**Q1.**A scientist used grasshoppers to investigate the effect of composition of air on breathing rate in insects. He changed the composition of air they breathed in by varying the concentrations of oxygen and carbon dioxide.

The scientist collected 20 mature grasshoppers from a meadow. He placed the grasshoppers in a small chamber where he could adjust and control the composition of air surrounding them. The small chamber restricted the movement of the grasshoppers.

His results for three of the grasshoppers are shown in the table below in the form in which he presented them.

|  |  |  |  |
| --- | --- | --- | --- |
|   |   |   | **Percentage of oxygen and carbon dioxide in different types of air breathed in by grasshoppers** |
|   |   |   | **AAir fromatmosphere** | **BPureoxygen** | **CGasmixture 1** | **DGasmixture 2** |
|   | **Gas** | **Oxygen** | 20.9 | 100.0 | 91.0 | 84.0 |
|   | **Carbondioxide** | 0.1 | 0.0 | 9.0 | 16.0 |
|   |   |
|   | **Breathing rate of grasshopper in different types of air /breaths per minute** | **Grasshopper1** | 53 | 11 | 99 | 107 |
|   | **Grasshopper2** | 48 | 25 | 88 | 99 |
|   | **Grasshopper3** | 61 | 13 | 96 | 93 |

(a)     The percentages of oxygen and carbon dioxide in Column **A** do **not** add up to 100% but in columns **C** and **D** they do.

Suggest **two** reasons for this difference.

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

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

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**(2)**

(b)     Use all the data to describe the effect of concentration of carbon dioxide on the breathing rate of grasshoppers.

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**[Extra space]** ................................................................................................

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**(3)**

(c)     One of the different types of air was similar to the air in the meadow where the grasshoppers were collected. It provides data that might be used to calculate a mean breathing rate for grasshoppers in the meadow.

(i)      Use the data to estimate the mean breathing rate of the three grasshoppers in the meadow. Show your working.

Mean breathing rate = ............................................. breaths per minute

**(2)**

(ii)     The estimate does not provide a reliable value for the mean breathing rate of all insect species in the meadow.

Other than being an estimate, suggest and explain **three** reasons why this value would **not** be reliable.

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

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**(3)**

**(Total 10 marks)**

**Q2.**(a)     Contrast the processes of facilitated diffusion and active transport.

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

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**(3)**

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

•        Group **A** plants had a substance that inhibited respiration added to the solution.

•        Group **B** plants did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in the figure below.

 
                  Time / minutes

(b)     Calculate the ratio of the mean **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants.

Ratio = ................................... :1

**(2)**

(c)     Explain the results shown in the figure above.

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

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**(4)**

**(Total 9 marks)**

**Q3.**(a)     When insulin binds to receptors on liver cells, it leads to the formation of glycogen from glucose. This lowers the concentration of glucose in liver cells.

Explain how the formation of glycogen in liver cells leads to a lowering of blood glucose concentration.

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**(2)**

People with type II diabetes have cells with low sensitivity to insulin. About 80% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Doctors investigated whether GBS affected sensitivity to insulin. They measured patients’ sensitivity to insulin before and after GBS. About half of the patients had type II diabetes. The other half did not but were considered at high risk of developing the condition.

The table below shows the doctors’ results. The higher the number, the greater the sensitivity to insulin.

|  |  |  |
| --- | --- | --- |
|   | **Patients** | **Mean sensitivity to insulin /arbitrary units(± SD)** |
|   | **Before gastricbypasssurgery** | **1 month aftergastric bypasssurgery** |
|   | Did not havediabetes |     0.55(± 0.32) |     1.30(± 0.88) |
|   | Had type IIdiabetes |     0.40(± 0.24) |     1.10(± 0.87) |

(b)     The doctors concluded that many of the patients who did not have type II diabetes were at high risk of developing the condition.

Use the data in the table to suggest why they reached this conclusion.

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**(2)**

(c)     The doctors also concluded that GBS cured many patients’ diabetes but that some were not helped very much.

Do these data support this conclusion? Give reasons for your answer.

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

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**(3)**

**(Total 7 marks)**

**Q4.**Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

•        leaves of plants

•        stems and roots of plants

•        non-photosynthetic soil organisms.

The table below shows the scientists’ results for these three parts of the ecosystem.

