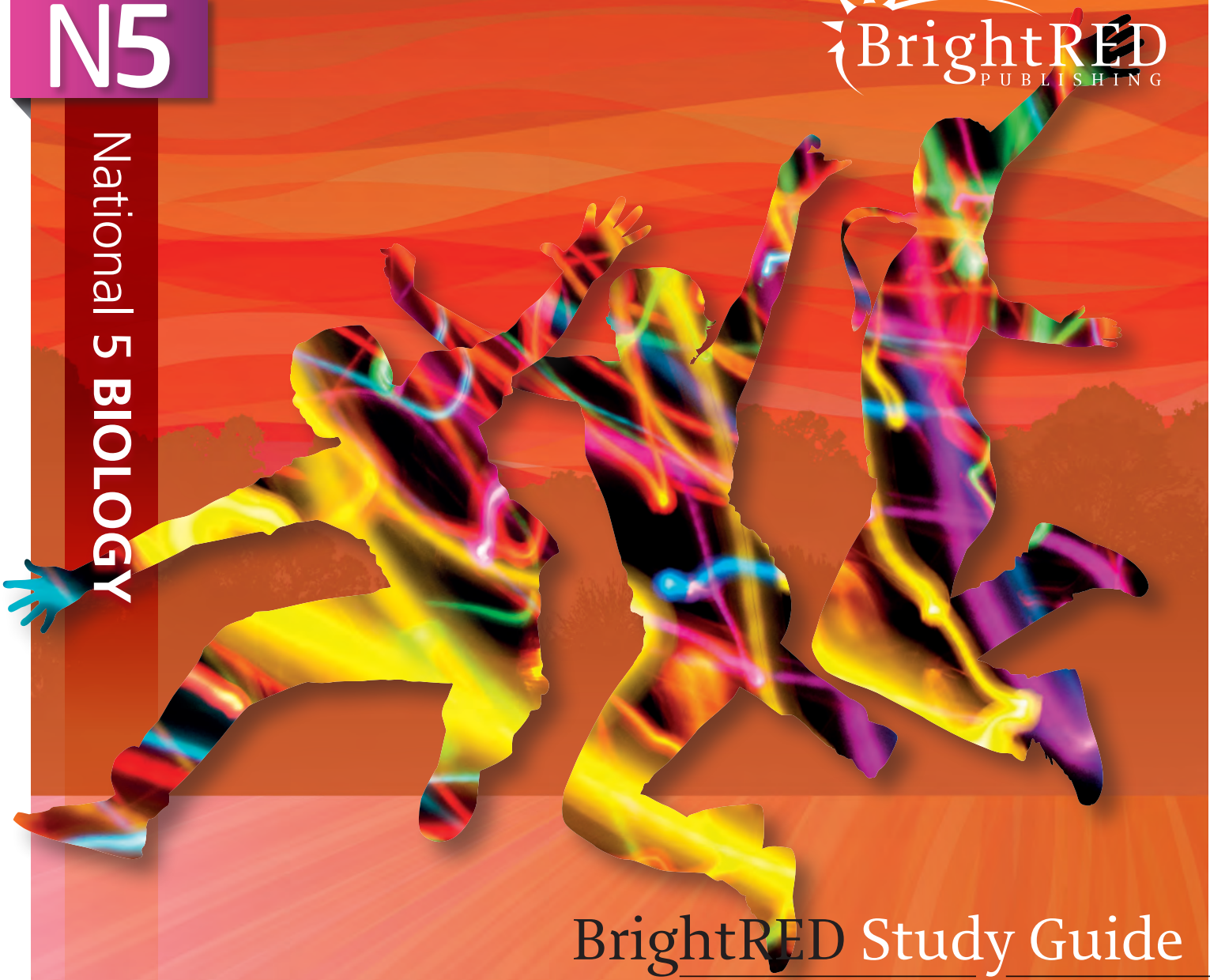
N5

National 5 BIOLOGY

BrightRED PUBLISHING



BrightRED Study Guide

Curriculum for Excellence

N5

BIOLOGY

REVISED AND UPDATED FOR SQA CHANGES

NEW EDITION

BrightRED DIGITAL ZONE

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BRIGHTRED STUDY GUIDE: NATIONAL 5 BIOLOGY

INTRODUCING NATIONAL 5 BIOLOGY

During this course we hope you will develop and apply skills for learning, skills for life and skills for work.

