



Fusion 3: B2.1 – Sorting and identifying		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: Why we sort living organisms into groups. What features are used in identification keys. How to use an identification key.	Teaching / Learning activities Lesson structure Starter – Plastic animal sort out Divide the pupils into small groups and give each group a handful of small plastic toy animals. Get the pupils to sort them into groups in any way they care to, although you should specify that they must have a valid stated reason for placing an organism into one of their groups and must write it onto a slip of paper to place beside the animals. When sorting has taken place, the pupils can rotate around each other's displays of animals and compare notes. Draw the class together again and discuss the groupings and the reasons for them. Seek out opinions as to whether some ways of sorting are more useful than others. (5–10 mins) Main After establishing that knowledge needs to be organised in order to be intelligible, emphasise the need for clear criteria in order to aid the process of organisation and subsequent identification process. Carry out a 'Whodunit?' investigation, using the fingerprint information in the pupil book. Using PowerPoint slides, set up an imaginary crime scene, victim and suspects. Provide the pupils with a worksheet containing a brief summary of events and three sets of entire fingerprints, one from each suspect, together with a partial fingerprint taken from the scene of the crime. Pupils should be given some time to consider the evidence and then decide which of the suspects is the guilty one, giving their reasons. Have a slide on the PowerPoint where the fingerprint from the scene of the crime floats successively over the suspects' ones until a clear match is shown. Using keys: Use the keys and pictures in the pupil book to identify the leaves and garden birds illustrated. This exercise can be carried out in a similar manner to that set out above (i.e. select a pupil to leave the room and then let the class pick a bird or a leaf for the pupil to identify), or worked through in groups. Repeat with a key to unfamiliar material, such as seaweed species. Some good keys to specific groups of organisms are produced by the Field Studies Council. Get the pupils to devise their own keys for subjects and objects that interest them, such as football team strips, pop stars, types of cars etc. They can try out their keys on each other, in small groups and then as a class. Get them to evaluate which features make the most successful keys. Plenary - Lost keys? Get the pupils to imagine a supermarket where the goods were not organised in any way, but were placed randomly on the shelves. Ask: 'What problems would people encounter without a system of organisation for types of goods?' In pairs, get the pupils to think of another example of the importance of organising knowledge and imagine the consequences of losing that system of organisation. (10–15 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Using the key to the garden birds, photocopy pictures of the birds and the separate features of the key. Get the pupils to link the features with the pictures. • Extension. Ask the pupils to devise a key which would enable a new teacher to identify any member of the class. • Learning styles. <i>Visual:</i> Using keys for identification. <i>Auditory:</i> Listening to criteria used to classify animals <i>Kinaesthetic:</i> Sorting animals into groups. <i>Interpersonal:</i> Working together to make a key. <i>Intrapersonal:</i> Devising a key for a group of objects. • Homework. Pupils to produce their own key for a subject that interests them. This could be started in the lesson, as suggested above, and then finished for homework.
Learning Outcomes <i>All pupils should be able to sort living organisms into their major groups.</i> <i>Most pupils should be able to use simple identification keys.</i> <i>Some pupils should also be able to select features which could be used in an identification key.</i>	Additional teachers notes Equipment and materials required Plastic animals, Lots of photocopied pictures of animals.	



Fusion 3: B2.2 – Putting living things into groups		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: What is meant by the terms 'species' and 'hybrid'? That living organisms are classified into five main groups called kingdoms. How the kingdoms are subdivided into smaller groups.	Teaching / Learning activities Lesson structure Starter - When is a dog not a dog? Get the pupils to write down the names of pairs of types of dogs which are very different from each other e.g. Chihuahua and Great Dane. Say you are going to choose some pupils to give their examples and do so. Share the recent true story of a shaved lamb being sold for a large amount of money in Japan, as it was taken to be a rare and expensive type of dog (probably a Bedlington!). The lamb definitely wasn't a dog but looked like one, and many dogs look very different indeed from each other. What makes a dog a dog? Discuss in small groups and feed back to the class, leading into the main lesson. (5–10 mins) Main Show the pupils a plastic model of a lion and one of a tiger. Tell the class that it is possible for a lion and tiger to mate. From the internet, show the pupils a picture of a Liger or Tigrion and ask why we don't often see these in zoos. Establish that they are closely related and can produce offspring, but that the offspring are sterile. Repeat the example this time with a horse and a mule. Introduce the concept of a species and get the pupils to write down the definition of a species from the pupil text. Remind the pupils of the previous lesson and the need for a system of classification. Introduce the pupils to the work of Linnaeus and the conventions of nomenclature, such as capitalisation of genus name, lower case species name and use of italics or underlining. Explain that the organisation of Linnaeus's taxonomy is hierarchical in nature. Show the pupils a video or PowerPoint, if available, of the five kingdoms and give the pupils a blank writing frame in which to enter the names and some features of the groups. As an alternative to the video or PowerPoint, liaise with the library to have sets of books referring to the different kingdoms and split the class to carry out text-based research and collectively report on features and examples of the kingdom they have studied to share with the rest of the class. Carry out the 'Sorting and describing' activity described in the pupil book. This activity can be done in small groups or individually. It could also be set as a homework exercise. Plenary - Spot the blots Give the pupils a sheet with a messed-up version of the notes from the lesson or definitions of terms such as 'key', 'species', 'hybrid' and 'kingdom'. Explain that someone wrote this and got loads of it wrong, and that your job is to spot the blots and to put them right. (5 – 10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Write the separate words of the definitions on cards and get the pupils to arrange these in the correct order. • Extension. Get the pupils to research the names of the taxonomic levels in order i.e. kingdom, phylum, class, order, family, genus and species. • Learning styles Visual: Viewing PowerPoint presentation or video. Auditory: Listening to an explanation of Linnaeus' system of classification. Kinaesthetic: Carrying out the 'Sorting and describing' activity. Interpersonal: Discussing in the starter and in the main lesson. Intrapersonal: Making their own notes on the five kingdoms. • Homework. Pupils could do their own research, using the internet and/or libraries, to find out about as many hybrids as they can (at least three). Some have been mentioned in the lesson, but there are others.
