Scheme of work

Biology – Cell biology

This resource provides guidance for teaching the Cell biology topic from our new GCSE in Biology. It has been updated from the draft version to reflect the changes made in the accredited specification. In particular minor changes have been made to the wording of the required practical – Microscopy in section 4.1.1.2, In addition some minor changes have been made in the specification made to sections 4.1.1.2 Animal and plant cells, 4.1.1.4 Cell differentiation and section 4.1.2.3 Stem cells. These alterations have not required changes to the scheme of work.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

**4.1 Cell biology**

**4.1.1 Cell structure**

The specification mentions a range of specialised cells and offers opportunities to use a microscope again later on in the course.

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes** *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources** *Reference to past questions that indicate success* |
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| 4.1.1.2 | Animal and plant cellsSection 4.2.1 Principles of organisation, is covered at KS3 so the content could be recapped now, rather than later in the course.Most animal cells have a nucleus, cytoplasm, membrane, mitochondria and ribosomes.Plant and algal cells also have a cell wall and often have chloroplasts and a permanent vacuole.Functions of the organelles.Required practical: MicroscopyUse a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included. | Label diagrams of animal and plant cells.Describe the function of the main organelles.Prepare slides of plant and animal cells and describe the procedure.Correctly use a microscope to observe cells under different magnifications.Describe the order of size of: cell, nucleus, chromosome and gene. | 2 | Recap cell structure from KS3 by drawing an animal and a plant cell on mini white boards. Class to vote on which are the best and why.Display diagrams of a plant and animal cell - students spot the difference between the two.Label diagrams of plant and animal cells.Complete a card sort to match the organelle to the function.Construct a table to compare animal to plant cells. Include organelles and processes that they carry out (eg respiration, photosynthesis and protein synthesis).Prepare slides and observe using a microscope.Watch video clips on plant and animal structures.Make a plant or animal cell model. | Prepare slides of onion epidermis, rhubarb epidermis, cheek cells, spirogyra, moss etc.Observe under a microscope. Make labelled drawingsModel plant and animal cells. | Observation activity materials:* microscopes
* slides
* coverslips
* tiles
* forceps
* mounted needles
* cotton buds
* iodine solution
* methylene blue
* onion
* rhubarb
* spirogyra
* moss.

[National Stem Centre – Cells and organ systems](http://www.nationalstemcentre.org.uk/elibrary/list/12273/cells-and-organ-systems)Video clips:[BBC Bitesize –Cells and their uses Classroom Resources](http://www.bbc.co.uk/education/topics/zqjpyrd/resources/1) |
| 4.1.1.34.1.1.4  | Cell specialisationCell differentiationCells differentiate to form different types of cells. Animal cells differentiate at an early stage, whereas many plant cells can differentiate throughout life. Differentiation is the generation of specialised cells which acquire different organelles to enable them to carry out specific functions.Cells may be specialised to carry out a particular function. | Explain the need for differentiation in a multicellular organism. Describe the differences between differentiation in plants and in animals.Explain how specialised cells are adapted for their function.  | 1 | Write a job description for a newspaper for each type of specialised cell (xylem, sperm cell, red blood cell etc), eg: ‘Sperm cell wanted- must be a strong swimmer…’ This could be done using ICT.Watch video clips showing specialised plant and animal cells.What am I? Describe the key features of different specialised cells - students guess the cell type. | Observe prepared slides of specialised cells under the microscope, or use bioviewers.Observe root hair cells under a microscope in sprouting mung beans. | Observation activity materials:* microscopes
* slides
* coverslips
* sprouting mung beans
* prepared slides
* bioviewers
* slide strips.

