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AS and A LEVEL

Delivery Guide

H022/H422

BIOLOGY B (ADVANCING BIOLOGY)

Theme: The development of species: evolution and classification 3.1.3

January 2016

OCR
Oxford Cambridge and RSA

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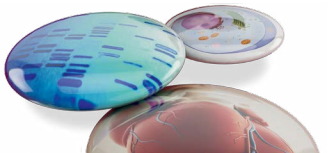


Introduction

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

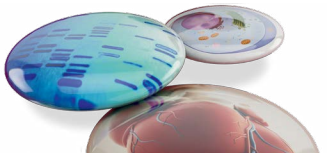
If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk

KEY

Click to view associated resources within this document.

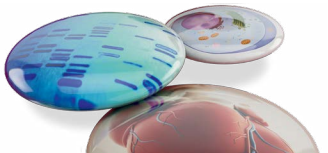
Click here — Click to view external resources

AS Level only — AS Level content only



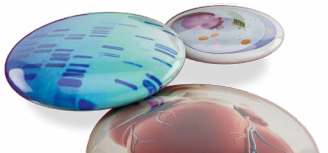
Curriculum Content

3.1.3 The development of species: evolution and classification		
(a)	the concepts of biological classification and species	To include taxonomic ranks in the hierarchy of classification (domain, kingdom, phylum, class, order, family, genus, species) **AND** An outline of the biological and phylogenetic species concepts.
(b)	the types of evidence used in biological classification and consideration of how theories change as new evidence is found	Evidence for hominid classification to include observable features (eg fossils) and molecular evidence (eg DNA). HSW7, HSW8
(c)	the use of DNA barcoding in biological classification, examples of the genes used and consideration of the reasons for the choice of these genes	To include the use of mitochondrial genes (eg cytochrome c oxidase 1) in animals, and chloroplast genes in plants (no details of electrophoresis are required).
(d)	the interpretation of phylogenetic trees and genetic data to show relatedness and classification in plants and animals	To include consideration of hominids, both extinct and extant, and hylobatids, including examples in which there is conflicting evidence. HSW5, HSW6, HSW8



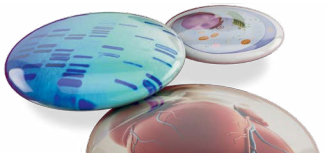
Curriculum Content

(e)	(i) behavioural, physiological and anatomical adaptations to the environment (ii) practical investigation into adaptations of plants to environmental factors	To include the following adaptations in Homo sapiens: tool use and cultural adaptations for social bonding (behavioural), lactose tolerance and skin pigmentation (physiological), bipedalism and brain size (anatomical) **AND** adaptations of plants to their environment including adaptations to extremes of temperature, light and water.
(f)	the evolution of language as an example of a scientific question with many competing theories	To include discussion of why some scientific questions (eg "how did language evolve?") are difficult to answer because of a lack of evidence, and consideration of competing theories (to include the "mother tongues" and "gossip" hypotheses). HSW1, HSW2, HSW3, HSW7, HSW8
(g)	adaptation and selection as components of evolution	To include the ideas of genetic variation, selection pressures and natural selection in relation to evolution.
(h)	the definition and measurement of biodiversity	To include a consideration that biodiversity can exist at the genetic, species and ecosystem levels. *M0.2, M0.3, M0.4, M1.1*
(i)	the calculations of genetic diversity within populations.	To include the percentage of gene variants (alleles) in a genome. $\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$ *M0.1, M0.2, M1.1, M2.2, M2.4*



