Year 8 Inheritance, Variation and Evolution Higher

Punnett Square Diagrams

75% (3 out of 4) chance of brown eyes
25% (1 out of 4) chance of blue eyes

50% (2 out of 4) chance of brown eyes
50% (2 out of 4) chance of blue eyes

- B – dominant brown eye allele
- b – recessive blue eye allele

- BB brown eyes
- Bb brown eyes
- bb blue eyes
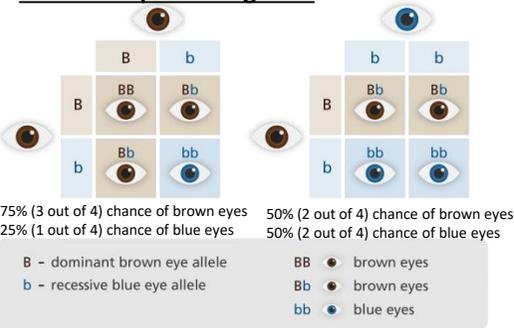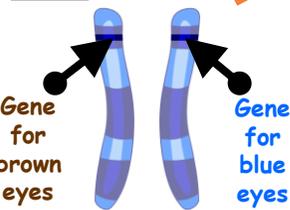
- Dominant alleles only need to appear once for the characteristic to show
- Recessive alleles need both alleles to appear to show the characteristic

Alleles

Gene for brown eyes

Gene for blue eyes

An allele is a different form of the same gene. E.g. a gene for eye colour:
- One allele is for blue eyes
- One allele is for brown eyes

Sex Chromosomes

- If a sperm cell carrying an X fuses with an egg cell, you get XX (a female), so a 50% chance of having a female

	X	Y
X	XX	XY
X	XX	XY

Sperm

eggs

- If a sperm cell carrying a Y fuses with an egg cell, you get XY (a male), so a 50% chance of having a male
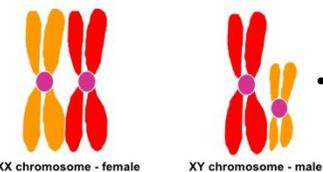
- Sperm cells carry either an X or a Y chromosome
- Egg cells always carry an X chromosome

XX chromosome - female

XY chromosome - male

START

A punnett square diagram shows the alleles of one parent against another and shows the possible combinations of the alleles in the offspring.

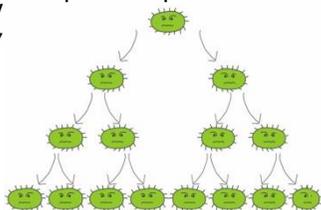## Structure of DNA

Nucleus
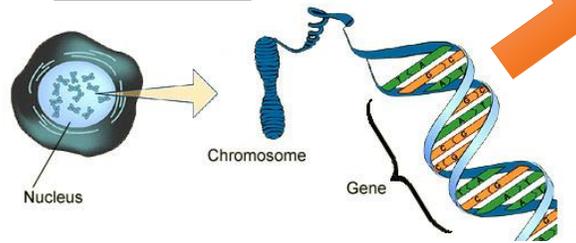
Chromosome

Gene

The nucleus contains chromosomes, which are long strands of DNA. Short sections of DNA make up genes. These genes control characteristics e.g. hair colour or eye colour. DNA has a double helix shape and has 4 bases: Adenine, Thymine, Cytosine and Guanine
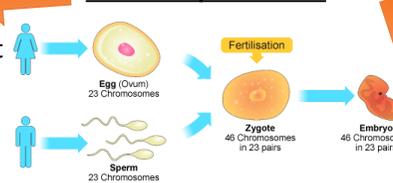
Keywords:
1. **DNA:** Deoxyribonucleic acid, the chemical that makes up genes
2. **Gene:** A short section of DNA that controls a characteristic
3. **Chromosome:** A long strand of DNA that contains genes
4. **Genome:** The complete set of DNA in an organism
5. **Mitosis:** The type of cell division that produces 2 genetically identical cells
6. **Meiosis:** The type of cell division that produces 4 different cells with half the number of chromosomes
7. **Gamete:** The sex cells (sperm cell and egg cell), they only contain 23 chromosomes
8. **Allele:** Different forms of the same gene

Asexual Reproduction

- Asexual reproduction only involves one parent
- Offspring are clones (genetically identical) of the parent
- This is how bacteria and plants reproduce

Sexual Reproduction

Egg (Ovum) 23 Chromosomes

Fertilisation

Zygote 46 Chromosomes in 23 pairs

Embryo 46 Chromosomes in 23 pairs

Sperm 23 Chromosomes

- Sexual reproduction is where 2 gametes fuse to create offspring
- The genes from each gamete mix to create offspring that are a genetic mix of both parents
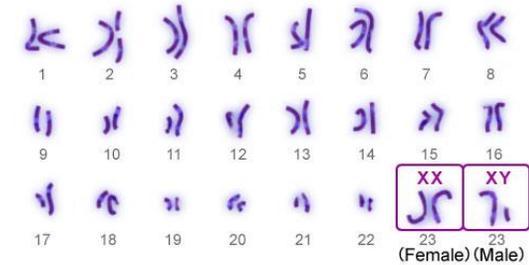
Human Genome Project

