Name: _____

Class teacher: _____

Combined Science

Biology - Paper 1

CB4 Natural selection and Genetic modification

Revision booklet

CB4 NATURAL SELECTION AND GENETIC MODIFICATION PART 1

Charles Darwin	*Theory of evolution by natural selection.*	Individual organisms within a particular species show a wide range of variation for a characteristic.
		Individual most suited to the environment are more likely to breed successfully.
		Characteristics enable individuals to survive are then passed on to the next generation.

Developed since its proposal from information gathered by other scientists.

Did much pioneering work on speciation but more evidence over time has lead to our current understanding.

Evidence from around the world, experimentation, geology, fossils, discussion with other scientists (Alfred Wallace) lead to:

Theory of evolution (Biology only)

Alfred Wallace	*Independently proposed the theory of evolution by natural selection*	Published joint writings with Darwin in 1858.
		Worked worldwide gathering evidence.
		Best know for work on warning colouration in animals and his theory of speciation.

Human evolution

Evidence for human evolution	
Fossils	*Stone tools*
Ardipithecus ramidus 'Ardi' from 4.4 million years ago	Earliest simple stone tools from 3.3 million years ago.
Australopithecus afarensis 'Lucy' from 3.2 million years ago	The age of different layers of rock can be dated. Stone tools found in those layers are the same age.
Leakey's discovery of *Homo habilis* from1.6 million years ago	

Charles Darwin 'On the Origin of the Species' (1859)	*Published the theory of evolution by natural selection*	Slowly accepted; challenged creation theory (God), insufficient evidence at time, mechanism of inheritance not yet known.

Both Darwin and Wallace's work contributed to the modern science of genetics and 'molecular biology'.

Classification of living organisms

The full human classification

Carl Linnaeus classified living things		
	Kingdom	Animalia
	Phylum	Chordata
	Class	Mammalia
	Order	Primates
	Family	Hominidae
	Genus	*Homo*
	Species	*sapiens*

The five kingdoms are animals, plants, fungi, protista, prokaryotes

Carl Woese	
3 domains instead of kingdoms based on genetic analysis.	
Archaea (primitive bacteria), true bacteria, eukaryota.	

Antibiotic resistance in bacteria provides evidence for evolution.

Antibiotic resistant bacteria	*Mutations produce antibiotic resistant strains which can spread*	Resistant strains are not killed.
		Strain survives and reproduces.
		People have no immunity to strain and treatment is ineffective.

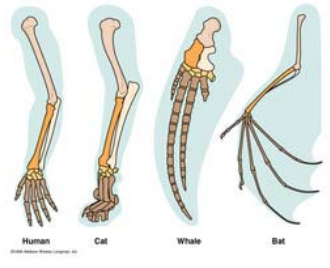
Evolution is widely accepted. Evidence is now available as it has been shown that characteristics are passed on to offspring in genes.

Evidence for evolution

Evidence for evolution from anatomy (Biology only)

The pentadactyl limb

Darwin suggested that the five finger (pentadactyl) limb found across many vertebrates suggest a common ancestor.



Selective breeding

Selective breeding

Choosing parents with the desired characteristics from a mixed population

Chosen parents are bred together.

From the offspring those with desired characteristics are bred together.

Repeat over several generations until all the offspring show the desired characteristics.

Choosing characteristics	
Desired characteristics are chosen for usefulness or appearance	
Disease resistance in food crops.	
Animals which produce more meat or milk.	
Domestic dogs with a gentle nature.	
Large or unusual flowers.	

CB4 NATURAL SELECTION AND GENETIC MODIFICATION PART 2

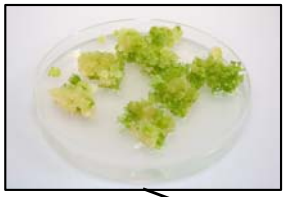
Agricultural solutions

(Biology only) Solutions to growing human populations		
	Fertilisers	**Advantages:** Increases the growth and yield of crop plants.
		Disadvantages: Excess fertiliser can run off into lakes and rivers and cause pollution leading to the death of other plants and animals.
	Biological control	**Advantages:** Insects can be used to control weed populations. No herbicides are necessary.
		Disadvantages: Introduced insects can complete for non weed plants and disrupt other species food chains.

