Imagine the future…….

It is the year 2050. You have set IIT as your goal for your undergraduate degree. You enroll in one of the numerous coaching classes that have an excellent success rate for cracking the JEE.

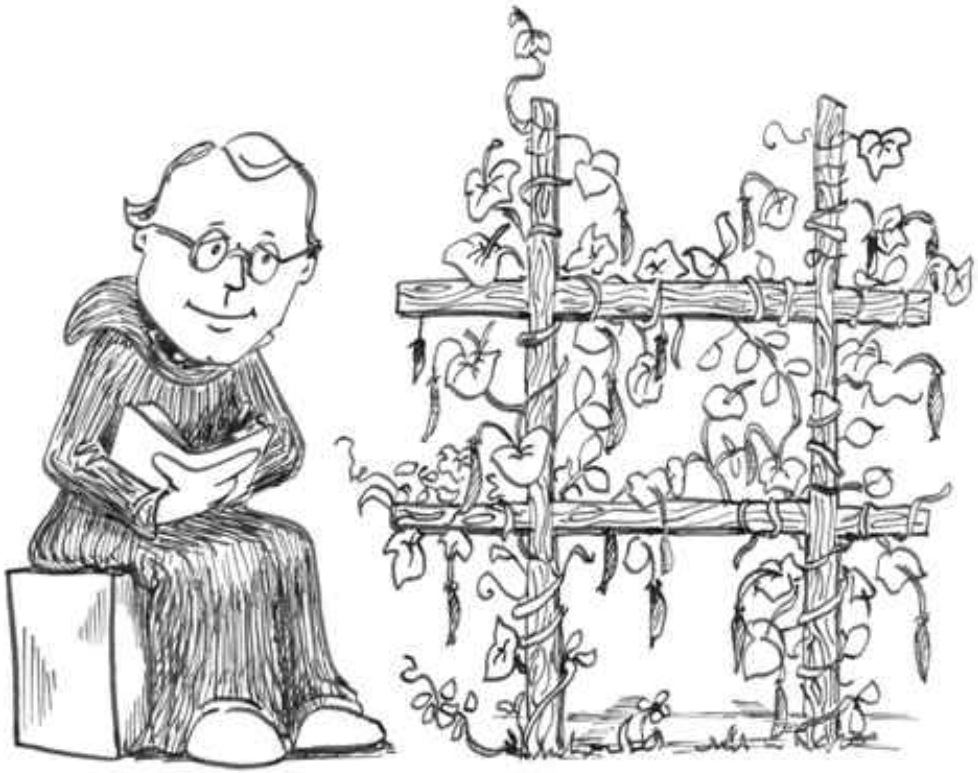
The first day you show up to the coaching class, you are asked to give a sample of your blood, which is given to a genetic testing lab to test your intelligence and ability to be an engineer. After 2 days, the results of your genetic test shows that you have a 90% probability of being an outstanding engineer. You are admitted into IIT Bombay immediately!

