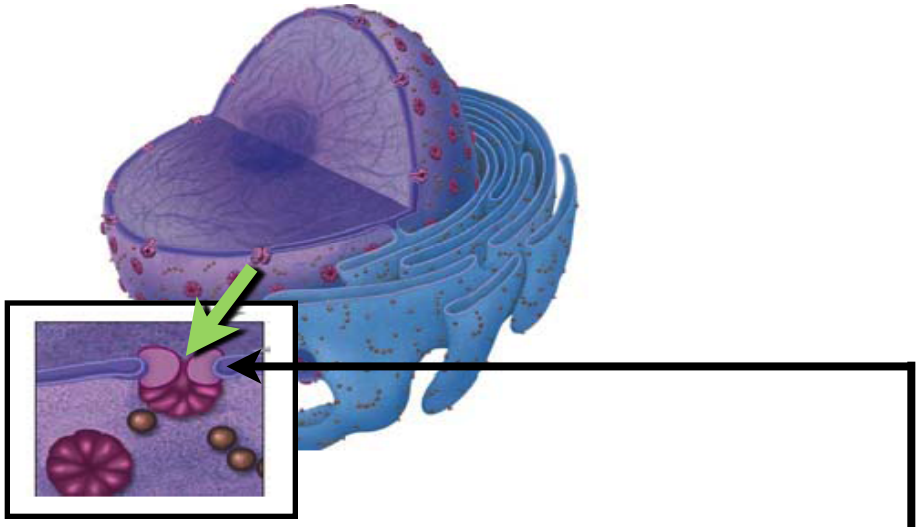
STUDY GUIDE - *Ch. 6.3 - Eukaryotic Cell's Genetic Instructions are Housed in the Nucleus and Carried out by the Ribosomes*
- Ch. 6.4 - The Endomembrane System Regulates Protein Traffic and Performs Metabolic Functions

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.*

When studying organelles, pay special attention to the structure and function of the organelles or parts of the organelles.
Make sure you see how the specific structure allows the specific function to happen!

1. **The nucleus is the organelle that contains MOST of the genes in EUKARYOTIC cells (mitochondria, for example, have some DNA with genes too!).** On the figure below, label the **nuclear envelope, nuclear pore, and pore complex**.



2. a. Describe the function of the **nuclear envelope**.

   b. How many **membrane layers** thick is this envelope? **These membranes are contiguous!** *(See image above)*

3. Study Figure 6.9. Describe the **structure AND function** of the following three parts of the nucleus.

   a. **Pore Complex Structure =**

   Pore Complex Function =

b. **Nuclear Lamina Structure =**

Nuclear Lamina Function =

c. **Nuclear Matrix Structure =**

Nuclear Matrix Function =

4. a. Found within the nucleus of Eurkaryotes are the chromosomes. What are **chromosomes**?

b. **In Eukaryotes**, chromosomes are made of chromatin. What are the **TWO components of chromatin**?

1. _____ **&** **2.** _____

c. When do the thin 30nm **chromatin fibers condense to become distinct chromosomes**?

5. a. When are the Eukaryotic **nucleoli (*nucleolus, singular*)** visible?

b. What **two activities take place in a nucleolus** inside the nucleus?

1.

2.

6. a. What do **ribosomes** do in the cytoplasm of **prokaryotic and eukaryotic cells**?

b. How is DNA and messenger RNA (mRNA) involved in aiding ribosomes with their purpose?

c. Why are ribosomes **not considered organelles**?

d. Remember the theme of **form fits function.** This concept applies to the composition of cells as well. Which **cells are expected to have a larger number of ribosomes in the cytoplasm and nucleoli in the nucleus**?

Why?

e. **All ribosomes in an organism's cell(s) are the same, but we distinguish between two types of ribosomes based on where they are found in any one moment *and* the destination of the protein product made by them at that moment.** What is the difference in location between free and bound ribosomes?

Free Ribosomes =

Bound Ribosomes =

f. What is the **difference in the destination of the protein product** made by free and bound ribosomes *(include three types protein categories made by bound ribosomes)*?

