Science 1.9 AS 90948

Demonstrate understanding of biological ideas relating to genetic variation

WORKBOOK

Working to Excellence

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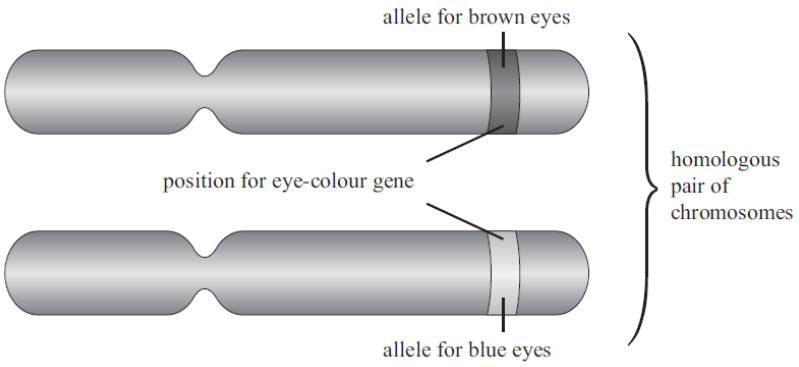
Writing Excellence answers to **DNA and Genes** questions

DNA and Genes QUESTION
Question: Use the diagram below to help you explain the relationship between chromosomes, genes, alleles, phenotype, genotype, and the molecule DNA.



ANSWER	
1. explain link between chromosomes and DNA	
2. describe the physical structure of DNA	
3. **Explain the pairing rule of DNA**	
4. link the **base sequence to trait and gene (use example)**	
5. Give the definition for an allele (use example)	
6. link pair of chromosomes to pair of alleles	
7. link alleles to base sequence	
8. give the definition of a genotype	
9. link genotype to phenotype	
10. give definition of dominant alleles	
11. give definition of recessive alleles	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

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Writing Excellence answers to **Genotype and Phenotype** questions

DNA and Genes QUESTION
Question: In rock pocket mice, dark fur colour (D) is dominant to light fur colour (d). Each mouse has two alleles for fur colour. Explain how they inherit these two alleles, and explain how the two alleles interact to produce different phenotypes. In your answer you should: •define phenotype and genotype •explain how the alleles are inherited from the parents •state the three possible fur colour genotypes for rock pocket mice. 

ANSWER	
1. define **genotype**	
2. define **phenotype**	
3. Explain where an individual gets a copy of each **gene**	
4. link **fertilisation** to the **gametes** involved and parents.	
5. give the definition of **dominant** alleles	
6. give the definition of **recessive** alleles	
7. define **homozygous dominant genotype** (use example above)	
8. define **heterozygous genotype** (use example above)	
9. define **homozygous recessive genotype** (use example above)	
10. link homozygous recessive **genotype to phenotype**	
11. draw a **Punnett square** showing how 2 dark coloured mice could produce both light(dd) and dark mice(DD or Dd)	

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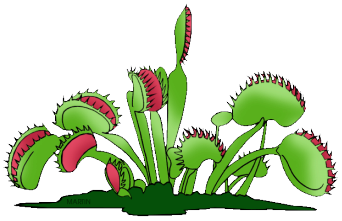
Science 1.9 AS 90948 Demonstrate understanding of biological ideas relating to genetic variation

Writing Excellence answers to **inheritable or non-inheritable variation** questions

inheritable or non-inheritable variation QUESTION	
Question: The Venus flytrap plants come in a number of different types, such as the "B-52" with a red leaf. A teacher brought two identical plants to class and put them in different parts of the classroom. The Venus flytrap put near a window grew short leaves and the Venus flytrap in the shade grew long leaves. Colour variation in the leaves of the Venus flytraps can be passed on to a plant's offspring, but the different leaf length cannot. **Explain why.** In your answer you should: •define inheritable and non-inheritable variation •explain what causes inheritable and non-inheritable variations.	
ANSWER	
1. define the term **inheritable variation**	
2. Explain what **effect** inheritable variation has	
3. define the term **non-inheritable variation**	
4. Explain what **effect** non-inheritable variation has	
5. link the **phenotype** related to **inherited variation** (give example from question)	
6. link the **phenotype** related to **non-inherited variation** (give example from question)	
7. complete the final statement	Genetics determines the characteristics you will be born with and this is called _____, but environment then affects these characteristics once you are born and this is called _____.

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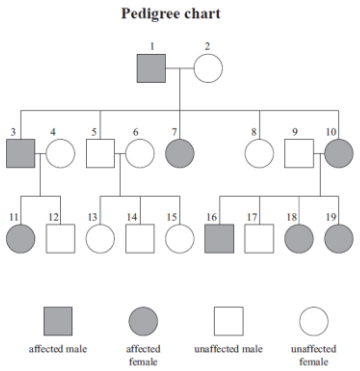
Science 1.9 AS 90948 Demonstrate understanding of biological ideas relating to genetic variation

Writing Excellence answers to **Inheritance predictions** questions

Inheritance predictions QUESTION
Question: Huntington's disease is a genetic disorder in humans. It is caused by a dominant allele (H). The normal allele is recessive (h). In the pedigree chart the phenotype ratio of Huntington's disease in the children of parents 9 and 10 is not the same as the predicted ratio in the Punnett square Give reasons why the predicted ratio in the Punnett square and the observed ratio in the children may NOT be the same.

	parent 10	
	H	h
parent 9 h	Hh	hh
h	Hh	hh

Fraction of children with Huntington's disease is 1/2
Fraction of children without Huntington's disease is 1/2
Phenotype ratio is 1:1.

ANSWER	
1. describe the purpose of **Punnett squares**	
2. describe the purpose of a **pedigree chart.**	
3. explain fertilisation as a **random** event	
4. link **phenotype of offspring to allele they have inherited** (use example from question)	
5. give phenotypes of offspring in **pedigree chart** and number of each	
6. compare to phenotypes predicted in **Punnett square** and number of each	

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Writing Excellence answers to **Test Cross** questions

Test Cross QUESTION
Question: Discuss how a farmer could develop a group of sheep that are pure breeding for white wool. Use **R** to represent the dominant allele for common white wool, and **r** to represent the recessive allele for black wool. In your answer you should: • state the genotypes of the male and female sheep the farmer should use to breed from • explain how the animal breeder can determine the genotypes of the male and female to produce sheep that all have white wool. You should include at least two Punnett squares with your explanation • explain how the animal breeder could make sure that the offspring would always be pure breeding. 

ANSWER	
1. Explain the **genotype** of the parents needed to produce a pure breeding white group	
2. describe how a **test cross** could be used to find out a sheep genotype (RR or Rr) Draw **2 Punnett Squares**	
3. explain the results of the test cross if the sheep was **RR** (Homozygous dominant) or pure breeding – link to Punnett Square	
4. explain the results of the test cross if the sheep was **Rr** (Heterozygous)or not pure breeding – link to Punnett Square	
5. explain the need for **many crosses** and link to chance	
6. explain the **requirements** for a pure breeding white flock of sheep	
7. discuss how a farmer could **continue to develop** a pure breeding white flock of sheep	

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Science 1.9 AS 90948 Demonstrate understanding of biological ideas relating to genetic variation

Writing Excellence answers to **Variation and Survival** questions

Variation and Survival QUESTION	
Question: Discuss why variation caused by sexual reproduction in a population of plants or animals is an **advantage** in a changing environment, such as a period of drought (a period of time of very dry weather, when there is no or very little rain) Support your answers with examples. 	
ANSWER	
1. define **genetic variation**	
2. explain **sexual reproduction** as the process that gives individuals genetic variation	
3. **link advantage to survival** to changing environment	
4. **discuss your example** and link to how it is an advantage in a drought (or other changing environment)	
5. link survival of some to **survival of the species**	

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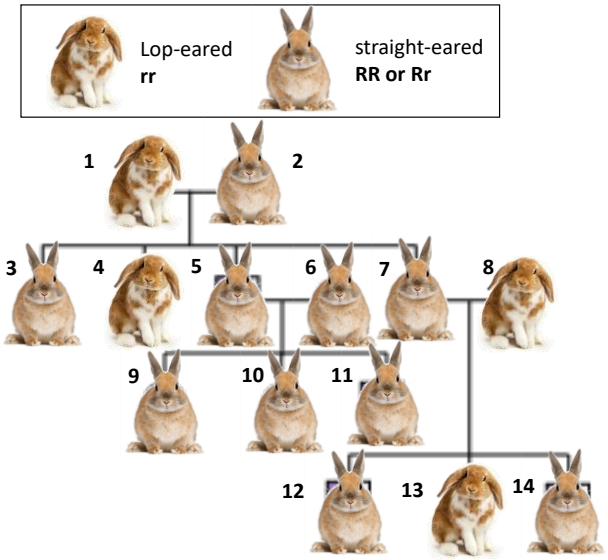
Science 1.9 AS 90948 Genetic Variation

Predicting genotypes from a pedigree chart

Success Criteria: complete each level before moving onto the next

- **Basic:** states one allele is inherited from each parent and that a dominant homozygous parent cannot have lop-eared offspring.
- **Proficient:** explains that an individual with lop-ears must have 2 recessive alleles and an individual with straight-ears must have at least 1 dominant allele and relates it to specific individual
- **Advanced:** Justifies the genotype of individuals by using the predicted genotype of both parents and offspring. Can use Punnett squares to give further explanation



Give the genotype of rabbit 7 and discuss how you were able to predict that based on the rabbits parents, 1 and 2, as well as the offspring, 12, 13 and 14. Give any further evidence to explain any of the previous rabbit's genotypes. Use Punnett squares to show the possible offspring for rabbit 1 and 2, and for rabbit 7 and 8.

