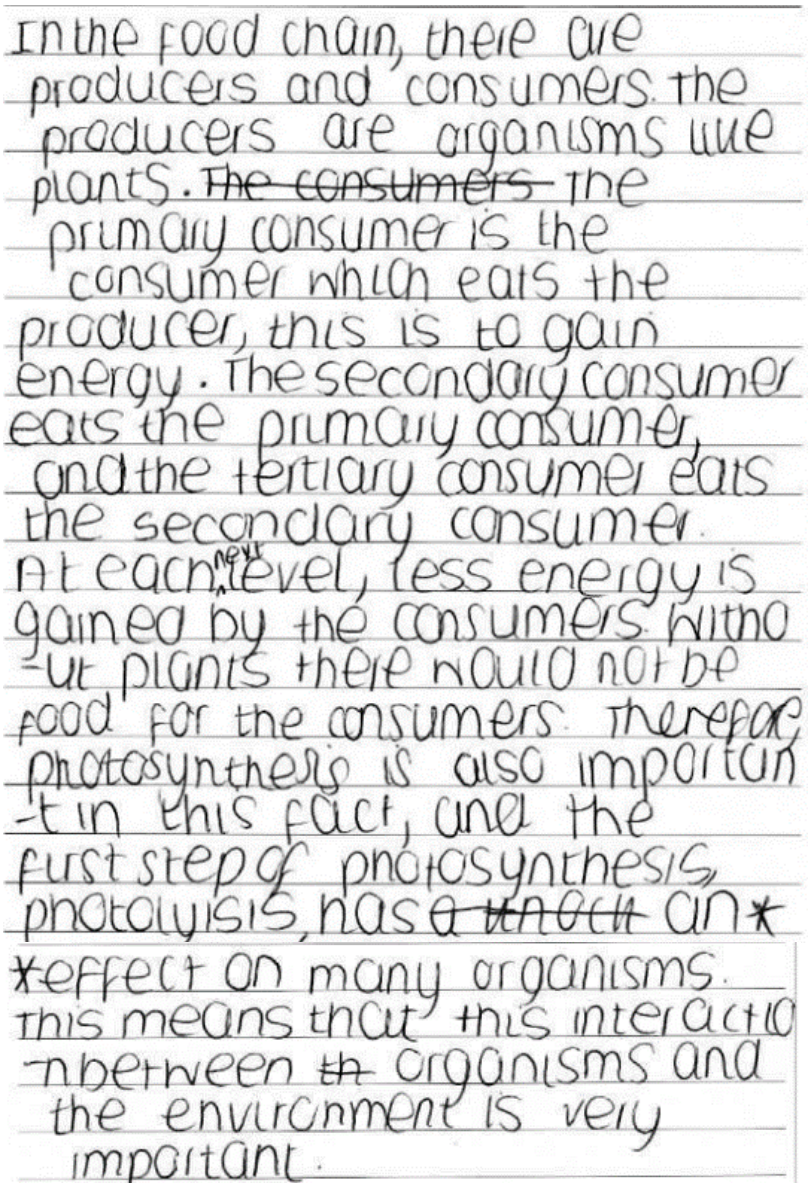

Photosynthesis occurs in two steps, the light independant reaction and the light dependant reaction. the light dependant reaction happens first. the first step is photolysis, where light is absorbed by the chlorophyll and is split into H^+, e- and oxygen. The H^+ forms re -duced NAD, the oxygen is rele -ased or used during respiration

The student suggests that light is split by chlorophyll, and suggests that a proton forms reduced NAD instead of reduced NADP. Overall, this constitutes a significant error.


and the electrons are used later to provide energy for the proton pumping. Without light, photosynt -hesis, neither the light indepen -dant reaction, nor the light dependant reaction would occur this is because although the light ndependant reaction does not equire light, the light dependant eaction must happen in order for the light independant reaction to happen). Therefore we see the mportance of organisms interacting with their environme -nt here, because if light was not absorbed, photosynthesis would not be able to occur, whi



This student's second topic is 3.5.1 Photosynthesis. Their AO1 description lacks A-level depth, and their attempt at the importance is not above GCSE level.



The student's third topic is 3.5.3 Energy and ecosystems; however, the AO1 content is GCSE level, and there is no attempt at the importance.

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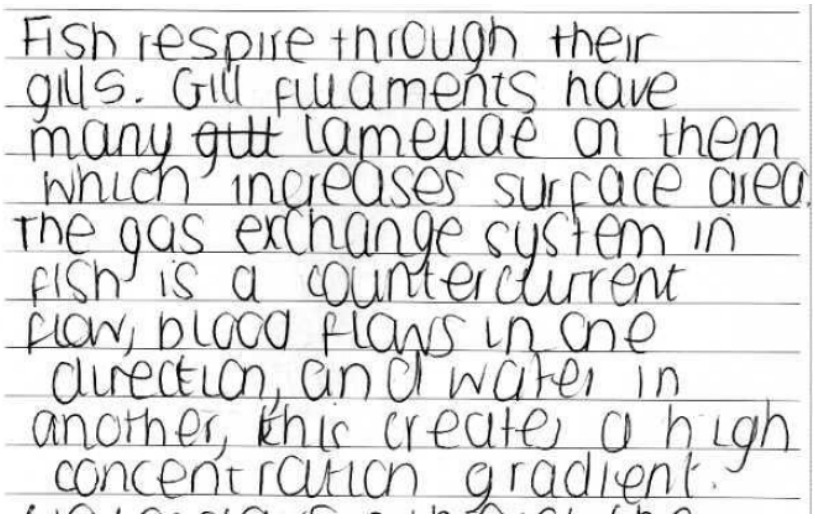
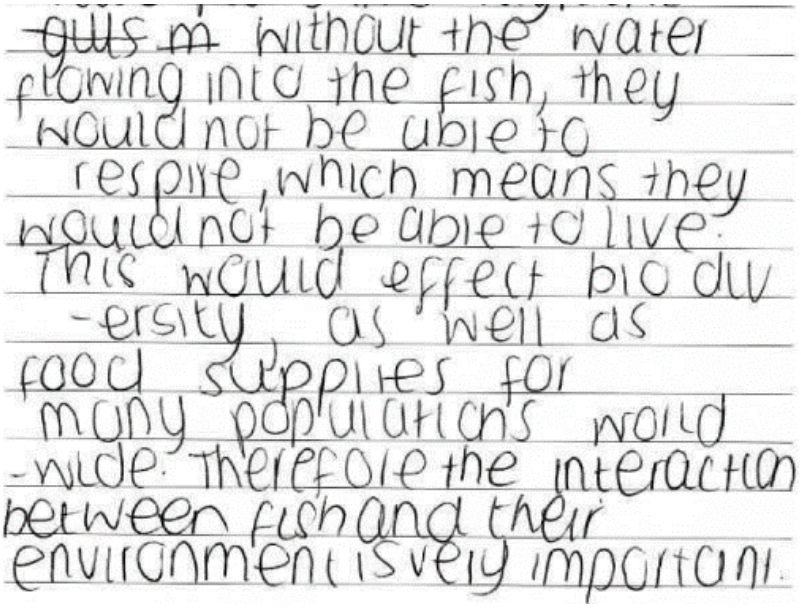

Fish respire through their gills. Gill fluaments have many ~~gtt~~ lamellae on them which increases surface area. The gas exchange system in fish is a countercurrent flow, blood flows in one direction, and water in another, this creates a high concentration gradient.

'Respire' here is taken to mean breathing, and is not a significant error.


~~gills~~ m without the water flowing into the fish, they would not be able to respire, which means they would not be able to live. This would effect biodiv-ersity as well as food supplies for many populations world-wide. Therefore the interaction between fish and their environment is very important.

The student's fourth topic of 3.3.2 Gas exchange starts with detail lacking. At this point the student would be expected to discuss a countercurrent flow allowing the maintenance of a concentration gradient across the whole length of the lamella(e).

