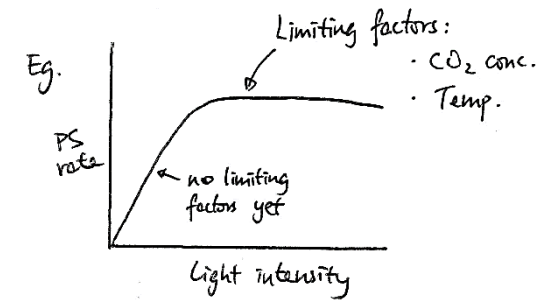


Topic 4.4	Rationale (layering, why this why now?)	Knowledge goals: <i>You need to know that how to</i>	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Bioenergetics Understanding processes in bioenergetics will allow us to better understand how plants and animals survive using raw materials and why they are interdependent on one another. Plants harness the Sun's energy in photosynthesis in order to make food. This process produces oxygen which has built up over millions of years in the Earth's atmosphere. Both animals and plants use this oxygen to oxidise food in a process called aerobic respiration which transfers the energy that the organism needs to perform its functions.	 KS3 NC: links to material cycles and energy: cellular respiration. Photosynthesis.  KS4 ladders to work on: Limiting factors. Measurement of the rate of photosynthesis. Uses of glucose produced in photosynthesis. Aerobic respiration. Anaerobic respiration. Effect of exercise on the body. Metabolism. Factors affecting metabolism. KS5 ladders to work on: the stages of respiration and photosynthesis, biochemical pathways and how ATP production is linked to electron transfer.	that photosynthesis is the process by which plants make food called glucose. that photosynthesis is an endothermic reaction. that limiting factors are those in short supply. that the rate photosynthesis is affected by a variety of factors which interact. how to measure the rate of photosynthesis. how to process data, describe trends and draw conclusions. that glucose produced in photosynthesis can be converted to different substances or stored. that respiration is an exothermic reaction which releases energy from glucose. that the energy released from respiration has various uses. that anaerobic respiration takes place without oxygen that the products of anaerobic respiration in animals and plants differ. that during exercise heart rate, breathing rate and breath volume increase. that changes during exercise supply muscles with more oxygen and glucose. that anaerobic respiration in muscle results in an oxygen debt.	carbon dioxide, oxygen, water, light, chlorophyll, glucose, exothermic, endothermic, chloroplasts. limiting factor, light, temperature, carbon dioxide, rate, interact, crops, economical, yield. pondweed, rate, photosynthesis, aquatic, light, inverse square law. respiration, starch, insoluble, fat, oil, cellulose, amino acids, proteins, nitrate ions. respiration, oxygen, glucose, aerobic, chemical reactions, movement, aerobically, energy transfer, synthesis, larger molecules, movement, keeping warm. anaerobic, animals, plants, lactic acid, ethanol, carbon dioxide, fermentation, bread, alcohol. heart rate, breathing rate, breath volume, oxygen, glucose, muscle contraction, energy release. lactic acid, carbon dioxide, oxygen debt, accumulated, contracting, react.	a) Subject specific skills Practical skills (RP6) - investigating the effect of light intensity on the rate of photosynthesis using aquatic organisms. Practical skills - measuring the body's response to exercise. b) Numeracy Use data to relate limiting factors to the cost effectiveness of adding heat, light or carbon dioxide to greenhouses. Plot and draw appropriate graphs of the rate of photosynthesis against light intensity selecting appropriate scales for axes. Use of inverse proportion – the inverse square law and light intensity in the context of photosynthesis. Use data to assess the energy production in aerobic and anaerobic exercise. Calculation of heart rate from graphs. c) Literacy d) Reading Etymology of 'photosynthesis.' Photo - light, synthesis - to make. Etymology of the word 'respiration'. Reading – making the best use of photosynthesis. How plant growers manipulate conditions/limiting factors to obtain high yields. Page 130-131 AQA Biology text.

Conversely, anaerobic respiration does not require oxygen to transfer energy.		that metabolism is the sum of all reactions that occur in the body. that metabolism includes a variety of different reactions such as respiration/lipid formation.	starch, glucose, lipids, fatty acids, glucose, nitrate, amino acids, respiration, proteins, excess proteins, respiration, enzymes, conversion.	d) Cultural capital links What happens to your body when you start exercising. https://ed.ted.com/best_of_web/WaARd3SV The importance of fermentation in bread and alcohol production. https://www.youtube.com/watch?v=y5XEwTDIriE f) Common misconceptions <i>Respiration – respiration is not produced/created or made! It is only released or transferred.</i> <i>Breathing <u>is not</u> the same as respiration. Breathing is the process of drawing air into and out of the lungs using the diaphragm, intercostal muscles, and ribs. Respiration is an exothermic chemical reaction. It occurs in all cells using glucose and releases energy or transfers energy to a chemical energy store – ATP the energy currency of the cell.</i> <i>Plants only photosynthesise – incorrect plants are living organisms so carry out the process of photosynthesis and respiration. Plants respire all the time not just at night when they have finished photosynthesising.</i> <i>Mitochondria – <u>release or transfer energy</u> in the cell. Energy cannot be created nor destroyed so do not write about energy being made.</i> https://www.saps.org.uk/animations/plant_biology/ <i>Animation from SAPS tackling the common misconception that respiration in plants does not</i>
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take place at the same time as photosynthesis, when actually it does!

Limiting factors – these are not factors 'affecting photosynthesis rate' they are factors which stop the rate of photosynthesis increasing further. Graphical representation can assist with learning.



Topic 4.1	Rationale (layering, why this why now?)	Knowledge goals: <i>You need to know that how to</i>	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Cell Biology Cells are the basic unit of all forms of life, studying cells will give us a clearer understanding of how organisms function. Structural differences between types of cells enables them to perform specific functions within the organism. These differences in cells are controlled by genes in the nucleus. For an organism to grow, cells must divide by mitosis producing two	← LINKING KS2 how animals and plants grow. KS3 NC links to structure and function of living organisms: cells and organisation → LOOKING KS4 ladders to work on: Specialised cells Cell differentiation Microscopes Culturing microbes Cell transport Diffusion Osmosis Active transport Cell cycle cell division (mitosis/meiosis). KS5 ladders to work on: Complex cellular structure animals, plants, fungi.	that prokaryotic cells are bacteria. that eukaryotic cells are plant and animal cells. that plant and animal cells have differences and similarities in their cellular structures. that sub-cellular structures carry out particular functions how to calculate magnification, image size and actual size. how to convert between units. that cells can be specialised to carry out different functions. that cells differentiate or specialise to carry out different functions. that plant cells retain the ability to differentiate throughout their life. that magnification and resolution are properties of microscopes. that electron microscopes have high resolution/magnification. how to use a microscope. how to make an observational drawing from a microscope that bacteria multiply by binary fission. BIOL ONLY that antibiotics and disinfectants can affect microorganisms. how to grow bacteria & investigate the effectiveness of antiseptics on their growth. BIOL ONLY	eukaryotic, prokaryotic, plasmid, nucleus, DNA bacteria, animals, plants. cell membrane, cell wall, cytoplasm, nucleus, chloroplast, vacuole, ribosomes, mitochondria, chloroplasts, vacuole. millimetre, micrometer, magnification, actual size, real size. sperm, neurone, muscle, epithelial, palisade, root hair. differentiation, specialisation, stem cells, differentiate, cell division. meristem, embryo, bone marrow. electron microscope, light microscope, sub-cellular structure, magnification, resolution. microscope, focus, light, electron, sub- cellular, magnification binary fission, nutrient broth, agar plate, disinfectants, antibiotics, inoculating loop. agar plate, inoculating loop, antiseptic, disinfectant,	a) Subject specific skills Practical skills - using microscopes. Practical skills (RP1) - observational drawings of cells. Practical skills (RP2) - culturing/growing BIOL ONLY microorganisms on agar plates/investigating the effect of antiseptics. Practical skills (RP3) - using top-pan balances to measure mass of plant tissue when placed into different concentrations of salt/sugar solution (osmosis). b) Numeracy Using the formula triangles to rearrange magnification equation conversion of units (mm into µm) Expression of answers/numbers in standard form. Calculating surface area: volume ratios. Calculating rates of water uptake/% change. Present observations as tables, graphs, or drawings. Use estimations to judge the relative size or area of sub-cellular structures. c) Literacy d) Reading Ethical impacts of stem cells and their use in science. How do they work? Page 32+33 AQA Biology text. Similarities and differences between optical and electron microscopes – page 4+5 AQA Biology text. e) Cultural capital links

new identical cells.	Cellular processes respiration, photosynthesis, control of blood glucose. Cell division. Stem cell types – pluripotent, multipotent, totipotent and IPS cells.	that the nucleus contains chromosomes made of DNA molecules. that cells divide in a series of stages called the cell cycle.	DNA, chromosomes, ribosomes, mitochondria, mitosis, growth, cell division, cell cycle, genetic material.	Therapeutic cloning https://www.bbc.co.uk/bitesize/guides/zs8y4qt/revision/7 Stem cell and bone marrow transplants https://www.nhs.uk/conditions/stem-cell-transplant/ https://www.bbc.co.uk/bitesize/guides/zs8y4qt/revision/6 Use of isotonic drinks in sport https://www.britishsoftdrinks.com/Sports-Drinks f) Common misconceptions <i>Distinguishing between cell membrane and cell wall. On any cell diagram the <u>inner line</u> is the cell membrane. <u>If</u> the diagram has an outer line, it is a <u>cell wall</u> and must be a bacterial, plant or fungal cell.</i> <i>Nucleus, it <u>is not</u> 'the brain of the cell'. Don't write this in exams! The nucleus controls the cells activities as it contains the genetic code (DNA) to make the cells proteins.</i> <i>Mitochondria – <u>release or transfer energy</u> in the cell. Energy cannot be created nor destroyed so do not write about energy being made.</i> <i>Differentiation – is <u>not</u> cell division. Cell division means cells specialising because of different genes being expressed. Cell division means cells splitting in half.</i> <i>Stem cells – they are <u>not</u> the cells found the stems of plants. In plants they are found in meristems and can differentiate into any cell type. Plants have stem cells throughout their entire lives.</i> <i>Distinguishing between the terms osmosis, diffusion and active transport and direction of movement. Specific teaching of this tier 3 vocabulary needed. Diffusion → movement down a concentration gradient passively.</i>
		that diffusion is the spreading out of particles. how to explain the effect of different factors on the rate of diffusion.	diffusion, concentration gradient, passive, temperature, surface area, SA:Vol ratio particles, rate, single celled, multicellular,	
		that water moves across a partially permeable membrane by osmosis.	osmosis, partially permeable membrane, dilute, concentrated, rate, % change in mass,	
		how to investigate the effect of a range of sugar concentrations on the mass of plant tissue.		
		that active transport moves substances against a concentration gradient. that active transport requires energy from aerobic respiration.	energy, respiration, dilute, concentrated, release, mineral ions, nitrate ions magnesium ions.	

