III. The Cell Cycle: How do living things grow and repair themselves?

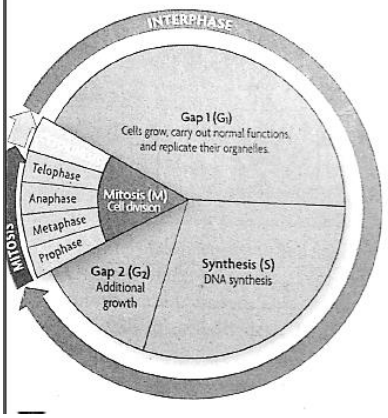
A. Critical Reading: Highlight the main idea and important information

Living things grow and develop. At times they suffer injury or damage, or cells simply wear out. New cells must be formed for the organism to survive.

The Cell Cycle

The cell cycle is a regular pattern of growth, DNA replication, and cell division that occurs in **eukaryotic** cells, which contain a nucleus. There are four main stages in in the cell cycle:

- G1 or Gap 1, normal cell growth
- S or Synthesis, DNA is copied
- G2 or Gap 2, more growth
- M or Mitosis, nuclear cell division



Cells grow and copy their DNA during interphase. During M stage, both the nucleus (in mitosis) and cytoplasm (in cytokinesis) are divided.

G1, S and G2 together are called interphase. In G1, also called the **growth phase**, the cell grows rapidly, while performing routine metabolic processes like cellular respiration. It also makes proteins needed for DNA replication and copies some of its organelles. A cell typically spends most of its life in this phase.

In **synthesis,** a cell puts together or synthesizes a whole copy of its nuclear DNA. At the end of this stage, there are two complete sets of DNA in a cell's nucleus.

There are two main parts to the M stage: mitosis and cytokinesis. **Mitosis** is the division of the cell nucleus and the DNA inside it. **Cytokinesis** is the division of the contents of the rest of the cell—the cytoplasm.

Regulation of the Cell Cycle

How cell division is controlled is a very complex cellular mechanism. The cell can determine irregular levels of certain chemicals during the "checkpoints" of the cell cycle and terminate the cell should something be amiss. Cells which have errors that are not caught and go unregulated can result in cancer.

Cancer is a disease that occurs when the cell cycle is no longer regulated and the cell is unable to break down when it is damaged (**apoptosis**). This may happen when a cell's DNA becomes damaged. Damage may result from exposure to harmful chemicals called **carcinogens** or hazards such as forms of radiation.

B. Reflect

1. Where is mitosis in the cell cycle?

2. What three phases are part of interphase?

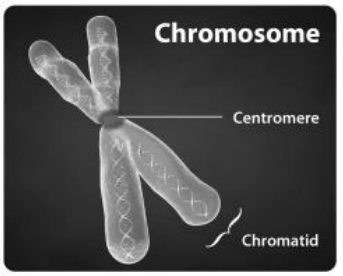
3. In which phase does a cell spend most of its life? What happens during this phase?

4. What is the S phase? What happens during this phase?

C. True or False

_____ 1. Cell division is basically the same in prokaryotic and eukaryotic cells.
_____ 2. Cytokinesis is the division of the cytoplasm.
_____ 3. Mitosis is the process in which the nucleus of the cell divides.
_____ 4. A cell spends most of its life in growth phase 1 of the cell cycle.
_____ 5. The correct order of phases of the cell cycle is $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$.
_____ 6. Interphase consists of mitosis and cytokinesis.
_____ 7. In prokaryotic cells, all organelles, such as the Golgi apparatus and endoplasmic reticulum, divide prior to cell division.
_____ 8. Organelles are made during growth phase 2.
_____ 9. In eukaryotic cells, DNA is replicated during the S phase of the cell cycle.
_____ 10. If the cell cycle is not regulated, cancer may develop.
_____ 11. Mitosis occurs in both prokaryotic and eukaryotic cells.

D. Enrichment: Visit http://www.nobelprize.org/educational/medicine/2001/cellcycle.html and play the cell game. Describe what needed to be done in order to keep your cell alive.



IV. Mitosis: Cells divide during mitosis and cytokinesis

A. Critical Reading: Highlight the main ideas

Chromosomes and Mitosis
Chromosomes are coiled structures made of DNA and proteins, and are a form genetic information takes during cell division. During other phases of the cell cycle, DNA is not coiled into chromosomes. DNA coils into the familiar X shaped form of a chromosome only after it has replicated during **synthesis**. Because it has already replicated, each chromosome actually consists of two identical copies. The two copies are called sister **chromatids**. They are attached to one another at a region called the **centromere.** The DNA of a chromosome is encoded with genetic instructions for making proteins. These instructions are organized into units called **genes.** Most genes contain the instructions for a single protein and there can be hundreds to thousands of genes on a single chromosome.

Replication
By the end of **interphase**, a cell is ready to divide. Mitosis divides the DNA, and cytokinesis divides the rest of the cell. The result is two identical cells. Mitosis happens in all of your body cells except cell that form eggs or sperm. Your cells divide for growth, development, and repair.

Mitosis and cytokinesis are continuous processes; they do not happen in steps. However, there are four main phases of mitosis: prophase, metaphase, anaphase, and telophase; a.k.a., PMAT. Cytokinesis begins at the end of anaphase or in telophase.

In **prophase**, chromatin condenses into tightly coiled duplicated chromosomes and the nuclear membrane breaks down. In **metaphase** the chromosomes line up in the middle of the cell. In **anaphase**, sister chromatids are pulled to opposite sides of the cell. Finally in **telophase**, nuclear membranes start to form again and chromosomes begin to uncoil.

B. Critical Writing: Describe the structure of a chromosome, using proper vocabulary. Discuss when and why a chromosome forms.