

AQA – Biology Unit 5

The Essay:

Marking the essay

Scientific content

Is the essay
Good (12 marks)
Medium (8 marks)
Poor (4 marks)?

Insert mark

Do you want to go to
the intermediate
mark?

Insert new mark

Put a tick in the box for each significant
reference to material that is beyond that
required at A-level

--

Final mark for scientific content

If the essay has been classed as good, add 2 marks if there is one
tick in the box, or 4 marks if there are two or more ticks.

Breadth

Topic	Tick box if at least one “paragraph” on topic
Physiology	<input type="checkbox"/>
Direct effects	<input type="checkbox"/>
Indirect effects	<input type="checkbox"/>

Topic	Tick box if at least one “paragraph” on topic
Pathogens	<input type="checkbox"/>
Life style	<input type="checkbox"/>
Genetics	<input type="checkbox"/>

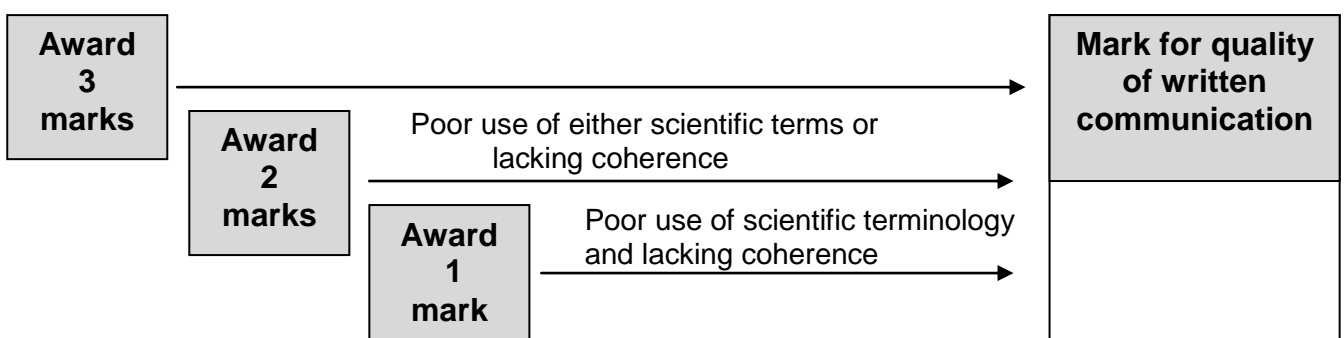
Give one mark for each box ticked

Relevance

Put a cross in the box for each significantly irrelevant comment

Number of crosses	Number of marks
None	3
2	2
More than 2	1

Quality of written communication



What are the examiners looking for:

✓ This is a sound piece of A-level knowledge. If it were an answer to another question, it would have gained a mark.

✗ This is clearly wrong.

Q A technical term has been used incorrectly or this doesn't make sense.

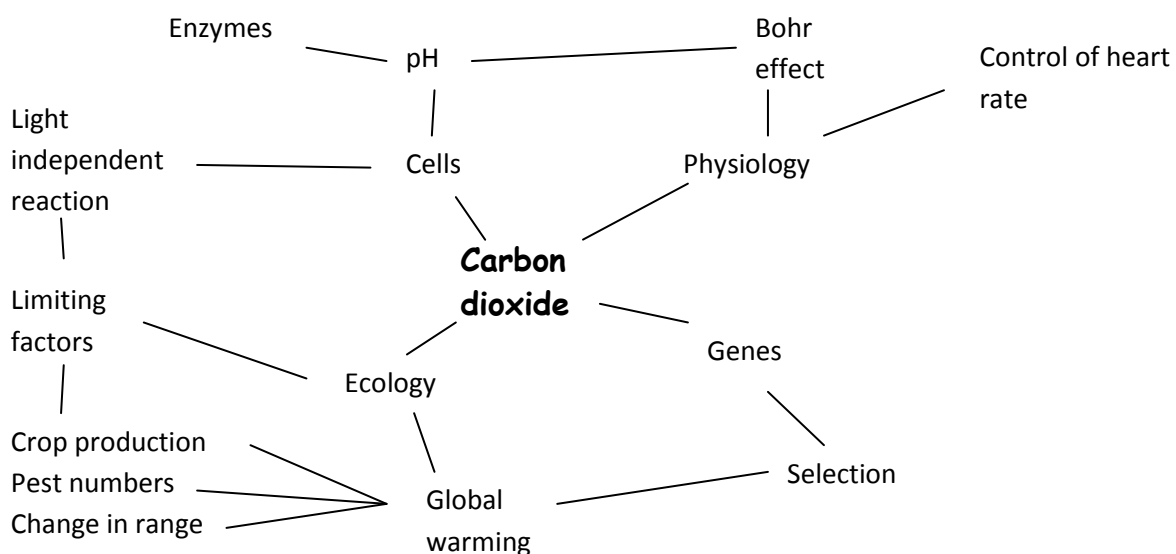
⚡ Clearly irrelevant. This has nothing to do with the title

|| Really good. Goes beyond the requirements of the specification.

What you should consider:

- Many grade E candidates produced plans but 20% did not; 10% ornamented their work with impressive doodles. All grade A candidates produced a plan.
- Candidates need an approach that enables them to explore the breadth of the specification . . . but A-level biology should not be about learning what each Unit contains.
- Spider diagrams are very popular.
- A plan can only help. Candidates cannot lose marks for anything written in a plan.
- The examiner should be able to read what is written in the plan. It certainly should not be heavily crossed out.
- A plan may help in gaining marks for skills **B** and **Q**.

Look at this title: 'Carbon dioxide may affect organisms directly and indirectly Describe and explain these effects.'



Try marking this essay.....

Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects.

Carbon dioxide is both a vital requirement for producers - the first organisms in any food chain, and at times a dangerous waste product.

Where plants use carbon dioxide during the Calvin cycle of photosynthesis, at night they also produce small quantities due to respiration. Fundamentally, carbon dioxide reacts with ribulose biphosphate to produce glycerate 3-phosphate in the light independent reaction. In turn glycerate 3-phosphate is reduced to triose phosphate using reduced NADP and ATP from the light dependent reaction. This follows through to produce products such as starch, and regenerate RuBP. Without this process, plants cannot produce the organic molecules which are a critical starting point for all food chains and webs.

