Scheme of work

Combined Science: Synergy
Transport over larger distances

This resource provides guidance for teaching the Transport over larger distances topic from our new GCSE in Combined Science: Synergy (8465). It has been updated from the draft version to reflect the changes made in the accredited specification. There have been some changes to the required practicals and minor changes in the specification content in sections; 4.2.1.1 Respiration, 4.2.1.3 – 4.2.1.7, 4.2.2.3 – 4.2.2.6 and 4.2.2.8 Plant diseases.

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.

4.2 Transport over larger distances

4.2.1 Systems in the human body

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4.2.1.1	Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen). Aerobic respiration is an exothermic reaction represented by word and symbol equations. glucose + oxygen carbon → dioxide + water An exothermic reaction is one that transfers energy to its surroundings. Organisms need energy for: • Chemical reactions to build larger molecules • Movement • Keeping warm.	State that all animals and plants produce carbon dioxide and water all the time as a by-product of aerobic respiration. Write the word equation for aerobic respiration. Define the term 'aerobic'. Describe what organisms need energy for. Describe tests for carbon dioxide and water. State the site of aerobic respiration and be able to give examples of cells that contain a lot of	1	Show energy drink, glucose tablets and a plant. Discuss substance the body uses as a source of energy and what aerobic means in order to build up the word equation for aerobic respiration. Demonstrate burning food is an exothermic reaction. Watch BBC video clip about respiration. Discuss how to show that humans transfer energy and produce water and carbon dioxide. Relate these observations to the word equation for aerobic respiration. Recap that mitochondria in cells are the site of aerobic respiration (links to 4.1.3.2).	Consider a bottle of Lucozade, glucose tablets and a plant. Demonstrate the release of energy from food. Investigate inhaled and exhaled air. Demonstrate that animals and plants in the dark respire and release carbon dioxide. Demonstrate that germinating peas/ seeds transfer energy as heat. Observe results in following lesson. Observe EM images of mitochondria in different types of cells and make conclusions.	Exampro user guide PowerPoint Discussion prompts for considering energy release: • bottle of Lucozade • glucose tablets • plant. Demonstration of release of energy: • mounted needle or tongs • piece of food • boiling tube of water • thermometer. Video clip: BBC Bitesize – Aerobic respiration

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		mitochondria (links with 4.1.3.2). Define the term 'metabolism'. Give examples of reactions in metabolism.		Discuss examples of cells that will contain many mitochondria. Discuss what metabolism means and examples of the reactions that make up metabolism. Does energy transfer between cells? Students research the role of ATP in energy transfer and link to mitochondria.	Show diagrams of 'classic' experiments, eg mouse in bell jar with or without a green plant, with sufficient annotations to enable students to deduce the rationale and findings of the investigations.	Exhaled air demonstration: • carbon dioxide in inhaled and exhaled air apparatus • limewater • mirrors • cobalt chloride paper • thermometers. Demonstrating evidence of respiration in an animal: • two bell jars connected to two containers of limewater that air is passing through via tubes (first container is fitted with thistle funnel

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						containing soda lime) • pump to draw air through system • small animal • plant • black paper. Demonstrating energy transfers as heat: • soaked peas/ seeds • boiled and cooled peas • thermos flasks with temperature probes.
4.2.1.1 cont.	Anaerobic respiration in muscles is also exothermic but it gives out less energy. It is represented by the word equation: glucose → lactic acid	Define the term 'anaerobic'. Explain why anaerobic respiration is less efficient than aerobic respiration.	1	Mini-practical: star jumps, jog on spot for 1 minute – what do you notice? Why have these changes happened? Plan an investigation about the effects of exercise on the body.	Investigate the effect of exercise on heart rate, breathing rate, depth of breathing and temperature. Investigate effect of muscle fatigue on	BBC Bitesize – Aerobic and anaerobic respiration Timer, pulse sensor and spirometer if available.

