

Keystone Practice Questions Set #2


- Cell Division, DNA & RNA, Mendelian Genetics, Human Genetics
- Module 2

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.

B. Mitosis occurs only in eukaryotic cells.

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

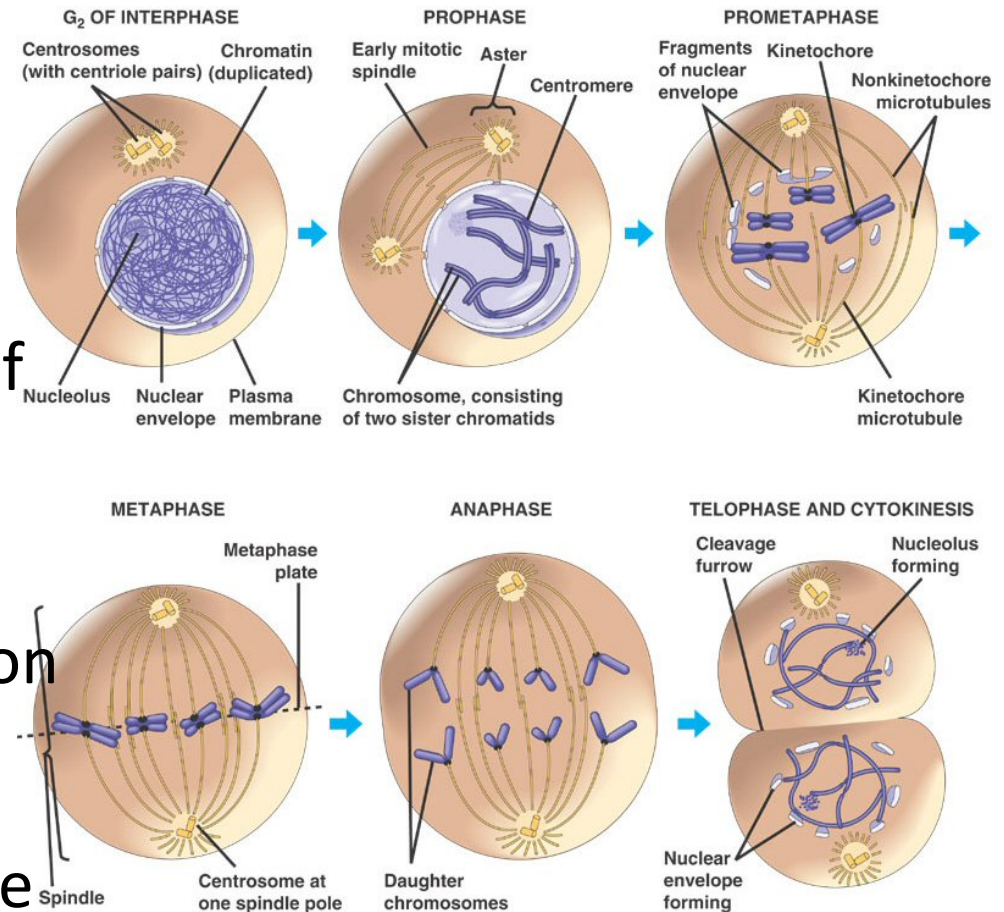
 D. Mitosis produces genetically identical daughter cells. *Meiosis produces genetically different cells as a result of crossing over and chromosome shuffling*

Cell Division (Mitosis)

Cell division results in two identical *daughter cells*.

