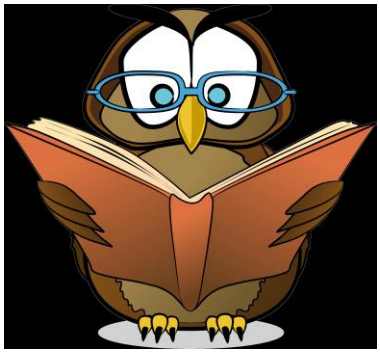


KNOWLEDGE

# ST MARY'S SCIENCE DEPARTMENT:

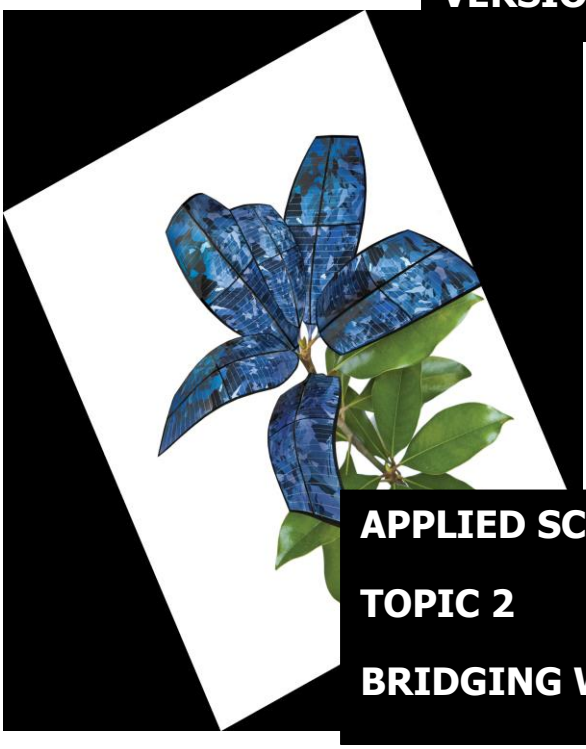
# APPLIED SCIENCE

# APPLIED SCIENCE BRIDGING COURSE
# Cell Structure and Function

**WEEK 2**

| | |
|---|---|
| **NAME** | |
| **CLASS** | |

**VERSION 1.1**



**APPLIED SCIENCE**

**TOPIC 2**

**BRIDGING WORK**

**THIS MUST BE BROUGHT TO LESSONS AT THE START OF YEAR 12.**

**WEEK 1**
**Contents**


**Overview**

This bridging course will provide you with a mixture of information about Extended Certificate Applied Science and what to expect from the course, as well as key work to complete. Students who are expecting to study Extended Certificate Applied Science, and are likely to meet the entry requirements, must complete the bridging course fully and thoroughly, to the best of their ability.

You should complete all work on paper and keep it in a file, in an ordered way. You will submit it to your teacher in September.

All of the work will be reviewed, and selected work will be assessed, and you will be given feedback on it. This work will be signalled to you. If you do not have access to the internet, please contact the school and appropriate resources will be sent to you.

If you are thinking about studying Extended Certificate Applied Science, you should attempt this work to see whether or not you think studying a subject like this is right for you. If you later decide to study Extended Certificate Applied Science, you must ensure you complete this work in full.

**This work should be completed after you have read and completed the Study Skills work that all of Year 12 should complete.**

## Introduction

Welcome to the Science Department at St Mary's Catholic School. I am delighted that you have chosen to study this qualification and hope you feel comfortable with your study environment, and that you value the support you will be given by your teaching staff. This book has been designed to inform you about your programme of study; including the ways you will be assessed and how to fully understand the grade you can achieve on completion.

BTEC courses do work differently to other subjects and you will be expected to work hard both in and out of your lesson to meet coursework deadlines. You will also be presented with many different opportunities to broaden your vocational learning, as this qualification contains a wide range of contemporary topics pertaining to Applied Science. A variety of assessment methods are used, ranging from external exams to course work. Additionally, this BTEC qualification has been designed with employers and representatives from higher education and professional bodies. In this way, the qualification is up to date and covers all of the knowledge, skills and attributes that are required across a range of technical science sectors.

I have high expectations of all students studying this BTEC qualification and all of the teachers in the department have researched and prepared in great depth to ensure that you receive quality teaching. Please use this book to get a feel of what the course is about and to ensure you are fully aware of what is expected of you. The Science Department has planned lots of innovative and creative ways to deliver the programme. This will help to promote your learning and successfully prepare you for the various assessments.

The Science Department has planned an exciting year ahead. We wish you the very best in your academic pathway and we look forward to working with you to achieve great success!

**Course Overview**

The BTEC Applied Science Extended Cerifiicate is a 2 year course comprising of 4 units.

**Year 12**

Unit 1 – 90 GLH
Unit 2 – 90 GLH

**Year 13**

Unit 3 – 120 GLH
Unit 10 – 60 GLH

GLH stands for Guideline Learning Hours, and represents the amount of time you will spend on each part of the course, and also how much each unit contributes to the final grade. You will see that Year 12 and 13 contribute equally to the final grade. In Year 12 Units, 1 and 2 are equally split and will take the same amount of time. In Year 13 Unit 3 contributes 66% of the mark and will take 66% of the time.

Each unit is awarded a grade (Distinction, Merit, Pass or Unclassified). Each grade is worth a certain number of marks.

| | **Unit 1*** | **Unit 2** | **Unit 3*** | **Unit 10** |
|---|---|---|---|---|
| Distinction | 24 | 24 | 32 | 16 |
| Merit | 15 | 15 | 20 | 10 |
| Pass | 9 | 9 | 12 | 6 |
| Unclassified | 0 | 0 | 0 | 0 |

*These units are examined. For examined units marks may be awarded between these boundries. These marks are the minimum you need for a grade.

To arrive at your final grade your marks are added together. The final grade boundries are shown in the table.

| **Grade** | **Points** | **A-Level Equivelent Grade** |
|---|---|---|
| Distinction* | 90 | A* |
| Distinction | 74 | A |
| Merit | 52 | C |
| Pass | 36 | E |

To gain a pass you must achieve a pass in all units. If you fail a unit you will fail the course regardless of your score.

In units 2 and 10, a numbes of assignments contribute to each unit. Your grade for that unit will be the lowest grade you achieve. For example if you achieved a P, M, D, D in Unit 2, your grade for that unit would be a Pass.

**Assessment Schedule**

In Year 12 you will complete Unit 1 and Unit 2

## Unit 2

This will be taught between the start of the year and Christmas.

You will complete 4 assignments

**Assignment A** – Titration and Colorimetry.
You will investigate methods to determine the pH of a solution. You will also use colorimetry to determine the concentration of a solution.

**Assignment B** – Calorimetry.
You will investigate different methods of measuring temperature. You will also use a cooling curve to determine the rate of cooling, and the melting point of different substances.

**Assignment C** – Chromatography.
You will use chromatography techniques to identify substances in a plant leaf extract and a mixture of amino acids.

**Assignment D** – Personal Review.
You will produce an assignment evaluating the personal and technical skills that you have developed over the unit.

This unit will be assessed by your teacher. All work must be submitted by the given deadline. A sample of assignments will be moderated by a Pearson moderator. Remember that you must pass the unit to pass the course, and that the grade awarded will be the lowest one you achieve.

You will be given interim and final deadlines for each assignment which must be met.

**Unit 1**
Unit 1 is made up of Biology, Chemistry and Physics theory, and will be taught by specialist teachers.
The level of difficulty is around that of A-level.

This will be taught between Christmas and May.

You will complete a Biology, Chemistry and Physics exam, each of which are worth 30 marks and last 40 minutes.

Biology

Chemistry

Physics

You are allowed to resit each exam once.

**Aim**

In this bridging course, we will outline the basic principles of the key topics covered in Unit 1.

In each topic, we will start by reviewing the understanding which you gained in GCSE Science and apply it to more advanced applications found in Extended Certificate Applied Science.

This is not a comprehensive overview of the Extended Certificate Applied Science specification, rather a taster on what is covered throughout the course.
This bridging course should give you an experience of the level you will be expected to study at, at the start of Year 12

**Important**

Please remember to look after your own wellbeing as you work through this bridging course.

Please take regular breaks as you go through this work.

This work should take approximately 5 hours, so should not be completed in one sitting.

Do not worry or panic if there is something challenging or which you do not understand at first. This is completely normal.

If you do not understand a concept after reviewing this work, please contact Mr. Turnbull on his school e-mail address.

# **WEEK 2:** BIOLOGY

# RECAP TASK

In the previous week, we looked at key concepts in the Chemistry found in Unit 1 of Applied Science.

This included looking at the principles of electronic structure of atoms, ionic bonding and covalent bonding.