_____

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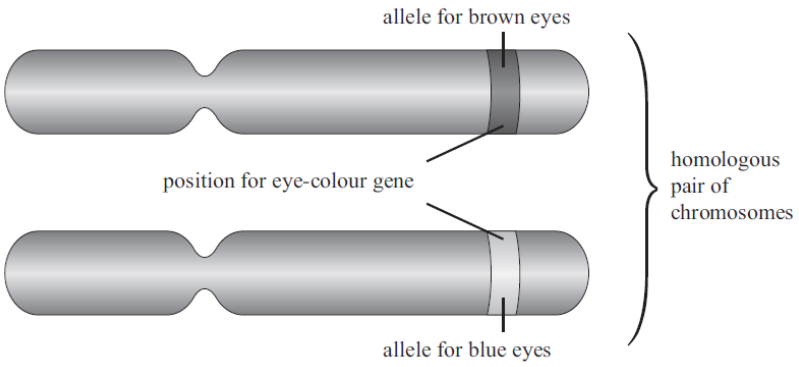
ANSWERS: Writing Excellence answers to **DNA and Genes** questions

DNA and Genes QUESTION
Question: Use the diagram below to help you explain the relationship between chromosomes, genes, alleles, phenotype, genotype, and the molecule DNA.



ANSWER	
1. explain link between chromosomes and DNA	Chromosomes are made up of DNA.
2. describe the physical structure of DNA	DNA is a large molecule that is coiled into a double helix (twisted ladder structure). It is responsible for determining the phenotype of an organism. Along this molecule are bases.
3. **Explain the pairing rule of DNA**	These bases pair up; A always pairs with T, and G with C.
4. link the **base sequence to trait and gene (use example)**	A sequence of bases which codes for a particular trait (eg, eye colour) is called a gene.
5. Give the definition for an allele (use example)	The different versions of each gene are called alleles, and these show the different variations of each characteristic, eg brown / blue eyes.
6. link pair of chromosomes to pair of alleles	Because chromosomes come in pairs for each trait, there will be two possible alleles
7. link alleles to base sequence	These different versions of genes (alleles) occur as the DNA base sequence is different.
8. give the definition of a genotype	This combination of alleles for each trait is called the genotype; this can be any combination of two of the available alleles.
9. link genotype to phenotype	The genotype determines the phenotype (the physical appearance) of the organism.
10. give definition of dominant alleles	Whichever alleles are present may be expressed. Dominant alleles (B) will be expressed over recessive alleles (b).
11. give definition of recessive alleles	Two recessive alleles are required for the recessive phenotype to be expressed

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ANSWERS: Writing Excellence answers to **Genotype and Phenotype** questions

DNA and Genes QUESTION	
Question: In rock pocket mice, dark fur colour (D) is dominant to light fur colour (d). Each mouse has two alleles for fur colour. Explain how they inherit these two alleles, and explain how the two alleles interact to produce different phenotypes. In your answer you should: •define phenotype and genotype •explain how the alleles are inherited from the parents •state the three possible fur colour genotypes for rock pocket mice.	
ANSWER	
1. define **genotype**	Genotype is the code for the alleles present for the gene.
2. define **phenotype**	Phenotype is the appearance of a trait, e.g. dark or light fur.
3. Explain where an individual gets a copy of each **gene**	Each mouse receives one copy of each gene from each of its parents during fertilisation
4. link **fertilisation** to the **gametes** involved and parents.	one gene comes from the father in the sperm and one gene comes from the mother from the egg, and so each offspring has two copies of each.
5. give the definition of **dominant** alleles	If either of these are the dominant allele the mouse will be dark, as the dark allele is dominant (and so masks the light allele).
6. give the definition of **recessive** alleles	If both of these are the recessive allele the mouse will be light
7. define **homozygous dominant genotype** (use example above)	A dark mouse can have the homozygous dominant genotype (DD)
8. define **heterozygous genotype** (use example above)	A dark mouse can also have the heterozygous genotype (Dd)
9. define **homozygous recessive genotype** (use example above)	the homozygous recessive genotype is (dd)
10. link homozygous recessive **genotype to phenotype**	A light mouse can only have the homozygous recessive genotype
11. draw a **Punnett square** showing how 2 dark coloured mice could produce both light(dd) and dark mice(DD or Dd)	