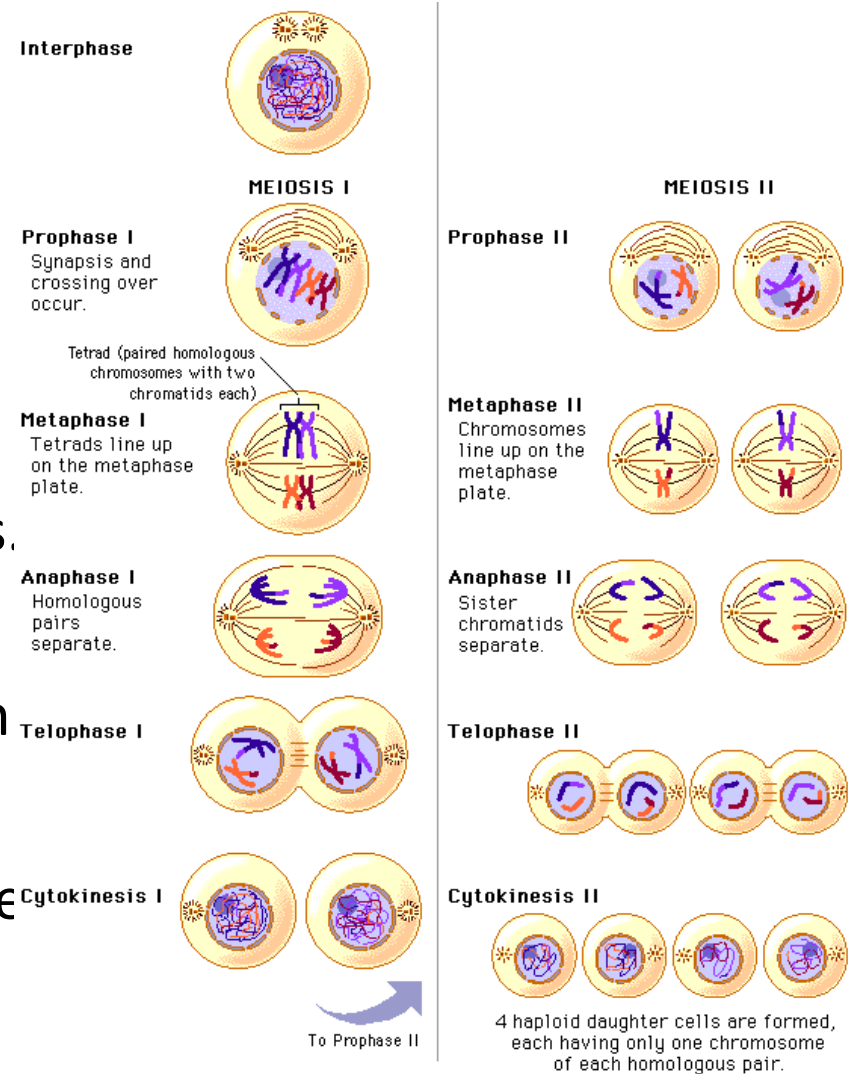
The process of cell divisions occurs in three parts:

- **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](#)



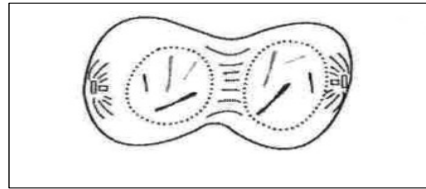
Meiosis

- 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



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 .

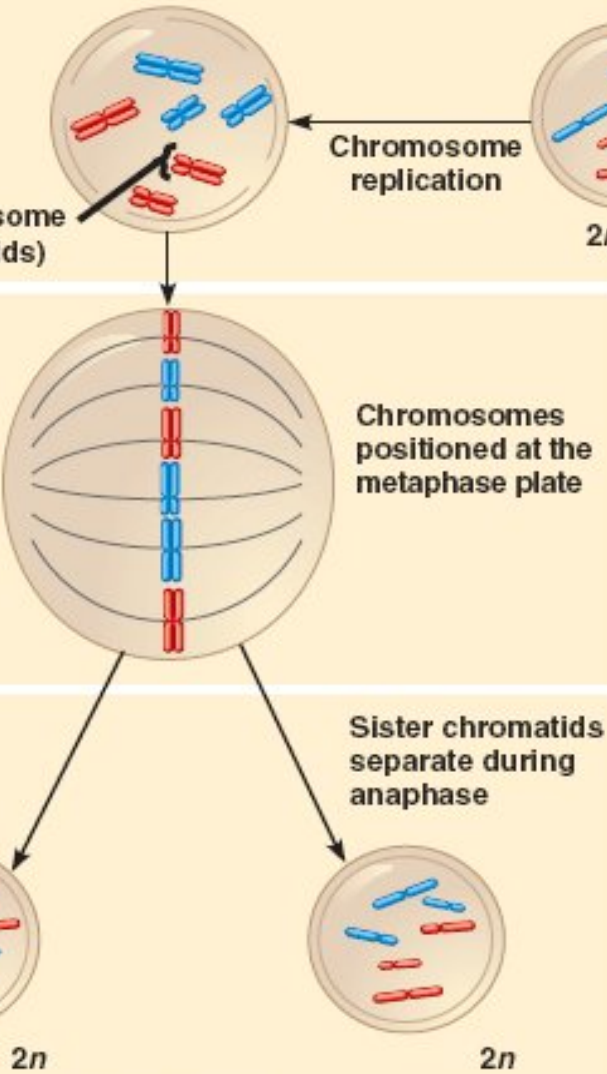
MITOSIS

Prophase

Duplicated chromosome (two sister chromatids)

Metaphase

Anaphase
Telophase



MEIOSIS

MEIOSIS I

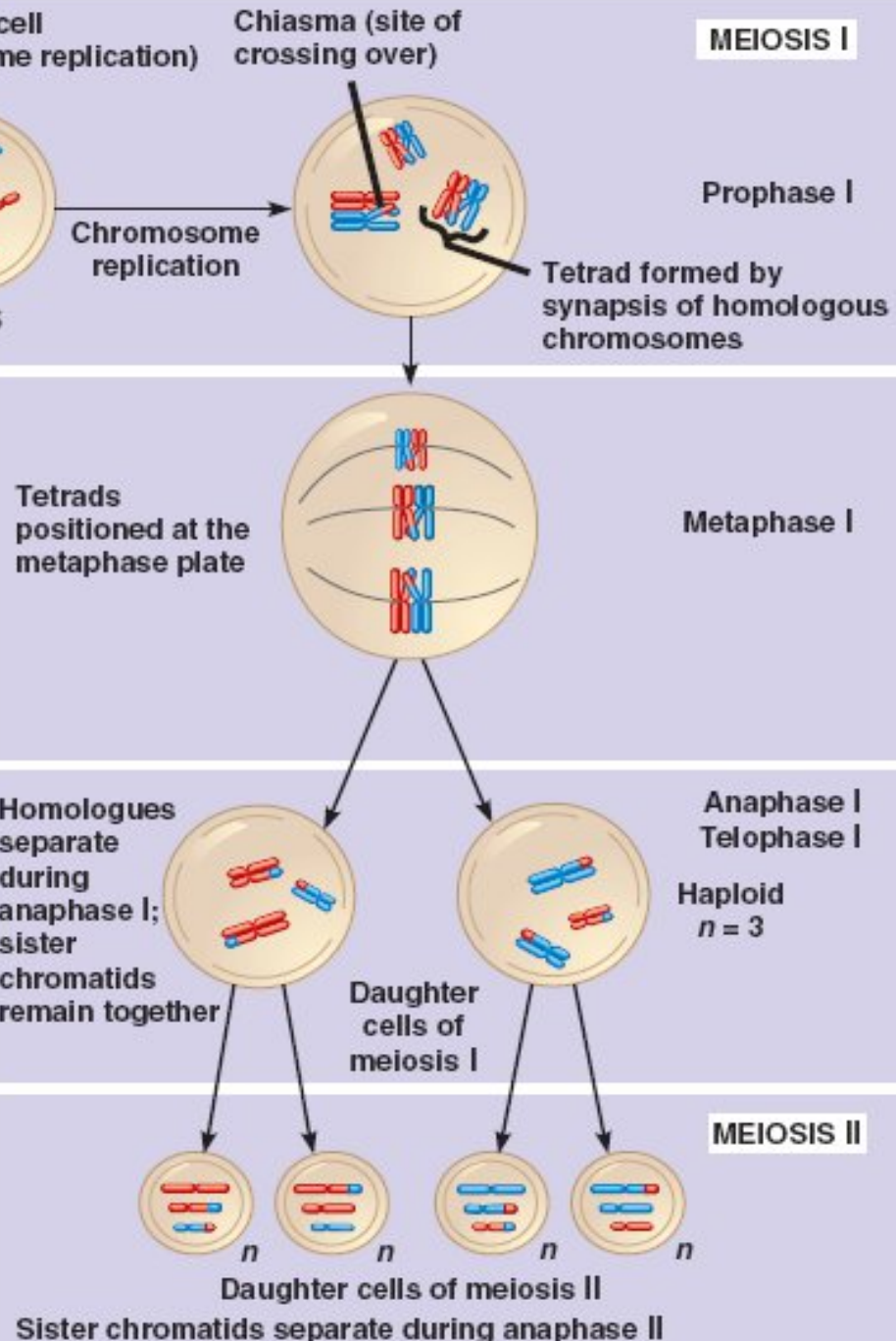
Prophase I

Metaphase I


Anaphase I
Telophase I

Haploid $n = 3$

MEIOSIS II

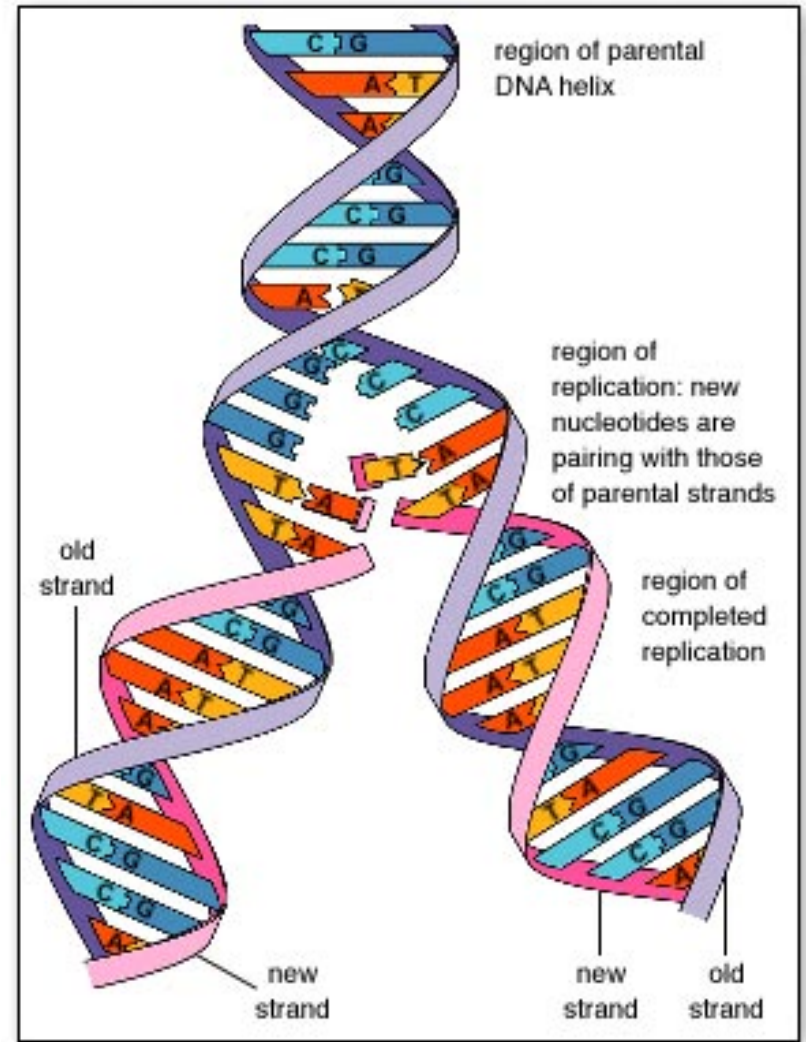


3.) Which process helps to preserve the genetic information stored in DNA during DNA replication?

- 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.

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 statement describes a cell process that is common to both eukaryotic and prokaryotic cells?

A. Both cell types carry out transcription in the nucleus

 B. Both cell types use ribosomes to carry out translation

C. Both cell types assemble amino acids to carry out transcription

D. Both cell types carry out translation in the endoplasmic reticulum

Transcription/Translation in Pro and Eu Cells

- Prokaryotic cells do not have a nucleus or other membrane-bound organelles.
- Both eukaryotic and prokaryotic cells have ribosomes that make proteins.

5. The endoplasmic reticulum is a network of membranes within the cell, and it is often classified as rough or smooth, depending on whether there are ribosomes on its surface. Which statement best describes the role of rough endoplasmic reticulum in the cell?

A. It stores all proteins for later use

B. It provides an attachment site for larger organelles

 C. It aids in the production of membrane and secretory proteins

D. It stores amino acids required for the production of all proteins

Rough ER and Ribosomes