Common Final Location of Proteins Made by **Free Ribosomes** =

Common Final **THREE** Locations of Proteins Made by **Bound Ribosomes** =

1.

2.

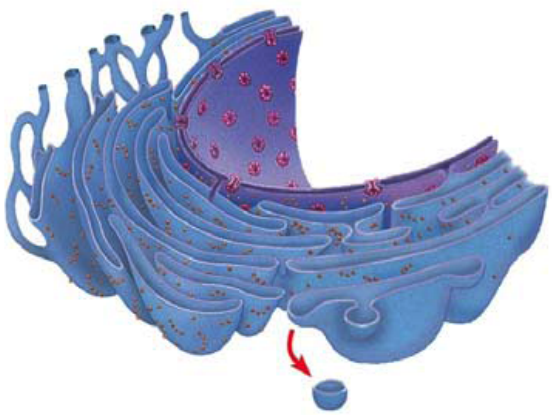
3.

7. a. List all the **organelles** that make up the **endomembrane system**.

b. How are the **membranes of these structures related**?

c. Are the membranes of the organelles of the endomembrane system **identical or different in structure and, thus, function**? Explain.

8. a. Read and review Figure 6.11. The endoplasmic reticulum (ER) makes up more than half the total membrane system in many eukaryotic cells. Use this sketch to identify the **cisternae**, **lumen or cisternal space**, **smooth endoplasmic reticulum**, **rough endoplasmic reticulum**, **nuclear envelope**, and **transport vesicles**.



b. Describe briefly these two terms.

Cisternae of the Endoplasmic Reticulum (ER) =

Cisternal Space (or ER Lumen) =

9. a. Describe the **difference in appearance between the smooth and rough ER**.

Smooth ER =

Rough ER =

b. List **four main functions of the Smooth ER** in various cells.

1.

2.

3.

4.

c. Which **three types of lipids may be synthesized by Smooth ER**?

1.

2.

3.

d. **Why** does **alcohol abuse**, for instance, **increase tolerance to not only alcohol but potentially other drugs** such as barbiturates or antibiotics as well?

10. a. Describe **two main functions of Rough ER**.

1.

2.

b. Like the Smooth ER, the **rough ER can build phospholipids (and thus more of its own membrane) too**. How does it do so?

c. How do the **ribosomes and Rough ER interact when making the secretory proteins**? Note that this is also what happens when making proteins that are to **remain in the lumen (interior) of the organelles of the endomembrane system** organelles: *Nuclear Envelope, Rough and Smooth Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Vesicles, Vacuoles, and Plasma Membrane.*

d. How do the **ribosomes and Rough ER interact when making the proteins that will become part of one of the membranes of the endomembrane system organelles or the cell's outermost plasma membrane?**

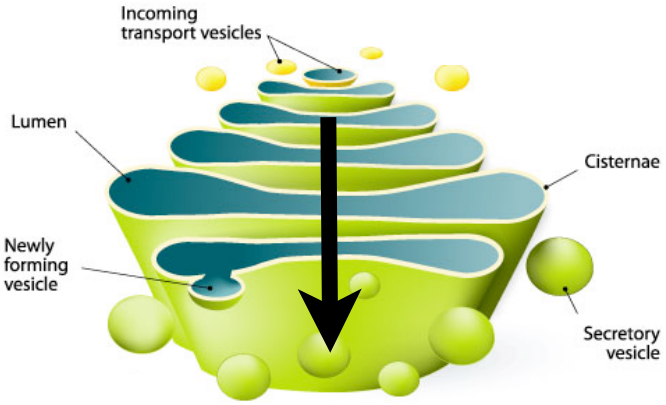
11. a. Endomembrane organelle proteins are synthesized with the help of bound ribosomes immediately to the exterior of the RER. Some of these proteins associated with the RER are destined to become edomembrane **membrane** proteins while others will become **dissolved proteins** in the lumen of an endomembrane organelle. When initially in the RER though, some of these proteins are turned into glycoproteins. What is a **glycoprotein**?

b. How are proteins and glycoproteins that form in the lumen (interior) of the Rough ER (RER) or proteins and glycoproteins that form in the membrane of the Rough ER, moved from the ER to other parts of the cell?