Biology is the study of living organisms so it is relevant to everybody. It plays a crucial role in our everyday existence, and is an increasingly important subject in the modern world. Advances in biological technologies have made the subject more exciting and more relevant than ever.

THE NATIONAL 5 BIOLOGY COURSE

National 5 Biology encourages you to become:

- a more confident learner
- a responsible citizen with an informed and ethical view of complex issues, through the study of relevant areas of biology such as health, environment and sustainability
- someone who thinks analytically, creatively and independently, and is able to make reasoned evaluations.

The National 5 course provides opportunities for you to acquire knowledge and skills relevant to current biological topics. The course covers major areas of biology, ranging from the study of unicellular organisms to the complex relationships between organisms in an ecosystem. Key areas focus on cells and cellular processes, leading to an understanding of the importance of cells and their roles. Body systems, reproduction and inheritance are investigated to broaden your understanding of living organisms. The comparison of the processes in multicellular plants and animals enables you to investigate increasing levels of complexity of these organisms. Key areas of biodiversity and interdependence are covered, along with the processes leading to evolution, and food security.

COURSE CONTENT

You will develop skills of scientific inquiry, investigation and analytical thinking, along with the required knowledge and understanding.

You will also research issues and communicate information related to your findings, developing skills of scientific literacy.

Topic 1 – Cell biology

The key areas covered are: cell structure; transport across cell membranes; DNA and the production of proteins; proteins; genetic engineering; and respiration.

Topic 2 – Multicellular organisms

The key areas covered are: producing new cells; control and communication; reproduction, variation and inheritance; transport systems – plants; transport systems – animals; and absorption of materials .

Topic 3 – Life on Earth

The key areas covered are: ecosystems; distribution of organisms; photo synthesis; energy in ecosystems; food production; and evolution in species.

The range of skills involved in the course are:

- demonstrating knowledge and understanding of biology by describing information, explaining and linking knowledge
- applying biological knowledge to new situations, interpreting information and solving problems
- planning, designing and safely carrying out investigations and experiments to test hypotheses or to show particular effects
- selecting information from a variety of sources
- presenting information in a variety of forms
- processing information (for example using calculations and units)
- making predictions and generalisations based on evidence and information
- justifying conclusions that are supported by evidence
- suggesting improvements to investigations and experiments
- communicating findings and information.

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THE EXTERNAL ASSESSMENT

At the end of the course you will be assessed externally by two components.

Component 1 – Question Paper (80% of total mark)

This is made up of a 2½-hour question paper in which:

- 25 marks are allocated to an objective test
- 75 marks are allocated to the written paper, which includes questions requiring a mixture of short (restricted) and extended answers.

Many of the marks will be given for applying knowledge and understanding. The other marks will be given for applying scientific inquiry, analytical thinking and problem-solving skills.

The question paper will be written and marked by the Scottish Qualifications Authority (SQA).

Component 2 – Assignment (20% of total mark)

The assignment will be an in-depth study of a biology topic you have chosen. There will be 20 marks awarded for the assignment and the majority of these will be awarded for applying scientific inquiry and analytical thinking skills. The other marks will be awarded for applying knowledge and understanding relating to the topic.

The assignment is carried out under controlled conditions and is externally marked by SQA. To prepare for the controlled assessment you will choose, research and investigate an appropriate topic. Your research involves gathering data or information from an experiment or fieldwork as well as from the internet or literature.

During the assessment you will present evidence of:

- an aim you have decided upon
- biological knowledge and understanding relating to your chosen topic
- a brief description of an experiment or fieldwork you have carried out, along with the results
- data or information from the internet or literature to compare with your experimental data
- a reasoned conclusion.

ONLINE

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CELL BIOLOGY

GENETIC ENGINEERING

THE TRANSFER OF GENETIC INFORMATION

Genetic material can be transferred from one cell to another, either by natural means or artificially, through the process of genetic engineering.

Scientists have studied the ways in which **viruses** transfer their nucleic acids into host cells. They found that viruses transferred their genetic material into the host so that it became attached to the host's DNA.

Research has shown that some bacteria living in the soil are responsible for causing tumours to develop in plant tissue. Scientists have studied this process to see how it works. They found that the bacterium actually transfers a piece of its own genetic material into the plant root, usually through a wound in the plant tissue. This genetic material is found in one of the bacterial plasmids and is responsible for causing a tumour in the plant root.

