



# Biology

Key Stage 4

Tutor Guidance



## Contents

---

Welcome to the Brilliant Tutoring Programme .....	2
Tutorial 1 – Introductions.....	6
Module 1 – Cells.....	7
Module 2 – Core Practicals .....	20
Module 3 – Homeostasis and Response .....	32
Module 4 – Infection and Disease.....	41
Module 5 – Inheritance and Genetics.....	49
Tutorial 14 – Refresher Session.....	59
Tutorial 15 – Feedback and Reflections.....	60

## Welcome to the Brilliant Tutoring Programme

Welcome to the Brilliant Tutoring Programme, run by The Brilliant Club. The Brilliant Club is an approved National Tutoring Programme provider. We are taking part in the national catch-up effort so pupils can access a future they deserve.

You'll be working with eight pupils per placement, split into two groups of four. You will help them re-engage and rebuild confidence in core curriculum subjects and inspire them with your knowledge and expertise. You'll usually deliver your tutorials virtually.

Each tutorial will normally be 1 hour long, so you'll have a minimum of 2 hours teaching time per week. However, this is likely to be more, depending on the schedule agreed with the school. You will also have to factor in some prep time per tutorial.

Tutorial	Description
Tutorial 1	You will introduce yourself and tell pupils a bit about the topic and your area of research or study.
Tutorial 2-13	These are the tutorials where you will teach around three modules based on the school curriculum.
Tutorial 14	This will be a refresher session where you will revisit a topic from one of the modules you have previously covered.
Tutorial 15	The final tutorial is for you to give some feedback to pupils and help them to reflect on their progress.

## Key contacts

---



Each school nominates a Lead Teacher to select the pupils, co-ordinate the tutorials in school, and support the pupils throughout. The lead teacher has a crucial role in helping the pupils to succeed on the programme.



You will be assigned a Programme Officer from The Brilliant Club. They will work closely with lead teachers to support programme logistics in school and support you to deliver your placement(s).

If you ever have any general questions, contact us on: [btptutors@thebrilliantclub.org](mailto:btptutors@thebrilliantclub.org)

For resources and guidance documents to support you during your placement, go to:

[thebrilliantclub.org/already-working-with-us/btp](https://thebrilliantclub.org/already-working-with-us/btp)

## Your responsibilities during your placement

---

During your placement we ask that you:

- **Complete registers within 24 hours of the tutorial (separate guidance on this process will be provided).** It is important that we have a record of attendance for child safeguarding and to monitor pupil progress.
- **Communicate regularly with your Programme Officer.** Remember that teachers and school staff can have competing demands on their time, therefore keep your Programme Officer in the loop so they can follow up on any issues. We also love hearing when things are going well too!
- **Give us as much notice as possible if you need to reschedule a tutorial.** Schools, parents and pupils find it challenging to change dates at short notice. You should only cancel tutorials at short notice if you are unwell or have an emergency.
- **Uphold your safeguarding responsibilities as set out in our Safeguarding Training:** [thebrilliantclub.org/tutor-training/introductory-module](https://thebrilliantclub.org/tutor-training/introductory-module)

## Preparing for your placement

---

Before you start your first tutorial, you should complete the following steps to make sure you're fully prepared:

- Complete or renew your DBS and Right to Work checks (You will be contacted about this if required)
- Complete all the relevant training modules
- Confirm your tutorial schedule, placement details and modules with your Programme Officer
- Receive the course materials, review these and tailor them as needed
- Read the virtual tutorial guidance for Microsoft Teams
- Receive your Microsoft Teams log in details and meeting link, and check these are working

You can find Teams guidance here:

[thebrilliantclub.org/already-working-with-us/btp](https://thebrilliantclub.org/already-working-with-us/btp)

You can find all the training modules here:

[thebrilliantclub.org/tutor-training](https://thebrilliantclub.org/tutor-training)

Password: tbctutors

## Knowledge Checks

---

Pupils complete a short Knowledge Check at the start and end of each module. These are short assessments in which pupils answer exam style questions on the module topic.

The purpose of these Knowledge Checks are to:

- See the progress pupils make between the start and end of each module
- Share this data with schools so they can monitor pupil progress
- Give you information about pupil progress to inform your tutorial planning

We strongly encourage pupils to complete these Knowledge Checks using the digital link that will be provided by your Programme Officer before the start of your placement, as this is the quickest and most efficient way for the information to be collected and shared with you.

However, if pupils aren't able to access the digital link, they can complete the assessment on paper or on a word document. They should then send their work to [btpschools@thebrilliantclub.org](mailto:btpschools@thebrilliantclub.org) and include their school and tutor name.

## Using your course resources and guidance

To support you to deliver your placement, you have a number of resources.

### This guidance document

---

The rest of this document is dedicated to providing facilitation notes and answers for each of the tutorials you'll deliver.

You should use it in conjunction with the tutorial presentations to prepare for each session.

### Tutorial presentations

---

Presentations for each tutorial are provided in PowerPoint (for Windows) and Keynote (for Mac) format.

These contain pre-prepared learning activities along with facilitation notes. We have indicated where you could add additional activities and slides based on your own knowledge and teaching ideas. You should also feel free to tailor any of the activities based on the needs of the pupils you are working with.

### Pupil handbook

---

Pupils will receive a printed course handbook and you'll get a digital copy of this. These contain space for them to complete learning activities, Knowledge Checks and reflections.

The activities will correlate to the presentations you have, but please ask pupils to use extra paper if they need more space.

### Setting homework

---

It is not an expectation for you to set homework, nor is homework compulsory for pupils to complete. If you feel the pupils you work with need or would like to complete extra work outside of tutorial time, you can agree this with them. However, it should be seen as an optional extra for them to practice or stretch themselves. Some examples have been included in this guidance or on the slides.

You'll be emailed all the documents you need, but will always be able to find copies at:

[thebrilliantclub.org/already-working-with-us/btp](https://thebrilliantclub.org/already-working-with-us/btp)

## Tutorial 1 – Introductions

The purpose of Tutorial 1 is to start getting to know your pupils and collect some information from the group that helps us to report programme impact to our school partners.

Further guidance about Tutorial 1 and supporting resources, such as accompanying slides, will be provided to you when your placement is confirmed.

This table outlines the suggested structure for Tutorial 1.

Section	Suggested Time	Additional Information
Introduction & Icebreaker	10 mins	Introduce yourself to the pupils and find out a bit about them.
Introduce your research	15 mins	An opportunity to engage pupils with your research/degree and link it to the BTP subject they are going to be studying.
Welcome to BTP	5 mins	Sharing a pre-recorded welcome video explaining the programme to pupils.
Pre-Programme Survey	10 mins	Pupils will complete a pre-programme survey using the link and codes your Programme Officer shares with you.
Knowledge Check	15 mins	Pupils will complete the Knowledge Check for the first module you'll be covering.

## Module 1 – Cells

This module is focused on cells as the basic unit of structure for biological understanding. The topic focuses on understanding cellular processes including division and transport, while also covering applications in medicine e.g. current methods of treatment. Some of this content should be familiar to students (especially in Session 1) but short answer questions on organelle functions are very common and easily forgotten in other revision topics.

Tutorial	Topic
Tutorial 1.1	Cell Structure
Tutorial 1.2	The Cell Cycle
Tutorial 1.3	Stem cells
Tutorial 1.4	Lifestyle and Disease

## Knowledge Check #1

---

Where possible, encourage students to complete these online using the link provided by your Programme Officer.

These three organelles are found only in plant cells

- a) Cell wall, Chloroplast, Vacuole ✓
- b) Flagellum, Cell membrane, Chloroplast
- c) Mitochondria, Cell membrane, Ribosome
- d) Golgi bodies, nucleus, cell wall

1. Select the incorrect comparison between Diffusion and Osmosis

- a) Both move down concentration gradients
- b) Both require energy ✓
- c) Both Osmosis is water only, diffusion can be movement of any particles
- d) Osmosis involves the semi-permeable membrane, this is not required for diffusion

2. Select the incorrect info of embryonic stem cells for medical treatment

- a) No need for stem cell removal from adults
- b) Cells can differentiate into any cell type (pluripotent)
- c) There is an ethical consideration involved in the process
- d) High risk of viral transmission (as would be with adult stem cells) ✓

3. A short section of DNA encoding a protein which determines a characteristic is known as

- a) Ribosome
- b) Guanine
- c) Gene ✓
- d) Cytosine

## Tutorial 1.1 – Cell Structure

---

In this tutorial you will look at:

- The structures in animal, plant, and bacteria cells
- How cells are viewed under light microscopes, and how to calculate magnification
- The differences between three types of cell transport

At the beginning of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions – the correct answers for these knowledge checks are noted on the previous page.

### Activity 1 and 2

The first part of this session should be very familiar and easily completed by students, as this content is repeated throughout KS3 and KS4. Bacterial cells are less common and may need some short explanations around the lack of a nucleus and presence of plasmids. Plasmid function is a common question that students find difficult, and they need to understand that the plasmid carries extra DNA which confers an advantage to the organism e.g. antibiotic resistance genes.

