OPHS Biology
Unit 5 Notes

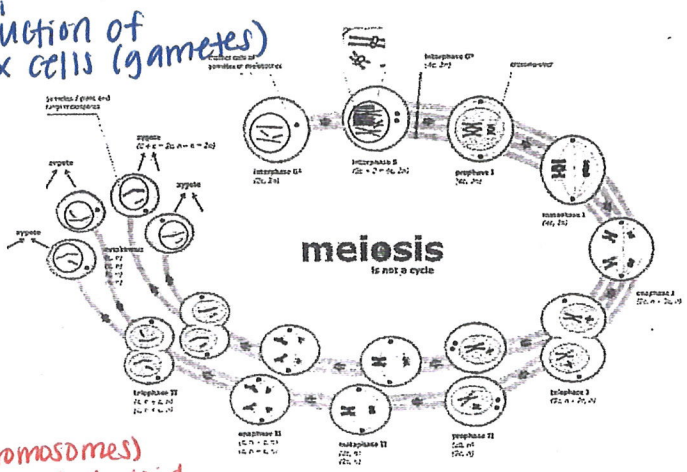
Name: _____
The Cell Cycle (Division)

Unit 5, Topic 3: Meiosis

production of sex cells (gametes)

By the end of this topic, you should be able to...

- *Compare and contrast sexual and asexual reproduction*
- *Illustrate meiosis I and meiosis II*
- *Explain fertilization of eukaryotic cells*
- *Explain production of egg and sperm cells*
- *Explain nondisjunction and read a karyotype*



Meiosis does two things

↳ 2n → n

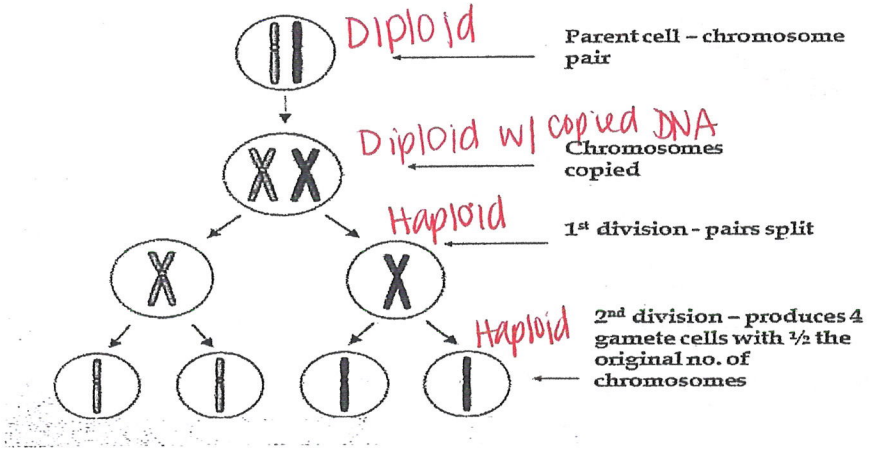
- 1) Meiosis takes a cell with two copies of every chromosome (diploid / 2n) and makes cells with a single copy of every chromosome (Haploid / n). Haploid = half the (chromosomes) DNA of diploid
  - In meiosis, one diploid cells produces _____.
- 2) Meiosis scrambles the specific forms of each gene that each sex cell (egg or sperm) receives.
  - This makes for a lot of genetic diversity. This trick is accomplished through independent assortment and crossing over.

– *Genetic diversity is important for the evolution of populations and species.* –

Why do we need Meiosis?

- Meiosis is necessary to halve the number of chromosomes going into the sex cells (in humans, body 46 → sex 23)
- Why halve the chromosomes in gametes?
  - At fertilization the male (23) and female (23) sex cells will provide ½ of the chromosomes each –

offspring receives genes from both parents (Humans = 23 mom's egg + 23 dad's sperm = 46 fertilized egg)



reduction division ↓

Meiosis I : separate homologous (genes are the same on chromosomes) chromosomes

- interphase (G1, S, G2) (THIS ONLY HAPPENS BEFORE MEIOSIS I, NOT IN BETWEEN I AND II)
  - DNA is replicated
  - The result is two genetically identical sister chromatids which remain attached at their centromeres

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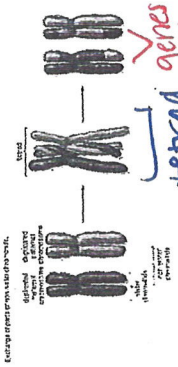
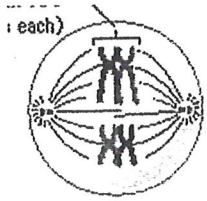
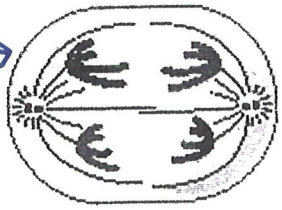
- **Prophase I** ← there are 2 rounds of division, so always include a number w/ stage name
  - During this phase each pair of chromatids don't move to the equator alone, they match up with their homologous pair and fasten together (synapsis) in a group of four called a **tetrad**
  - Extremely IMPORTANT!!! **crossing over happens here** AND ONLY EVER HERE!
  - Crossing Over is the exchange of segments during synapsis.