Basic principles of genetics

Mendel and the idea of Inheritance

Chapters 14, 15, 16, 17, 18

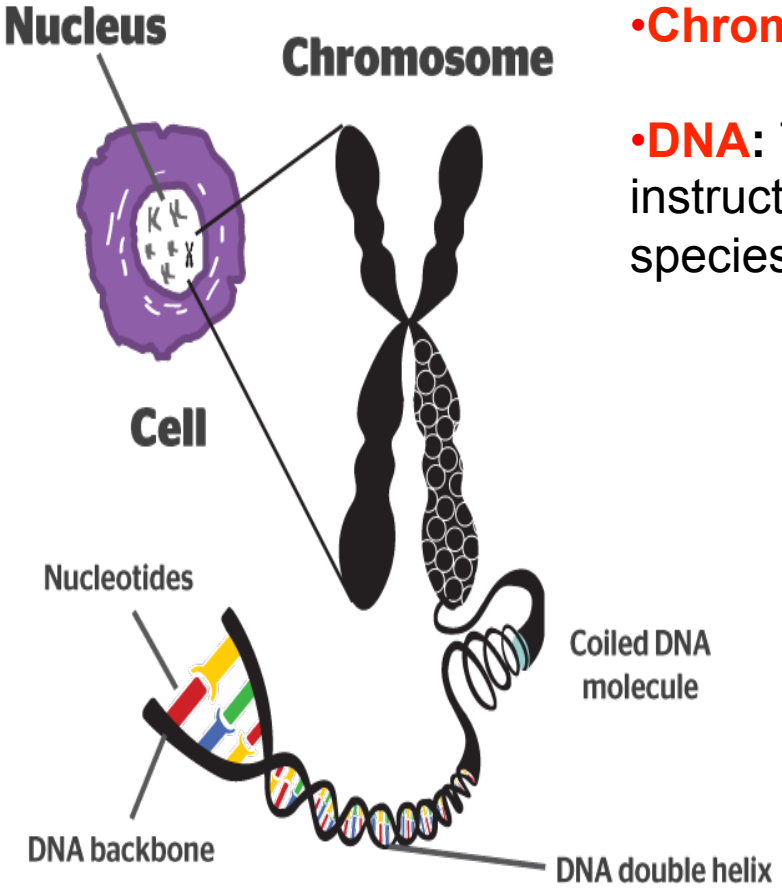
Lecture 2 & 3



1822-1884

Overview: Drawing from the Deck of Genes

What is the heritable material?



- **Chromosome**: A very long DNA plus proteins

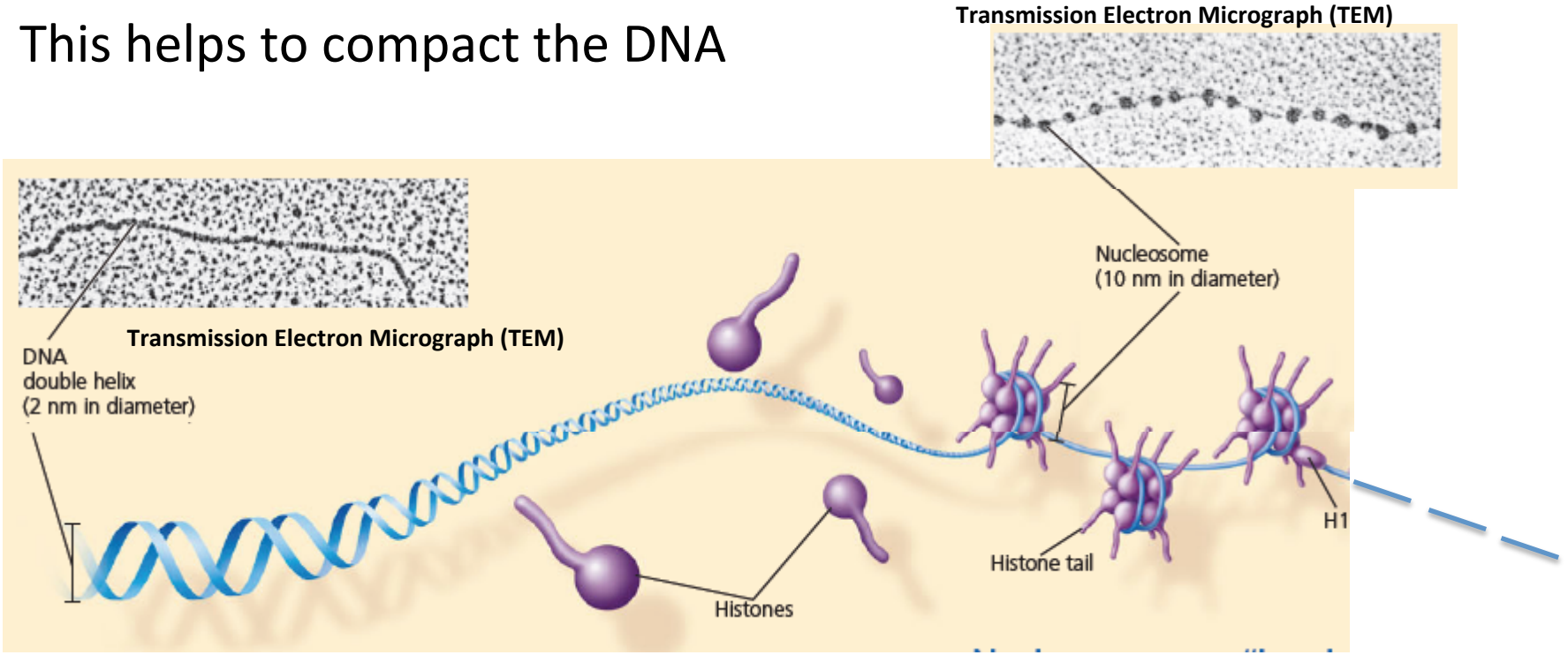
- **DNA**: The molecule that codes for genetic instructions in all living organisms and some species of virus

More information on STRUCTURE AND FUNCTIONS OF DNA in Tutorials

Eukaryotic DNA is organized into chromosomes (all the DNA in a cell is its genome)