**To recap and assess your understanding, answer the following questions on these topics.**

**1.**
In atoms, electrons fill up the sub-shells in order of increasing energy.

**1.1** Fill in the last two boxes in the table below to show the order in which the next two sub-shells are filled.

**[2 Marks]**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1s | 2s | 2p | 3s | 3p | 4s | | |

energy increases →

Electrons in atoms occupy orbitals.

**1.2** Explain the term **orbital**.

**[1 Mark]**

.....

.....

**1.3** Draw diagrams below to show the shape of an s-orbital and of a p-orbital.

**[2 Marks]**

s-orbital

p-orbital

**1.4** State the **total** number of electrons occupying **all** the p-orbitals in one atom of chlorine.

**[1 Mark]**

.....

.....

**1.5** State the number of electrons present in an ion of calcium, $Ca^{2+}$.

**[1 Mark]**

.....

.....

**Reference:** EdExcel A-Level Chemistry Examination Resources

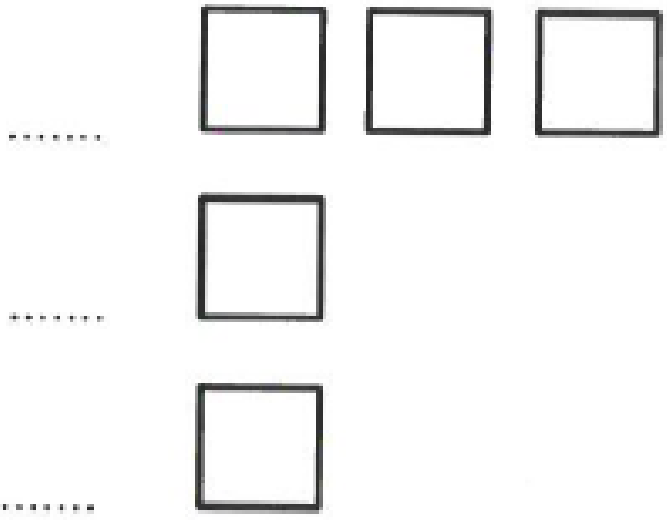
**2.1** Complete the table below

**[4 Marks]**

| | Number of electrons |
|---|---|
| The second electron shell | |
| The 3p subshell | |
| A d orbital | |
| A nitrogen atom | |

**2.2** Fill in the boxes to represent the electronic configuration of an oxygen atom. Label each level.

**[4 Marks]**



**Reference:** Zig Zag Educational Resources

**3.** Copper wire is used in electric cables because it is ductile and a conductor of electricity. The properties of copper are related to its structure.

**3.1** Explain why copper is ductile.

**[3 Marks]**

.....

.....

.....

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**3.2** Explain why copper is a conductor of electricity.

**[3 Marks]**

.....

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.....

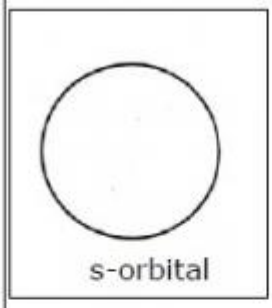
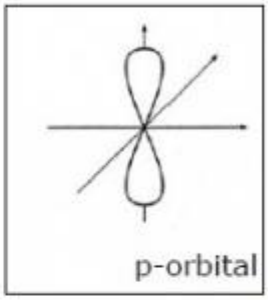
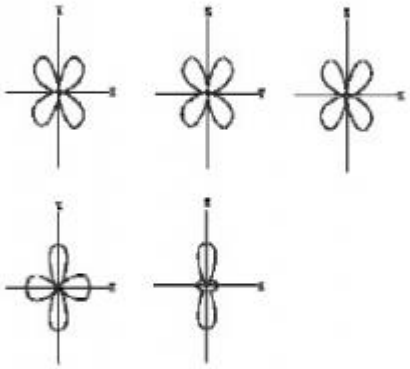
**Reference:** BTEC Applied Science Specimen Materials 3

# ANSWERS

**Q1.**

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1.1** | <table><tr><td>**1s**</td><td>**2s**</td><td>**2p**</td><td>**3s**</td><td>**3p**</td><td>**4s**</td><td>**3d**</td><td>**4p**</td></tr></table><br>3d 4p **(2)**<br><br>ALLOW<br><br>4p 3d scores 1 out of 2<br><br>4p 5s scores 1 out of 2<br><br>ALLOW use of capital letters e.g. "3D and/or 4P" | '4p 4d' or '4d 4p' gets 0 | **2** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1.2** | A region / space / volume (around the nucleus / atom) where there is a high probability / chance / likelihood / of finding an electron<br><br>ALLOW 'area' / 'sub-shell' as alternative for region<br><br>OR<br><br>A region where an electron is likely to be found | Just 'the path an electron takes orbiting around a nucleus'<br><br>Just 'Position of electrons in an atom' | **1** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1.3** |  s-orbital **(1)**  p-orbital **(1)** | For s-orbital do not allow ellipse for first mark<br><br>pi bond<br><br>d-orbitals shown below  | **2** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1.4** | 11 / eleven<br><br>ALLOW $2p^6 3p^5$ | <br><br>$1s^2 2s^2 2p^6 3s^2 3p^5$ | **1** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **1.5** | 18 / eighteen | $1s^2 2s^2 2p^6 3s^2 3p^6$ | **1** |

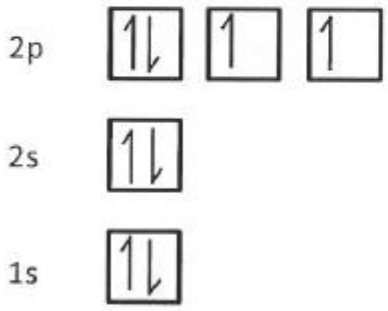
## Q2.

### 2.1

| | Number of electrons |
|---|---|
| The second electron shell | 8 |
| The 3p subshell | 6 |
| A d orbital | 2 |
| A nitrogen atom | 7 |

**[1]** for each correct answer **[4]**

### 2.2




Eight electrons **[1]**
Correct energy levels **[1]**
Paired electrons have opposite spins and unpaired electrons have the same spin **[1]**
Two paired electrons and two unpaired electrons in the 2p subshell **[1]**

**Q3.**

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| **3.1** | atoms are in rows/layers (1)<br><br>that slip/move over each over (1)<br><br>so metal can be drawn into wires without breaking (1) | | 3 |
| **3.2** | metallic structure (1)<br><br>delocalised electrons (1)<br><br>(electrons) carry (electric) charge (1) | accept metallic bonding<br><br>accept sea of electrons | 3 |
| | | | Total marks 6 |

# TOPIC 1: CELL THEORY
# SPEC CHECK

This the key specification points of the Applied Science course for this part of the topic.

| Specification | Learning Outcomes | Completed? |
|---|---|---|
| Know that cell theory is a unifying concept stating that cells are a fundamental unit of structure, function and organisation in all living organisms | • understand that differentiation is the process by which cells become specialised for a particular function from stem cells<br>• know that tissues are collections of similar specialised cells, performing a specific function/set of functions, to include epithelial, skeletal muscle and nervous tissue<br>• know that organs are collections of tissues performing specific physiological functions<br>• understand how organs are organised into systems, to include cardiovascular, respiratory, muscular, nervous systems | |
| Understand the ultrastructure and function of organelles, to include: | • understand the relationship between the ultrastructure and function of cell organelles listed for prokaryotic and eukaryotic (plant and animal) cells | |
| prokaryote cells (bacterial cell) – nucleoid, plasmids, 70S ribosomes, capsule, cell wall | [redacted] | |
| eukaryotic cells (plant and animal cells) - plasma membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum (smooth and rough), Golgi apparatus, vesicles, lysosomes, 80S ribosomes, mitochondria, centriole | | |
| eukaryotic cells (plant-cell specific) - cell wall, chloroplasts, vacuole, tonoplast, amyloplasts, plasmodesmata, pits | | |

# KEY INFORMATION

Read the information found in the key information to understand the concepts of this topic.

All living organisms are made of cells, which share some common features.
They all contain DNA, cytoplasm, ribosomes and have plasma.
However, some of these structures differ in prokaryote and eukaryote cells.
All cells have the four features, although they are not always the same.
For example, bacterial cells have 70S ribosomes, whilst plant and animal cells have 80S ribosomes.

It was not realised that living things are made from cells until Robert Hooke invented the microscope in 1665 and saw cells for the first time in tiny silvers of cork.

Light microscopes are extremely limited as to what they can allow us to see inside cells, because the wavelength of light is the limiting factor.

Electron beams have a much shorter wavelength than beams of light and allow much more detail to be seen through an electron microscope. However, electron microscopes can allow only dead material to be examined.

Bacteria are prokaryotes, made of a single cell with no membrane bound organelles.

