

Contents

	<i>Page no.</i>
Speaker's notes for Presentation IB1.1 <i>Introduction</i>	B1-F2
Speaker's notes for Presentation IB1.4 <i>Cloning plants</i>	B1-F5
Speaker's notes for Presentation IB1.29 <i>Cloning – science fact or science fiction?</i>	B1-F8
B1 You and your genes – Foundation Workbook answers	B1-F12
B1 You and your genes – Higher Workbook answers	B1-F16

Further guidance

Speaker's notes for Presentation IB1.1 *Introduction*

Slide	Image details	Slide label/caption	Notes/comment
1	You and your genes – module title	Introduction	
2	Large crowd of people – looking up.	People are all very similar, but still unique. How does this happen?	Inheritance passes all the complex information required to develop a human being from parents to fertilized egg. Much of this information is the same e.g. the same organs are usually produced in the same place.
3	Couple with newborn.	All the information to make this baby came from his parents.	Very subtle differences exist in some of the information we receive, producing unique individuals.
4	Computer artwork of a human sperm approaching an egg during the process of fertilisation.	Information from each parent is carried in their sex cells.	Brothers and sisters aren't identical (except for identical twins), so even people with the same parents must still get a unique combination of information from their parents.
5	Light micrograph of a human egg cell after fertilization.	All the information to develop a human being has to fit inside the nucleus of a fertilized egg cell.	To fit the complex information into such a small space, it must be carried as chemical molecules.
6	Illustration of nucleus → chromosomes → genes, showing that each chromosome in the nucleus contains thousands of genes.	There are about 30 000 pieces of information in the nucleus. Each piece of information is called a gene. Genes are joined up in chains called chromosomes.	Genes are made of a chemical called DNA (deoxyribonucleic acid). This is a chemical code carrying the information needed to make a human being, in a similar way that letters in the alphabet form a code that we read as words.

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
7	False-colour light micrograph of a normal female karyotype, the full complement of female chromosomes arranged in numbered homologous pairs.	These are all the chromosomes from one human cell. 99.9% of the information in any fertilized egg is the same. Only 0.1% of the information they carry make this person unique.	Each person has 23 pairs of chromosomes. One chromosome from each pair comes from the mother and one from the father. These chromosomes were taken from the nucleus of a white blood cell of a woman. We can tell that she was female because the 23rd pair of chromosomes are the same shape (called X chromosomes). In a man this pair of chromosomes are different (one X and one Y shape).
8	Diverse group of teenagers.	Most features are controlled by several genes and are also affected by the environment, e.g. height.	It is unusual for a feature to be controlled by a single gene. [From KS3, ask students to suggest features which are genetically controlled (e.g. blood group, gender) or also have an environmental component (e.g. weight, skin colour, hair colour).]
9	Detail from slide 8: Diverse group of teenagers.	Hair colour.	Hair colour: controlled by several genes and also affected by exposure to sunlight or use of hair dye.
10	Detail from slide 8: Diverse group of teenagers.	Eye colour.	Eye colour: controlled by several genes working together.
11	Football stand: full.	Sometimes genes are faulty. How many people in this photograph do you think have no faulty genes?	
12	Football stand: empty.	None? We all have some faulty genes.	This can be thought of as copying out a page of a textbook (the alphabet 'code') and making a spelling mistake. A small change in a gene will not necessarily cause serious harm. It depends where the change occurs.
13	Cystic fibrosis patient receiving physiotherapy to aid breathing.	A small number of faulty genes cause diseases. This person has cystic fibrosis.	One of the symptoms of cystic fibrosis is the production of extra-thick mucus. This clogs the lungs and has to be removed by daily physiotherapy.