				<i>Osmosis → diffusion/movement of water from a dilute to more concentrated solution passively via a semi or partially permeable membrane. Active transport → movement against a concentration gradient, it requires ATP.</i>
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Year 11 GCSE Biology topics (separates).

In Year 11 Biology we teach the following topics (4.1 – 4.7). We deliver these topics in line with schools in the MAT and in preparation for external exams. We start with topics 4.5 – 4.7 (September → December) then teach 4.1 – 4.4 (January → May) in the lead up to the first external examination (paper 1). Each topic draws on prior learning from previous years and builds on understanding from the KS3 programme of study. Each topic develops and deepens the core knowledge that will underpin all areas of the curriculum at KS4 and KS5.

Topic 4.5	Rationale (layering, why this why now?)	Knowledge goals: You need to know that how to	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Homeostasis and Response The study of homeostasis will allow us to understand how cells in the body can survive within narrow physical and chemical limits and how organisms use feedback mechanisms to control conditions in the body. Hormones are chemical messengers produced by glands. Hormonal coordination is particularly	 KS3 NC: links to structure and function of living organisms: reproduction  KS4 ladders to work on: Nervous system. Reflex actions. Brain. Eye. Temperature regulation. Hormones and the endocrine system. Control of blood glucose. Diabetes. Contraception. Control of fertility. Kidneys and urine formation.	that homeostasis is regulation of the bodies internal conditions. that blood glucose, body temperature and water levels need to be controlled. that nervous system allows humans to react to their surroundings and coordinate behaviour. that nervous pathways involve S>R>C>E>R. that reflex actions are automatic, rapid responses to stimuli which do not involve the brain. that synapses are junctions between neurones. how to measure reaction time using a ruler drop test. that the brain controls complex behaviour. BIOL ONLY that brain function/damage can be investigated in different ways. that the eye is a complex sense organ with different structures and functions.	homeostasis, optimal conditions, blood glucose, temperature, water levels, control systems. nervous system, receptors, neurones, CNS, stimulus, receptor, coordinator, effector, response. stimulus, receptor, sensory, relay, motor, neurone, synapse, diffuse, electrical, chemical. reaction time, seconds, milliseconds, mean, mode. brain, cerebral cortex, medulla, cerebellum, MRI scan, neuroscientists, complexity. retina, optic nerve, sclera, cornea, iris, ciliary muscle, suspensory ligaments, adaptation, circular muscle,	a) Subject specific skills Practical skills (RP7) - measuring reaction time using ruler drop test. Practical skills (RP8) – investigating the effect light on the growth of newly germinated seedlings. BIOL ONLY Interpreting diagrams showing negative feedback. Interpreting evolutionary trees. b) Numeracy Calculation of reaction times and conversion of units e.g., seconds to milliseconds. Calculating arithmetic means. Extract and interpret data from graphs e.g., showing hormone levels in the menstrual cycle. c) Literacy d) Reading Evaluation skills: comparing the relative advantages and disadvantages of kidney transplants to dialysis treatments. Page 188-191 AQA Biology text. Reading – uses of hormones in plants. Page 178-179 AQA Biology text.

important in reproduction as it controls the menstrual cycle. Understanding the role of hormones in reproduction has allowed scientists to develop not only contraceptive drugs but also drugs which can increase fertility. Cells in the body can only survive within narrow physical and chemical limits. They require a constant temperature and pH as well as a constant supply of dissolved food and water. In order to do this the body requires control systems that constantly monitor and adjust the composition of the blood and	Kidney disease. Plant tropisms. Uses of plant hormones. KS5 ladders to work on: detailed understanding homeostatic control mechanisms: blood glucose, kidney roles of hormones as second messengers and protein molecules affecting permeability of phospholipid bilayers.	how to identify key structures in the eye. BIOL ONLY	radial muscle, dilate, constrict.	Evaluate the benefits and risks of procedures used to analyse brain function. Page 153 AQA Biology text. e) Cultural capital links Homeostasis – water/nitrogen balance podcasted https://www.bbc.co.uk/bitesize/guides/zc8gdxs/revision/2 The discovery of insulin https://www.youtube.com/watch?v=Gk1D4VgM8jY How do the kidneys work (TED-ed) https://www.youtube.com/watch?v=FN3MFhYPWWo Kidney disease and dialysis (Fuse school)/ https://www.youtube.com/watch?v=9KZHowze7lq Plant tropisms https://www.youtube.com/watch?v=pCFstSMvAMl f) Common misconceptions <i>Learners often state impulses move across synapses, this is <u>incorrect</u>. Neurotransmitters diffuse across the synapse.</i> <i>Control of blood glucose – insulin raises blood glucose concentration, this is <u>incorrect</u>. Insulin acts to lower blood glucose concentration by causing glucose to move from blood into cells.</i>
		that accommodation is changing the lens shape to focus on near or distant objects. BIOL ONLY	accommodation, myopia, hyperopia, ciliary muscles, suspensory ligaments, lens, thicker, thinner, defects, myopia, hyperopia, laser eye surgery, spectacle lenses.	
		that body temperature is controlled by the thermoregulatory centre in the brain. BIOL ONLY	thermoregulatory centre, vasodilation, vasoconstriction, sweating, shivering, skeletal muscles.	
		that the endocrine system is made up of glands. how to identify the main endocrine glands in the body.	glands, oestrogen, testosterone, bloodstream, pituitary gland, pancreas, thyroid, adrenal, ovary, testes.	
		that blood glucose is controlled by the pancreas by negative feedback. that the pancreas produces the hormones insulin and glucagon.	pancreas, insulin, glucagon, hormone, pancreas, liver, muscle, negative feedback, bloodstream.	
		that diabetes is a disorder characterised by uncontrolled blood glucose concentration. how to compare the causes and treatments for type I/II diabetes.	type I, type II, diabetes, obesity, risk factor, uncontrolled high blood glucose concentration, injections.	
		that thyroxine from the thyroid gland stimulates basal metabolic rate. that thyroxine levels are controlled by –ive feedback.	Thyroxine, adrenaline, negative feedback, basal metabolic rate, adrenaline, oxygen, glucose, fight or flight.	