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Part ofecosystem** | **Mean rate ofcarbon dioxideproduction /cm3 m−2 s−1** | **Percentage oftotal carbon dioxideproduction measuredby the scientists** |
|   | Leaves ofplants | 0.032 | 25.0 |
|   | Stems androots of plants | 0.051 |   |
|   | Non-photosyntheticsoil organisms | 0.045 |   |

(a)     Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

**(2)**

(b)     A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student’s conclusion.

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**(2)**

(c)     What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

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**(2)**

(d)     The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

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**(2)**

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists’ results.


          Time of day

(e)     (i)      Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

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

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

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**(2)**

(ii)     Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

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**(2)**

(f)     The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i)      Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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**(2)**

(ii)     Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

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**(1)**

**(Total 15 marks)**

**Q5.**          (a)     The main stages in anaerobic respiration in yeast are shown in the diagram.



(i)      Name process **X**.

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**(1)**

(ii)     Give **one** piece of evidence from the diagram which suggests that the conversion of pyruvate to ethanol involves reduction.

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**(1)**

(iii)     Explain why converting pyruvate to ethanol is important in allowing the continued production of ATP in anaerobic respiration.

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**(2)**

(b)     Give **two** ways in which anaerobic respiration of glucose in yeast is

(i)      similar to anaerobic respiration of glucose in a muscle cell;

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

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

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**(2)**

(ii)     different from anaerobic respiration of glucose in a muscle cell.

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

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

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**(2)**

(c)     Some students investigated the effect of temperature on the rate of anaerobic respiration in yeast. The apparatus they used is shown in the diagram. The yeast suspension was mixed with glucose solution and the volume of gas collected in five minutes was recorded.



(i)      Each student repeated the experiment and the results were pooled. Explain the advantages of collecting a large number of results.

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**(2)**

(ii)     At 30 °C, one student obtained the following results.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Volume of gas collected in 5 minutes / cm3 | Result 1 | Result 2 | Result 3 |
|   | 38.3 | 27.6 | 29.4 |

Calculate the mean rate of gas production. Give your answer in cm3 s–1.

Answer ............................... cm3 s–1

**(2)**

(iii)     If aerobic respiration had been investigated rather than anaerobic respiration, how would you expect the volumes of gas collected at 30°C to differ from these results?

Explain your answer.

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**(3)**

**(Total 15 marks)**

**Q6.**Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.

The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|   | Concentration of bilesalts /% | 0 | 1 | 2 | 3 | 4 | 5 |
|   | Mean radius of triglyceride droplet / μm | 6 | 5 | 4 | 3 | 2 | 1 |

 (a)     Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

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

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**(3)**

(b)     (i)      The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

You can calculate the surface area of a droplet from the formula

A = 4*π*r2

Where  A = surface area
    r = radius
   *π* = 3.14

**(2)**

(ii)     Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

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

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**(3)**

**(Total 8 marks)**

**Q7.**Scientists tested a claim that modified citrus pectin (MCP) increased the production of antibodies by the immune system.

•        They divided a large number of mice into five groups.

•        They gave the mice in each group a different amount of MCP in their food.

•        The scientists then stimulated antibody production in the mice. They did this by injecting them with a solution containing sheep red blood cells.

The results are shown in the graph.

 

(a)     The data obtained in this investigation have been plotted on a graph. How would you join the points? Give a reason for your answer.

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**(1)**

(b)     Use the graph to describe the effect of MCP on mean antibody production.

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**(2)**

(c)     Calculate the percentage increase in antibody production from when there was no MCP in the diet to when the dose is 1.0 g per kg.

Answer ....................................................%

**(2)**

(d)     The dose of MCP given to the mice was calculated in g per kg body mass. Explain why the dose was calculated per unit mass.

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**(1)**

(e)     Explain how antibodies were produced when the mice were injected with sheep red blood cells.

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

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**(3)**

(f)      A newspaper suggested that these data show that taking MCP will give people increased resistance to disease. With reference to the data give **two** reasons why this conclusion may **not** be valid.

