

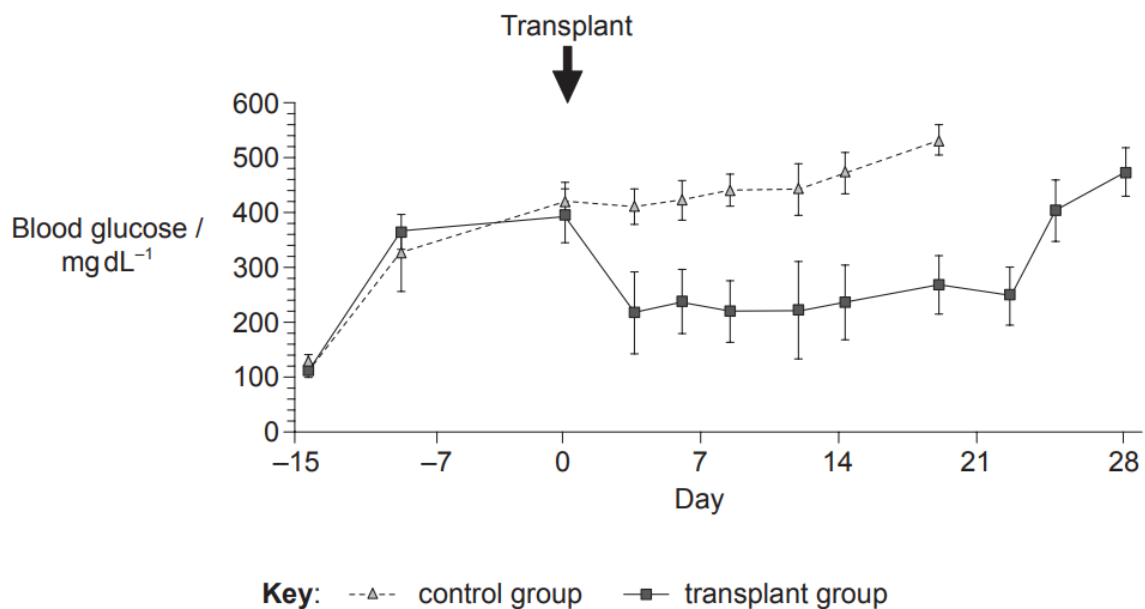
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0/65p

1.

Type I diabetes is a leading cause of death in advanced countries and is associated with various severe or fatal complications, including blindness, kidney failure, heart disease, stroke, neuropathy, and amputations. Embryonic stem cells are considered to be a powerful tool in the treatment of diabetes.

In a study, embryonic stem cells were grown in culture and tested for insulin mRNA. A drug was injected into two groups of healthy mice in order to simulate type I diabetes 15 days prior to the transplant of embryonic stem cells. The mice in the transplant group received embryonic stem cells that produce insulin mRNA. The control group did not receive the transplant. The graph shows the blood glucose concentration in both groups.



- a) State the highest mean concentration of blood glucose in the mice with transplants. In mg dL⁻¹

Answer:

450 mg dL⁻¹

Correct answer.

?/1p

- b) Outline the cause of type I diabetes in humans.

Answer:

Type I diabetes is developed at an early age where your body doesn't have the capacity of producing insulin at all.

Correct answer.

?/1p

- c) Describe the reason for testing for insulin mRNA in the embryonic stem cell cultures.

Answer:

This was done with the purpose of trying to differentiate the embryonic stem cells into insulin cells.

Correct answer.

?/1p

- d) Compare and contrast the concentration of blood glucose resulting from the embryonic stem cell transplant with the control.

Answer:

After the transplant, transplant group decreased its levels of blood glucose from week 1 to week 3, approximately, and after week 3 blood glucose levels increased. In the control group, blood glucose concentration was always increasing from -15 to 21 days. Both the control and the transplant group showed a high increase after 20 days.

Correct answer.

