Adv. Bio: Mitosis and Meiosis Study Guide

- Sections in the textbook: Chapter 9 and 10.1
- All vocabulary words – See Notes
- Binary fission and asexual reproduction
    - What is binary fission? – the asexual reproduction of a prokaryotic cell by division into two roughly equal parts (two daughter cells) genetically identical to the parent cell; uses less energy than mitosis.
    - Be able to diagram and explain binary fission.

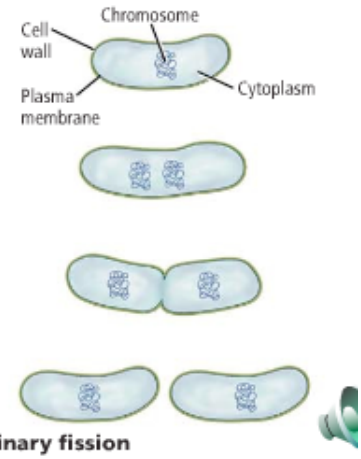
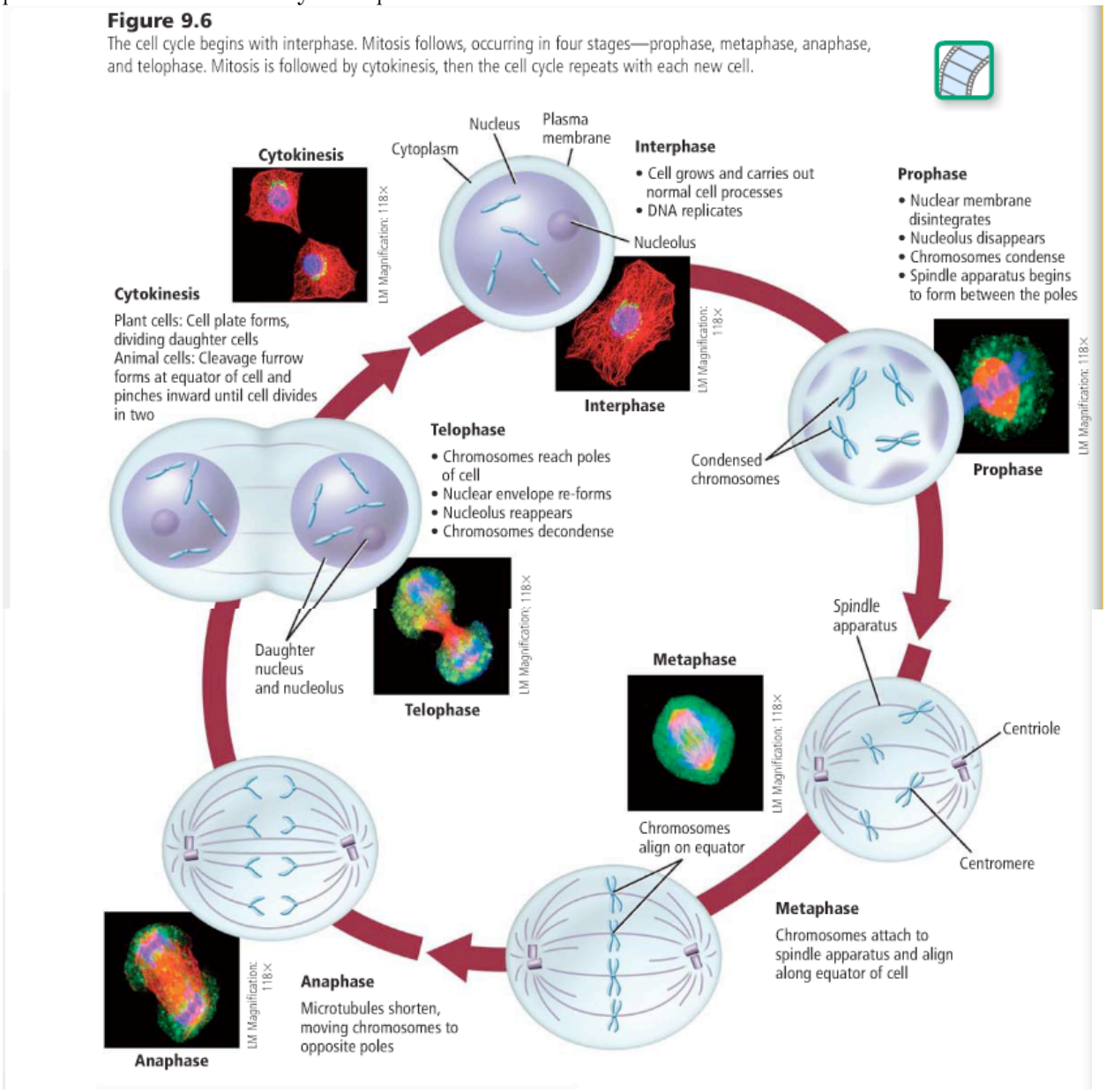