tissues. These control systems include receptors which sense changes and effectors that bring about changes.		that the kidneys maintain the water balance of the body. that the kidneys produce urine by filtration of the blood. BIOL ONLY	kidney, water, ions, glucose, urea, reabsorption, osmosis, urinary system, tubules.	<i>Confusion and use of the terms glycogen, glucagon, glucose and glycerol! Needs explicit teaching that glycogen is in effect a store of glucose, glucagon is a hormone which acts to raise blood glucose, glucose is sugar and glycerol a molecule that makes up parts of lipids. Explicitly teach this tier 3 vocabulary.</i> <i>Eye – mislabelling/identification of pupil and iris. Pupil is a hole that lets light in it is not coloured. Iris is coloured and contains circular and radial muscles. Cornea and lens <u>both</u> refract light and lens also has a job of focussing light. Refraction is not confined to the cornea.</i> <i>Vasoconstriction and vasodilation – learners often get these terms confused. Constrict narrower, dilate wider this needs reinforced again through teaching of tier 3 vocabulary.</i> <i>Capillaries cannot dilate/constrict – this is <u>incorrect</u>, they have <u>no</u> muscles. Blood vessels <u>do not</u> ‘move up’ to the surface of the skin! Blood vessels which supply the surface capillaries dilate.</i> <i><u>Urea</u> and <u>urine</u> are different! Urea is nitrogenous waste from the breakdown of amino acids, made in the liver. Urine is a liquid containing excreted urea, excess water and mineral ions – made in the kidney.</i> <i>Kidney function, needs to be clearly explained to learners that kidneys function to <u>filter substances</u> from the <u>blood</u> AND maintain water balance, <u>both</u> aspects are important. Learners often do not appreciate that kidneys act as part of a homeostatic mechanism to control water balance as a result of ADH release. If dehydrated there is an increase in ADH, if hydrated there is a decrease in ADH. Negative feedback loops aid understanding.</i>
		that ADH is a hormone produced by the pituitary gland. that ADH affects the permeability of the kidney tubules. BIOL ONLY	ADH, pituitary gland, kidney, permeability, tubules, dilute, concentrated, reabsorbed, negative feedback.	
		that kidney failure can be treated with transplants or kidney dialysis. BIOL ONLY	dialysis, partially permeable, transplant, immunosuppressant's.	
		that the menstrual cycle is controlled by hormones. that hormones interact via stimulation or inhibition.	menstruation, oestrogen, LH, FSH, progesterone, negative feedback, stimulate, inhibit, interaction.	
		that fertility can be controlled by hormonal and non-hormonal forms of contraception.	FSH, LH, hormonal, non-hormonal, contraceptive pull, IUD, condom.	
		that plants produce hormones to coordinate and control growth. that phototropism is response to light and gravi(geo) tropism is response to gravity.	phototropism, geotropism, gravitropism, auxin, gibberellin, unequal distribution, positive, negative.	
		how to investigate the effect of light on the growth of newly germinating seedlings. BIOL ONLY	maize, cress, seedlings, ruler, phototropism, mean, anomalous, chlorophyll.	
		that plant hormones have uses in agriculture and horticulture. that plant hormones include auxin, ethene and gibberellin. BIOL ONLY	weedkiller, rooting powder, germination, dormancy, flowering, auxin, ethene, and gibberellin.	