One way that carbon dioxide is released is through respiration. During the Krebs cycle carbon dioxide is removed when turning citrate into oxaloacetate, removing 2 CO_2 in each cycle. Directly, organisms release 6 CO_2 molecules for each molecule of glucose used in the respiratory pathway.

It is important that when breathing, excess carbon dioxide is removed from the body. In solution, carbon dioxide forms a weak acid called carbonic acid. This lowers the pH of the blood (in humans) and in return, this change in pH can affect many enzymes as well as the haemoglobin molecule. The lowered pH causes the shape of the haemoglobin molecule to change so it can offload more oxygen. This change in properties of the haemoglobin molecule displaces the oxygen dissociation curve to the right (Bohr shift) and lowers its affinity for oxygen.

To remove excess carbon dioxide, the sympathetic nerve from the medulla oblongata will send a series of impulses to the SAN in the heart as a result of chemoreceptors in the carotid artery detecting an increase in CO_2 concentration. The sympathetic nerve causes the SAN to increase the amount of heart beats per minute, so removing the carbon dioxide faster by transporting more blood to the lungs.

Another way of carbon dioxide accumulating in the atmosphere is via the carbon cycle when dead or decaying organisms are broken down by saprobionts and carbon dioxide is produced by microbial respiration.

Unfortunately, carbon dioxide may indirectly cause adverse effects to the climate in which organisms live. When radiation from the sun reaches the earth's crust, it is

reflected back. Carbon dioxide along with other greenhouse gases reflects this radiation and prevents it escaping. As more carbon dioxide accumulates, more heat is retained leading to rising temperatures and a warmer climate. An increasing temperature can have a number of effects on living organisms. At first thought, it might be considered that a combination of a greater concentration of carbon dioxide and a higher temperature will increase the rate of photosynthesis but this may not be the case. The enzyme Rubisco is involved in catalysing the reaction in which ribulose biphosphate combines with carbon dioxide. Rubisco also combines with oxygen however in a process called photorespiration. Photorespiration increases rapidly at higher temperatures so a rise in temperature could result in photosynthesis become less efficient, not more.

Crop yield is also related to pest damage. A higher temperature is likely to affect pest numbers. It might do this in a number of ways. The European corn borer is a pest of maize. Scientists have found that the number of generations of this pest decrease with distance north. A higher mean temperature will therefore lead to more generations and greater crop loss. The UK is at the northern limit of distribution for some pest insects. One of these is the southern green shield bug. This is a serious pest of some crops in continental Europe. Over the past few years, biologists have found more of these plant-sucking pests in southern England.

To conclude, carbon dioxide is both a harmful waste product and a necessity for the vital process of photosynthesis.

Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects.

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To conclude, carbon dioxide is both a harmful waste product and a necessity for the vital process of photosynthesis.

Marks awarded for this essay:

Scientific content	All of the material presented is of a sound A-level standard fully in keeping with the specification requirements. It can therefore be classified as a good essay. In addition, there are two substantial sections in which the content is more than that expected in the specification, reflecting a greater depth of study. This raises the mark to a maximum.	16 marks
Breadth	All three areas required in mark scheme have been covered.	3 marks
Relevance	There is nothing here that might be considered to be irrelevant.	3 marks
Quality of written communication	The essay is coherent and easy to follow, with excellent use of terminology.	3 marks

Now have a go at the one on the next page

The causes of disease

The causes of disease in humans are extremely varied. Some diseases are self-inflicted by a person's lifestyle. Others are genetic and others are caused by pathogenic organisms or viruses.

Self-inflicted diseases are caused by the lifestyle choice of the individuals or the individuals surrounding them. One such example is lung cancer caused by smoking. While some people develop cancer without ever smoking, the vast majority of lung cancer sufferers are smokers. Emphysema is another disease linked to smoking as chemicals cause your air passages to block up. The cilia also shrivel up and there is no way to reverse this process as they cannot be repaired. Many other diseases are caused by a poor diet and lack of exercise. Heart disease is one example.

Another cause of disease is genetics. Some diseases are inherited directly from a parent who is a carrier or a sufferer from the disease. Most of the time their genetic diseases are recessive traits so they require two doses of the recessive faulty gene for the illness to express itself as carriers have a faulty gene but no symptoms. Some genetic diseases such as haemophilia are sex-linked and the disease only expresses itself if a carrier female and a male sufferer produce offspring.

Other genetic diseases are not inherited but instead are caused by a problem in the genetic code. Some of these problems involve changing the base sequence but this may have no effect on the protein produced. This is because the new sequence of bases, for example AAA, may code for the same amino acid as the original one which might be AAT. This means that the amino acid is not changed so the protein is the same and the person does not get a disease.

Diseases can also be caused by pathogenic organisms and viruses. These can enter the body through various interfaces such as breaks in the skin, the digestive system, respiratory system and reproductive system. Such organisms invade the body and infect host cells. Many viruses work in the same way only they surround themselves with the host cell making it difficult to destroy them and rendering antibiotics useless against them. Pathogens which cause disease in humans can find their way into the body in many ways. Airborne pathogens which are expelled from an infected person can remain in the air in water droplets expelled by coughing or sneezing. Pathogens can also be picked up on the skin from unclean surfaces and can make their way into the body through cuts or damaged skin.

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Marks awarded for this essay:

Scientific content	Fits descriptor for four marks. Most of this is very superficial but the only real errors relate to the section in which the candidate says that "Some genetic diseases such as haemophilia are sex-linked and the disease only expresses itself if a carrier female and a male sufferer produce offspring."	4 marks
Breadth	All three areas required in mark scheme have been covered.	3 marks
Relevance	There is a section on mutation that is clearly irrelevant, but as it is only one in an essay of normal length, three marks is still awarded.	3 marks
Quality of written communication	The essay is coherent and easy to follow but there is some poor use of terminology with phrases such as "cause your air passages to block up" and cilia "shrivelling up"	2 marks

What sort of essay titles can you expect?

