Name: .....

The Leys School
Cambridge

Specimen

Sixth Form Scholarship Examination

B I O L O G Y

Time allowed: 60 minutes

Instructions

- Write your name in the box at the top of this page
- Answer as many questions as possible in the spaces provided
- The mark allocations are shown at the end of each question in brackets
- The use of a dictionary is not allowed

1. Read the following:

"Teasing out tissue from a bag of blood (*extract from* New Scientist 24 June 2006)

It would be the ultimate in tissue therapy. Simply supply a bag of your own blood and come back two weeks later to find it turned into cells from other tissues, ranging from brain and liver cells to the insulin-producing beta islet cells of the pancreas.

The idea is to revert a patient's blood cells to the stem cell stage and then chemically nudge them to re-specialise into particular tissue types that can be implanted to heal damaged tissue. A huge advantage over using donated tissue is that the transplant would be "autologous" - made of the patient's own cells, thus avoiding immune rejection.

"It's autologous, we don't need to worry about rejection of tissue, and immunosuppression", says Glenn Winnier of Pharmofrontiers, a company in Woodland, Texas. It now claims to have refined a way to produce stem cells from white blood cells called monocytes and develop them into many different tissue types including, crucially, insulin-producing cells.

The company says it can de-differentiate monocytes into "multipotent" stem cells by exposing them to certain nutrients and growth factors. Such stem cells can give rise to many but not all tissue types like "pluripotent" embryonic stem cells. Different combinations of growth factors can then turn the stem cells into a range of cell types.

Chris Major of University College London says most stem cell researchers have neglected the idea of de-differentiating adult cells in favour of using embryonic stem cells. However, he warned there could be problems with using adult cells, because they have suffered years of genetic damage."

Now answer the following questions:

(a) Explain the advantage over donated tissue, of using a patient's own blood cells to create tissue that could be used to heal damaged tissue"

.....

.....

.....

.....

.....(3)

(b) Name two other blood cells, apart from monocytes

(i) .....

(ii) .....(2)

(c) For one of the blood cells you have named, describe its function in the blood.

blood cell.....

function.....(1)

(d) What are insulin-producing cells called, and where are they found?

.....

.....

.....(2)

(e) Insulin is a hormone that affects the concentration of glucose in the blood. Describe the effect of insulin on blood glucose concentration.

.....

.....(1)

(f) The company suggests that it can turn monocytes into stem cells by "by exposing them to certain nutrients and growth factors". Name a nutrient chemical, other than glucose, that the monocyte might be capable of using to assist its growth and division into stem cells.

.....(1)

(g) Chris Major of University College London warned there could be problems with using adult cells because "they have suffered years of genetic damage". What environmental factor might cause genetic damage to an adult body cell, and what would be damaged inside the cell?

.....

.....

.....(2)

2. Stomata are the pores found mainly on the surface (epidermis) of leaves. They allow the diffusion of gases such as carbon dioxide and oxygen into and out of the leaf.

The mean number of stomata on the upper and lower surface of a leaf of two different species, P and Q, was found. An experiment was also carried out to determine the rate of water loss from each leaf in one hour as each was illuminated from above by an identical light source.

The mean number of stomata and the rate of water loss for each leaf is given in the table below.

	Mean no. stomata per cm^2		Rate of water loss (arbitrary units)
	Upper surface	Lower surface	
Leaf P	1850	1920	6.8
Leaf Q	0	3740	2.3

(a) (i) Suggest how you could estimate the mean number of stomata per cm^2 of leaf.

.....

.....

.....(2)

(b) (i) Describe the relationship between the distribution of stomata on the two leaves and the comparative rates of water loss.

.....

.....(2)

(ii) During the measurement of rate of water loss, the leaves were being illuminated from above. Explain how this may have influenced the results seen.

.....

.....

.....(2)

(c) (i) Give **two** environmental factors that influence water loss from a leaf

Factor 1 .....

Factor 2 .....(2)

(ii) For **one** of the factors you have given, explain its influence on water loss from the leaf.

.....

.....

.....(2)

(d) An examination of the way in which plants P and Q grow in their natural environment shows that plant P has leaves which stand vertically (like a grass), whilst plant Q has leaves which are held out sideways.

Suggest a reason, connected with this information, for the distribution of stomata on the upper and lower surfaces of the leaves of plants P and Q

.....

.....

.....

.....