### Activity 3

The thinking question refers to the point that bacteria can move DNA to wherever they like in their cell to make new proteins where they are needed. This means they do not need to have complicated transport systems like animals and plants, they just move the DNA where it is needed.

### Activity 4

Microscopy focus should be on the stages of preparing samples, the risks and the following calculations. Infrequently students can be asked to name parts of a microscope but this does come up in the Microscopy Core Practical so it could be referred to in the exam.

### Activity 5 and 6

The discussion question is to try and connect the idea of electrons (which they learn about in Chemistry) to see if they can build links. Electron microscopes use a beam of electrons in a vacuum to observe small specimens. The stains in this process are usually heavy metals, which repel the electrons and show the edges of a sample through this deflection. This is a good opportunity for students to recall this basic knowledge and cross-reference between the sciences to understand the interactions between disciplines.

### Activity 7

The final content is understanding how molecules can move in and out of cells. Often students are asked to compare, describe or explain how these processes work in relation to an example e.g. movement of waste materials out of body cells. Students tend to struggle

with Osmosis and the ideas of “dilute” meaning high concentration. Ribena dilution is a good example here and easily recalled later by students. Students may ask why water molecules move rather than salt – firstly because osmosis only refers to water movement, and secondly because the pores in the partially permeable membrane are too small for salt to pass through.

Answers:

1. Glucose concentration is higher in the blood than it is in the body cells
2. The solution inside the onion was more concentrated than the pure water it was placed in (1), so water moved into the onion by osmosis (1) causing the cell to expand until it was too full of water and burst (1).
3. Root hair cells use active transport to absorb water molecules from the surrounding soil (1). Active transport is an active process and requires energy (1), so root hair cells need mitochondria for respiration to produce energy (1).

## Activity 8

If students run short on time, please encourage them to complete their dual coding at home – this metacognitive technique is helpful as it provides an alternative view of the information and it can support students to connect topics together.

## Tutorial 1.2 – Cell Cycle

---

In this tutorial you will look at:

- The three parts of the cell cycle.
- How to complete calculations related to the cell cycle.
- Comparing Meiosis with Mitosis

This session is focussed on methods of cell division. The specific stages of Mitosis are not required at this point, but students do need to understand the mechanics occurring in cells in this process. The first part of the session looks directly at the cell cycle, diagrams are provided here to support student understanding but these will need discussion so students can create links between their understanding of DNA and the cycle.

### Activity 2

The calculation questions crop up frequently and refer to percentages and times. If students are struggling and want more practice, change the numbers and ask the same question again, until they can understand the process taking place.

### Activity 3

The practice question states that Stages 2 and 3 take 55 minutes and from the diagram students should identify that both stages together last for 25% of the cell cycle. This means Stage 1 lasts 3x as long as Stages 2 & 3 so  $55 \times 3 = 165$  mins. This should be converted to 2h 45 mins as the final step.

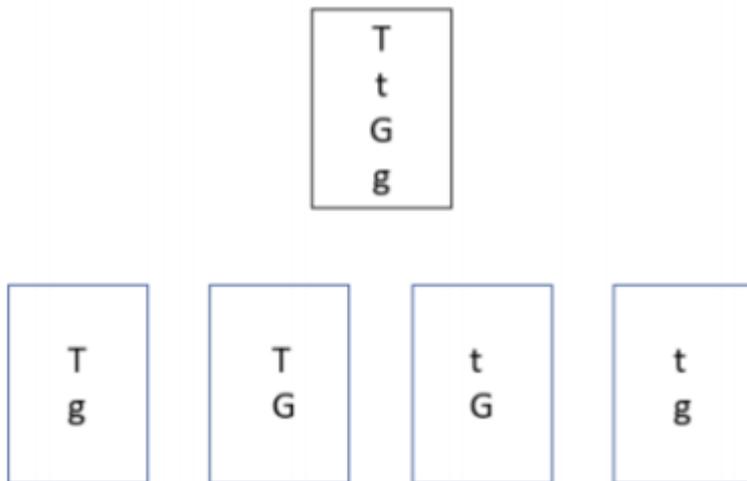
### Activity 4

Thinking Questions:

1. Any body cells that grow e.g. liver cells, skin cells etc. If they say brain cells remind them that neurones do not replicate so this would not earn a mark.
2. Testes and Ovaries need to produce gametes (egg and sperm cells) with half the genetic material so that a fertilised zygote will have the correct chromosome number.

## Activity 5

Meiosis practice:



## Activity 6

Comparison Question:

Students should include at least one similarity (max. 3) e.g. both are types of cell division, both produce daughter cells.

Differences should be in comparative sentences e.g. using “while” “but” “yet” etc.

Meiosis is sexual, Mitosis is asexual; differences in numbers of chromosomes, identical vs non-identical to parent cells; opportunity for swapping of chromosome sections in meiosis not in mitosis.

Differences must include products e.g. gametes in ovaries vs. growth of cells elsewhere in the body.

Thinking question: due to genetic reassortment it is unlikely one person would every produce the same gamete twice hence siblings will never be identical as they are all the production of different gamete fusions.

## Tutorial 1.3 – Stem Cells

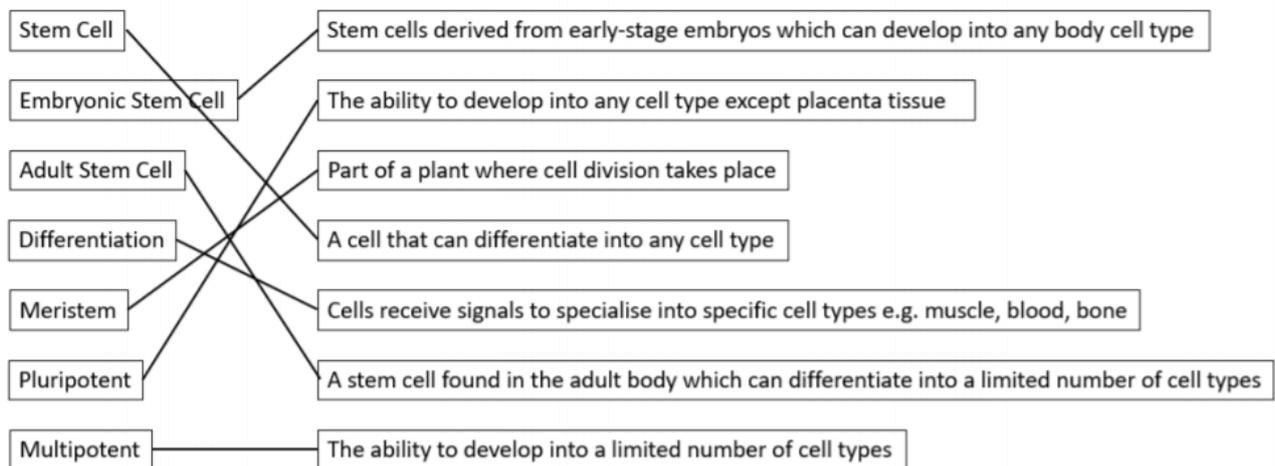
---

In this tutorial you will look at:

- The two types of stems cells, and how they are derived
- What is meant by ethics, and how this relates to stem cell use.
- Evaluating the use of stem cells in medicine.

### Activity 1

The first section about stem cells and their derivation is content students need to know, this could be made into flashcards to support memorisation (including the definitions). The match up should be:



### Activity 2

The basis of ethics is not too important here but it may be a new word for students so it is worth double-checking they understand the concept. The discussion question is supposed to encourage conversation and discussion but rules may be handy here e.g. “do not speak until the previous person has finished” or “if you disagree with an opinion, start your sentence with: I respect your opinion but I disagree because...” This should help keep discussion on track and polite. If at any point this becomes difficult to manage, suggest students continue their research online and come to you with any questions at another point in the course.

### Activity 3

Therapeutic cloning can be included in exam papers, students sometimes struggle with the source of egg donation and how specific cells can be grown. The addition of nutrients and hormones that signal the cell to switch genes on/off is sufficient detail but if they want to know more they can continue this research independently.

## Activity 4

The advantages/disadvantages labelling should be straightforward; they may ask about the risk of virus transmission (viruses can be living in adult stem cells and be transferred from donor to patient) or risk of tumour development (stem cells live longer than other cells and therefore have more opportunity to undergo spontaneous mutation, divide uncontrollably and develop into a tumour).

## Activity 5

The modelling of the evaluation question is very important as a metacognitive technique as students listen to you think your thought process for the question aloud and can follow the steps they should take when answering questions in a similar format. They should annotate along with you or make notes as they listen. If they have questions, ask that they write them down to ask at the end, as the interruption mid-way can be distracting for others.

You can use the structure below and add any extra information you think would be of help, the purpose is to show students the steps they should take rather than to recap content.

Begin with the question:

### **Evaluate the use of stem cells from a patient, rather than from an embryo**

Identify the command word and what this means: "we are going to evaluate, so I know I will be weighing up pros and cons of something. When I'm planning I should use a table to keep track of my ideas" (if a board is available drawing this out would be helpful).