The essay titles will be very similar to those in the synoptic papers on the legacy specifications (BYA8/W, BYA9/W and BYB678/B). Some of titles from these papers that are applicable to the new specification are listed below:

- The different ways in which organisms use ATP
- How the structure of cells is related to their function
- How the structure of cell organelles is related to their functions
- Write an essay about mitochondria.
- The roles of membranes in living organisms
- The biological importance of water
- The roles of enzymes in the control of metabolic pathways
- The structure and functions of carbohydrates
- How the structure of proteins is related to their functions
- The functions of nucleic acids.
- Polymers have different structures. They also have different functions. Describe how the structures of different polymers are related to their functions.
- Importance of Molecular shape
- Condensation and hydrolysis and their importance in biology.
- The importance of hydrogen bonds in living organisms
- Inorganic ions include those of sodium, phosphorus and hydrogen. Describe how these and other inorganic ions are used in living organisms.
- The process of osmosis and its importance to living organisms
- The process of diffusion and its importance in living organisms.
- How bacteria affect human lives
- The many causes of human disease.
- The ways in which different species of organisms differ from each other
- Why offspring produced by the same parents are different in appearance.
- The factors which determine an organism's phenotype.
- The movement of substances within living organisms
- Relationships between animals and plants
- Energy transfers which take place inside living organisms
- Energy is transferred to, within and from living organisms via light, heat, movement, electricity and chemical changes. Describe the ways in which energy can be transferred within living organisms.
- The transfer of energy between different organisms and between these organisms and their environment
- Heat and many different substances are transferred within the body and between the body and the environment. Explain how surface area is linked to this transfer.
- Describe how nitrogen-containing substances are taken into, and metabolised in, animals and plants.
- Explain how the cycling of carbon and nitrogen in ecosystems is influenced by human activity.
- Negative feedback and its importance in biology.
- Maintaining constant conditions in the body.
- How an amino acid gets from protein in a person's food to becoming part of a human protein in that person.

- How carbon dioxide gets from a respiring cell to the lumen of an alveolus in the lungs.
- Discuss the ways in which terrestrial organisms achieve efficient gas exchange while at the same time limiting water loss.
- The different ways in which living organisms obtain their nutrients.
- Write an essay about receptor molecules and their importance in biology.
- The roles of pigments in living organisms

Some sample essays from legacy AQA papers:

The part played by the movement of substances across cell membranes in the functioning of different organs and organ systems.

- 1 Plasma membranes and movement across (P)
- 2 Gaseous exchange system/ lungs (G)
- 3 Digestive system/small intestine (D)
- 4 Blood vascular system (B)
- 5 Transpiration/root/stem (T)
- 6 Mass flow/leaf/stem (Mf)
- 7 Nervous system/eye (N)
- 8 Excretory system/ kidney (K)
- 9 Muscle systems (M)
- 12 Liver, blood glucose (L)
- 11 Root mineral ions (U)
- 10 Lungs cystic fibrosis (Cf)

Any other sensible example of the movement of substances across cell membranes in the functioning of different organs and organ systems should be credited. In a good essay, the emphasis should be on **movement across membranes** involving organ function.

The part played by enzymes in the functioning of different cells, tissues and organs.

- 1) Action of enzymes (AE)
- 2) Enzyme properties (EP)
- 3) Extracellular digestion (ED)
- 4) Nutrient cycles (N)
- 5) Digestion in humans (D)
- 6) Replication of DNA (R)
- 7) Protein and enzyme synthesis (TT)
- 8) Metabolic pathways (Met)
- 9) Mutations (M)
- 10) Coenzymes and enzyme action (Co)
- 11) Homeostasis (H)
- 12) Neurone/synapse (S)
- 13) Muscle contraction (C)
- 14) Pesticide toxicity (P)

Any other sensible example of the part played by enzymes in the functioning of different cells, tissues and organs should be credited. In a good essay, the emphasis should be on the part played by enzymes.

Movements inside cells.

Topic areas for assessment of scientific content:

- 1) Plasma membranes and movement across (M)
- 2) Protein synthesis (P)
- 3) Movement through ER and Golgi (ER)
- 4) Cell division and chromosome movement (C)
- 5) Water movement in plants/xylem (W)
- 6) Translocation (P)

- 7) Neurones and synaptic vesicles (N)
- 8) Actin and myosin (S)
- 9) DNA replication and mutation (D)
- 10) Electron transport chains (Etc)
- 11) Molecular/atomic/ionic movement (K)

Any other sensible example of movement inside cells should be credited.

In a good essay, the emphasis should be on movement.

Assessment of breadth of knowledge

3 marks Coverage of 4 examples with sufficient detail to illustrate relation of content to movement.

2 marks 3 examples described in some detail.

1 mark Reference to 2 examples but without clear links to movement.

Transfers through ecosystems

Topic areas for assessment of scientific content:

- 1) Photosynthesis – energy transfer (P)
- 2) Respiration – energy transfer (B)
- 3) Carbon cycle (C)
- 4) Nitrogen cycle (N)
- 5) Food chains (F)
- 6) Ecological pyramids (E)
- 7) Pesticide toxicity/bioaccumulation (B)
- 8) Eutrophication (Eu)
- 9) Digestion and absorption (D)
- 10) Transfer of genetic material (G)
- 11) Water cycle (W)

Any other sensible example of transfer through ecosystems should be credited. In a good essay, the emphasis should be on transfers.

Assessment of breadth of knowledge

3 marks Coverage of 4 examples with sufficient detail to illustrate relation of content to transfers.

2 marks 3 examples described in some detail.

1 mark Reference to 2 examples but without clear links to transfers.

The transfer of substances containing carbon between organisms and between organisms and the environment

The following topics from the specification contain material that could be relevant and used in the essay. It is not expected that candidates would necessarily include all, or most, of the topics suggested. Other apposite points, e.g. from option content, could also be used.

Transfer between organisms:

- (1) Food chains and feeding relationships (F)
 - plants producers; idea of food chains as feeding relationships; with transfer energy ; in substances containing carbon
- (2) Digestion and absorption . (possible link to bacteria and fungi) (D)
 - digestion/hydrolysis of large carbon-containing compounds; by enzymes; producing small/soluble compounds; which can be absorbed
- (3) Transport of organic molecules in and out of cells/across exchange surface (possible link to bacteria and fungi) (T)

- organic molecules (including sugars and amino acids) cross cell membranes; by facilitated diffusion; active transport; which requires ATP from respiration; involving carrier proteins and/or enzymes

Transfer to/from the non-living environment

- (4) Carbon cycle (and relevant parts of nitrogen cycle) (C)
- carbon enters biotic by photosynthesis; leaves biotic by respiration/combustion; role of bacteria/fungi as decomposers; of dead organisms/ faeces/ excretory products/urea
- (5) Photosynthesis (P)
- light-independent reaction ; carbon dioxide reacts with ribulose biphosphate; glycerate 3-P reduced to sugar ; reduced NADP and ATP from light-dependent reaction ; Calvin cycle
- (6) Respiration (R)
- link reaction/Krebs cycle ; oxidation of intermediates ; generation of reduced coenzymes; loss of carbon dioxide
- (7) Exchange surfaces - for carbon dioxide for animals (EA) and plants (EP)
- large surface area - alveoli - mesophyll cells; short diffusion pathways - epithelium and endothelium - thin leaves and many stomata; maintaining diffusion gradient - capillary and respiration – photosynthesis; respiration in mesophyll cells (time of day); ventilation - breathing - via air spaces in leaf

Cells are easy to distinguish by their shape. How are the shapes of cells related to their functions?

- (1) Epithelial cells - intestinal, alveolar, gill lamellae (E)

Two examples allowed

As appropriate, relating to transport function(s):

- (collectively) large SA ; flattened - short diffusion pathway ; folded membrane - larger SA for stated function
- (2) Blood - transport (BT)
- red blood cells ; biconcave shape - increase SA for oxygen exchange; move through capillaries
- (3) Blood - exchange (BE)
- endothelial cells of capillaries; flattened - short diffusion pathway
- (4) Blood . white cells (BS)
- phagocytes/macrophages; amoeboid properties; related to movement into tissues/engulfing e.g. bacteria
- (5) Nervous system - neurones (and Schwann cells) (N)
- dendrites - make synaptic connection to other neurone; axon/dendron - carry nerve impulses over long distances ; shapes of relay, motor and sensory; related to function; myelin sheath - faster transmission of impulses
- (6) Nervous system - receptors - NB could be other than light (R)
- cone/rod cells with distinctive 'heads' - containing pigment; detect light; dendrites to synapse with bipolar/ganglion cell(s)
- (7) Muscle (M)
- elongated - contain rows of sarcomeres ; leads to contraction in length; force generated in particular plane ; branched in cardiac - give contraction in more than one plane
- (8) Ciliated (C)
- cells lining air passages/oviducts; push mucus/eggs along; remove trapped microorganisms/towards uterus

Plants and any other organisms:

- (10) Hair cells . of root (HR)
- root - extension of epidermal cell; increases SA ; for absorption of water and mineral ions
- (11) Hair cells - of leaf (HL)
- leaf - extension of epidermal cell ; reduces air flow/traps air near leaf surface ; reduces water potential gradient for diffusion of water ; reduces water loss by transpiration
- (12) Leaf cells (guard cell structure not in specification but they might know and use) (L)
- palisade mesophyll are elongated ; allows more to be packed side by side ; to absorb maximum amount of light for photosynthesis
- (13) Transport in xylem and/or phloem (T)
- elongated cells ; xylem vessels no end walls/ phloem sieve cells end plates ; rows end to end to form 'tubes'; no/less resistance to flow
- (14) Bacterial cells flagellum (B)
- rotates; pushes against external medium ; moves bacterium

Negative feedback in living organisms

Topic areas for assessment of scientific content:

- (1) principle of negative feedback - departure from a norm initiates changes which restore a system to the norm. (P)
- (2) importance in homeostasis; principles of detection of change, role of receptors, corrective response, role of effectors. (H)
- (3) thermoregulation; roles of thermoreceptors and hypothalamus in detection; heat loss and heat gain centres; sweating and vasodilatation in heat loss; vasoconstriction, hair erection, shivering and increased metabolism in heat gain. (T)
- (4) regulation of blood glucose; roles of receptors in pancreas, secretion of insulin or glucagon; effect of insulin on surface membrane receptors/carrier proteins in stimulating uptake of glucose and glycogenesis; role of glucagon in glycogenolysis. (G)
- (5) control of ventilation; stimulation of chemoreceptors in medulla; effect on inspiration; stimulation of stretch receptors in lungs; stimulation of expiratory cells in medulla. (B)
- (6) control of heartbeat; roles of chemoreceptors and pressure receptors; inhibitory and acceleratory centres in medulla; effect on SAN and rate of heartbeat; effect of change in rate on pH/pressure of blood. (HB)
- (7) metabolic pathways; examples of build-up of a product in a metabolic pathway resulting in inhibition of its formation. – enzyme inhibition(M)
- (8) population stability; effect of increasing competition/predation on increasing population size and restoration of balance. (Pop)
- (9) (selection . stabilising selection resulting in constancy of species) (S)
- (10) (Oestrous cycle; effect of feedback on hormone production, e.g. oestrogen on FSH and progesterone on both FSH and LH. From Option 8) (O)

Any other sensibly argued example showing negative feedback should be credited.

In a good essay the description of the changes in a system should be clearly related to the principles of negative feedback, with sufficient detail for the relationship to be explained.

Mean temperatures are rising in many parts of the world. The rising temperatures may result in physiological and ecological effects on living organisms. Describe and explain these effects.

Topic areas for assessment of scientific content:

- (1) principle of destabilising effect of rising temperature on metabolic systems within organisms and on balance in ecosystems. (P)
- (2) effect on rate of diffusion/gaseous exchange; possible consequences, e.g. increased evaporation, more rapid uptake of ions by plants. (D)
- (3) effect on proteins; possible increased rate of denaturation of tertiary structure. Increased rate of enzyme activity; possible increased dislocation of metabolic pathways. (E)
- (4) effect on photosynthesis (light independent reaction); increased rate with small increases, disruption with larger; increased rate of growth of (some) plants; possible increased rate of crop growth; effect of other limiting factors. (PS)
- (5) effect on transpiration; increased rate of water loss and hence wilting/dehydration; reduced stomatal opening may affect photosynthesis; possible consequences of drought on ecosystems. (T)
- (6) effect on respiration and metabolism; increased effect on growth and activity, especially of ectotherms. (M)
- (7) ecological effects of disruption of food webs and the dynamics of ecosystems, with changes in niches and hence communities. (EC)
- (8) effect on species; extinction of species that are unable to adapt, especially ones with specialised requirements; limited opportunity for plants and some animals to spread to more suitable conditions as climate changes. (S)
- (9) effect on agriculture; increased growth of some crops and loss of others, and effect on productivity; possible redistribution to different parts of the world, and overall loss of agricultural land. (A)
- (10) ecological effect of increased rates of growth and reproduction, especially of bacteria, insects and pests; possible increased incidence of disease. (R)
- (11) role of natural selection in adaptation to change. (N)

There are many possible alternative approaches to this essay and any biologically sensible effect of increasing change in temperature on living organisms should be credited. In a good essay the specific effects of rising temperature will be explained and explicitly linked to their possible effects on physiology or ecology. A good candidate will also recognise the complex interactions involved and avoid giving simplistic explanations and doomsday scenarios.

The process of osmosis and its importance to living organisms

- (1) definition (D)
- (2) **effects on cells** (C); turgity and support; plasmolysis (idea); lysis; cystic fibrosis
- (3) **importance in animals** (A) role in relationship between plasma and tissue fluid; reabsorption in gut; *sweat production neutral*
- (4) **importance in plants** (P) role in movement of water from soil to leaves in plants; role in mass flow hypothesis for movement in plants

Energy transfers which take place in living organisms

- (1) **ATP (A)** synthesis from ADP and P; role as an energy source
- (2) **photosynthesis (P)**; excitation of electrons; generation of ATP and reduced NADP; Photolysis; reduction of glycerate phosphate to carbohydrate; structure of chloroplast in relation to energy transfers
- (3) **respiration (R)**; net gain of ATP in glycolysis; production of ATP in Krebs cycle; synthesis of ATP associated with electron transfer chain; ATP production in anaerobic respiration; structure of mitochondrion in relation to energy transfers
- (4) **uses of energy in biological processes (B)**; active transport; muscle contraction; nerve transmission; synthesis; translocation; nitrogen fixation; receptors

Cycles in biology

Ecological cycles

- 1) Nitrogen cycle: role of microorganisms in the processes of saprophytic nutrition, deamination, nitrification, nitrogen fixation and denitrification. (Names of individual species are not required.)
- 2) Carbon cycle: role of microorganisms in breakdown (respiration) of complex organic compounds into carbon dioxide making it available for reuse (photosynthesis).

Metabolic cycles

- 3) Krebs cycle: acetylcoenzyme A combines with four-carbon molecule to produce a six-carbon molecule which enters Krebs cycle; the four carbon compound is regenerated during cycle involving series of oxidation reactions and release of carbon dioxide; production of ATP and reduced NAD and FAD.
- 4) Electron transport chain: cyclical reduction and oxidation of NAD, FAD and other 'carriers'
- 5) Synthesis and breakdown of ATP
- 6) Light-independent reactions - Carbon dioxide accepted by RuBP to form two molecules of glycerate-3-phosphate, reduction of glycerate-3-phosphate to carbohydrate, and regeneration of RuBP.

Physiological cycles

- 7) Negative feedback mechanisms: Regulation of body temperature / blood glucose / blood water potential.
- 8) Cardiac cycle: relate pressure and volume changes in the heart and aorta to maintenance of blood flow.
- 9) Role of tropomyosin, calcium ions and ATP in the cycle of actomyosin bridge formation.
- 10) Nerve function – depolarisation / repolarisation of a neurone in terms of differential membrane permeability and Na/K pumps, synthesis and re-synthesis of acetylcholine (synaptic transmission) / rhodopsin (rods) and restoration of a resting potential.

Life cycles

- 11) Mitosis / Cell cycle – explanation of stages of mitosis, importance in growth and asexual reproduction.
- 12) Meiosis – importance in maintaining constant chromosome number from generation to generation; outline of process (details of stages not required)
- 13) Examples of life cycles might be provided in terms of mitosis, meiosis, fertilisation and chromosome number.
- 14) DNA replication – semiconservative replication;
- 15) Predator / prey life cycles

Condensation and hydrolysis and their importance in biology.

Synthesis of proteins, carbohydrates and lipids from monomers

1. Large molecules are important in the structure and functioning of cells

Hydrolysis of proteins, carbohydrates and lipids from monomers

2. Large molecules are important in the structure and functioning of cells
3. Digestion of food
4. Digestion of cellulose

Condensation and hydrolysis of other substances

1. DNA, RNA and protein synthesis
2. The role of ATP

Ways in which different species of organisms differ from each other

1. Molecular differences

Large molecules are important in the structure and functioning of Cells (proteins)

2. Genetic differences

Genes incorporate coded information which determines the metabolism of organisms

Genes and environmental factors influence variation between individuals

Selection can influence the frequency of alleles in a population

Evolution has resulted in different species of organisms

3. Other aspects of biology

The cell is the basic unit of structure in prokaryotic and eukaryotic organisms

The concept of ecosystem (niches)

Different organisms possess different types of haemoglobin with different oxygen transporting properties

Limitation of water loss in xerophytic plants

Digestion of cellulose

Bacteria as examples of pathogenic microorganisms

The transfer of energy between different organisms and between these organisms and their environment.

1. Photosynthesis

Photosynthesis uses energy from sunlight to synthesis organic molecules from inorganic sources

2. Ecology

Energy is transferred through food chains and food webs in a community

3. Energy loss

Respiration produces ATP which is the immediate form of energy for many cell activities

Temperature control

Receptors convert stimuli into electrical impulses in nerve cells

Dietary demands of pregnancy

The causes of variation and its biological importance

1. **Gene mutation (G)**
addition; deletion ;substitution; effect on alleles; effect on polypeptide / protein
2. **Sexual reproduction (S)**
crossing over; independent assortment; random fusion
3. **Environmental (E)**
nutrients; disease; light; temperature
4. **Biological importance (B)**
enables adaptation; natural selection ; speciation; evolution

The process of diffusion and its importance in living organisms

Diffusion is involved in many modules

- 1) The process itself is in module 1 (AS1)
- 2) Together with osmosis, as a special case of diffusion of water and how substances enter and leave cells

Diffusion or osmosis are involved in:

- 3) Gaseous exchange in lungs, gills and leave (AS1)
- 4) The uptake of the products of digestion (AS1)
- 5) Exchange of material between blood in capillaries and tissue (AS3)
- 6) The uptake of water by roots and root pressure, and t in the mass flow hypothesis of translocation of sugars (AS3)
- 7) Regulation of blood water potential (A24)
- 8) Action potentials (A24)
- 9) Synaptic transmission (A24)

Importance of Molecular shape

- 1) Carbohydrates – storage / structural / glycoprotein etc.
- 2) Proteins – levels of structure / enzymes – specificity / properties
- 3) Lipids – phospholipids
- 4) Interaction with receptors
- 5) Drugs
- 6) Antibodies (antibody – antigen complex)
- 7) Hormones – seconds messenger / direct action
- 8) Neurotransmitters – synapses.

ATP and its roles in living organisms

- 1) The nature of ATP and its importance as energy currency in cells
- 2) Production of ATP in cytoplasm and mitochondria; aerobic respiration
- 3) Anaerobic respiration; role of chloroplasts in ATP production (photophosphorylation)
- 4) Uses – active transport' maintaining resting potential; reabsorption in nephron; absorption ion the gut; Calvin cycle; muscle contraction; biosynthesis (e.g. protein synthesis) contractile vacuoles.
- 5) ATP is involved in a large number of anabolic (building up) and physiological processes.

Describe how nitrogen-containing substances are taken into, and metabolised in, animals and plants.

Intake

- 1) Active transport and facilitated diffusion
- 2) Biological molecules, carbohydrates and proteins
- 3) Digestion and absorption of the products

Synthesis of polymers

- 4) Replication of DNA, Protein synthesis

Other metabolic reactions

- 5) Digestion of cellulose
- 6) Method of removing nitrogenous wastes. Deamination and the production of urea

Polymers have different structures. They also have different functions.

Describe how the structures of different polymers are related to their functions.

Polymers as molecules associated with storage

- 1) Biological molecules, carbohydrates and proteins
- 2) The release of energy from carbohydrate
- 3) The control of blood glucose

Polymers as informational molecules

- 4) Enzymes
- 5) DNA as genetic material, structure of nucleic acids
- 6) Principles of immunology
- 7) The transport of respiratory gases

Polymers as structural molecules

- 8) Cell ultrastructure, cell walls
- 9) Biological molecules, carbohydrates and proteins

Carbon dioxide in organisms and ecosystems.

Biochemistry

- 1) The biochemistry of photosynthesis
- 2) The biochemistry of respiration

Physiology

- 3) Gas exchange surfaces
- 4) Changes in cardiac output and pulmonary ventilation with exercise
- 5) The transport of respiratory gases

Ecology

- 6) The effect of carbon dioxide on productivity;
- 7) Decomposition and recycling maintain the balance of nutrients in an ecosystem
- 8) The greenhouse effect is not specifically mentioned but should be credited here if discussed

Hydrogen bonds and their importance in living organisms.

Hydrogen bonds associated with the properties of water

- 1) The passage of water through a plant and cohesion tension

Hydrogen bonds associated with secondary and tertiary structure

- 2) The structure of proteins, starch and cellulose
- 3) Enzymes

Hydrogen bonds associated with nucleic acids

- 4) DNA as genetic material, structure of nucleic acids
- 5) Gene technology

How nitrogen-containing substances are made available to and are used by living organisms.

Nutrient cycling

- 1) Nitrogen cycle
- 2) The influence of deforestation of nitrogen cycling

The uses of proteins

- 3) Proteins as biological molecules
- 4) Enzymes and enzyme action
- 5) Haemoglobin and the exchange of respiratory gases
- 6) The use of membrane proteins in the nervous system

The uses of nucleic acids and other nitrogen-containing substances

- 7) DNA and protein synthesis
- 8) Chlorophyll, NADP and photosynthesis
- 9) ATP and respiration

Why the offspring produced by the same parents are different in appearance

Genes

- 1) Genes incorporate coded information which influences phenotype
- 2) Gene mutation

Environment

- 3) Environment variation
- 4) Dietary requirements of insects

Chromosomes and cells

- 5) Meiosis
- 6) Principles of Mendelian inheritance
- 7) Polygenetic inheritance
- 8) Gametes and gamete formation. Fertilisation

Inorganic ions include those of sodium, phosphorus and hydrogen. Describe how these and other inorganic ions are used in living organisms.

Inorganic ions are involved in physiological processes

- 1) Nitrogen cycles
- 2) Action potentials and nerve impulses
- 3) Receptors convert stimuli into electrical impulses

Inorganic ions are incorporated into biologically important molecules

- 4) Respiration produces ATP which is the immediate form of energy for many cell activities
- 5) Photosynthesis uses energy from sunlight to synthesise organic molecules from inorganic sources
- 6) DNA as genetic material
- 7) Fertilisers and plant growth
- 8) Hydrogen ions affect pH
- 9) Factors which affect enzyme action
- 10) The control of blood pH
- 11) Digestion in the stomach and small intestine
- 12) The role of H⁺ in respiration & photosynthesis

bacteria affect the lives of humans and other organisms in many ways.

Apart from causing disease, describe how bacteria may affect the lives of other organisms.

Making use of bacteria

- 1) Commercial production of enzymes from microorganisms
- 2) Gene technology

Bacteria and the recycling of nutrients

- 3) Carbon and nitrogen cycles

Bacteria in mutualistic relationships

- 4) Nitrogen cycle and nitrogen fixation;
- 5) Cellulose digestion in ruminants

Describe the structure and function of membranes in organisms

Introduction

- 1) Plasma membrane present in all organisms
- 2) Membrane bound organelles
- 3) Fluid mosaic model

Role of plasma membrane

- 4) Diffusion
- 5) Facilitated diffusion
- 6) Active transport
- 7) Osmosis
- 8) Endo and exocytosis

Membranes within eukaryotic cells

- 9) Mitochondrion
 - a. Cristae and electron transport chain
- 10) Chloroplasts

- a. Thylakoid membranes and light dependent reactions
- 11) Rough endoplasmic reticulum
 - a. Ribosomes and protein synthesis
- 12) Golgi body, smooth ER
- 13) Prokaryotic cells
- 14) Mesosomes as site of respiration

The structure and functions of carbohydrates

- 1) Contain the elements, carbon, hydrogen and oxygen.
- 2) Monosaccharides: glucose and fructose, monomers of which other carbohydrates are composed.
- 3) Monosaccharides and disaccharides are small soluble molecules easy to transport – glucose transport in blood, sucrose in sieve tube.
- 4) Glucose: source of energy; a substrate in aerobic and anaerobic respiration; biochemistry of aerobic respiration (brief outline).
- 5) Structural formula of glucose, the condensation of glucose to form the disaccharide, maltose, and of glucose and fructose to form the disaccharide sucrose. The hydrolysis of disaccharides.
- 6) The formation and hydrolysis of the polysaccharides: starch, glycogen and cellulose; are polymers of glucose, differ in the number and arrangement of the glucose molecules.
- 7) Relationship of structure to function in starch, glycogen and cellulose molecules.
- 8) Starch: helical shape provides compact store (in plants); insolubility linked to storage (osmotically inactive), large size does not pass through membrane, provides large number of glucose molecules for respiration.
- 9) Starch-agar plates for assaying carbohydrase activity.
- 10) Glycogen: similar to starch but more branches, insoluble storage compound in liver and muscles (mammals). Conversion of glucose to glycogen for storage. Importance of control of blood glucose.
- 11) Cellulose: long straight chains of glucose molecules, OH groups of chains linked by hydrogen bonds forming microfibrils / macrofibrils. Layers of fibrils orientated in different directions are interwoven and embedded in a matrix - providing rigid cell wall; gaps in layers provide permeability.
- 12) Pentoses: Deoxyribose, Ribose in DNA and RNA – sugar-phosphate backbone providing strength.
- 13) Light-independent reactions: formation of carbohydrates, Carbon dioxide accepted by RBP, reduction of glycerate-3-phosphate to carbohydrate, and regeneration of RBP.

Read through the following essay – attempt to mark it. Note any mistakes. How could you improve this essay? Is there any other information you could include.?

The importance of carbohydrates in living organisms

Carbohydrates contain carbon, hydrogen and oxygen in the ratio of 1.2.1.. There are many different types of carbohydrate, all of which are useful to living organisms. The most important carbohydrate is probable glucose. Glucose is a monosaccharide and is the monomer unit which makes up more complex polysaccharides. Two glucose molecules can be joined in a condensation reaction, whereby water is removed, for example to produce maltose, a disaccharide. The bond between the glucose molecules is a α 1-4 glycosidic bond. Glucose is also soluble, a reducing sugar and the blood sugar of mammals. It is respired to produce ATP (adenosine triphosphate, a chemical energy store) and is therefore required for growth. During glycolysis, a process which occurs in the cytoplasm and generates 2 ATP, glucose is phosphorylated to produce a 6 carbon phosphorylated sugar. Glucose is essential for respiration and therefore essential for ATP production. ATP is required for various activities, for example active transport systems such as glucose reabsorption in the kidney, or muscle contraction.

There are two other monosaccharides: fructose and lactose. Fructose is found in sperm and in fruits, to make them more attractive to animals. Lactose is found in the milk of mammals and is an important energy supply for their young. These monosaccharides also help to build disaccharides. Glucose and fructose join together to form sucrose and glucose and lactose join to form galactose.

Sucrose is the major transport carbohydrate of green plants. It is transported in the phloem by translocation. It is formed in the leaves by photosynthesis. The Calvin cycle (the light independent reactions) which takes place in the stroma produces glucose, which in turn is changed into sucrose.

Complex carbohydrates (polysaccharides) are produced from glucose, monomers. Cellulose, for example, is a long chain of glucose units (about 3000 units). Each unit is joined to the next by a β 1- glycosidic bond. About 2000 cellulose chains are packed into cellulose fibres which make up plants' cell walls. Cellulose, therefore, is major structural carbohydrate of green plants. The cell wall containing cellulose provides support in herbaceous plants and when impregnated with lignin it acts as a water proofing layer and provides great strength.

Starch is another polysaccharide of green plants, it is their storage carbohydrate. Starch is made up of amylose and amylopectin.

Amylose is a long chain of glucose monomers, joined by α 1-4 glycosidic bonds whereas amylopectin is made up of shorter branched chains of glucose monomers. Starch is stored in chloroplasts as starch grains. It is used, in green plants, as the carbohydrate which respired to produce energy. It enters into glycolysis in the cytoplasm, in place of glucose. Therefore starch is extremely important for green plants because it is essential for ATP production. In green plants, ATP is used in the Calvin cycle, to help turn glycerate-3-phosphate into glyceraldehyde-3-phosphate and to help turn this back to ribulose bisphosphate.

Glycogen is a third polysaccharide, it is the storage carbohydrate of animals. Glycogen is formed from glucose in the liver cells, under the influence of the hormone insulin. This process is called glycogenesis. Glycogen is a n energy store and if blood sugar levels fall too low (for example during periods of dieting or fasting) it is turned back into glucose. This is called glycogenolysis and is influenced by the hormone glucagon. Glycogen, therefore, is important in homeostasis, the maintaining of a constant internal environment.

In conclusion, carbohydrates are extremely important to all living organisms and without them these organisms would die.

The roles of water in the lives of organisms

Water is perhaps the most important molecule for the survival and life of organisms. On the surface of the planet there is obviously much more area of water than land, which shows its significance.

It is mostly due to its specific properties that water is so useful. Perhaps the most obvious is that it has a very high specific heat capacity. It is noticeable that water is a much more stable environment for organisms to live in, as it does not cool so rapidly or heats up like air. This means that organisms living in water do not have to keep re-adjusting their body temperature for survival.

Water provides support for marine organisms such as jelly fish, both from the outside and inside. On the outside it allows for movement, as floating is possible, so joints are not required or hard skeleton for muscles to act upon. On the inside, it also provides support, so movement can be achieved by pushing water into the front, propagating itself along.

On earth water inside an organism also provides support. For example earthworms employ a hydrostatic skeleton, which allows muscles to be contracted against an incompressible substance.

Water is a universal solvent. It provides medium in which substances can be dissolved. It is present in cytoplasm of all organisms, so they cannot survive without it. Water is present in blood to allow digested substances such as glucose to be carried along to respiring cells and allows easier diffusion of materials between cells. Examples of this is in alveoli and capillaries. It is a lubricant and a transport substance.

Water allows toxic materials, such as urea to be dissolved so it does not harm the organism that has produced it during metabolic activities.

