An investigation of the effect of temperature on respiration in yeast.

Introduction

Yeast is a single-celled fungus. It can respire aerobically and anaerobically. During aerobic respiration, the transport of electrons is linked to the synthesis of ATP. In this investigation, these electrons will be accepted by a substance called methylene blue. When methylene blue accepts electrons, it changes from blue to colourless.

In this investigation you will use the time taken for methylene blue to go colourless to measure the rate of respiration at different temperatures.

You will carry out the experiment at 35°C. You will carry out the experiment at this temperature five times in total. You may assume that this will give you sufficient data for statistical analysis in this investigation. You will be supplied with data for the investigation at 25°C.

Materials

You are provided with the following

- yeast and glucose mixture
- methylene blue
- test tubes
- test tube rack
- beaker to act as a water bath
- a way of changing the temperature of the water bath
- graduated pipettes or syringes
- marker pen
- thermometer
- timer.

You may ask your teacher for any other apparatus you require.
Method

Read these instructions carefully before you start your investigation.

1. Use the beaker to set up a water bath at 35 °C
2. Label five test tubes 1 to 5.
3. Shake the yeast and glucose mixture.
4. Add 2 cm³ of the yeast and glucose mixture to all five tubes.
5. Place all five tubes in the water bath and leave them for 5 minutes.
6. Make sure the water bath stays at 35°C.
7. After 5 minutes add 2 cm³ methylene blue to test tube 1.
8. Immediately shake this tube for 10 seconds and replace the tube in the water bath.
9. Note the time and do not shake the tube again.
10. Record how long it takes for the blue colour to disappear in the tube.
11. Record your results in a table on the Candidate Results Sheet: Stage 1.
12. Repeat steps 7 – 11 for the other four tubes.
ISA BIO6T/Q12 Candidate Results Sheet: Stage 1

An investigation of the effect of temperature on respiration in yeast

Centre Number [ ] [ ] [ ] Candidate Number [ ] [ ] [ ]

Candidate Name..................................................................................................................................

Record your data in a table in the space below.

Hand in this sheet at the end of each practical session.

There are no marks awarded for the table at A2.
An investigation of the effect of temperature on respiration in yeast

The data in the table were obtained using the same method as in your investigation but at 25°C. Analyse your data and the data in the table. Use a statistical test to compare the results at 25°C and 35°C. You may use a calculator and the AQA Students’ Statistics Sheet that has been provided. You are provided with a sheet of graph paper. You may use this if you wish.

Hand in this sheet at the end of the practical session.

<table>
<thead>
<tr>
<th>Trial number</th>
<th>Time taken for methylene blue to go colourless at 25°C/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>520</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>560</td>
</tr>
<tr>
<td>4</td>
<td>485</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>

1 State your null hypothesis.

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........................................................................................................................................................................ (1 mark)

2 (a) Give your choice of statistical test.

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2 (b) Give a reason for your choice of statistical test.

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Carry out the test and calculate the test statistic. Show your working.

(1 mark)
Interpret the test statistic in relation to your null hypothesis. Use the words *probability* and *chance* in your answer.

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(2 marks)
What sort of data will you obtain from your investigation?

Measurements
Will your investigation involve taking measurements?

Will your investigation involve looking for associations between different measurements from the same sample?

Spearman rank correlation

Frequencies
Will your investigation involve finding the number of individuals in particular categories?

Will your investigation involve looking for differences between mean values?

Standard error and 95% confidence limits

χ² test

Standard error and 95% confidence limits

Calculate standard error, $SE$, for each sample from the following formula

$$SE = \frac{SD}{\sqrt{n}}$$

where $SD = $ standard deviation
and $n = $ sample size

95% confidence limits = $2 \times SE$ above and below the mean

For use in the ISA and EMPA assessment
The $\chi^2$ test

The chi-square ($\chi^2$) test is based on calculating the value of $\chi^2$ from the equation

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

where $O$ represents the results you observe in the investigation and $E$ represents the results you expect.

Table showing the critical values of $\chi^2$ at $P = 0.05$ for different degrees of freedom

<table>
<thead>
<tr>
<th>Degrees of freedom</th>
<th>Critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.84</td>
</tr>
<tr>
<td>2</td>
<td>5.99</td>
</tr>
<tr>
<td>3</td>
<td>7.82</td>
</tr>
<tr>
<td>4</td>
<td>9.49</td>
</tr>
<tr>
<td>5</td>
<td>11.07</td>
</tr>
<tr>
<td>6</td>
<td>12.59</td>
</tr>
<tr>
<td>7</td>
<td>14.07</td>
</tr>
<tr>
<td>8</td>
<td>15.51</td>
</tr>
<tr>
<td>9</td>
<td>16.92</td>
</tr>
<tr>
<td>10</td>
<td>18.31</td>
</tr>
</tbody>
</table>

Spearman rank correlation test

Calculate the value of the Spearman rank correlation, $r_s$, from the equation

$$r_s = 1 - \left[ \frac{6 \times \sum D^2}{n^3-n} \right]$$

where $n$ is the number of pairs of items in the sample and $D$ is the difference between each pair of ranked measurements.

Table showing the critical values of $r_s$ at $P = 0.05$ for different numbers of paired values

<table>
<thead>
<tr>
<th>Number of pairs of measurements</th>
<th>Critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.00</td>
</tr>
<tr>
<td>6</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>0.79</td>
</tr>
<tr>
<td>8</td>
<td>0.74</td>
</tr>
<tr>
<td>9</td>
<td>0.68</td>
</tr>
<tr>
<td>10</td>
<td>0.65</td>
</tr>
<tr>
<td>12</td>
<td>0.59</td>
</tr>
<tr>
<td>14</td>
<td>0.54</td>
</tr>
<tr>
<td>16</td>
<td>0.51</td>
</tr>
<tr>
<td>18</td>
<td>0.48</td>
</tr>
</tbody>
</table>

For use in the ISA and EMPA assessment