Learning Outcomes <i>All pupils should be able to</i> define a species and describe the main features of each of the five kingdoms. <i>Most pupils should be able to</i> describe how a hybrid is formed and understand the need for a universal system of classification. <i>Some pupils should also be able to</i> explain the hierarchical nature of classification.	Additional teachers notes Equipment and materials required Animal pictures and models. Safety	



Fusion 3: B2.3 - Vertebrates		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: The characteristic features of vertebrates. The names of the major groups of vertebrates. How vertebrates are classified into their groups.	Teaching / Learning activities Lesson structure Starter - Odd one out Show the pupils pictures of five vertebrates (one of each type) and an invertebrate. Ask them to write down the features some of these organisms share and then to identify which is the odd one out and why this is so. Discuss the class findings, acknowledging and valuing all sensible suggestions, whether they fit with the currently accepted scientific classification system or not. Move on from this to the main lesson, looking at the main features of vertebrates. (5–10 mins) Main Have available from the library a set of several books relating to each of the types of vertebrate. Divide the class into five groups of about five or six pupils. Explain that each group is going to produce a poster based on one of the types. Give each group a large A2 sheet of coloured sugar paper, some plain white A3, some lined A4, glue, scissors and colouring materials. Having internet access can also be very valuable, so some of the pupils can be given access on a rota basis to select and print out appropriate material. A section can usually be set up on the school intranet, with appropriate web pages on it, to speed up the process and avoid distraction. Give the pupils a specific set of targets to hit when producing the poster, e.g. they must have at least three named examples, they must have a section on the features which are used to categorise them as belonging to this type, they must have illustrations and be clearly legible, and so on. On completion of the exercise, the pupils are then to go around the other groups' work and assess their sheets against the same specific target sheet they were given. Encourage constructive criticism and the use of praise. As a piece of bookwork, give the pupils a pre-printed grid with five rows (labelled 'fish', 'amphibians', 'reptiles', 'birds' and 'mammals') and four columns (labelled 'reproduction', 'gas exchange', 'skin' and 'body temperature'). Pupils should then use the information from the posters, the discussion and the pupil text to fill in the table. On completion, go over the correct answers. Plenary - The tricky ones Divide the pupils into groups of about four or five and give them each a sheet of pictures and details of some of the vertebrates which are the more difficult to identify and those that are most commonly placed in the wrong groups. This should include penguins, whales and dolphins, snakes (pupils often think they don't have a backbone at all) and bats. As an interesting exception, show photographs of the duck-billed platypus. Mention that, as well as being an egg laying mammal, it has poisonous thumb spikes. Get the pupils to try to identify which groups the various animals belong to. They should write them on their photo sheets with reasons, then swap the sheets between groups to gain consensus. (10–15 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Make an enlarged version of the pre-printed grid and give pupils cards with the relevant features written on them, so that they can complete the grid of features for the groups of vertebrates. • Extension. Using the features of the different groups and the basic principles involved in a good key, ask the pupils to devise a key which can be used to identify which group a vertebrate belongs to. • Learning styles Visual: Looking at vertebrae and features of vertebrates. Auditory: Listening to the exposition on the features of the different groups. Kinaesthetic: Producing a poster on the different types of vertebrate. Interpersonal: Working within a group in the starter 'Odd one out'. Intrapersonal: Carrying out the word exercise on the advantages of being a vertebrate. • Homework. Get the pupils to carry out a limited word exercise, where they summarise the advantages of being a vertebrate in 10 words only. This can be extended to similar summaries of the advantages of being a fish, an amphibian, a reptile, a bird or a mammal.
