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# Lecture – 2

# Mendelian Principles of heredity

by

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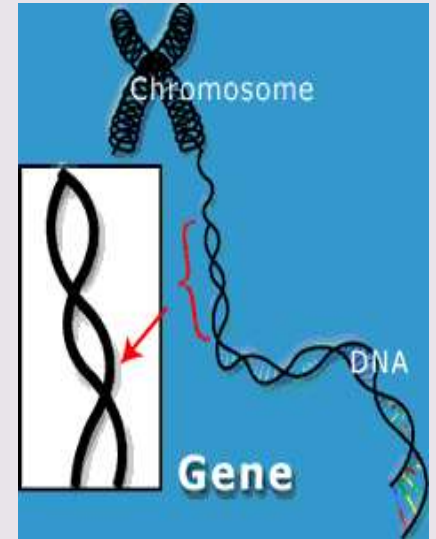


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# Genetics terms you need to know

- **Gene** – a unit of heredity; a section of DNA sequence encoding a single protein
- **Genome** – the entire set of genes in an organism
- **Alleles** – two genes that occupy the same position on homologous chromosomes and that cover the same trait (like ‘flavors’ of a trait).
- **Locus** – a fixed location on a strand of DNA where a gene or one of its alleles is located.





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- **Homozygous** – having identical alleles (one from each parent) for a particular characteristic.
- **Heterozygous** – having two different alleles for a particular characteristic.
- **Dominant** – the allele of a gene that masks or suppresses the expression of an alternate allele; the trait appears in the heterozygous condition.



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- **Recessive** – an allele that is masked by a dominant allele; does not appear in the heterozygous condition, only in homozygous
- **Genotype** – the genetic makeup of an organisms
- **Phenotype** – the physical appearance of an organism (Genotype + environment)



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- **Monohybrid cross:** a genetic cross involving a single pair of genes (one trait); parents differ by a single trait.
- **P** = Parental generation
- **F<sub>1</sub>** = First filial generation; offspring from a genetic cross.
- **F<sub>2</sub>** = Second filial generation of a genetic cross



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# Gregor Johann Mendel (1822-84)

- In 1866 he published *Experiments in Plant Hybridization*, (*Versuche über Pflanzen-Hybriden*) in which he established his Principles of Inheritance
- He tried to repeat his work in *Hieraceum* (facultative apomict), *Honey bees* (haploid male) and Rajama (Polygenic variation)
- Work was largely ignored for 34 years, until 1900, when 3 independent botanists rediscovered Mendel's work



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- Mendel was the first biologist to use Mathematics – to explain his results quantitatively.
- Mendel predicted
  - The concept of genes
  - That genes occur in pairs
  - That one gene of each pair is present in the gametes



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# Pea as an experimental material ?

- Contrasting forms
- Perfect flower
- Self pollinated crop
- Large flower- help in emasculation & pollination
- Short life cycle- annual
- Easy to grow occupy less space





















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## 7 Characteristics in Peas

Trait	Stem length	Pod shape	Seed shape	Seed color	Flower position	Flower color	Pod color
Characteristics	 <b>Tall</b>	 <b>Inflated</b>	 <b>Smooth</b>	 <b>Yellow</b>	 <b>Lateral</b>	 <b>Purple</b>	 <b>Green</b>
	 <b>Dwarf</b>	 <b>Constricted</b>	 <b>Wrinkled</b>	 <b>Green</b>	 <b>Terminal</b>	 <b>White</b>	 <b>Yellow</b>



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# Mendel's laws of inheritance

I. **Law of segregation:** During gamete formation, the alleles for each gene segregate from each other so that each gamete carries only one allele for each gene.

II. **Law of independent assortment:** Genes for different traits can segregate independently during the formation of gametes



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# Monohybrid cross

- Parents differ by a single trait.
- Crossing two pea plants that differ in stem size, one tall one short

T = allele for Tall

t = allele for dwarf

TT = homozygous tall plant

tt = homozygous dwarf plant

TT × tt



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# Mendel's Principles

- **1. Principle of Dominance:**

One allele masked another, one allele was dominant over the other in the  $F_1$  generation.

- **2. Principle of Segregation:**

When gametes are formed, the pairs of hereditary factors (genes) become separated, so that each sex cell (egg/sperm) receives only one kind of gene.



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# Dihybrid crosses

- Matings that involve parents that differ in **two** genes (two independent traits)

For example, flower color

P = purple (dominant)

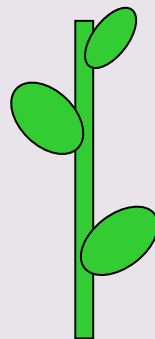


p = white (recessive)



and stem length:

T = tall



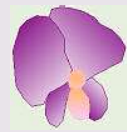
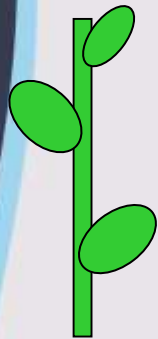
t = short





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# Dihybrid cross: flower color and stem length



$TT PP \times tt pp$   
(tall, purple) (short, white)



Possible Gametes for parents  $tp$   $tp$   $tp$   $tp$

$TP$  and  $tp$

$TP$	$TtPp$	$TtPp$	$TtPp$	$TtPp$
$TP$	$TtPp$	$TtPp$	$TtPp$	$TtPp$
$TP$	$TtPp$	$TtPp$	$TtPp$	$TtPp$
$TP$	$TtPp$	$TtPp$	$TtPp$	$TtPp$