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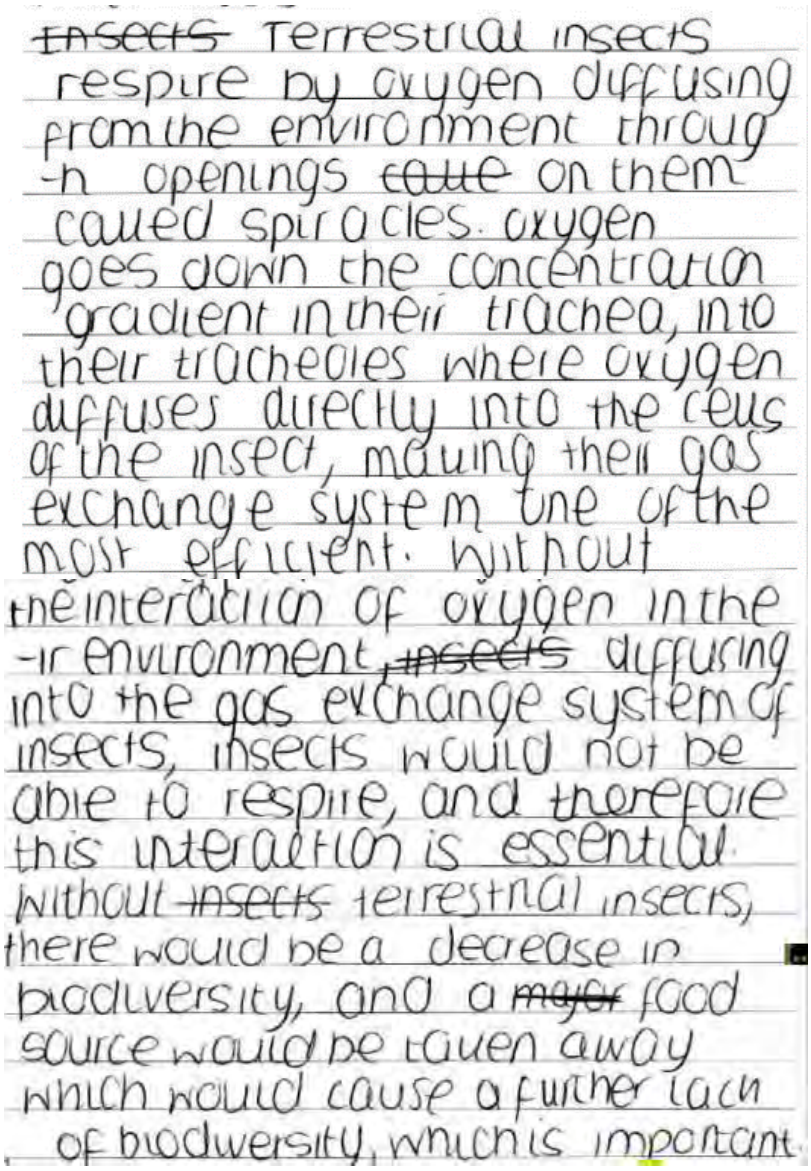
~~insects~~ Terrestrial insects respire by oxygen diffusing from the environment through openings ~~eoue~~ on them called spiracles. oxygen goes down the concentration gradient in their trachea, into their tracheoles where oxygen diffuses directly into the cells of the insect, making their gas exchange system one of the most efficient. Without the interaction of oxygen in the air environment, ~~insects~~ diffusing into the gas exchange system of insects, insects would not be able to respire, and therefore this interaction is essential. Without ~~insects~~ terrestrial insects, there would be a decrease in biodiversity, and a ~~major~~ food source would be taken away which would cause a further lack of biodiversity, which is important.

Topic 3.3.2 continues with insect gas exchange. Overall, this topic lacks appropriate A-level depth of both AO1 and AO2.

Overall, there are four topics, one of which is GCSE level, one of which shows superficial A-level depth, and two that are lacking A-level detail. The theme has not been addressed at the right level in any topic. There is one significant error. This essay is in the Multistructural level, just, at the bottom end and scores 11.

11 marks

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Unistructural

Student G

0 7 Write an essay on **one** of the topics below.

nerves Y2 ✓
immunology Y1 ✓
natural selection Y1 ✓
hormones + response Y2 ✓

Either

0 7 . 1 The importance of interactions between organisms and their environment.

[25 marks]

not

The nervous system will produce a response to a stimulus. The synaptic transmission means that impulses can be sent all around the body in response to a change in organisms and their environment. when ~~either~~ an impulse reaches the synapse calcium channels open this means that the calcium ions enter the synaptic bulb. These calcium ions move and fuse with vesicles. This produces the neurotransmitter acetylcholine. The acetylcholine will bind to pre-synaptic membrane. This causes the

Calcium ions fusing with vesicles, this producing acetylcholine, and acetylcholine fusing with the pre-synaptic membrane is a significant error.

neurotransmitter to diffuse across the synaptic cleft. When it reaches the post-synaptic membrane it will bind to the receptors. This will cause the calcium ions channels to close and the sodium ion channels to open so sodium

ions move in by active transport. This will produce an action potential which will reach a threshold of around 35 mv causing depolarisation. Impulses can be sent down the sympathetic nervous system to increase heart rate when exercising.

Sodium ions moving in by active transport is a significant error.

AO2

If the impulses were not transmitted through the synapse and along the sympathetic nervous system to the SAN then the heart rate would not increase. If the heart rate didn't increase then less blood containing oxygen wouldn't reach the heart. The heart muscles need oxygen for contraction of the heart - if there was less contractions of heart muscle then the heart tissues would die after being deprived of oxygen. An example of ~~when~~ a disease linked with impulses carried along the nervous system is multiple sclerosis as it occurs when the myleination which provides insulation is degenerates meaning action potential is lost and speed of impulses is slower creating the pain for multiple sclerosis.