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	Because the oxidation of glucose is incomplete in anaerobic respiration much less energy is given out than in aerobic respiration. If insufficient oxygen is supplied, anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a buildup of lactic acid and creates an oxygen debt. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.	Write the word equation for anaerobic respiration in animal cells. Describe and explain the changes that occur in the body during exercise. Design and carry out an investigation about the effects of exercise on the body. Present and interpret data about heart rate, breathing rate and breath volume. Interpret data relating to the effects of exercise on the body, eg spirometer tracings. Describe the effects of long periods of vigorous exercise on the body.		Interpret line graphs and spirometer tracings to compare rate of breathing before, during and after exercise. Use spirometer tracings to calculate breathing rate and depth of breathing. Interpret data on heart rate, temperature and depth of breathing during exercise. Interpret data to compare how fit different people are. Discuss causes and effects of muscle fatigue and relate these to lactic acid build up. Watch a video showing sprinters and discuss how the body reacts at the end of the race – paying back the oxygen debt. YouTube has a variety of videos of marathon runners struggling over the finish line	muscle strength and produce an article for a fitness magazine. Investigate how long it takes muscles to fatigue – repetitive actions, eg step ups, holding masses at arm's length or holding arm aloft and opening/closing fingers rapidly. Interpret spirometer traces. Calculate breathing rate and depth of breathing. Interpret data and draw conclusions. Show graphs of lactic acid concentration and speed or fitness. Students relate the data to the lesson and give a reasoned explanation.	Muscle strength meters. Timers and masses. AQA resources: PowerPoint B2.6 Aerobic and anaerobic respiration

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		Define the term 'oxygen debt'. Explain what happens to lactic acid once exercise stops.		– use them as a discussion starter, eg: Fantastic Marathon finishes and the agony of the feet or Extraordinary Human Beings in Slow Motion at the Twin Cities Marathon Finish Line		
4.2.1.2	A single-celled organism has a relatively large surface area to volume ratio. The tissues of a multicellular organism consist of cells with a similar structure and function. Organs, such as the heart and lungs, are made of tissues. One organ may consist of several tissues. Organ systems, such as the circulatory system, are groups of organs that perform a particular function.	Explain the terms cell, tissue, organ, organ system and organism, and be able to give examples of each. Have an understanding of the size and scale of cells, tissues, organs, organ systems and organisms.	1	Calculate and compare surface area: volume ratios Recap KS3 work on organisation using models and images of the human body and organs. Prepare a set of cards with images of different body organs and ask students to arrange the cards into organ systems. What is the function of each organ within its system? Students agree criteria to help them evaluate how effective different parts of the	Add boiling water to two different sized beakers and take temperature over 5–10 minutes. Plot line graphs and students suggest reasons for differences. Work out the SA:volume ratio. Working collaboratively, students investigate relationship between surface area and volume. Groups make one cube each 1 × 1 × 1 – 10 × 10 × 10. Discuss link between	Torso, models or images of systems, models or images of organs showing different tissues. Microscope slides or bio-viewers.

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	In multicellular organisms many organ systems are specialised for exchanging materials. The effectiveness of an exchange surface is increased by: • having a large surface area • a membrane that is thin, to provide a short diffusion path • (in animals) having an efficient blood supply • (in animals, for gaseous exchange) being ventilated.			body are at allowing diffusion.	SA, volume and diffusion. Students draw graphs: length of side against SA; against volume; against SA:volume ratio. Describe overall trends. Discuss implications for diffusion and how a circulatory/transport system enables larger organisms to develop. Use graphs to estimate other SA:volume ratios. MS 1c Calculate and compare surface area:volume ratios.	
4.2.1.3	The heart is a muscular organ that pumps blood around the body in a dual circulatory system.	Describe the functions of the heart and circulatory system	3	Describe the functions of the heart and circulatory system. Show pictures of a single and a double circulatory system. Students write down	Demo: show a model heart and identify the chambers, main blood vessels and valves.	Model heart Teachit Science resources (19772) 'Modelling the circulatory system'

