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**Biology**

**Unit 1 & 2**

**2016**

**Marking Key**

**Multiple Choice Answer Sheet**

For each question shade the box to indicate your answer.

**Suggested working time for this section is 40 minutes.**

1 [A] [B] [C] [D] 16 [A] [B] [C] [D]

2 [A] [B] [C] [D] 17 [A] [B] [C] [D]

3 [A] [B] [C] [D] 18 [A] [B] [C] [D]

4 [A] [B] [C] [D] 19 [A] [B] [C] [D]

5 [A] [B] [C] [D] 20 [A] [B] [C] [D]

6 [A] [B] [C] [D] 21 [A] [B] [C] [D]

7 [A] [B] [C] [D] 22 [A] [B] [C] [D]

8 [A] [B] [C] [D] 23 [A] [B] [C] [D]

9 [A] [B] [C] [D] 24 [A] [B] [C] [D]

10 [A] [B] [C] [D] 25 [A] [B] [C] [D]

11 [A] [B] [C] [D] 26 [A] [B] [C] [D]

12 [A] [B] [C] [D] 27 [A] [B] [C] [D]

13 [A] [B] [C] [D] 28 [A] [B] [C] [D]

14 [A] [B] [C] [D] 29 [A] [B] [C] [D]

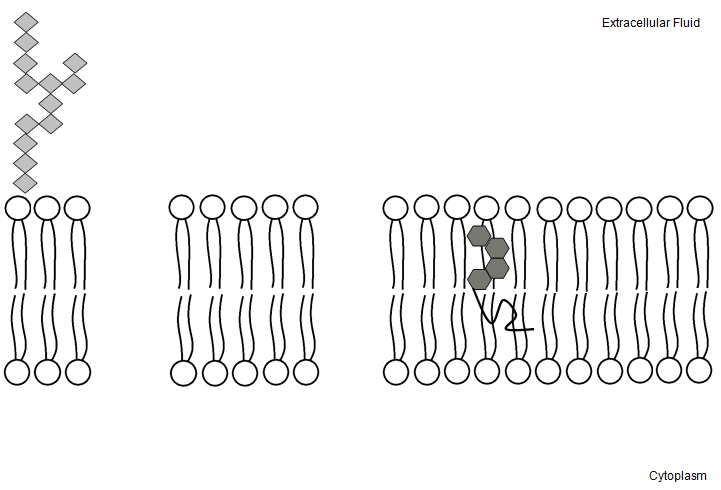
15 [A] [B] [C] [D] 30 [A] [B] [C] [D]

**Section Two: Short Answer 50% (100 marks)**

**Question 31 (20 marks)**

(a) In the space below, draw a labelled diagram of the fluid mosaic model of a cell membrane. The diagram must include proteins embedded within the membrane for molecular transport. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Phospholipid bilayer | 1 |
| Hydrophilic phosphate head | 1 |
| Hydrophobic lipid tails | 1 |
| Protein channel (diffusion) | 1 |
| Protein carrier (active transport) | 1 |
| Internal and external environment (cytoplasm and extracellular fluid) | 1 |
| **TOTAL** | 6 |

Eg.

(b) Identify **two** organelles within plant and animal cells that contain this type of membrane. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| *Accept two of the following organelles.*   * Mitochondria * Chloroplast * Nucleus | 1 – 2 |
| **TOTAL** | **2** |

(c) Animal cells contain cholesterol molecules within the membrane. What is the structural importance of this molecule to the membrane? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Structural stability | 1 |
| Flexibility (firm but fluid) | 1 |
| **TOTAL** | **2** |

(d) Differentiate between the terms diffusion and osmosis. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| **Osmosis**  Movement of water molecules from low solute to high solute concentration through a semi-permeable membrane. | 1 |
| **Diffusion**  Movement of molecules (solutes) from high to low concentration down the concentration gradient. | 1 |
| **TOTAL** | **2** |