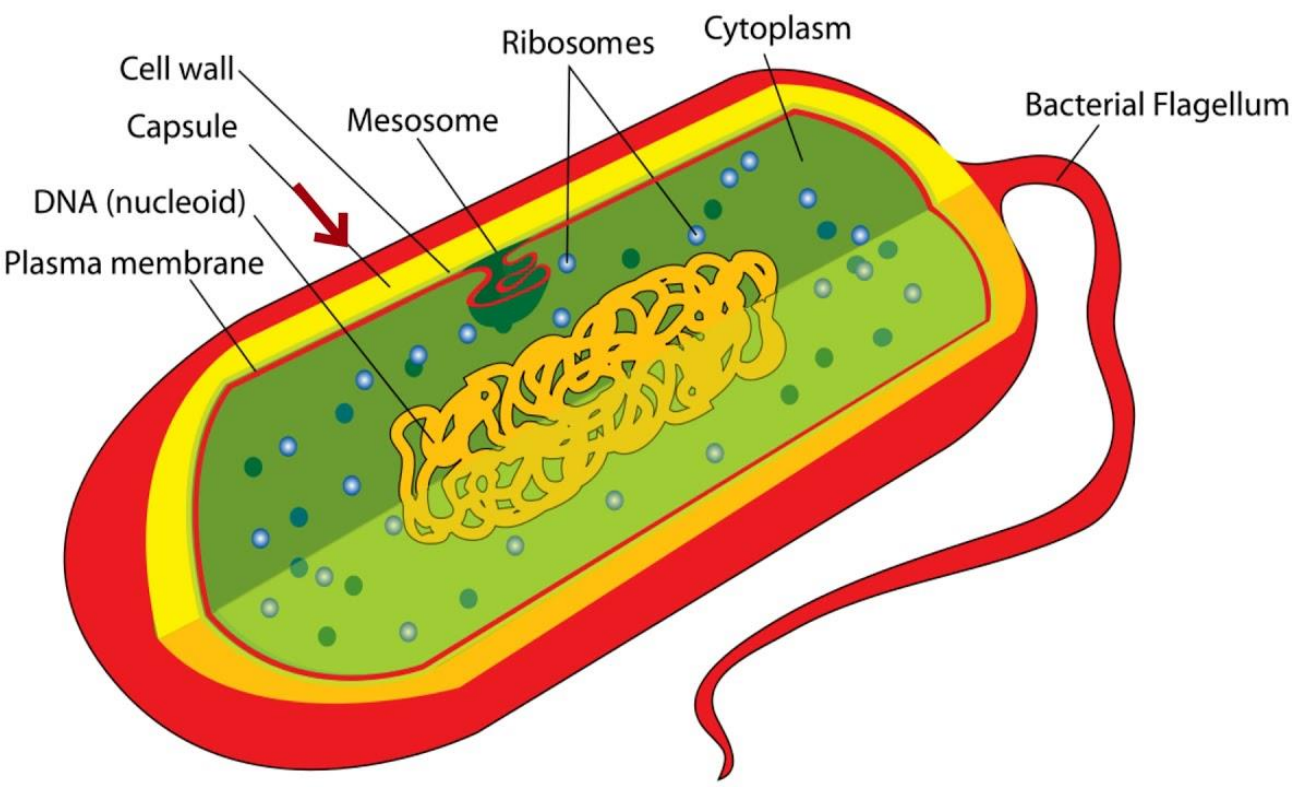
**Plasmids**
Double stranded DNA in a circular structure.
Often contain additional genes that aid the bacterium's survival, such as antibiotic resistance or toxin producing genes.

**Capsule**
Polysaccharide layer outside the cell wall.
Protects cells from drying out, being engulfed by, for example white blood cells.
Helps the cells to stick to the surfaces.

**Ribosomes**
Makes proteins
70S (S is a Svedberg, a measure of size by rate of sedimentation)

**Nucleoid**
Region where single circular, length of DNA is folded.
DNA carries all essential information.

**Cell Wall**
Made of long chained molecule made up of a sugar and amino acids called peptidoglycan.


Ribosomes
Cytoplasm
Cell wall
Capsule
Mesosome
Bacterial Flagellum
DNA (nucleoid)
Plasma membrane

# REVISION SHEET

Highlight or underline the key information on the revision sheet to consolidate your understanding.

| Definitions | |
|---|---|
| **Prokaryote** | a cell that is lacking membrane-bound organelles, with loose, looped DNA |
| **Eukaryote** | a cell with membrane-bound organelles and structured, organised DNA |
| **Nucleoid** | site where DNA is stored in prokaryotes |
| **Tonoplast** | partially-permeable membrane that surrounds the vacuole of plant cells |
| **Centriole** | tubes of microfilaments that form spindle tubules during mitosis |

At the most basic level, cells share astonishing similarities. Cells can be grouped according to the structures that they possess, and can be observed using microscopes.

## Cell theory

Before 1665, the basic structure of life was not understood. Before this time, scientists believed that life emerged spontaneously, through a process known as **spontaneous generation**. While we may think that this idea is absurd today, during this era, without microscopes, knowledge would have relied upon what could be seen – the spontaneous growth of grass from bare soil, mould appearing on rotting food, and animals being born from seemingly spontaneously pregnant adults. The invention of the microscope revolutionised our theory of life, and allowed the development of **cell theory**.

Cell theory states that the cell is the most basic level of life possible. There are three key parts of cell theory:

1. All living organisms are composed of cells – either a single cell, or an arrangement of multiple cells.
2. The cell is the most basic unit of structure, and cells organise and form organisms.
3. Cells cannot form spontaneously, and all cells arise from another cell.

| Definitions | |
|---|---|
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3. Cells cannot form spontaneously, and all cells arise from another cell.

**Credit:** Zig Zag Resources Revision Guide Editions

# VIDEO

To watch a video looking at this concept, please scan one of the following codes with your smartphone.


**Note**

All rights to this video belong to the creator of the video.

This external third-party content – please check the contents are appropriate.

# SELF ASSESSMENT

To practice your understanding, answer the following questions.

**DO NOT WORRY IF YOU STRUGGLE AT FIRST.**

The answers are found after the questions.

**A1.** Why do viruses **not** fit the rules of cell theory?

.....

.....

.....

.....

**A2.** Give **three** features of prokaryotes.

.....

.....

.....

.....

**A3.** How do the ribosomes in prokaryotes differ from the ribosomes in eukaryotes?

.....

.....

**A4.** Which part of a prokaryote is responsible for antibiotic resistance?

.....

.....

**A5.** What is the function of the nucleoid?

.....

.....

# ANSWERS

**A1.** They do not develop from other cells/they are not living.

**A2.** The features of prokaryotes include:
Cell wall made from peptidoglycan
70S ribosomes.
Some contain a capsule.
Smaller ribosomes than eukaryotes.
Contain plasmids.
Genetic material that is not enclosed – it is instead a nucleoid.

**A3.** The ribosomes in prokaryotes are smaller than the ribosomes in eukaryotes.

**A4.** Plasmids are responsible for antibiotic resistance in prokaryotes.

**A5.** The nucleoid contains the genetic information – the DNA in a single loop.

# KEYWORDS

To assess your understanding on this topic, complete this table with the keywords of this topic.

| | |
|---|---|
| The idea that states that all organisms are composed of cells that derive from other cells. | |
| Smallest-scale arrangement of the cell, only visible under a high-powered microscope. | |
| Specialised part within a cell which has a particular function. | |
| Term describing a cell without a nucleus or internal structures surrounded by membranes. | |
| Microscopic prokaryotic cells which can grow and divide very rapidly. | |
| Structure in prokaryotic cells where DNA can be found. | |
| Circular arrangement of DNA that is normally present in prokaryotic cells. | |
| The smaller type of protein-making machinery, found in prokaryotic cells. | |
| Sugar-based outermost layer that surrounds a bacterial cell. | |
| Layer outside the cell membrane in bacteria, which provides protection and helps the cell to maintain its shape. | |
| Bacteria with a thick cell wall which is easily stained with crystal violet dye. | |
| Bacteria with a thin cell wall between two cell membranes, which don't take up crystal violet dye, but absorb a safranin counterstain. | |
| Chemical that is used to kill bacteria. | |
| The material which bacterial cell walls are made from. | |
| Process which all cells carry out; producing proteins using the genetic code of DNA. | |
| Molecule which carries genetic information in all living organisms. | |

