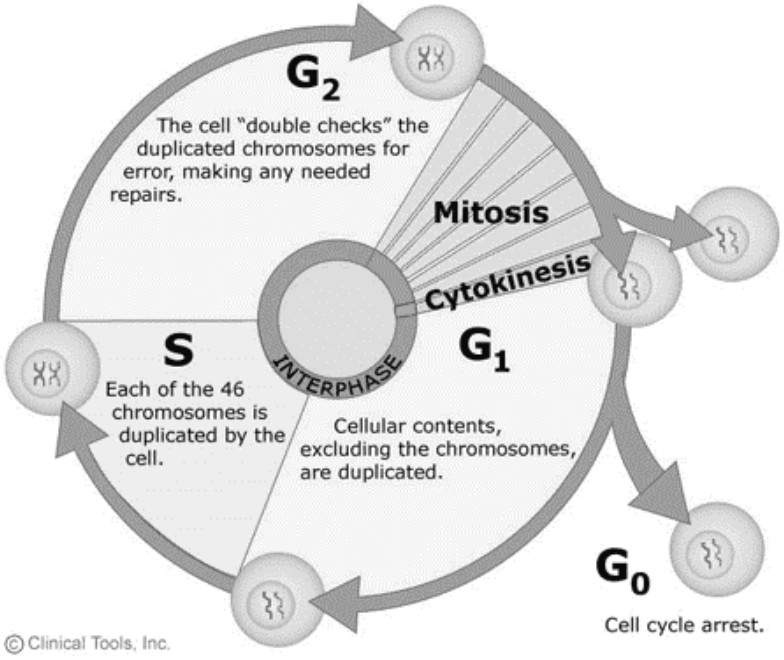
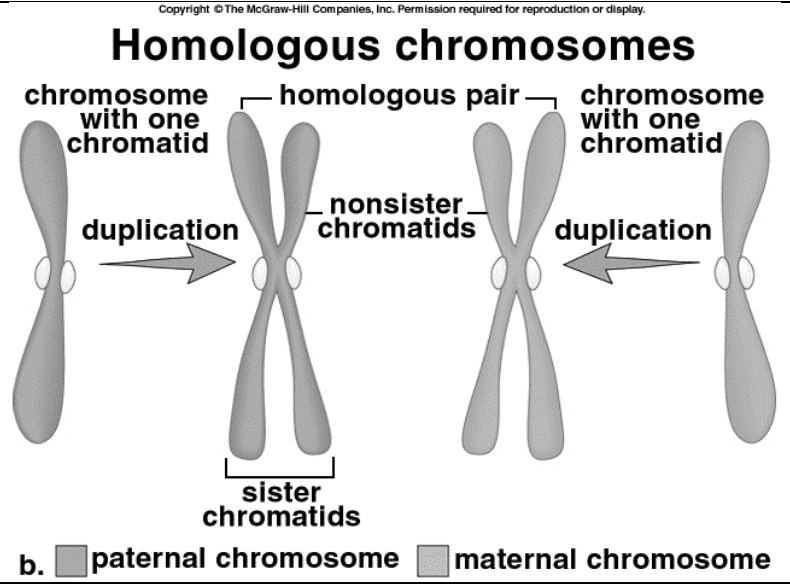
Essential Idea: Cell division is essential but must be controlled.

1.6 Cell Division

Why do cells divide:

- Sa:Vol Ratio
- Allows for growth of the organism
- Allows for cell differentiation
- Replace dead, damaged, or infected cells
- Embryonic development

Cell Cycle: series of events through which cells pass to divide and create two identical daughter cells.	
Chromosomes: - Eukaryotes have genes on chromosomes - Each chromosome has a partner (one from each parent) that contains same genes	
Different species have different chromosome numbers	Humans have 23 pairs (n=23) or 46 total Diploid cells have both copies (2n), example somatic cells or body cells Haploid cells have just one (n), example gametes or sex cells

vi. Interphase is a very active phase of the cell cycle with many processes occurring in the nucleus and cytoplasm.