Through further research, scientists have developed ways to substitute the genes which cause tumours with other DNA and they are now able to introduce useful genes into bacteria. The bacteria then pass these genes into the plant, allowing the plant to be **genetically modified** in certain ways.

When viruses and bacteria transfer their genetic material into cells, these cells are now able to make proteins which they previously could not. Scientists saw the potential of this and developed ways of using the technique to their advantage.

This technique has been used to create transgenic crops (plants with genes from another organism).

These crops have advantages over the natural varieties, such as increased yields or increased disease resistance, but controversy surrounds their use.

GENETIC ENGINEERING

The process of genetic engineering involves taking genetic material from one type of living organism and transferring it into another type of living organism. The organism with the altered genetic make-up is now 'reprogrammed', or transformed, to make different proteins which are useful to human beings.

Microorganisms, such as bacteria and yeast, are often reprogrammed to produce useful substances, including medicines and human proteins such as hormones. There are several advantages to using these single-celled organisms:

- They grow and multiply very quickly.
- Being individually small, they are easy to accommodate.
- They are relatively inexpensive to use.
- They are easier to reprogramme than more advanced organisms.

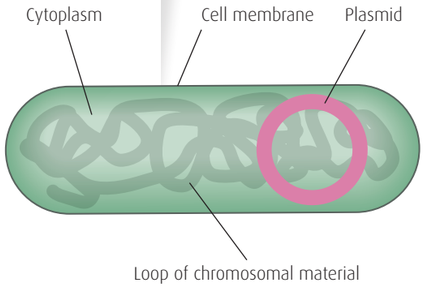
ONLINE

Have a look at the online debate about the banning of transgenic crops in India at www.brightredbooks.net/N5Biology

THE PROCESS OF REPROGRAMMING

The arrangement of the chromosomal material in a bacterium makes it an ideal organism for genetic engineering.

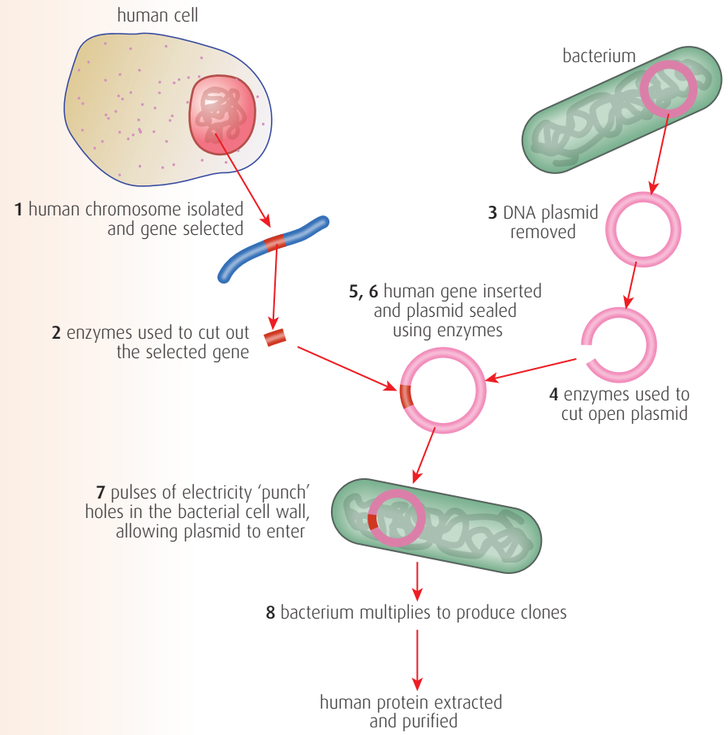
A bacterium has one large circular loop of chromosomal material, as well as several much smaller rings known as plasmids.



Plasmids are easily removed from bacteria. They are small enough to be removed, genetically altered and put back into a bacterium.

The stages involved in the reprogramming of bacteria to produce a human protein, such as insulin, are as follows:

1. The section of DNA in the human cell that has the required gene, is identified on its original chromosome.
2. The gene is cut out of the chromosome using an enzyme.
3. A plasmid is removed from a bacterium.
4. The plasmid is cut open using the same enzyme.
5. The required gene is inserted into the plasmid using another type of enzyme.
6. This is repeated many times.
7. The altered plasmids are then inserted into bacteria.
8. The reprogrammed bacteria are given the correct conditions to reproduce, making many identical copies.



Genetic engineering of bacteria

The bacteria that have been genetically modified (GM bacteria) with the transferred gene make large quantities of the gene's protein, if given suitable conditions.

One of the important advantages of using bacteria in this way is the rapid rate at which they reproduce. This means that the mass production of the desired protein using this method is a relatively quick process.

DON'T FORGET

Genetic information can be transferred from one cell to another by genetic engineering.

THINGS TO DO AND THINK ABOUT

Enzymes are used in several stages in the process of genetic engineering. Can you explain why the same enzyme can be used to cut the required gene from the human chromosome and to cut open the plasmid, but a different enzyme is required to put the gene into the plasmid?

ONLINE TEST

Test yourself on the transfer of genetic information online at www.brightredbooks.net/N5Biology

MULTICELLULAR ORGANISMS

VARIATION AND INHERITANCE 1

Shape of aspen leaves

Pattern of cone shells

Human faces

AN INTRODUCTION TO VARIATION

The members of a species are not identical, even though they all possess genetic information for the same range of characteristics. Individuals show variations which make them different from one another.

Some variations may be due to effects of the environment which influence the development of an individual. These variations are unimportant to the species as a whole because they are not passed on from parent to offspring.

Other variations are caused by differences in the genetic information of individuals and these can be inherited. Sexual reproduction involves combining genetic information from both parents. This allows mixing of genes in different ways and so contributes to variation. The photographs show some examples of variation between members of the same species.

Genes can exist in different forms, each capable of producing a variant of a particular characteristic. The different forms of a **gene** are called **alleles**.

DISCRETE VARIATION

Discrete variation of a characteristic shows only a limited number of distinct possibilities. This type of variation is found in characteristics that are coded by a single gene with a limited number of forms or alleles.

Discrete variation has been important in the study of inheritance. Characteristics which have easily recognised variants are observed in successive generations. The patterns of their inheritance have allowed researchers to work out the mechanism involved.

Examples of discrete variation include:

- cat hair length

A) short hair

B) long hair

- tongue-rolling ability.

A) Tongue-rolling ability

B) Non-tongue rolling ability

- blood groups

There are four possible blood groups. These are:

1 Group A **2** Group B **3** Group AB **4** Group O

CONTINUOUS VARIATION

Continuous variation of a characteristic shows a continuous range of possibilities between a minimum and a maximum value. There are no distinct groups and an individual's characteristic may have a value anywhere in the overall range of possibilities.

Continuous variation occurs because several different genes influence the same characteristic. Such a characteristic is said to be **polygenic**. When a number of genes contribute to a characteristic, it means that there are many different combinations of the various alleles involved. This produces many possible values for that characteristic, forming a continuous range of possibilities.

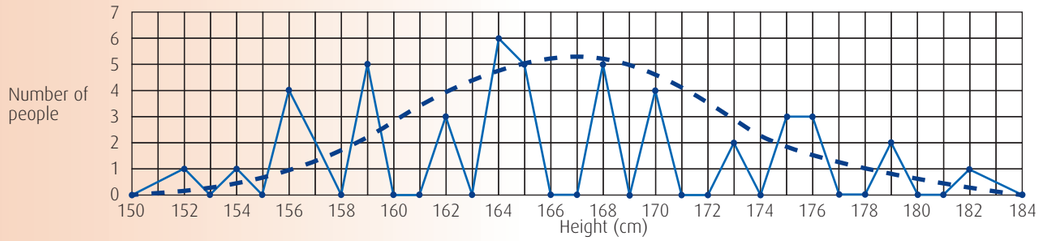
Examples of continuous variation include height, weight and hand span. Most visible characteristics are polygenic. It is probable that even some of those characteristics which show discrete variation and that are explained by single gene inheritance are influenced by more than one gene.

When the values for a polygenic characteristic are collected for a large number of individuals, it is found that they always show the same pattern of distribution. Relatively few individuals show values close to the extremes of the range. Most individuals show values close to the middle of the range, in other words a value close to the average.

This type of distribution is called a normal distribution. When it is plotted as a graph or chart, it shows a typical bell-shaped curve.

The photograph below shows a small group of people, all from the same university department, standing in order of their heights (in feet and inches).