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

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

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**(2)**

**(Total 11 marks)**

**Q8.**          (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 |

                                                                    Images by Edmund Beecher Wilson [Public domain], via Wikimedia Commons

(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)**

**M1.**(a)     1.      Other gases / nitrogen / water vapour in atmosphere / **A**;

2.      Only oxygen and carbon dioxide in gas mixtures / **C** and **D**;

3.      Composition of / gases in **A** not controlled / composition of gas mixtures / **C** and **D** controlled.

**2 max**

(b)     1.      Breathing rate *lowest* when no carbon dioxide / in (pure) oxygen /
         B;

*Idea of ‘lowest’ must be stated.*

2.      (Generally) presence of carbon dioxide increases breathing rate / as concentration of carbon dioxide increases breathing rate increases / there is a positive correlation;

*A general point incorporating all concentrations.*

3.      Breathing rate increases when (carbon dioxide) higher than 0.1% / concentration in atmosphere / A;

*This MP requires a specific comparison to 0.1% or the atmospheric concentration.*

*Accept ‘gas mixtures 1 and 2 / C and D’ for ‘higher carbon dioxide’.*

4.      Breathing rate of **grasshopper 3** falls in D / 16% / gas mixture 2 (whereas others increase).

*Restating data alone is insufficient for any mark point.*

**3 max**

(c)     (i)      54;

***OR***

1.      Correct data / column **A** chosen;

*A correct answer of 54 gets 2 marks.*

*MP1 and MP2 allow a possible mark for an incorrect calculation or choice of wrong data.*

2.      Correct calculation of mean from data chosen;

*Check − the three values must be from same column.*

**2 max**

(ii)     1.      Small sample / only 3 (grasshoppers)

         *so* may not be representative (of all grasshoppers / insects);

2.      Grasshoppers are not the only insects / species;

         *so* genetic / behavioural / metabolic differences;

3.      (Insects) not all mature / are at different stages of development / different sizes;

         *so* different metabolic rates;

4.      Movement not restricted / not at rest in meadow;

         *so* (rate of) respiration higher;

5.      (Naturally-occurring) carbon dioxide concentration lower in meadow;

         *so* breathing rate lower;

*Explanations required, therefore both parts of answer required for credit in each marking point.*

*Accept appropriate converse answers.*

*Accept ‘respiration’ for ‘metabolism’ and vice versa.*

**3 max**

**[10]**

**M2.**(a)     1.      Facilitated diffusion involves channel or carrier proteins whereas active transport only involves carrier proteins;

2.      Facilitated diffusion does not use ATP / is passive whereas active transport uses ATP;

3.      Facilitated diffusion takes place down a concentration gradient whereas active transport can occur against a concentration gradient.

*Since ‘contrast’, both sides of the differences needed*

**3**

(b)     3.3:1.

*Correct answer = 2 marks*

*If incorrect, allow 1 mark for 470–360 / 60 for rate in second hour*

**2**

(c)     1.      Group **A** – initial uptake slower because by diffusion (only);

2.      Group **A** – levels off because same concentrations inside cells and outside cells / reached equilibrium;

3.      Group **B** – uptake faster because by diffusion plus active transport;

4.      Group **B** fails to level off because uptake against gradient / no equilibrium to be reached;

5.      Group **B** – rate slows because few / fewer chloride ions in external solution / respiratory substrate used up.

**4 max**

**[9]**

**M3.**(a)     (Formation of glycogen)

1.      Glucose concentration in cell / liver falls below that in blood (plasma) which creates / maintains glucose concentration / diffusion gradient;

2.      Glucose enters cell / leaves blood by facilitated diffusion / via carrier(protein) / channel (protein);

*Not just diffusion*

**2**

(b)     1.      Insulin sensitivity similar to / not (significantly) different from those with diabetes;

*No values for non-obese, so comparisons with ‘normal’ not possible*

2.      Overlap of SDs;

*Accept SE*

3.      Their sensitivity (to insulin also) improved by GBS;

**2 max**

(c)     1.      Sensitivity (to insulin) does increase;

*This part of the question concerns spread of data, not overlap of SDs*

2.      But large SD / large variation (after GBS);

*Accept use of figures / use of SD values to make this point.*

*Ignore ref to SE*

3.      (So) some showing no / little change / get worse;

4.      Do not know what sensitivity to insulin is of non-diabetics (who are not obese);

*Accept ‘normal’ as non-diabetic*

**3 max**

**[7]**

**M4.**(a)

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Part ofecosystem** | **Mean rate ofcarbon dioxideproduction / cm3 m−2 s−1** | **Percentage oftotal carbon dioxideproduction measuredby the scientists** |
|   | Leaves of plants | 0.032 | 25.0 |
|   | Stems and roots of plants | 0.051 | **39.8** |
|   | Non-photosyntheticsoil organisms | 0.045 | **35.2** |