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
14	Football stand: almost empty.	Cystic fibrosis is the most common inherited disease in the UK. It affects 1 in every 2500 people.	
15	Football stand: beginning to fill up.	1 in 25 people carry the faulty gene that causes cystic fibrosis.	They have inherited the faulty gene from only one parent, not both. With cystic fibrosis (CF) this does not cause the disease. [Discuss what 1 in 25 means in relation to the class. Does this mean that one person in a class of 25 will <i>definitely</i> have a CF gene? Does it mean that <i>only</i> one person in a group of 25 people can have the CF gene?]
16	Genetic screening – Petri dish cultures of amniotic cells.	People may use this knowledge to make very important decisions.	Pre-natal genetic diagnosis looks at the genes of an embryo fertilized outside the woman's body by IVF (in vitro fertilization) techniques. People who are carriers of a faulty disease gene may choose to check if they have passed it onto their embryo, and only select embryos without the faulty gene for implantation in the womb. This use of genetic knowledge raises serious ethical questions – questions about what is considered right and wrong behaviour. [Although they are commonly called 'test-tube' babies, IVF is not carried out in a test-tube, but in a flat dish.]
17	British embryologist Dr Ian Wilmut with 'Dolly', the world's first sheep cloned from an adult sheep cell.	Should we try to develop cloning technology? Should we change faulty genes? How can we go about making this type of decision?	Cloning is another issue raised in this module. Again it provokes serious ethical concerns. If we can, should we clone people?

Further guidance

Speaker's notes for Presentation IB1.4 *Cloning plants*

Slide	Image details	Slide label/caption	Notes/comment
1	You and your genes – module title	Cloning plants	
2	Portrait of identical twins in adolescence.	Why are these two girls identical?	These two girls are identical twins. Identical twins are natural and more common than you might think – one in every 250 births worldwide.
3	Light micrograph of a human embryo at the morula stage of development.	This fertilized egg cell is dividing to produce an embryo.	This ball of eight cells has been produced from a human fertilized egg cell. It is three days old. [How many times has the fertilized egg cell divided?]
4		BUT... If the ball of cells splits, two embryos develop. Both of the embryos will come from the same fertilized egg cell. They will have the same genes. They will be clones.	[Are identical twins clones of their mother?]
5	Infant identical twins, one-year-old girls, being held by a proud father.	These twins are clones of each other, but not of their parents.	These twins have the same genes, but they're still the product of sexual reproduction. They're not a clone of their mother or their father.
6	Coloured scanning electron micrograph (SEM) of a dividing Bacillus bacterium.	Simple organisms often reproduce asexually. Asexual reproduction only passes on genes from one parent. The offspring are identical to each other and their parent.	Producing clones by asexual reproduction is very common as a way of reproducing for many organisms. This bacterium has copied its genes – now the cell is dividing. Both new cells will have a copy of each gene.

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
7	Strawberry/seedling/runners.	This strawberry plant is making clones by asexual reproduction.	Plants also use asexual reproduction. In plants, asexual reproduction often takes place using a side branch (called a runner). Roots and shoots grow from the side branch, developing a new plant. [What are the advantages of asexual reproduction for an organism? (e.g. It can make large numbers of offspring relatively quickly.) Are there any disadvantages? (e.g. With no variety, if the environment becomes disadvantageous, the whole population may be destroyed – disease, change in temperature, shortage of nutrients.)]
8	Harvested potato plant (<i>Solanum tuberosum</i>).	If these potatoes are grown, the new plants will be clones of this parent.	Storage organs like tubers and bulbs are another method for asexual reproduction, again producing clones.
9	A group of green hydra polyps, <i>Hydra viridis</i> , attached to a strand of water weed.	Simple animals also use asexual reproduction. This <i>Hydra</i> is making clones by budding.	Although simple animals can develop clones, it is not common in more complex organisms. [Why do you think this is?]
10	Man trimming a garden hedge with a hand-held electric hedge trimmer.	Plants can grow back because they keep some unspecialized cells as they develop. These cells can develop into any kind of cell a new plant needs.	All plants have some cells that are unspecialized, no matter how old they are. These cells can develop into any part of a new plant. This gives plants the ability to regenerate themselves.
11	Versicolour rose flower. The darker pink stripes on the petals of the versicolour rose (<i>Rosa gallica</i>), also known as the French rose, are known as irregular colour breaks. They occur as a result of unstable genes.	Selective breeding has produced varieties of plants and animals with features we want, for example: flowers with particular colours and scents ...	[What do we mean by selective breeding?]

