**Q1.**The ‘placebo effect’ describes the improvement in patients’ symptoms due to psychological effects. Scientists investigated the placebo effect in patients with asthma. They divided a large number of asthma patients into three groups, **1**, **2** and **3**.

•        Group 1 inhaled a spray containing albuterol every day. Albuterol is a drug used to treat asthma.

•        Group 2 inhaled a placebo spray every day. This was identical to the spray given to  
group 1 but it did not contain albuterol.

•        Group 3 did not receive any spray treatment.

(a)     Describe one way the scientists could have allocated the patients to each group.

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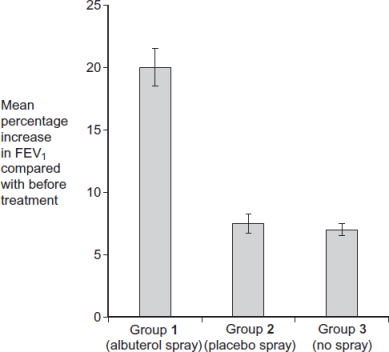
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**(2)**

The scientists measured the forced expiratory volume (FEV1 ) of each patient at regular intervals. The forced expiratory volume (FEV1 ) is the volume of air forced out of the lungs in the first second when breathing out. The scientists recorded each patient’s FEV1  before treatment started and after 60 days of treatment. They then calculated the mean increase in FEV1  for each group. Their results are shown in the graph. The bars show the standard deviation.



Patient group

(b)     What do the standard deviation bars suggest about the difference in the mean increase in FEV1  between Group **1** and the other groups? Explain your answer.

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**(2)**

(c)     What do the data suggest about the ‘placebo effect’ in this investigation? Explain your answer.

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**(2)**

(d)     On each occasion that a patient’s FEV1  was measured, a doctor repeated the measurement several times. Explain why.

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**(2)**

(e)     All the patients continued with their normal treatment for asthma. The normal treatment was the same for all patients and its effects were short-lived. The patients were told to stop this treatment 24 hours before FEV1  measurements were taken.

(i)      Suggest why all the patients were allowed to continue with their normal asthma treatment in this investigation.

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**(1)**

(ii)     Suggest why the patients were told to stop their normal asthma treatment 24 hours before their FEV1  measurements were taken.

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**(2)**

(f)     After 60 days, the patients in each group were asked to give themselves an *Improvement* Score from 0-10 to show how much they felt their symptoms had improved. This was done before their FEV1  was measured. The scientists calculated the mean *Improvement* Score for each group.

(i)      The scientists concluded that the data obtained for the Improvement Scores were less reliable than the data obtained measuring FEV1 . Suggest why they concluded this.

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**(2)**

(ii)     Group 3 reported the lowest mean *Improvement* Score. Suggest **one** explanation for this.

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**(2)**

**(Total 15 marks)**

**Q2.**          (a)     Mitosis is important in the life of an organism. Give **two** reasons why.

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**(2)**

A biologist used a microscope to investigate plant tissue where some of the cells were dividing by mitosis. She examined 200 cells and counted the number of cells in interphase and in each stage of mitosis.The table shows some of the cells she saw, and the percentage of cells in interphase and in two stages of mitosis, **A** and **B**.

|  |  |  |
| --- | --- | --- |
| **Stage of cell cycle** | | **Percentage of cells** |
| Interphase |  | 90 |
| Stage **A** |  | 3 |
| Stage **B** |  | 1 |

(b)     (i)      Explain why the biologist chose to examine 200 cells.

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**(1)**

(ii)     Name Stage **A** and Stage **B**. Give the evidence from the photograph that you used to identify the stage.

Name of Stage **A** ...................................................................................

Evidence ...............................................................................................

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Name of Stage **B** ...................................................................................

Evidence ...............................................................................................

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**(4)**

(c)     In this tissue one complete cell cycle took 20 hours.  
Using information from the table, calculate the mean time for these cells to complete mitosis. Show your working.

                                                            Answer ......................................

**(2)**

**(Total 9 marks)**

**Q3.**          Diabetes is a disorder affecting the ability to control blood glucose concentration. One type of diabetes can be due to an abnormality of the insulin receptors in the cell surface membranes of cells in the liver and muscles. A high blood glucose concentration and the presence of glucose in the urine are signs of this type of diabetes.

