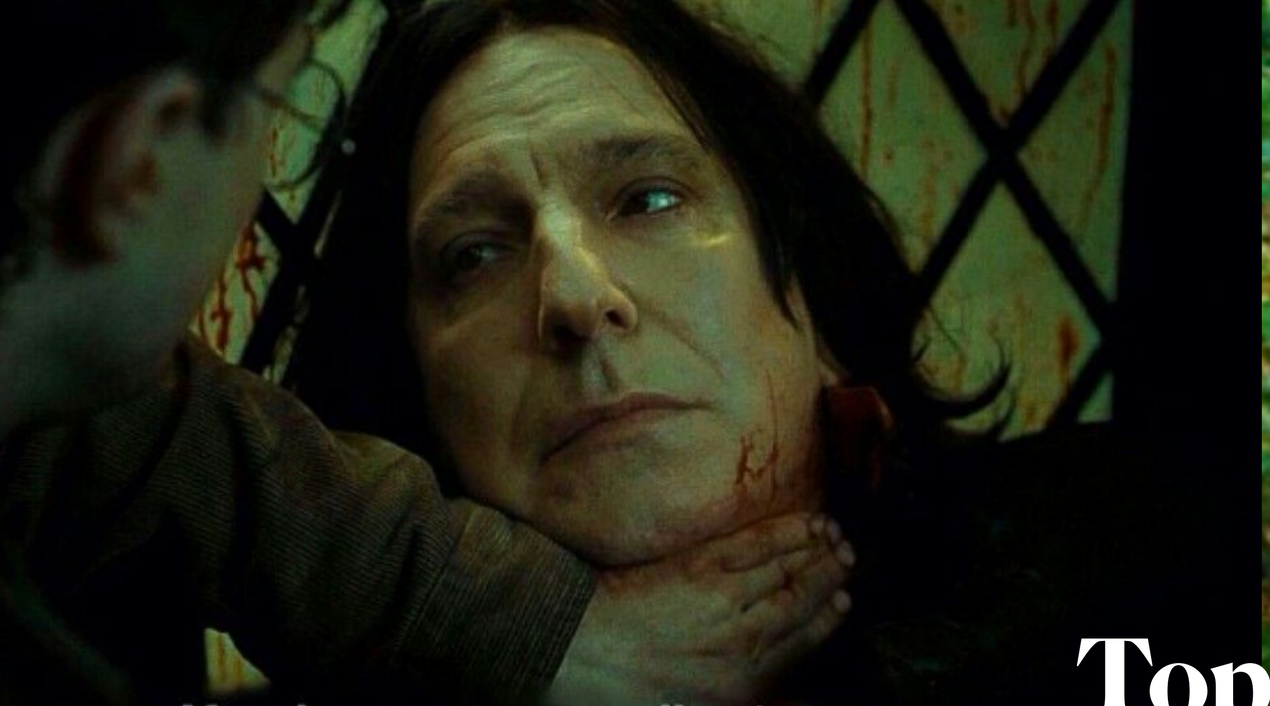
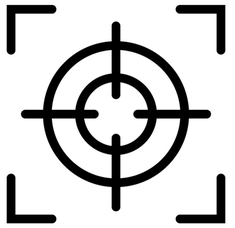


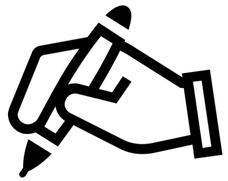
Topic 18: Inheritance

Chapter Analysis



FOCUS

- may be an abstract topic
- application questions



EXAM

- commonly tested in MCQ and structured questions
- tested once in section B in the past 5 years

WEIGHTAGE

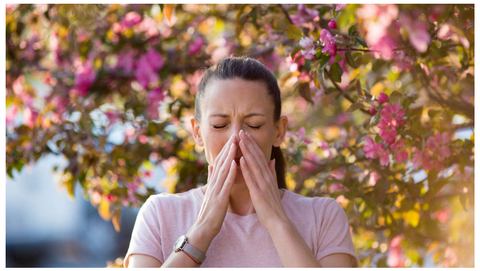
- Constitute to around 6.5% in Paper 2 in the past 5 years