- The human genome consists of 23 chromosomes (chromosomes 1-22 and the X and Y chromosome).
- The human genome project was a research project that found out the DNA sequence of these 23 chromosomes
- A mistake in the DNA sequence can cause a genetic disease e.g. cystic fibrosis and Huntington's disease
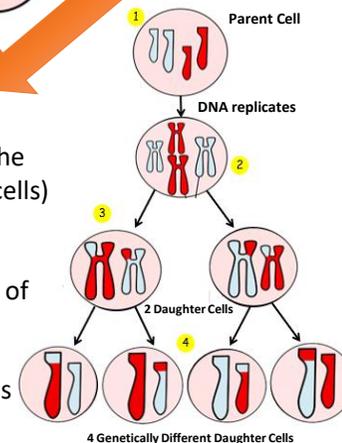
(Female) (Male)
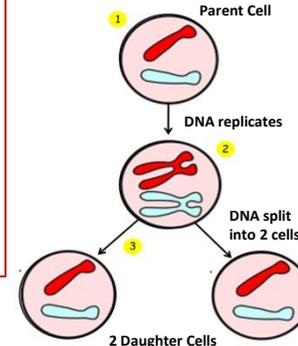
Mitosis

- Mitosis is the type of cell division used for repairing tissue
- It creates two new genetically identical cells (clones)

Parent Cell
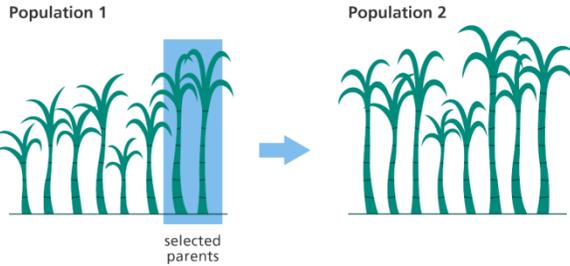
DNA replicates

DNA split into 2 cells

2 Daughter Cells

Meiosis

- Meiosis is the type of cell division used for making the gametes (egg and sperm cells)
- It creates 4 daughter cells with half the number of chromosomes (23 instead of 46)
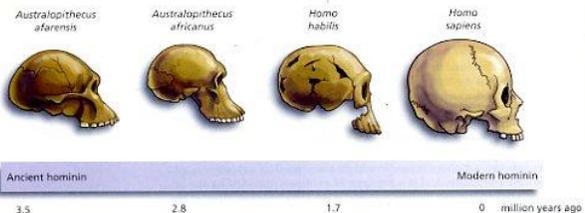- It creates 4 genetically different cells, so produces variation

Parent Cell

DNA replicates

2 Daughter Cells

4 Genetically Different Daughter Cells

Selective Breeding

Population 1 → Population 2

selected parents

- The process where humans breed animals or plants to get particular characteristics
- These are the steps in selective breeding :
1. Decide which characteristics are important
2. Choose parents that show these characteristics
3. Select the best offspring from parents to breed the next generation
4. Repeat this process
- Examples of desirable characteristics: disease resistance in food crops, cows that produce more meat

CONTINUE

Inherited Disorders

Some genetic diseases are inherited from parents to offspring e.g
- Polydactyly – caused by a dominant allele that leads to extra fingers or toes
- Cystic fibrosis – caused by a recessive allele that leads to problems with cell membranes

f is the cystic fibrosis allele

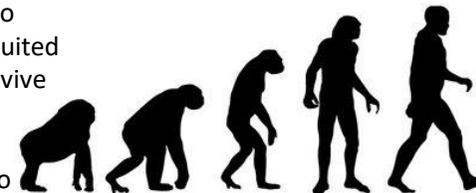|		mother	
		F	f
father	F	FF	Ff
	f	Ff	ff

f shows the recessive cystic fibrosis allele
Two unaffected parents with one copy of the cystic fibrosis allele (Ff) have a 25% (1 in 4) chance of having a child with cystic fibrosis

Keywords:
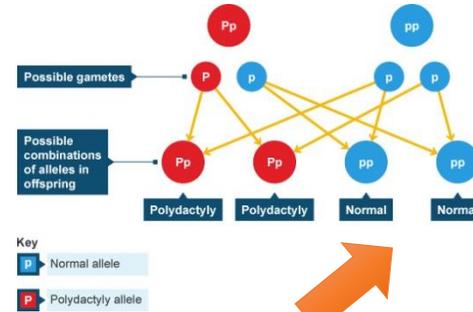1. **Dominant:** Only one allele needed to show the characteristic
2. **Recessive:** 2 alleles needed to show the characteristic
3. **Punnett Square:** Diagram used to predict the outcome of a genetic cross
4. **Variation:** differences in the characteristics of individuals in a population
5. **Genetic variation:** Differences in the DNA sequence
6. **Environmental variation:** Differences in an organism's characteristics caused by the surroundings
7. **Mutation:** A change in the DNA sequence
8. **Fossil:** the remains of organisms from millions of years ago
9. **Selective Breeding:** Process used by humans to make organisms with desirable characteristics

Polydactyly Polydactyly Normal Normal

Key
P Normal allele
P Polydactyly allele

- P shows the dominant polydactyly allele
- One affected parent (Pp) and one unaffected parent (pp) have a 50% (2 in 4) chance of having a child with polydactyly

Variation

- Variation is caused by the genes you have and the environment you live in
- Genes and the environment can interact to influence the physical characteristics of an organism

Mutation

Original sequence

Point mutation
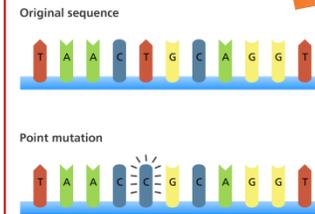
A mutation is the change in the DNA sequence

A mutation can change the characteristics of an organism to make it better suited to the environment

Fossils

- Fossils show what organisms used to look like in the past and allow us to see how organisms have changed over time
- Fossils can be formed when:
- Parts of the organism have not decayed
- Parts of the organism have been replaced by minerals as they decayed
- Traces of organisms are left e.g. footprints and burrows

Australopithecus afarensis Australopithecus africanus Homo habilis Homo sapiens

Ancient hominin   Modern hominin
3.5   2.8   1.7   0 million years ago

Evolution

- The theory of evolution is that all species of organisms have evolved from simple life forms that first appeared over 3 billion years ago
- If a mutation makes an organism better suited to its environment, it is more likely to survive and reproduce
- This mutation will then be passed on to offspring and since they are more likely to survive this mutation will spread throughout the species
- This idea is called natural selection

The evolution of modern humans

Questions (Page 1)

1. Put the following into order from smallest to largest: gene, chromosome, DNA, nucleus, cell
2. Describe the shape of DNA
3. How many chromosomes does each human cell contain?
4. How many pairs of chromosomes does each cell have?
5. Describe what is meant by the human genome
6. Name 2 diseases caused by a faulty genetic code
7. Name the two types of cell division
8. Describe 2 key differences between mitosis and meiosis
9. Describe 2 key similarities between mitosis and meiosis
10. Which type of cell division causes variation? Explain how you know this
11. Name the two types of reproduction
12. Describe the difference between sexual and asexual reproduction
13. What are gametes? Give two examples
14. Give some examples of organisms that reproduce sexually and asexually
15. Name the 2 sex chromosomes and describe their role
16. What is the chance of two parents having a boy? Use a punnett square diagram to support your answer
17. What is an allele? Use an example to support your answer

18. The dominant allele R is for being able to roll your tongue and the recessive allele r is for not being able to roll your tongue. Complete the Punnett square diagrams to show the cross between:

a) A parent with Rr and a parent with Rr alleles
b) A parent with RR and a parent with RR alleles
c) A parent with rr and a parent with rr alleles
d) A parent with Rr and a parent with RR alleles
e) A parent with Rr and a parent with rr alleles
f) A parent with RR and a parent with rr alleles

a)

	R	r
R		
r		

b)

	R	R
R		
R		

c)

	r	r
r		
r		

d)

	R	r
R		
R		

e)

	R	r
r		
r		

f)

	R	R
r		
r		

Questions (Page 2)

19. Give an example of a recessive allele and a dominant allele
20. F is the dominant allele for not having cystic fibrosis and f is the recessive allele for having cystic fibrosis. Construct the Punnett square diagrams and calculate the chance of having a child with cystic fibrosis for:
a) An unaffected parent (FF) and another unaffected parent (Ff)
b) An unaffected parent (FF) and another unaffected parent (FF)
c) An unaffected parent (FF) and an affected parent (ff)
d) An affected parent (ff) and an affected parent (ff)
21. P is the dominant allele for polydactyly and p is the recessive allele for not having polydactyly. Construct the Punnett square diagrams and calculate the chance of having a child with polydactyly for:
a) An affected parent (Pp) and an unaffected parent (pp)
b) An affected parent and another affected parent (Pp)
c) An unaffected parent (pp) and another unaffected parent (pp)
22. What is the difference between environmental and genetic variation?
23. What is a mutation? Give an example
24. What is the theory of evolution?
25. What is natural selection?
26. How do fossils show evidence of evolution?
27. Give 2 ways in which fossils are formed
28. What is selective breeding?
29. Describe the process of selective breeding
30. Give 2 reasons why humans would want to use selective breeding