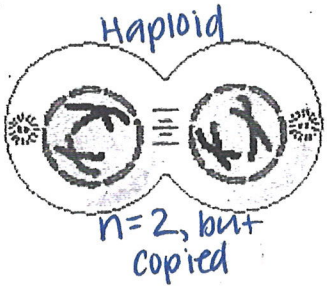
- **Metaphase I**
  - The chromosomes line up at the equator attached by their centromeres to spindle fibers from centrioles.
  - Still in homologous pairs



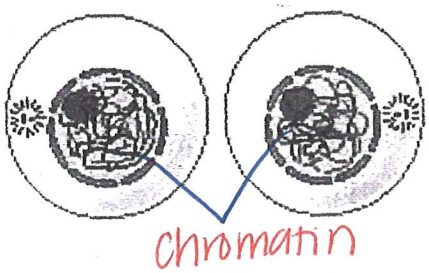
- **Anaphase I**
  - The spindle guides the movement of the chromosomes toward the poles
    1. **sister chromatids** remain attached
    2. Move as a unit towards the same pole keeping any genes that were exchanged
  - The homologous chromosome moves toward the opposite pole



- **Telophase I**
  - This is the end of the first meiotic cell division.
  - The cytoplasm divides, forming **TWO daughter cells** – NOT genetically identical.
  - Each of the newly formed cells has **half of** of the parent cell's chromosomes, but each chromosome is already replicated ready for the second meiotic cell division



- **Cytokinesis**
  - Occurs simultaneously with **telophase I**
    1. Forms 2 daughter cells
  - Plant cells – **cell plate**
  - Animal cells – **cleavage furrow**
  - NO FURTHER REPLICATION OF GENETIC MATERIAL PRIOR TO THE SECOND DIVISION OF MEIOSIS

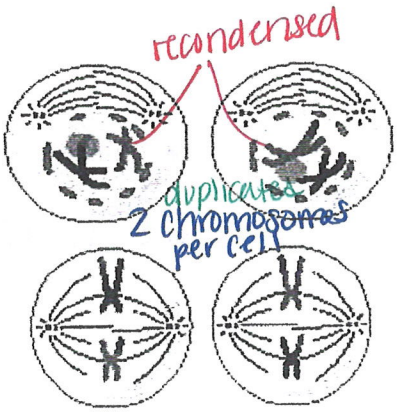


Meiosis II : separates SISTER CHROMATIDS (becoming individual chromosomes)

looks like mitosis

There is no Interphase II!!!!

- **Prophase II**
  - Each of the daughter cells forms a spindle, and the double stranded chromosomes move toward the equator
- **Metaphase II**
  - The chromosomes are positioned on the metaphase plate in a mitosis-like fashion



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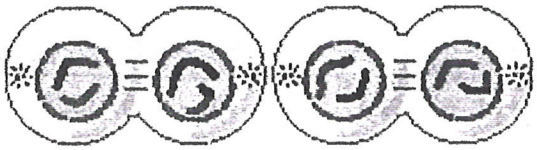
- Anaphase II
  - The centromeres of sister chromatids finally separate
  - The sister chromatids of each pair move toward opposite poles
    1. Now individual chromosomes

- Telophase II / cytokinesis
  - Nuclei form at opposite poles of the cell and cytokinesis occurs
  - After completion of cytokinesis there are four daughter cells
    1. All are haploid (n) = one set of chromosomes



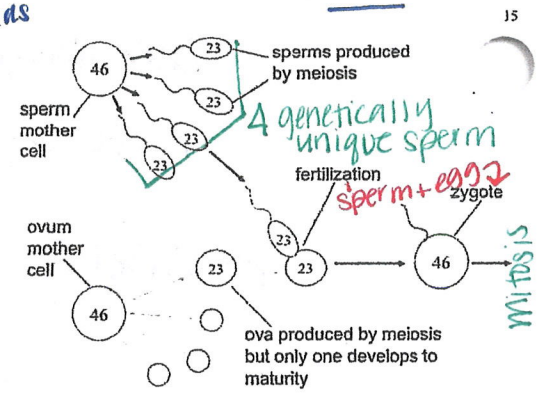
- One Way Meiosis Makes Lots of Different Sex Cells (Gametes) – independent assortment
  - Independent assortment produces 2^n distinct gametes, where n = the number of unique chromosomes.
  - In humans, n = 23 and 2^{23} = ~~6,000,0000~~.
- Another Way Meiosis Makes Lots of Different Sex Cells – crossing over
  - Crossing-over multiplies the already huge number of different gamete types produced by independent assortment.
  - Swapping genes is known as a crossing over
  - Crossovers occur while the homologous chromosomes are paired in PROPHASE I ONLY