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Lipid soluble molecules (non-polar) pass easily because of the internal lipid nature of the bilayer (which is also non-polar). | 1 |
| Examples of non-polar molecules are ethanol, steroids, CO2. | 1 |
| Lipid insoluble (polar) molecules need a carrier or channel to go through because they a repelled by the non-polar lipid tails. | 1 |
| Examples of polar molecules are glucose, amino acids, and nucleotides. | 1 |
| **TOTAL** | **4** |

(e) Using examples, explain why specific molecules can pass easily through the cell membrane while others cannot. (4 marks)

(f) Describe the differences between active transport and facilitated diffusion. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Facilitated diffusion is the movement of molecules (polar – like glucose) with the concentration gradient through specific protein channels. | 1 |
| Facilitated diffusion does not require energy. | 1 |
| Active transport is the movement of molecules **against** the concentration gradient using a carrier protein. | 1 |
| Active transport requires energy (ATP) to transport molecules through protein carriers. | 1 |
| **TOTAL** | **4** |

**Question 32 (20 marks)**

Consider the diagram below of a cellular process that occurs in plants.



(a) (i) State the name of the process in the diagram above. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Photosynthesis | 1 |
| **TOTAL** | **1** |

(ii) Write a balanced overall equation for this process. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Balanced input - 6CO2 + 12H2O | 1 |
| Arrow with *light energy* above and *chlorophyll* below | 1 |
| Balanced output - C6H12O6 + 6H2O + 6O2 | 1 |
| **TOTAL** | **3** |

(b) (i) In which organelle does this process take place? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Chloroplast | 1 |
| **TOTAL** | **1** |

(ii) In which section of this organelle do the following reactions take place? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Light-dependent in the **Thylakoid membranes** | 1 |
| Light-independent in the **Stroma** | 1 |
| **TOTAL** | **2** |

(c)

Identify the inputs and outputs for the two reactions of this cellular process. (8 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| **Light-dependent reactions** |  |
| **Input A**  Water (H20)  Chlorophyll | 1  1 |
| **Output A**  Oxygen gas (O2)  ATP and Hydrogen ions (H+) | 1  1 |
| **Light-independent reactions** |  |
| **Input B**  Carbon dioxide (CO2)  ATP and Hydrogen ions (H+) | 1  1 |
| **Output B**  Glucose (C6H12O6)  Water (H20) | 1  1 |
| **TOTAL** | **8** |

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Less output from light-dependent reactions – ATP, H+ and O2. | 1 |
| These outputs are required for light-independent reactions to synthesise glucose. | 1 |
| Less glucose available for cellular respiration will result in reduced ATP synthesis. | 1 |
| **TOTAL** | **3** |

(d)

Explain how reducing exposure of the plant’s cells to light would affect the plant’s metabolic processes. (3 marks)

(e) This cellular process can be compromised during times of drought. Describe **two** adaptations of Australian plants that enable normal function with limited water. (2 marks)

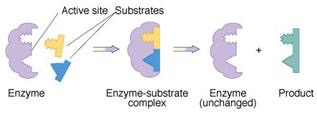
|  |  |
| --- | --- |
| **Description** | **Mark** |
| *Any two adaptations from the following list:*   * + Waxy leaves – stops water being lost from surface.   + Small flowers with reduced parts – less surface area to lose water.   + Small, thin leaves – less surface area to lose water.   + Hairy leaves and stems – traps moist are around stomata and reduces evaporation.   + Stomata on bottom surface of leaves – less evaporation and transpiration due to being in ‘shade’.   + Leaves hanging vertically – less evaporation and transpiration because sun not shining directly on to leaf surface. | 1 – 2 |
| **TOTAL** | **2** |

**Question 33 (20 marks)**

Enzymes are critical to the survival of all living things.