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	The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body. Valves prevent the blood from flowing back from the ventricles to the atria. Knowledge of the names of the heart valves is not required. Blood vessels associated with the heart include the aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries. Gas exchange takes place in the lungs. Important features of the lungs are the trachea, bronchi, alveoli and the capillary network surrounding the alveoli. The alveoli have the specialised surfaces for gas exchange between air and the blood.	Describe and label a diagram of the heart showing four chambers, vena cava, pulmonary artery, pulmonary vein and aorta. Describe the flow of blood from the body, through the heart and lungs and back to the body. Explain how the heart is adapted for its function. Describe the heart as a double pump and explain why this is efficient. Explain how the alveoli are adapted for efficient gas exchange. Explain how the blood vessels are		similarities and differences. Discuss the reasons why. Use computer simulation to show the flow of blood around the heart, lungs and body. Students model the circulatory system. Label a diagram of the heart and colour to show oxygenated and deoxygenated blood. Describe the flow of blood by sorting cards with names of blood vessels, chambers, lungs and body to show direction of blood flow. Research the work of Galen and William Harvey and produce a report. Recap KS3 work on the structure and function of the gas exchange system. Use a model and identify the main	Demo: Heart and lungs of a pig to show the associated vessels. Allow students to feel the vessels. Show students how to dissect their pig hearts and identify the vessels. Dissect a pig's heart. See Nuffield Foundation Practical Science suggestions. Show lungs and trachea of a sheep from a local butcher. Identify the main structures and discuss the roles. Inflate the lungs with a bicycle pump. Observe prepared slides of the different vessels, or use bio-viewers. Compare their size and structure.	Demo: heart and lungs of pig with vessels attached, board, scissors, mounted needle, gloves. Dissection: hearts with vessels attached, boards, scissors, mounted needles, gloves. Practical Biology: Looking at a heart BBC Bitesize; The human heart (video clip showing heart and pacemaker cells). Activity: Cards to sort The structure of the heart Torso or model of gas exchange system.

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	The natural resting heart rate is controlled by a group of cells that act as a pacemaker, located in the right atrium. Artificial pacemakers are electrical devices used to correct irregularities in the heart rate. The body contains three different types of blood vessel: • arteries • veins • capillaries.	adapted for their function.		organs in the gas exchange system. Label a diagram of the gas exchange system. Label a diagram of the alveoli and explain how they are adapted for efficient gas exchange. Use computer simulation or video clip showing the three types of blood vessels and comparing their functions. Extract information to explain the structure of the blood vessels. Label diagrams of the three types of blood vessel. Produce a table to compare the structure of the vessels and relate to their function. Demo: how valves in veins prevent backflow of blood using someone with prominent veins. Students	Students compare three types of blood vessel in a Venn diagram or similar. Measure pulse rate and blood pressure – lying down, sitting and standing.	Sheep lungs and trachea (PLUCK), bicycle pump Microscopes, prepared slides, bio-viewers. The blood vessels Pulse and blood pressure: timers or pulse rate sensor, blood pressure monitor. Teachit Science: heart and circulatory system resources

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				explain the principles of valve action. MS 1a, 1c Use simple compound measures such as rate. MS 1a, 1c Carry out rate calculations.		
4.2.1.4	Blood is a tissue consisting of plasma, in which are suspended: • red blood cells • white blood cells • platelets	Describe the four main components of blood. Explain how each component is adapted for its function. Identify pictures of the different blood cells.	1	Discuss the functions of blood and describe the four main components of blood. Draw and label diagrams of red blood cells, white blood cells and platelets. Students list the substances dissolved in plasma. How may these change over time? Watch BBC lesson about blood with animations (see resources). Produce models of red blood cells, white blood cells and platelets.	Observe prepared blood smears, or use bio-viewers. Compare the size and number of red and white blood cells. Given data, students construct a diagram showing the percentage of each main component of blood.	Microscopes, prepared slides or bio-viewers. BBC Bitesize: Blood