Risks and benefits

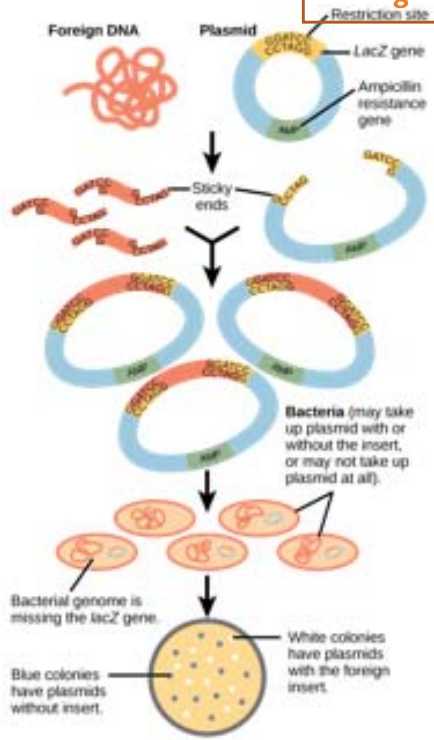
Risks and benefits (practical and ethical)	
Genetic engineering	**Risks:** Seeds from GM plants can be very expensive. Some people think eating GM plants is bad for health although there is no evidence to support this view.
	Benefits: decreased use of herbicide with increase in yield from food crops. Medicines tailored for individuals.
Selective breeding	**Risks:** alleles that may be useful in future may be bred out. Populations with low variation can be vulnerable to genetic diseases.
	Benefits: Increased growth and yield of plants and animals for food.

Tissues cultures



Cloning techniques in plants/animals	
Tissue culture	Small groups of cells to grow new plants in nutrient solution or solid agar. **Advantage:** Important for preservation of rare plants and commercially in nurseries.
	Small groups of human cells used to grow new tissues. **Advantage:** matched tissues can be grown that are not rejected by the body's immune system.

Genetic engineering



Modification of the genome of an organism to introduce desirable characteristics

Genetic engineering process (HT only)
1. Restriction enzymes are used to isolate and cut out the required gene.
2. If sticky ends of DNA on the isolated gene and the plasmid DNA match then they can be joined together.
3. DNA is joined in the plasmid DNA using the enzyme ligase – bacterial plasmid or virus.
4. Genes are transferred to plants/animals/microbes in a vector (bacteria or virus) at an early stage of development so they develop the required characteristics.

Advantages and disadvantages of genetic engineering	
Advantages	Modification of crop plants e.g. insect resistance from Bacillus thuringiensis. Modification of bacteria to produce human hormones e.g. human insulin made by bacteria.
Disadvantages	Resistant crops could pass on genes to wild plants affecting food chains. Insulin produced using GM bacteria is not identical to human insulin and not everyone can use it.

Genetically modified crops (GMO)		
	Crops that have genes from other organisms	To become more resistant to insect attack or herbicides.
		To increase the yield of the crop.

CB4 Revision Mat:

Evidence of human evolution:

What is evolution?

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Place the fossils in order of discover (oldest to youngest)

Homo sapiens, Homo habilis, Ardipithecus ramidus, Australopithecus afarensis and Homo erectus

Oldest: ……

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Youngest: ……

How do stone tools provide evidence for human evolution?

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Darwin's theory:

What is natural selection?

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How does natural selection lead to evolution?

