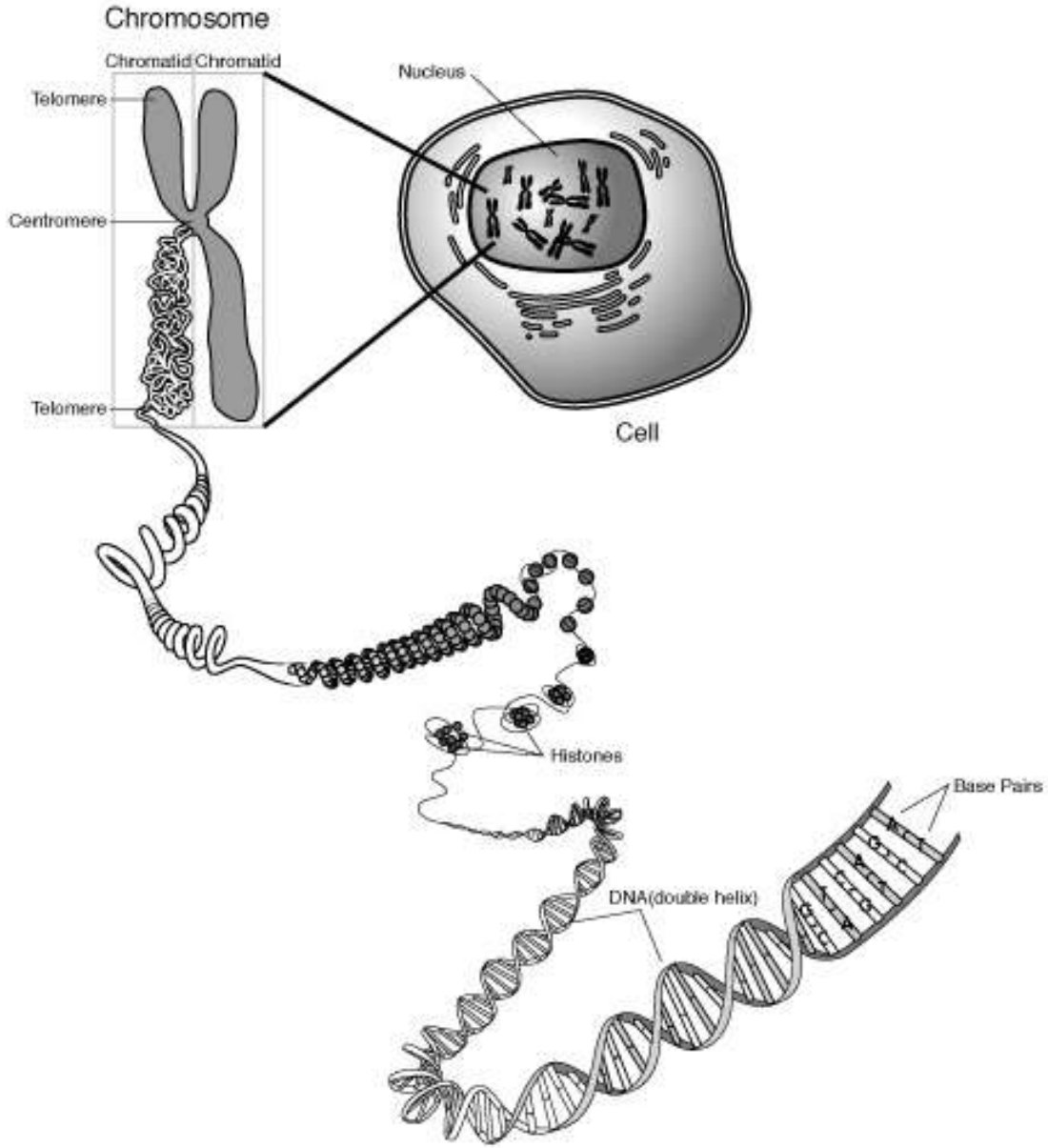
CELL REPRODUCTION

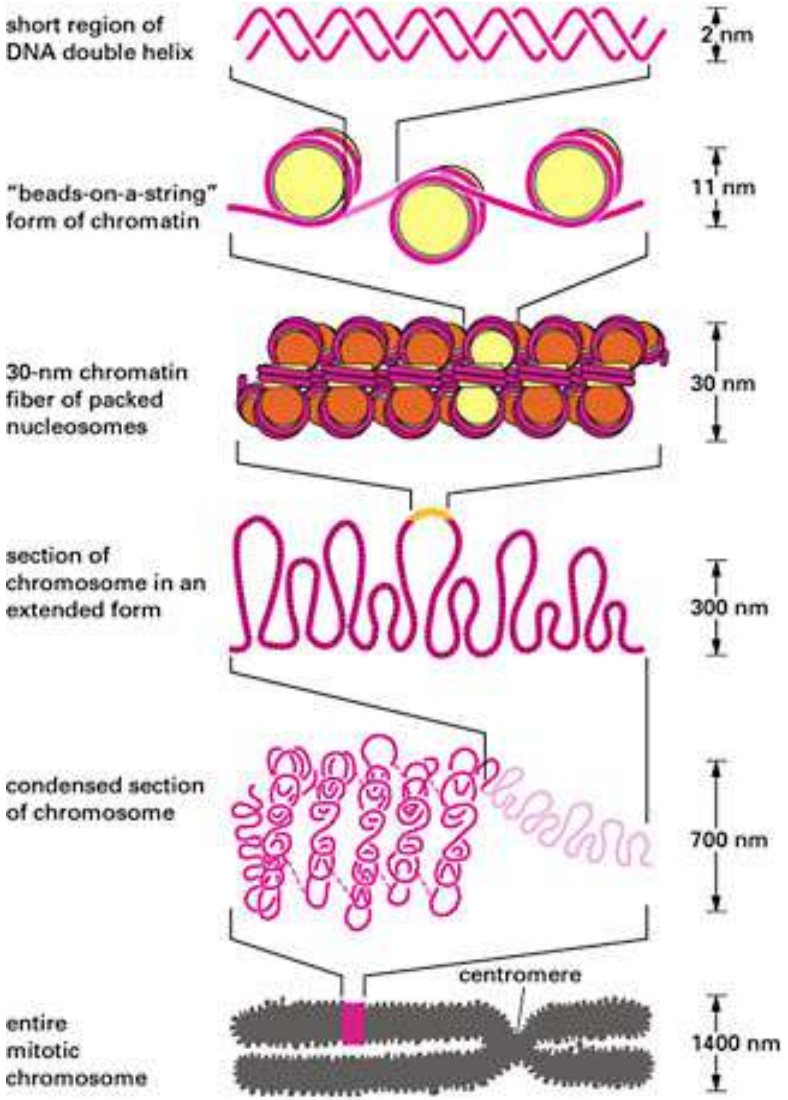
PART 1 – WHAT IS A CHROMOSOME?

CHROMOSOMES

- Rod shaped structures made of DNA and histone proteins (help maintain the shape of chromsomes and aid in DNA packaging)
- In dividing cells, chromosomes are visible inside the nucleus
- Nonhistone proteins – control activity of specific regions of DNA

- Chromosome is 2 identical halves, each half is a chromatid
- Constricted area is the centromere
- Centromere holds two identical sister chromatids together until they separate during cell division
- Once sister chromatids separate from each other, they ar3e now chromosomes again
- Chromosomes are uncoiled between cell divisions = chromatin


Chromosome
Chromatid
Chromatid
Telomere
Centromere
Telomere
Nucleus
Cell
Histones
Base Pairs
DNA(double helix)



NET RESULT: EACH DNA MOLECULE HAS BEEN PACKAGED INTO A MITOTIC CHROMOSOME THAT IS 50,000x SHORTER THAN ITS EXTENDED LENGTH

CHROMOSOME NUMBERS

- Each species has a distinctive # of chromosomes
- Does # of chromosomes indicated degree of complexity?
- Sex chromosomes determine the sex of an individual (humans, X and Y)
- All other chromosomes are autosomes

cont'd

- Every cell of an organism that reproduces by sexual reproduction has two copies of each autosome, one from each parent
- These are known as homologous pairs or homologues
- Homologues are the same size and shape and carry genes for the same traits
- Karyotype = photomicrograph of the chromosomes in a dividing cell

