Unit 2: Body Systems, Genetics, Microorganisms and Health

2.4 Genome, chromosomes, DNA and genetics

Content - CCEA Double Award Biology 2 – Fort Hill Integrated College HW Booklet Name: _____	Got it	Nearly	Haven't a clue
2.4 Genome, chromosomes, DNA and genetics			
Can you describe the genome as the entire genetic material of an organism;			
Chromosomes			
Can you identify and describe chromosomes as genetic structures occurring in functional pairs in the nucleus of cells, except gametes and bacteria?			
Genes and alleles			
Can you identify and describe genes and alleles as sections of chromosomes made up of short lengths of DNA that operate as functional units to control characteristics and demonstrate understanding that alleles are different forms of the same gene;			
DNA structure			
Can you demonstrate knowledge and understanding of the structure of DNA, including: • a phosphate and sugar (deoxyribose) backbone with interlinking bases to form a double helix; • base pairing rules and the unique nature of an individual's DNA; and • **the link between the DNA code and the build-up of amino acids in the correct sequence to form protein: the base triplet hypothesis (transcription and translation not required);** and			
Cell division			
Can you demonstrate knowledge and understanding of mitosis as part of the cell cycle, limited to cell growth and cell division, which allows organisms to: • grow; • replace worn out cells; and			

• repair damaged tissue.			
Mitosis			
Can you outline mitosis as the exact duplication of chromosomes producing daughter cells that are genetically identical to parent cells and clones (names of phases and details of DNA replication not required);			
Meiosis			
Can you demonstrate knowledge and understanding of meiosis as reduction division (one cell producing four genetically different, haploid daughter cells) **and as a process that, through independent assortment, reassorts the chromosomes to provide variation (crossing over and the stages of meiosis are not required);**			
Genetic diagrams and terminology			
Can you demonstrate knowledge and understanding of and interpret genetic diagrams consisting of a single characteristic controlled by a single gene with two alleles (monohybrid cross) in plants, animals and humans, including: • dominant and recessive alleles; • genotype, phenotype, gamete and offspring ratios, percentages and probabilities; • homozygous and heterozygous genotypes; • Punnett squares to determine genotype frequencies; • **test (back) crosses to determine an unknown genotype; and** • **pedigree diagrams;**			
The X and Y chromosomes			
Can you demonstrate knowledge and understanding of how sex is determined in humans; and			
Genetic conditions			
Can you demonstrate knowledge and understanding of and explain the inheritance of these genetic conditions: • **haemophilia;** • cystic fibrosis; • Huntington's disease; and			

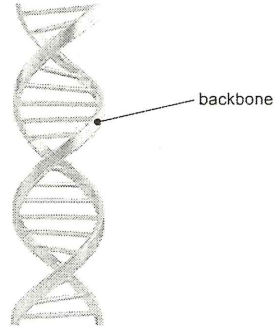
• Down's syndrome.			
Genetic screening			
Have you explored the increasing understanding of the human genome and evaluate associated ethical issues of genetic screening, including: • who decides who will be tested; • benefits and risks of amniocentesis compared to blood tests; • the dilemma for carriers of genetic conditions after a test that diagnoses abnormalities; and • making genetic information available to wider society, for example insurance companies; and			
Genetic engineering			
Can you demonstrate knowledge and understanding of genetic engineering as a process that modifies the genome of an organism to introduce desirable characteristics, **including:** • **the basic techniques used to produce human insulin for treatment of diabetes (transfer of a human insulin gene into a plasmid of a bacterial cell to form a genetically modified bacterium that can then be cultured in a fermenter to produce human insulin);** • **using restriction enzymes to produce 'sticky ends';** • **the need for down streaming (extraction, purification and packaging) to produce a pure form of insulin that can be used to treat diabetes; and** • **the advantages of producing human insulin and other products by this method.**			

B2.4 Genome, Chromosomes, Genes, DNA and Genetics

In this section, students develop understanding of the structure and function of chromosomes, genes and DNA. Students investigate the processes of cell division and monohybrid genetics. Students develop understanding that mutation can occur in genetic codes and they investigate opportunities and moral issues that are linked to our developing understanding in this area. They also learn about genetic engineering.

1. The diagram shows part of a DNA molecule.

Examiner Only | Marks | Remark



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(a) Name the two molecules found in the DNA backbone.

1. _____

2. _____ [2]

(b) Chargaff investigated the chemical composition of DNA in different animals. The table shows some of his results.

	Percentage of bases			
Mammal	**A**	**G**	**C**	**T**
Rat	28.6	21.6	20.4	28.4
Human	30.9	19.1	18.4	29.6
Pig	29.4	20.5	20.5	29.6
Sheep			21.0	

8956

(i) Give **three** conclusions from Chargaff's results.

Examiner Only | Marks | Remark

_____

_____

_____

_____

_____ [3]

(ii) Sheep have 21% cytosine (C) in their DNA.

Calculate the expected percentage of adenine (A) in sheep.

Show your working.

_____ [2]

2. **(a)** DNA from different people has similarities but it also has differences that cause each person to be unique.

(i) Describe the **similarities** in the structure of DNA molecules from different people.

_____

_____

_____

_____

_____ [3]

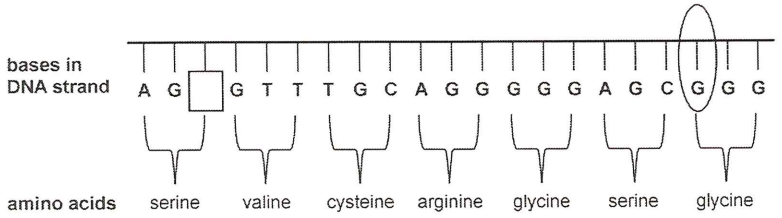
(ii) Describe how DNA differs from one person to another making each of them unique.

_____

_____ [1]

(b) DNA codes for the sequence of amino acids in a protein.

The diagram shows a section of a DNA strand and the sequence of amino acids that will be produced.



(i) Use the information in the diagram to give the letter of the missing base for the first amino acid.

_____ [1]

A mutation occurs in the DNA strand causing the base G, circled, to be replaced by another base, A.

(ii) Use the diagram to describe and explain what effect this mutation will have on the **final protein** produced.

_____

_____

_____

_____

_____

_____

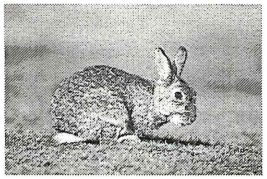
_____ [2]

[Turn over

3. Wild rabbits have brown fur.

Albino rabbits have white fur.

brown rabbit



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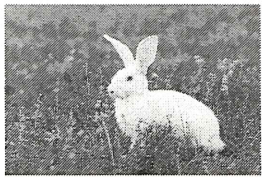
white rabbit



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Brown fur is controlled by a dominant allele **B**.

White fur is controlled by a recessive allele **b**.

(a) What is an allele?

_____

_____ [1]

(b) The diagram shows a cross between a brown rabbit and a white rabbit.

Parents brown × white

Genotypes **Bb** ☐

Gametes (**B**) (**b**) × (**b**)

Offspring

		White
		b
Brown	B	Bb
	b	bb

(i) **Complete the diagram** by adding the genotype of the white parent. [1]

(ii) What term is used to describe the genotype of the brown parent?

_____ [1]

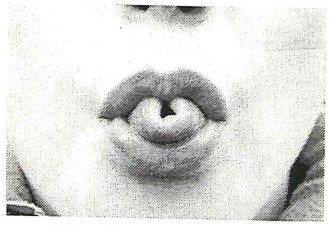
(iii) Name the grid used to work out the genotypes of the offspring.

_____ [1]

(iv) What is the ratio of genotypes in the offspring?

_____ [1]

4. The photograph shows a girl rolling her tongue.



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Tongue rolling is controlled by a gene.

(a) What is a gene?

_____

_____ [1]

The gene for tongue rolling has two alleles.

The allele for tongue rolling **(R)** is dominant to the allele for non-rolling **(r)**.

(b) **(i)** **Complete the Punnett square** to show the possible children of two people who can roll their tongue.

		Mother	
	Gametes	**R**	**r**
Father	**R**		Rr
	r		rr

[2]

(ii) Draw a (circle) around the genotype of the homozygous recessive child. [1]

(iii) What proportion of the children could be heterozygous?

_____ [1]

5. A student carried out a genetic cross between two pure breeding pea plants. The shape of the seed is controlled by two alleles.

Examiner Only	
Marks	Remark

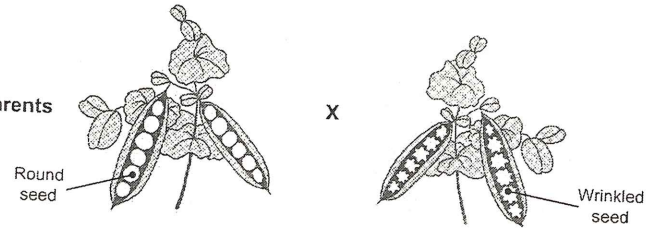
(a) What is an allele?

.....

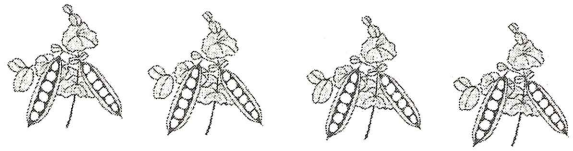
.....

[1]

The allele for round seed (**R**) is dominant to the allele for wrinkled seed (**r**).



Genotypes **RR** ☐



Genotypes **All Rr**

Look at the diagram.

(b) **Complete the diagram** by writing the genotype of the wrinkled seed parent in the box. [1]

The allele for wrinkled seed is recessive.

(c) Use evidence from the diagram to explain how you know that the allele for wrinkled seed is recessive.

.....

.....

.....

[1]

(d) A student grew plants using two seeds from the offspring.

He allowed these plants to fertilise each other.

(i) Complete the Punnett square to show the results of this cross.

		gametes	
		R	**r**
gametes	**R**		
	r		

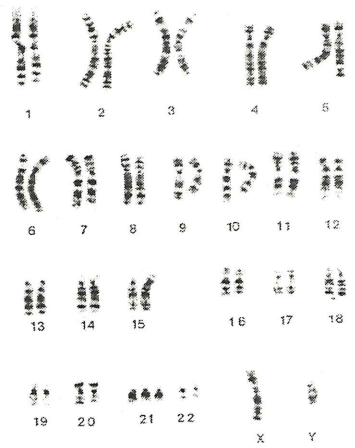
[2]

(ii) Draw a (circle) around the homozygous dominant genotype in the Punnett square. [1]

Examiner Only	
Marks	Remark

6. (a) Mutations can cause inherited conditions.

The diagram shows a set of chromosomes with a mutation.



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(i) Name the condition this mutation causes.

_____ [1]

(ii) Use evidence from the diagram to explain how you identified this condition.

_____

_____

_____ [2]

(iii) What evidence in the diagram suggests these chromosomes belong to a human?

_____

_____ [1]

(iv) What evidence in the diagram suggests these chromosomes belong to a male?

_____

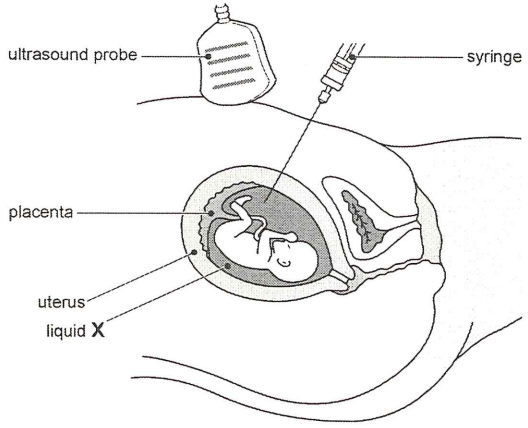
_____ [1]

(b) Genetic screening is used to find out if a developing foetus has a condition caused by a mutation.

Liquid containing foetal cells is removed using a syringe.

These cells are allowed to multiply in a Petri dish.

The chromosomes are examined to see if the foetus has the condition.



© Reproduced from: Royal College of Obstetricians and Gynaecologists. Chorionic villus sampling and amniocentesis. Patient Information Leaflet. London: RCOG; 2011, with the permission of the Royal College of Obstetricians and Gynaecologists.

(i) Name liquid **X**.

_____ [1]

(ii) Name this test.

_____ [1]

(iii) During the test the doctor uses an ultrasound probe to find the position of the foetus.

Why is this necessary?

_____

_____

_____ [1]

(iv) Give **two ethical** objections to genetic screening.

_____

_____

_____

_____ [2]

7.

During pregnancy the baby can be screened for chromosome abnormalities.

Cells from the baby are removed and allowed to divide. During the cell division the chromosomes are photographed.

(a) Name this type of screening test.

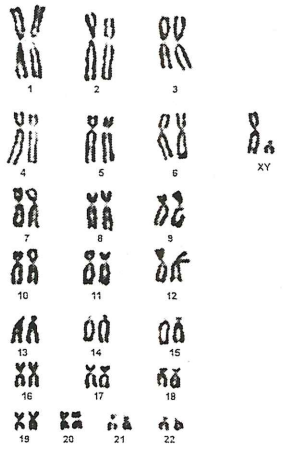
_____ [1]

(b) Name the part of the cell where chromosomes are found.

_____ [1]

The photographs show the chromosomes of two babies.

Baby A



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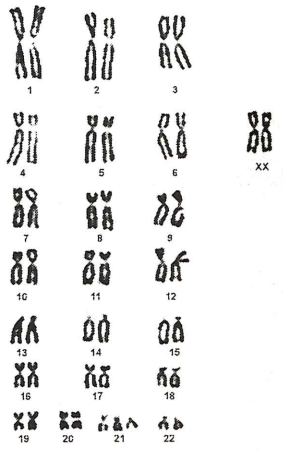
Baby B



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Baby **B** suffers from a chromosome abnormality.

(c) Name the condition caused by this chromosome abnormality.

_____ [1]

(d) What term describes the random change that causes chromosome abnormalities?

_____ [1]

Identical twins have identical sets of chromosomes.

(e) Give **one** piece of evidence from the photographs to explain why baby **A** and baby **B** are **not** identical.

_____ [1]

(f) Give **two** ethical issues that may arise because of this screening test.

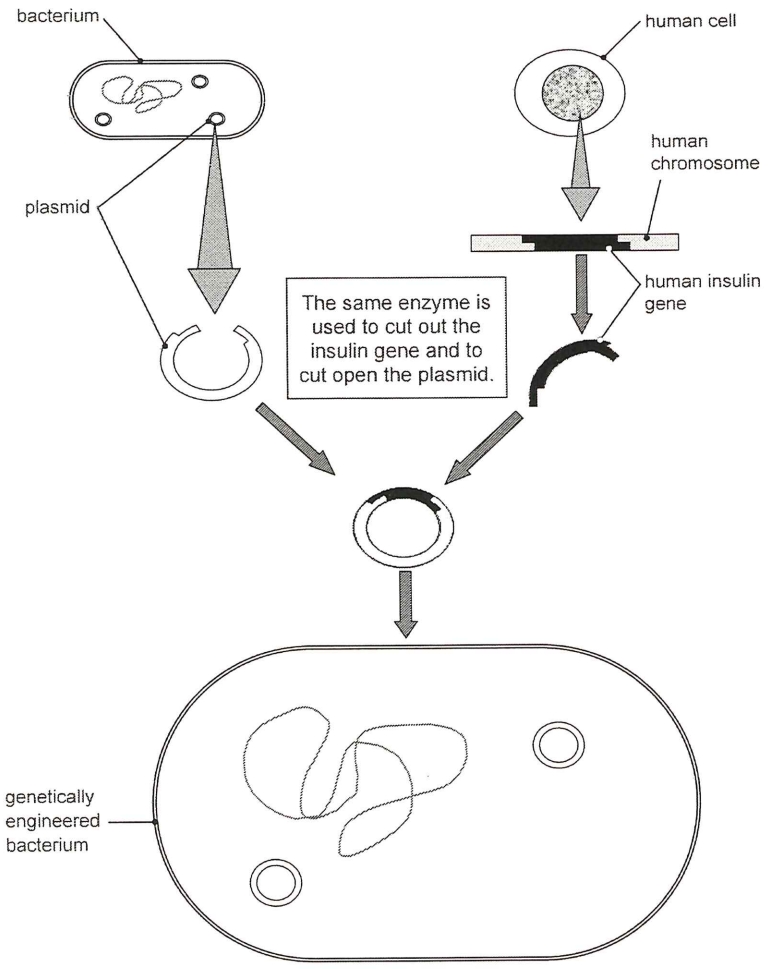
_____

_____

_____

_____ [2]

8. **(a)** The diagram shows how bacteria can be genetically engineered to produce human insulin.



(i) **Complete the diagram** of the genetically engineered bacterium. [1]

(ii) Name the type of enzyme used to cut out the human insulin gene and to cut open the plasmid.

_____ [1]

(iii) Explain why the same enzyme must be used to cut out the insulin gene and to cut open the plasmid.

_____

_____

_____

_____

_____

_____ [3]

(iv) Describe how this genetically engineered bacterium could be used to produce large quantities of human insulin **before** the insulin is downstreamed.

_____

_____

_____

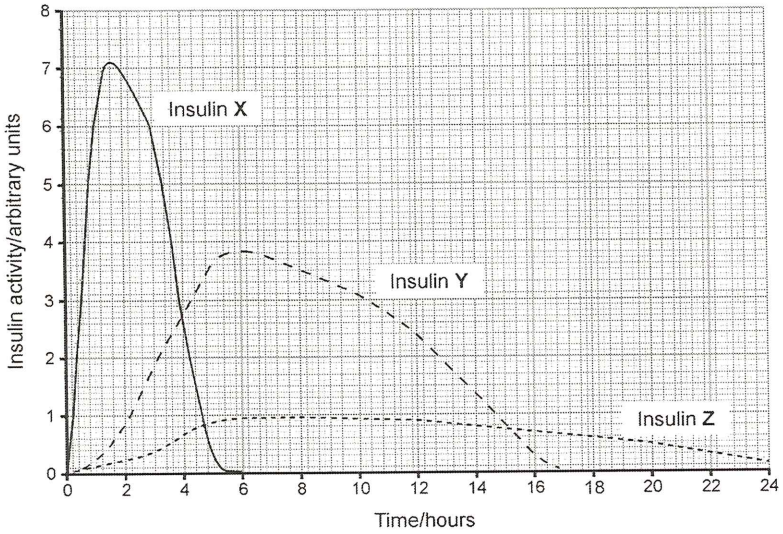
_____

_____ [2]

[Turn over

Genetic engineering can be used to produce different types of insulin for the treatment of diabetes.

The graph shows the activity of three types of insulin.



The blood glucose level of a patient suffering from diabetes rises rapidly after a meal.

(b) Suggest which type of insulin would be best to treat this patient.

Explain your choice and include **data** from the graph to support your answer.

Type of insulin _____

Explanation _____

_____

_____

_____

_____

_____

_____ [3]