(a)     (i)      Suggest **one** way in which the insulin receptors might be abnormal.

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**(1)**

(ii)     Explain how the presence of abnormal insulin receptors results in a high blood glucose concentration.

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**(2)**

(iii)     Explain how the kidneys normally prevent glucose appearing in the urine of a non-diabetic person.

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**(3)**

(b)     Twin studies have been used to determine the relative effects of genetic and environmental factors on the development of this type of diabetes. The table shows the concordance (where both twins have the condition) in genetically identical and genetically non-identical twins.

|  |  |
| --- | --- |
| **Concordance in genetically identical twins / %** | **Concordance in genetically non-identical twins /%** |
| 85 | 35 |

(i)      What do the data show about the relative effects of environmental and genetic factors on the development of diabetes?

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**(1)**

(ii)     Suggest **two** factors which should be taken into account when collecting the data in order to draw valid conclusions.

1 ..........................................................................................................

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2 ..........................................................................................................

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**(2)**

**(Total 9 marks)**

**Q4.**Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

(a)     (i)      Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

1 ............................................................................................................

2 ............................................................................................................

**(2)**

(ii)     Give **two** features of the design of this investigation that would ensure the reliability ofthe results obtained.

1 ............................................................................................................

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2 ............................................................................................................

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**(2)**

(b)     The incidence for this type of brain cancer is 6 cases per 100 000 per year.  
Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

                Answer..................................................................................

**(2)**

(c)     In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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**(1)**

(d)     During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm3of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline ‘Caffeine helps cut cancer risk’. Explain why scientists could **not** support this view solely on the basis of this investigation.

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*(Extra space)* .................................................................................................

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**(4)**

(e)     Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

(i)      Describe how the control group should have been treated.

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**(2)**

(ii)     Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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**(1)**

(iii)    The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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**(1)**

**(Total 15 marks)**

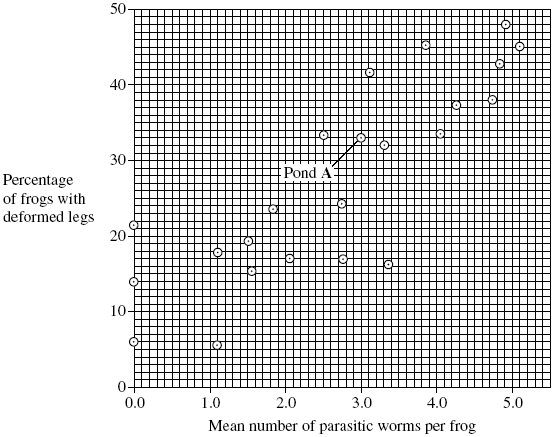
**Q5.**          (a)     In the USA, members of the public found many frogs with deformed legs. Scientists investigated this. They collected samples of the frogs. They wanted to get reliable data. Give **one** feature of the sample, other than a large sample size, that would help to make sure that their data were reliable.

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**(1)**

The team of scientists then investigated frogs in ponds. The team measured many different factors and then analysed their results. The graph shows the relationship between the percentage of frogs with deformed legs and the mean number of parasitic worms found in the frogs.



(b)     The scientists collected a sample of three frogs from pond **A**. What was the total number of parastic worms found in these three frogs?



**(1)**

(c)     One scientist suggested that the parasites caused the deformed legs found in frogs.

Does the graph support this suggestion? Explain your answer.

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**(4)**

(d)     The scientists wrote a paper. In their discussion they wrote that they found very few ponds that were free from human influence. The few that they did find were only in mountainous areas.

The scientists could not draw any reliable conclusions about whether human influence contributed to the frogs’ deformed legs. Explain why each of the following meant that they could not draw reliable conclusions.

(i)      There were very few ponds free from human influence.

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**(1)**

(ii)     The ponds free from human influence were found only in mountainous areas.

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**(2)**

In a second investigation, another research team investigated deformed legs in frogs in a different way.

•        They chose six ponds, all of which contained parasitic worms. Three of the ponds were close to fields and received agricultural run-off from these fields. The other three ponds did not receive agricultural run-off.

•        They built two cages in each of the six ponds. One cage in each pond allowed parasitic worms to enter and one cage did not.