Video clip:[BBC Bitesize –Plant and animal cell structures](http://www.bbc.co.uk/education/clips/znk9wmn) |
| 4.1.2.3 | Stem cellsTopic can be delivered after Cell differentiation, or later in the course as the technology involved relates to 4.6.2.5 Cloning. Stem cells are unspecialised cells that can differentiate to form many different types of cells. Stem cells from human embryos and adult bone marrow can be cloned and made to differentiate into different cells, eg nerve cells.Stem cells may be used to treat paralysis and diabetes in the future.In therapeutic cloning an embryo with the same genes as the patient is produced. Cells from this embryo will not be rejected by the patient.Risks eg transfer of viruses, associated with the use of stem cells in medicine.Stem cells from meristems in plants are used to produce clones quickly and cheaply. | Define the term ‘stem cell’.Describe where stem cells can be found in animals and plants.Describe in simple terms how nerve cells genetically identical to a patient could be obtained.Describe how stem cells could be used to help treat some medical conditions.Evaluate risks and benefits, as well as the social and ethical issues concerning the use of stem cells from embryos in medical research and treatments.Stem cells in plants – see 4.6.2.5 Cloning. | 1 | Watch a video clip showing cell differentiation in plants and animals.Watch the stem cell story at Europe’s stem cell website.Tell the story of Christopher Reeve (show photos of Superman or watch the Superman trailer) and get students to suggest how stem cells could be used to treat other people with paralysis.Provide a circus of different stem cell related articles which cover current uses, potential uses as well as pros and cons. Students circulate to complete a summary table on uses, pros and cons.Watch the Teacher’s TV video about the use of stem cells and Parkinson’s treatment. Students have different roles and must prepare and present their arguments in favour of or against the use of embryonic stem cells (eg doctor, person with diabetes, human rights activist). | Use of models. | [Europe’s stem cell hub – Stem cell videos and films](http://www.eurostemcell.org/films)[Wellcome Trust –Medical uses of stem cells](http://www.wellcome.ac.uk/About-us/Policy/Spotlight-issues/Human-Fertilisation-and-Embryology-Act/Stem-cell-basics/WTD040067.htm) [BBC Bitesize –Stem cells](http://www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/genetics/cloningstemcellsrev2.shtml)National Institute of Health – [Stem Cell Information](http://stemcells.nih.gov/Pages/Default.aspx)Teachers TV:[KS3/4 Science - Stem Cell Research - Resources - TES](https://www.tes.co.uk/teaching-resource/teachers-tv-ks3-4-science--stem-cell-research-6047949)[Daily News Articles - stem cells | The Scientist Magazine®](http://www.the-scientist.com/?articles.list/categoryNo/2884/category/Daily-News/tagNo/47/tags/stem-cells/)[Stem cells | Science | The Guardian](http://www.theguardian.com/science/stem-cells) |
| 4.1.1.1 | Plant and animal cells are eukaryotic cells which have a membrane, cytoplasm and a nucleus.Bacterial cells are prokaryotic cells. They are smaller than eukaryotic cells and have a cell wall, membrane and cytoplasm, but do not have a nucleus. Their genetic material is a single loop of DNA or several small rings of DNA called plasmids in the cytoplasm. | Identify plant, animal and bacterial cells and classify them as eukaryotic or prokaryotic cells.Label diagrams of bacterial cells.Describe the differences between eukaryotic and prokaryotic cells in terms of structure and size. | 1 | Develop an argument for and against bacteria cells to be classified as plants or animals.Label a diagram of a bacterial cell.Construct a table to compare the structure of plant, animal and bacterial cells. Use Teachit interactive resources about cells of animals, plants and bacteria. | Observe images of different types of bacterial, plant and animal cells and classify them as plant, animal or bacterial; eukaryotic or prokaryotic cells. | Assessment material:[Cells and simple cell transport B2.1 Powerpoint](http://filestore.aqa.org.uk/subjects/gcsescienceassessment/B2-1-CELLS-AND-SIMPLE-CELL-TRANSPORT.PPT)  |
| 4.1.1.5 | MicroscopyAn electron microscope has a much higher magnification and resolution than a light microscope, so it can be used to study cells in much finer detail and show organelles.$$real size=\frac{image size}{magnification}$$ | Describe the differences in magnification and resolution of light and electron microscopes.Explain how electron microscopy has increased understanding of organelles.Calculate the magnification of a light microscope.Carry out calculations using the formula:$$real size=\frac{image size}{magnification}$$Rearrange the equation to calculate image size or magnification.Convert values for the units: cm, mm, µm and nm. | 1 | Use a variety of resources to research the differences between a light microscope and an electron microscope.Use online materials to make a display of cell images from a light microscope and from an electron microscope.Write a newspaper article entitled: ‘Microscope…..the best invention ever!’ where students explain the significance of the microscope and discuss what the world would be like if microscopes were never invented.Calculate the real size of microscope images, and convert units as appropriate.Rearrange the equation to calculate a different unknown. | Use online and printed materials to calculate the real sizes of cells and structures.Limited to the differences in magnification and resolution. **Extension work** Use a microscope with graticule to measure cells and calculate their real size. | Observation activity materials:* microscope
* graticule
* prepared slides
* calculator.
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| 4.1.1.6 | Culturing microorganismsLinks with sections 4.3.1.1, 4.3.1.8 and 4.3.1.9 which could be taught with section 4.3 Infection and response. Students will require some knowledge of antibiotics before carrying out the Required practical. See sections 4.3.1.8 and 4.6.3.7.Bacteria multiply by simple cell division (binary fission) as often as once every 20 minutes if they have enough nutrients and a suitable temperature.Bacteria can be grown in a nutrient broth solution or as colonies on an agar gel plate.Uncontaminated cultures of microorganisms are required for investigating the action of disinfectants and antibiotics.Procedure to prepare an uncontaminated culture.Required Practical: MicrobiologyInvestigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.  | Know that bacteria multiply by simple cell division. Know how bacteria can be grown.Know procedure to prepare an uncontaminated culture. Explain why cultures are incubated at a maximum temperature of 25°C.Describe why uncontaminated cultures are necessary in research. | 1 | How many bacteria would be made during the lesson if there was:1. 1