Learning Outcomes <i>All pupils should be able to describe the characteristic features of vertebrates and name the five major groups.</i> <i>Most pupils should be able to describe the features of each major group of vertebrates.</i> <i>Some pupils should also be able to describe/explain similarities and differences between the different groups of vertebrates.</i>	Additional teachers notes Equipment and materials required Each group: a large A2 sheet of coloured sugar paper, some plain white A3, some lined A4, glue, scissors and colouring materials. Having internet access can also be very valuable.	



Fusion 3: B2.4 - Invertebrates		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: The meaning of the term 'invertebrate'. The names and characteristic features of the major groups of invertebrates. How to sort the invertebrates into groups.	Teaching / Learning activities Lesson structure Starter - Spine or no spine? Using projected images, show the pupils a number of organisms, including about equal numbers of ones which have a spine and ones which do not. Make it clear that when we mention a spine, we are referring to a spinal column of connected vertebrae, not a spine as in a spike or thorny structure. Get the pupils to note down which they think have spines and which do not. On completion, go over the pictures again and decide as a group which have spines and which do not. Some X-ray exposures of problem cases, such as snakes, may make some minds up. Introduce, or remind the pupils of, the word 'invertebrates'. Start to guide the conversation towards how the invertebrates could be broken up into smaller groups. (10–15 mins) Main Using PowerPoint, give the pupils an illustrated overview of the invertebrates, showing representatives of all the groups, giving them the correct names. Then, separate the arthropods from the rest and sub-divide them into their four sub sections of insects, crustaceans, arachnids and myriapods. Explain that the sub-divisions of Arthropoda depend on the number of legs (6 for insects, 8 for arachnids, 10–14 for crustaceans and lots of pairs for myriapods). There is some very engaging video footage of parasites, such as roundworms and flatworms, available, such as on the BBC's series 'Animal Planet'. Classifying invertebrates: Carry out the activity described in the pupil book. This could be modified by supplying the pupils with photocopied pictures of invertebrates for them to use for their presentation. This activity can either be done individually or in small groups. Plenary - Grid fill Give each pupil an empty grid with the names of the different type of organism they have been studying in the rows and their characteristic features in the columns. Get them to fill in the table. As differentiation, have some lists of types of organism and of features, and have some with some initial letters filled in for the lower attaining. (5–10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Extension. Invertebrates may be terrestrial or aquatic. Pupils could find out how the land living members of a major group or sub-group differ from the aquatic ones. Good groups to investigate would be molluscs, annelids or arthropods. • Learning styles Visual: Viewing the illustrations of the different types of invertebrate. Auditory: Listening to the opinions of others in activities. Kinaesthetic: Carrying out the activity 'Classifying invertebrates' or pond dipping. Interpersonal: Working as a team in research activity. Intrapersonal: Reflecting on the importance of classification. • Homework. The 'Classifying invertebrates' activity could be done as a homework exercise.
Learning Outcomes <i>All pupils should be able to explain what an invertebrate is and name the major groups of invertebrates.</i> <i>Most pupils should be able to describe the characteristic features of the major groups of invertebrates.</i> <i>Some pupils should also be able to use branching diagrams and Venn diagrams to classify the major groups.</i>	Additional teachers notes Equipment and materials required Books and the internet; pictures of invertebrates and a large sheet of paper each for the presentation.	



Fusion 3: B2.5 - Plants		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: The characteristics of plants. The names of the major groups of the plant kingdom. How plants are classified into groups.	Teaching / Learning activities Lesson structure Starter - Mouthless in the sunshine Show the pupils a series of images of a range of organisms and ask them if they have a mouth or not. Get them to respond by writing a 'Y' for 'Yes' or an 'N' for 'No' on an individual whiteboard (or any other suitable method of response). For the ones which get a 'No', ask what would happen to them if they were in total darkness. Plants are the ones which have no mouth and need light to survive. (5–10 mins) Main In advance, around the room, set up a display of plants from the different taxonomic groups (but not yet labelled as such). These should be identified by cards with letters on them. Get the pupils to circulate around the laboratory and fill in a work sheet, where they describe the plant as best they can, naming it if possible. At the start of the activity, select a plant as an example and carry out a descriptive exercise to show the pupils the kind of observations they should make. When everyone has had a chance to circulate and make their observations, pool the observations and comment on them. Ask the pupils if they if they can suggest any groupings. Discuss the importance of having a single internationally agreed system of classification. Classifying plants: Carry out the activity suggested in the pupil book. The pictures in the book can be supplemented with additional pictures. Use could be made of the scheme shown in the pupil book, adding pictures to the descriptions given in the boxes for each group. If available, show some video footage of the various types of plant as well as having specimens. Chris Beardshaw covered a lot of the ancient plant types in his 'Flying gardener' TV series. For a good website try searching for 'Plants of Jurassic Park'. Plenary - Key word splat Place all of the key words from the lesson on a board at the front of the class. Give two volunteer pupils fly-swats of different colours and, when asked a question relating to the material, have them whack the correct key word on the board. Whoever gets their swat down first on the correct answer wins and stays on. The loser chooses the next contestant. (10–15 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Using the scheme in the pupil book, give pupils the names of the groups, some small pictures and some of the characteristic features on cards and get them to make their own charts or a poster. • Extension. Using reference books and the internet, pupils could research one of the lesser known groups, such as the mosses, liverworts or ferns. • Learning styles Visual: Viewing images of the different types of plant and their characteristics. Auditory: Listening to other pupils' ideas about 'What is a plant?'. Interpersonal: Sorting out plants in pairs. • Homework. Plants are useful to humans in many ways. Pupils could either make a list with examples, as suggested in the pupil book, or investigate one aspect, such as building materials, finding out more details and presenting their findings as a written account.