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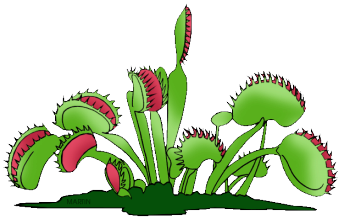
ANSWERS: Writing Excellence answers to **inheritable or non-inheritable variation** questions

inheritable or non-inheritable variation QUESTION	
Question: The Venus flytrap plants come in a number of different types, such as the "B-52" with a red leaf. A teacher brought two identical plants to class and put them in different parts of the classroom. The Venus flytrap put near a window grew short leaves and the Venus flytrap in the shade grew long leaves. Colour variation in the leaves of the Venus flytraps can be passed on to a plant's offspring, but the different leaf length cannot. **Explain why.** In your answer you should: •define inheritable and non-inheritable variation •explain what causes inheritable and non-inheritable variations.	
ANSWER	
1. define the term **inheritable variation**	Inheritable variation can be passed on to offspring and involves a change or mutation of information in the DNA (due to the base sequence)
2. Explain what **effect** inheritable variation has	The variation will be contained in the DNA of every cell in the body because it was present in the gametes (egg and sperm)
3. define the term **non-inheritable variation**	Whereas non-inheritable variation may be due to the environment (or only occurs in body cells) and is gained after fertilisation.
4. Explain what **effect** non-inheritable variation has	Non-inheritable variation affects only that organism during its lifetime, not its offspring.
5. link the **phenotype** related to **inherited variation** (give example from question)	The red colouration of the venus flytrap is due to DNA differences, and so can be passed on to its offspring– as long as the DNA in the gametes is also affected.
6. link the **phenotype** related to **non-inherited variation** (give example from question)	Lack of light has caused the fly trap in the shade to grow longer leaves. This is not due to a change in the DNA, and so cannot be passed on
7. complete the final statement	Genetics determines the characteristics you will be born with and this is called _____, but environment then affects these characteristics once you are born and this is called _____.

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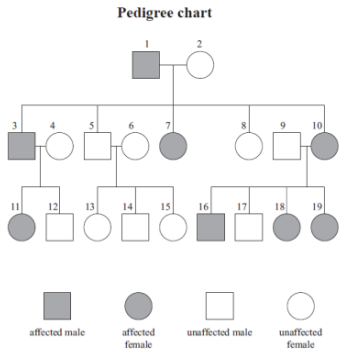
ANSWERS: Writing Excellence answers to **Inheritance predictions** questions

Inheritance predictions QUESTION
Question: Huntington's disease is a genetic disorder in humans. It is caused by a dominant allele (H). The normal allele is recessive (h). In the pedigree chart the phenotype ratio of Huntington's disease in the children of parents 9 and 10 is not the same as the predicted ratio in the Punnett square Give reasons why the predicted ratio in the Punnett square and the observed ratio in the children may NOT be the same.

	parent 10	
parent 9	H	h
h	Hh	hh
h	Hh	hh

Fraction of children with Huntington's disease is 1/2
Fraction of children without Huntington's disease is 1/2
Phenotype ratio is 1:1.

ANSWER	
1. describe the purpose of **Punnett squares**	Punnett squares predict probable offspring genotypes and therefore the expected phenotypes based on the alleles in the gametes of the parents.
2. describe the purpose of a **pedigree chart.**	Pedigree charts give the observed (actual) phenotypes of the offspring and parents.
3. explain fertilisation as a **random** event	Since each fertilisation is a random event, it is by 50:50 chance whether the offspring inherits which allele from both parents.
4. link **phenotype of offspring to allele they have inherited** (use example from question)	From the pedigree chart, the **offspring of number 10** that have inherited the dominant H allele has Huntington's (number 16, 18 and 19) and the offspring that have inherited the recessive h allele and does not have the disease. (number 17)
5. give phenotypes of offspring in **pedigree chart** and number of each	In the pedigree chart **3 of the 4** offspring have the disease. So 75% have inherited the H dominant allele from parent 10 
6. compare to phenotypes predicted in **Punnett square** and number of each	but only 2 out of 4 offspring would have been predicted from the Punnett square, so 50% of the offspring.