•        They put frogs that were not infected with parasitic worms into all twelve cages.

The table shows the results of this second investigation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Percentage of frogs with deformed limbs** | | | | | |
|  | Ponds with agricultural run-off | | | Ponds with no agricultural run-off | | |
| Pond number | 1 | 2 | 3 | 4 | 5 | 6 |
| Cage with mean mesh diameter of 500 µm | 22 | 27 | 24 | 3 | 4 | 7 |
| Cage with mean mesh diameter of 75 µm | 0 | 0 | 0 | 0 | 0 | 0 |

(e)     One of the boxes in the table has been shaded. Describe the information given in the shaded box.

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**(2)**

(f)      What conclusions can you draw from the data in the table about the factors causing deformed leg in frogs? Explain your answer.

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**(4)**

**(Total 15 marks)**

**Q6.**Lettuce is classified in the same family as dandelions. Dandelions commonly grow on roadside verges and may accidentally be sprayed with salt when salt is added to the road in winter.

Describe how you could use a transect to investigate whether the distribution of dandelions changed with increased distance from the road.

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*(Extra space)* ...........................................................................................................

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**(Total 4 marks)**

**M1.**(a)     1.      Random;

*Random number generator = 2 marks*

2.      Method e.g. number generator / number out of a hat;

*Same age = 2 marks*

***OR***

3.      Matched / all the same;

4.      For e.g. age / sex;

**2 max**

(b)     1.      (Differences) are real / significant / not due to chance;

*It = the difference*

2.      (As) bars / SDs do not overlap;

*2. Accept: ‘standard errors do not overlap’ as told ‘standard deviation’ in the question stem*

**2**

(c)     1.      No / slight (placebo) effect;

2.      Group **2** and **3** results are similar / the same / SDs / bars overlap;

*2. Accept: other descriptions of Groups* ***2*** *and* ***3***

*2. Accept: that Groups* ***2*** *and* ***3*** *are not significantly different*

**2**

(d)     1.      (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised / concordant results;

*Accept: ‘outliers’ instead of anomalies*

*1. Reject: idea of not recording anomalies / preventing anomalies from occurring*

*1. Accept: ‘cancels out anomalies’ as bottom line response*

2.      (Makes) average / mean (more) reliable;

*2.* ***Q*** *Neutral: makes the average / mean more accurate*

*2. Ignore: ‘more reliable’ alone*

**2**

(e)     (i)      1.      Unethical / unfair not to treat patients;

2.      Dangerous / could cause an asthma attack;

**1 max**

(ii)     1.      Ensures normal treatment does not affect results / improvements are only due to the spray;

2.      (As) normal treatment is short-lived / effective for less than 24 hours / (24h) is long enough for normal treatment to wear off;

**2**

(f)     (i)      1.      (Improvement scores) are qualitative / subjective / rely on own judgement / different patients may assess symptoms differently;

*Accept: converse arguments for measuring FEV1 e.g. quantitative / objective patients cannot lie*

2.      Some patients may lie / exaggerate / want to please doctors;

*1. Neutral: empirical evidence*

**2**

(ii)     1.      Not blind / patients knew they were not receiving treatment / patients did not receive treatment;

2.      (So) more likely to underestimate / give lower scores / did not expect to improve / less improvement;

**2**

**[15]**

**M2.**          (a)     1.      Growth / increase in cell number;

*Ignore growth of cells*

2.      Replace cells / repair tissue / organs / body;

*Ignore repair cells*

*Reject bacteria*

3.      Genetically identical cells;

*‘Produces 2 genetically identical cells’ does not reach MP1 as well as MP3*

4.      Asexual reproduction / cloning;

*Allow example or description*

**2 max**

(b)     (i)     (Ensures) representative (sample);

*Accept find some cells in mitosis / not in interphase.  
Accept ‘more reliable’ only if linked to percentage (of cells).‘Improves reliability’ on its own does not gain this mark*

*Neutral: Large sample*

**1**

(ii)     1.      A = metaphase;

2.      Chromosome / chromatids lie on equator;

*Reject homologous chromosomes Allow centre / middle*

3.      B = anaphase;

4.      Chromatids / chromosomes separating / moving apart / moving to poles;

*Reject homologous chromosomes*

**4**

(c)     2 hours / 120 minutes;

