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AS and A LEVEL

Delivery Guide

BIOLOGY A

H020/H420
For first teaching in 2015

Biodiversity 4.2.1

Version 2

www.ocr.org.uk/biology

Introduction

AS and A LEVEL *BIOLOGY A*

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.

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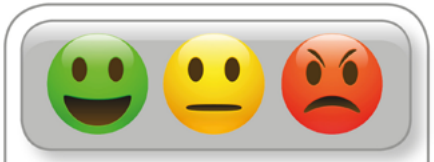

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Curriculum content

4.2.1 Biodiversity

(a)	how biodiversity may be considered at different levels	To include habitat biodiversity (e.g. sand dunes, woodland, meadows, streams), species biodiversity (species richness and species evenness) and genetic biodiversity (e.g. different breeds within a species).
(b)	**(i)** how sampling is used in measuring the biodiversity of a habitat and the importance of sampling **(ii)** practical investigations collecting random and non-random samples in the field	To include how sampling can be carried out i.e. random sampling and non-random sampling (e.g. opportunistic, stratified and systematic) and the importance of sampling the range of organisms in a habitat. *M0.2, M1.3, M1.5, M1.4, M1.6, M1.7, M1.9, M1.10, M3.2* **PAG3** HSW4, HSW5, HSW6
(c)	how to measure species richness and species evenness in a habitat	*M1.1, M1.5, M2.3, M2.4*
(d)	the use and interpretation of Simpson's Index of Diversity *(D)* to calculate the biodiversity of a habitat	To include the formula: $D = 1–(\Sigma(n/N)_2)$ **AND** the interpretation of both high and low values of Simpson's Index of Diversity (*D*). *M1.1, M1.5, M2.3, M2.4* HSW5
(e)	how genetic biodiversity may be assessed, including calculations	To include calculations of genetic diversity within isolated populations, for example the percentage of gene variants (alleles) in a genome. *proportion of polymorphic gene loci = number of polymorphic gene loci / total number of loci* Suitable populations include zoos (captive breeding), rare breeds and pedigree animals. *M1.1, M1.5, M2.3, M2.4* HSW5
(f)	the factors affecting biodiversity	To include human population growth, agriculture (monoculture) and climate change. *M1.3, M1.7, M3.1* HSW5, HSW10, HSW12
(g)	the ecological, economic and aesthetic reasons for maintaining biodiversity	• Ecological, including protecting keystone species (interdependence of organisms) and maintaining genetic resource • economic, including reducing soil depletion (continuous monoculture) • aesthetic, including protecting landscapes. HSW12
(h)	*in situ* and *ex situ* methods of maintaining biodiversity	• *In situ* conservation including marine conservation zones and wildlife reserves • *ex situ* conservation including seed banks, botanic gardens and zoos. HSW7, HSW9, HSW10, HSW12

Curriculum content

(i)	international and local conservation agreements made to protect species and habitats.	Historic and/or current agreements, including the Convention on International Trade in Endangered Species (CITES), the Rio Convention on Biological Diversity (CBD) and the Countryside Stewardship Scheme (CSS). HSW11, HSW12

Biodiversity is one of the biggest current issues in biology and should be considered as one of the most fundamental topics. As such it provides a number of specific challenges to teachers, including:

- inspiring students with enthusiasm for the natural world and an appreciation of its importance to humans
- supporting students with little background knowledge or experience of examples of species or habitats
- ensuring that the clarity and precision of language used to discuss biodiversity topics is equivalent to that used to discuss other A Level topics such as biological molecules.

Students are likely to have studied the environment at GCSE or before and most will have some awareness of the term *biodiversity*, random sampling with quadrats and the idea of conservation. However, the demands of the A Level specification are distinctly higher than GCSE and it may be best to begin teaching it with the assumption that everything needs to be taught as if for the first time.

The biodiversity topic does provide an opportunity for students to develop some of the practical skills required by Module 1
of the specification and to develop many of the mathematical skills listed in specification section 5e.

Activities

Activity 1
The different levels of biodiversity 4.21(a) and (e)

Introducing students to the definition of biodiversity at three different levels can be done in general terms or using specific examples. Students are likely to be comfortable with the species level of biodiversity.

Domestic dogs, with their large variety of breeds, can be used as an example of a species with high genetic diversity. Cheetahs are homozygous at almost all gene loci and are therefore an example of a species with low genetic diversity. This is a good point at which to introduce the idea of measuring the level of genetic diversity within a population (4.2.1e) and the opportunities for students using mathematical skills (M1.1, M1.5, M2.3, M2.4) it provides.