.....(2)

(e) The loss of water from the leaves of a plant is a process known as transpiration. Transpiration is sometimes described as "a necessary evil".

(i) Why is transpiration necessary for a plant?

.....

.....

.....(1)

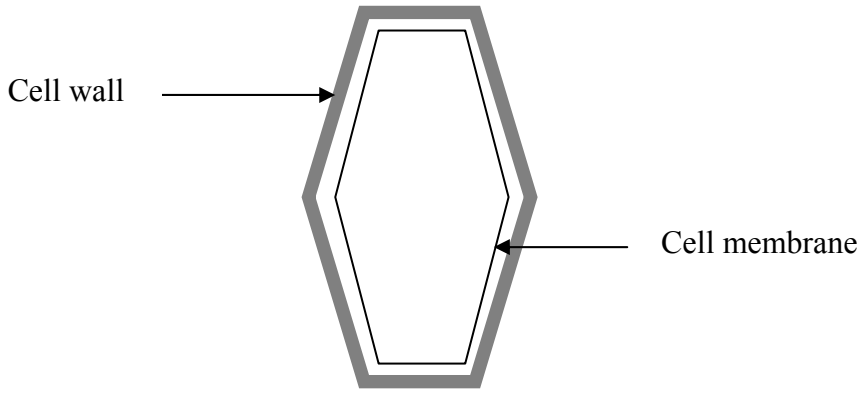
(ii) Why might transpiration be considered "an evil" for a plant?

.....

.....

.....(1)

3. This question is about osmosis in plant cells. The important structures in a plant cell, in relation to osmosis, are shown below.



(a) Define **osmosis**

.....

.....

.....(2)

(b) If the plant cell was placed in a hypertonic solution (**more** concentrated than the contents of the plant cell), describe what would occur to the cell

.....

.....

.....(2)

(c) Explain the reasons for your answer to (b)

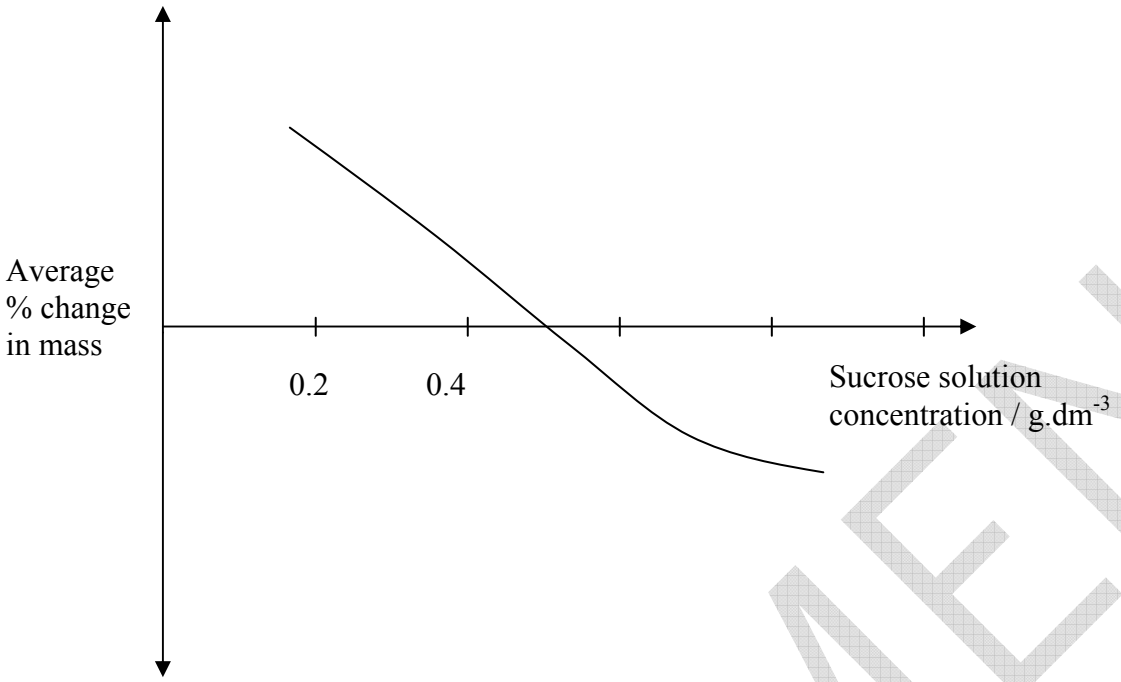
.....