2 correct = 2 marks;;

Adding rates to get 0.128 = 1;

*If rounded to 40 and 35 in table;*

*•    but working shows decimal points, then award 2 marks
•    but no working shown, then 1 max*

**2 max**

(b)     1.      Data only include (heterotrophic) soil organisms;

2.      Doesn’t include animals (above ground) / other (non-soil) organisms;

3.      Doesn’t take into account anaerobic respiration;

*Award points in any combination*

*Accept for 1 mark idea that CO2 for leaves doesn’t take into account photosynthesis – not told in dark until part (d)*

**2 max**

(c)     **All three** of following = 2 marks;;

**Two** of them = 1 mark;

Volume of carbon dioxide given off

(From known) area / per m2 / m-2

In a known / set time

*Ignore ‘amount’ / concentration of CO2*

*Accept per second / per unit time*

**2**

(d)     1.      (In the light) photosynthesis / in the dark no photosynthesis;

2.      (In light,) carbon dioxide (from respiration) being used / taken up (by photosynthesis);

**2**

(e)     (i)      (Rate of respiration)

*Assume “it” means soil under trees*

1.      In soil under trees (always) higher;

*Accept converse for soil not under trees*

*Accept ‘in the shade’ means under the trees*

2.      In soil under trees does not rise between 06.00 and 12.00 / in the middle of the day / peaks at 20:00-21.00 / in the evening;

3.      In soil **not** under trees, peaks at about 14:00-15:00 / in middle of day;

*2. and 3. No mm grid, so accept ‘between 18.00 and 24.00’ or ‘between 12.00 and 18.00’*

**2 max**

(ii)     (Between 06.00 and 12.00, (No Mark))

Respiration higher in soil under tree, (No mark)

*Do not mix and match mark points*

*No list rule*

1.      Tree roots carry out (a lot of) respiration;

2.      More / there are roots under tree;

*Accept converse for soil not under trees*

***OR***

3.      More food under trees;

4.      So more active / greater mass of / more organisms (carrying out respiration);

*Accept converse for soil not under trees*

***OR***

Soil not under trees respiration increases (No mark)

5.      Soil in sunlight gets warmer;

6.      Enzymes (of respiration) work faster;

*Accept converse for soil under trees*

**2 max**

(f)      (i)      1.      Photosynthesis produces sugars;

2.      Sugars moved to roots;

*Do not penalise named sugars other than sucrose*

3.      (Sugars) are used / required for respiration;

**2 max**

(ii)     Takes time to move sugars to roots;

*Look for movement idea in (i) – can carry forward to (ii)*

**1**

**[15]**

**M5.**          (a)     (i)      glycolysis;

**1**

(ii)     oxygen removed from pyruvate / reduced NAD is oxidised / donates hydrogen / donates electrons;

**1**

(iii)     allows NAD to be recycled / re-formed;
so that glycolysis / described / candidates answer to (i) can proceed / so that (more) glucose can be converted to pyruvate / so that process X can continue;

**2**

(b)     (i)      ATP formed / used;
pyruvate formed / reduced;
NAD / reduced NAD;
glycolysis involved / two stage process;

**2 max**

(ii)     ethanol / alcohol formed by yeast, lactate (*allow lactic acid)*by muscle cell; CO2 released by yeast but not by muscle cell;

*(note: need both parts of the comparison for the mark)*

**2**

(c)     (i)      allows anomalies to be identified / increases reliability (of means /
averages / results);
allows use of statistical test;

**2**

(ii)      = 31.8 / 31.76 / 31.77;

*(units not required)*

÷ (5 × 60) = 0.106 / 0.11 / 0.1;

*(correct answer scores two marks, however derived.)
(correct mean volume (31.8 cm3) however derived scores 1 mark)*

**2**

(iii)     Volume(s) less / no gas evolved;
So (volume) CO2 evolved = (volume of) O2 taken in;

**3**

**[15]**

**M6.**(a)     Measure with eyepiece graticule / scale;
Calibrate with stage micrometer / scale on slide / object of known size;
Repeats and calculate the mean;
***OR***Use a ruler to estimate the field diameter under microscope;
How many droplets go across the field;
Repeats and calculate mean;

*Accept references to radius*

**3**

(b)     (i)      Two mark for correct answer of 4 : 1;;
One mark for incorrect answer but working shows that candidate has clearly attempted to compare values of r2 / 62 and 32 / 36 and 9;