Meiosis Summary

- Sex cells divide to produce Gametes (sperm or egg).
- Gametes have HALF the # of chromosomes. (haploid)
- Occurs only in gonads (testes or ovaries).
  - Male: Spermatogenesis (testes-sperm)
  - Female: Oogenesis (ovaries- egg)
- Meiosis is similar to mitosis with some chromosomal differences

gen/esis = origin or formation

tetrads

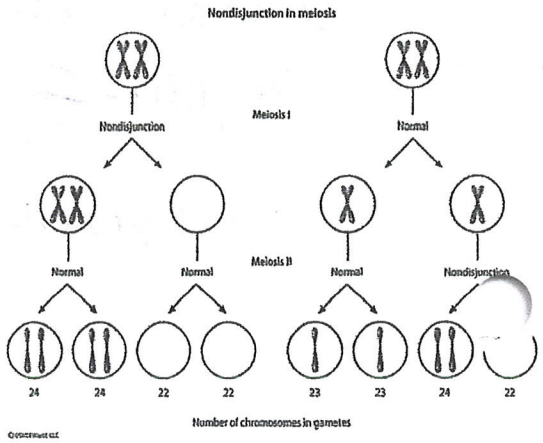


Fertilization

- The fusion of a sperm and egg to form a zygote.
- A zygote is a fertilized egg = diploid

Nondisjunction

- Occurs when chromosomes fail to separate.
- Can occur during anaphase I or anaphase II of Meiosis
- Result: eggs or sperm with the incorrect number of chromosomes
- ! If the mutated egg or sperm is fertilized, the child will have abnormalities.



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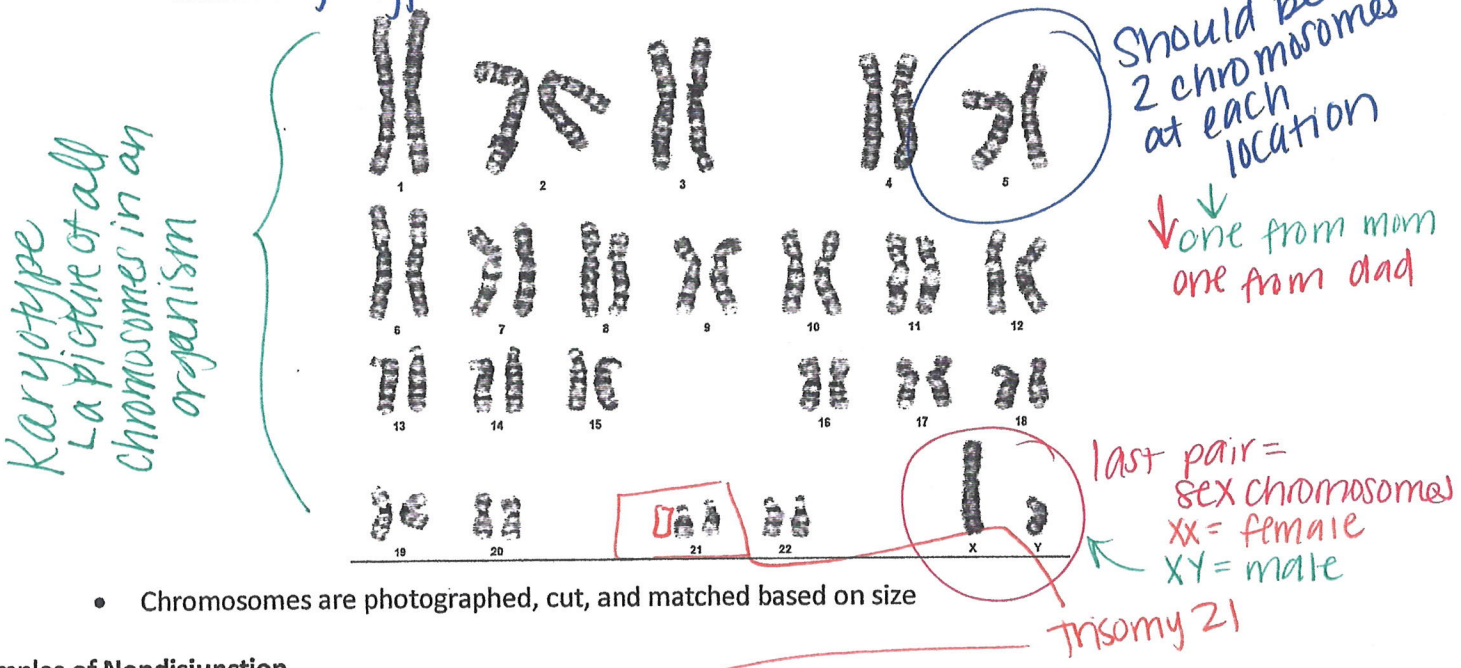
- *Note: It may also occur in anaphase of* mitosis *, but usually the abnormal cells die and the whole organism is not affected.*

