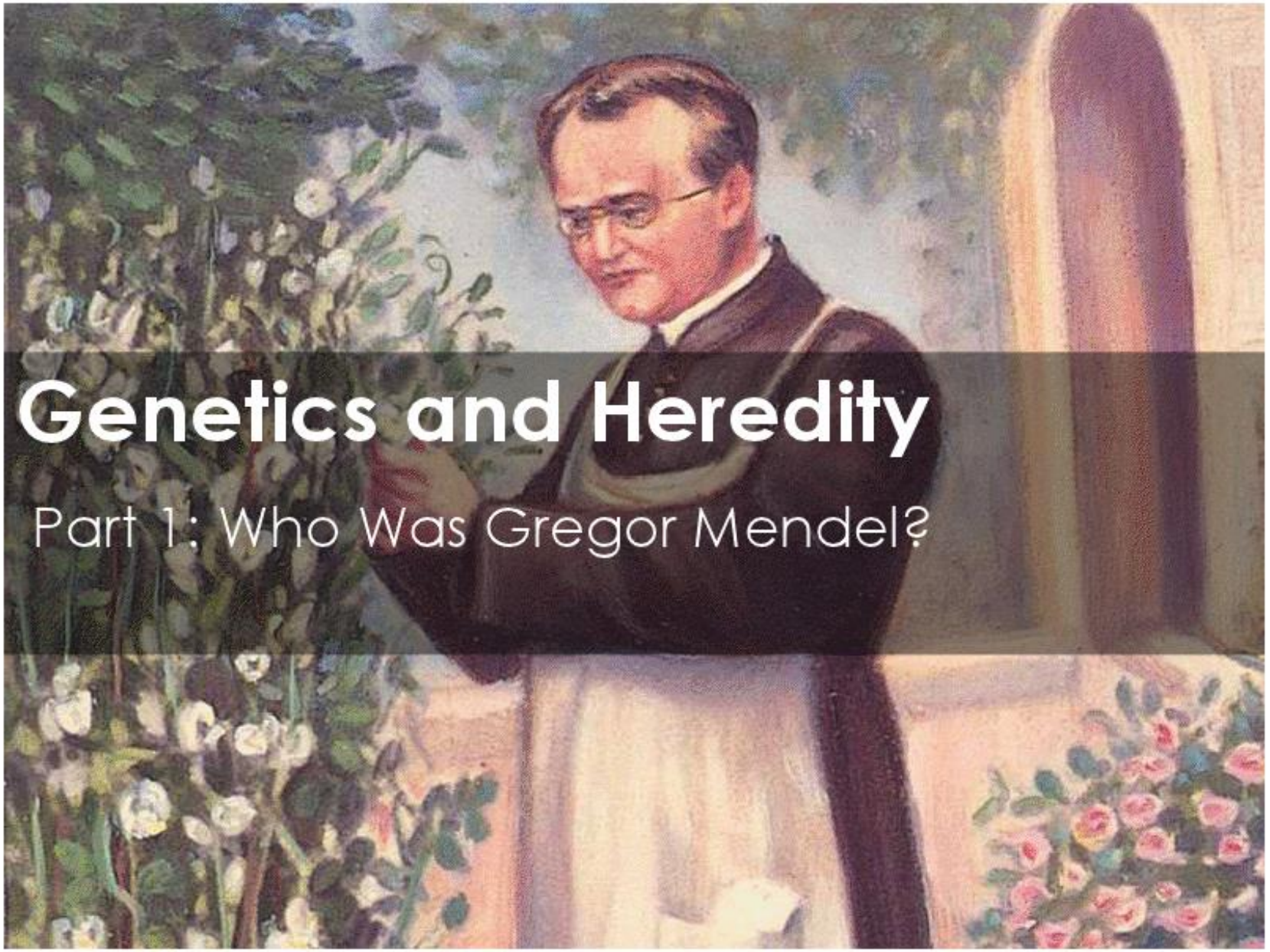


Genetics and Heredity

Part 1: Who Was Gregor Mendel?

Introduction

Genetics is the scientific study of heredity.

Heredity is the passing of physical characteristics from parent to offspring.

The first major experiments of heredity were done by a monk named Gregor Mendel.

Mendel is known as the father of modern genetics.

Inheritance Theory Prior to Mendel

- **Trait: characteristics to be passed from parent to offspring**

- **Passed on from parent to offspring by the blood, in "bloodlines".**

Gregor Mendel “Father of Genetics”

Mendel's Work

- Studied heredity – the passing of characteristics to offspring by their parents

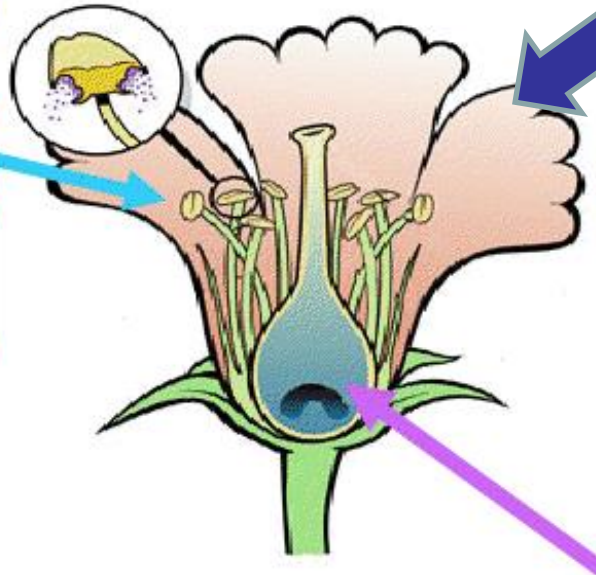
- Worked with pea plants.

Why did he study pea plants?

- **Pea plants reproduce sexually.**
- **There are male & female gametes (sex cells) in plants.**
- **Pollination: Joining of the gametes of plants. (fertilization)**

- Pea plants have **7 contrasting** traits or characteristics.
- Mendel was able to control the **pollination** (reproduction) of his pea plants.

Flower Anatomy



PETAL

Male

Anther

Releases pollen grains

Female

Ovary

Holds the egg cell

What Did Mendel Find?

- He discovered different laws and rules that explain factors affecting heredity.
  - Law of Segregation
  - Rule of Unit Factors
  - Rule of Dominance

Mendel's Work

For 7 years, Mendel grew and tested 28,000 pea plants.

He looked carefully at 7 individual traits:

- Height
- Flower Position
- Seed Shape
- Pod Shape
- Flower Color
- Seed Color
- Pod Color

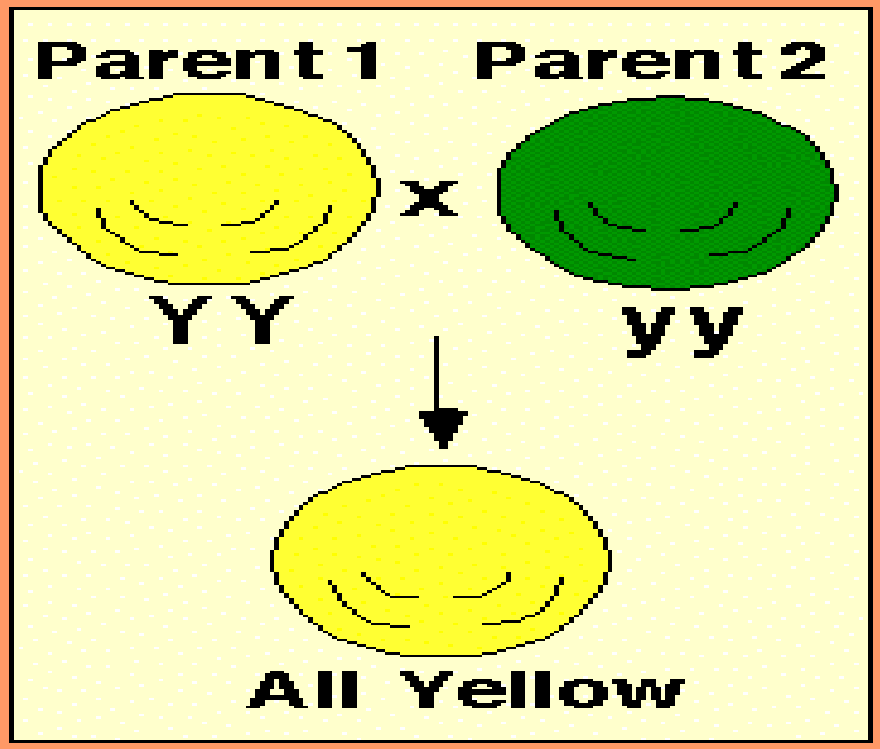
PAGE 128

Traits of Pea Plants

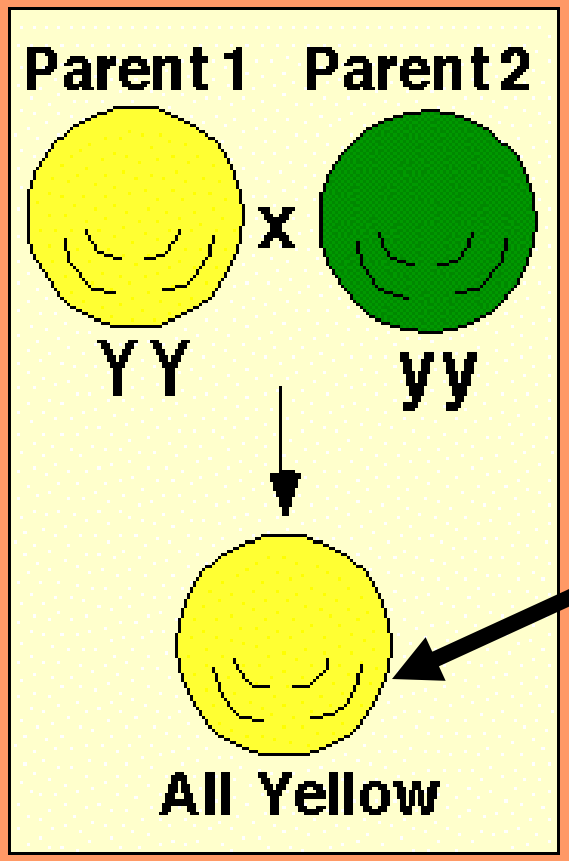
	Seed shape	Seed coior	Flower color	Flower position	Pod color	Pod shape	Plant height
Dominant trait	 round	 yellow	 purple	 axial (side)	 green	 inflated	 tall
Recessive trait	 wrinkled	 green	 white	 terminal (tips)	 yellow	 constricted	 short

Mendel studied contrasting traits.