"The stem cells from a patient must mean adult stem cells so I will annotate that on to my question. It says from a patient so that must mean the stem cells would be taken from the same person that the treatment will be given to, so I know there is no risk of virus transmission or rejection – they can go in my positives in my table."

"An embryo must mean embryonic stem cells – what do I know about those? They are pluripotent so that would be an advantage to using them and a disadvantage for using adult stem cells so I can put that in my table too."

Now I can check and add to the positives of using the patient stem cells:

- The stem cells would have the same genetic material as the patient so the tissue would not be rejected by the body
- There is no risk of virus transmission because the stem cells have come from the same person that will receive the stem cell transplant
- We would not be using embryonic stem cells: some people have an ethical objection as they believe in an embryo's right to life

Then we look at the negatives:

- Adult stem cells can only differentiate into a limited number of cell types, so it might not be possible to grow the type needed by the patient
- Stem cell removal can be painful for patients as you might need to remove cells from the bone marrow"

"This is an evaluation, so I have to give a judgement in my summary sentence, but it doesn't matter whether I agree or disagree as long as I can explain why I have chosen this judgement."

**A summary sentence could say: (choose which you agree with!)**

Using stem cells from the patient would be better because there is no risk of rejection by the body, or risk of virus transmission in a transplant so this process is safer than using a different source of embryonic stem cells.

**Or:**

Embryonic stem cells would be better because they are pluripotent and could differentiate into any required tissue type and treat any disorder. Embryonic stem cells would also remove the need for stem cell extraction from the patient as this procedure can be painful.

Explain why you chose your summary sentence and ask if students have any questions.

There is now one for students to attempt independently, give them up to 8 minutes to plan and write their answer. The mark scheme is below:

Up to 5 marks for:

- Using adult stem cells is less painful than extraction
- Not using embryonic stem cells (right to life)
- Risk of viral infection with adult stem cells
- Risk of rejection of adult stem cells
- Adult stem cells might not differentiate into the type of cells needed for treatment then embryos would need to be used anyway
- Any other valid argument could be included
- Final mark is for summary sentence – maximum 5 if no conclusion

When self-reflecting ask students to consider how well they explained their points. Did they include enough detail, did all their sentences make sense as to why they were pros or cons?

It would be beneficial to set pre-reading for the next session again due to the volume of content to cover. The first 2 pages should be sufficient.

## Tutorial 1.4 – Lifestyle and Disease

---

In this tutorial you will look at:

- The causes and associated risk factors related to cancer.
- The impacts of smoking on adults and unborn babies.
- How Coronary Heart Disease develops and how the treatments for this disease work.

Students do need to understand how tumours form and the types of risk factors associated with cancer development (usually just to identify e.g. obesity is linked to bowel cancer).

X-rays are listed as an example of ionising radiation to anchor the new knowledge to a commonly known process but if students are concerned the radiation from single X-rays is very low so they should not be worried if they have had/think they will need X-rays in the future.

### Activity 2

1. Cancers are caused by mutations in DNA \_\_T\_\_
2. Mutations cause single cells to grow much bigger, creating a lump \_F\_\_
3. Benign tumours can travel around the body \_\_F\_\_
4. Malignant tumours can invade other tissues and cause more tumours to grow \_\_T\_\_
5. Alcohol is a carcinogen \_\_T\_\_
6. Alcohol is linked to lung cancer \_\_F\_\_

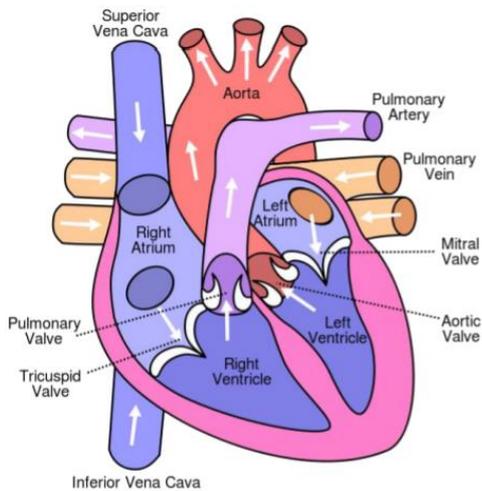
Students need to write correct statements for the false ones: number 2 might confuse them but they need to understand tumour are the result of mass cell division rather than one enlarged single cell.

### Activity 4

The link between smoking and low birth weight is connected to carbon monoxide replacing oxygen in red blood cells as this reduces oxygen reaching the growing foetus therefore the cells cannot respire as much and hence grow less/more slowly. Low birth weight refers to babies born weighing less than 5lb 8oz (2.5kg).

## Activity 5

The correct labels for the heart are:



Students do not need to know the specific valve names but should know which structures are valves and that valves prevent the backflow of blood (keep blood flowing in the right direction is also acceptable).

The Superior Vena Cava has been maintained on this diagram, only one is usually asked about so as long as students can identify that the Vena Cava is a vein on the right side of the heart, this is sufficient.

## Activity 6

The dual coding exercise is set up as a storyboard here to encourage students to break the text into chunks. This should support them in remembering the process as this will reduce the load in working memory. They may need support breaking the text down, if so providing a keyword support for each box could be helpful e.g. "your first box keyword is artery, the second is deposit" etc.

## Activity 7

There is no right or wrong answer to the choice of a treatment, this technique can sometimes encourage students to engage with a topic or make personal connections e.g. a family member that takes statins.

Their lifestyle advice should include reducing fatty foods in the diet, getting regular exercise, not smoking, limiting alcohol and processed meat intake, avoiding sunbeds/using sun protection etc. All of these should be linked to the idea of mutation/cancer development or the contribution of this to lung cancer or CHD development.

## Activity 8

The Consolidate discussion is to encourage students to consider that lifestyle diseases might have genetic factors as well e.g. CHD could be inherited within a family. Students do not need to know any detail on this but they might want to think about how genetics could influence risk e.g. could some people have narrower arteries than others?

## Knowledge Check #2

---

At the end of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions. You will also complete a reflection exercise so that pupils can take time to think about what they found challenging and where they did well – you'll find more details about this on the relevant tutorial slides.

Correct answers for the Knowledge Check are below. Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Cell division producing 2 identical daughter cell is known as
  - a) Mitosis ✓
  - b) Meiosis
  - c) Transfusion
  - d) Reproduction
2. Root hair cells need mitochondria to
  - a) Provide energy to enable them to obtain water through passive transport
  - b) Provide carbon dioxide to enable them to obtain water through active transport
  - c) Provide energy to obtain water through active transport ✓
3. Select the two types of Stem cells that can be derived from humans
  - a) Perinatal and adult stem cells
  - b) Adult and embryonic stem cells ✓
  - c) Cytokine and embryonic stem cells
4. Select the incorrect reason for development of coronary heart disease
  - a) Fats are carried in the bloodstream and deposited in the artery, building up over time.
  - b) The presence of the fats in artery reduces the diameter/space inside the blood vessel reducing blood flow to the heart.
  - c) Proteins are building blocks of the body, which in excess causes coronary heart diseases ✓
5. A skin cell is 0.3mm long. When observed down the microscope, the image appears to be 3cm. What is the magnification of this microscope?
  - a) 1
  - b) 10

c) 100

d) 1000 ✓

## Module 2 – Core Practicals

This module is focused on some of the Core Practicals students must understand. Some schools have resources and time to carry out all experiments, but several schools may not be able to do this and all students can be asked about these tests in their exams.

These sessions aim to look at planning and methodology as well as data analysis, so a variety of skills will be discussed in the contexts of different experiments.

Tutorial	Topic
Tutorial 2.1	Skills
Tutorial 2.2	Sampling and Fieldwork
Tutorial 2.3	Osmosis Practical
Tutorial 2.4	Enzymes and pH Core Practical

## Knowledge Check #1

---

Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. While completing the Osmosis Core Practical, Jacob records that the mass of the potato before the experiment was 3.2g. After the experiment, the potato had a mass of 2.9g. Select the correct percentage change in mass
  - a) 9.37 ✓
  - b) 9.73
  - c) 9.04
  - d) 8.97
2. State the positive result for the food test for Starch using Iodine
  - a) Iodine will turn blue-black when starch is absent
  - b) Iodine will turn blue-black when starch is present ✓
  - c) Iodine will remain colourless when starch is present
  - d) Iodine will turn blue-black only when starch is present in high quantity
3. What is meant by the 'repeatability' of an investigation or experiment?
  - a) When dissimilar results are obtained if the same person repeats their experiment with the same method and equipment
  - b) When similar results are obtained if the same person repeats their experiment with different method and equipment
  - c) When similar results are obtained if the same person repeats their experiment with the same method and equipment ✓
  - d) When dissimilar results are obtained if different people repeat their experiment with the same method and equipment

## Tutorial 2.1 - Skills

---

In this tutorial you will look at:

- How to identify variables in an experiment.
- Understanding the differences between accuracy, precision, reliability, reproducibility, and repeatability.
- Suggesting ways to reduce error in experiments.

At the beginning of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions – the correct answers for these knowledge checks are noted on the previous page.

This session is designed to cover common topics students struggle to understand, but that do not fit into one specific topic, including the difficulties determining the differences between keywords and how to improve different features of experiments.