- Interphase - is the longest part of the cell cycle which consists of 3 stages G1, S, G2
- Interphase is an active period in the life of the cell in which many metabolic reactions occur, including protein synthesis, DNA replication and production or mitochondria and/or chloroplasts.
- Protein synthesis - synthesis of proteins and enzymes (Gap 1), many of which are required for the synthesis phase during DNA replication and the production of microtubules and proteins in Gap 2; needed for mitosis.
- DNA replication - Fundamental process in which the cell replicates its DNA before it divides (protein synthesis and transcription is low in the S phase.
- Mitochondria and/or chloroplasts number increases during interphase in preparation for division.
- Cellular respiration also takes place interphase and mitosis
- G1 – This stage is called Gap 1 in which the cell grows. After a checkup by the cell, if they are not ready to divide they go into G0

i. Mitosis is division of the nucleus into two genetically identical daughter nuclei.

- During cell division (mitosis and cytokinesis) the cell divides into two genetically identical daughter cells.
- During S phase in the cell cycle, the cell will replicate its chromosomes to create to identical sets of chromosomes (now called chromatids) attached in the middle by a centromere.
- Replication is semi-conservative, meaning that each strand of the original double-stranded DNA molecule serves as template for the production of the new complementary strand. Thereby insuring two identical copies of the DNA are created.
- Proofreading and error-checking mechanisms during replication ensure near perfect copies of DNA.
- Each chromosome now contains double the genetic material as it enters mitosis.
- During mitosis, the pairs of sister chromatids line up along the metaphase plate, where each chromatid is attached to a spindle fiber connected to opposite poles in the cell.
- During anaphase each identical chromatid is pulled towards opposite poles resulting in two genetically identical nuclei at opposite poles in the cell.

ii. Chromosomes condense by supercoiling during mitosis.

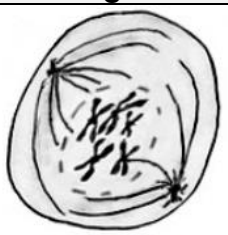
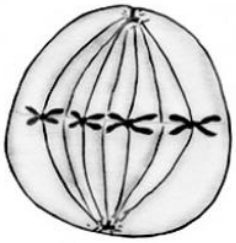
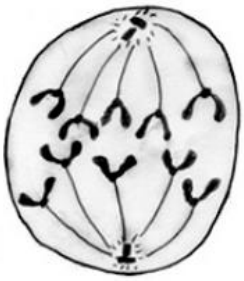
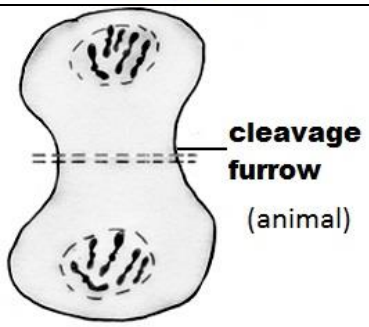
- During mitosis chromosomes condense into visible structures due to a process called supercoiling
- Since a nucleus is generally less than 5 μm in diameter and some of the DNA molecules are over 50,000 μm in length. They have to condense and coil around histone proteins making the chromosome much shorter and fatter.
- The nucleosomes (made of histones) will interact further with each other causing the chromosomes to supercoil.
- This supercoiling helps regulate transcription because only certain areas of the DNA are accessible for the production of mRNA by transcription. This regulates the production of a polypeptide.

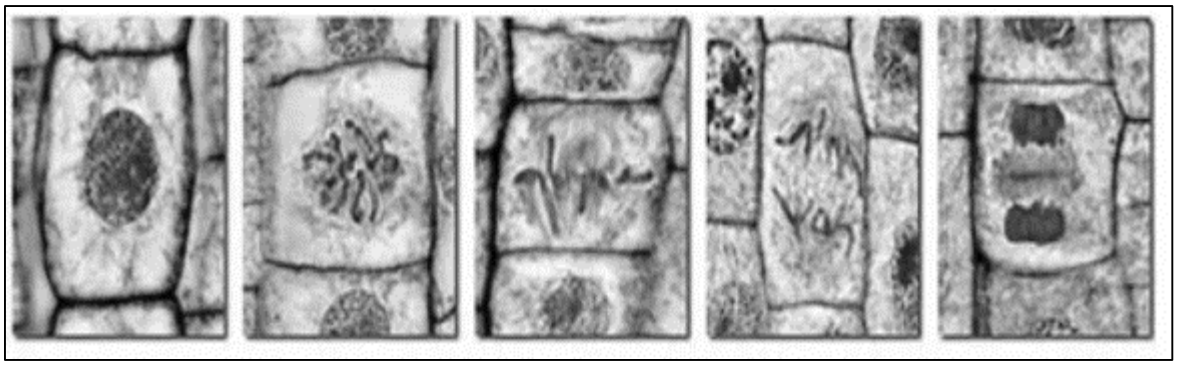
iii. Cytokinesis occurs after mitosis and is different in plant and animal cells.

- Cytokinesis is the process in which the cytoplasm of a single eukaryotic cell is divided to form two daughter cells after mitosis is complete.
- In plant cells tubular structures are formed by vesicles along the equator of the cell

- This continues until two layers of membrane exist across the equator, which develop into the plasma membrane of the two new cells
- Vesicles bring pectin and other substances and deposit these between the two membranes through exocytosis forming the middle lamella
- Cellulose is then brought and deposited by exocytosis between the membranes as well, forming the new cell walls
- In animal cells a cleavage furrow forms when the plasma membrane is pulled inwards around the equator by the contractile proteins actin and myosin
- Once the invagination reaches the center the membrane pinches off and to new cells are formed

Skill: Identification of phases of mitosis in cells viewed with a microscope or in a micrograph.

Mitosis Description	Diagrams
<u>Prophase</u> • Chromosomes become shorter and more condensed in the process called supercoiling. • The nuclear envelope begins to break down and disintegrate. • Microtubules that form the mitotic spindle begin to develop from the centrosomes in the cell. • Centrosomes move towards the poles as the spindle grows and lengthens.	 **Prophase**
<u>Metaphase</u> • The spindle fibers are attached to the centromeres of the chromosomes. • Chromosomes move towards the equator of the cell and line up along the metaphase plate. • The other ends of the microtubules of the spindle are attached to poles of the cell.	 **Metaphase**
<u>Anaphase</u> • The pairs of sister chromatids are pulled apart by the spindle fibers towards the poles. • The chromatids are now considered chromosomes. • The chromosomes move to the poles as a result of the shortening of the microtubule. • After anaphase the cell now has two genetically identical nuclei at each end of the cell.	 **Anaphase**
<u>Telophase</u> • Nuclear membranes now begin to form around each set of chromosomes. • Chromosomes begin to uncoil to form chromatin again. • The spindle fibers break down and nucleoli reform in each nucleus. • The cell elongates and gets ready for cytokineis.	 **cleavage furrow** (animal) **Telophase**

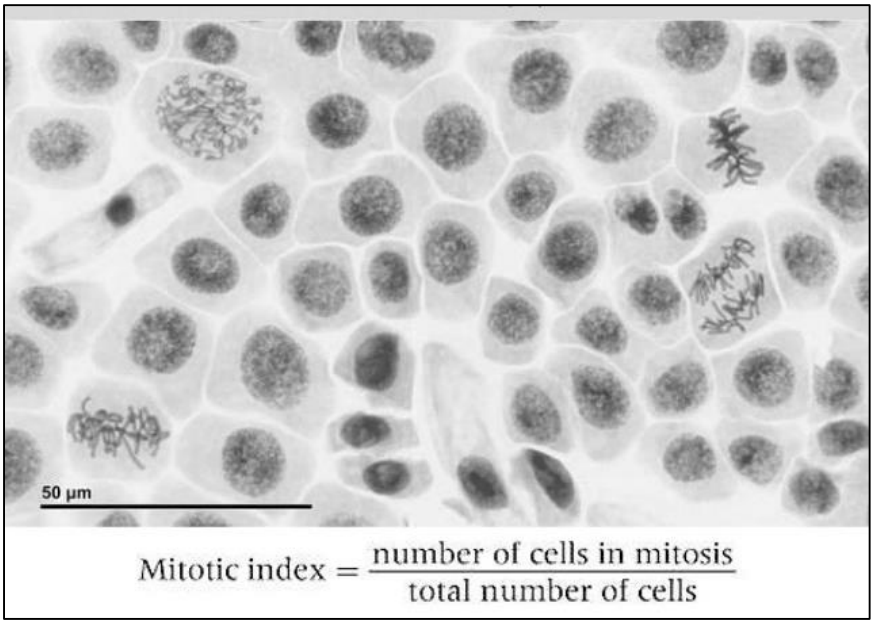


interphase prophase metaphase anaphase telophase

http://www.clt.astate.edu/mhuss/mitosis1.jpg

Skill: Determination of a mitotic index from a micrograph.

- The Mitotic index = number of cells containing visible chromosomes (in mitosis) divided by the total number of cells in field of view. What is the Mitotic index for this picture? _____



Label the parts of the cycle.

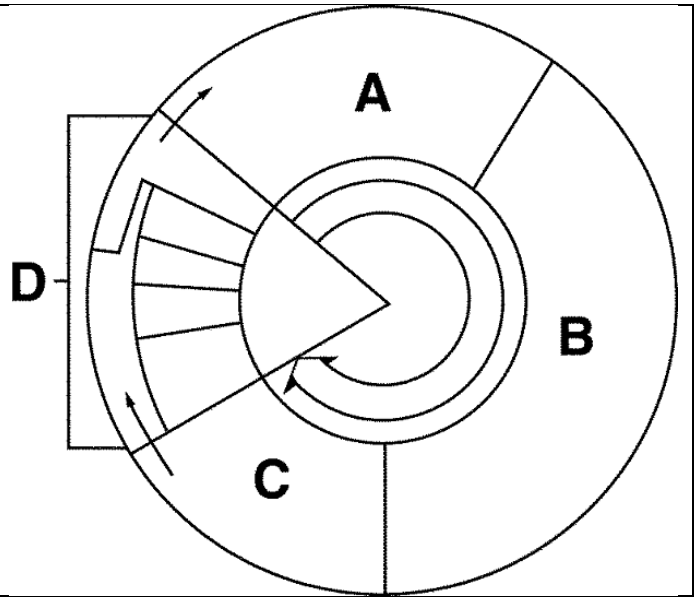
A: _____

B: _____

C: _____

D: _____

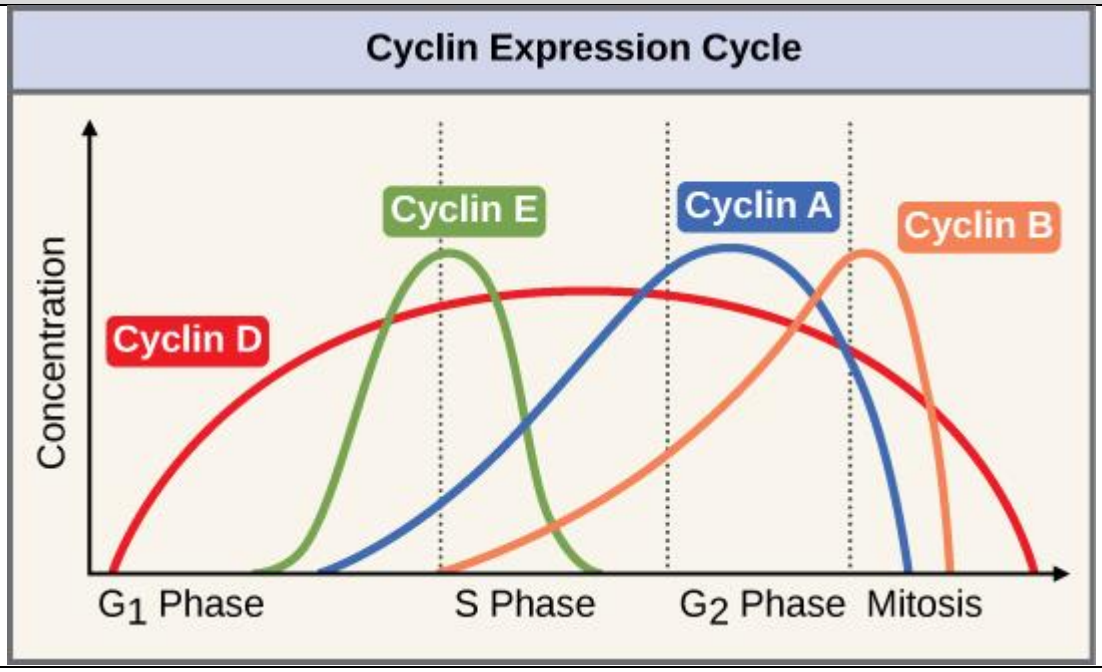
For part D label the steps of mitosis and cytokinesis on the picture to the right.



iv. Cyclins are involved in the control of the cell cycle.