*Idea of comparing ratios
A ratio of 1 : 4 should gain 1 mark*

**2**

(ii)     Small droplets have a larger surface area to volume ratio;

More surface for lipase (to act), leading to faster digestion of triglycerides;

Fatty acids are produced more quickly so pH will drop more quickly in curve Y / with bile salts / less fatty acids in curve Z / without bile salts so pH drop more slowly;

**3**

**[8]**

**M7.**(a)     Straight lines point to point as not possible to predict intermediate values / values between points;

**1**

(b)     Increases then levels / falls;
Maximum antibody production 180 units / at dose of 0.25 g per kg;

**2**

(c)     Two marks for correct answer of 57.14 / 57.1;;
One mark for incorrect answer in which candidate clearly divides difference in antibody production / 60 by 105;

**2**

(d)     Takes into account different masses of mice / allows comparison;

*Accept different weights of mice.
Do not accept different size.*

**1**

(e)     Sheep red blood cells have antigens (on their surface);
Antigens are proteins foreign to mice / are non-self;
Stimulate B cells to produce antibodies;

**3**

(f)     Response only observed in mice;
Disease organisms not investigated;
Not all disease caused by pathogens / cured by antibodies;

*i.e. not tested on humans*

**2 max**

**[11]**

**M8.**          (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]**

**E1.**(a)     Most were able to suggest two correct reasons for the difference. A minority misunderstood the question and attempted to suggest biological factors which may have brought about a change in the composition of the gas mixtures.

(b)     Many students made full use of all the data and were able to clearly describe the key effects shown. Only the best answers made a specific comparison to the breathing rate at the 0.1% carbon dioxide concentration. A number repeated all the data without describing the effect of a change in carbon dioxide concentration. A minority seemed unable to make any valid analysis of the data and made only simplistic statements about the general trend.

(c)     The majority of students produced an accurate calculation of breaths per minute. Incorrect answers included working out the mean for all grasshoppers or selecting data from the wrong column.

In part (b) most students were able suggest reasons why the mean may not be reliable but failed to go on and give a suitable biological explanation for the reason given. Many answers included references to possible anomalies and lack of reliability despite this being given in the question. Very few suggested that the carbon dioxide level may be lower in the meadow

**E3.**(a)    80% of students failed to score. Most repeated the stem of the question and wrote that formation of glycogen leads to a lowering of blood glucose. Others drifted into explanations of the mode of action of insulin and the role of the pancreas. The examiners were looking for the idea that formation of glycogen lowers the concentration of glucose in liver cells below that in the blood. As a result, there is a diffusion / concentration gradient for the entry of glucose into liver cells (from the blood).

(b)     Students scored much better on this part. Most noted that the insulin sensitivity was similar in both groups of patients. Some backed this up with observations about overlap of standard deviations. Again, the examiners accepted standard errors here but it should not be assumed that this applies in all cases. About 40% of students got both marks and a similar percentage got one mark.

(c)     It was heartening in this part to see many students using knowledge of standard deviations to answer this question correctly. Nearly 40% obtained all three marks and these students all included statements about the large standard deviations of the means after surgery and how these showed that some patients’ sensitivity to insulin did not increase after surgery. In this context, the examiners ignored references to standard errors, since it was the spread of data about the mean(s) that was important.

**E4.**(a)    About three quarters of students obtained both marks for the calculation in this part. Some students only scored one mark because of incorrect rounding of numbers in their calculations or answers.

(b)     This part proved far more challenging than intended. It was hoped that students would note that only (plants and) non-photosynthetic soil organisms are mentioned in the study and point out that there are lots of other organisms / animals that are not mentioned. The examiners accepted statements that carbon dioxide from leaves did not take into account effects of photosynthesis, because students were not told until (d) that measurements were taken in the dark. Quite a few students treated the leaves of plants and the stems and roots of plants as separate organisms, rather than different parts of the same organisms. Nearly three quarters of students failed to score any marks.

(c)     To obtain two marks in this part, students had to identify three measurements: volume of carbon dioxide, from a given / known area, in a set time. If they identified two of these, they obtained one mark. A quarter of students obtained two marks and about half failed to score. There were many vague references to *amount* of carbon dioxide and *time* unqualified and many students missed out area altogether.

(d)     This part was done well by many students and three quarters obtained both marks. They were able to state that there is no photosynthesis in the dark and photosynthesis would take up carbon dioxide. Some students were confused about whether it was photosynthesis or respiration that produces carbon dioxide, or uses it.