- For example what would happen if a pure plant that always produced yellow seeds was crossed with a pure plant that always produced green seeds



HYBRID



Mendel called the offspring of two pure bred parents, with different traits, hybrid

Mendel's Work

Mendel developed a new method to control exactly how the pea plants were fertilized:

Self-fertilization

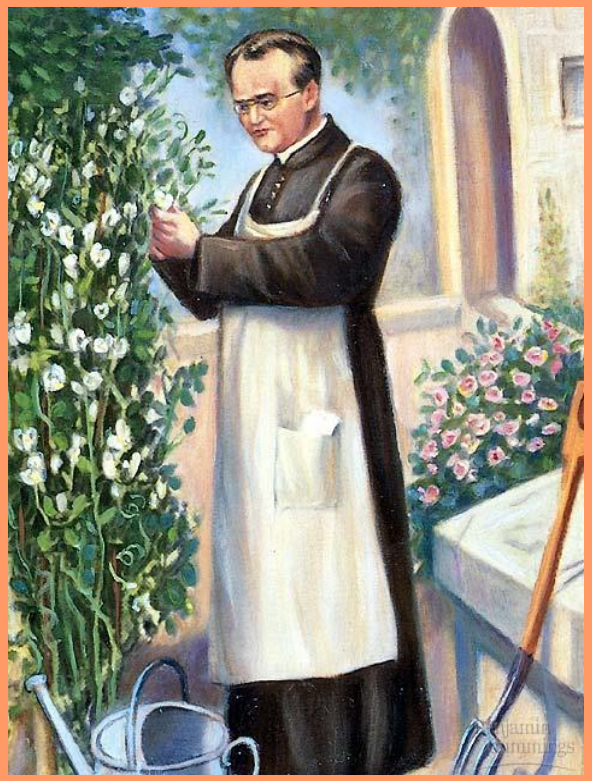
Always produces offspring with the same traits as the parent plant

Purebred

Cross-fertilization

Produces offspring that may be different or the same as the parent plant

Hybrid



Mendel controlled the pollination.

The flower of a pea plant

Stamen

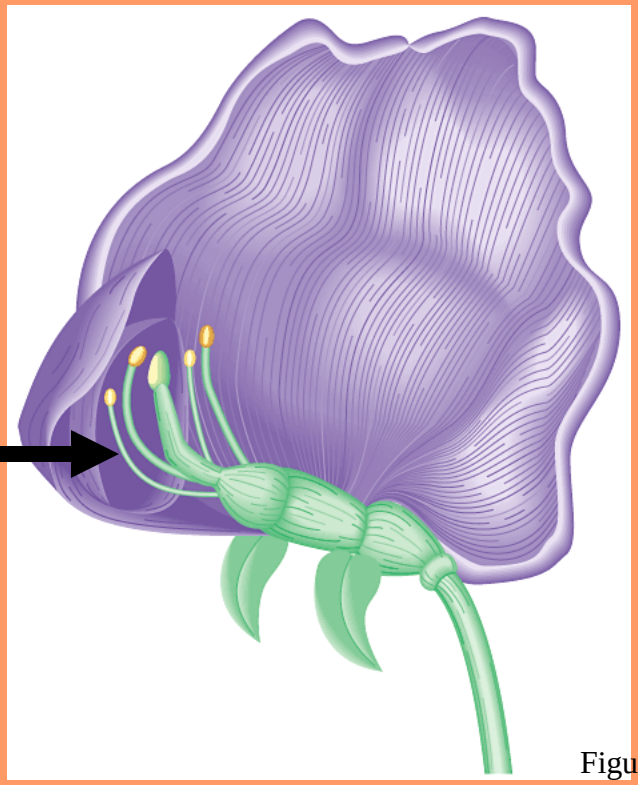
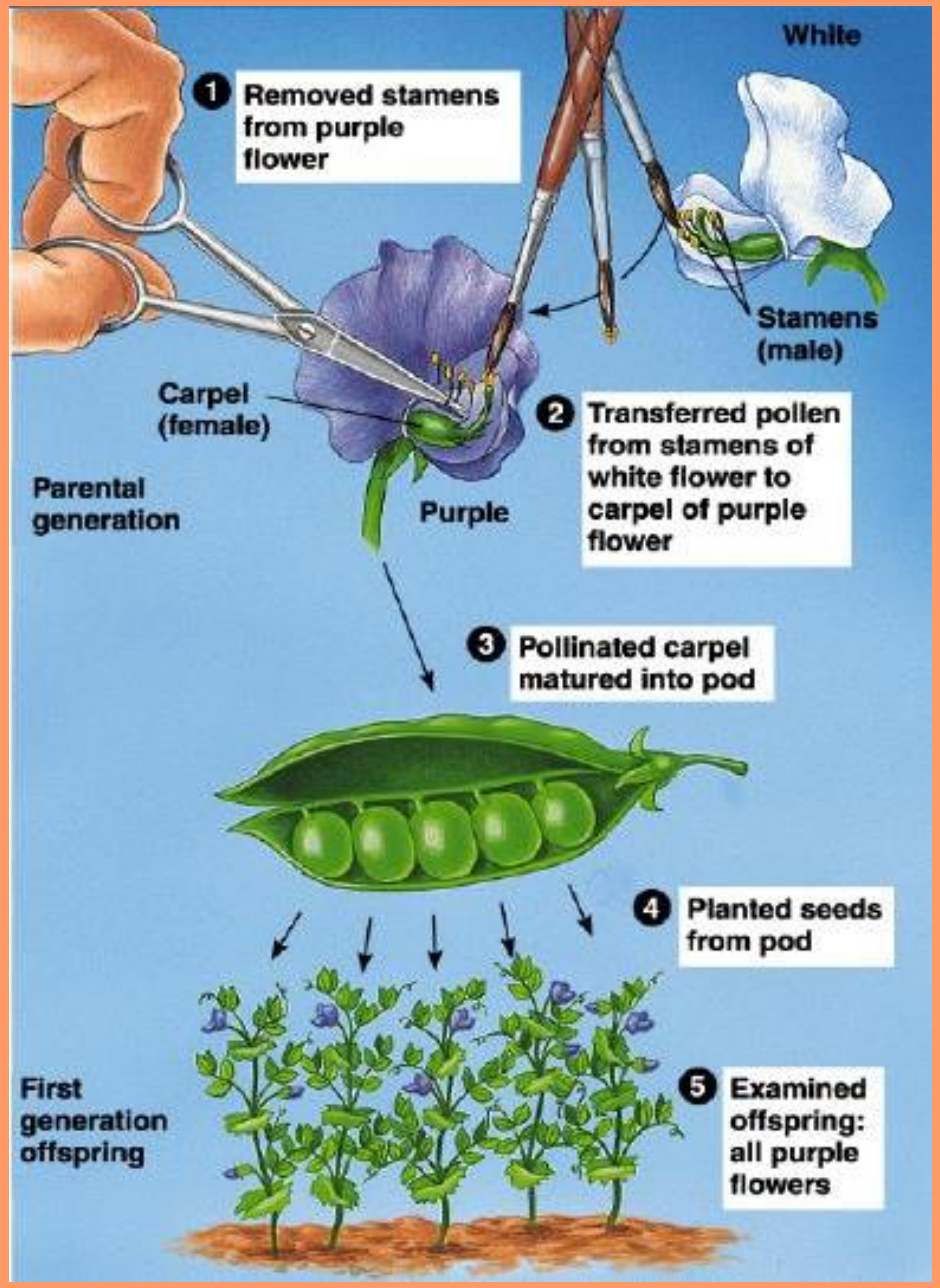
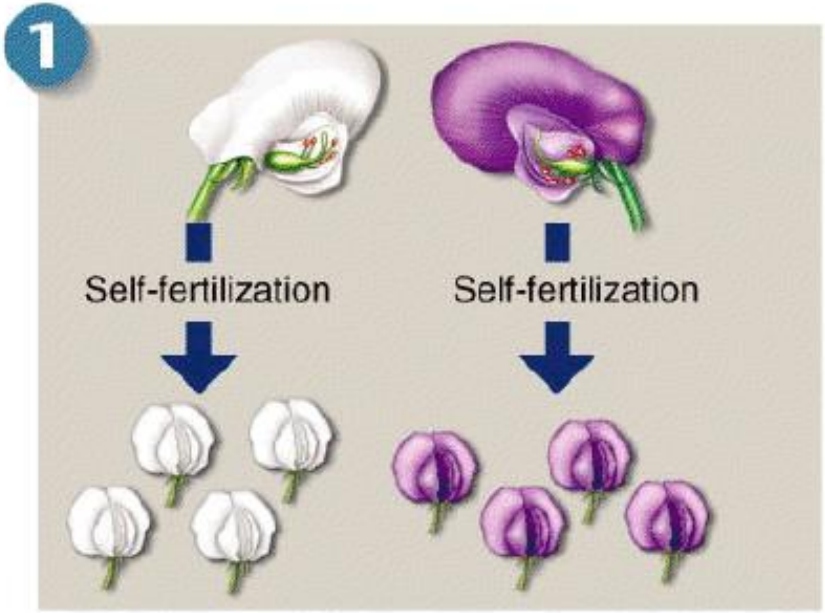


Figure 9.2A, B

Steps of Mendel's Experiment



Parent Generation (P)



Mendel let each variety **self-fertilize** for several generations, creating two **pure-breeding** parent (P) generations

Mendel grew many generations of pea plants.
He named every generation.

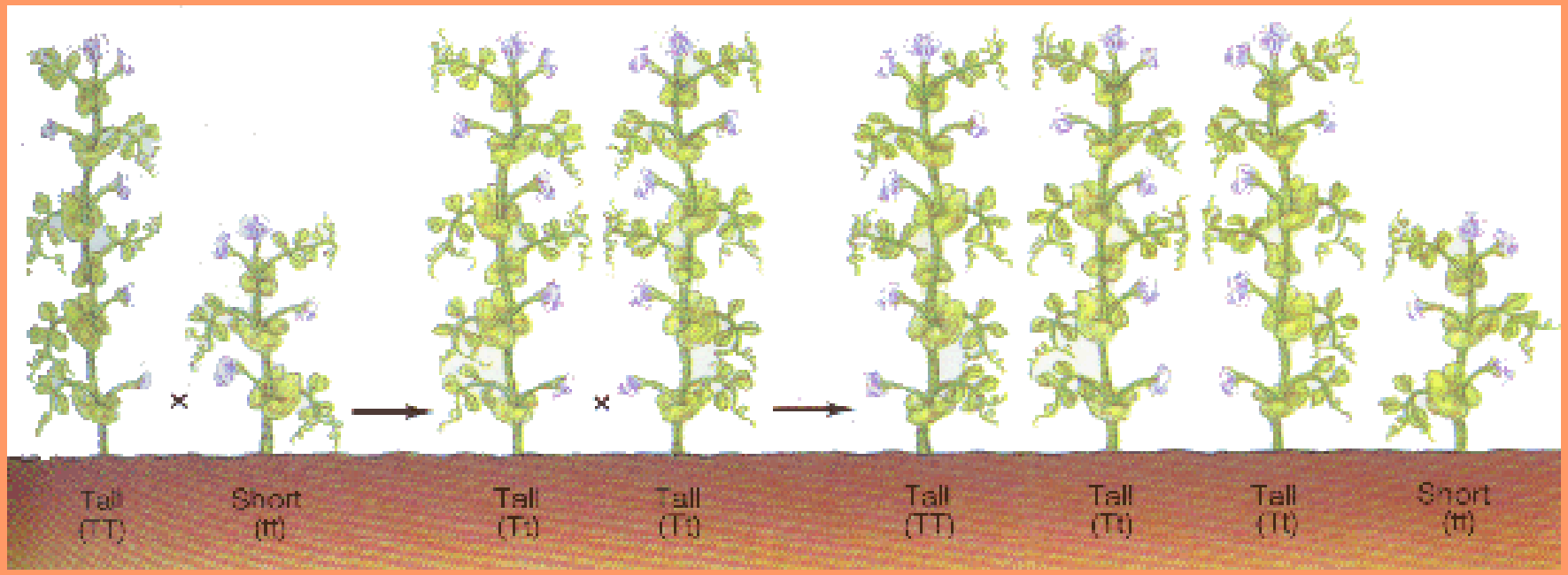
Starting generation –

P (parent) generation.(Pure bred)

F1 - first generation

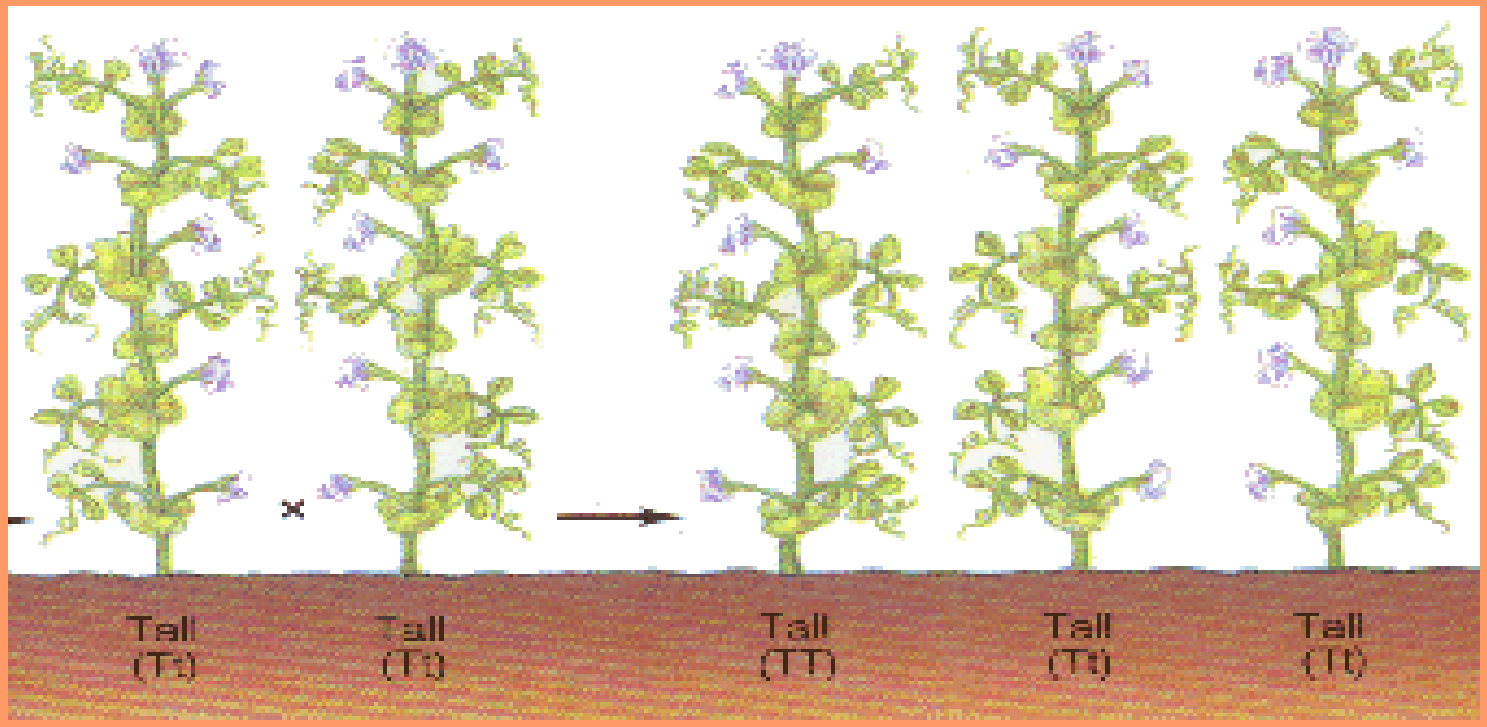
F2 - second generation

P → F1 → F2


Tall
(TT)
Short
(tt)
Tall
(Tt)
Tall
(Tt)
Tall
(TT)
Tall
(Tt)
Tall
(Tt)
Short
(tt)

- **Mendel first cross pollinated pure tall pea plants with one another.**

True breeding TALL plants



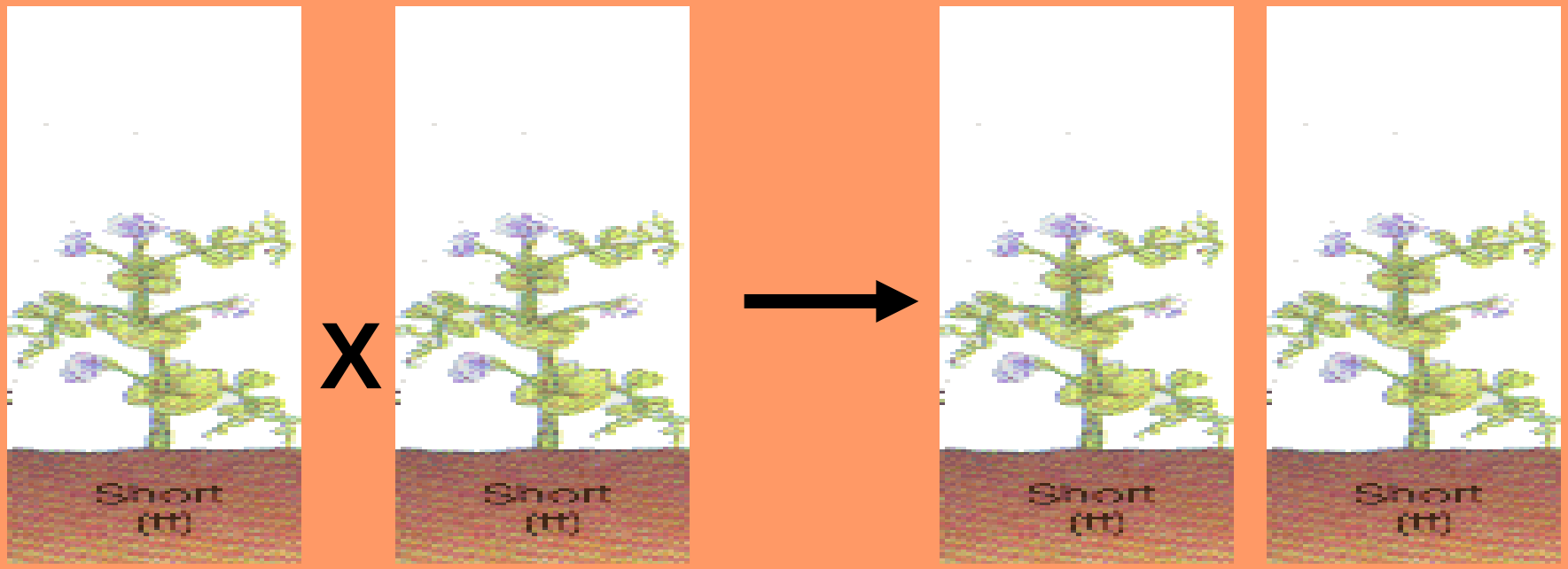
Mendel noticed, that only tall plants were produced in every generation.

He came to a conclusion, that the tall variety of a pea plant, must contain **some factor for tallness.**

He called these plants **“true breeding”**

Pure Short X Pure Short

True breeding short plants



All offspring were <u>short.</u>

- Mendel then cross pollinated **short pea plants** (height of plants in this variety were about one foot tall) **with each other**.

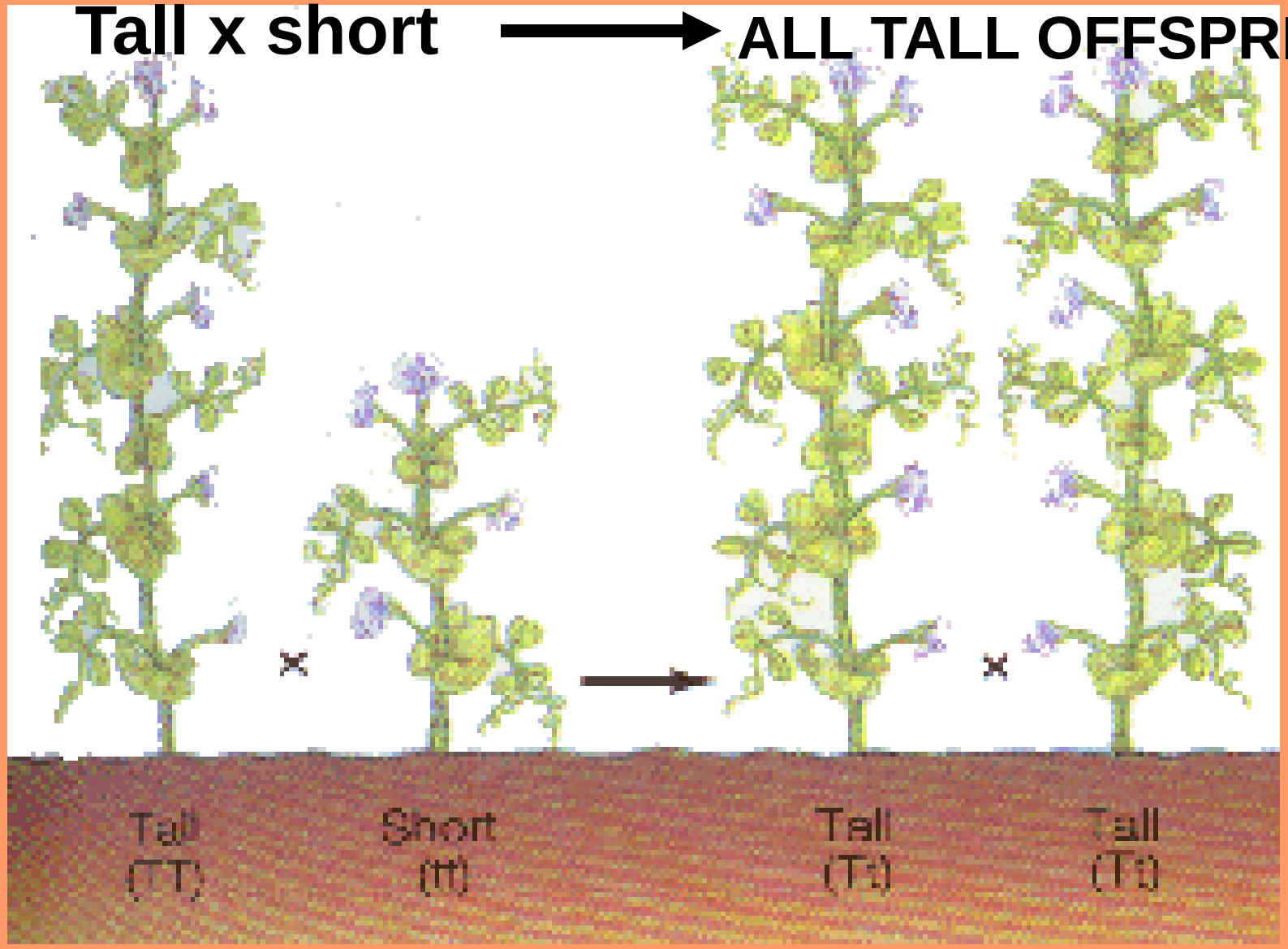
•In every generation of this plant only short plants were produced.

He called them **“true breeding”.**

Once again he concluded that pea plant must contain **some factor for height** (in that variety - for shortness).

- The next step of Mendel's experiment was to cross **pure tall** pea plants **with pure short** pea plants .

Tall x short → ALL TALL OFFSPRING!!!!!



- **The resulting plants were tall.**

  Only tall plants were produced!!

A MYSTERY!!

- **What had happened to the short characteristic?**
- **Why had the characteristic of shortness disappeared from the**

  F 1(first) generation?
- **Where was the “factor” that controlled shortness?**

More Cross Pollination

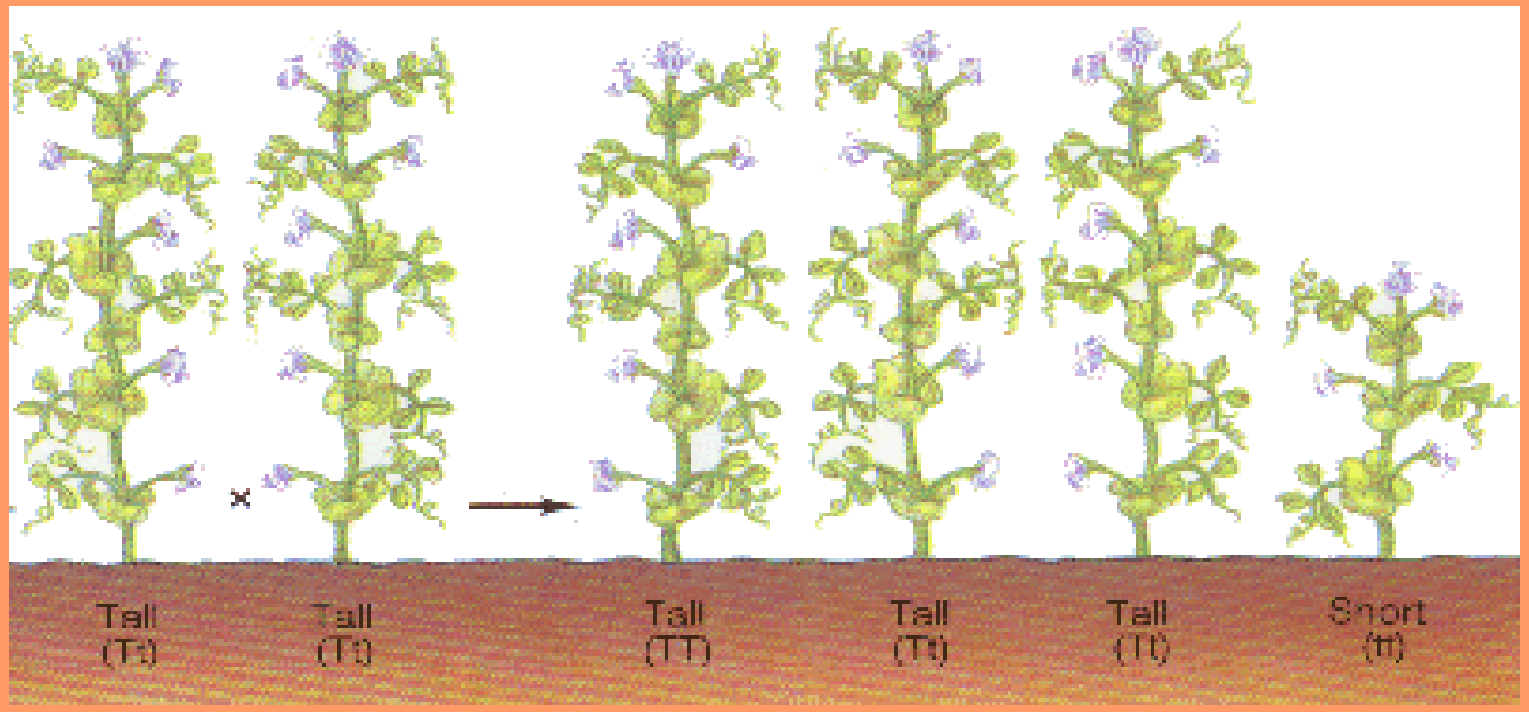
- **Mendel decided to cross pollinate the**

hybrid offspring from the F 1 Generation with one another.

- **The F 1 generation THEN produced the seeds that became the F 2 generation.**

SHORTY IS BACK

F1 F2

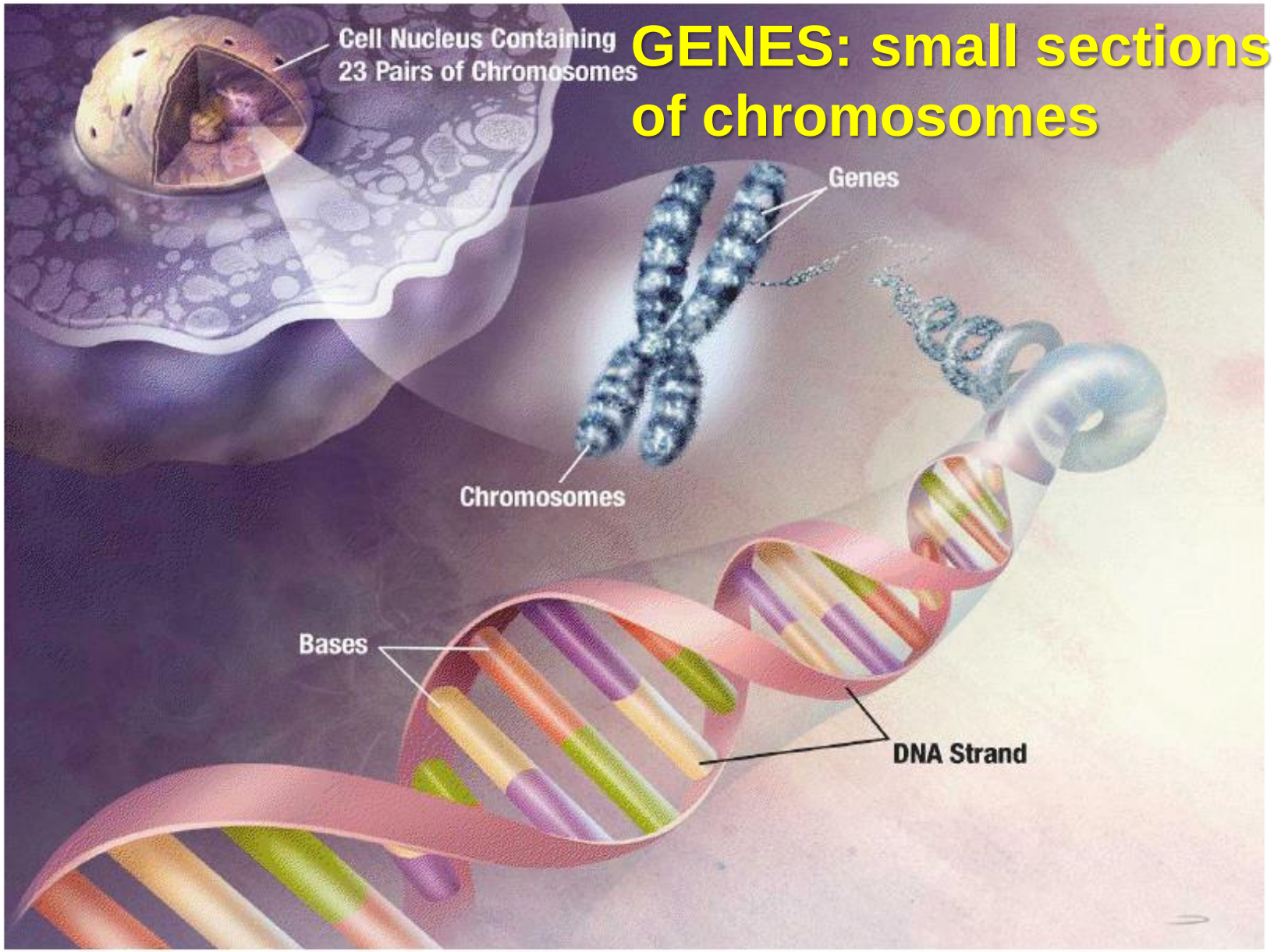


- From the experimental data, Mendel concluded that an organism has two factors (genes) for each inherited characteristic

- **The hybrid F1 plants each had one factor for tallness and one factor for shortness.**
  - **One factor comes from each parent**

What did Mendel conclude?

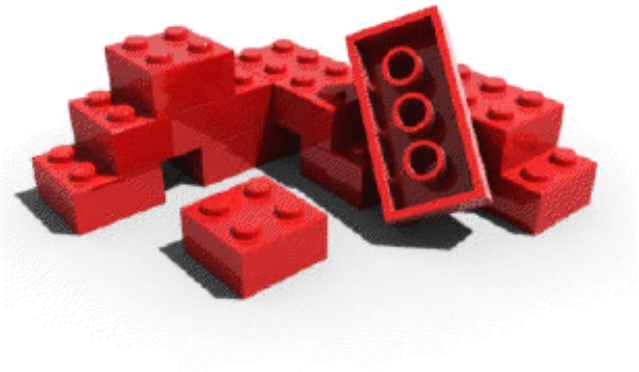
- Inheritance is determined by ***factors*** passed on from one generation to another.
- Mendel knew nothing about chromosomes, genes, or DNA. Why?
- These terms hadn't yet been defined.


Cell Nucleus Containing
23 Pairs of Chromosomes
GENES: small sections of chromosomes
Genes
Chromosomes
Bases
DNA Strand

The Protein Connection

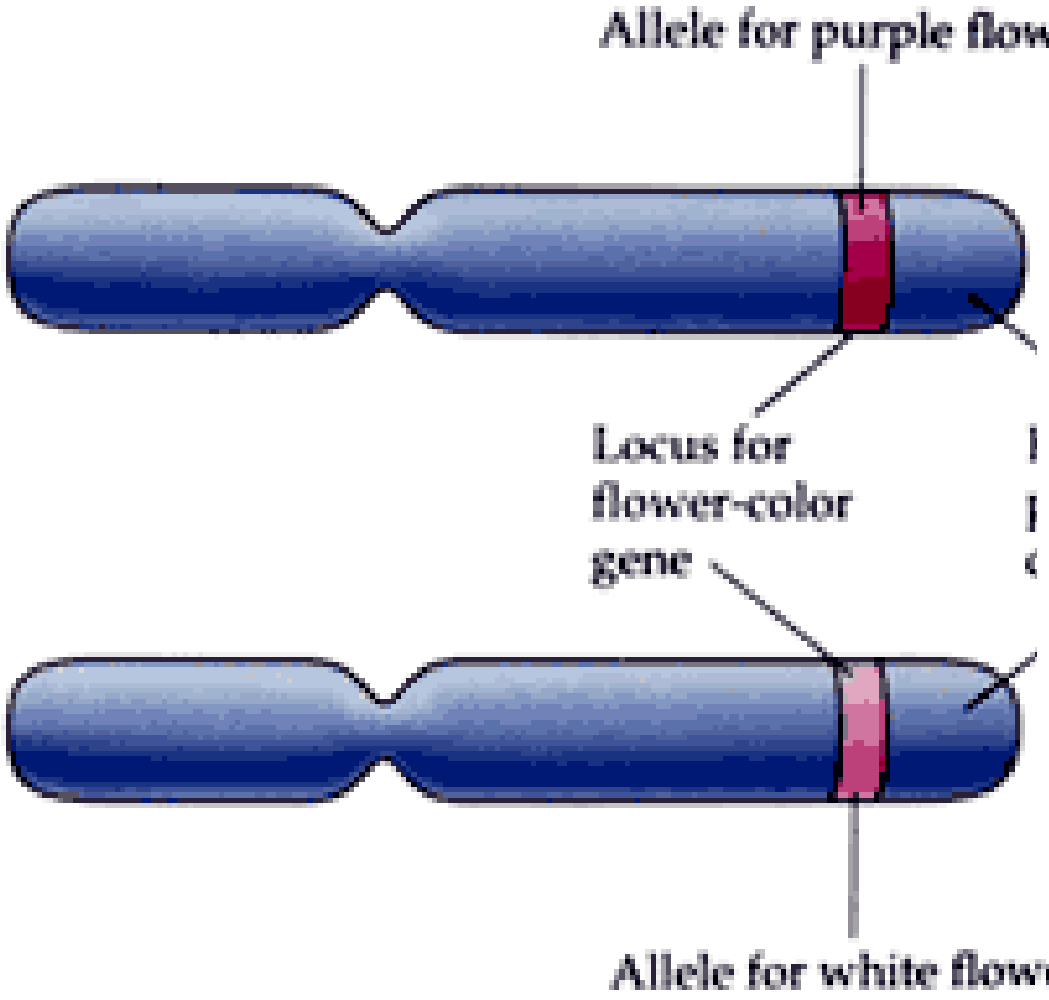
All organisms are built out of proteins.

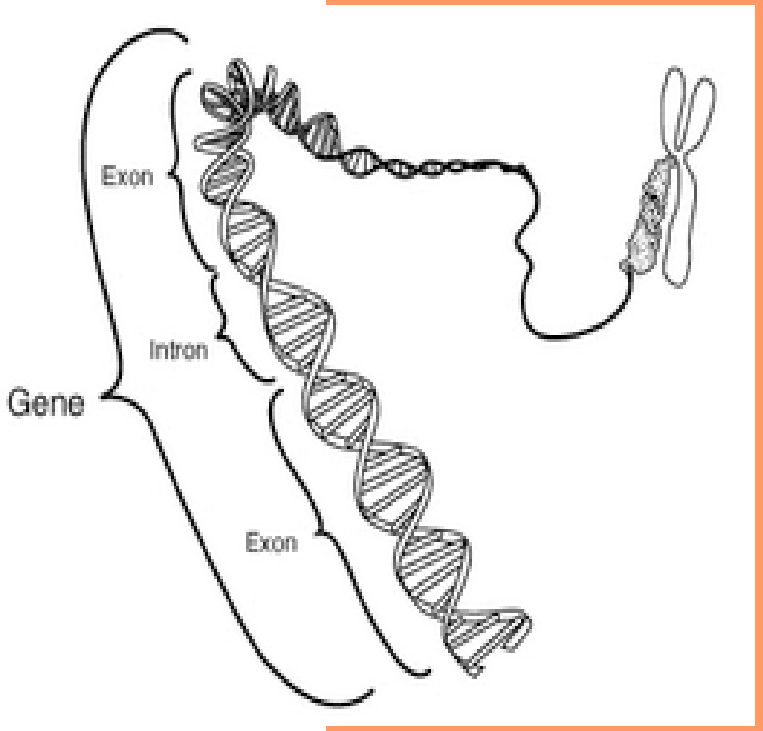
Proteins are the building blocks of all cells and organisms made up of cells.

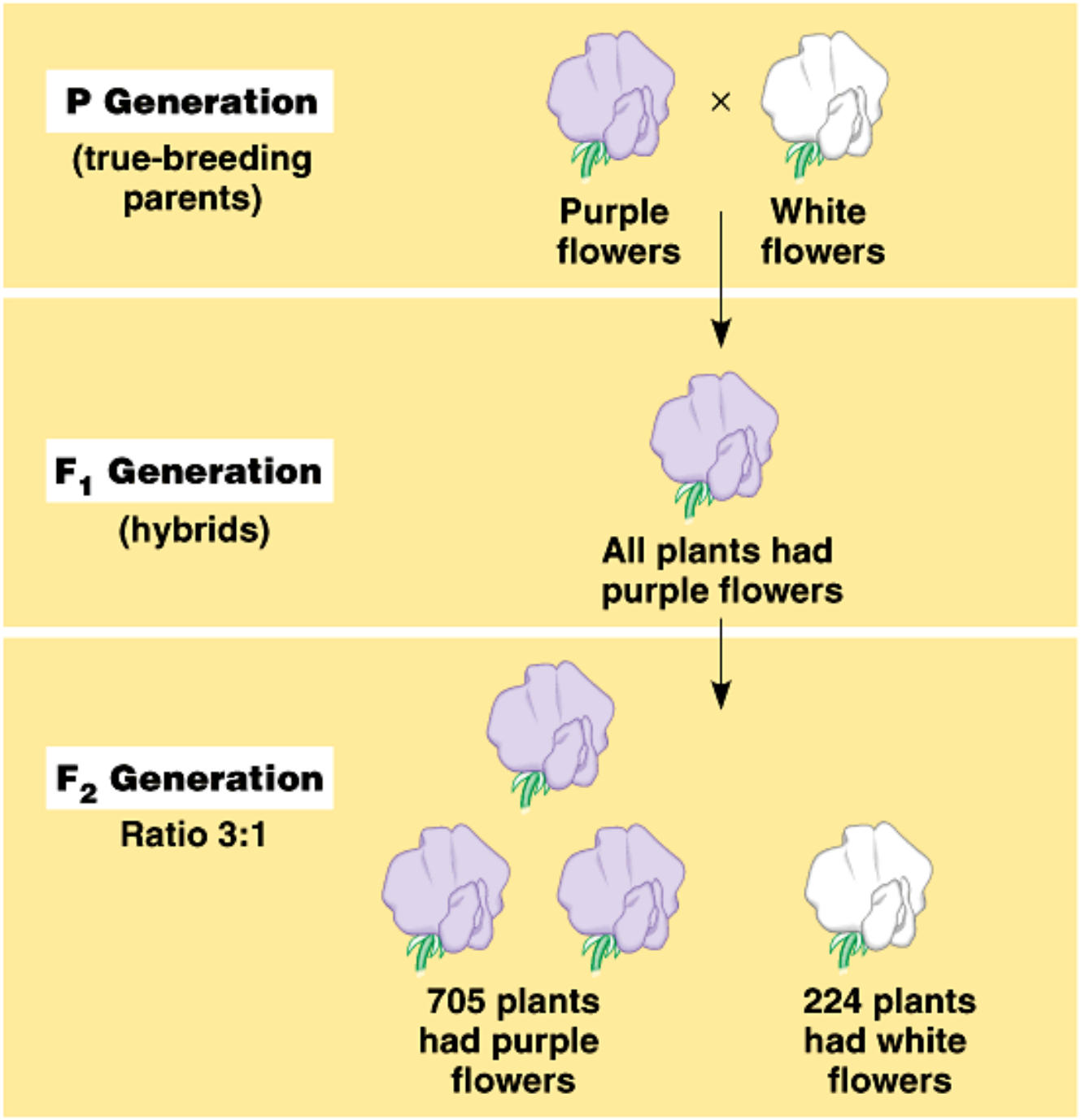


The type of proteins in an organism help determine its size, shape, color, and many other traits.

Allele: an alternative form of a gene for a specific trait.







- **There are forms of a gene known as <u>ALLELES</u>.**

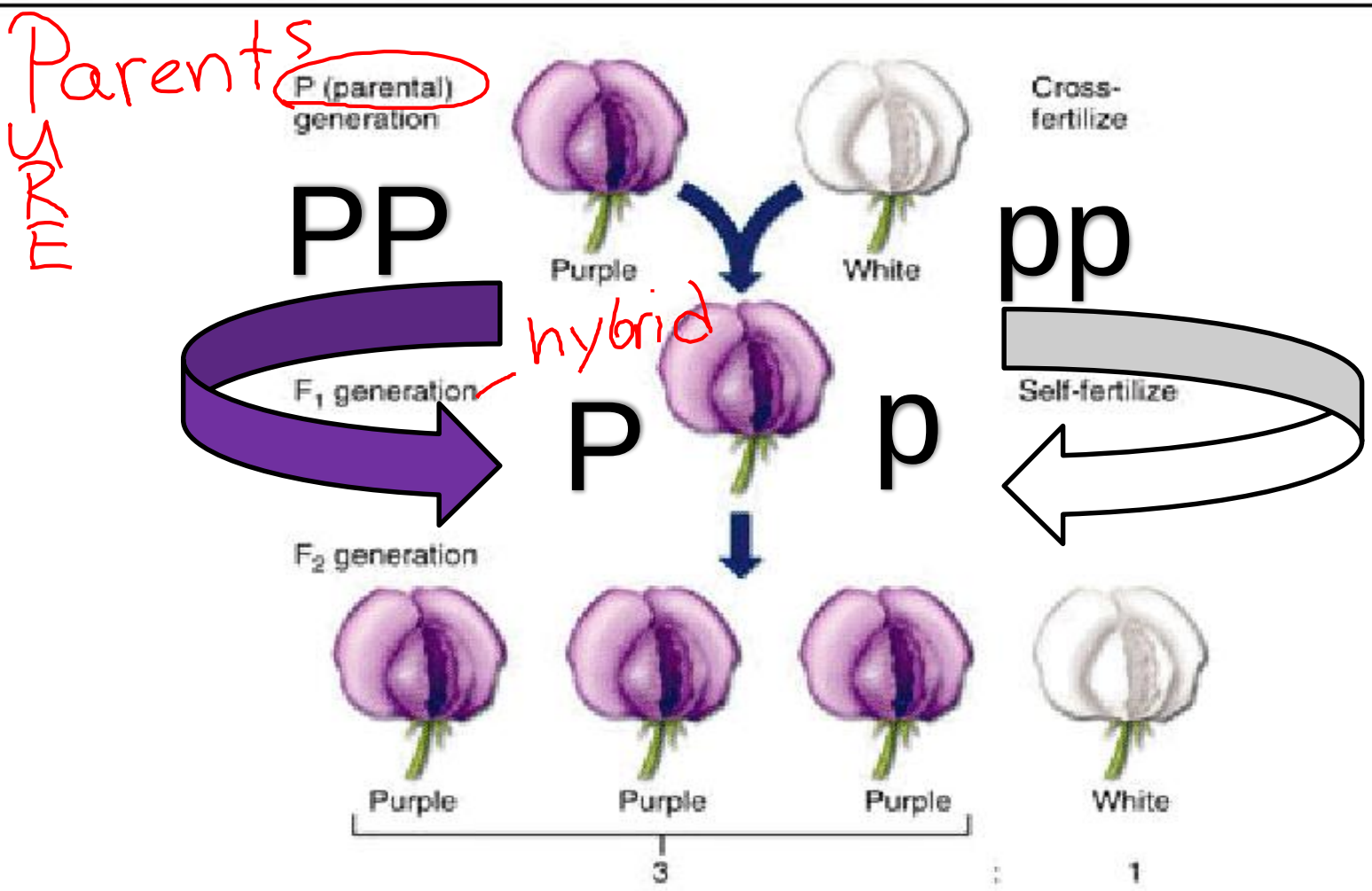
Rule of Unit Factors

- Each organism has two alleles for each trait
  - Alleles - different forms of the same gene
  - Alleles- located on chromosomes, they control how an organism develops

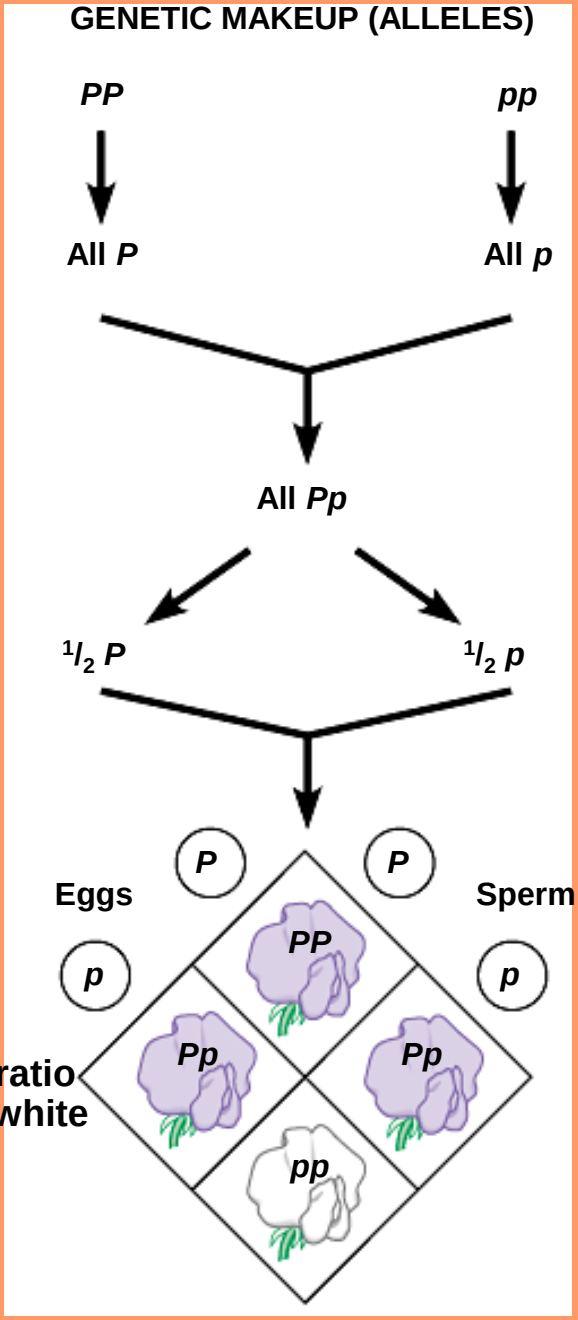
Law of Segregation

- The **two alleles** for a trait **must separate** when gametes are formed(during meiosis)
- A parent randomly passes only **one allele** for each trait to each offspring

A Summary


Parents
PURE
P (parental) generation
PP
Purple
White
pp
Cross-fertilize
hybrid
F1 generation
P
p
Self-fertilize
F2 generation
Purple
Purple
Purple
White
3
:
1

- A sperm or egg carries only one allele of each pair
  - The pairs of alleles separate when gametes form
  - This process describes Mendel's law of segregation



Rule of Dominance

- The trait that is observed in the F1 offspring of two pure parents with contrasting traits is the **dominant trait .**
- The trait that disappears in the offspring is the recessive trait.

There must have two "factors" or "versions" for each trait: one from each parent.

Traits = "genes" Factors/Versions = "*alleles*"

Some traits, like purple flowers, will always appear, even if only 1 factor is present.

Visible forms = *dominant alleles*

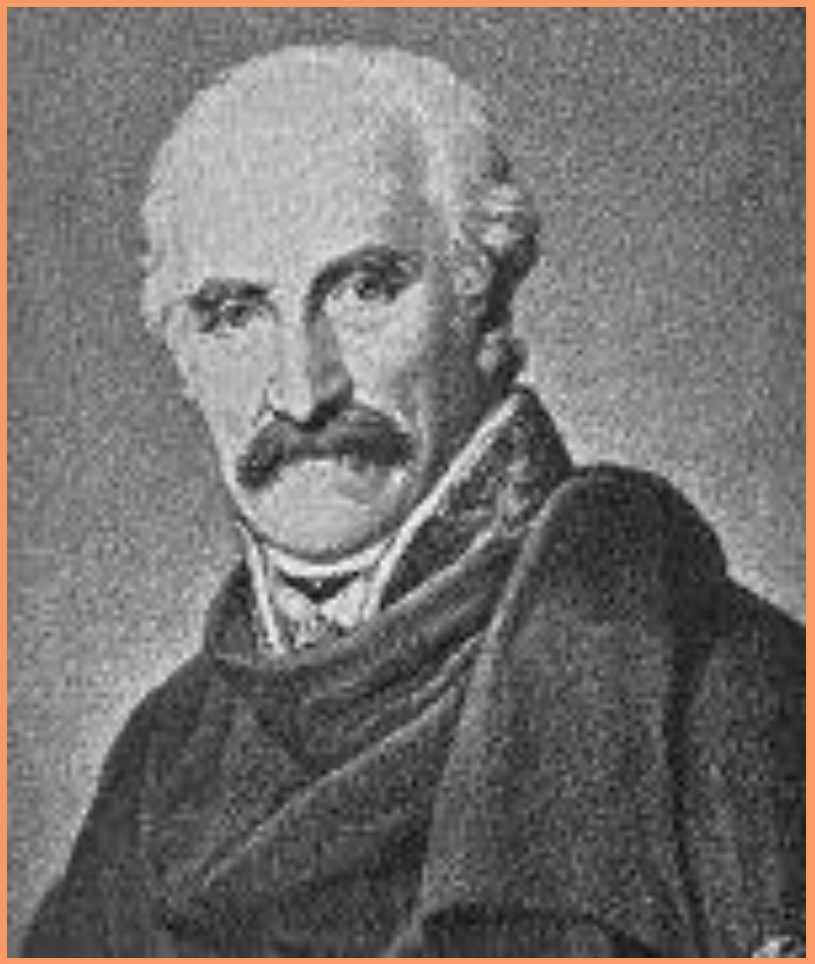
Other traits, such as white flowers, can be hidden by other factors.

Masked forms = *recessive alleles*

Punnett Squares

Punnett Square

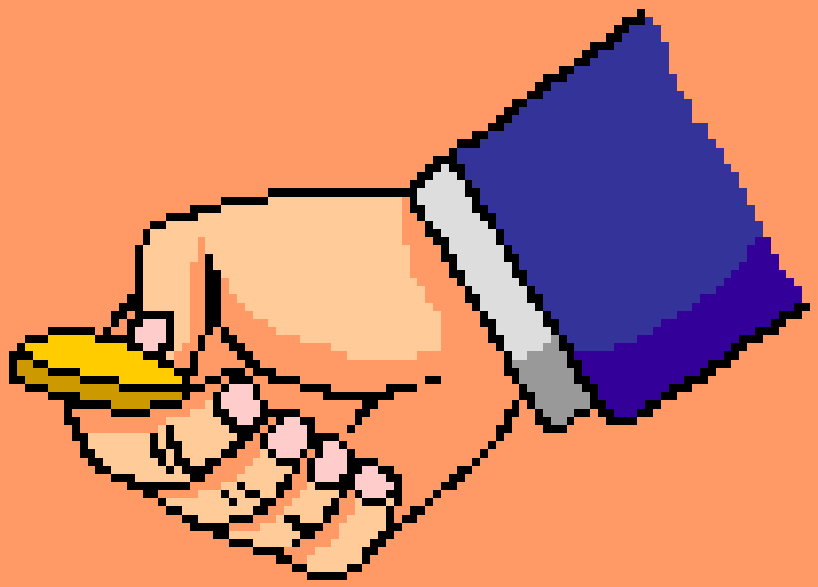
- **Developed by Reginald Punnett.**



Punnett Squares :

A Model used to show the _possible_ ways genes can _combine_ during fertilization.

Probability



- **The likelihood of a particular event occurring. Chance**
- **Can be expressed as a fraction or a percent.**
- **Example: coin flip.**

Punnett Squares

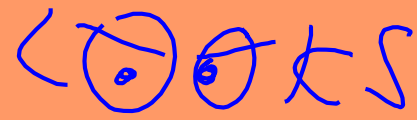
Help you to predict the probability of getting genetic outcomes.

- **Letters are used to represent the dominant and recessive alleles for a trait.**

Punnett Squares

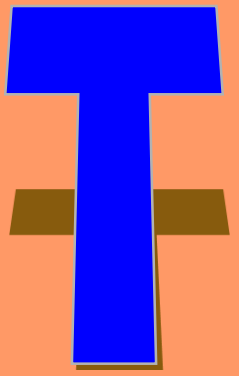
- **The genotype (genetic makeup) can be used to predict the phenotype (physical appearance) of the offspring.**

Punnett Squares

- **Genotype: the kind of alleles in a pair of genes.** ~letters
- **Phenotype: how an organism appears(looks)** 

Punnett Squares

A capital letter (T) is used for dominant alleles. T = tall



Punnett Squares

A lowercase letter (t) is used for recessive alleles.

t= short

Punnett Squares

If you wanted to know the type of offspring that a cross between two parents would produce, use a Punnett square.

Tt x Tt (the parents)

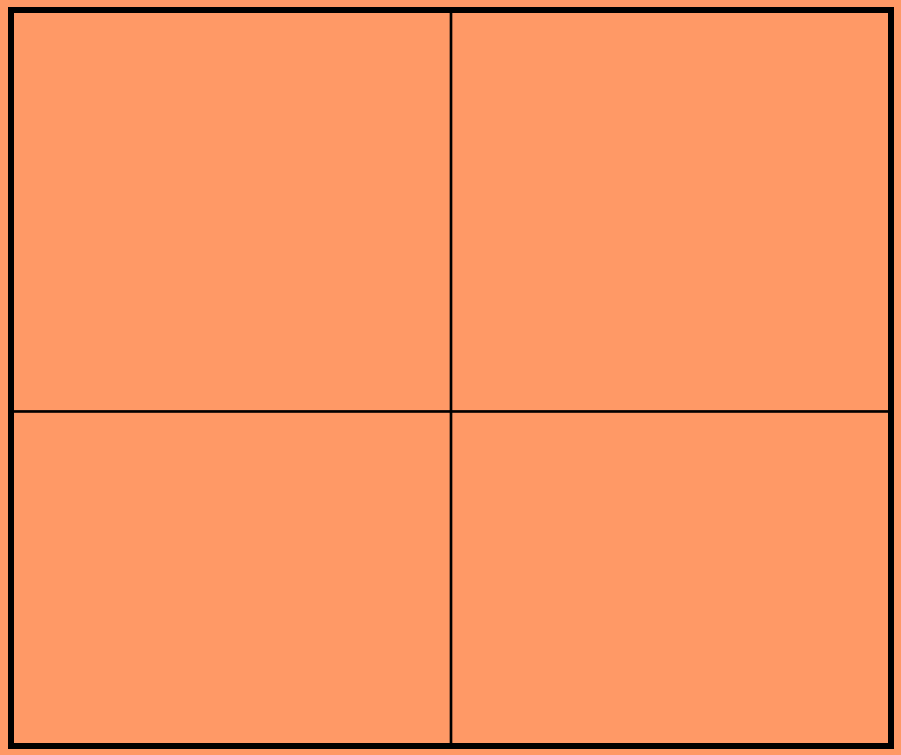
TT,Tt genotypes for tall

tt genotype for short

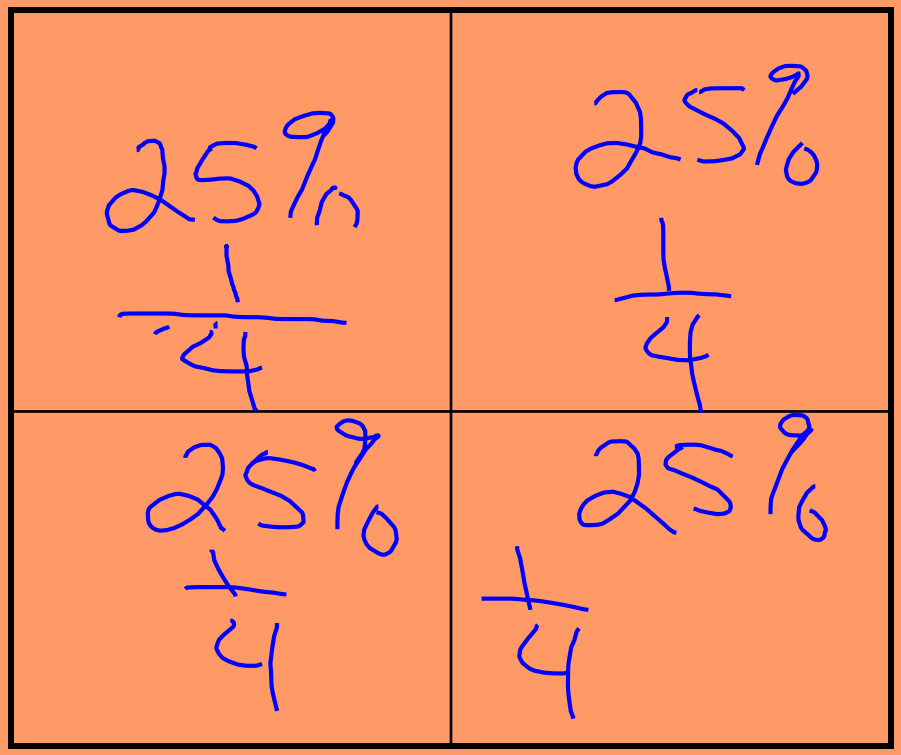
Punnett Squares

make 5

Punnett squares



Punnett Squares



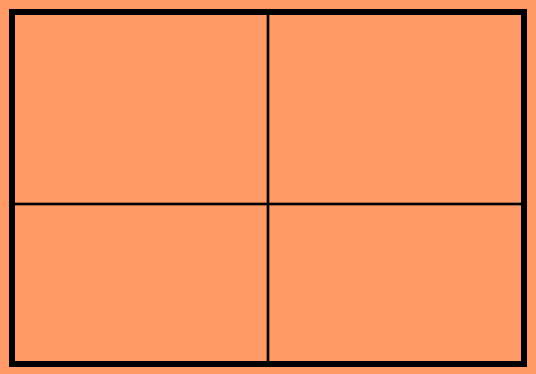
Punnett Squares

The letters representing the alleles from one parent are

placed along the top of the square.

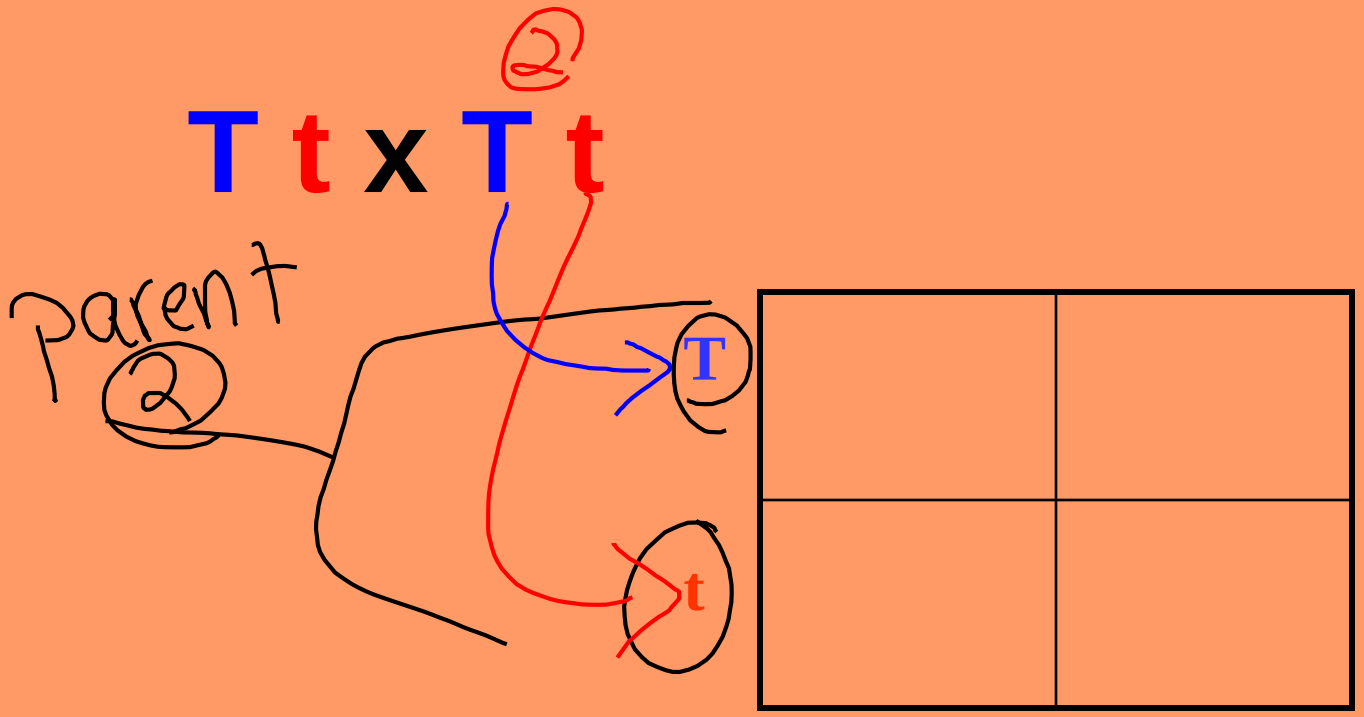
① ② ① parent 1

T t x T t



Punnett Squares

The letters representing the two alleles from the second Parent are places along the side of the square.



Punnett Squares

T t x T t

Tt = tT

tall tall

1

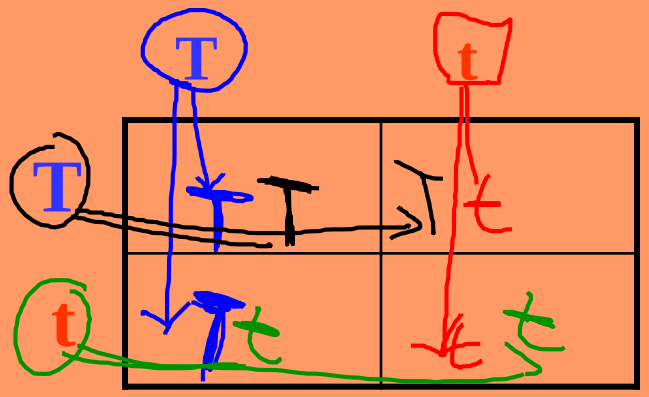
2

	T	t
T		
t		

offspring

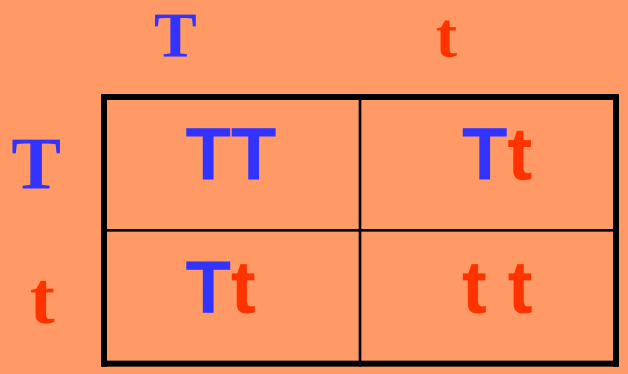
Punnett Squares

Squares are filled by writing the letter at the top beside the letter on the side.



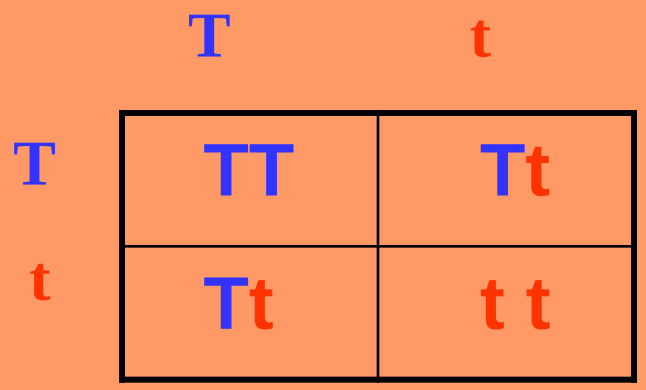
Punnett Squares

Squares are filled by writing the letter at the top beside the letter on the side.



Punnett Squares

The letters in each of the squares represents the Genotypes of the offspring that the parents could produce.



TT

Tt

Tt

t t

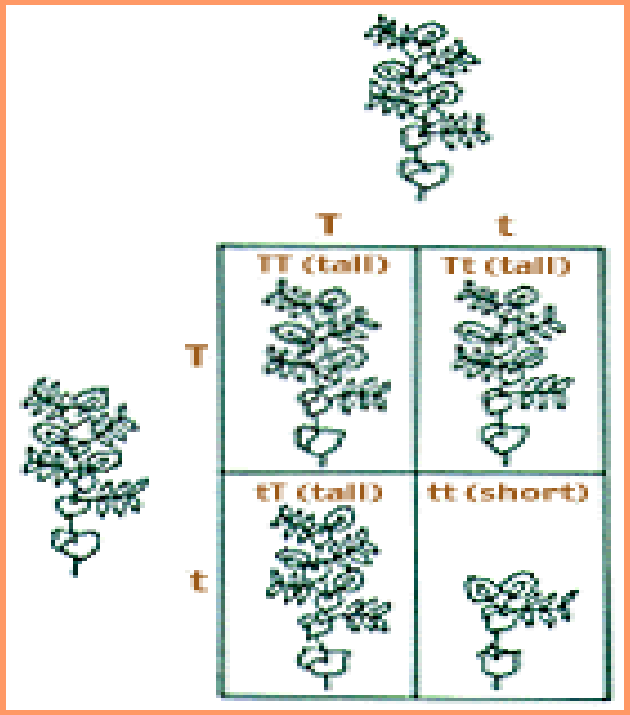
GENOTYPE vs PHENOTYPE

- **Genotype**
  - **The genetic makeup**
  - **Symbolized with letters**
  - **Tt or TT**

- **Phenotype**
- **Physical appearance of the organism**
- **What you would see in a photograph!**
- **Expression of the trait**
- **Short, tall, yellow, smooth, etc.**

Punnett Sqaures

Genotype	Phenotype
TT	tall
Tt	tall
Tt	tall
t t	short



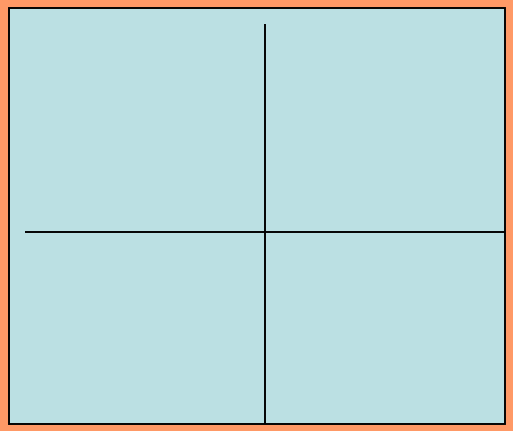
Genotype

- ***Homozygous*** = when an organism possesses two identical alleles. ex.
  - ***TT or tt***
- ***Heterozygous*** = when an organism possesses different alleles. ex.

  Tt

PRACTICE PROBLEM

- **What possible genotypes and phenotypes might be produced by a homozygous tall and a homozygous short parent?**



	T	T
t	Tt	Tt
t	Tt	Tt

What <u>genotypes</u> are produced?

What are the % of each of these <u>genotypes</u>

TT

Tt

tt

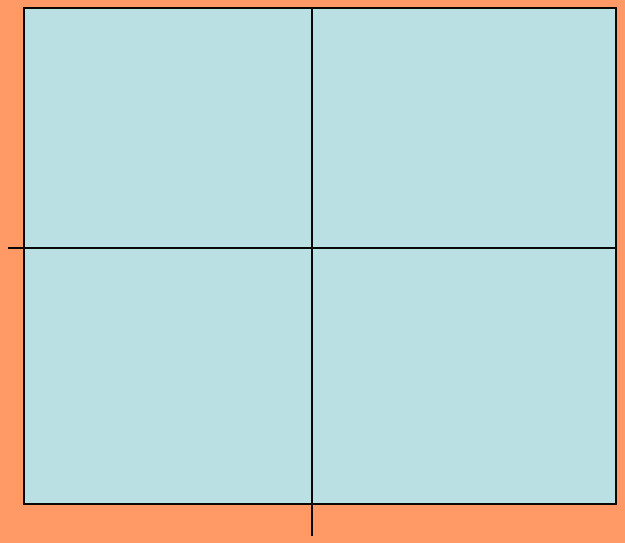
<u>PHENOTYPE:</u>

Tall

Short

PRACTICE PROBLEM # 2

- **Tt X tt**
- **What are the possible genotypes?**
- **What are the possible phenotypes?**



Here we crossed two peas which contained both tall and short information.

	T	t
T	TT	Tt
t	Tt	tt