Hello. I’m Dr Alex Lathbridge and this is Bitesize Biology.

This series is all about exam techniques. Basically, tips and tricks that are going to help you pass your exams.

Today, we’re going to talk about questions related to practicals. Yes, it's experiments time.

You will do several Required Practical Activities throughout your biology lessons.

These are specific experiments that count towards your GCSE grade. On top of these, you will also be asked questions about practicals in your exams.

So, it’s probably a really good idea to go over some of the key things to remember about practicals, investigations, and the techniques involved.

Today, we're going to talk about planning experiments, safety precautions, results, conclusions and evaluations.

Let’s start with planning.

Which can be boiled down to: What are you measuring? What are you going to use? And how will you use it?

Generally, scientific experiments are based around testing a hypothesis, which is an idea that’s based on known facts, but hasn’t yet been proved with evidence. So, how do you get that evidence?

Variables are used in experiments to test the hypothesis. You normally change one variable and measure how it affects another.

An independent variable is the variable you change in your investigation, eg: the temperature.

A Dependent variable is the variable you measure in response to changing the independent one, eg: the rate of reaction.

The Control variables are variables that are kept constant throughout an experiment, such as the concentration of the reactants.

Control variables are important as they make sure an investigation is valid. Everything that could potentially affect the results of an investigation needs to be kept controlled.

Remember to use the word “valid” rather than “fair test”, because it’s more scientifically accurate and you’re not in Year Nine anymore.

When planning a method, you also need to think about the appropriate equipment that you’ll use. For example, how to measure a volume of liquid depends on the amount being used.

Would it be better to use a beaker, a measuring cylinder or a burette, which can measure very small amounts? Remember, you’ve got to think about how you can take accurate measurements.

Use a piece of equipment with the smallest possible units and read it to the smallest possible reading. And also, be sure to have a good sample size, the larger your sample size is, the more accurate your data will be.

Remember: Never, ever, ever just write the word “amount” because that’s too vague. When you’re talking about measurements in an experiment, you have to state the units involved. Are you measuring the mass, volume, temperature, concentration? What is it? Just writing the word “amount” will not get you a mark.

You’ll also need to consider any risks and safety precautions when planning an experiment. Some examples of risks include using chemicals like acids and bases, fire hazards from equipment like Bunsen burners, and electrical equipment needs to be used safely.

Remember there are ways you can reduce risks (you will have done these yourself during practicals.) Things like wearing gloves, a lab coat and safety goggles for chemicals, putting a Bunsen burner on a heat proof mat.

Remember to think: is this hot? Is it going to burn me? is it sharp? Could it cut me? If something in the investigation has a danger, you need to counter it with a safety measure.

There are some words beginning with R that you need to remember when it comes to an investigation. Good experiments need to give results that are repeatable and reproducible.

Repeatable means that similar results will be found if the same person does the same experiment again and again. Reproducible means that similar results be found if a different person does the same experiment again.

If an investigation is both repeatable and reproducible, we can say that the data is reliable. To make an investigation more reliable, scientists do experiments again and again and again.

Now let’s think about what might happen when you collect your data. There are things known as random errors. Random errors are generally human errors, usually made by the person carrying out the measuring. Things like being inaccurate when it comes to reading equipment or timing.

Random errors might also come about due to things that humans have no control over, such as soil pH or microorganisms. Repeating your investigations and finding a mean (a type of average) will reduce the effect of random errors.

Systematic errors are due to problems with the equipment in the investigation eg: balances that aren't working properly so your measurements are inaccurate, or when using a water bath, the temperature that you require isn't always properly maintained.

A specific type of systematic error you need to know about are zero errors. This is where faulty equipment doesn't reset to zero properly, like the needle on a weighing scale failing to go back to zero. So, it's important before measuring anything, to check that the equipment reads zero when it should.

If it's a systematic error, repeating the experiment in the same way won't reduce the systematic error, the equipment will still be faulty no matter how many times you do it.

An anomalous result is something that doesn't fit in with the rest of the dataset at all and so it will stand out from your other data points. If time permits, it is good practice to repeat the measurements so that you can be confident that the anomalous reading can be discarded.

If not, the anomalous result can be crossed out in a results table and not included in the mean calculation.

So, you have done your experiment, and you have got your results. Now you'll need to know about displaying and analysing the results. You might be asked to display data using the most appropriate techniques, this could be graphs or tables.

You might have to draw a bar chart, histogram or line graph, or find the mean, median, mode or range, which are all averages.

Now we don't have time to get into all that in detail here, but we do talk about them in our episodes on maths and data analysis, and it's really important that you understand it, so listen to those once you are done here.

We're nearly there. We've done the experiment, so time to come up with a conclusion. This will involve taking the data and looking for patterns, seeing if you can suggest or confirm a relationship between the independent and dependent variable.

Is there no correlation, is there a directly proportional relationship, or a positive or negative correlation? Make sure that your conclusion is true of the data in front of you and you're not just making things up that aren't true.

You'll need to include actual figures from the results to back up your points in your conclusion. And in your conclusion, you'll need to bring it all back to the original hypothesis and conclude whether the data from the experiment supports or disproves the hypothesis.

Something you'll have to think about is correlation and causation. They sound similar but they're actually quite different. A correlation is a link between two things, a factor and an outcome.

So, if an outcome happens when a factor is present, and doesn't happen when the factor is absent, then there's a correlation, a relationship. But there might be other reasons for that, other factors involved.

Here's an example. There's a correlation between the pollen count in the air and incidences of hay fever. The pollen count increases from spring onwards, reaching a peak in mid-summer. It's therefore possible that pollen causes hay fever.

But there's also a correlation between the amount of ice cream sold during the summer and the number of hay fever cases, but you wouldn't go around suggesting that ice cream causes hay fever.

So, if there's no scientific explanation, then there's only a correlation. It can't be shown that the factor causes the outcome. You can only conclude that a correlation shown in an experiment is demonstrating causation if you've controlled all the variables, so you can be as sure as possible that one factor is causing the outcome.

We've reached the final stage of an investigation: the evaluation, also known as judging the strength of the evidence. This is one of the most vital parts of good science.

You're looking at the experiment as a whole and considering what went well and what could be improved next time.

You can evaluate different aspects of the method: were there any random or systematic errors? Were the measurements precise? Were the control variables kept constant to make the results valid?

Could you suggest improvements to the method: more repeats? larger sample size? more accurate measuring equipment?

You'll also need to think about the strength of the data: were the results repeatable and reproducible?

Remember, repeatable means doing it yourself and getting similar results, reproducible means someone else doing it and getting similar results.

Did you have large variation in your results, or any anomalous readings? Were enough repeat readings done and a mean calculated?

Doing an evaluation isn't a way of poking holes in your experiments and saying that what you did was wrong. No, it's the opposite. It's saying that you have a good understanding of what you did and an eye to the future of how you could do it better.

And remember, science is collaborative. So by comparing data with different groups who did the same method, you can see if the same conclusion was reached by others.

So, there are many stages to experiments. Remember:

What are the variables?

What is the method?

What are the safety risks?

How are you displaying the results?

What patterns can you conclude from them?

And how can you evaluate this investigation?

I’m Dr Alex Lathbridge and this is Bitesize Biology. All episodes available now on BBC Sounds.