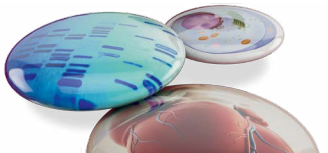
Curriculum Content

Activities	Resources
Mnemonic creation to remember taxonomic ranks A fun and useful starter exercise is for students to create their own mnemonics as a method for remembering the order of taxonomic ranks in classification (eg 'Don't Keep Pickled Cucumber Or Fried Gherkin Sauce'). *Specification reference: 3.1.3 a*	
OCR Topic Exploration Pack for 3.1.3 This pack provides an introduction to the topics of phylogeny *(3.1.3 d)*, adaptation *(3.1.3 e i)* and language evolution *(3.1.3 f)*. It includes three sets of activities: phylogenetic tree construction and interpretation, a research and discussion activity on human adaptations, and a research project on language evolution. http://www.ocr.org.uk/Images/169850-topic-exploration-the-development-of-species-teacher-pack-.pdf *Specification references: 3.1.3 d, ei, f*	Click here
DNA barcoding presentation (Coastal Marine Biolabs) http://www.educationandbarcoding.org/getting_started.php The 'Introduction to DNA barcoding' link provides an attractive animated presentation that gives a detailed overview of DNA barcoding. *Specification reference: 3.1.3 c*	Click here
DNA barcoding video (DNA Learning Center) http://www.dnalc.org/resources/dnatoday/111103-history-dna-barcoding.html A short video that outlines the history of DNA barcoding. *Specification reference: 3.1.3 c*	Click here



Curriculum Content

Activities	Resources
Investigating plant adaptations using a potometer (Science and Plants for Schools) http://www.saps.org.uk/secondary/teaching-resources/1263-investigating-transpiration-with-a-potometer A potometer can be used to measure the transpiration rate of plants under different environmental conditions. The responses of plants that are adapted to different ecosystems can be compared. SAPS provide detailed, downloadable student and teacher notes. The volume of water taken up by a potometer can be calculated as: (distance moved by bubble) x (πr^2) (where r = radius of the capillary tube). *Specification references: 3.1.3 e(i), e(ii)* *Practical reference: PAG5* *Maths reference: M4.1*	Click here
Language evolution articles (New Scientist) http://www.newscientist.com/data/doc/article/dn19554/instant_expert_6_-_the_evolution_of_language.pdf (Scientific American) http://www.scientificamerican.com/article/could-language-have-evolved/ (New Scientist) http://www.newscientist.com/article/mg20026834.200-monkey-gossip-hints-at-social-origins-of-language.html Some useful articles that outline the theories of language evolution and explain the methods that scientists employ to research this topic. *Specification reference: 3.1.3 f*	Click here Click here Click here



Thinking Conceptually

Approaches to teaching the content

In general, the concepts in this unit are couched in terms of the classification and evolution of humans and other hominid species. This does not mean other examples cannot be used to teach the content.

The topics in 3.1.3 require students to employ a range of skills and approaches to learning. The concepts of classification *(3.1.3 a, b)*, phylogeny *(3.1.3 d)*, adaptation *(3.1.3 e (i))* and natural selection *(3.1.3 g)* can be taught using a range of examples from many taxa, not only hominids. Once students have grasped the fundamental principles of these concepts, they can attempt to interpret and explain novel examples using the ideas they have learned. DNA barcoding *(3.1.3 c)* and language evolution *(3.1.3 f)* may be suited to class discussion and independent learning. Students can investigate plant adaptations by designing potometer experiments *(3.1.3 e (ii))*. The concept of biodiversity *(3.1.3 h, i)* tests their mathematical skills.

Common misconceptions or difficulties students may have

Some students might assume that all extinct species on a phylogenetic tree are ancestors of extant (living) species. It is important to emphasise that it is the nodes/branching points in a tree that represent the common ancestors of species.

When teaching the topic of adaptation, it can be stressed to students that competing theories and conflicting evidence often exist.

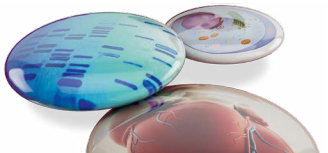
Some students may find it difficult to comprehend the time scale over which different species evolve from a common ancestor (eg in the context of evolution, 2 mya would be considered recent).

The difference between the definitions of evolution and speciation might need to be reinforced (ie evolution as a gradual change in the inherited traits within a population, and speciation as the formation of a new species resulting from the evolution of two reproductively isolated populations).

Conceptual links to other areas of the specification – useful ways to approach this topic to set students up for topics later in the course.