### Activity 1

The first section looks at variables and should be more a recap than new information to pupils. The answers to the tasks are:

- 1a) Independent Variable = shoe type  
Dependent Variable = speed (time taken to run 100m could also be used)
- b) Control variables should include the running surface, temperature, clothing worn etc to ensure these do not impact his data
2. How does the pH of a solution affect the rate of photosynthesis? OR How does the pH of a solution affect gas production by a plant?
- 3.

Length of workout (mins)	Heart rate (bpm)

When looking at this table ensure students have included their units as this can earn them a final mark in table design.

### Activity 2

The second section focuses on keywords: the majority of students will use these keywords interchangeably without understanding the differences between their meanings. The key focus should be on students understanding the definitions and how these can be assessed in experiments – what should they look for in their data to check if their experiment meets these criteria?

## Activity 3

Answers:

1. Accurate data is close to the true result (1) whereas precise data is close to the mean (or all data points are close together) (1)
2. The data is repeatable and precise (1) as the readings have been taken multiple times and are close together (1).
3. a) Simon = 70.3; Aya should have the anomaly circled and ignored therefore 67.5  
b) Simon's is more accurate (1): Aya's would have been more accurate if not for the anomaly but this show there is an error in her data  
c) Simon's is repeatable (1) as he did not have any anomalies (1) so his method works every time. Aya's did not hence she took a data point that could not be used,  
d) They should repeat their experiment several more times (1) and calculate new means from their data (1)

## Activity 4

The final section looks at types of error – students can be asked about this, usually in the context of reducing error within an experiment. Understanding the key mistakes that could be made should help them look at methods and data more critically to find sources of error.

- Counting bubbles incorrectly due to not concentrating R
- Repeatedly measuring a pulse 5 minutes after exercise rather than immediately S
- Using a scale that has not be “zero-ed” before you used it S
- Miscounting the number of bacteria colonies on a plate R
- Standing on a scale differently each time you weigh yourself R
- Measuring the mass of a sample with a fan on nearby S
- Using a metal ruler to measure the same feature in hot and cold conditions S

## Tutorial 2.2 – Sampling and Fieldwork

---

In this tutorial you will look at:

- How to carry out random sampling
- How to use a transect to investigate the effect of light intensity
- Planning and evaluating experimental methods

This session focuses on methodology, both planning methods and evaluating ones that are given. Students often find ecology difficult to explain and may have varying opportunities to trial the experiment dependent on their school and location. This session covers both random and systematic sampling which students must understand and be able to apply in exam scenarios.

### Activity 1

It is worth double checking that students know what a quadrat is and that this is the apparatus – some students confuse the quadrat and transect which then causes them to lose marks in planning. If you can find one to show them, even better!

If you have time, read through the method in the first section and apply it to the diagram below so students can visualise how this experiment is organised. The equation employed here is not provided on a formula sheet so students should be familiar with this – a flashcard would be an effective technique for learning this.

The converting of the method into images/single keywords should not be a long process but it should support students in learning key steps to include in planning, and will ensure they read the method independently and have the opportunity to clarify steps with you.

### Activity 2

#### Practice Questions:

1. Random placement ensures no bias in the data therefore it is valid and more likely to be repeatable
2.  $900 / (10 \times 0.0625) \times 96 = 138,240$

### Activity 3

1. Differences between random and systematic sampling:
  - Random sampling is counting the number of plants in a given area, systematic sampling is assessing the impact of a factor on plant growth
  - Systematic sampling requires the measuring of the factor e.g. light intensity – this would not be needed with random sampling
  - Random sampling places quadrats randomly, systematic sampling places these at regular intervals
  - Random sampling takes place across an area, systematic sampling takes place along a transect

2. As light intensity increases, the number of plants increases (1) NOTE: this is a describe question (not an explanation) so no reason needs to be given here, just the link.
3. To ensure repeatability they should repeat the experiment (1) and take means at each interval (1) along the transect
4. To ensure reproducibility they should ask someone else to repeat the experiment (1) using a different light meter (1) and compare their data.

**Decide whether each experiment described should use random sampling (R) or Systematic sampling (S)**

- Investigate whether seaweed growth is dependent on the distance from the seashore (S)
- Investigate the percentage grass cover on a football field (R)
- Investigate how pollution impacts growth of Dogs Mercury plants (S)
- Investigate how grass cover changes between open land and forest (S)
- Investigate how many pineapples are growing in a field (R)

## Activity 4

When looking to mark the planning question, students should have included:

- An equipment list: tape measure for transect line, quadrat(s), table for recoding data
- The experiment needs to use systematic sampling
- The idea of drawing a transect from the seashore and away from the sea
- Using the quadrat at regular intervals
- Explaining how to count within the quadrat

Before you mark the question together you could ask to see student plans or see if they have made a plan based on the instructions on the previous page. This could help students identify parts they have missed and the use of a plan in a question like this.

After you have marked the question, ask students to improve their answer based on your discussion of the mark scheme or to write an improvement in the space provided. This continual reflection should give them some guidance for their independent revision and practice.

## Activity 5

The final example should be followed as a group but could be done either using a class reading approach or as a "Walking Talking Mock" where you think aloud as you read and make notes together. This verbalisation of your thought process can support students to identify key steps in their application to similar questions. This would be particularly useful when reading the 3 facts you are given – spot the problems straight away. These are written up underneath as well, should students wish to refer back to them later.

The three improvements should include:

- This should be a random sampling experiment so a transect is not required
- He should use more quadrats
- He should use bigger quadrats
- He should use random numbers to determine his placement of the transects

Students might struggle to identify that a transect should not be used so if they say "quadrats should be placed at equal intervals" this should be encouraged as a correct point in regards to systematic sampling but this would not earn a mark as systematic sampling should not be employed in this experiment.

#### Self-reflection

Ask students to reflect on the session so they are continually aware of their progress and how confident/prepared they feel. If they ask for further support ideas, direct them to school staff or revision websites/textbooks.

## Tutorial 2.3 – Osmosis Practical

---

In this tutorial you will look at:

- The aims and method of the Osmosis core practical
- How to calculate percentage change using recorded data
- Plotting data on a suitable graph and explain the findings

This session is focussed on data analysis and relating data to the explanations that students need to give in exams.

### Activity 1

The first section focusses on a recap of osmosis – most students should be familiar with this and be able to explain the process. The relation of osmosis to the plant mass can be a stumbling block as students struggle to visualise the potato cylinder membrane as the semipermeable membrane from the definition. The salt molecules do not move because they are too large to cross the partially permeable membrane.

The results of the experiment are explained before we go into the practical – these can be used throughout the session to relate data or calculations back to the aims of the experiment.

- Independent variable = concentration of salt solution
- Dependent variable = percentage change in mass/length of the potato cylinder
- Control variables = potato cylinder diameter, volume of salt solution, time left in solution, temperature of the laboratory

### Activity 2

Calculating change:

1.  $1.8 - 0.5 = 1.3\text{g}$
2.  $2.7 - 3 = -0.3\text{cm}$

Double check students have kept their negative values this way as this is needed to calculate percentage change and plot data correctly.

### Activity 3

Calculating percentage change:

1.  $3.2 - 5/5 \times 100 = -36\%$
2.  $4.1 - 3.3/3.3 \times 100 = 24.24\%$

## Activity 4

Completed Values

	<b>0.25 mol/dm<sup>3</sup> sugar solution</b>
<b>Initial mass in g</b>	1.9
<b>Final mass in g</b>	2.7
<b>Change in mass in g</b>	0.8
<b>Percentage change in mass %</b>	42.15%
<b>Initial length in cm</b>	4.3
<b>Final length in cm</b>	4.6
<b>Change in length in cm</b>	0.3
<b>Percentage change in length %</b>	6.98%

## Activity 6

1. Percentage change controls for differences in mass at the start of the experiment (1)
2. Tube A contained pure water which will have been more dilute than the carrot cylinder (1). Water will have moved by osmosis from the dilute solution outside to the concentrated solution inside the carrot causing the mass of the carrot to increase (1).
3. The concentration of the solution inside the carrot must have been equal to the concentration of the solution outside the carrot (1) therefore water will not move in either direction so the mass will stay the same (1).
4. Increased temperature will increase the rate of osmosis, so all tubes should be kept at the same temperature to ensure this does not impact the results of the experiment i.e. this is a control variable (1)
5. Carrots might not have been dried before each mass reading so extra water might have been stuck to the potato and influenced the reading (1) Some tubes might have been near a window while others were near a heater, influencing osmosis rates (1) Tubes could have been taken from different carrots with varying salt concentrations (1) 6 Measurements could have been taken inaccurately e.g. not reading the scales to 2 decimal places each time (1)

## Tutorial 2.4 – Enzymes and pH

---

In this tutorial you will look at:

- How amylase breaks down starch with reference to the lock and key model
- The aims and variables of the amylase experiment
- Interpreting pictorial representations of results and predicting alternative outcomes

This session focusses on the Core Practical identifying the optimal pH for Amylase digestion. Students can struggle explaining the lock and key model (specifically how products are released post-digestion) and identifying why multiple enzymes are needed by the body. These topics are covered in the first section and will take varying time to recap, based on the group you are working with.

