

## UNIT 3: GENETICS

### 1. Inheritance and Reproduction

**Genetics** - the study of the inheritance of biological traits (characteristics)

**Inheritance** - the passing of traits from parent to offspring

= heredity

- kinds of traits inherited:

#### a) **Species Characteristics**

= traits specific to a group of organisms

ie. Humans always have red feathers



#### b) **Individual Characteristics**

= traits making an individual within a species unique

ie) finger prints

- passing of traits occurs via the process of reproduction



### **Reproduction Review**

- all living things reproduce in order to continue their species

- the instructions for all of an organisms traits are within the nuclei of its cells on structures called chromosomes

- an organism must have a full set of instructions, and therefore a full set of chromosomes in each body cell to function normally

- two types of reproduction:

#### **A) Asexual Reproduction**

: Offspring are produced from only one parent

: Offspring are then genetically identical to the parent (clones)

: this is seen in:

- Unicellular organisms = binary fission of cells to produce offspring

- Multicellular organisms = growth & repair of cells within the organism

: somatic cells are produced through cell division called Mitosis

#### **Mitosis**

- daughter cells are identical to parent cell

- before a mother cell splits, its chromosomes are duplicated into 2 sets

- when cell division occurs, 1 set of chromosomes goes to each of the 2 daughter cells

## B) Sexual Reproduction

- : Offspring are produced from two parents
- : Each parent donates one special sex cell called a gamete
- : Each gamete contains only half of the full number of chromosomes for that organism = haploid number (n) Ex. Humans:  $n = 23$
- : Two gametes will fuse in a process called fertilization producing a zygote with the full chromosome number diploid (2n)

Ex. Humans:  $2n = 46$

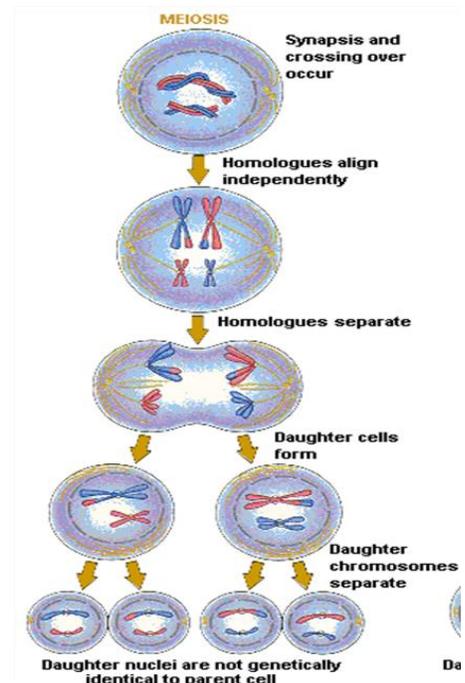
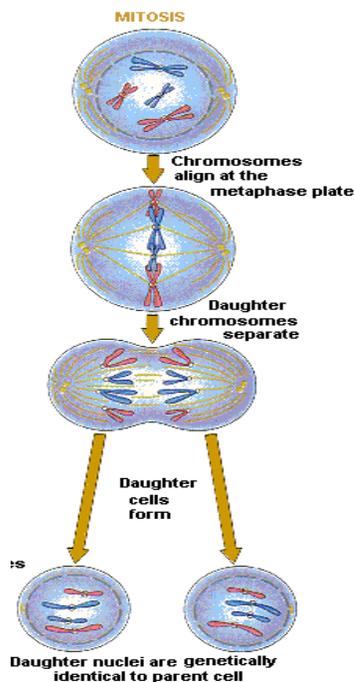
- : This assures genetic variation within the species
- = offspring are never identical to one parent as each parent passes only 1 allele for each trait (like shuffling cards before dealing)
- : Gametes are produced through a type of cell division called Meiosis

### Meiosis (Reduction Division)

- occurs in germ cells of the gonads (ovaries and testes)
- daughter cells (gametes) contain only half the number of chromosomes as the parent cell, therefore, division must occur twice

<https://www.youtube.com/watch?v=EEeMCNwowJg>

Mitosis vs Meiosis <https://www.youtube.com/watch?v=5kVVaRcEI1Y>



	<b>Mitosis</b>	<b>Meiosis</b>
<b>Type of cell in which it occurs</b>	All body cells	Certain cells of the reproductive organs
<b>Number of Cells produced</b>	Two	Four
<b>Number of chromosomes in the parent cell</b>	Diploid (2n)	Diploid (2n)
<b>Number of chromosomes in the daughter cells</b>	Same as the parent cell. Diploid (2n)	Half as many as the parents cell. Haploid (n)
<b>Type of cell produced</b>	Various body cells	Gametes (sex cells)
<b>Function of process</b>	Growth and repair	Ensure variation and diversity

[Amoeba Sisters Mitosis vs Meiosis](#)

<https://www.youtube.com/watch?v=x0RFVyD6qDw>

[http://sepuplhs.org/high/sgi/teachers/genetics\\_act3\\_sim.html](http://sepuplhs.org/high/sgi/teachers/genetics_act3_sim.html)

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ie. Humans always have red feathers

#### b) **Individual Characteristics**

= traits making an individual within a species \_\_\_\_\_

ie) finger prints

- passing of traits occurs via the process of \_\_\_\_\_

### **Reproduction Review**

- all living things reproduce in order to \_\_\_\_\_

- the \_\_\_\_\_ for all of an organisms traits are within the nuclei of its cells on structures called \_\_\_\_\_

- an organism must have a \_\_\_\_\_ of instructions, and therefore a full set of chromosomes in each body cell to function normally

- two types of reproduction:

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: Offspring are produced from only \_\_\_\_\_

: Offspring are then \_\_\_\_\_ to the parent (clones)

: this is seen in:

-Unicellular organisms = \_\_\_\_\_ of cells to produce offspring

-Multicellular organisms = \_\_\_\_\_ of cells within the organism

: somatic cells are produced through cell division called \_\_\_\_\_

#### **Mitosis**

-daughter cells are identical to parent cell

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## B) Sexual Reproduction

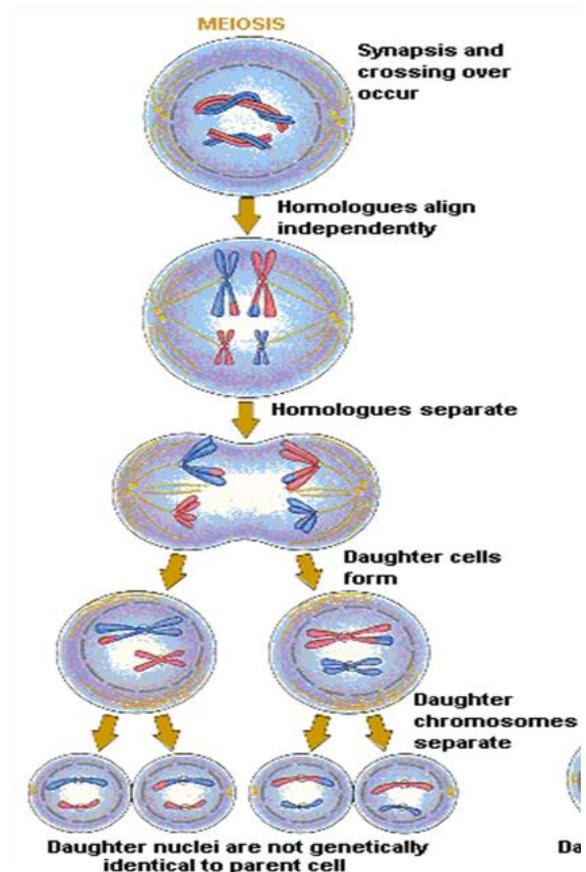
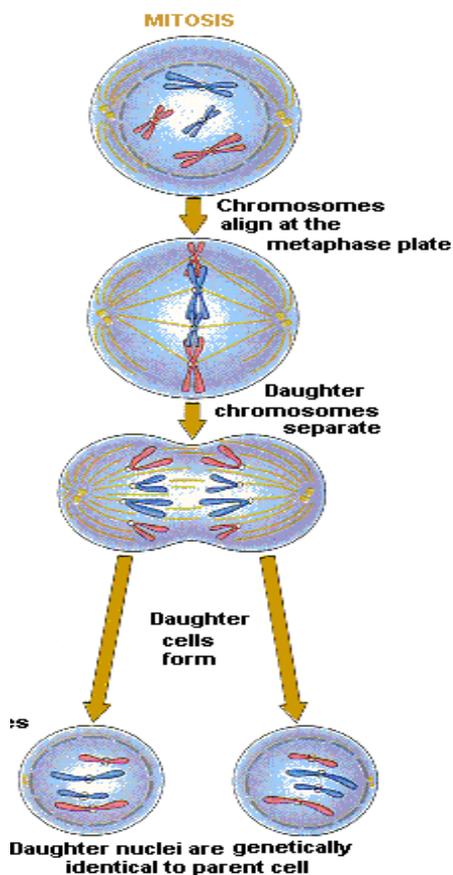
- : Offspring are produced from \_\_\_\_\_
- : Each parent donates one special sex cell called a \_\_\_\_\_
- : Each gamete contains only \_\_\_\_\_ of the full number of chromosomes for that organism = \_\_\_\_\_ Ex. Humans:  $n =$  \_\_\_\_\_
- : Two gametes will fuse in a process called \_\_\_\_\_ producing a zygote with the full chromosome number \_\_\_\_\_  
Ex. Humans:  $2n =$  \_\_\_\_\_
- : This assures genetic \_\_\_\_\_ within the species
- = offspring are never identical to one parent as each parent passes only 1 allele for each trait (like shuffling cards before dealing)
- : Gametes are produced through a type of cell division called \_\_\_\_\_

### Meiosis (Reduction Division)

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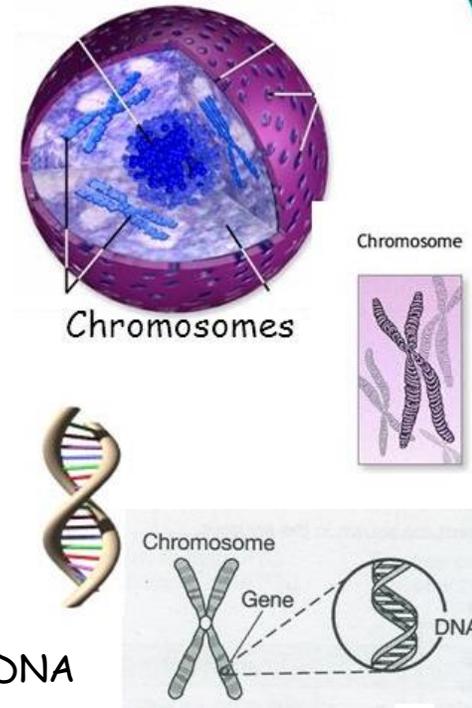


	Mitosis	Meiosis
Type of cell in which it occurs		
Number of Cells produced		
Number of chromosomes in the parent cell		
Number of chromosomes in the daughter cells		
Type of cell produced		
Function of process		

Amoeba Sisters: <https://www.youtube.com/watch?v=zrKdz93WIVk>

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## 2. Inheritance and Probability

### :Inheritance

- heredity is controlled by chromosomes composed of DNA
- the instructions for each trait are found in sections of chromosomes called **genes** which are arranged in a **specific order** on each chromosome
- different genes control different **traits** and different chromosomes are made up of different genes
- each trait is controlled by at least 2 forms of a gene called an **allele**
- kinds of characteristics inherited

#### a) Species Characteristics

- = traits specific to **a group of organisms**  
ie. Humans always have opposable thumbs

#### b) Individual Characteristics

- = traits making an individual in a species unique
- in complex organisms an offspring is always different from its parents because it is a **combination** of the parents  
ie. A child has mother's hair color and father's nose
- for each trait one allele is inherited from the **father**, and one comes from the **mother**  
= offspring can inherit different combinations of alleles from parents
- for each trait offspring can inherit:

2 dominant alleles

2 recessive alleles

1 dominant and 1 recessive allele

**:Probability: chance that an event will occur**

- even though we inherit from our parents, our environment will affect the **full potential** of what we inherited  
Ie. Sunlight - lightens hair and darkens freckles
- in genetics, we work with a strict **mathematical probability**, we do not consider items like the environment, or other factors
- NEVER consider things you have seen on television, or personal experiences when you answer genetics questions, use only probability mathematics.

### **3. Mendel's Laws of Heredity**

**Gregor Mendel** = Father of the science of genetics

- Austrian monk who studied garden peas and their traits
- Looked at peas because he observed that:
  - a) peas have a number of traits that are **expressed in 1 of 2 ways**
  - b) peas are both **self-fertilizing and cross-fertilizing**
- This allowed Mendel to look at single characteristics at a time and also to look at several generations of offspring to trace heredity
- He applied probability math to all his data formulating his laws

#### **Mendel's Laws**

##### **A. The Law of Dominance**

- When two different "factors" (alleles) control a trait:
  - the effect of one allele **masks** the effect of the other allele
    - :the expressed allele is known as **dominant**
    - :the masked allele is called **recessive**
- Mendel proved this by crossing plants with round seeds with plants having wrinkled seeds
  - All the offspring always had round seeds
  - = **round is dominant and wrinkled is recessive**
- Mendel's cross can be illustrated using a **Punnett Square**
  - = diagram which shows the probability of the offspring inheriting certain alleles from a cross between two different individuals
- In Mendel's experiment the parents were pure for their traits:

Round = RR wrinkled = rr  
= homozygous

### Monohybrid cross (1 trait is crossed)

P<sub>1</sub> = RR x rr

Results = F<sub>1</sub> (First Filial Generation)

a) **Phenotype** (how trait is expressed or what you see)

= 100% round

b) **Genotype** (genetically or which alleles are possessed for a trait)

= 100% Heterozygous round (two different alleles)

= Hybrid (Rr)

### B. The Law of Segregation

- Chromosomes are arranged in homologous pairs
- Since a pair of genes control each trait in a diploid (2n) organism,

when gametes are formed, a homologous pair is separated so that each gamete gets only one of the 2 alleles for the trait

- Mendel proved this by crossing the plants from the F<sub>1</sub> generation

### Illustration of Cross Using Punnett Square

Parents: Heterozygous round seeds (hybrids): Rr

F<sub>1</sub> = Rr x Rr

Results = F<sub>2</sub> (Second Filial Generation)

a) **Phenotype**: 75% round

25% wrinkled

Ratio = 3:1 (probability)

b) **Genotype**: 25% (RR) homozygous dominant  
round

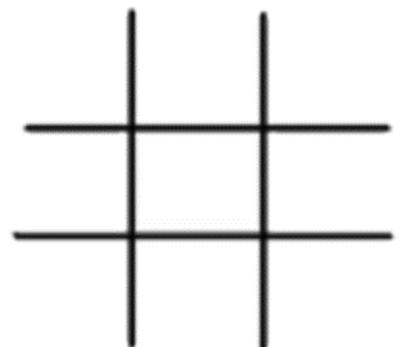
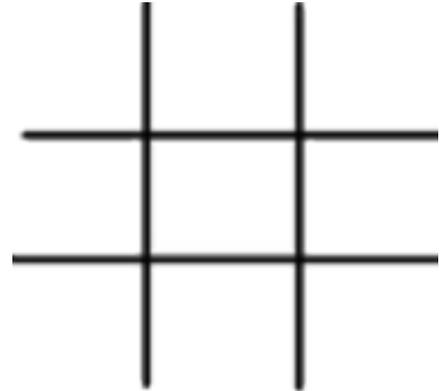
50% (Rr) heterozygous round

25% (rr) homozygous recessive

wrinkled

Ratio: 1:2:1

<https://www.youtube.com/watch?v=0vAAf4g5iF8>



## General Steps to Making a Punnett Square

- 1) Determine parents genotype - ex. **AA** or **Aa** or **aa**
- 2) Determine the possible gametes for each parent (sort alleles)  
Ex. A parent who is **AA** can pass on only one type of allele: **A**  
A parent who is **Aa** can pass on two types: **A** or **a**
- 3) Place the gametes from one parent vertically (across the top) and those from the other parent horizontally (along the side) of the square
- 4) Combine the traits together for each square. This represents the possible genotypes of each of the offspring
- 5) Interpret genotypes & phenotypes as required to determine the chance of one offspring inheriting any given genotype or phenotype (use %'s & ratios)

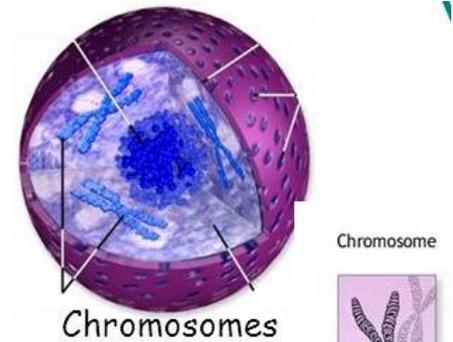
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**Genetics** - study of the \_\_\_\_\_ of biological traits

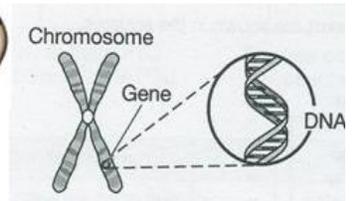
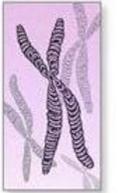
**Heredity**- the passing of traits from \_\_\_\_\_

= Inheritance

- heredity is controlled by a \_\_\_\_\_ in our DNA
- this genetic code is located in \_\_\_\_\_
  - :are sections of chromosomes
  - :are arranged in a \_\_\_\_\_ on each chromosome
- different genes control different \_\_\_\_\_ and different chromosomes are made up of different genes
- each trait is controlled by at least 2 forms of a gene called an \_\_\_\_\_
- passing of traits occurs via the process of \_\_\_\_\_



Chromosome



### **Reproduction Review**

- all living things reproduce in order to \_\_\_\_\_
- Two Types Of Reproduction:

#### **A) Asexual Reproduction**

- Offspring are produced from only \_\_\_\_\_
- Offspring are then \_\_\_\_\_ to the parent (clones)
- = \_\_\_\_\_ - daughter cell is identical to parent cell
- Seen in: Simple organisms like bacteria = offspring  
Multicellular organisms = growth and repair

#### **B) Sexual Reproduction**

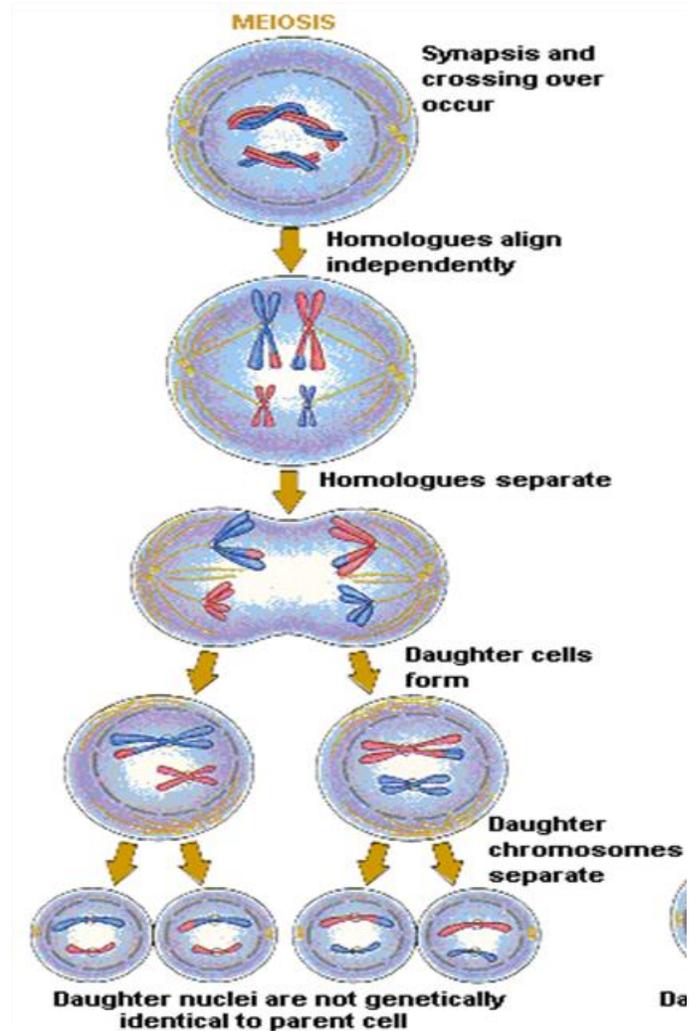
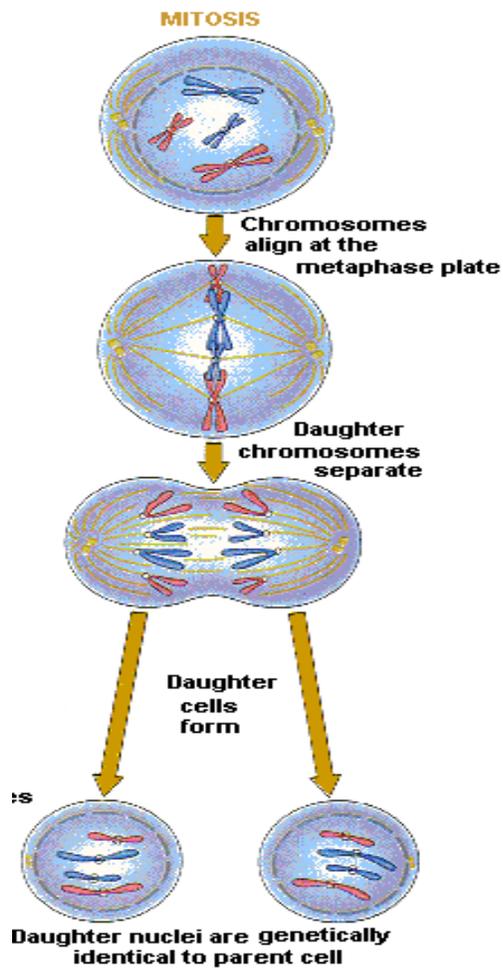
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- Type of cell division occurring in \_\_\_\_\_
- Gametes contain only \_\_\_\_\_ the number of chromosomes as the parent cell therefore,

division must occur \_\_\_\_\_

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Mitosis

Meiosis

Type of cell in which it occurs		
Number of Cells produced		
Number of chromosomes in the parent cell		
Number of chromosomes in the daughter cells		
Type of cell produced		
Function of process		

### Environmental Factors

- even though we inherit from our parents, our environment will affect the \_\_\_\_\_ of what we inherited  
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- in genetics, we work with a strict \_\_\_\_\_ we do not consider items like the environment, or other factors
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- Probability: \_\_\_\_\_

## 2. Probability Genetics: Mendel's Laws of Heredity

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  - b) peas are both \_\_\_\_\_

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## Mendel's Laws

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  - All the offspring always had round seeds
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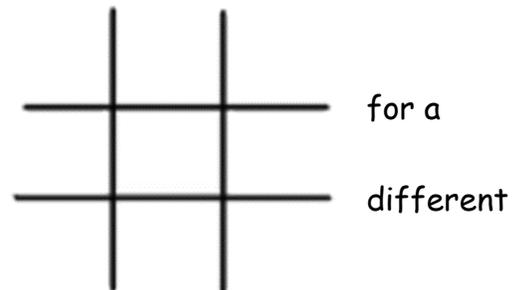
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a) **Phenotype** (how trait is \_\_\_\_\_ or what you see)  
= \_\_\_\_\_

b) **Genotype** (genetically or which alleles are possessed trait)

= 100% \_\_\_\_\_ round (two alleles)

= \_\_\_\_\_



### B. The Law of Segregation

- Chromosomes are arranged in \_\_\_\_\_
- Since a pair of genes control each trait in a diploid (2n) organism, when gametes are formed, a homologous pair is \_\_\_\_\_ so that each gamete gets only \_\_\_\_\_ of the 2 alleles for the trait
  - Mendel proved this by crossing the plants from the F<sub>1</sub> generation

## Illustration of Cross Using Punnett Square

Parents: Heterozygous round seeds (hybrids): Rr

F<sub>1</sub> = \_\_\_\_\_

Results = F<sub>2</sub> (Second Filial Generation)

a) Phenotype: \_\_\_\_\_ round

\_\_\_\_\_ wrinkled

Ratio = \_\_\_\_\_ (probability)

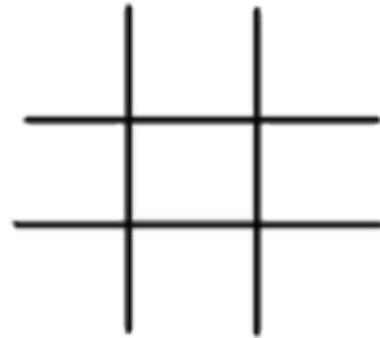
b) Genotype: 25% (RR) \_\_\_\_\_

50% (Rr) \_\_\_\_\_

25% (rr) \_\_\_\_\_

Ratio:

\_\_\_\_\_



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### Stages of Meiosis

#### **A) Meiosis I**

- consists of phases similar to Mitosis

- Chromosomes have replicated during interphase and are double stranded

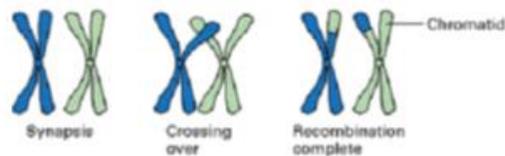
- During Prophase I, each chromosome pair up with another chromosome that

is similar in size and shape to form tetrads via a process called synapsis.

:A tetrad contains four sister chromatids = **homologous pair**

- As the homologous chromosomes move closer together, they intertwine and can break and exchange genetic information
- This is called crossing-over

- During anaphase I: the centromeres do not come apart  
= one double stranded chromosome moves to each pole  
segregation



via

### Result of Meiosis I:

- 2 haploid (n) daughter cells, each has  $\frac{1}{2}$  the # of chromosomes as the parent cells
- = The number of chromosomes is reduced by half

**B. Interkinesis** = resting stage between Meiosis I and Meiosis II  
= NO REPLICATION of chromosomes

### C. Meiosis II

- Occurs at the same time in each haploid daughter cell
- is basically a Mitotic division of each daughter cell, except the spindles are formed perpendicular to those in meiosis I

### Result of Meiosis II:

- 4 haploid daughter cells which are called GAMETES