Figure 18.6 Binary fission is an asexual form of reproduction used by some prokaryotes. Conjugation is a method of exchanging genetic material used by some prokaryotes.

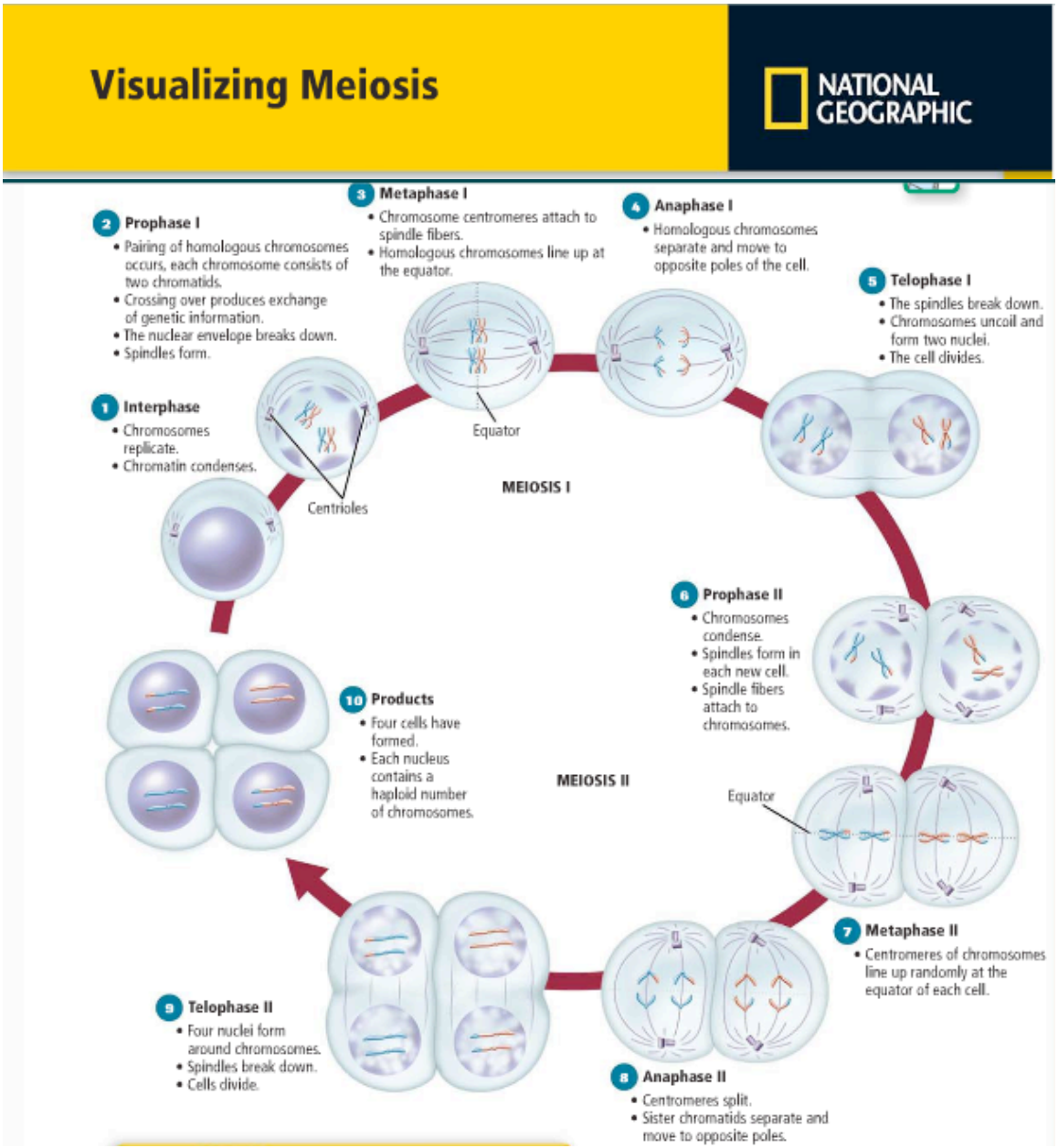
    - What is the difference between asexual and sexual reproduction?
        - Asexual – the organism inherits all of its chromosomes from a single parent. Therefore, the new individual is genetically identical to its parent and any other offspring produced, barring any mutations. Bacteria reproduce asexually.
        - Sexual – the organism inherits half of its chromosomes from its father, and the other half from its mother.
        - Bacteria reproduce asexually, whereas most protists reproduce both asexually and sexually. Many plants and many of the more simple animals can reproduce both asexually and sexually, compared to more advanced animals that reproduce only sexually.
    - What kind of cells go through binary fission? - Prokaryotes
    - Binary fission and mitosis are both asexual – both produce daughter cells genetically identical to the parent cell. They are both asexual reproduction. Binary fission occurs in prokaryotes, while mitosis occurs in eukaryotes. Mitosis splits by binary fission. Binary fission uses less energy than mitosis.
- Why does a cell need to divide? – As a cell grows, it's volume increases faster than it's surface area – therefore cells might have a hard time moving nutrients into and out of the cell.
    - Surface Area to Volume Ratio – diffusion over large distances is slow; smaller cells function better
    - Reasons – communication is better in a small cell
- Identify the phases of mitosis and be able to describe the phases:
    - Prophase - the first stage of mitosis and the longest phase. In this stage, the cell's chromatin tightens, or condenses into chromosomes. In prophase, the chromosomes are shaped like an X as shown in the picture above. At this point, each chromosome is a single structure that contains the genetic material that was replicated in interphase.
    - Metaphase - the sister chromatids are pulled by motor proteins along the spindle apparatus toward the center of cell and line up in the middle, or equator of the cells. Mitosis is one of the shortest stages of mitosis, but when completed successfully, it ensures that the new cells have accurate copies of the chromosomes.
    - Anaphase - the chromatids are pulled apart during the 3rd stage of mitosis. In anaphase, the microtubles of the spindle apparatus begin to shorten. This shortening pulls at the centromere of each sister chromatid, causing the sister chromatids to separate into two identical chromosomes. All of the sister chromatids separate simultaneously, although the exact mechanist that controls this is unknown. At the end of anaphase, the mictrotubles, with the help of motor proteins, move the chromosomes toward the poles of the cells.
    - Telophase - the last stage of mitosis during which the chromosomes arrive at the poles of the cell and begin to relax or decondense. Two new nuclear memebranes begin to form and the nucleoli reappear. The spindle apparatus disassembles and some of the microtubles are recycled by the cell to build various parts of the

cytoskeleton. Although the four stages of mitosis are now complete and the nuclear material is divided, the process of cell division is not yet complete.

Figure 9.6
The cell cycle begins with interphase. Mitosis follows, occurring in four stages—prophase, metaphase, anaphase, and telophase. Mitosis is followed by cytokinesis, then the cell cycle repeats with each new cell.



- Identify the phases of meiosis and be able to describe the phases:
  - Meiosis 1
    - Prophase 1 – (**Diploid cell**) chromosomes pair with their homologous chromosomes and form a tetrad. Crossing over also occurs.
    - Metaphase 1 - Homologous chromosomes line up in the middle of the cell. Spindle fibers attach to the chromosomes.
    - Anaphase 1 – Spindle fibers pull homologous chromosomes toward opposite ends of the cell.
    - Telophase 1(And Cytokinesis) – Nuclear membrane starting to reform. One cell begins to separate into 2 cells. Produces **two haploid cells.**
  - Meiosis 2 (II)
    - Prophase 2 – (**2 haploid cells**.) Half of the number of chromosomes from the original cell.
    - Metaphase 2 – chromosomes line up in the center of the cell (similar to how they line up in mitosis).
    - Anaphase 2 – Sister chromatids separate. Move to opposite ends of the cell.
    - Telophase 2 (And Cytokinesis) – 4 haploid cells formed



- What is the difference between mitosis and meiosis?
  - Which one occurs in somatic cells? - Mitosis
  - Which one occurs to produce gametes? What are gametes? – Meiosis. Gametes are sex cells that have half the number of chromosomes. Although the number of chromosomes varies form one species to another, in humans each gamete contains 23 chromosomes. The symbol *n* can be used to represent the number of chromosomes in a gamete.
  - Know the difference between sperm and egg – spermatogenesis/oogenesis
    - Spermatogenesis: The formation of male gametes, they are haploid gametes called sperm, which are produced by meiosis.
    - Oogenesis: The formation of female gametes, mature eggs or ova. The cell divisions at the end of meiosis I and I are uneven – this happens that way the one cell that becomes the egg receives most of the cytoplasm. The other three cells that are produced during oogensis are called **polar bodies** and they do not have a role in reproduction.

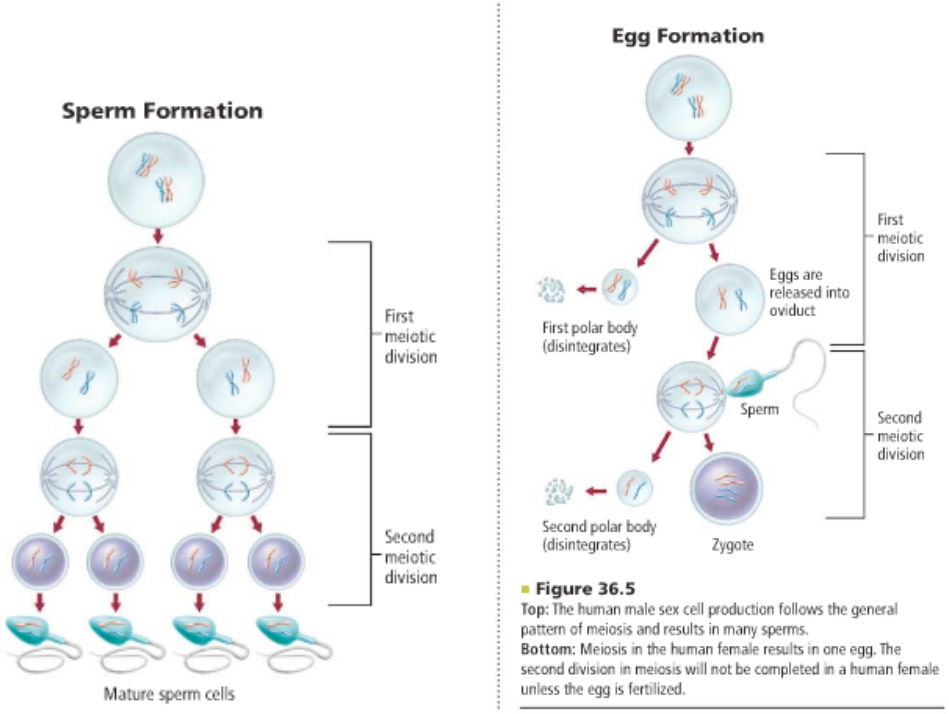
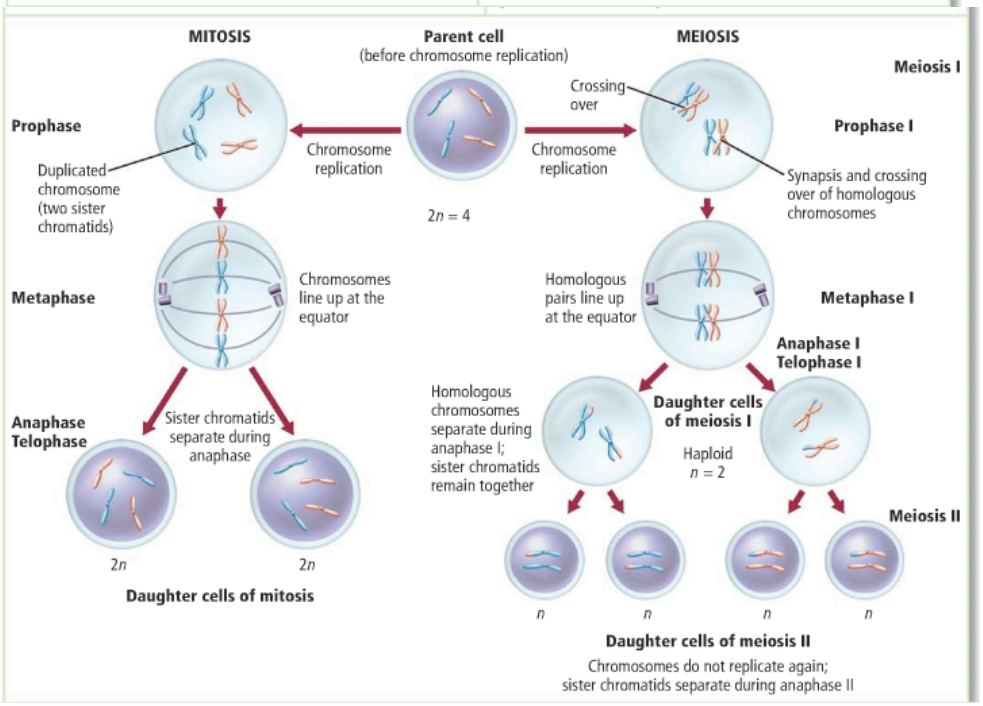


Figure 36.5
Top: The human male sex cell production follows the general pattern of meiosis and results in many sperms.
Bottom: Meiosis in the human female results in one egg. The second division in meiosis will not be completed in a human female unless the egg is fertilized.

Table 10.1 **Mitosis and Meiosis**

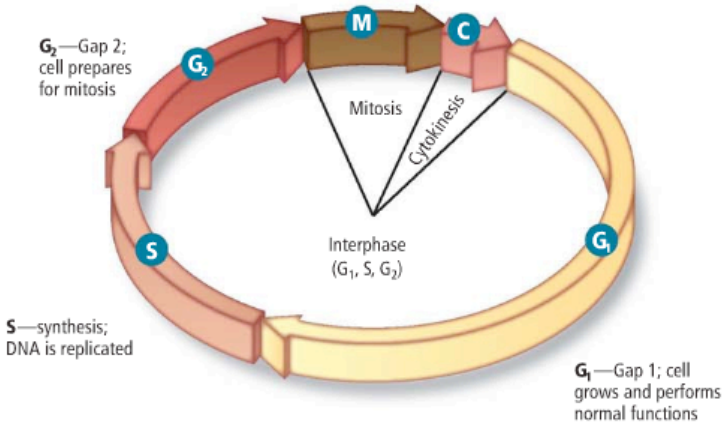
Interactive Table To explore more about mitosis and meiosis, visit biologygmh.com.

Mitosis	Meiosis
One division occurs during mitosis.	Two sets of divisions occur during meiosis: meiosis I and meiosis II.
DNA replication occurs during interphase.	DNA replication occurs once before meiosis I.
Synapsis of homologous chromosomes does not occur.	Synapsis of homologous chromosomes occurs during prophase I.
Two identical cells are formed per cell cycle.	Four haploid cells (n) are formed per cell cycle.
The daughter cells are genetically identical.	The daughter cells are not genetically identical because of crossing over.
Mitosis occurs only in body cells.	Meiosis occurs in reproductive cells.
Mitosis is involved in growth and repair.	Meiosis is involved in the production of gametes and providing genetic variation in organisms.

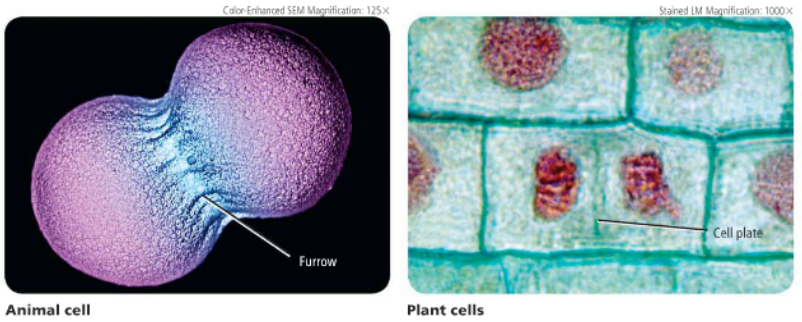


- What is a zygote? When does it form? – A fertilized egg formed in meiosis.

Figure 9.3 The cell cycle involves three stages—interphase, mitosis, and cytokinesis. Interphase is divided into three substages.
Hypothesize *Why does cytokinesis represent the smallest amount of time a cell spends in the cell cycle?*



- Cell Cycle:
  - Interphase – made up of three parts; the stage during which the cell grows, carries out cellular functions, and replicates.
    - G1: Gap 1 – Cell spends a lot of time in this phase, growing occurs and cell caries out its functions
    - S: Synthesis – DNA replication (copy)
    - G2: Gap 2 – More replication
  - Mitosis – Division of nucleus and nuclear material Has 4 stages – prophase, metaphase, anaphase, and telophase.
  - Cytokinesis – cytoplasm divides, producing two new cells.



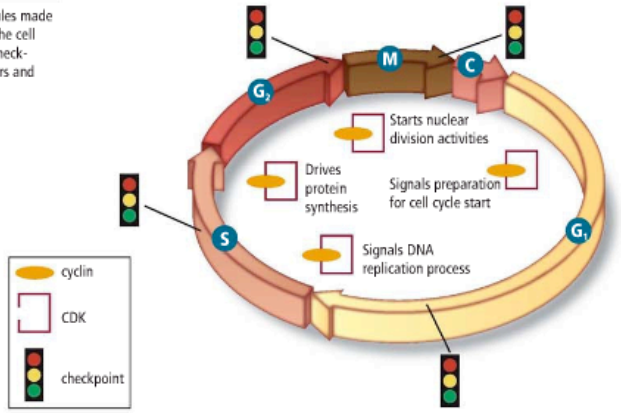
    - What is the difference between plant and animal cell cytokinesis
      - Animal cells – the cell membrane punches inward until there is a division of the cytoplasm of almost 2 equal parts.
      - Plant cells – a cell plate forms and it gradually develops into a separating membrane and the cell wall start to be seen in the cell plate.
    - What is G0? – Some cells that don't divide. They cannot be replaced (and you are born with them). Example – Brain cells
    - Do all cells go through the cell cycle at the same pace? – No