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				Produce a Mind map to explain the composition of blood and describe the functions of plasma, red blood cells, white blood cells and platelets. Write a word equation for the reaction of oxygen with haemoglobin.		
4.2.1.5	The digestive system uses enzymes to break down large molecules in food into small soluble molecules that can be absorbed into the blood through the walls of the gut. The blood carries the small molecules to the cells of the body where they can be used for respiration or to make the new large molecules that the cells need as reserves of energy or for growth and repair.	Describe the functions of the digestive system to digest and absorb foods. Identify the positions of the main organs on a diagram of the digestive system. Know that food molecules must be small and soluble in order to be absorbed into the blood. Describe how amino acids are broken	2	**Required practical 7**: use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars, iodine test for starch and Biuret reagent for protein. Biology AT 2. Recap the functions of the digestive system, and organs in the system from KS3. Label a diagram of the digestive system and colour areas where digestion, digestion and absorption of	Demonstrate the digestion show: • mouth is potato masher in a bowl (add food and mash). Squirt in saliva • transfer into a sandwich bag (stomach) and squeeze with 'enzymes' • transfer into another bowl via a sieve (small intestine)	Model of the digestive system and organs. BBC Bitesize: Digestive system • Two bowls • Masher • Food • Bottle of 'saliva' and 'enzymes' • Sieve • Two sandwich bags • Scissors • Microscopes

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	Starch is a carbohydrate. Its molecules consist of a long chain of glucose molecules. Digestion by carbohydrase enzymes breaks down insoluble starch to water-soluble glucose. Cells use glucose during respiration. Lipids are fats and oils. Digestion by lipase enzymes breaks down lipids to glycerol and fatty acids. Cells reform fats from the fatty acids and glycerol molecules. Fats are stored as a source of energy because cells can break them down and use them in respiration. Proteins are long-chain molecules made up of many amino acids linked together. Digestion by protease enzymes breaks down proteins to amino acids. Cells use amino	down in the liver to form urea for excretion by the kidneys as urine.		food and absorption of water occur. Watch the video of digestion of an egg sandwich (see resources). Describe the pathway of an egg sandwich from mouth to anus. Tell it as a story. Links to 4.7.4.7 Enzymes Students design a board game to aid learning. They should include: nutrient, structure and function, digestive enzyme, product. Make connections between products of digestion and other organ systems. Students research high-protein diets. Calculate the % difference between RDA (g/kg) of protein and (g/kg) intake in a high-protein diet. Some researchers have expressed concerns that a high-protein diet may cause	• what is left in the sieve must be soaked up with a sponge (large intestine) then emptied into a small sandwich bag (rectum) • cut a hole in corner of bag for anus and show egestion View sections of the small intestine under a microscope Make a model to show how the villi increase the surface area of the small intestine. Use play dough to model structure of three key nutrients. Students research a topical issue connected to dietary advice, eg sugar in diet, Omega-3,	• Slides of small intestine. Digestion of egg sandwich video Teachit Science resource (25126) 'Digestive enzymes - dominoes'

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	acids to make new proteins. The liver breaks down unwanted amino acids to urea, which is then carried by the blood to the kidneys. The kidneys excrete urea in solution as urine.			kidney damage. How might this be?	cholesterol, antioxidants, 'super foods'. Can they find quantitative data to support claims? How do cells make new proteins? Students use the particle model to explain the process of digestion and absorption.	
4.2.1.6	The nervous system enables humans to react to their surroundings and to coordinate their behaviour. Information from receptors passes along cells (neurones) as impulses to the central nervous system (the brain or the spinal cord). The central nervous system coordinates the response of effectors which may be muscles	Explain the importance of being able to respond to environmental changes and coordinate behaviour. Explain how the nervous system is adapted for its functions. Describe the functions of the main structures in the nervous system.	2–3	Starter: any short clip that has a 'surprise'. Explain how detection of stimuli protects the body from danger. Demo: response to different temperatures. Detecting different tastes on the tongue – draw results on diagram of tongue. Investigate sensitivity of different areas of the body.	Plan and manage a variety of stimuli to illustrate body responses. Present and analyse results, eg: • response to temperature • taste receptors • skin sensitivity. Evaluate different methods for measuring reaction time. Give data for conduction velocity	Body responses: • three bowls of water – hot, warm and ice-cold • salt, sugar, coffee and lemon solutions to taste • hairpins, ruler, blindfolds. Teachit Science resource (20696) 'Touch testing'