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
12	Carrots (<i>Daucus carota</i>) hanging in a bunch.	... or vegetables that grow quickly and are resistant to disease.	But what if we find a 'perfect' plant, and we want one that is exactly the same? If it is bred with another plant, some of the characteristics we like may not be present in the next generation – they'll be a mixture of both parents.
13	Plant cutting sequence: the base of a plant cutting, i.e. showing where it has been cut.	Cloning the plants ensures that these good features will be passed on. A piece of the plant is cut off. New shoots and roots develop.	Taking cuttings solves this problem. A piece of the plant is cut off. The unspecialized cells in the cutting develop into new shoots and roots.
14	Plant cutting sequence: showing differentiation at leaf edge, e.g. new roots developing.	The new plant has the same genes as the parent. It is a clone.	The new plant has the same genes as the parent – it is a clone. All of the desirable features of the parent plant will be present.
15	A cloned plant produced by tissue culture.		

Further guidance

Speaker's notes for Presentation IB1.29 *Cloning – science fact or science fiction*

Slide	Image details	Slide label/caption	Notes/comment
1	You and your genes – module title	Cloning – science fiction or science fact?	
2	Artwork of a science fiction comic with space predictions in the style of the 1950s.	<ul style="list-style-type: none"> This prediction of spacewalking was made just fifty years ago. Other predictions from the 1930s–1950s include flying cars and video telephones. 	<p>Predictions made in the 1930s about the world of 2000 included flying cars and videophones.</p> <p>In 1964 an American company launched its latest product, the Picturephone. They spent 500 million dollars developing it, predicting that by 1969 every home in America would have a videophone. It was a flop. People found it too expensive, and hardly anyone else had one so it wasn't worth buying one.</p> <p>For science fiction to become reality we have to:</p> <p>(a) discover the science to make it happen</p> <p>(b) use it to make things that people are prepared to spend money on</p> <p>Video conferencing is now common because it's much cheaper than people in different locations, perhaps in different countries, travelling to meet in person.</p>
3	Astronaut Edward H. White II floating in space on 3 June 1965 during the <i>Gemini IV</i> space mission. White spent 21 minutes outside the spacecraft, becoming the first American to walk in space. He wore a specifically designed spacesuit and was attached to the spacecraft by an 8-metre-long tether and umbilical line (gold).	First American spacewalk, 1965	This image of the first American space walk doesn't look that different from the 1950s prediction, although a great deal of new technology was used to make the suit.

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
4	Astronaut Bruce McCandless floats free above the Earth in his manned manoeuvring unit (MMU) on 7 February 1984, during the tenth space shuttle flight. McCandless, who helped design the MMU, was the first person to fly it, thus becoming the first 'human satellite' in orbit around the Earth. The MMU is propelled by small nitrogen thrusters which are controlled by the astronaut's hands. Because no umbilical cord attaches the astronaut to the spacecraft, it gives much greater mobility than was available to earlier spacewalkers.	First manned manoeuvring unit flight, 1984	More scientific advances were needed to develop this suit, which allows free movement in space – the astronaut is not linked to the spacecraft.
5	Front page of the <i>Daily Mail</i> , Saturday 1 January 1994.		In the 1930s science fiction writers also discussed atomic power and rocket ships, both of which later became reality. Huge invading bugs and aliens of many kinds have always been very popular with science fiction writers, but, as far as we know, they're not reality. The scariest science fiction is often that which is very close to reality – things we can almost do, things we can imagine being used negatively as well as positively, and, for some of us, things we don't think should be allowed at all.
6	Front cover of <i>The World of A</i> by A. E. van Vogt, Simon and Schuster, 1948.	<ul style="list-style-type: none"> Who was Null-A? Even he didn't know – only that he could be killed and then live again, to be used by someone unknown in an evil plot spanning the galaxy... 	The first major novel to discuss cloning, <i>The World of Null-A</i> , was written by a Canadian, A. E. van Vogt, in 1945. The text is taken from an early review of the book.
7	Front cover of <i>The World of Null-A</i> by A. E. van Vogt, Orb Books, 2002.	<ul style="list-style-type: none"> The book has been reprinted many times, including this edition in 2002. It has been claimed that the first human clone was born on 26 December 2002. 	Cloning humans may or may not be a reality. It is an issue that people have very different points of view on.

