Acknowledgements

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BIOMEDIA MELTDOWN

"In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed."

Charles Darwin

Competition entry from
Convent of Jesus and Mary
Language College,
Willesden, London

Introduction

BioMedia Meltdown Project

The BioMedia Meltdown Project was created to encourage students to take a broader interest in biology by demonstrating to them that a wide range of skills and passions are all of significant value to science and scientific careers. The project is aimed at Key Stage 3 students of all abilities. This activity book has been developed to help educators teach aspects of the biology national curriculum through creative media, with each activity addressing a different topic via an artistic hands-on approach. The activities are divided into two types; starter activities will help introduce students to a topic, whereas main activities will explore a topic in much greater detail.

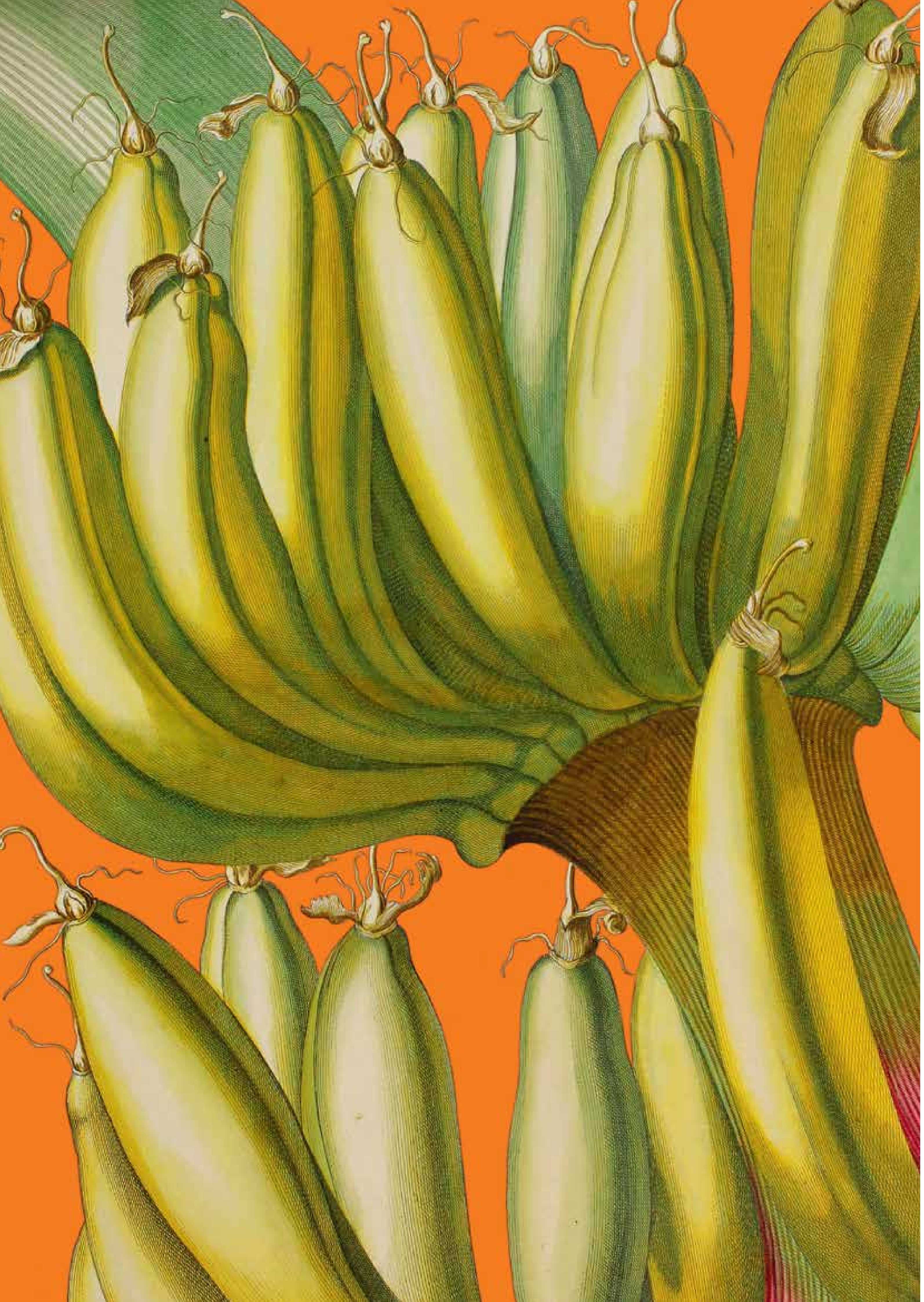
The BioMedia Meltdown Project was kindly funded by John Lyon's Charity, whose mission is to promote life-chances for children and young people through education.

The Linnean Society of London

The Linnean Society of London is the world's oldest active biological society. Founded in 1788, the Society takes its name from the Swedish naturalist and taxonomist Carl Linnaeus (1707-1778), whose botanical, zoological and library collections have been in its keeping since 1829. The Society promotes the study of all aspects of the biological sciences, with particular emphasis on evolution, taxonomy, biodiversity and sustainability.

Linnean Learning was established in 2009 to enable the Society to share its collections and wealth of scientific knowledge with wider audiences, including students and the general public, in order to inspire and engage the next generation with the natural world and biological sciences as a whole.

Contents



Facing page
Banana, *Musa*, from Christopher Jakob Trew, *Plantae Selectae* (1750-1773).

Artist's Study of Heredity

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *heredity*

Learning objective
To develop an understanding of heredity.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of what genes are and how they are inherited. Students should also have an understanding of the meaning of the term 'trait'.

Key words
Heredity
Genetics
Traits

Context
Heredity is the process by which genetic material is passed from one generation to the next. This genetic material, DNA, contains the information that codes for the physical traits (observable characteristics) that cause offspring to look like their parents. The pea plant, *Pisum sativum* (Figure 1), was named by Carl Linnaeus and was used by Gregory Mendel, enabling him to make his discovery about inheritance. Gregory Mendel's explanation of inheritance details how physical traits of the pea plant are passed from one generation to the next. This understanding of how inheritance works has allowed us to breed new crops with selected traits, such as drought resistance or higher nutritional value. Breeding new crops is extremely important in meeting the demand for highly nutritional food to feed the world's population.

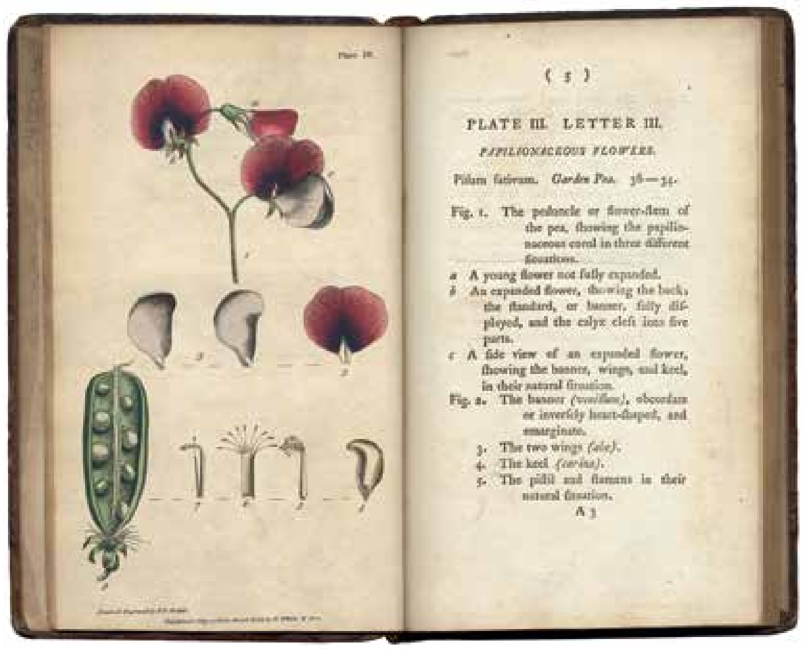


Figure 1
The pea plant, *Pisum sativum,* taken from Thomas Martyn, *Thirty-eight plates, with explanations; intended to illustrate Linnaeus's system of vegetables, and particularly adapted to the Letters on the elements of botany* (1794).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- School library or computer room

An artist's study breaks down the different elements of its subject in order to understand each part's shape, form, colour and function. Scientists undertake exactly the same process when studying organisms (Figure 2).

Ask your students to use one of the 3 pieces of botanical art of edible food (Figure 3), provided for inspiration, to assist them in creating an artist's study about heredity.

1 Students should first choose an edible plant (any fruit or vegetable).

2 Next, students should sketch each part of their plant (leaves, flowers, fruit and seeds).

3 Lastly, students should do some research to add annotations to their sketches on the following points:
- How their plant is bred / reproduces
- The different varieties that there are of their chosen plant
- The history of their edible plant (which wild plant was it domesticated from?)
- Where the plant originated from (its local climate)
- Which traits were selected and why

Figure 2
Banana, *Musa × paradisiaca*, from Hendrik van Rheede, *Hortus Malabaricus* (1678-1693).

A

B

C

Figure 3
Prints of edible plants:
A. Guava, *Psidium guajava*,
B. Pineapple, *Ananas comosus*, and
C. Papaya, *Carica papaya*, illustrated by
Christopher Jakob Trew, *Plantae Selectae* (1750-1773).

Paradoxical Natural Selection

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *natural selection*

Learning objective
To develop an understanding of heredity.

Preparation time
10 minutes

Running time
50 minutes

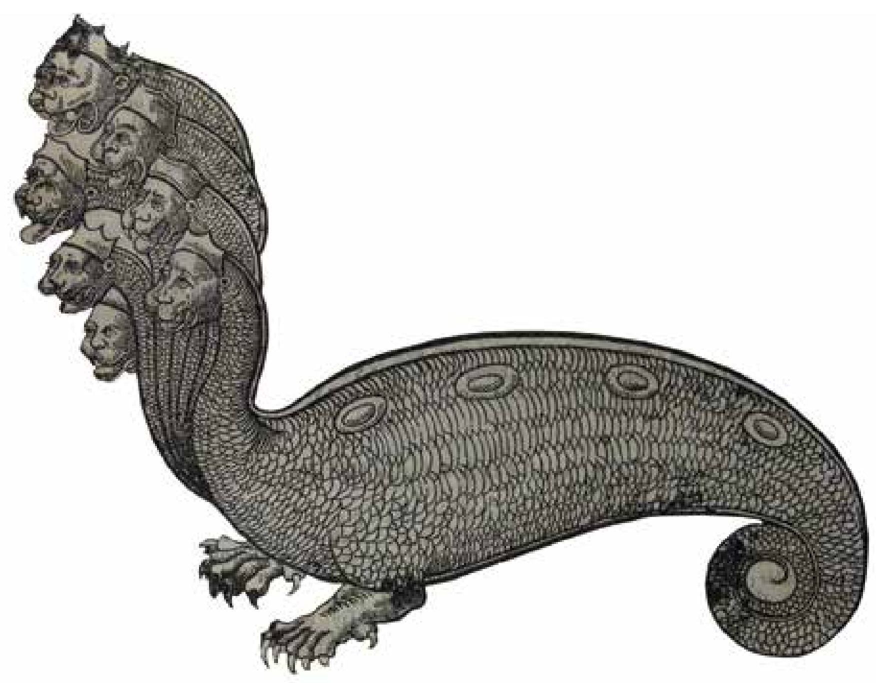
Prior understanding
Students should have an understanding of natural selection and adaptation.

Key words
Adaptation
Natural selection

Context

Natural selection is the process by which organisms become better adapted to their environment, thus improving their chances of survival and reproduction. Each environment has a different set of unique selection pressures that, over many generations, shape the organisms that live there. It is these different sets of pressures that cause the wide variety of adaptations seen in different organisms. Whilst Carl Linnaeus was developing his system of classification, he created a group called *Animalia Paradoxa* meaning 'contradictory animals'. Animals that were placed under the *Animalia Paradoxa* were those that he had heard of, but had never actually seen. These animals included the Hydra (Figure 4), which had the body of a snake, two feet, and seven heads; the Monoceros, a unicorn; and the Phoenix, a bird reborn from its own ashes after its life had ended in a burst of flames.

Figure 4
An illustration of a Hydra from Conrad Gesner, *Historiae Animalium* (1551-1558).



Facing page
Monstrous seahorse from Ulisse Aldrovandi, *Monstrorum Historia* (1642).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials

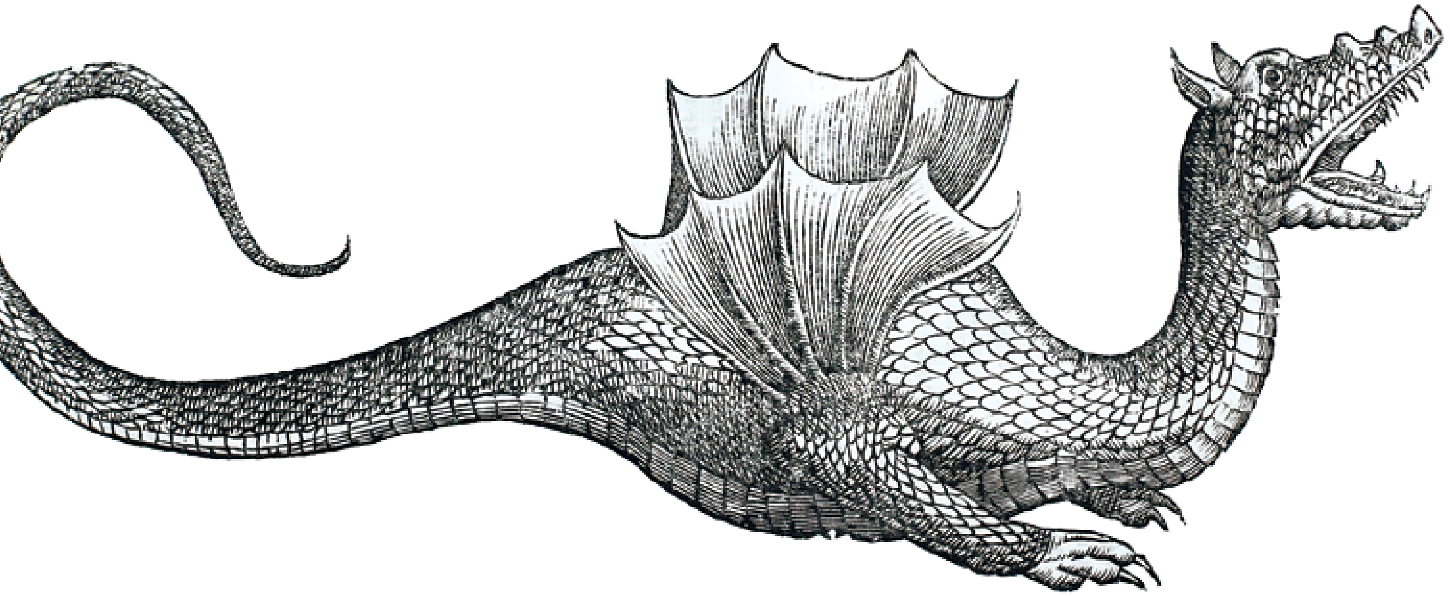
Ask your students to write and illustrate a text message or email to Linnaeus about their own *Animalia Paradoxa*.

1 Students should begin by illustrating their own *Animalia Paradoxa*.

2 Next, using the templates provided (Figure 5), ask your students to compose a text or email to Carl Linnaeus. In their message they should explain how their animal is adapted to its environment and how it might evolve if selection pressures were to change.

3 Lastly, to challenge your students, ask them to include words such as 'adaptation', 'natural selection' and / or 'heredity'.

Below
Dragon from Ulisse Aldrovandi, *Monstrorum Historia* (1642).



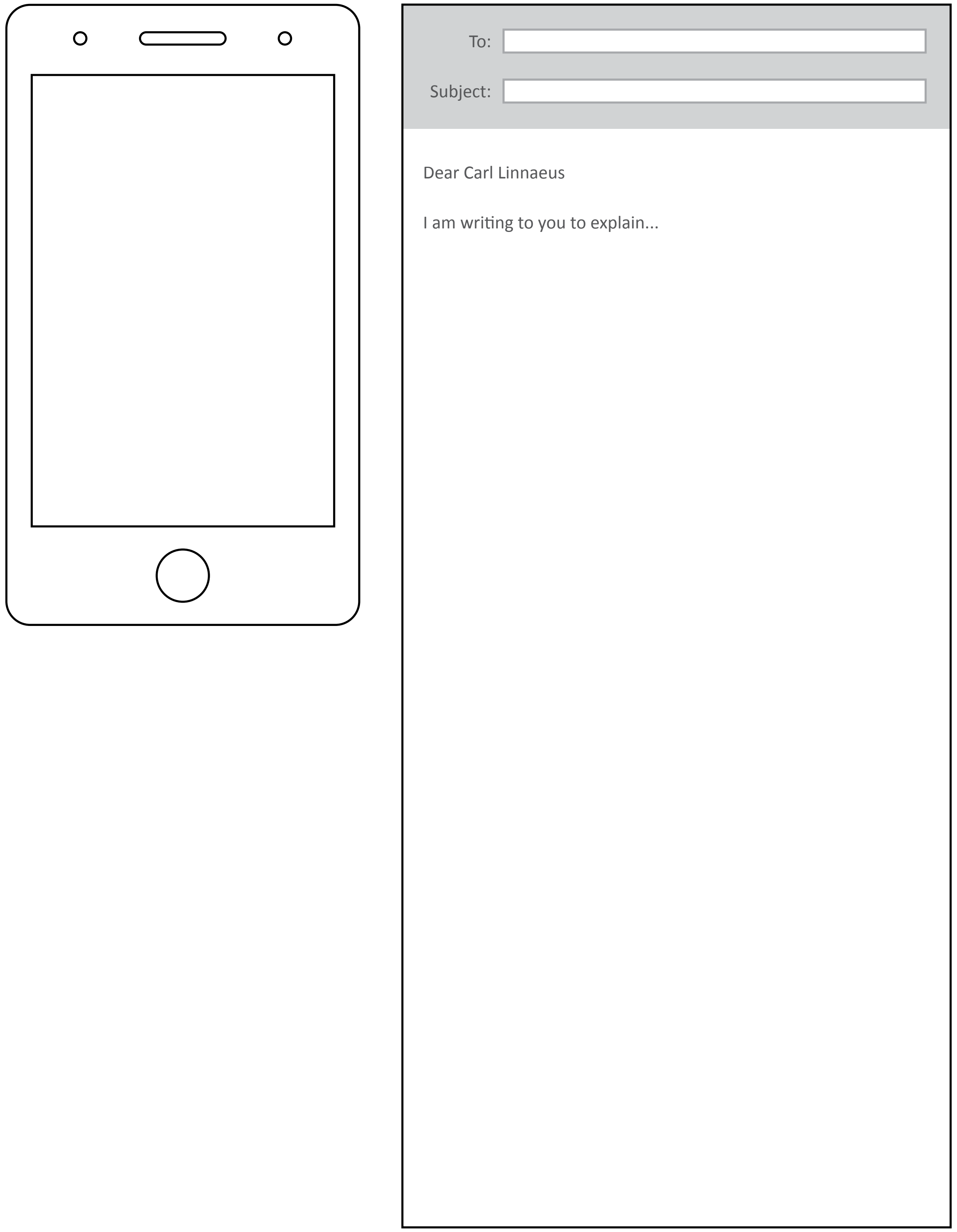
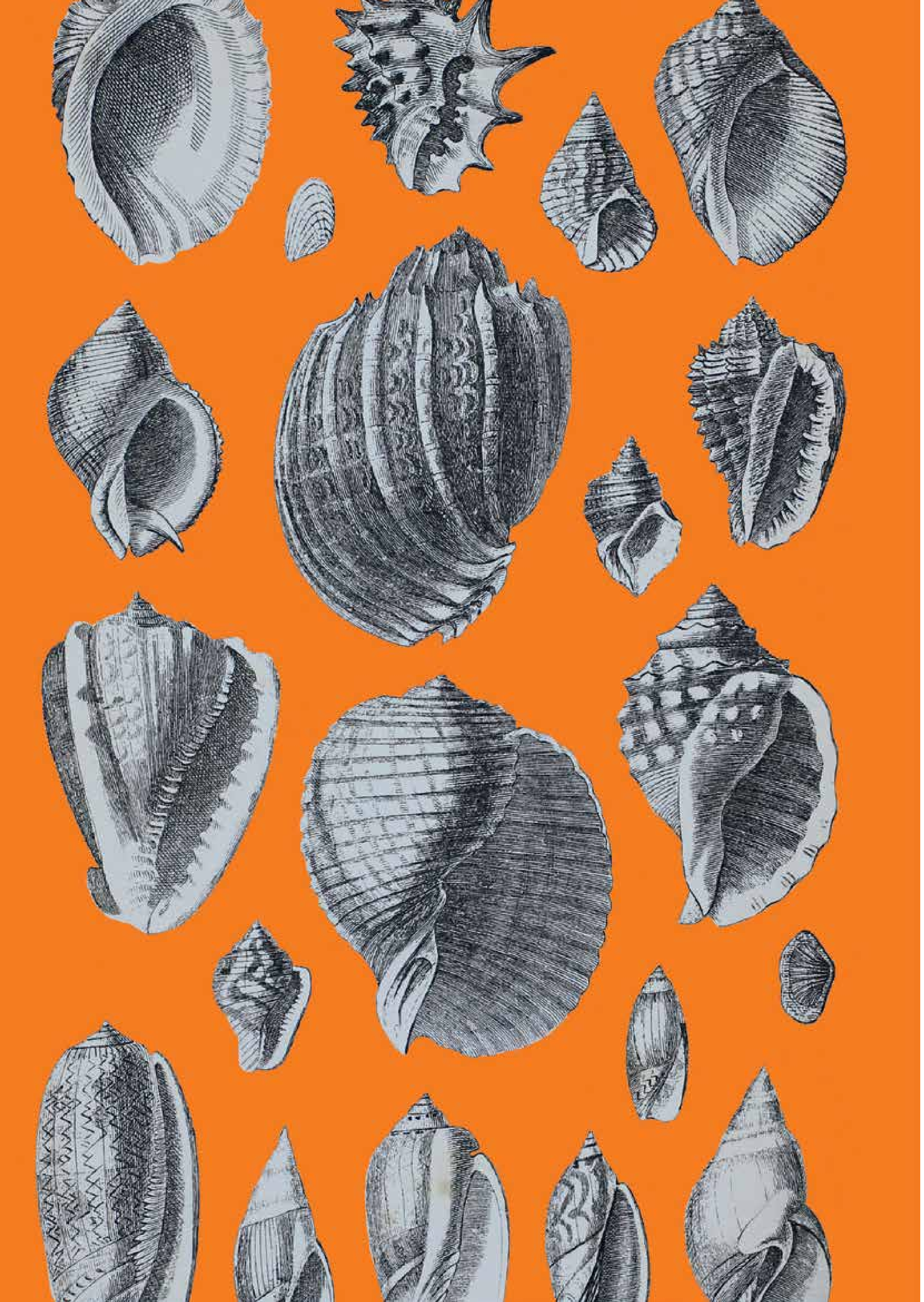


Figure 5
Templates in which to compose a text message or email to Carl Linnaeus.



Dog Whelk Variation

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *variation between individuals within a species*

Learning objective
To develop an understanding of how the environment can have an impact on phenotypic variation within a species.

Preparation time
20 minutes

Running time
30 minutes

Prior understanding
Students should have an understanding of the impact that the environment may have on variation.

Key words
Variation
Phenotype
Genotype

Context
Variation describes both the phenotypic and genotypic differences between organisms. A phenotype is the observable physical characteristics of an individual, controlled by the interaction between its genes and the environment. Genotype refers to an individual's specific genes. Variation exists between different species, but is also found within a single species, as can be seen in dog whelks (*Nucella lapillus*, sea snail; Figure 6). Carl Linnaeus collected and classified a great number of shells, including those of the dog whelk. The dog whelk shell shows significant variation in texture. This variation is, in part, a phenotypic adaptation to the differential amount of wave action exposure that each population of dog whelks experiences on the shore. If the dog whelk is directly exposed to wave action, its shell is smooth with intermittent growth lines. If the dog whelk is sheltered from wave action, its shell is rough and appears to be composed of plates or flakes.[1]

[1] Pascoal S, Carvalho G, Creer S, Rock J, Kawaii K, Mendo S, Hughes R (2012) *Plastic and Heritable Components of Phenotypic Variation in Nucella lapillus: An Assessment Using Reciprocal Transplant and Common Garden Experiments.* PLOS ONE 7(1).

Facing page
Shells from Thomas Martyn, *Universal Conchologist* (1789).

Activity

Activity type
Starter activity

Equipment required
- A4 plain white paper
- Art materials

Ask your students to complete the scale (Figure 7) to explore the variation in dog whelk shell texture.

1 Using the information and images provided (Figure 6), ask your students to sketch, on the scale, what they think the dog whelk shells might look like with different amounts of wave exposure.

2 Next, get your students to annotate or present their scale, justifying why they have chosen to illustrate their images in the way that they have.

A

B

Figure 6
Dog whelk shells (*Nucella lapillus*) from Carl Linnaeus's collections showing variation in texture.
A. is smooth as a phenotypic adaptation to high wave exposure, whilst B. is rough as an adaptation to low wave exposure.

