√+

Name Leonie Hoeher Period _____

Chapter 16: The Molecular Basis of Inheritance

Concept 16.1 DNA is the genetic material

1. What are the two chemical components of chromosomes?

   DNA and protein

2. Why did researchers originally think that protein was the genetic material?

   Proteins are specific in function and there are many different kinds.

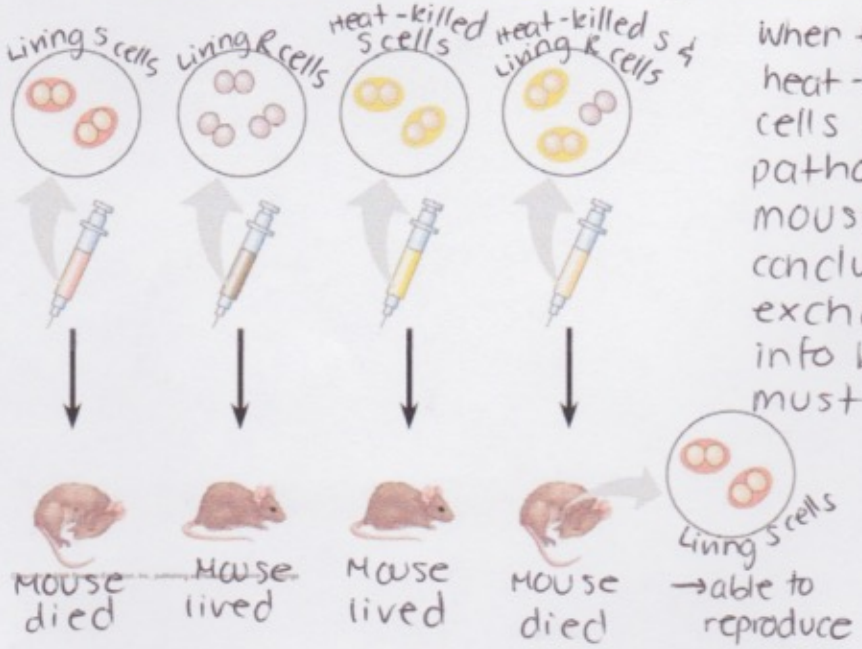
3. Distinguish between the virulent and nonvirulent strains of *Streptococcus pneumoniae* studied by *Frederick Griffith*.

   Griffith studied the smooth strain, which caused pneumonia and the rough strain, which did not.

4. What was the purpose of Griffith's studies?

   Griffith wanted to test for the trait of pathogenicity in the bacteria.

5. Use this figure to summarize the experiment in which Griffith became aware that hereditary information could be transmitted between two organisms in an unusual manner.



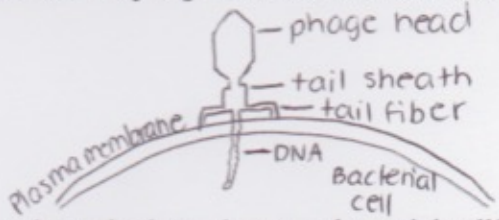
When the mixture of heat-killed pathogenic cells and living non-pathogenic caused the mouse to die, Griffith concluded that an exchange of genetic info between the bacteria must have occured.

6. Define *transformation*.

   A change in genotype and phenotype because of the addition of outside DNA to a cell.

7. What did Oswald Avery determine to be the *transforming factor*? DNA Explain his experimental approach.
Avery tested DNA, RNA, and protein of the heat-killed bacteria and showed that only when DNA remained active did a transformation of live nonpathogenic bacteria occur.

8. Sketch a *T2 bacteriophage* and label its *head*, *tail sheath*, *tail fiber*, and *DNA*.



9. How does a bacteriophage destroy a bacterial cell? Look ahead to Chapter 19, Figure 19.5, to explain this.
The phage attaches to the cell and injects its DNA, which causes the degradation of the host cell's DNA. The phage DNA directs production of more phages, using resources in the cell. Different proteins assemble the phages with the phage genome inside. Then the bacterial cell wall is damaged, fluid enters, and the cell bursts, freeing 100-200 phage particles.

10. How did Hershey and Chase "label" viral DNA and viral protein so that they could be distinguished? Explain why they chose each radioactive tag in light of the chemical composition of DNA and protein.
They labelled DNA with radioactive phosphorus and protein with radioactive sulfur. They used these because only protein (not DNA) contains sulfur and phosphorus labeled only the DNA, where most phosphorus is located.

11. Describe the means by which Hershey and Chase established that only the DNA of a phage enters an *E. coli* cell. What conclusions did these scientists draw based on these observations?
E. coli was allowed to be infected by the protein- and the DNA-labeled phages. They observed that only the phage DNA entered the bacterial cells, not protein. They concluded that DNA must function as the genetic material of phage T2.

12. What are *Chargaff's rules*? How did he arrive at them?
1) Base composition varies between species
2) In a species, number of A and T are equal and G and C are equal
Chargaff analyzed base composition of DNA from a number of different organisms and found a regularity in the nucleotide bases and that amount of nucleotides is different in different species.

13. List the three components of a nucleotide.
Phosphate group, sugar, nitrogenous base.

14. Who built the first model of DNA and shared the 1962 Nobel Prize for discovery of its structure?

Watson and Crick (+Wilkins)

15. What was the role of Rosalind Franklin in the discovery of the *double helix*?

She made images of DNA with a technique called X-ray crystallography, which Watson analyzed and recognized as helical.

16. Distinguish between the structure of *pyrimidines* and *purines*. Explain why adenine bonds only to thymine.

Purines have two organic rings and pyrimidines have one. Adenine bonds only to thymine because of their chemical side graps that form H-bonds only with each other.

17. How did Watson and Crick's model explain the basis for Chargaff's rules?

It showed why the number of A and T or G and C in a species is equal.

18. Given that the DNA of a certain fly species consists of 27.3% adenine and 22.5% guanine, use Chargaff's rules to deduce the percentages of thymine and cytosine.

Thymine : 27.3%

Cytosine : 22.5%

19. Name the five nitrogenous bases, and put a checkmark in the correct column for each base. Also indicate if the base is found in DNA (D), RNA (R), or both (B).

Nitrogenous Base	Purine	Pyrimidine	D, R or B
Adenine	✓		B
Guanine	✓		B
Thymine		✓	D
Cytosine		✓	B
Uracil		✓	R

20. Explain the base-pairing rule.
A pyrimidine always has to pair with a purine so the DNA has a uniform diameter.
A – T/U G – C

21. Describe the structure of DNA relative to each of the following:

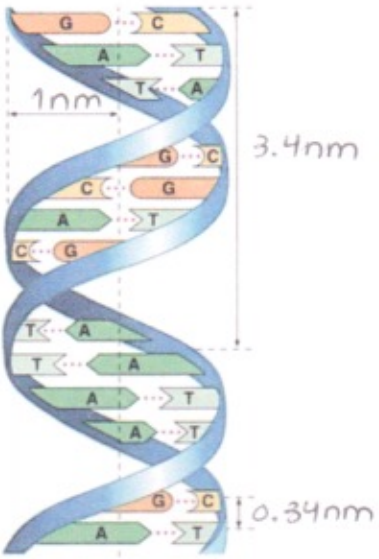
a. distance across molecule 2 nm

b. distance between nucleotides 0.34nm

c. distance between turns 3.4nm

d. components of the backbone phosphate, sugar

e. components of the "rungs" A, G, T, C



22. Explain what is meant by 5' and 3' ends of the nucleotide.
The 5' end is the end with the phosphate grap and the 3' end has the OH group of the sugar.