- Ribosomes that are attached to the rough ER produce proteins that are destined to be exported from the cell=secretory proteins
- Proteins that can be found in the plasma membrane are considered exports
- Free-floating ribosomes in the cytoplasm produce proteins that are meant to stay and be used inside the cell

6. A genetic mutation resulted in a change in the sequences of amino acids of a protein, but the function of the protein was not changed. Which statement best describes the genetic mutation?




- A. It was a silent mutation that caused a change in the DNA of the organism
- B. It was a silent mutation that caused a change in the phenotype of the organism
- C. It was a nonsense mutation that caused a change in the DNA of the organism
- D. It was a nonsense mutation that caused a change in the phenotype of the organism

DNA Mutations

- A nonsense mutation alters the DNA so that the resulting amino acid sequence is unrecognizable and may create a nonfunctioning protein.
- A silent mutation alters the DNA so that the amino acid sequence does not change or the changed amino acid does little to affect the overall protein structure.

7.) 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.**

8. Use the table below to answer the question.

Genotype(s)	Phenotype
ii	O
$I^A I^A$, $I^A i$	A
$I^B I^B$, $I^B i$	B
$I^A I^B$	AB

Blood type is inherited through multiple alleles, including I^A , I^B , and i . A child has type A blood. If the father has type AB blood, what are all the possible phenotypes of the mother?

A. Phenotypes O or A

B. Phenotypes A or AB

C. Phenotypes A, B, or AB

 D. Phenotypes O, A, B, or AB

Blood Type

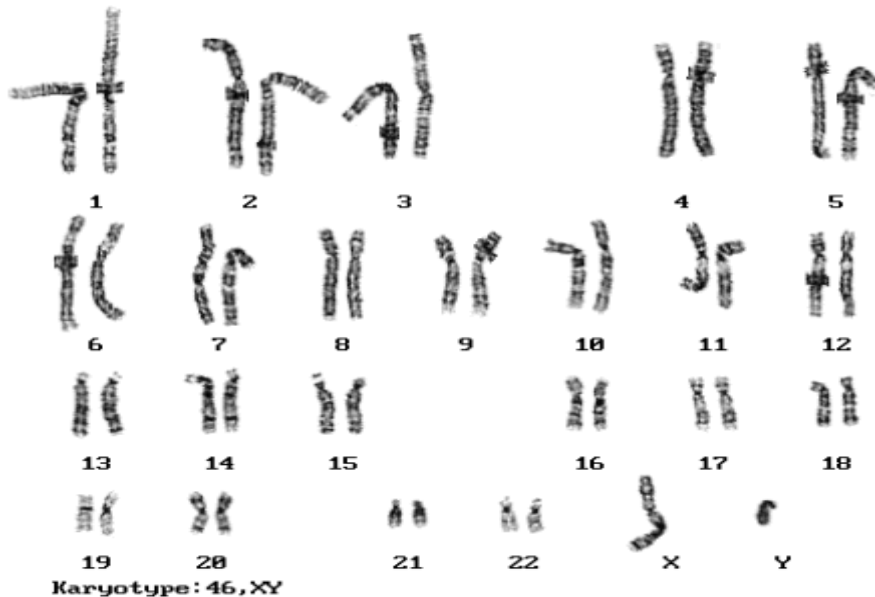
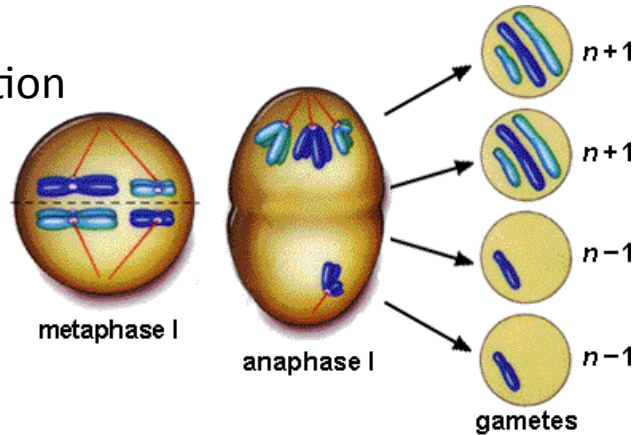
- The father must give his I^A allele or else the child would not have type A
- The mother could be any of the blood types.
- If the mother is O she has ii , either of these could produce a child with type A
- If the mother has A should could have the genotype $I^A i$ or $I^A I^A$, if the child inherits i or I^A it will have type A
- If the mother has B should could have the genotype $I^B i$, she could give the i allele and the child will have type A blood.
- If the mother is AB she would have to give the I^A allele so the child will have type A

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

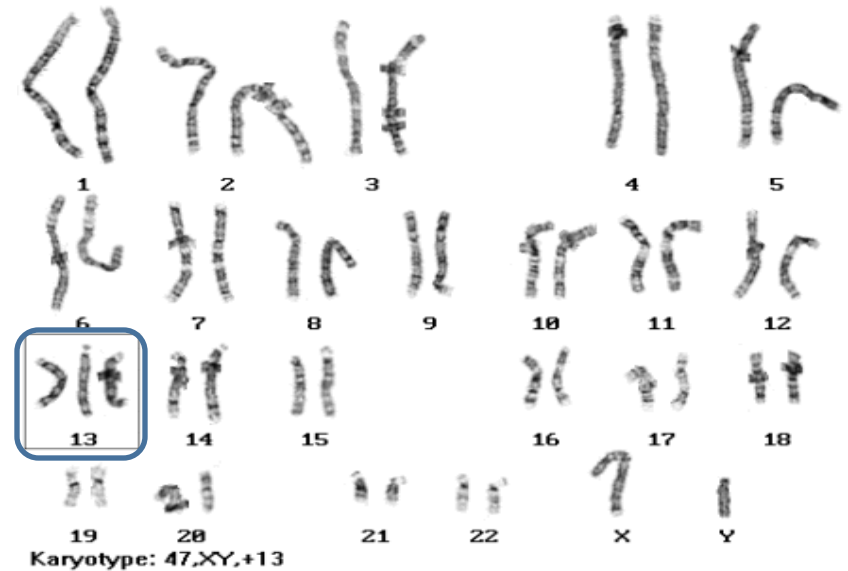
- **Part A:** Identify the step during the process of meiosis when chromosomes would **most likely** fail to separate.
- *Most likely **chromosomes would fail to separate during anaphase I or Anaphase II.** In anaphase, chromosomes (anaphase I) or sister chromatids (anaphase II) are supposed to separate, 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.*

Nondisjunction and Patau's syndrome

Nondisjunction



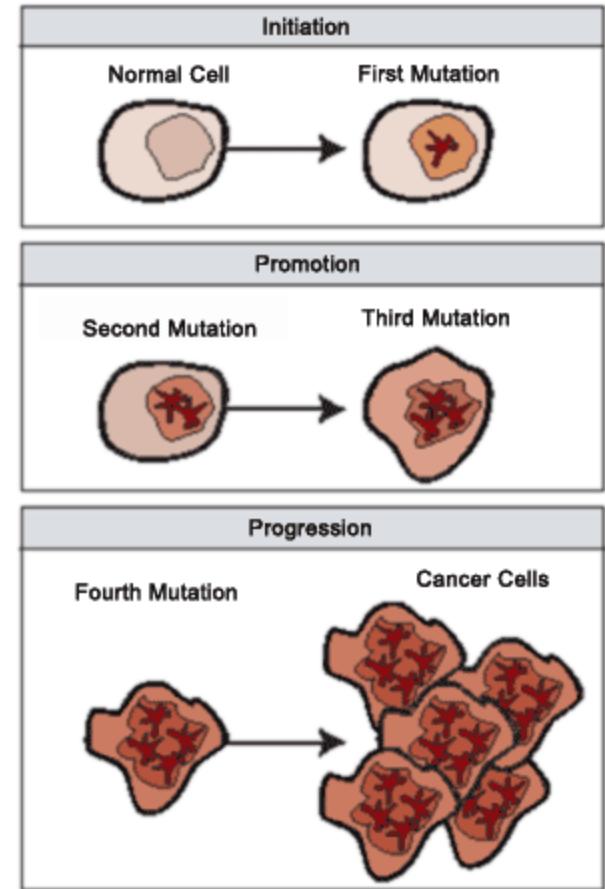
Karyotype of a normal male



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

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.*



10. A cattle farmer genetically crosses a cow (female) with a white coat with a bull (male) with a red coat. The resulting calf (offspring) is roan, which means there are red and white hairs intermixed in the coat of the calf. The genes for coat color in a cattle are codominant.

- **Part A:** Although a farm has cattle in all three colors, the farmer prefers roan cattle over white or red cattle. Use the Punnett square to show a cross that would produce only roan offspring.
- **Part B:** Explain how a roan calf results from one white and one red coated parent. In your explanation, use letters to represent genes. Be sure to indicate what colors the letter represent.
- **Part C:** Predict the possible genotypes and phenotypes of the offspring produced from two roan cattle.

Codominant Inheritance

Part A

	R	R
R'	RR'	RR'
R'	RR'	RR'

Part B:

In cattle, R is the red allele and R' is the white allele. Since this is a codominant trait, when both alleles are present, both are expressed in the phenotype, this makes the color roan. A white cow must have the genotype R'R' and a red bull must have the genotype RR. Since each parent is homozygous, they can only pass on one allele for red and one allele for white, creating roan offspring.

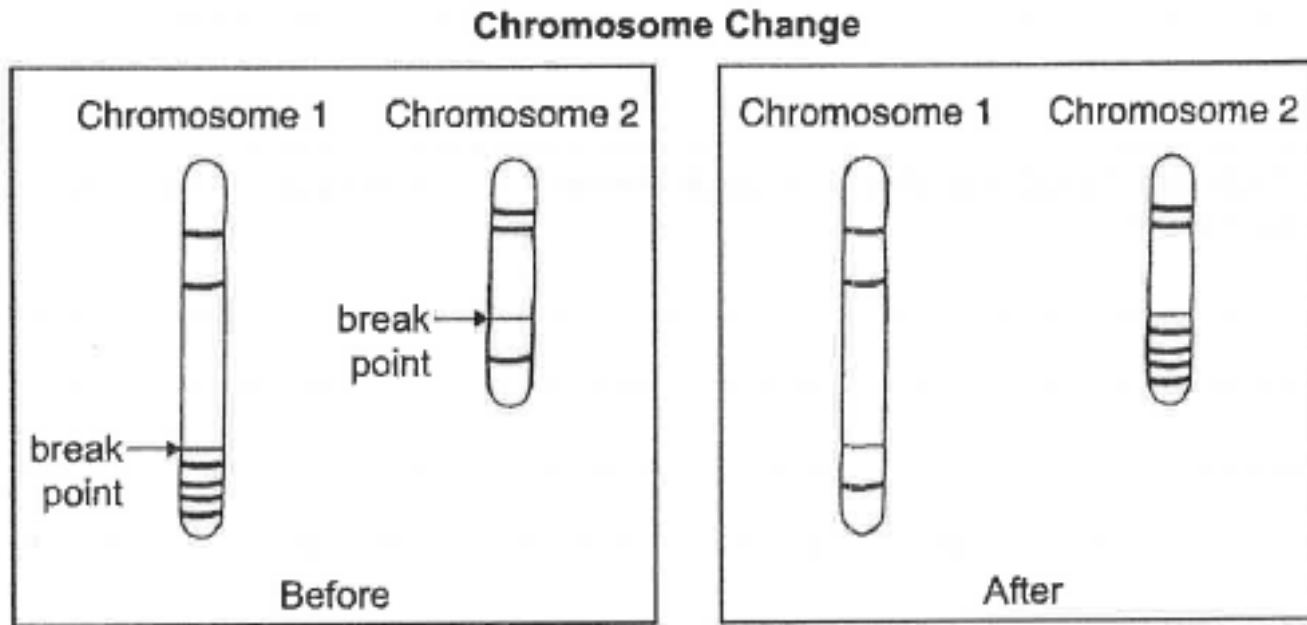
Codominant Inheritance

Part C:

If you do a Punnett square, you will find 25% of the offspring will be red, 50% will be roan, and 25% will be white.

	R	R'
R	RR	RR'
R'	RR'	R'R'

11. Use the diagram below to answer the question. Which type of change in chromosome composition is illustrated in the diagram?



A. Deletion

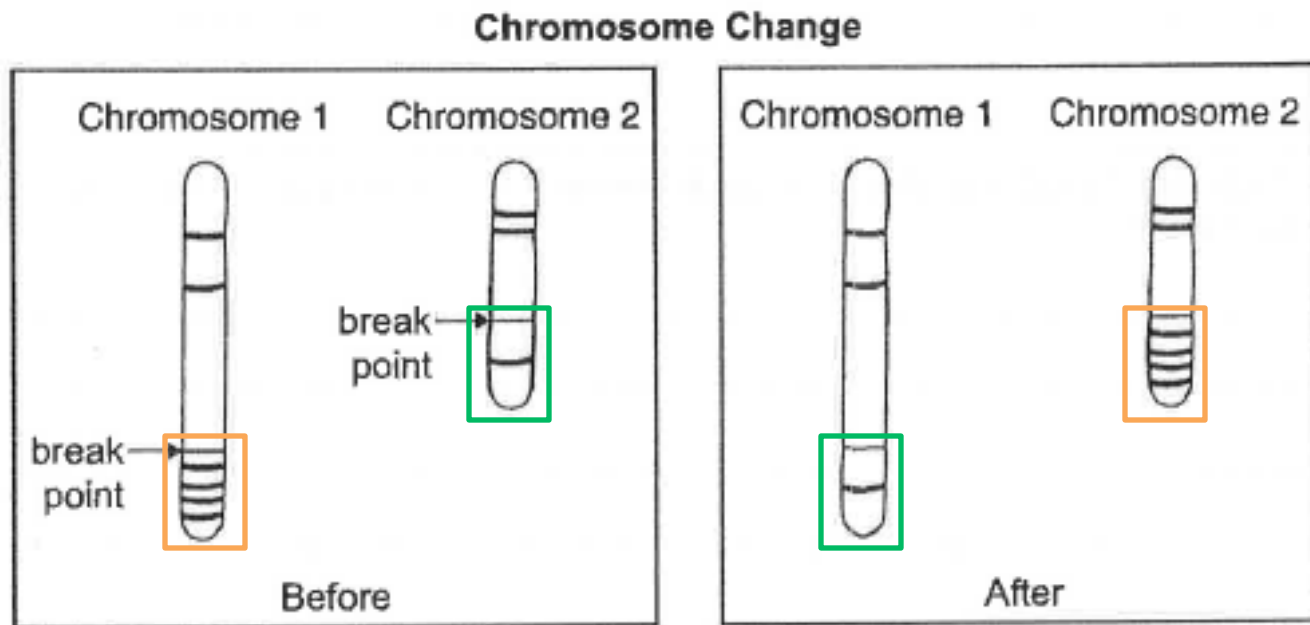
B. Insertion

C. Inversion

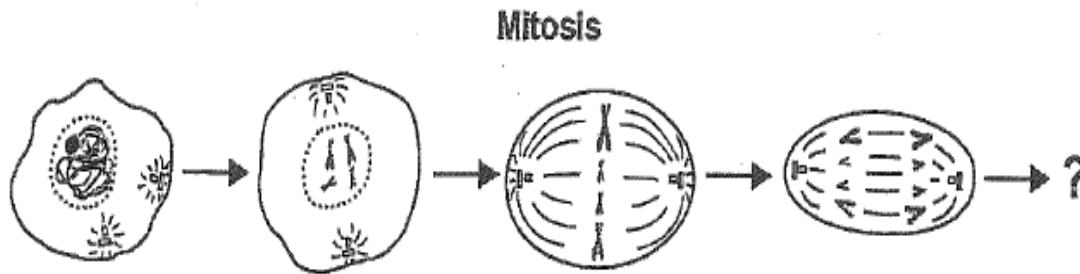
D. Translocation

Chromosome Changes

- The chromosome change seen in this diagram is translocation because a portion of DNA is being swapped between two chromosomes.



12. Use the diagram to answer the question.



Which event **most likely** occurs next in mitosis?