				<i>Auxin – misunderstanding of role, both promote and inhibit elongation of cells.</i>
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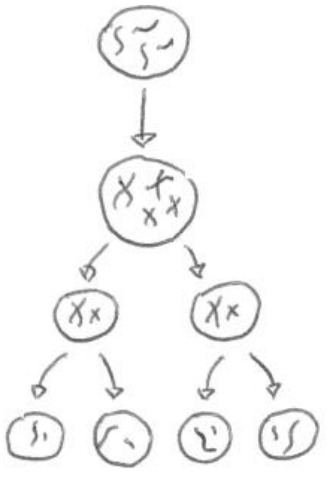
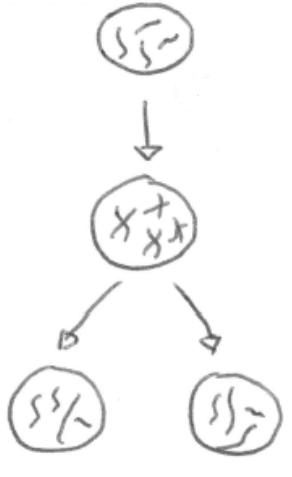
Topic 4.3	Rationale (layering, why this why now?)	Knowledge goals: <i>You need to know that how to</i>	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Infection and response Studying infection and response will allows us to explore how we can avoid diseases by reducing contact with them, as well as how the body uses barriers against pathogens. Pathogens are microorganisms such as viruses and bacteria that cause infectious diseases in animals and plants. When at risk from unusual or dangerous diseases our body's natural system can be enhanced by the use of vaccination and the use of antibiotics developed in the 1940s.	 KS2 living things have characteristics essential for keeping them alive and healthy. KS3 NC: links to structure and function of living organisms: nutrition and digestion, health.  KS4 ladders to work on: Bacterial disease. Fungal disease. Viral disease. Culturing microbes. Defence mechanisms. Vaccination. Monoclonal antibodies and medicine.	that communicable diseases can be spread. that pathogens can cause communicable disease.	communicable, pathogen, spread, viruses, fungi, bacteria, toxins reproduction.	a) Subject specific skills Practical skills – streak plating sterile water, growing microbes, looking at the effect of disinfectants on microbial growth using agar plates and paper discs. Development of hypotheses about the effectiveness of antibiotics or antiseptics used. b) Numeracy Calculation of clear zones/cross sectional areas using TTr^2 . Calculating numbers of bacteria given the mean division time. Expressing processed data in standard form. Calculation of % increase or decrease in the number of confirmed cases of a disease e.g. measles. c) Literacy skills d) Reading Vaccination – preventing and treating disease page 98+99 AQA Biology text. Evaluation skills - uses of monoclonal antibodies in medicine pages 108+99 AQA Biology text. e) Cultural capital How antibiotics were discovered (Fleming). https://www.youtube.com/watch?v=ZAGY36JYQlg
		that salmonella is a bacterial disease spread by bacteria in food. that gonorrhoea is a sexually transmitted disease.	salmonella, food poisoning, toxins, spread, diarrhoea, vomiting, gonorrhoea, STD.	
		that rose black spot is fungal disease of plants. that TMV is a viral infection of plants e.g., tomatoes.	rose black spot (RBS), tobacco mosaic virus (TMV), fungicide, mosaic pattern of discolouration, photosynthesis.	
		that protists are pathogens that cause malaria. that malaria can be treated by preventing vectors reproducing and using nets.	malaria, vector, mosquito, fever, breeding, life cycle, recurrent.	
		how to grow uncontaminated cultures of microorganism by streaking/aseptic methods. BIOL ONLY	petri dish, inoculating loop, sterilised, flame, transfer, microorganisms.	
		that plant disease can be detected by different methods. BIOL ONLY that ion deficiency in plants leads deficiency diseases.	stunted, spots, decay, growths, malformed, pests' discolouration, nitrate stunted growth, magnesium, chlorosis, website, manual.	
		that plants have defence mechanisms to prevent infection from pathogens and herbivores. BIOL ONLY	physical, chemical, mechanical, antibacterial chemicals, poisons, thorns, leaves, cellulose. mimicry, deter.	

	KS5 ladders to work on: Detailed bacterial and structure. Idea of viruses being acellular and their detailed structure/HIV. Bacterial replication and use of bacteria in determining DNA replication methods.	resistant strains of bacteria cannot be killed by killed. MRSA is a type of resistant bacteria. (Links to 4.6.3.4).	resistance, antibiotic, mutations, MRSA, immune	Understanding the importance and dangers of antibiotic resistance https://www.bbc.co.uk/bitesize/guides/z8fkmsg/revision/4 Monoclonal antibodies production and uses https://www.bbc.co.uk/bitesize/guides/zt8t3k7/revision/1 Antibiotic resistant bacteria Ted-Ed https://www.youtube.com/watch?v=znnp-lvj2ek f) Common misconceptions <i>Antibiotics can be used to treat all pathogens – bacteria, viruses, and fungi - <u>this is incorrect</u>. Antibiotics are only effective against bacteria, and damage bacterial cell walls or stop protein synthesis at ribosomes. Most antibiotics are made by fungi.</i> <i>When antibiotics no longer work bacteria <u>are not</u> 'immune' they have developed resistance to the antibiotics.</i> <i>Viruses are made from cells, <u>this is incorrect</u>. Viruses are acellular and reproduce inside cells. Antibiotics cannot kill viruses as the virus is inaccessible to the antibiotics.</i> <i>Communicable diseases – are diseases which are spread but students often do not appreciate the different <u>modes of transmission</u>. Pathogens can be spread via direct contact, contaminated food, sexual contact, or droplet infections. Students need this exemplified through specific examples.</i>
		that humans have non-specific defence mechanisms (barriers).	skin, nose, trachea, bronchi, stomach, non-specific defence.	
		that specific defence mechanisms involve white blood cells/immune system. that phagocytosis, antibody, and antitoxin production help to defend against pathogens.	white blood cell, phagocytosis, antibody, antitoxin, immune system.	
		that immunity is the ability to resist disease. that vaccination induces immunity and can help to prevent illness.	inactive/dead pathogen, white blood cells, antibodies, specific, herd immunity, proportion, population, herd immunity.	
		that drugs are tested and developed in a series of stages. that drugs are sourced from animals, plants, and microorganisms.	drug, placebo, clinical, trial, digitalis, aspirin, penicillin, pre-clinical, double blind.	
		that monoclonal antibodies are identical and produced in a lab using lymphocytes and cancer cells. that monoclonal antibodies have uses in medicine, diagnosis, and disease treatment. BIOL ONLY	lymphocyte, cancer, tumour, hybridoma, pregnancy test, diagnosis, cancer treatment, research.	