?/2p

- e) Evaluate the effectiveness of the embryonic stem cell treatment in controlling blood glucose.

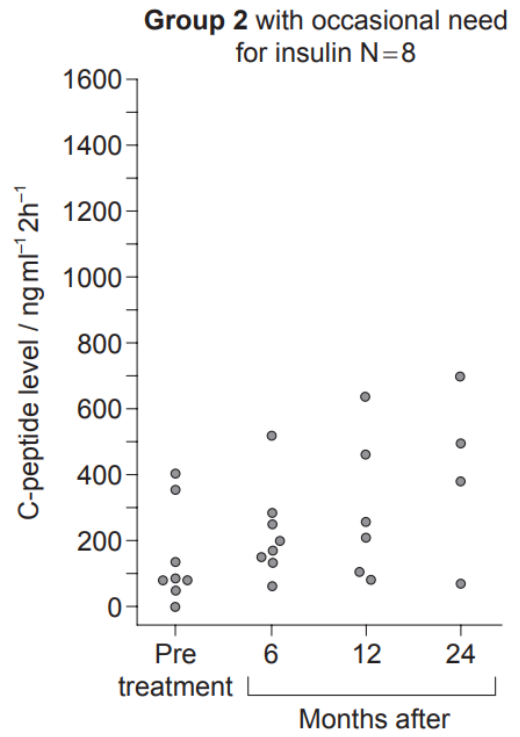
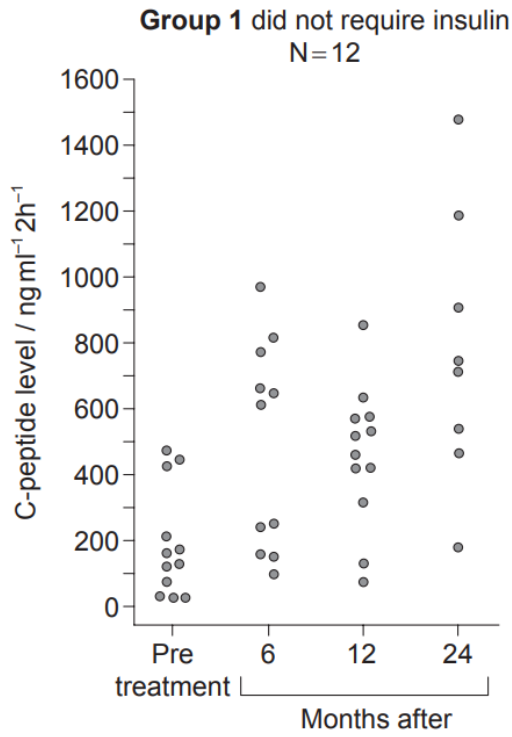
Answer:

Transplanting embryonic stem cells results in the decrease of the concentration of blood glucose. Meaning that a therapeutic use for stem cells is the control of blood glucose levels.

Correct answer.

?/2p

In a second study, a group of patients recently diagnosed with type I diabetes received a transplant of stem cells. Based on their need for insulin after the transplant, participants were divided into two groups. Their C-peptide production levels were measured for 24 months as the levels indicate the degree of pancreatic beta-cell function. Group 1 did not require insulin and group 2 required insulin occasionally during the study. The graphs show the levels of C-peptides in each individual of both groups 1 and 2.



f) State the highest rate of production of C-peptides after 24 months in group 2. In $\text{ng ml}^{-1} 2\text{h}^{-1}$

Answer:

$700 \text{ ng ml}^{-1} 2\text{h}^{-1}$

Correct answer.

?/1p

g) Insulin is produced by cutting C-peptide from the precursor molecule proinsulin. Suggest why group 1 has a greater level of C-peptide than group 2.

