Middle Years Programme

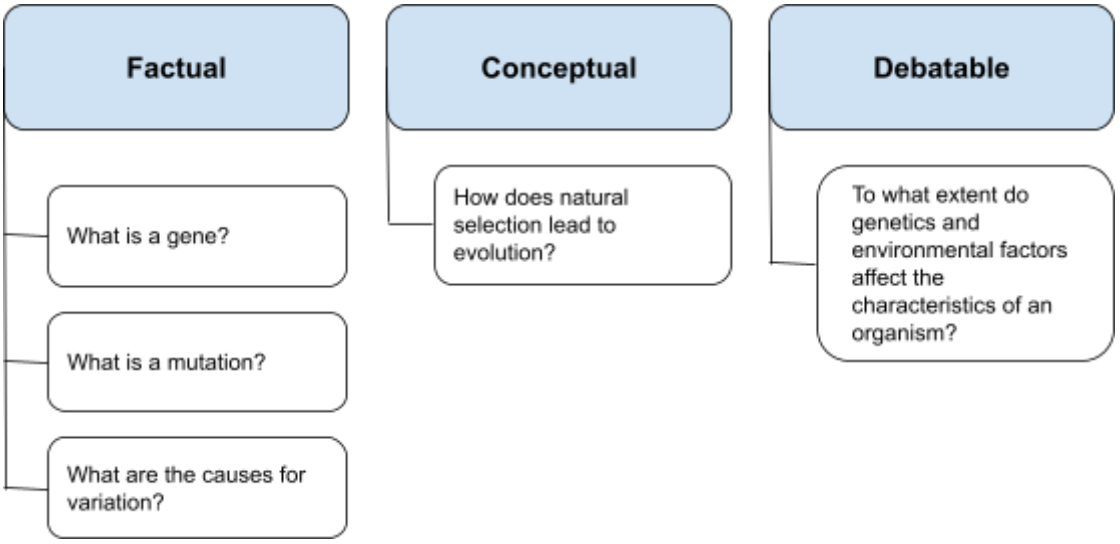
Name:	Class:

Inheritance & Variation

Lesson No.	Content	Lesson No.	Content
1	Variation	6	Genes and Mutation
2	Selective Breeding	7	Genetic Crosses
3	Natural Selection	8	Genetic Disorders
4	Introduction to DNA	9	Genetic Engineers
5	DNA Extraction	10	Criterion A Assessment

Statement of Inquiry: Evolution is a consequence of change in the environment that affects inheritance.

In this unit, we will consider these questions:



These concepts will be covered…

Key concept: Change

Related concepts: Consequences, Environment

Global Concept: Scientific and technological innovation

This unit will give the opportunity to improve in these skills…

- Critical-thinking skills
- Information Literacy

Assessment opportunities in this unit include…

Criterion A: Knowing and Understanding

Keywords list

InherIted characteristics/How variation occurs

Word	Pronunciation	Meaning
characteristics		
DNA		
gamete	***gam****-meet*	
gene	*jeen*	
genetic information		
inherited		
variation		
Mutation		

Different varieties/Environmental effect

Word	Pronunciation	Meaning
environment		
environmental factors		
resistant		
species	***spee****-shees*	
variety		

Animal breeding

Word	Pronunciation	Meaning
breed		A set of animals that are in some way different from other members of the same species.
breeding		To mate two organisms of the same species to produce offspring.
cross-breeding		When different varieties or breeds are mated with one another.
selective breeding		When humans choose certain animals and plants that have useful characteristics and breed more of these organisms.
yield		How much of something useful to humans that an organism produces.

Inheritance

Word	Pronunciation	Meaning
allele		
homozygous		
heterozygous		
genotype	***jeen*** *-o-type*	
phenotype	***feen****-o type*	
dominant		
recessive		
punnett square		

Lesson 1: Variation
Learning Objectives:

- Define the term *variation*.
- Discuss the fact that variation occurs within as well as between species.
- Describe the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms.
- Explain both genetic and environmental causes of variation.

Task

Variation exists in all species. Inheritance is the science of how all species inherit our traits and therefore maintain variation within species.

Gregor Mendal was one of the first scientists to experiment with the nature of Inheritance.

Research what Gregor Mendel did and why he is called 'the father of genetics.'

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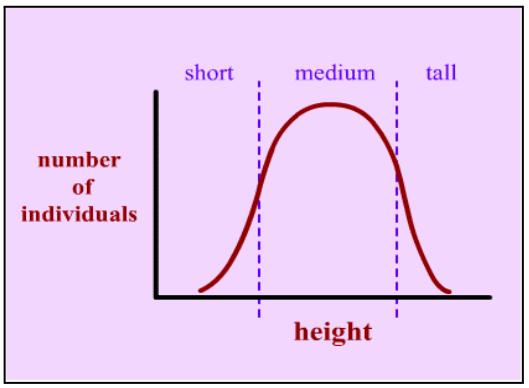
Types of Variation

The traits that Mendal was looking at could be in two categories, the same as any trait in humans too. Define the terms below.

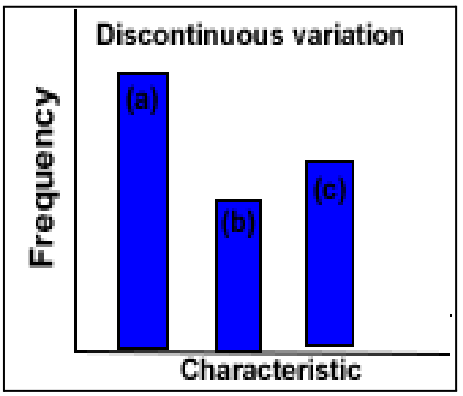
Continuous Variation……

Discrete Variation……

Continuous



Discrete



What type of graph would we use to plot discontinuous data?

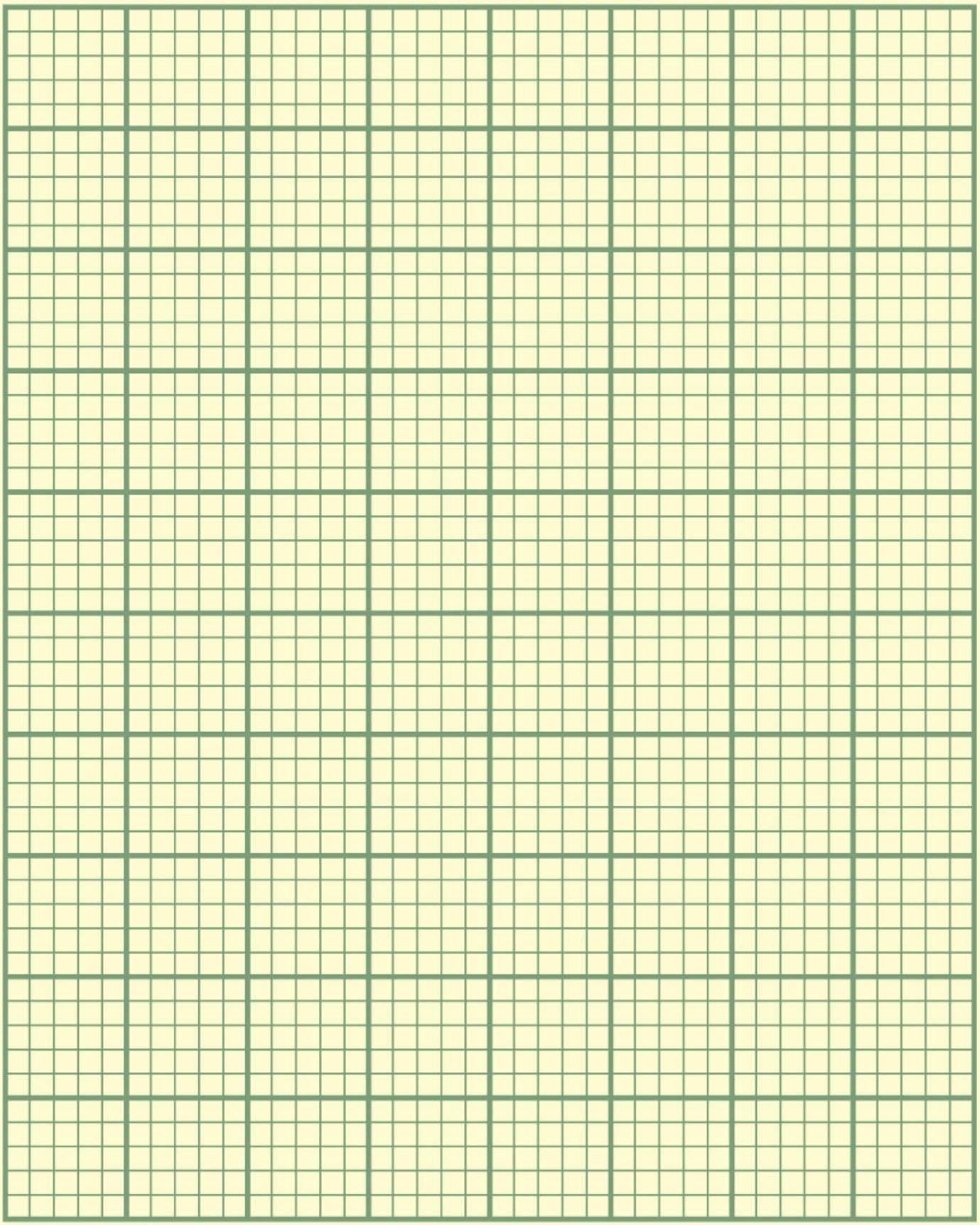
On the next page, plot a bar graph of this data.