or 1. 10 bacteria to start with.

Discuss what bacteria would need to multiply. Demo the techniques of producing inoculated agar plates. Explain importance of each step to partner or produce a technician’s guide to inoculating plates for research. If you’re not doing required practical at this point, do further work on comparing growth of bacteria on different students’ plates. Calculate the number of bacteria in a population after a certain time given the mean division time.Calculate cross sectional area of colonies.  | Preparation of inoculating plates. |  |

**4.1.2 Cell division**

This section of the specification contains some difficult concepts, which you may want to teach later in the course.

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| 4.1.2.1 | ChromosomesChromosomes are found in the nucleus. They are made of DNA. Each chromosome carries a large number of genes.In body cells chromosomes are found in pairs. | Describe what a chromosome is and where chromosomes are found in the cell. | 0.5 | Draw and label diagrams showing cell, nucleus, chromosome and gene.Consider the scale of these structures.Observe images of human karyotypes as seen under the microscope and arranged into pairs. Students could attempt to arrange chromosome images into pairs.This could be extended to show karyotypes of males, females, Down syndrome and Turner syndrome. Discuss the differences and suggest what the possible reasons and consequences of these differences are.Research on chromosome abnormalities. | Observe chromosomes using bioviewers or prepared slides. | Observation activity materials:* microscopes
* prepared slides
* bioviewers.

National Human Genome Research Institute:[Chromosome Abnormalities Fact Sheet](https://www.genome.gov/11508982) |
| 4.1.2.2 | Mitosis and the cell cycleThis topic could be left until later and taught with Asexual reproduction in 4.6.1.Mitosis occurs during growth or to produce replacement cells.During mitosis: * copies of the genetic material separate
* the cell then divides once to form two genetically identical cells.

Mitosis forms part of the cell cycle. | Describe simply how and why body cells divide by. Knowledge and understanding of the stages in mitosis are **not** required.Draw simple diagrams to describe mitosis.Draw a simple diagram to describe the cell cycle in terms of:* cell growth, when the number of organelles increases
* replication of chromosomes, so the genetic material is doubled
* separation of the chromosomes: division of the nucleus
* division of the cell to form two identical cells.
 | 1 | Watch video clip showing mitosis.Discuss how organisms grow and relate this to cell division.Observe mitosis in cells.Role play the process of mitosis or use plasticine, pipe cleaners, beads etc to make a simple model.Draw simple diagrams to describe the cell cycle and mitosis.Activity: What would happen if…? eg1. ….DNA did not replicate?
2. …..chromosomes did not line up down the middle?
3. …..organelles did not replicate?
 | Use bioviewers or root tip squashes to show chromosomes and mitosis. Model mitosis. | Video clip:[BBC Bitesize –Stages of mitosis or cell division](http://www.bbc.co.uk/education/clips/z7tkq6f)[BBC Bitesize – The building blocks of cells](http://www.bbc.co.uk/schools/gcsebitesize/science/add_edexcel/cells/) (first part of Mitosis and meiosis)Observation activity materials:* bioviewers
* microscopes
* slides
* coverslips
* root tips.

