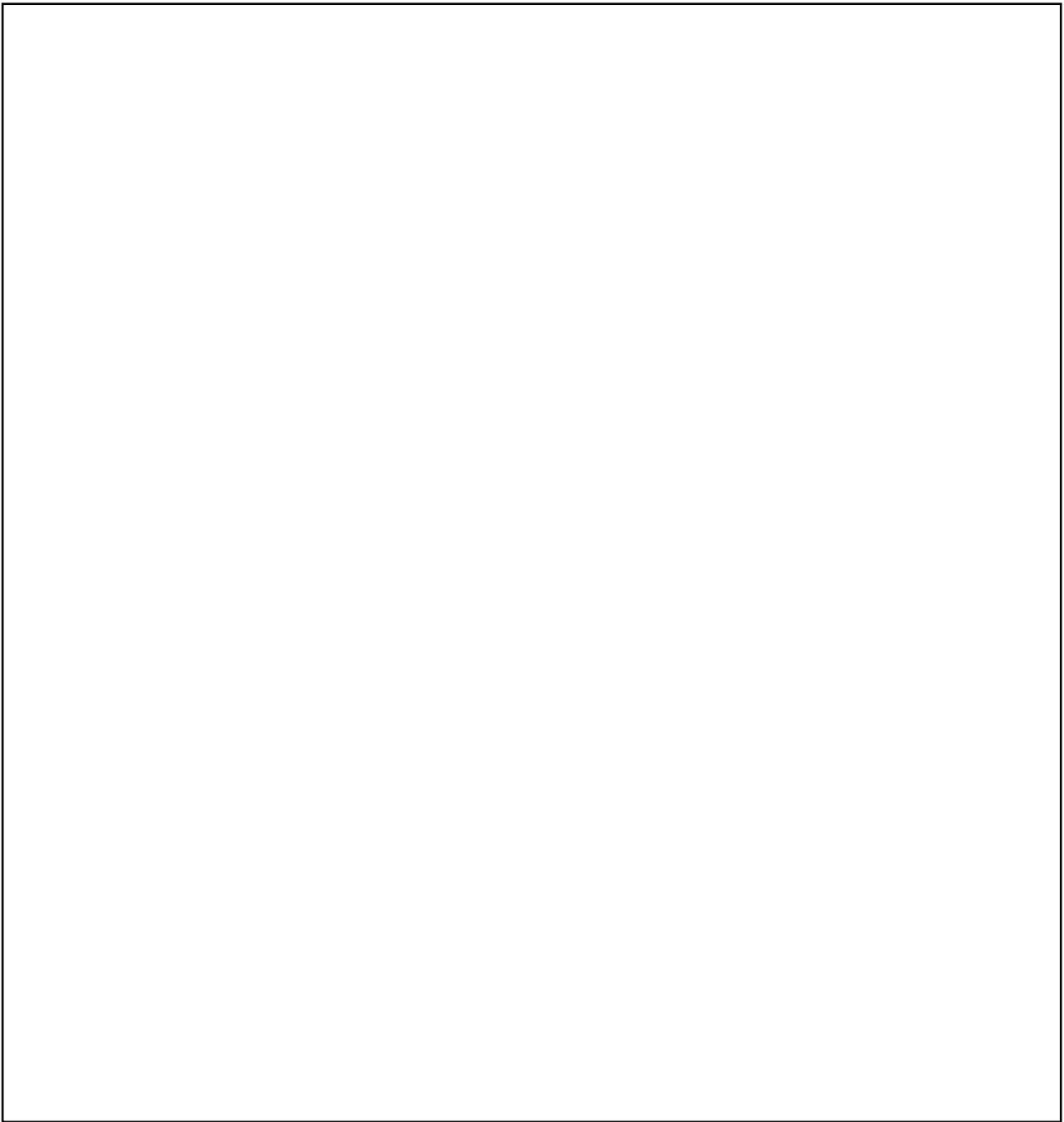


- **PHYSICALLY PRINT OUT** this PDF and **HANDWRITE** (with a black or blue pen) your answers directly on this PDF. Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.
  - **Importantly, study guides are NOT GROUP PROJECTS!!!** You, and you alone, are to 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. **When a signal transduction pathway is activated in a cell by a ligand (also referred to as a first messenger or signaling molecule), changes in cell activities occurs either in the cytoplasm or at the genetic level.**
    - a. **What occurs when the response to a signal transduction pathway involves molecules in the cytoplasm?**
    - b. When the **response involves DNA**, what is the **type of target protein** called that ends up getting activated at the end of signal transduction?
    - c. What **two possible effects does the activation of these types of nuclear proteins have on genes?**
      - 1.
      - 2.
    - d. Transcription factors influence gene expression ("turning on or off" genes). When a gene is being expressed ("is on") transcription occurs as you learned in Chapter 1. What is gene **transcription** again?
    - e. What will the **cell use the mRNA for** that is made when transcription factors activate gene expression?
  2. Epidermal growth factor (EGF) is a ligand that results in the stimulation of the EGFR tyrosine kinase receptor, which in turn stimulates intracellular signal transduction, involving a phosphorylation cascade that results in enhanced transcription of genes, which promote cell division. Study Figure 11.15 to understand well how a ligand like EGF can influence activities at the genetic (DNA) level. Then, draw in the box below, **a MODEL (illustration) showing what occurs, in correct time sequence, when EGF binds to tyrosine kinase receptors, leading to the activation of key genes that allow the cell to then make specific proteins.** Your drawing should:
    1. Have all relevant locations in the cells **as well as** all key molecules involved **labeled**.
    2. Include **numbered, step-by-step explanations of what occurs at each key step** of your the signal transduction pathway from ligand binding to the final cell response.

## Model of Epidermal Growth Factor-Induced Signal Transduction Pathway in Skin Epithelial Cells



3. What are the four ways **cells regulate the extent and specificity of a response to a signaling molecule?**

1.

2.

3.

4.

4. What is occurring in a cell's cytoplasm when a **signal is amplified during transduction?**
5. Study Figure 11.16 well, which highlights how the signal is amplified when epinephrine stimulates glycogen breakdown in a liver cell.
- How many total glucose-1-phosphate molecules are released in response to just one signaling molecule, epinephrine molecule, binding to the liver cell receptor? (*FYI: Usually more than one ligand binds of course*)
  - Calculate **the factor by which the response is amplified** at **EACH** of the seven steps of the signal transduction pathway following 1 ligand binding onto 1 receptor.
    - Factor by which response is amplified between one receptor activating due to one ligand binding to it and the G proteins being activated?
    - Factor by which response is amplified between each activated G protein and Adenylyl Cyclase being activated?
    - Factor by which response is amplified between each activated Adenylyl Cyclase and the amount of cAMP being produced?
    - Factor by which response is amplified between each cAMP made and Protein Kinase A being activated?
    - Factor by which response is amplified between each activated Protein Kinase A and Phosphorylase Kinase being activated?
    - Factor by which response is amplified between each activated Phosphorylase Kinase and Glycogen Phosphorylase being activated?
    - Factor by which response is amplified between each activated Glycogen Phosphorylase and the amount of glucose released from glycogen breakdown?

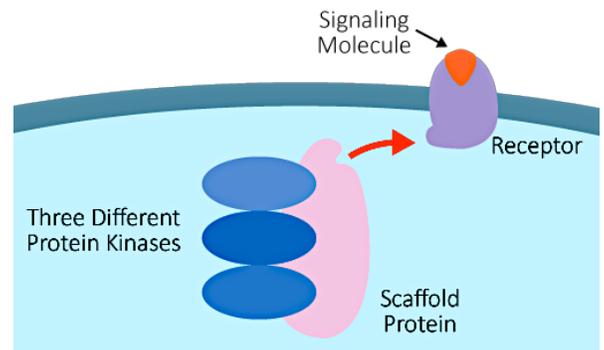
*(Check your answers to question #5.a & b by going to the **Figure Questions Figure 11.16** answer in Appendix A)*

6. One type of tissue cell may respond to a signaling molecule by changing its behavior while a different type of tissue cell may not. Moreover, two cells may each respond to the same signaling molecule, but their resulting behaviors may be very different from each other. How is this **specificity** accomplished in cell signaling? (*How does a cell control what response it will have to a signaling molecule?*)

7. Study Figure 11.17 well, showing you different possible signal transduction pathway scenarios.
- Comparing Cell A and Cell D, explain, in your own words, precisely how the **same ligand can result in two different responses in two different cells**.
  - Comparing Cell B and Cell C, in your own words, what are the differences in the cell response between a **signal transduction pathway that branches** versus multiple **signal transduction pathways that crosstalk**?

8. a. What are **scaffolding proteins**?

b. Why are they **important to efficient signal transduction**?



9. Any change in cell behavior in response to a signaling molecule needs to be able to be undone again. What are four ways that the **termination of a signal accomplished**?
- - 
  - 
  -

10. Some human diseases are associated with malfunctioning protein phosphatases. How would such a protein problem affect signaling pathways? (*Check your answer by going to [Ch.11.4 Concept Check Question #3](#) in Appendix A*)
11. a. What occurs during the process of cellular **apoptosis** (*programmed cell death*)?
- b. Why does this type of cell death, as opposed to just lysing (breaking open) the cell, protect neighboring cells?
12. The ligand (1st messenger) that triggers apoptosis is sometimes called a **Death Signal**, for obvious reasons.
- a. Explain why the response of the cell in the nematode worm, *C. elegans*, to a death signal involve cytoplasmic changes as opposed to changes at the genetic level?
- b. Study Figure 11.20 a. and b. well, highlighting apoptosis regulation in *C. elegans*. Since a cell always has the proteins essential for apoptosis ready-made in its cytoplasm, why does the cell **NOT** commit suicide in the absence of a death signal ligand?
- c. How does a **death signal lead to the cell activating the protease enzymes (caspases) and nucleases** that will help hydrolyze and destroy proteins and DNA in a cell? *Make a numbered list of the steps that take place from the moment the ligand reaches the outer surface of the cell to the point of cell response.*
13. a. *Think*: If apoptosis occurred when it should not, what types of protein defects might be the cause?!!!

b. *Think*: What types of protein defects might result in apoptosis not occurring when it should?!!!

*(Check your answers to 12.a & b by going to the **Ch.11.5 Concept Check Question #2** answer in Appendix A)*

14. In mammals, what are three sources of signals that trigger a cell to engage in **apoptosis**?

1.

2.

3.

15. Proceed to the **TEST YOUR UNDERSTANDING** section at the end of the chapter. **Study your chapter sections and all Ch.11 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 reread any pertinent material to refresh your memory. *(Check some of your answers by going to the **Ch.11 Test Your Understanding** answers in Appendix A)*

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_ 6. \_\_\_\_\_ 7. \_\_\_\_\_

8. Your drawing should be **labeled** and should show each protein prior and after activation.

10.