Blood Group	Percentage of population
A	42
B	10
AB	4
O	45

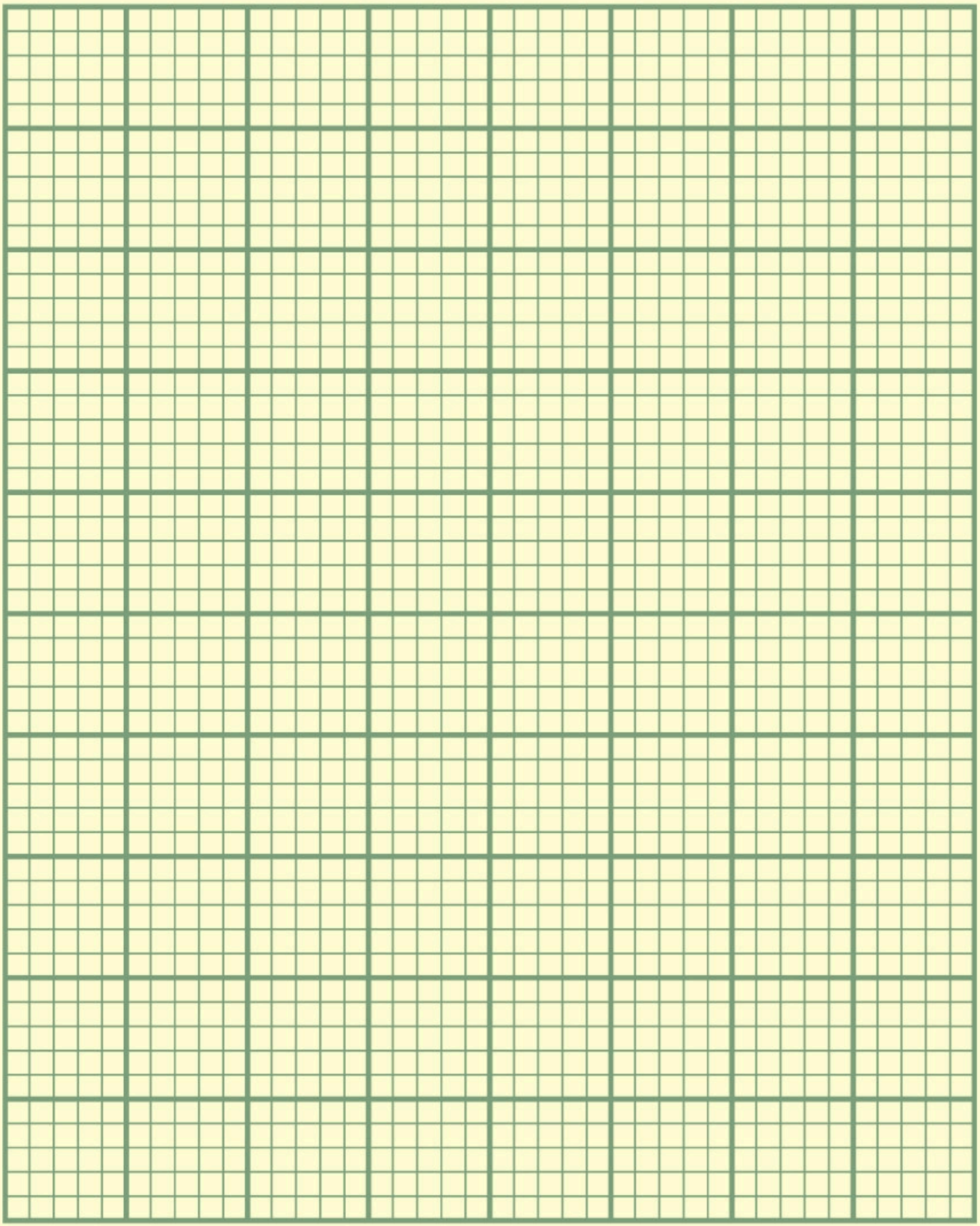
What type of graph would we use to plot continuous data?
On the next page also, plot a line graph of this data.

Height (cm)	Number of people
Up to 129	0
130-134	5
135-139	9
140-144	16
145-149	10
150-154	6
155-159	4
Over 160	1

5 Squares/Inch Engineering Graph Paper



5 Squares/Inch Engineering Graph Paper



9Ab/3 Variation and varieties

Some pupils measured the masses of two different varieties of apple. There were five apples of each variety. The results are recorded in the table.

	Variety 1 mass (g)	Variety 2 mass (g)
Apple 1	125	150
Apple 2	120	147
Apple 3	122	150
Apple 4	130	152
Apple 5	125	158

1 Draw a bar chart to show the differences in mass for variety 1.

2 Why do you think the variety 1 apples have different masses?

3 Plot the masses for variety 2 on the same chart.

4 Why do you think the variety 2 apples have different masses?

5 Why do you think variety 2 apples have larger masses than variety 1 apples?

S knowledge, presenting, considering

9Ab/4 Variation and varieties

Some pupils measured the masses of two different varieties of apple. There were five apples of each variety. The results are recorded in the table below.

	Variety 1 mass (g)	Variety 2 mass (g)
Apple 1	125	150
Apple 2	120	147
Apple 3	122	150
Apple 4	130	152
Apple 5	125	158

1 Enter the data in a spreadsheet.

2 Use the spreadsheet to draw a bar chart to show the range in mass for variety 1.

3 Use the spreadsheet to draw a bar chart to show the range in mass for variety 2.

4 Why do you think apples within a variety have different masses?

5 Work out the mean mass of each variety and plot this information on the chart.

6 Why do you think variety 2 is different to variety 1?

Optional extra

7 Calculate the following averages for these apples and explain what each average shows.

a mean **b** median **c** mode

S knowledge, numeracy, presenting, considering

Lesson 2 - Selective Breeding

Learning Objectives

- Define Selective Breeding
- Explain the process, using examples from different species
- Discuss the advantages and disadvantages of the process

True or False

1. The color of your eyes is a characteristic that is inherited.
2. You inherit characteristics from your mother only.
3. Your brothers or sisters inherit exactly the same characteristics as you.
4. All animals inherit some characteristics from their parents.
5. Plants are not able to inherit characteristics.
6. Not all characteristics are inherited.
7. The environment has no effect on your characteristics.
8. Genes carry genetic information and are found inside every cell.
9. There are half as many genes in gametes as there are in normal cells.
10. Fertilisation is when a sperm cell fuses with an egg cell.
11. A fertilised egg cell only contains half the genetic information of a normal body cell.

Selective Breeding

Roughly 10 000 years ago **……**

One of the first animals farmed was the Auroch. They were gathered into herds and over hundreds of years the ones that

……

Now the auroch is extinct but its descendants, the modern cow, is one of the most farmed animals on the planet.

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It is how we have got the modern day**……**

Dog Breeding

Ever wonder how your dog evolved? There are more than 350 different breeds of dog, each one - from the Chihuahua to the Great Dane - descended from the Grey Wolf.

Over the thousands of years, we have shaped wolves through breeding into dogs with floppy ears, sleek coats, and short noses - exactly the opposite of their distant ancestors.

We have created dogs to suit our needs. This process of breeding dogs for different useful characteristics is called **selective breeding.**

You will be given a picture of a dog. Answer these questions about the dog:

1. What useful characteristics does the dog have?

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2. Write down the reasons why the dog was bred in the past e.g. hunting, companionship?

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3. Give some reasons why the breed is still popular today.

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Now you will do some selective breeding.
Decide which two dogs you will breed to create a new breed of dog that will suit the jobs below:

1. Dog needed for racing. Must be very fast but medium sized (50cm tall). An enthusiastic worker and also a good hunter.

2. Very intelligent dog that has an excellent sense of smell is needed. Must be a large dog (65cm tall) and live a long life (more than 12 years).

3. Large (60cm tall), strong, muscular dog wanted for large game hunting. Must be able to work in a team and be away from home for long periods of time.

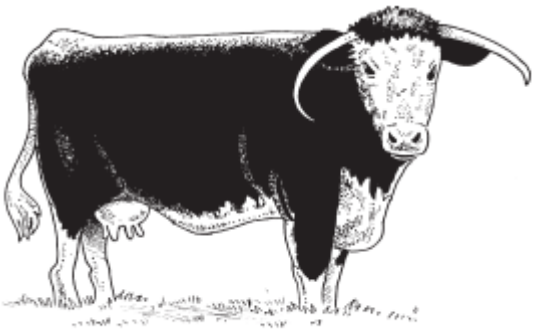
4. Kind, patient, good-looking, long-haired dog wanted. Preferably light coloured fur and large (65-70cm tall). Must be easy to train, obedient and able to get on with other people including children and strangers.

5. Large dog (65-70cm tall), must like water and be a good swimmer and hunter. Must have good stamina and be an excellent guard-dog.

6. Small (35-40cm tall) very friendly dog required as a companion to children. Long white hair is preferable. Needs to be welcoming to strangers and able to live outside.

7. Dog required that must be an excellent hunter (very fast) and retriever of game. Must be medium sized (around 55cm tall) with a short haired coat and definitely not slobber or smell.

Rare Breeds L7-9



An English longhorn cow.

Popular farm animals now have been created from old breeds through selective breeding. The old breeds do not have characteristics that farmers now want. So they do not go extinct they are kept in rare breed farms. A good example are Shire horses (large work horse) they were used to pull ploughs. They are no longer needed as we now have machines and tractors for that.

Animals at rare breeds farms are involved in breeding programs to ensure the species lives on. It is important they are kept incase their characteristics are needed again.

Phoenix Cockerel

Robert Bakewell in the 18th century bred English Longhorns. He was the first to selectively breed cattle for farmers. He selected for large rear ends and quick growth. English longhorns were popular until the early 19th century after this the short horn became popular.

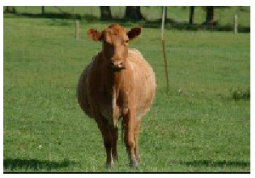
Each breed of animal has certain characteristics and a breed is only classed as a breed if all of its offspring have these same characteristics. It has to exist for 6 generations or more (roughly 75 years).

Questions:

1. How are new breeds of farm animal created?
2. Where are old breeds kept?
3. Why do we keep rare breeds ?
4. Why are shire horses no longer needed?
5. How long does a breed need to exist before it is called a breed?
6. How would you know if something is a new breed or not?
7. What characteristics were selected in the English longhorn?
8. Why are they useful?
9. Suggest why the shorthorn became more popular
10. Which feature has the phoenix cockerel been selected for?
11. Why do farmers no longer breed animals that just look interesting?

SELECTIVE BREEDING IN COWS

Look at the cows below:



Gertrude – produces extra creamy milk, not much meat

Betsy – has low milk production but lots of tasty meat

Penelope – Has little meat but produces milk that contains lots of extra of vitamins and minerals

Alma – lots of meat, good milk production but milk sours quickly.

Look at the bulls below:

Bruiser – can be violent. Has lots of muscle. Cannot survive hot, dry conditions but does very well in damp climate

Rufus – Can cope extremely well in hot, dry conditions. Has little meat but it is very tasty.

Donald – has lots of meat, can survive well in temperate climates. Comes from a family line of cattle that produce high quantities of milk.

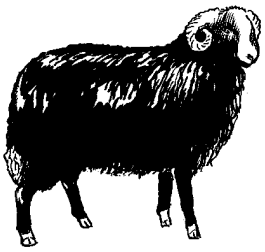
Boris – has lots of muscle but can cope with hot, dry conditions. Family line does not produce much milk.

Questions

Which bull and cow would the farmer mate together to get:

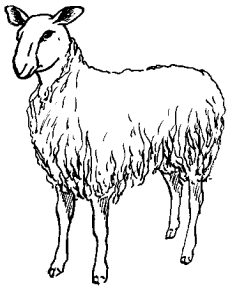
1. Lots of meat and creamy milk. The animal should be able to survive in hot dry climates.
2. Lots of milk with vitamins and minerals and can survive well in hot dry climates
3. Can produce extremely expensive delicious meat. No need to produce milk for drinking
4. Can survive in temperate climate and produces lots of milk and meat

Selective Breeding



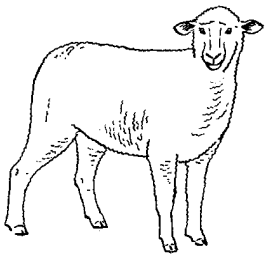
A

The Balwen mountain sheep is able to live in cold, harsh conditions.



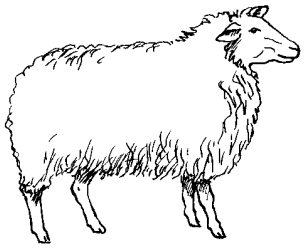
B

The Bluefaced Leicester sheep produces good quality wool.



C

The Polled Dorset sheep produces good quality meat.



D

The Friesian Milk sheep produces a lot of milk.

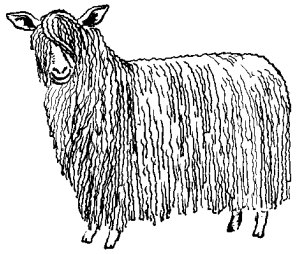
1. Each of these sheep has been produced by **selective breeding**. For each sheep write down one characteristic that has been selected

Farmers often want to breed two different breeds of sheep together. This is called **cross-breeding**. The offspring produced by this method should have characteristics from both parent sheep

2. Which of the sheep above might a farmer use to breed sheep with good meat and good wool?

3. Which of the sheep might a farmer use to produce sheep with good wool that can survive in the Welsh mountains?

A sheep farmer has a flock of Wensleydale sheep. To win a prize at the local farming show, he wants to have sheep with very long wool. Some time ago, he took the ewes (female sheep) and rams with the longest wool and allowed them to breed. He allowed the new lambs to grow and then kept the ones with the longest wool and allowed them to breed. The others were sold at market. It took him eight years to produce sheep with wool long enough for him to win a prize.