The second section is designed to encourage students to apply their understanding of a method to the skills learned in the first session of this unit. The experiment can be complex, so it is worth reading through as group, identifying key information e.g. what is being measured, how is this being measured, what is changing etc. Working through this aloud should support students to do this independently when faced with an exam paper.

### Activity 2

Answers:

1. pH of the reaction (1)
2. The time it takes for the Iodine to stop changing colour i.e. the rate of Amylase digestion of Starch (1)
3. How does pH affect the rate of Amylase digestion of Starch? (1)
4. Any three from:
  - Volume of Starch/Amylase – to ensure equal volumes are used so equal amounts of enzyme and substrate are available for reaction in each test
  - Temperature – temperature is a different condition which can impact Starch digestion so this must be controlled to ensure only factor is under investigation
  - Samples taken every 10 seconds so that data is reproducible and precise
  - Source of Amylase is the same each time – different types of Amylase might have slightly varying optimal conditions
5. This controls the temperature and mimics internal environment of the body – closest to optimal conditions for the enzyme to work at its best (1)
6. Colour change can be difficult to judge when between absolute colours therefore some scientists might judge a colour to be closer to blue-black than brown leading to variation in results – this is a good topic for discussion (using colour indicators) (1)
7. This is not a good idea, data will be less accurate as timings between samples are larger (1)

### Activity 3

Spotting file: 70 seconds – we know because every depression contains a sample taken 10 seconds apart so we add them up and multiply by the 10 seconds for our final answer.

### Activity 4

pH 1	✓	✓	✓	✗
pH 2	✓	✗	✗	✗
pH 3	✓	✓	✗	✗
pH 4	✓	✓	✓	✓

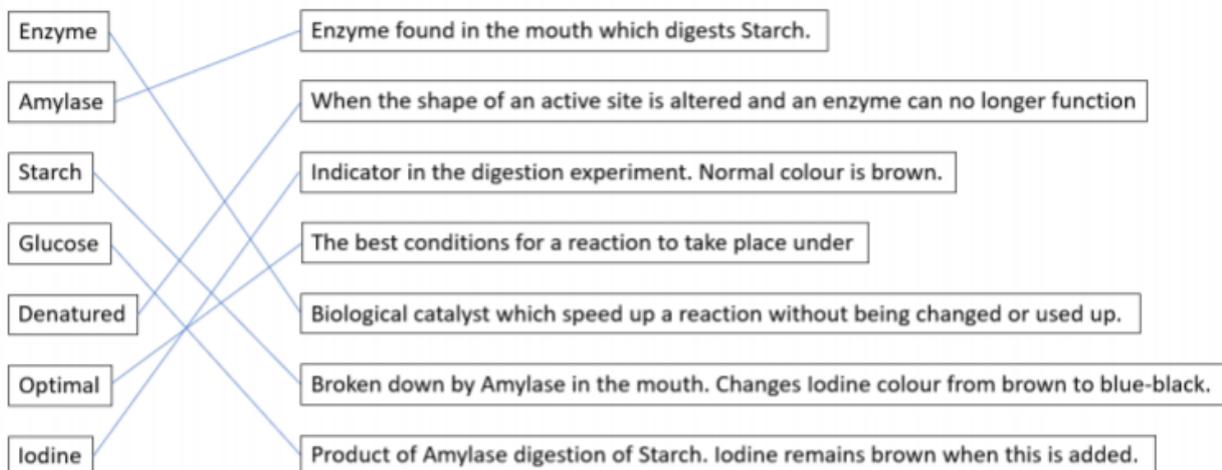
Note: pH3 could also have 3 ticks and 1 cross alike to the pH1 result.

We expect to see this because we know the pH of the stomach is pH2 therefore this is the optimal condition for protease enzyme (1) as this is where protease is produced and functions. pH3 is closer to pH2 than pH4 so some enzyme activity may still be possible (1), but this would be slower than at pH2.

If there is a cross in the first depression, this means there is contamination of the student's Amylase solution (1) as this should be a negative control. If this is contaminated then all her samples will be (1), therefore this data is unusable, and she should begin again.

Temperature is controlled to ensure this does not impact the data as this can also affect enzyme activity (1). Incubating at 35oC mimics the optimal temperature as this close to body temperature (1)

### Activity 5



## Knowledge Check #2

---

At the end of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions. You will also complete a reflection exercise so that pupils can take time to think about what they found challenging and where they did well – you'll find more details about this on the relevant tutorial slides.

Correct answers for the Knowledge Check are below. Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Define precision
  - a) How far the results are to the mean (or to each other)
  - b) How 100% accurate the instrument is every time
  - c) How close the results are to the mode
  - d) How close the results are to the mean (or to each other) ✓
2. A carrot cylinder is cut and measured to 3.5 cm long. This is placed in pure water for 6 hours before being removed and measured again. The cylinder is now 3.8cm long. Select the correct percentage change to two decimal places
  - a) 8.75%
  - b) 8.57% ✓
  - c) 8.32%
  - d) 9.57%
3. What is the definition of a dependent variable?
  - a) The factor being measured in the investigation ✓
  - b) A factor changed by the scientist in the investigation
  - c) A factor being changed during the course of the investigation
  - d) A factor being disproved during the investigation

## Module 3 – Homeostasis and Response

The Homeostasis unit is predominantly focused on systems and whether students can relate information together e.g. how is temperature monitored and adjusted by the use of the nervous system?

The content of this unit focuses on the nervous and endocrine systems in the body, and how to answer specific types of exam questions. The mark schemes for each session with any key information can be found below. Students may ask for specific key terms to be explained, you can find exam board definitions online or encourage them to think about what specific words might mean and why. This will help them link content and root words together for novel application questions.

Tutorial	Topic
Tutorial 3.1	The Human Nervous System
Tutorial 3.2	Homeostasis
Tutorial 3.3	Regulation of Blood Glucose
Tutorial 3.4	Hormonal Control of Reproduction

## Knowledge Check #1

---

Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Homeostasis can be described as the way the body regulates the internal conditions of cells, even when the environment around us is constantly changing. Which of the following is not an example of homeostasis?
  - a) Control in body temperature
  - b) Water level
  - c) Blood glucose levels
  - d) Control amount of blood in body ✓
2. Which hormone regulates blood glucose levels?
  - a) Insulin ✓
  - b) HCG
  - c) Oxytocin
  - d) Adrenaline
3. What are the roles of FSH in the female reproductive system?
  - a) Only causes egg follicle to mature
  - b) Cause egg follicle to mature and causes release of oestrogen ✓
  - c) Causes release of egg into the fallopian tube
  - d) Helpful for healthy development of fetus

## Tutorial 3.1 – The Human Nervous System

---

In this tutorial you will look at:

- The structures and functions of the nervous system and neurons
- The structure and function of a synapse
- Explaining how a reflex is controlled

At the beginning of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions – the correct answers for these knowledge checks are noted on the previous page.

Neurones maintained in parts of the body which do not require rapid response (e.g. digestive system) do not always have a myelin sheath as there is no need for the signal to jump along the axon for speed purposes.

### Activity 5

Reflex Action	Stimulus	Receptor	Effector	Action
1	Smell	Nose (olfactory receptors)	Salivary Gland	Release of saliva
2	Pain	Pressure receptors on arm	Arm muscle (bicep/tricep)	Contraction of arm muscle
3	Pain	Pressure receptors on leg	Leg muscle	Contraction of leg muscle
4	Light	Light receptors on retina	Pupil muscles	Contraction of eye muscle

### Activity 6

The 6 mark question should have included:

- The idea that a stimulus is detected by a receptor with correct named examples
- The 3 neurones in the right order (sensory, relay, motor)
- The brain should NOT be included in this answer as this is an unconscious pathway
- The effector and how it responds e.g. contraction of a muscle (with named examples within their chosen pathway)

Encourage students to write as if in an exam, without discussing with partners to see their own progress. Self-reflection having heard the mark scheme above is useful for progression e.g. how did you decide what to write? What did you miss? How could you improve your answer next time?

Thinking question: We know reflexes are unconscious because their pathways do not enter the brain, only the spinal cord. This means the brain is not able to impact these actions, they will happen of their own accord.

## Tutorial 3.2 - Homeostasis

---

In this tutorial you will look at:

- The parts of the body involved in homeostasis
- How thermoregulation works
- How water regulation and thermoregulation are connected

### Activity 3

#### Shivering

- Stimulus: change in temperature
- Receptor: temperature receptors
- Co-ordination centre: brain
- Effector: body muscles (students can be more specific here if they like e.g. arm muscles)

#### Trapping warm air

- Stimulus: change in temperature
- Receptor: temperature receptors
- Co-ordination centre: brain
- Effector: muscles under hairs on the skin

### Activity 5

#### Sweating

- Stimulus: change in temperature
- Receptor: temperature receptors
- Co-ordination centre: brain
- Effector: glands under hairs on the skin

#### Vasodilation

When temperature detectors in the skin detect that body temperature has increased, they send a message to the brain. The brain sends a message to the blood vessels near the surface of the skin (arterioles and capillaries), telling them to dilate and become wider. This increases the amount of blood near the surface of the skin and therefore more heat is lost to the air by radiation.

