

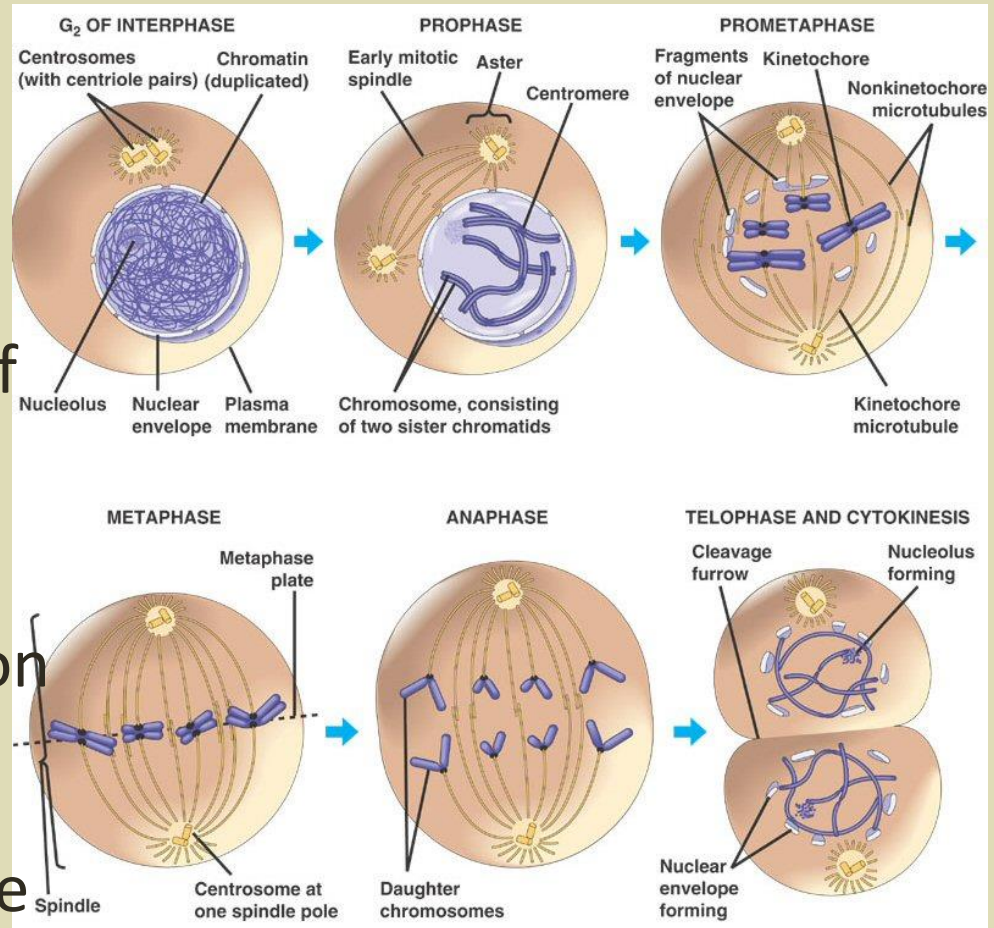
Cell Growth and Genetics

Cell Division (Mitosis)

Cell division results in two identical *daughter cells*.

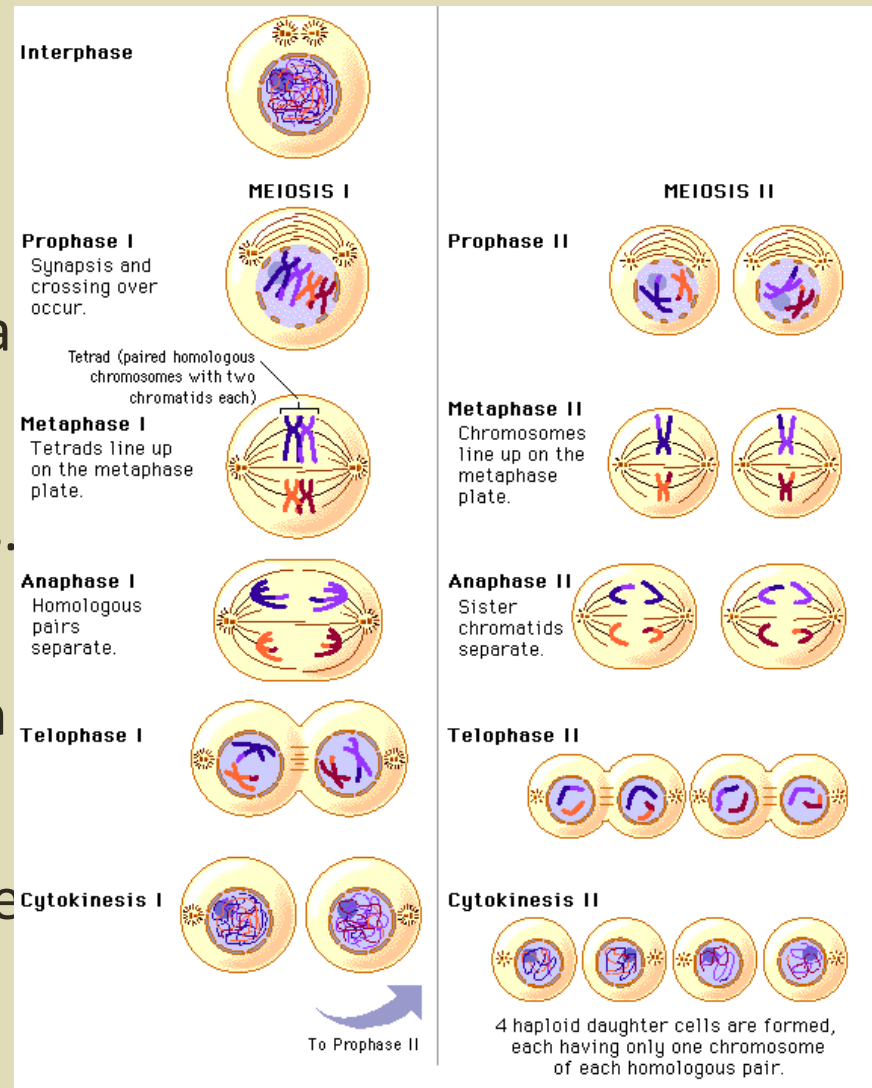
The process of cell divisions occurs in three parts:

- **Interphase** - duplication of chromosomes and preparing the nucleus for division
- **Mitosis** – organized division of the nucleus into two identical nuclei
- **Cytokinesis**- division of the cell and cellular contents into two identical daughter cells
- [Animation](#)



Meiosis

- Meiosis occurs during the formation of sex cells (sperm and egg). It is necessary so that the sex cells only have half the number of chromosomes (23 in us) so that at fertilization, the normal chromosome number is returned (46 in us)
- Meiosis involves two divisions. It begins with the replication of the chromosomes, divides up the cell into two cells, then divides again (without replication) into 4 genetically different sex cells with half the normal number of chromosomes



1.) Mitosis and meiosis are processes by which animal and plant cells divide. Which statement best describes a difference between mitosis and meiosis?

A. Meiosis is a multi-step process.

Both processes have multiple steps (prophase, metaphase, anaphase, and telophase, but meiosis has two sets of these stages with slight differences than the mitosis versions)

B. Mitosis occurs only in eukaryotic cells.

Mitosis occurs in prokaryotic and eukaryotic cells

C. Meiosis is used in the repair of an organism.

Mitosis is the process used to repair an organism by creating more of the same type of cell (for example, to heal a cut on the leg)

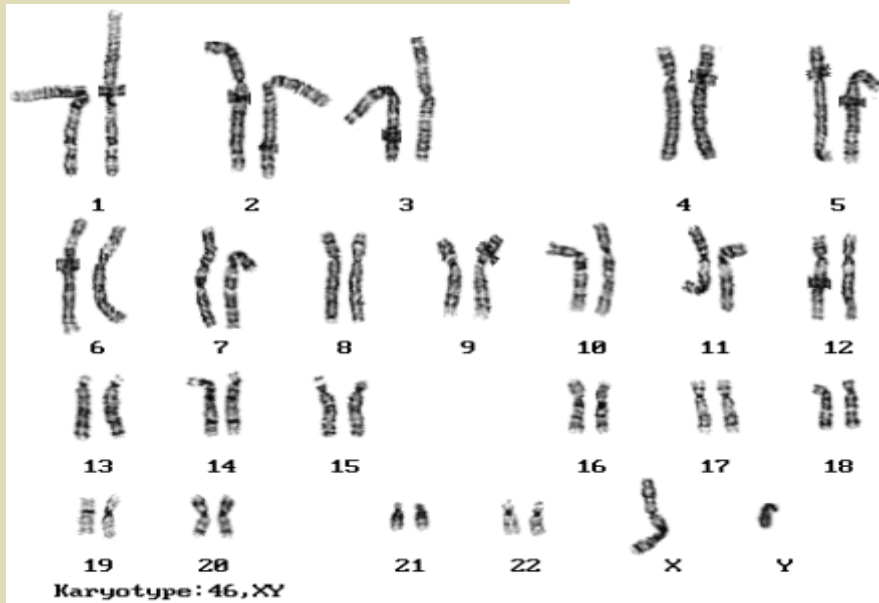
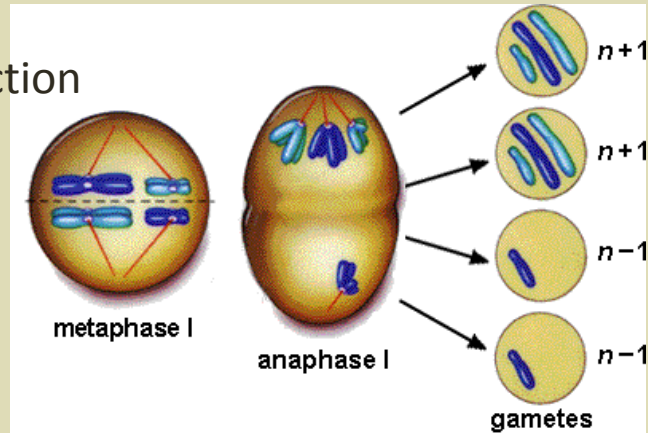


D. Mitosis produces genetically identical daughter cells.

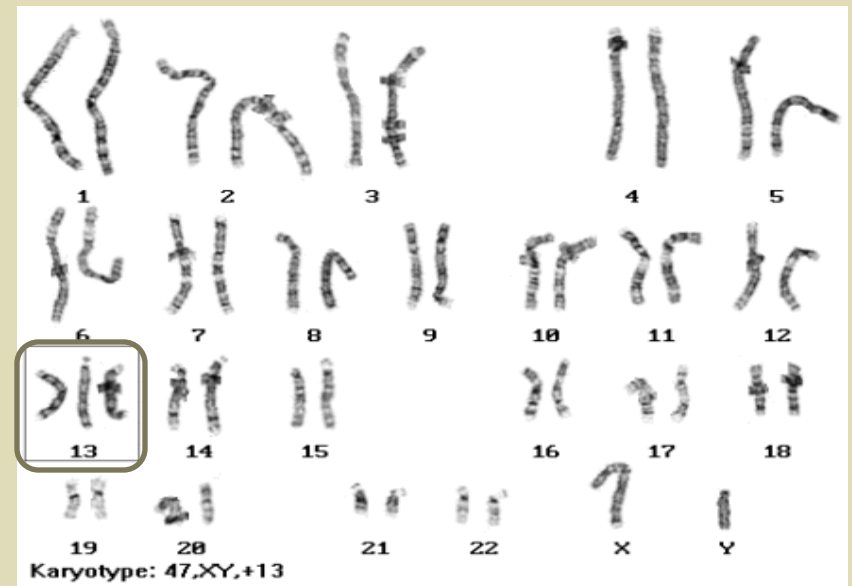
Meiosis produces genetically different cells as a result of crossing over and chromosome shuffling. Half chromosomes.

Nondisjunction and Patau's syndrome

Nondisjunction



Karyotype of a normal male



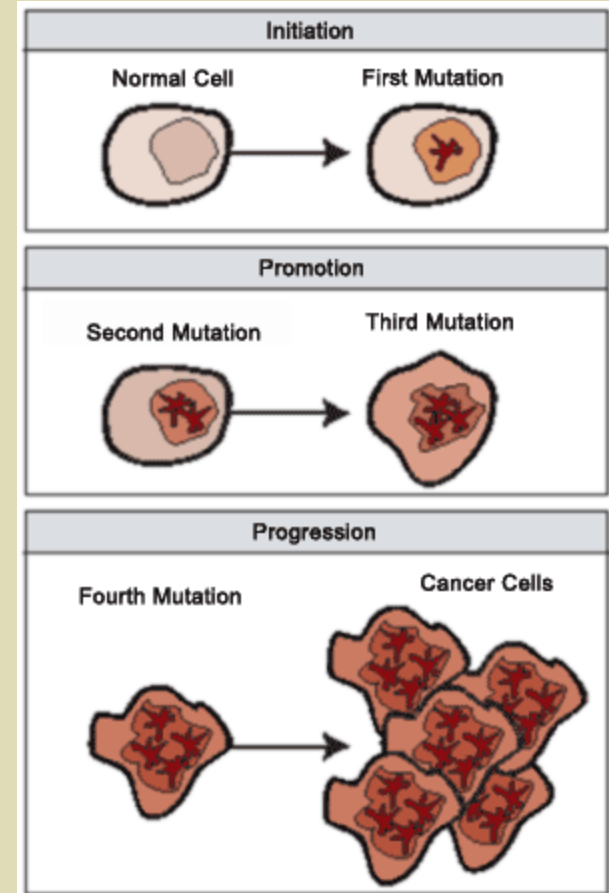
Karyotype of a Patau's male (notice chromosome #13 has three chromosomes instead of two)

3.) Patau syndrome can be a lethal genetic disorder in mammals, resulting from chromosomes failing to separate during meiosis.

- **Part A:** Identify the step during the process of meiosis when chromosomes would **most likely** fail to separate.
- *Most likely **chromosomes would fail to separate during anaphase I or Anaphase II**. In anaphase, chromosomes (anaphase I) or sister chromatids (anaphase II) are supposed to separate, or move AWAY from each other. This is called Nondisjunction.*
- **Part B:** Describe how chromosome separation in meiosis is different from chromosome separation in mitosis.
- *During meiosis cells and the genetic material **is divided twice** (the first set of division is meiosis I and the second set is meiosis II). In mitosis, the cell and chromosomes divide once.*

Part C: Compare the effects of a disorder caused by chromosomes failing to separate during meiosis, such as Patau syndrome, to the effects of chromosomes failing to separate during mitosis.

- *Due to the improper number of chromosomes, the organism has an improper amount of genetic material in the form of DNA of the sperm or egg. This mutation will be found in every cell of the organism's body.*
- *If chromosomes fail to separate during mitosis, it does not affect the sex cells but a body cell. This mutant body cell then can be reproduced and produce more of the abnormal cells. The cell either dies or is replicated quickly. This could possibly lead to cancer if the cells are not destroyed by the immune system.*



MITOSIS

Prophase

Duplicated chromosome
(two sister chromatids)

Metaphase

Chromosomes
positioned at the
metaphase plate

Anaphase
Telophase

Sister chromatids
separate during
anaphase

$2n$

Daughter cells
of mitosis

$2n$

Parent cell
(before chromosome replication)

Chromosome
replication

$2n = 6$

MEIOSIS

Chiasma (site of
crossing over)

MEIOSIS I

Prophase I

Tetrad formed by
synapsis of homologous
chromosomes

Tetrads
positioned at the
metaphase plate

Metaphase I

Homologues
separate
during
anaphase I;
sister
chromatids
remain together

Anaphase I
Telophase I

Haploid
 $n = 3$

Daughter
cells of
meiosis I

MEIOSIS II

Daughter cells of meiosis II

Sister chromatids separate during anaphase II

n

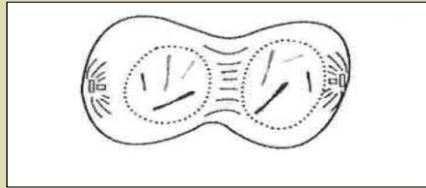
n

n

n

2.) Use the illustration below to answer the question.

Cell Division



Which statement best describes the phase of the cell cycle shown?

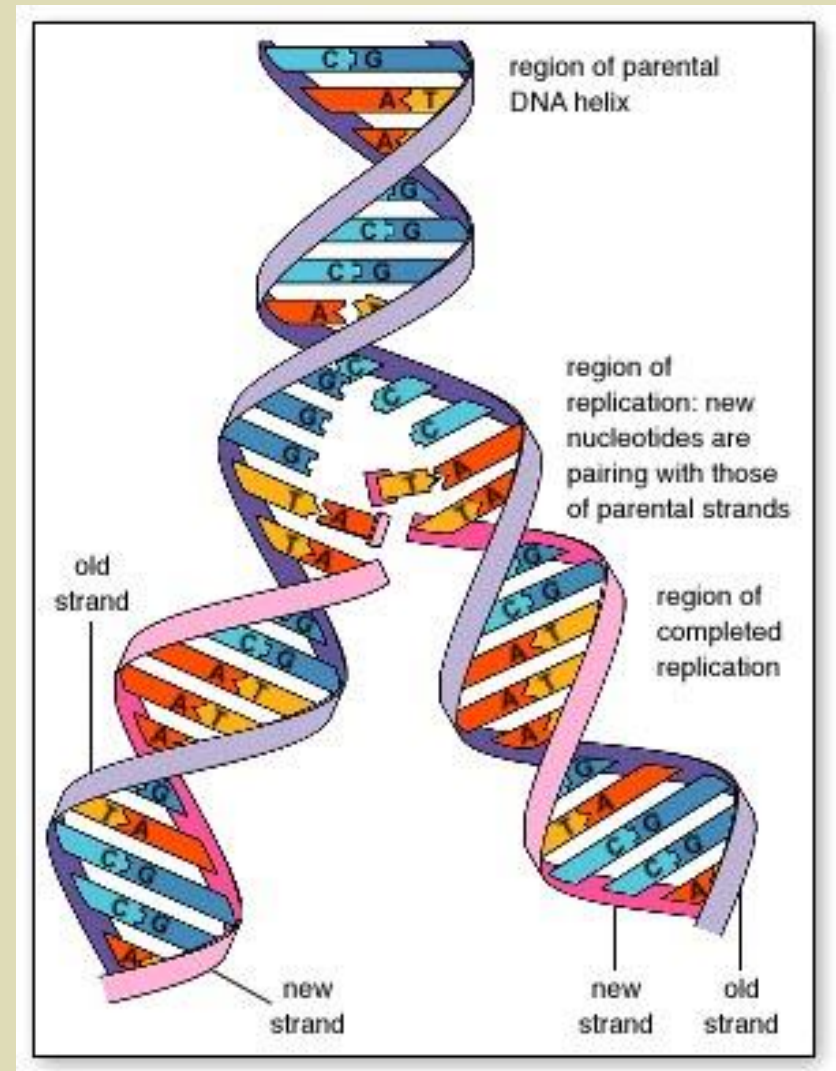
This diagram is showing the formation of two cells

- A. The cell is in prophase of mitosis because the number of chromosomes has doubled.
- B. The cell is in prophase I of meiosis because the number of chromosomes has doubled.
- C. The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
- D. The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.

At the end of meiosis, you would see 4 genetically different cells with only one copy of each chromosome (here you see 2 cells, and each has 2 matching "sticks" in it)

DNA Replication

- *This is key for DNA replication. DNA (a double stranded molecule) splits into two halves, and each half serves as a “template” or pattern to build the new half.*
- *The result is two identical strands of DNA*
 - *Adenine always pairs with Thymine (straight line letters AT go together) and Guanine always pairs with Cytosine (curvy letters GC go together)*




4.) Which process helps to preserve the genetic information stored in DNA during DNA replication?

A.) The replacement of nitrogen base thymine with uracil.

B.) Enzymes quickly linking nitrogen bases with hydrogen bonds.


C.) The synthesis of unique sugar and phosphate molecules for each nucleotide.

 D.) Nucleotides lining up along the template strand according to base pairing rules.

An embryonic cell divides repeatedly, with each new cell containing all the genetic information to form the entire organism. Which feature of DNA ensures that genetic information is conserved as it is replicated?

- a. the role of DNA in proteinsynthesis
- b. the polymeric nature of the DNA molecule
- c. the complementary nature of DNA nucleotides
- d. the triplet code with which information is stored on DNA

25.) In a flowering plant species, red flower color is dominant over white flower color. What is the genotype of any red-flowering plant resulting from this species?

- A. Red and white alleles present on one chromosome.
- B. Red and white alleles present on two chromosomes.
- C. A red allele present on both homologous chromosomes
-  D. A red allele present on at least one of two homologous chromosomes.

Genetics

- *Dominant traits are represented by capital letters, while recessive (non-dominant traits) are represented by lower case letters.*
 - *Each parent has two copies of the gene, so they will get two letters. The different letters represent the different alleles (flower pedal color) of a trait.*
 - *Since white is the recessive trait, in order to have white petals, the flower has to be **ff or pure for the white trait.***
 - *Since red color is dominant, the red parent could be **Ff or FF** since it shows red petals. It is either pure for the red trait or a hybrid for red.*
- *When the dominant trait shows, only one allele (form of the gene) must be present to show the trait.*

How to Make a Punnett Square

Punnett squares allow geneticists to predict the possible genotypes and phenotypes of offspring.

In this example, both parents are heterozygous for yellow-pea allele (Yy).

Parent 1



Parent 2



1 Make the grid

Place the alleles of the gametes of one parent along the top of a grid and those of the other parent along the left-hand side.

Yy →	Y	y
→ Y		
→ y		

2 Fill in the grid





Combine the parent alleles inside the boxes. The letters show the genotypes of the offspring.

	Y	y
Y	YY	Yy
y	Yy	yy

The genotype ratio is 1:2:1, meaning 1 YY , 2 Yy , 1 yy .

3 Fill in the offspring

Use the Law of Dominance to determine the phenotypes and phenotype ratio of the offspring.

	Y	y
Y	 YY	 Yy
y	 Yy	 yy

The phenotype ratio is 3:1, meaning 3 yellow peas to 1 green pea.

Punnet Square Animation

5. Green Pods are dominant over yellow pods in pea plants. What is the probability of producing a plant with green pods if two plants both heterozygous for pod color, are crossed?

a. $\frac{1}{4}$

b. $\frac{1}{2}$

c. $\frac{3}{4}$

d. 1