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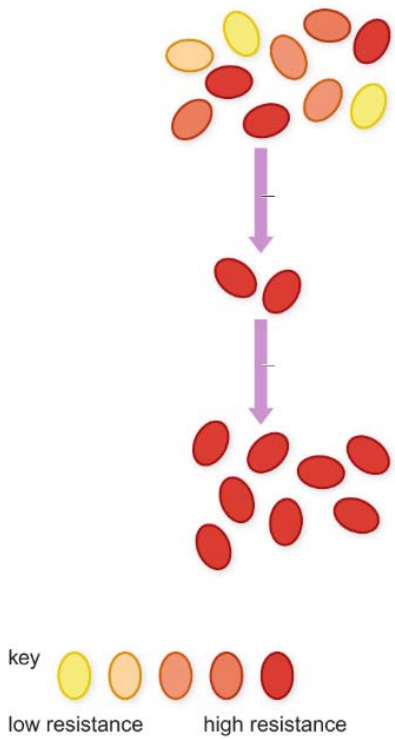
Darwin's theory cont.



Explain how bacteria become resistance to antibiotics, supporting Darwin's theory.

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Classification:

Complete the table identifying the kingdoms and their main characteristics.

Kingdom	Characteristics

What can be said about the DNA analysis of closely related organisms?

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Explain how genetic analysis led to Archaea being placed in their own domain.

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Breeds and varieties

What is selective breeding?

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State characteristics that plants and animals are bred for:

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What is genetic engineering?

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Explain the advantages and disadvantages of GM rice ' golden rice'

Advantages:

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Disadvantages:

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Genes in agriculture and medicine

What are the benefits of selective breeding?

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What are the risks of selective breeding?

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Explain the advantages and disadvantages of **GM herbicide resistant plants:**

Advantages

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Disadvantages

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Explain the advantages and disadvantages of **GM insulin**

Advantages

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Disadvantages

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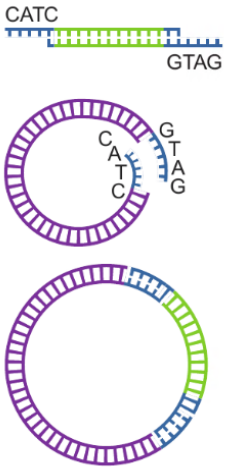
Genetic engineering of bacteria (Higher)



Explain how genetic engineering of bacteria is carried out.
Include following keywords: restriction enzymes, sticky ends, ligase, vector

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CB4 Health, disease and genetic modification exam questions (28 marks)

Foundation questions

Q1.

Figure 12 shows the times when *Homo sapiens* and some of their ancestral species are thought to have lived.

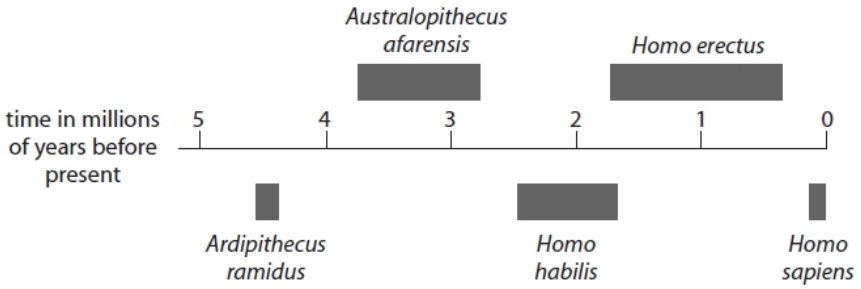

Figure 12

Fossil remains of *Ardipithecus ramidus* were discovered in Ethiopia.

(i) Calculate the number of years *Ardipithecus ramidus* is thought to have inhabited the Earth.

(2)

Answer .....

(ii) Describe the evidence that scientists might have used to show that *Ardipithecus ramidus* inhabited the Earth earlier than *Homo habilis*.

(2)

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(iii) Suggest an explanation for the extinction of *Homo habilis*.

(2)

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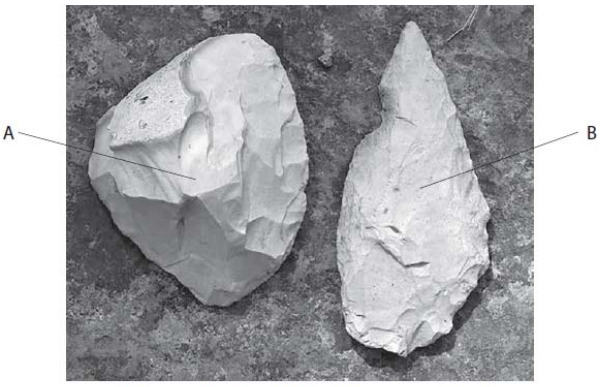
(iv) Figure 13 shows two stone tools, one used by *Homo habilis* and one used by *Homo erectus*.