The graph which follows it shows the distribution of their heights (in centimetres). The distribution is not a perfect normal distribution but the dotted line shows the overall pattern. If the sample size had been greater (more people included) then we would expect the pattern of height distribution to be closer to the typical normal distribution.



The distribution of heights in a group of people

ONLINE TEST

Check how well you've learned about variation online at www.brightredbooks.net/N5Biology

DON'T FORGET

The production of haploid gametes from diploid body cells and the random combination of gametes at fertilisation both contribute to genetic variation.

THINGS TO DO AND THINK ABOUT

1 What is the most common height of the people in the group?

2 Can you calculate their average height to the nearest centimetre?

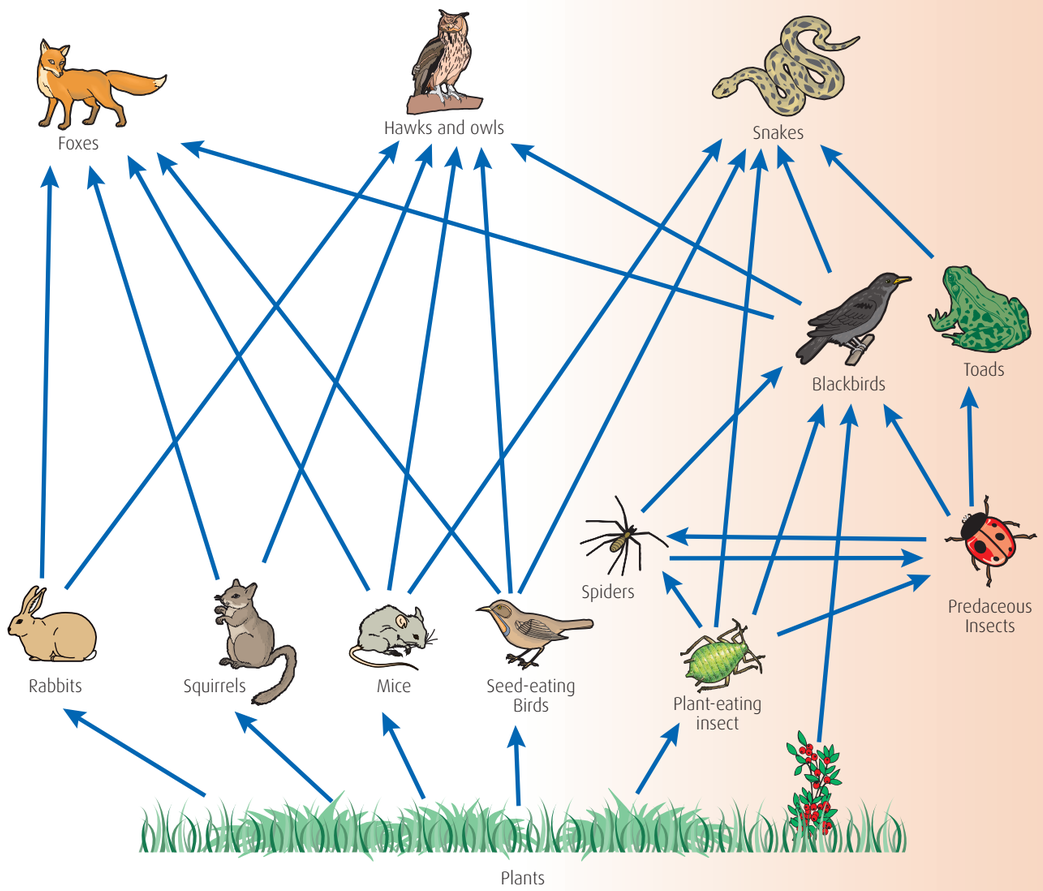
ECOSYSTEMS 2

FOOD WEBS

In reality, the transfer of energy in an ecosystem is not as simple as it appears in a food chain. This is because most organisms have more than one food source and any one type of organism may be eaten by a range of predators. Therefore, most food chains are interlinked into more complicated systems called food webs.

For example, part of a food web involving the organisms from the food chain is shown below.

A food web



A description of the position that an organism occupies in a food web is very close to a description of its niche.

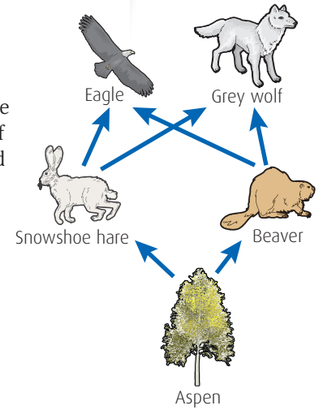
It is possible to find many individual food chains in a food web such as this.

ONLINE TEST

Test yourself on Ecosystems at www.brightredbooks.net/N5Biology

EFFECTS OF THE LOSS OF ORGANISMS FROM A FOOD WEB

Food webs can be affected by changes in the population of any of the organisms which are part of it. For example, in the food web on page 76, if the aphid population was to fall then there would be a decrease in the number of spiders and predaceous insects. This would cause a decrease in the blackbird and toad populations which, in turn, would affect the populations of foxes, hawks and owls, and snakes. There would be further consequences for the populations of rabbits, squirrels, mice and seed-eating birds.

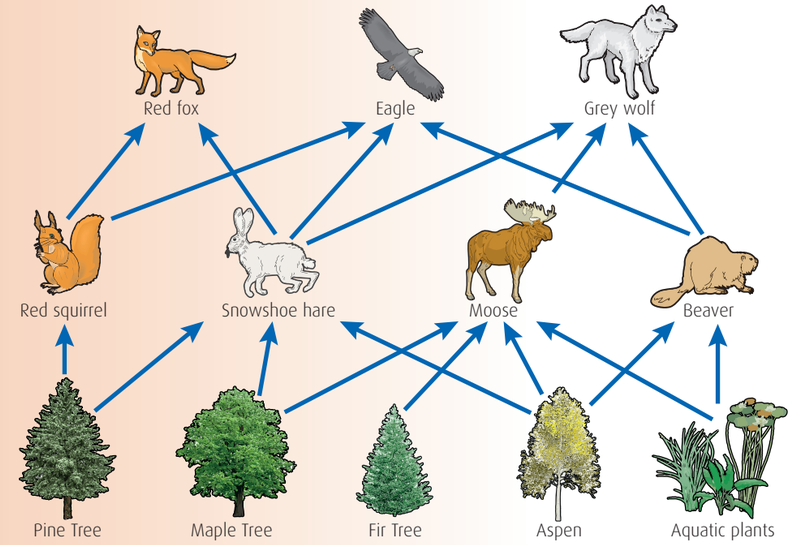


The greater the complexity or biodiversity of a food web, the more stable it is likely to be. This means that it will be able to adapt to changes caused by the loss of some organisms.

Consider the Canadian food web on the right:

If the beaver population fell because of a fatal disease, then a major food source of eagles and wolves would be lost. With hares then being the only food source for the eagles and wolves, the population of hares would soon become too small to support the eagles and wolves. Therefore the whole food web would have collapsed.

Compare this situation to the more complex food web below.



In this case, the loss of the beavers would not have such a catastrophic effect because the eagles and wolves still have several other food sources available. The extra demand placed on these other food sources would cause some fluctuations in numbers but in time a new balance would be achieved amongst the remaining populations.

VIDEO LINK

Watch the video at www.brightredbooks.net to learn more about ecosystems.

DON'T FORGET

The greater the biodiversity (number of different species present) in a food web, the greater is its ability to adapt to changes caused by the loss of one species.

THINGS TO DO AND THINK ABOUT

From the food web on page 76:

(a) name all the herbivores

(b) name all the omnivores

(c) name all the carnivores

(d) name all the animals which are both predator and prey.

BrightRED Study Guides

Curriculum for Excellence

NEW EDITION

N5 BIOLOGY

Margaret Cook and Fred Thornhill

This BrightRED Study Guide is just the thing you need to tackle your course and gain the exam skills essential to succeed at National 5 Biology. Written by trusted authors and experienced Biology teachers Margaret Cook and Fred Thornhill, this book is packed with brilliant examples, tasks and advice. It is the ultimate companion to your studies.

- **Contains all of the essential course information**, arranged in easily digestible topics.
- **Designed in full colour, highly illustrated, accessible and engaging** to make sure all that study sticks!
- ***Don't forget!*** pointers offer advice on key facts and on how to avoid common mistakes.
- ***Things to do and think about*** sections at the end of each topic allow for further practice and research.
- **Worked examples** show you how to approach a range of concepts and questions.
- **A glossary of key terms** helps you really learn and revise important course concepts.

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