Dog Whelk Variation

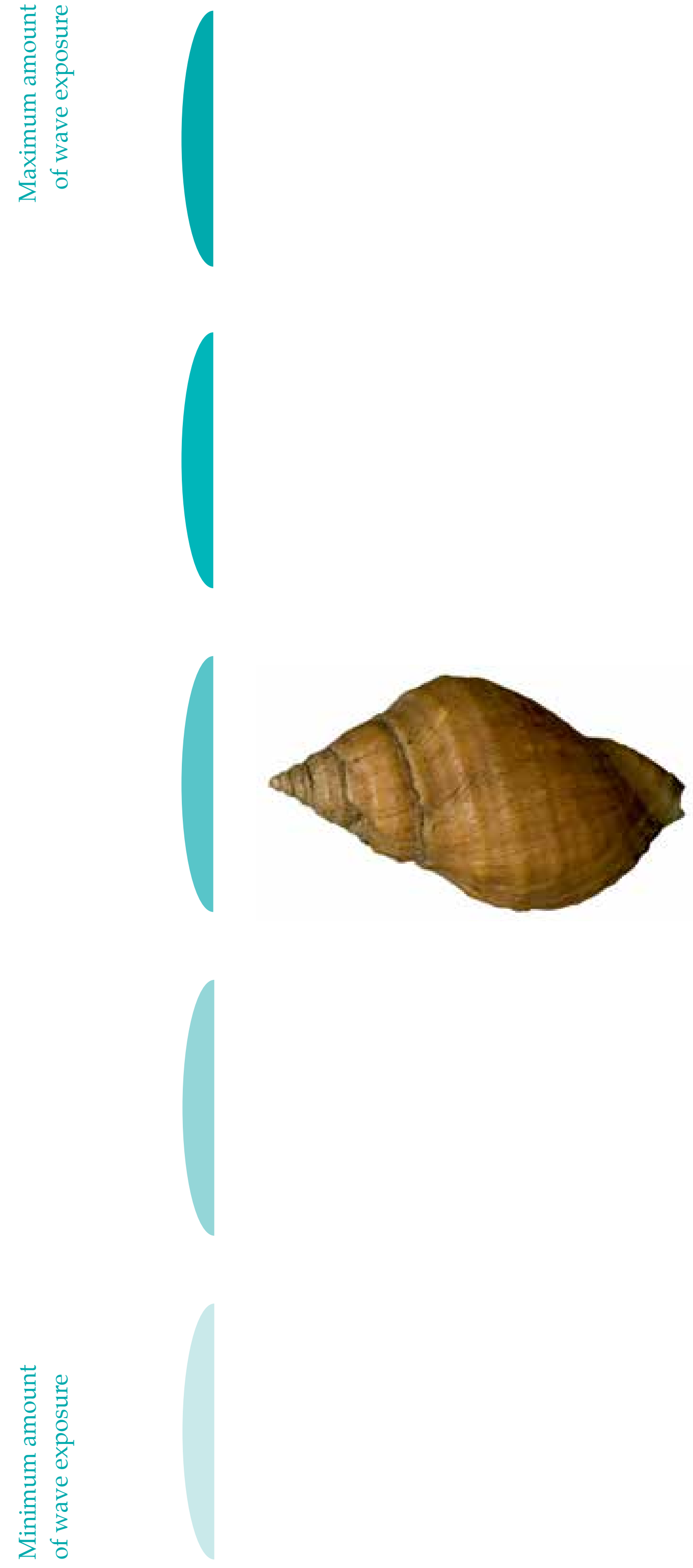


Figure 7
Scale to be used to sketch the texture of dog whelk shells at different amounts of wave exposure.

Beak Variation

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *variation between species*

Learning objective
To develop an understanding of the variation that exists between different species.

Preparation time
5 minutes

Running time
30 minutes

Prior understanding
Students should have an understanding of the types of diet that different bird species have, and should also understand the term 'variation'.

Key words
Variation

Context
The variation that exists within a species is far less than that which exists between different species. Gray's *Genera of Birds* exemplifies this greater variation between different species in its illustrations of birds. One of the most noticeable and simplest ways to identify different species of birds from each other (Figure 8) is by examining and comparing the variation in their beaks. The shape of the beak is dependent on the primary food source of the bird.

Facing page
Oriole, *Icterus*, by David William Mitchell and Joseph Wolf, from George Robert Gray, *Genera of Birds* (1844-1849).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials

Ask your students to match each bird's beak to its primary food source.

1. Ask your students to examine and compare the beaks in the illustrations provided (Figure 8) to suggest what each bird's primary food source might be, such as insects or nectar.

2. Next, get your students to complete the table (Figure 9) by illustrating each of the beaks under the correct food source heading.

3. To challenge your students, ask them to explain the structure of each of the beaks in relation to their function.

Right
Cinnamon-bellied flowerpiercer, *Diglossa baritula*, by David William Mitchell and Joseph Wolf, from George Robert Gray, *Genera of Birds* (1844-1849).

A

B

C

D

E

Figure 8
Prints of birds with varying beak morphology:
A. Nacunda nighthawk, *Chordeiles nacunda*,
B. Red-billed streamertail, *Trochilus polytmus*,
C. Spotted kingfisher, *Actenoides lindsayi*,
D. Indian eagle-owl, *Bubo bengalensis*, and
E. Blue nuthatch, *Sitta azurea*, illustrated by David William Mitchell and Joseph Wolf, from George Robert Gray, *Genera of Birds* (1844-1849).

Figure 9
Table to be used to match each bird's beak with its primary food source.

Small mammals	Nectar	Generalist	Insects	Fish

Classification Jigsaw Puzzle

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *differences between species*

Learning objective
To develop an understanding of the differences between species within the system of classification.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have a basic understanding of the system of classification.

Key words
Classification
Class
Order
Family

Context
Classification is the process by which organisms are grouped together based on detectable similarities. Carl Linnaeus created the system of classification in order to make sense of the natural world by grouping organisms together, so that they could be universally identified. When an organism is classified it is placed into a group with other organisms which are similar. These groups are then broken down further into smaller and smaller groups based on increasingly detailed similarities between organisms within the group (Figure 10).

Facing page
Capuchin, *Cebus capucinus*, from Etienne Geoffroy Saint-Hilaire, Frédéric Cuvier, *Histoire Naturelle des Mammifères* (1824).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- Computer room

Ask your students to research the system of classification so that they can illustrate the missing puzzle pieces in the images (Figure 11).

1 Students should first use the internet to research the Class group given to each animal.

2 Based on their research, they should illustrate the Class puzzle piece using the general features specific to that group.

3 Next, students should use the internet to research the Order group, then illustrate the Order puzzle piece, again using general features specific to that group.

4 Finally, students should research and illustrate the Family group.

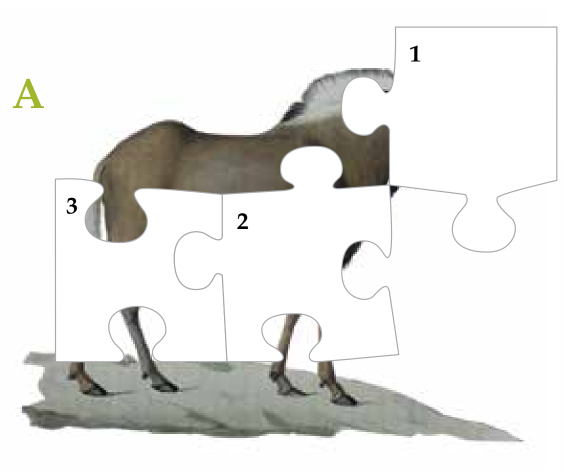
5 By researching each classification level (puzzle piece) in turn, students will be able to illustrate the image with increasing accuracy, allowing them to identify the animal. In doing so, they will realise the importance of naming and classifying organisms through increasing levels of detail.

Increasingly detailed information

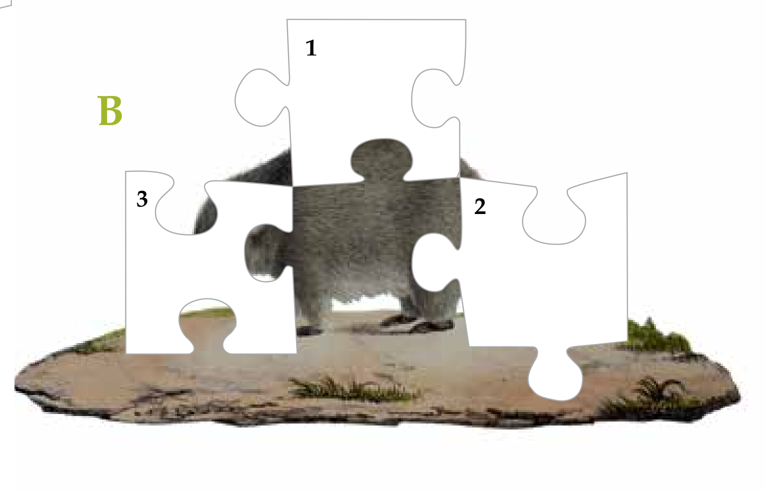
- Kingdom - Animalia
- Phylum - Chordata
- Class - Mammalia
- Order - Cetartiodactyla
- Family - Bovidae
- Genus - *Bison*
- Species - *bison*

Figure 10
An example of a classified organism: Bison, *Bison bison*.

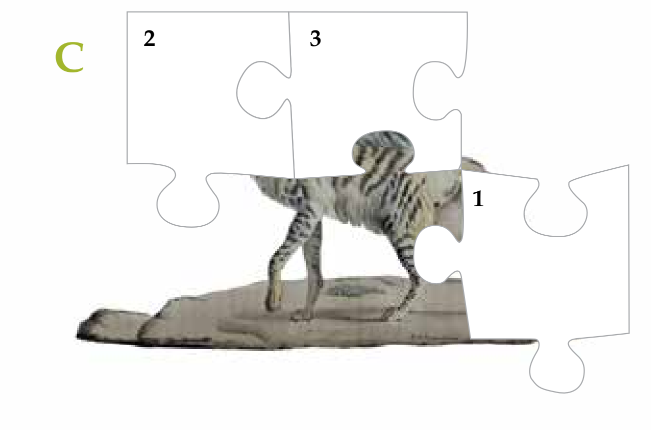
Classification Jigsaw Puzzle



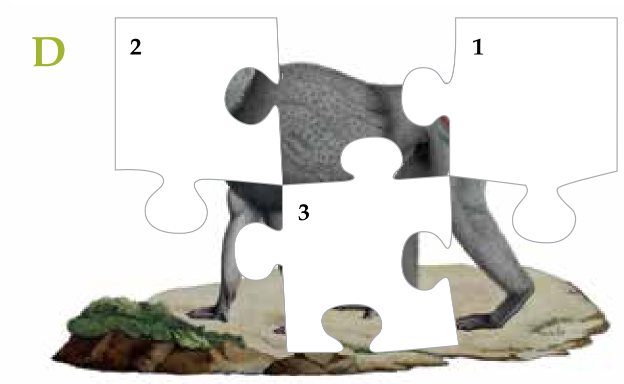
1 Class - Mammalia
2 Order - Cetartiodactyla
3 Family - Bovidae



1 Class - Mammalia
2 Order - Diprotodontia
3 Family - Vombatidae

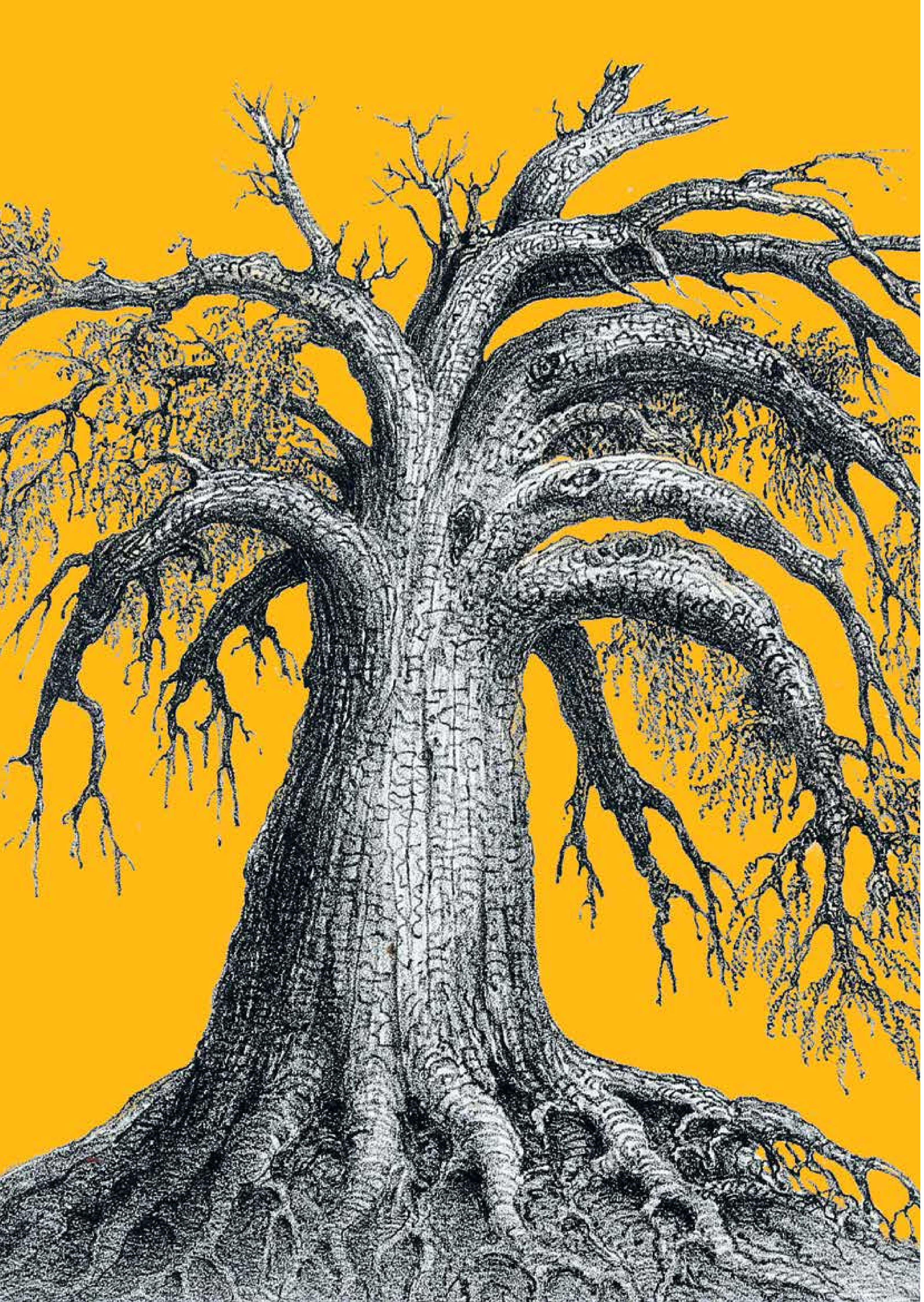


1 Class - Mammalia
2 Order - Carnivora
3 Family - Hyaenidae



1 Class - Mammalia
2 Order - Primates
3 Family - Cercopithecidae

Figure 11
Illustrations of various mammals: A. *Connochaetes taurinus*, B. *Lasiorhinus krefftii*, C. *Hyaena hyaena*, and D. *Papio anubis*, from Etienne Geoffroy Saint-Hilaire, Frédéric Cuvier, *Histoire Naturelle des Mammifères* (1824).