- Cyclins are a family of proteins that help regulate the cell cycle. These proteins ensure that task are performed at the correct time and the cells move to the next stage at the appropriate time.
- They bind to enzymes called cyclin-dependent kinases, activating these cdk enzymes causing them to attach phosphates to other protein in the cell, which triggers other proteins to become active and carry out specific tasks.

4 main types of cyclin in human cells.



- Cyclin D – causes G0 to move to G1 and G1 to move to S phase
- Cyclin E – causes the cell to prepare for replication in S phase
- Cyclin A – activates DNA replication in S phase
- Cyclin B – causes the mitotic spindle to begin to form and other tasks needed in the preparation of mitosis

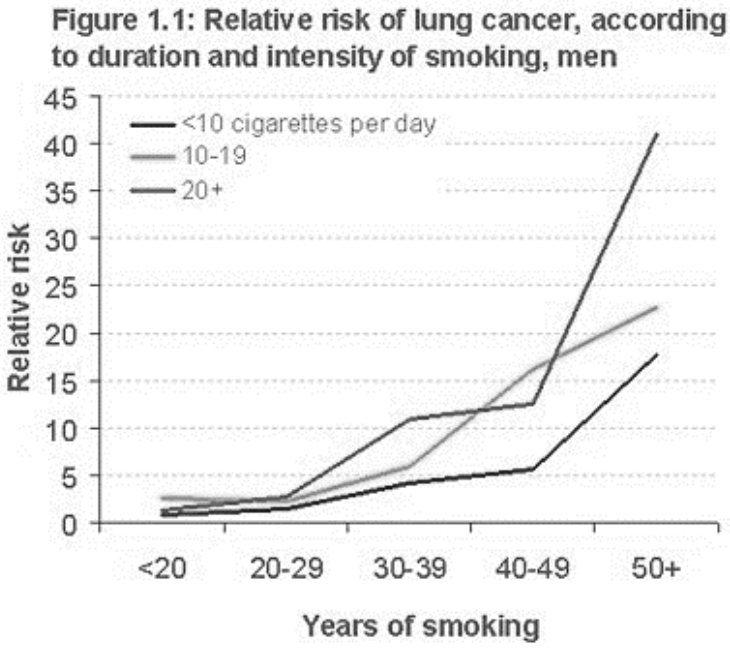
v. Mutagens, oncogenes and metastasis are involved in the development of primary and secondary tumours.

- Tumors are the result of uncontrolled cell division, which can occur in any organ or tissue.
- These abnormal growths can either be localized (primary tumours), meaning they do not move to other part of your body. These tumours are benign. If the cancer cells detach and move elsewhere into the body (secondary tumours), they are called malignant and are more life-threatening
- Diseases due to malignant tumours are known as cancer
- Metastasis is the movement from a primary tumour to set up secondary tumours in other parts of the body
- Cancer is usually caused by genetic abnormalities due to a variety of different sources called carcinogens or due to inheritance or errors in DNA replication.
- Carcinogens are agents that can cause cancer, such as viruses, X-Rays, UV Radiation and many chemical agents
- Mutagens are agents that can cause mutations in one's DNA which can lead to cancer

- Mutagens and carcinogens are strongly correlated and many mutagens can be carcinogens
- In cancer two types of genes are usually affected, oncogenes and tumor suppressor genes.
- Oncogenes are mutated forms of proto-oncogenes (which typically control synthesis of proteins involved in cell signaling or cell division). These cells with activated oncogenes cause uncontrolled growth and cell division, prevent the cancer cell from dying and allow them to invade other tissues.
- Tumor suppressor genes usually control replication and the cell cycle. In cancer cells these genes are generally inactivated causing a loss of normal function.

Application: The correlation between smoking and incidence of cancers.

- A correlation is a relationship between two variable factors
- There is a strong positive correlation between smoking and cancer
- Surveys have shown that the more cigarettes that one smokes per day, the higher the death rate due to cancer.
- The main cancers involved are cancer of the mouth, pharynx, larynx, esophagus and lungs



http://islaslab.blogspot.ca/2014_04_01_archive.html