If you could not increase body temperature, enzymes in the body would not be able to function optimally so other processes would slow down e.g. digestion, nervous system communication etc. Students should be able to link the idea of biological molecules in the body with optimal conditions.

## Activity 6

### Regulation of Water

The effector in the ADH pathway is the Pituitary Gland as this is signalled to release the hormone. Effectors must always be muscles or glands so we can also say it could not be the Kidney because this is an organ.

The reason we need to drink more on a hot day is because we will lose more water through sweat when it is warm, therefore we need to replace these liquids which we would not have to do on a cold day (1).

## Activity 7

The first practice question is asking for a description of thermoregulation, students would be expected to write about 4 of the 6 processes described in the session correctly e.g. sweating and vasodilation with shivering and vasoconstriction. They should include the receptors at least once and inclusion of the appropriate effectors can support the gaining of higher marks.

Ask each student to read one part of their answer to you and compare this to the notes they have on this method – does their answer make sense? Have they identified the stimulus, receptor, co-ordination centre and effector? This is good practice in helping them structure their longer answers.

The second question refers back to the sweating association: when exercising she will sweat more and lose liquid this way, therefore she will need to replace this lost liquid to maintain homeostasis.

Challenge: people with one kidney will find it harder to reabsorb/lose water as quickly as people with 2 kidneys and may stay dehydrated for long periods which could lead to low blood pressure/dizziness – this is simply to see if students can link the idea of less liquid in the body with any symptoms.

## Tutorial 3.3 – Regulation of Blood Glucose

---

In this tutorial you will look at:

- The processes controlling glucose levels in the body
- Understanding the differences between Type 1 and 2 Diabetes
- Analysing data with regards to Diabetes patients

Recap Qs: amylase in the mouth and small intestine breakdown carbohydrates into glucose, this is then absorbed by diffusion in the small intestine across the villi membranes into the blood.

### Discussion Question

RE: T2 Diabetes – the reduced calorie diet is focused on removing large amounts of glucose from the body so the pancreas reduces its insulin production. This change in the composition of the blood is thought to reactivate the insulin receptors on body cells so that they can begin responding to the hormone again. It is usually a 6-8 week diet but can only be used when appropriate for the patient – here you could discuss why elderly patients might not be prescribed this treatment and instead just told to monitor their sugar intake.

### Activity 4

Graph questions:

1. Diabetes in men consistently increases (1) between ages 0 to 70 but the number decreases above 71. If students ask why this might be, it could be due to increased death as we age anyway therefore fewer diabetic patients are reaching 71 years of age.
2. 110 women (1) to 130 men (1) this question is mainly checking students can read graphs correctly e.g. work out each small square is worth 4 and read the correct answer
3. Type 2 diabetes is a long term disease i.e. it takes a long time to develop (1) due to constant increased insulin levels so it is more likely that older women will develop diabetes because they have had longer periods of time where their cells are constantly bombarded with Insulin (1)

Ask students to self-reflect on these questions: could they answer these types of questions confidently? What other support do they think might be useful and where could they access this? You could direct them to online practice (online platforms such as Educake or BBC Bitesize) or to speak to their class teacher about specific points they would like support with.

## Tutorial 3.4 – Hormonal Control of Reproduction

---

In this tutorial you will look at:

- Knowing the hormones involved in the menstrual cycle
- How hormones interact to control the menstrual cycle
- Explaining how hormonal contraception works

### Activity 2

- Ovaries: site of egg follicle storage
- Oviducts: tubes connecting ovaries with the uterus. Mature eggs travel down these after ovulation. Fertilisation with sperm cells takes place here.
- Uterus: chamber for zygote implantation and embryo growth
- Cervix: lower part of the uterus which opens into the vagina
- Vagina: female sex organ and birth canal

### Activity 4

1. Ovulation is the release of a mature egg from its follicle in the ovary
2. Day 14
3. LH peaks highest at this point
4. Days 1-5
5. Days 14-21

### Activity 6

Evaluation question – 4 marks total

3 marks for the arguments from the following points (or other valid reasons)

- Advantages of IUD over injection e.g. it doesn't run out or need replacing as frequently, rates of pregnancy are lower, stops sperm entering the uterus due to cervical barrier.
- Disadvantages of IUD compared to injection e.g. uncomfortable in uterus/could damage the uterus, if having side effects, it is difficult to remove and needs removing by medical professional

The final mark can be given for their judgement – which is best and why?

In the discussion, encourage students to be positive with themselves and identify good practice or interesting ideas they have included. Students can find these questions daunting and think negatively about these and their answers, we want them to be confident in their ideas and their writing. Aim for 2 positives and 1 improvement to keep this balance.

## Knowledge Check #2

---

At the end of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions. You will also complete a reflection exercise so that pupils can take time to think about what they found challenging and where they did well – you'll find more details about this on the relevant tutorial slides.

Correct answers for the Knowledge Check are below. Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Select the correct definition of 'hormone'
  - a) Chemical messengers released by glands into the blood and carried to a target organ/organs ✓
  - b) Chemical messengers released by glands into the nervous system and carried to a target organ/organs
  - c) Biological messengers released by target organs to regulate autonomic nervous system
  - d) Chemical messengers released by glands into the blood to regulate heart functions
2. Select the function of ADH hormone in water regulation
  - a) Sends signal to hypothalamus to increase the feeling of being thirsty
  - b) Acts on the kidney to increase the volume of water that is reabsorbed by the body ✓
  - c) Acts to increase the osmosis of cell membrane
  - d) Acts on the kidney to decrease the volume of water that is reabsorbed by the body
3. What is meant by 'vasoconstriction'?
  - a) When blood vessel squeeze and blood flow through the vessel is reduced ✓
  - b) When blood vessel squeezes and shrinks in size permanently
  - c) When blood vessel dilate and blood flow through the vessel is increased
  - d) When blood vessel increases in size permanently

## Module 4 – Infection and Disease

This topic is relatively short compared to other units of work in the specification but it requires a lot of specific knowledge that is not used elsewhere, so this is an opportunity to consolidate understanding and ensure students are happy with these ideas.

Tutorial	Topic
Tutorial 4.1	Pathogens
Tutorial 4.2	The Immune System
Tutorial 4.3	Vaccination
Tutorial 4.4	Antibiotics and Resistant Bacteria

## Knowledge Check #1

---

Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Select the correct 4 types of pathogens
  - a) Virus, Bacteria, Protist and Fungus ✓
  - b) Virus, Bacteria, Protist and Algae
  - c) Virus, Bacteria, Protist and Lichen
  - d) Virus, Bacteria, Fungus and Algae
2. Select the incorrect way that white blood cells respond to pathogens
  - a) Engulfing pathogen
  - b) Creating antibodies to bind pathogen antigen
  - c) Creating red blood cells to bind pathogen antigen ✓
  - d) Creating antitoxins to bind toxins from bacteria
3. Select the correct way that you could prevent pathogen transmission.
  - a) Allowing infected people to interact with each other
  - b) Washing your hands if you sneeze or cough ✓
  - c) Allowing pathogen to transmit quickly to attain herd immunity
  - d) Allowing pathogen life cycle to complete at it's natural growth rate

## Tutorial 4.1 - Pathogens

---

In this tutorial you will look at:

- The four types of pathogens and how they make us sick
- How pathogens are transmitted between humans
- How prevention methods work and evaluate a potential prevention method

At the beginning of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions – the correct answers for these knowledge checks are noted on the previous page.

The focus of this session is on disease-causing organisms and their methods of transmission. We also briefly look at preventative methods.

### Activity 1

The table in the powerpoint contains information students need to know –at least one example from each pathogen type and both Salmonella and E. coli crop up in exam questions frequently. Encourage the use of flashcards if possible.

### Activity 2

Dual coding supports students to commit novel ideas to memory by learning the information both as written word and in imagery. This can be used for any topic so if students are struggling with other content please encourage them to try this as well.

### Activity 3

Preventative method answers:

- a) Being hygienic (condom use)
- b) Being hygienic (washing frequently)
- c) Isolation
- d) Vector destruction
- e) Vaccination

### Activity 4

The malaria question is designed to see if they can work out the pros of reducing mosquito numbers e.g. reduced malaria transmission, no chemical use etc vs the disadvantages of the scheme taking several years to have an impact and the possible changes to ecosystems due to the removal of the mosquito (both as prey and predator). The student can argue pro or con, they would be marked on how well they argue as opposed to whether the examiner agreed with their judgement.

When you go through the student answers, try to offer the opposing view where you can so you can see if they can argue their decision more concisely. Encourage students to re-read their answers or read their classmates' answers to identify points they could have included.

## Tutorial 4.2 – The Immune System

---

In this tutorial you will look at:

- The parts of the non-specific immune system and its function
- How white blood cells protect against disease
- Describing and explaining how monoclonal antibodies are produced and used in medicine

This session is information heavy and students need to have a good understanding of the non-specific immune system and methods of protection used by the body. They also need to know the three methods used by white blood cells to protect against specific pathogens (and how these pathogens cause diseases e.g. bacteria by toxin release).