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	contracting or glands secreting hormones. stimulus → receptor → coordinator → effector → response Reflex actions are automatic and rapid; they do not involve the conscious part of the brain. An example of a simple reflex action is the pain withdrawal reflex. This can be explained in terms of a reflex arc. Sensory neurones carry impulses from receptors to the spinal cord and brain. Relay neurones carry impulses within the CNS. Motor neurones carry impulses from the CNS to effectors. Where two neurones meet, there is a tiny gap called a synapse. Impulses cross this gap using chemicals.	Explain the role of chemicals at synapses. Describe and use different methods to measure reaction time. Required practical Make a plan to investigate a factor on human reaction time. Explain the importance of reflex actions and give examples. Describe the differences between voluntary and reflex actions. Describe the stages of a reflex action.		Measure reaction time using different methods, eg Sheep Dash Activity (see resources). **Required practical 8**: plan and carry out an investigation into the effect of a factor on human reaction time. Biology AT 1, 3 and 4 Plan for required practical. Use knee-jerk and pupil reflexes as a stimulus for discussion. Students discuss their importance and gather other examples leading into explanation of why they are faster than a voluntary action. Label a diagram of a reflex arc. Draw a flow diagram or use cards to show the sequence in a reflex action.	(m/s) and axon diameter. Discuss scale choice for axes and appropriate number at origin. Students plot graph. Show and discuss line of best fit. Required practical 4: investigate the effect of a factor on human reaction time. Biology AT 1, 3 and 4 MS 2c, 4a	BBC Bitesize: The nervous system Reaction time test BBC Sheep reaction time test Nervous system BBC Bitesize – The nervous system AQA PPT: B1.2 The nervous system

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	Reaction times vary from person to person. Typical values range from 0.3s to 0.9s. This topic links with 4.7.1.10 Stopping distances			Use BBC activity (see resources) as a summary of the nervous system.		
4.2.1.7	The endocrine system is composed of glands which secrete hormones directly into the bloodstream. Hormones are large molecules. The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system the effects are slower but act for longer. The pituitary gland in the brain is a 'master gland'. It secretes several hormones which act on other glands to stimulate other hormones to be released. (HT only) Adrenaline is produced by the adrenal	Describe the endocrine system and define the term hormone. Relate hormone release and hormone action to the control system model introduced in 4.3.1.4 Label a diagram of the organs in the endocrine system. Explain why the pituitary gland is often called the master gland. Compare the actions of the nervous and endocrine systems.	2	Collective memory or Card sort using hormone name, function and location. Self-assess. Pin the tail on the donkey type activity – give each student a card and get them to stick it on a large body outline, self-assess the end result. Label a diagram of the endocrine system using information on the cards. Write definitions for endocrine system and hormone. Discuss why the pituitary gland is called the master gland.	Relate hormone release and hormone action to the control system model. Negative feedback – make an analogy to relaxing in a hot bath. Too hot at first, add more cold, just right, then cools as time passes, add more hot and so on. Ask students to make up/ find their own examples of negative feedback: what do these systems have in common?	Torso and large image of the human body. BBC Bitesize – homeostatic control

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	gland. It boosts the delivery of oxygen and glucose to the brain and muscles and prepares the body for 'flight or fight'. (HT only) Thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development. (HT only) The control of thyroxine levels involves negative feedback. Negative feedback tends to stabilise a system. Any change in the system leads to a response that tends to reverse the change.			Compare the actions of the endocrine system with the nervous system. WS1.2, MS 2c (HT only) Interpret and explain simple diagrams of negative feedback control.		