Phylogenetic Tree

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *differences between species*

Learning objective
To develop an awareness of the five kingdoms.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of the kinds of organisms that belong to each of the five kingdoms.

Key words
Kingdoms
Phylogenetic tree

Context
The first step in classifying any organism is to decide what kingdom it belongs to. The different kingdoms are based on the characteristics of an organism's cells. The five kingdoms are Animals, Plants, Fungi, Protoctists and Prokaryotes. The evolutionary relationship between kingdoms can be represented using a branching diagram called a phylogenetic tree. Famously, a phylogenetic tree was used by Darwin in his explanation of the theory of evolution by natural selection in *On the Origin of Species*, but they were also used by many other famous historical scientists, such as Ernst Haeckel (Figure 12). These phylogenetic trees were used to show the evolutionary relationship between different organisms.

Facing page
Histoire naturelle des Iles Canaries by Philip Barker Webb and Sabin Berthelot (1836-1850).

Activity

Activity type
Main activity

Equipment required
- A3 plain white paper
- Art materials

Ask your students, in groups, to create a phylogenetic tree with their handprints (Figure 13).

1 Students should start by creating a handprint using any chosen art materials.

2 Next, get your students to label each of the fingers with one of the five kingdoms.

3 Lastly, students should create another handprint at the end of each finger on the original handprint, and then try to name as many organisms as they can that belong to that kingdom.

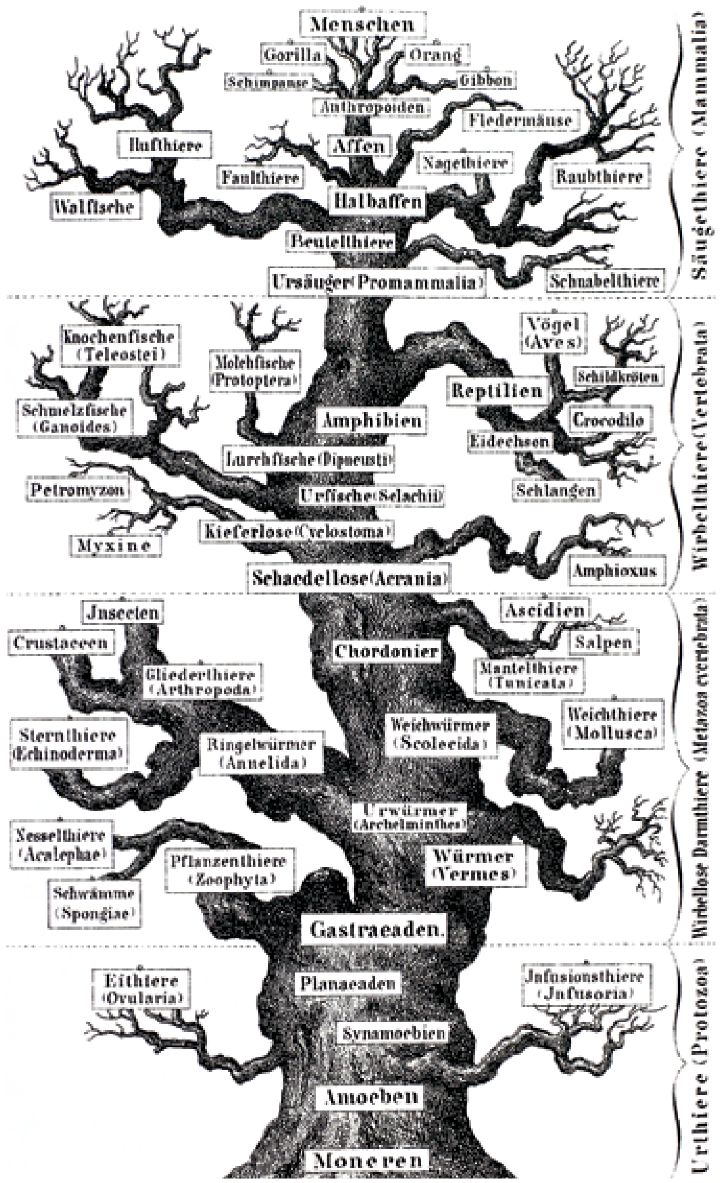


Figure 12
The 'great oak', a family tree of animals; from Ernst Haeckel, *Anthropogeny or History of Human Development* (1874).

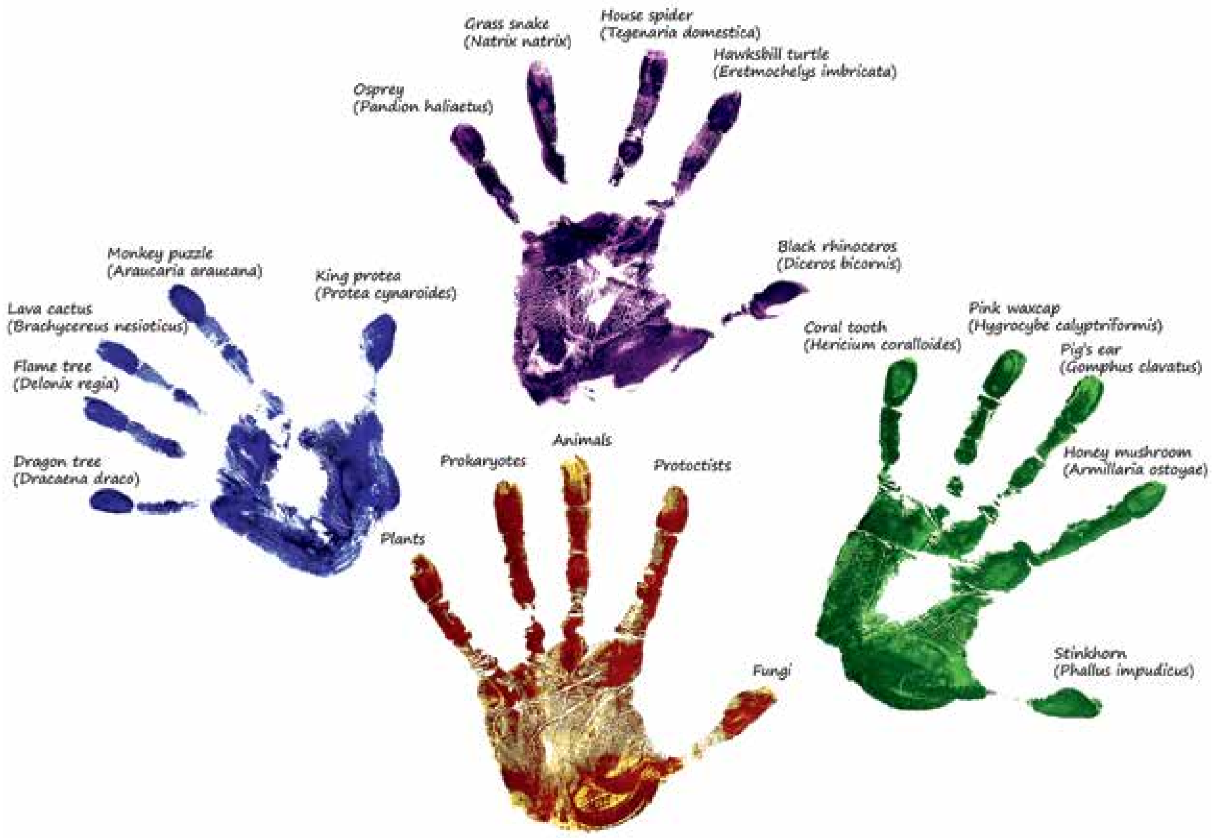
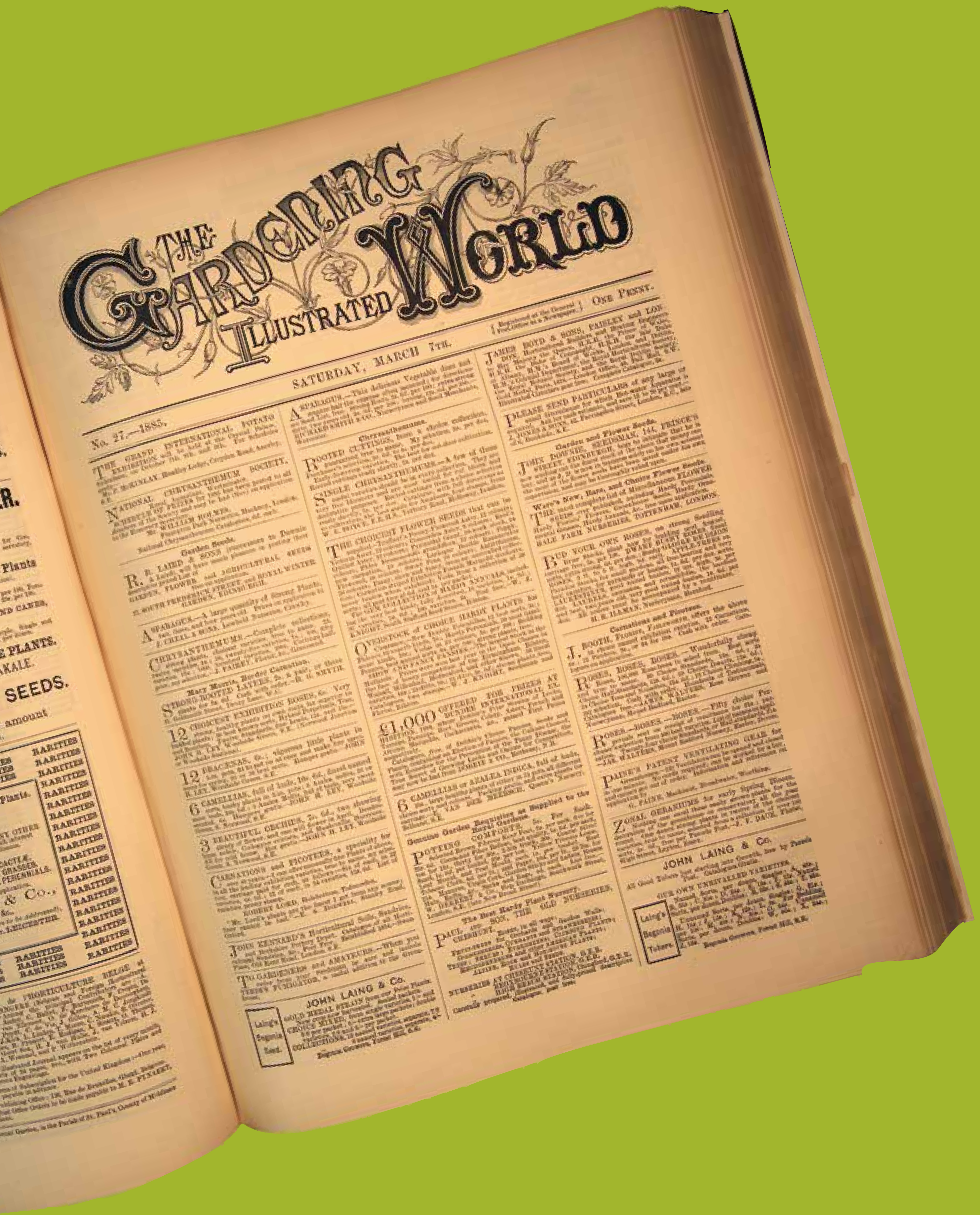


Figure 13
An example of a handprint phylogenetic tree.



Advertising Changes in the Environment

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *changes in the environment*

Learning objective
To develop an understanding of how environmental changes affect individual species.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of how environmental changes can affect animals with particular adaptations.

Key words
Environmental changes
Habitats
Adaptation
Extinction

Context
Species that are endangered are at risk of extinction. The main reason for organisms becoming endangered, or going extinct, is due to the loss of suitable habitats in which they can live. Suitable habitats are those that organisms are specifically adapted to live in. The loss of suitable habitats is largely due to human activity, such as large-scale agriculture. Since the Victorian era, agriculture has become increasingly commercial and has therefore been undertaken on a much larger scale. This increase in commercial farming has resulted in the destruction of large areas of suitable habitats, endangering many species. For example, the increase in palm oil plantations has caused destruction of large areas of forest, which is the habitat of the orangutan. With the loss of their habitat, orangutans are becoming endangered.

Facing page
An advertising page from *The Gardening World Illustrated* Vol. 1 (1885).

Advertising Changes in the Environment

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- Computer room

Ask your students to make a Victorian-style advert (Figure 14). Their advert should inform the general public why they should be concerned with the protection of habitats for the conservation of endangered species. Their advert should clearly show how human activity is contributing to the loss of habitats.

Below
Possible habitats that students could focus on.

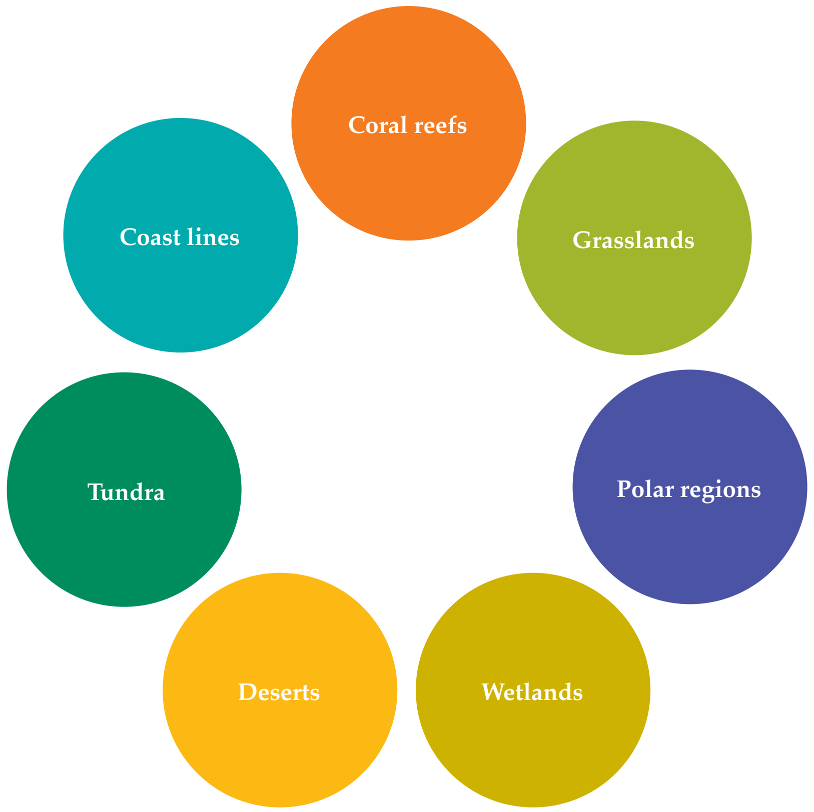


Figure 14
Victorian adverts from *The Gardening World Illustrated* Vol. 1 (1885).

Recording Biodiversity

Background

National Curriculum link
Inheritance, chromosomes, DNA and genes: *the importance of maintaining biodiversity*

Learning objective
To develop an understanding of the importance of maintaining biodiversity.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of the definition of biodiversity and of the importance of maintaining it.

Key words
Biodiversity
Habitat

Context
Biodiversity describes the variety of all life in a particular habitat. It is considered to be highly valuable because of the potential it holds for food, medicine, industrial products, and ecosystem services such as pollination. The Linnean Society of London is home to an extensive herbarium, which is a collection of plant specimens preserved for the purposes of identification, research and education (Figure 15 A). These collections are pivotal for ongoing research on plant biodiversity. In order for a herbarium sample to be of use to a researcher it needs to be displayed in such a way that all of the plant's key structural parts can be seen and studied. You can arrange to come and view herbarium specimens at The Linnean Society of London, Burlington House.

Facing page
Herbarium specimen, *Delphinium grandiflorum*, from Carl Linnaeus's personal collection.

Activity

Activity type
Main activity

Equipment required
- Tape measure
- Pencils
- Pressing: heavy flat object (heavy books or bricks on top of card)
- Stiff card (corrugated)
- Blotting paper or other absorbent paper
- PVA glue
- A4 paper
- Tape

Ask your students to make their own herbarium specimen (Figure 15 A).

1 In dry weather, collect a typical plant (from your own property or, with permission, the school's property); one which is healthy, has average-sized leaves and flowers, and which is no bigger than an A4 sheet of paper.

2 Record the following: the date the plant was collected, the name of the site it was collected from, the dimensions of the plant, and its colour, using the colour chart made by James Sowerby (Figure 15 B). This chart can be used by placing an asterisk inside the block of colour that is most representative of your flower. Attach this completed chart to your herbarium specimen.

3 Remove any excess soil attached to the specimen and place it on top of blotting paper that has been laid on top of a solid flat surface. In the following order, place on top of the plant another piece of blotting paper, one sheet of stiff card (corrugated or other), and then a heavy object such as a book or brick (Figure 16).

4 Ensure that pressing occurs in a warm, dry and well ventilated room. Check on the plant every 24 hours. The drying process can take from 3 days up to 3 weeks depending on the specimen.

5 Once dry, attach the plant to an A4 sheet of paper by sparingly using PVA glue and tape. Write the information recorded when the specimen was collected onto the paper on which the plant has been mounted. Finally, identify the plant and title the herbarium sample with its species name. To challenge your students, get them to explain the function of each of the plant's structural parts.

A

Figure 15
A herbarium specimen (Potato, *Solanum tuberosum*) from Carl Linnaeus's collections, with example annotations.

B

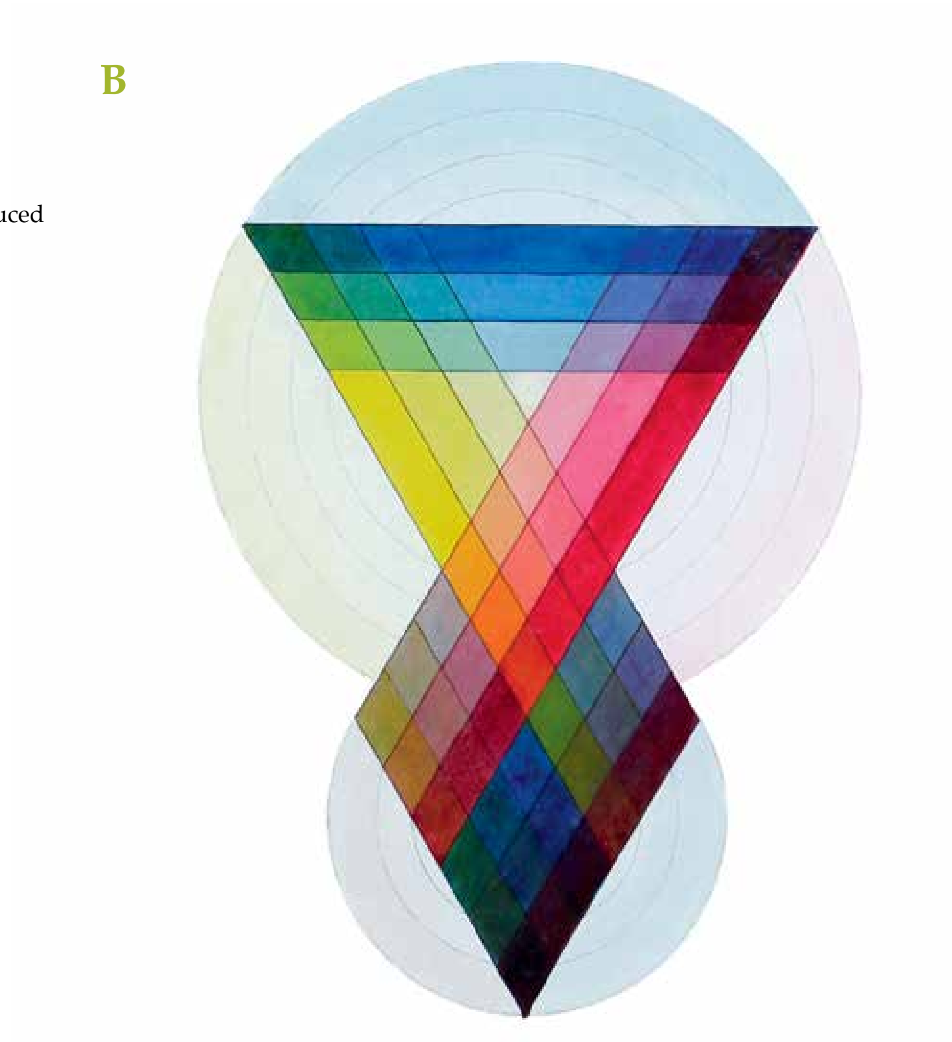


Figure 15
A colour chart produced by James Sowerby, *A New Elucidation of Colours* (1809).

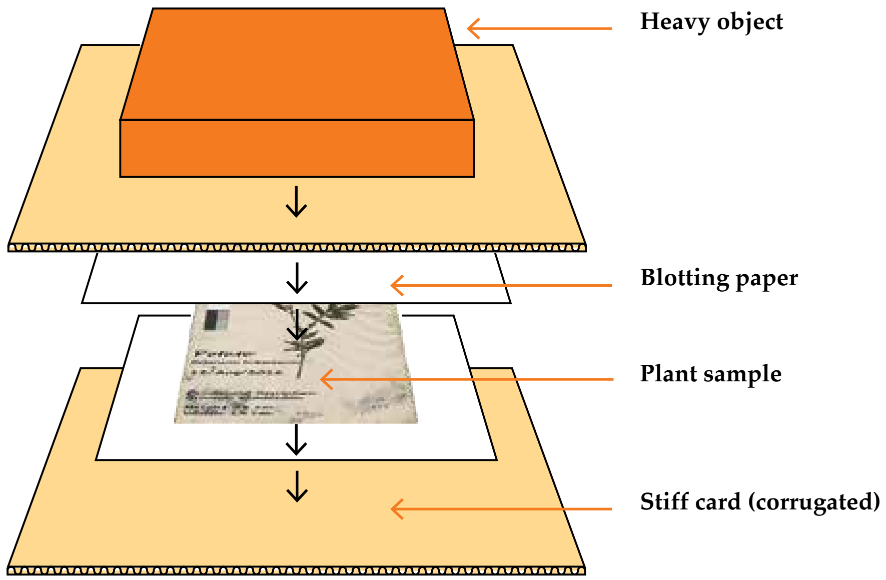
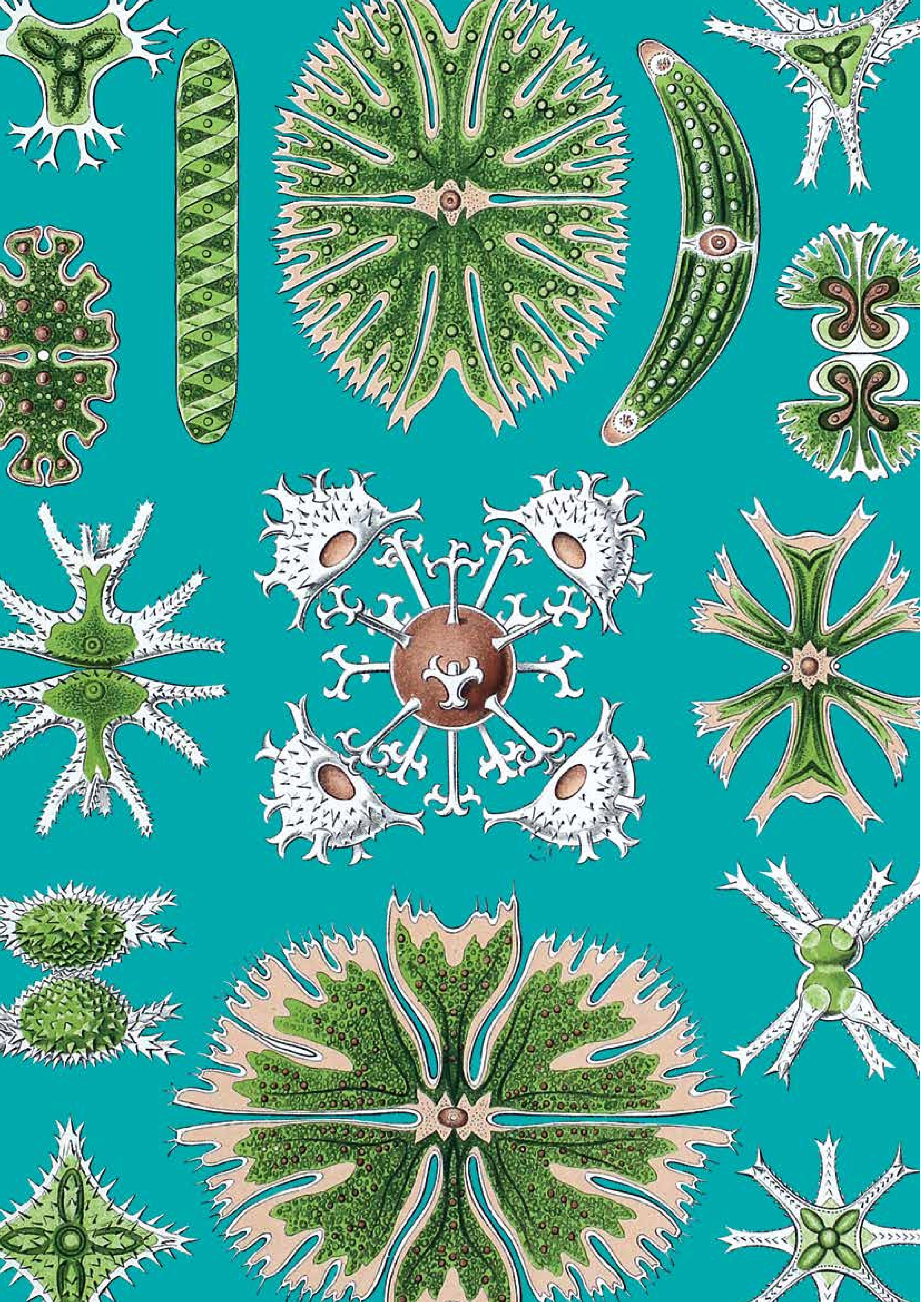


Figure 16
Diagram showing how the plant specimen should be pressed and dried.



Tracing Algae Surface Area

Background

National Curriculum link
Photosynthesis:
algae biodiversity and surface area

Learning objective
To develop an understanding of the adaptations of algae for photosynthesis.

Preparation time
10 minutes

Running time
30 minutes

Prior understanding
Students should have an understanding of how the large surface area of algae assists with the process of photosynthesis.

Key words
Photosynthesis
Chlorophyll
Green pigment
Surface area

Context
Green algae are a diverse group of photosynthetic organisms that are responsible for almost 50% of all photosynthesis. They are highly effective at photosynthesis due to the large surface area to volume ratio that their shape affords. This large surface area increases the algae's ability to capture sunlight, and increases the rate of diffusion of oxygen and carbon dioxide across the cell membrane. Ernst Haeckel was, amongst other things, a biologist and artist who created many drawings of natural forms across diverse species, one of which was green algae (Figure 17). In his illustrations he clearly showed the algae's large surface area to volume ratio, and further highlighted their abundance of chlorophyll with the green hues that he used to colour his images.

Facing page
Algae by Ernst Haeckel, *Kunstformen der Natur* (1904).

Activity

Activity type
Starter activity

Equipment required
- A4 tracing paper
- A4 graph paper
- String
- Ruler
- Art materials

Ask your students to make a tracing of Ernst Haeckel's illustrations to learn about the importance of the surface area to volume ratio.

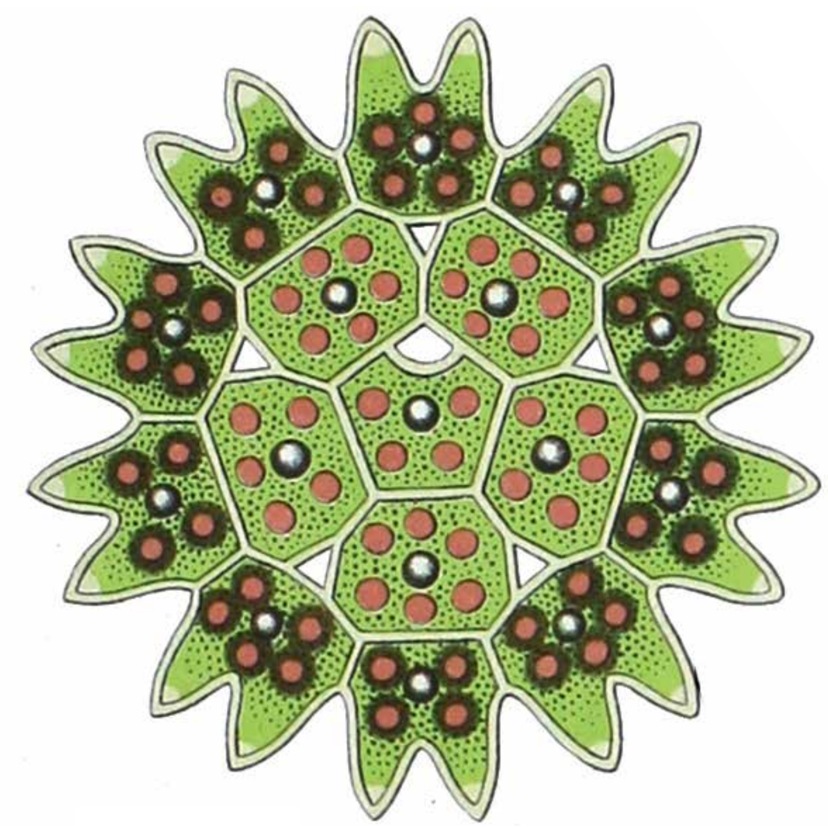
1 Ask your students to study the large surface area to volume ratio of algae by tracing over the Ernst Haeckel illustrations provided (Figure 17).

2 Next, students should place their tracing on top of graph paper to work out the volume of their chosen algae.

3 The surface area can then be calculated by measuring the outer surface of the algae with a piece of string and a ruler.

4 Lastly, students should colour and annotate their algae with an explanation as to why this large surface area to volume ratio is important.

Right
Algae, *Pediastrum*, by Ernst Haeckel, *Kunstformen der Natur* (1904).



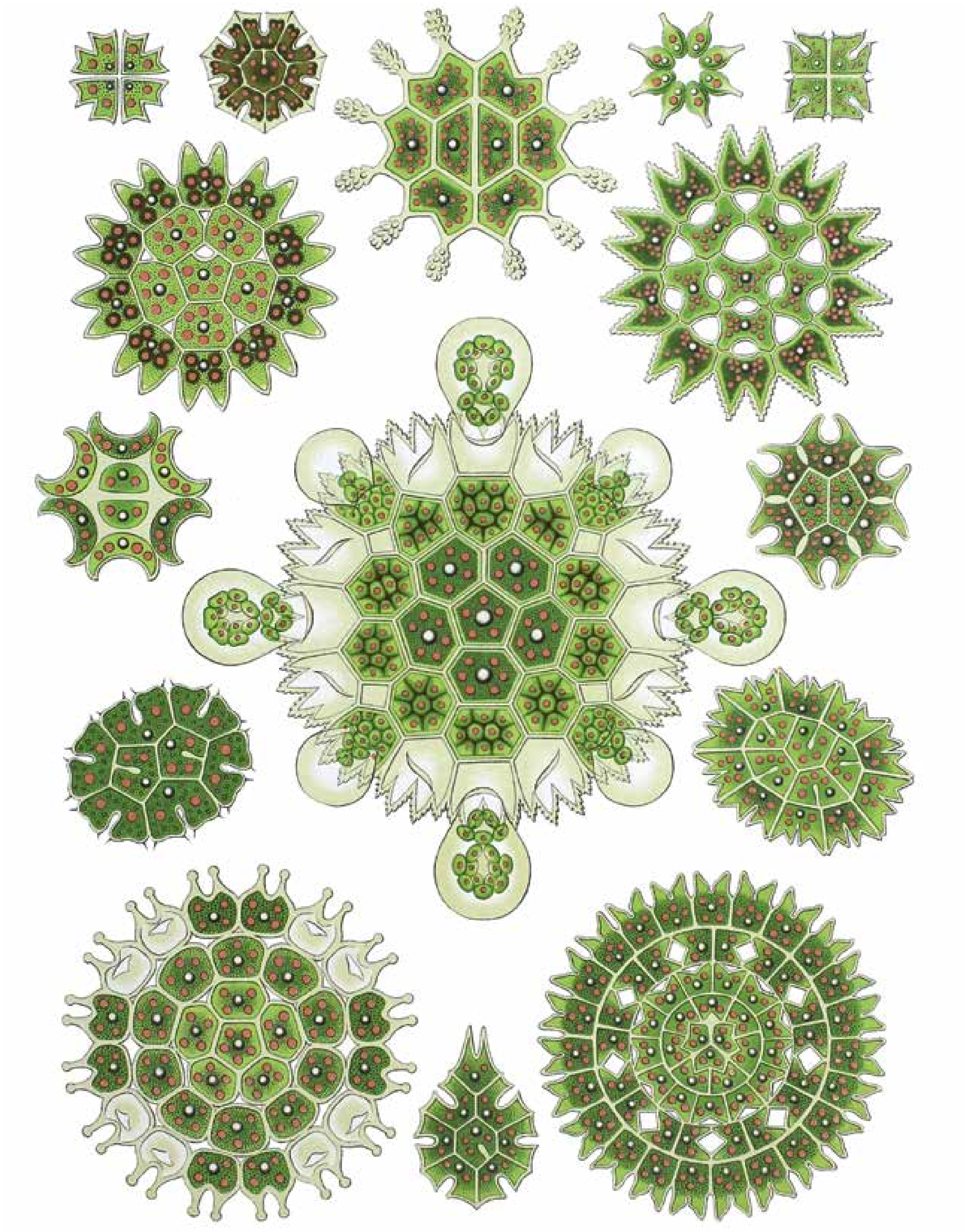


Figure 17
Illustrations of algae by Ernst Haeckel, *Kunstformen der Natur* (1904).

Leaf Colouring

Background

National Curriculum link
Photosynthesis:
the adaptations of leaves for photosynthesis

Learning objective
To develop an understanding of the adaptations of leaves for photosynthesis.

Preparation time
10 minutes

Running time
30 minutes

Prior understanding
Students should have a basic understanding of the primary function of the different structures in plants, such as the stem, leaves and petals.

Key words
Photosynthesis
Chlorophyll
Green pigment

Context
Chlorophyll is the green pigment found in plants that is responsible for photosynthesis and for their green colour. The distribution of chlorophyll throughout a plant's various structures is dependent on their function, e.g. the stem's primary function, is transport, whereas the leaves (which are chlorophyll rich) are for photosynthesis. Colour is very important for the identification of plants. Unfortunately, however, in Elizabeth Blackwell's physician reference book for medicinal plants, *A Curious Herbal*, all the prints were done in black and white (Figure 18).

Facing page
Tea plant, *Camellia sinensis*, by Elizabeth Blackwell, *A Curious Herbal* Vol. I (1737-1739).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- Computer room

Ask your students to show their understanding of the primary function of chlorophyll by accurately colouring in the plate prints provided (Figure 18).

1 Ask your students to choose one of the plate prints from *A Curious Herbal* and research what the plant actually looks like in colour.

2 Next, using any chosen medium, students should attempt to colour in their selected plate print as accurately as possible.

3 Lastly, students should annotate their print with notes that explain why there might be a variation in green shades across the plant, e.g. some parts of their plant may be greener than others due to their position or function in photosynthesis.

Right
Evening primrose, *Oenothera fraseri* from *Curtis's Botanical Magazine* Vol. 40 (1814).

A

B

C

Figure 18
Printed illustrations of plants with medicinal value: A. Citron tree, *Citrus medica*, B. Mallow, *Malva arborea*, and C. Cotton, *Bombax*, by Elizabeth Blackwell, *A Curious Herbal* Vol. I (1737-1739).

Digital Flower Structures

Background

National Curriculum link
Reproduction: *reproduction in plants, including flower structure*

Learning objective
To develop an understanding of the structures found in flowers.

Preparation time
10 minutes

Running time
2 hours

Prior understanding
Students should have a basic understanding of the different structures found in a flower.

Key words
Stigma
Anther
Nectar
Pollen
Stamen

Context
Flowers are reproductive organs that plants must develop to enable male sex cells to meet female sex cells. An understanding of the structures found in flowers is crucial in enabling scientists to compare reproduction between different plants, and in helping to identify otherwise similar-looking species. Today, the use of photography can be highly advantageous in assisting with identification. Niki Simpson, a Linnean Society Fellow, creates accurate botanical images using digital photographs that can be viewed on printed paper as well as on screen (Figure 19).

Facing page
Niki Simpson, a Linnean Society Fellow, uses digital photographs to create accurate botanical illustrations which can be viewed printed on paper as well as enlarged on screen (Figure 19).

Activity

Activity type
Main activity

Equipment required
- Phone camera or camera
- Printer
- A3 plain white paper
- Ruler for measuring flower structures
- Flowering stems of large flowers (rose or poppy as these are easier to photograph)
- Glue
- Basic dissection kits

Ask your students, in groups, to use Niki Simpson's work (Figure 19) for inspiration to create their own poster of all the structures found in a flower.

1 Select a large flower, such as a rose or poppy.

2 Closely observe the flower to locate and identify the following structures: stigma, anther, pollen, nectary, stamen, sepal, petals, leaves.

3 Photograph the whole flower on the stem in a natural position against a white background, e.g. stand it up in a vase in front of a white wall, or a wall covered in white paper.

4 Carefully dissect the flower and separate out all the different structures.

5 Photograph each individual flower structure against a white background. Avoid shadowing by working in a bright room away from direct light.

6 Print out images that best represent the flower's structures.

7 Cut them out, arrange them onto a poster and then glue them down.

8 Label each part of the flower's structures as highlighted in the key in Figure 19, then title the page with the species name and the date the specimen was collected.

