*WJEC/Eduqas AS/A-level Biology Exam practice answers*

# Unit 3 Energy, homeostasis and the environment

## 1 Importance of ATP

1

a The intermembrane space of the mitochondria would have the lowest pH (1) because it has the highest concentration of protons (1).

b This would reduce the surface area of the inner mitochondrial membrane (1), meaning there would be fewer electron transport chains/proton pumps (1). Therefore, less ATP would be produced by oxidative phosphorylation (1), meaning that the cell would be less able to carry out a function that requires ATP, such as active transport/protein synthesis/any other relevant example (1).

c There are no electron transport chains on the inner membrane of the chloroplast (1). The electron transport chains are on the thylakoid membrane in the chloroplast (1).

## 2 Photosynthesis uses light energy to synthesise organic molecules

1

a As the concentration of carbon dioxide increases the rate of photosynthesis also increases (1). This is because carbon dioxide is fixed in the light-independent reaction of photosynthesis (1). The light-independent reaction produces the products of photosynthesis (1). Increasing carbon dioxide concentration therefore leads to an increase in the production of photosynthetic products in a given time, meaning the rate of photosynthesis increases (1).

b As the concentration of carbon dioxide increases the rate of photosynthesis does not increase (1). Another limiting factor must be limiting the rate of photosynthesis (1), such as temperature or light intensity (1).

c 0.25% carbon dioxide (1). Above this concentration of carbon dioxide there is no increase in the rate of photosynthesis with increasing carbon dioxide – therefore, it would not be cost-effective to have a higher concentration than this (1).

2

a To ensure water did not enter the chloroplast by osmosis when in a hypotonic solution (1), because this would cause the chloroplasts to lyse (1).

b The light-independent reaction of photosynthesis is not occurring because glucose is not being produced (1). This is because the herbicide inhibits non-cyclic photophosphorylation (1). As the cyclic photophosphorylation is still able to occur, this

  

suggests that PS II, which is not involved in cyclic photophosphorylation, is inhibited (1). Excited electrons are not lost from PS II, so photolysis does not occur and so no oxygen is produced (1). Glucose can still be produced when the products of non-cyclic photophosphorylation are added; this shows that the herbicide does not directly affect the light-independent reaction (1).

c The herbicide prevents glucose being formed in photosynthesis; therefore, the rate of respiration decreases (1). The rate of respiration does not fall to zero immediately because the plant cell is using stored glucose, for example in starch, to maintain respiration (1).

## 3 Respiration releases chemical energy in biological processes

1

a Oxaloacetate has four carbon atoms (1). This is because a four-carbon compound reacts with acetyl coenzyme A/a six-carbon compound undergoes decarboxylation twice to form a four-carbon compound (1).

b Malate dehydrogenase oxidises malate (1), reducing a coenzyme/NAD/FAD (1).

c In anaerobic conditions the Krebs cycle cannot occur and oxaloacetate would not be formed from a previous Krebs cycle intermediate, so the concentration falls (1). This is because there is no NAD available due to reduced NAD not being reoxidised to NAD in the electron transport chain (1), as there is no oxygen available to act as the final electron acceptor (1).

2

a As reduced NAD reacts with electron carrier 1 it is able to fuel enough proton pumps to produce three ATP per molecule of reduced NAD (1). As reduced FAD reacts with electron carrier 2 it is only able to fuel enough proton pumps to produce two ATP per molecule of reduced FAD (1).

b If electrons cannot pass through electron carrier 3 then the electron transport chain will stop (1) because electron carriers will not be able to pass on electrons, and oxygen will not be able to act as the final electron acceptor (1). This will mean protons are not pumped/an electrochemical gradient is not created, so ATP is not produced by oxidative phosphorylation (1). Organisms die without ATP due to their inability to carry out active transport/nerve transmission/muscle contraction (1).

c In anaerobic respiration glycolysis occurs (1). Pyruvate is reduced to lactic acid (1) by reduced NAD being reoxidised to NAD, allowing glycolysis to continue (1).

