

Unit 5, Topic 1: DNA Organization

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

1. Identify the parts of a chromosome
2. Explain why DNA has to copy and coil before cell division
3. Explain why cells cannot continue to grow forever
4. Explain how prokaryotes reproduce (binary fission)

Organization of Genetic Material

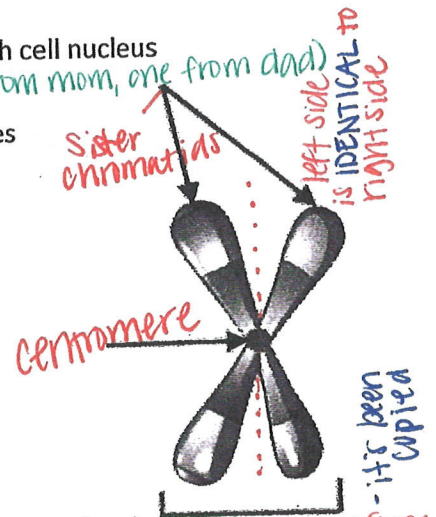
- All the DNA in a cell constitutes the cell's Genome
- A genome can consist of a number of DNA molecules (humans: about 3 billion base pairs)
- DNA molecules in a cell are packaged into chromosomes
- Eukaryotic chromosomes consist of chromatin (see image) a complex of DNA and protein that condenses during cell division
- Every eukaryotic species has a characteristic number of chromosomes in each cell nucleus

How many chromosomes are in humans? 46 (23 pairs - 1 set from mom, one from dad)

- Non-reproductive cells have two sets (diploid) of chromosomes

DNA terms (LABEL THE IMAGE TO THE RIGHT!)

- In preparation for cell division, DNA is replicated and the chromosomes condense
- Each duplicated chromosome has two sister chromatids (condensed) which separate during cell division
- The centromere - is where the two chromatids are most closely attached



Chromatin and Condensed Chromosome Structure

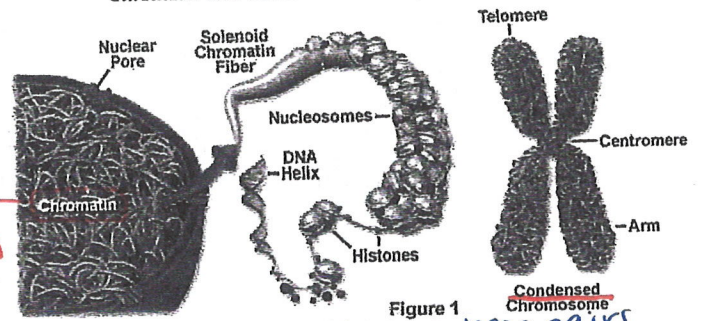


Figure 1

somatic cells
Body cells

loose, uncoiled (interphase)

Growth vs. Division

- When an animal or plant grows, what happens to its cells? Does an animal get larger because each cell increases in size (grows) or because it produces more of them?
It's growing because it has MORE cells - it's cells are dividing, producing more cells (which takes more space = growth)

Why can't cells grow forever?

- REASON #1:** NOT enough DNA. As the cell increases in size, it keeps the same amount of DNA. Eventually the cell will grow too much for the DNA to control all its activities

- What is "DNA Overload?" The cell has TOO MANY tasks for the DNA to efficiently control (like building proteins); too many tasks, too little DNA
- Why do we age? many reasons, but one is that when cells divide, the ends (telomeres) become shorter & shorter (eventually stop dividing)

NOT TESTED →

- REASON #2:** SURFACE area of membrane doesn't increase as quickly as cell VOLUME
- Too little membrane → not enough exchange of materials in and out of the cell

Solution

- Smaller cell: larger: volume (cytoplasm/inside) grows FASTER than surface area (membrane)
- Before a cell becomes too large, it divides to form 2 daughter cells
- This process is called cell division

↳ they are genetically identical

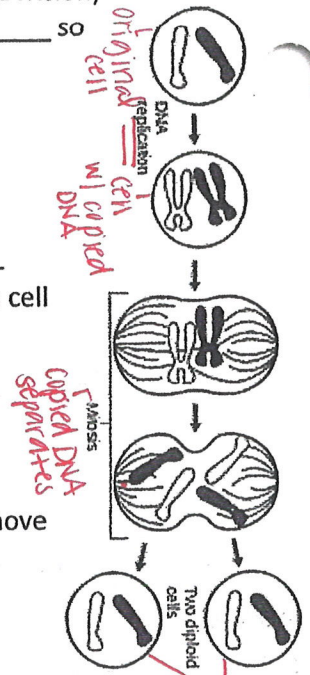
- Cell division can only happen once a cell has made a copy of DNA so that each daughter cell can have a full genetic library

Why Divide?