(e)    (i)       Most students noted that respiration in soil under trees is always higher in this part. Over a third went on to describe a difference in the peak times of respiration in soil under trees and soil not under trees. Although a 2 mm grid was not given on the graph, the examiners expected some attempt to describe time frames, rather than just *earlier* or *later*.

(ii)     Correct answers to this part usually revolved around respiration in soil not under trees increasing because the soil gets warmer in sunshine and this leads to faster enzyme activity. Very few looked back to the table and noted the high rate of respiration in roots of plants, of which there would be a lot under trees. Many students thought that photosynthesis by the trees would make more oxygen available in the soil under the trees. Others thought that photosynthesis by the soil not under the trees would increase during the day.

(f)      As the final interpretive question on the final paper, this part was intended to be challenging and so it proved. Very few students appear to appreciate the relationship between photosynthesis and respiration in plants in terms of respiratory substrate. This was tested last year and proved challenging then. Students should appreciate that plants make their own respiratory substrates via photosynthesis. Those students who did score in this part did understand this. Given that many students treated leaves and roots of plants as separate organisms in (b), it was perhaps not surprising that very few students suggested it takes time for sugars to travel from leaves to roots. Some got ‘close’ by suggesting it took time for oxygen from photosynthesis to travel to the roots.

**E5.**          (a)     Many candidates scored full marks on this section. They were able to identify process **X** as glycolysis and to cite evidence from the diagram, such as the loss of oxygen from pyruvate, to support the suggestion that the conversion from pyruvate to ethanol involves reduction. In part (iii), most realised that the conversion of pyruvate to ethanol regenerates NAD, which can then be used again in glycolysis. The formula for pyruvate was quoted incorrectly in the diagram. There was no evidence from the scripts that candidates were disadvantaged by this.

(b)     Most candidates were able to suggest two similarities between anaerobic respiration in yeast and anaerobic respiration in a muscle cell, but were less well able to suggest two differences. Whilst a good number knew that a muscle cell produces lactate rather than ethanol, far fewer knew that muscle cells do not produce carbon dioxide during anaerobic respiration.

(c)     (i)      Many responses made clear that repeating the experiment and pooling results would increase reliability and minimise the impact of anomalies. However, some confused reliability with accuracy, whilst others thought that anomalous results would be eliminated altogether.

Disappointingly, very few suggested that a large data set would allow a valid statistical analysis.

(ii)     Many candidates were able to calculate the mean rate of gas production and, of those who did not get this far, most were able to at least calculate the mean volume produced.

(iii)     Many candidates did not read the question carefully enough and based their answers on the amount of carbon dioxide produced rather than on the amount of gas collected. Good candidates realised that, because the RQ of glucose is 1.0, the volume of carbon dioxide produced would be matched by an equal volume of oxygen taken in; there would, therefore, be no net change in volume, so no gas would be collected.

**E7.**(a)     Relatively few candidates appeared to be aware that points on a graph should be joined with straight lines if it is felt that the position of intermediate points cannot be predicted reliably. Given that this decision had been made by candidates in drawing their graphs in stage 2, this was somewhat surprising.

(b)     Although many candidates were able to describe how the curve rose to a maximum value at 180 units or a dose of 0.25 g per kg, a significant number missed the point plotted for a zero dose. Other candidates misread the second point as representing a dose of 0.5 g per kg.

(c)     It remains disappointing that so few candidates can calculate percentage increase or decrease. There were many incorrect answers to this question, frequently from otherwise sound candidates.

(d)     Most candidates appeared to appreciate that calculating the dose per unit mass allowed differences in mass to be considered and a comparison to be made. Many responses, however, failed to gain credit because of the vague use of terms such as “bigger mice” and “size” rather than mass.

(e)     It would appear that some candidates had been taught about the immune response in much greater detail than required by the specification. This additional detail tended to confuse rather than help the candidates and reduced their marks for this question. It was relatively uncommon to see three marks awarded for what should have been a straightforward account. Common errors made by less able candidates involved the confusion of antibody and antigen or failing to identify the antigens as being on the surface of the sheep red blood cells.

(f)     Most candidates correctly pointed out that this investigation was carried out on mice and, therefore, the results might not apply to humans but only the better candidates were able to suggest a second valid reason.

**E8.**          (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.