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Enzymes are biological catalysts – speed up chemical reactions | 1 |
| Without enzymes, chemical reactions in our bodies would not occur quickly enough, if at all, to maintain proper functioning. | 1 |
| **TOTAL** | **2** |

(a) Define the term enzyme and state why enzymes are critical for survival. (2 marks)

(b) In the space provided, draw a labelled diagram of the **lock-and-key** model of enzyme function for an **anabolic** reaction. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Enzyme | 1 |
| Substrates | 1 |
| Active site | 1 |
| Enzyme-substrate complex | 1 |
| Unchanged enzyme and product | 1 |
| Anabolic reaction correct (building new substances) | 1 |
| **TOTAL** | **6** |

*Example:*

|  |  |
| --- | --- |
| **Description** | **Mark** |
| *Any* ***two*** *from the following list:*   * pH * Temperature * Concentration of enzyme and/or substrate * Co-enzymes | 1 – 2 |
| **TOTAL** | **2** |

(c) Identify **two** factors that affect enzyme function. (2 marks)

A biology class were learning about the immune system and fever. They were keen to find out why a fever could be fatal.

(d) Using your knowledge of enzyme function, design an experiment to test the effect of fever on the human body.

|  |  |
| --- | --- |
| **Description** | **Mark** |
| 1. Appropriate hypothesis for chosen experiment – must include independent and dependent variable in statement.   *Eg., “Enzyme function will decrease with increasing temperature”.* | 2 |
| 1. Variable being changed in experiment.   *Eg., Temperature of solvent in which enzyme is placed.* | 1 |
| 1. Variable being measured. Include units if applicable.   *Eg., Positive and negative results from an enzyme function test such as iodine (starch) and Benedict’s (glucose) tests.* | 1 |
| 1. Two variables to be kept the same to ensure validity.   *Eg.1, Amount of time the enzyme solution placed in each temperature.*  *Eg.2, Amount of enzyme added to the solution.* | 1 – 2 |
| 1. Four major points of experimental design must be explained in passive past-tense in enough detail so the experiment could be copied. Must include trials for fairness and a control in each test.   Eg.,   * Three warm water baths were set up at 37, 39 and 43oC to simulate normal body temperature, a high fever and a dangerously high fever. * Four test tubes for each temperature test (total 12) were filled with 6mL of identical starch solution. 1mL of the solution from each test tube was used to conduct an iodine test for the presence of starch. * The test tubes were placed into the warm water baths (3 in each) for 10 minutes. After 10 minutes 1 mL of the enzyme was placed into three of the four test tubes from each water bath. The last test tube served as a control. * The test tubes were left for another 10 minutes to allow any reaction to take place. After 10 minutes, all 12 test tubes were tested for the presence of starch and glucose using the iodine test (starch) and the Benedict’s test (glucose). | 1 – 4 |
| **TOTAL** | **10** |

**Question 34 (20 marks)**

The Hairy Marron (*Cherax cainii*) is endemic to southwest Western Australia and one of the only two species of marron in the world. The Margaret River Hairy Marron population is under threat and has been listed as “fauna that is likely to become extinct” under our State legislation, and “critically endangered” on both the federal and IUCN lists. Unlike the Smooth Marron, the Hairy Marron has hair-like setae that cover its carapace. The two species of marron were not identified as genetically distinct until 2002. It is believed that the smooth marron invaded the Margaret River in the early 1980s, and have been interbreeding with their hairy relatives. Hairy Marron are now only found in pools of the upper reaches of Margaret River and undisturbed woodland. While marron fishing is banned in these areas, enforcement of fishing regulations is difficult due to the remote location and limited resources.

(a) Identify **two** reasons why it is important to save the Hairy Marron. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| *Two points from the following:*   * + Biodiversity maintenance for the ongoing health of ecosystems.   + Maintain genetic and ecological diversity of the freshwater ecosystem.   + Protect the marron from extinction, likely caused by humans. | 1 – 2 |
| **TOTAL** | **2** |

(b) What is the most likely explanation for the appearance of Smooth Marron in Margaret River in the 1980s? (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Escaped from nearby dams where they are cultivated by farmers. | 1 |
| Purposely placed there by humans (without private dams) to grow marron for their own benefit. | 1 |
| **TOTAL** | **2** |

(c) Identify and describe the **three** greatest threats to the recovery and survival of the Hairy Marron in Margaret River. (6 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| **Climate change**  There is less water available for aquatic ecosystems due to reduced rainfall, leading to a reduction in available habitat. | 1  1 |
| **Illegal fishing**  Taking incorrect species and taking marron from restricted places continues to occur. | 1  1 |
| **Genetic dilution / interbreeding**  If the smooth marron continue to live in the hairy marron habitat and breed with them, the gene pool could be changed to such an extent that the distinct species may not persist. | 1  1 |
| **TOTAL** | **6** |

(d) Explain why breeding of Hairy Marron “brood stock” may be problematic to conservation efforts. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Hybrid marron may accidently be used as breeding stock. | 1 |
| This could further dilute the hairy marron gene pool. | 1 |
| Translocation of animals could be expensive and difficult. | 1 |
| Finding appropriate sites for breeding genetically pure stock in the natural environment could be problematic. Must remove any predators or smooth marron first. | 1 |
| **TOTAL** | **4** |

(e) Describe how smooth marron populations could be effectively removed from the Hairy Marron’s habitat and suggest why this is important to the continuation of the Hairy Marron as a species. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Best method in the aquatic environment for a similar species is random grid locations. | 1 |
| Lay traps (specific for catching marron) in randomly selected grid positions or crustaceans. *May need boat or canoe to access*. | 1 |
| Baited traps are best to attract the marron. Are left for a few hours or overnight. | 1 |
| Animals are tagged or possibly micro-chipped and genetic samples taken without harming the marron. Tagged for reference – know if the marron has been caught and if removal is necessary due to genetic difference from pure Hairy Marron. | 1 |
| **TOTAL** | **4** |

|  |  |
| --- | --- |
| **Description** | **Mark** |
| The smooth marron could be trapped or caught and physically removed on a regular basis until population of smooth and hybrid marron are completely eradicated (from hairy marron habitats that are under threat). | 1 |
| This will stop the interbreeding of smooth and hairy marron and maintain genetic purity of hairy marron population. | 1 |
| **TOTAL** | **2** |

(f) Outline the **four** most appropriate methods for monitoring freshwater animal populations that are similar to the Hairy Marron. (4 marks)

**Question 35 (20 marks)**

(a) Describe the major functions of the four main processes of the gastrointestinal system listed in the table below. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| **Ingestion** - taking in of food (eating). | 1 |
| **Digestion** - chemical and mechanical. | 1 |
| **Absorption** - taking in of digested material from intestines to bloodstream. | 1 |
| **Egestion** - removing waste products of digestion from body. | 1 |
| **TOTAL** | **4** |

(b) Describe why the function of the pancreas is crucial for digestion. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Produces pancreatic juices that contain digestive enzymes.  Enzymes are required for digestion of proteins, carbohydrates and lipids. | 1 – 2 |
| **TOTAL** | **2** |

(c) Define the term peristalsis. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| The muscular contraction of structures of the gut.  These contractions assist the movement of food and waste through the digestive tract. | 1 – 2 |
| **TOTAL** | **2** |

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Length of the small intestines increases the space for nutrients to be absorbed. | 1 |
| Villi are convolutions containing blood and lymph vessels that increase the surface area for nutrient absorption. | 1 |
| Villi have hairs or microvilli that further increase the surface area. | 1 |
| Blood vessels within the villi provide a continual supply of blood so that the gradient for molecule diffusion is always greater inside the small intestine. | 1 |
| **TOTAL** | **4** |

(d) Explain how the structure of the small intestine helps to increase the absorption of nutrients into the bloodstream. (4 marks)

Some organisms possess a large caecum in their digestive tract.

(e) (i) What is the main diet of an organism with a large caecum? (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Animals with a large caecum are herbivores with a large amount of very fibrous material in their diet – eg., koalas, kangaroos, cows. | 1 |
| **TOTAL** | **1** |

(ii) Describe how a caecum functions in order to aid digestion in these organisms.

(3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Fermentation occurs in the caecum (Eg., hind-gut fermenters). | 1 |
| Fermentation is required to extract more energy from the low calorific food. It cannot be extracted from ‘normal’ digestion like omnivores. | 1 |
| The caecum often contains symbiotic bacteria that aid in fermentation process. | 1 |
| **TOTAL** | **3** |

|  |  |
| --- | --- |
| **Description** | **Mark** |
| *Any four points from the following*:   * + Severe dehydration resulting from diarrhoea.   + Weight loss because fewer nutrients are absorbed.   + Vitamin deficiency (like iron) due to less absorption of necessary vitamins and minerals from small intestines.   + Repair and reproduction of somatic cells affected. Less protein is being absorbed into blood.   + Fatigue because less glucose available for cellular respiration.   + Immune system affected because less building materials (protein) and energy for maintenance and production of new cells. Person may be more susceptible to minor infections and colds etc… | 1 – 4 |
| **TOTAL** | **4** |

(f) Crohn’s Disease is a disease of the digestive system that causes inflammation and the formation of large ulcers in the small intestine. Describe **four** **symptomatic effects** that this may have on the health of an individual diagnosed with Chrohn’s. (4 marks)

**Section Three: Extended Answers 20% (40 marks)**

**Unit 1 –** Choose either **Question 36** or **Question 37**

**Question 36 (20 marks)**

Over the last century, the health of many ecosystems has been negatively affected as a result of human impact.

(a) Discuss how and why the use of pesticides, such as DDT, and industrial pollutants has had an ongoing negative effect on species and ecosystems. You must ensure that you use examples to support your answer. (10 marks)

* Many pesticides and pollutants that have been used in the last century are non-biodegradable. They cannot be broken down or metabolised by living organisms. (1)
* Non-biodegradable chemicals remain in the environment and accumulate in all living organisms in an ecosystem. While the toxicity is low at the producer level, as the chemicals build up with each trophic level, so does the concentration. This is known as biomagnification.  (1)
* DDT and dieldrin are organochlorides that were used in the mid-19th century by the armed forces to eradicate mosquitoes and in agriculture as an insecticide (one of the most widely used insecticides in the world).  (1)
* DDT and dieldrin stay in the soil profile for long periods of time so successive generations of plants and crops are affected. (1)
* Industrial pollutants such as mercury are introduced into ecosystems through dumping of industrial waste or air and water pollution from combustion reactions. They enter waterways and leach into soils where they are taken up by primary producers. (1)
* The most affected organism are those at the top of the food chain – top predators. As the biomass decreases the concentration increases. The damage caused by non-biodegradable chemicals is revealed by top consumers. (1)
* The chemicals build up or accumulate in the tissues of the top consumers and have caused reproductive problems, increased death rates and thin egg shells in predatory birds. (1)
* Australian animals known to be affected by biomagnification are the Peregrine falcon, pelicans and bandicoots. Numbers had severely declined following the use of DDT in there habitats. (1)
* In the years following the banning the use of DDT and dieldrin, (evidence showed that) the incidence of eggshell thinning slowly decreased and the populations of affected animals began to recover. (1)
* New insecticides have been produced that rapidly degrade into non-toxic substances and do not accumulate in living tissues. These include organophosphates and pyrethrum. (1)

*NB – Answers may vary due to class-specific content. Teachers may accept answers that use alternate chemicals to show understanding of the concept.*

Many species that have been introduced into the Australian environment have become pests. The control and/or eradication of most pest species is problematic for both agriculture and natural resource management.

(b) Using a specific example, describe the effect of the introduction of an invasive animal species on the ecosystem in which it lives. (10 marks)

* Appropriate choice of invasive species. Eg., fox, cane toad, cat, kookaburra (WA). (1)
* Identified the ecosystem/habitat in which this species lives. (1)
* Stated the food preferences of the species – Herbivore, carnivore, omnivore. (1)
* Described how this species hunts. (1)
* Identified native animals it may kill to eat. (1)
* Described its success as an introduced species. (1)
* Identified level of damage is has caused in the time it has been in Australia. (1)
* Described the flow-on effects on the ecosystem in terms of:
  + native species abundance,
  + displacement, and
  + increasing susceptibility to extinction. (1 – 3)

**Question 37 (20 marks)**

Individual species are influenced by both biotic and abiotic factors in the environment.