# ANSWERS

| | |
|---|---|
| ***Cell theory*** | The idea that states that all organisms are composed of cells that derive from other cells. |
| ***Ultrastructure*** | Smallest-scale arrangement of the cell, only visible under a high-powered microscope. |
| ***Organelle*** | Specialised part within a cell which has a particular function. |
| ***Prokaryotic*** | Term describing a cell without a nucleus or internal structures surrounded by membranes. |
| ***Bacteria*** | Microscopic prokaryotic cells which can grow and divide very rapidly. |
| ***Nucleoid*** | Structure in prokaryotic cells where DNA can be found. |
| ***Plasmid*** | Circular arrangement of DNA that is normally present in prokaryotic cells. |
| ***70S ribosomes*** | The smaller type of protein-making machinery, found in prokaryotic cells. |
| ***Capsule*** | Sugar-based outermost layer that surrounds a bacterial cell. |
| ***Cell wall*** | Layer outside the cell membrane in bacteria, which provides protection and helps the cell to maintain its shape. |
| ***Gram-positive*** | Bacteria with a thick cell wall which is easily stained with crystal violet dye. |
| ***Gram-negative*** | Bacteria with a thin cell wall between two cell membranes, which don't take up crystal violet dye, but absorb a safranin counterstain. |
| ***Antibiotics*** | Chemical that is used to kill bacteria. |
| ***Peptidoglycan*** | The material which bacterial cell walls are made from. |
| ***Protein synthesis*** | Process which all cells carry out; producing proteins using the genetic code of DNA. |
| ***DNA*** | Molecule which carries genetic information in all living organisms. |

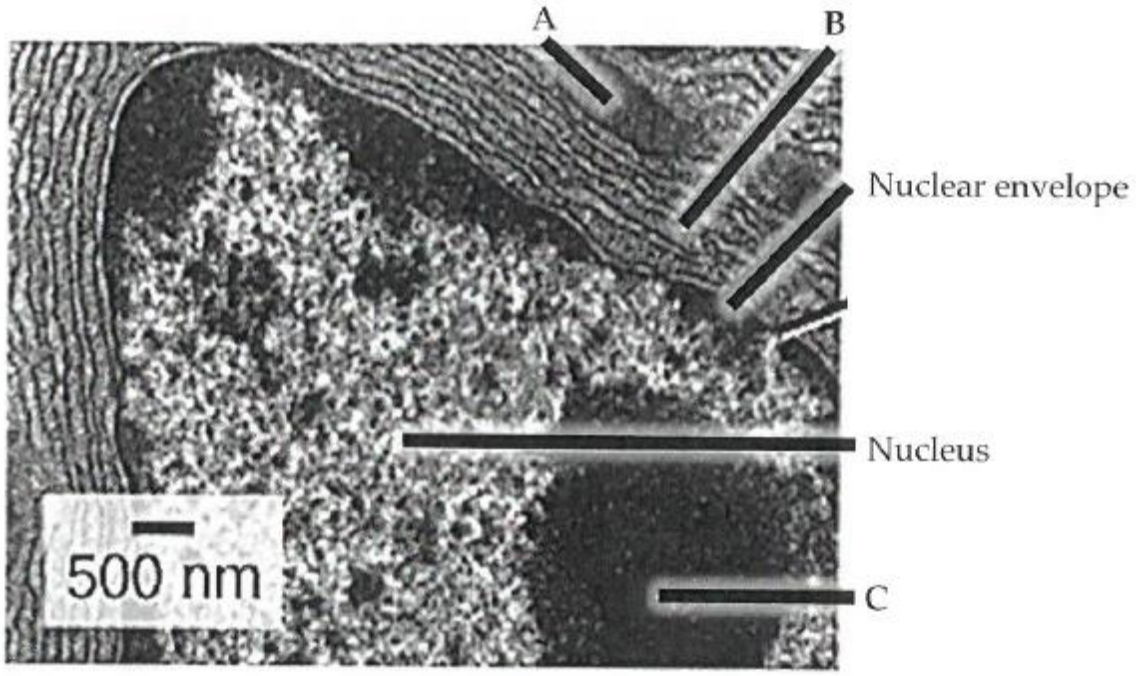
# ASSESSMENT QUESTION

Please answer this assessment question on this topic in Applied Science.

This work will be formally assessed with feedback given.

This work will be submitted at the start of the KS5 course in Year 12.

If we require any help or you wish to receive immediate feedback, please e-mail Mr. Turnbull.




A

**[1 Mark]**

.....

.....

B

**[1 Mark]**

.....

.....

C

**[1 Mark]**

.....

.....

**Reference:** Zig Zag Educational Resources

**2.**

A student studied three different cells: an animal cell, a bacterial cell and a plant cell.

For each of the statements below, put a cross ☒ in the box that corresponds to the correct statement.

**2.1** DNA is located in the nucleus in

**[1 Mark]**

- ☐ **A** the animal cell only
- ☐ **B** the bacterial cell only
- ☐ **C** two of the cells only
- ☐ **D** all three cells

**2.2** A cell wall is present in

**[1 Mark]**

- ☐ **A** the animal cell only
- ☐ **B** the bacterial cell only
- ☐ **C** the plant cell only
- ☐ **D** two of the cells only

**2.3** Centrioles are present in

**[1 Mark]**

- ☐ **A** the animal cell only
- ☐ **B** the plant cell only
- ☐ **C** two of the cells only
- ☐ **D** all three cells

**2.4** A cell surface membrane is found in

**[1 Mark]**

- ☐ **A** the bacterial cell only
- ☐ **B** the plant cell only
- ☐ **C** two of the cells only
- ☐ **D** all three cells

**2.5** Mitochondria are found in

**[1 Mark]**

- ☐ **A** the bacterial cell only
- ☐ **B** the plant cell only
- ☐ **C** two of the cells only
- ☐ **D** all three cells

**2.6** Ribosomes are found in

**[1 Mark]**

- ☒ **A** the animal cell only
- ☒ **B** the bacterial cell only
- ☒ **C** two of the cells only
- ☒ **D** all three cells

**2.7** Smooth endoplasmic reticulum (SER) is present in

**[1 Mark]**

- ☒ **A** the animal cell only
- ☒ **B** the bacterial cell only
- ☒ **C** the plant cell only
- ☒ **D** two of the cells only

**2.8** Amyloplasts may be present in

**[1 Mark]**

- ☒ **A** the animal cell only
- ☒ **B** the bacterial cell only
- ☒ **C** the plant cell only
- ☒ **D** all three cells

**Reference:** EdExcel A-Level Biology Examination Resources

# TOPIC 2: CELL STRUCTURE
# SPEC CHECK

This the key specification points of the Applied Science course for this part of the topic.

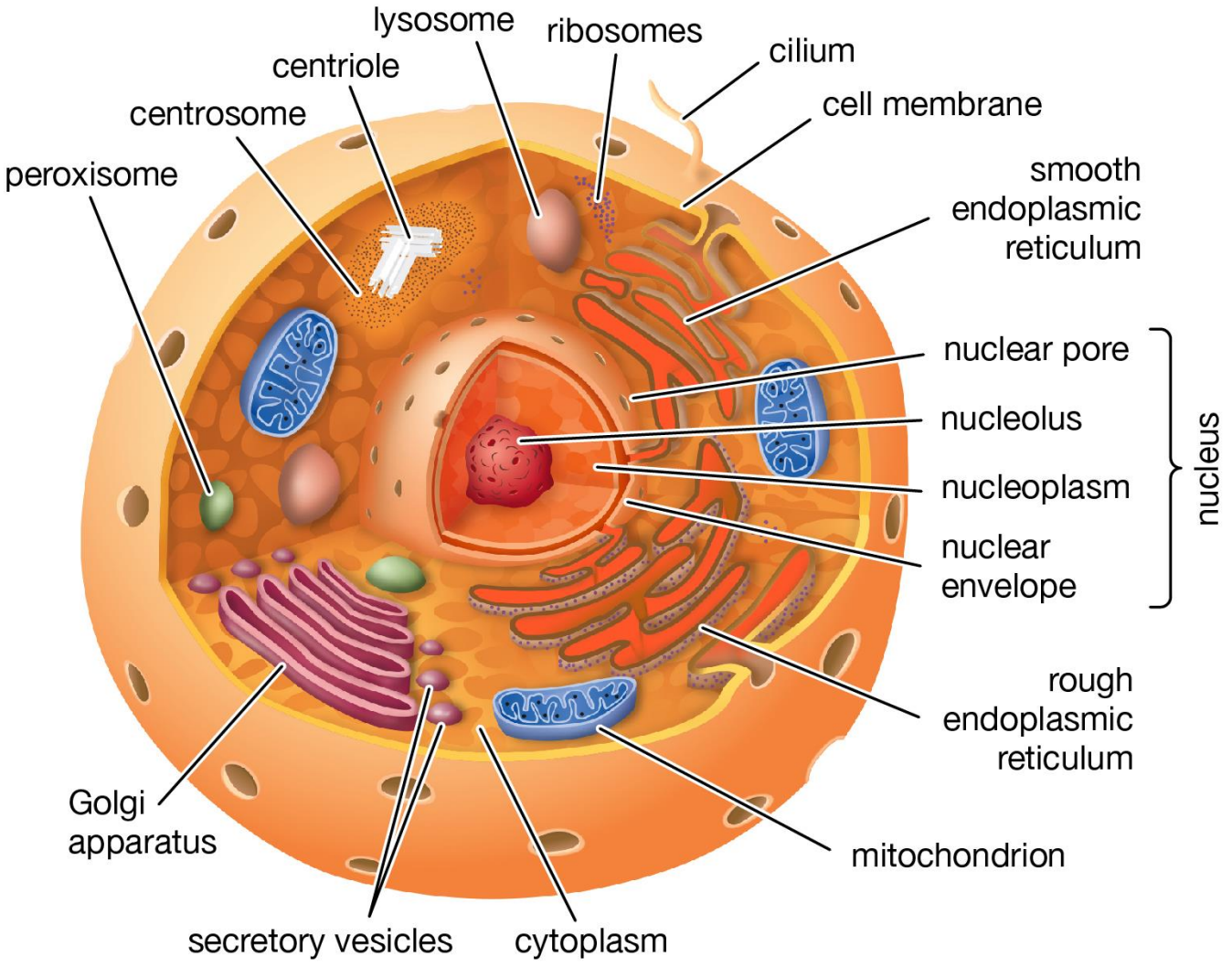
| Specification | Learning Outcomes | Completed? |
|---|---|---|
| Understand the similarities and differences between plant and animal cell structure and function | [redacted] | |

# KEY INFORMATION

Read the information found in the key information to understand the concepts of this topic.

