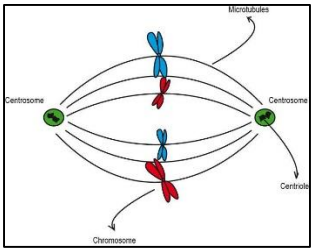
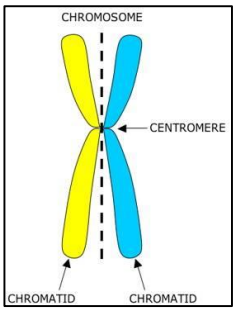
Unit 3 Exam Study Guide

I. Cell Cycle/Mitosis

A. Vocabulary

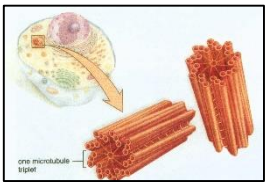


1. Spindle – a network of microtubules that forms during mitosis and moves chromatids to the poles.

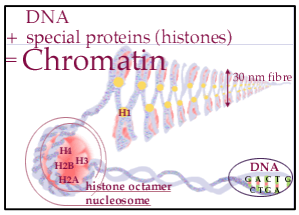


2. Centromere – the region of the chromosome that holds the two sister chromatids together during mitosis.

3. Chromatid – one of the two strands of a chromosome that become visible during meiosis or mitosis.

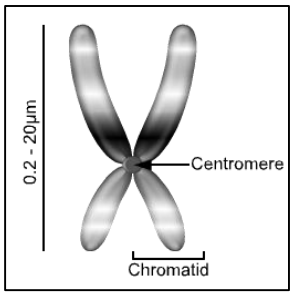


4. Centrioles – a structure that creates spindle fibers that attach to chromosomes.



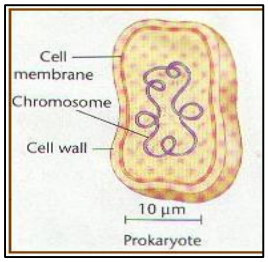
5. Chromatin – the substance that composes eukaryotic chromosomes, which consists of specific proteins, DNA and small amounts of RNA.

6. Chromosomes – a structure within a cell that holds genetic material (DNA or RNA, depends on which type of organism it is).

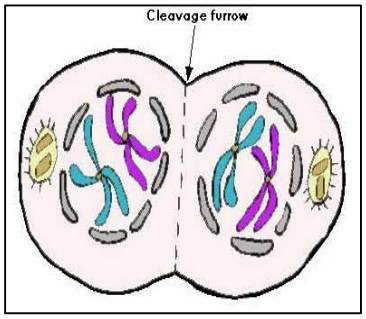


Eukaryotic: made up of DNA and protein; in the mitochondrion or chloroplast; threadlike structure.

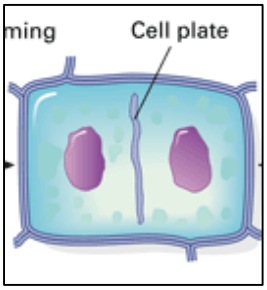
Prokaryotic: made up the main ring of DNA; in the cytoplasm; circular strand.



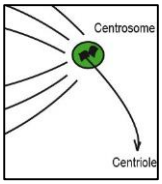
7. Cleavage furrow – a groove formed from the cell membrane in a dividing cell of Telophase in either mitosis or meiosis to prepare for cytokinesis; appeared only in animal cells.



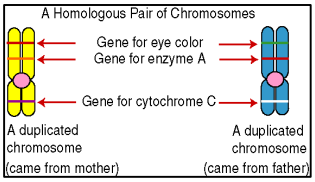
8. Cell plate – a structure of in the plane of the equator of the spindle that separates two sets of chromosomes during cytokinesis; appeared only in plant cells.



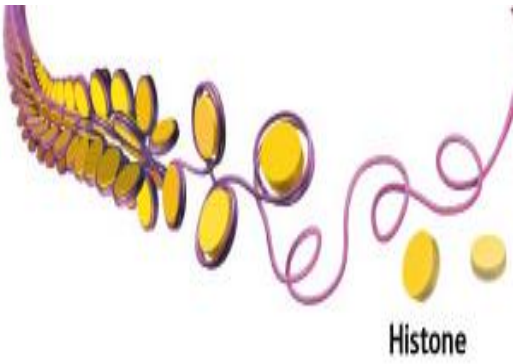
9. Centrosome – an organelle that contains the centrioles and is the center of dynamic activity in mitosis.



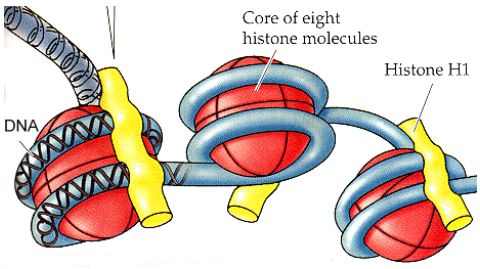
10. Homologous chromosome – chromosomes that have the same sequence of genes and structures, which pair together during meiosis.



11. Histone – a class of proteins served as the first level of packaging of chromosomes; eight histones come together to form a disc-shaped histone core -> the long DNA molecule is wound around the histones -> form chromatin.



12. Nucleosome – the structure made up of a histone core and the DNA around it.



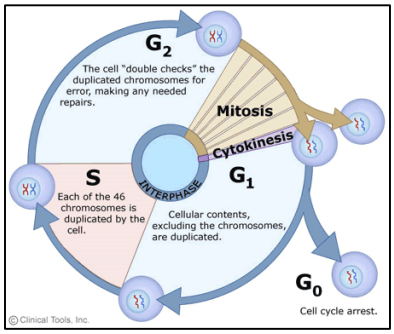
B. Chromosomes

* Prokaryotes: single circular strand; loop contains thousand genes; condensed through repeated twisting/winding.

* Eukaryotes: condensed, duplicated; two thick strands (legs) made of single, long molecule of DNA – chromatid; sister chromatids held by centromere.

C. Cell Cycle

* Repeating sequence of cellular growth and division during the life of a cell.

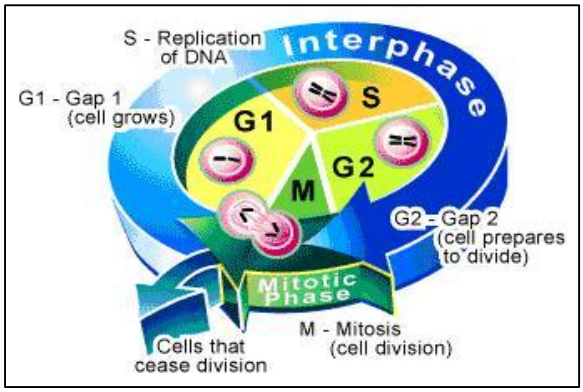


* Made up of 5 phases:

- 1st three phases: Interphase

- Last two phases: Cell Division

D. Interphase



* Cells are not dividing, they grow.

* Time spent at interphase may varies:

- Divide frequently -> less time (i.e. skin)

- Divide seldom -> most time (i.e. nerve)

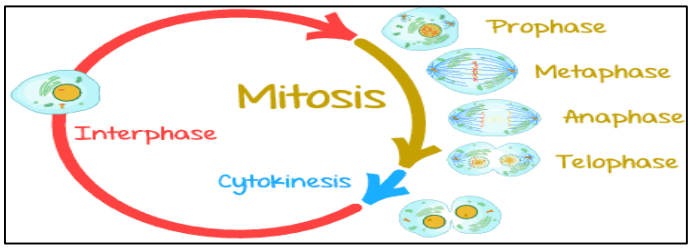
* 3 phases:

- G1 (first gap phase): grows by building more organelles; major portion.

- S (synthesis phase): cell's DNA is copied (DNA replication); at the end, each chromosome has two chromatids attached at the centromere.

- G2 (second gap phase): grow and prepare for division; microtubules formed in cytoplasm to prepare for division.

E. Cell Division



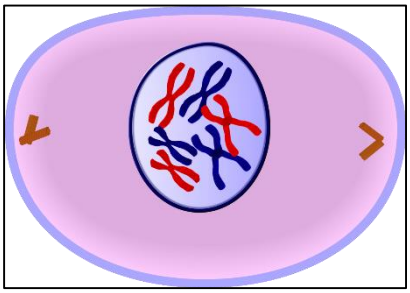
* 2 phases:

- Mitosis & Cytokinesis

F. Mitosis

* A process when cell is divided to form two new identical cells.

* Restore dead, repair damaged, reproduce somatic cells.



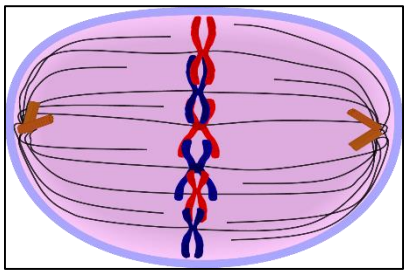
* 4 stages:

1./ Prophase

- Chromosome condenses

- Nuclear membrane dissolves

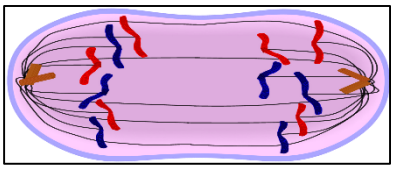
- Centrosome moves to opposite poles -> Spindle fiber forms



2./ Metaphase

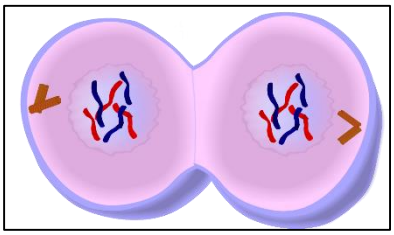
- Chromosome lines up along the equator

- Spindle fiber attaches to opposite poles



3./ Anaphase

- Spindle shortens, chromatids are pulled towards opposite poles.



4./ Telophase

- New nuclear membrane formed

- Spindle dissolves

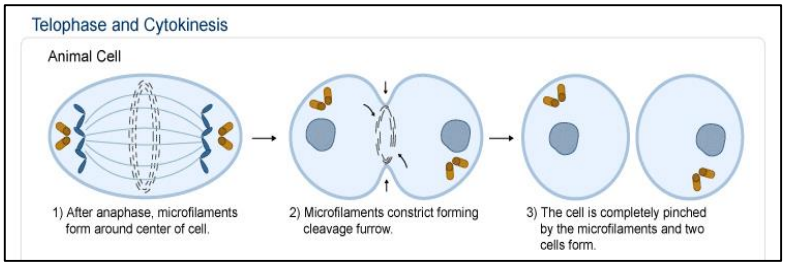
- Chromosome uncoils.

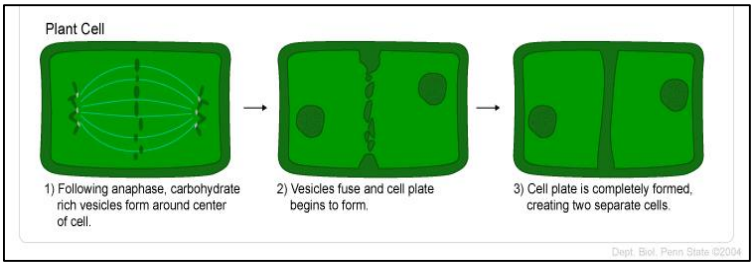
G. Cytokinesis

* The division of cytoplasm of a cell.

- Animal: pinched in ½ by a belt of protein threads.

- Plants: formed a cell plate then the cell plate will done the separation.





H. Disorder

* DNA Overload: when the cell grows too large and DNA can't support the high demand. Protein then stopped being made and cell stopped growing.

=> May lead to cancer, tumor, etc.

I. Cancer

* Cancer - group of diseases characterized by uncontrolled growth and spread of abnormal cells.

* Carcinogen – anything that is an agent directly involved in causing cancer.

* Treated under 2 ways:

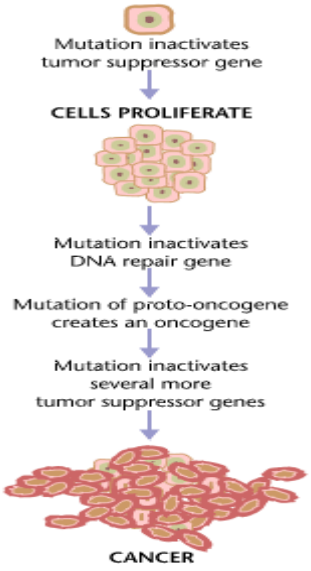
1./ Chemotherapy: consuming drugs that kill the fast-growing cancer cells.

2./ Surgery: remove the affected organ by radiation therapy, etc.

* Prevention:

1./ Avoid ultraviolet radiation in sunlight.

2./ No cigarettes to avoid its hazardous chemical.



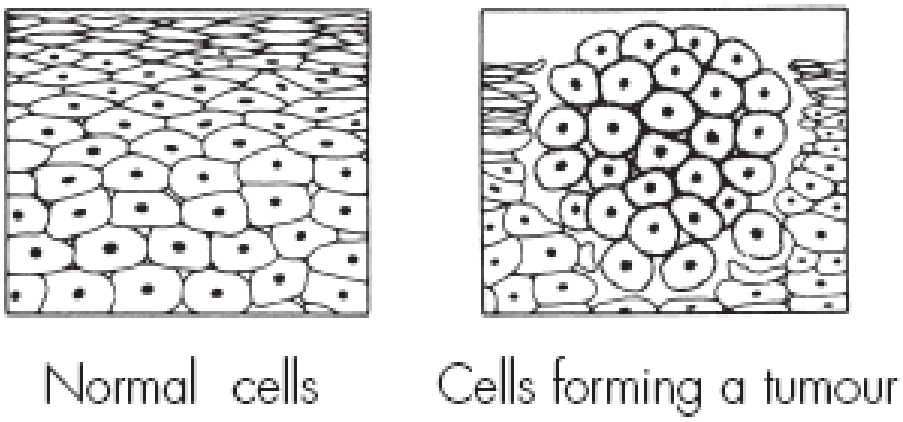
J. Tumor

* Tumor – a growth that arises from normal tissue but that grows abnormally in rate and structure and lacks a function.

* 2 types of tumor:

1./ Benign tumor – doesn't spread; can be removed by surgery.

2./ Malignant tumor – invades and destroys nearby tissues/organs; cancer.



II. Meiosis

A. Vocabulary

1. Gamete – reproductive cell; sperm for male, ovum for female.
2. Zygote – the resulting cell of fertilization (fertilized egg); has a combination of genetic material from both parents.
3. Diploid – a somatic cell that has two sets of chromosomes; 2n
4. Haploid – a gamete cell that has one set of chromosomes; n
5. Homologous chromosomes – chromosomes that are similar in size, shape, and kinds of genes that they contain.
6. Autosomes – chromosomes with genes that determined traits.
7. Sex chromosomes – chromosomes with genes that determined sex; XX (female), XY (male).
8. Meiosis – a form of cell division that produces daughter cells with half the number of chromosomes that are in the parent cell.
9. Genetic variation – advantageous, help a population survive a major environmental change; 3 types: crossing-over, independent assortment, and random fertilization.
10. Crossing-over – a process when chromatids exchange genetic materials; occurred in Prophase I.
11. Independent assortment – random distribution of homologous chromosomes during meiosis; occurred in Metaphase I.
12. Random fertilization – a random process that adds genetic variation; due to the randomness, therefore, the number of possible outcomes will be squared.
13. Life cycle – a cycle that shows all of the events in the growth and development of an organism until the organism reaches sexual maturity.
14. Spermatogenesis – meiosis in males; results: 4 sperms lived.
15. Oogenesis – meiosis in females; results: 1 ovum lived; 3 ova died.
16. Karyotype – pictures of an individual's chromosomes.
17. Locus – position of a gene, which shares the same position with homologous chromosomes.
18. Synapsis – homologous chromosomes come together to form tetrad.

19. Chiasmata – sites of crossing-over.

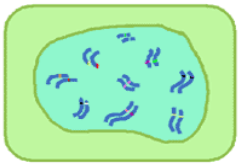
20. Tetrad – homologous pairs carry genes controlling the same inherited traits.

21. Non-disjunction – homologous chromosomes fail to separate during meiosis.

22. Trisomy – a non-disjunction where there are three chromosomes in a set.

23. Monosomy – a non-disjunction where there is one chromosome in a set.

B. Sexually reproductive organisms have 2 types of cells:

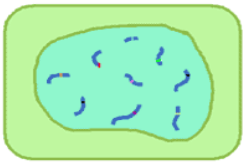


Somatic Cell

A. Somatic – normal

- Diploid (2n)

- Determined traits, i.e. skin, brain, etc.



Gamete Cell

B. Gamete – sex

- Haploid (n)

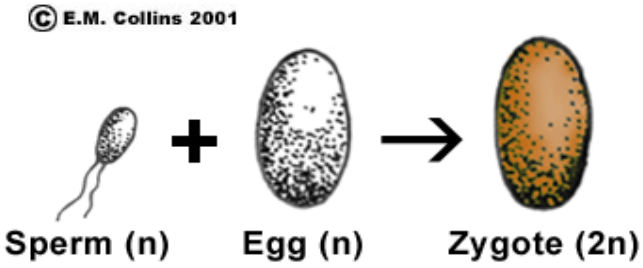
- Male: sperm, produced from testes.

- Female: ovum, produced from ovaries.

C. Ovulation & Fertilization

* Ovum is released from the ovary -> transported to where fertilization occurs.

* Fertilization occurs in the Fallopian Tube, produced zygote.



D. Chromosomes

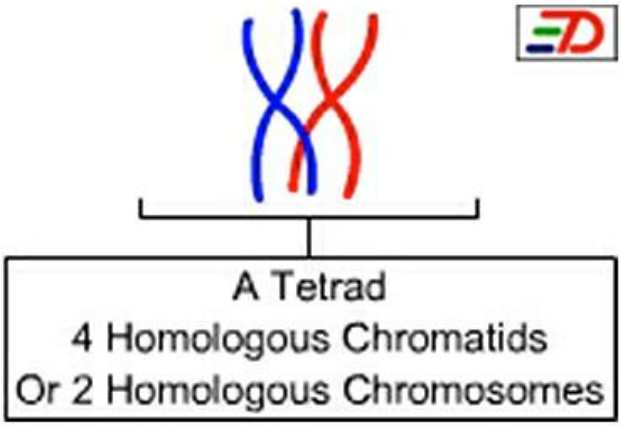
1. Homologous Chromosomes

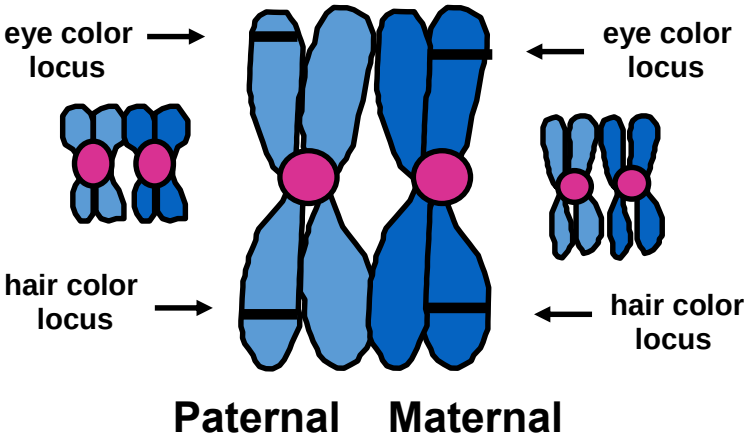
* Two chromosomes from parents; same size & shape.

* Pairs of homologous chromosomes = tetrads (carry genes that control inherited traits).

* Position of a gene is called locus – in the same position of homologous.

* Humans have 23 pairs of homologous chromosomes; 46 chromosomes.

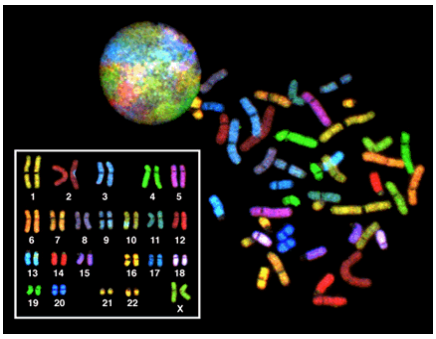




2. Autosomes

* Determined a human's trait.

* Humans have 22 pairs of autosomes.



3. Sex Chromosome

* Humans have 1 pair of sex chromosome.

* XX: Female; XY: Male.

E. Meiosis

* The process by which gametes are produced.

* Diploid reduces into haploid.

* No meiosis -> Chromosomes of new generation is doubled -> Offspring died.

* Two cells division with only one chromosomes duplication.

- Meiosis I

- Meiosis II

1./ Interphase – DNA Replication

* Chromosomes (S Phase) and centriole pairs replicate.

* Duplicated chromosomes have two similar chromatids, attached at centromeres.

* Nucleus and nucleolus are visible.

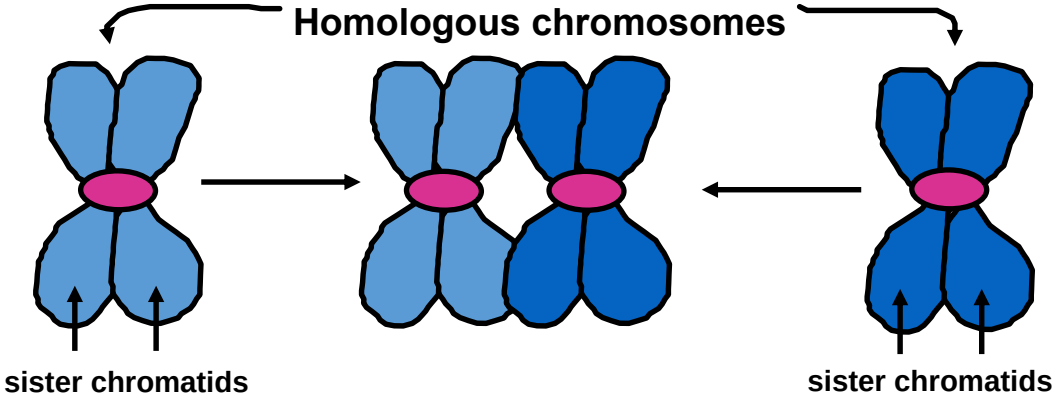
* Only occurred once during the process of meiosis.

2./ Prophase I – Synapsis

* Longest and most complex; 90% of the process spent here.

* Chromosomes condense, Tetrad becomes 2 chromosomes/4 chromatids.

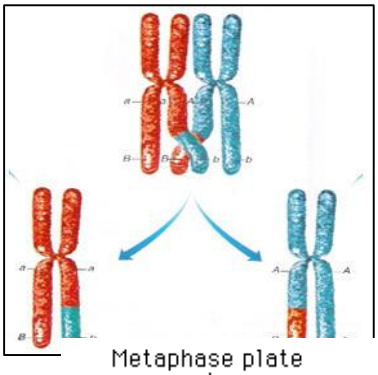
* Synopsis: homologous chromosomes come together to form tetrads.



a. Crossing over

* Segment of non-sister chromatids break and reattach to the other chromatid. Chiasmata – sites of crossing over.

* Creates variation in offspring's trait.



3. Metaphase I

* Shortest.

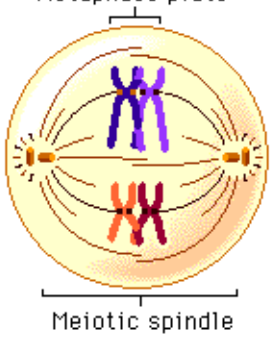
* Tetrads line on metaphase plate.

a. Independent Assortment

* Orientation of pairs to poles: random.

=> Variation.

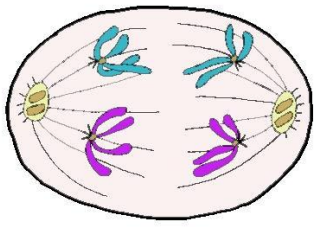
* Formula to total possible outcomes: 2^n



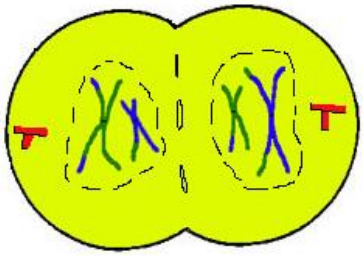
4. Anaphase I

* Homologous chromosomes separate and move toward the poles.

* Sister chromatids remain attached at centromeres.



5. Telophase I



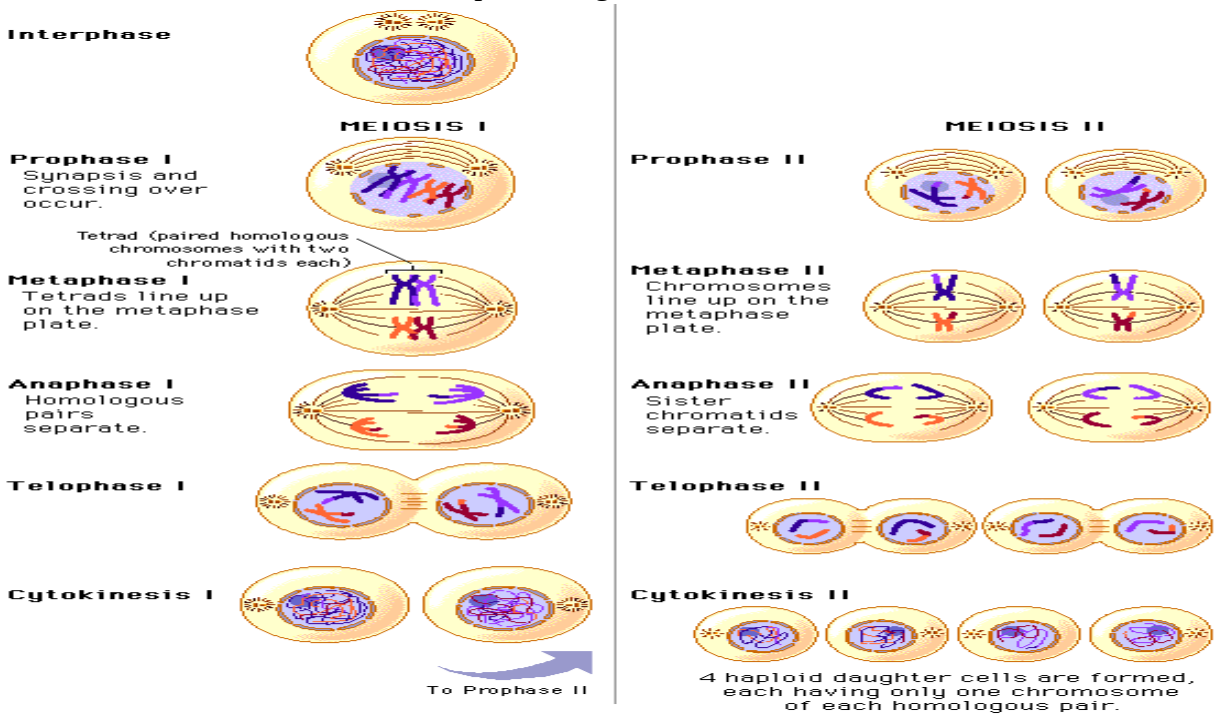
* Each pole now has a haploid set of chromosomes.

* Cytokinesis occurs and two haploid daughter cells are formed.

6. Meiosis II

* Procedures = Meiosis I; however, initiate with 2 cells, rather than 1.

* Results: 4 haploid daughter cells.



F. Meiosis occurs at different genders.

* Male: spermatogenesis, produces sperm.

  - 4 sperm cells are produced from each spermatocycle.

  - All 4 sperm cells survived.

* Female: oogenesis, produces ova.

  - Results: 1 ovum and 3 polar bodies from each primary oocycle.

  - Polar bodies died, ovum survived.

G. Non-disjunction

* Failure of homologous chromosomes, or sister chromatids, to separate during meiosis.

* Have two “fashions”

1. Monosomy: only one chromosome for that set.

2. Trisomy: three chromosomes for that set.

* Common non-disjunction disorders

1. Down's Syndrome: Trisomy 21

2. Turner's Syndrome: Monosomy 23 (X)

3. Kleinfelter's Syndrome: Trisomy 23 (XXY)

4. Edward's Syndrome: Trisomy 18

I. Amniocentesis

* A procedure a pregnant woman can have in order to avoid genetic disorders.

III. Mendelian Genetics

I. Vocabulary

1. Genetics – the science of heredity and of the mechanisms by which traits are passed from parents to offspring.

2. Fertilization – the union of a male and female gamete to form a zygote.

3. Trait – a genetically determined characteristic.

4. True-breeding (Pure-breeding) – describe organisms or genotypes that are homozygous for a specific trait and thus always produce offspring that have the same phenotype for that trait.

5. Hybrid – the offspring of a cross between parents that have differing traits; a cross between individuals of different species, subspecies, or varieties.

6. Segregation – a law that states when an organism produces gametes, each pair of alleles is separated and each gamete has an equal chance of receiving either one of the alleles.

7. Independent assortment – the random distribution of the pairs of genes on different chromosomes to the gametes.

8. Gametes – a haploid reproductive cell that unites with another haploid reproductive cell to form a zygote.

9. Homozygous – describes an individual that carries two different alleles of a gene.

10. Heterozygous – describes an individual that carries two different alleles of a gene.

11. Phenotype – an organism's appearance or other detectable characteristic that results from the organism's genotype and the environment.

12. Genotype – the entire genetic makeup of an organism; also the combination of genes for one or more specific traits.

13 Allele – each alternate version of a gene.

14. Dominant – an allele that is fully expressed whenever the allele is present in an individual.

15. Recessive – an allele that is expressed only when no dominant allele is present in an individual.

16. Incomplete dominance – an offspring has a phenotype that is intermediate between the traits of its two parents.

17. Codominance – a condition in which both alleles for a gene are fully expressed.

18. Punnet Square – a graphic used to predict the results of a genetic cross.

19. Monohybrid trait – cross between individual with contrasting traits.

20. Dihybrid trait – cross between individual that have different alleles for the same gene.

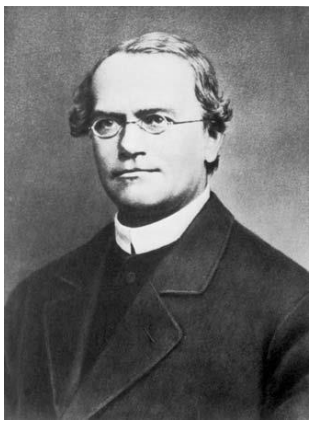
21. Multiple alleles trait – a genetically determined characteristic that has more than two alleles.

22. Polygenic trait – a character that is influenced by more than one gene.

23. Heredity – the passing of genetic traits from parent to offspring.

24. Karyotype – picture of an individual's chromosomes.

II. Gregor Mendel (1822-1884)



* Austrian, "Father of Genetics"

* Studied the inheritance of traits in pea plants => Developed the laws of inheritance.

* Work was not recognized until 20th century.

* 1856 to 1863, cultivated and tested 28,000 pea plants.

* Found that the plants' offspring retained traits of the parents.

III. Mendel's Experiment

1. Pea – pisum sativum.

* Grown in small area

* Lots of offspring

* Pure plants when self-pollinate

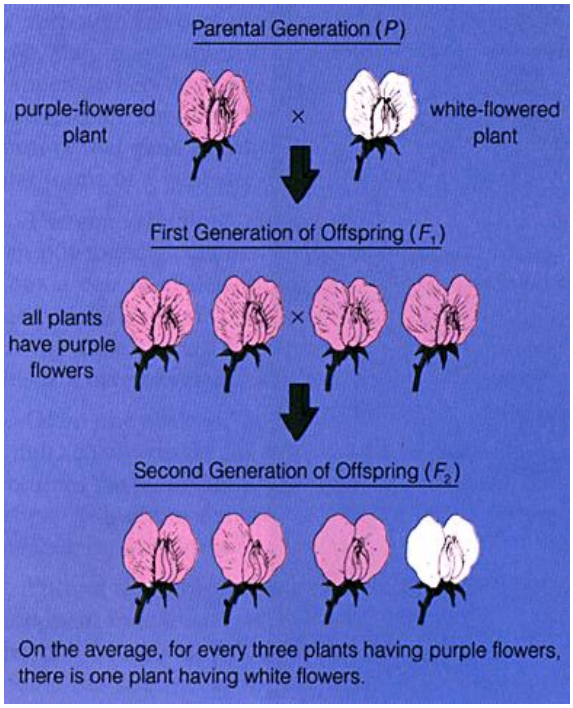
* Artificially cross-pollinated

2. Mendel's First Experiment

- Parental Generation (P): allow self-pollinate for several generation -> allow true-breeding.

- First Filial Generation (F_1): crossed two plants from parental generation that had contrasting trait (i.e. purple with white) -> recorded the number of plants that had each trait.

- Second Filial Generation (F_2): allowed plants from first filial generation to self-pollinate => recorded the number of plants that had each trait.



=> F_1's ratio is 1:1.

- Heterozygous

=> F_2's ratio is 3:1

- Homozygous dominant, homozygous recessive, heterozygous

=> Can be expressed by using a monohybrid cross.

3. Mendel's Law

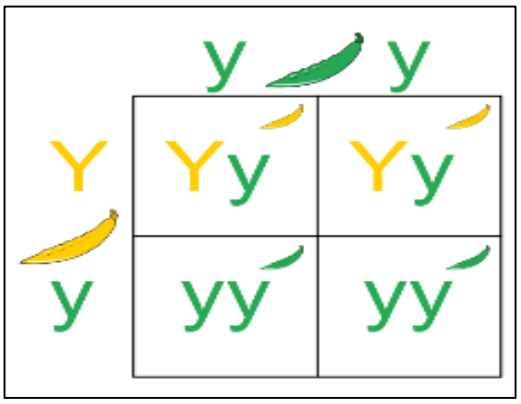
	y	y
Y	Y y	Y y
Y	Y y	Y y

- Law of Dominance: cross one dominant trait with one recessive trait.

- Explains First Filial Generation (F_1)

=> Results: Heterozygous (genotype); dominant (phenotype)

- Law of Segregation: cross two heterozygous trait together.

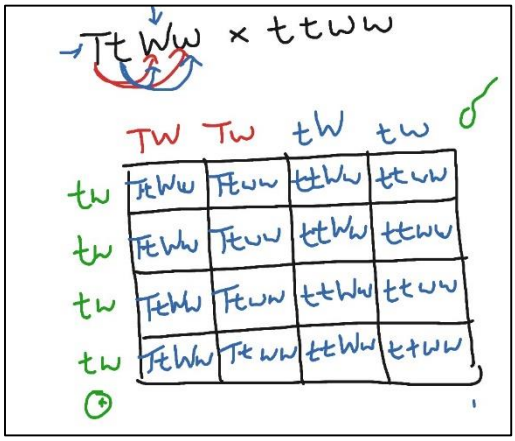


- Explains Second Filial Generation (F2)

=> Results: 1:2:1 (homo dom:hetero:homo rec); 3:1 (dom:rec).

- 25% dominant/recessive; 50% heterozygous (genotype)

- 75% dominant, 25% recessive (phenotype)



- Law of Independent Assortment: different traits are crossed.

- Allele pairs separate independently during the formation of gametes.

- Demonstrated by a dihybrid crosses.

=> Results: 9:3:3:1

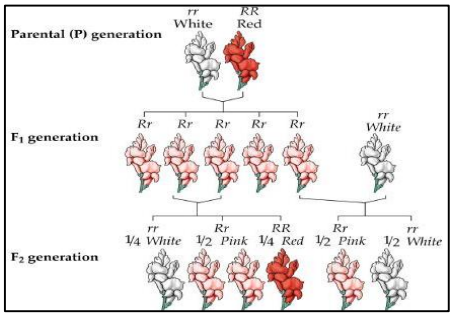
4. Polygenic Inheritance, Incomplete Dominance and Codominance

- The Mendelian inheritance pattern is rare in nature; other patterns include polygenic inheritance, incomplete dominance, multiple alleles, and codominance.

a. Polygenic Inheritance

* Character that is influenced by more than one gene.

b. Incomplete Dominance



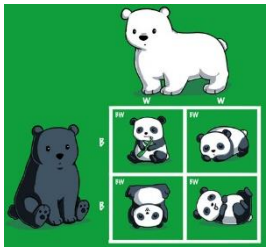
* Offspring have appearance in between the phenotypes of two parents.

- Main traits are mixed/blended.

* Occurs when two or more alleles influence the phenotype, neither one is completely dominant.

c. Codominance

* Both alleles in a heterozygous organism are expressed.



- Both of them contribute to the phenotype.

- Don't blend together, but present both.

II. Modeling Mendel's Experiment

1. Punnett Square

* Invented by Reginald Punnett.

* Model that predicts the likely outcomes of a genetic cross.

* Simple way to find out the trait of two organisms.

* Can't be accurate for organisms that has many offspring.

1. Monohybrid

* Cross the genotype of parents.

2. Dihybrid

* Cross the two genotypes of two different species.

1. Factored the genotypes.

i.e. TtWw X ttww

1st column: TW, Tw, tW, tw

2nd column: tw, tw, tw, tw

2. Do a cross similar like monohybrid.

Tips: One genotype at a time to avoid messed-up.

2. Pedigree Chart

* Family tree; shows how a trait is inherited over several generations.

* Key benefit: can detect genetic disorder most accurate.

* Look for autosomal/X-linked; dominant/recessive before interpret.

1. Read a Pedigree Chart

a. Male 

b. Female 

c. Married Couple 

d. Siblings 

e. Fraternal Twins 

f. Identical Twins 

g. Normal 

h. Affected 

i. X-Linked 

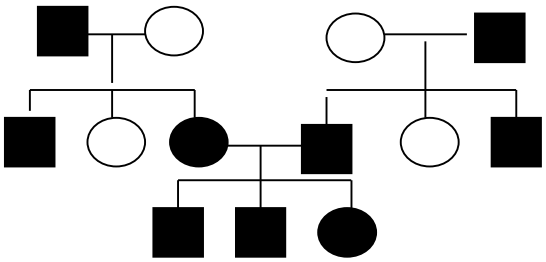
j. Autosomal Carrier 

k. Deceased 

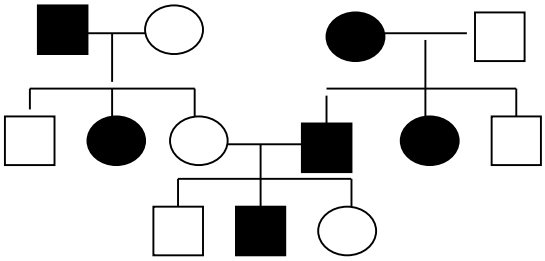
l. Marriage between cousins 

2. Sex-Linked Gene VS. Autosomal

* Most of the males in the pedigree = X-linked.

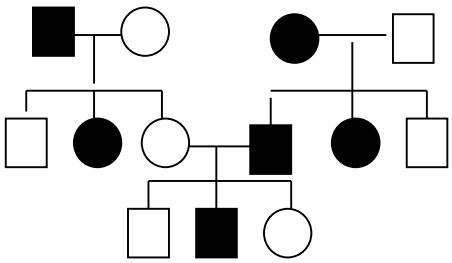


* 50-50 ratio of male and female = Autosomal.

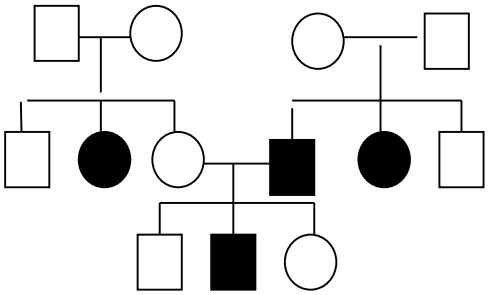


3. Dominant VS. Recessive

* Parents has the disorder = Dominant.



* None of the parents has = Recessive



4. Heterozygous VS. Homozygous

* Homozygous dominant parents' offspring will show dominant.

* Heterozygous parents' offspring may has recessive.

* Homozygous recessive parents' offspring will has recessive.