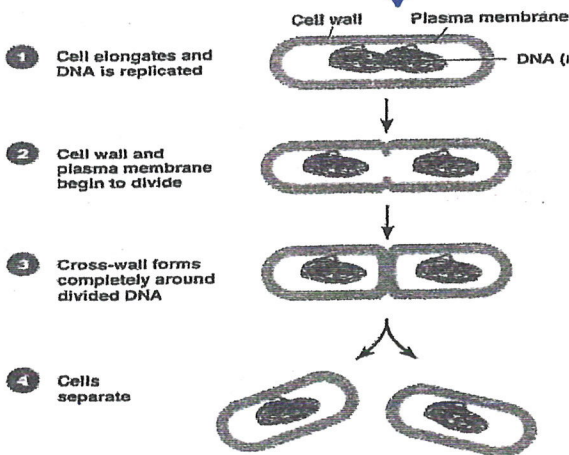
- Multicellular organisms depend on cell division for Growth (1st page), repair (skinned knee, broken bone) and development from a fertilized cell
- Cell division is an integral part of the cell cycle, the life of a cell from formation to its own division all parts of a cell's life

Binary Fission in Bacteria = simplistic version of cell division

- Prokaryotes (bacteria and archaea) reproduce by a type of cell division called Binary fission (Bi=2, fission=split) each cell is an organism
- In binary fission, the DNA replicates, and the two daughter chromosomes actively move apart
- The cell membrane pinches inward, dividing the cell into two one parent, 2 identical offspring

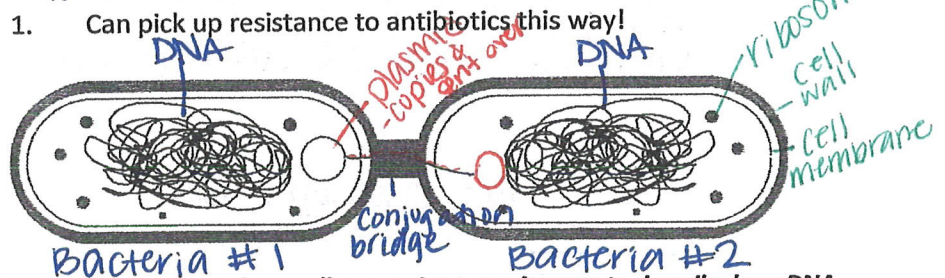


Bacterial Reproduction (binary fission)



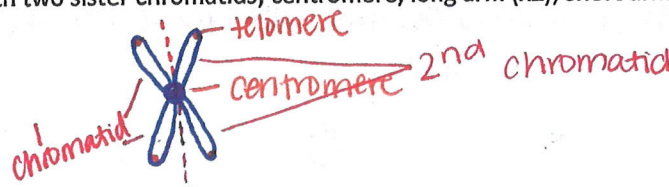
{a} A diagram of the sequence of cell division.
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- Binary Fission (ASEXUAL): cell parts reproduce and cell divides in half no genetic variation
- The most common form of bacteria reproduction
- Produces genetically identical daughter cells. only b/c there's sharing of DNA
- Conjugation (SEXUAL): exchange of genetic material (plasmid) between two bacterium
- One bacterium transfers the plasmid to the other bacterium through the conjugation bridge. extra/nonessential DNA
- This produces genetic diversity in bacteria that may increase chances of survival



[[Language Target for Topic 1: I can identify the parts of a chromosome given a diagram; I can use images to describe how DNA coils up before cell division and verbally explain the purpose.]]

- Draw and label a chromosome with two sister chromatids; centromere; long arm (x2); short arm (x2); telomere



- Explain why DNA coils up prior to cell division: