Practical resources to support the teaching of A level Biology in England

Core Content	Additional Options for Practical Work
Biodiversity	
• the variety of life, both past and present, is extensive, but the biochemical basis of life is similar for all living things • biodiversity refers to the variety and complexity of life and may be considered at different levels • biodiversity can be measured, for example within a habitat or at the genetic level • classification is a means of organising the variety of life based on relationships between organisms and is built around the concept of species • originally classification systems were based on observable features but more recent approaches draw on a wider range of evidence to clarify relationships between organisms • adaptations of organisms to their environments can be behavioural, physiological and anatomical • adaptation and selection are major factors in evolution and make a significant contribution to the diversity of living organisms	http://www.nuffieldfoundation.org/practical-biology/observing-patterns-distribution-simple-plant patterns in plant distribution http://www.nuffieldfoundation.org/practical-biology/investigating-response-worms-soil-improvers investigating the behaviour of animals to different soil conditions http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard using quadrats to measure biodiversity http://www.nuffieldfoundation.org/practical-biology/model-natural-selection-%E2%80%93-spaghetti-worms modelling natural selection http://www.biology-fieldwork.org/woodland/woodland-plants/investigation-comparing-two-areas-of-woodland.aspx Investigation into ground vegetation in two contrasting areas of woodland, including a spreadsheet for calculating Simpson's Diversity Index http://bigpictureeducation.com/video-whats-buttercup Wellcome Trust video and accompanying data for field work http://www.saps.org.uk/secondary/teaching-resources/258 http://www.saps.org.uk/secondary/teaching-resources/127 http://www.saps.org.uk/secondary/teaching-resources/768 online activities to practice sampling techniques before you get into the field, looking at measuring abundance, random sampling and distribution of species across a footpath
Exchange and Transport	
• organisms need to exchange substances selectively with their environment and this takes place at exchange surfaces • factors such as size or metabolic rate affect the requirements of organisms and this gives rise to adaptations such as specialised exchange surfaces and	http://www.nuffieldfoundation.org/practical-biology/effect-size-uptake-diffusion - experiment on rate of diffusion using agar cubes. http://www.nuffieldfoundation.org/practical-biology/estimating-rate-transpiration-

mass transport systems • substances are exchanged by passive or active transport across exchange surfaces • the structure of the plasma membrane enables control of the passage of substances into and out of cells	plant-cutting rate of transpiration and an animation that supports the ideas of water transport http://www.saps.org.uk/secondary/themes/1274 http://www.nuffieldfoundation.org/practical-biology/tracking-active-uptake-minerals-plant-roots active uptake of minerals in plant roots http://www.nuffieldfoundation.org/practical-biology/investigating-effect-temperature-plant-cell-membranes effect of temperature on plant cell membranes (can use colorimeter) http://www.nuffieldfoundation.org/practical-biology/looking-heart heart dissection, looking at structure of organs – link to mass transport system. http://www.nuffieldfoundation.org/practical-biology/modelling-human-ventilation-system modelling human ventilation system http://www.nuffieldfoundation.org/practical-biology/using-spirometer-investigate-human-lung-function using a spirometer to measure lung function http://www.nuffieldfoundation.org/practical-biology/measuring-rate-metabolism measuring metabolic rate
Cells	
• the cell theory is a unifying concept in biology • prokaryotic and eukaryotic cells can be distinguished on the basis of their structure and ultrastructure • in complex multicellular organisms cells are organised into tissues, tissues into organs and organs into systems • during the cell cycle genetic information is copied and passed to daughter cells • daughter cells formed during mitosis have identical copies of genes while cells formed during meiosis are not genetically identical	http://www.nuffieldfoundation.org/practical-biology/looking-heart heart dissection, looking at structure of organs http://www.nuffieldfoundation.org/practical-biology/dissecting-lungs lung dissection tissue and organ structure http://www.nuffieldfoundation.org/practical-biology/comparing-flower-structure-different-angiosperms dissection and comparison of different flower structures http://www.nuffieldfoundation.org/practical-biology/aseptic-techniques aseptic techniques for the culturing of bacteria on agar plates http://www.nuffieldfoundation.org/practical-biology/investigating-mitosis-allium-