This student's first topic is 3.6.2.2 Synaptic transmission. The student's strategy of separating their AO1 and AO2 content does make it clear for the examiner. However, their AO1 content is lacking detail, and the attempt at the importance is weak.

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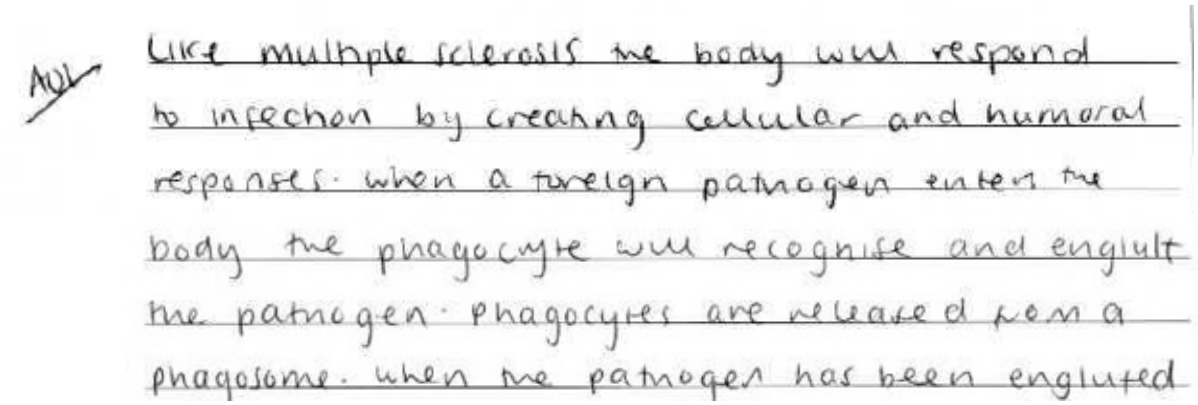
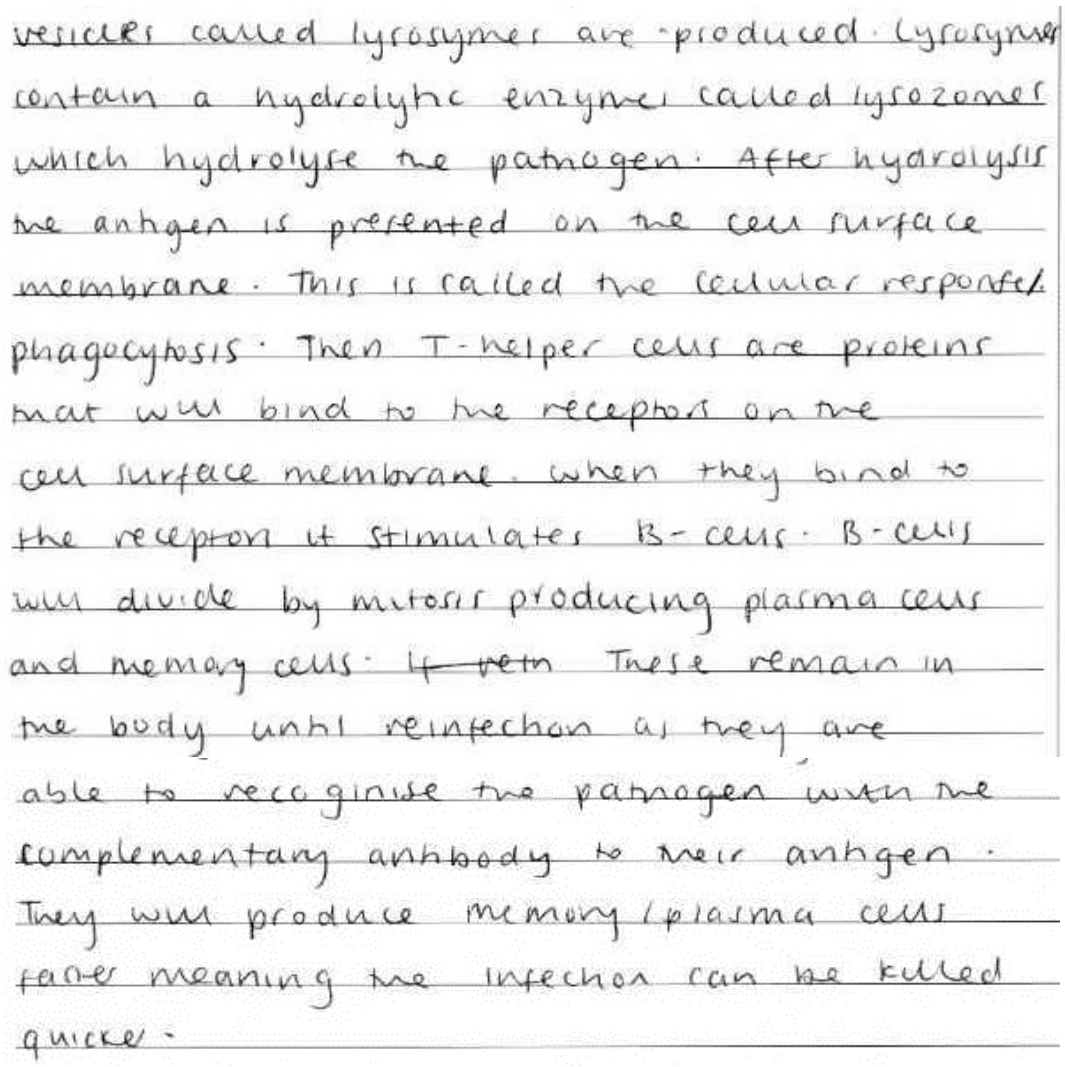
This section on multiple sclerosis is not about the interactions between organisms and their environment, and is therefore an irrelevant section.