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
8	Light micrograph of a human embryo at the morula stage of development.	For many years mammals have been cloned by splitting embryos.	<p>One method for cloning mammals is to remove an embryo from a donor female (or fertilize an egg cell by IVF) and then wait for it to reach the 8–16-cell stage. At this point it is split into its constituent single cells, which are encouraged to grow and divide into new embryos. These are then implanted into the uterus of recipient females, where hopefully they will implant and grow.</p> <p>[Is this cloning the parent?]</p> <p>This is not cloning of an adult. It is artificially doing what happens naturally when identical twins, triplets etc. are born.</p>
9	Dolly the sheep.	<ul style="list-style-type: none"> • Dolly was the first adult mammal to be cloned. • The method used to produce Dolly was first used to clone adult frogs in 1952. 	<p>Cloning an adult mammal was first achieved with Dolly the sheep in 1997. There were 276 unsuccessful attempts to clone a sheep at the Roslin Institute, Edinburgh, before Dolly was born.</p> <p>It had taken 45 years for the technology that was used to clone adult frogs to be translated into cloning adult mammals.</p> <p>This illustrates the difficulties with cloning technology. The reasons why it is not always successful, or why many mammals cloned this way suffer from degenerative illnesses, are not fully understood. One suggestion is that the transplanted nucleus has already aged and that it takes this 'age' with it to the new individual. Other suggestions relate to the role of mitochondrial DNA within a cell, which is not transferred with the nucleus into the new cell.</p>

Further guidance

Slide	Image details	Slide label/caption	Notes/comment
10	Illustration of the stages of nuclear transplantation.		<p>An egg cell from one sheep had its nucleus removed.</p> <p>A cell was taken from the mammary gland of another adult sheep, and the nucleus extracted.</p> <p>This nucleus was placed into the egg cell that was (now) missing a nucleus.</p>
11	Front page of the <i>Evening Standard</i> , 27 February 2002.	<ul style="list-style-type: none"> • It's not just reproductive cloning – copying people – that we could use this technology for. • Cloning human cells may be useful in treating illnesses. • This is called therapeutic cloning. 	<p>Some people object to the idea of cloning people – reproductive cloning – but are less sure about therapeutic cloning, because they think it may have benefits for curing illnesses.</p> <p>Other people believe that therapeutic cloning is also wrong. They believe that creating a fertilized egg for any purpose other than reproduction is wrong.</p>
12	http://www.guardian.co.uk/genes		[The special genes report at http://www.guardian.co.uk/genes contains an animation describing the difference between reproductive and therapeutic cloning.]