- TRISOMY (tri = 3) :Each cell has an **extra** chromosome
- MONOSOMY (mono = 1) :Each cell has **one less** chromosome
- Karyotype : can detect chromosomal abnormalities



- Chromosomes are photographed, cut, and matched based on size

amples of Nondisjunction

- Trisomy 21 → Down Syndrome
- Trisomy 13 → Patau Syndrome
- Turner Syndrome → only has an X in pair 23 (missing another sex chromosome)
- Klinefelter Syndrome → has XXY (an extra sex chromosome)

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DO ON OWN

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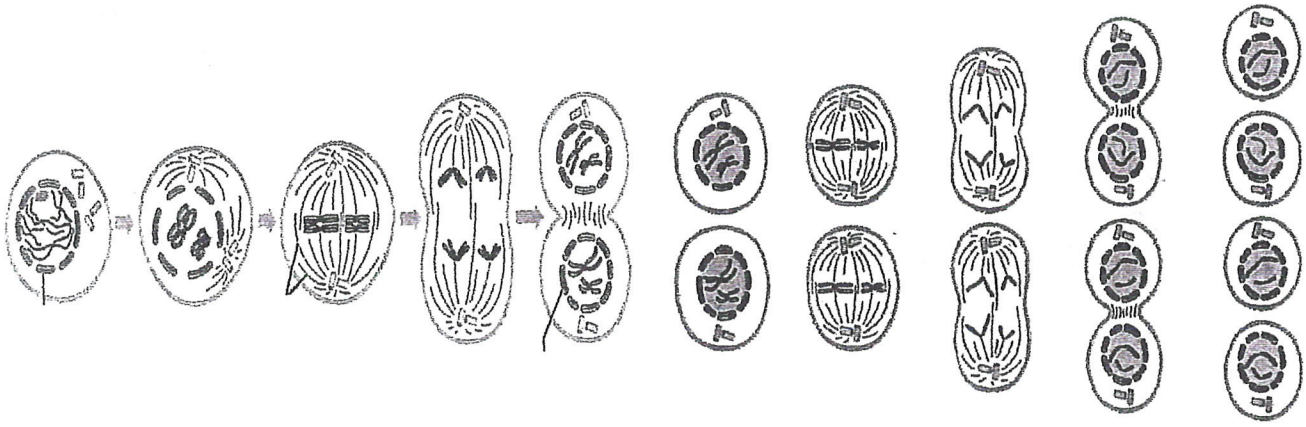
[[Language Target for Topic 3: I can create a Venn Diagram to compare and contrast sexual and asexual reproduction; I can diagram the stages of Meiosis I and provide written descriptions for each stage; I can diagram the stages of Meiosis II and provide written descriptions for each stage; I can explain how meiosis creates egg and sperm cells; I can locate an abnormality on a karyotype and explain how nondisjunction caused it.]]

1. Complete the following table comparing sexual and asexual reproduction:

	Asexual Reproduction		Sexual Reproduction	
Number of parents				
Genetic info compared to the parents	Same	Different	Same	Different
Complexity of organism that uses this method	Simple	Complex	Simple	Complex
Example of an organism that uses this method				

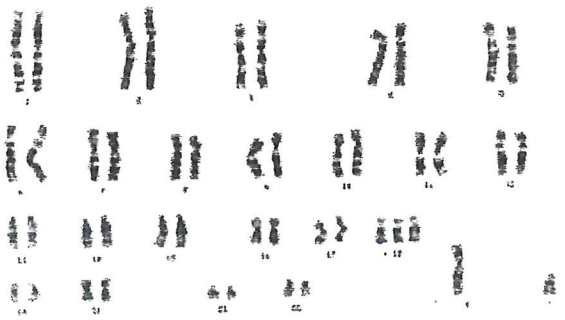
Provide an advantage for asexual reproduction: _____
Provide an advantage for sexual reproduction: _____
Provide a disadvantage for asexual reproduction: _____
Provide a disadvantage for sexual reproduction: _____

2. Label each stage of meiosis in the following diagrams:



3. Why must egg and sperm cells be haploid?

4. Analyze the following karyotype:



Sex of individual: _____

Normal/Trisomy/Monosomy: _____

If tri- or monosomy, on which chromosome? _____