FYI: The sugar portions of glycoproteins are added to newly forming RER proteins by enzymes embedded in the inside portion of the membrane of the Rough ER. When newly synthesized glycoproteins are forming which **will be embedded in** the membrane of the Rough ER (not floating in the lumen of the Rough ER), **the carbohydrate polymer will thus be attached to the protein on the side of the protein facing the INSIDE of the RER (the side facing the lumen - NOT the side facing the cytoplasm of the cell)!!!**

12. a. The transport vesicle formed by **budding** off the Rough ER, **fuses** with the Golgi apparatus. Describe the **functions of the Golgi apparatus with regards to the proteins it receives from the Rough ER.**

b. Label the **cis and trans faces of the Golgi apparatus** on the illustration below, the large arrow indicating the direction of cisternal content maturation and the direction of the movement of the Golgi's cisternae.



c. Which two types of molecules or portions of molecules may be **modified within the Golgi apparatus**?

1.

2.

d. Besides proteins, what **other products are manufactured within the Golgi apparatus**?

e. Provide one **example** of the nonprotein products mentioned in 11.d produced in plants.

_____

Explain **how the product you listed reaches its final destination** after being made in the Golgi.

f. After reading and studying Figure 6.12 and reviewing all you have learned so far in this section, imagine there is a new protein going to be synthesized. This protein, which happens to be made up of one polypeptide, is destined to work inside the Rough ER's lumen, but it first requires further chemical modification in the Golgi apparatus before being functional. Make a list to **describe in detail, and with proper terminology, the protein's path through the cell**, *starting with the exiting of the mRNA molecule from the nucleus*, the mRNA containing the instructions for the ribosome to use to construct the primary structure of this proteins polypeptide. *(Check your answer by going to the **Ch.6.4 Concept Check Question #3** answer in Appendix A)*

13. a. What are **lysosomes**?

b. Let's analyze how **lysosomes form**. Given all you have learned in this section, explain how and where their membrane (phospholipids), membrane proteins, **AND** their internal dissolved hydrolytic enzymes (proteins) are made and how those items become part of the final lysosome's structure. *Think through the steps carefully.*

Where might the lysosomal membrane phospholipids be made?

How do the lysosomal membrane phospholipids become part of the lysosome?

Where are the protein meant for the membrane of the lysosome made? *(Take care to be accurate!)*

How do these membrane proteins become part of lysosomal membranes? Explain the process.

Where are the hydrolytic enzymes (dissolved proteins) of the lumen (inside) of the lysosome made? *(Take care to be accurate!)*

How do the hydrolytic enzymes (dissolved proteins) become packaged in the lumen (inside) of the lysosome? Explain the process.

c. For the enzymes of the lysosome to function, what **internal environment** is needed in the lysosome?

d. If a lysosome bursts open inside the cell, the cell's cytoplasmic contents are not immediately digested. Cellular digestion is possible only if a significant number of lysosomes release their contents into the cell, the cell then **autodigesting** itself. Why would the **cell not autodigest with the release of just one lysosome's contents**?

It is essential that you learn how to explain answers fully, walking the reader from the start of a scenario through each change and its consequence, step-by-step, in chronological order, until you get to the final outcome.

For example, here, first discuss in your answer what pH measures in a solution. Next, discuss how a lysosome spilling its acidic contents into the large volume of cytoplasm would or would not affect the pH of that cytoplasm/cytosol. Finally, discuss the consequences on the activity of lysosomal enzymes that have also spilt into this cytoplasm (with the pH it has), contrasting the activity of these lysosomal enzymes in this cytoplasm with their behavior previously inside an intact lysosome (and the pH it had), remember from Ch.5 what you learned about protein shape and its effects on function.

Part 1 of Explanation - What does pH measure?

Part 2 of Explanation - How does one lysosome lysing affect the pH of the cytoplasm? *Elaborate on why you claim what you claim.*

Part 3 of Explanation - What are the consequences to the lysosomal enzymes (in terms of protein shape and then function) when they leave the lysosomal environment and enter this particular cytoplasmic environment where one lysosome's content has leaked out? *Elaborate on why you claim what you claim.*

e. *Think:* Why would the consequences be different if numerous lysosomes spilled their contents into the cell cytoplasm in unison? Just as you practiced doing above, *explain first what the immediate consequence is on cytoplasmic pH of increasing the number of lysosomes leaking their contents out. Then, explain how this causes yet another consequence down the line in lysosomal enzyme (protein) shape and thus behavior. And, lastly, discuss how this latter will affect the integrity of the cell and the macromolecules that form its internal structures.*

14. a. One function of lysosomes is intracellular digestion of particles engulfed by **phagocytosis**. 1. Describe this **process of phagocytosis**. 2. Include a **labeled drawing showing the steps** involved in this process.

b. What is an example of a human cell that carries out phagocytosis?

c. A second function of lysosomes is to recycle cellular components in a process called **autophagy**. 1. Describe this **process of autophagy**. 2. Include a **labeled drawing showing the steps** involved in this process.

d. What are **lysosomal storage diseases**? One example is **Tay Sachs, a disease that results in brain cell death due to the abnormal accumulation of certain undigested lipids in lysosomes, the lysosomes subsequently enlarging and then causes other cellular activities to fail.**

15. a. What are **vacuoles**?

b. Describe the **functions of various types of vacuoles** found in different types of eukaryotic cells.

1.

2.

3.

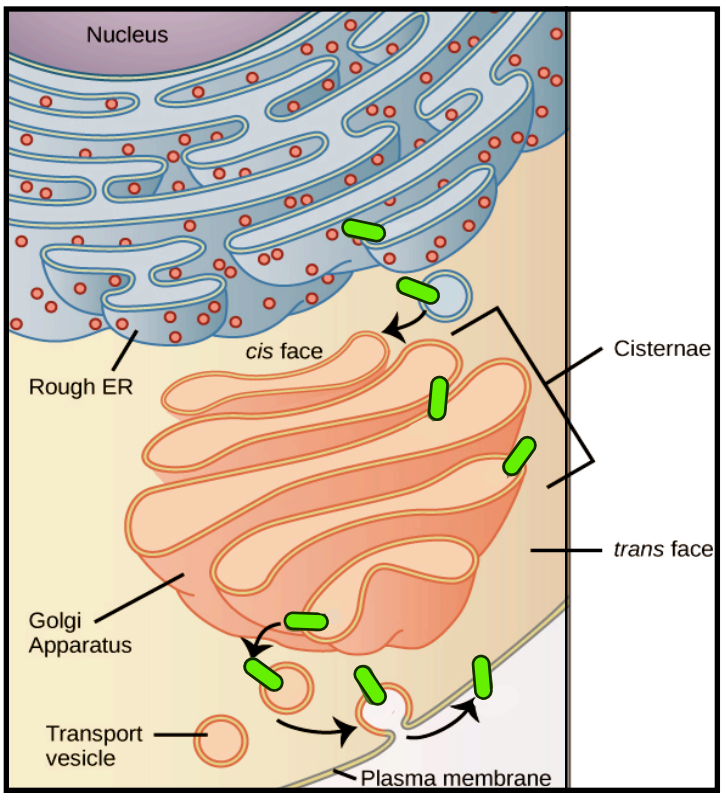
4.

5.

6.

7.

16. a. Study Figure 6.15 well. Then, refer back to the glycoprotein constructed in 11.b. If this Rough ER **glycoprotein were destined for inclusion in the plasma membrane**, on what side of the plasma membrane would the sugar portion of the glycoprotein end up???



b. As evidence for your answer to part a., **add the sugar group to the correct side of the protei**n in the illustration to your right when the protein is part of the membrane still of the Rough ER, part of the membrane in the transport vesicle headed for the Golgi, part of the Golgi's cisternal membranes, in the secretory vesicle's membrane, and finally in the plasma membrane.

c. Let's return to the protein discussed in 12.e. Imagine, instead of the Rough ER being this protein's final destination, that this **protein is destined for secretion from the cell**. Add this soluble protein to the illustration. Show where it would be in the Rough ER, transport vesicle, Golgi apparatus, & secretory vesicle once it has fused with the plasma membrane.