



# Biology

Key Stage 4

Tutor Guidance



## 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

BTP Tutor

## Knowledge Check #1

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Where possible, encourage students to complete these online:

<https://forms.office.com/r/PMwqFk95cU>

1. 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
2. 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
3. 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) ✓
4. 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

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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

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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.

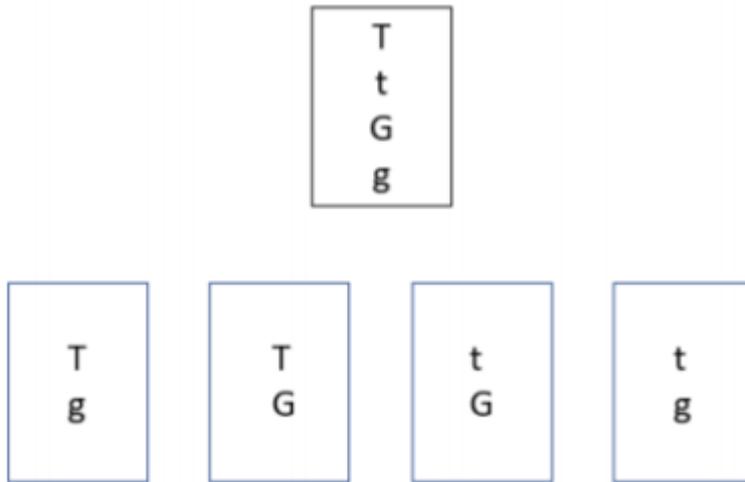
### Activity 4

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.

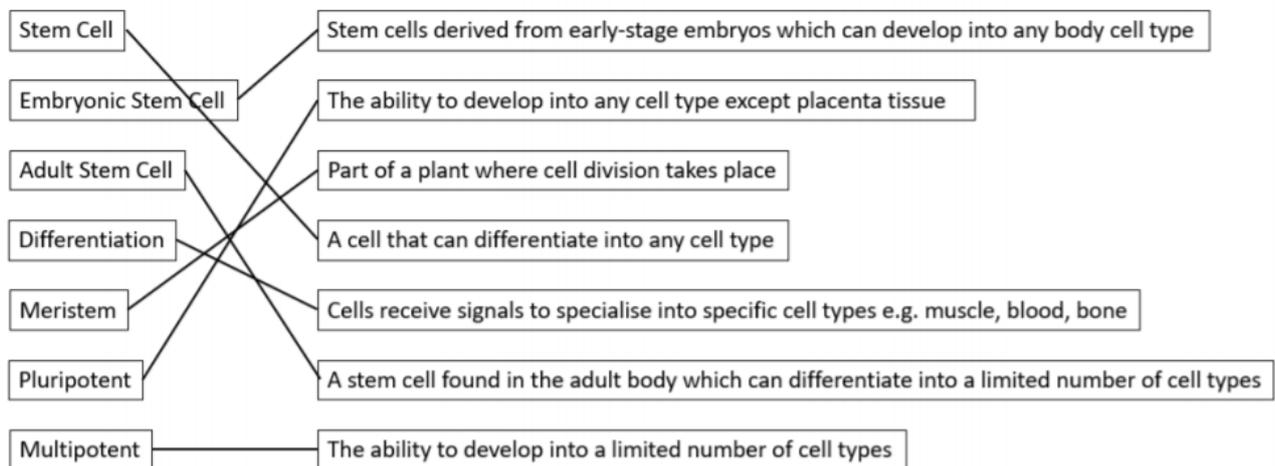
## Tutorial 1.3 – Stem Cells

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

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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\_\_

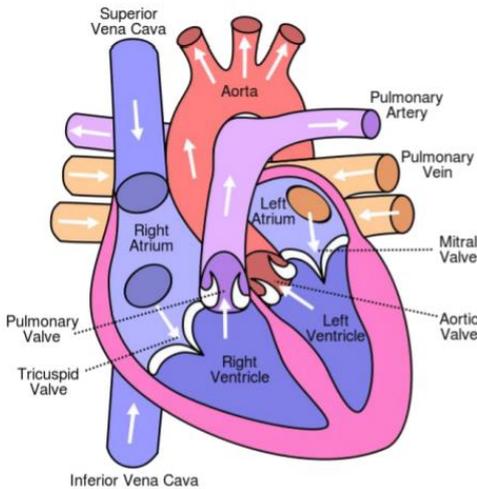
Students need to write correct statements for the false ones: number 2 might confuse them but they need to understand tumour are the result of mass cell division rather than one enlarged single cell.

### 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

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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. Students can complete this online by going to: <https://forms.office.com/r/YSBZVdeFx1>

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 ✓

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