All the definitions they are asked to find are in the content, but they may want to check these with you.

### Activity 4

When completing the bacteria question they can write about all three methods used by white blood cells because it refers to bacteria – if they were completing the same question for viruses it would be worth reminding them they could not write about antitoxin production as this only occurs (under the AQA specification) in bacterial infection. Stating each method would provide 1 mark per method, the description of how each works would give a second mark for each method.

## Tutorial 4.3 - Vaccination

---

In this tutorial you will look at:

- What vaccines are and what they are made from
- How vaccines work with reference to primary/secondary response
- Evaluating whether children should be vaccinated against MMR

The primary take-aways from this session need to be:

- The contents of vaccines
- How vaccines prime the immune system and protect people against pathogens
- The differences between the primary and secondary responses
- The MMR vaccine controversy as unreliable data which has persisted despite further trials proving its safety.
- Evaluation technique using pros and cons (as in session 1)

### Activity 2

1. Vaccines expose the body to small parts of a pathogen (1) and provide the body time to create antibodies (1) specifically to counteract this pathogen (1). When the pathogen is encountered the body has a ready supply of antibodies it can use (1), providing better protection.
2. Day 23 (1)
3. More antibodies (1) more quickly (1)

Discussion question: multiple vaccinations should boost immunity and ensure protection. You could also argue that you could use vaccinations against two different parts of a pathogen to make sure the immune system recognises it when the organism invades.

The addition of egg components to boost immunity has an impact on those allergic to any parts of egg but could also be considered unethical by vegans, again increasing the pool of people who will not take up the vaccine. Egg-free versions are now usually made too.

## Tutorial 4.4 – Antibiotics and Resistant Bacteria

---

In this tutorial you will look at:

- How antibiotics work, and their targets in bacteria
- How MRSA evolved from a previously non-resistant species
- Analysing the results of antibiotic sensitivity testing

Students really struggle with the method by which bacteria develop resistance: some common misconceptions include that antibiotic-resistant bacteria are just different to “normal” ones and that people are resistant to antibiotics rather than bacterial species.

**These can be taught as errors e.g. you can pose the question “can people be resistant to antibiotics?” and discuss the idea as a group.**

### Activity 2

Students often get asked about MRSA as an example organism but it is important they recognise that this is only an example and others do exist, so they can apply this knowledge to other superbugs in exams, even if they do not know the specific organism they are asked about.

1. Any bacterial species e.g. *S. aureus*, *E. coli*, *Salmonella* (1)
2. A change in a DNA sequence which alters a gene (either positively or negatively) (1)
3. A mutation occurs creating a resistance gene (1). When put under antibiotic pressure this bacterium survives (1) and the plasmid with this gene is shared among other bacteria nearby (1). More bacteria now have the resistance gene and can survive and reproduce (1), creating a resistant species.

### Activity 3

Antibiotic sensitivity is often used to determine whether students understand the use of the discs and what the sizes might mean. These can also be used to eke out variables e.g. what would the independent variable be in an antibiotic sensitivity test (type of antibiotic). **Encourage students to review their thinking where possible – how did you know that? What information are you using to come to that conclusion?** Students can then map their thinking more clearly so when they see similar questions, they are equipped with an approach for answering them.

## Knowledge Check #2

---

At the end of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions. You will also complete a reflection exercise so that pupils can take time to think about what they found challenging and where they did well – you'll find more details about this on the relevant tutorial slides.

Correct answers for the Knowledge Check are below. Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Select the correct body's response to a vaccine and its subsequent exposure to the same pathogen
  - a) The second exposure (to the pathogen) produces less antibodies more quickly than the vaccination.
  - b) The second exposure (to the pathogen) produces more antibodies more quickly than the vaccination. ✓
  - c) The second exposure (to the pathogen) produces more antibodies slower than the vaccination.
  - d) The second exposure (to the pathogen) produces less antibodies slower than the vaccination.
  
2. Select the incorrect things which a vaccine might be made from
  - a) A dead pathogen
  - b) A weakened or inactive pathogen
  - c) Antigen from the pathogen
  - d) A live pathogen ✓
  
3. Select the incorrect description of how a virus causes a disease in a human
  - a) Virus invades human body cells and use cell machinery to make copies of themselves, which after multiple cycles causes symptoms ✓
  - b) Virus invades human body cells and use cell machinery to make 2 copies of themselves, which causes symptoms
  - c) Virus invades human body and causes an anaphylactic response
  - d) Virus invades human body and causes a localised response which is easily curable

## Module 5 – Inheritance and Genetics

This module is focused on DNA and its inheritance and manipulation for human benefit. Students often find this content challenging due to its slightly abstract nature (in comparison to topics they can associate visuals with). Students often have a lot of questions about these topics, sometimes it is worth taking the time to answer these but if your sessions are short on time it might be worth asking students to write questions down and give them to you at the end so you can find answers/discuss these at another time.

Tutorial	Topic
Tutorial 5.1	Inheritance
Tutorial 5.2	Variation and Evolution
Tutorial 5.3	Selective Breeding
Tutorial 5.4	Genetic Engineering

## Knowledge Check #1

---

Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Mary's mother has blue eyes, while her father is heterozygous and has brown eyes. What is the probability and likelihood of Mary inheriting blue eyes?
  - a) 50% or  $\frac{1}{2}$  ✓
  - b) 75% or  $\frac{3}{4}$
  - c) 25% or  $\frac{1}{4}$
  - d) 0% or 0
2. Select the size order from smallest to biggest
  - a) Gene, DNA, Chromosome, Nucleus, Cell
  - b) DNA, Gene, Nucleus, Chromosome, Cell
  - c) DNA, Gene, Chromosome, Nucleus, Cell ✓
  - d) DNA, Gene, Cell, Chromosome, Nucleus
3. How many chromosomes does a gamete have, compared to a body cell %?
  - a) 75%
  - b) 55%
  - c) 50% ✓
  - d) 45%

## Tutorial 5.1 – Inheritance

---

In this tutorial you will look at:

- How DNA is passed between generations
- How Punnett squares can be used to show inheritance
- Inheritance of genetic disorders

At the beginning of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions – the correct answers for these knowledge checks are noted on the previous page.

The first few pages of this session focus on the basics of DNA structure and inheritance through fertilisation of an egg cell – some students will not need this reminder and can skip straight to completing definitions as a connect activity before moving into Punnett squares. To see whether this is possible I would suggest asking students:

1. Put Nucleus, DNA, gene and chromosome in order from largest to smallest (Nucleus, Chromosome, Gene, DNA is correct)
2. Ask them how many chromosomes are in a sperm cell (23)
3. What is the difference between a genotype and a phenotype with an example (genotype is the alleles present, phenotype is the observed characteristic e.g. Bb, brown eye colour)
4. Define homozygous dominant/recessive and heterozygous.

If they stumble at any particular question you can follow the content from that point.

Students will want to know about DNA and genetic disorders and why they have green eyes when everyone else in their family has blue etc – this content is not on the exam (even the specifics of genetic diseases) but will encourage them to think about the subject more thoroughly, so please answer the sensible questions if you can or direct them to research online.

### Activity 8

The final topic about Haemophilia is tricky and may take students some time to get their head around, especially the nomenclature. Refer to the X chromosome and Y chromosome when talking through this to remind them where the letters come from and what they mean.

The answer to the final task is

- a) 0% - the unaffected mother's X chromosomes will mask the mutated X in the female offspring; and the father will pass on the Y only to his sons.
- b) 50% - both females will be carriers of the mutated gene, while sons will only have the unaffected X from their mother.

## Tutorial 5.2 – Variation and Evolution

---

In this tutorial you will look at:

- The two types of variation
- Natural selection and how it works
- How natural selection leads to evolution

### Activity 2

Students usually find the definitive answers easier e.g. eye colour is inherited, but can find it difficult to explain why some features fall under both categories. Height should fall in the middle of the Venn diagram because while you have the genetic disposition to grow to a certain height, your diet could be poor preventing you from reaching that height.

- Inherited: hair colour, blood group, ability to roll your tongue,
- Environmental: hair length, accent, scars, muscle strength
- Both: height, weight

### Activity 3 and 4

Students find the explanation of natural selection difficult, especially the order that the steps occur in. It is important students realise that mutations create variation, and a variant is better suited, rather than thinking that an organism undergoes a mutation while living in an environment which now makes that animal better suited than it was before. The summary diagram should help this, students could use this to plan an answer to any variation on this theme. A mnemonic device could help them remember the order, this would be good to derive as a group dependent on the dynamic (monkeys are always well remembered for "M"s!).

### Activity 5

The long answer question would be worth 6 marks in an exam and a mark would be awarded to each step of the summary flow chart with examples. The idea is that the algae bloom would turn the surface of the water green, therefore green frogs have the advantageous mutation and would survive as they camouflage against the water as opposed to black frogs which will now stand out against the background and will be preyed upon. Ask students to read their explanations if you have time, to see how they have understood the content and applied the frog content to the idea of natural selection.