The habitat (or ecosystem) level of diversity is harder to exemplify but a domestic house and garden, with a lawn, pond, border, patio or decking and of course the house itself, represents a relatively small area of land with a large variety of habitats

Activity 2
Sampling techniques 4.2.1(b)

Many biology teachers lack confidence in teaching sampling techniques and there are many external courses available from providers such as the Field Studies Council: http://www.field-studies-council.org/. However, these might be better done as part of Module 6. Many local independent providers also exist, often at only a small cost, for example:

Teesmouth Field Centre http://www.teesmouthfieldcentre.org.uk/

Wildwood wildlife park Kent http://www.wildwoodtrust.org/

These are local, specific examples of groups that provide a location, resources and help in teaching biodiversity. Similar organisations exist elsewhere in the country.

Activity 3
Sampling techniques in school 4.2.1(b) and (d)

It is not always appropriate to take students out of school. The requirements of Module 4 can be taught fairly easily with a basic knowledge of sampling techniques. No specific techniques are listed in the specification but it is reasonable to expect students to have used a quadrat to carry out both random and systematic sampling and to have considered the limitations
of quadrat sampling, e.g. quadrats are not suitable for counting trees or most animals.

Practical sampling activities can be carried out on any school field or local park. Random sampling using randomly generated coordinates and systematic sampling using a transect satisfies the requirements of the specification. A spreadsheet could be used to process class results and data generated using random sampling could be used in later lessons to calculate Simpsons Index of Diversity (4.2.1d).

Carrying out any of these practical activities could support the OCR Biology Practical Endorsement (**PAG3**) and could cover the following learning outcomes:

- From Module 1: 1.1.1 (a-c), 1.1.2 (a,c), 1.1.3 (a-c), 1.1.4 (a-e), **1.2.1 (a-g)** and **(j)**, **1.2.2 (k-l)** and **(f)**.
- From How Science Works: HSW4, HSW5, HSW6.
- From the list of mathematical skills: *M0.2, M1.3, M1.4, M1.5, M1.6, M1.7, M1.9, M1.10, M2.3, M3.2.*

Activity 4
Class-based sampling exercise 4.2.1(b) and (c)

If there is no convenient site for external sampling, or equipment is lacking, a paper based simulation could be carried out. The teacher can produce A3 sheets covered in icons representing plant species and mini quadrats can be made from squares cut out from sheets of acetate.

Activities

Activity 5
Richness and evenness 4.2.1(c)

Calculating species richness and evenness can be done as part of a random sampling procedure such as that described above and covers mathematical skills *M1.1, M1.5, M2.3, M2.4.*

In class, discussion of richness and evenness could be based upon two areas, visually represented as squares on a screen or board, both of which have the same total number of species, but one is dominated by large numbers of one species.

Activity 6
Simpson's Index of diversity 4.2.1(d)

There are many worked examples of calculating Simpson's Index of Diversity available in textbooks or on the internet.

Simpson's Diversity Index *(*Offwell Woodland and Wildlife Trust)
http://www.countrysideinfo.co.uk/simpsons.htm
Provides a worked example with discussion of richness and evenness.

Students can then practise calculating Simpson's Index from their own data from fieldwork, or secondary data from other sources. At this point mathematical skills *M1.1, M1.5, M2.3 and M2.4* can be covered, as can HSW5.

Activity 7
Maintaining biodiversity 4.2.1(f-i)

There are two main ways to approach teaching of these learning outcomes. Either sequentially building up the knowledge and exemplifying each part as it is covered, or from the point of view of individual case studies, which are then related to the learning outcomes. Delivery of these outcomes can cover HSW5, HSW7, HSW9, HSW10, HSW11 and HSW12 and mathematical skills M1.3, M1.7 and M3.1.

Sequential approach

Activity 8
Significant factors 4.2.1 (f-g)

Factors that affect biodiversity and reasons for conservation can be discussed before researching on the internet.

Having generated lists of factors affecting biodiversity and reasons for conservation students can then rank the significance
of these in the context of a selection of endangered species given by the teacher (see below for suggested resources).

Activity 9
Millennium Seed Bank Partnership (Royal Botanic Gardens) 4.2.1 (h – i)
http://www.kew.org/science-conservation/millennium-seed-bank
This site focuses on the conservation role of the millennium seed bank.

Students could research the millennium seed bank online or visit a local botanic garden.

Activity 10
Conservation agreements 4.2.1 (i)

CITES
http://www.cites.org/
Website for CITES.

Having researched conservation agreements, students could construct a table or Venn diagram showing main points, similarities and differences between each agreement.

The Rio Conventions
http://www.cbd.int/rio/
Website for Rio Convention on Biological Diversity.

Countryside Stewardship Scheme (Natural England)
http://webarchive.nationalarchives.gov.uk/20140605090108/http://www.naturalengland.org.uk/ourwork/farming/funding/closedschemes/css/default.aspx
Website for information on the Countryside Stewardship Scheme, which ran from 1991 – 2014.

You may also find the new Natural England site useful:
https://www.gov.uk/government/organisations/natural-england

Activities

Case studies approach

Activity 11
Each student, or group of students, is given a species to research and a list of criteria that cover learning objectives (f) to (i). They then present their findings in an appropriate format.

There are many species that would be suitable and many sites that list them. One example of a list of species is:

WWF
https://www.worldwildlife.org/species/directory?direction=desc&sort=extinction_status

One specific example is the great bustard.

Reintroducing The Great Bustard to the UK (The Great Bustard Group)
http://greatbustard.org/
Describes the reintroduction of the great bustard to the UK along with measures to ensure successful conservation.

Thinking conceptually

Approaches to teaching the content

Students inevitably have some prior knowledge and understanding of conservation and sampling techniques. It is possible therefore, to teach the topic from the top down, beginning with a location or species and visiting all the learning outcomes in context. This can be engaging and interesting for students and can help them relate the learning outcomes to a wider context. However, this approach can be at the expense of a rigorous understanding of key terms and the ability to describe concepts using precise language. It is essential at some point, to reinforce the use and understanding of key terms and definitions.

Common misconceptions or difficulties students may have

The whole topic of biodiversity is steeped in context and most students begin the course with little contextual knowledge or understanding. Lack of familiarity with any species, other than *Homo sapiens*, makes the understanding of contextual examples of biodiversity doubly difficult. It is not surprising to find students who think a vulture is a mammal and students' knowledge of plant based examples is even weaker.

The other main difficulty students have is in using key terms correctly and using clear and precise language in examinations. This can be a problem for some students in many areas of biology but it is particularly evident in biodiversity. Many students use terms such as biodiversity, habitat, ecosystem, environment, population and community as synonyms for one another.

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

When individual species or habitats are considered there are links to many learning outcomes, for example 3.1.3(e) and 5.1.1(d). However, the topic of biodiversity necessarily overlaps with 4.2.2 in the same module and both should be taught in a complementary fashion. Future topics with significant contextual links are 6.3.1 in its entirely and 5.2.1(g), 6.1.2(a, e-h), 6.1.3(g), and 6.2.1(f, h).

When studying any particular species or habitat the ideas of adaptation and selection pressure can be introduced to complement teaching of 4.2.2.

Activities

Learner Activity 1
Key terms activity - glossary or card sort

As an introduction to the topic, key terms can be given as a card sort or students asked to research definitions and produce a glossary. This can be followed by a test on definitions and peer marking of answers. A basic but effective activity involves selecting the most appropriate words to fill in a passage where some words are missing. Students can be asked to justify inclusion of a key word.

Learner Activity 2
Linking terms activity

At the end of the topic key terms can be written spread out on an A3 sheet. Students then link each term with a line on the paper and explain along the line why they have made the link.

Learner Activity 3
SAPs - Investigating the biodiversity of different habitats: Introducing STEM Careers 4.2.1(a-c)

http://www.saps.org.uk/secondary/teaching-resources/844-investigating-the-biodiversity-of-different-habitats-introducing-stem-career

SAPs have a range of resources available to schools, for example using this resource students will investigate the biodiversity of different habitats.

Learner Activity 4
Nuffield Foundation – Ecology and Simpson's Diversity Index 4.2.1(d)

https://www.stem.org.uk/resources/elibrary/resource/457530/ecology-and-simpsons-diversity-index

Although this Nuffield Foundation resource links to some A2 content, the coverage of Simpson's Index of Diversity makes it very useful at this stage.

Thinking contextually

Activities

The biodiversity topic is almost inevitably taught in context. Indeed the ideas contained in most of the learning outcomes make little sense outside a specific context – examples are needed at all stages. Examples can be found at a local level: within school grounds or, if conveniently situated, botanic gardens or nature reserves. The internet contains many worldwide examples and, as we all live on the same planet it is important that students appreciate the global nature of biology.

Giving each student or group of students a particular species or ecosystem to research can introduce students to a number of relevant examples and make them more comfortable about applying their knowledge and understanding to unfamiliar contexts. Below are listed some potential sources of information at a local, national and international level but there are many more available.

Having been introduced to a range of examples, students can then relate each of the learning outcomes to the context of the examples being discussed.

Activities

Learner Activity 1
Joint Nature Conservation Committee (DEFRA)
http://jncc.defra.gov.uk/default.aspx?page=5

This is a government website which contains links to more specific, local organisations and examples.

Learner Activity 2
The IUCN Red List of Endangered Species
http://www.iucnredlist.org/

Lots of information about individual endangered species at a global level.

Learner Activity 3
The IUCN Red List of Ecosystems
http://www.iucnredlistofecosystems.org/

Lots of information about individual ecosystems at a global level.

Learner Activity 4
British Wildlife Centre
https://britishwildlifecentre.co.uk/education/objectives/projects/

Examples of specific UK conservation projects.

Learner Activity 5
PAG3 Biodiversity investigations (OCR)
https://interchange.ocr.org.uk/Downloads/PAG3.zip

There are 3 possible investigatons linked to PAG3 for which there are student and teacher sheets available:
PAG3.1 The calculation of species diversity.
PAG3.2 Measuring the distribution and abundance of plants in a habitat.
PAG3.3 Investigating a correlation between a species and a biotic factor.

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