F1 Generation: All tall, purple flowers ( $Tt Pp$ )



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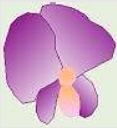
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# Dihybrid cross

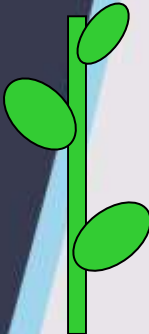
9 Tall



purple



3 Tall



white



3 Short



purple



1 Short



white



TP

*Tp*

*tP*

*tp*

TP

TT**PP**

TT**Pp**

T**tPP**

T**tPp**

*Tp*

TT**Pp**

TT**pp**

T**tPp**

T**tpp**

*tP*

T**tPP**

T**tPp**

**ttPP**

**ttPp**

*tp*

T**tPp**

T**tpp**

**ttPp**

**ttpp**

Phenotype Ratio = 9:3:3:1



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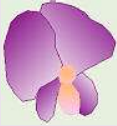
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# Dihybrid cross

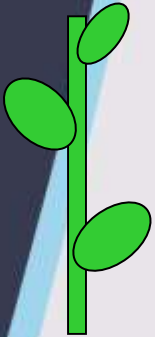
9 Tall



purple



3 Tall



white



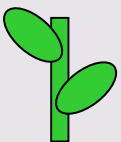
3 Short



purple



1 Short



white



TP

*Tp*

*tP*

*tp*

TP

TT**PP**

TT**Pp**

T**tPP**

T**tPp**

*Tp*

TT**Pp**

TT**pp**

T**tPp**

T**tpp**

*tP*

T**tPP**

T**tPp**

**ttPP**

**ttPp**

*tp*

T**tPp**

T**tpp**

**ttPp**

**ttpp**

Phenotype Ratio = 9:3:3:1





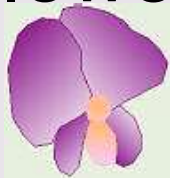
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# Test cross

When you have an individual with an unknown genotype, you do a **test cross**.

**Test cross:** Cross with a homozygous recessive individual.

For example, a plant with **purple** flowers can either be **PP** or **Pp**... therefore, you cross the plant with a **pp** (white flowers, homozygous recessive)



P ? ×

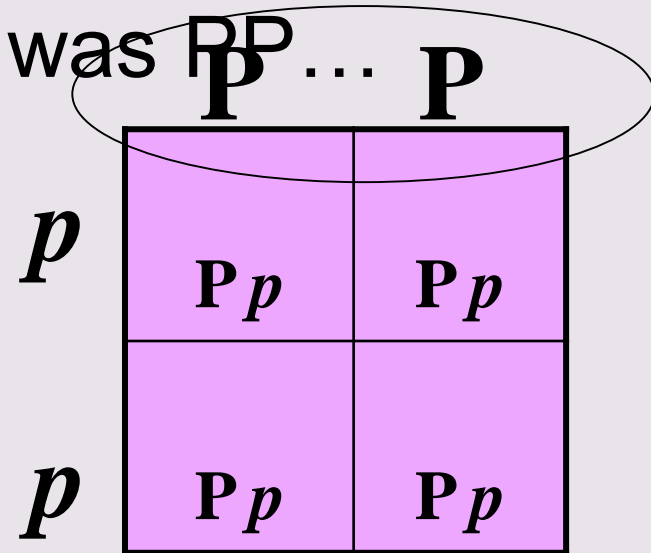




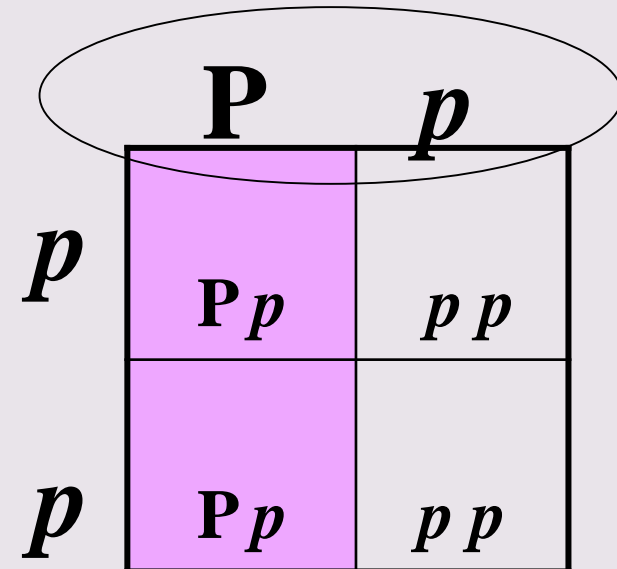
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# Test cross

- If you get all 100% purple flowers, then the unknown parent was  $P^P \dots P$



- If you get 50% white, 50% purple flowers, then the unknown parent was  $Pp \dots$



# Exceptions To Mendel's Original Principles



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- **Incomplete dominance**
- **Codominance**
- **Multiple alleles**
- **Polygenic traits**
- **Epistasis**
- **Pleiotropy**
- **Environmental effects on gene expression**
- **Linkage**
- **Sex linkage**



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**THANK YOU**