Inheritance

Inheritance is the process by which genetic information is passed on from parent to child

Hereditary traits that can be passed down to you by your parents:

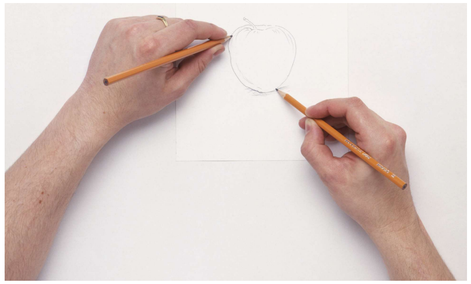
ability to roll tongue



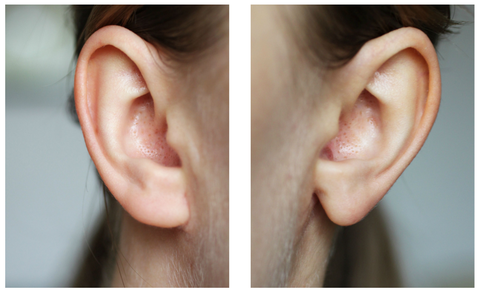
allergy

ability to taste PTC (bitter compound)

dimples



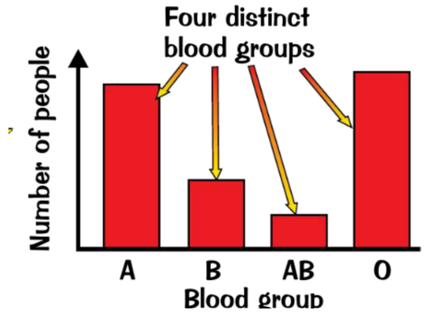
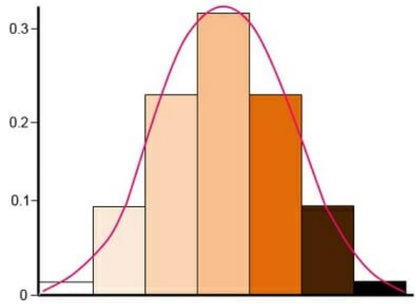
right or left handed



attached or free earlobe

variation

Variations are **differences** in traits **between individuals** of the **same species.**

	Discontinuous variation	Continuous variation
Phenotype	Few **clear-cut phenotypes** with no intermediate	**Range** of phenotypes.
Environment influence	**Rarely affected** by environmental conditions	**Greatly affected** by environmental conditions.
Genes	Controlled by **one or few genes**	Controlled by **many genes**
Additive effect	Not present	The effect of many genes add together and contribute the phenotype
Graph	Discrete groups 	Normal distribution 
Examples	Blood groups, eyelid, flower colour in pea plant	Height, skin colour, weight, intelligence

Key Concept

monohybrid hesitance
codominance
sex determination

terms

definitions

Gene	Gene is sequence of DNA nucleotides that stores information used to make a polypeptide, therefore **gene is a unit of inheritance** passed from parents to offspring
Chromosome	• Chromosome is a compact structure visible in the nucleus during cell division and it is **made up of DNA** • The place on the chromosome where the gene is located is called the gene locus.
Allele	• Alleles are **different forms of a gene**. • Alleles of a gene occupy the same locus on a pair of homologous chromosomes. • For example, eye colour gene has brown allele and blue allele
Dominant	A dominant allele is the allele that is **always expressed in the phenotype**, no matter under homozygous or heterozygous condition.
Recessive	A recessive allele is the allele that is **only expressed under homozygous recessive** condition.
Codominant	• When both alleles have an equal effect on the phenotype of the offspring. • **Both alleles are expressed** in the phenotype.
Homozygous	Organisms having **two identical alleles of a particular gene**. Allele can be either both dominant or both recessive.
Heterozygous	Organisms having **two different alleles** of a particular gene.
Phenotype	• Phenotype refers to the **expressed trait** in an organism. • The phenotype of an organism is the result of its **genes** and the effects of its **environment**.
Genotype	• A genotype is the **genetic makeup** of an organism. • An organism's genotype is homozygous for a trait if the two alleles controlling the trait are identical, heterozygous for a trait if the alleles controlling the trait are different.

