Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	Non-coding DNA ✓ Transcription✓ Ribosomes ✓ Translation ✓	4 (4 x AO 1.1)	**Examiner's Comments** This gap fill question all candidates attempted and the majority scored either three or four marks. Only a small number were not given any marks here. The most common given marks were for transcription and translation identified correctly. The most common error candidates made was stating that genes can be switched on by coding DNA instead of non-coding DNA.
		ii	(Genetic engineering) introduce a gene from another organism ORA ✓	1 (AO 1.1)	**AW** adding/transfer/insert for introduce **IGNORE** change/replace genes/DNA from another organism **ALLOW** only uses gene from one organism **Examiner's Comments** This question proved the most challenging to the candidates assessing their knowledge and understanding of genetic engineering. Most candidates were not able to describe the process of genetic engineering. Vague references to vectors and various enzymes were answered. Where candidates did identify moving a gene, they did not clearly identify that the gene was from another species. Common responses included genetic engineering swaps/replaces a gene. **Misconception** There has been a knowledge gap identified and most candidates did not

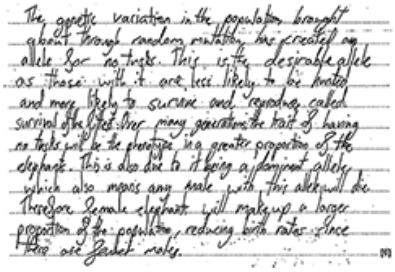
					know that in genetic engineering genes are introduced from one organism to another. Misconceptions included, swapping genes / replacing genes and part of selective breeding. Revisiting key ideas throughout the GCSE course would help remove and eliminate these misconceptions.
			Total	**5**	
2	a		(Huntington's) prevents/reduces the cerebrum/brain sending impulses (to move the legs) ✓ (MD) cannot contract muscles/effectors (to move the legs) ✓ (SMA) prevents/less impulses being carried by motor neurones✓	3 (3 x AO 2.1)	**AW** signals throughout **ALLOW** spinal cord can receive less impulses **ALLOW** brain sends impulses to spinal cord **ALLOW** muscles contract to move legs **ALLOW** prevents/less impulses reaching muscles/effectors **ALLOW** motor neurones send impulses to muscles/effectors **Examiner's Comments** This question challenged the candidates and demonstrated a knowledge gap whereby candidates could not apply their knowledge of the co-ordinated nervous responses to this question. The most common given mark candidates were awarded was identifying in MD cannot contract muscles. A lot of candidates rewrote the question that they can't move because muscle cannot be made. This was one of the lowest scoring questions on the paper. **Assessment for learning** This has been identified as a knowledge gap. Candidates did not use scientific language to describe nervous impulses, instead spoke about messages and communication.

					Many candidates described the part of the nervous system affected incorrectly or had the impulses passing the wrong direction. Revisiting key knowledge across the GCSE course is invaluable in ensuring candidates are used to using key scientific terms in the correct context.
	b		Huntington's/dominant as it produces a protein and MD & SMA/recessive because it doesn't produce a protein (that causes the disease) ✓ **AND** Only one affected allele would cause the disease in Huntington's ✓ **OR** Both alleles would need to be affected to have the disorder in MD & SMA ✓	2 (2 x AO 2.1)	**ALLOW** only need one (affected) allele to be expressed when it is dominant. **ALLOW** need both (affected) alleles to be expressed when it is recessive **Examiner's Comments** Over half of candidates achieved a mark here but very few were able to gain both marks. The most common given mark was for candidates having appreciated that Huntington's produces and protein and in MD and SMA it doesn't produce a protein. Very few could qualify this by applying their knowledge of genetic inheritance that this was because you only need one affected allele to be expressed when it is dominant or need both affected alleles when it is recessive. This was one of the most challenging questions for candidates to obtain full marks.
	c		**Any two from**: Rejection (of cells) ✓ New cells would be damaged again by protein/not work ✓ Cells could mutate and become cancerous/form tumours ✓ Open to Infection/disease ✓	2 (2 x AO 1.1)	**AW** immune response **ALLOW** immunocompromised / immunosuppression / weakened immune system / transfer virus **IGNORE** unknown long-term effects / ethical issues

					Examiner's Comments Candidates demonstrated a lack of knowledge and understanding on the risks of using stem cells. Over half could identify that the cells could be rejected but very few could identify another risk factor. Many misinterpreted the question and spoke about ethical issues, which are not risk factors only negative arguments or stated vague effects such as side effects. Many candidates did not score on this question. **Assessment for learning** This has been identified as a knowledge gap. Candidates would benefit revisiting key knowledge throughout their GCSE course to embed key ideas. Candidates should be able to develop their scientific enquiry skills such as being able to differentiate risks with ethical issues in their evaluation skills.
			Total	**7**	
3			**Level 3 (5–6 marks)** Detailed explanation why the number of tuskless elephants is rapidly increasing in East Africa using ideas of both inheritance and natural selection. **AND** Explains why the spread of this allele may have negative effects on the elephant population *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Explanation why the number of tuskless elephants is rapidly increasing in East Africa using ideas from either inheritance or natural selection.	6 (2 x AO 1.1) (2 x AO 2.1) (2 x AO 3.2a)	**AO1.1 Demonstrates knowledge and understanding of scientific ideas to explain the significance of the allele being dominant**. **Inheritance:** • Dominant allele is **always** expressed if present • **Only one** tuskless allele needed to give phenotype/for elephant to be tuskless **AO2.1 Applies knowledge and understanding to explain why the proportion of tuskless elephants are increasing**. **Inheritance:** • 50% chance of offspring inheriting this allele (if mother is tuskless)

			AND Explains why the spread of this allele may have negative effects on the elephant population *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Explanation why the number of tuskless elephants is rapidly increasing in East Africa using ideas from either inheritance or natural selection. **OR** Explains why the spread of this allele may have negative effects on the elephant population *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant*. **0 mark** *No response or no response worthy of credit.*		• 50% chance of female elephants born with tusks (if mother is tuskless) • only females born tuskless • 100% of male elephants born with tusks / 0% male elephants born with no tusks (if inherit dominant allele) • Males can only survive as homozygous recessive • Accept correct Punnett square showing heterozygous x homozygous recessive **Natural selection:** • Tuskless elephants are less likely to be hunted ORA • The tuskless elephants are more likely to survive and breed ORA • The allele for tuskless is more likely to be passed on ORA • The frequency of the tuskless allele will increase in the population over time • No males born without tusks **AO3.2a Analyses information to explain why the spread of the allele may have negative effects**. • (The allele is lethal to male embryos) so fewer male elephants will be born/male population will fall • This will cause the number of males to females in the population to be unbalanced • Female elephants may find it harder to find a mate • More males hunted with tusks so less males • (Female) elephants will not be able to defend themselves without tusks. • Idea tusks are used to access food **<u>Examiner's Comments</u>** Just under half of candidates were

					given Level 2 in the Level of Response extended writing question and could access the question where they had to apply their knowledge and analyse information to explain why the number of tuskless elephants is rapidly increasing and why this may have negative effects on the population. Just under half of candidates achieved Level 1 or Level 3 and a small number were not given any marks. The most common given explanation was understanding that if less males are born due to the allele being fatal to them, so females would have less mates available to reproduce. Some candidates got confused that males would still be born but tuskless and unable to defend themselves however that would be the argument that the consequence for the tuskless females. Most candidates who correctly explained why the population of tuskless elephants are increasing identified the natural selection idea. Some candidates were able to provide a detailed explanation using their ideas of natural selection and genetic inheritance. Candidates who tried to explain using their knowledge of genetic inheritance got confused that males could pass on the allele so offspring could be homozygous dominant which could not happen. The most common credited response regarding explanations using genetics were candidates appreciating that the dominant allele is always expressed if present. Some candidates stated incorrectly that the dominant allele is always expressed in the offspring if the parent has it which cannot happen as the female cannot be homozygous dominant. Exemplar 1

					 The candidate explains why the number of tuskless elephants are increasing due to natural selection and explains why the spread of this allele will have negative consequences on the population so was given Level 2. The candidate did not provide a detailed explanation of why the numbers are increasing because they did not explain using ideas about genetic inheritance.
			Total	**6**	
4			**D**	1 (AO 1.1)	
			Total	**1**	
5			**A**	1 (AO 2.1)	**Examiner's Comments** This was one of the lowest scoring questions in this section despite over half achieving this mark, demonstrating good knowledge of genetic inheritance. The most common incorrect question was stating Rat 2 is homozygous dominant which was incorrect because all offspring would be grey if this was the case when reproduced with Rat 3.
			Total	**1**	
6			**B**	1 (AO 2.1)	**ALLOW** 4 **Examiner's Comments** This was one of the lowest scoring questions in this section on meiosis. Just under half of candidates could not identify the diploid number of chromosomes and did not see that meiosis is a process whereby DNA is replicated first then undergoes two divisions to end with a haploid

					number. The most common incorrect response was identifying the haploid number in the daughter cells as the diploid number. **Assessment for learning** Centres should make sure that meiosis is revisited more than once during the GCSE course as it has been identified as a knowledge gap. This could be through multiple choice questions, progress checks and knowledge retrievals.
			Total	**1**	
7		i	(Larger seeds) will not be spread by the wind ✓ (New buddleia) less likely/will not spread to other habitats ✓	2 (2 xAO 3.1a)	**ALLOW** (larger seeds) mean less seed dispersal by wind **ALLOW** (larger seeds) will not be spread by other insects/butterflies **IGNORE** less seeds **ALLOW ORA** for smaller seeds **ALLOW** less/no colonisation **IGNORE** damage to habitats **Examiner's Comments** This question required candidates to analyse the information and draw conclusions about why larger seeds would reduce damage to habitats, which candidates seemed to find challenging. The most successful responses were able to link larger seeds having less chance of seed dispersal via wind. The majority of unsuccessful responses stated that the larger seeds meant fewer seeds produced which is why there was less damage to habitats. **Assessment for learning** Centres could provide more opportunities for candidates to analyse information and draw conclusions. These AO3 skills are accessed in the

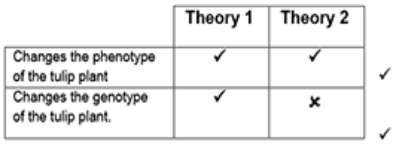
					exam and make up 20%. ExamBuilder can be used to filter for questions that focus on analysis for practice with candidates.
		ii	(Uneven numbers of chromosomes will) prevent gametes being made (by meiosis) ✓ Buddleia will slow down/not be able to produce seeds/reproduce ✓	2 (2 xAO 3.1a)	**AW** ovule and/or pollen for gametes **ALLOW** prevent haploid cells being made **IGNORE** prevents meiosis/replicate **ALLOW** slow down/stop fertilisation **ALLOW** number of seeds reduce **Examiner's Comments** A large number of candidates gained at least 1 mark on this question, mostly given for less reproduction/fewer seeds produced when meiosis is prevented. The most successful responses also correctly identified that fewer gametes would be produced as a result. Some responses that were not given any marks just reworded the question and said stopping meiosis would stop cell division and therefore growth of the buddleia bushes. This did not correctly identify that it's stopping gamete production specifically.
			Total	**4**	
8		i	Asexual (reproduction) ✓	1 (AO 1.1)	**ALLOW** vegetative / cloning / budding **DO NOT ALLOW** mitosis **Examiner's Comments** More than half of candidates could correctly identify asexual reproduction as how duckweed reproduce. Most common unsuccessful response was mitosis. **Misconception** Candidates confused mitosis, which is the type of cell division which produces genetically identical daughter cells, with asexual reproduction, which produces genetically identical offspring and

					does not require fusion of gametes. Centres should make sure this difference is passed onto the candidates when learning about asexual reproduction.
		ii	5 ✓	1 (AO 3.1a)	**ALLOW** 4 **Examiner's Comments** Half of all candidates could correctly analyse the information to work out the correct number of generations present after 10 days.
			Total	**2**	
9			**D**	1 (AO 2.1)	
			Total	**1**	
10			**C**	1 (AO 1.1)	
			Total	**1**	
11			**A**	1 (AO 2.1)	**Examiner's Comments** This was the most accessible question on the multiple choice Section A, with most candidates correctly answering A and calculating the number of males in the population from a percentage.
			Total	**1**	
12			**C**	1 (AO 1.1)	**Examiner's Comments** This was one of the most accessible questions on the multiple choice Section A, with most candidates correctly answering C and knowing the correct definition of the genome.
			Total	**1**	
13			**B**	1 (AO 1.1)	**Examiner's Comments** This was one of the most accessible questions on the multiple choice Section A, with most candidates correctly answering B and knowing that Gregor Mendel helped develop

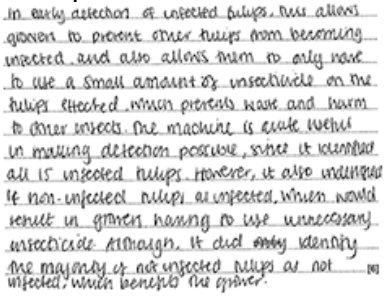
					our understanding of dominant and recessive characteristics.
			Total	**1**	
14	a		Has Down's syndrome/does not have Edward's syndrome ✓ Female/a air! ✓	2 (2 ×AO 3.2b)	**DO NOT ALLOW** more likely to/may have Down's syndrome/less likely to have Edward's syndrome **IGNORE** they have an extra chromosome/47 chromosomes **Examiner's Comments** This AO3.2b question required candidates to draw suitable conclusions from the diagram. A good number of candidates recognised the 2 X chromosomes and the 3 copies of chromosome number 21. They concluded that this child was a female, and that they had Down's syndrome. A surprising number of candidates were distracted by the Y on the diagram and suggested this was a male. This child does have Down's syndrome so answers that said, 'may have' or 'could have' Down's syndrome did not score the second marking point.
	b	i	**Any two from:** Down's syndrome increases as the age of the mother increases ✓ Edward's syndrome increases as the age of the mother increases ✓ Down's syndrome is more common than Edward's syndrome (at any age) ✓ Down's syndrome increases more rapidly after the age of 25-29/30-34/35-39/40/40 or older ✓ Edward's syndrome increases more rapidly after the age of 30-34/35-39/40 or older ✓	2 (2 × AO 3.2b)	**ORA** for all marking points **Examiner's Comments** This AO3.2b question was extremely well answered by all candidates. Most candidates scored full marks as they could draw correct conclusions from the graph. A very small number of candidates only scored 1 mark. This was because one of their conclusions was too vague, referring to genetic diseases or genetic conditions instead of Down's syndrome and/or Edward's syndrome as seen on the key on the graph.
		ii	In older women meiosis takes longer which increases the chance of an egg being made with an extra chromosome/ a mutation occurring ✓	1 (AO 3.2b)	**IGNORE** eggs have been in a woman longer with no reference to duration of meiosis **Examiner's Comments** This AO3.2b question proved to be very challenging, even for some of the

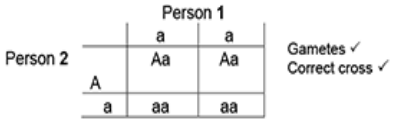
					higher ability candidates. Very few candidates scored the mark. Some candidates correctly suggested that meiosis had been going on for longer but then didn't link it to increasing the chance of an egg having a mutation or an extra chromosome to explain the trends shown in the graph. Many answers referred to the menopause, or that older women had been making eggs for longer or that they now do not have any eggs. None of these answers would explain the trends in the graph as required by the question.
	c	i	Haploid is half the number of chromosomes/one chromosome from each pair/one set of chromosomes ✓ Diploid is the full number of chromosomes/the chromosomes are all in pairs/two sets of chromosomes ✓	2 (2 × AO 1.1)	**ALLOW** haploid cells have 23 chromosomes and diploid cells have 46 chromosomes **IGNORE** incorrect chromosome numbers **ALLOW** haploid cells have half the genetic information **Examiner's Comments** The majority of candidates were able to score at least 1 mark on this AOI .1 recall question. 'Haploid cells have half the number of chromosomes' was the most common marking point seen. Some candidates found it more difficult to express how diploid cells were different. Incorrect answers included they 'were full cells' and 'two pairs of chromosomes'. Some candidates scored 1 mark for stating that haploid cells have 23 chromosomes and diploid cells have 46 chromosomes. A good number were able to express the difference in terms of sets of chromosomes for full marks.
		ii	(Meiosis makes gametes/cells) that are haploid/have half the number of chromosomes ✓ **or** (meiosis makes gametes/cells) with 23 chromosomes/that do not have an extra chromosome/that do not have 24 chromosomes ✓ Idea that after fertilisation, the diploid/full number of chromosomes is	2 (2 × AO 1.1)	**Examiner's Comments** Candidates found the second part of 22a more challenging and only a small number scored full marks on this AO1.1 question. Many candidates knew that gametes were haploid, and that the gametes would not have any extra chromosomes if the children did not have a genetic disorder. Many responses included lots of detail about the process of meiosis to make these

			restored/the zygote has 46 chromosomes ✓		haploid gametes. Very few candidates went on to explain how these gametes would make children without these genetic disorders. **Assessment for learning** A good technique for centres to adopt would be for their candidates to be able to de-construct the question. The first part of this question is asking for an explanation of how meiosis makes gametes. The second part of this question is asking for an explanation of how children are produced without the genetic disorders. This required a response about the 2 gametes joining at fertilisation to make a diploid zygote, or to restore the full chromosome number.
			Total	**9**	
15	a		**Any two from:** All the offspring will be identical/clones ✓ Bulbs will grow/flower faster (than seeds) ✓ Idea that they know exactly what the flowers will look like / will be able to replicate desirable plants ✓	2 (2 × AO 1.2)	**DO NOT ALLOW** grow faster if linked to reproduce/finding a mate/having one parent **IGNORE** there will be more tulips made **IGNORE** ideas about cost/profit/efficiency **Examiner's Comments** Many candidates were able to score at least 1 mark on this AO2.2 question by knowing that the bulbs would all be identical. It was common to see the incorrect answer that asexual reproduction was quicker as there was only one parent, showing a misinterpretation of the question. Candidates that scored full marks said that the bulbs grow quicker or that the gardeners will be able to get the desirable plants.

					Misconception There was a misconception that the seeds and bulbs undergo sexual and asexual reproduction themselves, respectively, rather than being the product of the two different types of reproduction. This led to the incorrect answers about asexual reproduction of bulbs being faster, or that bulbs do not need to find a mate.
	b		 ✓ ✓	2 (2 × AO 2.1)	1 mark for each correct row **Examiner's Comments** Candidates scored well on this AO2.2 question if they followed the instructions and put ticks or crosses in the table. Those that scored 1 mark got the first row correct with 2 ticks but omitted the cross in the second row. **Assessment for learning** Candidates should practice a variety of questions asking for just ticks or ticks and crosses. This would encourage candidates to read the question carefully and to follow the directions in the question.
	c	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2112.68 award 2 marks** $\frac{2 \times 10^9}{14200} \times \frac{1.5}{100}$ ✓ 2112.68 ✓	2 (AO 1.2) (AO 2.2)	**ALLOW** any correct rounding of 2112.676056 **ALLOW** 2112/2113 for total number of infected tulips for 2 marks **ALLOW** correct answer in standard form **Examiner's Comments** Most candidates carried out this calculation well and scored full marks. Those that did not score often missed out the division by 14 200 hectares to convert their answer to the number of infected tulips in one hectare of land.

		ii	**Level 3 (5-6 marks)** Discusses the advantage of early detection and appreciates its consequences **AND** Discusses the usefulness of the machine including judgements based on the data *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** States an advantage of early detection **AND** Discusses the usefulness of the machine *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** State an advantage of early detection **OR** Discusses the usefulness of the machine *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit*	6 (2 × AO 2.1) (2 × AO 1.1) (2 × AO 3.2a)	**AO1.1 Demonstrates knowledge and understanding to state the advantages of early detection** • less insecticide/spray is needed • less chance that the virus is spread to other tulips (by the insects) **AO2.1 Apply knowledge and understanding to appreciate the consequences of early detection.** • less insecticide sprayed means less chance of pollution/less damage to the environment • less insecticide sprayed means less cost to grower • less insecticide sprayed means less risk to other insects **AO3.2a Analyse information to make judgements on the usefulness of the machine.** • machine can reduce the time needed to inspect tulips/the machine is faster • fairly accurate diagnosis/all/15 infected tulips are identified • only 14 diagnosed incorrectly • 14 diagnosed incorrectly can lead to more area being sprayed/loss of biodiversity • idea that although some non-infected are diagnosed, no infected tulips are missed **<u>Examiner's Comments</u>** * There were a lot of well-constructed answers to this Level of Response question covering the AO1.1 and AO3.2a components. Most candidates could state that early detection of the virus would stop the spread of infection and that the machine helped the farmer to quickly identify the infected tulips. Many candidates discussed the diagnosis rates of the machine and although it did identify