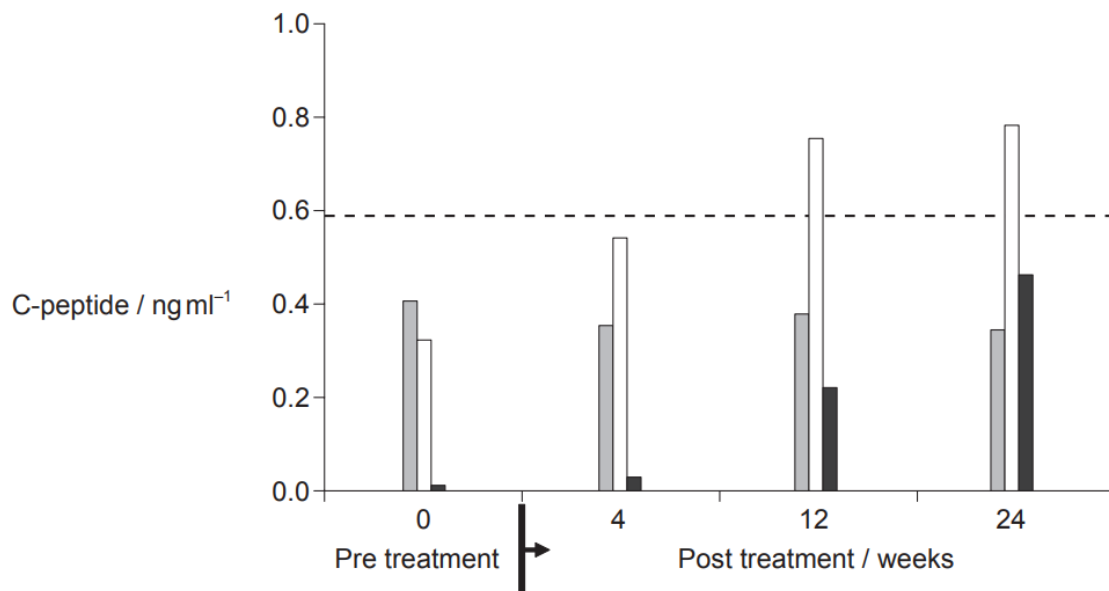
Answer:

Because patients in grupo 1 did not require insulin, they needed to produce more levels of insulin to compensate by cutting C-peptide, hence a greater presence of C-peptide.

Correct answer.

?/2p

A few years later, a third study used a treatment with umbilical cord stem cells on patients who had suffered from moderate or severe type I diabetes for an average of 8 years. They were divided into two groups: group 1 had moderate diabetes and group 2 had severe diabetes. The patients' blood was circulated outside the body and exposed to umbilical cord stem cells before returning to the patients' circulation. The control group had moderate diabetes and received the same treatment but without umbilical cord stem cells.



Key: ■ control group moderate, no exposure □ group 1 moderate, exposure to stem cells
 - - - - lower limit for normal C-peptide ■ group 2 severe, exposure to stem cells

- h) Compare and contrast the results of the treatment on group 1 with the results of the treatment on group 2.

Answer:

Group 1 increased C-peptide levels in the first 4 weeks. Between week 4 and week 12, it increased 0.2 ng ml⁻¹ more, and between 12 and 24 weeks it remained the same but surpassed the lower limit for normal C-peptide, being at 0.7 ng ml⁻¹. Group 2 was in very low levels of C-peptide during week 4 and began increasing more in week twelve, with a 0.2 ng ml⁻¹ increase, and continued to grow on week 24 at a 0.5 ng ml⁻¹ level. Both groups 1 and 2 increases as the weeks post treatment progressed.

Correct answer.

?/3p

- i) Suggest an ethical advantage of using this type of therapy over embryonic stem cell therapy.

Answer:

Cord blood stem cells are extracted from an adult's preserved umbilical cord. The extractment of such cells from this source cause no physical harm to a person. Whereas for embryonic stem cell extraction, the extermination of the embryo is required, killing a potential human being.

Correct answer.