.....

.....

.....(2)

(d) Potato tissue was exposed to a range of different concentrations of sucrose solution, and the average % change in mass calculated. The data was presented graphically - as shown below.



(i) At what sucrose concentration was there no change in the mass of the potato tissue?

Sucrose concentration …… $g.dm^{-3}$ (1)

(ii) Describe the effect on the potato tissue of concentrations of sucrose solution below 0.4 $g.dm^{-3}$

……

……

……(1)

(iii) Explain why this effect is seen

……

……

……

……(2)

4. Scientists carried out some investigations into the uptake of amino acids by human liver cells. In the first investigation, isolated liver cells were immersed in an aerated solution containing amino acids. After ten hours, the liver cells were removed and the concentration of amino acid in the liver cell cytoplasm was determined. The results are shown in the table.

	Concentration in solution /mmol per dm^3	Concentration in cell cytoplasm /mmol per dm^3
Amino Acid	8.2	98.4

(a) Suggest why the culture was aerated

.....

.....

.....

.....(2)

(b) The accumulation ratio is the number of times greater the concentration of amino acid is inside the cell cytoplasm, compared to that in the external solution.

Calculate the accumulation ratio for the amino acid. Show your working.

Answer …….. (2)

(c) These results suggest that the mechanism for the uptake of amino acid into liver cells is likely to be active transport? Explain why.

.....

.....

.....

.....(2)

(d) The scientists also investigated the effect of temperature on the uptake of the amino acids. The liver cells were kept in aerated solution at a range of temperatures, and the concentration of amino acids in the cell cytoplasm was measured after ten hours. The results are shown in the table below.

Temperature °C	Concentration of amino acid/ mmol per dm^3
5	35
15	42
25	70
40	95
55	52

(i) What effect does temperature have on the concentration of amino acids in cell cytoplasm?

.....

.....

.....

.....(2)

(i) Suggest an explanation for these results

.....

.....

.....

.....(2)

(e) Suggest a use for the amino acids taken up, by the liver cells.

.....

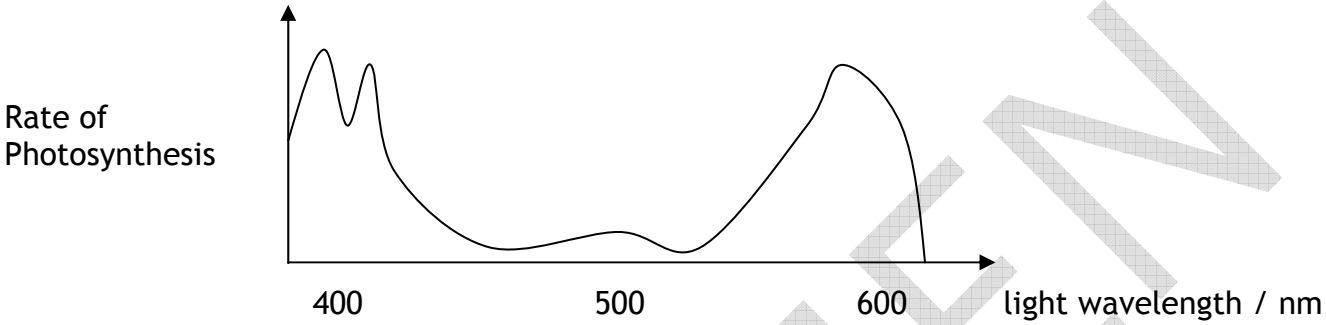
.....(1)

5. This question is about the process of photosynthesis in plants.

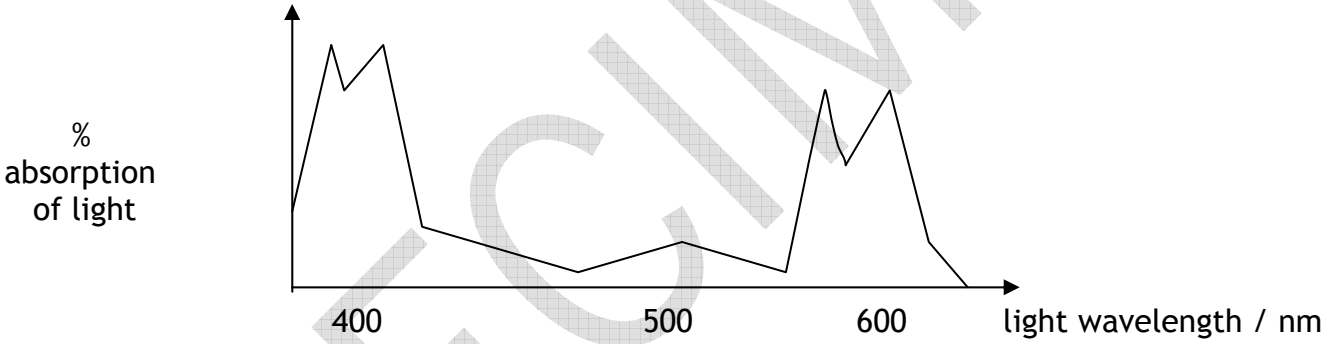
(a) Write out below the chemical equation for photosynthesis