					some non-infected tulips as infected, they recognised that it did not miss out any infected tulips. The most common score was Level 2, 4 marks. The discussion of the advantage for AO2.1 was rarely seen to score at Level 3, as many candidates mentioned that there would be a disadvantage to using the machine if it detected noninfected tulips as infected. Exemplar 2  In early detection of infected tulips, this allows growers to prevent other tulips from becoming infected and also allows them to only have to use a small amount of insecticide on the tulips effected which prevents waste and harm to other insects. The machine is quite useful in making detection possible, since it identified all 15 infected tulips. However, it also identified 4 non-infected tulips as infected. When would result in growers having to use unnecessary insecticide. Although, it did identify the majority of not infected tulips as not infected, which benefits the grower. [6] This response represents an excellent example of how to gain maximum marks. The candidate has clearly stated the advantage of early detection by 'preventing other tulips from being infected' for AO1.1. They also discuss the advantage of the early detection as 'the use of a small amount of insecticide on the tulips effected, preventing waste and harm to other insects' for AO2.1. The candidate then discusses how useful the machine is, 'since it identified all 15 infected tulips' for AO3.2a. The communication is clear, concise and all aspects of the question have been covered so it scores Level 3, 6 marks. **OCR support** This 'how to answer 6 mark Level of Response questions' set of activities will be useful to share with candidates https:/www.ocr.org.uk/Images/561672-how-to-answer-6-mark-lor-activities.zip. It will allow them to practice identifying key parts of questions, as well as familiarise themselves with different levels of answer.

			Total	**12**	
16		i	<table><tr><th></th><th>Number of people in the family</th></tr><tr><td>males</td><td>6</td></tr><tr><td>people who are **homozygous recessive** for the gene</td><td>6 ✓</td></tr><tr><td>people who are **homozygous dominant** for the gene</td><td>0 ✓</td></tr></table>	2 (2 × AO 2.1)	**Examiner's Comments** Many candidates scored at least 1 mark on this AO2.1 question as they could identify and count the 6 people that were homozygous recessive for the gene, by counting the white circles and squares. The second number was only identified by the higher ability candidates as it required further application and understanding of the inheritance of the dominant allele in the family tree diagram. Some candidates counted the black circles and squares so put 5, without recognising the offspring genotypes that couldn't be produced if these parents were homozygous dominant. These parents had to be heterozygous to get the offspring shown on the family tree, so the answer should have been 0. **Assessment for learning** Candidates should practice genetic crosses using family tree diagrams. This would encourage candidates to work out the genotypes from the genetic crosses shown in the diagram and from the key of circles and squares and not assume that all people are either homozygous dominant or homozygous recessive.
		ii	 Probability = 0.5 / 50% ✓	3 (2 × AO 2.1) (AO 3.2b)	**ALLOW ECF** correct cross for incorrect gametes for 1 mark **ALLOW** ½, 1:1, 1 in 2 **Examiner's Comments** Even if the candidate had suggested incorrectly that person 2 was homozygous dominant in their count in Question 19(a)(i) they did not always use this information to complete the genetic diagram in this question and went on to score full marks. If the

					gametes and cross were both correct for AO2.1, then most candidates went on to score full marks by concluding the probability was 50% for the AO3.2b part of the question. Candidates that did not get the gametes correct, as they did not appreciate that person 2 was heterozygous were able to score 1 mark for the ECF for the correct offspring.
			Total	**5**	