**D2 - Case Studies to evaluate the importance of homeostasis in maintaining the healthy functioning of the body.**

*Your responses to the following case studies will demonstrate your ability to evaluate the importance of homeostasis.*

Gemma is 23 years old, she was diagnosed with Type 1 Diabetes 8 months ago has been prescribed twice-daily insulin and diet modifications but is known to be non-compliant with this regime This is due to her commitment to maintaining her pre-diagnosis body image. She has not coped well with her diagnosis of Type 1 diabetes, being a hitherto independent young woman who travelled the world.

What should a normal blood glucose level be?

*A normal blood sugar should be between 4-8 mmols.*

What could the consequences be if Gemma doesn’t follow her treatment?

*If blood glucose levels are not controlled the excessive glucose will cause damage to the blood vessels and nerves. Damage to the blood vessels causes problems with the peripheral circulation particularly of the feet and will also increase the risk of heart disease and strokes. The kidneys can become damaged (nephropathy). Nerve damage is known as Neuropathy.*

What might happen if blood glucose levels fall below or rise above their normal range?

*Normally blood sugar levels are regulated by the production of insulin. If the blood glucose falls the amount of insulin produced would be decreased in response and the body may also secrete glucagon from the alpha cells of the islets of Langerhans to convert glycogen stored in the liver back into glucose in the blood stream.*

*If the blood glucose is rising then this will stimulate the release of more insulin from the beta cells of the pancreas to regulate and lower the blood glucose by converting the excess glucose in the blood stream into glycogen in the muscles and liver.*

*However Gemma has diabetes type 1 which means that her pancreas is not secreting insulin.*

Gemma has been admitted to A&E after collapsing at work. She is unconscious, and her hospital record identifies her as diabetic. Her symptoms suggest either acute hypoglycaemia or Diabetic Ketoacidosis (DKA) (hyperglycaemia).

Explain the difference between hypoglycaemia and hyperglycaemia.

*Hypoglycaemia means a very low level of glucose in the blood. This will result with the body not having enough energy to carry out its activities. This is described as a 'hypo'. It is most commonly associated with* [*diabetes*](http://www.nhs.uk/Conditions/Diabetes/Pages/Diabetes.aspx) *and usually occurs if someone with diabetes takes too much insulin, misses a meal, or exercises too hard.*

*Most people will have some warning that their blood* [*glucose levels*](http://www.nhs.uk/Conditions/Diabetes-type2/Pages/glucose-levels.aspx) *are too low, which will give them time to correct them. Symptoms usually occur when blood sugar levels drop under 4 millimoles per litre and include feeling hungry, sweating, dizziness, tiredness, trembling or shakiness,* [*anxiety*](http://www.nhs.uk/conditions/Anxiety/Pages/Introduction.aspx) *or irritability and fast pulse. In severe hypoglycaemia the person may have difficulty concentrating and may appear confused or drunk.*

*Hyperglycaemia occurs when people with diabetes have too much sugar in their bloodstream and is defined as a blood glucose level greater than 7.0 mmol/L   
when fasting or Blood glucose levels greater 11.0 mmol/L 2 hours after meals.*

*Symptoms of hyperglycaemia are feeling thirsty, needing to urinate often, feeling tired, feeling hungry despite having eaten recently and not being able to think as clearly as usual. Blood sugar levels constantly over 7 mmol/L can start to cause damage to internal organs.*

Why is it important to be sure whether Gemma has hypoglycaemia or hyperglycaemia?

*The treatments for both conditions are different if you give a person with Hypo extra insulin this will decrease the blood glucose further and could cause death.*

*If you give extra glucose in Hyperglycaemia this will increase the blood glucose level and as there isn’t enough insulin to allow the glucose to be taken up and used by the cells. The body will then break down body fat to use for energy. This results in ketones being produced,* as *a result ketones in the blood rise making the blood more acidic which will affect the breathing as it becomes heavier and more rapid; it also results in increased thirst as the body tries to remove the ketones and nausea and vomiting. The high blood glucose also results in glucose being passed into the urine which then pulls water out of the body causing dehydration. Diabetic Ketoacidosis is a serious emergency as it can lead to death.*

An immediate blood glucose test is carried out on admission using a standard Glucometer, and is found to be 1.3 mmols. This confirms the diagnosis of hypoglycaemia.

If Gemma’s blood Glucose level is not corrected what is likely to be the consequence?

*If Gemma is not given glucagon to release her glycogen stores and the hypoglycaemia is not corrected, the lack of glucose for the brain cells is likely to result in fitting and possible death.*

Why might Gemma be suffering from hypoglycaemia?

*The most likely cause of Gemma’s hypoglycaemia is that she has not taken an incorrect dose of insulin – too much or she has taken a normal dose of insulin but has not eaten for several hours after taking this.*

What would have been the effect if Gemma had not taken her prescribed insulin and had snacked on chocolate and crisps during the day ?

*If Gemma has not taken her insulin and then snacks throughout the day each snack would result in the increasing of her blood glucose level as the snack was digested and the glucose absorbed into the blood stream, as she will not have the insulin to ensure the glucose is removed to the cells and liver for storage. Eventually because glucose is not entering the cells, the body will start to break down stored fat resulting in Diabetic Ketoacidosis.*

*This results in ketones being produced,* as *a result ketones in the blood rise making the blood more acidic which will affect the breathing as it becomes heavier and more rapid; it also results in increased thirst as the body tries to remove the ketones and nausea and vomiting. The high blood glucose also results in glucose being passed into the urine which then pulls water out of the body causing dehydration. Diabetic Ketoacidosis is a serious emergency as it can lead to death.*

Case Study 2:

Stuart is a keen jogger goes out for a run every morning regardless of the weather. Today the weather is just above freezing, it is raining heavily and windy because of this Stuart decides to put a thin long sleeve top on instead of his usual vest top. He considers doing at short run but when out he feels warm and does his usual run.

On arriving home Stuart feels cold and appears irritable, despite being fit Stuart is breathing much more heavily than usual and can feel his heart racing; beginning to shiver he goes upstairs to get changed.

What is the normal range for body temperature?

*36.4o C – 37.3o C*

Why was Stuart breathing heavier than usual and more aware of his own heart beat?

*The hypothalamus responds to a fall in body temperature by effector mechanisms such as vasoconstriction of peripheral blood vessels, increased muscle tone, shivering and release of catecholamines to try and increase the body temperature. Behavioural adaptations also usually occur which include putting on warm clothes tend to occur when we shiver. However shivering whilst running is not reliable as it is hard to shiver and run, so Stuart would not be aware that he was losing heat and this has resulted in a significant lowering of his body temperature and he has only started to shiver when he has stopped running.*

*In order to try and warm the body the body uses rhythmic involuntary contractions of the muscles in the form of shivering to generate heat. During activity energy needs to be made by breaking down glucose this creates heat, which should increase the body temperature. The activity increases the demand for oxygen for cellular respiration, which results in the heart and breathing rates increasing.*

A few minutes later his partner finds him in the bedroom still in his wet running clothes. Stuart has stop shivering but his partner is concerned that he seems to be confused and looks pale and clammy. She thinks he may be ill and checks his pulse to find it is 50 beats per minute.

She decides to call an ambulance and get Stuart out of his wet clothes.

What are the possible reasons for Stuart’s lower pulse rate?

*As the temperature drops the body decides that it is fighting a losing battle in trying to raise the temperature of the whole body and concentrates its efforts purely on survival. As the body cools further, shivering will stop and blood is drawn into the core and the vital organs, shutting down the peripheral circulation making Stuart appear pale. This causes the heart rate and breathing to slow down as the demand for muscle movement has reduced due to the shivering having stopped.*

What are the consequences of having a slow pulse rate?

*Blood will not be pumped around the body so less oxygen will get to the cells and without sufficient oxygen the cells cannot metabolise glucose so energy levels drop further and the body temperature will continue to fall. As the blood cools it becomes more viscous this means it takes more effort to pump round and is less able to carry oxygen. As his circulation slows this will reduce the amount of oxygen to the brain and eventually he will lose consciousness.*

Why is Stuart likely to have a slow pulse rate along with the other symptoms?

*This is because his body temperature is continuing to fall.*

A paramedic arrives and takes Stuarts temperature using a tympanic thermometer, getting a recording of 33.5 C . He wraps in a silver space blanket and asks Stuarts partner to get Stuart a drink of warm but not hot milk whilst they are waiting for the ambulance to arrive.

Why did the paramedic use a tympanic thermometer?

*This will give a more accurate reading than an axilla recording which is likely to be 0.5oc lower than the core body temperature*

What does a reading of 33.5C show?

*This shows that Stuart is suffering from mild hypothermia but is close to becoming moderately hypothermic.*

Why did he wrap him in a silver space blanket and asks for a warm but not hot drink for Stuart?

*The silver blanket will stop further heat loss and therefore warm milk will help to replace lost energy as milk is high in natural sugars and will provide Stuart with easily broken down food for energy production. The warm milk will also gently increase the body temperature from the inside out without drawing blood away from the essential organs.*

What would have happened physiologically if the symptoms of hypothermia had not been spotted and Stuart had been left in his wet clothes?

*Heat is lost by conduction due to direct contact with cooler and wet clothes, as the body temperature continues to fall Stuart would become incoherent and may be irrational due to the poor oxygen supply to the brain. His skin will become pale and clammy as the peripheral circulation slows down.   
  
Below 32C, he is likely to begin to lose consciousness and his heart beat can become irregular. The body no longer has the energy to make the muscles work to generate heat so stops trying and releases the blood it has managed to keep warm into the full circulatory system, this may result in the person trying to remove clothing as they suddenly feel warm again despite their core body temperature. At 28C a cardiac arrest is almost a certainty, as the heart muscle will not have the energy supply in the terms of glucose and oxygen to function.*