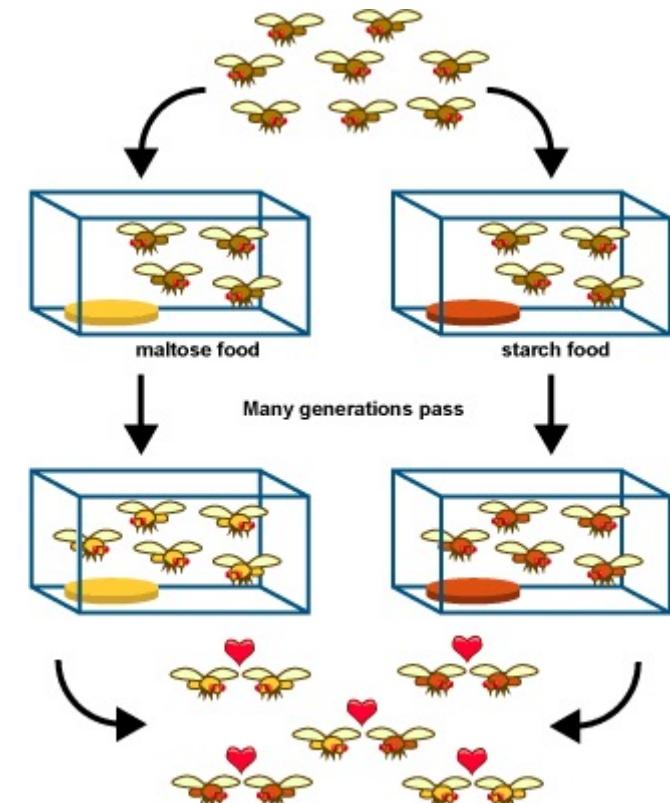


# Testing Evolution

- Evolutionary theory: hypotheses have been tested numerous times the last 150 years
- Older species in the fossil record (going backwards) are less similar to modern ones; younger species more similar
- Experiments (e.g. artificial selection) have been conducted
- Gradual change approaching formation of new species has been observed



# Biology: what is life?



**Reproduction**



**Growth and development**



**Order**



**Response to the environment**



**Regulation**



**Evolutionary adaptation**



**Energy processing**

- **Living organisms:** Reproduction, growth, adaptation, response to environment, order, regulation, energy processing (i.e. metabolism)

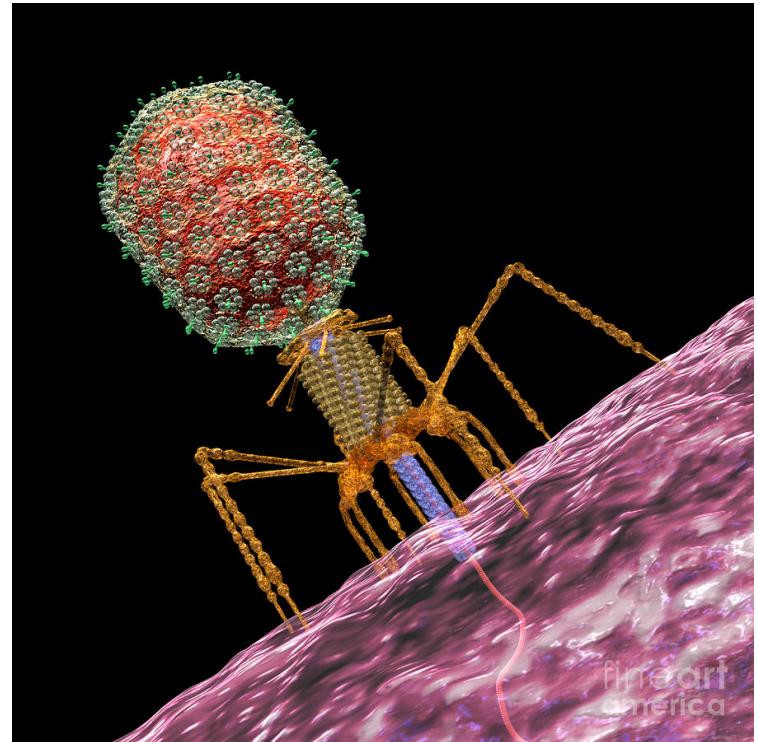
# Bacteria? (sing. bacterium)

- Reproduction ✓
- Growth ✓
- Adaptation ✓
- Response to environment ✓
- Order ✓
- Regulation ✓
- Metabolism ✓



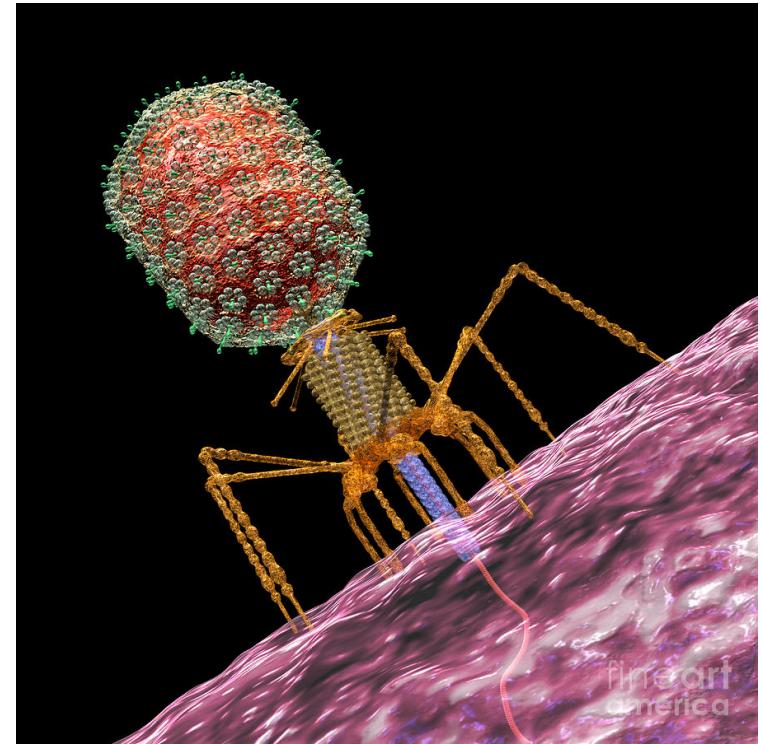
# Virus?

- Reproduction ✓ (only parasitically)
- Growth -
- Adaptation ✓
- Response to environment -
- Order ✓
- Regulation -
- Metabolism - (makes use of host metabolism)



# Virus?

- Reproduction ✓ **(only parasitically)**
- Growth -
- Adaptation ✓
- Response to environment -
- Order ✓
- Regulation -
- Metabolism -



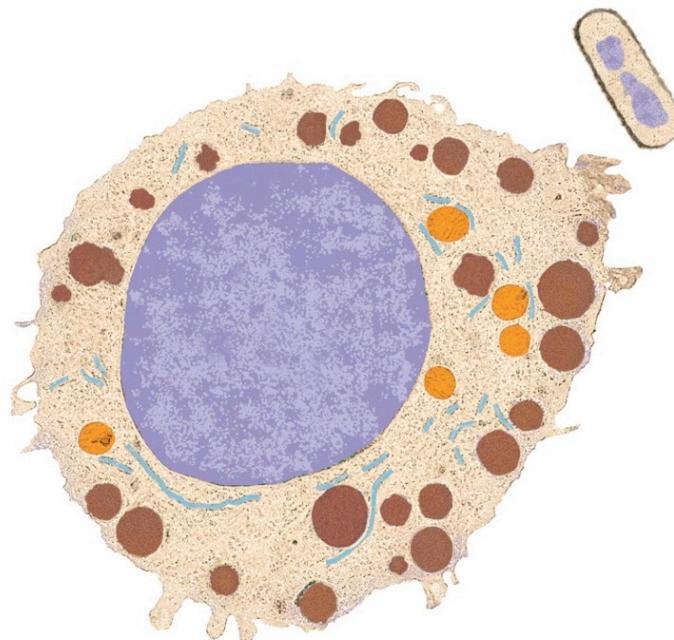
Viruses are not really living organisms, but still very important in biology

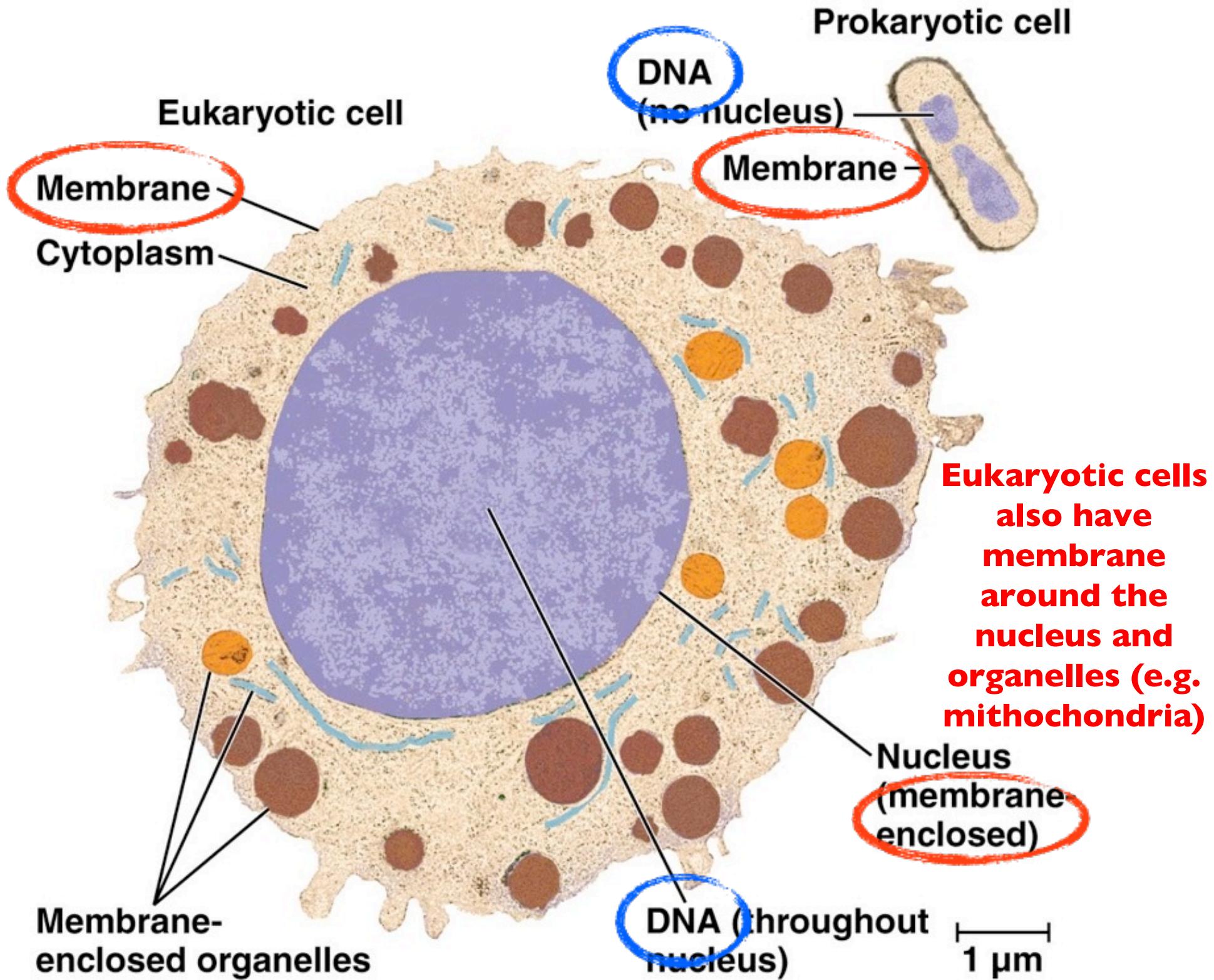
# What makes up an individual living organism

The **cell** is the smallest unit of organization that can perform all activities required for life

All cells share certain characteristics, e.g., a **cell membrane** and at least one **chromosome** (DNA with associated protein)

Two main forms: **prokaryotic** and **eukaryotic**





# Introduction to Genetics



- Living organisms usually show a great deal of variation
- Some (but not all) of the variation is heritable

## 19th century :

-Scientists know that much of the variation in nature is heritable

The big question at the time is:

*What principles account for the transmission  
of traits from parent to offspring?*

Several hypotheses were proposed...

# “Blending” vs. Particulate Inheritance

- **Blending:** the idea that genetic material contributed by the two parents mixes in a manner analogous to the way blue and yellow paints blend to make green
- **Particulate:** parents pass on discrete heritable units (genes) that retain their separate identities in offspring; i.e., more like a deck of cards than a pail of paint



# Gregor Mendel tested these hypotheses



- Lived 1822-1884
- Discovered some of the fundamental laws of inheritance
- Work not fully appreciated until after his death

# Gregor Mendel



- Austrian monk
- Conducted botanical experiments in the abbey gardens

# Gregor Mendel



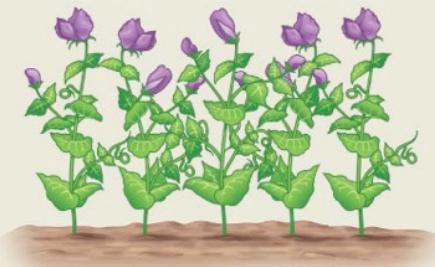
- Reproduction and hybridization experiments with garden pea plant
- Rediscovered and findings confirmed by other scientists early 1900s- Genetics

CHARACTER	CONTRASTING TRAITS
SEEDS	round/wrinkled yellow/green

# Why peas?

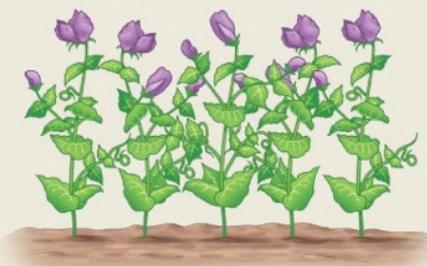


- Many distinct traits
- Easy to do both cross-fertilization and self-fertilization
- Fairly short generation time



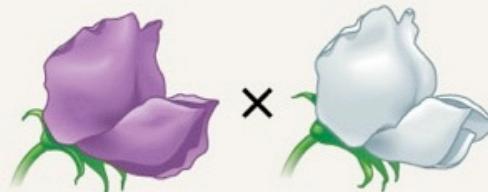


- Mendel tracked inheritance of characters with two discrete forms
- Started with varieties of pea plants that had only always produced the same variety via self-pollination  
= true-breeding



## EXPERIMENT

P Generation  
(true-breeding  
parents)



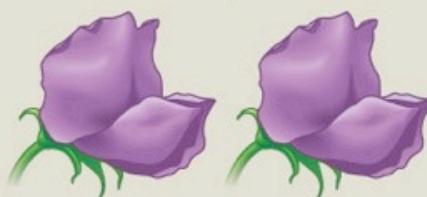
Purple flowers      x      White flowers

F<sub>1</sub> Generation  
(hybrids)

All plants had purple flowers

Self- or cross-pollination

F<sub>2</sub> Generation



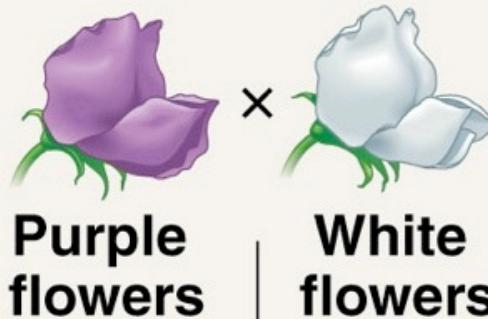
705 purple-  
flowered  
plants



224 white-  
flowered  
plants

## EXPERIMENT

P Generation  
(true-breeding parents)



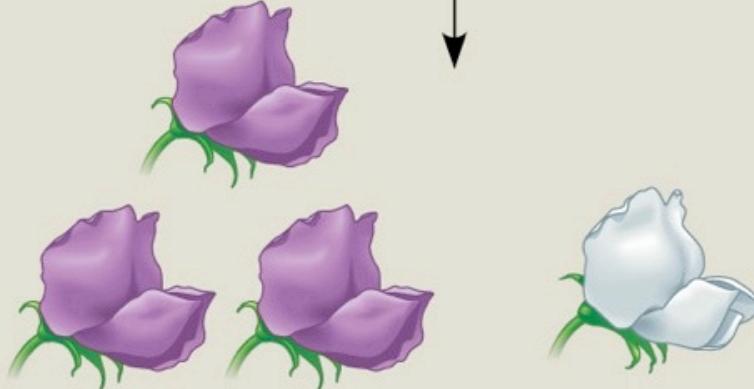
F<sub>1</sub> Generation  
(hybrids)

All plants had purple flowers



Self- or cross-pollination

F<sub>2</sub> Generation



705 purple-flowered plants

224 white-flowered plants

F1: white is in a hidden “heritable factor”?

F2: close to 75% purple and 25% white (3 to 1)

# Mendel's Model

- I) Trait variation is due to alternative variations (**alleles**) of "heritable factors" (**genes**)

i.e., inheritance is *particulate*

# Mendel's Model

- 1) Trait variation is due to alternative **variations** (**alleles**) of "heritable factors" (**genes**)
- 2) For each character an organism inherits two alleles, one from each parent
- 3) **Dominant** alleles mask **recessive** alleles
- 4) Two alleles for a heritable character segregate (separate) during gamete formation and end up in different gametes (= **Law of Segregation**)

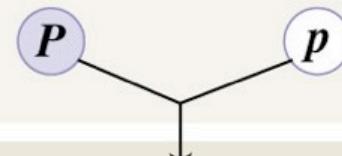
## P Generation



Appearance: Purple flowers White flowers

Genetic makeup:  $PP$   $pp$

Gametes:



## F<sub>1</sub> Generation

Appearance:

Genetic makeup:

Gametes:

Purple flowers

$Pp$

$\frac{1}{2}$   $P$        $\frac{1}{2}$   $p$

## F<sub>2</sub> Generation

Sperm from F<sub>1</sub> ( $Pp$ ) plant

	$P$	$p$
$P$	$PP$	$Pp$
$p$	$Pp$	$pp$

Eggs from  
F<sub>1</sub> ( $Pp$ ) plant

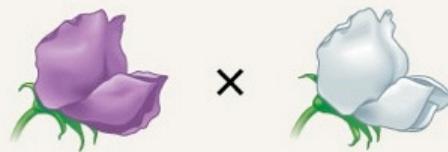
3 : 1

The allele for purple color is dominant (P), white is recessive (p)

Genes occur in pairs in most cells, but are separated in gametes i.e. gametes are haploid whereas somatic cells are diploid

Punnett square explains 3:1 ratio in F<sub>2</sub>

## P Generation



Appearance: Purple flowers

Genetic makeup:  $PP$

Gametes:



## $F_1$ Generation

Appearance: Purple flowers

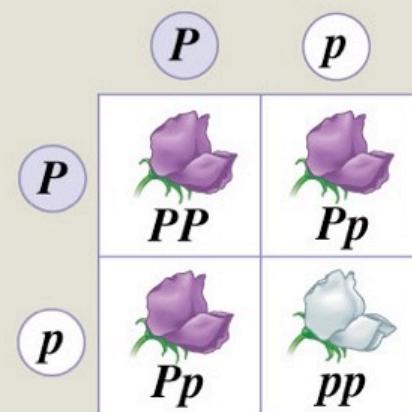
Genetic makeup:  $Pp$

Gametes:



## $F_2$ Generation

Eggs from  $F_1 (Pp)$  plant

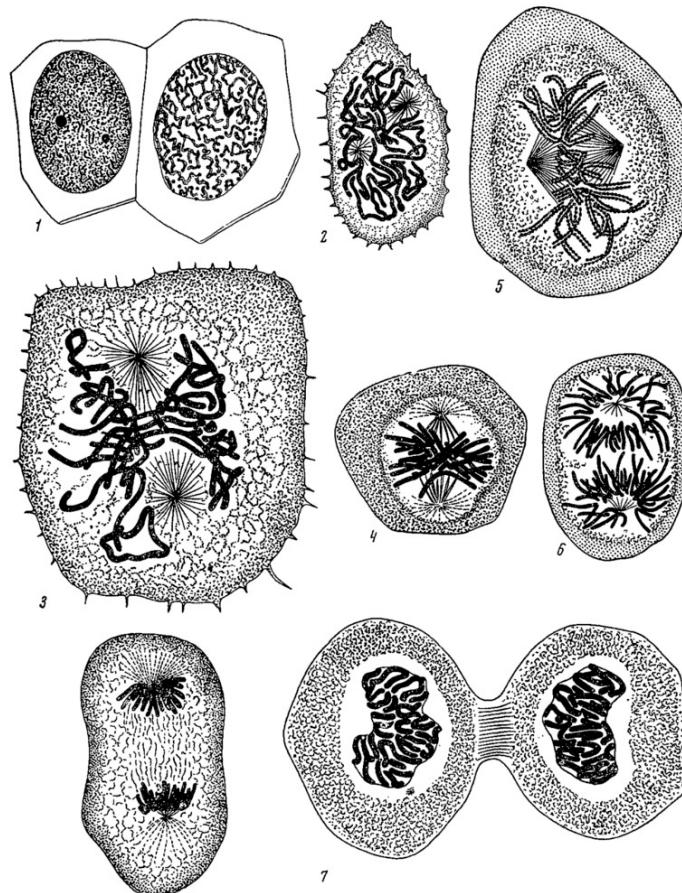


3 Purple : 1 White

**Individuals with two identical alleles are called **homozygous** ( $PP$ ,  $pp$ ) vs. individuals with different alleles : **heterozygous** ( $Pp$ )**

# Chromosomes

- Other scientists discovered **chromosomes**, and suspected that Mendel's “factors” (genes) were situated on these



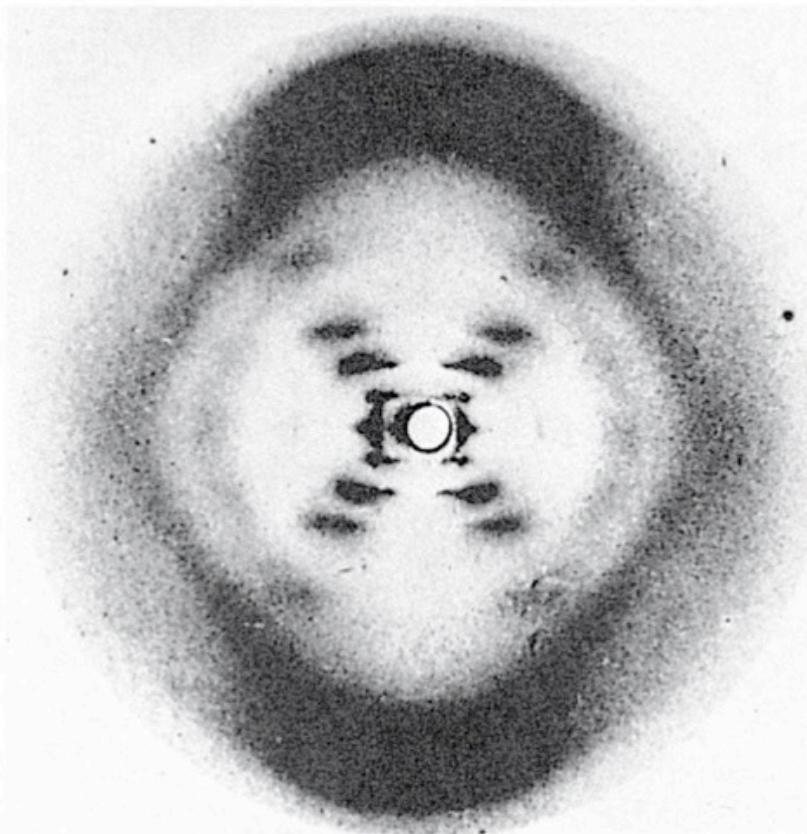
- Chemical analysis showed that they consisted of proteins and a more mysterious substance called **nucleic acid**

# But what is the structure of nucleic acids?

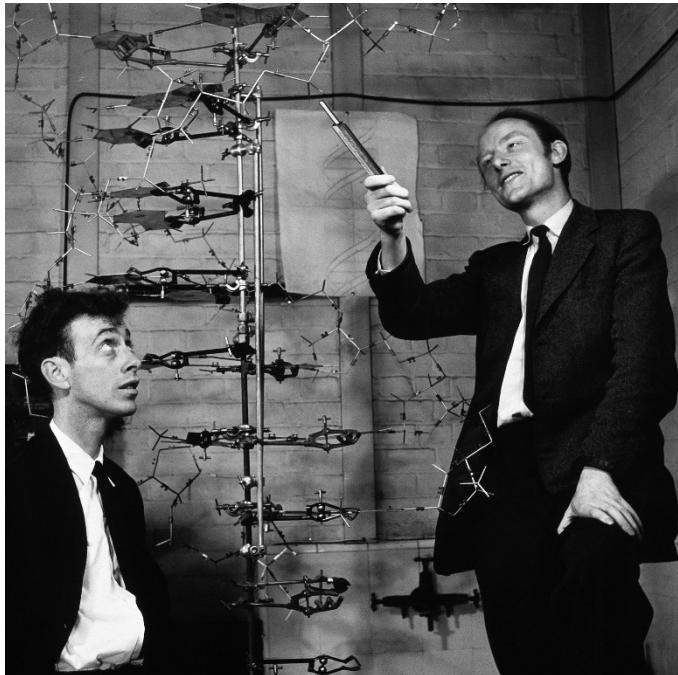


**(a) Rosalind Franklin**

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**(b) Franklin's X-ray diffraction photograph of DNA**



# DNA

- Structure described by **Watson and Crick 1962** using images by **Rosalind Franklin's lab**
- A double helix, antiparallel strands

