Mapping proposed GCSE The Sciences against RSB's Evolving 5-19 Biology – December 2022

Wales proposed content: Knowledge, understanding and skills
Variation, mutation and natural selection that leads to diversity, including inheritance, the genome and competition

Wales proposed content: Appendix items	**Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification**	**RSB Curriculum Committee commentary on proposals**
Could include: Types of variation i.e. heritable and non-heritable. Monohybrid inheritance and sex determination. DNA structure and its function in inheritance and mutations. Purposes of mitosis and meiosis. Gene technology - benefits and drawbacks. Natural selection and the evidence for it, e.g. fossils.	Sexual reproduction leads to variation in populations whilst asexual reproduction leads to populations of genetically identical individuals. The cell growth cycle, including mitosis. The role of meiotic division in halving the chromosome number to form gametes. Monohybrid inheritance could be covered under 'models of single gene inheritance, including dominant and recessive characteristics and homozygous and heterozygous genotypes'. Sex determination in humans The structure of DNA How the genome, and its interaction with the environment, influence the development of the phenotype of an organism, including protein synthesis Genetic variants result from mutations which are changes in the DNA; these may occur during cell division or as a result of environmental factors Genetic technology as a process which involves modifying the genome of an organism to change its phenotype. Benefits, issues and risks of using genetic technology in modern agriculture and medicine. Evolution is a change in the inherited characteristics of a population over many generations through a process of natural selection, which may result in the formation of new species. Evidence for evolution includes fossils, domestication of species by selective breeding, DNA analysis, and modern examples including antibiotic resistance in bacteria.	*To some extent the content matches with that in the RSB's Evolving 5-19 Biology appendix: Exemplification of the curriculum framework for ages 11-16 (pages 49-63), but details are missing – there is a chance that this could be covered when the exam board writes the specification but there are some large gaps in terms of the areas covered in the genetics component here.* *Proposals do not specify if students will be learning about the processes of* ***mitosis and meiosis.*** ***Genetic technology*** *does not specify which areas it will focus on so there is a chance it could miss* ***medicine or agriculture.*** *There is no mention that* ***evolution*** *is intended to be included in this topic, yet* ***natural selection and variation, along with the fossil record*** *are the exact place for evolution to be included.* *There is no indication that the* ***formation of fossils*** *will be included.* *There is no indication that* ***extinction*** *will be included in the content.*

Wales proposed content: Knowledge, understanding and skills
Dynamic ecosystems

Wales proposed content: Appendix items	**Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification**	**RSB Curriculum Committee commentary on proposals**
Could include: Relationships between niche, habitat, population, community and ecosystem. Biotic and abiotic factors in an ecosystem and how they interact. Energy transfer through an ecosystem and the (relative) efficiency of these transfers. Increase in human population leading to negative impacts on local and global ecosystems and how these are being counteracted. Positive and negative impacts of human activity on biodiversity, both local and global.	The size of one or more populations in a community may be affected if the environmental conditions change. The abundance of organisms and different conditions within an ecosystem can be investigated scientifically. Pupils should learn that ecosystems are made up of biotic (living) and abiotic (non-living) components. Many different materials cycle through the abiotic and biotic components of an ecosystem. Abiotic and biotic factors affect biodiversity within an ecosystem The differences between trophic levels within a food web. Pyramids of biomass, how biomass is lost between the different trophic levels and how this affects the number of organisms at each trophic level and has implications for human food security. Calculate the efficiency of biomass transfers between trophic levels The positive and negative effects on biodiversity of human interactions within ecosystems. The benefits and challenges of maintaining local and global diversity Biotechnological and agricultural solutions, including genetic technologies, to meet the needs of the growing human population. Human actions affect a range of local and global habitats, and the organisms that live there, in both positive and negative ways. Some of our actions affect organisms that we depend on for food and other resources. Biodiversity loss and sustainability affect the security of our supplies of food and other resources.	*There is no mention of **carbon or nutrient cycling in the ecosystem** in the Welsh proposed content.* *Whilst there is a mention of **energy transfers, which will be assumed as food chains**, there is no mention of **decomposition, microorganisms or factors affecting decomposition.*** *This would also be a good place to link to **climate change**, if that is with the interdisciplinary learning or not.* *There is a brevity surrounding the **energy transfers through an ecosystem**, it would be beneficial to include **pyramids of biomass and the calculations needed for the efficiency of transfers of energy between the trophic levels.*** *Qualifications Wales goes further than the Evolving 5-19 Biology exemplification by requiring the definitions of the various stages of an ecosystem.*

Wales proposed content: Knowledge, understanding and skills

Biological processes that maintain life by supporting the functions of cells, tissues, organs and organ systems.

Wales proposed content: Appendix items	**Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification**	**RSB Curriculum Committee commentary on proposals**
Could include: functions of cells, tissues, organs and organ systems Photosynthesis and its application to increasing the yield / biomass of plants grown for personal and commercial use. Aerobic and anaerobic respiration in humans and the uses of the energy released. How foods are digested to give useful products that can be absorbed and assimilated for use. How essential materials are transported in both plants and animals. Impact of the loss of control of biological processes. How molecules move across membranes. How enzymes control rates of reaction.	Photosynthesis: A two stage model can be used to describe the process of photosynthesis in plants and algae: The first stage requires light and water, the second stage does not need light but uses carbon dioxide to make glucose and oxygen. The effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis, and the interaction of these factors in limiting the rate of photosynthesis. The process of anaerobic cellular respiration in humans and micro-organisms, including fermentation. The differences between aerobic and anaerobic cellular respiration in terms of the reactants, the products formed and the implications for the organism. The structure of the human digestive system, including adaptations to function. The importance of carbohydrates, lipids and proteins and the role of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of these molecules. Substances move into and out of cells through diffusion, osmosis and active transport. The adaptations of xylem and phloem to their functions in plants. The uptake of water and mineral ions by plants The processes of transpiration and translocation, including the structure and function of the stomata The effect of a variety of environmental factors on the rate of water uptake by a plant, including light intensity, air movement and temperature. Chemical reactions in living cells occur because the activities of enzymes, which are biological catalysts. The mechanism of enzyme action including the active site, enzyme specificity and factors affecting the rate of enzyme-controlled reactions.	*There needs to be a clearer link between the Qualifications Wales proposal* ***to increasing yield/ biomass of plants and the teaching of limiting factors in photosynthesis.*** ***Anaerobic respiration*** *is included in this topic but* ***only in reference to humans, with no look to industry or other processes such as fermentation.***

Wales proposed content: Knowledge, understanding and skills
Human health and well-being and factors that can positively or negatively affect it

Wales proposed content: Appendix items	**Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification**	**RSB Curriculum Committee commentary on proposals**
Could include: Human health and well-being affects how well an individual copes with physical, emotional, environmental and social challenges. Assessing genetic and environmental risk of an individual developing (non-communicable) diseases /conditions and mitigating any risk. Infectious diseases caused by a variety of pathogens, and methods of transmission. Natural defence systems and enhanced immunity, and their role in preventing or mitigating infectious diseases. Disease treatment options for enhancing health and well-being.	A number of lifestyle factors affect physical and mental health in positive and negative ways. The physical and mental health of an individual organism results from interactions between the organism's body, behaviour, environment and other organisms. The risk of an individual developing non-communicable diseases depends on interacting factors including the information stored in their genome, their environment and aspects of their lifestyle. The individual and societal benefits of promoting good health, compared to treating ill health. Many human diseases are caused by the interaction of a number of biological (including genetic) and lifestyle factors, including cardiovascular diseases (atherosclerosis and hypertension), many forms of cancer, some lung and liver diseases, mental ill health and diseases influenced by nutrition, including type 2 diabetes. Pathogens that cause diseases in animals and plants can be identified using microscopy and cultures. The ways in which the spread of infectious diseases may be reduced or prevented in animals and plants. The specific defences of the human immune system, including the role of white blood cells in phagocytosis and antibody production Chemical plant defences including production of antimicrobial substances How vaccines establish immunity and their use in the prevention of disease	***How pathogens cause the symptoms of disease in animals and plants*** ***Infectious diseases and natural defence systems do not clarify if they will be for humans, animals and plants.*** *Disease treatment options for enhancing health and wellbeing is very broad –* ***is there going to be a focus on communicable diseases, non-communicable or both****?* *No mention of* ***vaccines or any specific medicines.*** *No mention of* ***alcohol or drugs*** *No mention of* ***diet***