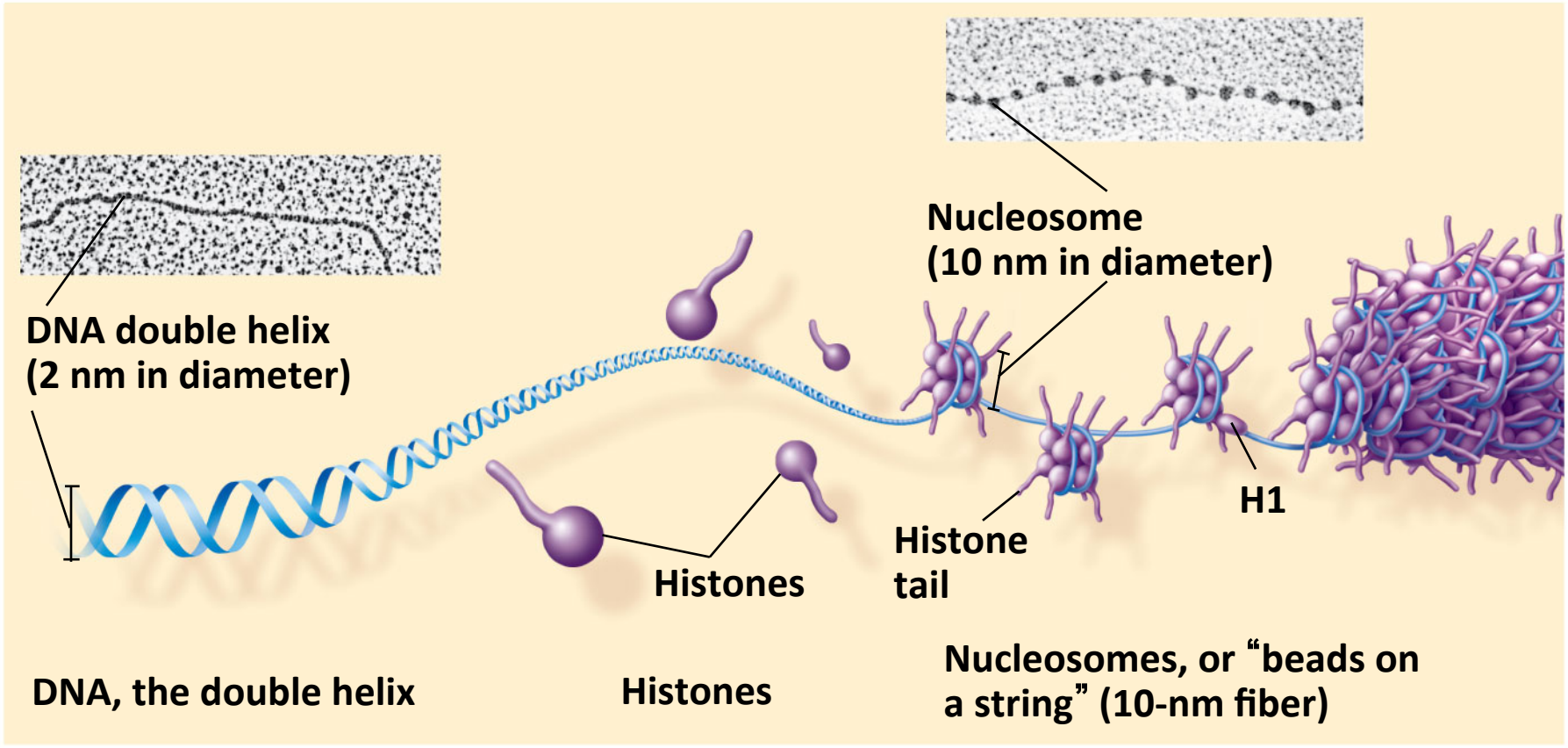
Histones (H2A, H2B, H3 and H4) are positively charged proteins that can interact with negatively charged DNA

This helps to compact the DNA



- Nucleosomes are also called 'beads on a string'

Eukaryotic genomes are organized into chromosomes

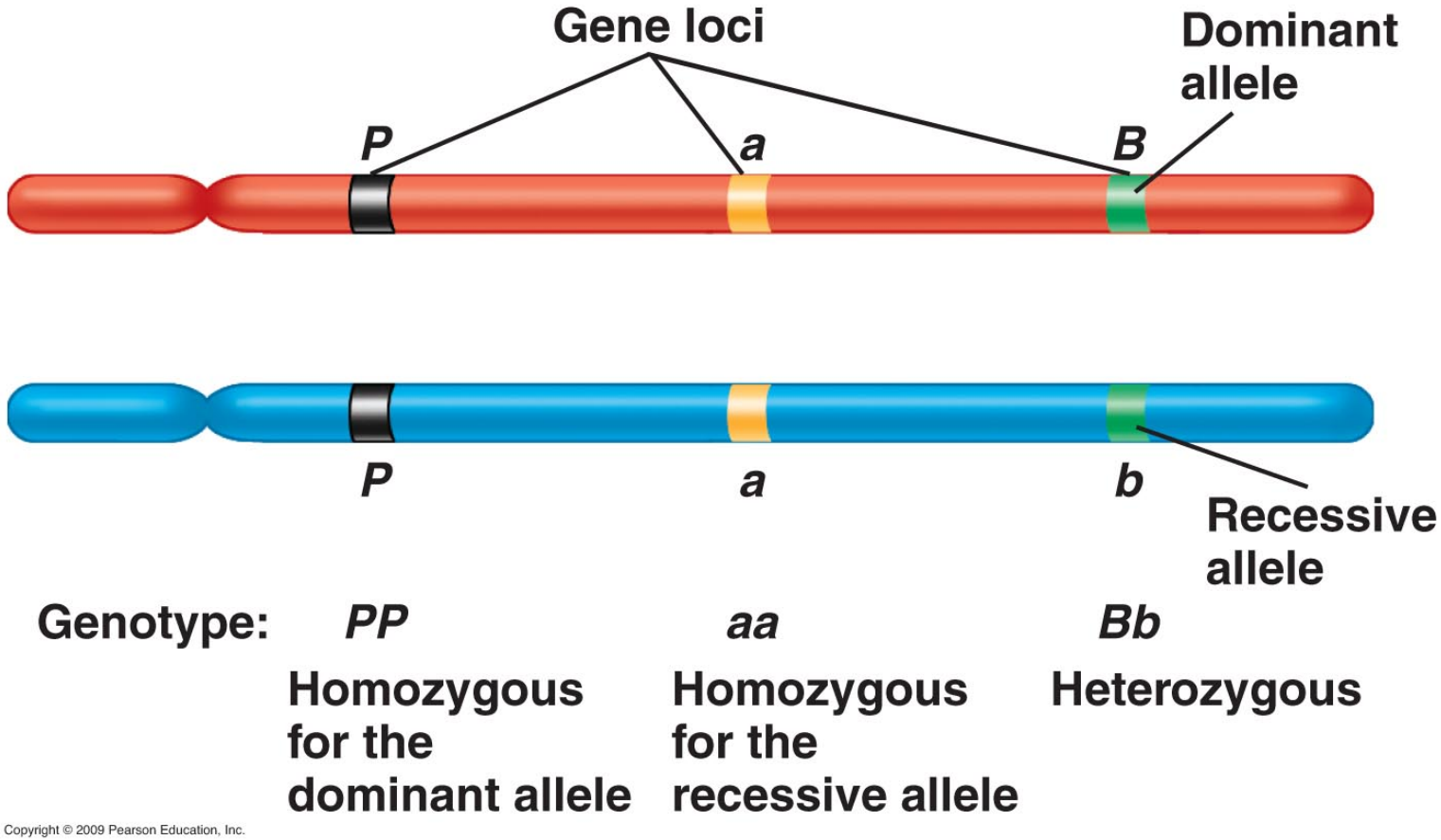


Higher order structures use histone H1 and form fibers and chromatids

Chromosomes and Alleles

•**Gene:** Certain stretches of DNA that code the hereditary information. It is the hereditary unit of life.

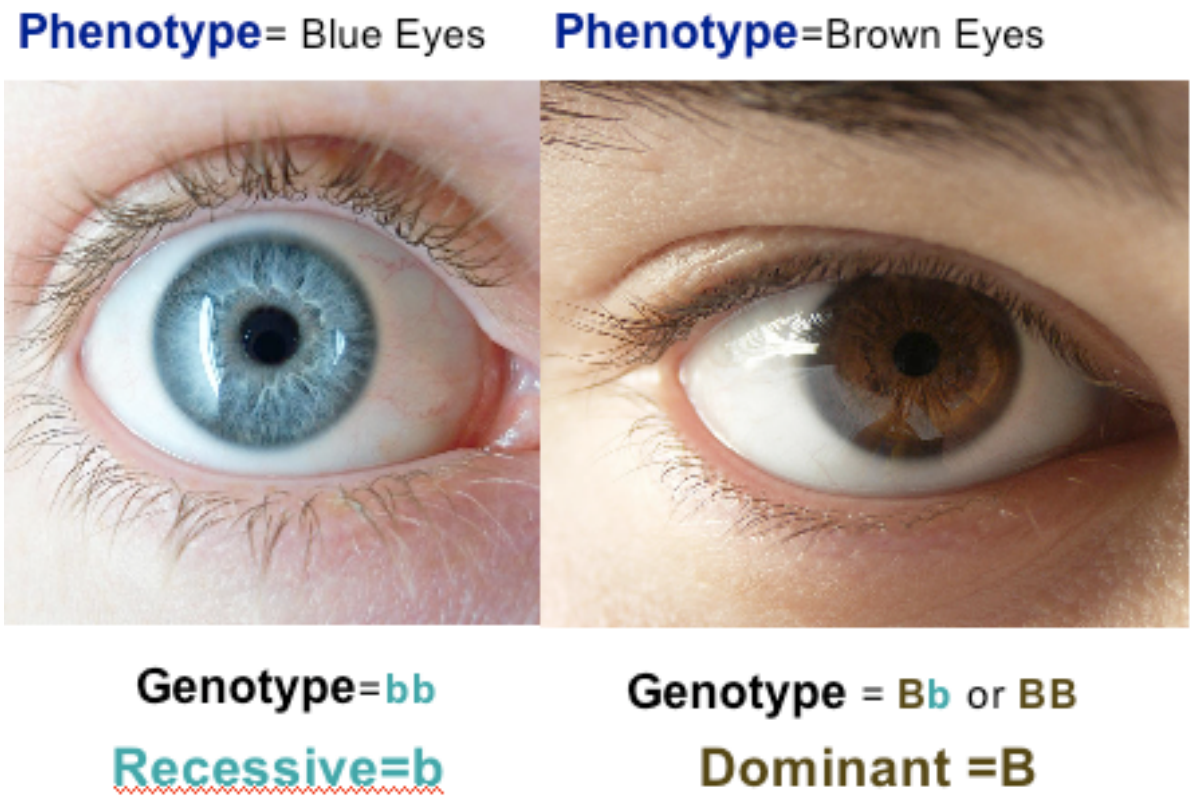
• **Allele:** Alternative forms of a single gene or gene loci



Genotype & Phenotype

Genotype: An organisms full hereditary information

Phenotype: Actual observed properties



Flow of heritable traits

Heritable traits

Phenotypic characters that are passed on from parent to offspring
e.g. eye and hair color

Imagine a future where a test that predicts whether you will get cancer. Today, Uzbekistan is using genetic testing to find future Olympians.

Main question

What are the genetic principles that account for the transmission of such traits ?

Around 1860, Gregor Mendel provided the laws of inheritance to define the genetic principles

How to define heredity

- Blending hypothesis
- Particulate hypothesis ---- leads to the idea of gene

❖ Collection of genes is like deck of cards

Player 1 → Player 2 → Player 3

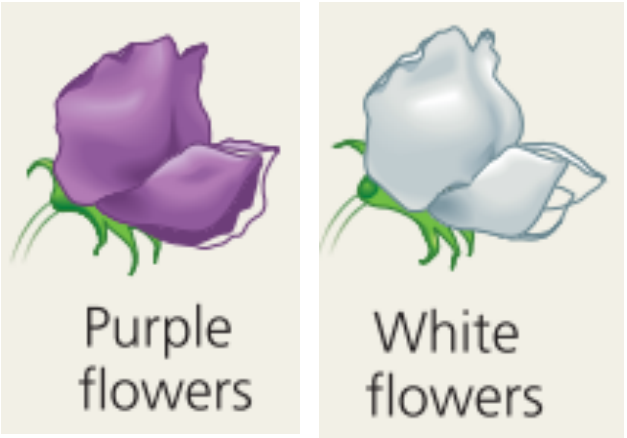
Parent → Son/daughter → Grand son/daughter

❖ Shuffled and passed along

Mendel: elucidation of principle of heredity

- Mendel's choice of experimental system -- pea plants

Why pea plants?



1. Availability in many variations
2. Short generation time
3. Large number of offspring from each mating
4. Easier crossing due to well separated pollen producing and egg bearing organs
5. Cross pollination is easy

Distinct heritable variation: characters

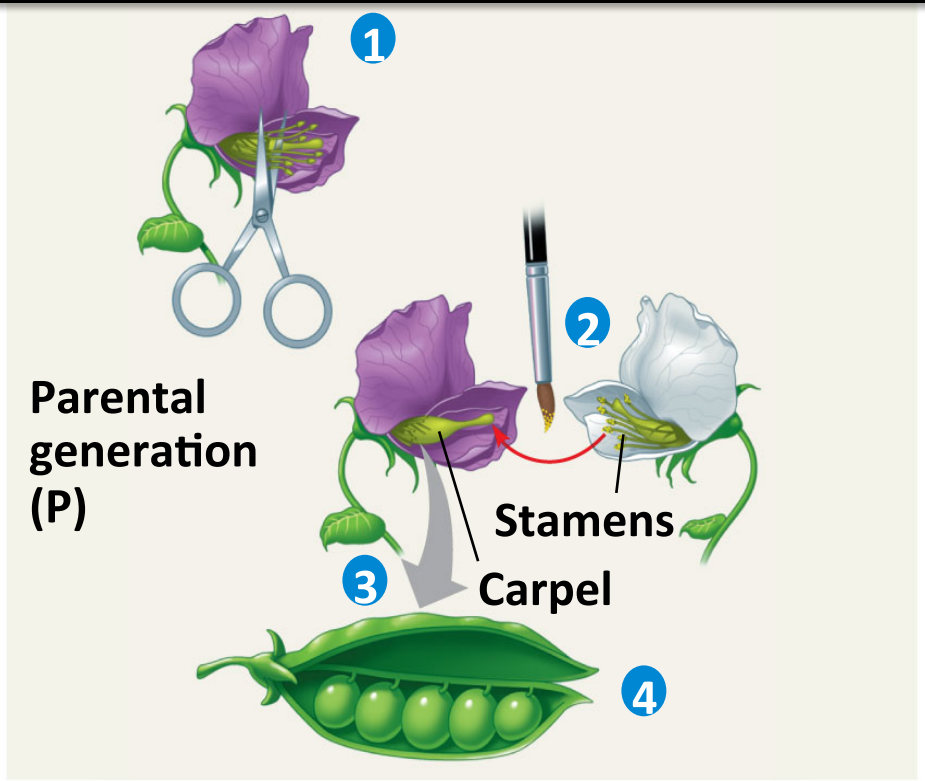
Chose characters that showed distinct alternative forms

Character	Dominant Trait	×	Recessive Trait
Flower color	Purple 	×	White 
Flower position	Axial 	×	Terminal 
Seed color	Yellow 	×	Green 
Seed shape	Round 	×	Wrinkled 

Pod shape	Inflated 	×	Constricted 
Pod color	Green 	×	Yellow 
Stem length	Tall 	×	Dwarf 

Character variants are called traits

What is cross-pollination?



A **carpel** is the ovule and seed producing reproductive organ in flowering plants (like female).
A **stamen** is the pollen-producing reproductive organ of a flower (like male).

Pea flowers have both!

1: Remove the stamens of purple flowers so they cannot pollinate

2 & 3: Pollinate a purple flower carpel with the stamens of a white flower

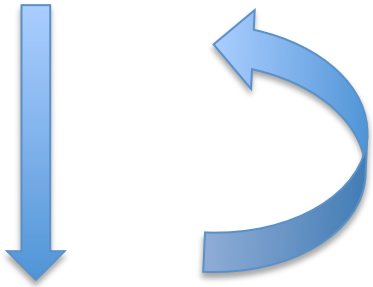
4: The fertilized purple flower will give rise to seeds which can be planted

5: Observe the offspring for the trait (purple or white flowers?)

Before starting the real experiment, Mendel made sure

- Chose only **true breeding** varieties

Purple-flowered plant X Purple-flowered plant



Always purple-flowered plant

Results of mating (crossing) of two contrasting traits

P = parental

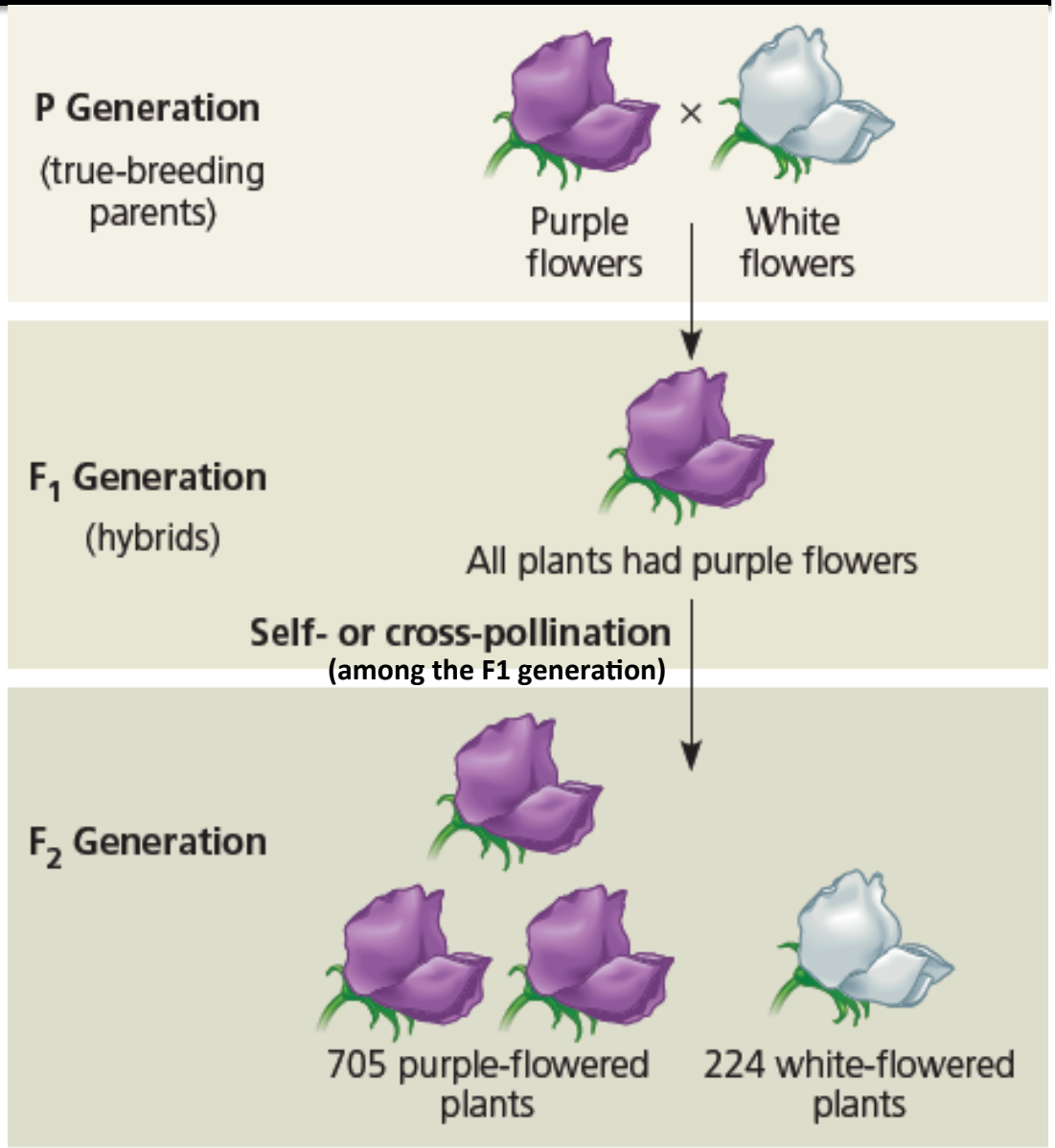
F = filial (child)

Purple flowers

Dominant trait

White flowers

Recessive trait



Inferences made by Mendel (he was a smart guy)

1. Inheritance of each trait is determined by "units" or "factors" that are passed on to descendants unchanged

2. Individual inherits one such unit from each parent for each trait

3. A trait may not show up in an individual but can still be passed on to the next generation

Defining laws of inheritance

- Analysis of thousands of F_2 plants helped in elucidating:
  1. Law of segregation
  2. Law of independent assortment

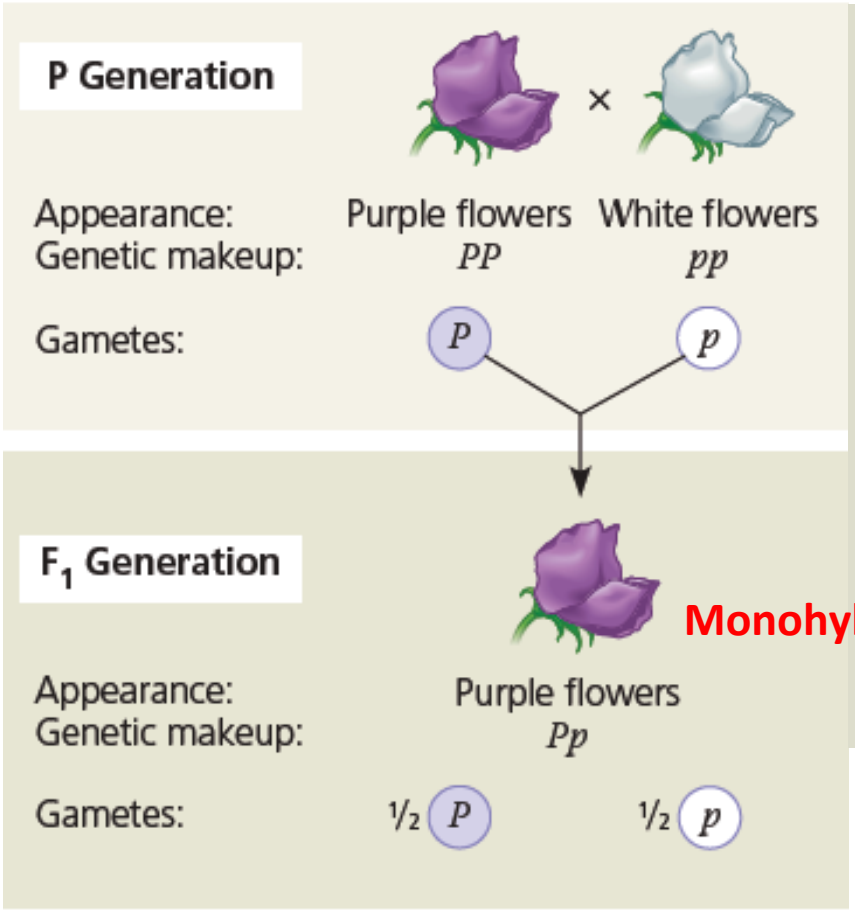
Observation of F_2 plants

Character	Dominant Trait	×	Recessive Trait	F_2 Generation Dominant: Recessive	Ratio
Flower color	Purple 	×	White 	705:224	3.15:1
Flower position	Axial 	×	Terminal 	651:207	3.14:1

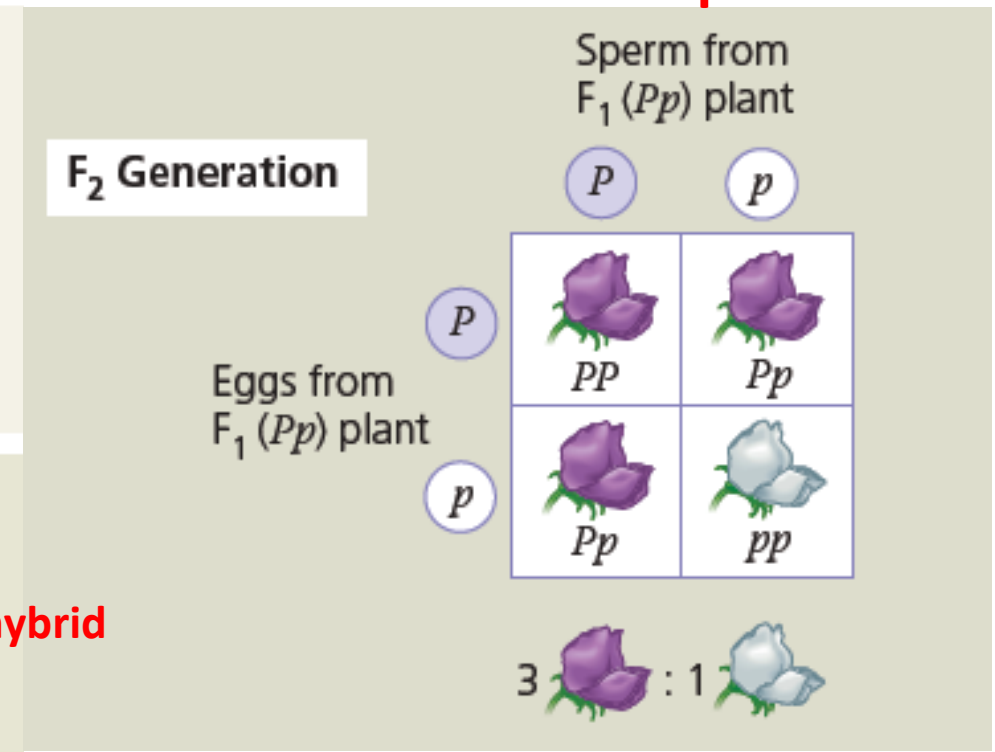
The ratio of dominant vs recessive trait is 3:1

Mendel proposed a reason for the 3:1 ratio

- Law of segregation -- Two units (called alleles today) for a heritable traits separate from each other during gamete formation and end up in different gametes



Punnett square



F_2 plants – a cross between 2 monohybrids