23. What do we mean when we say the two strands of DNA are *antiparallel*?
They run in opposite directions.

Concept 16.2 Many proteins work together in DNA replication and repair

24. What is the *semiconservative model of replication*?
This model proposes that the parental strands seperate, each functioning as a template for the production of a new, complementary strand.

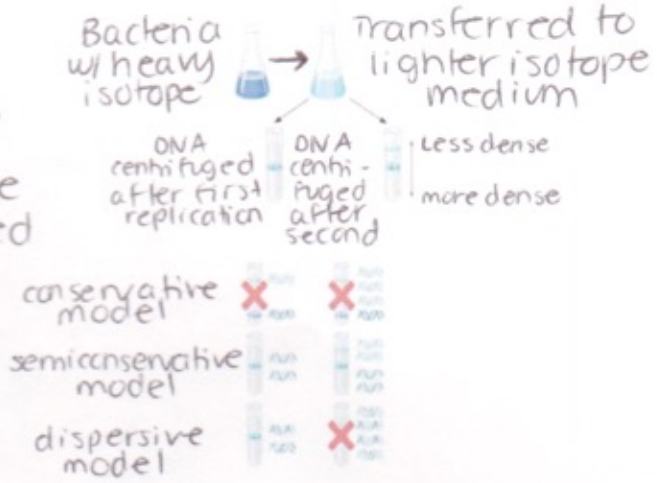
25. Who performed the experiments that elucidated the correct mechanism of DNA replication?
Matthew Meselson and Franklin Stahl

26. How did Meselson and Stahl create "heavy" DNA for their experiments?

They cultured the cells in a medium that was labeled with a heavy isotope of nitrogen, ^{15}N.

27. Use Figure 16.11 to explain how Meselson and Stahl confirmed the semiconservative mechanism of DNA replication.

The results eliminated the conservative model because the first replication produced a band of hybrid DNA. The dispersive model was also eliminated because the second replication produced light and hybrid DNA. The semiconservative model was supported.



28. Define the *origins of replication*.

Short stretches of DNA with a specific nucleotide sequence where replication of a DNA molecule begins.

29. Distinguish between the *leading* and the *lagging strands* during DNA replication.

On the leading strand, DNA pol III continuously adds nucleotides to the new strand, where only one primer is needed. The lagging strand is synthesized away from the replication fork, discontinuously in a series of fragments.

30. What is the direction of synthesis of the new strand?

5' → 3'

31. What are *Okazaki fragments*? How are they welded together?

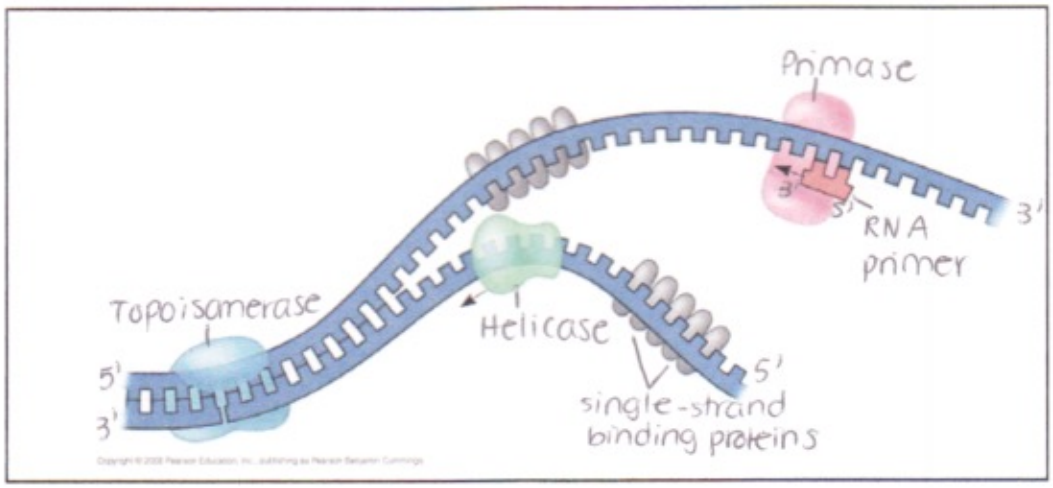
Segments of the lagging strand, welded together by DNA ligase, which joins the backbones.