..... (2)

(b) In the graph below, a plant's rate of photosynthesis is shown for different wavelengths of light. This is known as an **action spectrum**



Chlorophyll is the green pigment found in plant cell chloroplasts, that absorbs light energy. Its absorption spectrum is shown in the graph below.



(i) Compare chlorophyll's absorption spectrum with the plant's action spectrum.

.....

.....

.....(2)

(ii) Explain the reason for any connection you can see between the plant's action spectrum and the chlorophyll's absorption spectrum.

.....

.....

.....

.....(2)

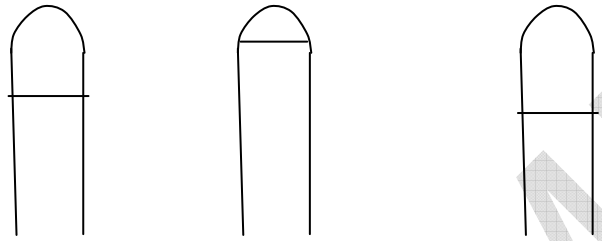
(c) A piece of Canadian pondweed is suspended in water below an inverted funnel, with an inverted test tube full of water above it. Light from a bench lamp is directed at the pondweed. Over several days, gas collects at the top of the test tube.

i) What test could you do to demonstrate the nature of the gas?

.....(1)

ii) Light filters of different colours were fitted over identical versions of this experiment, with the results shown below.

Volume of gas collected in the test tubes



Red filter Green filter Blue filter

Explain the difference seen between the amounts of gas collected in each test tube.

.....

.....

.....

.....

.....(3)

6. A student was carrying out an investigation into food substances and their energy content. A simple way to estimate the energy content of a food substance is to burn a known mass of the substance below a conical flask containing a known volume of water at a known temperature. If the rise in temperature is measured, the heat released by the food substance can be calculated, as follows:

Heat released (J) = volume water (ml) x temperature rise (^{o}C) x 4.2

She obtained the results shown below:

Food substance	Mass (g)	Water Volume (ml)	Start temp. (^{o}C)	End temp. (^{o}C)
Peanut	1.00	100	20	41
Quaver (crisp)	1.20	100	22	36
White bread	2.00	100	19	40

(a) Calculate the heat released by the sample of Quaver. Show your working.

Heat released …… J (2)

(b) By reference to the data, state which food substance she would consider to be the most "energy -rich", and explain how she would arrive at this conclusion.

……

……

……

……

……

……(3)

The student now wants to discover what types of food substance are present in the Quavers. She is aware of the following food tests:

Test Name	Substance tested for	Starting colour	Positive result colour
Iodine	Starch	Orange brown	Blue-black
Benedict's	Glucose	Blue	Deep orange
Biuret	Protein	Pale blue	Purple
Emulsion	Fats / oils	Translucent	Milky white

The student carries out this series of tests on some samples of Quaver. Her results are shown below:

Iodine Test	Benedict's Test	Biuret Test	Emulsion Test
Blue - black	Blue	Blue	Milky white

(c) What food substances does the Quaver (crisp) contain?

.....(2)

(d) On examining the peanut sample, the scientist discovered that it contained protein, starch and oils. What other two groups of food substance (apart from water) would be required in the peanut, to consider it as a source of a "balanced diet"?

.....