DIPLOID vs HAPLOID

- Diploid – two sets of chromosomes, one from each parent (2n)
- All somatic cells have the diploid number
- Reproductive cells have only one set of chromosomes and are said to be haploid
- Haploid cells have half of the diploid number (1n)
- Diploid number is restored at fertilization

CELL DIVISION

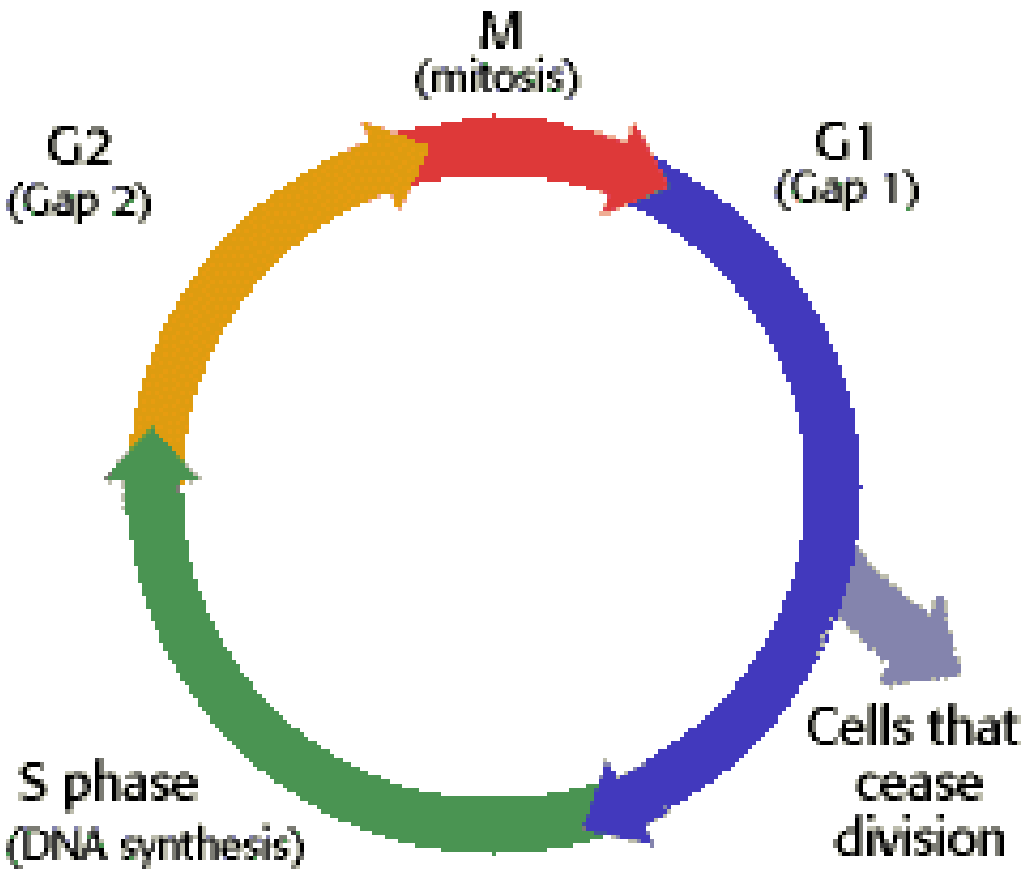
- Prokaryotes – binary fission
  - Circular chromosome makes a copy of itself; 2 identical chromosomes (circular) attached to cell membrane
  - Cell grows until 2x size; cell wall forms and cell splits into 2
  - Each new cell is genetically identical to the other

CELL DIVISION - EUKARYOTES

- Mitosis = results in 2 genetically identical cells
- Unicellular organisms use this for reproduction; growth and repair in multicellular organisms
- Meiosis – reduces chromosome number by 2 (haploid cells); division in gametes (fertilization later restores diploid number)