(a) Describe how naturally occurring abiotic factors in the environment affect spatial and temporal distribution and the abundance and diversity of a given species. Ensure that you incorporate specific examples to support your answer. (10 marks)

Students answers will vary according to the chosen examples and ecosystems studied in each school.

*Allocate marks (at teacher discretion) for understanding and discussion of:*

* Abiotic factors (at least 2). (1)
* Spatial distribution. (1)
* Temporal distribution. (1)
* Species abundance. (1)
* Species diversity. (1)
* Selection of an appropriate species to discuss. (1)

*How well they relate their chosen example to:*

Spatial distribution in terms of **species diversity** and **abundance**. (1 – 2)

Temporal distribution in terms of **species diversity** and **abundance**. (1 – 2)

*NB - Both species* ***diversity*** *AND* ***abundance*** *must be described to receive full marks.*

Natural disasters can be detrimental to both populations of species and entire ecosystems.

(b) Describe the beneficial effects of fire (non-prescribed) on a terrestrial ecosystem. Outline the adaptations of native Australian plants to cope with the effects of fire and assist with growth and development. (10 marks)

* Fire impacts abiotic interactions by increases space for plants to grow and nutrient-rich soil for seed germination. Stimulates secondary succession. (1 – 2)
* Fire releases carbon that is ‘locked-up’ into the carbon cycle, providing nutrients to establishing species. (1)
* Fire-stick farming by early Aboriginal people gave rise to native species that require fire to complete their life-cycle. (1)
* Fire can eliminate non-native species that are not adapted to survive fire. (1)
* Plants that survive a fire have adaptations to regrow. Underground tubers and epicormic budding are common in native species. (1 – 2)
* Germination of seeds from many species require the occurrence of fire. The heat of a fire splits the seed’s hard coat or the chemicals produced in the smoke can stimulate germination and growth. (1 – 2)
* The new growth in a regenerating post-fire community attracts colonising, mobile animals that can support further regeneration of plants through pollination and seed dispersal. (1)

**Unit 2 -** Choose either **Question 38** or **Question 39**.

**Question 38 (20 marks)**

Most animals obtain their oxygen requirements from the surrounding air. Unlike energy, oxygen cannot be stored and therefore must be continually obtained from the environment.

(a) Describe how breathing occurs in the mammalian lung. Identify the requirements for efficient gas exchange by referring to specific structures used throughout this mechanism.

(10 marks)

**Mechanism for breathing:**

* Breathing involves inspiration (air in) and expiration (air out). (1)
* Inspiration occurs when atmospheric pressure is greater than internal lung pressure. Diaphragm contracts, increasing the volume of the lungs, and air moves in. (1)
* Air passes in through the mouth and nose, down the throat, larynx, and trachea and into one of two bronchi. From here it travels through dividing branches of bronchioles until it reaches the terminating cluster or air filled sacs called alveoli. These are covered with a net of capillaries. (1)
* Expiration occurs when the pressure inside the lungs is greater than outside. The diaphragm relaxes, reducing the volume of the lungs and air is ‘forced’ out. (The air moves out of the lungs in the opposite direction from which it came.) (1)
* Changes in internal pressure are due to the rates of diffusion of gases into and out of the bloodstream (determined by metabolic processes). (1)
* Breathing rate may vary (increase or decrease) depending on how much activity an animal is doing and how much oxygen their cells require at any given time. More activity = increased breathing rate, little activity = slow breathing rate (relaxed). (1)

**Requirements for efficient gas exchange:**

* The inner surface of the gas exchange membrane (alveoli) must be moist. (*This allows the gases to dissolve in the water so they can then diffuse through the membrane from the lung to the capillaries.*) (1)
* The membrane for gas exchange must be very thin and permeable. (*Alveoli are usually one cell thick. The gas molecules need to be able to pass through very quickly.*) (1)
* Internal surface of the lung must have a very large surface area to volume ratio. (*This allows the diffusion of a large amount of gas to meet the animal’s requirements.*) (1)
* A concentration gradient must be available so that gases can diffuse from one side to the other as required. (*This can be established by changing the volume of the lungs through inspiration and expiration. Concentration of gases in the blood also varies as it moves continuously over the alveoli.)* (1)

*NB – Those descriptions in italics do not need to be included to receive full marks.*

All animals possess adaptations to increase the exchange of gases with their external environment. Unlike their terrestrial ancestors, aquatic animals are specially adapted to obtain oxygen from the water.

(b) Describe the mechanism of gas exchange for a bony fish. Compare gas exchange in bony fish with gas exchange in mammals. (10 marks)

* Structure of gas exchange (O2 and CO2) in bony fish are gills as compared to lungs in a mammal. (1)
* Gills have the same features as the mammalian lung, which are required for all gas exchange surfaces. Eg., Moist, thin, permeable, large surface area to volume ratio. (1)
* Gills rely on buoyancy of water the fish is in to expand the surface areas. Out of the water the gills collapse. (1)
* Most bony fish maintain a flow of water over gills by ‘drinking’ water. Instead of swallowing they force the water out over the gills. (1)
* Gills are covered by an operculum that protects and aids movement of water over gills. (1)
* Structure of gills increases surface area. This exposes more area of blood supply to oxygen-rich water. (1 – 2)
  + Two piles of leaf-like filaments projecting from gill arch.
  + Gill plates on upper and lower surface of filaments.
  + Adjacent filaments touch so water is directed over gas exchange surfaces.
* Artery is contained in gill arch brings deoxygenated blood to gill plate full of capillaries. (1)
* Water flowing over gills will diffuse O2 into the bloodstream and CO2 out of the bloodstream via concentration gradients, as per mammalian lung. (1 – 2)

**Question 39 (20 marks)**

The production of energy is essential for life.

(a) Outline the three main processes involved in the production of ATP during aerobic cellular respiration. Identify where each process occurs, the chemical reactions that take place and total energy yields. Annotated diagrams may be useful in your response. (10 marks)

* The three main processes in the production of ATP are Glycolysis, Krebs Cycle and the Electron Transport Chain (or chemiosmosis / chemiosmotic phosphorylation). (1 - 3)
* The overall equation for the process of aerobic cellular respiration can be summarised as:

**C6H12O6 + 6O2 🡪 6CO2 + H2O + 36 ATP** (adenosine triphosphate) (1 - 2)

* Glycolysis takes place in the cytoplasm. (1)
* Glucose (from digestion) is converted into pyruvate through a series of reactions in the absence of oxygen. 2 ATP are formed. (1)
* The pyruvate molecules enter the mitochondria. The Krebs Cycle and Electron transport chain occur within the inner membranes of the mitochondria. (1)
* These two processes require oxygen to proceed. Within the mitochondria, the chemical reactions that take place convert oxygen and pyruvate into CO2 (carbon dioxide), H2O (water). (1)
* 34 molecules of ATP are produced from Krebs Cycle and Electron Transport Chain. (1)

Energy production can be affected by a number of factors that can change how the process takes place, the chemical reactions that occur and the amount of energy produced.

(b) Describe the process of anaerobic cellular respiration. Identify what influences the onset of this process and describe the outputs for both plant and animal cells. (10 marks)

* Both plants and animals are able to produce small amounts of energy in the **absence of oxygen**. This is called anaerobic respiration or fermentation. When oxygen is unavailable, anaerobic respiration will take over as the process by which energy is produced. (1)
* Anaerobic respiration occurs only in the cytoplasm. (1)
* The first step is glycolysis. (1)
* Pyruvate and 2 ATP are formed from the partial breakdown of glucose. (1)
* In **animal cells**, the pyruvate is converted into **lactic acid**. (2)
* In **plant cells**, the pyruvate is converted into **ethanol and CO2**. (2)
* No further reactions take place without oxygen, so no more ATP is produced. (1)
* Fermentation prevents the build up of pyruvate in the cells. When oxygen supply is restored, aerobic respiration resumes and enzymes breakdown the accumulated lactic acid. (1)

**End of Exam**