Learning Outcomes <i>All pupils should be able to describe the characteristics of plants and name the major groups.</i> <i>Most pupils should be able to describe the characteristics of the major groups of plants.</i> <i>Some pupils should also be able to classify plants into their groups.</i> How Science Works Communicate effectively and use appropriate scientific terminology and conventions in discussion and written work. (1.1c)	Additional teachers notes Equipment and materials required Pictures and living specimens of the different plant types; need leaves, fruits, flowers as appropriate.	



Fusion 3: B2.6 - Variation		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: Why we look similar to our parents. What is meant by inherited and environmental variation? The differences between continuous and discontinuous variation.	Teaching / Learning activities Lesson structure Starter - Difference list Give the pupils a short, set time limit (decide this on the ability of the particular class). Working in pairs, get each pupil to make a list of ways in which they differ from each other. Establish that these must be physical differences, such as hair colour, ear shape, eye colour or height, and draw lines of decency on the allowable comments. At the end of the time limit, nominate a pair of scribes to write the ideas down on the board and, through questioning, draw out the various differences. (5–10 mins) Main Draw out the meanings of the words 'inherited' (link this to inheriting money or property from deceased relatives) and 'environmental' (link to environmental action groups). Get the pupils to write down the meanings in their books. Measuring variation: Investigate the range of variation of pupils in the class by carrying out the activity suggested in the pupil book. Arrange a circus of apparatus around the room to measure different types of variation, being aware that some pupils may be sensitive about personal data. The circus could include several of each of the following: Height stations: Ideally use proper height determination apparatus, otherwise use pairs of metre rulers, end on end, Blu-tacked to the wall. Show the pupils how to use these by placing a ruler horizontal across the head of a pupil and having them walk away. Weight stations: Use several sets of bathroom scales. Some pupils may feel self conscious about their weight and so make this measurement optional. Strength stations: Have several sets of bathroom-type scales, but with the scale in newtons. Demonstrate to the pupils how to squeeze the scales with both hands. Have a companion read their highest continuously held force (hold for a count to 3 if there is argument). Various body part measurements such as head circumference, arm length can be carried out using tape measures. Body temperature can be most easily quickly and hygienically measured using liquid crystal forehead thermometers. Eye colour can be assessed by peer opinion. Some anomalies may arise so the teacher may have to discern between different types or produce a pre-prepared colour chart. Quinine tasting: Some pupils may lack the gene which allows them to taste quinine. Have a supply of quinine impregnated slips of filter paper and get pupils to place one on their tongue. Draw the group together again and discuss the findings. Plenary - I, E, C or D? Give the pupils a set of 'Show me' individual white boards. Show some slides of different examples of variation, or alternatively just describe them. Get the pupils to decide whether they are inherited, environmental, continuous or discontinuous and write the initial letters of the appropriate word or words on their boards. (5–10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Give pupils definitions of the key words as sentences with gaps, into which they have to put the correct term. • Extension. Pupils could use height ranges, as suggested in the pupil book, and produce a normal distribution curve for the class. • Learning styles Visual: Making observations. Auditory: Listening to the explanations and definitions. Kinaesthetic: Measuring the variation. Interpersonal: Working in a group gathering data. Intrapersonal: Writing out the meanings of the terms. • Homework. Each pupil is to choose one of the physical features which shows continuous variation (height, mass, strength or body part size) and design an investigation which would accurately reflect the variation in their year group.
Learning Outcomes <i>All pupils should be able to understand why we look similar to our parents and what is meant by inherited variation.</i> <i>Most pupils should be able to distinguish between inherited and environmental variation.</i> <i>Some pupils should also be able to explain the differences between continuous and discontinuous variation.</i> How Science Works Explain how the presentation of experimental results through the routine use of tables, charts and line graphs makes it easier to see patterns and trends. (1.2d)		Additional teachers notes Equipment and materials required Apparatus for measuring the different types of variation. Most of this is described in the notes for the lesson above.