*Allow 1 mark if working shows candidate understood that mitosis would take 10%*

**2**

**[9]**

**M3.**          (a)     (i)      different shape / different tertiary structure /   
different sequence of amino acids;

**1**

(ii)     insulin unable to attach to receptors;  
reduced / no uptake of glucose into cells / no carrier proteins /   
channels for glucose transport;

**2**

(iii)     glucose reabsorbed / absorbed into blood;  
from proximal tubule;  
by active transport / involving membrane carriers;

**3**

(b)     (i)      larger genetic component;

*(must be comparative)*

**1**

(ii)     number of cases studied;  
matched samples;  
age of twins;  
named environmental factor;;

*(allow 2 marks for 2 different factors if no overlap in effect)*

family history of diabetes;  
method of diagnosis;  
same sex in non-identical twins;

**2 max**

**[9]**

**M4.**(a)     (i)      1.      Sex;

2.      Lifestyle;

*Stress, smoking, diet etc are examples of lifestyle.*

3.      Body mass;

*3. Allow weight for mark point 3.*

4.      Health;

*Reject: height.*

5.      Ethnicity;

6.      Genetic factors / family history;

**2 max**

(ii)     1.      Large sample / number / 410 000;

*Reject: random*

2.      Long time period / 8.5 / many years;

3.      Different countries / more than one country;

**2**

(b)     Correct answer of 209 / 209.1 = 2 marks;

*Answer of 210 = one mark*

Incorrect answer but multiplies by 8.5 = 1 mark;

**2**

(c)     Age affects risk of cancer;

*Must relate to cancer not just to illness*

**1**

(d)     1.      Correlation does not mean causal relationship;

*1. Reject casual for point 1.*

*Reference to 'due to other factors' on its own is not enough for a mark*

2.      Tea / coffee contains other substances / different amounts of caffeine / estimated intake (of tea / coffee);

3.      No control group;

4.      Only one type of cancer studied / further studies required / only one investigation / study / group;

**4**

(e)     (i)      1.      Treated the same;

*2. Accept decaffeinated*

2.      No caffeine;

*2. Reject placebo.*

**2**

(ii)     1.      Absorb different amounts;

*Reject: Different body masses*

2.      Broken down by enzymes / digested;

3.      Different blood volumes;

4.      Differences in metabolism;

5.      Caffeine from a different source;

**1 max**

(iii)    1.      Less oxygen / glucose to (cancer) cells;

*'Reduces cell division' on its own should not be credited.*

2.      Less carcinogens;

3.      Reduces spread of cancer (cells);

**1 max**

**[15]**

**M5.**          (a)     Randomly collected / collected from many ponds / same species / same time of year;

*Accept other answers providing they might reasonably impact on data*

**1**

(b)     9;

**1**

(c)     Curve / line of best fit;

Shows upward slope / positive correlation / description of positive correlation;

Correlation does not necessarily mean causation;

Some other factor might be involved;

Some ponds had no worms but had frogs with deformed legs;

***Q*** *No mark awarded for “yes” or “no”*

**4 max**

(d)     (i)      Sample too small to establish a pattern / to be representative / to identify anomalies;

**1**

(ii)     Must compare like with like / must be a fair test;

*Note that fair test is acceptable if used in context defined in How Science Works glossary*

Some factors differ in mountains / named factor differs in mountains;

**2**

(e)     27% of the frogs had deformed legs in pond 2;

Agricultural run-off and cage mesh diameter of 500 µm;

**2**

(f)      Worms cause deformed legs;

Deformed legs in 500 µm mesh cages / deformed legs when worms in cage;

Run off (on its own) does not cause deformed legs;

No deformed legs with run off and 75 µm mesh / no worms;

When run off present makes effect of worms worse;

Quantitative statement e.g. increased by factor of 7 to 8 times;

**4 max**

**[15]**

**M6.**Lay tape / rope at right angle / perpendicular to road;  
Take samples at regular / stated intervals;  
Using a quadrat;  
Count numbers / percentage cover of dandelions;  
Use several transects;

**4 max**

**[4]**

**E1.**(a)     60% of students scored full marks and the first route on the mark scheme was the most popular. Students scoring one mark typically mentioned ‘random’. However, some responses conveyed a failure to read the question stem carefully enough. Consequently, they answered a different question from the one asked and produced answers such as ‘reduces bias’, ‘use a double blind trial’, ‘ensure there is the same number of patients in each group’ and ‘do not tell patients which treatment they are receiving’.