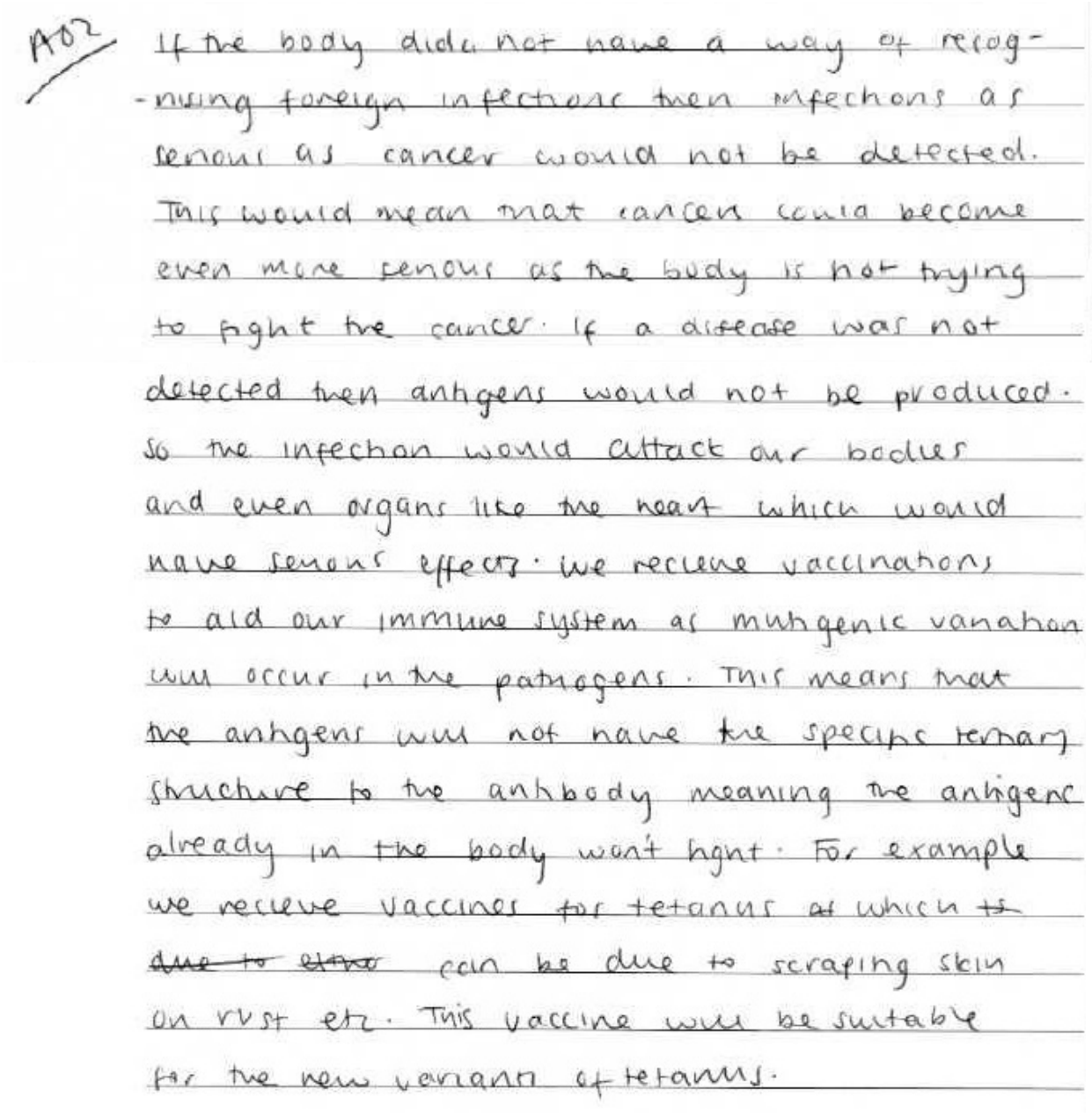
Like multiple sclerosis the body will respond to infection by creating cellular and humoral responses. When a foreign pathogen enters the body the phagocyte will recognise and engulf the pathogen. Phagocytes are released from a phagosome. When the pathogen has been engulfed