Fusion 3: B2.7 – Genes and inheritance		
National Curriculum Link up *3.3d		
Learning Objectives Pupils should learn: What is meant by the term 'gene'? How genes are linked to inherited characteristics. How inherited characteristics are passed from parents to their offspring.	Teaching / Learning activities Lesson structure Starter - Genes means . . . ? Get the pupils to complete this sentence for themselves, either by telling a fellow pupil what their idea is, writing it down (choose some individuals to read theirs out) or by interviewing pupils using a hand-held digital voice recorder, which can quickly capture pupils' offerings to be played back to the class for discussion. Give all sensible suggestions acknowledgement (although, correct false ones by drawing out better versions) and introduce the aims of the lesson. (10–15 mins) Main Show a simple animation of meiosis, without naming the process or the stages. There should be just a few pairs of chromosomes, differently coloured and shaped. The animation should show the formation of sperm, the formation of eggs and finally the joining of the two together to form a zygote with the same number of chromosomes as the parent cells. Get the pupils to count the number of chromosomes on each cell at each stage. Get them to think what would happen if the sperm and egg cells had the same number of chromosomes as their parent cells. Show a karyotype of human chromosomes and identify that there are 46 in total, 23 pairs. Starting with a group discussion as to how different types of twins are formed, hold an 'open questions' session about inheritance, siblings and twins. It is a good idea to have previously prepared some ways of visualising the answers to expected questions, such as those in the pupil text. Twins surgery leaflet activity: The objective is to produce a leaflet for a doctor's surgery giving basic information about how twins are formed. Plenary - Scene of Crime Officer Allow the pupils to work in small groups and tell them that each group is investigating a crime scene. Ask them to compile a list of suitable genetic material from the scene that might help to identify a criminal. For each type of material, they should say what precautions they need to take to make sure that the material is not contaminated. (10–15 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Put key words and definitions from the lesson on laminated cards and get pupils to match them up. • Extension. Pupils could research the occurrence of conditions, other than Down's syndrome, that are attributed to an extra chromosome or the lack of a chromosome. There are several associated with the sex chromosomes (XXY etc.). • Learning styles Visual: Observing the animation of meiosis. Auditory: Listening to the discussion on how twins are formed. Kinaesthetic: Working at the surgery leaflet activity. Interpersonal: Co-operating in a group on the 'Scene of Crime Officer' plenary. Intrapersonal: Completing the sentence in the 'Genes means ...' starter. • Homework. In preparation for the next topic, ask the pupils to make a list of ways in which they are similar to and different from other members of their family.
Learning Outcomes <i>All pupils should be able to describe genes and know that they are responsible for inherited characteristics.</i> <i>Most pupils should be able to describe how inherited characteristics are passed from parents to their offspring.</i> <i>Some pupils should also be able to explain how we get one set of genes from each parent.</i>	Additional teachers notes Equipment and materials required Safety	



Fusion 3: B2.8 – Passing on the genes		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: What determines whether we are male or female? How we inherit a particular feature. What we can learn from looking at family trees.	Teaching / Learning activities Lesson structure Starter - Cause of gender (before) In small groups, or individually, get the pupils to write down their own ideas on what causes some babies to be born as boys and some as girls. On completion, hold a class discussion and draw out any current sets of ideas among the pupils. (10–15 mins) Main Explain that genes are sections of DNA coding for a particular characteristic. Give examples of what is meant by a characteristic. Explain that in each body cell we have two genes for each characteristic, one which came from our father and one from our mother. Explain that when we make gametes, only one characteristic is placed inside the sperm or egg, otherwise we would finish up with four copies in the fertilised egg cell. What would happen if the father has blue eyes and the mother has brown ones? Introduce the word 'alleles' as being alternative versions of a gene. Show a short animation or PowerPoint presentation to introduce the terms 'dominant' and 'recessive', where one allele dominates another one. Introduce the conventions that dominant alleles are shown by capital letters and recessive ones by lower case versions of the dominant allele letter. Working in couples, get them to write out some pairs of dominant and recessive alleles which they choose and decide on the letters themselves. Briefly get some to share with the class. Introduce Punnet squares, either by PowerPoint or by moving lettered transparencies on an OHP. Give the pupils some pre-printed empty examples, so that they don't have to waste time drawing them. Get them to go through a series of exercises completing Punnet squares for homozygous dominant vs. homozygous recessive, homozygous dominant vs. heterozygous, homozygous recessive vs. heterozygous and heterozygous vs. heterozygous. Introduce the conventions of family trees (e.g. circles for females, squares for males). Plenary - Cause of gender (after) Refer back to the class set of ideas at the start of the lesson. Hold a discussion and see which pupils have changed their minds as to the causes of gender, or who can explain it now when they couldn't at the start of the lesson. Summarise formally the cause of gender and memorise it. (5-10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Draw out a large Punnet square on a piece of thin card, make cards with different alleles on them and some with the characteristics, so that the pupils can fill in the squares for different combinations of alleles. • Extension. In addition to the determination of gender, the sex chromosomes carry genes for other characteristics. Pupils could research this and find out more about sex-linked conditions. What are the differences between the X and the Y chromosomes? Why is the Y chromosome sometimes referred to as 'genetically empty'? Learning styles Visual: Viewing family trees. Auditory: Listening to explanations of the key words and ideas. Kinaesthetic: Working out the Punnet squares. Interpersonal: Working in pairs on Punnet squares. Intrapersonal: Reflecting on the inheritance of chromosomes. <ul style="list-style-type: none"> • Homework. Pupils could draw their own eye colour family tree (beware of possible social complications). This could be broadened to include tongue rolling, dimples, dangly ear lobes, straight thumbs or any other characteristic that the individual pupils choose.