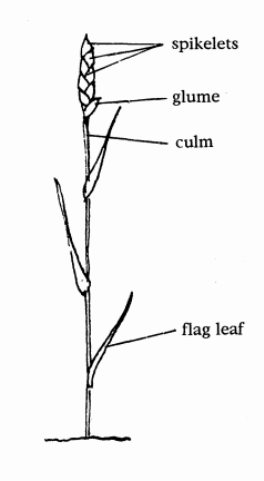


4. What is a male sheep called?
5. Why is this farmer's method an example of selective breeding?
6. Suggest why it took him so long to win a prize.
7. Think about the weather conditions where you live. Write down a list of characteristics that a sheep should have if it were to be farmed in your area.
8. What other characteristics would you like your sheep to have and why?

The Plant Breeding Game

This game is played in a similar way to 'rummy'. 2, 3 or 4 people can play.

1 Shuffle the pack of cards.
2 Deal cards face down until each player has 5 cards.



The 'hand' of five cards you hold represent a crop of wheat. The cards tell you the characteristics of your crop. For example, one card might show that your crop has few spikelets per ear - a poor characteristic, because it means fewer seeds from each plant, and so a lower value crop. The object of the game is to exchange cards in order to improve your crop.

3. Deal one card face-up in the centre of the table and place the remaining pack of cards face down beside it.

4. The player on the left of the dealer starts.

5 When it is your tum, you may do one of three things: • pass (Le.do nothing!) • exchange one of your cards for the top card on the 'face up pile • put one of your cards onto the 'face-up' pile and take the top card from the 'face-down' pile The tum then passes to the next player on your left.

6. After the tum has gone round six: times, the game is over. Each player must lay down their hand face up.

7 Use the scoring sheet to find out how much your crop is worth. The player with the most valuable crop is the winner!

Plant Breeding Game Score Sheet

Each of the 5 cards in your 'hand' contributes something to the value of your crop. Use the table below to look up the value of each of your cards. Add the values together to find the value of seed from your new wheat variety in HK$ per tonne. (But, if you have two or more cards for anyone attribute - e.g. 2 cards for brittleness - then you can only count the average value of these, not the total)

Crop attribute	Value	Crop attribute	Value
FEW spikelets per ear	HK$ 0	VERY HAIRYglumes	HK$ 5
AVERAGE spikelets per ear	HK$ 15	MEDIUM glumes	HK$ 5
MANY spikelets per ear	HK$ 30	NON HAIRYglumes	HK$ 5
LIGHT grain	HK$ 5	PALE coloured glumes	HK$ 5
AVERAGE grain	HK$ 15	MEDIUM coloured glumes	HK$ 5
HEAVY grain	HK$ 35	DARK coloured glumes	HK$ 5
EASY to thresh	HK$ 20	VERY STIFF culms	HK$ 25
MEDIUM for threshing	HK$ 10	MEDIUM culms	HK$ 15
HARD to thresh	HK$ 5	WEAK culms	HK$ 5
LARGE flag leaf	HK$ 25	GOOD germination rate	HK$ 15
MEDIUM flag leaf	HK$ 15	MEDIUM germination rate	HK$ 5
SMALL flag leaf	HK$ 5	POOR germination rate	HK$ 0
VERY brittle ear	HK$ 0	GOOD response to fertilizer	HK$ 30
MEDIUM brittle ear	HK$ 10	AVERAGE response	HK$ 15
NON brittle ear	HK$ 25	POOR response	HK$ 5
EYESPOT resistant	HK$ 10	GOOD for bread making	HK$ 20
MILDEW resistant	HK$ 20	AVERAGE for bread making	HK$ 10
ERGOT resistant	HK$ 25	POOR for bread making	HK$ 0
NOT disease resistant	HK$ 0	HIGH protein content	HK$ 20
HIGH shattering	HK$ 0	MEDIUM protein content	HK$ 10
MEDIUM shattering	HK$ 10	LOW protein content	HK$ 0
LOW shattering	HK$ 15	EARLY maturation	HK$ 15
LATE maturation	HK$ 15	MEDIUM maturation	HK$ 5

Q1. Many different types of animals are produced using selective breeding.

Some cats are selectively bred so that they do not cause allergies in people.

(a) Suggest **two other** reasons why people might selectively breed cats.

1 .....

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2 .....

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(2)

(b) Selective breeding could cause problems of inbreeding in cats.

Describe **one** problem inbreeding causes.

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(1)

(c) Many people have breathing problems because they are allergic to cats.

The allergy is caused by a chemical called Fel D1.

Different cats produce different amounts of Fel D1.

A cat has been bred so that it does not produce Fel D1.

The cat does **not** cause an allergic reaction.

Explain how the cat has been produced using selective breeding.

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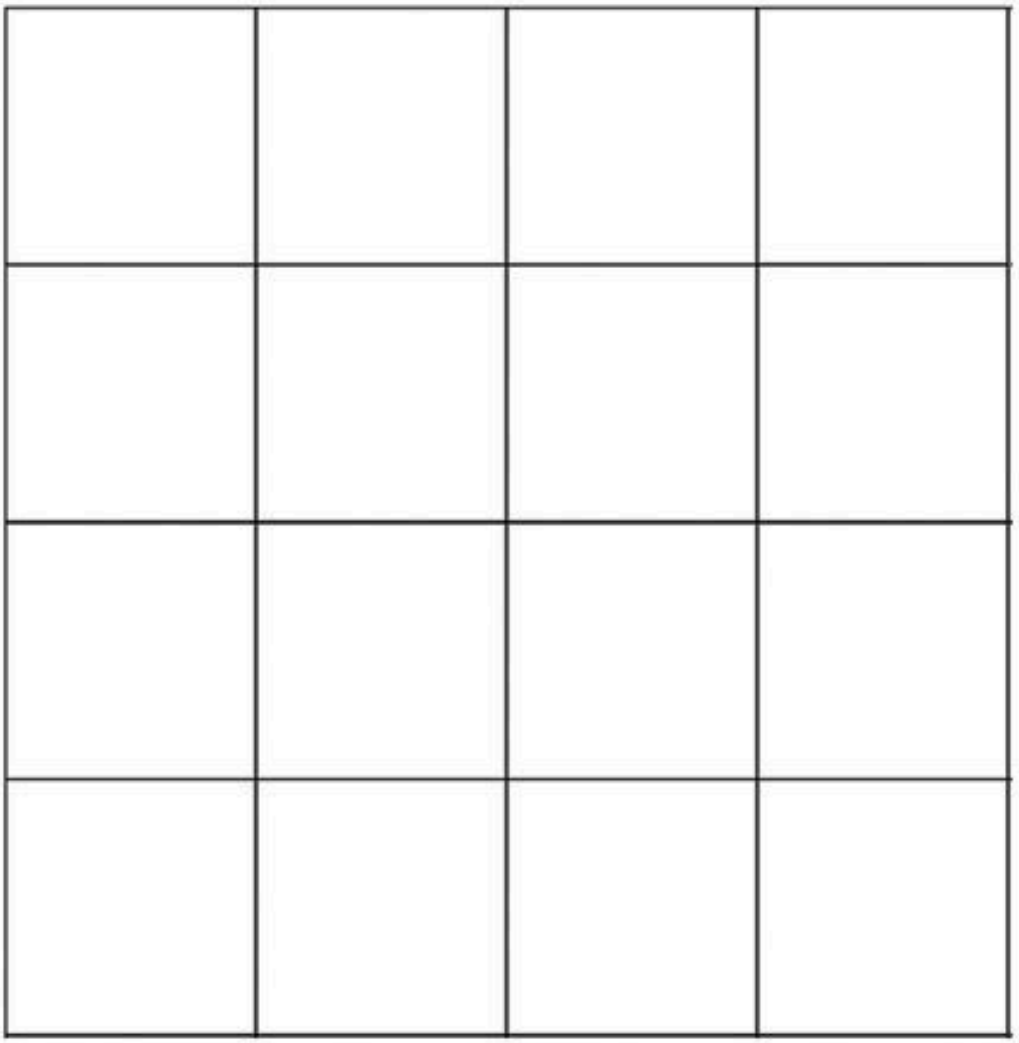
(4)

(Total 7 marks)

BINGO



Lesson 3 - Natural Selection

- Describe the theory of natural selection.
- Model Natural Selection.