Monohybrid Inheritance

Parental Generation

x

F1 Generation

F2 Generation

- The gene for flower colour of pea plant has two alleles: dominant **purple allele** (P) and recessive **white allele** (p')
- When a **homozygous** purple plants (PP) is crossed with a homozygous white plant (p'p'), each organism inherits **one allele from the mother** and **one allele from the father** during sexual reproduction
- The offspring generation consisted of **all purple-flowered** plants even though their genotype is **heterozygous (Pp')** as the **dominant purple allele (P) is** expressed over recessive white allele
- Self-pollination in the F1 generation produced a F2 generation where the phenotypic ratio of purple-flowered to white-flowered plants is 3:1

Genetic Diagram

Let P represent the allele for purple flowers
Let p' represent the allele for white flowers

Parental phenotype	Purple flower	X	White flower
Parental genotype	PP	X	p'p'
Gametes	P P		p' p'
F1 generation genotype	Pp'	Pp'	Pp' Pp'
F1 generation phenotype	Purple flower	Purple flower	Purple flower Purple flower
Gamete	P p'		P p'
F2 generation genotype	PP	Pp'	Pp' p'p'
F2 generation phenotype	Purple flower	Purple flower	Purple flower White flower

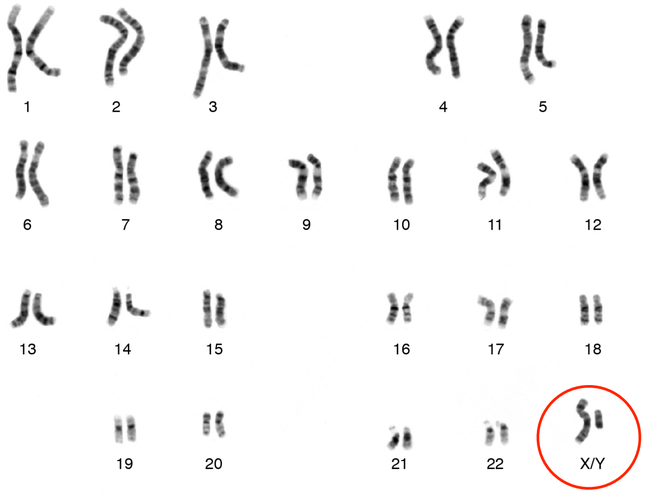
F2 generation phenotypic ratio: 3 purple flower : 1 white flower

3 purple flower: 1 white flower is the **expected ratios**, but the **actual observed ratio can be different** especially when there are small numbers of progeny, because

- Fertilisation of the ova and sperms is a **random event**.
- Therefore the expected ratios are only based on **chance and probabilities.**