Nuffield Foundation- Investigating mitosis in allium root tip squashAnimation:[Animal Cell Mitosis](http://www.cellsalive.com/mitosis.htm)  |
| 4.1.2.3 | Stem cellsThis topic is covered in section 4.1.1 - it links to Cell differentiation, 4.1.1.4. Alternatively, you may want to create a separate section about biotechnology where stem cell research, genetic engineering and cloning could be taught together. |  |  |  |  |  |

**4.1.3 Transport in cells**

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| 4.1.3.1 | DiffusionSubstances can move into and out of cells across membranes by diffusion.Definition of diffusion and factors affecting rate.Oxygen, carbon dioxide and urea passes through cell membranes by diffusion.Single celled organisms have a bigger surface area to volume ratio than multicellular organisms, so transfer sufficient substances across their surface.Multicellular organisms require specialised organ systems to exchange sufficient substances.Factors affecting the effectiveness of an exchange surface. | Define the term ‘diffusion’.Explain how temperature, concentration gradient and surface area affect the rate of diffusion.Give examples of substances that diffuse into and out of cells.Calculate and compare surface area: volume ratios.Explain how the small intestine and lungs in mammals, and roots and leaves in plants, are adapted for exchange of substances.Describe and explain how an exchange surface is made more effective. | 2 | Observe demos and suggest explanations:* Time how long it is before students can smell a perfume placed in a corner of the room.
* Is the rate of diffusion different for different gases? Use concentrated ammonium hydroxide and hydrochloric acid in a large glass tube.
* Does temperature affect the rate of diffusion? Fresh beetroot placed in iced water and warm water.

Record observations and suggest explanations.Watch a video or computer simulation of diffusion on BBC or McGraw-Hill website.Role play diffusion in gases and liquids at different temperatures and concentrations.Observe micrographs of exchange surfaces in plants and animals. Make drawings and relate structure to function.Produce a mind map to summarise diffusion and exchange surfaces. | Choose investigations as appropriate:* potassium permanganate in beaker of water; potassium permanganate on agar
* investigate diffusion of different acids and alkalis through agar
* investigate rate of diffusion of glucose through cellulose tubing
* use digital microscope to observe diffusion of particles in milk or yogurt solution.

Model diffusion.Observe slides or micrographs of villi, alveoli, root hair cells and leaves. Calculate surface area: volume ratios for different sized objects or using data about organisms. | Demo materials:* strong perfume
* concentrated NH4OH
* concentrated HCl
* gloves
* mask
* forceps
* cotton wool
* long glass tube with strips of damp litmus along length
* beetroot
* beakers
* kettle
* ice
* two gas jars of NO2
* two empty gas jars.

Optional demo materials:* beaker of water
* pot perm
* crystals
* straw
* forceps
* agar in test tube or Petri-dish
* agar plates impregnated with UI solution
* cork borers
* solutions of acids and alkalis
* beakers
* cellulose tubing
* glucose solution
* timers
* test tubes
* Benedict’s solution and water bath or glucose test strips.

Activity:[BBC Bitesize - Movement across cell membranes](http://www.bbc.co.uk/education/guides/zc9tyrd/activity)McGraw-Hill Higher Education:[Animation: How Diffusion Works](http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_diffusion_works.html) |
| 4.1.3.2 | OsmosisWater may move across cell membranes by osmosis.Osmosis is the movement of water from a dilute solution to a more concentrated solution through a partially permeable membrane.Required Practical: OsmosisInvestigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue. | Define the term ‘osmosis’.Apply knowledge of osmosis to unfamiliar situations and make predictions. | 2 | Set up a simple osmometer at the start of the lesson and measure how far the liquid in the capillary tube rises during the lesson.Explain the movement of water molecules as a special type of diffusion through a partially permeable membrane.Predict and explain what will happen to cellulose tubing bags filled with water or sugar solution, placed in beakers of water or sugar solution.Observe and explain the effects of water and concentrated salt solution on cells of onion/ beetroot/ rhubarb.Use a model to show osmosis or get students to make a model.Watch a computer simulation of osmosis in plant and animal cells.Watch a video clip of osmosis in blood cells. | Make predictions with explanations.Investigate the effect of water and concentrated salt solution on onion/ beetroot/ rhubarb cells.Model osmosis. | Demos:1) Cellulose tubing filled with conc sugar solution attached to capillary tube held in clamp, beaker of water.2) Four beakers (two of water and two of sugar solution); four cellulose sausages (two of water and two of sugar solution).Observation activity materials:* living plant cells: onion/ beetroot/ rhubarb
* microscopes
* slides
* coverslips
* water
* concentrated solution
* pipettes
* blotting paper.

Model materials: * clear plastic box
* plasticine for membrane
* different sized balls for water and solute.

[Animation: How Osmosis Works](http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_osmosis_works.html)Video clip:[BBC Bitesize – Movement across cell membranes](http://www.bbc.co.uk/education/guides/zc9tyrd/video)  |
| 4.1.3.3 | Active transportThis topic is covered in section 4.2.3.2 Plant organs and referred to when teaching digestion and absorption. There are links with 4.3.3.1 Plant diseases. |  |  |  |  |  |