(b)     It was disappointing that 60% of students were unfamiliar with the use of standard deviation and scored zero. Only a quarter of students stated that the bars did not overlap and related this to the difference in results between Group **1** and the other groups as being significant, or not due to chance. Weaker responses that did make reference to the standard deviation bars usually went no further than to state that the bar for Group **1** was larger than that of the other groups.

(c)     Three-quarters of students were aware that there was no evidence of a placebo effect, or that this effect was slight. However, the ability to link this to data shown in the graph proved to be a good discriminator.

(d)     Two-thirds of students gained one mark for the idea that anomalies could be identified. However, some thought that repeats prevented anomalies from occurring or being recorded. It was only the best responses that referred to allowing a more reliable mean to be calculated. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘a more accurate mean’ were not credited. Weaker responses often referred to ‘the results’ being more reliable or more accurate, without further qualification.

(e)     (i)      Just over half of students gained this mark. Students who failed to score typically repeated information given in the question stem. The most typical response seen was ‘so that the normal treatment was the same for all patients’.

(ii)     Almost all students scored at least one mark. This was usually for appreciating that the normal treatment would not affect the results. Weaker responses usually relied on vague, stock *How Science Works* phrases, e.g. ‘so a comparison can be made’, ‘it would give less reliable results’ and ‘to make it a fair test’. There was also evidence that a minority of students failed to read the question carefully enough. Their responses referred to albuterol as, the normal treatment or FEV as the experimental drug.

(f)     (i)      80% of students scored at least one mark. This was usually for stating that improvement scores are subjective or qualitative. Only 10% of students went further and suggested that some patients might lie, exaggerate or want to please doctors. Again, weaker responses typically repeated information given in the question stem, e.g. ‘the improvement score is how much the patients felt their symptoms had improved so it less reliable’.

(ii)     Almost all students scored at least one mark. This was usually for the idea that patients knew they were not receiving any treatment. However, two-thirds of students were able to complete the story by linking this to patients being more likely to give lower improvement scores.

**E2.**          (a)     The role of mitosis in growth was generally well known and clearly expressed. Some responses did not give precise enough wording to distinguish between replacement or repair of individual cells, the former gaining credit but the latter not.

(b)     (i)      Inappropriate answers often related to reliability or other aspects of general experimental design. Some very good answers demonstrated practical experience of finding cells undergoing the division process, but many disappointed with references, in particular, to the identification of anomalies.

(ii)     This question was generally answered well; most incorrect responses identified **A** as prophase. Descriptions of evidence were generally good. Sometimes references were made to the spindle moving to opposite poles. Some answers referred to pairs of chromosomes, suggesting a confusion with meiosis.

(c)     While quite a high proportion of students made little or no attempt at this calculation, the majority of those that did gained at least one mark. Some students clearly spent a lot of time in very lengthy compution; they would benefit from understanding that, for a maximum of two marks, they would not be expected to have to carry out such a procedure. The main mistake was to regard stages **A+B** as being all of mitosis giving 3 + 1 as 4% of the total time, rather than taking 90% of the time in interphase, so 10% in mitosis.

**E3.**          This question also resulted in the full range of marks.

(a)     (i)      Although most candidates correctly referred to shape as being important, many of these explained their answer in terms of active sites and so could not be awarded the mark.

(ii)     There were many full and accurate answers showing a good understanding of the role of insulin. However, many answers showed considerable confusion. Many candidates stated that glucose was unable to bind to the receptors, that the release of insulin was stopped or that insulin converted glucose to glycogen with no reference to glucose uptake into cells or enzyme activation.

(iii)     This was answered well by the majority of candidates. Most realised that the glucose was reabsorbed, but some stated that the molecule was too large to pass through Bowman’s capsule. Similarly, most candidates stated correctly the site and method of reabsorption. Candidates tended to lose marks as a result of incomplete rather than incorrect answers.