CELL CYCLE

http://www.cellsalive.com/cell_cycle.htm



INTERPHASE

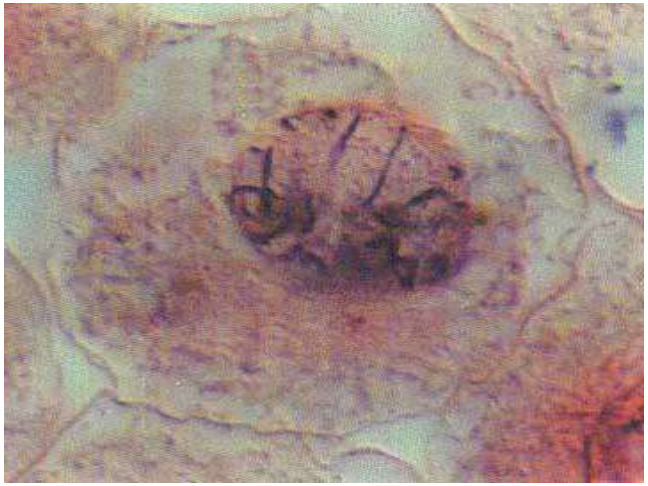
- G_1
- S
- G_2
- G_0

MITOSIS

- Division of the nucleus
- 4 stages: prophase, metaphase, anaphase, telophase
- Prophase – first stage
  - Chromatin condenses into chromosomes
  - Nuclear envelope + nucleolus disassembles
  - Centrosomes migrate to opposite sides of the cell
  - Spindle fibers radiate from centrosomes

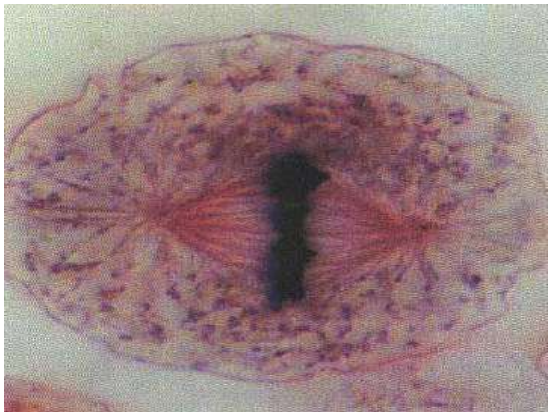
Prophase (cont'd)

- 2 kinds of fibers:
  - Kinetechore – attach to centromere
  - Polar – span cell from centrosome to centrosome



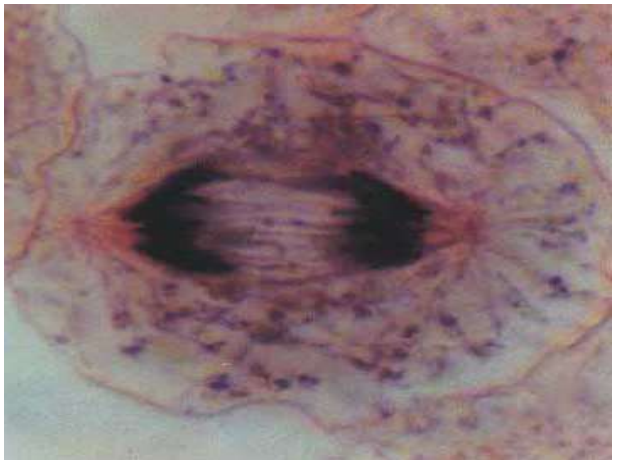
METAPHASE

- Chromosomes line up at equator of cell, courtesy of kinetechore fibers
- Karyotype made from metaphase chromosomes