?/1p

- j) Using the data from all three studies, evaluate the use of embryonic stem cells as a treatment for type I diabetes.

Answer:

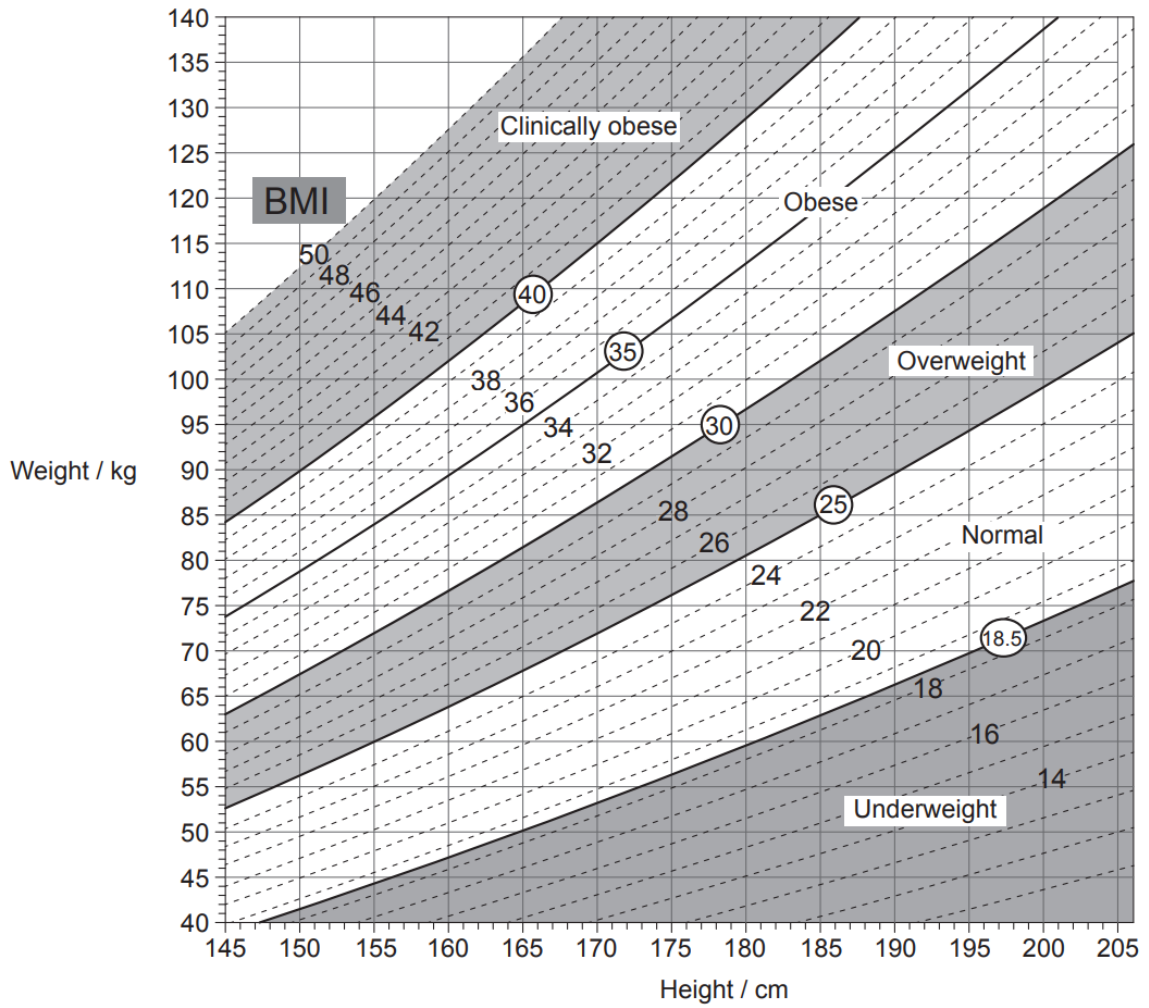
Transplanting embryonic stem cells that produce mRNA insulin results in the control of blood glucose concentrations, meaning that the presence of these cells decrease the blood glucose concentration si it can be moderated. After a stem cell transplant, patients that didn't require insulin anymore had very high levels of C-peptide production which contributes to the pancreatic beta-cell function. Post treatment results from ubillical stem cells increases C-peptide levels as well, however, for moderate diabetes, these C-peptide levels surpass the limit of a normal C-peptide level, which can cause irregularities. However, there is always the ethics on the issue present. Where an embryo has to be killed in order to successfully retrieve these stem cells.