4.2.2 Plants and photosynthesis

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4.2.2.1	Meristem tissue contains the cells in a plant that divide as the plant grows. This type of tissue is found at the growing tips of shoots and roots. The cells differentiate into different types of plant cells depending on where they are in the plant.	Describe the function of meristems in plants.	0.5	Discuss how plants grow compared to animals. Show students a time lapse video of seedlings growing. Students list the tissues and organs meristem cells differentiate into.	Look at dividing cells in prepared root tip squash slides.	Show images of meristem tissue YouTube time lapse – tomato plant Prepared slides and microscopes or bioviewers of root tip squashes Nuffield – root tip squash practical. BBC Bitesize –cell specialisation SAPS – cell growth in plants animation
4.2.2.2	Plants, like other multicellular organisms, need specialised structures for transporting and exchanging materials. The roots, stem and leaves form a plant organ system for transport of substances around the plant.	Label the main organs of a plant and describe their functions. Name the substances transported into and out of plants, to include carbon	0.5	Discuss which substances a plant needs to transport. Build up a class annotated diagram to show the substances transported and		

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	Plants take in carbon dioxide from the atmosphere for photosynthesis and oxygen for respiration. Plants take in water from the soil with dissolved ions including nitrate ions to make proteins and magnesium ions to make chlorophyll.	dioxide, oxygen, water with dissolved nitrate and magnesium ions. Describe why plants needs to transport each of these substances.		their role within the plant.		
4.2.2.3	Water is drawn into the roots of plants from the soil. Water moves into the root hairs by osmosis. Mineral ions move from the soil into the root hairs by active transport. Water flows from the roots through xylem in its stems to its leaves. Xylem tissue is composed of hollow tubes strengthened by lignin adapted for the transport of water in the transpiration stream from the roots to the leaves.	Describe the organs that make up the plant transpiration system. Describe the role of xylem, phloem and root hair cells and explain how they are adapted for their functions. Define the term 'transpiration'.	2	Demonstrate capillary action using in a long capillary tube and coloured dye. Discuss common misconceptions about plants such as obtaining food from soil. Demonstrate transport of coloured dye in celery or a plant	Prepare sections of celery or plant stem and observe under a microscope. Observe prepared slides or bioviewers of xylem and root hair cells; draw them and estimate their size. Investigate the effect of oxygen availability on	Demonstrate long piece of capillary tubing supported in clamp, beaker of coloured water. Plant stalks: celery or plant stalk in beaker of coloured water, scalpels, tiles, slides and coverslips, microscopes. Prepared slides: of xylem, phloem and root hair cells, microscopes, bioviewers. BBC Bitesize: The need for transport BBC Bitesize: Movement across cell membranes Tracking active uptake of minerals by plant roots Stomata: Leaves from privet and spider plants, kettle, beakers, nail varnish, slides, coverslips and microscopes.

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	Water evaporates in the leaves and the water vapour escapes through tiny holes in the surface of leaves called stomata. The stomata can open or close as conditions change because the guard cells can gain or lose water by osmosis. The rate of transpiration varies with: • light intensity, which affects the opening of stomata • air movements, which affect the concentration of water vapour in the air around leaves • temperature, which affects the rate at which water evaporates.	Explain why there are more stomata on the lower surface of a leaf. Describe the role of stomata and guard cells to control water loss and gas exchange. Calculate stomatal density. Describe and compare the processes of diffusion, osmosis and active transport. Explain how factors such as light, humidity and moving air affect the rate of transpiration.		stem then allow students to take sections and observe the dye in the xylem vessels under the microscope. Observe and draw xylem, and root hair cells. Estimate the size of the cells. Describe how they are adapted for their functions. Recap diffusion and osmosis. Compare them with active transport. Produce a comparison table. Introduce active transport as absorption	the growth of plants. Observe results in later lessons. Nuffield - investigate the effect of changing conditions on the rate of transpiration using a photometer. Students predict then research the effect of humidity on the rate of transpiration. Calculate size of stomata given images and scale bar.	Demo: 2 cylindrical balloons, sellotape. Measuring stomatal density Stomata: Leaf structure, stomata and carbon dioxide video clip Rap: BBC Bitesize: Photosynthesis rap Nuffield – Measuring the rate of water uptake by a plant shoot using a photometer. Oxygen: gas jars with lids, glass tubes, fresh and boiled water to make mineral ion solution(s), black paper.