The final part of this topic is understanding that evolution is occurring in all species at all times, as mutations happen randomly. Current areas under investigation in humans is the development of lactose intolerance (we have evolved to be lactose tolerant having previously only ingested lactose in milk until 6 months of ages) and the narrowing of women's hips due to an increase in C-section births over time. The examples are not too

important, more the understanding that this is a continual process, taking anywhere from thousands to millions of years, and is still ongoing.

## Tutorial 5.3 – Selective Breeding

---

In this tutorial you will look at:

- What selective breeding is and how it can be used by humans
- The positive and negative impacts of selective breeding
- Evaluating the use of embryo screening

### Activity 1 and 2

The steps of the selective breeding process are often asked about as a single 4 mark question, so it is important that students understand how the steps link together and can describe these clearly.

### Activity 3

The pros and cons of selective breeding can be asked singularly e.g. give one advantage; or they can be asked in an evaluation e.g. evaluate the use of selective breeding in context of an example. Students should be able to identify some positives easily (better 3 quality/more food produced) but the disadvantages are harder to identify and they may need some hints from the text below.

### Activity 5

Once the selective breeding content is covered, the process to focus on is planning answers. Students have a habit of rushing answers or missing parts out because they have not stopped to plan – this should not be an extensive process and should take them 3 minutes maximum but is an important step to make sure they have read the question correctly and will include all the key information they need.

### Activity 6

Embryo screening is a small part of the specification, but students can be asked:

- How the process works
- To evaluate DNA collection methods (when given some base information)
- To give positive and negative impacts of embryo screening

There is no right or wrong answer to the discussion question, but this can help students identify one of the concerns that is sticking in their brain more easily than the others, so if they are asked for one disadvantage, they have an answer ready to go. Sometimes, this can be tricky if students have opposing views and want to discuss them, as the lesson is not the forum for that discussion (of right/wrong) but please remind them that there is no right or wrong answer to something, their ideas are all valid as we all hold differing beliefs.

## Activity 7

The long answer question is a good opportunity to encourage the students to plan again, there are no hints to help them so it would be good to review their plans after they have written their full answer up e.g. is there anything you could have put in your plan that would have helped?

## Tutorial 5.4 – Genetic Engineering

---

In this tutorial you will look at:

- How genetic engineering works and its uses in food and medicine
- The advantages and disadvantages of genetic engineering
- Explaining how modified plants can be produced on a large scale

### Activity 2

Students are often asked to describe the process by which a genetically engineered organism is made, so understanding the steps in the diagram is key for this.

1. The gene is added into the new plasmid using enzymes to seal the two pieces of DNA together
2. We use bacteria to produce insulin because they reproduce rapidly and so can produce high quantities of the hormone rapidly.

### Activity 4

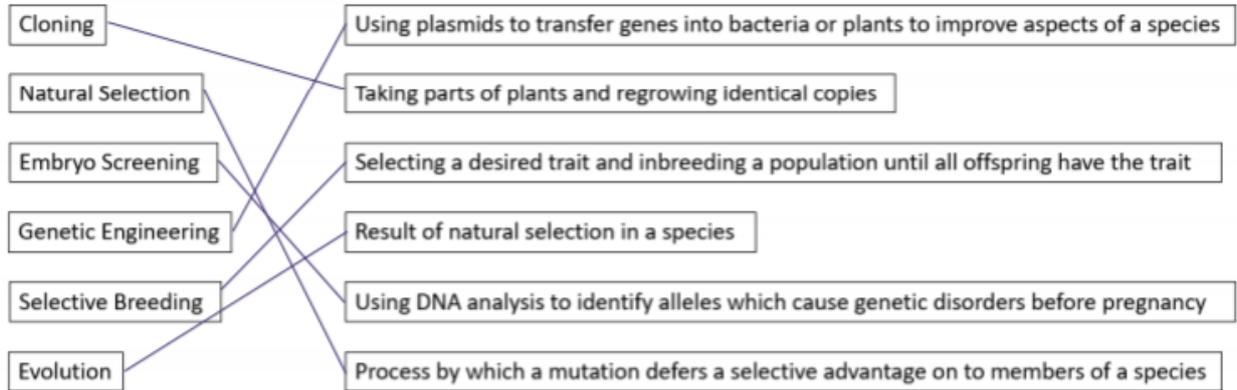
When planning their long answer, some students will struggle to decide how to plan – a table for these is always good and can help them organise their thoughts. Ask students not to refer back to their books when planning but to see what they can remember first, then they can refer back to improve their plan before they write. Any of the pros and cons in the booklet would earn marks; this question would be worth 6 so students should have 3 pros and 3 cons.

Peer assessment has been included here to encourage discussion. The purpose is to share ideas and encourage students to aim for the clearest explanations possible. Positivity is key here, if students have found it difficult you could suggest they use a revision tool (flashcards etc) before trying the question again later.

Students need to know how the two cloning methods are carried out and why they would be used e.g. for mass production vs saving a rare plant species.

## Activity 5

Final match-up:



## Knowledge Check #2

---

At the end of this tutorial you will guide pupils through a set of confidence and Knowledge Check questions. You will also complete a reflection exercise so that pupils can take time to think about what they found challenging and where they did well – you'll find more details about this on the relevant tutorial slides.

Correct answers for the Knowledge Check are below. Where possible, encourage students to complete these online using the link provided by your Programme Officer.

1. Select an incorrect example of a feature determined by genetic variation is
  - a) Natural hair colour
  - b) Blood group
  - c) Any eye colour
  - d) Length of toenail ✓
  
2. An insect species has been found with a gene that provides resistance against common herbicides. Which step is incorrect when it could be used to produce a new species of herbicide-resistant crops
  - a) The gene of interest would be isolated from the insect DNA by cutting with an enzyme.
  - b) The same enzyme would be used to cut plasmid DNA from a bacterium
  - c) The gene would be stuck into the cytoplasm and added to the plant cells. ✓
  - d) The gene would then become part of the plant cell DNA creating a herbicide-resistant species.
  
3. Name the process where DNA is obtained from egg cells and tested for the presence of alleles indicative of genetic disease.
  - a) Embryonic Screening ✓
  - b) Embryonic Processing
  - c) Allelic Screening
  - d) Genetic Screening

## Tutorial 14 – Refresher Session

This tutorial gives you the opportunity to catch up or revisit content, or expand on one of the topics you've covered.

Here are a few different approaches for using this tutorial effectively. You can use your own judgement when planning this session and get in touch with your Programme Officer if you need support.

### Approach 1: Continue completing a module

---

- If one of the modules is taking longer to complete, this session can be used to continue teaching
- You could also complete the final Knowledge Check for the last module you covered in this tutorial

### Approach 2: Revisit challenging concepts

---

- Identify an area of the course where pupils struggled to master a concept or theme - revisit this concept and address misconceptions
- Formative assessment can help you to decide which topic to revisit.
- These prompts can help guide your approach:
  - Consider if a particular method worked effectively for another area of the course and use it here
  - Think about how you can scaffold the learning further by breaking it down into smaller chunks
  - Explore 'wrong' answers and support pupils to explain why they are wrong to help address misconceptions.

### Approach 3: Stretch and challenge

---

- Review pupil progress and identify an area of the course where pupils mastered a concept confidently - further stretch and extend pupil learning
- This could involve bringing in a higher-level concept. For example, you could consult the [National Curriculum](#) to see how the concept is further developed as pupils progress through school
- Consider linking the learning to your own research/degree or encourage pupils to explore how it applies to real world issues. Encouraging pupils to ask questions can help to create a rich and exciting discussion

## Tutorial 15 – Feedback and Reflections

Tutorial 15 is a chance to celebrate pupil progress and successes, encourage further self-reflection and support pupils to look ahead in their learning.

You can find slides to support with delivering this session on the website:

[thebrilliantclub.org/already-working-with-us/btp](https://thebrilliantclub.org/already-working-with-us/btp)

### Session Structure

---

Section	Suggested Time	Additional Information
Group feedback	15 mins	Start by reviewing trends and results from Knowledge Checks and provide some broad group feedback. For example, share areas of strength and celebrate group successes.
Individual Feedback and Self-Reflection	15 mins	Next, share individual feedback forms with pupils. Give pupils 5 minutes to review their feedback independently then use the feedback to help them with some self-reflection.
Looking ahead	15 mins	You should encourage pupils to consider what skills they we developed through BTP tutorials and how do these link to their future learning.  We'd love it if you also use this time to share some of your own experiences of higher education and answer questions from students about university.
Post-Programme Survey	15 mins	Pupils will complete a post-programme survey using the link and codes your Programme Officer shares with you.

### Acknowledgments

---

This course was designed in partnership between Dr Hannah Langham-Lopez and The Brilliant Club.



[thebrilliantclub.org](https://thebrilliantclub.org)

The Brilliant Club is a registered charity in England and Wales (no. 1147771) and Scotland (no. SC048774).  
The Brilliant Club is a registered company limited by guarantee in England and Wales (no. 7986971).  
The Brilliant Club, 17th Floor, Millbank Tower, 21-24 Millbank, SW1P 4QP