Further guidance

B1 You and your genes – Foundation Workbook answers

1	a	Missing words: alike, features, unique, variation, genes, environment
	b	<ul style="list-style-type: none"> • Environment: pierced ears, scar • Genes: (natural) hair colour, eye colour, blood type • Both environment and genes: height, weight <p>(Note: Students may well consider hair colour to be affected by both environment and genes if they dye their hair.)</p>
2		Labels from left to right: nucleus, NUCLEUS, chromosomes, genes
3	a	Missing words: genes, father, alike, unique, mixture
	b	<ul style="list-style-type: none"> • Inherited from Kyle: e.g. shape of nose • Not inherited from anyone: e.g. hair length
4	a	<ul style="list-style-type: none"> • One gene: blood type • Many genes: height
	b	There are four distinct blood types. If many genes were involved there would be more combinations and therefore many possible blood types. You would expect a smoother curve, as with height.
	c	e.g. nutrition and health as a child (i.e. when growing)
5	a	An organism that is genetically identical to another organism
	b	Bacteria, some simple plants and animals, e.g. <i>Hydra</i>
	c	The plants have grown in different environmental conditions. They may have received different amounts of water, light, or nutrients from the soil.
	d	Notes or labels from left to right: egg cell, sperm cell, fertilized egg cell, fertilized egg cell starts to divide, embryo splits into two, producing two identical fetuses/babies
6	a	A specialized cell has a particular structure to enable it to do a particular job (e.g. muscle cell, nerve cell, blood cell).
	b	Unspecialized cells can develop into any cell a plant needs during its life (e.g. they can make new stems or leaves if the plant is cut down).
	c	<p>Answer will depend on the method students have experienced during the course. Description of taking cuttings or tissue culture would both be acceptable.</p> <p>For example: cut a piece of healthy shoot (just below a joint), dip the end into rooting powder, plant it into some compost; some of the cells at the base of the stem will develop into root cells, other cells will form new leaves.</p>
	d	<ul style="list-style-type: none"> • Advantages of cloning: e.g. Grow plants with favourable characteristics which you want them to have (e.g. disease resistance, flower colour); produce large numbers of plants more quickly than growing from seed. • Disadvantages of cloning plants: e.g. There is no genetic variation, so all plants could be destroyed by a disease or other harsh environmental conditions. (If there is genetic variation some of the plants may be able to survive harsh environmental conditions.)
7	a	Missing words: 23, sex, X, Y, XY, X, XX

Further guidance

	b	<table border="1"> <tr> <td>XX</td> <td>XY</td> </tr> <tr> <td>XX</td> <td>XY</td> </tr> </table> <p>Male 50%, female 50%</p>	XX	XY	XX	XY					
XX	XY										
XX	XY										
8	a	Missing words: fertilization, female, twice/double									
	b	Missing numbers from the diagram: 23 (egg), 23 (sperm), 46 (fertilized egg)									
	c	Chromosomes of egg and sperm are in singles, chromosomes of fertilized egg are in pairs.									
	d	1, 6, 12, 7, 9, 11, 5, 3, 8, 4, 10, 2									
9	a	Missing words: two, same, place, two									
	b	<ul style="list-style-type: none"> Completed diagram of pair 7 showing taste receptor gene and colour vision gene on each chromosome. Completed diagram of pair 15 showing hair colour gene and eye colour gene on each chromosome. 									
10	a	You need only have one copy of a dominant allele to have its features.									
	b	You must have two copies of a recessive allele to have its features.									
	c	dimples = D, no dimples = d									
	d	<p>i One of Jim, Jane, Simon, or Paul.</p> <p>ii Louise must have inherited a d allele from both her parents. Her father, Carlo, does not have dimples, so he must have dd alleles. Her mother, Jane, must have Dd alleles. Jane passed on a copy of her d allele to Louise.</p>									
11		A person with Huntington's disorder has problems controlling their muscles, they get forgetful, find it harder to understand things, and eventually they can't control their movements. Sadly the condition is fatal.									
12	a	Missing words: X, Y, half, one, fertilization, cross									
	b	<table border="1"> <tr> <td></td> <td>d</td> <td>d</td> </tr> <tr> <td>D</td> <td>Dd</td> <td>Dd</td> </tr> <tr> <td>d</td> <td>dd</td> <td>dd</td> </tr> </table> <p>Chance of baby having dimples is 50%</p>		d	d	D	Dd	Dd	d	dd	dd
	d	d									
D	Dd	Dd									
d	dd	dd									
	c	Brothers and sisters each get a different mixture of genes from their parents (except identical twins).									
13	a	Lungs blocked with mucus, leading to chest infections. Mucus blocks enzymes in the gut, leading to poor digestion and lack of nutrients being absorbed.									
	b	Physiotherapy to clear lungs of mucus, antibiotics for chest infections, tablets containing missing enzymes									