A. The chromatin condenses.

B. The nuclear envelope dissolves.

C. The chromosomes double in number.

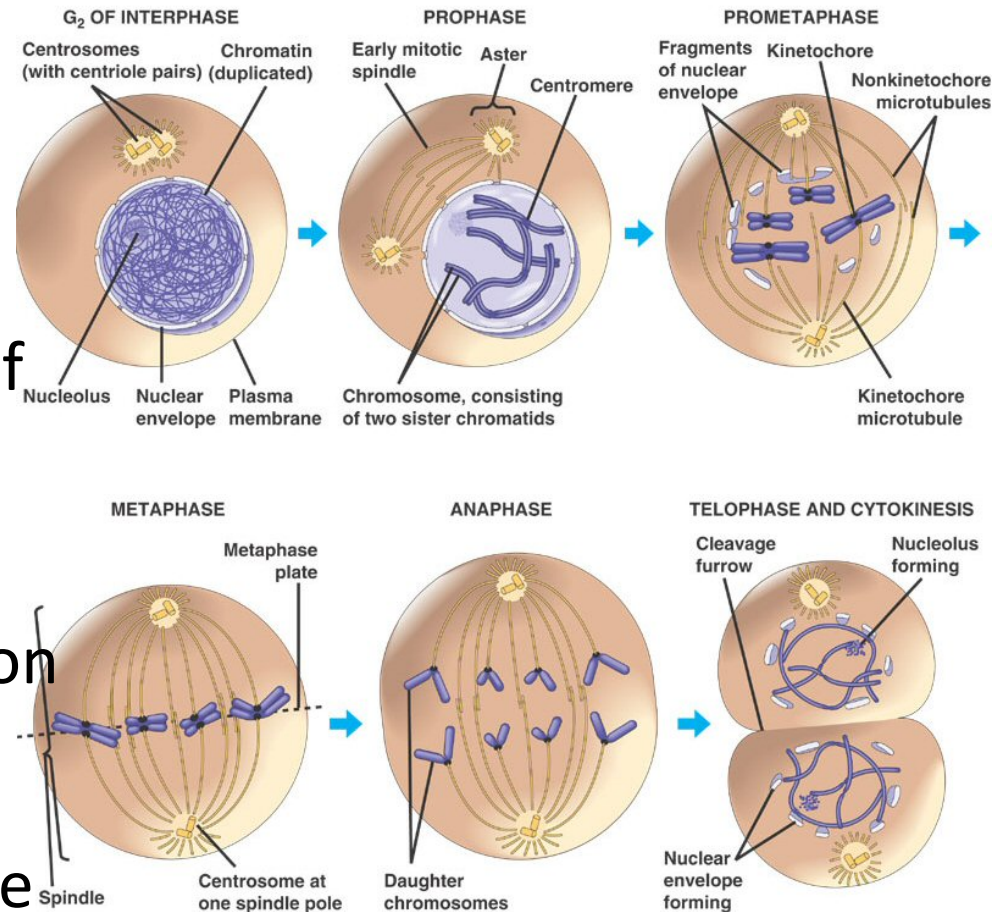
D. The cell membrane pinches inward to divide the cytoplasm.

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](#)



13. A scientist observes that a certain trait is determined by a single allele. An organism inherited one version of the trait from one parent and another version from the other parent. Both versions of the trait are expressed in the phenotype of the offspring. Which pattern of inheritance **best** classifies the observed trait?

A. dominance

B. sex-linked

C. co-dominance

D. incomplete dominance

Dominance- one version of the trait masks the other

Sex-linked- the allele is on the X chromosome

Co-dominance- both alleles are equally dominant, so both versions of the trait are expressed in the phenotype at the same time
ie. Roan coat= both red and white hairs in the coat


Incomplete dominance-the two alleles blend to make a third phenotype

14. The bacterium *Acetobacter aceti* is found in acidic environments and has an acidic cytoplasm. For this reason, most of its proteins are able to function in acidic conditions. This property distinguishes *Acetobacter aceti* proteins from those of most other organisms. Which characteristic does *Acetobacter aceti* **most likely** share with other organisms?

- A. the method that the organism uses to reproduce itself
- B. the physical and chemical responses to environmental changes
- C. the type of organelle used to produce energy for cellular functions
- D. the process used to form proteins by transcription and translation

- Since bacteria are prokaryotic, A, B, and C are not likely to be true of eukaryotes.
- Both prokaryotes and eukaryotes contain ribosomes and undergo transcription and translation.

15. A mutation occurs at the midpoint of a gene, altering all amino acids encoded after the point of mutation. Which mutation could have produced this change?

-  A. deletion of two nucleotides
- B. deletion of three nucleotides
- C. insertion of six nucleotides
- D. insertion of twelve nucleotides

- Genes (DNA) are transcribed to produce mRNA.
- mRNA is translated in segments of 3 nitrogen bases= codons
- Each codon codes for a particular amino acid
- A mutation that involves an addition or deletion of a multiple of 3 would not “alter all amino acids encoded after the point of mutation”. There would just be extra or missing amino acids.