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				against the concentration gradient. Discuss when this might be useful. Observe a video or pictures of plants growing in soil and in hydroponic solutions. Suggest why farmers and gardeners turn the soil and hydroponic solutions must be kept aerated. Use the Nuffield activity. Students can carry out a similar investigation to demonstrate the		

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				need for oxygen. Observe images of the mitochondria in root hair cells and cells lining the small intestine. Relate to active transport. Observe a computer simulation of active transport. MS 1a, 1c Understand and use simple compound measures such as the rate of a reaction. MS 4a Translate information between		

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				graphical and numerical form. MS 4a, 4c Plot and draw appropriate graphs, selecting appropriate scales for axes. MS 2c, 4a Extract and interpret information from graphs, charts and tables.		
4.2.2.4	The chlorophyll and other pigments in plant leaves can be separated and identified by chromatography. Chromatography can be used to separate mixtures and can give information to help identify substances. The ratio of the distance moved by a compound	Students should be able to: • suggest how chromato-graphic methods can be used for distinguishing pure substances	1	Describe a method for paper chromatography. Explain what happens to substances during the process of	**Required practical 9:** investigate how paper chromatography can be used to separate and tell the difference between coloured	Video clips: YouTube: Basics of chromatography YouTube: Paper and thin layer chromatography RSC experiment – 'Chromatography of leaves'

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	(centre of spot from origin) to the distance moved by the solvent can be expressed as its R_f value: $R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$ Different compounds have different R_f values in different solvents, which can be used to help identify the compounds. The compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents.	from impure substances • interpret chromato-grams and determine R_f values from chromato-grams.		chromatography. Describe to another student what the R_f value is and instructions on how to calculate the R_f value.	substances. Students should calculate Rf values. Chemistry AT 1 and 4	
4.2.2.5	Photosynthesis takes place in the chloroplasts in the cells of the leaves of plants. The chloroplasts contain the chlorophyll, which absorbs sunlight. Photosynthesis is an endothermic reaction that	Write the word and symbol equation for photosynthesis. Explain why photosynthesis is important for	2	Collective memory activity for students on leaf structure – self assess. Watch BBC video clip to recap how	Put cards in order to create equation. Set up experiments to show that light, carbon dioxide and chlorophyll	BBC Bitesize – Photosynthesis in plant leaves Photosynthesis equation cards Nuffield foundation- photosynthesis experiments: BBC Bitesize - Van Helmont's experiments on plant growth

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	can be represented by word and symbol equations: carbon dioxide + water → glucose + oxygen The glucose produced in photosynthesis may be: • used for respiration • converted into insoluble starch for storage • used to produce fat or oil for storage • used to produce cellulose, which strengthens the cell wall • used to produce amino acids for protein synthesis. To produce proteins, plants also use nitrate ions that are absorbed in solution form the soil.	the survival of other organisms. Investigate the need for light, carbon dioxide and chlorophyll to make glucose. Explain why plants should be de-starched before photosynthesis experiments and describe how this is done. Describe experiments to show that plants produce oxygen in the light. Describe how glucose produced in respiration is		leaves are adapted for photosynthesis. Discuss what plants need to survive and how plants are useful to other organisms in order to come up with the word equation for photosynthesis. Set up experiments or demos. Test leaves in following lesson. Set up a demo to show that plants produce oxygen.	are needed to make starch – follow up with testing a leaf for starch in later lesson. Consider controls. Predict what will happen and why. Consider how theories develop over time. Carry out the test and interpret the results. Recall test for oxygen. Interpret results of test and relate to photosynthesis equation.	SAPS – BBC video clip –production of oxygen in plants Teachit Science resource (20867) 'Photosynthesis text analysis'

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		used by the plant.		Observe results in following lesson. Write word and symbol equations for photosynthesis – produce cards for equation and put into correct order. Watch BBC video clip about Van Helmont's experiment. Test leaves for starch, putting the results for all the different experiments into a table. Use a cut-out to put the steps for the test on a leaf in order, and match a	Amend the method to measure rate of photosynthesis. Use a model to embed understanding of process.	