## 4 Microbiology

1

a The bacteria are cocci (1) and are Gram-negative (1), so have a thin peptidoglycan cell wall with a lipopolysaccharide layer (1).

b This conclusion is incorrect (1). The bacteria could be obligate anaerobes or facultative anaerobes (1) because both are able to grow where no oxygen is present (1).

c Experiments should be carried out with culturing the bacteria at temperatures between 15°C and 40°C, with 5°C increments (1). All other conditions should be kept the same at each temperature (1). The temperature where the bacteria grew the most in a set time would be the optimum temperature (1).

2

a It is not possible to tell when using a haemocytometer if the bacteria being counted are living or dead (1). Therefore, living and dead bacteria are counted, which will give an overestimation of the population size (1).

b Clumping is when two or more colonies merge together (1). This occurs due to underdilution of the bacterial culture in dilution plating (1).

c An autoclave can be used to sterilise apparatus (1) by heating it to 121°C (1) under pressure (1).

## 5 Population size and ecosystems

1

a Secondary succession (1)

b There may be different environmental factors now from when the primary succession first occurred (1). Therefore, different organisms may colonise the area and create a different succession, resulting in a different climax community (1).

c It is important to conserve ancient woodland because if it is destroyed, even if woodland grows back, it will be different (1). The habitats will therefore be different (1), which could lead to a reduction in biodiversity (1).

d It would reduce the amount of photosynthesis (1). Dead trees would be decomposed/burned, releasing further carbon dioxide (1), leading to an increase in carbon dioxide levels in the atmosphere (1).

2

a Fertiliser runoff from the fields could enter the waterways (1). This could lead to eutrophication (1).

b Legumes have nitrogen-fixing bacteria, *Rhizobium*, in their root nodules (1), which fix atmospheric nitrogen into nitrogen-containing compounds such as amino acids and ammonia (1). These compounds are transferred to the legumes; when these die and decompose, ammonification (1) and nitrification occur, increasing nitrate concentration in the soil, and leading to increased crop growth (1).

c Digging drainage ditches would help drain the soil, making it more aerobic (1) and therefore decreasing the action of denitrifying bacteria, which convert nitrate in the soil into atmospheric nitrogen (1). However, digging drainage ditches can damage habitats (1), reducing biodiversity (1).

# 6 Human impact on the environment

1

a The pH of the ocean decreased from 8.11 in 1985 to 8.06 in 2015 (1).

b Over time the concentration of carbon dioxide in the atmosphere has increased (1). The carbon dioxide dissolves in the seawater, forming carbonic acid and decreasing the pH (1).

c The ocean acidification boundary (1).

d Reduction in human-made carbon dioxide emissions (1). Any example of a human-made carbon dioxide emission that could be reduced (1).

e Any two from: the climate change boundary (1); the land use boundary, by reducing deforestation (1); the biodiversity boundary, due to the reduction in the effects of climate change on habitats (1).

2

a Over time, the average cultivated area per farm increased slowly from 1880 to 1960, with a large increase between 1960 and 1980 (1).

b difference between 1980 and 1900 = 0.65 − 0.31 = 0.34

percentage increase = $\frac{34}{0.31} \times 100$ = 110% increase (nearest whole percentage)

c As farm area increases the hedgerow area would be likely to decrease (1).

d The reduction in hedgerows would lead to a decrease in biodiversity (1). This is because hedgerows are important habitats for a wide range of species (1), and they allow organisms to move between different areas without having to cross open farm land and potentially being predated/act as wildlife corridors (1).

# 7 Homeostasis and the kidney

1

a The patient would produce a small volume of concentrated urine (1). This is because there would be a high concentration of ADH in their blood (1), so the collecting duct would be very permeable to water (1). Therefore, large quantities of water would be reabsorbed into the tissue fluid of the medulla and then into blood (1).

b

i As more water is being reabsorbed the blood would become more dilute, reducing the concentration of sodium in the blood (1).

ii The water potential of the blood would increase (1). The tissues of the brain would have a lower water potential, so the water would move from the blood into the brain by osmosis (1).

2

a A higher density of mitochondria would mean more ATP produced in aerobic respiration (1), while the mitochondria having more cristae would increase the number of electron transport chains, so more ATP could be produced per mitochondrion by oxidative phosphorylation (1). More ATP means that more $Na^+$ and $Cl^-$ will be actively transported out of the ascending limb (1). This would reduce the water potential in the tissue fluid of the medulla and lead to more water being reabsorbed from the collecting duct, thus producing concentrated urine (1).

b Animals that are adapted to survive in low-water environments have relatively longer loops of Henle (1). This means that more salts are concentrated in the tissue fluid of the medulla, lowering the water potential and leading to more water being reabsorbed (1).

## 8 The nervous system

1

a i In a synapse the toxin would prevent the $Ca^{2+}$ entering the synaptic knob, so the synaptic vesicles would not move to the presynaptic membrane (1) and the neurotransmitter would not be released by exocytosis (1). This would mean that the neurotransmitter would not enter receptors on the postsynaptic membrane (1) and an action potential would not be generated in the postsynaptic membrane (1).

ii The toxin would not affect the nodes of Ranvier (1) because calcium ions are not involved in the generation of an action potential at the nodes of Ranvier (1).

b Sodium ions flow through ion channels at nodes of Ranvier and the postsynaptic membrane (1) for depolarisation to occur and to generate an action potential (1).

2

a A nerve net (1)

b Axons with a wider diameter have a faster rate of conduction (1). This would allow a faster response to escape predators, increasing the chance of the organism surviving (1).

c Human axons are myelinated, while the Cnidarian axons are not (1). This increases the rate of nerve conduction (1) because saltatory conduction occurs (1).

d Increasing the temperature would increase the speed of nerve conduction (1) because the ions would have a greater kinetic energy and so would diffuse faster (1). It could be considered unethical if raising the temperature stressed or harmed the Cnidarian (1).

# Unit 4 Variation, inheritance and options

## 9 Sexual reproduction in humans

1

a FSH stimulates the maturation of a follicle in the ovary and the follicle to produce oestrogen (1). LH causes ovulation to occur (1) and stimulates the formation of the Graafian follicle (1).

b Progesterone inhibits the release of LH (1), which prevents ovulation, so no secondary oocyte can be released to be fertilised (1). LH stimulates ovulation so would not be suitable for use as a contraceptive (1).

c hCG is produced by the developing embryo (1). Therefore, it should only be produced if a woman is pregnant, preventing false positives occurring, while false negatives could be due to hCG concentrations being too low (1).

2

a i One gamete is produced per primary oocyte in oogenesis (1). Four gametes are produced from one primary spermatocyte in spermatogenesis (1).

ii Spermatogenesis produces large numbers of spermatozoa (1). This is important because large numbers need to be ejaculated to increase the chance of fertilisation occurring (1). Oogenesis only produces one secondary oocyte per menstrual cycle for fertilisation to occur (1). This means that the ovum can be very large, providing nutrients for the developing embryo (1).

b The polar body does contain a haploid set of chromosomes, so could fuse with a spermatozoan to produce a diploid set of chromosomes (1). However, the polar body is not a gamete and has very little cytoplasm (1), so is unlikely to successfully form a zygote and then an embryo (1).

c Male and female fertility increases from age 15 in both males and females as gametogenesis begins at puberty in both sexes (1). Male and female fertility decreases from the age of 25 onwards, with male fertility decreasing less steeply than female fertility, with fertility falling to zero at 50 in females, while in males it never reaches zero (1). This is because spermatogenesis continues throughout the life of the male (1), while oogenesis stops after the age of 50 in females (1).

## 10 Sexual reproduction in plants

1

a As the concentration of gibberellin increases the percentage of seeds germinated increases (1). This is because the gibberellin diffuses into the aleurone layer causing hydrolytic enzymes to be produced (1). These enzymes hydrolyse stored nutrients, which can then be used in germination (1).