(b)     This was answered well by the majority of candidates. The weaker candidates tended to repeat the data in the table rather than explaining it or did not make a comparison. Most candidates gave at least one valid factor, with many also scoring a second mark. Some failed to score because of vague references to the environment being the same, rather than giving a named environmental factor.

**E4.**(a)     (i)      Over 80% of students had little difficulty obtaining both marks in this question. Students who obtained one mark often provided two examples of lifestyles or referred to age which was excluded in the stem of the question.

(ii)     This was also well answered with over 70% of students gaining both marks. Most students referred to the large sample size and that the study took place over a long period of time. Some weaker students incorrectly answered the question in terms of additional features which may have been desirable in this investigation.

(b)     Approximately half the students obtained both marks for this calculation. 20% of students obtained a single mark for their method of calculation or provided an answer of 210 rather than 209 / 209.1.

(c)     Most students made the link between age and the risk of getting cancer. Answers which linked age to caffeine consumption were not credited.

(d)     The majority of students obtained at least two marking points often for stating that a correlation does not mean a causal relationship and for mentioning that tea /coffee contains other substances. All the other marking points were seen by examiners but surprisingly few responses included a reference to the lack of a control group in this investigation.

(e)     (i)      The vast majority of students gained at least one mark by stating that the control group would be treated in exactly the same way as the experimental group. Over 50% of these students gained a second mark by mentioning that the control group should not have caffeine. Answers which were limited to using a placebo without mentioning lack of caffeine were not credited.

(ii)      Almost two thirds of students gained this mark often by referring to different rates of absorption, different sources of caffeine or to people having different blood volumes.

(iii)     Slightly less than half the students obtained this mark usually by referring to a lack of oxygen supplied to the cancer cells or to the spread of cancer cells being reduced.

**E5.**          (a)     Most candidates gained credit for their answers to this part of the question.

(b)     There were many incorrect responses to this straightforward calculation. The answers to this part, and to others within this question, suggested a very limited understanding of the concept of percentages.

(c)     Most candidates correctly recognised the positive correlation between the percentage of frogs with deformed legs and the mean number of parasitic worms per frog but some, despite the length of their answers, were unable to progress beyond this point. Many, however, pointed out that correlation does not necessarily mean causation and supported their answers with references to the involvement of other factors, or to the fact that there were frogs with deformed legs in ponds where there were no parasitic worms.

(d)     Most responses to part (i) recognised that very few ponds meant that the sample was small but then went no further than to rewrite the question and explain that this meant that the scientists involved could not draw reliable conclusions. Answers to part (ii) were generally better, and most were able to suggest that there would be factors that might apply specifically to mountainous areas. Only the better candidates pointed out the need to compare like with like before valid conclusions could be drawn. Among less able candidates there was concern about the risk to biologists working in mountainous regions and much philosophical discussion over whether a pond that was studied by a biologist could be said to be free of human influence.

(e)     One of the purposes of this question was to help candidates to understand the complex table. Very few were able to describe the information in the shaded box in terms of the column and row headings. There were two particularly disconcerting approaches. Many candidates saw the figure as representing an anomaly, even going as far as to suggest that the scientists shaded the box to show that the figure was anomalous. Many of the candidates who approached the question in the right way failed to note that this figure was a percentage and referred to 27 frogs having deformed limbs.

(f)      This question was targeted at the more able candidates and, in view of this, it was extremely encouraging to note that many of those whose ability was more limited were able to make a number of pertinent observations for which they gained credit. The weakest candidates, however, made little progress, usually because they failed to note that this was a properly designed investigation. They resorted to a stock answer that would have been more appropriate in answering part (c). There was, however, widespread recognition that the parasites caused deformities and most candidates were able to support this with appropriate evidence. Better candidates also recognised the role of run-off in increasing this problem. Candidates were awarded credit for supporting their statements with calculations based on the data provided. It was disturbing to note the number who treated percentages in a totally inappropriate way, totalling the figures or calculating means.

**E6.**More sophisticated answers were required to gain credit here. Those students who wrote ‘food source’ rarely went on to state ‘food source for the plant-eating fish’. Similarly, those who wrote ‘shelter’ rarely went on to describe why this would be important for reducing stress or avoiding predators. Some gave acceptable alternative answers relating to plants providing a place for fish to lay eggs.