Scientific curiosity skills

Wales proposed content	Wales proposed content: Appendix items	Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification	RSB Curriculum Committee commentary
Make sound and rational choices	Considering science as both a process and a body of knowledge which places importance on evidence and peer review. Using evidence to weigh-up scientific, pseudo-scientific and non-scientific claims, recognising biases. Using science to inform decisions affecting individuals, society and the environment, locally and globally.	Consider ways in which biological knowledge changes people's behaviour, including the decisions they make and how they interact with other organisms and the environment Consider ways in which individuals, organisations and governments are responsible for safe and ethical use of biological knowledge and its applications. Evaluate information and claims related to scientific issues, from a range of sources, and decide how much confidence can be placed in them.	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*
Explore scientific models and factors which influence them	Understanding that science uses conceptual, mathematical, digital and physical models to explain phenomena. Evaluating the strengths and limitations of models to explain phenomena, testing them using real data, and making suggestions to improve them. Considering historical examples of models and theories tested by the evidence, and then superseded over time.	Use scientific models to explain complicated ideas and make predictions Identify the benefits and limitations of scientific models Learn about how scientific explanations, classification systems and models are developed and modified to account for the available evidence, using historical and contemporary examples.	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification, and goes even further to discuss the types of models that students may be engaging with.*
Identify areas which can be understood through scientific inquiry	Recognising questions that can/cannot lead to scientific answers. Asking questions that can be answered using science, to develop a new inquiry. Selecting and developing a new, or newly adapted, inquiry involving primary or secondary data (or both) that includes innovative ways to try to answer questions. Making predictions and hypotheses (using prior experience or knowledge), if appropriate.	Generate their own questions and consider how they could be answered. Identify questions that could be answered using a scientific approach to collect data (observations and measurements). Ask questions and develop lines of enquiry based on observations of the biological world, alongside prior knowledge and experience. Select and plan appropriate scientific enquiries to help answer questions, test hypotheses or test predictions. Generate their own testable hypotheses and predictions.	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*

Wales proposed content	Wales proposed content: Appendix items	Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification	RSB Curriculum Committee commentary
Explore and select approaches to designing a method of inquiry	Developing a plan for an inquiry, adapting known methods and making preliminary observations as appropriate. Considering whether to collect primary or secondary data (or both). Recognising the limitations of the method being used.	Compare the strengths and weaknesses of different investigative designs. Select and plan appropriate scientific enquiries to help answer questions, test hypotheses or test predictions. Identify and describe appropriate methods and tools (apparatus, instruments and technology) that can be used to collect data in a repeatable way that will maximise the accuracy and precision of measured values Compare the strengths and weaknesses of different investigative designs	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*
Collect, record and present primary data, while evaluating and improving data quality	Carrying out an inquiry involving primary data. While collecting data and making observations, striving for accuracy, precision, repeatability. Appropriate use of tables, charts, graphs, drawings and other visual representations. Considering the quality of data as it is being collected. Use of apparatus and techniques appropriate to GCSE-level practical inquiry. Using digital tools to collect data where possible.	Translate data from one form to another, including interconverting units and graphical representation Use appropriate methods, tools (apparatus, instruments and technology), and materials to collect data in the laboratory and in the field They work carefully to avoid mistakes, and they work with objectivity to reduce bias. They work to reduce sources of random and systematic error to increase the precision and accuracy of measured values Work to maximise the accuracy and precision of measured values Work in a repeatable way	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*
Collect, record and present secondary data, while evaluating data quality	Carrying out an inquiry involving secondary data, exploring existing datasets. Searching books, the internet and other sources for evidence. Considering the validity of secondary sources. Using techniques appropriate to GCSE-level research – the selection of relevant information from evidence presented on the internet and elsewhere as text, numerical data, tables, charts, graphs, drawings, infographics and other visual representations, audio, etc. Referencing sources of data and information.	Engage with scientific information presented in a range of formats (written, numerical, and graphical)	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*

