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**Unit 4a: Mitosis**

**Structure of DNA**

1. Centromere – structure that holds two identical DNA molecules together
2. Chromatid – each individual molecule of DNA
3. Sister chromatids – identical molecules of DNA
4. Chromosomes – contains DNA (genetic material) that are passed from one generation to another

**DNA Packing (Supercoiling) & Unpacking**

* DNA is a very long molecule which make proteins

(We can’t see it)

* + In order to make proteins the code (letters) needs to be visible
* The DNA begins to supercoil by wrapping around proteins and folding itself. This is called Chromatin. (we can see it)
  + When Chromatin are wrapped on itself it turns into an “X” shape known as a Chromosome.

**Why does a cell need to divide?**

1. Growth - creating more cells of an organism
2. Embryonic development – creating cells in order for a embryo to develop
3. Tissue repair – create new cells because the existing cells are damaged
4. A sexual reproduction – creating new identical cells (example – bacteria in binary fission )

**Why does a cell need to divide?**

* Ratio of surface area to volume limits the size of a cell
* The greater the volume the smaller the ratio of surface area to volume. This ratio limits how large cells can be (ratio begins at 6 then to 3 then to 1.5 then to 1)
* As cells grow, the amount of surface area becomes too small to allow materials to enter & leave the cell
* Smaller cells are more efficient at exchanging materials (diffusion is fast & efficient over short distances)

**What are Chromosomes?**

* Human cells have 46 Chromosomes

1. Humans get 23 from the mother and 23 from the father.
2. The DNA is copied before it is wrapped into a chromosome.
3. Before cell divides each DNA supercoils into a chromosome
4. One side of the chromosome is the original chromosome
5. The other side of the chromosome is the copy of the original chromosome.

**The Cell Cycle= Interphase & Mitosis**

Interphase – before mitosis (longest phase in the cell cycle)

* **G1 phase**
* cell growth
* production of new organelles
* **S phase = Double the DNA**
* DNA replication (duplicate)
* **G2 phase**
* cell prepares to divide
* finishes growing
* DNA begins to condense (supercoiling)

The M (Mitosis) Phase

* **Prophase**
  + Chromosomes shorten, thicken and become visible
  + Nucleus and other organelles break down and disappear
  + Organelles called *Centrioles* begin to make spindle fibers
* **Metaphase**
  + Spindle fibers become present and attach to centromeres of chromosome pairs
  + Chromosomes line at center cell (metaphase plate = equator)
* **Anaphase**
  + The *Chromatids* are pulled apart towards polar ends of the cell
* **Telophase**
  + New nuclei form around each set of chromosomes
  + Two new cells start to take shape
  + Chromosomes begin to make proteins
* **Cytokinesis**
  + In animal cells
    - Animal cells undergo cytokinesis by pinching off along their equator
    - This works because their membrane is flexible
  + In Plant cells
    - Plants have a cell wall which makes things more challenging
    - Plants send vesicles filled with cell wall material to their equator where they fuse together
    - This fusion creates cell plates that fuse with the cell wall separating the two cells

When Mitosis doesn’t stop

* Cancer occurs
* Results in tumors forming throughout the body
  + A tumor is a bunch of cells in one area of the body that keep dividing
  + These cells can then move on to other parts of the body causing tumors to develop in other regions
* Cancer kills by causing your organs to malfunction

Body Cells vs. Sex Cells

* **Somatic cells are body cells**
  + Make up most of your body cells
  + These are diploid (2n)
    - Have two sets of chromosomes
    - 1 set from father an d1 set from mother
* **Gametes = sex cells (sperm/egg cells)**
  + These are haploid (n)
    - Have only one set of chromosomes
* **Types of Chromosomes**
  + Autosomes: contain genes not associated with sex
  + Sex chromosomes: directly control sexual traits

**Unit 4b: Meiosis**

Meiosis – The Creation of Sex Cells

* **Interphase (G1, S, G2/0**
  + All your cells start off all diploid cells (2n): cell with two of each kind of chromosome (in humans = 46 [23 from each parent])
  + G1 : cell grows; DNA is long and stringy and is not visible. (so the DNA can be copied)
  + S :DNA gets replicated (copied)
  + G2: cell continues growing and prepares to divide

Meiosis 1

* **Prophase** I
  + The chromatin wind- up, creating chromosomes which can now be seen.
  + Centrioles create spindle fibers
  + Nuclear envelope disappears
  + Each chromosome pair hen actively seek out its homologous chromosome pair
    - Homologous pairs are the same size and shape
    - This is called a tetrad (4 chromatids)
    - Crossing over will now happen.
      * Where two non-sister chromatids exchange genetic material
* **Metaphase I**
  + The spindle fibers attach to the centromere on each chromosome pair
  + Homologous chromosomes are lined up on the metaphase plate (euquator)
  + 2 rows of 23 chromosome pairs = 46 pairs total
* **Anaphase I**
  + The tetrad gets pulled apart = homologous chromosomes separate
    - Chromatids do not get pulled apart yet1
    - Each homologous chromosome moves to opposite poles

End of Meiosis I

* Two cells are created each with 23 chromosome pairs
* Prophase II
  + Each dyad (2 chromatids = 1 chromosome pair) are connected by a centromere
  + Nuclear envelope disappears
  + The centrioles create spindle fibers again

Meiosis II

* **Metaphase II**
  + The spindle fibers attach to the centromere on each dyad (I chromosome pair = 2 chromatids)
  + The dyads are lined up on the metaphase plate (equator) by the spindle fibers
  + 1 row of 23 chromosome pairs in each cell
* **Anaphase II**
  + The individual sister chromatids from each dyad get pulled apart by the spindle fibers
  + Each sister chromatid ends up on opposite poles of the cell
* **Telophase II / Cytokinesis**
  + The shape of the cell changes, beginning to form two cells
  + New nuclei form around each sets of chromosomes
  + The cytoplasm of both cells divides once again
  + Four gametes (sex cells) are now created

End of Meiosis II

* Four unique haploid cells are created, each with a half set of chromosomes compared ti the original (Original Parent cell had 46, each daughter cell has only 23 chromosomes
* Haploid (n) : cell with only 1 kind of each kind of chromosome (in humans = 23 chromosomes)