  

b Broad beans are non-endospermic seeds (1), so gibberellin is not involved in their germination (1).

c Water is important in germination for mobilisation of enzymes (1) and transport of the products of the hydrolysis of storage molecules, such as starch (1). Oxygen is important in germination for aerobic respiration (1).

2 a

i Sexual reproduction requires a method of transporting the male gamete to the reproductive partner (1). Angiosperms to do this by transporting the male gamete in pollen grains carried by insects or the wind (1).

ii The male gamete and the female gamete need to fuse in order for fertilisation to take place (1). The pollen tube carries the two male nuclei from the pollen grain to the female nuclei in the ovule (1).

iii Fruit is adapted to disperse seeds on land (1) using animals or wind (1).

iv Seeds have tough resistant coats (testa) to prevent desiccation (drying out) (1) and food stores to allow the seed to survive and germinate (1).

b The coconut seeds drop onto the shoreline, where they can then be carried by the sea (1). This allows the seeds to be widely dispersed and colonise new areas (1).

## 11 Inheritance

1 a Blue feathers (1) and short beaks (1) are dominant to red feathers and long beaks, which are recessive (1).

b **B** – blue feathers

**b** – red feathers

**H** – short beaks

**h** – long beaks

Parents: blue feathers and short beak × blue feathers and long beak

**BbHh** × **Bbhh**

(1)

Gametes: **BH** **Bh** **bH** **bh** × **Bh** **bh**

Cross:

| | **BH** | **Bh** | **bH** | **bh** |
|---|---|---|---|---|
| **Bh** | **BBHh** | **BBhh** | **BbHh** | **Bbhh** |
| **bh** | **BbHh** | **Bbhh** | **bbHh** | **bbhh** |

(1)

Phenotype ratio:

3 blue feathers and short beak (2 **BbHh** + 1 **BBHh**):

3 blue feathers and long beak (1 **BBhh** + 2 **Bbhh**):

1 red feathers and short beak (1 **bbHh**):

1 red feathers and long beak (1 **bbhh**) (1)

The statement is incorrect because one of the offspring in the cross has red feathers and a long beak (1).

2

a The chance is 0.5 (1). The chance of having a son is always the same, no matter what sex the previous children are (1).

b In order for the daughters to be colour blind they would have to have two copies of the recessive allele (1). This could only happen if the mother was either colour blind or a carrier of the recessive colour-blind allele (1).

c No, it cannot be determined if the father is colour blind (1), because the colour-blind son inherited the Y chromosome, which does not carry the colour-blind gene, from his father (1).

## 12 Variation and evolution

1

a

i If the new island had very different selection pressures then the gene pool of the island would change due to natural selection (1), with certain alleles providing a selective advantage under these new selection pressures (1). The frequency of these alleles would increase (1).

ii If the new island was very similar to the original islands then the selection pressures would be very similar on both islands and natural selection would not have a great effect (1). Allele frequencies in the gene pool would only change slowly (1) due to genetic drift (1).

b Island A mean = 83.5; island B mean = 18.5 (1)

| **Island A** | $(x - \bar{x})$ | $(x - \bar{x})^2$ |
|---|---|---|
| 78 | –5.5 | 30.25 |
| 85 | 1.5 | 2.25 |
| 91 | 7.5 | 56.25 |
| 67 | –16.5 | 272.25 |
| 82 | –1.5 | 2.25 |
| 98 | 14.5 | 210.25 |

| **Island B** | $(x - \bar{x})$ | $(x - \bar{x})^2$ |
|---|---|---|
| 30 | 11.5 | 132.25 |
| 5 | –13.5 | 182.25 |
| 17 | –1.5 | 2.25 |
| 27 | 8.5 | 72.25 |
| 19 | 0.5 | 0.25 |
| 13 | –5.5 | 30.25 |

variance, $s^2 = \Sigma(x - \bar{x})^2/(n - 1)$

variance of site A = 573.5/5 = 114.7 (1)

variance of site B = 419.5/5 = 83.9 (1)

$t = [\bar{x}_1 - \bar{x}_2]/\sqrt{[(s_1^2/n_1) + (s_2^2/n_2)]}$

$= [83.5 - 18.5]/\sqrt{[(114.7/6) + (83.9/6)]}$

$= 65/\sqrt{[19.12 + 13.98]}$

$= 65/5.75$

$= 11.30$ (1)

degrees of freedom $= (6 - 1) + (6 - 1) = 10$

critical value = 2.228

$11.30 > 2.228$

As the *t* value is greater than the critical value, there is a significant difference between the grass lengths on islands A and B (1).

2

a

i Population A would have a less diverse gene pool (1). It would have a smaller range of alleles, with high frequencies (1).

ii Population B would have a more diverse gene pool (1). It would have a larger range of alleles, with low frequencies (1).

b The scientist would be better able to use the Hardy-Weinberg equation to analyse the allele frequencies in population A than in population B (1). This is because one of the assumptions of the Hardy-Weinberg principle is that there is no movement of organisms into or out of the population (1), and there are high levels of immigration and emigration in population B (1).

# 13 Application of reproduction and genetics

1

a As the number of cycles increases the number of copies increases, with an initial gradual increase followed by a rapid increase (1); then the number of copies levels off and remains constant (1).

b Initially the number of copies of DNA doubles with each cycle (1). Then limiting factors slow the rate of copy formation and eventually prevent any further copies being formed (1). These limiting factors could include all the nucleotides or the primers being used up or the enzyme denaturing (1).

c Add more primers (1) and more nucleotides at the start of the PCR reaction (1).

2

a Restriction enzymes cut DNA at specific base sequences, so the same enzyme is used to cut the required gene and the plasmid (1). This produces complementary sticky ends, so that the required gene can be inserted into the plasmid (1).

  

b Reverse transcription is used on the mRNA that codes for the required gene (1). This produces single-stranded cDNA, which codes for the gene; DNA polymerase can then be used to produce a double-stranded copy of the gene (1).

c A marker gene (e.g. for antibiotic resistance/fluorescence) is inserted into the plasmid (1). Bacteria that take up and express the required gene also express the marker gene, allowing them to be identified (1).

d Plasmids are used as vectors (1) to insert the required gene into the bacterium (1).

## 14 Option A: Immunology and disease

1

a A Bacteriostatic (1)

B Bactericidal (1)

b The antibiotic has weakened the bacterial cell wall (1). The bacteria were in a hypotonic solution (1), so water moved into the bacterial cell by osmosis, causing it to lyse (1).

c If antibiotic A inhibited transcription then mRNA would not be produced (1). This means that translation would also not occur, so proteins would not be produced (1). Therefore, the bacteria would not be able to produce proteins essential for replication, such as enzymes (1).

## 15 Option B: Human musculoskeletal anatomy

1

a The symptoms are likely to include painful, stiff, swollen joints with restricted movement (1).

b The drugs will act as steroids (1), reducing inflammation in the joint (1), which in turn will reduce the swelling and ease the pain (1).

c Do not smoke (1) and avoid a high intake of red meat (1) and coffee (1).

## 16 Option C: Neurobiology and behaviour

1

a Worker bees were doing the dance (1).

b Both the bees and the woodlice would not be moving in a specific direction and both would appear to be moving in circles (1). The woodlice's behaviour is kinesis – it is not moving in a particular direction but will be moving faster and turning more frequently because the environment is dry (1). The bee's behaviour is a dance to indicate the distance of a food source (1). The round dance indicates that the food is less than 70 metres away (1).

c The bees are not exhibiting latent learning (1) because while they may be exploring new surroundings, they are doing it to directly satisfy a need – in this case obtaining food (1). It also seems unlikely that the bees are exhibiting imitation learning

(1), because the bees are not learning from each other but are displaying innate behaviour in response to the location of food (1).