				<i>Distinguishing between the terms antigen, antibody and antibiotic. Specific teaching of this tier 3 vocabulary. Antibodies → Y shaped protein made by WBC, they kill pathogens, Antigen → cell surface protein for self/foreign recognition, antibiotic → chemical produced by fungi which kills bacteria.</i> <i>Misunderstanding of the reason of the maximum temperature allowed in schools and colleges to grow microbes. This is 25°C but not because it denatures enzymes and kills bacteria! It reduces the risk of developing harmful pathogens.</i> <i>Malaria – is <u>not</u> caused by bacteria/fungi, it is caused by a protest.</i> <i>Monoclonal antibodies – understanding of what a 'hybridoma' is. They do not exist naturally and are made by fusion of a <u>B-lymphocyte</u> (must use this term) and a <u>tumour cell</u>.</i>
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Topic 4.6	Rationale (layering, why this why now?)	Knowledge goals: <i>You need to know that how to</i>	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Inheritance, Variation & Evolution The study of inheritance will allow us to understand how genetic material is passed from one generation to the next and how we can use knowledge of DNA to benefit humans. DNA is the cells genetic material retained in the nucleus and arranged into chromosomes. The number of chromosomes is halved during meiosis and then combined with new genes from the sexual partner to produce unique offspring.	 KS3 NC: links to genetics and evolution: Inheritance, chromosomes, DNA and genes.  KS4 ladders to work on: Reproduction. DNA structure. Protein synthesis. Genetic inheritance. Sex determination. Inherited disorders. History of genetics. Variation Evolution. Theories of evolution: Darwin and Lamarck. Speciation. Selective breeding. Cloning of animals. Cloning of plants. Fossils. Extinction. Classification methods.	that sexual reproduction involves gametes fusing. that asexual reproduction involves one parent and no fusion of gametes.	sexual, asexual, sperm, egg, pollen, ova, clones, mitosis, fusion.	a) Subject specific skills Modelling the behaviour of chromosomes during meiosis. b) Numeracy Interpreting pedigree charts Determining the %, ratio or fraction of offspring with inherited disorders. Calculation of the length of DNA in a cell using numerical data. Converting between mm, µm and nm. Extract and interpret information from graphs and charts. c) Literacy and d) reading skills Evaluation and summary of the pros/cons of genetic engineering of plants for use by humans e.g. those resistant to Bt toxin. Page 230-231 AQA Biology text. Evaluation and summary of the pros/cons of screening embryos for genetic disorders. Page 214-215 AQA biology text. Evaluation of the potential benefits and risks of cloning in agriculture/medicine and that people have ethical objections. Page 229 AQA Biology text. Reading - Gregor Mendel's discoveries about monohybrid inheritance, reading/comprehension p 234-235 AQA Biology text.
		that meiosis is a type of cell division that halves the number of chromosomes. that meiosis involves two cell divisions.	meiosis, gametes, single set, restore, embryo, differentiate, fertilisation, variation, fertilisation.	
		that sexual and asexual forms of reproduction have advantages/disadvantages. BIOL ONLY	sexual, asexual, natural section, parent, time, energy efficient.	
		that DNA is a polymer arranged in a double helix. that a small section of DNA is called a gene	DNA, double helix, polymer, gene, codes , genome, human genome project,	
		that DNA contains 4 bases A, T C and G. that proteins are synthesised at ribosomes, according to a template. BIOL ONLY	DNA, bases, nucleotide, phosphate, common sugar, amino acids, proteins, repeating units, protein synthesis	
		how to carry out genetic crosses for inherited disorders. how to calculate probability, percentages, and ratios from genetic crosses/experiments.	gamete, chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype, probability, percentage, ratio.	
		that the 23 rd pair determines a person's sex. how to carry out genetic crosses to show sex inheritance.	chromosomes, XX, XY, females, males, pairs, characteristics, gametes, homozygous, heterozygous.	
		that Gregor Mendel developed the understanding of inheritance through experiments with pea plants.	Gregor Mendel, chromosomes, units of inheritance, gene function, descendants, gene theory.	