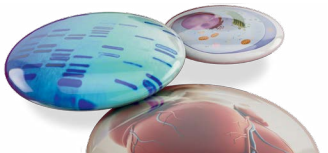
The calculation of species diversity *(3.1.3 h)* is introduced in this unit. Later, students will be able to apply this calculation to data they have obtained through ecological sampling *(4.3.1 m (ii) (A level students only), relates to PAG3)*.

The principles of evolution will be encountered again when students learn about antibiotic resistance *(3.2.3 f)*, natural selection and population genetics *(5.1.2 a, d (A level students only))*, speciation *(5.1.2 e (A level students only)*) and Hardy Weinberg equations *(5.1.2 c (A level students only)*).



Thinking Conceptually

Activities	Resources
An interactive phylogenetic tree (Wellcome) http://www.wellcometreeoflife.org/interactive/ This interactive evolutionary tree includes many taxa, broadening students' understanding of classification and phylogeny. *Specification reference: 3.1.3 b*	Click here
'Battling Beetles' natural selection activity (Howard Hughes Medical Institute) http://www.hhmi.org/biointeractive/classroom-activities-battling-beetles This is a detailed activity that aims to engage students in thinking about the mechanism of natural selection. Students collect their own data and attempt to recognise patterns. It requires simple materials such as coloured sweets, food storage bags, coloured pencils, and paper cups. An extension of this activity allows students to use Hardy-Weinberg calculations *(5.1.2 c (A level students only))*. This activity was designed to accompany a very interesting lecture series on evolution which can be found here: http://www.hhmi.org/biointeractive/evolution-constant-change-and-common-threads	Click here

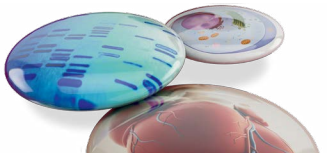


ACTIVITIES

Within the specification, many of the principles of classification, phylogeny, adaptation and evolution are expressed in the context of hominid species, including *Homo sapiens*. The OCR Topic Exploration pack 'The Development of Species' (http://www.ocr.org.uk/Images/169850-topic-exploration-the-development-of-species-teacher-pack-.pdf)is likely to be a useful tool in supporting the delivery of 3.1.3. Many other taxa can be used to provide alternative contexts, however.

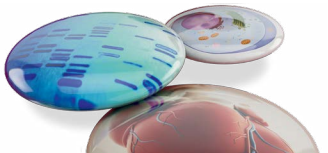
One of the threads that runs through the topics in 3.1.3 is that scientific theories are subject to change (HSW 7). The different types of evidence used in classification are often conflicting and can be interpreted in different ways. An emphasis should be placed on the changeable nature of science as a result of the discovery of new evidence. For example, phylogenetic trees are not fixed; new evidence can cause a re-evaluation of evolutionary relationships and a rearrangement of trees.

Activities	Resources
Phylogenetic tree construction activity (Science in School) http://www.scienceinschool.org/2010/issue17/bioinformatics Students can analyse the base sequences of hominid species and calculate the closeness of their evolutionary relationships. This information can then be used to construct a phylogenetic tree. This is a useful tool for placing phylogeny *(3.1.3 d)* in the context of molecular evidence *(3.1.3 b)*. *Specification references: 3.1.3 b, d*	Click here
Video: the evolution of the rock pocket mouse (Howard Hughes Medical Institute) http://www.hhmi.org/biointeractive/making-fittest-natural-selection-and-adaptation A ten minute video that discusses an interesting example of natural selection in a context other than human evolution. *Specification reference: 3.1.3 g*	Click here



Thinking Contextually

Activities	Resources
Natural Selection card sorting activity (Nuffield Foundation) http://www.nuffieldfoundation.org/sites/default/files/evolution-cards-476.pdf A potential plenary activity. Students are given cards relating to bacterial resistance and the evolution of the peppered moth. They need to order the statements to fit each example with general statements about the theory of natural selection. *Specification reference: 3.1.3 g*	Click here
Activity: Darwin's Finches & Natural Selection (Arkive) http://www.arkive.org/education/teaching-resources-16-18 This is a hands-on activity that enables students to explore the principle of genetic variation and its connection to the theory of natural selection. The context is Darwin's investigation into finches on the Galapagos Islands. *Specification references: 3.1.3 g, h*	Click here

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