Correct answer.

?/4p

2.

2. The image shows a nomogram.



- a) (i) Using the nomogram, state the lower weight limit for a woman with the height of 155 cm who is classified as overweight, giving the units. Lower weight limit:

Answer:

100 kg

Correct answer.

?/1p

- b) (ii) State a major health problem of the circulatory system that is correlated with obesity.

Answer:

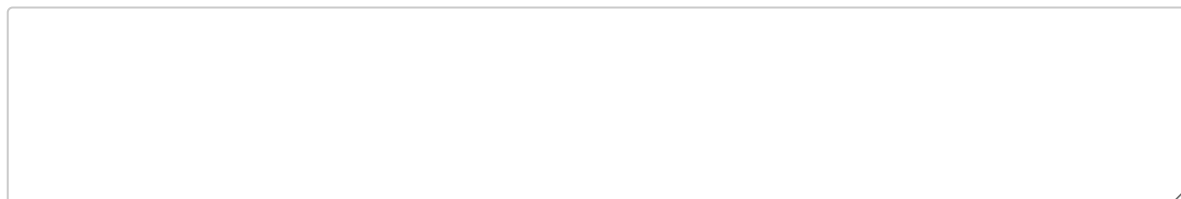
Atherosclerosis consists of plaque formations caused because of an unhealthy diet, normally from obese people. If atherosclerosis occurs in the coronary arteries, it might result in a myocardial infarction.

Correct answer.

?/1p

- c) Draw the structure of a saturated fatty acid. [Upload a photo of your drawing made on paper.]

Answer:



No student answer.

Correct answer.

?/2p

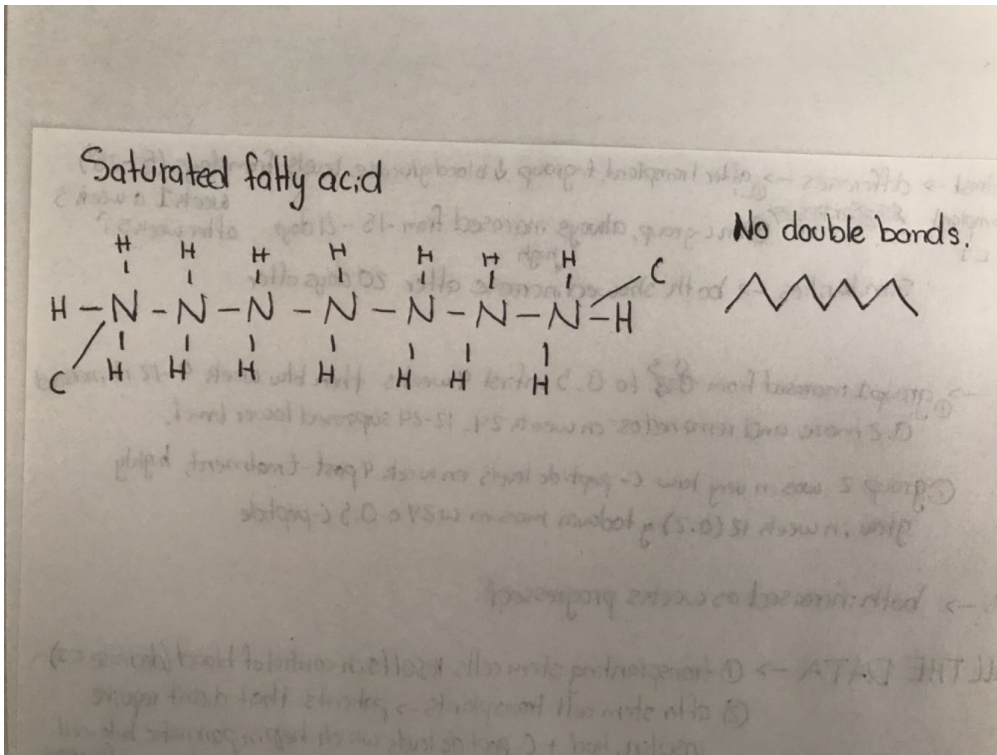
- d) Describe how the hormone leptin helps to prevent obesity.