Phagocytes are not released from a phagosome. This is a significant error.



vesicles called lysosymes are produced. Lysosymes contain a hydrolytic enzyme called lysozomes which hydrolyse the pathogen. After hydrolysis the antigen is presented on the cell surface membrane. This is called the cellular response/ phagocytosis. Then T-helper cells are proteins that will bind to the receptors on the cell surface membrane. When they bind to the receptor it stimulates B-cells. B-cells will divide by mitosis producing plasma cells and memory cells. ~~If~~ ~~then~~ These remain in the body until reinfection as they are able to recognise the pathogen with the complementary antibody to their antigen. They will produce memory/plasma cells faster meaning the infection can be killed quicker.

This student has confused antibody and antigen. This is further qualified in the next paragraph ('then antigens would not be produced'). This is a significant error.



AO2

If the body did not have a way of recog-
-nising foreign infectious then infections as
serious as cancer would not be detected.
This would mean that cancer could become
even more serious as the body is not trying
to fight the cancer. If a disease was not
detected then antigens would not be produced.
So the infection would attack our bodies
and even organs like the heart which would
have serious effects. We recieve vaccinations
to aid our immune system as mutagenic variation
will occur in the pathogens. This means that
the antigens will not have the specific tertiary
structure to the antibody meaning the antigens
already in the body won't fight. For example
we recieve vaccines for tetanus as which ~~is~~
~~due to etc~~ can be due to scraping skin
on rust etc. This vaccine will be suitable
for the new variant of tetanus.

This student's second topic is 3.2.4 Cell recognition and the immune system. There is only superficial AO1 A-level content, and their AO2 section contains no creditworthy A-level depth material.

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AO1

The environment changes constantly and so do organisms. Natural selection highlights how certain organisms will adapt for survival. eg species will have a mutation of allele which is passed when a species reproduces. This allele would be adapted to increase survival and the advantageous allele would be passed on through the generations. This highlights the importance of the interactions with the environment as it means that the organism is more likely to survive. The change in the environment could be changes in weather to for example animals with black hair eventually lightens to release more heat or the mutation may occur to camaflauge from preyete.

AO2

If the species did not adapt alleles for survival then the species could eventually die out. For example if a species This would be due to outdated appearences and if it was for the context of food source the competion would push them to extinction. If the adapted allele was not passed down generations new generations wouldn't be adapted for new environment highlighting the importance of the interactions.

This student's third topic is 3.4.4 Genetic diversity and adaptation. However, their AO1 content is GCSE level, and their AO2 section contains no creditworthy material.

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AO1 Hormones will bind to receptors on target cells which produce a response. This can be seen in osmolarity. This will interact with the changes in environment. The hypothalamus contains osmoreceptors which will detect a low water potential in the blood. This means electrical impulses are sent to the posterior pituitary gland where an anti-diuretic hormone is released. This will travel to the collecting duct where it will bind to the receptors increasing the permeability of the collecting duct. This means that more water can enter which increases Ψ in blood. This water will be reabsorbed at the PCT which means that the person is more hydrated. This is an example of negative feedback as more or less of the homone is release depending on how hydrated the person is.

Water reabsorbed at the PCT is a significant error.