(Source: Frederic Surmely/look at sciences/Science Photo Library)

Figure 13

Explain which stone tool was most likely to be used by *Homo erectus*.

Use information from Figure 12 and Figure 13.

(2)

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Q2.
Corn is one of the world's most important crop plants.

Native Americans grew an early form of corn called teosinte.
Modern corn has been developed by selective breeding of teosinte plants.

Describe how selective breeding has produced modern corn.

(3)

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Q3.
Corn is one of the world's most important crop plants.

Native Americans grew an early form of corn called teosinte.
Modern corn has been developed by selective breeding of teosinte plants.

Genetic engineering can also be used to produce a new variety of modern corn.

Describe how the genome of this new variety of corn is different from the genome of corn that has not been genetically engineered.

(2)

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Q4.

Colistin is an antibiotic used to treat infections in the bloodstream.

Some bacteria are resistant to Colistin.

Explain how these bacteria have become resistant to Colistin.

(4)

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(Total for question = 4 marks)

Q5.
Corn is one of the world's most important crop plants.

Native Americans grew an early form of corn called teosinte.
Modern corn has been developed by selective breeding of teosinte plants.

Figure 8 shows some stages in the development of modern corn.

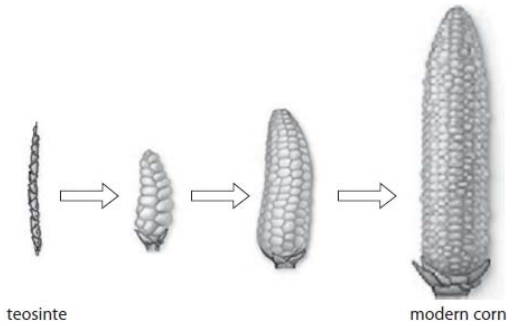

Figure 8

Give reasons why native Americans selectively bred teosinte.

(2)

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Higher questions

Q6.

Penicillin, isolated from a fungus, was the first antibiotic used to treat bacterial infections and is still widely used today

Scientists have genetically engineered bacteria to produce large amounts of penicillin.

Describe how scientists would produce a genetically modified bacterium that produces penicillin.

(4)

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Q7.
Figure 3 shows a plasmid containing the human insulin gene.

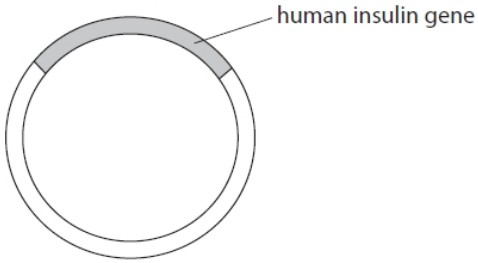

Figure 3

Explain how the human insulin gene can be inserted into a plasmid.

(3)

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Q8.
Organisms can be classified by the five kingdom or three domain method.

(i) What is the name of the domain that plants belong to?

(1)

- ☒ **A** Eukarya
- ☒ **B** Archaea
- ☒ **C** Monera
- ☒ **D** Protista

(ii) Plant cells contain chloroplasts.

What happens in a chloroplast?

(1)

☒	**A**	oxygen produced	sunlight absorbed by chlorophyll
☒	**B**	carbon dioxide produced	sunlight absorbed by mitochondria
☒	**C**	oxygen produced	sunlight absorbed by mitochondria
☒	**D**	carbon dioxide produced	sunlight absorbed by chlorophyll

(iii) Give a reason why the three domain method of classification has been suggested.

(1)

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Mark Scheme

Q1.

Question number	Answer	Mark
(i)	• 4.6 million – 4.4 million (1) • 0.2 million years/200 000 years (1)	(2)

Question number	Answer	Additional guidance	Mark
(ii)	An answer that combines knowledge (1 mark) and understanding (1 mark) to provide a logical description: • (scientists might look for) differences in the structural features of the fossil (1) • and *Ardipithecus ramidus* would be deeper in the rock layer than *Homo* {*habilis*/stone tools} (1)	e.g. *Ardipithecus ramidus* smaller cranial capacity	(2)

Question number	Answer	Additional guidance	Mark
(iii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • likely to be out-competed by *Homo erectus* (1) • {for resources essential for survival/due to the presence of a new selection pressure} (1)	accept: named resources accept: named selection pressure, e.g. climate change, environmental change, disease	(2)

Question number	Answer	Additional guidance	Mark
(iv)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • stone tool B because it is more {sophisticated/worked} (1) • and *Homo erectus* lived more recently than *Homo habilis* (1)	accept: data quoted from the timeline	(2)

Q2.

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • best characteristics/named characteristic chosen (1) • parents bred together (1) • offspring produced showing some of the best characteristics are selected (1) • selection and breeding process repeated (1)	accept reference to pollination / fertilisation	(3)

Q3

Question number	Answer	Mark
	An answer that provides a description by making reference to: • an extra/new gene (1) • present in the DNA/chromosome (1)	(2)

Q4.

Question	Answer	Additional guidance	Mark
	An explanation linking four of the following:		AO2 1 (4)
	• people do not finish their course (of Colistin) (1)	accept overuse / repeated exposure (to the antibiotic)	
	• natural selection /evolution (occurs) (1)	accept they have evolved	
	• some bacteria have a mutation/ (genetic) variation (1)	accept some bacteria have a {**gene/allele**} for resistance	
	• (these) resistant bacteria survive /resistant bacteria reproduce (1)	accept the non-resistant bacteria die / the fittest bacteria survive ignore immune bacteria	

Q5.

Question number	Answer	Additional guidance	Mark
	• to produce more food (1)	bigger plants , produce more kernels,	(2)
	• to improve quality of food (1)	more sweet/juicy, pest resistant,	

Q6.

Question number	Answer	Mark
	An answer that combines knowledge (2 marks) and understanding (2 marks) to provide a logical description: • use restriction enzymes to remove the gene and cut the plasmid (1) • use of ligase to join DNA molecules together (1) • cut the gene from the genome of the fungus and extract a plasmid from the bacteria (1) • insert the recombinant plasmid back into the bacteria (1)	**(4)**

Q7.

Question number	Answer	Additional guidance	Mark
	An explanation linking the following: • cut the gene (from the genome) using **restriction** enzymes (1) • cut the plasmid with a **restriction** enzyme (1) • to leave {complementary / matching} sticky ends (1) • join the DNA using **ligase** (1)	accept endonucleases accept endonucleases accept the same sticky ends reject lipase	**(3)** AO1(1)

Q8.

Question number	Answer	Mark
(i)	A Eukarya **i. The only correct answer is A** ***B** is not correct because plants are not single celled prokaryotic organisms* ***C** is not correct because plants are not single celled prokaryotic organisms and Monera is a kingdom* ***D** is not correct because Protista is a kingdom and not a domain*	**(1)** AO1 (1)

Question number	Answer	Mark
(ii)	A oxygen produced sunlight absorbed by chlorophyll **ii. The only correct answer is A** ***B*** *is not correct because photosynthesis doesn't produce carbon dioxide and sunlight is not absorbed by mitochondria* ***C*** *is not correct because sunlight is absorbed by chlorophyll not mitochondria* ***D*** *is not correct because photosynthesis doesn't produce carbon dioxide it produces oxygen*	**(1)** AO1 (1)

Question number	Answer	Mark
(iii)	Any one from: • (improved) genetic analysis (1) • DNA/RNA {screening/sequencing} (1) • domain theory is based on genetics (1) • differences between coding and non-coding DNA (1)	**(1)** AO1