Answer:

Leptin is secreted by adipose cells which are fat storage cells. These secretions causes the hypothalamus in the brain to inhibit appetite and therefore food intake. Hence, prevents obesity.

Correct answer.

?/3p



3.

The image shows a transverse section of an intestinal wall at 100× magnification.



[Source: Ed Reschke/Getty Images]

- a) Identify the tissues labelled I and II on the image.

Answer:

I: Serosa
II: Circular and longitudinal muscles (smooth muscles)

Correct answer.

?/2p

- b) All motor neurons use acetylcholine to activate skeletal muscle. Explain the effect of neonicotinoid pesticides in insect synapses in the central nervous system.

Answer:

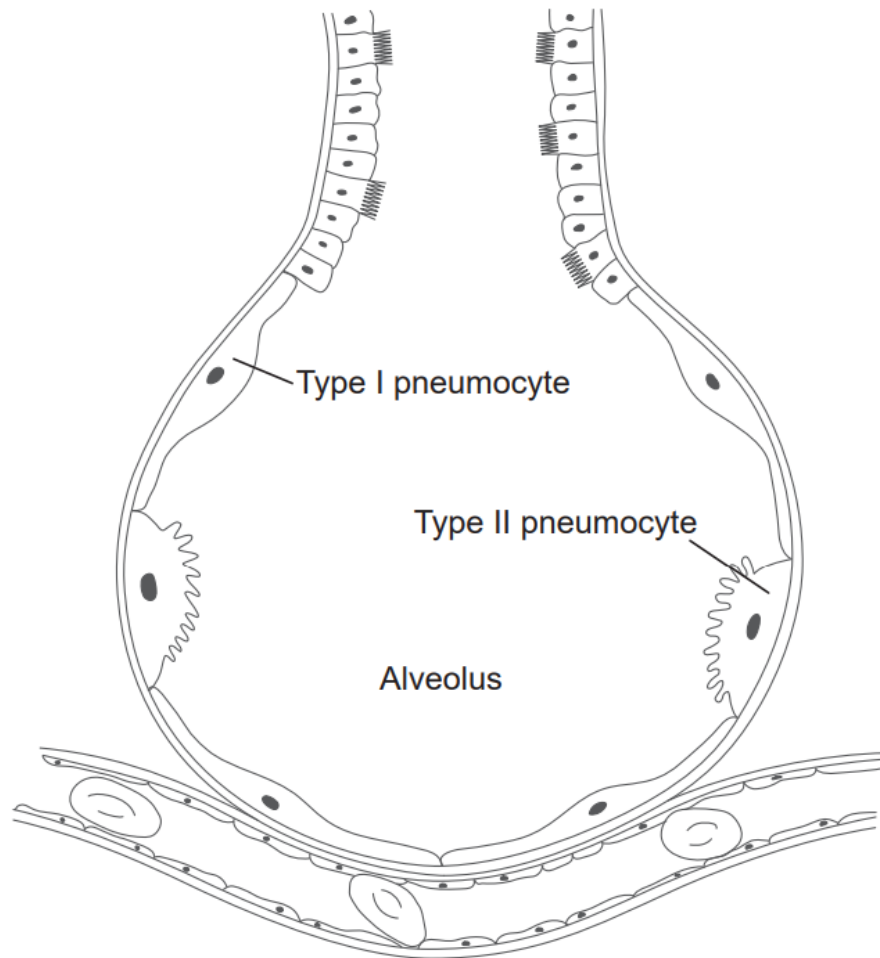
Neonicotinoid pesticides causes acetylcholine in insects to stop diffusing from a pre synaptic neuron to a post synaptic neuron. The prevention of this causes an accumulation of acetylcholine in the synapse, where transmissions are also blocked. Excess of acetylcholine in the neurons will cause an eventual paralysis and death from insects.