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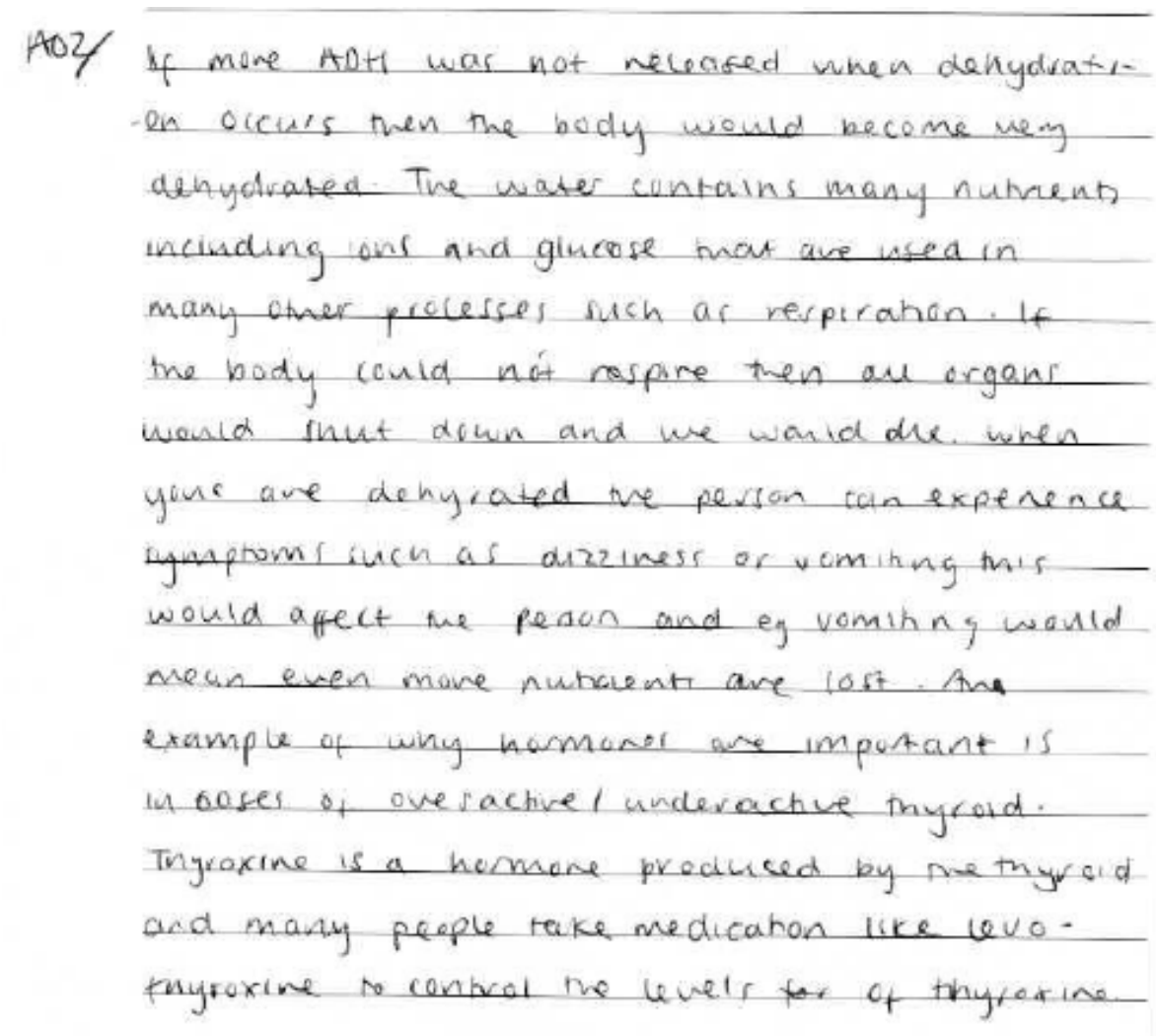
AO2

If more ADH was not released when dehydration occurs then the body would become very dehydrated. The water contains many nutrients including ions and glucose that are used in many other processes such as respiration. If the body could not respire then all organs would shut down and we would die. When you are dehydrated the person can experience symptoms such as dizziness or vomiting this would affect the person and eg vomiting would mean even more nutrients are lost. An example of why hormones are important is in cases of overactive / underactive thyroid. Thyroxine is a hormone produced by the thyroid and many people take medication like levo-thyroxine to control the levels for of thyroxine.

This student's final topic is 3.6.4.3 Control of blood water potential. The AO1 content is lacking A-level detail, and their AO2 section contains no creditworthy material.

Overall, there are four topics. Two topics are lacking in A-level depth, one topic contains superficial A-level depth and one topic is at GCSE level. There is no creditworthy attempt at the theme. There is one irrelevant section and five significant errors. This essay would be in the Multistructural level, but the number of errors drop it into Unistructural level, but at the top end with a score of 10.

10 marks

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Student H

0 7 . 2 The importance of membranes in the functioning of cells.