Further guidance

	c	A carrier is a person who has one normal allele and one faulty allele in a pair. The faulty allele is recessive. The carrier does not show the feature or disease caused by the faulty allele, but they can pass the faulty allele on to their offspring.
14	a	A decision based on what you believe is right and wrong.
	b	<ul style="list-style-type: none"> Any decision that does not involve ethics, e.g. which bus route to take to get to the cinema Any decision that does involve ethics, e.g. whether to drop your litter in the street, read someone's diary, have your baby immunized
15		<ul style="list-style-type: none"> False-positive: a test result that wrongly says a person has a medical condition when they don't False-negative: a test result that wrongly says a person doesn't have a medical condition when they do
16		<p>Any three opinions about testing fetuses for genetic disorders, e.g.:</p> <p>A positive test might lead to a decision to terminate the pregnancy. Some people believe termination is wrong. They believe that a human being begins when an egg is fertilized, and that a fertilized egg should have the same protection as an adult human being.</p> <p>A family may feel that they could not look after a child with a serious illness properly, so they want to have a genetic test.</p> <p>Many people lead happy lives, despite having a serious genetic disorder, so terminating those pregnancies denies them the right to life.</p>
17		Doctors give a woman fertility drugs so that her body produces several eggs at the same time. The eggs are collected and mixed in a glass dish with sperm from a man. Sperm fertilize the eggs. The fertilized eggs grow into embryos. Doctors test the embryos for the genetic disorder. They will only choose an embryo that does not have the genetic disorder to implant into the mother's womb.
18	a	Missing words: alleles, normal, therapy, SCID, cystic fibrosis
	b	<ol style="list-style-type: none"> The gene that causes the genetic disorder is located on a chromosome. Chromosomes from someone who does not have the disorder are used to find the 'normal' allele. This is copied. Copies of the 'normal' allele are put into the cells of a person suffering from the genetic disorder.
	c	<p>Any three opinions about gene therapy, e.g.:</p> <p>It is interfering with nature so should not be done.</p> <p>It may cause problems which we cannot predict, so should not be done.</p> <p>It may help improve the quality of lives for some people with very serious illnesses.</p>
19	a	Missing words: unspecialized, any, blood, skin, diseases, new, few, embryonic, different
	b	<p>See diagram on textbook page 28.</p> <p>Labels from left to right:</p> <p>The nucleus is taken out of human egg cell and replaced with a nucleus from one of the patient's cells.</p> <p>30 hours – the egg cell is triggered to develop into an embryo</p> <p>3 days</p> <p>5 days – cells removed from the embryo with a pipette</p> <p>Stem cells grown in a dish containing nutrients</p>

Further guidance

20	a	Cloning human adults would mean taking a cell from a person's body and using it to produce another adult person with the same genes. Stem cells are taken from cloned embryos that are only a few days old. There is no intention for these embryos to be grown into an adult person.
	b	<ul style="list-style-type: none"> • Underlined text could include (in the last section): 'it means human embryos are destroyed', 'religious beliefs', and 'it is the same as killing a child, because human life begins at the moment of fertilization'. • Ringed text could include: (second section) 'embryonic stem cells will be more useful in research to cure diseases', (third section) 'Degenerative diseases and serious injuries to organs and tissues may be treated through stem therapies'.
	c	<p>For example:</p> <ul style="list-style-type: none"> • Fact: (second section) 'Adult stem cells can only develop into one type of cell.' • Opinion: (last section) 'The destruction of human embryonic life is unnecessary...continue to be developed.' • Theory: (fourth section) 'the cloned embryo would have the same genes as the patient, so cells from it would not be rejected' • Speculation: (third section) 'Degenerative diseasesstem cell therapies.'