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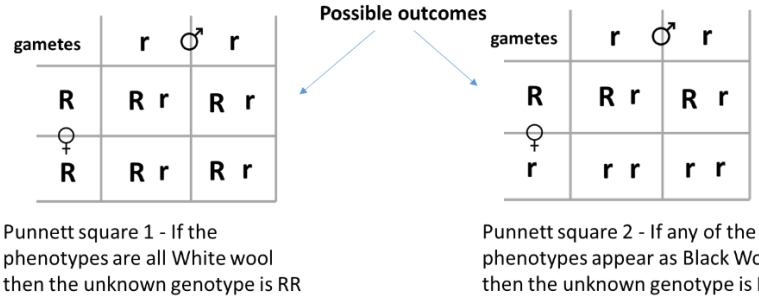
ANSWERS: Writing Excellence answers to **Test Cross** questions

Test Cross QUESTION	
Question: Discuss how a farmer could develop a group of sheep that are pure breeding for white wool. Use **R** to represent the dominant allele for common white wool, and **r** to represent the recessive allele for black wool. In your answer you should: • state the genotypes of the male and female sheep the farmer should use to breed from • explain how the animal breeder can determine the genotypes of the male and female to produce sheep that all have white wool. You should include at least two Punnett squares with your explanation • explain how the animal breeder could make sure that the offspring would always be pure breeding. 	
ANSWER	
1. Explain the **genotype** of the parents needed to produce a pure breeding white group	To breed a group of white sheep, a breeder should use sheep that are both RR. Homozygous dominant
2. describe how a **test cross** could be used to find out a sheep genotype (RR or Rr) Draw **2 Punnett Squares**	The breeder can determine if a white sheep is RR by crossing a white sheep with a black sheep. The black sheep is homozygous recessive and will give 1 black allele (r) to each offspring) 
3. explain the results of the test cross if the sheep was **RR** (Homozygous dominant) or pure breeding – link to Punnett Square	If the white sheep is RR, none of the offspring will be black. As the sheep gave one R allele to each offspring and as this is dominant then the offspring will all be white – this can be seen in Punnett square 1
4. explain the results of the test cross if the sheep was **Rr** (Heterozygous)or not pure breeding – link to Punnett Square	If a black offspring is produced, the breeder can be certain the white parent was Rr. As black sheep are only produced when the offspring inherit a recessive (black) allele from each parent. – this can be seen in Punnett square 2
5. explain the need for **many crosses** and link to chance	The breeder would need to carry out many crosses to show that it was not just due to chance that a black sheep had not been produced, as Punnett squares are only predictions.
6. explain the **requirements** for a pure breeding white flock of sheep	The farmer should breed only with an RR male and white wool females, as this will ensure that all offspring are white.
7. discuss how a farmer could **continue to develop** a pure breeding white flock of sheep	if any black sheep appeared they should not be allowed to breed as this would remove the recessive allele from the group. Eventually the flock would become pure breeding with no r alleles present

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ANSWERS: Writing Excellence answers to **Variation and Survival** questions

Variation and Survival QUESTION	
Question: Discuss why variation caused by sexual reproduction in a population of plants or animals is an **advantage** in a changing environment, such as a period of drought (a period of time of very dry weather, when there is no or very little rain) In your answer you should: • define sexual reproduction • explain how ONE important process in sexual reproduction helps to produce variation in offspring (Support your answers with examples)	
ANSWER	
1. define **genetic variation**	Genetic variation is variety within a population of their traits or phenotype. It means there are different alleles possible for each gene.
2. explain **sexual reproduction** as the process that gives individuals genetic variation	Sexual reproduction involves combining DNA from two parents using gametes. These gametes (sex cells) are formed during meiosis. Gametes have only one set of chromosomes, and so these can be combined with another parent to make a unique individual. This increases variation [OR crossing over OR independent assortment OR meiosis OR fertilisation].
3. **link advantage to survival** to changing environment	The advantage of variation to a population is that it may see some individuals survive if environment changes, in this case if drought occurs If there is variation in their alleles (DNA / genes) some individuals may have phenotypes that are more suited to the environment; therefore they will be more likely to survive.
4. **discuss your example** and link to how it is an advantage in a drought (or other changing environment)	For example: The length of a giraffe's neck, a phenotype, is controlled by genes. There is continuous variation of the neck length within a population. A longer neck will help giraffes reach leaves higher in the tree but makes it more difficult for the animal to drink and for blood to circulate to the head compared to a shorter neck giraffe. In a year where there is a drought, and a shortage of food, the giraffes with a longer neck phenotype are more able to reach higher into the trees for food than the shorter necked giraffes can. The extra food that the longer necked giraffes can eat may mean their survival and reproductive rate is higher than shorter necked giraffes and they pass their alleles onto the next generation and allow the species to survive.
5. link survival of some to **survival of the species**	Because of variation, not all individuals will be wiped out. Those with favourable alleles (traits / phenotypes) such as the long neck in giraffes, will survive and be able to pass on genetic material to offspring and therefore survival of the species occurs.

