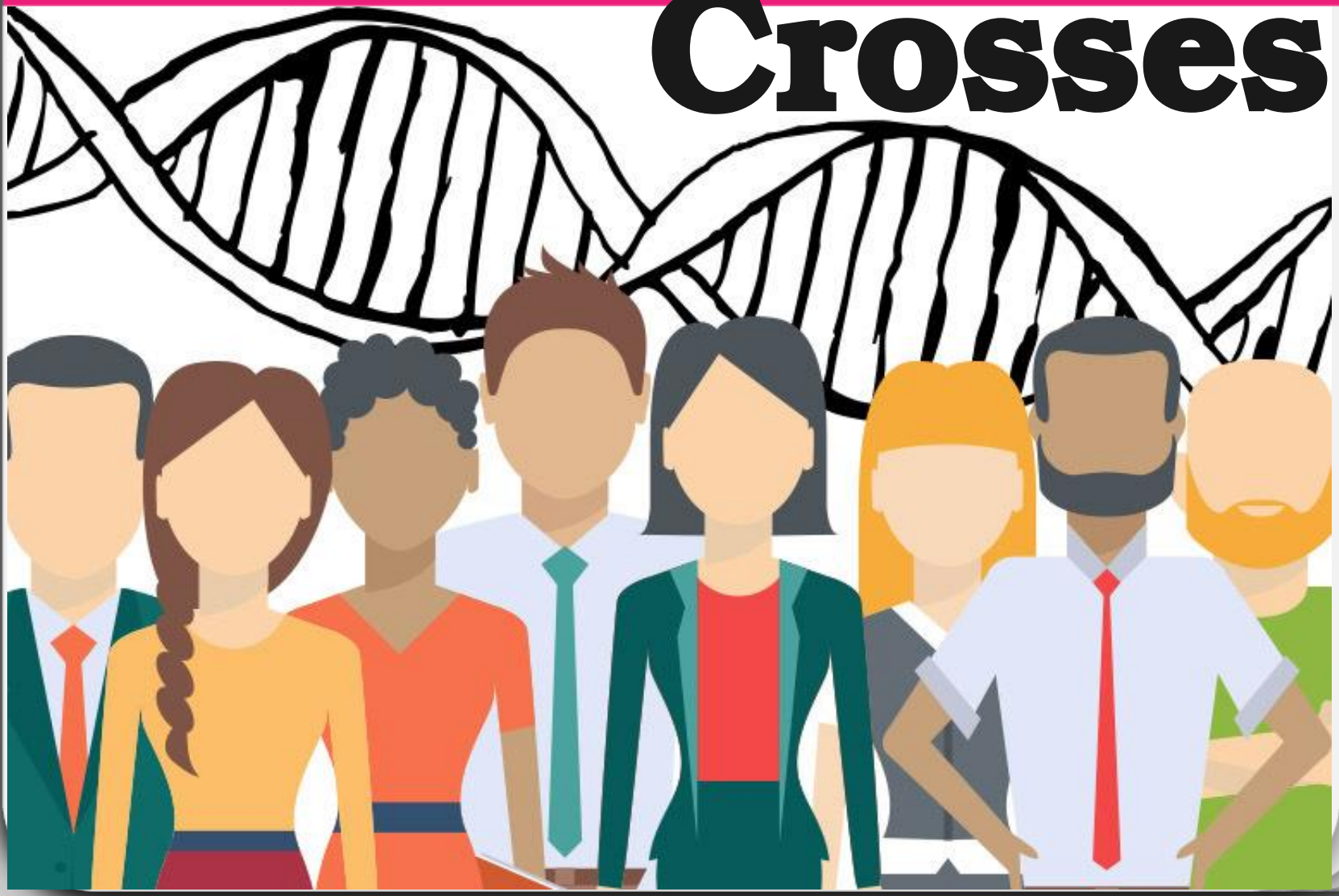
Genetic Crosses

01



What I need to know …01

- 2(k) **Explain** the terms *locus, allele, dominant, recessive, codominant, incomplete dominance, homozygous, heterozygous, phenotype, genotype* and *sex linkage*
- 2(l) **Explain** how genes are inherited from one generation to the next via the germ cells or gametes
- 2(n) **Use genetic diagrams** to solve problems in dihybrid crosses

Definitions

02

- Common understanding of the term
- Allows scientists, researchers and doctors to be on the “same page” during discussions

- Important in solving genetic crosses

Definitions

02

- 2011 STQ Paper

(a) Explain what is meant by the terms dominant and allele.

dominant .....

.....

allele .....

.....[2]

Definitions

02

- 2015 STQ Paper

(d) The inheritance of sickle cell anaemia is autosomal recessive.

Explain what is meant by autosomal recessive inheritance.

.....

.....

.....

.....[2]

Definitions

02

List of words

- Locus
- Allele (Dominant & Recessive)
- Codominant
- Incomplete dominant
- Homozygous & Heterozygous
- Phenotype
- Genotype
- Sex Linkage

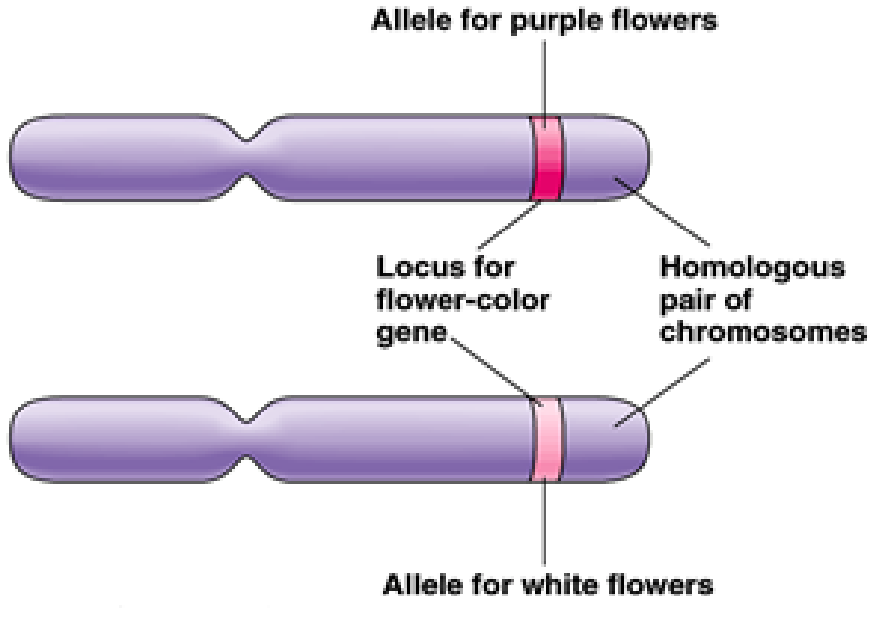
Pg.1

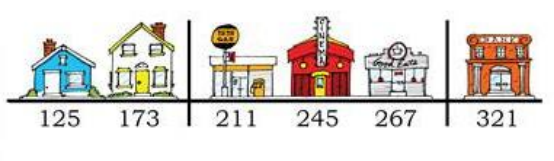
Definitions

02

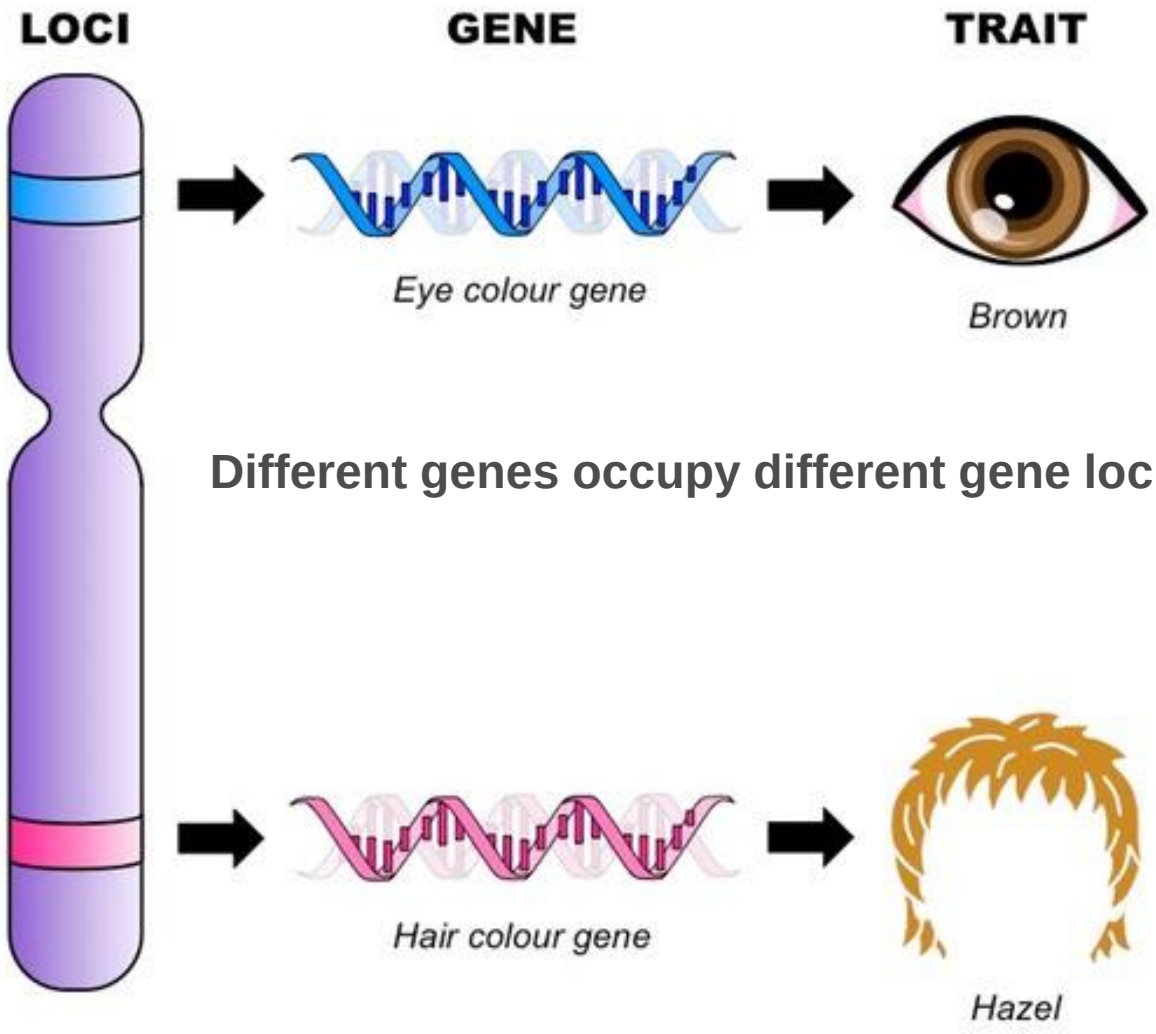
Locus *(singular)*

- Loci *(plural)*
- The fixed position on a particular chromosome that each gene occupies





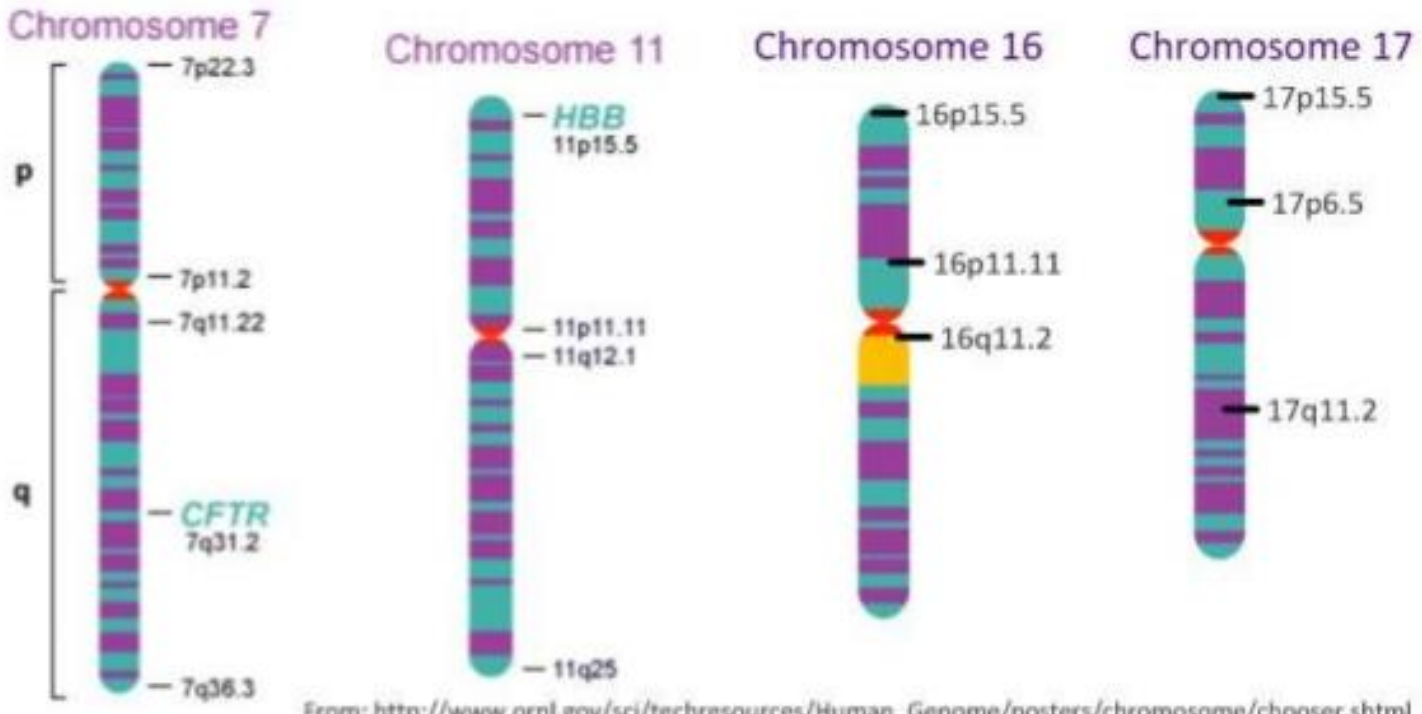
Definitions



Pg.1

Definitions

02



From: http://www.ornl.gov/sci/techresources/Human_Genome/posters/chromosome/chooser.shtml

Definitions

02

List of words

- Locus
- Allele (Dominant & Recessive)
- Homozygous & Heterozygous
- Codominant
- Incomplete dominant
- Phenotype
- Genotype
- Sex Linkage

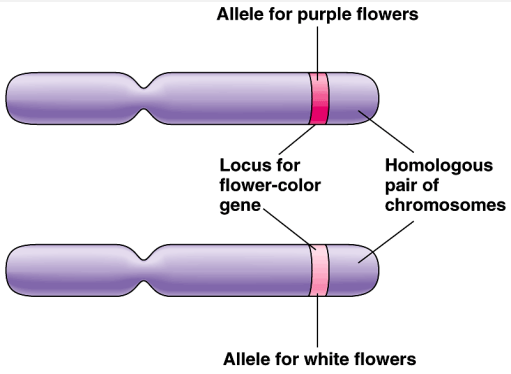
Pg.1

Definitions

02

Allele

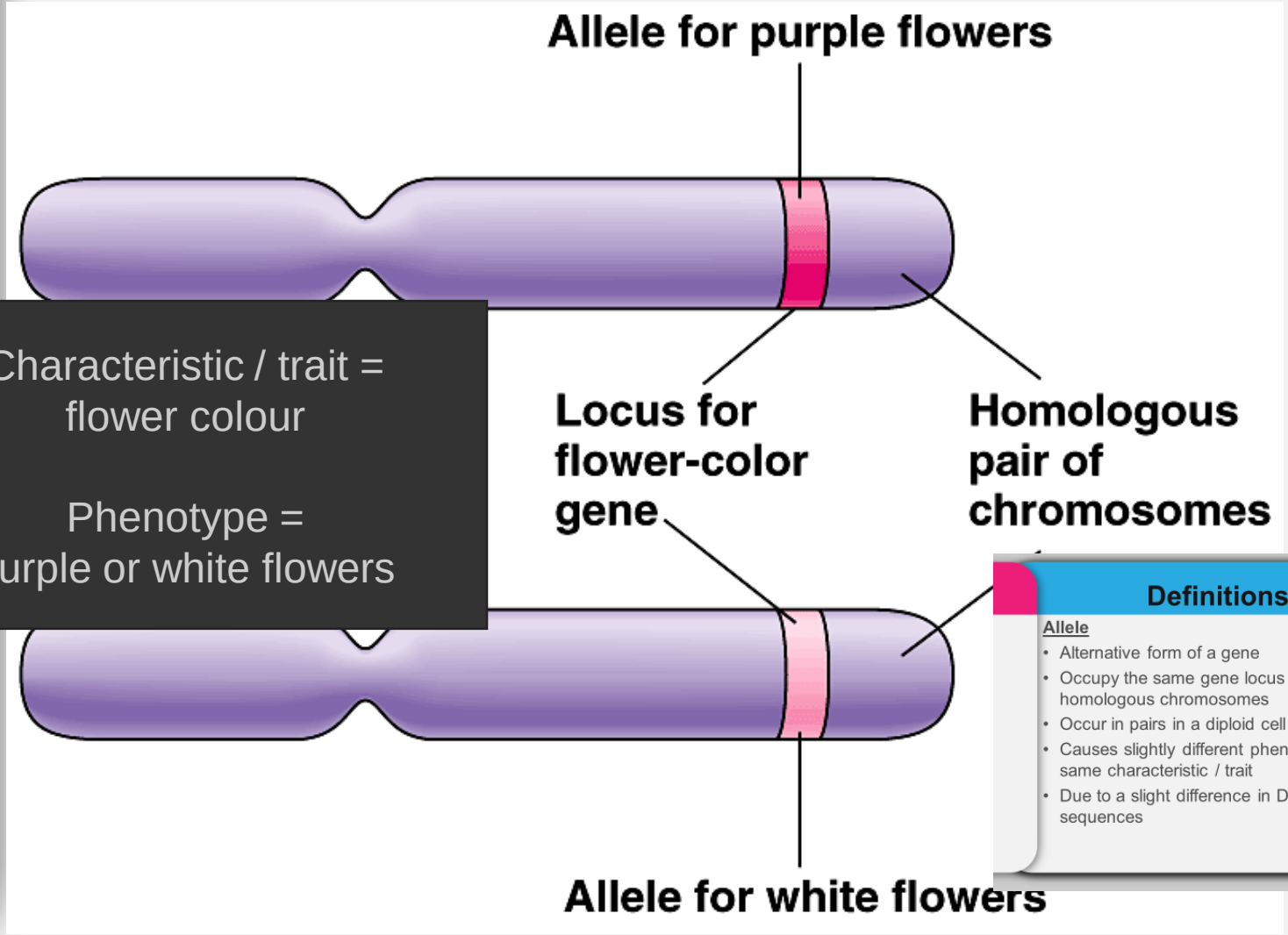
- Alternative form of a gene
- Occupy the same gene locus on homologous chromosomes
- Occur in pairs in a diploid cell
- Causes slightly different phenotypes for the same characteristic
- Due to a slight difference in DNA seq.



Pg.1

Definitions

02



Characteristic / trait = flower colour

Phenotype = purple or white flowers

Definitions 02

Allele

- Alternative form of a gene
- Occupy the same gene locus on homologous chromosomes
- Occur in pairs in a diploid cell
- Causes slightly different phenotypes for the same characteristic / trait
- Due to a slight difference in DNA sequences

Pg.1

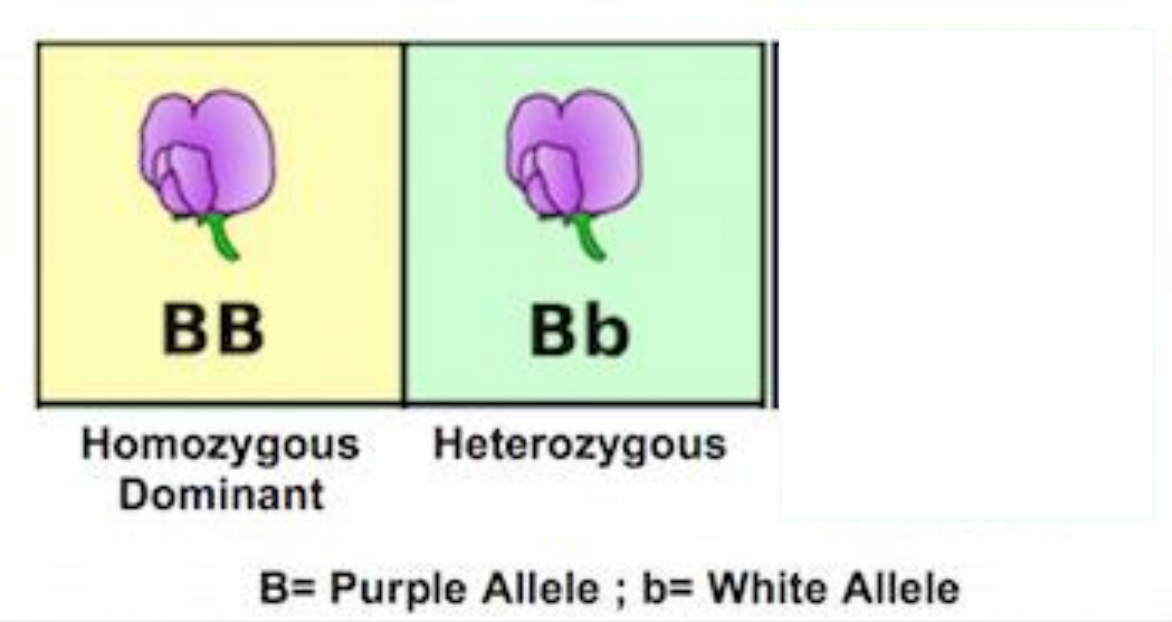
Definitions

02

Gene is transcribed into mRNA, and mRNA being translated into polypeptide

Dominant allele

- Allele whose effect is **expressed** in the phenotype in **both** homozygous and heterozygous conditions



Pg.1

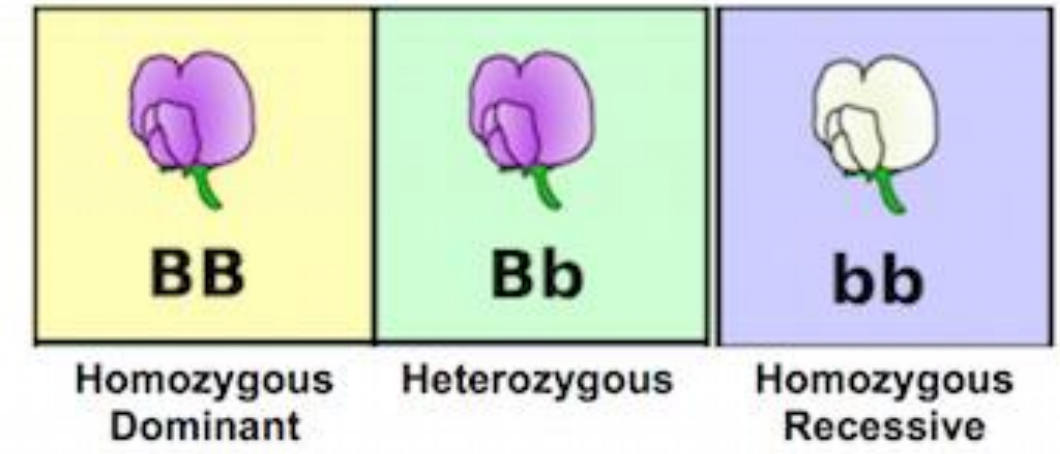
Definitions

02

Recessive allele

Gene is transcribed into mRNA, and mRNA being translated into polypeptide

- Allele whose effect is **expressed** in the phenotype **only** in the presence of another identical allele / in homozygous condition



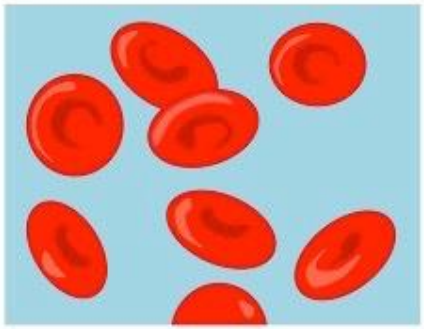
Pg.1

Definitions

02

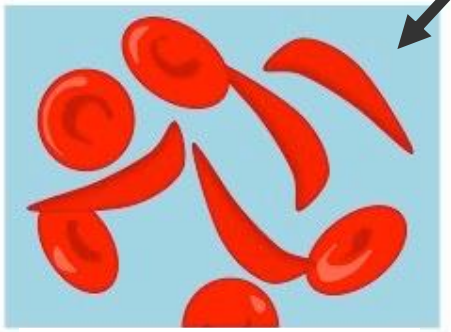
Codominant

- Both alleles are **equally expressed**
- in the phenotype of the **heterozygote**



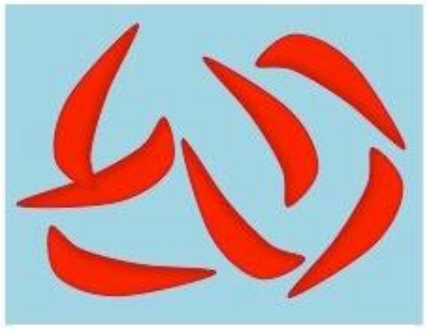
Hb^AHb^A

Normal



Hb^AHb^S

Sickle cell trait



Hb^SHb^S

Sickle cell anaemia

Codominance

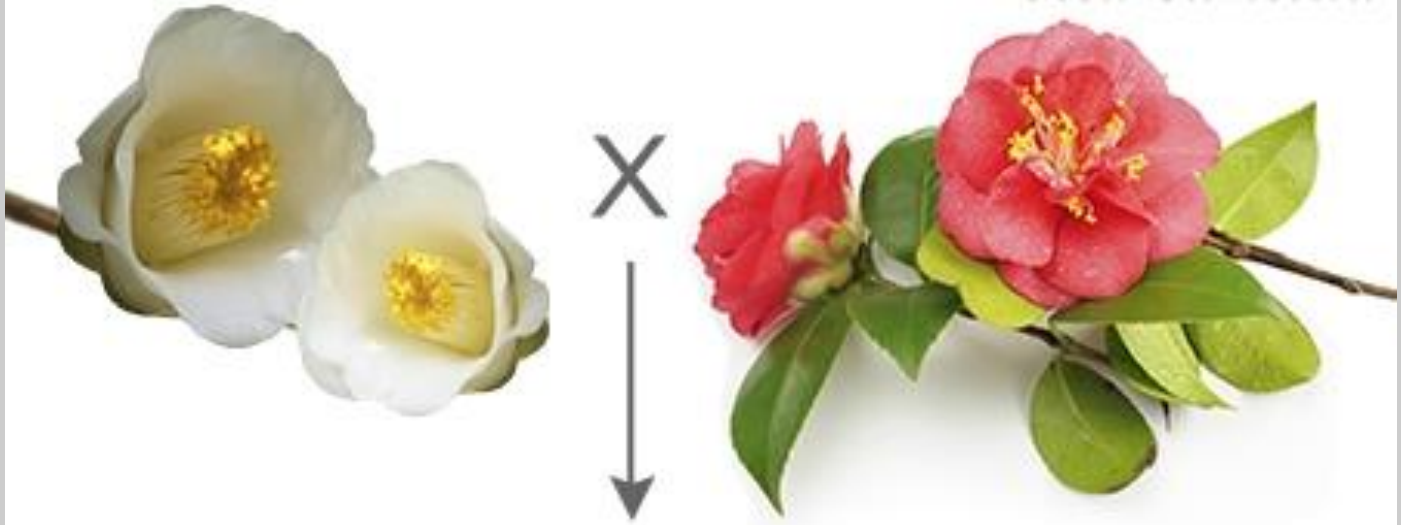
White Bull

Red Cow

Roan Offspring (red and white hairs are expressed equally)

White Camellia

Red Camellia



Red and White Camellia

Pg.1

Definitions

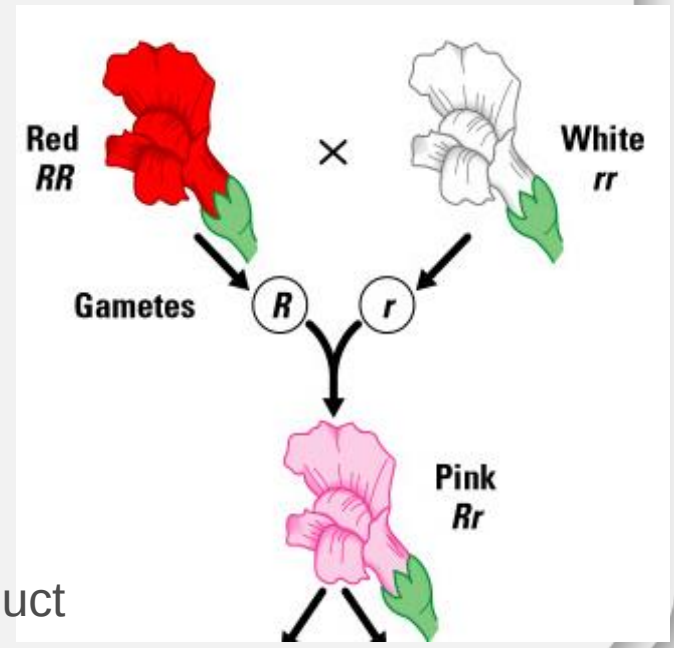
02

Incomplete dominance

- Situation where the **heterozygote** exhibits a phenotype which is **intermediate** between the homozygous dominant & recessive forms

Generally due to the **quantitative effect** of the number of copies of a wild-type allele

Two copies produce the **most** mRNA transcripts & functional protein products;
One copy => less protein products
Zero copy => no functional transcript/product



Definitions

02

List of words

- ✓ Locus
- ✓ Allele (Dominant & Recessive)
- ✓ Codominant
- ✓ Incomplete dominant
- Homozygous & Heterozygous
- Phenotype
- Genotype
- Sex Linkage

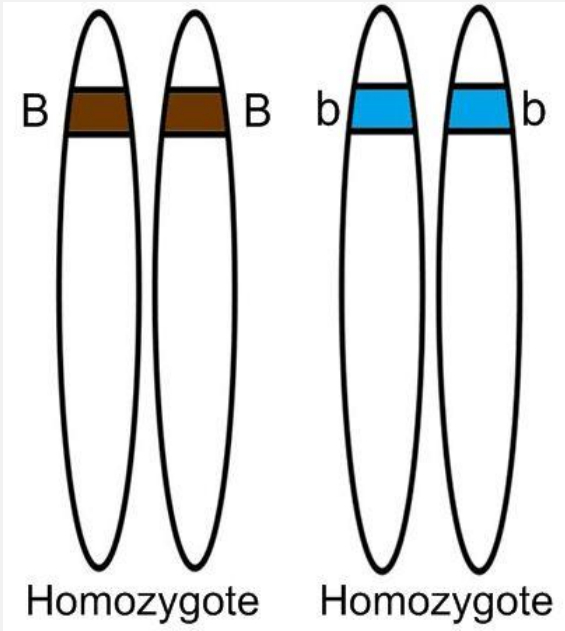
Pg.1

Definitions

02

Homozygous

- Genotype of two **identical** alleles of a gene
- at a particular gene locus of homologous chromosomes
- e.g. 2 dominant alleles or 2 recessive alleles in the genotype