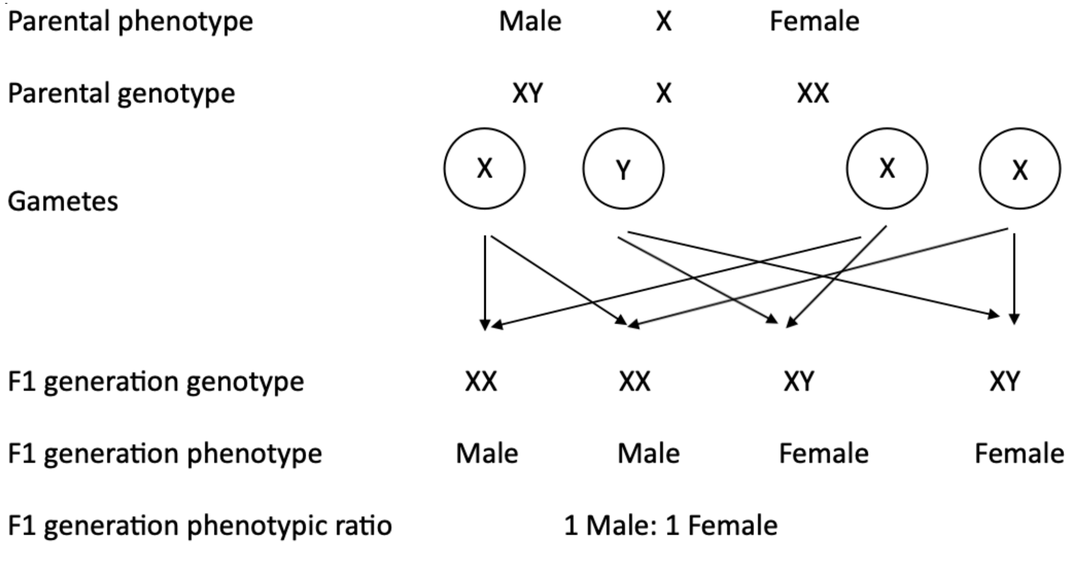
With small number of offspring, the observed ratios often differ from expected ratios. But, with **large number of offspring** (large sample size), the **observed ratios will be closer to expected ratios.**

sex determination



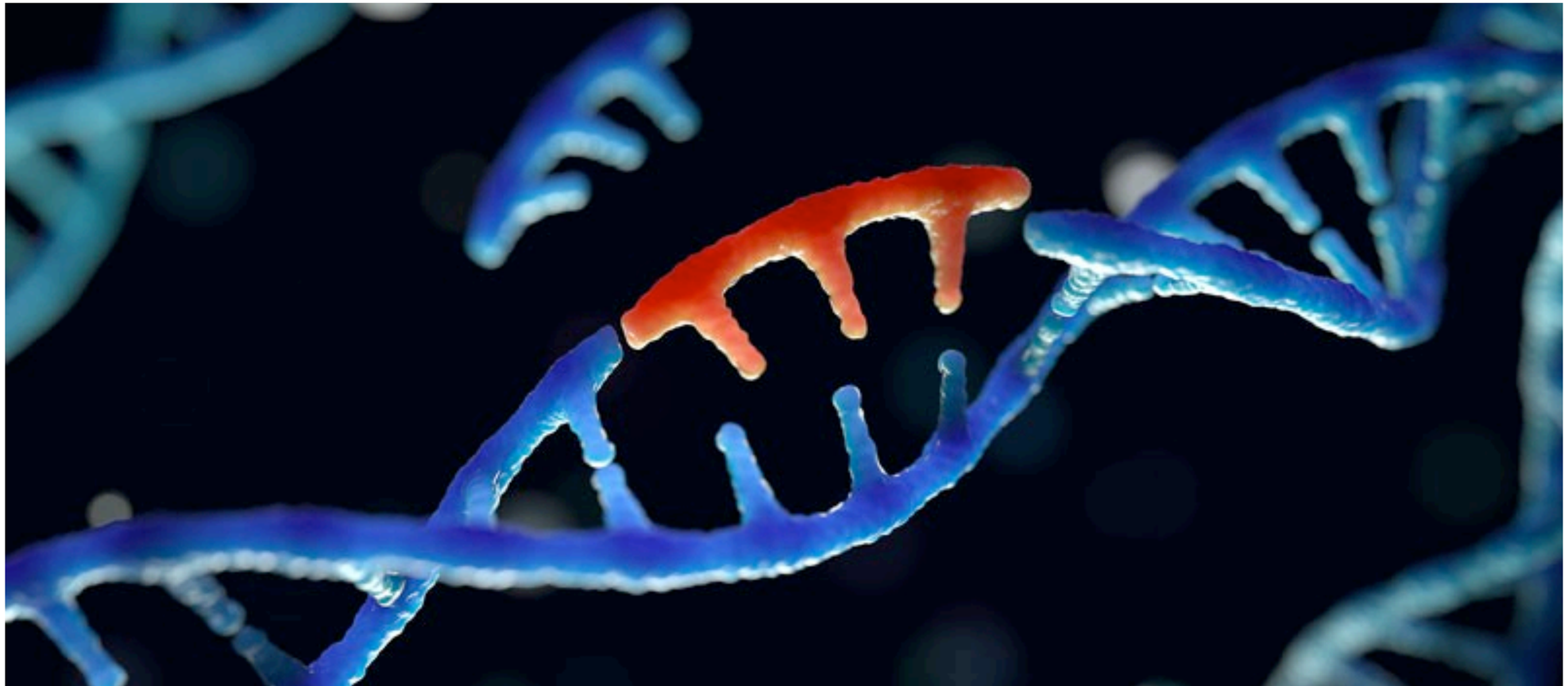
- A human cell has 23 pairs of chromosomes and the last pair is the sex chromosomes
- In humans, sex is determined by sex chromosomes. Human sex chromosomes are the X chromosome and the Y chromosome.
- X chromosome is much larger than the Y chromosome.
- Human males have one X chromosome and one Y chromosome (XY genotype) while human females have two X chromosomes (XX genotype)

Example of sex determination cross:
equal probability of a male or female offspring

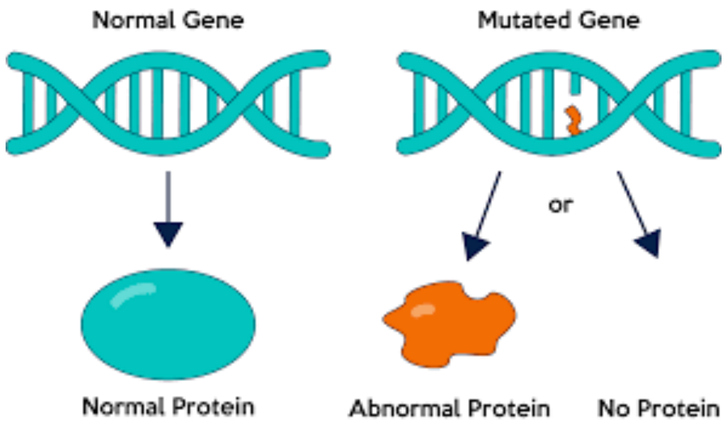


Key Concept

mutation



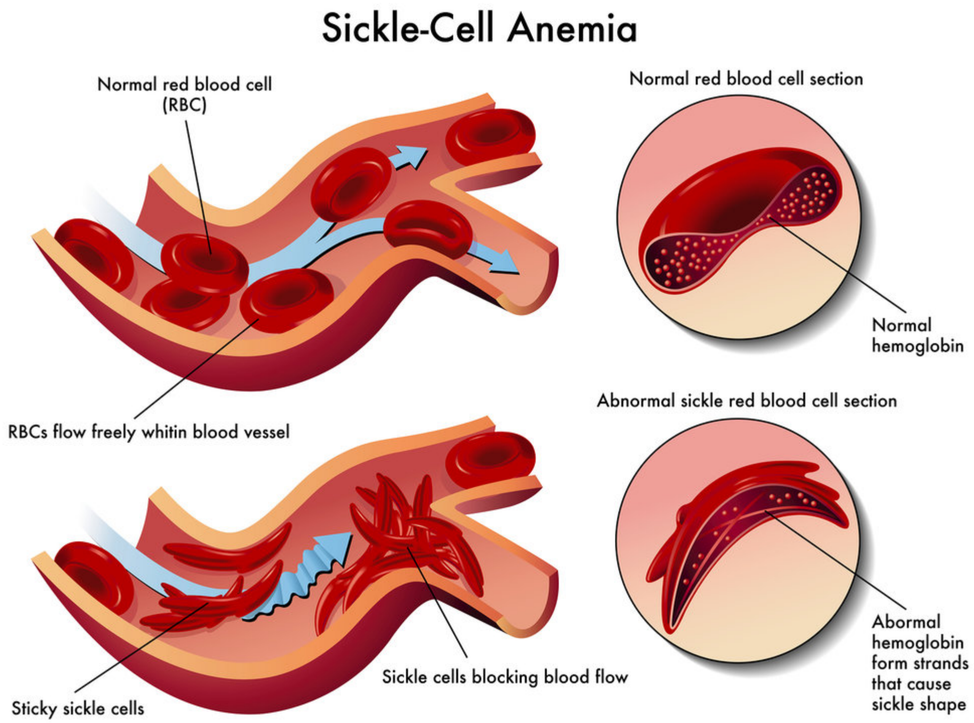
mutation



Mutation

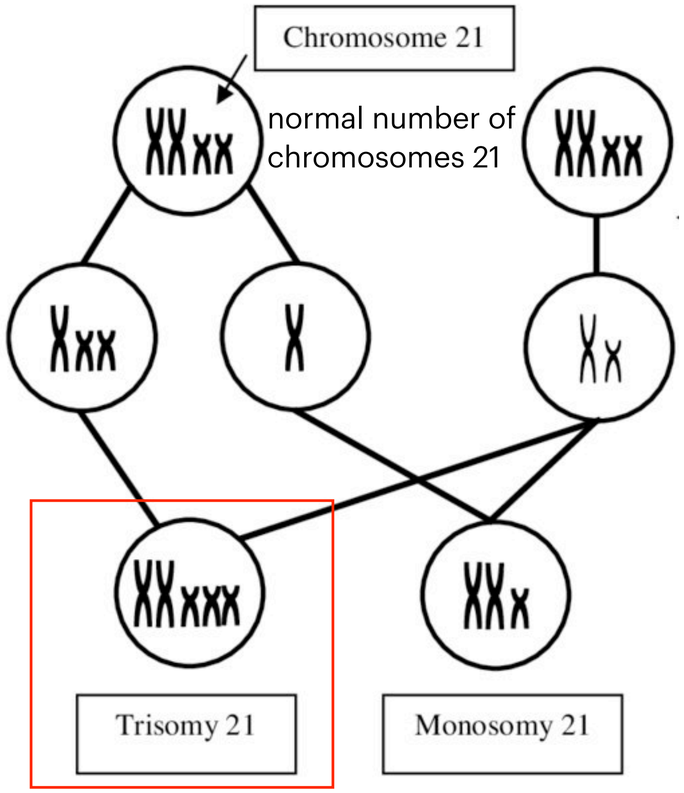
- Mutation is a random change in the **structure of a gene** or in the **chromosome number**
- Mutations that take place in body cells other than gametes are called somatic mutations, which will not be passed on to the next generation
- Mutation is **spontaneous** and can occur during replication of DNA
- **Mutagen** increase the **rate of mutation**
  - Ultraviolet radiation, x rays, gamma rays
  - Chemicals such as benzene, ethidium bromide

gene mutation



- **Sickle-cell anaemia** is caused by a **change in the sequence of nucleotides** coding for haemoglobin
- It is a **recessive condition,** which means mutated allele only expresses in homozygous recessive condition
- **Heterozygous** individual with one normal allele, one mutated allele are healthy but are **carrier**
- **Normal** red blood cells are **flexible** and can change their shape in order to pass through capillaries.
- Mutated gene produces **Haemoglobin S (HbS)** that tend to clump together, which result in **sickle-shaped red blood cells** that can block capillaries
- When oxygen concentration in the blood drops, the red blood cells become sickled-shaped and this **lowers their surface area to volume ratio for diffusion of oxygen**. Hence, they **cannot transport oxygen as effectively** as the normal red blood cells.

chromosomal mutation



down syndrome is also known as trisomy 21

- Down syndrome is a condition caused by a **chromosome mutation during meiosis** (gamete production)
- The **gamete has 2 copies of chromosome 21**, thus upon fertilisation, the **zygote inherits 3 copies of chromosome 21** and a total of 47 chromosomes
- This mutation is present in all body cells due to mitosis during zygote development.
- This chromosome mutation is far more likely to occur during ovum production than during sperm production.
- Women above 30 have a higher risk of carrying babies with Down syndrome.

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