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Information sheet

Example 1 - giraffe and neck length variation

The length of a giraffe's neck, a phenotype, is controlled by genes. There is **continuous variation** of the neck length within a population. A longer neck will help giraffes reach leaves higher in the tree but makes it more difficult for the animal to drink and for blood to circulate to the head compared to a shorter neck giraffe. During 'typical' years when there is sufficient food an average length neck will be favoured.

In a year where there is a drought, and a shortage of food, the giraffes with a longer neck phenotype are more able to reach higher into the trees for food than the shorter necked giraffes can.

The extra food that the longer necked giraffes can eat may mean their survival and reproductive rate is higher than shorter necked giraffes and they pass their alleles onto

the next generation and allow the species to survive.

If there was no variation in giraffe neck length, and no giraffe could reach higher than another, then in a drought year every giraffe would face equal opportunity of starving and the entire population of giraffes would be at risk of extinction.

Example 2 – Tasmanian Devil and aggression variation

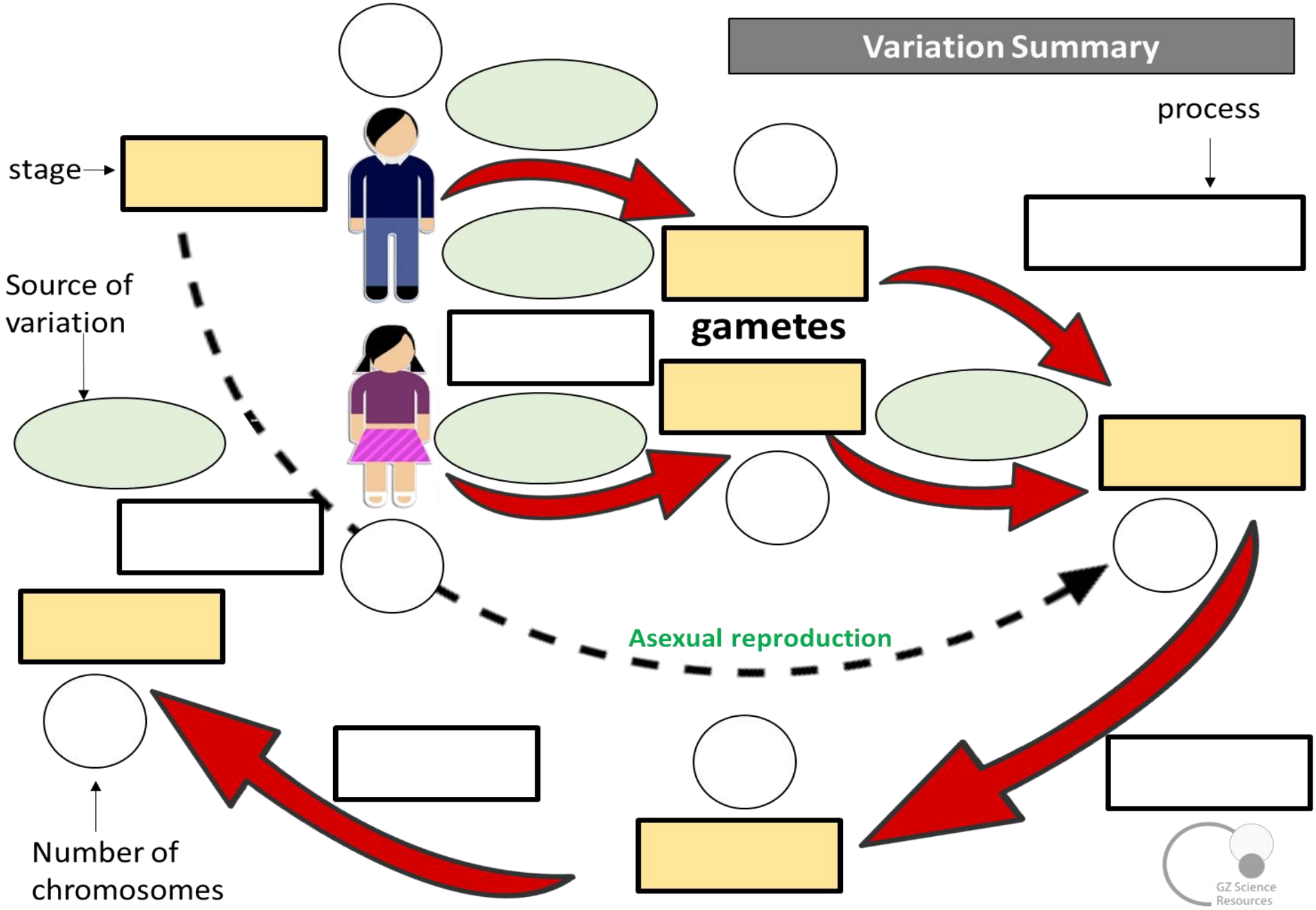
Tasmanian Devils are a species of meat-eating marsupial mammal native to Australia. They are the size of a small dog, and the males especially, are very aggressive towards each other most of the time. Aggression is a behavioural phenotype that is controlled by genes.