Water acts as a shock absorber, for example in cavities in the brain (the cerebrospinal fluid) which cushions the delicate organs against damage. It is present in joints to allow easy movement and protection against friction. In the eye to give it shape and support (as aqueous and vitreous humour). It is present in mucus in the mouth to allow easy swallowing of food, in the gut for moving the food along and dissolving enzymes to break down food and antibodies or bacteria for protection against disease.

Water is essential in homeostasis (in urine, as I have already mentioned and in control of the body temperature as specific heat capacity allows for cooling of the skin in sweat).

In plants water has significance importance. It allows for support, as water is an incompressible fluid. It fills the cells which are surrounded by cell walls and so keep them turgid.

It is also a transport medium, just like in animals) substances, such as ions are dissolved in it and carried in the xylem. The sugars produced by photosynthesis are also dissolved in water and carried to respiring cells.

Water is an essential ingredient in photosynthesis as it is where the oxygen comes from (Hill's reaction) as water is split into oxygen and hydrogen ions (and also electrons).

Water is important in moving substances up the transpiration stream. Water evaporates from the surface of the leaf, and therefore the substances from the soil are drawn up.

Another method of water movement up the xylem is by cohesion-tension theory. The molecules of water are attracted to the walls of the xylem (adhesion) due to its polar structure, and to each other (cohesion) so it moves up the stream because the walls of the lignified xylem can take the pressure.

Fertilisation in some organisms relies on water. Fish release their eggs *into* the river, so that the male can then fertilize them outside the body. Some plants rely on water to transport pollen in the water.

Terrestrial animals are also dependent on the lubricating property of water. Humans release mucus by their sexual organs to allow for easier penetration. Sperm is also released in a semi-liquid (containing water) this allows for easier movement to reach the egg. The mucus produced by females in the vagina, also protects against infections as water dissolves the antibodies.

One other aspect of water I have not mentioned is its insulating properties. Water expands on heating, due to its original property and structure. The ice which forms, floats on the rivers, so heat does not escape from the water below and organisms are able to survive.

Water vapour in the atmosphere also acts as a greenhouse gas, allowing for radiation to warm up the earth's surface, but not allow the heat to escape back into the atmosphere.

From all this information it is clear how many functions water has in the living organisms. Water is not only present in eyes to support and keep its shape, but to lubricate it and protect it from infection and it also helps to keep our environment warm. It makes up about 65% of human mass and up to 95% in plants. This clearly indicates its great significance.

Suggested mark for this essay

Scientific content: the essay covers most of the material that might be expected. Some of the areas are explained well, such as specific heat capacity, fertilisation and the role of water in photosynthesis. However, there is too little development of several of the topics raised, e.g. vague references to water as a lubricant, no explanation of turgidity and an inadequate explanation of sweating. Furthermore, there are one or two confused references, such as dissolving antibodies and bacteria. (Mark: 13/16)

Breadth of knowledge: all of the main areas are addressed and there are references to both plants and animals. (Mark: 3/3)

Relevance: There are few errors and no irrelevant points. (Mark: 2/3)

Quality of written communication: spelling, punctuation and grammar are reasonably sound (e.g. note the mis-spelling of 'capillaries' and 'cerebrospinal fluid') and technical terms are generally used appropriately. There is an attempt at an introduction and a conclusion. However, the material is not logically presented, with a fairly disjointed structure and some repetition.

Some of the paragraphs could have been amalgamated and put into a more logical order. (Mark: 2/3)

(Total mark: 13 + 3 + 2 + 2 = 20/25)

Mark this essay

The role of lipids in living organisms

Lipids are organic compounds that are insoluble in *water* but soluble in organic solvents such as ethanol. They are composed mainly of carbon, hydrogen and oxygen, and a number of important biological molecules can be classified as lipids. This essay will describe the general structure of lipids and review the wide variety of roles that they play in living organisms.

The simplest lipids are triglycerides, composed of glycerol joined to three fatty acid molecules. The fatty acids are joined to the glycerol molecule by condensation reactions and the resulting bonds are known as ester bonds. The fatty acids within a particular triglyceride may be identical or different. In general, fatty acids are classified as saturated (containing no carbon/carbon double bonds), e.g. stearic acid, or unsaturated (containing one or more carbon/carbon double bonds), e.g. linoleic acid. It is the different combinations of these fatty acids that give triglycerides their different properties. For example, highly unsaturated triglycerides tend to be liquid at room temperature and are known as oils, whereas saturated triglycerides are solid at room temperature and are known as fats. The main function of triglycerides is to act as energy stores in plants and animals. They are ideally suited for this purpose as they are compact, insoluble and store nearly twice as much energy per gram as carbohydrates. For example, the major energy storage materials of seeds are usually oils.

Another major form of lipids are phospholipids. These have a similar structure to triglycerides, but one of the three fatty acids is replaced by a phosphate group joined to another organic molecule. Phospholipids are the main component of cell membranes. The phosphate 'head' of the molecule is hydrophilic (water soluble) and the fatty acid 'tail' is hydrophobic (insoluble in water). This property of phospholipids means that they form a bilayer in aqueous solutions, which is an important factor in the formation of the membranes.

Lipids have a protective and an insulating role in animals. They are stored around vital organs to cushion them against damage, especially in areas where skeletal protection is lacking, such as the kidneys. Lipid storage in the skin is also important for thermoregulation. This can be shown by looking at the distribution of subcutaneous fat in mammals living in cold environments.

Polar bears, seals and whales all have a thick layer of fatty tissue to keep them warm in arctic conditions. Lipids also act as electrical insulators in the nervous system, where most neurones are surrounded by a myelin sheath. Myelin is composed of a mixture of phospholipids and cholesterol (a steroid) and the myelin sheath insulates the neurone as well as speeding up the conduction of nerve impulses.

There are a number of other important roles of lipids in living organisms. They aid buoyancy in aquatic mammals (as well as providing thermal insulation) and also act as a source of metabolic water (water from respiration) in animals living in arid environments, such as the kangaroo rat. Waxes are a class of lipids that are used for waterproofing in leaves and the exoskeleton

of insects. Steroids are another class of lipids that are used as hormones in mammals. For example, the sex hormones testosterone, oestrogen and progesterone are all steroids.

In conclusion, lipids are a very important class of biological molecules. They have a wide range of structures and a variety of functions in both plants and animals.

Possible ways of producing a plan