	root-tip-squash mitosis in a root tip squash, there is an animation to support this practical http://saps.org.uk/secondary/themes/1290 http://www.nuffieldfoundation.org/practical-biology/preparing-anther-squash meiosis in an anther squash http://www.nuffieldfoundation.org/practical-biology/making-reebops-model-meiosis model of meiosis http://www.saps.org.uk/secondary/teaching-resources/770-microscopy-looking-at-xylem-and-specialised-cells xylem cells
Biological Molecules	
• biological molecules are often polymers and are based on a small number of chemical elements • in living organisms nucleic acids (DNA and RNA), carbohydrates, proteins, lipids, inorganic ions and water all have important roles and functions related to their properties • the sequence of bases in the DNA molecule determines the structure of proteins, including enzymes • enzymes catalyse the reactions that determine structures and functions from cellular to whole-organism level • enzymes are proteins with a mechanism of action and other properties determined by their tertiary structure • enzymes catalyse a wide range of intracellular reactions as well as extracellular ones • ATP provides the immediate source of energy for biological processes	http://www.nuffieldfoundation.org/practical-biology/extracting-dna-living-things extraction of DNA practical work http://www.nuffieldfoundation.org/practical-biology/quantitative-food-test-protein-content-powdered-milk establishing the quantity of protein in powdered milk http://www.britishecologicalsociety.org/wp-content/uploads/Education-Water-lesson.pdf range of practical activities relating to the properties of water http://www.nuffieldfoundation.org/practical-biology/microscale-investigations-catalase-activity-plant-extracts catalase activity in plants http://www.nuffieldfoundation.org/practical-biology/investigating-effect-temperature-activity-lipase temperature impact on lipase http://www.nuffieldfoundation.org/practical-biology/investigating-effect-ph-amylase-activity amylase and the impact of pH http://www.nuffieldfoundation.org/practical-biology/modelling-sliding-filament-hypothesis proteins and muscle movement

Ecosystems	
• ecosystems range in size from the very large to the very small • biomass transfers through ecosystems and the efficiency of transfer through different trophic levels can be measured • microorganisms play a key role in recycling chemical elements • ecosystems are dynamic systems, usually moving from colonisation to climax communities in a process known as succession • the dynamic equilibrium of populations is affected by a range of factors • humans are part of the ecological balance and their activities affect it both directly and indirectly • effective management of the conflict between human needs and conservation help to maintain sustainability of resources •	http://www.nuffieldfoundation.org/practical-biology/nitrogen-fixing-bacteria-free-living-soil - links to nitrogen cycle, recycling chemical elements and impact that humans can have on ecosystems. http://www.biology-fieldwork.org/freshwater/freshwater-animals/investigation-freshwater-energy-flow.aspx An investigation into energy flow using freshwater invertebrates, to construct pyramids of numbers, biomass and energy and calculate efficiency http://www.biology-fieldwork.org/seashore/sand-dunes/investigation-primary-succession-in-sand-dunes.aspx An investigation into primary succession in sand dunes http://www.biology-fieldwork.org/grassland/grassland-plants/fieldwork.aspx Fieldwork techniques for investigating the effects of mowing and trampling in grasslands (human impact on ecosystems) http://www.saps.org.uk/secondary/teaching-resources/127 online activity to explore the how to look at distribution of species across a footpath before you go out into the field
Control Systems	
• homeostasis is the maintenance of a constant internal environment • negative feedback helps maintain an optimal internal state in the context of a dynamic equilibrium. Positive feedback also occurs • stimuli, both internal and external, are detected leading to responses • the genome is regulated by a number of factors • coordination may be chemical or electrical in nature	http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-breathing-rate-locust investigating the factors that affect breathing rate http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-heart-rate-daphnia investigating factors that affect heart rate http://www.nuffieldfoundation.org/practical-biology/observing-effects-exercise-human-body effects of exercise on humans http://www.nuffieldfoundation.org/practical-biology/using-choice-chamber-investigate-animal-responses-stimuli animals response to stimuli

	http://www.nuffieldfoundation.org/practical-biology/investigating-response-calliphora-larvae-light larvae response to light
Genetics and Evolution	
• transfer of genetic information from one generation to the next can ensure continuity of species or lead to variation within a species and possible formation of new species • reproductive isolation can lead to accumulation of different genetic information in populations potentially leading to formation of new species • sequencing projects have read the genomes of organisms ranging from microbes and plants to humans. This allows the sequences of the proteins that derive from the genetic code to be predicted • gene technologies allow study and alteration of gene function in order to better understand organism function and to design new industrial and medical processes	http://www.nuffieldfoundation.org/practical-biology/preparing-anther-squash meiosis in an anther squash http://www.nuffieldfoundation.org/practical-biology/making-reebops-model-meiosis model of meiosis http://www.saps.org.uk/secondary/teaching-resources/706 new effective technique for cloning cauliflowers http://www.nuffieldfoundation.org/practical-biology/cloning-living-organism taking cuttings from plants http://www.nuffieldfoundation.org/practical-biology/gene-induction-%C3%9F-galactosidase-e-coli induction of genes (genetic control) http://www.nuffieldfoundation.org/practical-biology/following-gene-transfer-conjugation-bacteria horizontal gene transfer in bacteria http://www.yourgenome.org/ range of activities and animations from Sanger Institute
Energy for biological processes	
• in cellular respiration, glycolysis takes place in the cytoplasm and the remaining steps in the mitochondria • ATP synthesis is associated with the electron transfer chain in the membranes of mitochondria and chloroplasts • in photosynthesis energy is transferred to ATP in the light- dependent stage and the ATP is utilised during synthesis in the light-independent stage	http://www.nuffieldfoundation.org/practical-biology/how-do-plants-and-animals-change-environment-around-them#node-2978 investigating levels carbon dioxide produced by animals and plants in light and dark conditions http://www.nuffieldfoundation.org/practical-biology/investigating-light-dependent-reaction-photosynthesis using DCPIP as an electron acceptor – investigating light dependent reaction

	http://www.saps.org.uk/secondary/teaching-resources/235 investigating photosynthesis using algal balls and an animation that outlines respiration and photosynthesis http://www.saps.org.uk/secondary/themes/1281 http://www.nuffieldfoundation.org/practical-biology/measuring-rate-metabolism measuring metabolic rate http://www.nuffieldfoundation.org/practical-biology/measuring-respiratory-quotient measuring the respiratory quotent http://www.saps.org.uk/secondary/teaching-resources/181 thin layer chromatography for photosynthetic pigments

Practical resources to support the teaching of practical skills in Biology A levels in England

Practical techniques	Additional options for practical work
use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH)	http://www.saps.org.uk/secondary/teaching-resources/235 investigating photosynthesis using algal balls (pH and colour)
use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer	http://www.nuffieldfoundation.org/practical-biology/measuring-rate-water-uptake-plant-shoot-using-potometer using a potometer http://www.saps.org.uk/secondary/teaching-resources/1263 a simpler set of potometer apparatus http://www.nuffieldfoundation.org/practical-biology/quantitative-food-test-protein-content-powdered-milk establishing the quantity of protein in powdered milk – can use a colorimeter in this practical http://www.nuffieldfoundation.org/practical-biology/investigating-effect-temperature-plant-cell-membranes effect of temperature on plant cell membranes (can use colorimeter) http://www.saps.org.uk/secondary/teaching-resources/235 and http://www.saps.org.uk/secondary/teaching-resources/1224 investigating photosynthesis using algal balls (can use a colorimeter)
use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions	
use of light microscope at high power and low power, including use of a graticule	http://www.nuffieldfoundation.org/practical-biology/investigating-mitosis-allium-root-tip-squash mitosis in a root tip squash http://www.nuffieldfoundation.org/practical-biology/preparing-anther-squash meiosis in an anther squash http://www.saps.org.uk/secondary/teaching-resources/770-microscopy-looking-at-xylem-and-specialised-cells xylem cells, trichomes

	http://www.saps.org.uk/secondary/teaching-resources/1325 preparing a temporary slide to show and measure phloem and xylem
produce scientific drawing from observation with annotations	http://www.nuffieldfoundation.org/practical-biology/investigating-mitosis-allium-root-tip-squash mitosis in a root tip squash http://www.nuffieldfoundation.org/practical-biology/preparing-anther-squash meiosis in an anther squash http://www.nuffieldfoundation.org/practical-biology/comparing-flower-structure-different-angiosperms dissection and comparison of different flower structures http://www.saps.org.uk/secondary/teaching-resources/770-microscopy-looking-at-xylem-and-specialised-cells xylem cells, trichomes http://www.saps.org.uk/secondary/teaching-resources/1325 phloem and xylem
use qualitative reagents to identify biological molecules	http://www.nuffieldfoundation.org/practical-biology/quantitative-food-test-protein-content-powdered-milk establishing the quantity of protein in powdered milk – can use a colorimeter in this practical
separate biological compounds using thin layer/paper chromatography or electrophoresis	http://www.saps.org.uk/secondary/teaching-resources/181thin layer chromatography for photosynthetic pigments
safely and ethically use organisms to measure: - plant or animal responses	http://www.nuffieldfoundation.org/practical-biology/microscale-investigations-catalase-activity-plant-extracts catalase activity in plants http://www.nuffieldfoundation.org/practical-biology/how-do-plants-and-animals-change-environment-around-them#node-2978 investigating levels carbon dioxide produced by animals and plants in light and dark conditions http://www.nuffieldfoundation.org/practical-biology/investigating-response-worms-soil-improvers investigating the behaviour of animals to different soil conditions

- physiological functions	http://www.nuffieldfoundation.org/practical-biology/using-choice-chamber-investigate-animal-responses-stimuli animals response to stimuli http://www.nuffieldfoundation.org/practical-biology/investigating-response-calliphora-larvae-light larvae response to light http://www.nuffieldfoundation.org/practical-biology/using-spirometer-investigate-human-lung-function using a spirometer to measure lung function http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-breathing-rate-locust investigating the factors that affect breathing rate http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-heart-rate-daphnia investigating factors that affect heart rate http://www.nuffieldfoundation.org/practical-biology/observing-effects-exercise-human-body effects of exercise on humans http://www.getinthezone.org.uk/ Practical activities (kits were delivered to free to all schools in 2012) with link to online database for analysis
use microbiological aseptic techniques, including the use of agar plates and broth	http://www.nuffieldfoundation.org/practical-biology/aseptic-techniques standard practice for aseptic techniques http://www.nuffieldfoundation.org/practical-biology/incubating-and-viewing-plates standard practice for viewing and incubating agar plates http://www.nuffieldfoundation.org/practical-biology/making-nutrient-agars making up nutrient agars http://www.nuffieldfoundation.org/practical-biology/pouring-agar-plate how to pour agar plates

safely use instruments for dissection of an animal organ, or plant organ	http://www.nuffieldfoundation.org/practical-biology/looking-heart heart dissection, looking at structure of organs http://www.nuffieldfoundation.org/practical-biology/dissecting-lungs lung dissection tissue and organ structure http://www.nuffieldfoundation.org/practical-biology/comparing-flower-structure-different-angiosperms dissection and comparison of different flower structures http://www.saps.org.uk/secondary/teaching-resources/1325-a-level-set-practicals-dissection-and-microscopy-of-a-plant-stem dissection of plants
use sampling techniques in fieldwork	http://www.nuffieldfoundation.org/practical-biology/observing-patterns-distribution-simple-plant patterns in plant distribution http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard using quadrats to measure biodiversity http://www.biology-fieldwork.org/woodland/woodland-plants/fieldwork-collecting-vegetation-data.aspx Sampling strategies and use of quadrats for sampling ground vegetation in woodlands http://www.biology-fieldwork.org/woodland/woodland-invertebrates/fieldwork-sampling-woodland-invertebrates.aspx Sampling strategies and capture techniques for sampling woodland invertebrates. http://www.biology-fieldwork.org/woodland/woodland-invertebrates/investigation-sampling-snail-populations.aspx Use of mark-release-recapture and Lincoln Index for estimating the size of populations http://bigpictureeducation.com/video-whats-buttercup Wellcome Trust video and accompanying data for field work http://bigpictureeducation.com/animation-surveying-populations Animation shows sampling methods in different environments

	http://www.saps.org.uk/secondary/teaching-resources/258 http://www.saps.org.uk/secondary/teaching-resources/127 http://www.saps.org.uk/secondary/teaching-resources/768 online activities to practice sampling techniques before you get into the field, looking at measuring abundance, random sampling and distribution of a species across a footpath
use ICT such as computer modelling, or data logger to collect data, or use software to process data	http://www.dnadarwin.org/ explore the molecular evidence for evolution through practical bioinformatics activities that use data analysis tools and molecular data.

Additional links to teaching resources

Society of Biology www.societyofbiology.org

Society of Biology and Nuffield Resource http://www.nuffieldfoundation.org/practical-biology

Field Studies Council http://www.biology-fieldwork.org/

British Ecological Society http://www.britishecologicalsociety.org/education/

Biochemical Society http://www.biochemistry.org/Education/Teachers.aspx and www.sciberbrain.org and http://www.biochemistry.org/Portals/0/Education/Docs/Biochem_Booklet_web.pdf

Science and Plants for Schools http://www.saps.org.uk and

http://www.saps.org.uk/secondary/teaching-resources/1304-a-level-set-practicals (a collection of new practical resources to support the practical endorsement)

Society for General Microbiology http://www.sgm.ac.uk and http://www.microbiologyonline.org.uk

Wellcome Trust www.wellcome.ac.uk/education

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