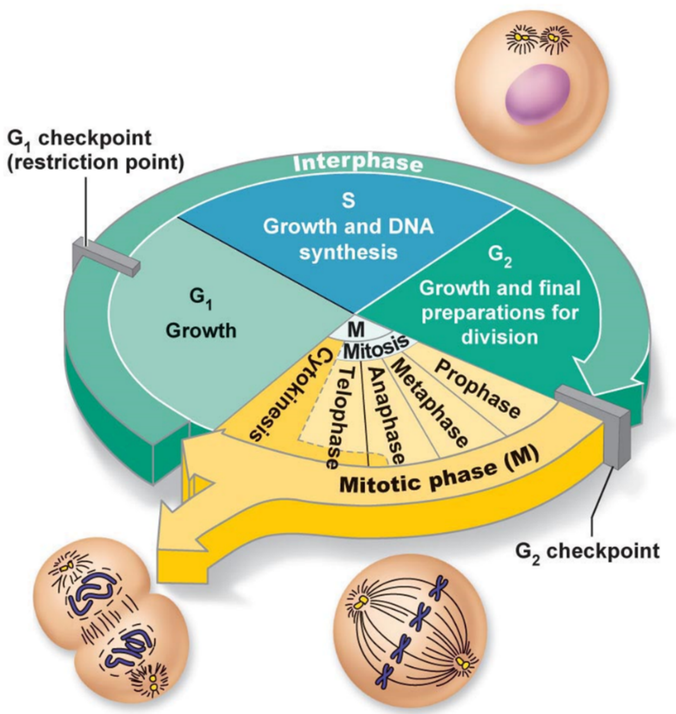
LABORATORY #7-- BIOL 111
DNA, Chromosomes, and the Cell Cycle

One of the defining characteristics of living things is the ability to reproduce. This applies to a whole organism and to individual cells of an organism. One of the ways that an organism can grow is to make new cells. Every cell in every organism grows, develops and reproduces at some point (i.e., one cell turns into two cells). For an organism to remain healthy, each cell must produce an exact copy of itself. If the process does not work perfectly, then the mistakes remain forever. For example, we all started off as a single cell (known as a zygote); if a mistake was made in producing one of the two cells that came from this first cell, then this mistake would be present in ½ of all the cells in your body. This is why some people have different colored eyes. A mistake in copying the cell's DNA (genes) was made very early in life, with the result that half of the eye cells produce blue eye color and the other half produce brown eye color. In multicellular organisms, cell division is called mitosis. A cell that is destined to divide prepares to divide in a series of steps called the cell cycle. Obviously, the cell cycle must be done perfectly. This lab shows us how this cell cycle proceeds.

All living organisms are composed of one or many cells and (nearly) all cells have a set of instructions for constructing proteins called genes. Genes are composed of DNA and are found on structures called chromosomes. Because all cells that are destined to give rise to new cells must contain genes (that among other things, direct the division of the cell to make two new cells), a mechanism is needed to ensure that both new cells have a full set of genes. This means that all the genes of the old cell must be copied, and then sorted into two new cells.



This diagram breaks the cell cycle down into several sub phases, each of which helps the cell make perfect copies of itself. Cancer is a disease that results from DNA mutations that disrupt the normal regulation of the cell cycle. Cells divide to often and result in masses of cells called tumors.

Each part of the cell cycle is described in detail below. You will try to identify different parts of the cell cycle in pictures of onion cells engaged in the cell cycle and preparing to divide.

<u>I. INTERPHASE</u> -- This is the entire period starting directly after cytokinesis and ending just before mitosis. During this chunk of time the cell does most of the functions that each cell type is known for (e.g., stomach cells secrete digestive enzymes). This phase contains three portions (occurring in this order): **G_1, S,** and **G_2**. During the **G_1** and **G_2** portions of interphase, the cell grows, (the "G" is for Gap) does a lot of biosynthesis, and checks itself for possible errors. During the **S** portion, the cell synthesizes (thus, the "**S**") new DNA (i.e., it duplicates its genes in a process called **replication**). After making new genes, the cell also spends part of **G_2** preparing for the next step of the cell cycle: **mitosis**.

Cells in INTERPHASE can be identified by the presence of the nuclear membrane wrapped around the nucleus and a prominent **nucleolus** (or several **nucleoli**).

<u>II. MITOSIS</u> contains four separate subphases known as prophase, metaphase, anaphase, and telophase. The critical importance in understanding and studying mitosis is that each process is a necessary step for ensuring that each new cell has <u>exactly</u> the same genes as the old cell. If something goes wrong during this process, then the mistake is there forever because the cells with the incorrect genes will pass on the mistakes to the new cells. Here's how to tell each phase apart:

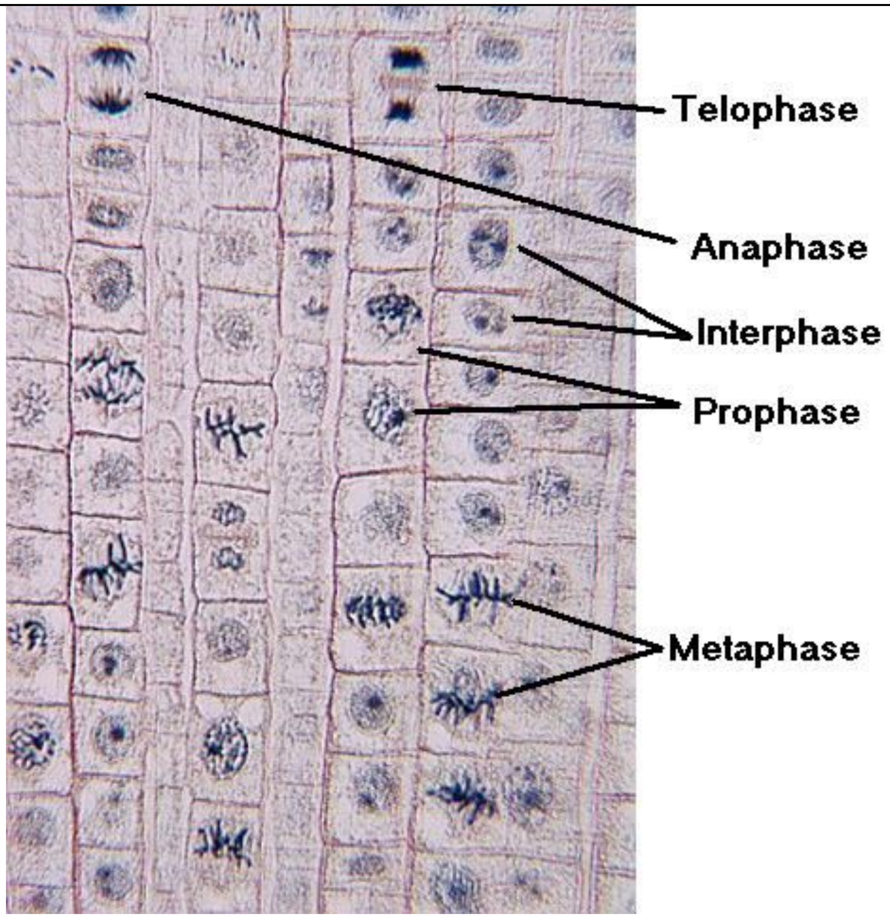
Prophase -- the nuclear membrane begins to disintegrate and the chromosomes "condense"; this means that you can actually begin to see the chromosomes (they are not apparent during interphase). This marks the beginning of mitosis;

Metaphase -- the chromosomes (now fully condensed) align along the "equatorial plane of the mitotic spindle." This just means that all the chromosomes are in the middle of the cell and the nuclear membrane is completely gone (for now);

Anaphase -- the chromosomes are pulled apart. Each half of each chromosome gets "pulled" by a microtubule (part of the mitotic spindle) to one end of the cell;

Telophase -- the nuclear membrane begins reforming and the chromosomes begin "decondensing" (or unraveling). This marks the end of mitosis.

Onion root cells---near tip, engaged in mitosis.



Good Videos: www.youtube.com/watch?v=kmWOGye7yGI

www.youtube.com/watch?v=aDAw2Zg4IgE

Procedure:

Before you start, answer question 1 in the requirements page!

1. Obtain a slide of *Allium* root tips. Scan the 3 slices of root and become familiar with the slide. Be able to focus on individual cells near the tip of the root. This is the part of the root where the most growth is occurring. You should be able to see cells at 100X total mag. but will probably need 400X total mag. to see clearly enough to proceed to step 2.

2. Examine cells located near the tip (but not at the very tip) of the growing onion root tip—in an area in which you notice a fair number of cells in some stage of mitosis! Try to find at least one cell in each phase shown above. Go back to the area you started and begin to identify and count cells in interphase and mitosis. Track an area, counting every cell. Place a mark in the correct box of the table when you locate cells in each phase. Make sure your lab partner agrees with the identification of cells.

1. Count at least 50 cells. When done, there should be at least 50 marks on the table (one mark for each cell). You may need to count more than 50 to find at lest one of every phase.

4. Calculate the proportions, and estimate the amount of time spent in each phase and subphase. The table will lead you through how this works. Take the number of cells in a particular phase, divided by the total number of cells examined (i.e., 50—or more), then multiply by 24 (the number of hours an average onion root tip cell takes to complete the entire cycle. This should give the hours a cell spends in each phase.
Again, this assumes, that the entire cell cycle for onion root cells is 24 hours. This time can vary in different organisms.

Attach this page to the Requirements section!!
FILL-IN this table with the results of your count of 50 or more cells:

Phase/Subphase	# of cells	Calculation (fraction of cells X total hours of the cell cycle	**# hours spent in this subphase (of 24 hour total cycle)**
INTERPHASE		# cells/ 50 X 24 hrs.	
PROPHASE		# cells/ 50 X 24 hrs.	
METAPHASE		# cells/ 50 X 24 hrs.	
ANAPHASE		# cells/ 50 X 24 hrs.	
TELOPHASE		# cells/ 50 X 24 hrs.	

Hours spent in Interphase? ____________________
Hours spent in Mitosis? ____________________ **Mitosis =** prophase + metaphase + anaphase + telophase)

Name_________________________

Requirements Lab 6

Please attach the associated table!

1. Which do you think takes longer, interphase or mitosis? Provide a hypothesis and support the hypothesis with reasoning from your introduction to the lab. (4 pts)

2. According to <u>your data</u>, which takes longer, interphase or mitosis? How did your data collection method allow you to determine this? *(4 pts)*

3. According to <u>your data</u>, which **subphase** (prophase, metaphase, anaphase or telophase) does an onion root tip cell spend most of its time in? The least time? Give a possible reason why one subphase is rather long relative to another. Be specific, mentioning what happens in specific subphases *(4 pts)*

4. Do you think that **all types of cells** spend the same amount of time in each stage as onion root tip cells? Explain your answer. *(3 pts)*