Who is responsible for the theory of evolution by Natural Selection?

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What did he notice about the animals and plants which he was looking at?

Write down the major points from the video, the summary contains all the information.

https://www.youtube.com/watch?v=UKETe78t5p8

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Variation

1. Which of these features is an example of continuous variation?

   Gender Blood Group Weight

2. Which of these features is an example of discontinuous variation?

   Forearm length Blood group Height

3. Which of these features shows inherited variation?

   Brown eyes Scars Pierced ears

4. Which of these features shows environmental variation?

   Scars Blood Group Eye colour

5. Where is most variation found?

   Between species Within one species Between lions and tigers

Natural Selection

You will be given a card showing a bird and its matching beak type:

Throughout each round try to 'eat' as much food as you can. You can only use your beak to get beans into your petri dish (stomach).

Butter Bean	1 point	
Black Bean	2 points	
Mung Bean	5 points	

Points to survive:	25
Points to survive and reproduce:	50

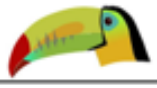
Instructions:

Season 1: You have 30 seconds to 'eat' as much food as you can.

Season 2: There's a famine, now only half of the food is available. You must compete to get enough food to survive and reproduce! You have 30 seconds to 'eat' as much food as you can.

Season 3: There's been a change to the environment. Everyone must now use their non-dominant hand. You have 30 seconds to 'eat' as much food as you can.

Season 4: There's a mutation! Bird number 4 now has a spoon shaped beak. You have 30 seconds to 'eat' as much food as you can.

				
Season 1 – normal breeding				
Season 2 - famine				
Season 3 – change to the environment				
Season 4 - mutation				

Follow-Up Questions:

1. During the 'normal' breeding season, was there one bird who was better adapted to collecting food than the other birds? How do you think this would affect the number of birds with this beak in the population?

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2. Describe what happened during the 'famine' season. Did any bird outperform the others?

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3. How did the change to the environment impact feeding during the third season? How do you think this would affect the number of birds with each beak in the population?

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4. Did the mutation impact feeding during the fourth season? How do you think this would affect the number of birds with each beak in the population?

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- Describe the structure of DNA, using the keyword list below
- Describe the structure of DNA using diagrams.
- Explain how the bases on the two strands link together.
- Describe in simple terms how DNA and genes link to proteins and characteristics

DNA Structure

Fill in the blanks, and use the notes on the next page to help.

_____ has a structure like a twisted ladder. The structure is called _____.

DNA has _____. Each strand is made of units called _____ joined together.

Each unit contains three parts: _____.

There are _____ different bases each represented by the letters _____.

The two strands are complementary with ____ linked ____ and _____ linked to _____.

As there are many units, the whole structure is called a _____.

A sequence of three bases is the genetic code for a particular _____.

The order of bases controls the order in which _____ are assembled to produce a particular _____.

When the _____ chain is complete it folds up to form a _____.

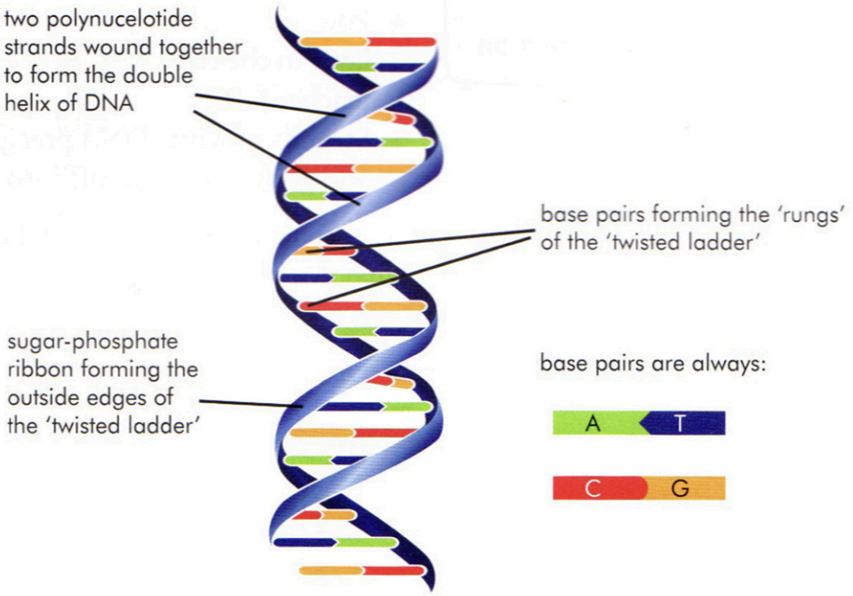
_____ occur continuously.

A few _____ code for an altered _____ with a different _____.

protein, bases, four, amino acids, C, unique shape, two strands, mutations, protein, sugar molecule, DNA, mutations, GACT, A, protein, phosphate group, shape, double helix, T, polymer, G, amino acid, nucleotides.

The structure of DNA

A DNA molecule is made of two strands of **polynucleotides** spiralling around one another to form a double helix shape. A nucleotide is made up of a sugar, phosphate and a base. If you imagine the DNA double helix as a twisted ladder, the sides of the ladder consist of an alternating series of sugars (deoxyribose) and phosphates. The rungs of the ladder are composed of pairs of bases. One base of each pair forms half a rung (Figure 5.28).



Each base projects from one side of the ladder, towards the middle of the double helix. Here it matches up with a complementary base, projecting from the opposite side of the ladder. There are four bases, usually known by their initial letters, as follows: adenine (A), thymine (T), guanine (G) and cytosine (C).

The bases can only pair up according to the following rules:

A can only form a pair with a T
G can only form a pair with a C.

The double helix structure of DNA was proposed in Cambridge by James Watson and Francis Crick in 1953. Later they were awarded a Nobel Prize for this work. They had solved the riddle of the structure of this important molecule and they also realised how it could be accurately copied (replicated) as part of cell division. This discovery opened the way for enormous advances in understanding how DNA works and in the development of techniques of gene technology that have become an important part of scientific work in the 21st century, with applications in many fields.

When a DNA double helix is split lengthwise into two halves, the missing half of each ladder is rebuilt. Because A always pairs with T, and G always pairs with C, the sequence of bases in the two new complete molecules of DNA is identical. This is crucial when a cell divides by mitosis as it ensures that each new daughter cell gets a full set of chromosomes (and therefore, the same genes) from the original parent cell.

Extracting DNA from Fruit

Introduction

Have you ever wondered how scientists extract DNA from an organism?

All living organisms have DNA, which is short for deoxyribonucleic acid; it is basically the blueprint for everything that happens inside an organism's cells. Overall, DNA tells an organism how to develop and function, and is so important that this complex compound is found in virtually every one of its cells.

In this activity you'll make your own DNA extraction kit from household chemicals and use it to separate DNA from fruit (e.g. strawberries or kiwis).

Background

Whether you're a human, rat, tomato or bacterium, each of your cells will have DNA inside of it (with some rare exceptions, such as mature red blood cells in humans). Each cell has an entire copy of the same set of instructions, and this set is called the genome. Scientists study DNA for many reasons: They can figure out how the instructions stored in DNA help your body to function properly.

We can use DNA to make new medicines or genetically modify crops to be resistant to insects. They can solve who is a suspect of a crime, and can even use ancient DNA to reconstruct evolutionary histories!

To get the DNA from a cell, scientists typically rely on one of many DNA extraction kits available from biotechnology companies. During a DNA extraction, a detergent will cause the cell to pop open, or lyse, so that the DNA is released into solution. Then ethanol added to the solution causes the DNA to precipitate out. In this activity, strawberries or kiwis will be used because each fruit cell has eight copies of the genome, giving them a lot of DNA per cell. (Most organisms only have one genome copy per cell.)