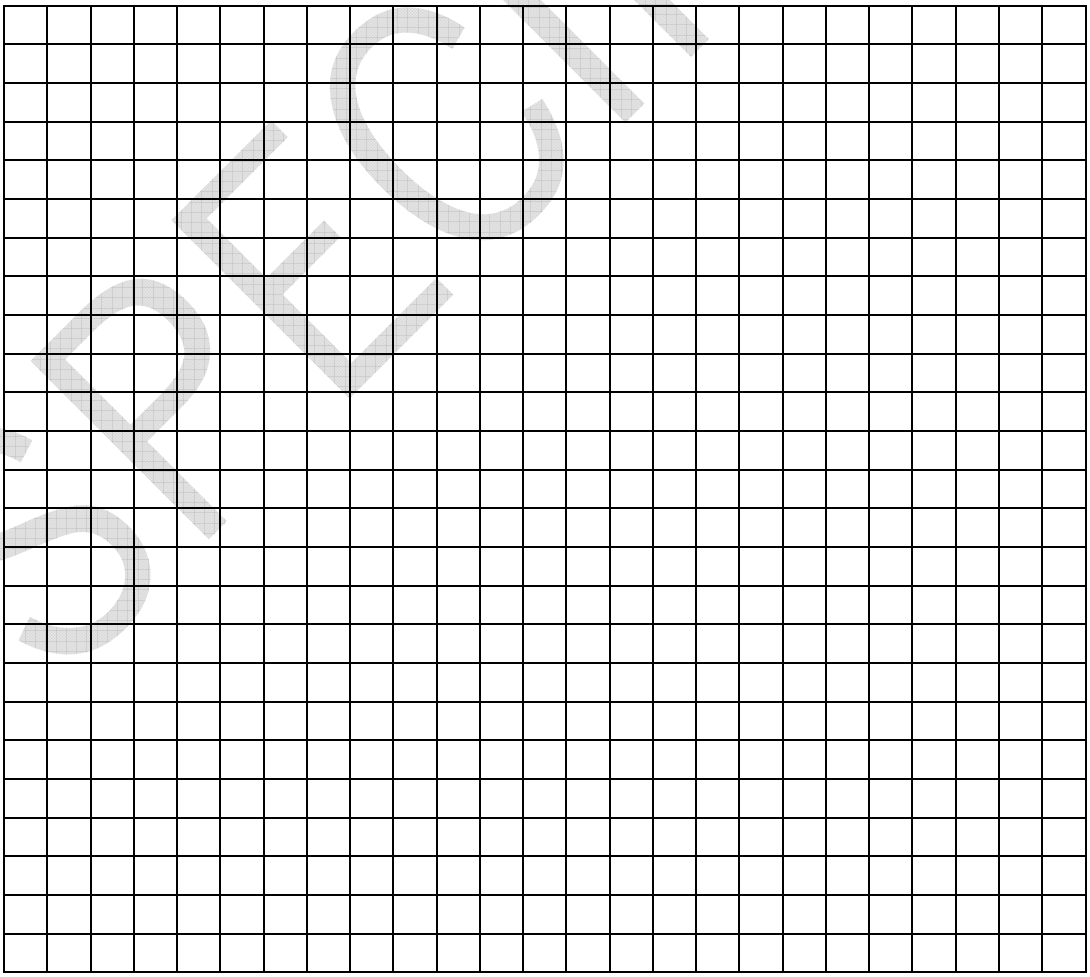
.....

.....(2)

7. Haribo sweets are made largely from the protein gelatin. A student carried out some work into the breakdown of the protein gelatin at different pH values, in order to determine how different levels of acidity in the stomach might affect the rate of digestion of such sweets. She used a protease enzyme called pepsin, which is produced naturally in the stomach of mammals. Her results were as follows:

pH	Time taken for gelatin to disappear / s
1	480
3	120
5	360
7	500
9	No gelatin breakdown

(a) Present these results appropriately on the graph paper below. (5)



(b) (i) At which pH is the rate of gelatin breakdown greatest?

.....(1)

(ii) Describe the trend in rate of gelatin breakdown between pH 3 and 9

.....

.....

.....

.....(2)

(iii) Explain the reasons for this trend being seen.

.....

.....

.....

.....(2)

(c) What would the breakdown products of the gelatin be?

.....(1)

(d) Stomach cells that make the protease enzyme pepsin do not actually release the enzyme itself, but an inactive form, which is converted to the active form by hydrochloric acid in the stomach.
(i) Suggest why this might be so.

.....

.....

.....(2)

(ii) People who do not produce much mucus from their stomach lining cells often suffer from stomach ulcers, where the lining appears to be eaten away, and damage to small blood vessels below results in bleeding. Suggest why this might be the case.

.....(1)