Learning Outcomes <i>All pupils should be able to describe how their gender is decided and how particular features are inherited.</i> <i>Most pupils should be able to explain the inheritance of a particular feature such as hair colour, using the correct terminology.</i> <i>Some pupils should also be able to explain how the chances of inheriting a particular characteristic are calculated.</i>		Additional teachers notes Equipment and materials required Some pre-printed Punnet squares. Safety



Fusion 3: B2.9 – Breeding animals		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: What characteristics are required in domestic animals? What is meant by selective breeding? How selective breeding can produce animals with the required characteristics.	Teaching / Learning activities Lesson structure Starter - Dogs' jobs Show the pupils pictures of half a dozen or more types of dog. Give them a list of descriptions of the jobs the dogs have to do and get them to match the type of dog to the job description. This could be either a small group task or an individual one. Hold a discussion on the findings and get the pupils to speculate as to how the dogs became suited for their various tasks over time. Lead this into the main lesson content. (10–15 mins) Main Place around the room a range of photographs of animals which have features which may have been developed or enhanced through selection. In a circus, starting at any point but all going around in the same direction, get the pupils to look at the pictures and fill in a worksheet naming the animals and describing the features which human beings would have deliberately bred into them. Give a short fixed time limit and conclude by drawing out from them the agreed selected features of the animals and speculating as to how this may have been done. Hold a 'gut responses' session where you show a picture of a highly selected animal such as the Belgian Blue cattle mentioned in the pupil text (you could point out the double buttocks – it appears to have four cheeks) and get them to discuss how they feel about this, without leading opinion. Give examples of difficulties which are associated with pedigree breeding in certain varieties of dogs, such as the hereditary hip problems, breathing and eye defects. Give the pupils 'Show me' individual white boards and get them to draw horizontal line across the centre. Put a capital 'A' (for Agree) on the left of the line and a capital 'D' (for Disagree) on the right hand end. Display or read out a number of statements concerning the benefits and ethical problems which can arise from selective breeding. Get the pupils to draw a cross on their line to show to what extent they agree or disagree with each statement. Pick on some pupils to explain their choice of position, especially those who chose extreme ends of the statement line. Plenary - Selection of the ant people Show a number of castes of ants with various features and specialists such as soldier ants, queens, workers. Get the pupils to imagine what would happen to the human race if they were artificially selected for particular purposes. Discuss this in small groups and feed-back imaginative ideas. (5–10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Pupils could be given pictures of different breeds of working dogs to match with the names of the jobs they do. This could be extended to other groups of animals, such as horses and cattle. • Extension. Pupils could draw up a flow chart to summarise the stages of the selective breeding of cattle that would increase milk production in the herds in an African country. • Learning styles Visual: Viewing the different examples of selective breeding. Auditory: Listening to the explanations of how selective breeding occurs. Kinaesthetic: Working out the selected features from the examples displayed. Interpersonal: Working together to discuss issues. Intrapersonal: Considering their own views on the ethical problems of selective breeding. • Homework. Pupils could write a short account explaining the purpose of the domestication of animals. They could be encouraged to consider why some animals, such as dogs and horses, were chosen for domestication and not others, such as bears.