Wales proposed content:	Wales proposed content: Appendix items	Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification	RSB Curriculum Committee commentary
Perform data analysis	Appropriate use of tables, charts, graphs drawings, infographics and other visual representations. Using digital tools to represent and analyse data (e.g. spreadsheets). Using statistical thinking (types of average value, range etc.). Identifying uncertainties. Identifying trends and patterns. Identifying and handling anomalies. Comparing data with previously existing datasets. Comparing data with peers' datasets.	Translate data from one form to another, including interconverting units and graphical representation. Interpret data presented in a range of forms, including identifying patterns, trends and correlations. Identify anomalous results and outliers. Identify sources of random and systematic error.	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*
Formulate conclusions and evaluate approaches	Describing trends, patterns and observations. Developing explanations for data trends, patterns and observations. Comparing explanations with predictions/hypotheses (where made). Making conclusions, comparing with prior experience or knowledge. Reviewing quality of inquiry and method, including the degree of confidence in conclusions. Justifying improvements in inquiry and method, if appropriate. Developing new, testable predictions /hypotheses, if appropriate.	Interpret data presented in a range of forms, including identifying patterns, trends and correlations. Suggest explanations for patterns, trends, and correlations in primary and secondary data, including cause-effect links. Make inferences and draw conclusions from data. Suggest ways in which the quality of data could be improved, and identify further questions for investigation. Use data to evaluate predictions and the hypotheses upon which they are based. Data may agree or disagree with a prediction or hypothesis. In either case, the prediction of hypothesis may be tested further by planning and carrying out additional investigations.	*This content is a good match to the Evolving 5-19 Biology curriculum exemplification.*

Bringing the sciences together to solve problems

Wales proposed content: Knowledge, understanding and skills	Wales proposed content: Appendix items	Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification
Tackling climate change and achieving a sustainable future	The problems involved in the effects of climate change, and creating ways to solve them Could include: • Earth's atmosphere. • Why and how the atmosphere and climate is changing. • Short and long-term effects of climate change. • What can be done in response to a changing climate. • Alternative energy resources. • Biodiversity and preventing extinctions. • Sustaining human food supplies and water security.	Almost all life on life on Earth depends on the ability of photosynthetic organisms to build organic molecules and to maintain levels of oxygen and carbon dioxide in the atmosphere. The impacts of climate change on the distribution of organisms. Biodiversity can be measured and valued at genetic, species and ecosystem level. The positive and negative effects on biodiversity of human interactions within ecosystems. The benefits and challenges of maintaining local and global biodiversity. The impact of biodiversity loss on human food and water security.
Exploring space	The problems involved in exploring Earth and its place in the universe, and creating ways to solve them Could include: • Exploring the Earth's interior and deep water, using seismic waves and magnetism. • The solar system, Earth's formation and overall structure. • Observing the universe using waves. • Observable stages in the life cycle of stars. • The expansion of the universe and the origins of the solar system. • Sustaining life in space. • The effects on the human body of spaceflight, particularly long-duration flights away from Earth. • Probes, and human exploration of space.	*Whilst the human body is covered in the Evolving 5-19 Biology curriculum exemplification, it is not covered in this context.*

Wales proposed content: Knowledge, understanding and skills	**Wales proposed content: Appendix items**	**Curriculum content for 14-16 age range detailed in Evolving 5-19 Biology exemplification**
Improving health and well-being through sport and movement	The problems involved in maximising health and well-being through sport, and creating ways to solve them Could include: • Benefits of sport to the body and mind. • Aspects of a healthy diet – salts, water, nutrition. • Physiology - breathing, respiration, circulation and nervous system (e.g. related to reaction times). • Movement - skeletal system and muscles, biomechanics. • Posture, stability, energy used during an activity, forces to overcome during sport performance (friction, gravity). • Sport activity and measurements, digital devices to measure physical performance, e.g. speed, time, mass (weight) lifted, length, height, acceleration, distances covered, heart rate responses/recovery. • Monitoring performance and physiology through sensors and smart devices. • Recognising and treating sports injuries, e.g. imaging and tracing. • Disability and sports aids. • Cheating in sport, e.g. drugs, enhancers, blood doping, match fixing. • Use of smart materials – in prosthetics, textiles, equipment, injury prevention, protection and healing.	Content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed. The impact of variation between individuals and lifestyles on dietary requirements. The consequences of imbalances in the diet, including obesity, starvation and deficiency diseases. The mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases. Cellular respiration is a process which is continuously occurring in all living cells During cellular respiration ATP is made as molecules of glucose are broken down The process of anaerobic cellular respiration in humans and micro-organisms, including fermentation. The differences between aerobic and anaerobic cellular respiration in terms of the reactants, the products formed and the implications for the organism. The adaptations of the human circulatory system to its functions The relationship of the circulatory system to other organ systems in the body. The structure and functions of the human skeleton, including support, protection, movement and making blood cells. The function of muscles and examples of antagonistic muscles. Biomechanics- the interaction between skeleton and muscles, including the measurement of fore exerted by different muscles.