Correct answer.

?/3p

4.

The diagram shows the structure of an alveolus and an adjacent capillary.



[Source: © International Baccalaureate Organization 2019]

- a) Outline the functions of type I and type II pneumocytes.

Answer:

type I pneumocytes: the cells in charge of diffusing molecules in and out, they are very thin.
type II pneumocytes: responsible for secreting surfactant which makes alveoli moist and prevents them from sticking to each other.

Correct answer.

?/2p

- b) Explain how gases are exchanged between the air in the alveolus and the blood in the capillaries.□

Answer:

Oxygen enters the lungs through inspiration eventually reaching the alveoli, located in the bronchioles. Alveoli are stuck with a capillary network that brings in deoxygenated blood from the pulmonary artery. The capillary passes next to the alveolus where the diffusion of oxygen from the alveoli to the blood occurs and the diffusion of carbon dioxide from the capillary network also occurs. Carbon dioxide leaves the body through expiration and oxygenated blood travels back to the heart and then to the rest of the body.

Correct answer.

?/3p

5.

(a) Outline the stages in the production of mRNA by transcription. [4]

(b) Describe the functions of proteins in cell membranes. [4]

(c) Explain how natural selection can lead to speciation. [4]

Answer:

No student answer.

Correct answer.

?/15p

6.

(a) Describe how detritivores obtain nutrition and the effects they have in ecosystems. [4]

(b) Outline the role of amylase in digestion in humans. [4]

(c) Explain how plants capture and use light in photosynthesis. [7]

Answer:

(a) Detritivores are known as decomposers. They feed from detritus (waste) through internal digestion which is the ingestion and digestion of such matter. The waste that detritivores produce is later on used by other organisms, contributing to the nutrient cycle. Detritivores have an effect on the ecosystem in the sense that they are the ones in charge of removing waste that is produced by other organisms and also provide autotrophs with necessary nutrients from the waste they produce.

(b) Amylase is an enzyme produced by the human pancreas that is secreted to break down food, more specifically, starch. Amylase breaks down starch through a catabolic reaction, resulting in the product of maltose, a monosaccharide that can later on be absorbed.

(c) Plants use photosynthesis because it's a process that helps them synthesize organic compounds for feeding methods. Sunlight is a contributor to this process in the sense that photons from the sun enter the plant to split water molecules, this process is known as photolysis. When photons split these molecules, oxygen is released as a waste product which is a necessary molecule for other organisms to survive. Another molecule that photolysis produces consists of hydrogen ions that later on contribute to the synthesis of carbon compounds. Plants capture light in a way that they absorb it. A pigment found in a plant's chloroplast, known as chlorophyll, is the one responsible for absorbing some wavelengths of light and reflecting others. In this case, chlorophyll absorbs a wide range of wavelengths from UV light to infrared but absorb green pigments, which explains why a plant's color is green. However, a limiting factor in the rate of photosynthesis is light intensity. If it's dark or a plant is not exposed to light (in a shadow), the rate of photosynthesis will decrease and the process won't be as quick as it can be.

Correct answer.

?/15p