Further guidance

B1 You and your genes – Higher Workbook answers

1	a	Missing words: alike, features, unique, variation, genes, environment
	b	Environment: pierced ears, scar Genes: (natural) hair colour, eye colour, blood type Both environment and genes: height, weight (Note: Students may well consider hair colour to be affected by both environment and genes if they dye their hair.)
2	a	Labels from left to right: nucleus, NUCLEUS, chromosomes, genes
	b	Structural proteins are used to build cell parts and cells. Enzymes speed up chemical reactions.
3	a	Each child gets a mixture of their parents' genes. So brothers and sisters may look alike, but they will all be unique because they each get a different mixture of their parents' genes.
	b	<ul style="list-style-type: none"> Inherited from Kyle: e.g. shape of nose Not inherited from anyone: e.g. hair length
4	a	One gene: blood type Many genes: height
	b	There are four distinct blood types. If many genes were involved there would be more combinations and therefore many possible blood types. You would expect a smoother curve, as with height.
	c	e.g. nutrition and health as a child (i.e. when growing)
5	a	An organism that is genetically identical to another organism
	b	Bacteria, some simple plants and animals, e.g. <i>Hydra</i>
	c	The plants have grown in different environmental conditions. They may have received different amounts of water, light, or nutrients from the soil.
	d	<ul style="list-style-type: none"> Natural animal cloning (from left to right): egg cell, sperm cell, fertilized egg cell, fertilized egg cell starts to divide, embryo splits into two, producing two identical fetuses/babies Artificial animal cloning: (top left) nucleus removed from an unfertilized egg cell, (top right) nucleus from a body cell put into the empty egg cell, (bottom) embryo grown for a few days then implanted into uterus
6	a	Answer will depend on the method students have experienced during the course. Description of taking cuttings or tissue culture would both be acceptable. For example: cut a piece of healthy shoot (just below a joint), dip the end into rooting powder, plant it into some compost; some of the cells at the base of the stem will develop into root cells, other cells will form new leaves.

Further guidance

	b	<ul style="list-style-type: none"> Advantages of cloning: e.g. Grow plants with favourable characteristics which you want them to have (e.g. disease resistance, flower colour); produce large numbers of plants more quickly than growing from seed. Disadvantages of cloning plants: e.g. There is no genetic variation, so all plants could be destroyed by a disease or other harsh environmental conditions. (If there is genetic variation some of the plants may be able to survive harsh environmental conditions.) 				
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XX	XY					
XX	XY					
	c	Every fertilization happens randomly and separately from every other fertilization. There is a 50% chance for every egg of being fertilized by an X sperm or a Y sperm.				
	d	<p>(SRY = sex-determining region of the Y chromosome)</p> <ul style="list-style-type: none"> SRY gene causes a male embryo's testes to develop (at about 6 weeks). The testes produce a male sex hormone. Male sex hormone makes the embryo develop into a male. 				
8	a	Missing words: fertilization, female, twice/double				
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12	a	Missing words: Z, Y, half, one, fertilization, cross									
	b	<table border="1" style="margin-left: 20px;"> <tr> <td></td> <td>d</td> <td>d</td> </tr> <tr> <td>D</td> <td>Dd</td> <td>Dd</td> </tr> <tr> <td>d</td> <td>dd</td> <td>dd</td> </tr> </table> <p>Chance of baby having dimples is 50%</p>		d	d	D	Dd	Dd	d	dd	dd
	d	d									
D	Dd	Dd									
d	dd	dd									
	c	Brothers and sisters each get a different mixture of genes from their parents (except identical twins).									
13		<ul style="list-style-type: none"> • Symptoms: Lungs blocked with mucus, leading to chest infections. Mucus blocks enzymes in the gut, leading to poor digestion and lack of nutrients being absorbed. • Treatment: Physiotherapy to clear lungs of mucus, antibiotics for chest infections, tablets containing missing enzymes • A carrier is a person who has one normal allele (dominant) and one faulty allele (recessive). They can pass the faulty allele on to offspring. 									
14	a	A decision based on what you believe is 'right' and 'wrong'									
	b	<ul style="list-style-type: none"> • Any decision that does not involve ethics, e.g. which bus route to take to get to the cinema • Any decision that does involve ethics, e.g. whether to drop your litter in the street, read someone's diary, have your baby immunized 									
15		<ul style="list-style-type: none"> • False-positive: a test result that wrongly says a person has a medical condition when they don't • False-negative: a test result that wrongly says a person doesn't have a medical condition when they do 									
16		<p>Any three opinions about testing fetuses for genetic disorders, e.g.:</p> <p>A positive test might lead to a decision to terminate the pregnancy. Some people believe termination is wrong. They believe that a human being begins when an egg is fertilized, and that a fertilized egg should have the same protection as an adult human being.</p> <p>A family may feel that they could not look after a child with a serious illness properly, so they want to have a genetic test.</p> <p>Many people lead happy lives, despite having a serious genetic disorder, so terminating those pregnancies denies them the right to life.</p>									
17	a	<ul style="list-style-type: none"> • Genetic screening programmes: to find out who in a population are carriers/sufferers so they can inform parents of the risks of passing on a genetic disorder before conception. • Insurance companies: to find out the risk of having to pay out for medical treatment/care for a person in the future. • Employers: to find out the risk of an employee being unable to do a particular job through illness in the future, which might be disruptive and expensive for the employer. 									