Learning Outcomes <i>All pupils should be able to describe some of the characteristics required in domestic animals and how selective breeding occurs.</i> <i>Most pupils should be able to describe how to select suitable animals with the required characteristics for breeding.</i> <i>Some pupils should also be able to explain the advantages and disadvantages of selective breeding with specific examples.</i> How Science Works. Explain some issues, benefits and drawbacks of scientific developments with which they are familiar. (1.1b) See Great debates.		Additional teachers notes Equipment and materials required Safety



Fusion 3: B2.10 – Selective breeding in plants		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: What characteristics are selected for breeding in plants. How selective breeding is carried out in plants.	Teaching / Learning activities Lesson structure Starter - Cave man diet Take the pupils on an imaginary time machine trip to the Stone Age. Ask them what they would find to eat and how it would be different from their food today. Hand around some grass seeds, but do not let the pupils eat them. You could show a PowerPoint slide show giving examples of how plants have been changed by humans over the centuries. As examples, show sloes and plums, crab apples and modern varieties, ancient wheat and modern varieties. Summarise the differences in a few written sentences. (5–10 mins) Main Versatile brassicas: Bring in a range of brassica plants such as various types of cabbage, including red cabbage (cut across the grain to show its beautiful internal patterning), sprouts (on the stem if possible), kohlrabi, cauliflower (including coloured varieties and the fractal patterned Romanesque), cress, rape, broccoli and some of the more exotic brassicas. Have them arranged in a circus around the room. As an alternative, if the plants themselves are not available, use photographs. As an observation exercise, get the pupils to describe the similarities and differences between the plants and to make notes on these which they can compare with those of their peers. In his series 'Jamie at Home', the TV chef Jamie Oliver grows brassicas and demonstrates some interesting recipes using them. (If relevant, show a video of a recipe or Jamie explaining the different types, or link with Food Technology.) If your school has a greenhouse, consider carrying out some hand pollination exercises. Instead of a fine paint brush, some plant scientists use a dead bee glued to a stick to transfer the pollen from the anthers to the stigmas. (If you choose to use this method, beware of allergies and potential for adverse pupil response.) If no practical is to be carried out, some video footage of the process taking place would be appropriate here. If a computer suite or a class set of laptops is available, look on the internet for selective breeding simulation programmes. Allow the pupils to work their way through, supplying a prompt sheet if required. Plenary - The pollinator Search the Planet Science website for an interactive game called 'The pollinator'. The objective is to produce a black flower by hand pollinating a sequence of flowers with the pollen from other ones. Try this first and work out the combination of alleles, so that you can guide the pupils before the exercise becomes too time consuming. (10–15 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. There is a great deal in this lesson which is accessible to all abilities, but, if appropriate, pupils could be given pre-printed labels for pictures of the brassicas, to carry out a matching exercise. • Extension. Pupils to find out what a seed bank is. Ask: 'Why are seed banks important?' • Learning styles Visual: Viewing the slide show or circus of brassicas. Auditory: Listening to explanations of plant selection. Kinaesthetic: Carrying out the hand pollination. Interpersonal: Discussing plant selection. Intrapersonal: Describing how to set up the Competition for homework. • Homework. Pupils could write an account of how they would organise a sunflower growing (or any other vegetable) competition for a Year 7 class, making it as fair as possible and establishing the judging criteria. Height is not the only criterion – it could be suggested to them that there are other ways of assessing growth and productivity [weight of seed produced, numbers of seeds produced, diameter of flower head].
Learning Outcomes <i>All pupils should be able to describe some desirable characteristics of crops and other plants.</i> <i>Most pupils should be able to describe the principles of the selective breeding process.</i> <i>Some pupils should also be able to describe in detail and explain the process of selective breeding.</i>	Additional teachers notes Equipment and materials required Grass seeds for Cave man starter. A range of brassicas as listed in the notes. For hand pollination activity: Suitable plants with flowers, paint brushes, scalpels, polythene bags, rubber bands.	



Fusion 3: B2.11 - Evolution		
National Curriculum Link up •3.3d		
Learning Objectives Pupils should learn: About the life and work of Charles Darwin. What is meant by the term 'evolution'. How some animals, such as giraffes, have evolved. How we can use evidence to support or disprove a theory.	Teaching / Learning activities Lesson structure Starter - What's in a word? Ask the pupils to write down what they understand by the word 'evolution'. Emphasise that there is not going to be any judgement of whether their understanding agrees with the official scientific meaning of the word. Tell them that you are interested in their current understanding of the word. Ask some pupils to read out what they have written and follow this with a discussion, which then leads into the main lesson. (5–10 mins) Main Show a video summarising the work of Darwin (David Attenborough's 1998 "The Origin of Species: An Illustrated Guide" is particularly good but there are many worthy others). A set of questions, appropriate to your class, can be prepared in advance to accompany the chosen video. Flag up the keywords and their meanings as the video progresses, pausing as need be to allow the pupils to answer the questions. Pay particular attention to the evolution of beak types in the finches and relate this to the appropriate sections of the pupil text. Divide the class into groups and, using packs of large paper cut-outs with relevant phrases printed on them, get the pupils to assemble the sequence of events which result in evolution. On completion, allow the pupils to circulate and check each other's orders and to suggest corrections if necessary. It is important to establish that a large amount of time is needed for the events of evolution to occur. Get the pupils to research the evidence for evolution themselves, citing evidence from fossils, DNA as well as anatomical evidence, such as the evolution of the horse. Plenary – What's the sequence A sequencing exercise of horse precursors could be provided for pupils to reinforce the ideas in the lesson. (5 – 10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Key words and their meanings could be written on separate strips of paper, so that a matching exercise can be carried out. • Extension. Charles Darwin was not the only person to develop a theory of evolution. Pupils could research other ideas on evolution, including those of Lamarck, Aristotle, William Paley, James Hutton, Charles Lyall, Georges Cuvier, Georges-Louis Buffon and Erasmus Darwin. Any pupils interested in geology could research how influential knowledge of fossils has been to the ideas on evolution. • Learning styles Visual: Viewing the picture and videos of Charles Darwin. Auditory: Listening to the views of others in the discussions about evolution. Kinaesthetic: Assembling the sequence of events in the evolutionary process. Interpersonal: Working in a group to sort out the meaning of 'evolution'. Intrapersonal: Carrying out individual research on evolution. • Homework. Great debates: Pupils could write a short speech in favour of Darwin's theory or against it, in preparation for a debate on the subject. They should be encouraged to use as much evidence as they can in support of their views. In order to get a balanced view from the class, you could suggest that half the pupils write a speech in support of the idea and half take the opposite view.
