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Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Biology

Advanced Subsidiary

Unit 3: Practical Biology and Research Skills

Tuesday 1 November 2016 – Morning

Time: 1 hour 30 minutes

Paper Reference

WBI03/01

You must have:

Calculator, HB pencil, Ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions.

- 1 Plant cells can be grown in culture media containing auxin (IAA) to form a mass of undifferentiated cells called a callus.

A student studied the effects of two different types of auxin, A and B, on the growth of calluses. Small pieces of tissue (explants) of crested wheatgrass (*Agropyron cristatum*) were used.

The calluses were grown on agar containing an auxin, mineral salts, cytokinin and sucrose.

Working in sterile conditions, the explants were removed from one plant. These explants were placed on the agar. This procedure was carried out using agar containing different concentrations of auxin A or auxin B.

After two weeks, the dry mass of each callus was recorded.

- (a) (i) State the **two** independent variables in this investigation.

(1)

1

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- (ii) Describe how the dry mass of a callus could be determined accurately.

(3)

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(iii) Describe how the student could ensure that the culture media contained the same concentration of sucrose. (2)

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(b) The results of this study are shown in the table below.

Concentration of auxin / mg dm ⁻³	Dry mass of callus / mg	
	auxin type A	auxin type B
0	0.0	0.0
2	0.0	0.0
4	7.2	0.0
6	15.0	14.7
8	23.0	31.7

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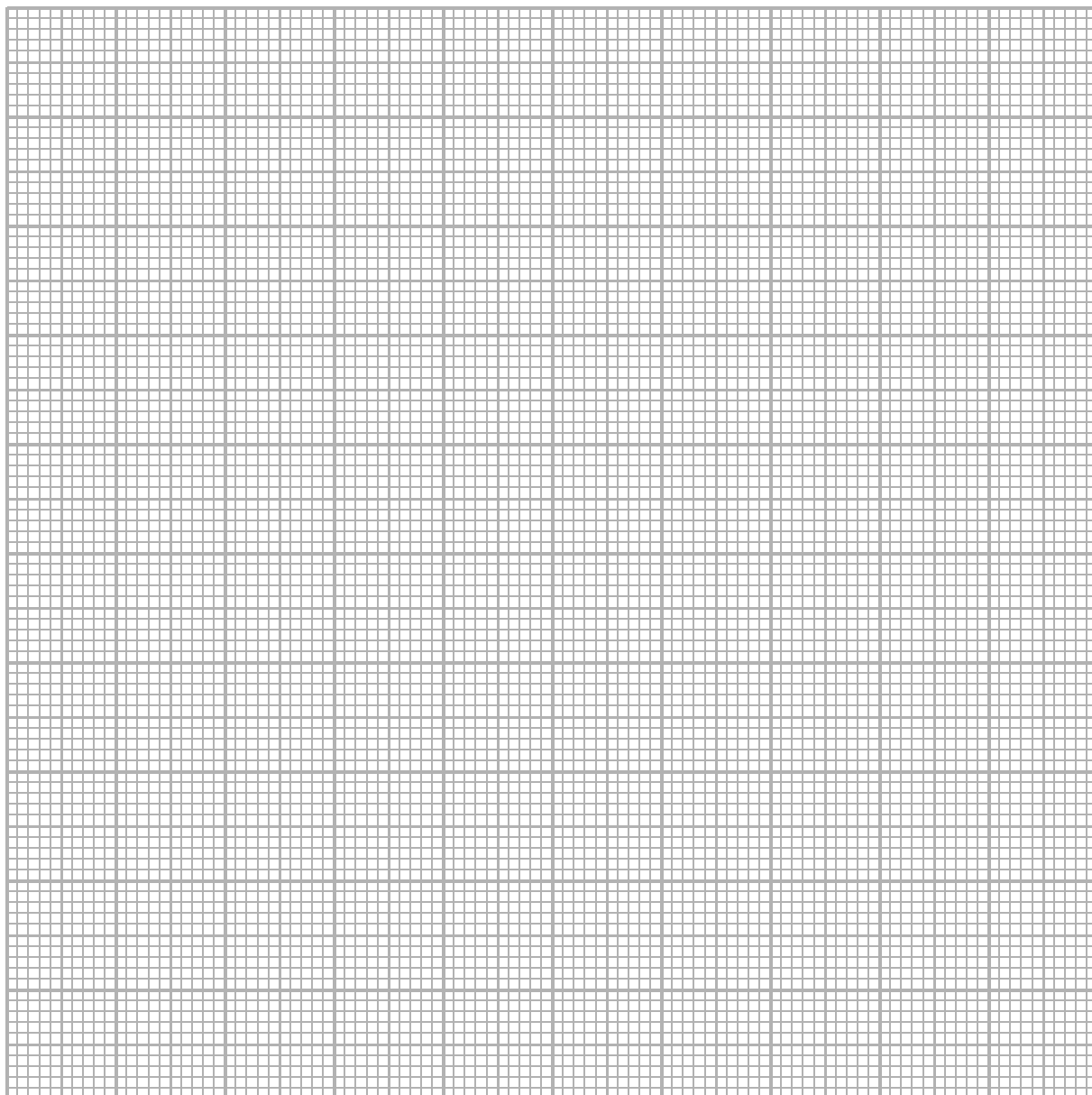
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- (i) Using a line graph, plot the data to compare the effects of the two types of auxin on callus growth. Join the points with ruled, straight lines.

(5)



(ii) Compare the effects of these two types of auxin on callus growth in this plant.

(3)

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(iii) Suggest what further information is needed in order to be more confident that any differences are significant.

(3)

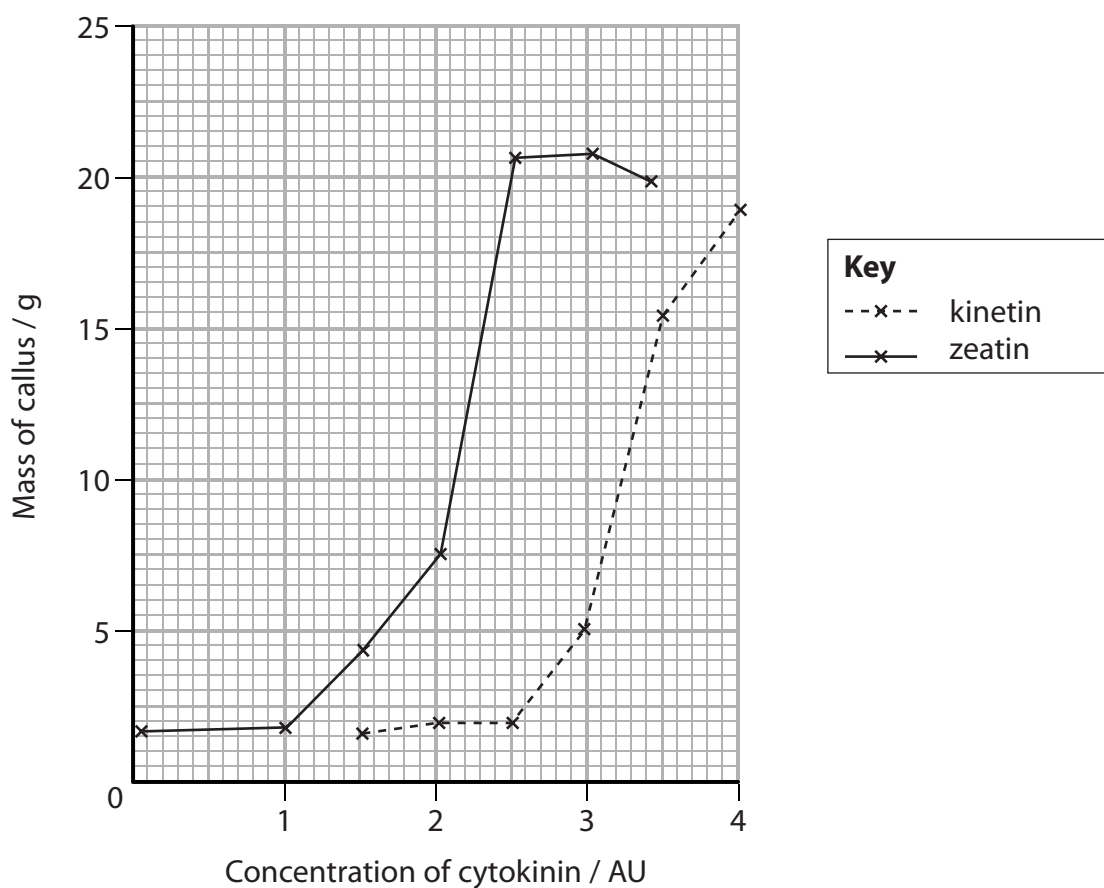


(c) Auxin and cytokinin are plant growth substances.

In a further study, two types of cytokinin, called zeatin and kinetin, were compared.

In this study, explants of crested wheatgrass were grown on media containing different concentrations of the cytokinins. The concentration of auxin in the medium was kept constant.

The results are shown in the graph below.



Using all the information in this question, describe the contents of a culture medium that could be used for the maximum growth of a callus from crested wheatgrass.

(3)

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(Total for Question 1 = 20 marks)



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P 5 0 7 0 3 A 0 9 1 6

2 Read the following extract from a student's unfinished issue report on the topic of osteoporosis.

1. Osteoporosis is a condition where the bones become thin, weak and break easily. It frequently goes undiagnosed until a fracture occurs, as there are no warning signs. The spine, wrist and hips are particularly vulnerable to fracture. Three million people in the UK suffer from osteoporosis and every year about 300 000 fractures occur because of osteoporosis. Sixty thousand of these are hip fractures, and 8% of these patients subsequently die from complications. This is three times the number of women who die annually from breast cancer. An osteoporosis sufferer cannot live a normal day-to-day life.
2. There are two types of treatment, anabolic and antiresorptive. Antiresorptive treatments include bisphosphonates, hormone replacement therapy, selective oestrogen-receptor modulators (SERMs) and calcitonin. Anabolic ones include Teriparatide, fluorides and parathyroid hormones. Teriparatide is the most common drug used to treat osteoporosis.
3. Teriparatide is an artificial form of a natural hormone, parathyroid hormone (PTH). It increases bone density and strength. The drug is very effective, widely used by patients and has few side effects compared to other drugs. Once-daily injections of Teriparatide have a net effect of stimulating new bone formation, leading to increased bone mineral density. Kidney stones are a very rare side effect.
4. Teriparatide is delivered by a daily injection. This can be very painful and scars can be made. Microchips provide a new and efficient method of delivery. Microchips are cleverly designed to cause minimum discomfort. They are very small in size, being only the size of a grain of rice. Their invention is a major breakthrough in the delivery of Teriparatide and other drugs.
5. In a small study of microchip use, eight women had a significant increase in their bone density. This was a small cohort study of a drug delivery microchip, implanted under the skin. Human parathyroid hormone (hPTH) fragment was delivered from the device. hPTH is an approved anabolic osteoporosis treatment, but requires daily injections, making effective treatment difficult for the patients. The trial was carried out on women aged 65 to 70 with osteoporosis. They were implanted with the microchip and after eight weeks, these microchips released 19 daily doses of Teriparatide. They found that the doses dispensed from the microchip produced responses that were comparable to those produced by the injection.
6. The use of Teriparatide increases bone mineral density (BMD) in men and women and reduces the risk of fractures. This means that elderly people will have healthier bones and they are more likely to be independent in terms of doing their work. As they may be independent, they would not need any extra support or care from the health service so this could save money. As long as older people are healthy, they tend to live alone rather than in care homes. In this way the government can save money. However, the implantation of microchips can fail and it is possible for microchips to get lost between the muscles. The processes of fixing these damages can cost a large sum of money. These costs will be very high when microchips are newly introduced, due to lack of experience. Even though the implantation of the microchip costs a lot, money is still saved from the treatment of fractures as the cost of hip fractures alone is £2bn a year. Microchips also reduce the cost of daily injections.