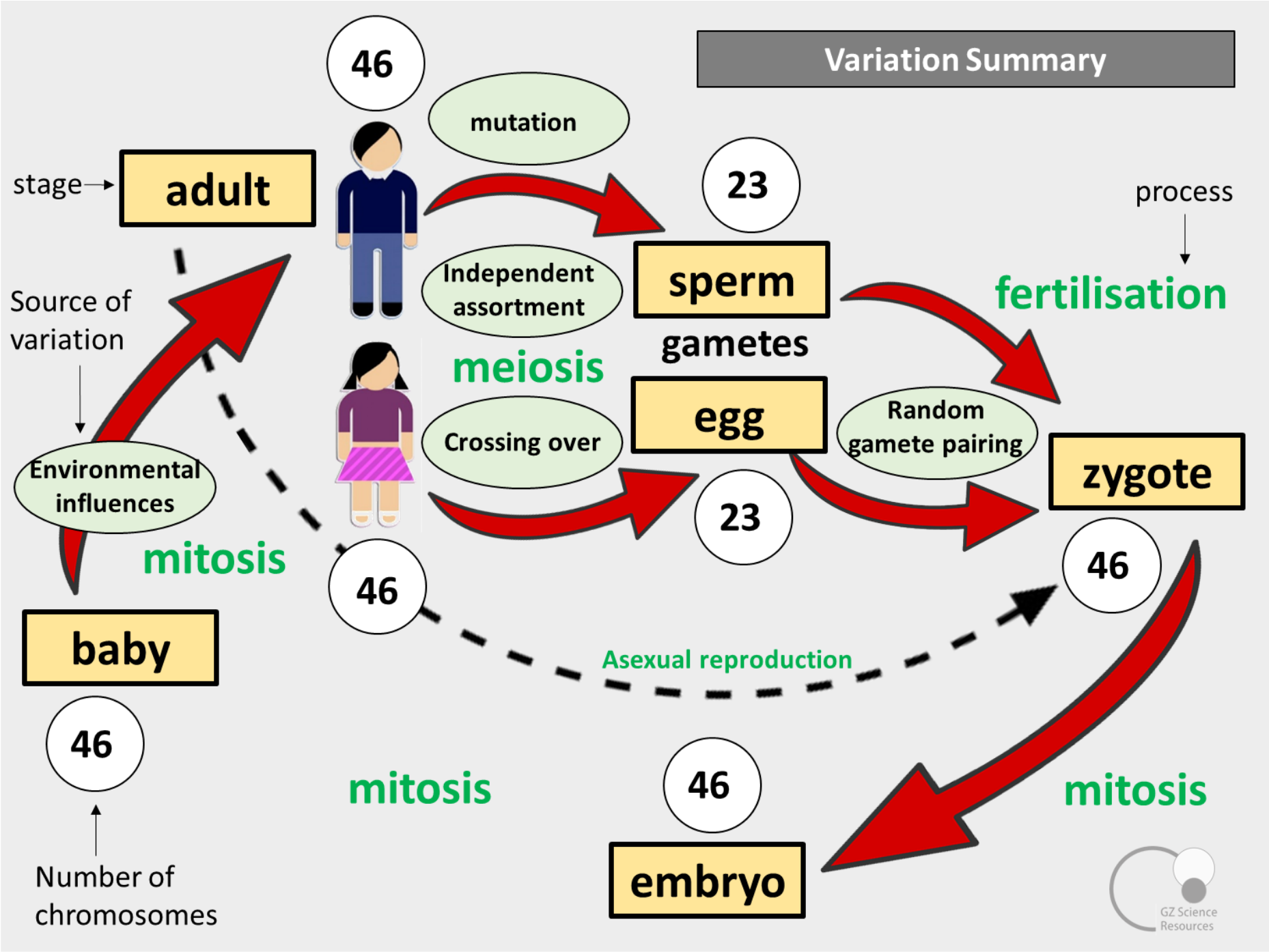
Tasmanian Devils aggression helps males fight off competitors from breeding females therefore ensuring their genes get passed to the next generation. Aggressive behaviour also ensures survival of an individual when born. A female Tasmanian Devil gives birth to 20-30 small young but only has 4 milk teats in her pouch.

However, aggression costs the animal energy and risk of injury so it can also reduce the survival rate of an individual if the behaviour becomes excessive.