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				reason for each step. Observe demo set up previous lesson and test gas collected to see if it is oxygen. Discuss how this could be used to measure the rate of photosynthesis. Use computer simulation to investigate factors that affect the rate of photosynthesis.		
4.2.2.6	The rate of photosynthesis depends on: • the energy available from light • the concentration of carbon dioxide	State factors that can limit the rate of photosynthesis. Interpret data showing how	2	Ask students to consider what would happen to a plant if we: • put it in the fridge	Consider different methods of gathering evidence.	Nuffield practical – investigating factors affecting the rate of photosynthesis

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	• the temperature (HT only) The rate of photosynthesis may be limited by: • low temperature • shortage of carbon dioxide • shortage of light. (HT only) Increasing any one of the factors speeds up photosynthesis until the rate is limited by the factor which is in shortest supply.	factors affect the rate of photosynthesis. Required practical: carry out an investigation, collect, present and analyse the results. Calculate the rate using numerical information or graphs.		• removed CO_2 • put it in a cupboard • took chlorophyll from the leaves. Discuss how the rate of photosynthesis could be measured and consider different methods. Required practical: ask students to identify various factors, select one to control, plan investigation to investigate its effect and explain the	Interpret graphs and calculate the rate of photosynthesis. **Required practical 10:** investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed. Biology AT 1, 2, 3, 4 and 5	

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				procedure and conclusion. MS 1a, 1c, 2c, 4a, 4c Extract and interpret information from graphs, charts and tables. WS 3.5 (HT only) Understand and use inverse proportion – the inverse square law and light intensity in the context of factors affecting photosynthesis.		
4.2.2.7	Phloem tissue is composed of tubes of elongated living cells adapted for translocation of sugars from where they are produced by photosynthesis in the	Define the term 'translocation'. Describe the structure of phloem and	0.5	Observe and draw phloem. Recap transport in plants and summarise by labelling a	Model plant vascular bundles using long cardboard cylinders and boxes.	Prepared slides: of phloem and microscopes or bioviewers. BBC Bitesize – transport systems and processes in plants

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	leaves to other parts of the plant for immediate use or storage. Cell sap containing sugars and other nutrients is able to move easily from one phloem cell to the next as the end walls have pores.	relate to its function. Describe how sugar is transported to different parts of the plant. Explain why sugar is transported to other parts of the plant.		diagram of a plant to show that water enters via the roots and travels in the xylem to the leaves; carbon dioxide enters leaves via stomata; light is absorbed by chlorophyll in leaves; dissolved sugars are transported from the leaves in the phloem to other parts of the plant.	Estimate the scale of the model from given data about xylem and phloem.	
4.2.2.8	Tobacco mosaic virus is a widespread plant pathogen affecting many species of plants including tomatoes. It gives a distinctive 'mosaic' pattern of discolouration on the leaves, which affects	Define the term 'communicable diseases'. Describe the causes, symptoms and control methods	1	Students research the effects of tobacco mosaic virus and rose black spot fungus.	Explore images of plant disease on Rothamsted Research website.	RHS rose black spot video UMN article 'Tomato- Tobacco mosaic virus' APSnet article 'Tobacco mosaic virus disease' http://www.rothamsted.ac.uk/bioimaging/images

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	the growth of the plant due to lack of photosynthesis. Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. The disease is spread by spores of the fungus that are produced in the black spots. Common control methods for tobacco mosaic virus include: • removing and destroying infected plants • washing hands and tools after handling infected plants • crop rotation to avoid planting in soil that has been infected for at least two years.	of tobacco mosaic disease and rose black spot.		Prepare advice on how horticulturists can control the spread of tobacco mosaic virus and rose black spot. WS 1.4 Explain applications of science to prevent the spread of plant diseases. Should chemical control be used on garden plants such as roses? Groups of students investigate different aspects of the question such as value of		

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	Methods to control black spot include: • not planting roses too close together – to allow the air to flow freely around them • avoiding wetting the leaves when watering – wet leaves encourage the fungal disease • cleaning up any infected leaves from the ground round the roses – to avoid spores spreading • using a fungicide to prevent infection – spraying, especially in advance of warm, wet weather.			horticulture to the economy, organic methods of control, selective breeding and GM, toxicity and persistence of chemicals involved.		