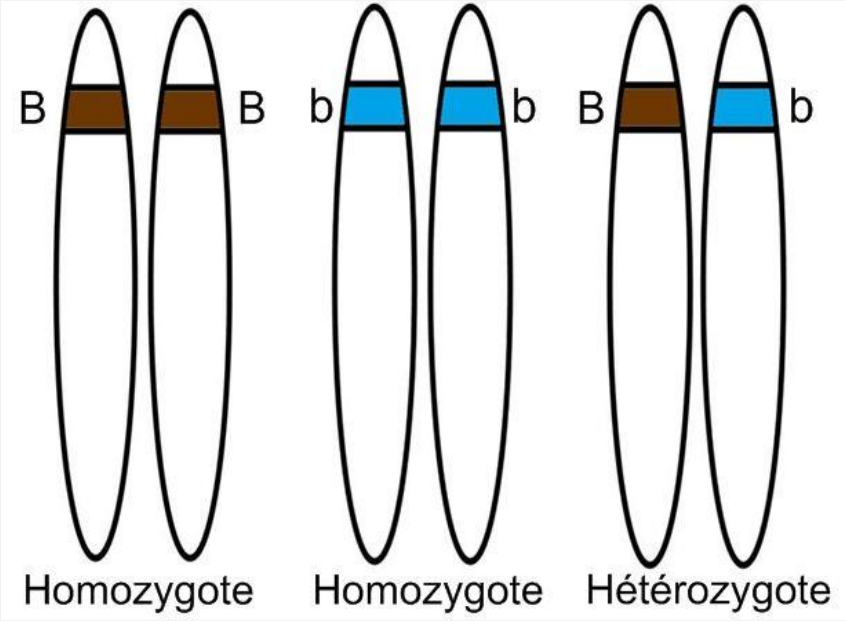
Pg.1

Definitions

02

Heterozygous

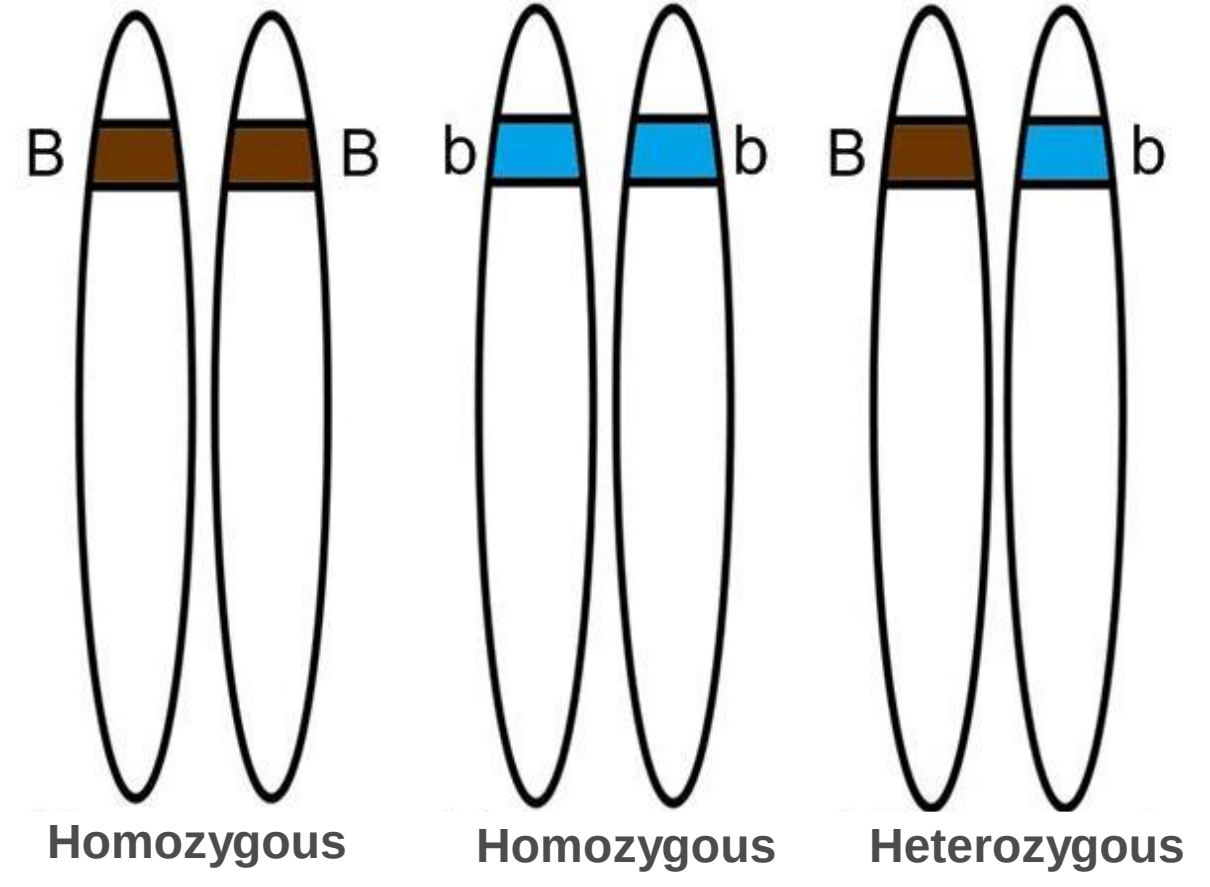
- Genotype of two **different** alleles of a gene
- at a particular gene locus of homologous chromosomes



Pg.1

Definitions

02



Definitions

02

List of words

- ✓ Locus
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- Phenotype
- Genotype
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Test Yourself!

Which of the following statements about recessive alleles is correct?

1. They are expressed phenotypically when homozygous.
2. They are not expressed phenotypically when codominant.
3. They are masked by dominant alleles in homozygotes.
4. They do not undergo transcription in heterozygotes.

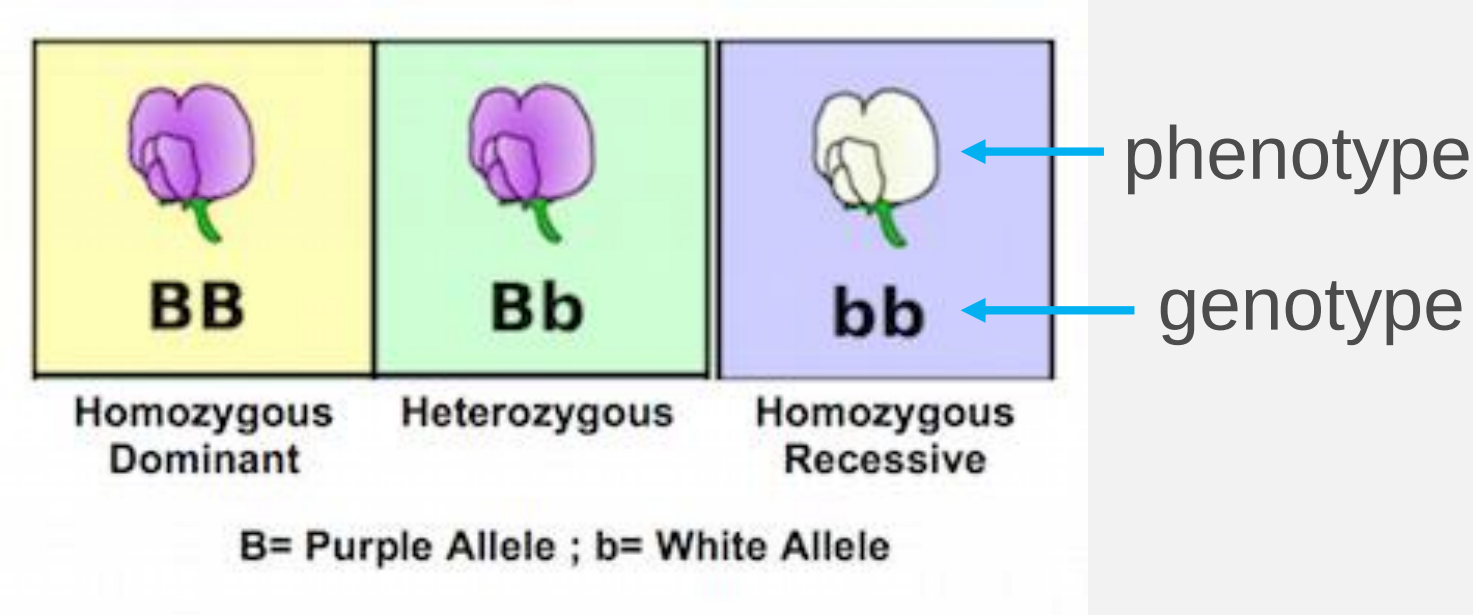
Pg.2

Definitions

02

Genotype :

- Is determined by the alleles of specific genes / genetic make-up with respect to the alleles



Pg.2

Definitions

02

Phenotype :

- The physical manifestation / trait resulting from a specific genotype

trait

	Flower color	Flower position	Seed color	Seed shape	Pod shape	Pod color	Stem length
P	Purple × White	Axial × Terminal	Yellow × Green	Round × Wrinkled	Inflated × Constricted	Green × Yellow	Tall × Dwarf
F_1	Purple	Axial	Yellow	Round	Inflated	Green	Tall

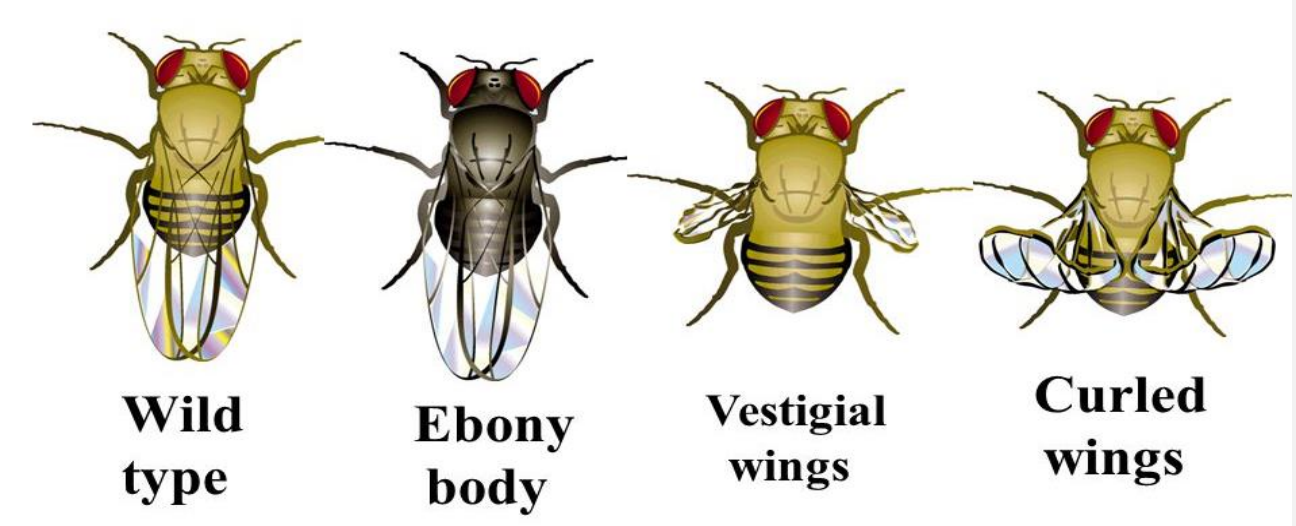
Pg.2

Definitions

02

Phenotype :

- The physical manifestation / trait resulting from a specific genotype



Pg.2

Definitions

02

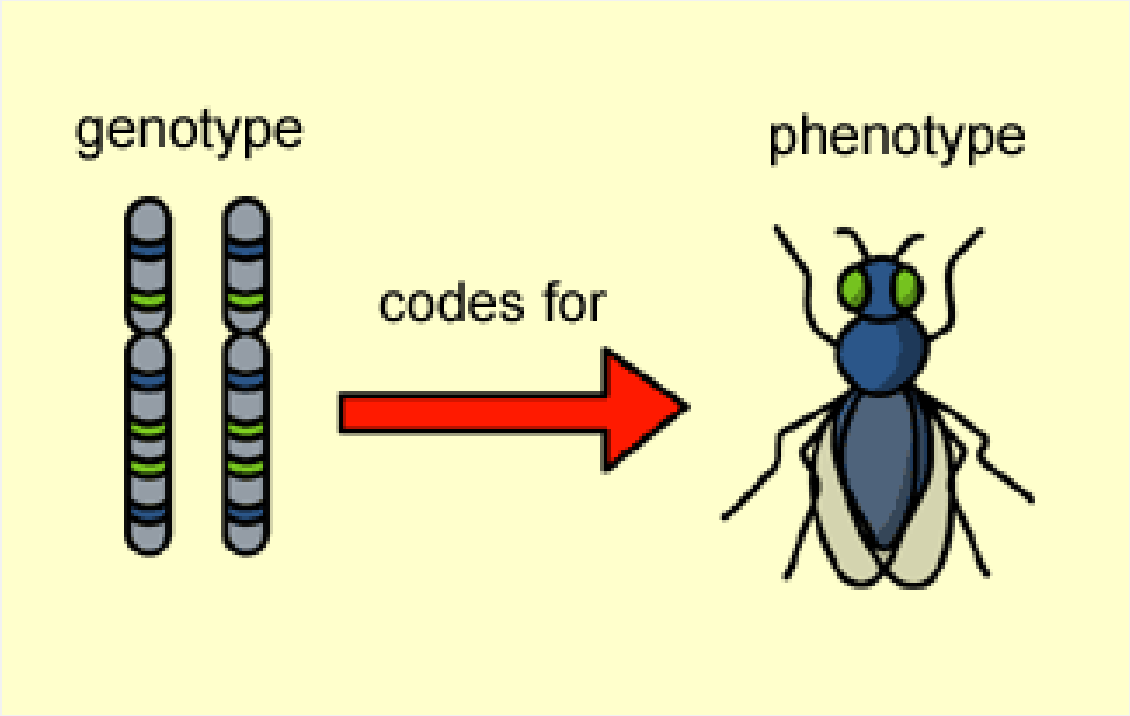
Phenotype :

- The **physical** manifestation / trait resulting from a specific **genotype**
- And its interaction with the **environment**

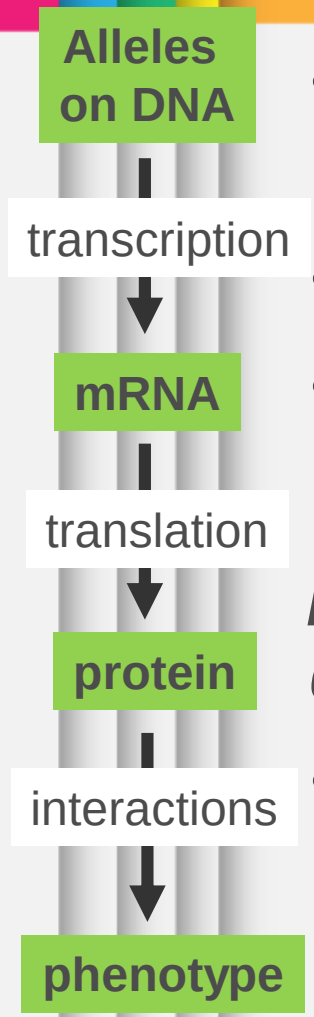
Extra information…

01

- **Explain** how genotype is linked to phenotype



How genotype is linked to phenotype 05



- Diff. alleles differ slightly in their DNA sequences
- Diff. alleles **transcribed** to form diff. **mRNA**;
- Diff. mRNA **translated** into diff. **polypeptide** chain(s) / protein(s);

[Different alleles will result in the production of different polypeptide chain(s) / protein(s)]

- Different gene products / proteins may affect different cellular pathways / different parts of a pathway / different functions;
- Resulting in **different phenotypes**

How genotype is linked to phenotype

05

[At gene gene loci > diff. genotype > diff. phenotype]

- The alleles present for each particular gene may be dominant or recessive;
- Dominant alleles mask the effect / influence of recessive alleles;
- Hence only the effect of the dominant allele will be expressed in the phenotypes of homozygous dominant and heterozygous organisms;
- Phenotypes of recessive individuals will only be expressed when both alleles are recessive

Definitions

02

List of words

- ✓ Locus
- ✓ Allele (Dominant & Recessive)
- ✓ Homozygous & Heterozygous
- ✓ Codominant
- ✓ Incomplete dominant
- ✓ Phenotype
- ✓ Genotype
- Sex Linkage

Pg.2

Definitions

02

Sex Linkage:

- Situation where a **gene is located on a sex chromosome.**
- This results in the characteristic being expressed mainly in one sex.