Materials:

Goggles
Fruit (either strawberries or kiwi)
Ice cold ethanol
Water
Spatula
Beaker x2
Table salt (sodium chloride)
Detergent (dishwashing liquid)
Muslin (cheesecloth)
Funnel
Conical flask
Scissors
Resealable plastic sandwich bag
Glass rod

Method:

1) Make the 'extraction liquid' by mixing approximately 50cm^3 of water with one spatula of salt and a pipette full of detergent in a beaker.

2) *Either:* - collect two strawberries and pull off the green leaves/stalk
Or: - collect half a kiwi and cut off any skin

3) Place the fruit into a resealable bag. Push out all of the air and seal the bag.

4) With your fingers, squeeze the fruit reducing it to a liquid mush with no lumps.

5) Add the extraction liquid, push out all of the extra air and reseal the bag.

6) Again, with your fingers, squeeze and mix the fruit mixture for about three minutes.

7) Set up the muslin cloth in a funnel ready to filter.

8) Cut a small hole in the bottom of the resealable bag and squeeze the mixture from the bag into the funnel. Let it drip through the cloth and into a conical flask.

9) Once all the liquid has been filtered, pour the filtrate into a clean beaker.

10) Tilt the beaker and very slowly pour approximately 50 cm^3 of ethanol down the side so that it 'floats' on the top of the filtrate - try not to allow the fruit mixture and ethanol mix.

11) Study the mixture, especially where the two layers meet. The fruit DNA will precipitate out into the ethanol layer and you should see a gooey clear/white stringy material.

12) Use a glass rod to pull the DNA out of the mixture and place it onto some paper towel.

Observations and analysis:

1) How does the detergent (in the extraction mixture) affect the fruit cells?

2) How does the salt affect the DNA in the fruit cells?

3) Why does the ethanol need to be poured very slowly into the final beaker?

4) Were you able to see DNA when you added the cold ethanol? Which layer was the DNA in? Describe what it looks like.

5) DNA is an extremely thin molecule. How is it possible that you can see it?

Extension: We use strawberries and kiwi fruit as the cells are “octoploid”. What does octoploid mean and how does this compare to human cells? Why do you think strawberries were used in this experiment?

RECREATE A FACE

DNA key

Gene	DNA clue	Face feature
Eye colour	C T C C T C	brown eyes
	T G T C T C	green eyes
	T G T T G T	blue eyes
Hair colour	G A A T G T	blonde hair
	G A A A G G	brown hair
	G A T A G G	black hair
Hair type	A G A A T T	curly hair
	A G A T T T	wavy hair
	A G T T T T	straight hair
Freckles	T G G C A T	lots of freckles
	T G G G A T	some freckles
	C G T G A T	no freckles

RECREATE A FACE

Worksheet

Skeleton number: _____

Appearance:

Eye colour	☐ brown	☐ green	☐ blue
Hair colour	☐ blonde	☐ brown	☐ black
Hair type	☐ curly	☐ wavy	☐ straight
Freckles	☐ lots	☐ some	☐ none

Skeleton name: _____

Lesson 6 - Genes and Mutations

- Define mutation.
- Describe how mutations are the source of genetic variation.
- State the causes of mutations.

Task 1

1. (a) What is the definition of a mutation?

……..

(b) Mutations have an effect on the organism by changing the DNA sequence. What is the purpose of DNA in the first place, i.e. what does DNA code for?

……..

Remember DNA is a code, so if the code is changed, this can cause problems. Or sometimes a benefit, but the characteristics of an organism (phenotype) can change.

Imagine this sentence is DNA

the cat saw the bat

If a letter is swapped the sentence may still make sense.

the cat saw the mat

But DNA is actually 'read' 3 bases at a time.
So what would happen if a base was added or deleted?

the rca tsa wth eba

Adding the r, in completely messed up the sentence.
Same if a letter was deleted.

the cat awt heb at

Deleting the s changed the DNA completely.

2. Look at the following DNA base sequences. What type of mutation has occurred?

Original DNA sequence: …..CCTAGGAACTGATAC…...

(a) ...CCTAGCAACTGATAC... =

(b) ...CCTAGGACTGATAC... =

(c) ...CGCTAGGAACTGATAC... =

3. Determine whether the following mutations are beneficial, harmful or have no effect on the survival of the organism.

(a) A seagull with a longer wingspan living on a deserted island.

(b) Roses with a stronger scent grown in a greenhouse.

(c) An albino tiger living in a zoo.

(d) A plant with narrower leaves in a tropical rainforest.

Extension question:

Suggest the type of environment in which the organisms above will have a survival advantage. How does the mutation help the organism to better adapt to the named environment?

……...

……...

……...

Task 2

1. Link the following cancers to their most likely cause:

Lung cancer	o	o	UV radiation
Cervical cancer	o	o	alcohol
Skin cancer	o	o	human papilloma virus
Liver cancer	o	o	poor diet
Colon cancer	o	o	air pollution

2. The cancers listed above are known as preventable cancers.

(a) What is a “preventable” cancer?

……...

(b) Suggest ways by which each of these cancers can be prevented.

……...

(c) Explain why skin cancer is not inherited.

……...

……...

Extension question:

Suggest why the risk of developing cancers is linked to age.

……...

……...

……...

……...

……...

……...

Plenary:

What are the three key learning points from the lesson?

1.

2.

3.

Lesson 7 - Genetic Crosses

Define the terms genotype, phenotype, dominant and recessive allele, homozygous and heterozygous.

Predict probabilities of outcomes from genetic crosses.

What is a gene?

……

……

What is an allele?

……

……

Humans inherit **two** copies of every gene you have. One from each parent. So when a characteristic is expressed in you, which trait do you show?

Gregor Mendel discovered that genes can be passed on, but sometimes one is not expressed while the other is, but the not expressed trait can still be passed on again.

What is the definition of…..

Dominant allele

……

……

Recessive allele

……

……

Watch this youtube video first.

Question 1:

Trait: Brown eyes are dominant, blue eyes are recessive.
Alleles for eye colour can be shown using letters: B = brown eyes, b = blue eyes

Mum only has alleles for brown eyes and Dad only has alleles for blue eyes.

a) Write down the alleles of the parents using the letters for the different eye colours? (Remember, all genes come in pairs)

Mum = Dad =

b) What colour eyes will mum have?

c) What colour eyes will dad have?

Children inherit half their genes from mum and half from dad. This means that although both mum and dad have two copies of the genes for eye colour, only one copy of the gene from each parent will be inherited by their children. We can show how this happens using a Punnett square.

Separate each parents' genes for eye colour and add dad's in the first row and mum's in the first column:

Mum \ Dad		

Now combine the letter in each row with the letter in the corresponding column in the squares. This gives us the potential combinations of genes that the children could inherit:

Mum \ Dad	b	b
B		
B		

d) What colour eyes will their children have?

Now try the following exercises….

Key words:

(a) What does the term **heterozygous** mean?

……

……

(b) What does **homozygous** mean?

……

……

(c) What does **genotype** mean?

……

……

(d) What does **phenotype** mean?

……

……

Question 2:

(a) Both parents are **heterozygous** for brown eyes.

(i) What is the **genotype** for each parent?

Mum =

Dad =

(ii) What will be the genotypes of their children? Fill in the Punnett square below.

Mum \ Dad		

(c) What is the probability that their children will have brown eyes?

Extension Question:

In pea plants, height is also controlled by a gene where tall is dominant and short is recessive.

(a) Select a letter for height and write down the key for the alleles:

(b) A short plant was crossed with a heterozygous tall plant. What are the genotypes for the parents?
Short parent =
Tall parent =

(c) Complete the Punnett square below for the inheritance cross.

Tall \ Short		

(d) How many different genotypes are possible in the offspring?

(e) What phenotypes are possible in the offspring?

(f) What is the probability for the offspring being short?

1. A heterozygous rabbit is crossed with a homozygous dominant rabbit. What are the results? (B = grey b = white).

2. In cats having hair is dominant (H) over not having hair (h). If a male cat that is heterozygous for hair is crossed with a hairless cat what are the genotypes and phenotypes that their offspring may have?