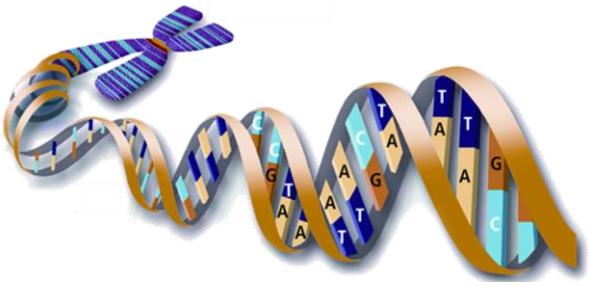
Variation of the aggressive behaviour trait in the population of Tasmanian Devils helps the species survive.

The more aggressive Tasmanian Devils survive when there is a lack of mates or food for the females to produce milk. The more peaceful Tasmanian Devils survive when there is plenty of food and mates and they suffer less injuries, while conserving energy.


Variation Summary
process
stage
Source of variation
gametes
Asexual reproduction
Number of chromosomes
GZ Science Resources


Variation Summary
stage
adult
46
mutation
23
process
Source of variation
Independent assortment
sperm
fertilisation
gametes
meiosis
egg
Random gamete pairing
Crossing over
zygote
Environmental influences
23
mitosis
46
46
baby
Asexual reproduction
46
mitosis
46
mitosis
embryo
Number of chromosomes
GZ Science Resources

Genetic Definitions



creates

gametes:

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Meiosis:

Genetic variation:

which can be

continuous variation:

that join together during

fertilisation:

with genetic material held in

Chromosomes:

shown by the

phenotype:

or which can be

discontinuous variation:

shown by a

Punnett Square:

which gives a

Phenotype ratio:

a full set are seen in a

karyotype:

is determined by the

genotype:

when it creates a

zygote:

and the chromosomes are made of

DNA:

heterozygous: (Rr)

or

homozygous: (RR) or (rr)

which can be

that continues to grow by

mitosis:

lengths of which form a

gene:

a single unit of which is a

nucleotide:

also called

Pure breeding:

that create a

trait:

different varieties are called

alleles:

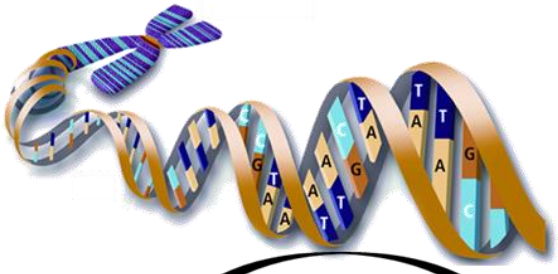
and can be

dominant:

or

recessive:

Genetic Definitions



gametes: sex cell eg sperm or egg. Only contains half the DNA (Chromosomes) of normal body cells.

creates

Meiosis: The process of cell division for the production of gametes.

caused by

Genetic variation: the range of characteristics that exist between individuals as a result of genetic differences.

which can be

continuous variation: Variation that shows a range of possible of possibilities e.g. skin colour, height and weight.

that join together during

fertilisation: when a male and female gamete fuse to form a diploid.

with genetic material held in

Chromosomes: a package of DNA containing many genes

shown by the

phenotype: the physical characteristic expressed

or which can be

discontinuous variation: Variation that is "either/or" eg blood groups or ability to roll tongue.

shown by a

Punnett Square: the grid of squares that may be drawn to show the range of combinations of genes that may occur.

which gives a

Phenotype ratio: ratio of phenotypes e.g. 3 brown hair: 1 blond hair. (a prediction of the phenotypes)

a full set are seen in a

Karyotype: A photograph or diagram of the chromosomes of a cell organised by number and size.

is determined by the

genotype: the allele combination present

when it creates a

zygote: The cell formed when a sperm cell fuses with an egg cell.

and the chromosomes are made of

DNA: Deoxyribonucleic acid – a double helix shaped molecule that carries a genetic code.

heterozygous: (Rr) 2 different alleles are present

or

which can be

homozygous: (RR) or (rr) 2 copies of the same allele are present

that continues to grow by

mitosis: cell division producing body cells for growth and repair.

lengths of which form a

gene: a section of DNA on a chromosome that codes for a particular characteristic (e.g. eye colour)

a single unit of which is a

nucleotide: consisting of a phosphate and a sugar connected to a base. The bases are A joined to T and C joined to G

also called

Pure breeding: a pure breeding individual has 2 copies of the same allele (homozygous)

that create a

trait: Another word for a characteristic, e.g. brown hair

different varieties are called

alleles: a specific version of a gene (e.g. blue eye colour)

and can be

dominant: only one dominant allele present for that characteristic to be expressed so if present then it is expressed.

or

recessive: two recessive alleles must be present for that characteristic to be expressed