Eukaryotic cells contain organelles, which are structures in cells with specialised functions often bound by a membrane.

## Animal cell






**Plasma Membrane**
Protects cell from its surroundings.
Regulates movement of substances in and out of cells.

**Vesicle**
Small, membrane bound sac.
Transports and stores substances in the cell.

**Nucleolus**
Region of dense DNA and protein.
Makes ribosomes.

**Nucleus**
Surrounded by a double membrane (envelope).
Pores in the nuclear envelope.

**Centrioles**
Two hollow cylinders
Arranged at right angles to each other.
Makes the spindle in cell division.

**Lysosome**
Enclosed by a single membrane.
Containing digestive enzymes.
Destroys old organelles and pathogens.

**Golgi Apparatus**
A series of curved, single sacs enclosed by a membrane.
Many vesicles cluster around the Golgi apparatus.
Modifies proteins and packages them in vesicles for transport.

**80S Ribosomes**
Site of protein synthesis

**Cytoplasm**
Fluid that fills a cell.
Many molecules dissolved in solution (e.g. enzymes).
Site of many metabolic processes.

**Mitochondria**
Surrounded by a double membrane (envelope).
Inner membrane folded into finger like projections called cristae (singular: crista).
Central area contains a jelly called the matrix.
Containing 70S ribosomes and DNA.
Site of respiration.

**sER (Smooth endoplasmic reticulum)**
A series of singular, tubular sacs made of membrane.
Lipids made here.

**eER (Rough endoplasmic reticulum)**
A series of singular, flattened sacs enclosed by a membrane.
Has ribosomes on the surface.
Proteins made here.

**Plant Cells**
Plant are eukaryotes, but their cells differ from those of other eukaryotes such as animals.

Plant cells include all the structures (except centrioles) that are in animal cells as well as:

**Chloroplasts**
For photosynthesis

**Vacuole**
Stores water and other substances

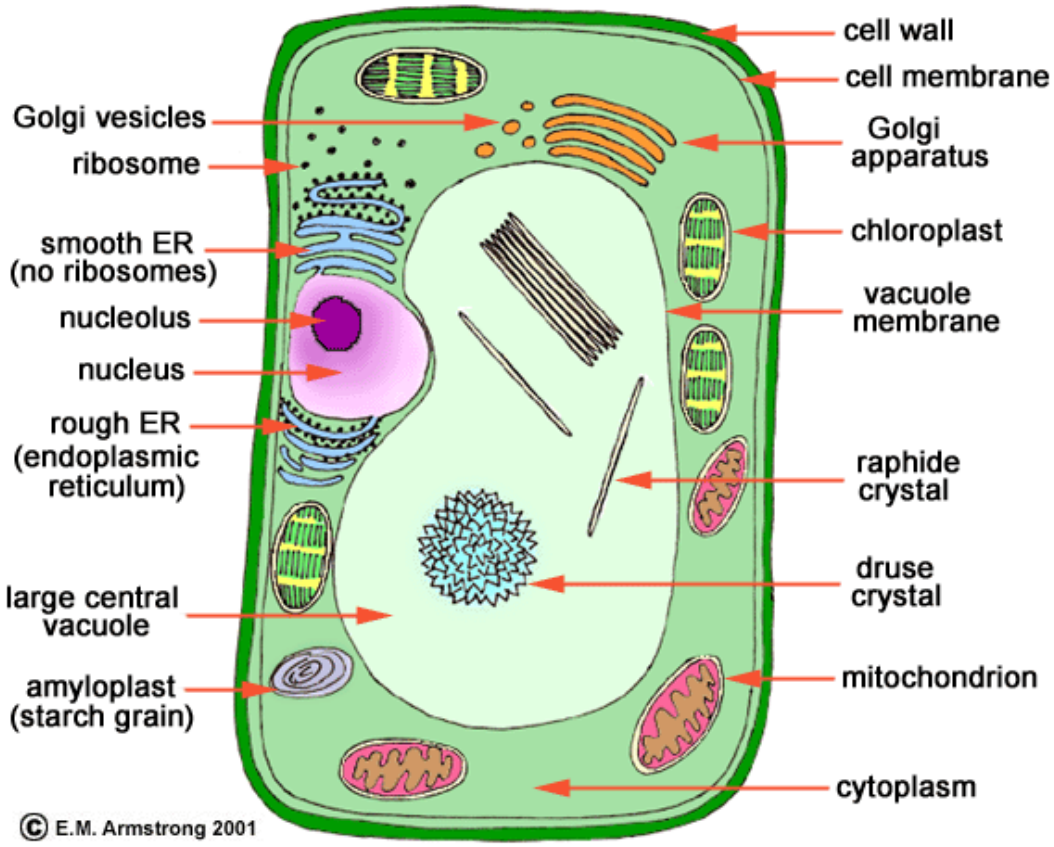
**Tonoplast Membrane**
Controls movement of molecules into and out of the vacuole

**Cell Wall**
For support and protection

**Amyloplasts**
To store starch

**Middle Lamella**
To stick cells together

**Plasmodesmata or Pits**
Allow communication between one cell and another.



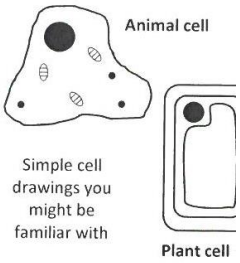
# REVISION SHEET

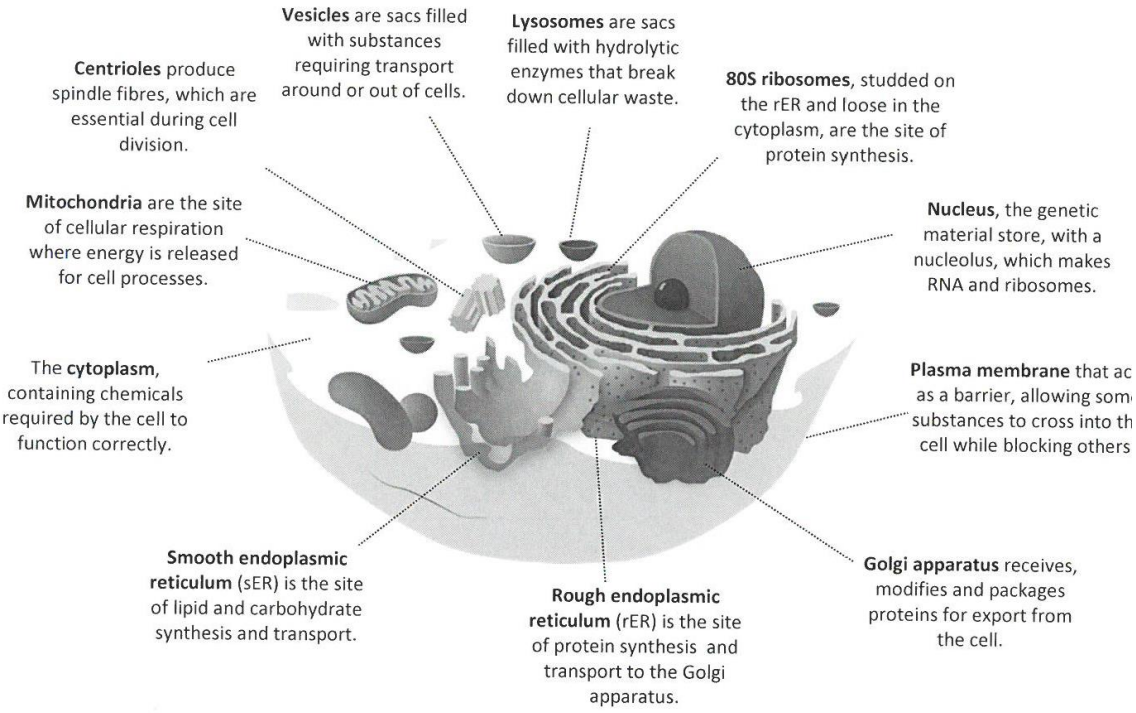
Highlight or underline the key information on the revision sheet to consolidate your understanding.

## Eukaryotes

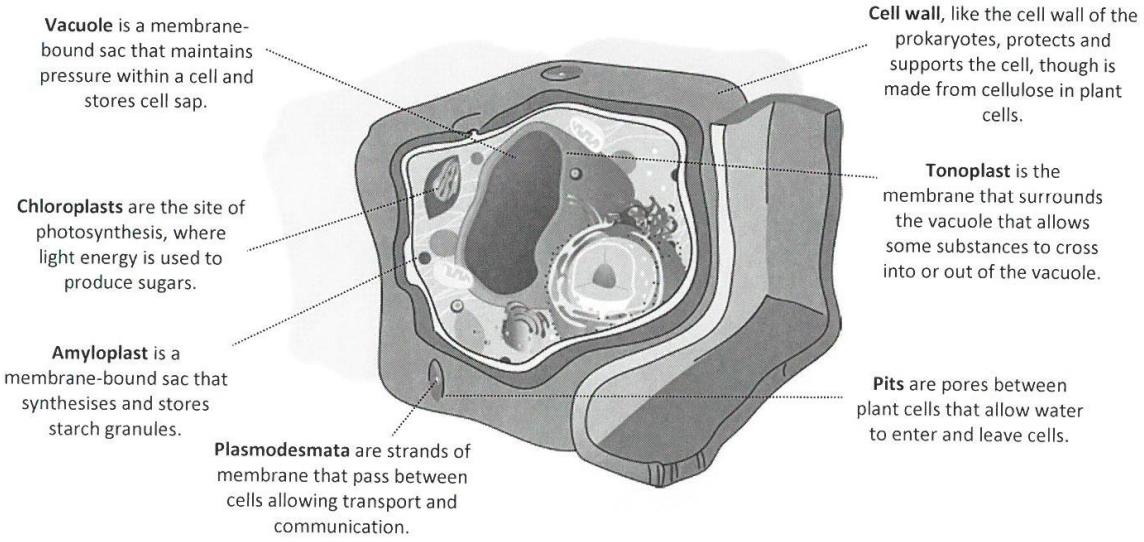
Unlike prokaryotes, eukaryotes contain membrane-bound organelles, including an organised **nucleus** containing the genetic material of the cell. All animal cells and plant cells are eukaryotes.

You might be used to seeing 2D representations of cells such as those shown to the right, but at this level, cells appear far more complex. Several organelles are common to all eukaryotes, regardless of their plant or animal origin. An animal cell is shown below with all of the adaptations that are common to all eukaryotes.




As well as the organelles described above, plant cells have several additional adaptations.



| Key similarities | Key differences |
|---|---|
| Contain membrane-bound genetic material as cell division is slower and more controlled | Chloroplasts are only found in plant cells as only these cells perform photosynthesis |
| Contain a cell membrane to contain the organelles and cell contents | Vacuole is needed in plants as they rely on the vacuole for storage |
| Mitochondria, as respiration is essential and mitochondria are the location for respiration in these cells | Cell wall is needed by plants so the cells can become turgid with water, giving strength and support |

**Credit:** Zig Zag Resources Revision Guide Editions

# VIDEO

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# SELF ASSESSMENT

To practice your understanding, answer the following questions.

**DO NOT WORRY IF YOU STRUGGLE AT FIRST.**

The answers are found after the questions.

**A1.** Which organelles are found in plant cells but not in animal cells?

.....

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**A2.** What is the function of the centrioles?

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.....

**A3.** Why do plant cells need a cell wall but animals do not?

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**A4.** What is the function of the Golgi apparatus?

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# ANSWERS

**A1.** Plant cells have the following organelles which are not found in animal cells, a vacuole, tonoplast, cell walls, chloroplasts, amyloplast, plasmodesmata, pits.

**A2.** Centrioles are required to make the spindle fibres when the cells divide.

**A3.** Animal cells do not need a cell wall because they do not need the same strength and support as plant cells.

**A4.** The Golgi apparatus receives, modifies and packages the proteins for export from the cell.

# KEYWORDS

To assess your understanding on this topic, complete this table with the keywords of this topic.

| | |
|---|---|
| Organism which stores its genetic material in a nucleus. | |
| Structure that acts as a barrier, selectively allowing substances to move in and out of the cell. | |
| Jelly-like substance in which all of the cell's organelles are suspended. | |
| Part of the cell that contains the DNA and controls its activities. | |
| Part of the nucleus which assembles the cell's protein-making machinery. | |
| Organelle with functions including protein folding. Covered in ribosomes. | |
| Organelle whose functions mainly include lipid synthesis and metabolism. | |
| Organelle that packages and modifies substances such as proteins, and produces vesicles. | |
| Small cellular structure that consists of a lipid bilayer filled with fluid. | |
| Small organelle containing enzymes that break down biological materials. | |
| A larger version of the cell's protein-making machinery, which is specific to eukaryotic cells. | |
| Site of respiration in cells. | |
| Cell organelle that is the source of spindle fibres. | |
| Site of photosynthesis in plant cells. | |
| Adaptation of plant cells and algae that maintains the strength of the cell, and prevents bursting. | |
| Permanent space in plant cells that is surrounded by a membrane, and filled with cell sap. | |
| Membrane which surrounds a plant cell's permanent storage structure. | |
| Organelle used for storing starch in plant cells. | |
| Thread of cytoplasm that passes between cells, allowing movement of molecules. | |

# ANSWERS

| | |
|---|---|
| ***Eukaryote*** | Organism which stores its genetic material in a nucleus. |
| ***Plasma membrane*** | Structure that acts as a barrier, selectively allowing substances to move in and out of the cell. |
| ***Cytoplasm*** | Jelly-like substance in which all of the cell's organelles are suspended. |
| ***Nucleus*** | Part of the cell that contains the DNA and controls its activities. |
| ***Nucleolus*** | Part of the nucleus which assembles the cell's protein-making machinery. |
| ***Rough endoplasmic reticulum*** | Organelle with functions including protein folding. Covered in ribosomes. |
| ***Smooth endoplasmic reticulum*** | Organelle whose functions mainly include lipid synthesis and metabolism. |
| ***Golgi apparatus*** | Organelle that packages and modifies substances such as proteins, and produces vesicles. |
| ***Vesicle*** | Small cellular structure that consists of a lipid bilayer filled with fluid. |
| ***Lysosome*** | Small organelle containing enzymes that break down biological materials. |
| ***80S ribosomes*** | A larger version of the cell's protein-making machinery, which is specific to eukaryotic cells. |
| ***Mitochondria*** | Site of respiration in cells. |
| ***Centriole*** | Cell organelle that is the source of spindle fibres. |
| ***Chloroplasts*** | Site of photosynthesis in plant cells. |
| ***Cell wall*** | Adaptation of plant cells and algae that maintains the strength of the cell, and prevents bursting. |
| ***Vacuole*** | Permanent space in plant cells that is surrounded by a membrane, and filled with cell sap. |
| ***Tonoplast*** | Membrane which surrounds a plant cell's permanent storage structure. |
| ***Amyloplast*** | Organelle used for storing starch in plant cells. |
| ***Plasmodesmata*** | Thread of cytoplasm that passes between cells, allowing movement of molecules. |

# ASSESSMENT QUESTION

Please answer this assessment question on this topic in Applied Science.

This work will be formally assessed with feedback given.

This work will be submitted at the start of the KS5 course in Year 12.

If we require any help or you wish to receive immediate feedback, please e-mail Mr. Turnbull.

**1.** The pancreas is responsible for producing a large number of different proteins for the digestion of food substances.
Suggest the cell organelles that will be most abundant in the pancreatic cells, explaining the reason for each.

**[3 Marks]**

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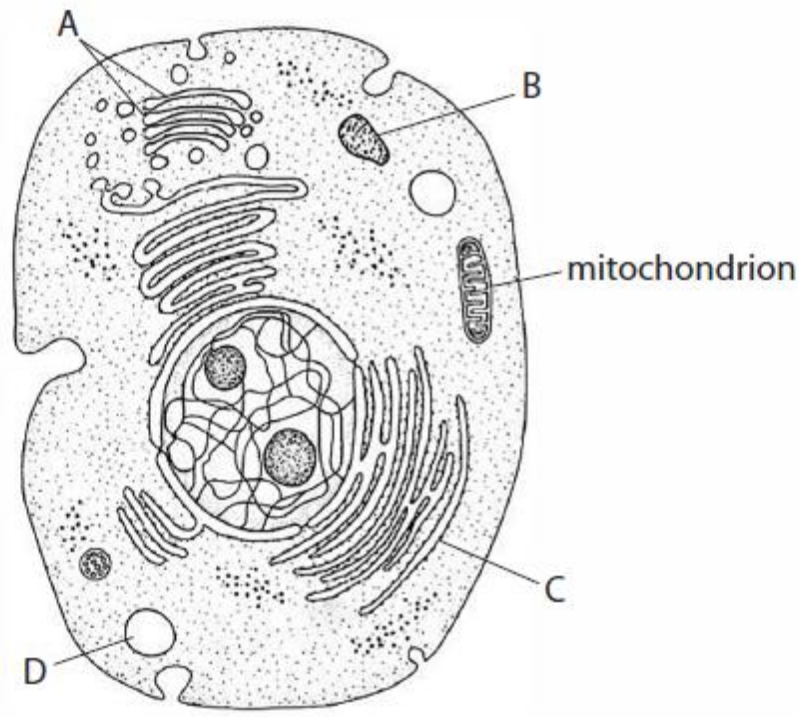
**Reference:** Zig Zag Educational Resources

**2. Figure 1** shows the ultrastructure of an animal cell.




(Source: http://m.everythingmaths.co.za/science/lifesciences/grade-10/02-the-basic-units-of life/images/5aaa292660adc2b15e6153c598f3ff07.jpg)

**Figure 1**

**2.1** Which part of this cell is the Golgi apparatus?

**[1 Mark]**

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

**2.2** State **two** functions of the Golgi apparatus.

**[2 Marks]**

.....

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**2.3** Name an organelle found in a plant cell that is not present in this animal cell.

**[1 Mark]**

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The actual length of the mitochondrion in the animal cell is 10.0 µm.
**2.4** Calculate the magnification of the mitochondrion in the image.
Show your working.

**[2 Marks]**

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Mitochondria contain DNA. Mutations in the DNA in mitochondria can cause mitochondrial disease. These mutations can be inherited.
In 2015 the UK became the first country in the world to allow 'three-parent' babies.
Producing a 'three-parent' baby removes the risk of the baby inheriting mutated DNA.
**Figure 2** shows some of the steps involved in producing a 'three-parent' baby.
DNA is found in the mitochondria and in the nucleus of a cell.

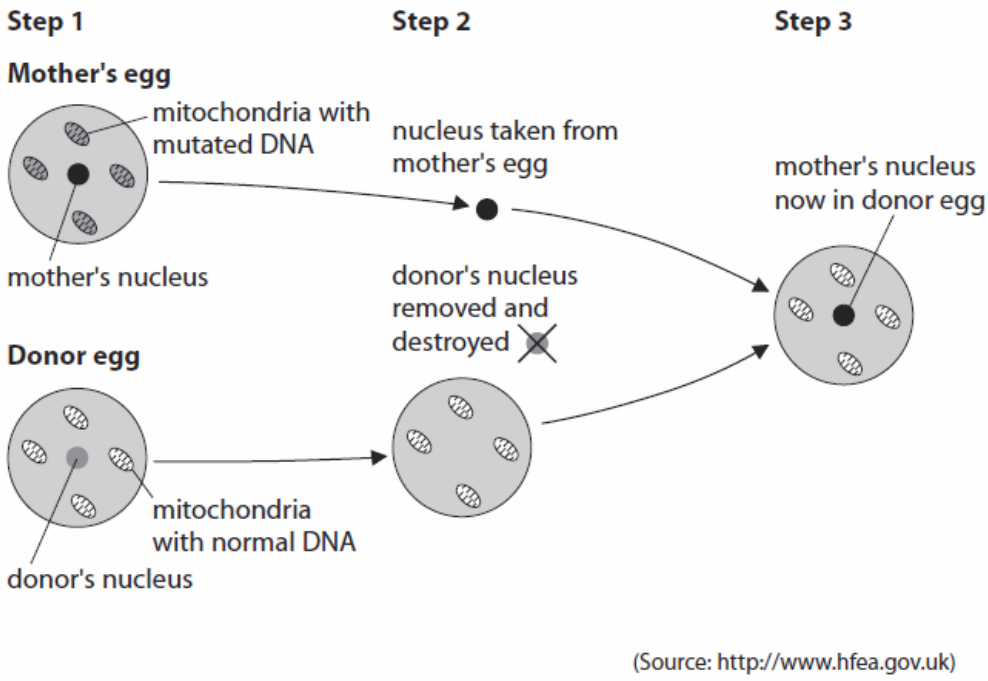



**Figure 2**

**2.5** Complete **Table 1** to show the source of the DNA that contributes to a 'three-parent' baby.

**[3 marks]**

| Parent | Source |
|---|---|
| Mother | |
| Donor | |
| Father | |

**Table 1**

**Reference:** BTEC Applied Science Specimen Materials 1

# TOPIC 3: GRAM STAINING
# SPEC CHECK

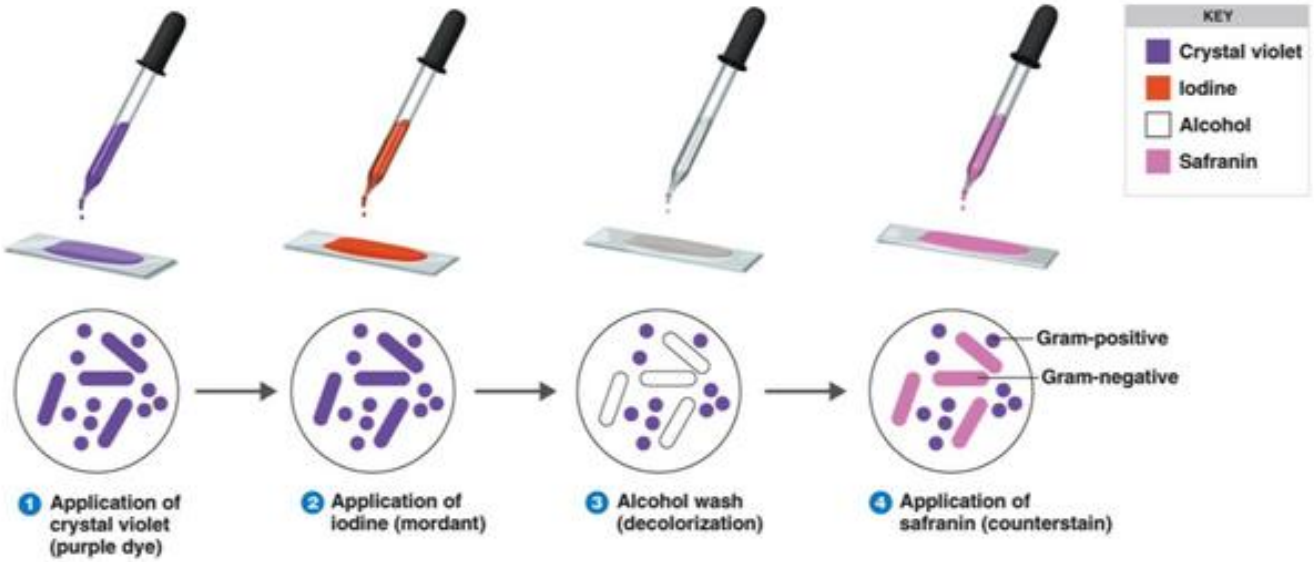
This the key specification points of the Applied Science course for this part of the topic.

| Specification | Learning Outcomes | Completed? |
|---|---|---|
| Understand how to distinguish between Gram-positive and Gram-negative bacterial cell walls and why each type reacts differently to some antibiotics | Know how to carry out the Gram stain to distinguish between Gram positive and Gram-negative bacteria<br><br>Understand that Gram positive bacteria have a wall made of a thick layer of peptidoglycan and no outer lipopolysaccharide membrane<br><br>Understand that Gram negative bacteria have a wall made of a thin layer of peptidoglycan and an outer lipopolysaccharide membrane<br><br>Understand that Gram positive bacteria are susceptible to some antibiotics, such as penicillin, that can damage the peptidoglycan layer<br><br>Understand that Gram negative bacteria are not susceptible to some antibiotics, such as penicillin, because the peptidoglycan layer is protected by the lipopolysaccharide outer membrane which is not susceptible to some antibiotics | |