Gene mutations occur continuously and on rare occasions can affect the functioning of an animal or plant. Very rarely a new mutation can be beneficial and consequently, lead to increased fitness in the individual. Variation generated by mutation and sexual reproduction is the basis for natural selection; this is how species evolve. Through selective breeding scientists have produced livestock with favoured characteristics. Once new varieties of plants or animals have been produced it is possible to clone individuals to produce larger numbers of identical individuals all carrying the	KS5 ladders to work on: protein synthesis, transcription and translation. Detailed understanding of the processes of cell division and gene expression. Epigenetic control of gene expression.	that the importance of Mendel's work was not recognised until after his death. BIOL ONLY		e) Cultural capital links Darwin's theory of Evolution by Natural Selection. Development of this idea and rejection by some. https://www.youtube.com/watch?v=JOk_0mUT_JU Formation of new species. https://www.youtube.com/watch?v=HPQF9BQnw2A f) Common misconceptions <i>Plants only reproduce asexually, this is <u>incorrect</u>. Plants reproduce sexually and asexually.</i> <i>Avoid – 'inheriting a characteristic' better to say 'inherit a specific gene/allele that codes for specific characteristics'.</i> <i>Natural selection – organisms cannot <u>choose</u> to adapt to their environment. A random mutation or pre-existing genetic variation leads to natural selection. Idea that natural selection is a theory to explain the process of evolution.</i> <i>Genes, DNA and chromosomes - specific teaching of this vocabulary and the correct hierarchy which is regularly confused by learners.</i> <i>Gene → DNA → Chromosome</i> <i>DNA – chemical that carries genetic information. Gene – section of DNA that codes for a protein/which determines characteristics. Chromosomes – supercoiled DNA molecule/thread like structure, contains genes/found in the nucleus.</i>
		that variation is the differences in the characteristics of a population. that variation has genetic and environmental causes.	variation, genetic, environmental, mutations, phenotype, genes, environment, mutations.	
		that evolution is the change in the characteristics of a population over time. that evolution occurs by natural selection.	evolution, inherited, change, characteristics, species, phenotypes, variants.	
		that different theories of evolution were proposed by Darwin and Lamarck. that Darwin's theory was gradually accepted. BIOL ONLY	evolution, natural selection, acquired characteristics, mechanism, Jean-Baptiste Lamarck, Charles Darwin, variation.	
		that speciation is the formation of a new species. that speciation occurs through geographic isolation. BIOL ONLY	speciation, genetic variation, biotic factor, abiotic factor, natural selection, evolution, gene pools, fertile offspring.	
		that selective breeding involves choosing and mating animals or cross breeding plants for particular characteristics.	desired characteristics, breed, mate, generations, artificial selection.	
		that animals can be cloned by embryo splitting or adult cell cloning. that cloning of animals has implications. BIOL ONLY	cloning, genetically identical, adult cell cloning, embryo splitting, nucleus, genes, specialised, host mother, electric shock.	
		that plants can be cloned by tissue culture and cuttings. BIOL ONLY	cells, plant, identical, preserving, rare, economical, nurseries.	

favourable characteristic. Genes can be taken from one species and then introduced into the genome of another species by the process of genetic engineering.		that fossils are the remains of organisms found in rocks. that fossilisation can occur by different methods.	fossils, extinct, remains, mineralisation, decay, preserved traces, footprints.	<i>Cell division – misunderstanding of terms diploid and haploid, specific teaching of this vocabulary. Haploid cells contain $\frac{1}{2}$ genetic information or one set of chromosomes/no-pairs and vice versa.</i>
		that extinction is permanent loss of all members of a species.	extinct, predators, climate change, disease, environmental change, catastrophic events	<i>Cell division processes – mitosis/meiosis diagrams often mis-drawn/misinterpreted by learners.</i>
		that Linnaeus classified organisms into three groups based structural characteristics. that Carl Woese classified organisms into domains based on DNA/RNA evidence.	Linnaeus, Woese, kingdom, phylum, class, order, family, genus, species, archaea, bacteria, eukaryota, evolutionary tree.	<i>Chromosomes drawn initially as single strands then 'X' shape after DNA replication – i.e. chromosomes appear double stranded. Then one cell division (mitosis) or two (meiosis).</i> For meiosis  For mitosis  <i>Important scientists, learners often confuse their work.</i> <i>Mendel – characteristics determined and passed on in 'units'. Lamarck – changes that occur during an organism's lifetime are passed on. (we now know this is wrong)! Darwin – natural selection, survival of the fittest. Wallace – used Darwin's work to develop speciation theory. Linnaeus – developed the classification system – K,P,C,O,F,G,S. Woese – 3 domain system based on DNA/RNA.</i>