[25 marks]

Membranes as a whole are an important factor of all cells that help cells to function.

One example of this are cell surface membranes. These have the function of controlling what can and cannot enter and leave the cell. This prevents any harmful cells or products from entering the cell. If the cell surface cell membranes are semi-permeable meaning that only certain molecules or items can enter the cell. For example, the item must be small as it needs to be able to diffuse across the membrane. If the cell membrane was to stop working, harmful items or pathogens would be able to enter the cell which could cause it to die. It means no harmful bacteria can enter a cell and cause diseases.

This student's first topic is 3.2.3 Transport across cell membranes. However, there is no creditworthy A-level AO1 content, and the theme has not been addressed at an appropriate level.

Another example of a membrane that has importance in relation to the functioning of cells is the synaptic membranes. For example, the presynaptic membrane is responsible for containing the vesicles that contain the neurotransmitters that need to be released in order to regulate hormone levels or mood level for example. If the presynaptic membrane was faulty, then there would be a lack of neurotransmitters

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binding to receptors on the post synaptic membrane as they won't be able to leave the vesicles.

leading on from the last paragraph, the post synaptic membrane is another example of a membrane having importance. For example, the post synaptic membrane is where the receptors are found. When the vesicles release the neurotransmitters into the synaptic cleft, the neurotransmitters will travel down a concentration gradient to the post synaptic membrane and they will then bind to the receptors or 'sodium channels'. These neurotransmitters can then be absorbed into the post synaptic membrane. If the post synaptic membrane was faulty,

Absorbing of neurotransmitters into the post-synaptic membrane is a significant error.

the entire process of synaptic transmission will not be able to happen effectively as the receptors may not work correctly so no neurotransmitters can be absorbed.

This student's second topic is 3.6.2.2 Synaptic transmission. There is some superficial A-level AO1 content, but the importance is not at A-level depth.

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Another example of an important membrane is the thylakoid membrane. The thylakoid membrane is important as it is the location of the light dependent reaction. During the light independent reaction, ions will be pushed up into the thylakoid membrane from which they will leave through the enzyme ATP Synthase through diffusion which ~~is~~ will form ATP. This means the ions have diffused down a concentration gradient and down a membrane in order to form ATP. This process is also known as chemiosmosis.

If this membrane was faulty, the entire process of photosynthesis will not work as the products made in the light dependent reaction are then used in the light independent reaction so if the light dependent reaction fails, so will the light independent reaction.

This student's third topic is 3.5.1 Photosynthesis. There is some superficial A-level AO1 content, but the importance is not at A-level depth.

One final membrane that has importance is the Synovial membrane. This holds importance as it ~~is~~ provides bones ~~by~~ and ligaments with flexibility and it acts as a form of lubrication for the

Synovial membranes are a beyond specification topic. However, there is no A-level depth. Synovial membranes do not provide bones with flexibility; this is a significant error.

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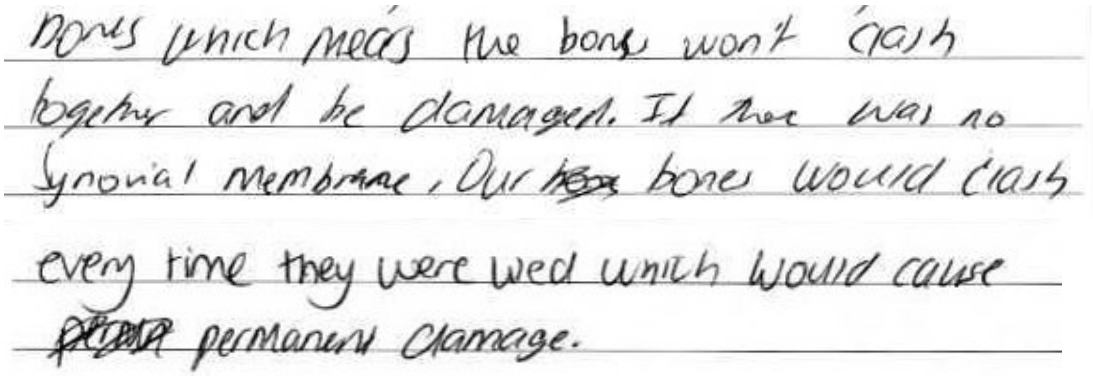

Overall, there are four topics. Two topics show superficial A-level depth, one topic contains A-level material, and the attempt at beyond specification material is lacking depth and contains a significant error. The theme is not addressed at the right depth in any topic. This essay is in the Unistructural level. Having two topics with some superficial A-level detail puts it towards the middle of the level, with a score of 7.

7 marks

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