# KEY INFORMATION

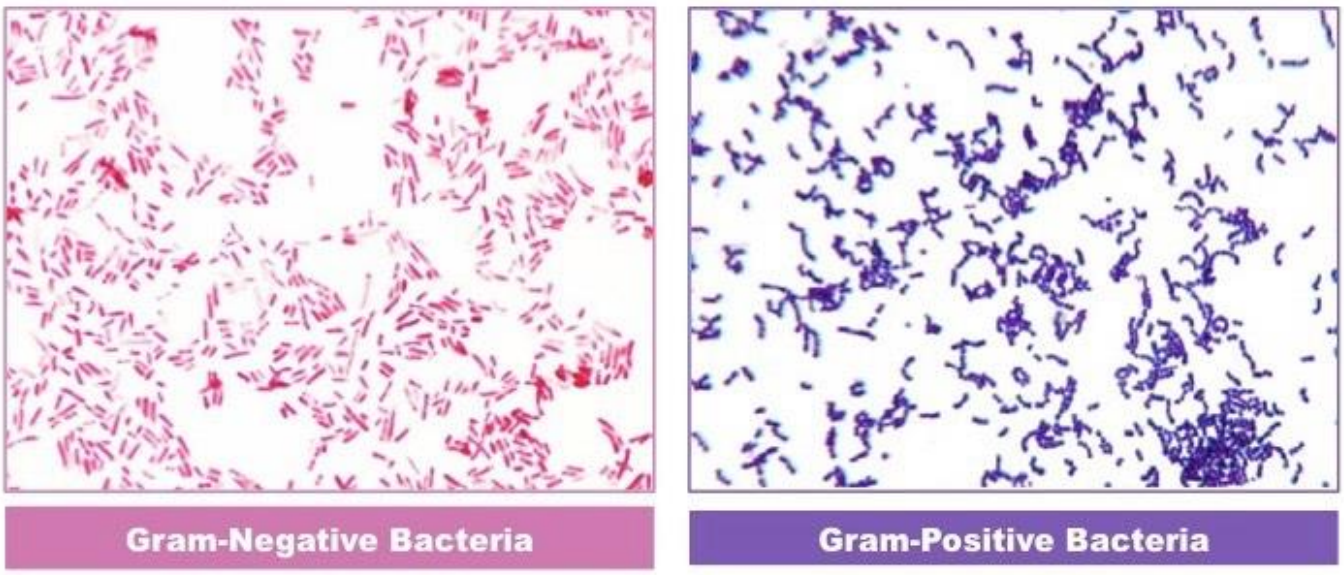
Read the information found in the key information to understand the concepts of this topic.

Gram staining is a test used to differentiate between different types of bacteria.
Below is the process of a gram stain test.




**Gram-negative** bacteria **do not** retain the gram stain (crystal violet) when washed with acetone and absolute alcohol because their cell wall has an outer layer.

**Gram -positive** bacteria **do** retain the gram stain because the thick peptidoglycan wall absorbs the stain and they do not have an outer wall.




Gram -negative bacteria are more resistant to antibiotics than gram-positive bacteria. This is because gram-negative bacteria have a cell wall with an outer membrane, which protects them from antibiotic.

# REVISION SHEET

Highlight or underline the key information on the revision sheet to consolidate your understanding.

**Definitions**

| | |
|---|---|
| **Bacteria** | prokaryotic organisms that can produce toxins that damage cells and cause illness |
| **Stain** | substance applied to a slide or sample of cells that identifies a particular molecule or cell type |
| **Counterstain** | substance applied to a slide or sample of cells that contrasts cells from their background |

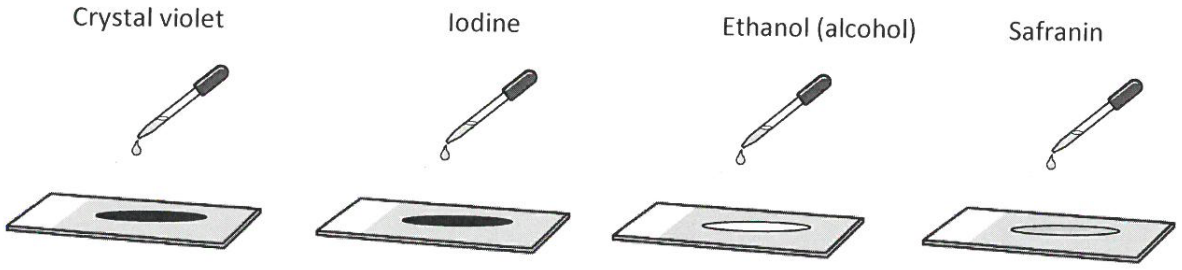
At present, the total number of identified bacterial species is approximately 10,000, while estimates suggest that the true number of different bacterial species could be in the region of $10^{19}$, though it is likely that we will never come into contact with the vast majority of these.

In spite of this, it is important to place some sort of order on the characteristics of different bacteria. In 1882, Danish biologist Hans Christian Gram devised his method of categorising bacteria, denoting all bacteria as either Gram positive or Gram negative.

## Gram staining

The Gram staining method relies on the structure of the cell wall of bacteria. Therefore, because animal cells do not contain a cell wall, animal cells cannot be Gram stained. Stains are applied, and the specific nature of the wall determines the result of the stain.

1. Bacterial culture is smeared onto a slide.
2. Heat is applied to fix the bacteria onto the slide.
3. Crystal violet stain is applied to the fixed bacteria.
4. Iodine is applied to trap crystal violet onto cell.
5. Alcohol is applied to rinse excess stain from the slide.
6. Counterstain e.g. safranin is applied to stain unstained bacteria.




Gram-positive bacteria remain **purple** as a result of the crystal violet stain, while the Gram-negative bacteria are **pink/red** as a result of safranin.

Gram-positive bacteria have a **thick peptidoglycan** cell wall, which dehydrates upon addition of alcohol, and traps the stain inside. Gram-negative bacteria have a more complex cell wall, with **a fatty layer** surrounding the peptidoglycan cell wall. When alcohol is applied, the stain is easily removed from the cell wall, removing the purple stain and allowing the safranin to be seen.

Antibiotics will respond differently to the two groups:

1. **Penicillin** stops the synthesis of the cell wall in Gram-positive bacteria, killing the bacteria.
2. Gram-negative bacteria **will not respond** to penicillin in the same way, thus a different treatment is required.

**Credit:** Zig Zag Resources Revision Guide Editions

# VIDEO

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# SELF ASSESSMENT

To practice your understanding, answer the following questions.

**DO NOT WORRY IF YOU STRUGGLE AT FIRST.**

The answers are found after the questions.

**A1.** Describe the steps you would take to Gram stain a bacterial culture.

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**A2.** What colour will Gram-positive bacteria turn, and what colour will Gram-negative bacteria turn? Which stains are these colours changes the result of?

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**A3.** Why would Gram staining **not** work on an animal cell?

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**A4.** Suggest why a patient infected with a Gram-negative bacterium will not respond to penicillin?

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# ANSWERS

**A1.** First, a smear a bacteria culture onto a slide and heat it to fix it to the slide. Next, apply crystal violet stain and iodine to trap the crystal violet onto the cell. Rinse the slide with alcohol and apply counterstains to stain any unstained bacteria.

**A2.** Gram positive bacteria remain purple from the crystal violet stain. Gram negative bacteria turn pink/red from safranin.

**A3.** Gram staining would not work with an animal cell as it requires a cell wall.

**A4.** Gram negative bacteria have a thin cell wall with two lipid layers.
Penicillin works by stopping the synthesis of components of the Gram-positive cell wall.

# ASSESSMENT QUESTION

Please answer this assessment question on this topic in Applied Science.

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This work will be submitted at the start of the KS5 course in Year 12.

If we require any help or you wish to receive immediate feedback, please e-mail Mr. Turnbull.

**1.** Bacterial cells can be classified as either gram negative or gram positive using a test.
**1.1** What part of a bacterial cell determines the result of the test

**[1 Mark]**

| | | |
|---|---|---|
| A | Nucleoid | |
| B | Plasmid | |
| C | Cell wall | |
| D | Ribosome | |

**1.2** How is this test performed?

**[5 Marks]**

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**1.3** How the result of this test be used to decide the method of treatment for bacterial diseases?

**[2 Marks]**

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**Reference:** Zig Zag Educational Resources

**2.** In a hospital laboratory, a bacterial culture is isolated from a patient.
The patient's infection has caused a chesty cough and phlegm production.
The laboratory technician suggests performing a Gram test.

**2.1** Outline the procedure for performing a Gram test.

**[4 Marks]**

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**2.2** What do Gram stain results indicate about the ultrastructure of the bacteria?

**[2 Marks]**

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**1.3** What does this information suggest about the response of the bacteria to antibiotics?

**[1 Mark]**

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**Reference:** Zig Zag Educational Resources

**EXTENSION**

To further extend your understanding in the Applied Science course to prepare yourself for Year 12 course, read over information on the following topics:

Microscopy – Light and Electron Microscopes

Epithelial Tissues

Blood Vessels and Atherosclerosis

Fast and Slow Twitch Muscles

Nerve Tissues

Nerve Impulses

Synapses

**Acknowledgements**

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This document has been produced for the Applied Science Extended Certificate Specification.

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Only constructive and reasoned feedback will be considered.