3. A homozygous dominant tomato plant is crossed with a homozygous recessive tomato plant. What are the results? (T = tall t = short)

4. If two black mice are crossed, ten black and three white mice result. a. Which allele is dominant? b. Which allele is recessive? c. What are the genotypes of the parents?

5. If long floppy ears is dominant (L), over short spiked ears (l) and you find a puppy with long floppy ears, how could you determine the puppy's genotype?

6. Tongue rolling is a dominant trait. Can a husband and wife who are not able to roll their tongues produce a child that is able to roll his or her tongue?

Name: Date:

Student Exploration: Mouse Genetics (One Trait)

Directions: Follow the instructions to go through the simulation. Respond to the questions and prompts in the orange boxes.

Vocabulary: allele, DNA, dominant allele, gene, genotype, heredity, heterozygous, homozygous, hybrid, inheritance, phenotype, Punnett square, recessive allele, trait

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

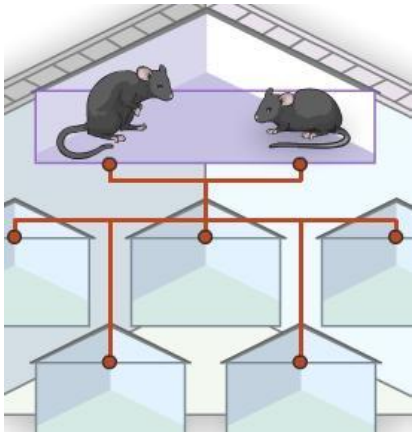
1. The image shows a single litter of kittens. How are they similar to one another?

2. How do they differ from one another?

3. What do you think their parents looked like?

Gizmo Warm-up

Heredity is the passage of genetic information from parents to offspring. The rules of **inheritance** were discovered in the 19th century by Gregor Mendel. With the *Mouse Genetics (One Trait)* Gizmo™, you will study how one **trait**, or feature, is inherited.



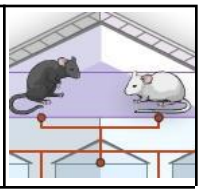
1. Drag two black mice into the **Parent 1** and **Parent 2** boxes. Click **Breed** to view the five offspring of these parents.

   What do the offspring look like?

   The appearance of each mouse is also called its **phenotype**.

2. Click **Clear**, and drag two white mice into the parent boxes. Click **Breed** several times. What is the phenotype of the offspring now?

3. Do you think mouse offspring will always look like their parents? Explain:

Activity A: **Patterns of inheritance**	Get the Gizmo ready: • Click **Clear**. • Drag a black mouse and a white mouse into the parent boxes, but don't click **Breed** yet.	

Question: What patterns are shown by offspring traits?

1. Predict: What do you think the offspring of a black mouse and a white mouse will look like?

2. Observe: Click **Breed** several times. What do you see?

3. Observe: Drag two offspring into the **Holding Cages**. These mice are called **hybrids** because their parents had different traits. Click **Clear**, and then breed the two hybrids.

   What do you see now?

4. Experiment: Turn on **Show statistics**. Click **Breed** until there are 100 offspring.

   How many offspring were black? How many were white?

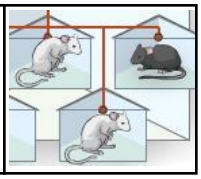
5. Explore: Try other combinations of mouse parents. Write the results of each experiment in your notes. When you have finished, answer the following questions. (Note: You can refer to the parents as "pure black," "pure white," or "hybrid.")

   A. Which parent combination(s) yield only white offspring?

   B. Which parent combination(s) yield only black offspring?

   C. Which parent combination(s) yield a mixture of black and white offspring?

6. Challenge: Based on experiments similar to these, Gregor Mendel devised a theory of inheritance. Use your own observations to come up with your own explanation of how a trait such as fur color is passed down from parents to offspring. If possible, discuss your theory with your classmates and teacher.

Activity B: **Genetics basics**	Get the Gizmo ready: • Click **Clear**. • Drag a black mouse and a white mouse into the parent boxes.	

Introduction: Inherited traits are encoded on a molecule called **DNA** (deoxyribonucleic acid). **Genes** are segments of DNA that control a particular trait. Most genes have several different versions, or **alleles**. The **genotype** is the allele combination an organism has.

Question: How do alleles determine fur color?

1. Observe: Turn on **Show genotype**. Move your cursor over a mouse to see its genotype.

   A. What is the genotype of the black parent? _____ White parent? _____

   These mice are **homozygous** for fur color, meaning both alleles are the same.

   B. Click **Breed**. What is the genotype of the offspring mice? _____

   These mice are **heterozygous** for fur color, meaning the alleles are different.

2. Analyze: **Dominant alleles** are always expressed when present. **Recessive alleles** are not expressed when the dominant allele is also present. Look at the two alleles for fur color.

   A. Which allele is dominant, and which fur color does it produce?

   B. Which allele is recessive, and which fur color does it produce?

3. Predict: Place two of the *Ff* offspring into the **Holding Cages**. Click **Clear**, and then place them into the parent boxes.

   A. Which allele(s) could the offspring inherit from parent 1?

   B. Which allele(s) could the offspring inherit from parent 2?

   C. What are the possible genotypes of the offspring?

4. Experiment: Click **Breed** several times, and look at the genotypes of the offspring. Did you find all the predicted genotypes? Explain.

Activity C: **Modeling inheritance**	Get the Gizmo ready: • Click **Clear**. • Drag a black mouse and a white mouse into the parent boxes.	

Question: How do scientists predict the genotypes of offspring?

1. Model: Scientists use a **Punnett square** to model the different possible offspring genotypes from a parent pair. The parent genotypes are written across the top and side of the square, as shown. The four possible offspring genotypes are then filled in.

   The first square is filled in for you. Fill in the remaining squares.

	F	***F***
f	**Ff**	
f		

   A. What are the genotypes of the offspring?

   B. What percentage of the offspring will have black fur?

   C. What percentage of the offspring will have white fur?

2. Experiment: Click **Breed** several times.

   Were your predictions correct?

3. Model: Use the Punnett squares below to model each parent combination. After filling in each Punnett square, predict the percentages of black and white offspring.

Parent 1: Heterozygous black (*Ff*)
Parent 2: Heterozygous black (*Ff*)

Predicted % black offspring: _____

Predicted % white offspring: _____

Parent 1: Heterozygous black (*Ff*)
Parent 2: Homozygous white (*ff*)

Predicted % black offspring: _____

Predicted % white offspring: _____

4. Experiment: Turn on **Show statistics** and **Show as approximate percentage**. For each combination, breed approximately 500 offspring. Record the results in the table below.

   (Hint: To obtain an *Ff* mouse, breed an *FF* mouse to an ff mouse. Place two *Ff* offspring into the holding cages, click **Clear**, and then drag the *Ff* mice into the parent boxes.)

Parent 1 Genotype	**Parent 2 Genotype**	**% Black offspring**	**% White offspring**
Ff	*Ff*		
Ff	*ff*		

5. Draw conclusions: How well did the Punnett squares predict the offspring percentages for each parent pair?

6. Summarize: In your own words, describe what heredity is and how it works in mice.

7. Think and discuss:
   Do you think most traits are inherited the way mouse fur color is? Why do you think this is?

Lesson 8 - Genetic Diseases

Describe what is meant by a genetic disorder.

Predict probabilities of outcomes from genetic crosses of recessive or dominant genetic disorders.

1) A different version of a gene
2) Traits that will always be expressed
3) A section of DNA that codes for a particular trait
4) Having two alleles that are the same
5) The alleles that an individual has

Activity 1: Watch the youtube clip on Inherited Genetic Disorders (https://www.youtube.com/watch?v=UC-YwiB_FFg)

Q1) What is a genetic disorder?

.....

.....

Q2) What type of allele causes polydactyly?

.....

.....

Q3) Cystic fibrosis is caused by a recessive allele.

(a) Two parents are both **carriers** for the disease. What percentage of their children would be likely to inherit cystic fibrosis? Use a Punnett square to show the pattern of inheritance.

Mum \ Dad		

(b) What would be the probability of a child inheriting cystic fibrosis if one parent is normal but the other parent is homozygous recessive? Use a diagram to support your answer.

Mum \ Dad		

Q4) Outline the similarities and differences between polydactyly and cystic fibrosis in how each genetic disorder is inherited.

Similarities	Differences

Activity 2:

(a) Both parents are **heterozygous** for brown eyes.

(i) What is the **genotype** for each parent?

Mum =

Dad =

(ii) What will be the genotypes of their children? Fill in the Punnett square below.

Mum \ Dad		

(c) What is the probability that their children will have brown eyes?

Genetic Modification

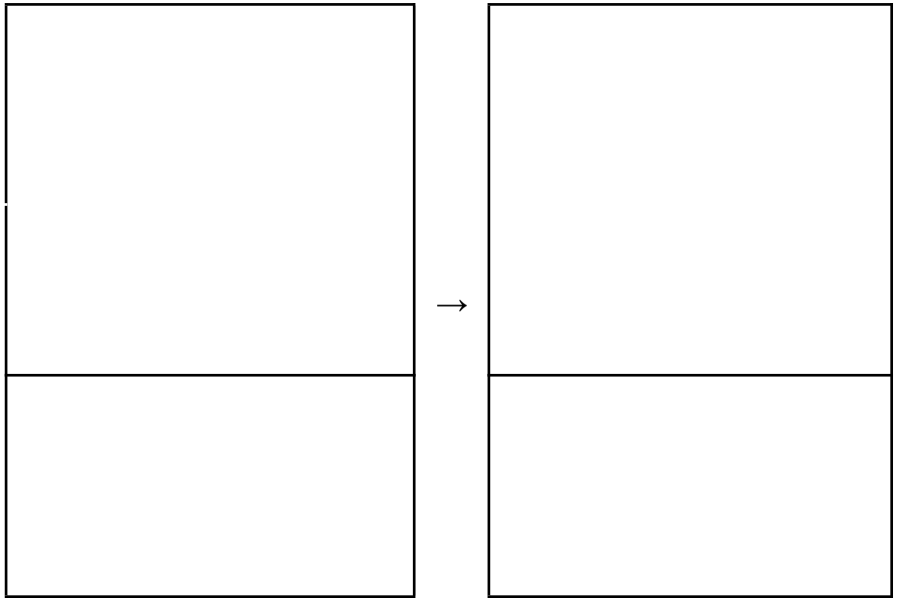
1. Use this space to write some notes about genetic modification:

2. Cut and stick your work about plasmids on the back of this page.

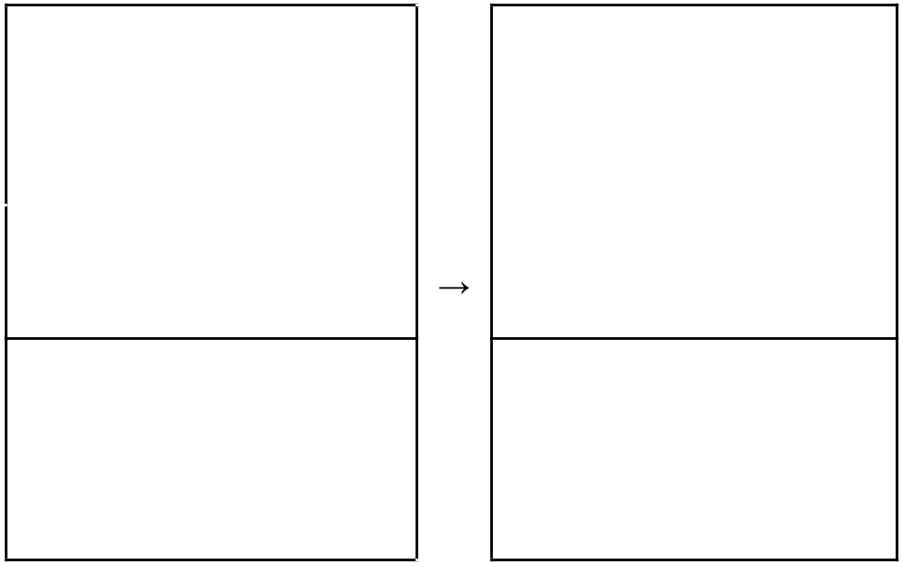
3. FIll in this table with some benefits and drawbacks of genetically modifying organisms:

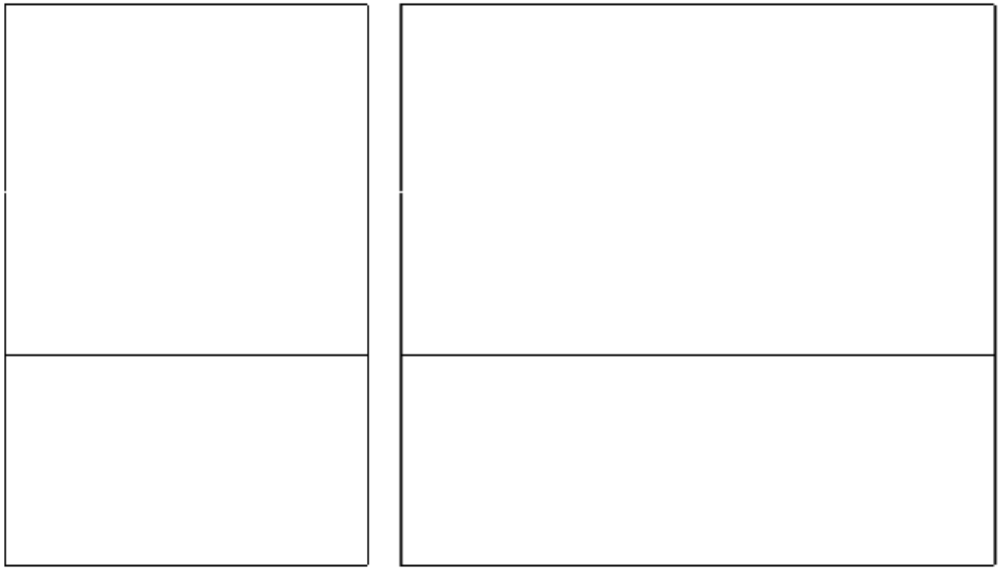
Positives	Negatives

Human

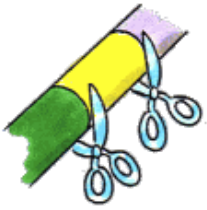


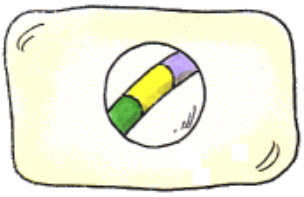
Bacteria



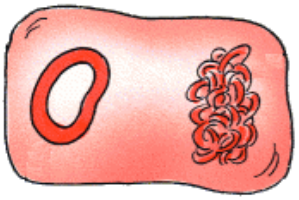


Use a different enzyme to stick the human insulin gene into the bacteria plasmid.



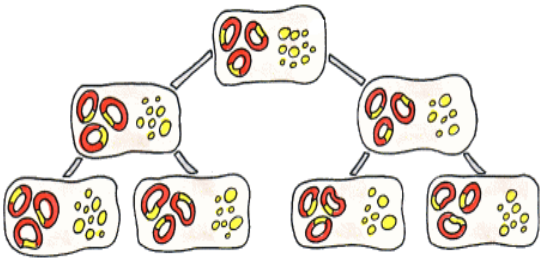


human cell



bacterial cell

The bacteria reproduce and start to make human insulin.



Bacteria cells contain a ring of portable DNA called a plasmid.

Human cells contain a gene for making insulin.

Use an enzyme to cut the insulin gene out of the DNA.

Use the same enzyme to cut bacteria DNA plasmid.

Layout: