Name: _____ Date: _____ Block: _____

Guided Notes
Unit 6: Classical Genetics

Chapter 6: Meiosis and Mendel

I. Concept 6.1: Chromosomes and Meiosis

a. Meiosis: _____

_____

i. *(In animals, meiosis occurs in the sex organs—the testes in males and the ovaries in females.)*

b. Somatic Cells and Gametes

i. Somatic cells: _____

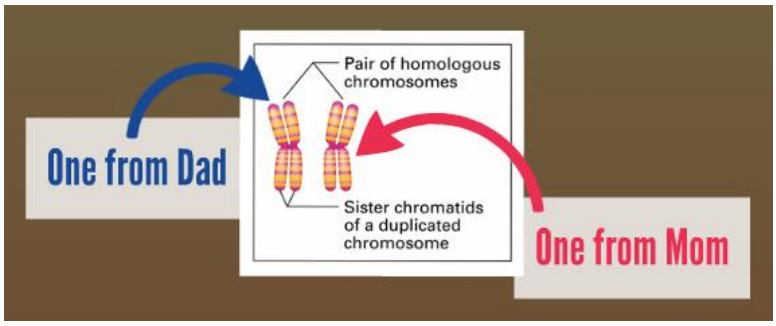
ii. Gametes: _____ (example: egg and sperm cells)

c. Homologous Chromosomes

i. Cells from males and females of the SAME species have the SAME number and types of chromosomes.

ii. Homologous chromosomes: _____

_____ (one chromosome in the pair comes from the mother, one comes from the father)



d. Chromosomes

i. Humans have _____ homologous pairs of chromosomes.

1. (So you have _____ chromosomes in total.)

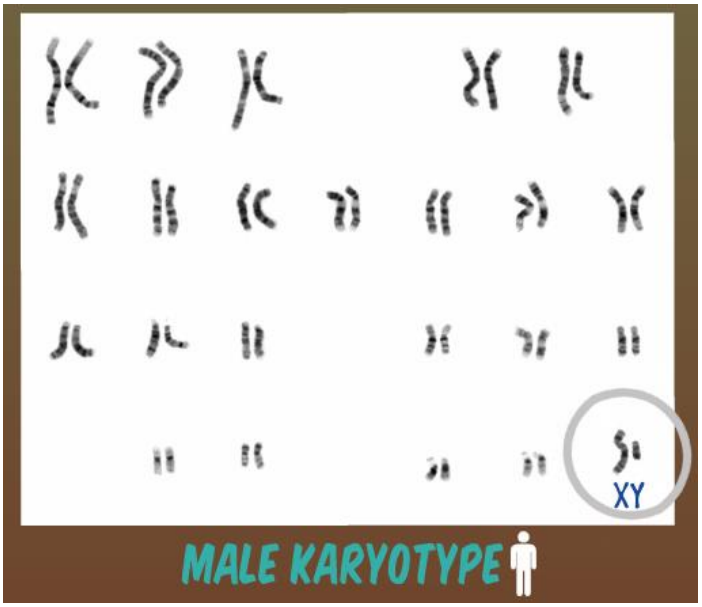
ii. Autosomal chromosomes: chromosome pairs 1-22 in humans

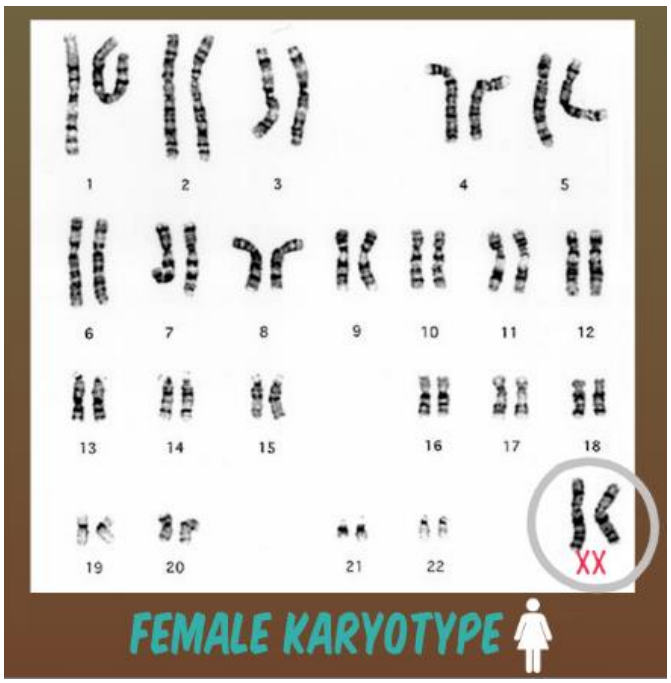
iii. Sex chromosomes: _____; the 23rd pair of chromosomes; occurs in two forms, called X and Y

1. Male mammals = _____
2. Female mammals = _____

e. Karyotypes

i. Karyotype: a display of _____ of an individual (46 in humans)





f. Diploid and Haploid Cells

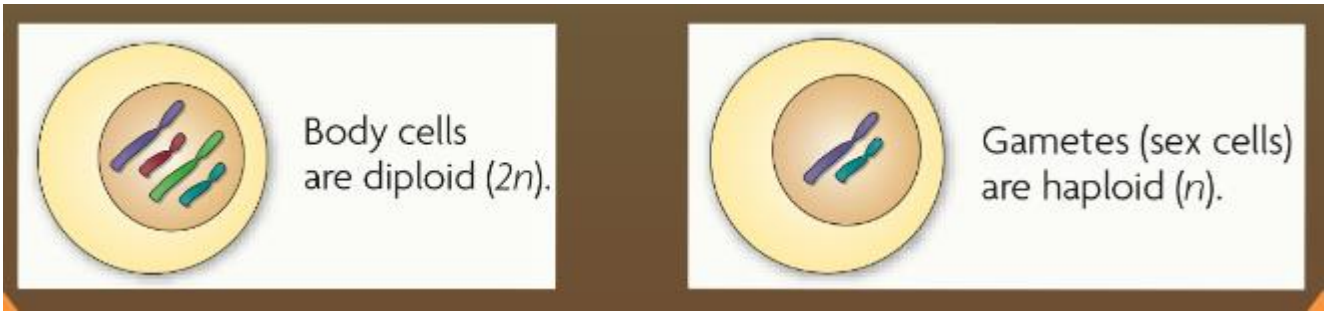
i. Diploid (2n): _____

1. Example: body cells

ii. Diploid number: the total number of chromosomes in the cell (46 in humans)

iii. Haploid (n): _____

1. Example: gametes (sperm & egg cells)



g. Human Life Cycle

i. _____ + _____ → _____

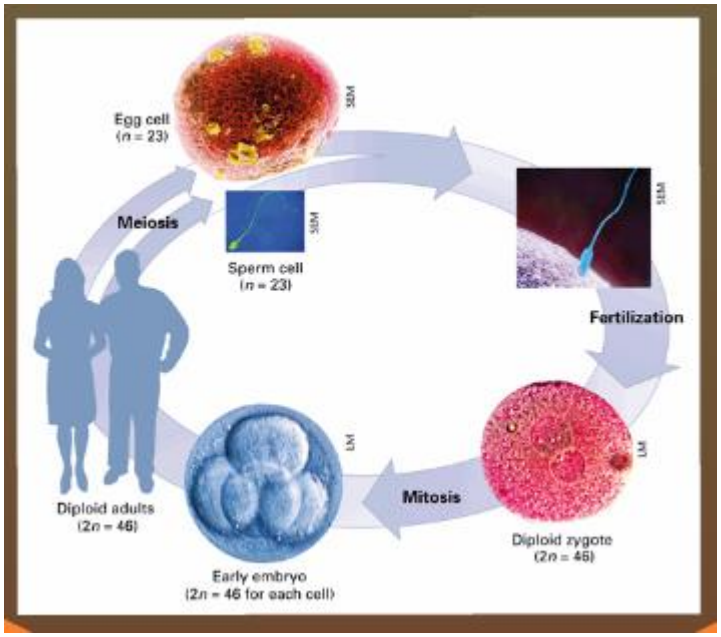
(fertilization)

ii. Zygote: has _____

_____;

develops into a sexually mature adult with trillions of cells produced by mitosis

Human Life Cycle



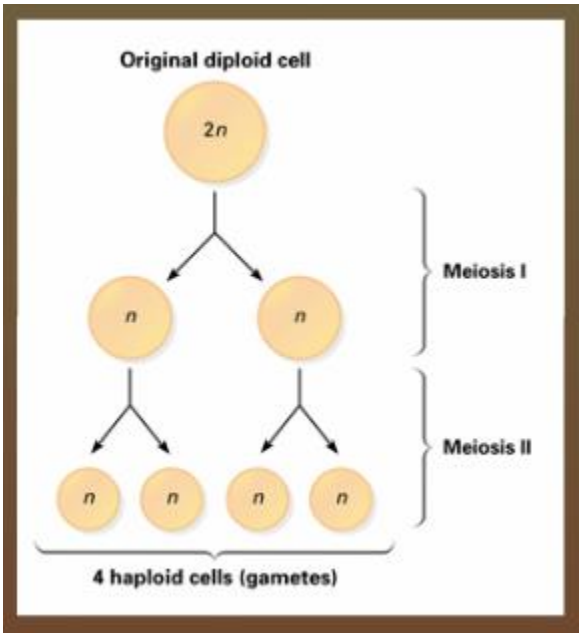
h. The Process of Meiosis

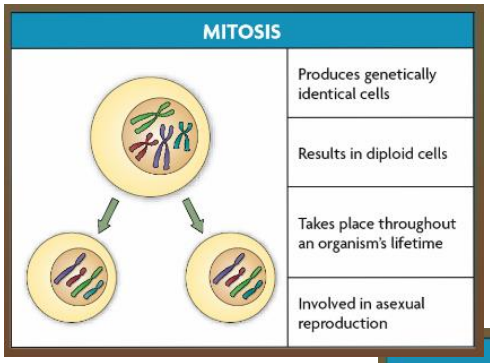
i. Meiosis is different from mitosis.

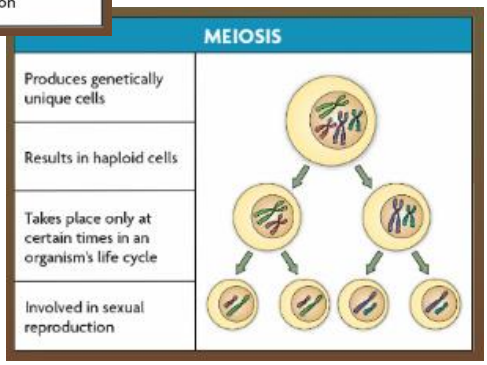
ii. Meiosis produces _____ new offspring cells, each with one set of chromosomes—thus half the number of chromosomes as the parent cell.

iii. *(Mitosis produces _____ offspring cells, each with the same number of chromosomes as the parent cell.)*

iv. Meiosis produces four haploid cells, rather than two diploid cells. Also, meiosis involves two divisions, whereas mitosis involves only one.







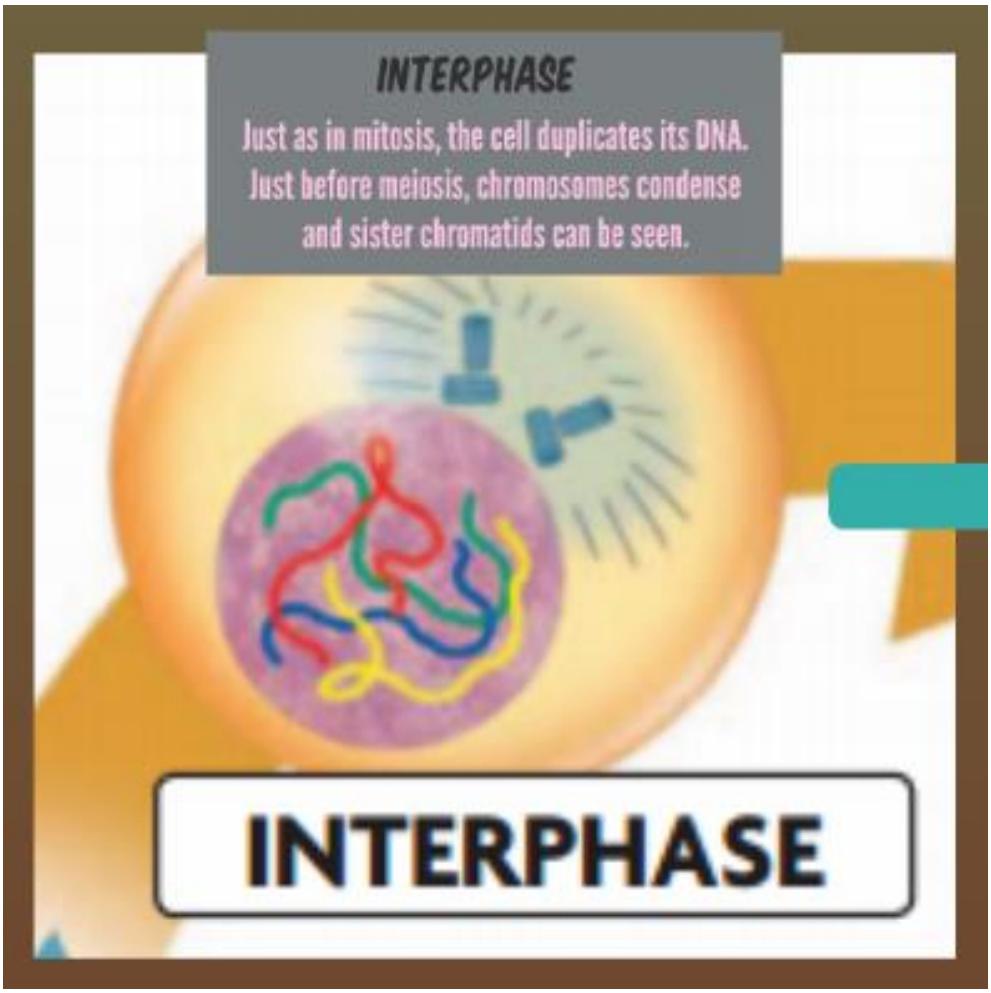
II. Concept 6.2: Process of Meiosis

a. Meiosis consists of two distinct parts — _____ and _____.

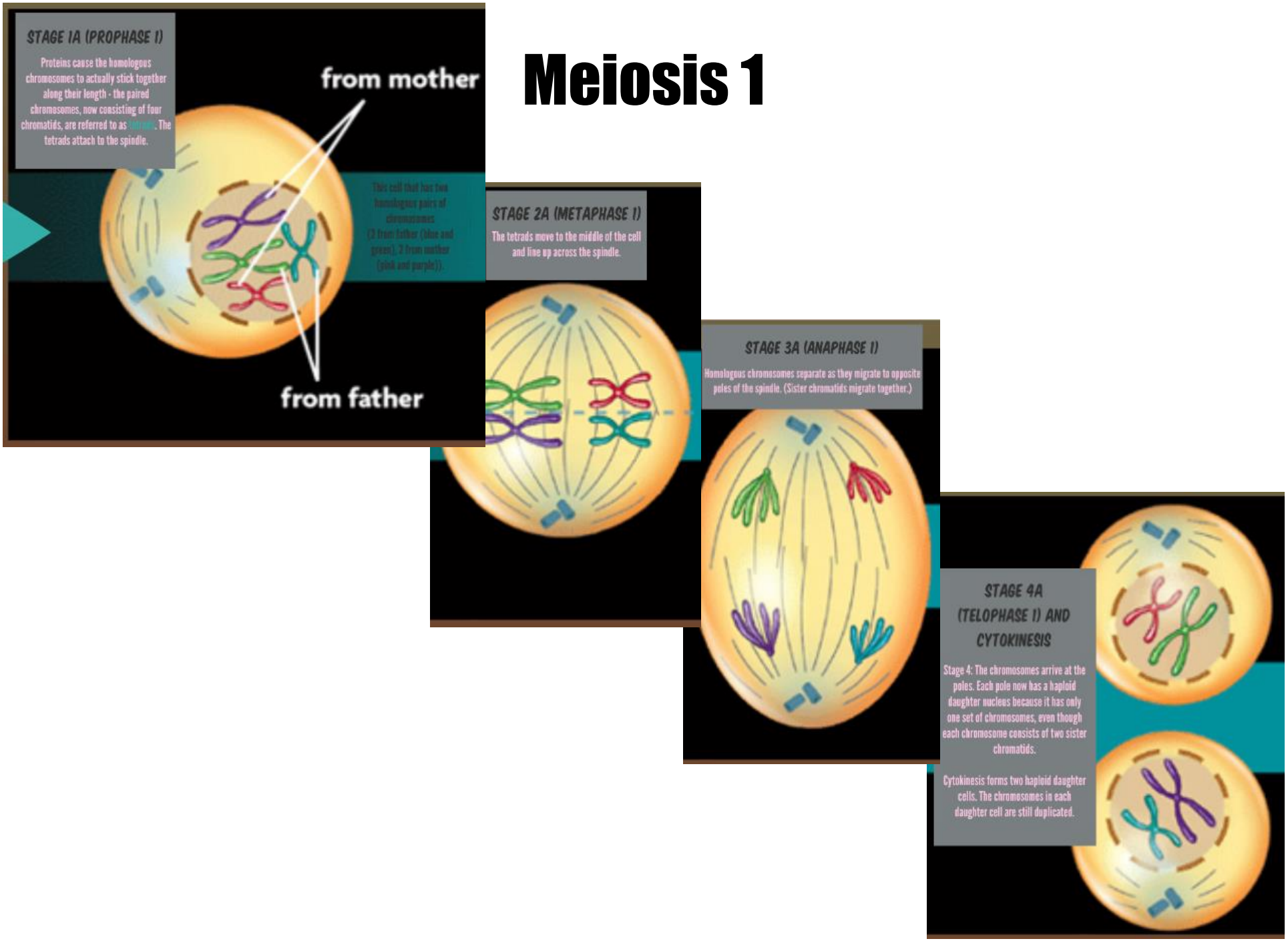
i. In meiosis I, homologous chromosomes, each composed of two sister chromatids, are separated from one another.

ii. In meiosis II, sister chromatids are separated much as they are in mitosis. However, the resulting cells are haploid rather than diploid.

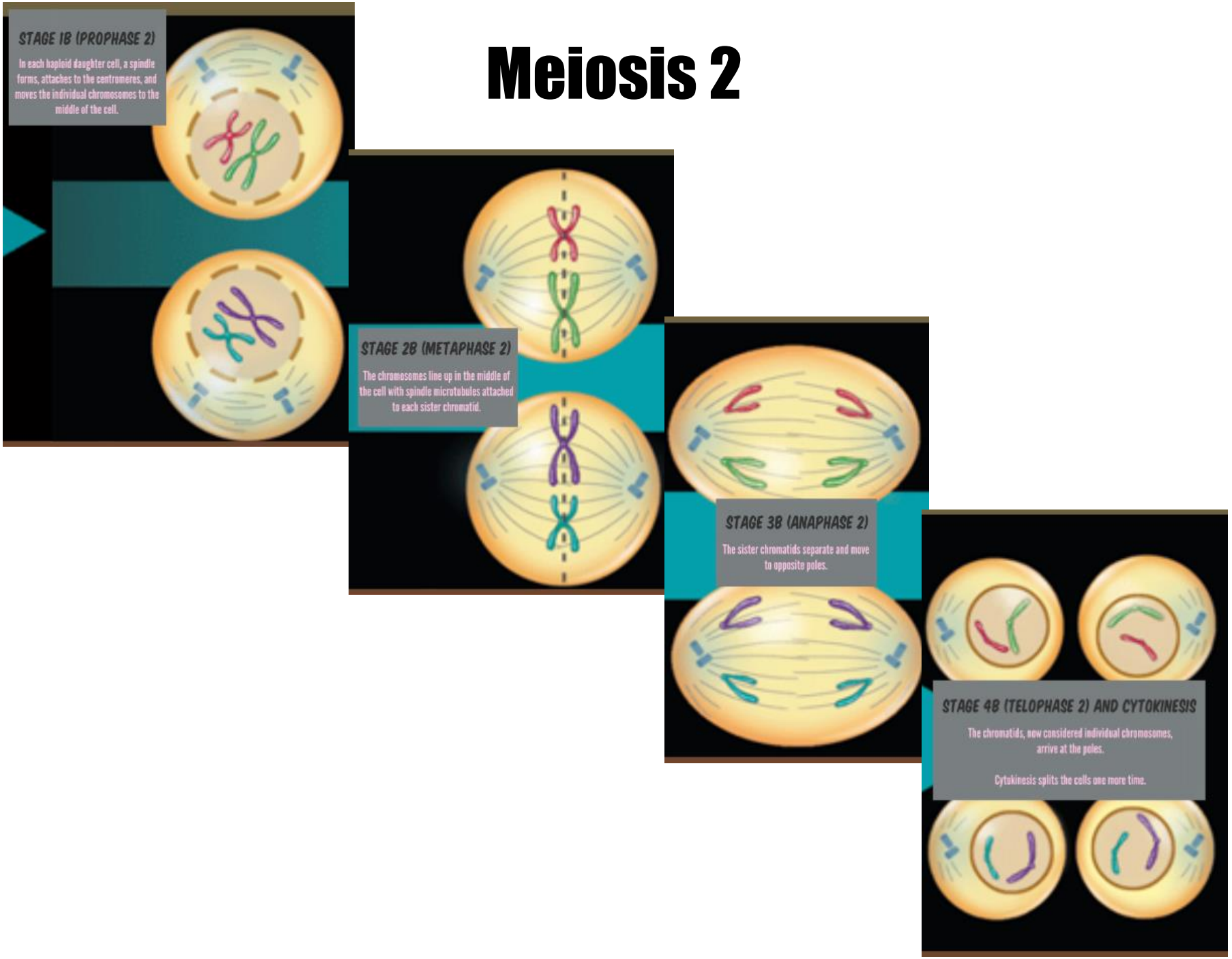
b. Interphase



Meiosis 1


STAGE 1A (PROPHASE I)
Proteins cause the homologous chromosomes to actually stick together along their length - the paired chromosomes, now consisting of four chromatids, are referred to as tetrads. The tetrads attach to the spindle.
from mother
from father
This cell that has two homologous pairs of chromosomes (2 from father (blue and green), 2 from mother (pink and purple)).
STAGE 2A (METAPHASE I)
The tetrads move to the middle of the cell and line up across the spindle.
STAGE 3A (ANAPHASE I)
Homologous chromosomes separate as they migrate to opposite poles of the spindle. (Sister chromatids migrate together.)
STAGE 4A (TELOPHASE I) AND CYTOKINESIS
Stage 4: The chromosomes arrive at the poles. Each pole now has a haploid daughter nucleus because it has only one set of chromosomes, even though each chromosome consists of two sister chromatids.
Cytokinesis forms two haploid daughter cells. The chromosomes in each daughter cell are still duplicated.

Meiosis 2

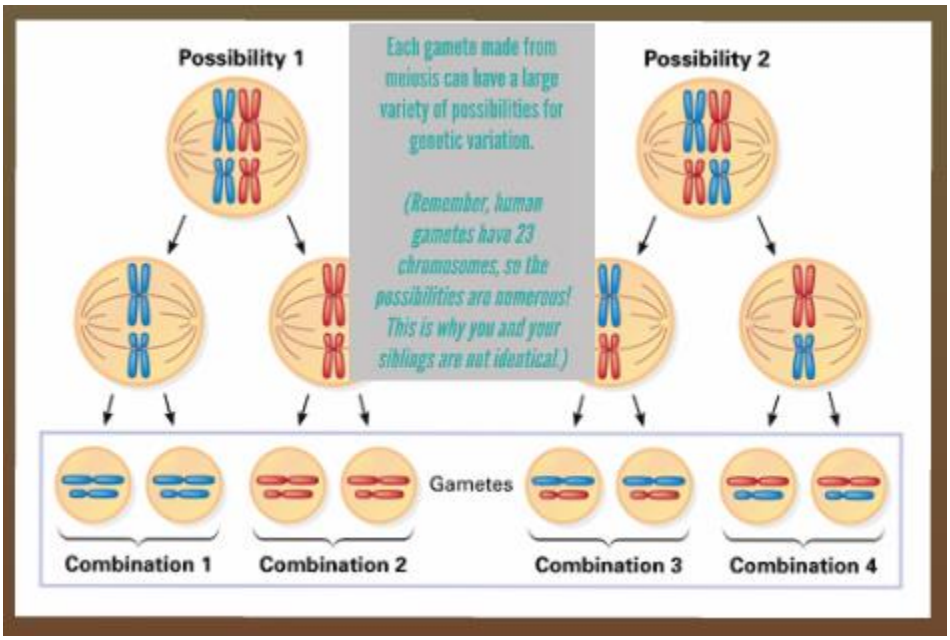

STAGE 1B (PROPHASE 2)
In each haploid daughter cell, a spindle forms, attaches to the centromeres, and moves the individual chromosomes to the middle of the cell.
STAGE 2B (METAPHASE 2)
The chromosomes line up in the middle of the cell with spindle microtubules attached to each sister chromatid.
STAGE 3B (ANAPHASE 2)
The sister chromatids separate and move to opposite poles.
STAGE 4B (TELOPHASE 2) AND CYTOKINESIS
The chromatids, now considered individual chromosomes, arrive at the poles.
Cytokinesis splits the cells one more time.

c. Meiosis

i. The process of meiosis is completed, producing _____ cells as a final result.

ii. Each gamete made from meiosis can have a large variety of possibilities for genetic variation.

1. *(Remember, human gametes have 23 chromosomes, so the possibilities are numerous! This is why you and your siblings are not identical.)*



d. Review: Comparison of Mitosis and Meiosis

iii. Mitosis

1. Provides for _____
2. Produces daughter cells that are genetically identical to the parent cell
3. Involves _____ division of the genetic material in the nucleus (usually accompanied by cytokinesis, producing two diploid cells)

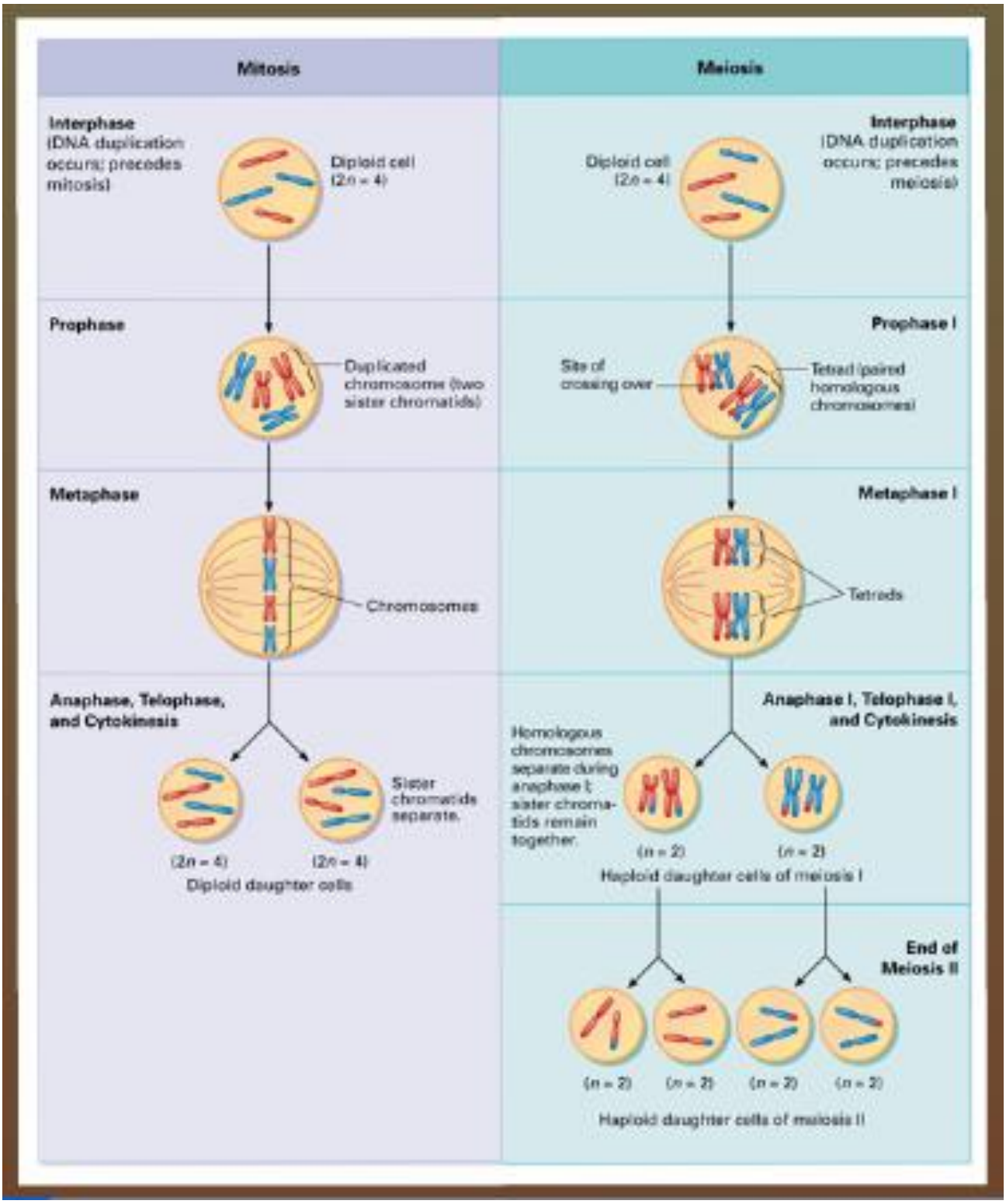
iv. Meiosis

1. Produces _____, which allows for sexual reproduction
2. Yields haploid daughter cells with only one set of homologous chromosomes
3. Involves _____ nuclear divisions, yielding four haploid cells
4. Duplicated homologous chromosomes form tetrads
5. The chromosome number in each of the two daughter cells is haploid

v. Both Mitosis and Meiosis

1. Chromosomes duplicate only once, in the preceding Interphase
2. Meiosis II is basically identical to mitosis. (The sister chromatids separate, and each cell divides in two.)

3. Both make it possible for cells to inherit genetic information in the form of chromosome copies



III. ***Concept 6.3: Mendel and Heredity***

a. Vocabulary

i. Trait: _____

1. (Example: a plant's trait of having red flowers, or yellow flowers, etc.)

ii. Genetics: _____

_____

b. Gregor Mendel: an Austrian monk who found the _____

_____

i. (He showed that traits are inherited as discrete units!)

c. Prior to Mendel

i. Blending hypothesis: hypothesis in 1800s to explain how offspring inherit traits from both parents

1. (Example: red and yellow flowered plants could produce an orange flowered plant)

ii. BUT this was _____!

d. Mendel's Work

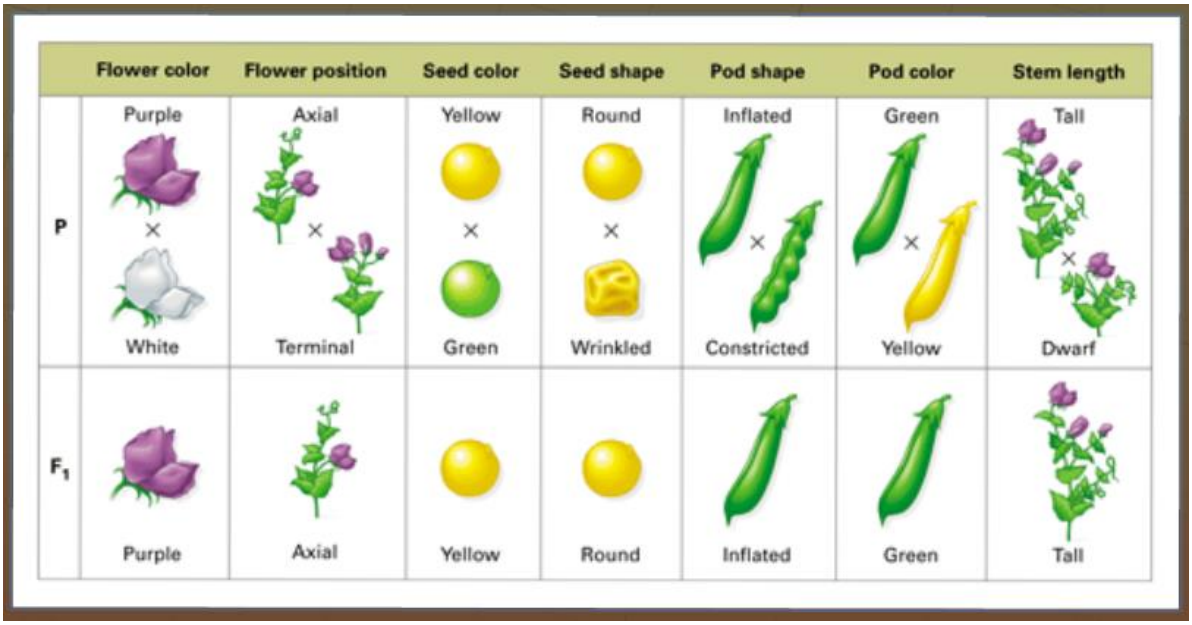
i. Mendel bred pea plants and recorded _____ in the offspring for 7 years.

ii. True-breeding Plants

1. Mendel fertilized true-breeding pea plants - meaning when they_____, the offspring are identical to the parent pea plant.

a. (Example: purple-flowered pea plant makes purple-flowered pea plant offspring)

b. (Your book refers to "true-breeding plants" as ***purebred****.)*

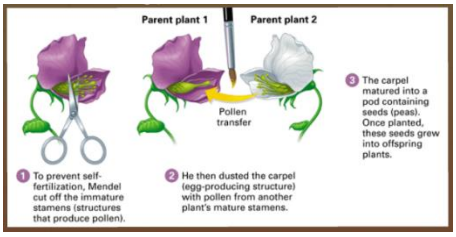


2. (Mendel experimented with these seven pea plant characters.)

iii. Cross-Fertilization

1. Cross-fertilization: _____

_____



Cross seen above: purple flower x white flower

iv. Hybrids

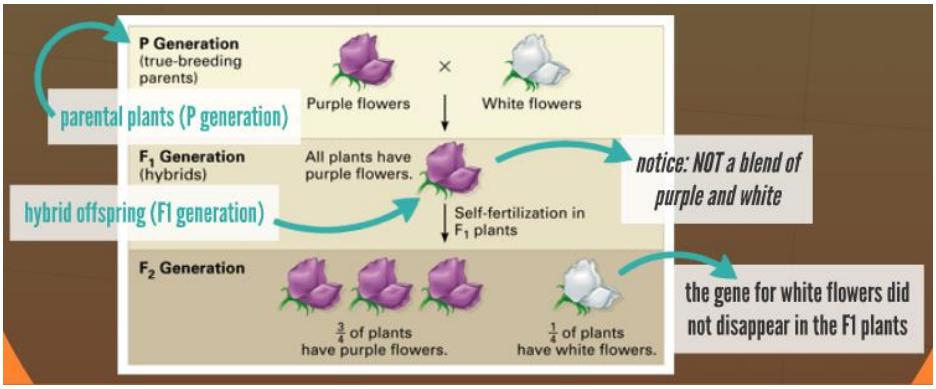
1. Hybrid: _____

_____

2. Monohybrid cross: a pairing in which the parent plants differ in only one (mono) character

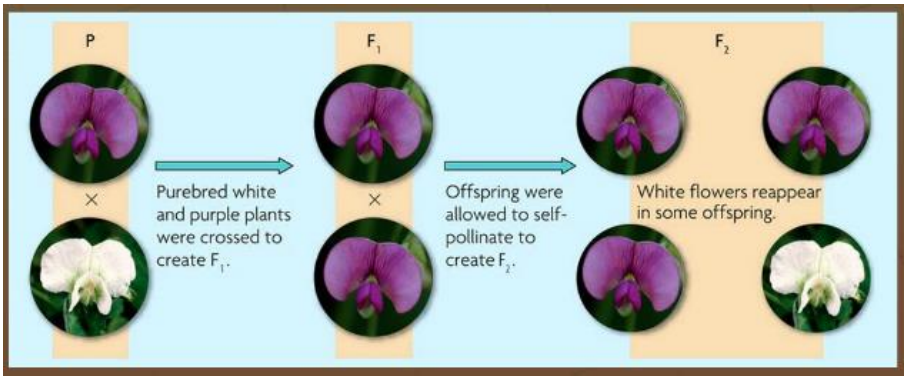
v. Mendel's Experiment

1. Mendel crossed the _____ generation to produce the _____ generation.
2. Notice the results:



vi. Mendel's Conclusion

1. F1 generation: all plants had purple flowers
2. F2 generation: some plants had purple flowers and some had white



3. Mendel concluded that the trait for the white flower had _____

_____.

vii. Cross Results

1. Mendel performed many crosses to help him observe inheritance patterns.

FIGURE 6.10 MENDEL'S MONOHYBRID CROSS RESULTS

F_2 TRAITS	DOMINANT	RECESSIVE	RATIO
Pea shape	5474 round	1850 wrinkled	2.96:1
Pea color	6022 yellow	2001 green	3.01:1
Flower color	705 purple	224 white	3.15:1
Pod shape	882 smooth	299 constricted	2.95:1
Pod color	428 green	152 yellow	2.82:1
Flower position	651 axial	207 terminal	3.14:1
Plant height	787 tall	277 short	2.84:1

viii. Mendel's Three Conclusions

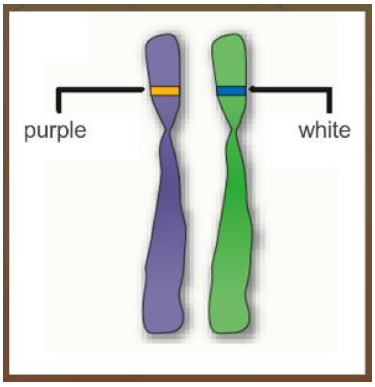
1. Traits are _____.
2. Organisms inherit _____ copies of each gene, _____ _____.
3. The two copies _____.
    a. *(Numbers 2 and 3 make up Mendel's Law of Segregation.)*

IV. ***Concept 6.4: Traits, Genes, and Alleles***

a. Genes

i. Gene: _____ _____

ii. Each gene has a locus, a _____ _____ on a pair of homologous chromosomes.



b. Alleles

i. Alleles: _____

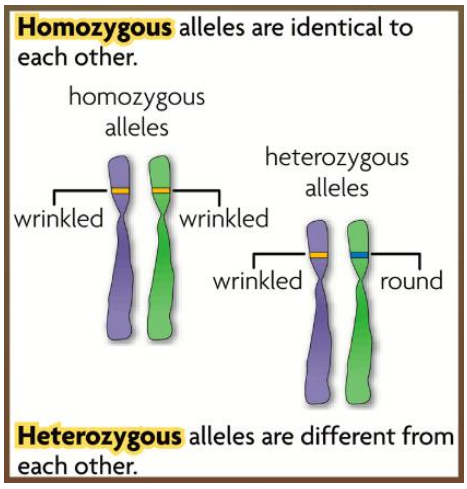
1. (Example: allele for blue eyes (b) vs. allele for brown eyes (B))
2. Each parent donates one allele for every gene.

ii. Homozygous: two alleles that are the _____ at a specific locus

1. (Example: BB or bb)

iii. Heterozygous: two alleles that are _____ at a specific locus

1. (Example: Bb)



c. Genotype and Phenotype

i. Genotype: genetic makeup or combination of alleles (_____)

1. Example: PP

ii. Phenotype: an observable trait (_____)

1. Example: purple flowers

d. Allele Dominance

i. Dominant allele: an allele in a heterozygous individual that

_____

_____

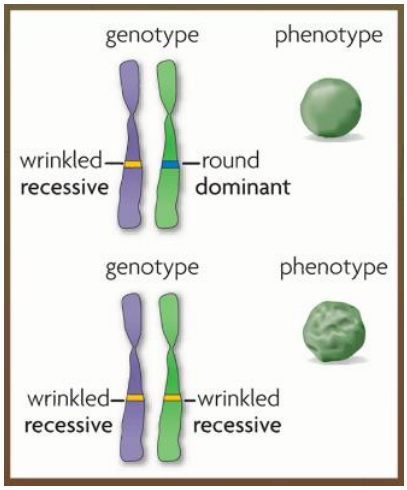
1. (Example: allele for brown eyes (B))

ii. Recessive allele: an allele in a heterozygous individual that

_____

_____

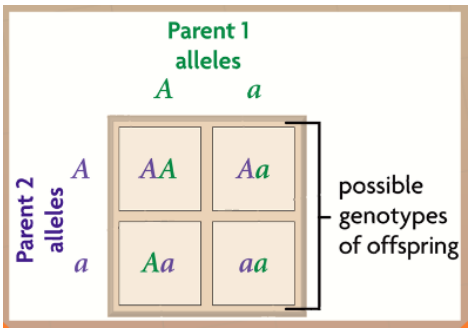
1. (Example: allele for blue eyes (b))



V. ***Concept 6.5: Traits and Probability***

a. Punnett Square

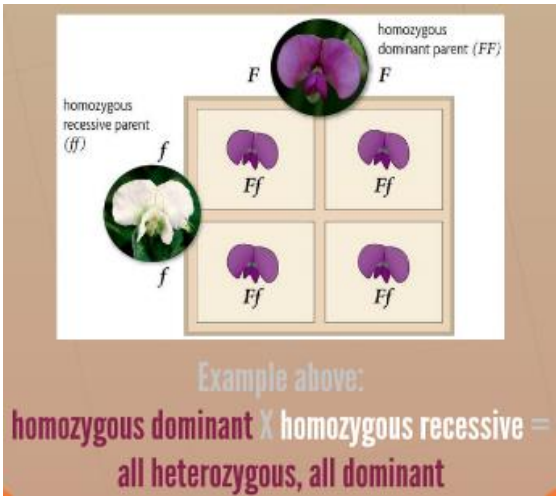
i. Punnett square: a grid system for predicting all possible genotypes resulting from a cross - it gives the ratio of possible _____ _____

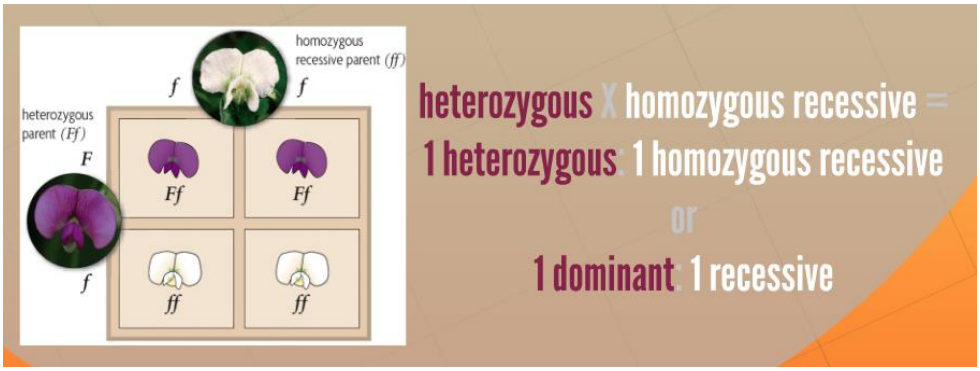


b. Monohybrid Cross

i. Monohybrid cross: examine the inheritance of _____

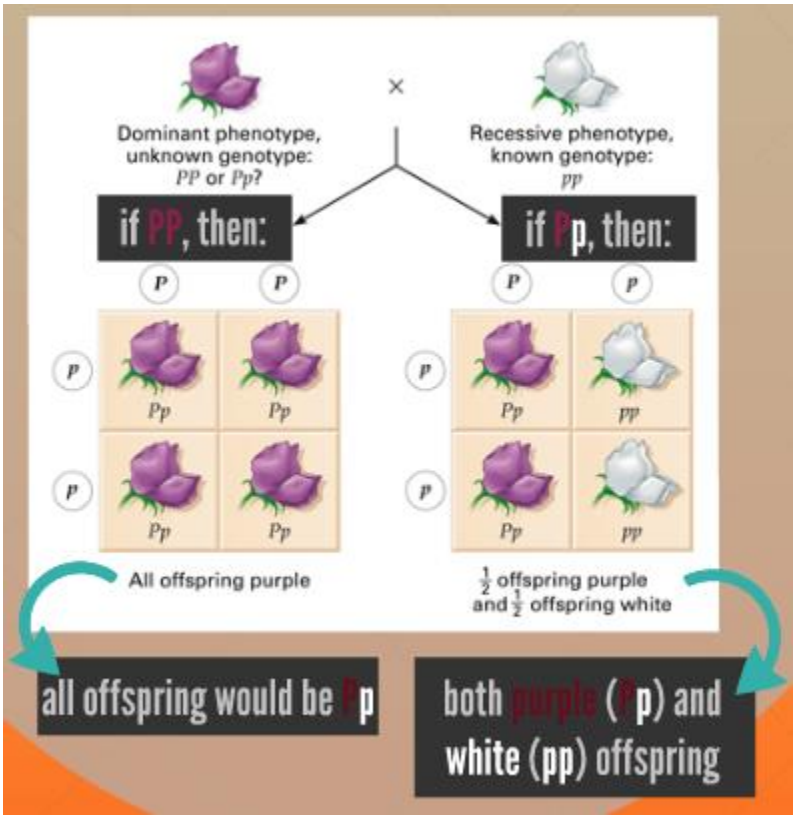
ii. Examples:





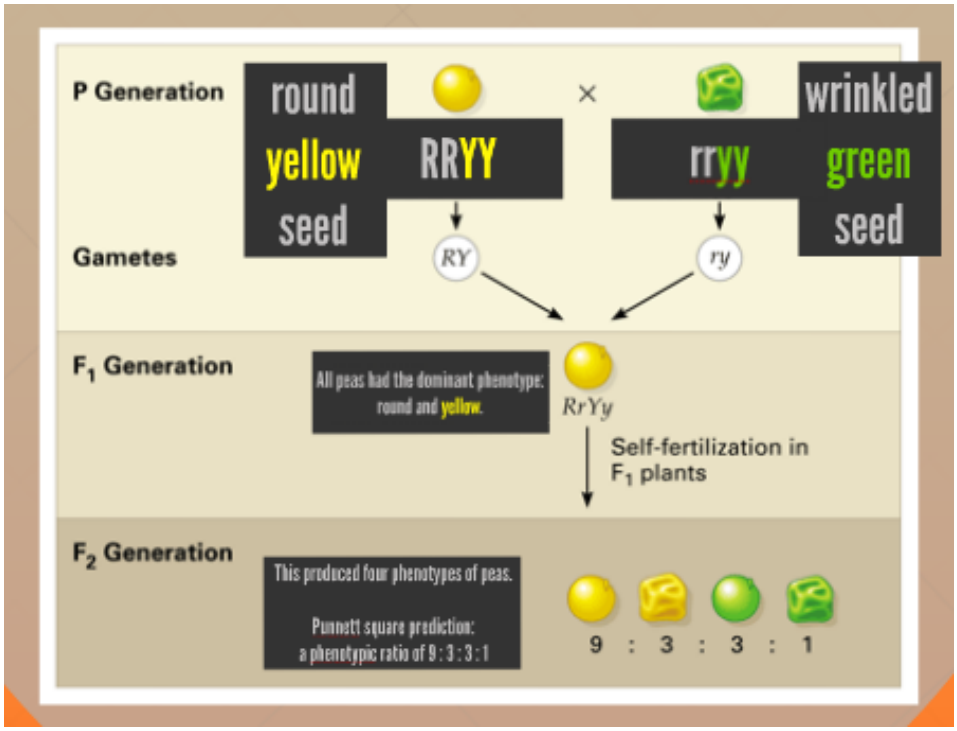
c. Testcross

i. Testcross: a cross between an organism with _____ genotype and an organism with _____ phenotype



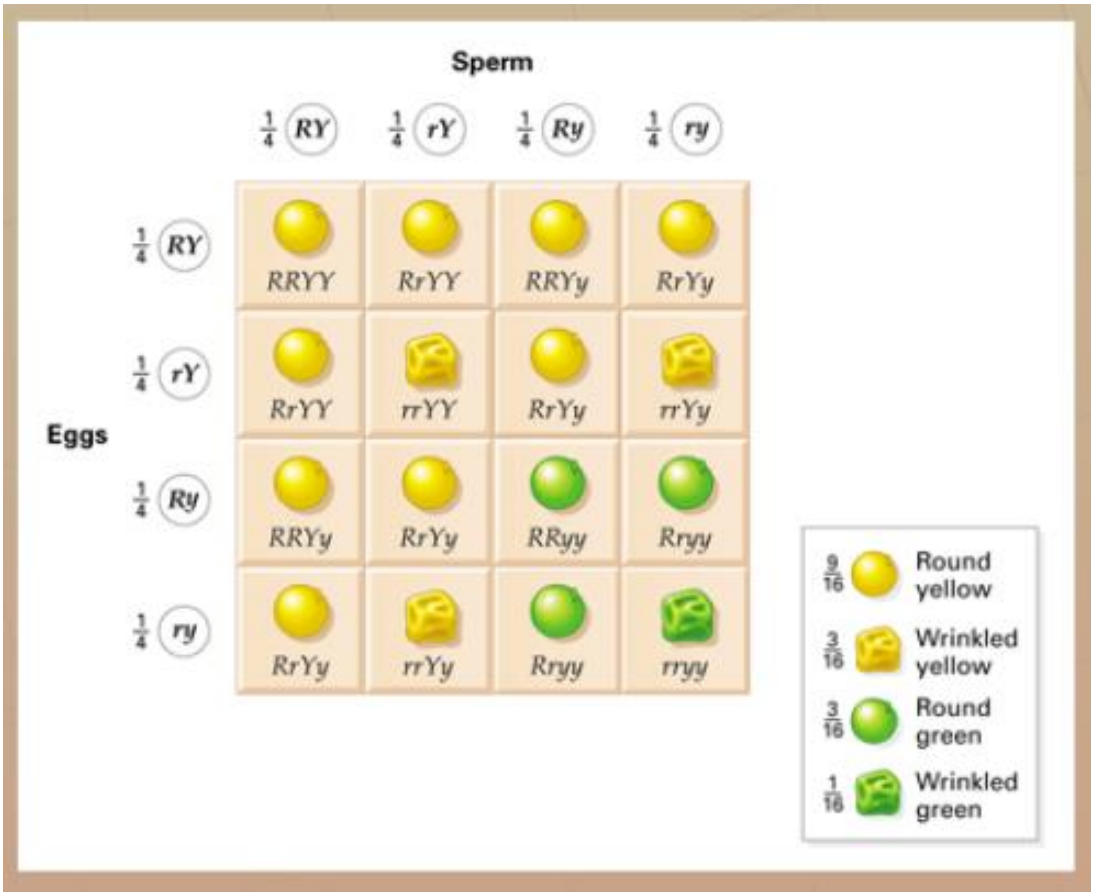
d. Dihybrid Cross

i. Dihybrid cross: examines the inheritance of _____



ii. Independent Assortment

1. Mendel's dihybrid crosses led to his second law, the _____ _____. This law states that allele pairs separate _____ of each other during meiosis.



(Example (above): R can end up with either Y or y, and r can end up with either Y or y)

e. Probability

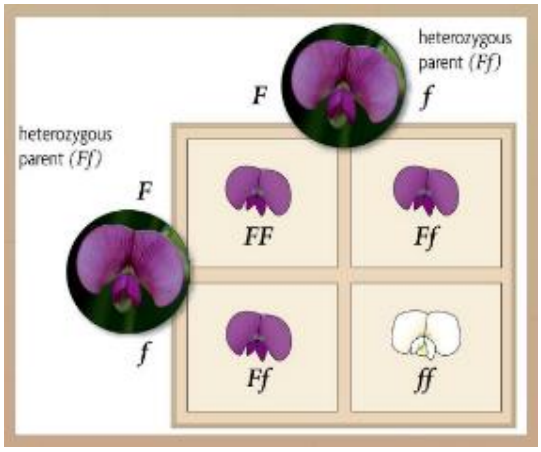
i. Probability: _____

1. Genotypic ratio: the ratio of the _____

   a. (1 PP : 2 Pp : 1 pp)

2. Phenotypic ratio: the ratio of the _____

   a. (3 purple : 1 white)



IV. ***Concept 6.6: Meiosis and Genetic Variation***

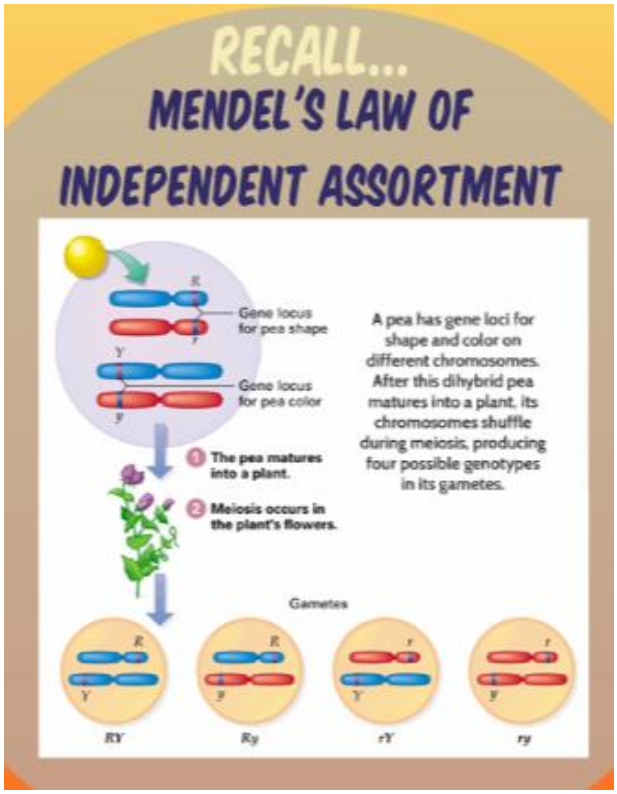
a. Genetic Variation

i. Sexual reproduction creates unique combination of genes.

ii. How?

1. _____ in meiosis

a. (Think back to Mendel's law...)



2. _____

a. AKA - you don't know which gamete will be used to make the zygote!

iii. Unique phenotypes may give a reproductive advantage to some organisms.

Chapter 7: Extending Mendelian Genetics

I. ***Concept 7.1: Chromosomes and Phenotype***

a. Autosomal Genes

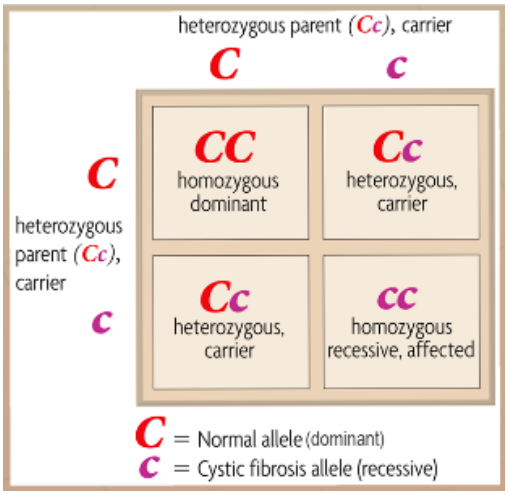
i. Autosomal gene: _____ _____(chromosomes 1-22 in humans)

ii. _____ copies of each autosomal gene affect phenotype.

iii. Autosomal Disorders

1. Mendel's rules of inheritance apply to autosomal genetic disorders.
2. Carrier: _____

   _____
3. Disorders caused by dominant alleles are uncommon.



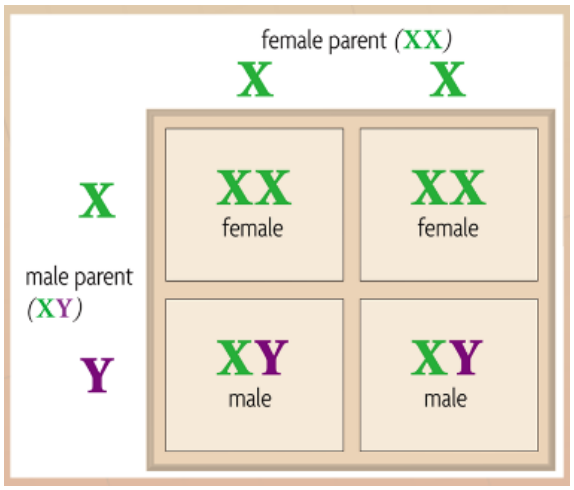
b. Sex-Linked Genes

i. Sex-linked genes: _____ (chromosome 23 in humans)

1. Y chromosome genes in mammals are responsible for male characteristics.
2. X chromosome genes in mammals affect many traits.

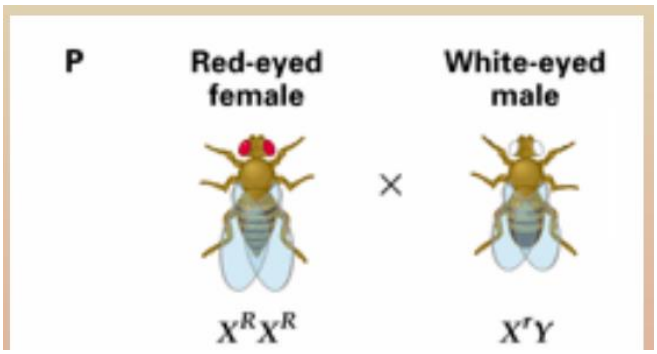
ii. Male and Female Genotypes

1. Male mammals: _____ genotype
   a. All of a male's sex-linked genes are expressed.
   b. Males have no second copies of sex-linked genes.
2. Female mammals: _____ genotype
   a. Expression of sex-linked genes is similar to autosomal genes in females.
   b. X chromosome inactivation randomly "turns off" one X chromosome.

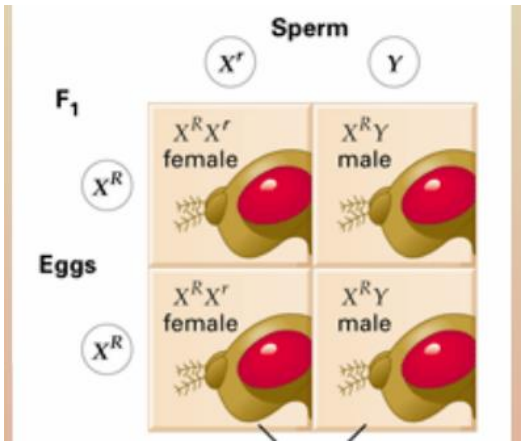


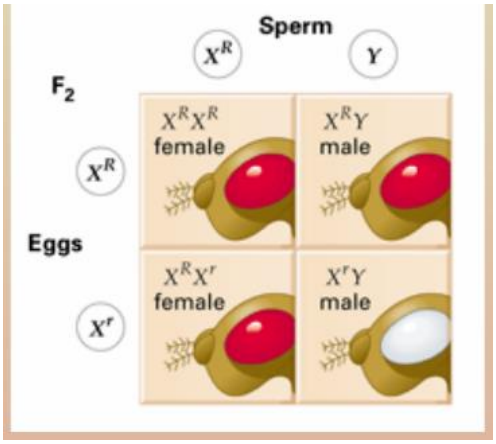
iii. Sex-Linked Cross

1. Example: fruit flies
2. Allele for red eyes = dominant
3. Allele for white eyes = recessive
4. It is extremely rare to find a female with white eyes.
5. Why might this be?



   a. This inheritance pattern is located only on the X chromosome. There is no corresponding eye color locus on the Y.
   b. Females (XX) carry _____ copies for eye color.
   c. Males (XY) carry only _____ for eye color.
      i. *(SO - a female will have white eyes only if she has the white-eye allele on both her X chromosomes, but males will only need one allele on their one X chromosome.)*





iv. Sex-Linked Disorders

1. Sex-linked disorders are disorders that are inherited as _____ _____. *(the same way as the white-eye trait in fruit flies)*
2. Examples: red-green color blindness and hemophilia *(a disease in which blood fails to clot normally)*
3. These are more common in _____.
   a. *(If a human male inherits the sex-linked recessive allele from his mother, the allele will be expressed - whereas females must inherit two alleles to exhibit the trait!)*

II. ***Concept 7.2: Complex Patterns of Inheritance***

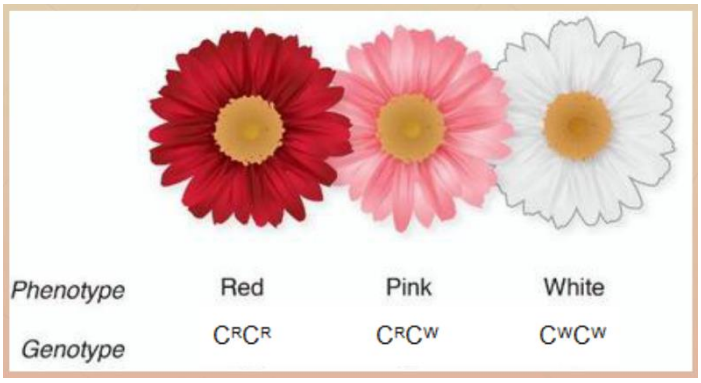
a. Many characters of organisms have more complicated inheritance patterns than those studied by Mendel.

b. Incomplete Dominance (sometimes referred to as Intermediate Inheritance)

i. For some characters of organisms, _____.

ii. Incomplete dominance: pattern of inheritance where _____

_____

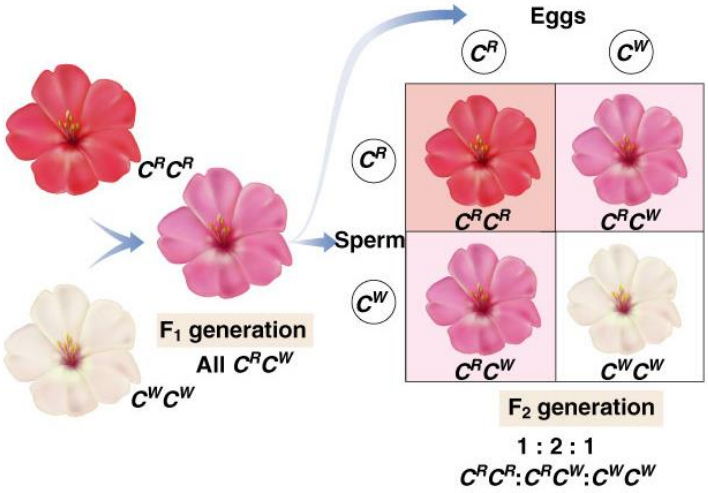


1. Example: red and white parents produce F1 hybrid offspring that are pink - neither the red nor white allele is dominant

iii. This inheritance pattern _____

_____.

1. *(This is because the parent phenotypes can reappear in the F2 generation.)*



c. Codominance (sometimes referred to as Multiple Alleles)

i. Codominant alleles will _____.

ii. Codominant alleles are _____.

1. The ABO blood types result from codominant alleles.
2. Three alleles for blood type in the human population: ____, ____, ____
3. *(But note that any one person has only two alleles for blood type.)*
4. Result in 6 genotypes & 4 phenotypes

PHENOTYPE (BLOOD TYPE)		GENOTYPES
A	antigen A	I^AI^A or I^Ai
B	antigen B	I^BI^B or I^Bi
AB	both antigens	I^AI^B
O	no antigens	ii

a. Alleles I^A and I^B are _____.

b. Allele *i* is _____.

iii. The individual's phenotype is not incomplete, but rather shows the separate traits of both alleles.

d. Polygenic Inheritance

i. Polygenic inheritance: _____

_____

_____ - the variation in phenotypes can become even greater

1. Example: height, eye color, and skin color (in humans)

GENE NAME	DOMINANT ALLELE	RECESSIVE ALLELE
BEY1	brown	blue
BEY2	brown	blue
GEY	green	blue

e. Environmental Affect

i. An individual's _____as well as on genes.

1. (Example: a tree's genotype does not change, yet the tree's leaves vary in size, shape, and greenness from year to year (depending on exposure to wind and sunlight))

ii. For humans, many phenotypes vary due to environmental factors.

iii. On the other hand - some phenotype with little or no influence from the environment.

1. Example: human blood type

iv. In summary, the product of a genotype is generally not a single, rigidly defined phenotype, but a range of possibilities influenced by the environment.

III. ***Concept 7.4: Human Genetics and Pedigrees***

a. How to Study Inheritance Patterns

i. To study the inheritance of a human trait:

1. _____

_____

2. Organize the information in a _____

3. _____ by applying Mendel's concepts of dominant and recessive alleles and his principle of segregation

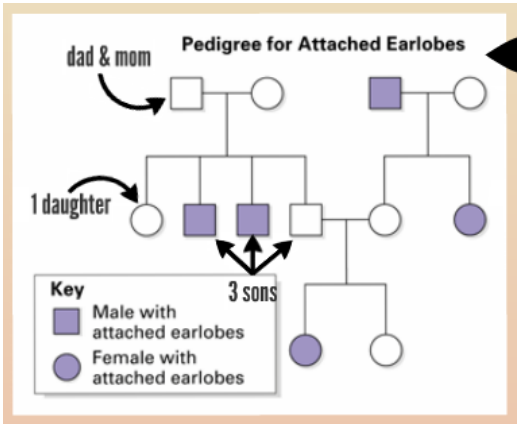
b. Pedigrees

i. Pedigree: _____

_____

1. Squares = _____
2. Circles = _____
3. Colored shapes = individuals that _____

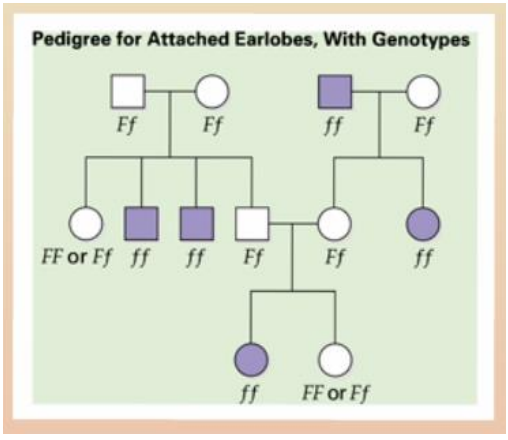
ii. Parents are connected by horizontal lines, with their children beneath them in the order of birth.



1. Example: Earlobes are either free or attached. This pedigree tracks the occurrence of attached earlobes in three generations of a family.

iii. How do you figure out genotypes of each?

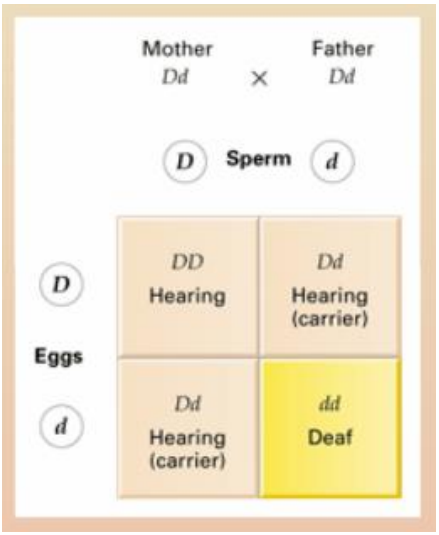
1. Determine the pattern in which the trait occurs
2. *(Example: Notice that the first-born daughter in the third generation has attached lobes, although both of her parents have free earlobes. - so the attached-earlobe trait must be recessive. If the trait for attached earlobes were dominant, then at least one of her parents would have attached earlobes.)*



3. The genotypes of most family members can be determined.

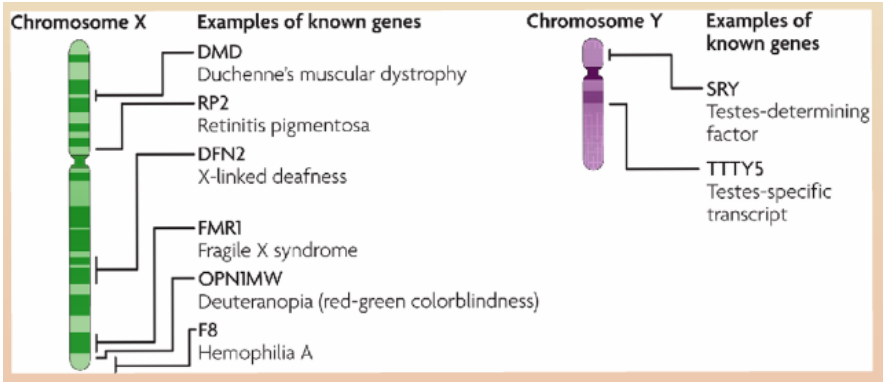
c. Types of Disorders
    i. Disorders inherited as recessive traits
    ii. Disorders inherited as dominant traits
    iii. Sex-linked disorders (both dominant and recessive)

d. Disorders Inherited as Recessive Traits
    i. Most human genetic disorders are recessive.
    ii. Carrier: _____
    _____
    iii. Example: a particular form of deafness is inherited as a recessive trait.



e. Disorders Inherited as Dominant Traits
    i. A _____ number of human disorders are inherited as dominant traits.
    ii. Example: achondroplasia (a form of dwarfism - "little people")
        1. *(About 1 out of 25,000 people has achondroplasia - all individuals with this disorder are heterozygous. More than 99.99% of the population is homozygous for the normal, recessive allele so it clear that dominant alleles are not necessarily more plentiful than recessive alleles in a population.)*

f. Sex-linked Disorders



i. Females _____ sex-linked genetic disorders.

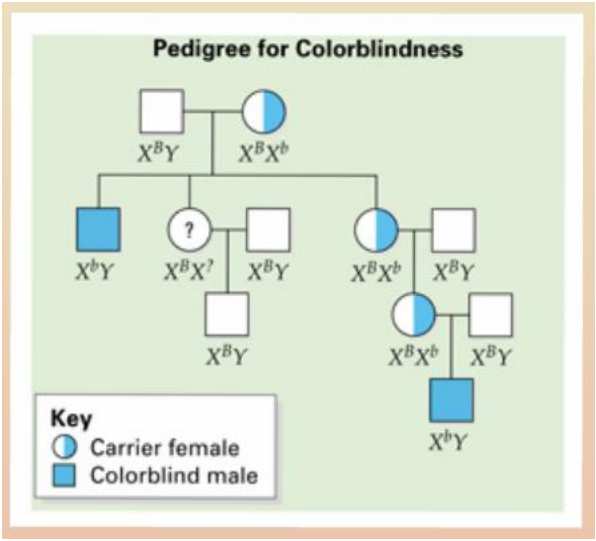
ii. Males (XY) _____ their sex linked genes.

iii. Most sex-linked alleles are located on the X chromosome. A male only receives such sex-linked alleles from his mother. (The homologous Y chromosome is always inherited from the father.)

iv. Therefore, if the phenotype is more common in males, the gene is likely sex-linked.

v. Pedigrees for Sex-Linked Disorders

1. Example: red-green colorblindness
2. The half-filled circles represent _____.
3. *(This pedigree shows the appearance of colorblindness in four generations of a family.)*
4. It is rare—but not impossible—for females to exhibit sex-linked (X-linked) traits.



Chapter 9: Frontiers of Biotechnology

I. ***Concept 9.6: Genetic Screening and Gene Therapy***

a. Genetic Screening

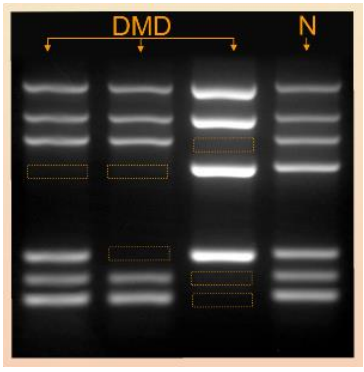
vi. Genetic screening: _____ _____

i. Determines risk of having or passing on a genetic disorder

ii. Used to detect specific genes or proteins

iii. Can detect some genes related to an increased risk of cancer

iv. Can detect some genes known to cause genetic disorders



b. Gene Therapy

vii. Gene therapy: _____

_____

i. Gene therapy replaces defective or missing genes, or adds new genes, to _____

_____.

ii. Gene Therapy Techniques

1. Genetically engineered viruses used to “infect” a patient’s cells
2. Insert gene to stimulate immune system to attack cancer cells
3. Insert “suicide” genes into cancer cells that activate a drug

iii. Gene Therapy Challenges

1. Inserting gene into correct cells
2. Controlling gene expression
3. Determining effect on other genes