Inheritance

- Homologous chromosomes are chromosomes with similar structure & composition.
- Haploid is $\frac{1}{2}$ the no. of chromosomes of a diploid cell. Haploid is n (23), Diploid is 2n (46)
- Zygote (a diploid cell) results from the fusion of 2 haploid gametes

Key notes

→ X & Y chromosomes are non-matching chromosomes that determine the sex of an individual hence called sex chromosomes.

→ All other matching chromosomes are autosomes.

→ Females have 2 X chromosomes.

→ Chromosome pairs are distinguished by the distinct banding patterns when stained.

★ Meosis

- Meosis is a form of nuclear division whereby the chromosome no. is halfved. Due to this, it is also known as reduction division.
- It also produces genetic variation in gamete cells.

Stages of Meosis

Forms 2 daughter cells with half no. of chromosome

Meosis I Meosis II

Prophase I: Nuclear envelop disintegrates. Homologus chromosomes pair up in a process called synapsis. Each homologous pair is called a bivalent. The centrosomes start moving to the opposite ends of the nucleus.

Metaphase I: Crossing over between the chromatids of the homologous chromosomes happens. The produces genetic variation variation. Bivalent chromosomes line up at the equator. Spindle is formed.

Anaphase I: Whole chromosomes move up to opposite ends of the spindle (poles), centromeres first.

Telophase I: Nuclear envelope reforms, nucleolus reappears, chromosomes reach the poles, cytokinesis occurs in animal cells before Meosis II while in plant cells, many go straight into meosis II without the reformation of the nuclear envelop or nucleolus.

★ Meosis II: Reduction cell division
→ Similar to mitosis
Sister chromatids separate, and haploid cells form.

Genetics

- Gene: A length of DNA that codes for a polypeptide molecule

- Allele: A different form of the same gene

- Genotype: Genetic makeup of an organism

Hetrozygous → Diff alleles

Homozygous → same alleles

→ Dominant alleles are always expressed if present
→ Recessive alleles are only expressed when dominant is not present

→ Co-dominant alleles both have an effect on a heterozygous organism's phenotype.

Generations & Test crosses

- F_1 generation is the offspring formed as a result of a cross between an organism of homozygous dominant and one with homozygous recessive.

- F_2 generation is the offspring resulting from a cross b/w 2 heterozygous F_1 organisms

Sex inheritance and linkage

- The sex chromosomes are not alike and do not always have the same genes in the same positions

- The inheritance of some genotypes is dependant on the sex chromosomes that carry the gene.
  - For example: The X chromosome carries the gene for factor VIII, without which haemophilia develops.

* Dihybrid crosses

- Dihybrid crosses refer to the inheritance of two genes at once. This is due to independant assortment during meosis I.

- Independant assortment is the formation of random combinations of chromosomes in meosis and of genes on different pairs of homologous chromosomes by the passage of one of each diploid pair of homologous chromosomes into each gamete independantly of each other pair.

- It is important to note that dihybrid cross are not for autosomal-linked genes.

Ex - allelle G and g are for coat colour grey n white, and T & t for tail length for long or short tail length.

(GgTt) (GgTt)

	GT	Gt	gT	gt
GT	GGTT	GGTt	GgTT	GgTt
Gt	GGTt	GGtt	GgTt	Ggtt
gT	GgTT	GgTt	ggTT	ggTt
gt	GgTt	Ggtt	ggTt	ggtt

★ Autosomal linkage

→ When two genes are located on the same chromosome, causing them to be inherited together instead of being inherited by independant assortment.

Chi-squared Test

- The chi-squared test is a statistical test used to determine significant difference b/w the expected results and the observed results.

Example

Actual crosses

54	grey, L
4	g, S
4	w, L
18	w, s

Expected

G & L = 9
G & S = 3
w & L = 3
w & S = 1

Null Hypothesis: There is no significant difference b/w observed & expected phenotype

	G, L	G, S	W, L	W, S
Observed no (O)	54	4	4	18
Expected ratio	9	3	3	1
Expected no. (E)	45	15	15	6
$(O-E)^2$	81	121	121	169
$(O-E)^2/E$	1.8	8.07	8.07	33.8

$$\chi^2 = 51.47$$

$P < 0.05$: the difference is significant. Reject null
$P > 0.05$: the difference is not significant. Accept null.

Degree of freedom = $n-1$

$= 4-1$

$= 3$

Then see from table of greater than 0.05 no. is 7.82. Then check trend and identify where your calc χ^2 value will lie. Here $P < 0.05$ ∴ Reject null as difference is significant.

✱ Gene Mutations

- Different alleles of genes come about by mutation.
- A gene mutation is a change in the structure of a DNA molecule resulting in the production of a different allelle. Sometimes, whole chromosomes are affected by mutations.

* Sickle cell anaemia is the result of a base substitution. The change in β-globin polypeptide that causes haemoglobin to be less soluble. The molecules stick to each other forming a sickle shape which transport less oxygen and get stuck.

* Albinism

- Albinism is a homozygous recessive trait. In humans, the pigment melanin is partially or fully absent from eyes, hair & skin.
- Albinism is sex-linked
- Albinism is caused by a mutation in the gene for the enzyme tyronase. This mutation either results in the lack of production or an inactive tyrosinase in the cells.
- Hence tyrosin isn't converted to Dopa, which converts to melanin.

* Huntington's Disease

A neuro-degenarative disease that results in duntary movements, progressive mental deterioration and loss of brain cells.

Its caused by an unstable segment on chromosome 4.

★ Haemophilia

- Haemophilia is a genetic condition where body is unable to make blood clots, causing people to bleed for longer times

- It is a sex-linked recessive disease due to a defect on X-chromosome

★ Gene control

1. Gene control in Prokaryotes

- Transcription factors are factors that bind to a specific DNA sequence and control the flow of information from DNA to RNA.

- Structural genes are genes that code for proteins needed by the cell. The form part of the cellular structure and can sometimes act as enzymes.

- Regulatory genes are genes that code for proteins to regulate the expression of other genes.

- Repressible enzymes: These enzymes can be prevented from being synthesized by the binding of a repressor protein to the operator on the bacteria's DNA.

- Inducible: An inducible enzyme is an enzyme that is synthesized only when its substrate is present. The transcription of the enzyme's gene starts as a result of the substrate being present.

Operon: A length of DNA making up a unit of gene expression in a bacterium. They have one or more structural genes and regions of DNA that are recognized by the by-products of regulatory genes.

✱ The Lac Operon

- The lac operon is an operon that regulates the coding for enzyme β-galactosidase. This enzyme catalyses the breakdown of lactose to glucose & galactose.

- The amount of enzyme available in a bacteria like E coli depends on concentration of lactose in medium it is growing in.

- The structural genes are
  - → lacZ coding for β-galactosidase
  - → lacY coding for permease
  - → lacA coding for transacetylase

When lactose is absent

- The regulatory gene codes for a protein called a repressor
- The repressor binds to the operator close to the β-galactosidase
- Because of the binding of the repressor, RNA polymerase cannot bind to DNA at the promoter region
- Therefore, no transcription of the 3 structural genes can take place.

When lactose is present

→ The bacterium will take up lactose. Lactose will bind to the repressor protein, preventing it from binding to the DNA at the operator site. This will allow RNA polymerase to bind, causing transcription of the three structural genes.

* Gene control in Eukaryotes

- Transcription factor (PIF) cannot bind to gene promoter while Della protein is binded to it.
- Gibberlin bends with a receptor & an enzyme. This initiates the destruction of Della protein.
- The transcription factor (PIF) can now bind with promoter and transcription of amylase can be initiated.