Learning Outcomes <i>All pupils should be able to describe some of the contributions made by Charles Darwin to the theory of evolution.</i> <i>Most pupils should be able to explain how giraffes have evolved.</i> <i>Some pupils should also be able to summarise the evidence for evolution.</i> How Science Works. Use criteria to select relevant scientific data and other sources of evidence to support or negate an argument. (1.1a3) Explain how scientific evidence from a range of sources can be used to support or disprove theories. (1.1a3) See Great debates.		Additional teachers notes Equipment and materials required Safety



Fusion 3: B2.12 – Cloning and gene therapy		
National Curriculum Link up •1.2b, 3.3d		
Learning Objectives Pupils should learn: What is meant by cloning? How cloning can be carried out. How gene therapy works. The ethical issues involved in human cloning.	Teaching / Learning activities Lesson structure Starter - Cloning Using PowerPoint, establish what is meant by a clone, showing examples of organisms with identical genes. Examples could include identical twins (discuss any examples which are present in the school or known to the pupils), Spider plant runners and plants which reproduce using bulbils, such as the Mexican hat plant <i>Bryophyllum diagamontiana</i> or various species of <i>Kalanchoe</i> , a picture of Dolly the sheep. (5–10 mins) Main Cuttings activity: Pupils will have carried out a 'cuttings' practical during Year 7, but may be interested in doing another one, especially if they can use a different type of plant. If they have already taken cuttings of geraniums, try using a very attractive and varied plant, such as flame nettles (<i>Coleus</i>). Bulbils from the previously mentioned plants (Spider plant and Mexican hat plant) are also easily set up as an asexual reproduction exercise. Emphasise that some animals can carry out asexual reproduction as a method of increasing their numbers rapidly during favourable environmental conditions. Aphids are a good example. Another example is the simple aquatic organism <i>Hydra viridis</i> , which can be found in many school ponds or it can be purchased from biological supplies companies such as Blades. Other examples of asexual reproduction could include flatworms which, when their head is partially cut in two in the right way, will successfully separate. Get the pupils to carry out a bookwork or worksheet exercise to reinforce and record the coverage. This should include a table of advantages and disadvantages of using cloning. This could be finished off for homework. Discuss the ethical issues involved in the Great Debates box. Compassion in World Farming will supply free videos on GM (genetic modification) and cloning to schools. They are very well put together and have good support material, but they adopt a negative standpoint. For a positive view, the public information from the Monsanto website could be used as a counterbalance. Plenary - Copy cat On an interactive white board or on stand-alone computers, either singly or in groups, play the Flash game 'Copycat' on the Museum of Canada website (search for 'The Geeee! in Genome' then 'try it!' then 'online games'). The objective is to identify the cloned kittens from a litter using DNA analysis in a fun way. (5–10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Get the pupils to design and make a poster to show how to take successful cuttings. The pupils could be supplied with pictures and/or with text that has to be arranged in the correct order. • Extension. Using the internet and any other resources available, pupils could find out about the possibilities of gene therapy for conditions other than cystic fibrosis. • Learning styles Visual: Watching videos/PowerPoints. Auditory: Listening to the discussions on ideas about cloning. Kinaesthetic: Carrying out the 'cuttings' practical activity. Interpersonal: Working in a group in practical. Intrapersonal: Reflecting on the ethics of human cloning. • Homework. Pupils to carry out, or complete, the bookwork or worksheet exercise suggested in the main lesson. The particular emphasis here should be on the advantages and disadvantages of cloning.
Learning Outcomes <i>All pupils should be able to describe a clone, give some examples of clones and how to carry out the process.</i> <i>Most pupils should be able to explain what a clone is and to describe an example of gene therapy, listing some ethical issues involved in human cloning.</i> <i>Some pupils should also be able to explain how genetic engineering is linked to gene therapy, and produce a balanced view of the ethical issues involved in human cloning.</i> How Science Works. Recognise that different decisions on the use and application of scientific and technological developments may be made in different economic, cultural and social contexts. (1.1b) See Great Debates.	Additional teachers notes Equipment and materials required Suitable plants as suggested in the lesson notes, knives, rooting powder, pots, compost, polythene bags. Safety Care with scalpels or knives.	