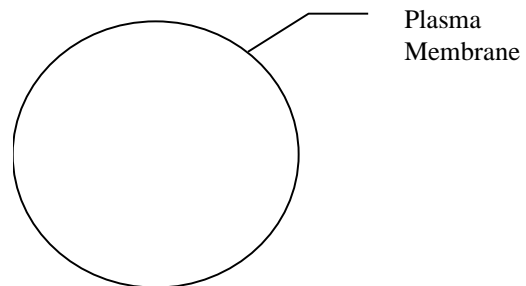
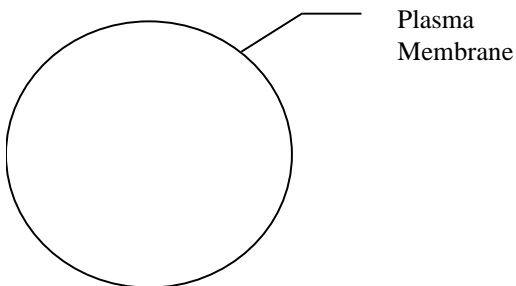


6. a. Name the enzyme responsible for lengthening each strand during DNA replication by repeatedly adding nucleotides to the 3' end of each strand.
- b. How does this enzyme “know” which nucleotide to use during DNA replication—that is, what “rules does the enzyme follow.
- c. Name the enzyme that proofreads and corrects any errors it finds in the DNA strands after the completion of DNA replication.
- d. What is a mutation? Why do they occur?
- e. During which phase of the cell cycle do mutations occur?

Relating DNA Replication to the Cell Cycle

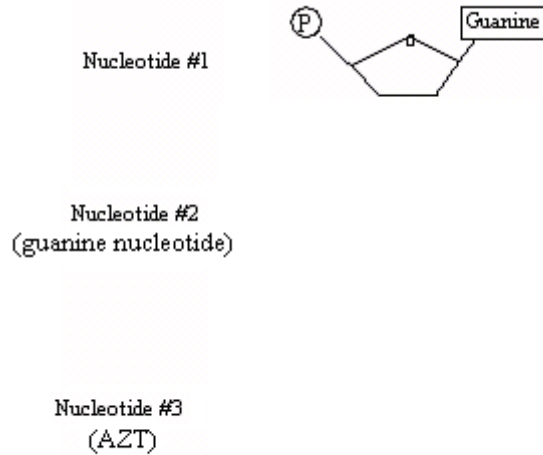
7. a. As in mitosis, the chromosomes are duplicated prior to the start of meiosis I. How many duplicated chromosomes will there be in a human “pregamete” cell just before the start of meiosis I?
 - b. How many DNA molecules are in a human “pre-gamete” cell just before the start of meiosis I?
 - c. Just after meiosis II and cytokinesis (the division of the cytoplasm) how many chromosomes are there in each gamete?
 - d. Just after meiosis II and cytokinesis how many DNA molecules are there?
8. Diploid “pregamete” cells from a hypothetical mammal were examined under a microscope and found to contain 4 chromosomes.
 - a. Draw one of these cells in metaphase I of meiosis. Consider the size and shape of your chromosomes.
 - b. A drug is given to this animal so that the S phase (DNA replication) does not occur. Draw one of these cells in metaphase I of meiosis. Draw your chromosomes so that the size and shape is consistent with the cell you drew in part a.



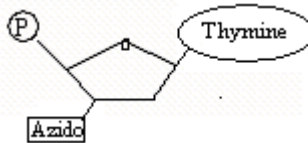
Applying your knowledge

9. a. Diagram the way in which two guanine nucleotides would join together to form a single strand of DNA two nucleotides long. Use the guanine nucleotide drawn below as the first nucleotide (nucleotide #1, below), and draw another guanine nucleotide in the space to the right of the label “Nucleotide #2.”

- Label the sugar, base, and phosphate portions of the first nucleotide.
- Number the carbons in the sugar of the first nucleotide.
- Label the 5' and 3' ends of this mini DNA molecule
- Be sure to connect the two nucleotides together in the appropriate places by a covalent bond—see figures 11.5 and 11.8 in *Essentials of Biology by Mader 2nd ed* if you need help understanding how to connect nucleotides.



b. AZT (Azido thymidine) is a drug currently used to treat AIDS patients. AZT is similar to the thymine nucleotide (i.e. the “T” nucleotide found in all DNA). AZT differs from the T nucleotide in that an “azido” chemical group is attached to its sugar. Now add an AZT (Azido thymidine) nucleotide (shown below) to the growing strand in the diagram above. Connect the AZT nucleotide by a covalent bond to the guanine nucleotide above it.



c. Explain why AZT prevents another nucleotide from being added to the growing DNA strand and then explain how AZT will affect DNA replication.

10. Most nerve cells do not replicate their DNA upon reaching maturity. Suppose that a cell biologist measured the amount of DNA in several different types of human cells:

- 1) Nerve cells
- 2) Sperm cells
- 3) Bone cells just starting interphase
- 4) Skin cells in the S phase
- 5) Intestinal cells just beginning mitosis

She found x amount of DNA in the nerve cells. Use this fact and the information in the table below to identify Cells A - D. Note: If the cell cycle and mitosis are a bit rusty, review Section 8.2 in *Essentials of Biology by Mader*.

Cell Type	Amount of DNA in Cell	Identity of Cell
Nerve Cell	x	Nerve Cell
Cell A	2x	
Cell B	1.6x	
Cell C	0.5x	
Cell D	x	

11. Over-exposure to ultra violet light from the sun or cancer beds (i.e. tanning beds!) may cause a person's skin to burn and eventually peel. What is the biological/genetic cause/reasons why burnt skin peels? What are the biological advantages and disadvantages of peeling? Your response should include a discussion of DNA repair enzymes, apoptosis, and the p53 gene.

Something you may find interesting.....

The number of times a cell is capable of dividing is called the Hayflick limit—named after Leonard Hayflick, the biologist that discovered it in 1961. It's intriguing to note that the cells of longer-lived species of animals have a larger Hayflick limit (e.g. Human fibroblast cells have a Hayflick limit of 40-60, the long-lived Galapagos Tortoise (lifespan >> 150 years) has a Hayflick limit of about 110), while those of short-lived species have smaller Hayflick limit (e.g. mice live 2-3 years and have a Hayflick limit of about 10-15). The Hayflick limit appears to be related to the length of the telomeres associated with that species. Although cells continue living when they reach the Hayflick limit, they often become senescent. Senescent cells are dedifferentiated (i.e. do not perform the functions they were originally programmed to do), appear structurally abnormal under the microscope, and gradually lose their ability to function properly. On the other hand, many cells cease to divide after they are formed (e.g. most neurons in the brain), yet they do not normally become senescent. Although the exact relationship between the Hayflick limit and longevity is still unclear, it is a hot area of current research.

12. What are telomeres and why are they essential for the survival of our species and all other eukaryotic species?

13. Most somatic cells (i.e. body cells) in the human body can divide about 40-60 times before they ultimately stop dividing. On the other hand, cancer cells, stem cells (undifferentiated cells that divide to give rise to other cell types; e.g. stem cells in the bone marrow give rise to the various types of blood cells, including RBC's and WBC's), and the germ stem cells (those that produce the gametes—egg and sperm cells) are *not* limited in the number of times they can divide. Explain why stem cells and cancerous cells have unlimited reproductive capability, while somatic cells can divide only a finite number of times. What roles do the telomerase gene and the enzyme telomerase play?