FIGURE 5.2 CELL DIVISION	
CELL TYPE	**APPROXIMATE LIFE SPAN**
Skin cell	2 weeks
Red blood cell	4 months
Liver cell	300–500 days
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

Figure 9.11 Signaling molecules made of a cyclin bound to a CDK kick off the cell cycle and drive it through mitosis. Checkpoints monitor the cell cycle for errors and can stop the cycle if an error occurs.

Personal Tutor

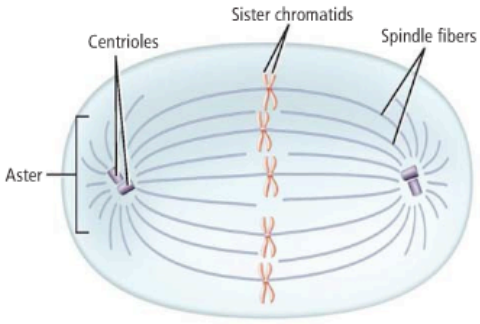
To learn about the cell cycle, visit biologygmh.com.



- Cell Cycle checkpoints: - has built in checkpoints that monitor the cycle and can stop it if something goes wrong.

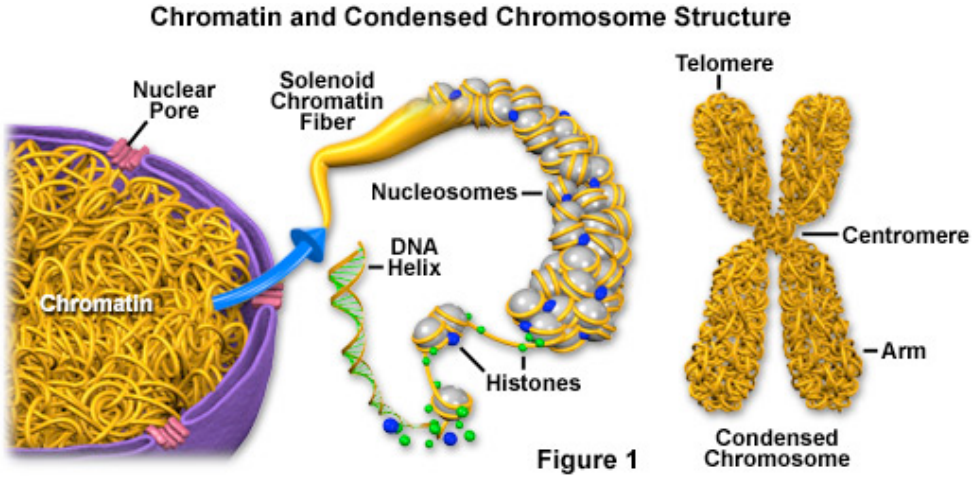
Quality control checkpoints Recall the process of starting a car. Many manufacturers use a unique microchip in the key to ensure that only a specific key will start each car. This is a checkpoint against theft. The cell cycle also has built-in checkpoints that monitor the cycle and can stop it if something goes wrong. For example, a checkpoint near the end of the G_1 stage monitors for DNA damage and can stop the cycle before entering the S stage of interphase. There are other quality control checkpoints during the S stage and after DNA replication in the G_2 stage. Spindle checkpoints also have been identified in mitosis. If a failure of the spindle fibers is detected, the cycle can be stopped before cytokinesis. **Figure 9.11** shows the location of key checkpoints in the cell cycle.

  - When do they occur? –
    - near the end of G1 – stage monitors for DNA damage and can stop the cycle before entering the S stage of interphase
    - During S
    - After DNA replication in the G2 stage
    - Mitosis
  - Why do they occur? – to stop it if something goes wrong
  - What happens during them? – see above
- What are telomeres? – at the end of chromosomes. They contain DNA that does not code for a gene.
- What are autosomes and sex chromosomes?
  - Autosomes: 44 autosomes, 22 pairs – Chromosomes numbers 1 to 22. **Aren't sex chromosomes.**
  - Sex Chromosomes: humans bond 2 sex chromosomes, x or y. Female- xx, Male - xy
- Centrioles: Two small structures in the cytoplasm that are bear the nuclear envelope, they separate anf go to opposite pole or ends of the nucleus.
  - What types of cells do they occur in? – **Animal** and most protist cells
  - What is their association with asters? What are asters? – Centrioles migrate to the ends, or poles, of the cells.. Coming out of the centrioles are yet another type of microtubule called aster fibers, which have a star like appearance. Spindle Apparatus – the whole structure, including the spindle fivers, centrioles, and aster fibers.



- What are spindles? Where do they originate in plants and animals? – microtubule structure that helps to pull the chromosome apart. Spindle fibers form during prophase.

- Centromeres:
  - What are centromeres? - the structure at the center of the chromosome where the sister chromatids are attached. Where are they found? - center of the chromosome
  - What are they used for? - This structure is important because it ensures that a complete copy of the replicated DNA will become part of the daughter cells at the end of the cell cycle.
- Chromatin and Chromosomes:



  - What is the difference between the two?
    - Chromatin is the relaxed form of DNA in the cells nucleus (DNA plus protein (histones))
    - Chromosomes – Structures that contain the genetic material that is passed from genration to generation. (Condense at the beginning of mitoisis. DNA wraps around proteins histones that condense it)
  - When is chromatin present? - Interphase
  - When are chromosomes present? – Mitosis
  - What is the difference between an unreplicated chromosome and a replicated chromosome? – Single chromosome, double chromosome
  - What are sister chromatids? – held together by a centomere
- Levels of Biological Organization: cells, tissues, organs, organ systems, organisms
- Cancer:
  - What are the causes of cancer? - the uncontrolled growth and division of cells – a failure in the regulation of the cell cycle. When unchecked, cancer cells can kill an organism by crowding out normal cells, resulting in the loss of tissue function.
  - How can you prevent cancer? –
    - Stay out of sun, don't smoke or be around people that do, stay away from asbestos
    - the tumors could be removed if it hasn't spread but if it has spread, you should leave the primary tumor in.
  - What are carcinogens? - substances and agents that are known to cause cancer
  - What does metastasize mean? – spread of cancer from the primary site to other parts of the body
  - What is a tumor? – masses of cells
  - What are the two types of tumors?
    - Benign (ben-good): are noncancerous tumors and does not spread to healthy tissue or other parts of the body.

        - Malignant (mal-bad): are cancerous tumors that invade and destroy surrounding tissue.
    - What is cyclin? - proteins that bind to enzymes called cyclin-dependent kinases
        - Cyclin-dependent kinase (CDKs) – enzymes that cyclin binds to in the stages of interphase and mitosis to start the various activities that take place in the cell cycle. Different cyclin/CDK combination control different activities at different stages in the cell cycle. The picture above illustrates where some of the important combinations are active.
- What is the difference between haploid and diploid?
    - Haploid – a cell with n number of chromosomes. Haploid comes from the Greek word haploos, meaning single.
    - Diploid – a cell that contains 2n number of chromosomes
- What are homolgous chromosomes? - the chromosomes that make up a pair, one chromosome from each parent.
    - Why do somatic (body) cells have homologous chromosomes? – same size/length, same centromere position, usually contain genes for the same triat
- How many chromosomes does a human have? How many pairs of chromosomes? – 46, 23 pairs
- What is crossing over? - a process during which chromosomal segments are exchanged between a pair of homologous chromosomes. Genetic variation increases because of it.
    - When does it happen? – Prophase I
- Compare mitosis and meiosis. – See chart above