9 To take the activity further, ask students to identify the rest of the structures as labelled in Figure 19.

Digital Flower Structures

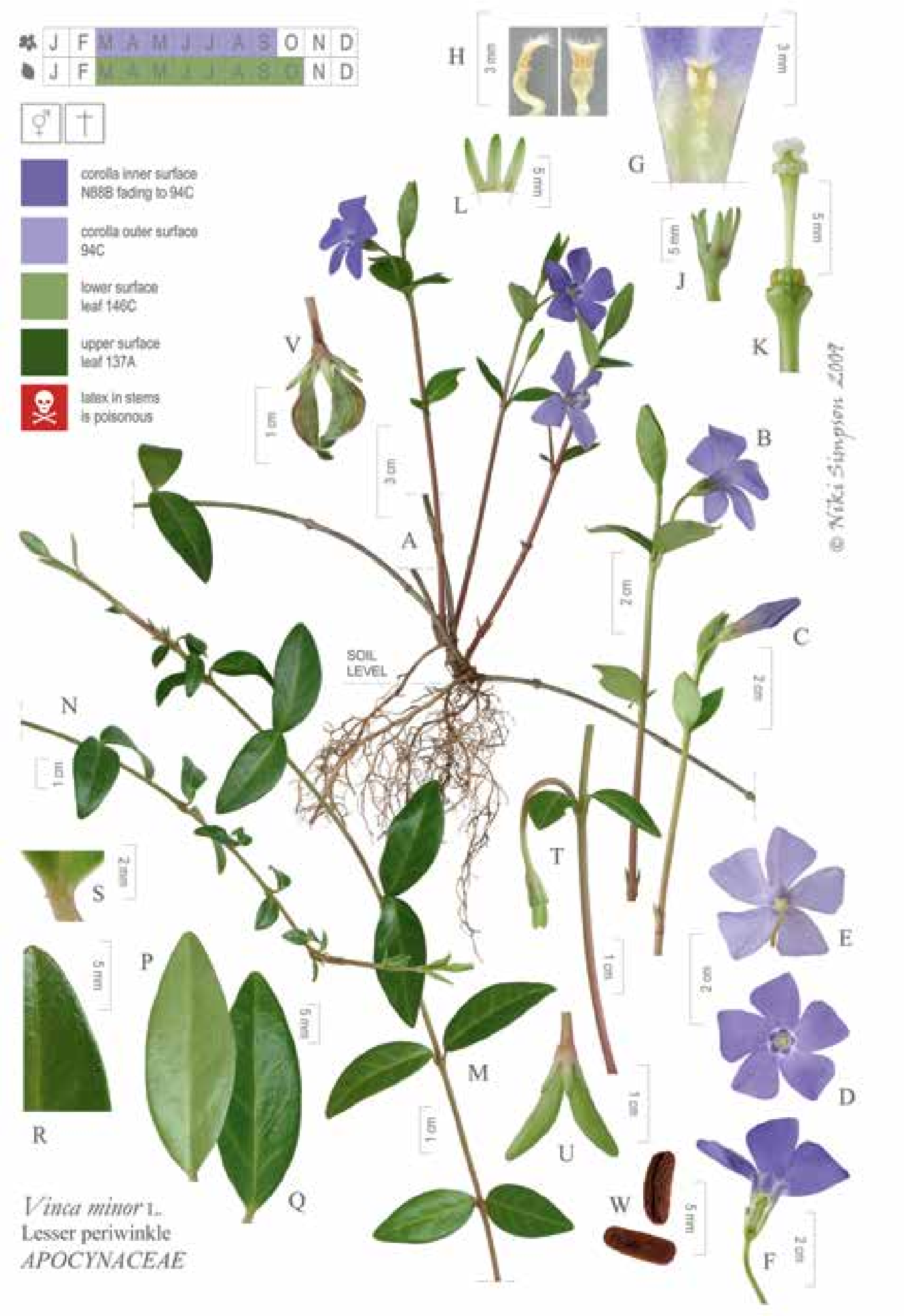


Figure 19
An example of a digitally produced botanical image by Niki Simpson (Fellow of The Linnean Society of London).

Periwinkle, *Vinca minor*
A. flowering plant, B. upright flowering stem, C. flowering stem with bud, D. flower seen from above, E. flower seen from below, F. vertical section through a flower, G. attachment of a single stamen, towards the base of flower where the petals are joined to form a tube, H. 2 views of a stamen, with the anther at the tip, J. calyx made up of sepals, K. female part of the flower, showing stigma at top of style and 2 nectaries at the base, L. portion of the calyx opened out showing 3 sepals, M. arching non-flowering shoot showing paired arrangement of leaves, N. spreading shoot showing point of rooting, P. lower surface of leaf, Q. upper surface of leaf, R: leaf tip and leaf edge, S. leaf stalk with tiny glands, T. portion of upright stem with developing fruit, U. developing fruit, V. ripe fruit having split open and released the seeds, W. 2 seeds.

Seed Dispersal Map

Background

National Curriculum link
Reproduction:
seed and fruit dispersal

Learning objective
To understand the different methods of seed dispersal.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of the difference between fruit and seeds, and should have a basic knowledge of the mechanisms of seed dispersal.

Key words
Seed dispersal
Dispersal mechanisms

Context:
Seeds are dispersed away from the parent plant in order to reduce competition for resources between the parent and their offspring, and between siblings. The dispersal of seeds also assists with the propagation of the parent plant's genes over a greater area.

Facing page
Coconut tree, *Cocos nucifera*, from Köhler Franz Eugen, *Medicinal Plants in Nature-Loving Illustrations with brief Explanatory Text* (1887-1898).

Seed Dispersal Map

Activity

Activity type
Main activity

Equipment required
- A3 plain white paper
- Art materials

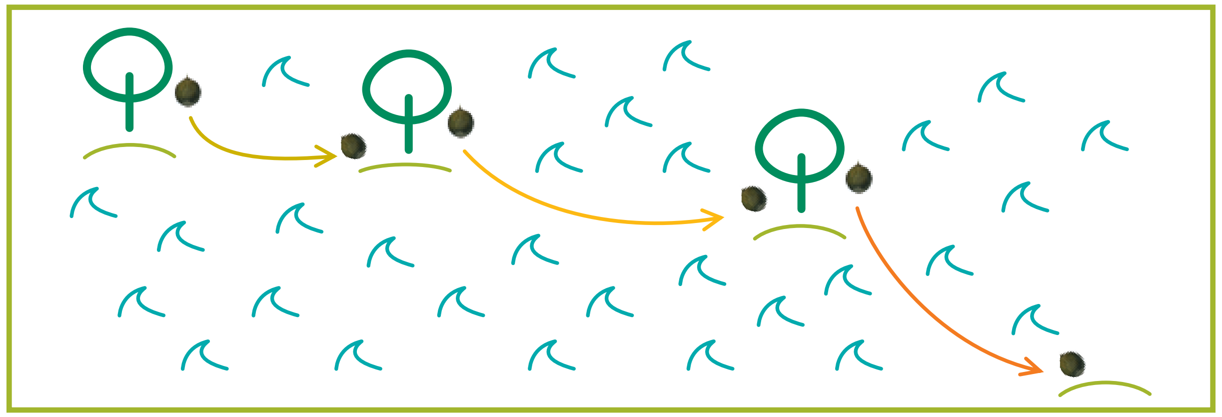
1. Students should each select a seed from the table provided (Figure 20). They should then complete the *Seed Key* section of their seed dispersal map (Figure 21 A and B), designing their own symbol to represent their chosen seed.
2. Using the *Landscape Key* section of their seed dispersal map, each student should draw out a landscape on the template provided, making sure to clearly show the location of the parent plant. Extra symbols can be created to represent additional environmental features, but these should also be included in the map's landscape key.
3. Students should then pass their map to another member of their group.
4. Next, on their new map, each student should show how seeds from the parent plant will disperse across the landscape over 3 years, using a different colour for each year.
5. Lastly, to check for understanding, each student should present their map in order to explain why their seed dispersed in the way that it did.

Figure 20
Seed dispersal methods.

Dispersal method	Description of fruit and their seed	Range	Example
Self-propelled	Water pressure in the seed pod walls builds up causing them to burst when touched, resulting in them spraying out small, lightweight, smooth seeds.	Short distance	*Impatiens*
Animals or humans (internally)	An indigestible seed contained within an attractive looking and tasting fruit that will be eaten by an animal or human. As the seed is indigestible it passes through the animal.	Distance limited by range of animal or human	Blackberries
Animals or humans (externally)	A lightweight fruit that has an adhesive surface (hooks, spines, barbs or mucus) in which the seed sits.	Distance limited by range of animal or human	Goosegrass
Wind	Lightweight parachute-like fruit to which the seed is attached.	Long distance	Dandelion
Water	The coconut seed is encased in a durable, strong and waterproof fruit that is adapted to floating long distances in water.	Long distance	Coconut

Seed Dispersal Map

A



Landscape Key

Land
Wind
Sea
River
Mountains
Canyon
Parent plant
Year 1
Year 2
Year 3

Seed Key

Seed name: Coconut
Dispersal method: Water
Seed symbol

B

Landscape Key

Land
Wind
Sea
River
Mountains
Canyon
Parent plant
Year 1
Year 2
Year 3

Seed Key

Seed name
Dispersal method
Seed symbol

Figure 21
A. An example of a seed dispersal map. B. Template for creating a seed dispersal map.

Floral Pattern Pollination

Background

National Curriculum link
Reproduction:
reproduction in plants, including flower structure, wind and insect pollination

Learning objective
To understand the features of wind- and insect-pollinated flowers.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of the parts of the plant involved in reproduction. They should also have a basic understanding of pollination.

Key words
Pollination
Stigma
Anther
Nectar
Pollen

Context
Pollination is the movement of pollen grains from the anther of one flower to the stigma of another. Flowers have evolved different structural adaptations depending on whether pollination occurs via the movement of insects or wind (Figure 22).

Facing page
Elephant apple, *Dillenia indica,* from James Edward Smith, *Exotic Botany* (1804).

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- Tracing paper
- Scissors
- Sticky tape

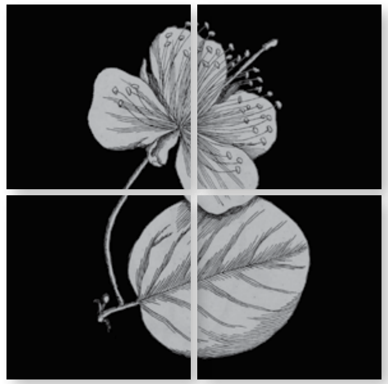
Ask your students to illustrate their own insect- or wind-pollinated flower and then turn it into a floral pattern (see the instructions on the facing page).

To take this activity further, choose the best illustrated flowers, photocopy them, and then give them back to students to organise into two different piles; wind-pollinated and insect-pollinated.

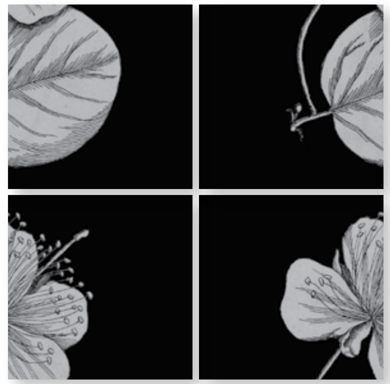
Figure 22
Anatomical descriptions of insect- and wind-pollinated flowers.

Insect-pollinated	Wind-pollinated
Large colourful petals	Small dull petals
Sweet scent	Not scented
Contains nectar	No nectar
Few pollen grains	Many pollen grains
Sticky or spiky pollen	Light and smooth pollen
Firm anthers inside the flower	Floppy anthers that hang outside the flower
Stigma inside the flower	Stigma hangs outside the flower
Sticky stigma	Feathery or net-like stigma

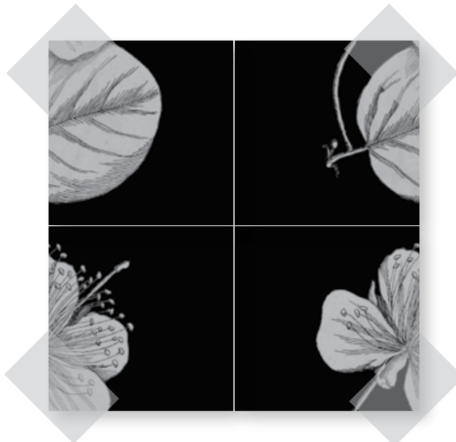
1 Create a simple line drawing of either an insect- or a wind-pollinated flower.



2 To turn the line drawing into a floral pattern, cut the drawing into four equal parts.



3 Move each quarter of the drawing to its opposite corner.



4 To create a floral design template, use clear sticky tape to fix the squares into their new positions.

5 Place tracing paper on top of the floral design template and draw over the lines. Next, place the template either directly next to, above, or below the first tracing and trace the floral design again. Moving the floral design and making traces should be repeated until the desired size of the floral pattern is achieved.

Typographical Pollinators

Background

National Curriculum link
Reproduction: *reproduction in plants, insect pollination*

Learning objective
To understand that there are many different pollinators, of which some are more effective than others.

Preparation time
10 minutes

Running time
50 minutes

Prior understanding
Students should have an understanding of the physical structures of insects that allow them to be effective pollinators.

Key words
Pollination

Context
Pollinators are crucial for food security as their activity pollinates plants, which in turn produce fruit and vegetables that all humans depend upon to survive. Most pollination occurs through insect pollinators such as bees, wasps, ants, flies, butterflies, moths and flower beetles. These pollinators vary in their effectiveness at transferring pollen from the anther of one flower to the stigma of another. Pollinator effectiveness depends on multiple factors, most notably the ability to fly, attachment points for pollen, and the number of flowers visited over its given lifespan.

Facing page
Typographical art of a stag beetle, *Lucanus cervus*, by Beth Aucott.

Activity

Activity type
Main activity

Equipment required
- A4 plain white paper
- Art materials
- Computer room

Ask your students to work out which of the specimens (Figure 23) is the most effective pollinator.

1 Students should select two specimens from Figure 23 (A-D) and compare their body structures. They should create notes describing any similarities and differences.

2 Next, students should use their comparisons to choose the most effective pollinator from their two specimens.

3 Lastly, students should create a piece of typographical art for their chosen specimen using the words they wrote down to describe it.

Right
Bees from Christian Godofredi Ehrenberg, *Symbolae Physicae* (1828-1900).

Typographical Pollinators

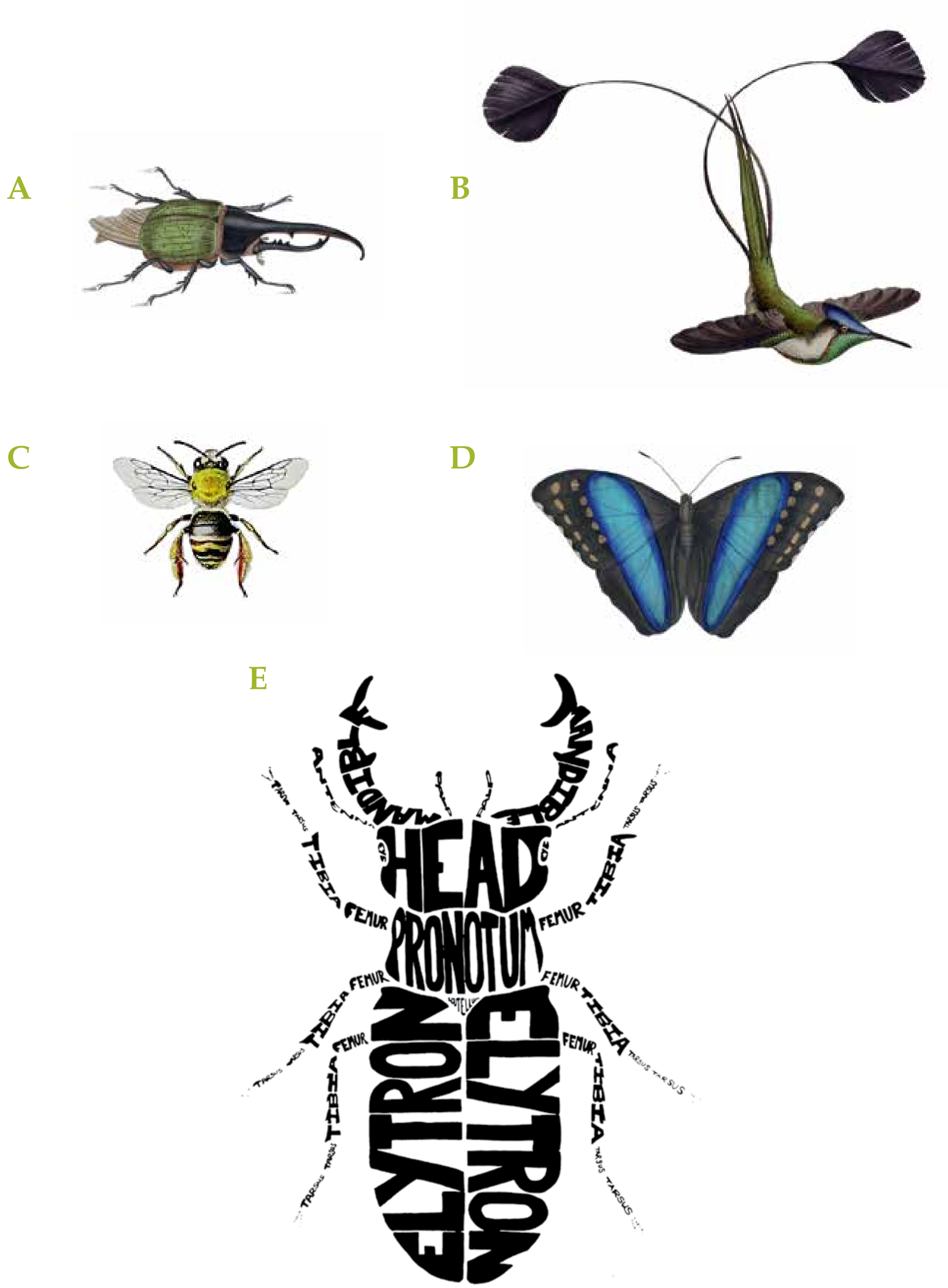


Figure 23
Examples of pollinators: A. Hercules beetle, *Dynastes hercules*, B. Hummingbird, *Mellisuga mirabilis*, C. Bee, *Eucera helvola*, D. Great blue-banded butterfly, *Morpho achilles*, and E. typographical art of a stag beetle, *Lucanus cervus*, by Beth Aucott. Images from: A. and D. George Shaw and Frederick Nodder, *The Naturalist's Miscellany* (1790); B. George Robert Gray, *Genera of Birds* (1844-1849); C. William Forsell Kirby, *List of Hymenoptera* (1882).

Food Web Builder

Background

National Curriculum link
Relationships in an ecosystem: *the interdependence of organisms in an ecosystem, including food webs and food chains*

Learning objective
To understand food webs and give an example of a food chain.

Preparation time
10 minutes

Running time
30 minutes

Prior understanding
Students should have a basic understanding of what different animals eat.

Key words
Producer
Predator
Primary consumer
Secondary consumer
Tertiary consumer

Context
A food chain describes a linear pathway of the feeding relationships between different organisms. A food chain begins with a producer and ends with an apex predator. A food web describes the feeding relationships between several different food chains.

Facing page
Lioness, *Panthera leo*, from Etienne Geoffroy Saint-Hilaire, Frédéric Cuvier, *Histoire Naturelle des Mammifères* (1824).

Activity

Activity type
Starter activity

Equipment required
- A4 plain white paper
- Art materials
- Computer room

Ask your students to see how many food chains they can make by using the Food Web Builder (Figure 24).

1. Students should start by selecting an organism (plant or animal) and drawing this in the centre circle of the Food Web Builder.
2. Next, students should draw organisms in the surrounding circles that are directly consumed by, or are consumers of, the organism in the centre.
3. Students should include arrows that represent the flow of energy.
4. To take this activity further, students should cut out each of the organisms from their Food Web Builders and then reorganise these to create one large food web for the entire class.

Below
North Atlantic right whale, *Eubalaena glacialis*, from Frédéric Cuvier, *The Natural History of Cetaceans* (1836).

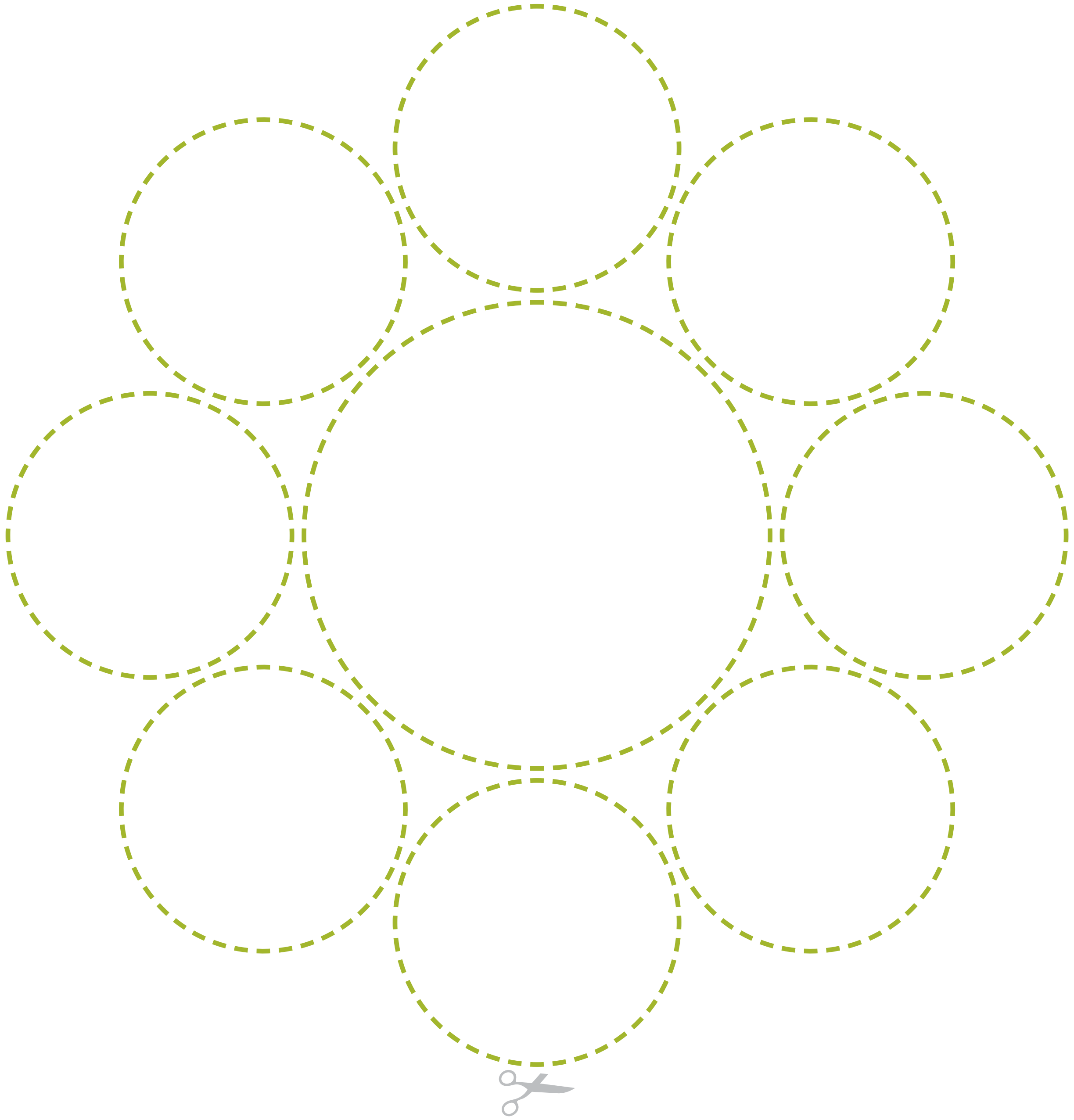


Figure 24
Food Web Builder template.

Crib Sheet

Artist's Study of Heredity
Students should have addressed each of the main points given.

Paradoxical Natural Selection
Students should have commented on how their paradoxical animal's characteristics might aid its survival.

Dog Whelk Variation
Students' sketches should have depicted the shell getting smoother the closer it gets to the maximum amount of wave exposure, and rougher the closer it gets to the minimum amount of wave exposure.

Beak Variation
A. Insects
B. Nectar
C. Fish
D. Small Mammals
E. Generalist

Classification Jigsaw Puzzle
A. Wildebeest, *Connochaetes taurinus*
B. Wombat, *Lasiorhinus krefftii*
C. Hyena, *Hyaena hyaena*
D. Baboon, *Papio anubis*

Phylogenetic Tree
Students should have labelled all five kingdoms and correctly given five species examples for a minimum of three kingdoms.

Advertising Changes in the Environment
Students should have included at least one accurate reason as to why people should be concerned with the protection of habitats for the conservation of endangered species. Students should also be awarded marks for using real-life examples of endangered species and environments.

Recording Biodiversity
Students should have included their own data for all of the information points indicated in point 2.

Tracing Algae Surface Area
Students should have taken the correct steps to work out the surface area to volume ratio. Students should also have given one accurate reason for algae's large surface area to volume ratio, e.g. a large surface area increases the rate of diffusion of gases both in and out of the algae, and therefore allows for more effective photosynthesis to occur.

Leaf Colouring
Students must have accurately coloured their chosen plant, paying particular attention to the different shades of green that various plant structures have depending on their functionality for photosynthesis.

Digital Flower Structures
Students should be assessed on the number of structures that they have clearly represented and accurately labelled.

Facing page
Crab, *Epialtus marginatus,* illustrated by John Obadiah Westwood, *Transactions of the Zoological Society of London* (1835).

Crib sheet

Seed Dispersal Map
Students' maps must have taken into consideration the effects that seed morphology, dispersal method and physical barriers will have on how far their seed will travel.

Floral Pattern Pollination
Students' floral pattern design drawings should have included sufficient detail from the anatomical descriptions (Figure 22) to make it distinguishable as either a wind- or insect-pollinated flower.

Typographical Pollinators
Students should have created a piece of typographical art for the most effective pollinator from their chosen two insects, using its physical attributes that they have described. From the most to the least effective pollinator, the examples given are ordered in the following way:

C. Bee, *Eucera helvola*
B. Hummingbird, *Mellisuga mirabilis*
D. Great blue-banded butterfly, *Morpho achilles*
A. Hercules beetle, *Dynastes hercules*

Food Web Builder
Students' food chains should be accurate.

Competition entry from Greenford High School, Southall, London