Further guidance

	b	Reasons for one of the above might be: <ul style="list-style-type: none"> Genetic screening programmes: Individuals may not want to know if they are carriers because this would affect how they feel, live, and the choices they make. Insurance companies: Individuals may find themselves paying high premiums or being refused insurance altogether. Employers: Individuals may be discriminated against when going for job interviews, or treated adversely at work.
	c	Student's personal views, with explanation
18		Doctors give a woman fertility drugs so that her body produces several eggs at the same time. The eggs are collected and mixed in a glass dish with sperm from a man. Sperm fertilize the eggs. The fertilized eggs grow into embryos. Doctors test the embryos for the genetic disorder. They will only choose an embryo that does not have the genetic disorder to implant into the mother's womb.
19	a	Missing words: alleles, normal, therapy, SCID, cystic fibrosis
	b	<ol style="list-style-type: none"> The gene that causes the genetic disorder is located on a chromosome. Chromosomes from someone who does not have the disorder are used to find the 'normal' allele. This is copied. Copies of the 'normal' allele are put into the cells of a person suffering from the genetic disorder.
	c	Any three opinions about gene therapy, e.g.: It is interfering with nature so should not be done. It may cause problems which we cannot predict, so should not be done. It may help improve the quality of lives for some people with very serious illnesses.
20	a	<p>...they are unspecialized, so can develop into any type of cell the animal/plant needs.</p> <p>...they could be used to treat certain diseases, by making new cells to replace faulty ones.</p> <p>...they can develop into many different types of cells, whereas adult stems cells can develop into only a few types.</p> <p>...the cloned embryo would have the same genes as the patient.</p>
	b	<p>See diagram on Textbook page 28.</p> <p>Labels from left to right:</p> <p>The nucleus is taken out of human egg cell and replaced with a nucleus from one of the patient's cells.</p> <p>30 hours – the egg cell is triggered to develop into an embryo</p> <p>3 days</p> <p>5 days – cells removed from the embryo with a pipette</p> <p>Stem cells grown in a dish containing nutrients</p>
21	a	Cloning human adults would mean taking a cell from a person's body and using it to produce another adult person with the same genes. Stem cells are taken from cloned embryos that are only a few days old. There is no intention for these embryos to be grown into an adult person.

Further guidance

b	Underlined text could include (in the last section): 'it means human embryos are destroyed', 'religious beliefs', and 'it is the same as killing a child, because human life begins at the moment of fertilization'.
c	Ringed text could include: (second section) 'embryonic stem cells will be more useful in research to cure diseases', (third section) 'Degenerative diseases and serious injuries to organs and tissues may be treated through stem therapies'.
d	<p>For example:</p> <ul style="list-style-type: none"> • Fact: (second section) 'Adult stem cells can only develop into one type of cell.' • Opinion: (last section) 'The destruction of human embryonic life is unnecessary...continue to be developed.' • Theory: (fourth section) 'the cloned embryo would have the same genes as the patient, so cells from it would not be rejected' <p>Speculation: (third section) 'Degenerative diseasesstem cell therapies.'</p>