STUDY GUIDE - ***Ch.12.3*** - ***The Eukaryotic Cell Cycle is Regulated by a Molecular Control System*** **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First****, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. a. What **controls the cell cycle**? Review your text and the experimental procedure and conclusion highlighted in Figure 12.14 to help you answer this question.

   b. With regards to experiment 2 in Figure 12.14, why do the nuclei resulting from experiment 2 contain different amounts of DNA? (*Check your answer by going to the **Ch.12.3 Concept Check Question #2** answer in Appendix A)*

2. a. Cell cycles are said to have checkpoints. What is a **cell cycle checkpoint**?

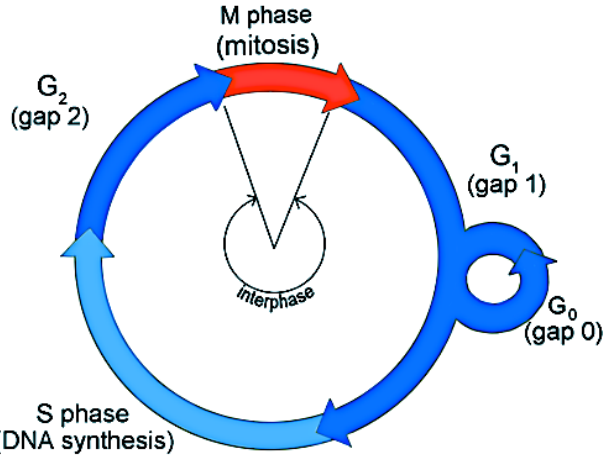
   b. What are **three of the major cell cycle checkpoints** called **AND when** do they take place during the cell cycle? (Memorize your Ch.12.1 & 2 Study Guides so you are clear on what happens during each of the phases of the cell cycle and sub-phases of interphase when these checkpoints are engaged in controlling cell cycle progression)

      1. _____ =

      2. _____ =

      3. _____=

   c. **Label the three main checkpoints** on the figure to the right.



3. Kinases work not only as part of various signal transduction cascades, but also play crucial roles in helping cells progress through their cell cycle. What is a **protein kinase**?

4. The particular kinases that drive the cell cycle must be activated by attachment of a _____ molecule.

   For this reason, we refer to this category of kinases as _____.

5. Only when the allosteric activator is bound to the kinase, when the cyclin-Cdk complex has formed, is the kinase active and able to, therefore, alter cell behavior. **Cyclin-Cdk complex activity rises and falls during different periods of the cell cycle.** Compare the **relative concentration of Cdks versus cyclins present in the cell's cytoplasm throughout the cell cycle**.

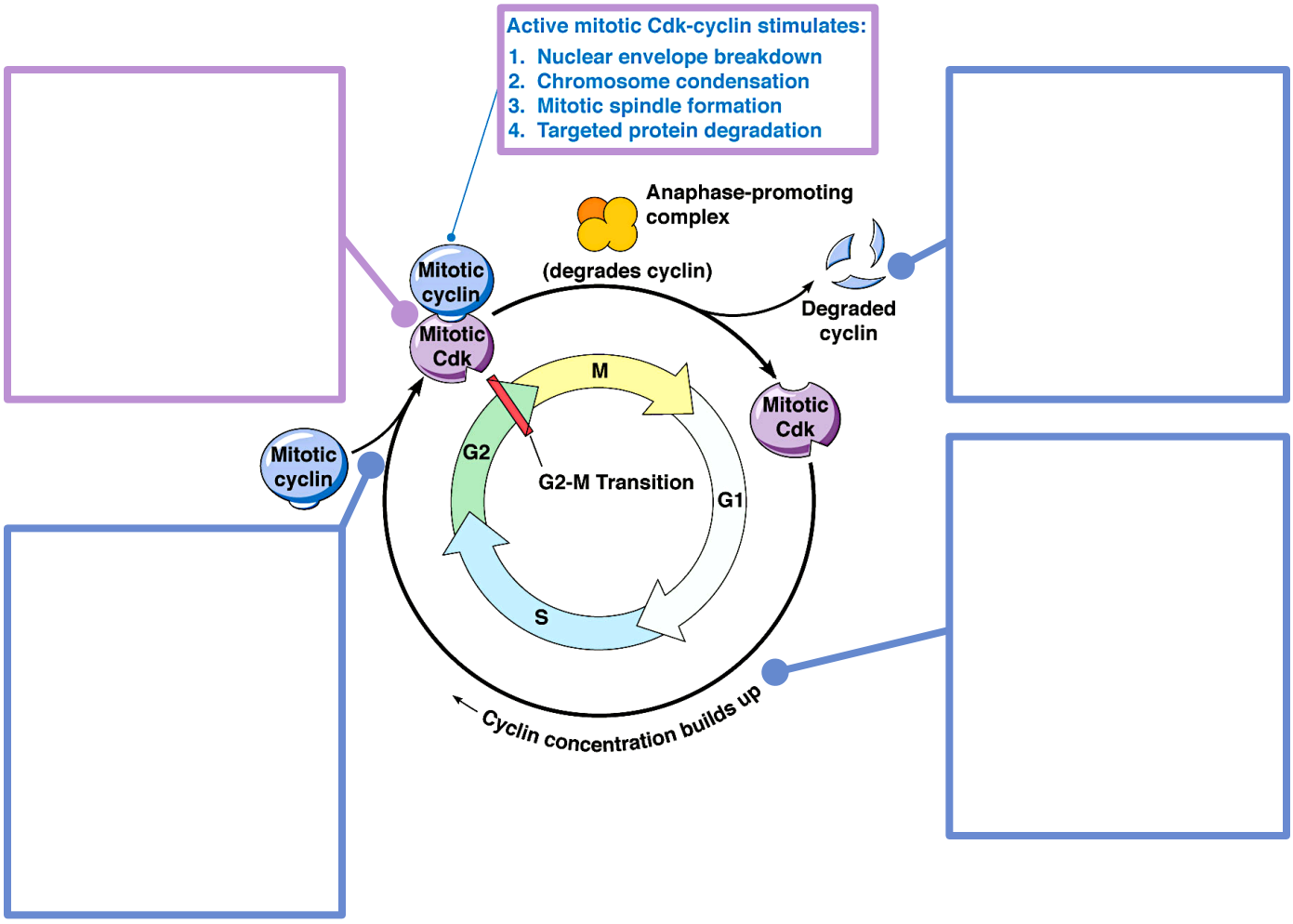
   Pattern of **Cdk concentrations** throughout a cell's cell cycle =

   Pattern of **cyclin concentrations** throughout a cell's cell cycle =

6. Read your text and **study Figure 12.16** well in order to understand how the example of the **cyclin-Cdk complex known as MPF works to help push the cell out of G_2**. *(Note: A similar process takes place at the G_1 checkpoint, involving at least three different cyclin-dependent kinases and several different cyclins)*

   a. What does "**MPF**" stand for?

   b. To the four boxes, add explanations for the **four main events involved in the molecular regulation of the cell cycle at the G_2 checkpoint** as illustrated below. **Be sure to note what MPF activation promotes in the cell.**



7. While activated, **Cdks helps cells pass through the G_1 and G_2 checkpoints**. **Cells, however, also have ways to stop from passing through a checkpoint and, thus, ways to halt a cell from moving through the cell cycle towards dividing.**

   a. What phase of interphase are most of your body cell in at any given moment?

b. Explain the **G_0 phase**.

c. Explain **relationship muscle, nerve, and liver cells have to the G_0 phase.**

8. **Internal and external signals help determine if a cell proceeds through a G_1 and G_2 checkpoint.** For example, the cumulative effects of these internal and external signals influence the activation cyclin production (the turning on cyclin genes) and also influence Cdk-cyclin complex activation or inhibition. **Not all checkpoints in the cell cycle though rely on Cdk activation.**

   a. What happens if all **chromosome kinetochores are not attached to spindle fibers during metaphase of M phase**?

   b. When this occurs, **which checkpoint is not passed**?

   c. What happens **once the kinetochores on every sister chromatid of each duplicated chromosome are all attached to the kinetochore microtubules of the mitotic spindle**?

   c. Why does a **cell benefit from this mechanism**?

9. Researchers have discovered two **new checkpoints**. Describe the value of...

   a. The checkpoint that takes place **during S phase** of interphase.

   b. The checkpoint that takes place at the **end of anaphase**, before the start of telophase during the cel's M phase.

10. What are **two external factors that can influence if a cell passes the G1 checkpoint,** for example, in order to start preparations for eventual division?

    1.

    2.

11. What are **growth factors**?

12. a. How does **PDGF (platelet-derived growth factor) stimulate fibroblast division**?

    b. What is the **purpose of platelets (blood fragments) releasing PDGF** and stimulating fibroblast division?

c. Study Figure 12.18. PDGF is known to signal cells by binding to a cell-surface receptor that is a receptor tyrosine kinase *(make sure you remember how this receptor works by reviewing Ch.11).* If you added a chemical that prevented this receptor from getting phosphorylated, how would the results in the second cell culture, with PDFG added, differ from what was initially seen? **Explain** your reasoning by listing each step of what occurs or not, in order.

13. Cancer cells exhibit different behaviors than normal cells. **Density-dependent inhibition and anchorage dependence are two normal cell behaviors cancer cells NO LONGER display.** Describe each behavior in normal, healthy cells.

    a. What is **density-dependent Inhibition** as seen in noncancerous cells?

    b. In reference to signal transduction mechanisms, **how do neighboring cells know not to divide when they are touching** each other?

    c. What is **anchorage dependence** as seen in noncancerous cells?

    d. In reference to signal transduction mechanisms, **how do cells know to divide only when they are touching a certain substrate like the extracellular matrix (ECM) of certain tissues**?

14. What are **cancer cells**?

15. What is meant by the term **transformation**?

16. Give two **reason why a cancer cell may divide even in the absence of external growth factor signals.**

    1.

    2.

17. Refer back to question 12. What would be witnessed in culture 1 (where PDFG growth factor was NOT added) if you performed this experiment with transformed (cancerous) fibroblast cells that contained a mutation in the tyrosine kinase gene, resulting in the production of a receptor that is always activated even in the absence of its ligand. **Explain** your reasoning by listing each step of what occurs or not, in order.

18. a. How many **times can the typical normal cell divide before dying**?

b. Unlike normal cells, HeLa cells and many other cancer cells are immortal! What is one reason for this?

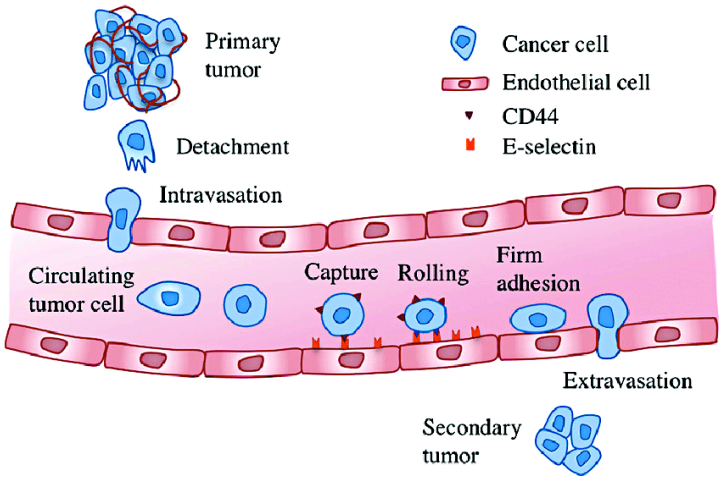
19. What are the differences between benign and malignant tumors?

Benign Tumor =

Malignant Tumor =

20. What are some of the multiple ways cells of malignant tumors (cancer cells) behave different from healthy cells?

21. What is **metastasis**?



22. List two **treatments for cancer** and describe how they **function** in treating cancer.

1. _____ =

2. _____ =

Cancer is caused by 6 to 7 DNA mutations that together alter the cell's ability to control when a particular gene that influences the cell cycle is being expressed (resulting in the production of **too much or too little of certain proteins** which help control proper cell cycle progression) **OR** **that result in the production of malfunctioning proteins that do not behave normally and so negatively influence a cell's cell cycle progression** (**failing to stop the cell from going through the cell cycle when it should stop** or **promoting a cell to go through the cell cycle when it should not proceed**).

- As we keep gaining better understandings of how a person's specific DNA mutations alter the behavior of genes and/or lead to specific abnormal protein activity in a their cancer cells, new **"personalized" drugs** are being designed that can target the exact malfunctioning genes or proteins in a person's cancer cells, leading to drugs that better target and inhibit those particular cancerous cells, hopefully also without causing as many side effects in healthy cells.

23. Proceed to the TEST YOUR UNDERSTANDING section at the end of the chapter. **Study your chapter sections and all Ch.12 study guides first!** *Then, do your best to try to answer these from memory first in order to test how well you grasped the material before. If you are unsure, return to the relevant section of your chapter and restudy any pertinent material to refresh your memory.*

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____

11. *(This question assesses your understanding of homologous chromosomes and your understanding that the goal of mitosis is to produce genetically identical daughter cells)*

13.