

## INTRODUCTION

This module is concerned with the structure and dynamics of ecosystems. It contains material on the growth of plants, but concentrates on how food webs are built up, what happens when food passes from one level in a food chain to another, and the implications of the distinctive properties of ocean- and land-ecosystems.

In designing material, we focussed on these elements of the National Curriculum for Key Stage 3 Science:

*Basic understanding of photosynthesis, and the need for elements such as N for plant growth*  
*Interdependence of plants and animals within a habitat*  
*How predation and competition for resources affect the size of populations*  
*How food webs comprise several food chains, and how these can be quantified using pyramid of numbers*  
*Use of artificial satellites to explore the Earth*

We have sought to promote the following skills and aspects of scientific enquiry:

*The interplay between empirical questions, evidence and scientific explanations*  
*Testing predictions against evidence*  
*Make observations and measurements to an appropriate level of precision*  
*Communicate qualitative and quantitative data with a wide range of methods*  
*Consider anomalies in data and try to explain them*  
*Consider whether data are adequate, and suggest improvements*  
*ICT opportunities – using data handling software to create, analyse and evaluate charts and graphs*  
*ICT opportunities – simple models of populations*

Below, we summarise the materials available for this module at Key Stage 3. There is a separate *Users' Guide*, which gives more information about each type of resource.

## RESOURCES

### 1. Teaching aids

Please see the notes relating to teaching aids in the *Users' Guide*.

The following PowerPoint™ slide sequences are provided to support this science module:

*How plants grow [extended]*  
(intended for Key Stages 2-3)

Describes the process of photosynthesis, rapid growth of plankton algae through cell division, and control by grazers. Linked spreadsheet exercise dealing with cell division and a worksheet (appropriate for Key Stage 2).

*Plants and light in the ocean [basic]*  
(intended for Key Stage 2 and younger or less able students at Key Stage 3)

A description of the relationship between plant growth and light. It introduces the change in light with depth, and how this determines the types of plants in different parts of the oceans.

*Plants and light in the ocean [extended]*  
(intended for Key Stages 3-4)

Basic description of the relationship between plant growth and light, and how this determines the types of plants growing in the ocean. Includes explicit treatment of exponential decay of light through the water column. There is a more detailed and extended study of the limits on plant growth intended for Key Stage 4 in Module 1, with two associated spreadsheets and two worksheets. There is a more simple treatment of cell division in a spreadsheet intended for Key Stages 2-3.

*Food chains and food webs: who eats whom? [extended]*  
(intended for Key Stages 2-3)

Provides a description of food chains, introducing the terms 'producer', 'consumer', 'herbivore', 'predator'. Introduces the idea of losses along a food chain. Links to three quizzes suitable for Key Stage 2 and a spreadsheet exercise designed for Key Stage 3.

*Ecosystems and food webs: comparing land and ocean*  
(intended for Key Stages 3-4)

Introduces the main features of land and ocean ecosystems, focussing on the key differences between plants in the two systems. Includes a summary of sizes of different organisms in oceanic ecosystems. Links to a quiz for Key Stages 3-4.

*Ecosystems and food webs: putting in some numbers*  
(intended for Key Stages 3-4)

A treatment of oceanic food chains that quantifies the idea of trophic efficiency and establishes its effects in short and long food chains. Links to a quiz for Key Stages 3-4, worksheets, a spreadsheet for Key Stage 3 and a more complex spreadsheet for Key Stage 4.

*Ecosystems and food webs: biomass and production*  
(intended for Key Stages 3-4)

Introduction to biomass and production in food chains. Examines the pyramid of biomass in land ecosystems and tests its application in a marine food chain. Links to a quiz for Key Stages 3-4, worksheets, a spreadsheet for Key Stage 3 and a more complex spreadsheet for Key Stage 4.

2. On-line activities

Please see notes on quizzes and spreadsheets in the *Users' Guide*.

*Dividing cells*  
(spreadsheet exercise intended for Key Stage 2 and younger students at Key Stage 3)

A spreadsheet exercise that looks at cell division. The exercise uses a simple geometric version of the calculation of cell numbers. Students are presented with an initial example, then follow through instructions to complete a dataset and plot their results. Tests understanding of the properties and consequences of cell division, reinforces numerical skills, uses basic spreadsheet techniques

*Foodchain*  
(spreadsheet exercise intended for Key Stage 3 and younger Key Stage 4)

A spreadsheet exercise that highlights the effects of differing food chain length and trophic efficiencies on ecosystem productivity. Students are presented with an initial example, then follow through instructions to complete datasets and plot their results. They can undertake 'what if' experiments by testing the effects of changing variables. Tests understanding of the properties and consequences of different food chain characteristics, reinforces numerical skills, uses basic spreadsheet techniques.

3. Worksheets

Please see notes on worksheets in the *Users' Guide*.

*Light in the ocean*  
(intended for Key Stages 3-4)

The worksheet relates to the PowerPoint slide set *Plant growth in the ocean: resources and controls* (Key Stage 4, Module 1), but could also be used in conjunction with *Plants and light in the ocean* (Keys Stages 3-4, Module 2). The sheet provides a framework in which to calculate and plot light levels at different depths for various values of water absorption (turbidity). There are two suggested scenarios – one in which 2% of light is absorbed per metre and a second in which 5% is absorbed per metre. Other scenarios could be attempted. Students should understand how to complete the calculations with reference to the 'methods box' at the bottom of the page.

When they have completed their graphs, they should see a rapid decrease in light in shallow depths, followed by a more moderate decrease. They should appreciate that this is a classic exponential decay, where each value is a proportion of the preceding value. The sheet tests appreciation of models of physical processes, and simple numerical- and graphical-skills. The exercise could be extended by considering what factors contribute to light absorption, including the plankton algae themselves – a good example of a negative feedback loop.

A specimen answer for this worksheet is available as a separate PDF file in this module.

*Food web [extended]*  
(intended for Key Stage 3)

The worksheet is based on a food web illustrated in the PowerPoint slide set *Food chains and food webs: who eats whom?* (Key Stages 2-3), and in other slide sets for Key Stage 3 Module 2. Students are asked to add arrows to complete a food web involving the animals illustrated. The information needed to do this is presented in the table, including the items of diet for each animal. Some elements of vocabulary may need clarification. The sheet also includes the concept of efficiency – values are presented in the data table and students are asked to enter these into boxes next to each animal. There are four supplementary questions relating to the number of food chains (pathways through the food web), their length and overall efficiency. The sheet tests knowledge of food chains and food webs, the ability to interpret tabular and visual data, and to assess relationships.

*Food chain numbers*  
(intended for Key Stages 2-3)

The worksheet builds on concepts introduced in the PowerPoint slide sets *Food chains and food webs: who eats whom?* (intended for Key Stages 2-3), *Ecosystems and food webs: putting in some numbers* and *Ecosystems and food webs: biomass and production* (both intended for Key Stages 3-4). The exercise is simple, but builds on a basic understanding of how material is lost along a food chain through respiration and egestion, leaving little for growth and reproduction. Students are required to complete a short table, in which they calculate the growth (production) at different levels in a food chain using data in the table. They should then plot the results as a histogram (bar chart) in the graph panel. It will be impossible to plot the last two trophic levels, which have values of 1.2 and 0.05 – this should be used to demonstrate how little primary production finds its way to levels in the food chain. The sheet tests understanding of food chains, simple calculation skills (including an understanding of proportions and percentages), and involves graph-plotting.

A specimen answer for this worksheet is available as a separate PDF file in this module.

*Ecosystem template – note that there are three versions of this worksheet (intended for Key Stages 3-4)*

This worksheet is designed to support practical exercises in understanding the dynamics of food chains, much as the spreadsheets Foodchain and Foodweb scenario. The templates provide a framework in which to calculate the production at different levels along four food chains, using defined values of the ratio between growth and ingestion (referred to here and elsewhere by the shorthand term 'efficiency'). The value of primary production for each food chain is set by the student. Different values for each food chain can be used to simulate a simple food web, where different shares of primary production flow along different food chains. The template is supplied in three versions. The first is completely blank, and could be used for any ecosystem (land or ocean). The second has a worked example with names, efficiency and production values for the first food chain – the student can then go on to complete the other three food chains. The third version has all four food chains completed to simulate the Southern Ocean food web. In all cases, production at a particular trophic level is calculated by multiplying the efficiency by the production at the preceding trophic level (that is, to the left). The third template is useful to show how levels can be omitted to simulate different lengths of food chain.

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