Definitions

02

List of words

- Locus
- Allele (Dominant & Recessive)
- Homozygous & Heterozygous
- Codominant
- Incomplete dominant
- Phenotype
- Genotype
- Sex Linkage

Pg.3

(Additional) Definitions

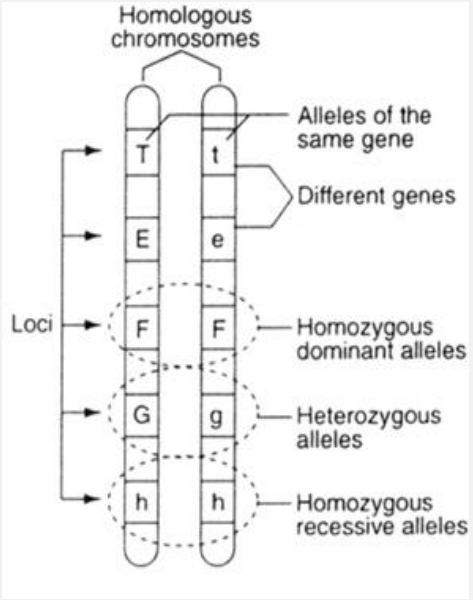
02

- **Gene**

- Heritable sequence of nucleotides along a DNA molecule which codes for a polypeptide and hence may result in a phenotypic effect.

- **Gene pair**

- Two alleles of a particular gene present in a diploid cell



(Additional) Definitions

02

- **Cross**

- Deliberate mating of 2 individuals in genetic analysis

- **Selfing**

- Fertilisation of female gamete by a male gamete from the same individual. Used for plants

- **Sibling mating**

- Mating between siblings.

Dangerous due to inbreeding. Offspring have a high chance of inheriting any deleterious alleles in the family gene pool.

Because of this, plants practice fruit and seed dispersal whereas animals practice sex-biased dispersal, kin avoidance and kin selection.

(Additional) Definitions

02

- **Pure line / true-breeding / pure breeding**

- Selfing over many generations can produce a pure line
- Members of a pure line are **homozygous at each gene locus.**
- They are said to **breed true** or are **true-bred** or **pure bred**
- They are either **homozygous dominant or homozygous recessive** but never heterozygous

Pg.4

Mendel's 2 Laws

03

Gregor Johann Mendel
1822 - 1884

1822-1884; Czech Republic; family of farmers

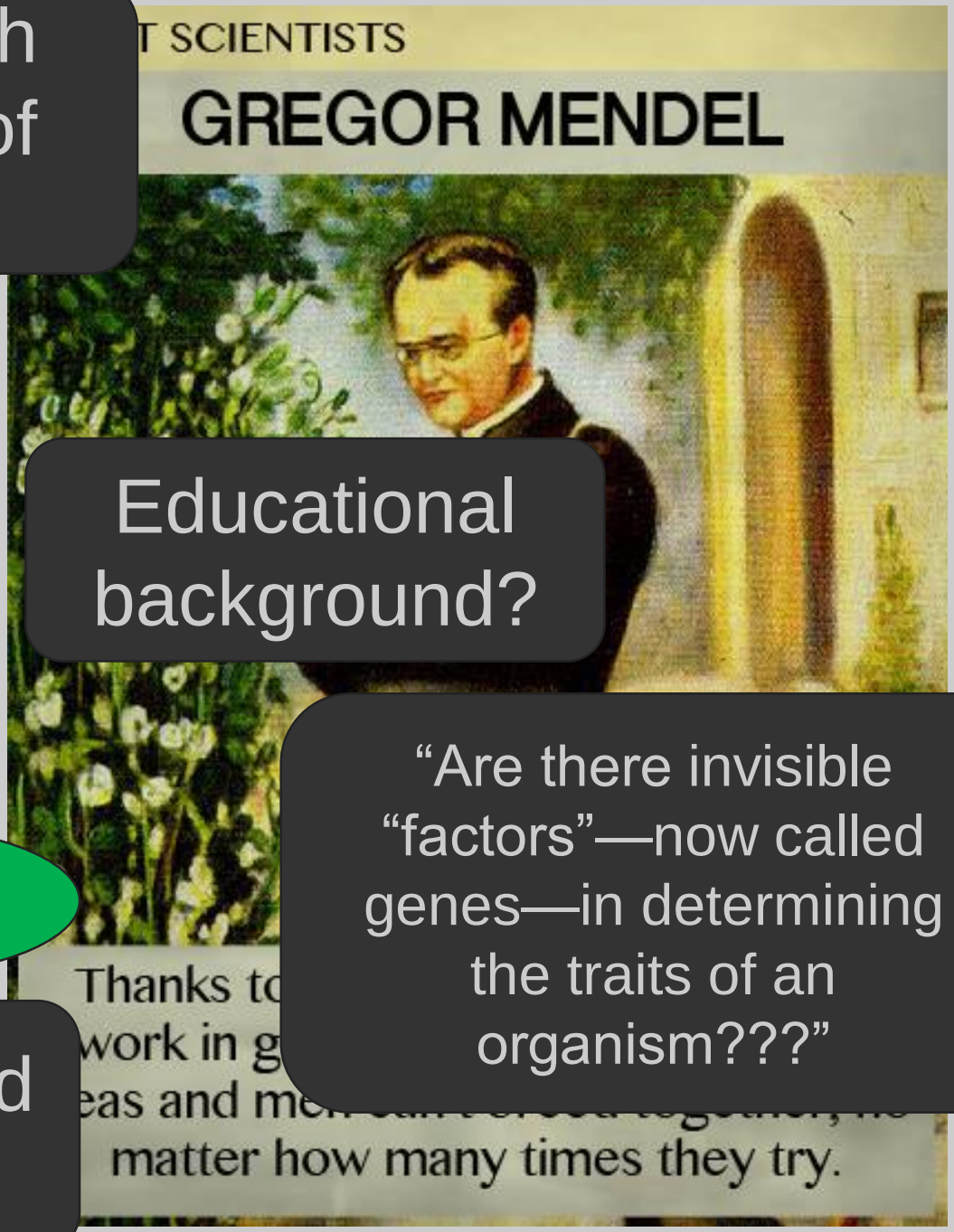
Priest / teacher in monastery

Dreams

Scientist as well

Joy of learning

What organisms did he research on?



Educational background?

"Are there invisible "factors"—now called genes—in determining the traits of an organism???"

1822-1884; Czech Republic; family of farmers

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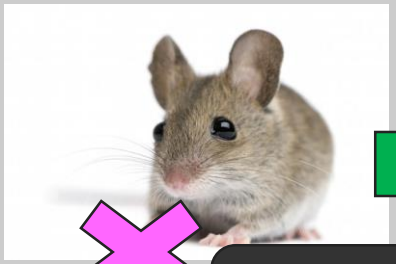
Scientist as well

Joy of learnir



Say “NO” to study of animal sex

Educational background?

“Are there invisible “factors”—now called genes—in determining the traits of an organism???”

Pg.4

Mendel's 2 Laws

03

- Gregor Mendel observed the patterns of inheritance in pea plants and formulated two laws in the 1860s.

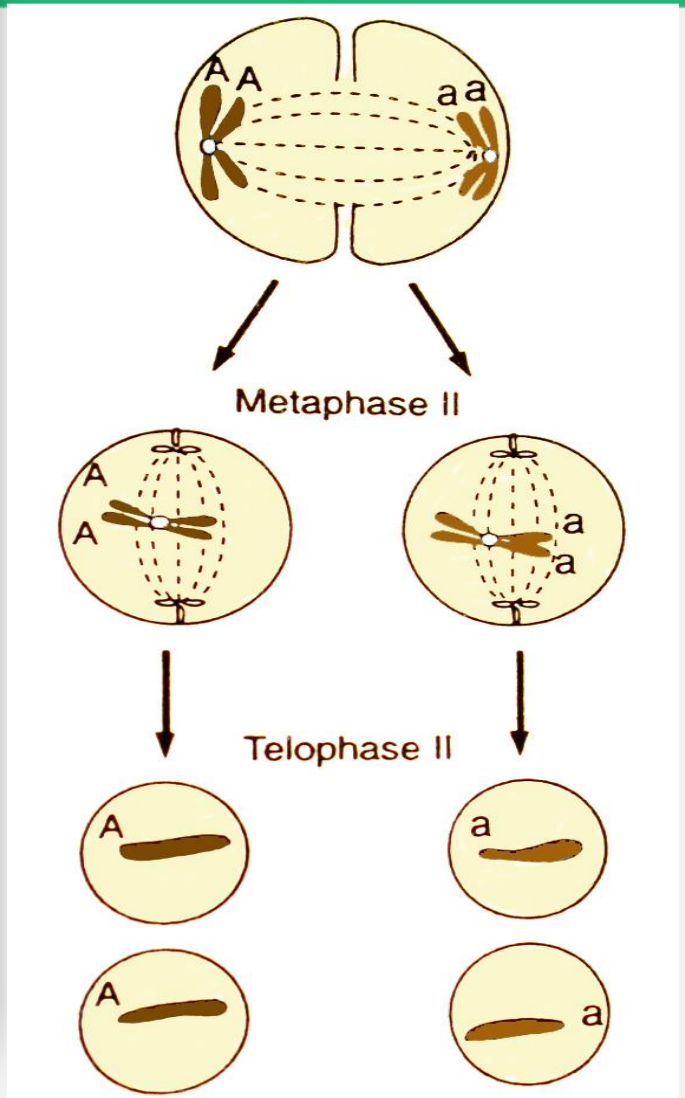
- Both laws could be related to the behaviour of chromosomes during meiosis.

1. **Law of Segregation**
2. **Law of Independent Assortment**

Pg.4

Law of Segregation

03

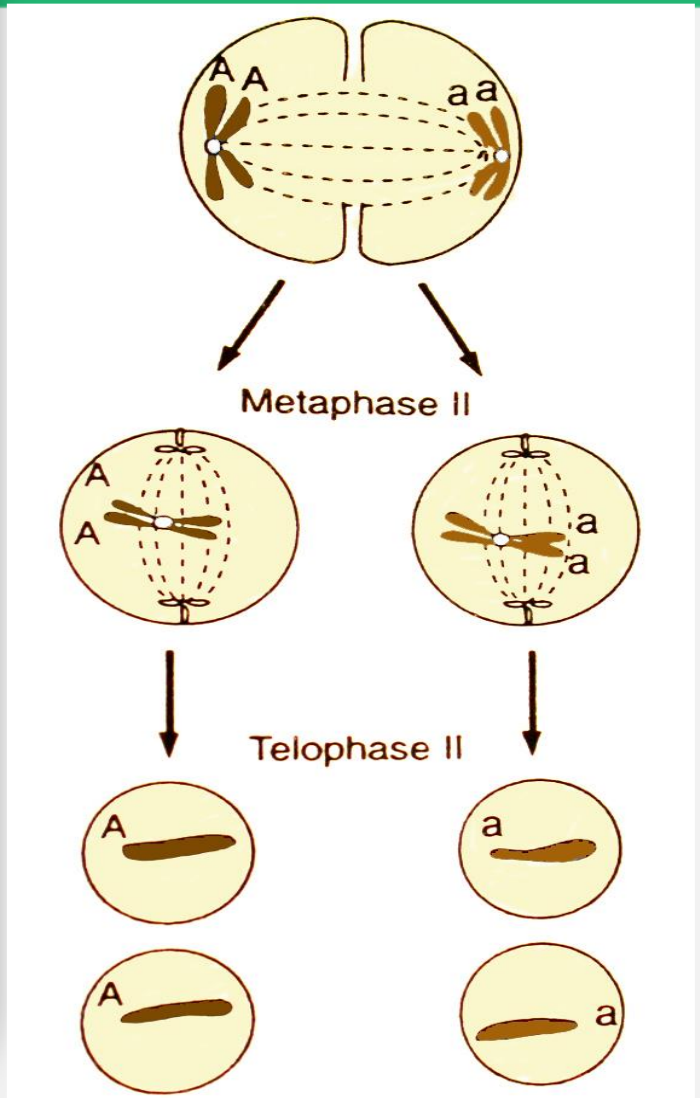


- Involves a **single gene locus only** *(gene A)*
- Related to the **separation of homologous chromosomes** during anaphase I of meiosis

Pg.4

Law of Segregation

03

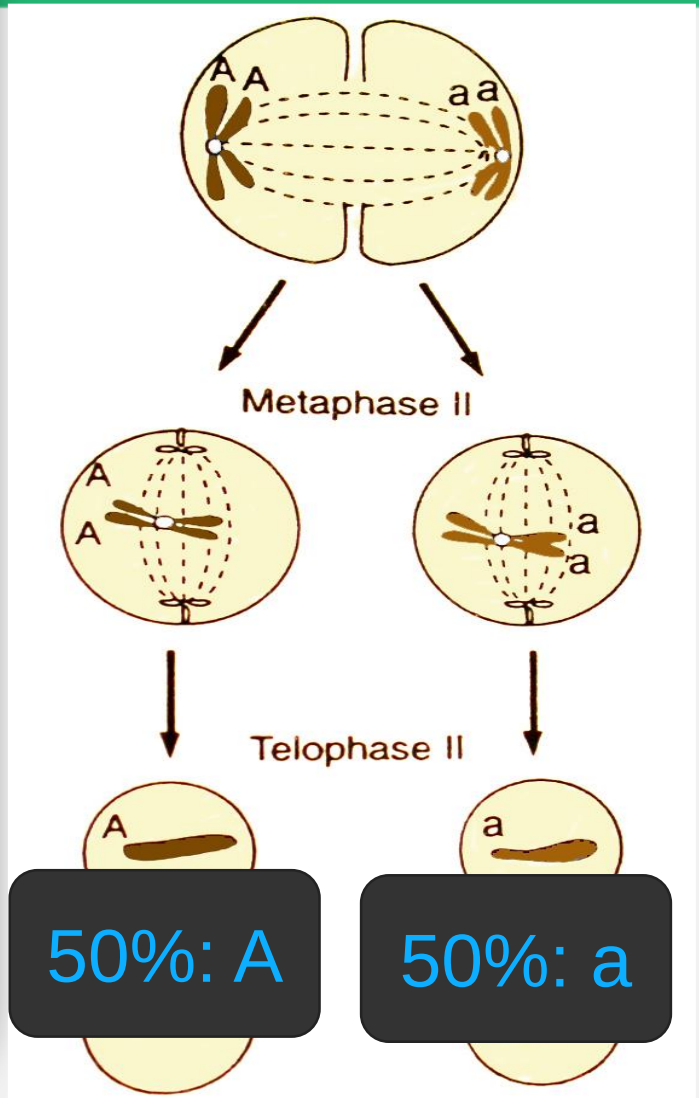


- The two alleles *(alleles A and a)* for each characteristic **segregate** during anaphase I of meiosis, which occurs during the formation of gametes.

Pg.4

Law of Segregation

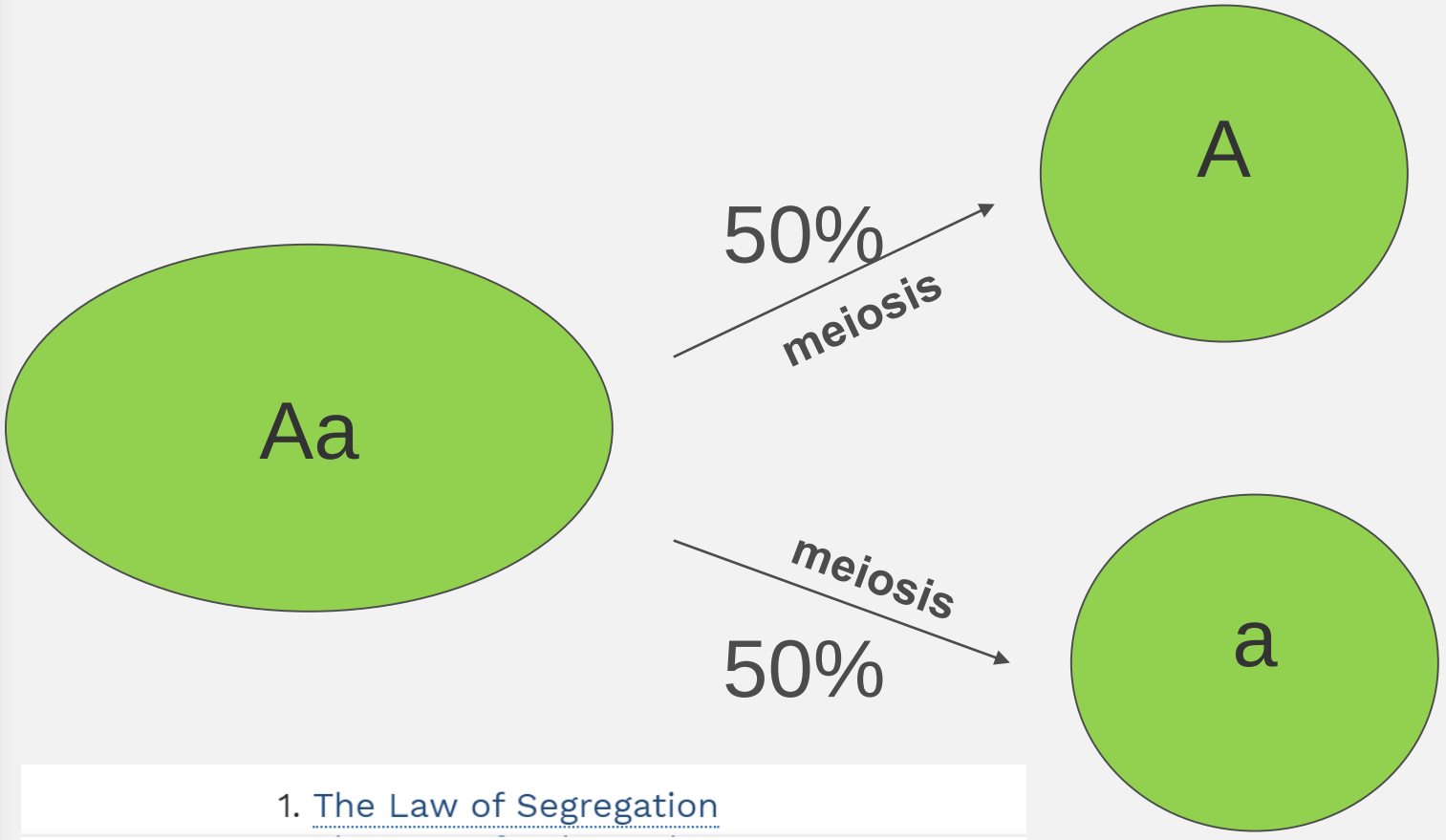
03



- Half of the gametes carry one allele of a gene pair while the other half carries the other allele.
- The Law of segregation was based on work involving **monohybrid crosses**.

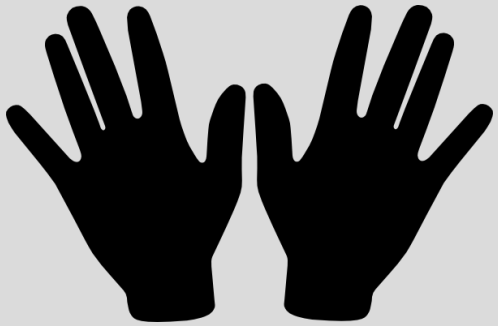
i.e. the study of inheritance of **one** trait controlled by **one** gene

Law of Segregation 03



1. The Law of Segregation

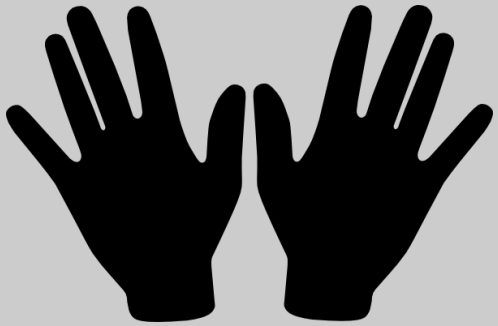
The Law of Segregation states that every individual organism contains two alleles for each trait, and that these alleles segregate (separate) during meiosis such that each gamete contains only one of the alleles.



Worked Example (Pg.6)

A pure-breeding tall pea plant was crossed with a pure-breeding short pea plant. Both are referred to as the parental generation.

How do I represent a genetic cross correctly?



Worked Example (Pg.6)

A pure-breeding tall pea plant was crossed with a pure-breeding short pea plant. Both are referred to as the parental generation.

A key shows
- ***symbols of alleles used***
- ***relationship between alleles***

Key :

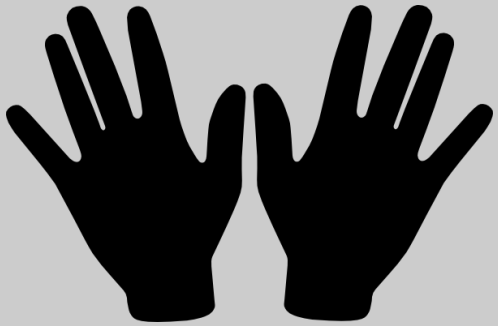
Let T represent the allele for tall plant

Let t represents the allele for short plant

The allele for tall plant (T) is dominant to the allele for short plant (t)

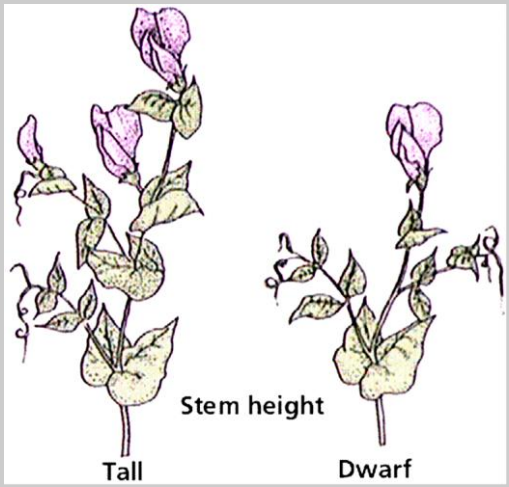
Provide a key if not given in question.
Choose an alphabet to represent the trait (height of plant)
Use the **capital letter** of the chosen alphabet to represent the **dominant allele** for the trait. Dominant allele accounts for the dominant (tallness) phenotype.
Use the **small letter** of the chosen alphabet to represent the **recessive allele** for the trait. Recessive allele accounts for the recessive (shortness) phenotype.

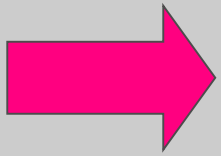
Worked Example (Pg.6)

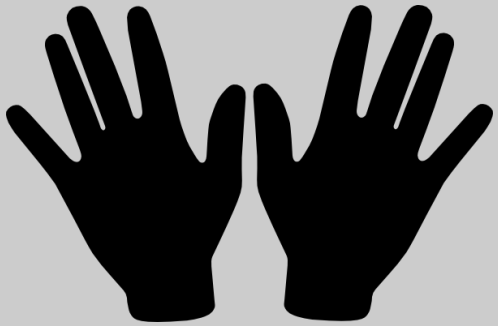


Crossing of parents

Parental phenotype	:	**Tall plant**		**Short plant**
Parental genotype	:	**TT**	**X**	**tt**
Parental gametes	:	**T**	*Gametes are always circled!*	**t**
F1 genotype	:		**Tt**	
F1 phenotype	:		**All tall plants**	



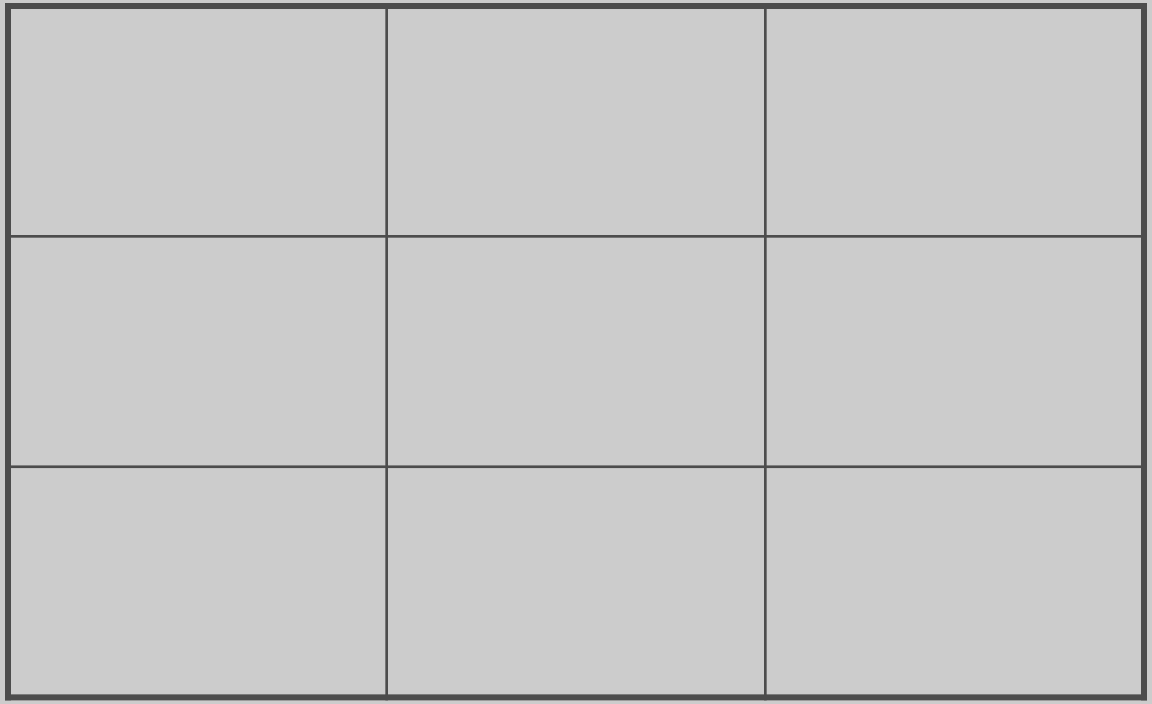




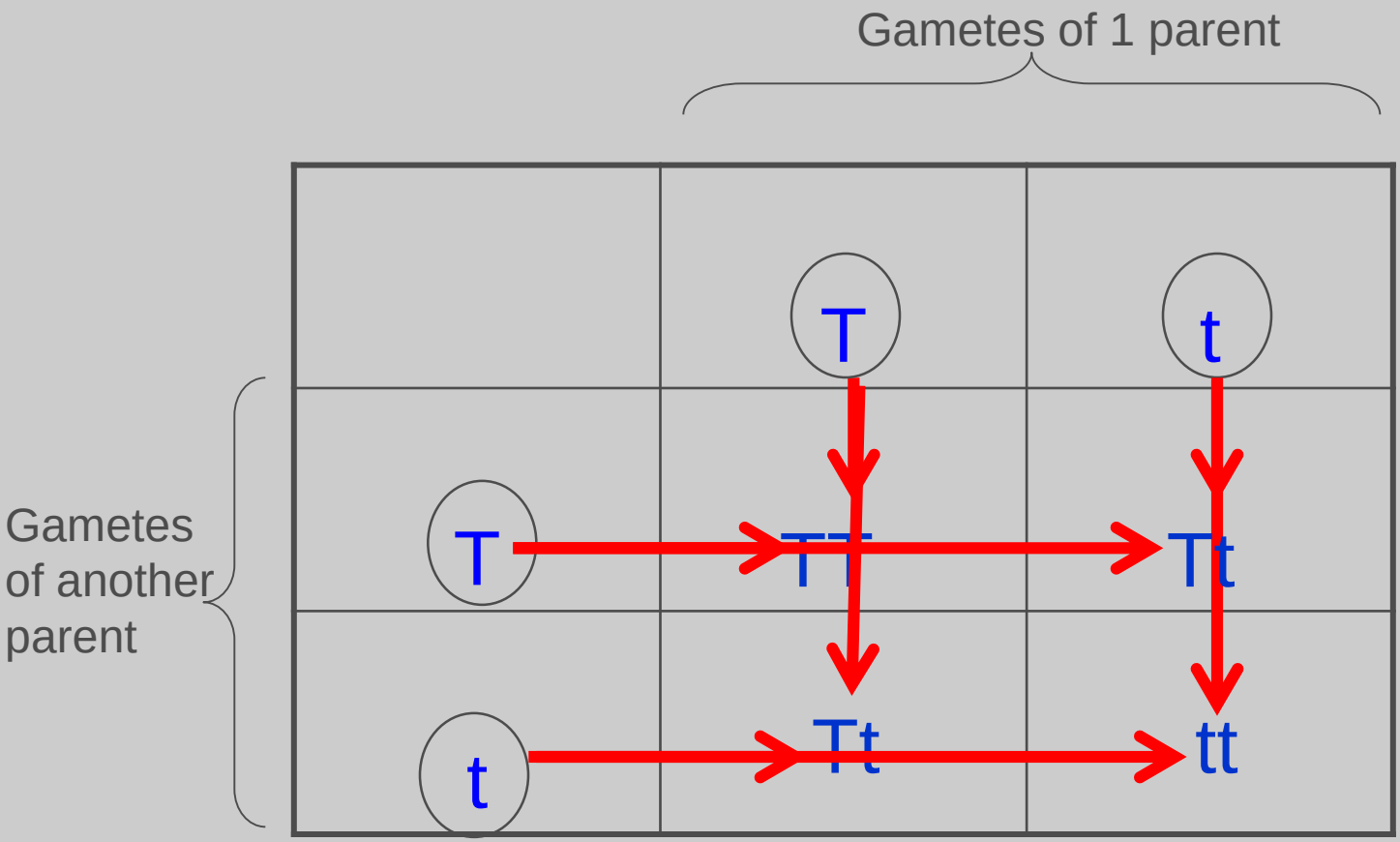
Worked Example
(Pg.6)

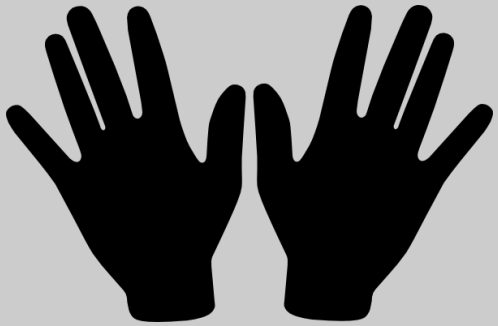
What will be the results of selfing the F1 plants?

How to use a Punnett square



How to use a Punnett square





Worked Example (Pg.6)

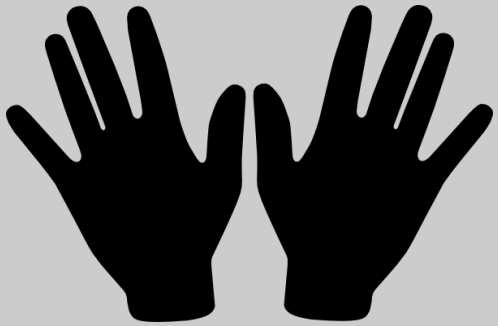
Selfing of F1 (self-pollination)

Parental phenotype	:	**Tall plant**				**Tall plant**
Parental genotype	:	**Tt**		**X**		**Tt**
Parental gametes	:	**T**	**t**		**T**	**t**

Punnett square

	T	**t**
T	**TT**	**Tt**
t	**Tt**	**tt**

F2 genotype	:	**TT**	**Tt**	**Tt**		**tt**
F2 phenotype	:	**Tall plant**				**short plant**
F2 phenotypic ratio	:	**3**			**:**	**1**
F2 genotypic ratio	:	**1**	**:**	**2**	**:**	**1**



Worked Example (Pg.6)

Selfing of F1 (self-pollination)

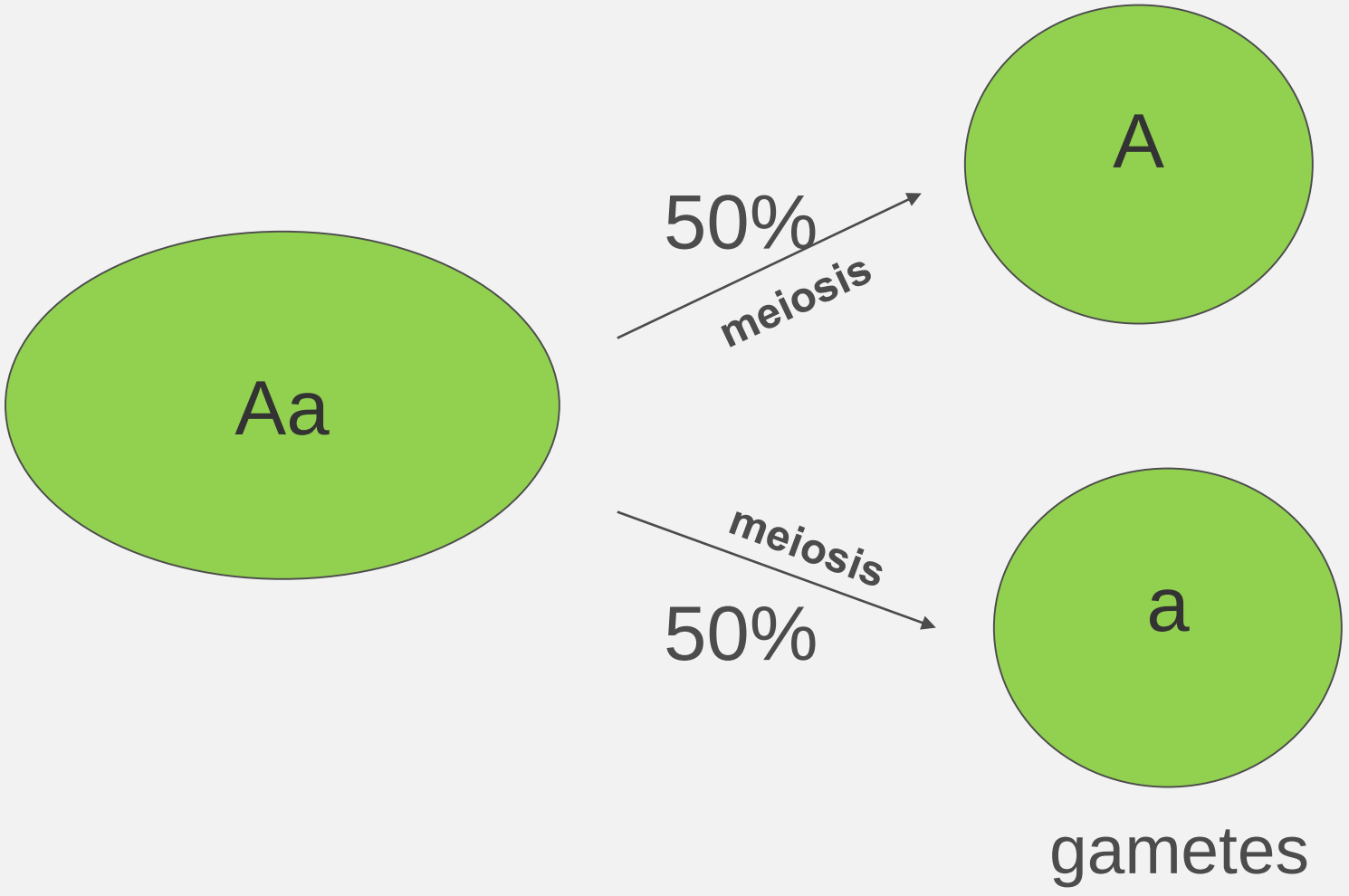
Parental phenotype	**:**	**Tall plant**			**Tall plant**	
Parental genotype	**:**	**Tt**		**X**	**Tt**	
Parental gametes	**:**	**T**	**t**		**T**	**t**

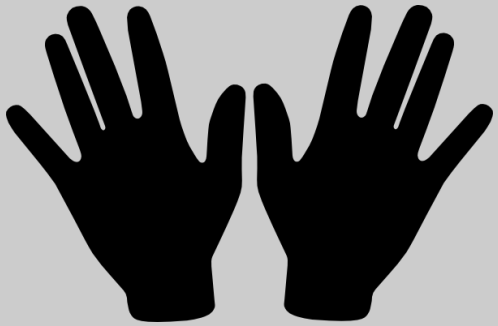
Punnett square

	T	**t**
T	**TT** tall	**Tt** tall
t	**Tt** tall	**tt** short

F2 phenotypic ratio : 3 tall plants : 1 short plant

Law of Segregation 03





Worked Example (Pg.6)

Selfing of F1 (self-pollination)

Parental phenotype : **Tall plant** **Tall plant**

Parental genotype : **Tt** **X** **Tt**

Parental gametes : **T** **t** **T** **t**

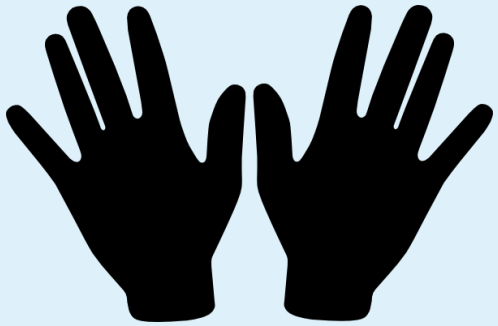
Punnett square

In each parent, during meiosis, the alleles T and t are randomly separated into gametes

	T	**t**
T	**TT** **tall**	**Tt** **tall**
t	**Tt** **tall**	**tt** **short**

When 2 gametes fuse, the resulting offspring (both F1 and F2) will have two alleles again

F2 phenotypic ratio : **3 tall plants** : **1 short plant**

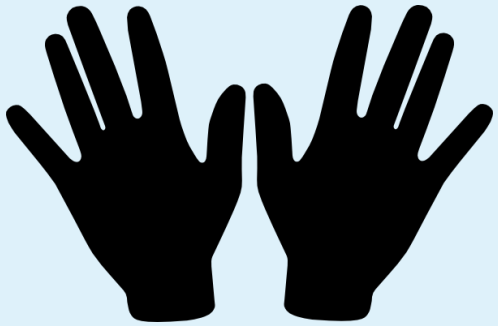


Practice 1 (Pg.7)

A **heterozygous tall** pea plant was crossed with a **pure-breeding short** pea plant.

Both are referred to as the parental generation. Tall trait is dominant over short trait.

What will be the **genotypes**, **phenotypes** and **phenotypic ratio of the F_2 generation** after cross fertilization of both F_1 genotypes?



Practice 1 (Pg.7)

A heterozygote tall pea plant was crossed with a pure-breeding short pea plant. Tall trait is dominant over short trait.

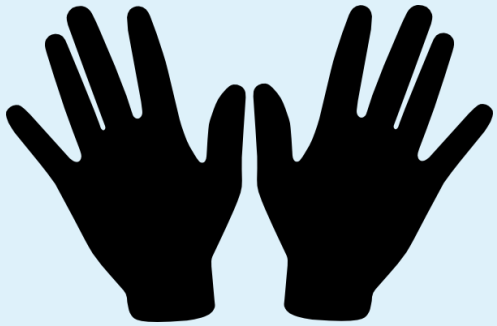
What will be the genotypes, phenotypes and phenotypic ratio of the F_2 generation **after cross fertilization of both F_1 genotypes**?

Key :

Let T represent the allele for tall plant

Let t represents the allele for short plant

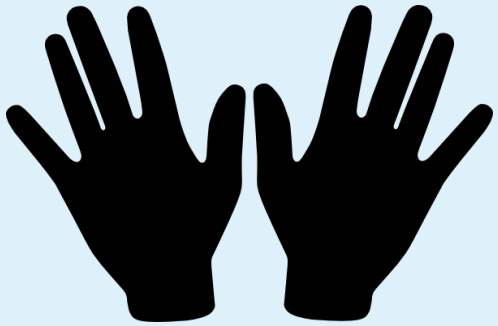
The allele for tall plant (T) is dominant to the allele for short plant (t)



Practice 1 (Pg.7)

Crossing of parental generation

Parental phenotype	**:**	**Tall plant**		**Short plant**
Parental genotype	**:**	**Tt**	**X**	**tt**
Parental gametes	**:**	**T** **t**		**t**
F1 genotype	**:**	**Tt**		**tt**
F1 phenotype	**:**	**Tall plant**		**Short plant**
F1 phenotypic ratio	**:**	**1**	**:**	**1**



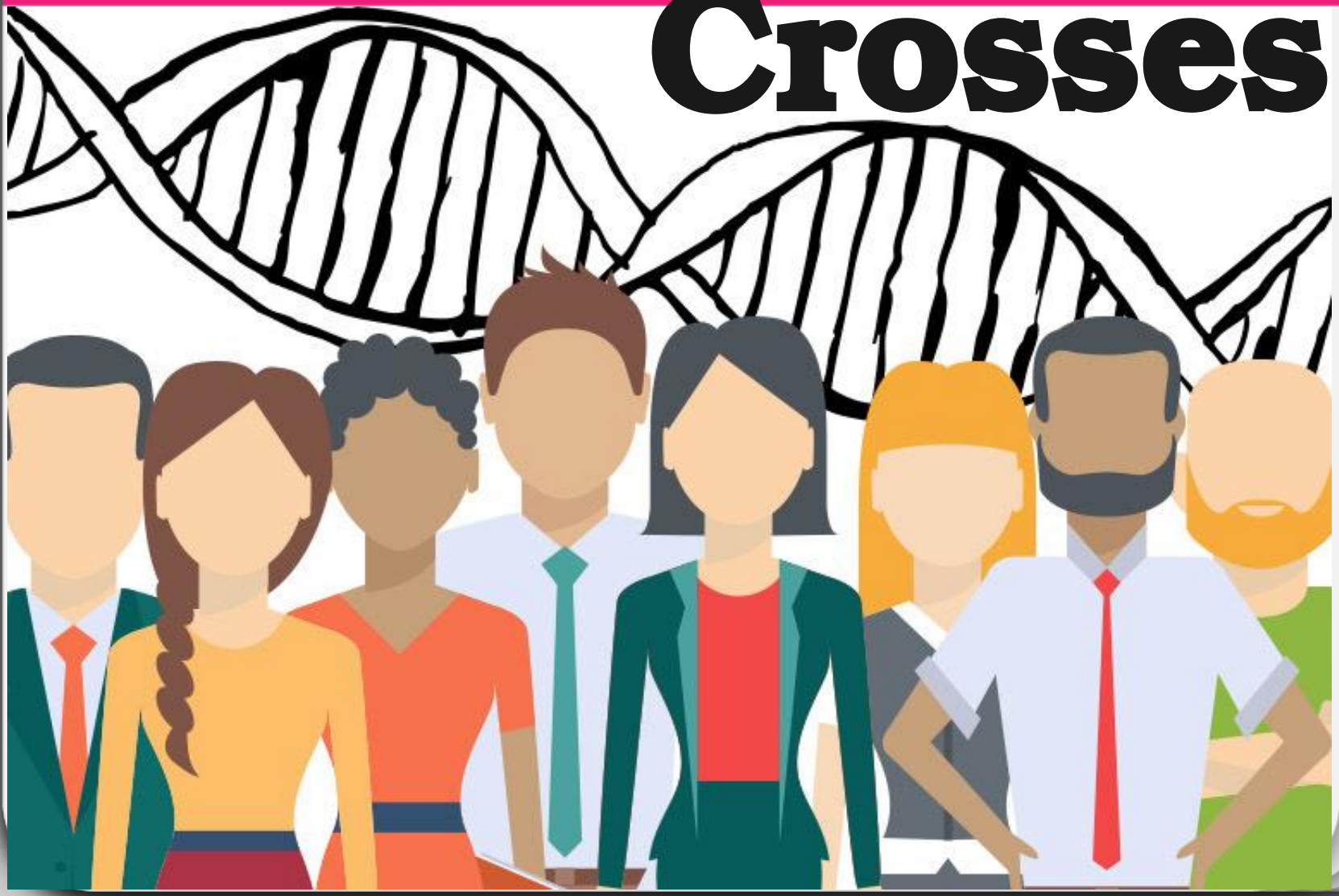
Practice 1 (Pg.7)

Cross fertilisation of both F1 genotypes

F1l phenotype	:	Tall plant		Short plant
F1 genotype	:	Tt	X	tt
F1 gametes	:	(T) (t)		(t)
F2 genotype	:	Tt		tt
F2 phenotype	:	Tall plant		Short plant
F2 phenotypic ratio	:	1	:	1

Genetic Crosses

01



Pg.8

Mendel's 2 Laws

03

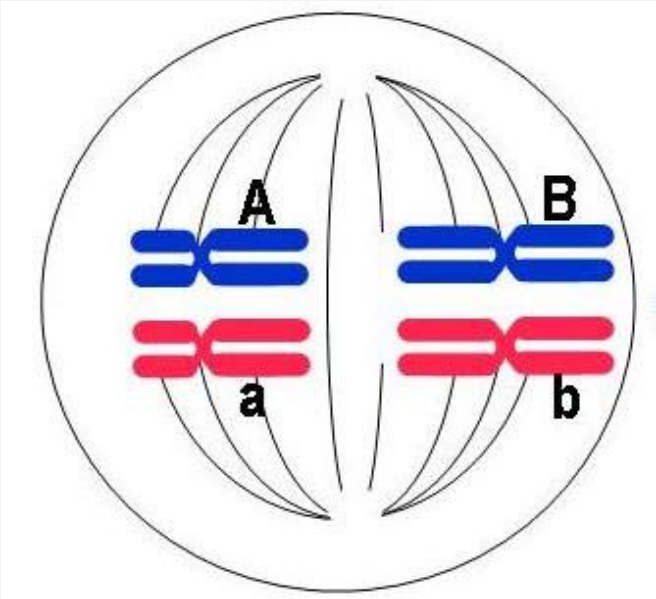
- Gregor Mendel observed the patterns of inheritance in pea plants and formulated two laws in the 1860s.
- Both laws could be related to the behaviour of chromosomes during meiosis.

1. **Law of Segregation**
2. **Law of Independent Assortment**

Pg.8

Law of Independent Assortment 03

- Mendel's law of independent assortment addresses the process of how **two different genes** on **different pairs of homologous chromosomes** segregate

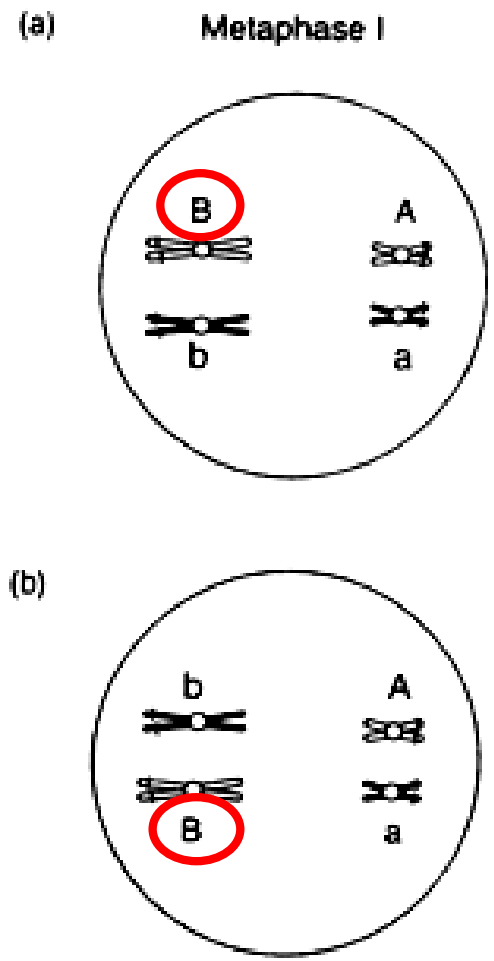


Chromosome 6
Chromosome 3

Gene for colour of seed
Gene for smoothness of seed
====➔ dihybrid cross

Pg.8

Law of Independent Assortment 03

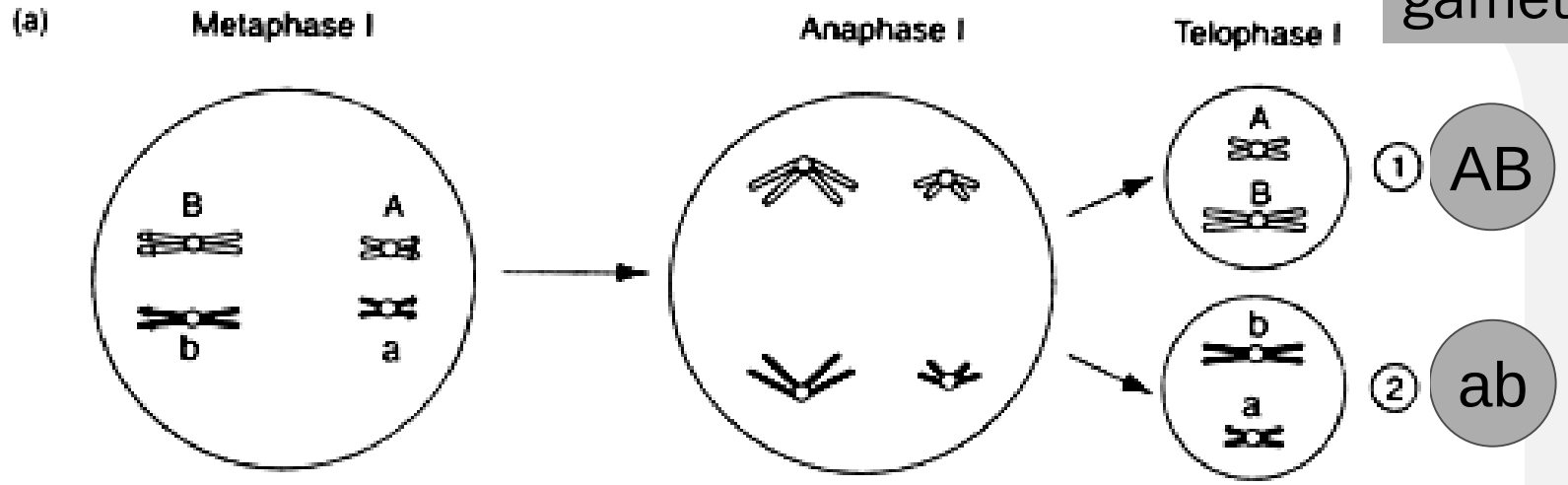


- Orientation of homologous chromosomes shown in (a) is as likely to occur as that in (b) because the arrangement of one homologous pair is independent of the other