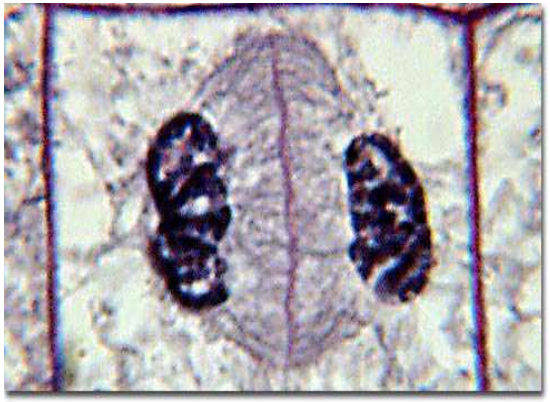
ANAPHASE

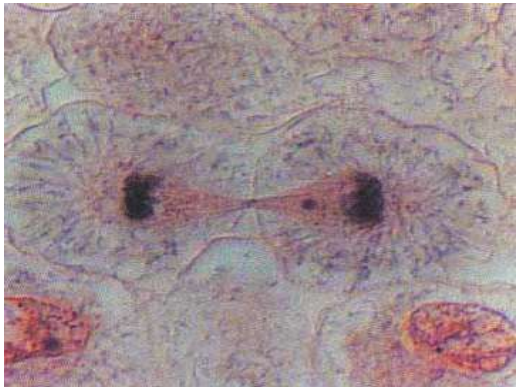
- Chromatids are pulled to opposite sides of the cell
- Chromatids are now again called chromosomes



TELOPHASE

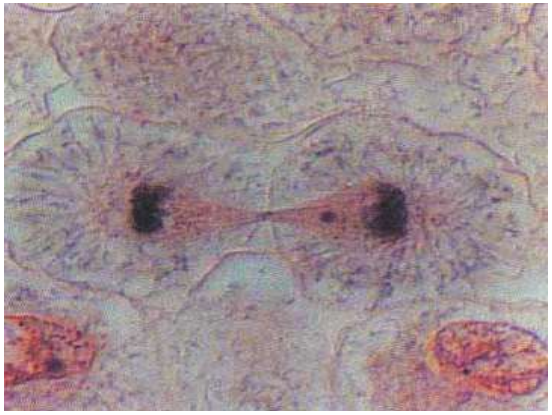
- Spindle fibers disassemble
- Chromosomes return to less coiled state (chromatin)
- Nuclear envelope and nucleolus reassemble





CYTOKINESIS

- In animal cells, cell membrane pinches in – cleavage furrow
- This divides cytoplasm and organelles between the two new daughter cells
- Eventually, two individual cells, each genetically identical result



- In plant cells, cell plate forms from fusion of Golgi vesicles

MEIOSIS

- Two stages: meiosis I and meiosis II
- Cells have gone through interphase, therefore, they have a duplicated set of chromosomes
- Two divisions, one reduces the diploid # of chromosomes to the haploid, the second separates sister chromatids into chromosome (just like mitosis)

- In Prophase I, homologues line up (synapsis)
- Each pair of homologues is a tetrad
- Crossing over may occur
- This permits exchange of genetic material between maternal and paternal chromosomes
- Results in genetic recombination

- Metaphase I, tetrads line up randomly at the midline of the cell
- Spindle fibers attach to centromeres of each homologue
- Anaphase I, each homologue moves to opposite pole of dividing cell
- This random separation of homologues is independent assortment and adds to the genetic variation of the offspring

- Telophase I = chromosomes reach opposite sides of cell and cytokinesis begins
- At the end of Meiosis I, two haploid cells, each containing ONE of each homologous pair
- BUT each chromosome is still composed of two sister chromatids

MEIOSIS II

- No replication of DNA
- Similar to mitosis (separating sister chromatids)
- Results in four new cells, each with half of the original cell's number of chromosomes
- Each cell is genetically different (due to crossing over and independent assortment)

GAMETE FORMATION

- In humans, occurs in testes and ovaries
- Spermatogenesis = production of sperm cells
- A diploid reproductive cell divides meiotically to form 4 haploid cells called spermatids, which develop into mature sperm

- Oogenesis = production of mature egg cells (ova)
- Results in ONE ovum; three other cells (polar bodies) disintegrate
- Ovum contains most of the cytoplasm of the three polar bodies

ASEXUAL REPRODUCTION

- Offspring are clones of one parent
- Unicellulars, binary fission or mitosis
- Multicellulars can reproduce asexually by budding

SEXUAL REPRODUTION

- Meiosis
- Offspring are genetically different from parents
- Offspring contain unique combinations of parental genes
- Advantage?

http://www.stolaf.edu/people/giannini/flashanimat/celldivision/meiosis.swf

http://nobelprize.org/medicine/educational/2001/cellcycle.html