Topic 4.2	Rationale (layering, why this why now?)	Knowledge goals: <i>You need to know that how to</i>	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Organisation Understanding how organisms are built will give a clearer understanding of process that occur in living organisms. Organisation from cell to complex organ systems is fundamental to all multicellular organisms. The human digestive system provides the body with nutrients and the respiratory system provides it with oxygen and removes carbon dioxide. In each case they provide dissolved materials that need to be moved quickly around the body in the blood by	 KS2 describe ways in which nutrients and water are transported within animals. KS3 NC: links to structure and function of living organisms: nutrition and digestion, gas exchange systems.  KS4 ladders to work on: Enzymes. Digestive enzymes. Liver and the role of bile. Enzyme based experiments. Transport in animals. Heart and blood vessel structure. Transport in plants. Non-communicable diseases. Effect of lifestyle on development of disease. Cancer and risk factors. Transpiration and factors affecting.	that cells are organised into tissues, tissues in organs and organs into organ systems	cell, tissue, aggregation, organ, organ system, organism.	a) Subject specific skills Practical skills (RP5) – enzymes effect of a known variable on enzyme activity e.g., pH/temperature. Recognising the different types of blood cell from photographs. Practical skills- observing and drawing stomata or blood cells under a microscope. Practical skills (RP4) – qualitative food tests. b) Numeracy Calculating rates from enzyme reactions. Expressing data in standard form Understanding of size and scale of in relation to cells, tissues, organs, and systems. Interpret data relating to risk factors for specific diseases. c) Literacy and d) Reading Using stimulus material to evaluate the use of heart valves from biological and mechanical sources. Reading – artificial hearts page 59 AQA Biology text. d) Cultural capital links Dr William Beaumont discovery and importance of digestive enzymes. https://bit.ly/2VI2Wlf
		that tissues in the plant leaf include epidermal, palisade, mesophyll, xylem, and phloem.	epidermal, palisade, mesophyll, xylem and phloem, root, stem, stomata.	
		that enzymes catalyse specific reactions in cells. that enzyme models can be used to explain enzyme action.	lock & key theory, enzyme, catalysts substrate, active site, complex, temperature, pH.	
		that digestive enzymes convert food into small soluble molecules which can be absorbed into the blood.	small, soluble, molecule, carbohydrases, proteases, lipases, active site, catalyst, enzyme-substrate complex.	
		how to investigate the effect of pH on enzyme reactions.	pH, amylase, rate, digest, starch, enzyme, substrate.	
		how to carry out qualitative food tests for carbohydrate, fat and protein.	iodine, biuret solution, benedict's solution, ethanol, qualitative test.	
		that bile is made in the liver and stored in the gall bladder that bile assists with fat digestion and neutralises stomach acid.	bile, alkaline, liver, emulsify, droplets, surface area, rat, lipase.	
		that the heart pumps blood around the body in a double circulatory system.	atria, ventricles, aorta, pulmonary artery, vena cava, pulmonary vein, pacemaker, double	

the circulatory system. In plants the transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis.	KS5 ladders to work on: Detailed heart structure and how it beats in a coordinated manner. Transport in plants Tissue fluid formation in organisms. Cancer and the effect of epigenetic factors and genes on development of cancer.	that the heart contains 4 chambers, 4 vessels and valves.	circulatory system/pump.	Importance of maintaining a healthy lifestyle in relation to developing non-communicable diseases. https://www.nhs.uk/live-well/ https://www.nhs.uk/conditions/coronary-heart-disease/ Cancer causes and risk factors. https://www.macmillan.org.uk/cancer-information-and-support https://www.bbc.co.uk/bitesize/guides/z372ng8/revision/2 e) Graph reading skills Graphical analysis of data, frequency tables, bar charts and histograms. Plot graphs using appropriate scales for axes. f) Common misconceptions <i>Enzymes <u>are not alive!</u> so, they cannot die, they can only be denatured. Enzymes are protein molecules that are found within cells, they are denatured by extreme pH or temperature. This leads to a change in the shape of the active site.</i> <i>Deoxygenated blood is blue – <u>this is incorrect</u>, enforced by the idea of ‘blue blood’ in textbooks. Blood is deep red, but our veins look blue due to the scattering of light by the skin.</i> <i>Heart – right side of the heart pumps blood a greater distance around the body, <u>this is incorrect</u>. The right ventricle contains a smaller proportion of muscle so only pumps blood to the lungs. The left side with a greater</i>
		that blood is a tissue composed of red and white cells and platelets suspended in plasma.	red blood cells, white blood cells, platelet, plasma, oxygenated, deoxygenated, exchange.	
		that the body contains three types of blood vessel.	artery, vein, capillary, oxygen, carbon dioxide, muscle, lumen,	
		that coronary heart disease is a non-communicable disease. that stenting and statins can be used to treat CHD.	coronary artery, fatty material, stents, statins, heart valves, biological, mechanical.	
		that heart valves can become faulty (leak/don't open). that artificial hearts are used to keep people alive while they are waiting for a heart transplant.	heart valve, stent, donor heart, artificial valve, mechanical valve, effectiveness, efficacy, heart transplant.	
		that risk factors are linked to an increased rate of disease. that diet, stress and life situations can affect health and well-being.	health, disease, interact, communicable, asthma, skin rashes, depression, cancer lifestyle diseases, obesity, alcohol, smoking, carcinogens, diabetes, risk factor, cardiovascular disease.	
		that cancer is uncontrolled cell division. that tumours can be benign or malignant.	malignant, benign, uncontrolled, cell division, secondary tumour, risk factors.	

		that transpiration is loss of water from plant leaves via the stomata. that transpiration is affected by various factors.	transpiration, temperature, humidity, light intensity, root hair cell, xylem vessel, stomata, stomatal density, water uptake, potometer, guard cells.	<i>proportion of muscle pumps blood to the body. The heart is a double pump.</i> <i>Plants obtain water from their leaves <u>this is incorrect</u>. Plants obtain water from their roots via their root hair cells. In fact, most plant leaves are adapted to direct water to the ground e.g., drip tips in rainforest plants. Leaves have stomata to allow exchange of gases.</i>
		that roots, stems and leaves form the plant organ system. that xylem and phloem are adapted for transport.	xylem, phloem, water, mineral ions, glucose, translocation, transpiration, guard cells.	<i>Plants are living! this is a fact. Unlike animals' plants do <u>not eat</u>. Carbon dioxide, water and minerals <u>are not</u> the plants food. Plants produce food during photosynthesis (a chemical reaction) this is why they are called producers.</i>