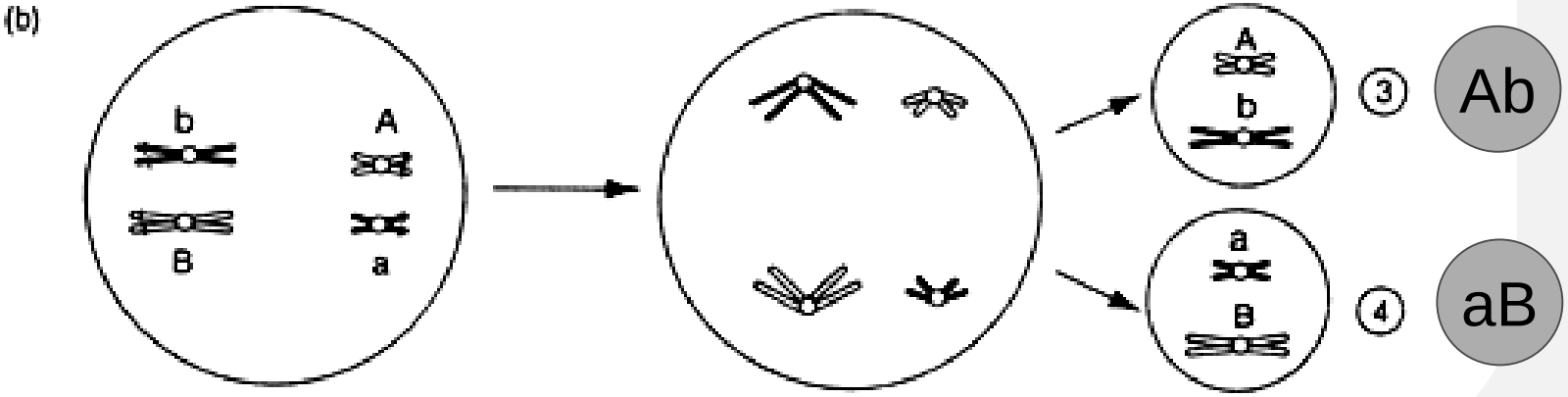
Pg.8

Law of Independent Assortment 03

Scenario 1

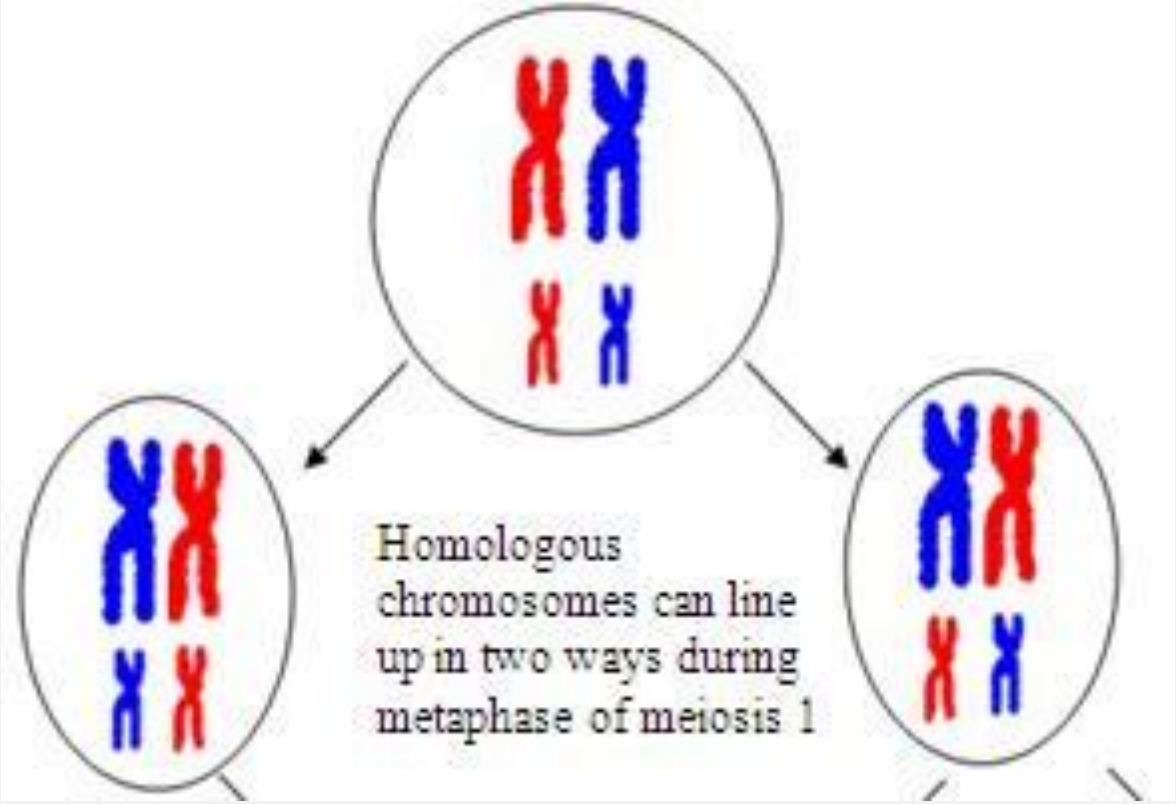


Scenario 2



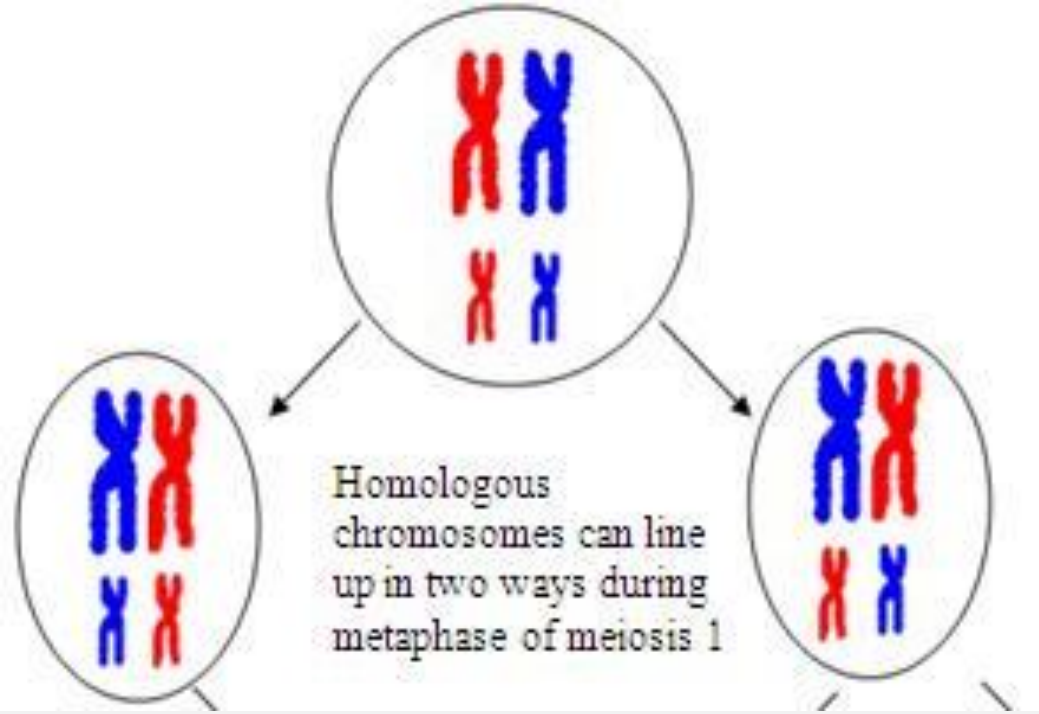
Law of Independent Assortment 03

- During meiosis, the separation of the alleles of one gene pair is **independent** of the separation of alleles of other gene pairs

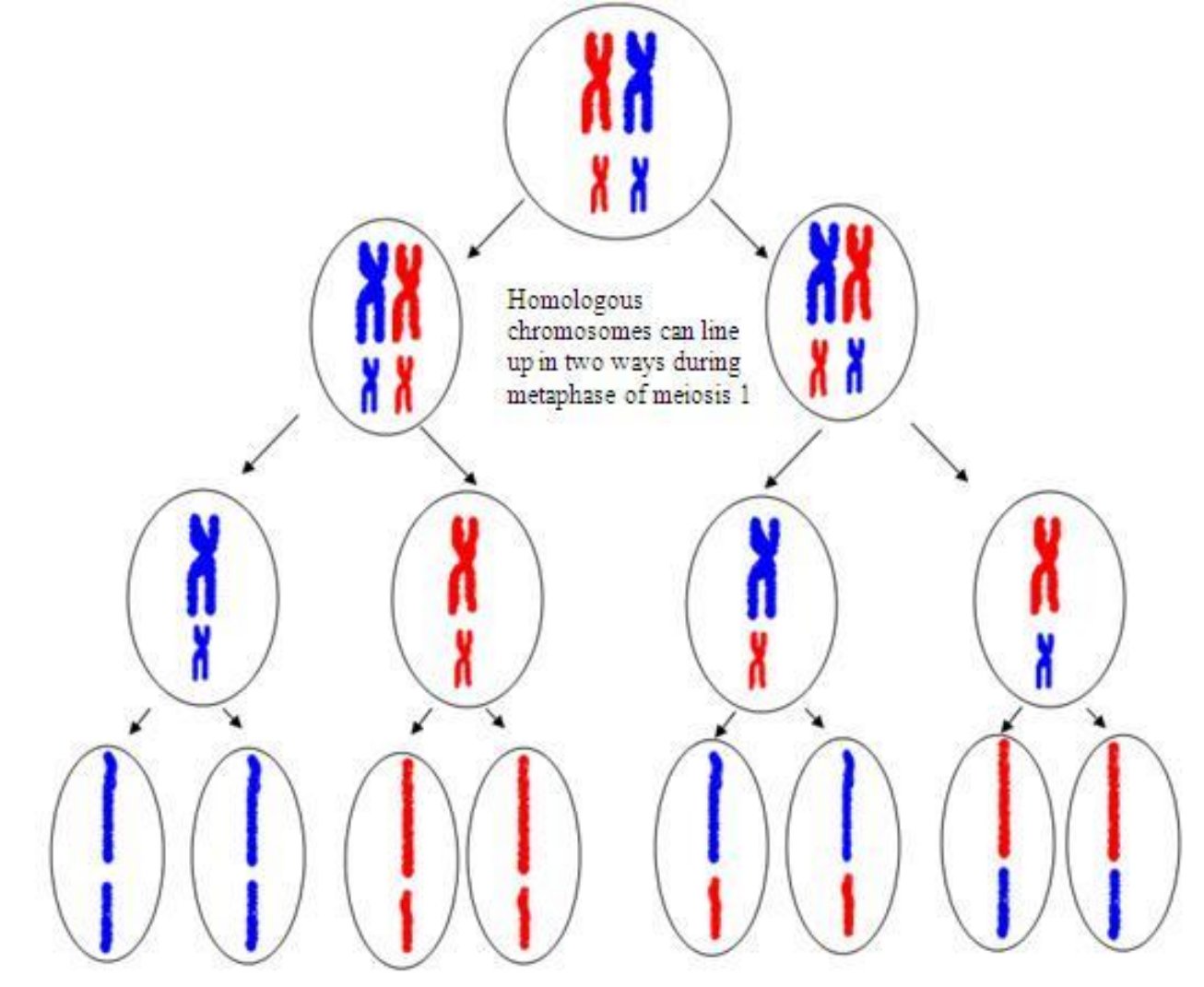


Law of Independent Assortment 03

- Related to the independent arrangement during metaphase I, and subsequent separation of homologous chromosomes during anaphase I.



Law of Independent Assortment 03



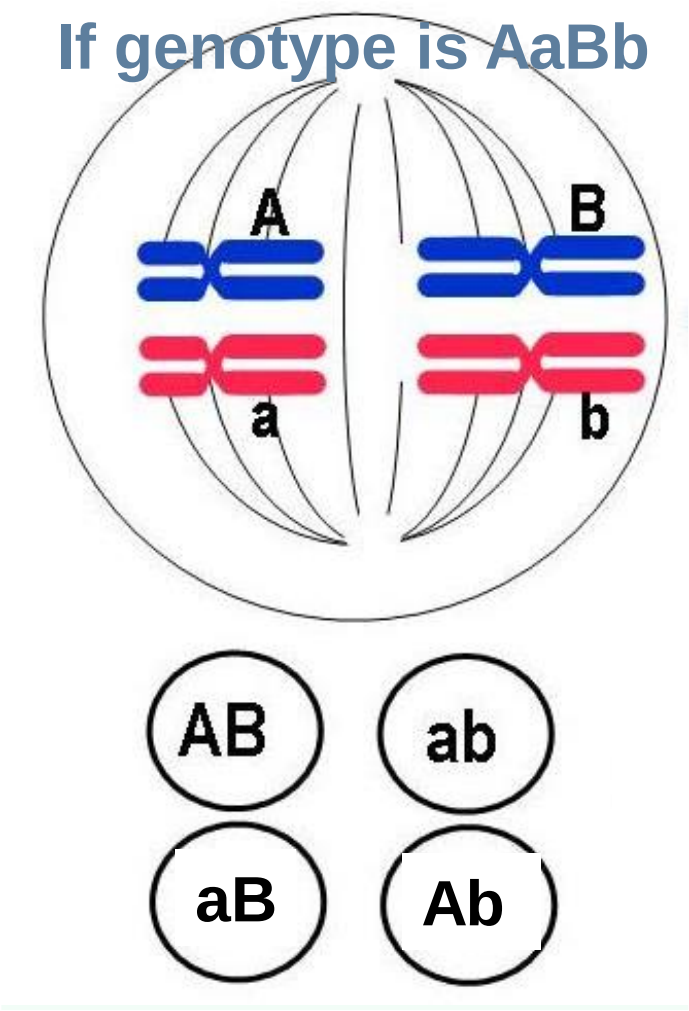
Pg.8

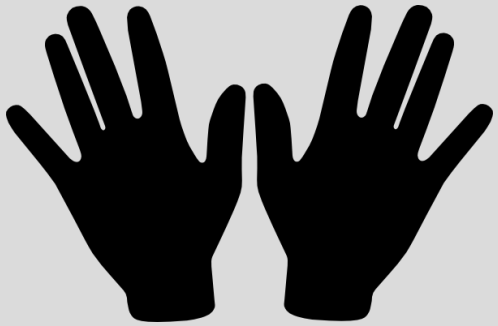
Law of Independent Assortment

03

- The Law of independent assortment was based on work involving **dihybrid crosses**

  i.e. the study of inheritance of **two** traits controlled by **two** genes





Worked Example (Pg. 10)

Method of Mendel's experiment

- Pure-bred pea plants grown from **round seeds with yellow cotyledons** were crossed with pure-bred pea plants grown from **wrinkled seeds with green cotyledons**.
- The above cross gave rise to the F_1 generation.
- The F_1 plants were selfed to produce the F_2 generation.

Worked Example (Pg. 10)

Monohybrid cross

Stem length — Tall × Dwarf

1 gene

T x t

Dihybrid cross

Seed color — Yellow × Green

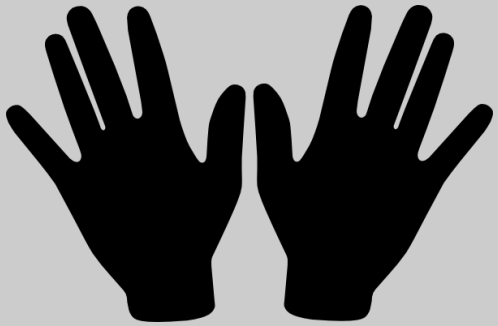
2 genes

Y x y

Seed shape — Round × Wrinkled

R x r

2 traits

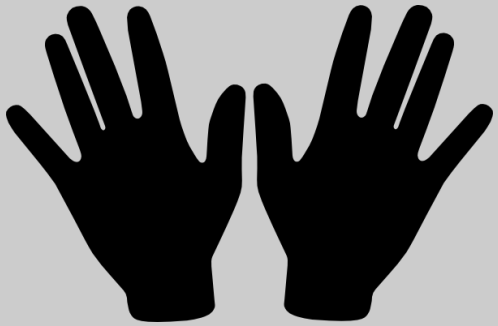


Worked Example (Pg. 10)

Method of Mendel's experiment

- Pure-bred pea plants grown from **round seeds with yellow cotyledons** were crossed with pure-bred pea plants grown from **wrinkled seeds with green cotyledons**.

2 genes code for 2 traits:
1. Shape of seed (round or wrinkled)
2. Colour of cotyledon (yellow or green)



Worked Example (Pg. 10)

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- The above cross gave rise to the F_1 generation.
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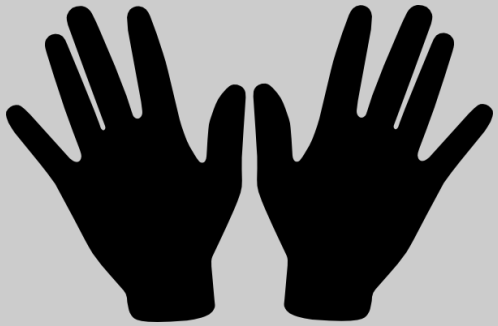


Worked Example
(Pg. 10)

Parental:

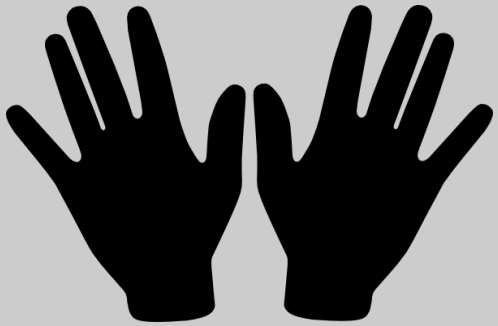
round seeds with yellow cotyledons **X**

wrinkled seeds with green cotyledons

F1 generation

F2 generation

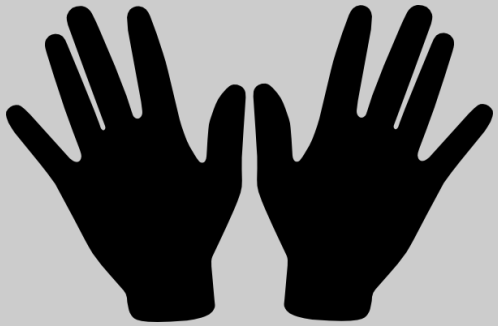
Which alleles are dominant, and which are recessive?



Worked Example (Pg. 10)

Results of Mendel's experiment

- All individuals of the **F_1 generation** produced **round seeds with yellow cotyledons**.



Worked Example (Pg. 10)

Parental:

X

round seeds with yellow cotyledons **X**

wrinkled seeds with green cotyledons

F1 generation All

Alleles for round seeds and yellow cotyledons are dominant

Worked Example (Pg. 10)

Results of Mendel's experiment

- All individuals of the F_1 generation produced round seeds with yellow cotyledons.
- The F2 generation showed the following phenotypic ratio

F_1 phenotype:

X

F_2 phenotypic ratio:

9

3

3

1

Key :

Let R represent the allele for round seed

Let r represent the allele for wrinkled seed

Let Y represent the allele for yellow cotyledon

Let y represent the allele for green cotyledon

The allele for round seed (R) is dominant to the allele for wrinkled seed (r)

The allele for yellow cotyledon (Y) is dominant to the allele for green cotyledon(y).

Parental phenotype	**:**	**Round seed Yellow cotyledon**		**Wrinkled seed Green cotyledon**
Parental genotype	**:**	**RRYY**	**X**	**rryy**
Parental gametes	**:**	**RY**		**ry**

Parental phenotype	:	**Round seed Yellow cotyledon**		**Wrinkled seed Green cotyledon**
Parental genotype	:	**RRYY**	**X**	**rryy**
Parental gametes	:	**(RY)**		**(ry)**

F1 genotype	:	**RrYy**
F1 phenotype	:	**All round seed yellow cotyledon**

Selfing F1 generation

F1 genotype	:	**RrYy**		**X**	**RrYy**	
F1 gametes	:	**(RY)**	**(Ry)**		**(RY)**	**(Ry)**
		(rY)	**(ry)**		**(rY)**	**(ry)**

Selfing F1 generation

F1 genotype	**:**	**RrYy**		**X**	**RrYy**	
F1 gametes	**:**	**RY**	**Ry**		**RY**	**Ry**
		rY	**ry**		**rY**	**ry**

	RY	Ry	rY	ry
RY	RRYY (Round,yellow)	RRYy (Round,yellow)	RrYY (Round,yellow)	RrYy (Round,yellow)
Ry	RRYy (Round,yellow)	RRyy (Round,green)	RrYy (Round,yellow)	Rryy (Round,green)
rY	RrYY (Round,yellow)	RrYy (Round,yellow)	rrYY (wrinkled,yellow)	rrYy (wrinkled,yellow)
ry	RrYy (Round,yellow)	Rryy (Round,green)	rrYy (wrinkled,yellow)	rryy (wrinkled,green)

Selfing F1 generation

F1 genotype	**:**	**RrYy**		**X**	**RrYy**	
F1 gametes	**:**	**RY**	**Ry**		**RY**	**Ry**
		rY	**ry**		**rY**	**ry**

	RY	Ry	rY	ry
RY	RRYY (Round,yellow)	RRYy (Round,yellow)	RrYY (Round,yellow)	RrYy (Round,yellow)
Ry	RRYy (Round,yellow)	RRyy (Round,green)	RrYy (Round,yellow)	Rryy (Round,green)
rY	RrYY (Round,yellow)	RrYy (Round,yellow)	rrYY (wrinkled,yellow)	rrYy (wrinkled,yellow)
ry	RrYy (Round,yellow)	Rryy (Round,green)	rrYy (wrinkled,yellow)	rryy (wrinkled,green)

	RY	Ry	rY	ry
RY	RRYY (Round,yellow)	RRYy (Round,yellow)	RrYY (Round,yellow)	RrYy (Round,yellow)
Ry	RRYy (Round,yellow)	RRyy (Round,green)	RrYy (Round,yellow)	Rryy (Round,green)
rY	RrYY (Round,yellow)	RrYy (Round,yellow)	rrYY (wrinkled,yellow)	rrYy (wrinkled,yellow)
ry	RrYy (Round,yellow)	Rryy (Round,green)	rrYy (wrinkled,yellow)	rryy (wrinkled,green)

F2 phenotype	**:**	**Round seed Yellow cotyledon**	**Round seed Green cotyledon**	**Wrinkled seed Yellow cotyledon**	**Wrinkled seed Green cotyledon**
F2 phenotypic ratio	**:**	**9 :**	**3 :**	**3 :**	**1**

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Key:

- Round seed, yellow cotyledon
- Round seed, green cotyledon
- Wrinkled seed, yellow cotyledon
- Wrinkled seed, green cotyledon

DO NOT USE HIGHLIGHTER OR SHADING IN PUNNETT SQUARE/LEGEND

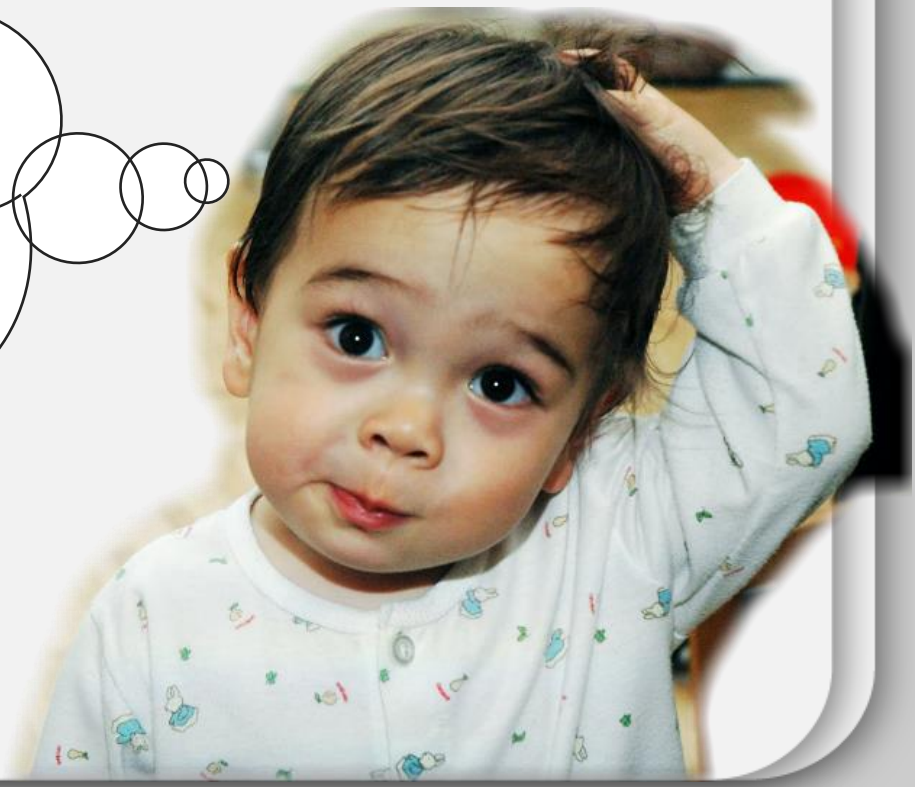
Law of Independent Assortment 03

- When Mendel considered **dihybrid** cross, as opposed to **monohybrid**, resulting F_2 generation (after selfing of F_1) did not have 3:1 dominant : recessive phenotypic ratios.
- The two traits, if considered to inherit independently, fit the principle of segregation.
- Instead of 4 possible genotypes from a monohybrid cross, dihybrid crosses have as many as **16 possible genotypes**, with phenotypic ratios of **9:3:3:1**

Sample mark scheme

04

What is crucial in a genetic cross diagram?

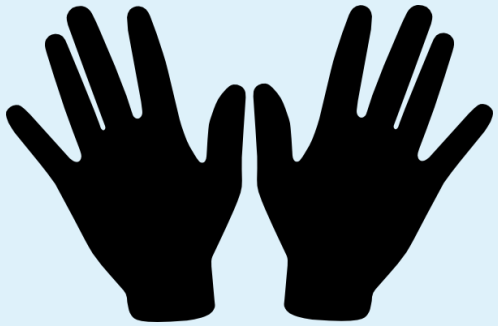


Sample mark scheme

04

- Parental gametes (circled)
- F1 genotypes
- F1 phenotypes
- F1 gametes (circled)
- Punnett square showing all F2 genotypes
- Genotypes correspond to phenotypes / legends for Punnett square
- F2 phenotypic ratio

Pg.11



Practice 2 (Pg. 12)

In a certain species of a garden plant, pure-bred plants with red flowers and thorny stems were crossed with pure-bred plants with white flowers and smooth stems. This cross gave rise to the F_1 generation. The F_1 plants were selfed to produce the F_2 generation. All the progeny plants of the F_1 generation had red flowers and thorny stems.

Draw a genetic diagram of the cross, including gametes, showing the genotypes and phenotypes of the F_1 and F_2 generations. Give the ratio of phenotypes expected in the F_2 generation.

5 minutes

Key :

Let R represent the allele for red flowers

Let r represent the allele for white flowers

Let T represent the allele for thorny stems

Let t represents the allele for smooth stems

The allele for red flowers (R) is dominant to the allele for white flowers (r)

The allele for thorny stems (T) is dominant to the allele for smooth stems (t)

Parental phenotype	**:**	**Red flowers Thorny stems**		**White flowers Smooth stems**
Parental genotype	**:**	**RRTT**	**X**	**rrtt**
Parental gametes	**:**	**RT**		**rt**

Parental phenotype	**:**	**Red flowers Thorny stems**		**White flowers Smooth stems**
Parental genotype	**:**	**RRTT**	**X**	**rrtt**
Parental gametes	**:**	**(RT)**		**(rt)**

F1 genotype	**:**	**RrTt**
F1 phenotype	**:**	**All red flowers, thorny stems**

Selfing F1 generation

F1 genotype	**:**	**RrTt**		**X**	**RrTt**	
F1 gametes	**:**	**(RT)**	**(Rt)**		**(RT)**	**(Rt)**
		(rT)	**(rt)**		**(rT)**	**(rt)**

Selfing F1 generation

F1 genotype	**:**	**RrTt**		**X**	**RrTt**	
F1 gametes	**:**	**RT**	**Rt**		**RT**	**Rt**
		rT	**rt**		**rT**	**rt**

	RT	Rt	rT	rt
RT	RRTT (Red, thorny)	RRTt (Red, thorny)	RrTT (Red, thorny)	RrTt (Red, thorny)
Rt	RRTt (Red, thorny)	RRtt (Red,smooth)	RrTt (Red, thorny)	Rrtt (Red,smooth)
rT	RrTT (Red, thorny)	RrTt (Red, thorny)	rrTT (white,thorny)	rrTt (white,thorny)
rt	RrTt (Red, thorny)	Rrtt (Red,smooth)	rrTt (white,thorny)	rrtt (white, smooth)

	RT	Rt	rT	rt
RT	RRTT (Red, thorny)	RRTt (Red, thorny)	RrTT (Red, thorny)	RrTt (Red, thorny)
Rt	RRTt (Red, thorny)	RRtt (Red,smooth)	RrTt (Red, thorny)	Rrtt (Red,smooth)
rT	RrTT (Red, thorny)	RrTt (Red, thorny)	rrTT (white,thorny)	rrTt (white,thorny)
rt	RrTt (Red, thorny)	Rrtt (Red,smooth)	rrTt (white,thorny)	rrtt (white, smooth)

F2 phenotype	**:**	**Red flowers Thorny stems**	**Red flowers Smooth stems**	**White flowers Thorny stems**	**White flowers Smooth stems**
F2 phenotypic ratio	**:**	**9 :**	**3 :**	**3 :**	**1**

What I need to know …01

- 2(k) **Explain** the terms *locus, allele, dominant, recessive, codominant, incomplete dominance, homozygous, heterozygous, phenotype, genotype* and *sex linkage*
- 2(l) **Explain** how genes are inherited from one generation to the next via the germ cells or gametes
- 2(n) **Use genetic diagrams** to solve problems in dihybrid crosses

How genes are inherited from one generation and passed to the next via gametes

05

- **Genes** are present on **chromosomes** ;
- during **meiosis**, chromosomes randomly align at the metaphase plate during metaphase I and are subsequently separated during anaphase I ;
- giving rise to **haploid gametes** ;
- which contain unique combinations of alleles;
- **random fusion of 2 gametes** gives rise to an offspring with inherited alleles from parents

SUMMARY

Scenario	Phenotypic ratio
Monohybrid cross Heterozygote x Heterozygote e.g. Aa x Aa	3 : 1
Dihybrid cross Heterozygote x Heterozygote e.g. AaBb x AaBb	9 : 3 : 3 : 1