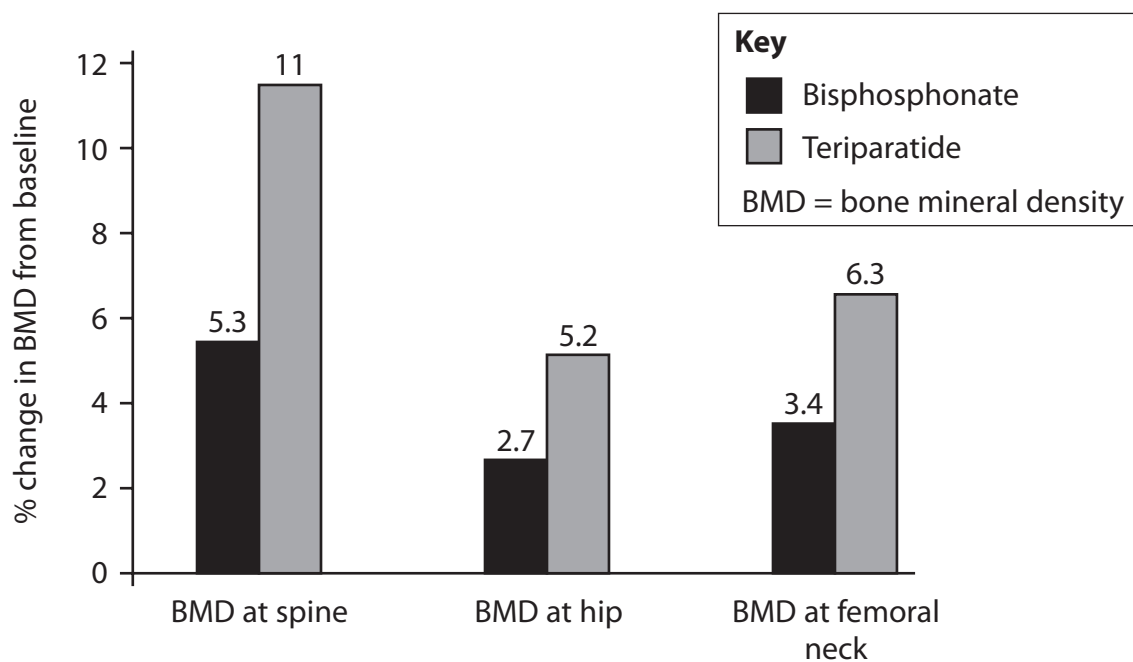
7. Many do not mind injections but they object to microchips. This is because they have been introduced very recently and there is only one study to support them. People are not fully aware of the benefits and safety measures. Many individuals feel that microchips inserted for treatment purposes could be misused for tracking and spying purposes. Moreover, many people also think that use of microchips is an unnatural interference with the body's function.
8. Bisphosphonates are also used against osteoporosis. Bisphosphonates are antiresorptive medicines, meaning that they slow or stop the natural process that dissolves bone tissue, resulting in maintained or increased bone mineral density. Bisphosphonates work by binding to hydroxyapatite crystals in the bone, inhibiting bone demineralisation.
9. Bisphosphonates have a lot of side effects and some of them are life threatening, such as oesophageal cancer. Rare side effects include skin rash, bone pain and skin inflammation, but fever and osteomalacia are more common.
10. Calcitonin is a naturally occurring hormone. It helps regulate calcium levels in the body and is involved in the process of bone building. When taken by injection or nasal spray, it slows the rate of bone thinning. It treats osteoporosis by binding to the tissue osteoclasts and inhibiting mineral resorption to the bloodstream. Calcitonin can also relieve pain in patients who have sustained a fracture. Thus some doctors give calcitonin to osteoporosis patients if pain is a problem.
11. In comparison to bisphosphonates and Teriparatide, calcitonin is the least effective in increasing bone mineral density. Therefore it is only prescribed to sufferers when they experience pain and it is less effective for postmenopausal osteoporosis compared to the other two drugs. Also, two studies found that calcitonin had no beneficial effect outside the spine, but other studies have shown improvement. Therefore many people believe that it is not very efficient. Since then, its use has been reduced and the uses of the other two drugs has become more common.
12. In conclusion, Teriparatide is better than the alternative solutions. According to the data above, it is even better when delivered by a microchip. Going back to the main question, so far technology has enabled us to discover a remarkable treatment for osteoporosis; delivery of Teriparatide using a microchip. According to the research, the benefits outweigh the risks, being even better than Teriparatide injections.



- (a) (i) The report lacks visual material to illustrate some of the points made. Sketch a visual to illustrate the numerical information given about osteoporosis in paragraph 1.

(3)

- (ii) In addition, the student found the following diagram.



State the paragraph number where this diagram should be included.

(1)

Paragraph number



(iii) Write a paragraph to summarise the information in this diagram.

(3)

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(b) Explain **two** economic implications of osteoporosis identified in this report.

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- (c) Information about the small study referred to in paragraph 5 is shown below.

First-in-Human Testing of a Wirelessly Controlled Drug Delivery Microchip
Robert Farra, Norman F. Sheppard, Laura McCabe, Robert M. Neer, James M.
Anderson, John T. Santini, Michael J. Cima and Robert Langer
Published in Science Translational Medicine February 16 2012
Sci Transl Med 22 February 2012:
Vol. 4, Issue 122, p. 122

- (i) Using the information write a full reference to this paper as it should have been presented in the report.

(3)

- (ii) Suggest why this research paper has so many authors.

(2)



(d) Complete the table below by giving **one** benefit and **one** risk of each drug. (4)

Drug	Benefit	Risk
bisphosphonates		
Teriparatide		

(Total for Question 2 = 20 marks)

TOTAL FOR PAPER = 40 MARKS

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