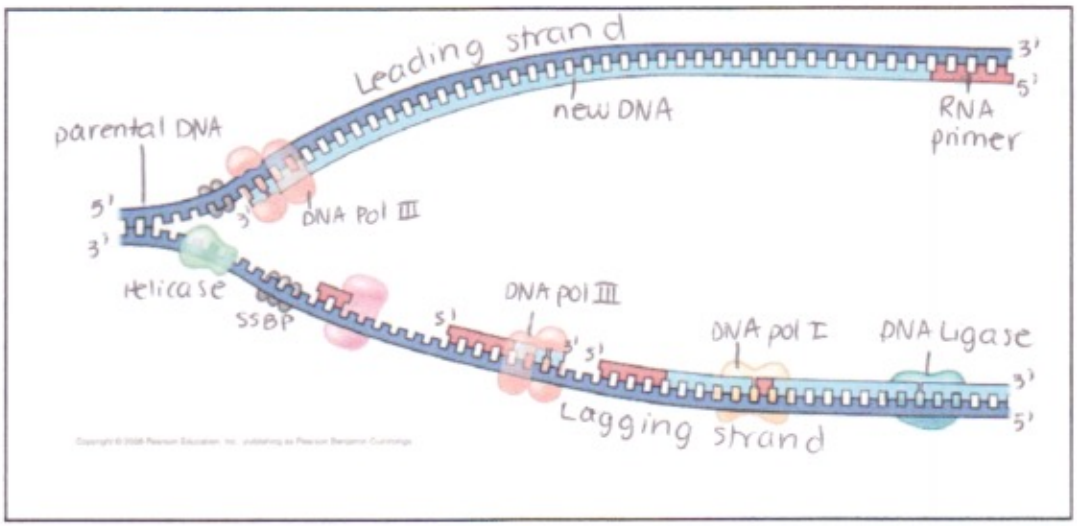
32. Which enzyme . . .?

a. untwists and separates strands	DNA Helicase
b. holds DNA strands apart	single-strand binding protein

c. synthesizes RNA primer	Primase
d. adds DNA nucleotides to new strand	DNA Polymerase III
e. relieves strain caused by unwinding	Topoisomerase
f. joins DNA fragments together	DNA Ligase
g. removes RNA primer and replaces with DNA	DNA Polymerase I

33. Label the following figures. Include ~~3' and 5' strands~~, ~~RNA primer~~, ~~primase~~, ~~SSBP~~, ~~topoisomerase~~, ~~helicase~~, ~~leading strand~~, ~~lagging strand~~, ~~DNA pol I~~, ~~DNA pol III~~, ~~DNA ligase~~, ~~parental DNA~~, and ~~new DNA~~.





34. *Put it all together!* Make a detailed list of the steps that occur in the synthesis of a new strand.

① DNA Helicase unwinds
② Primase makes DNA primers
③ DNA pol III adds nucleotides (5'→3')
④ SSBP stabilizes unwound strands
⑤ Leading strand continuously
⑥ DNA pol III detaches when another primer is reached & starts again
⑦ DNA pol I removes primers & replaces them with DNA nucleotides
⑧ DNA ligase joins 3' end of second fragment to 5' end of first fragment

35. Explain the roles of each of the following enzymes in DNA proofreading and repair.

Enzyme	Role
DNA polymerase	proofread each nucleotide against its template as soon as it is added and replaces incorrect ones
Nuclease	DNA-cutting enzyme that removes a segment containing damage
Ligase	Fills gap made by nuclease along with DNA polymerase
Repair enzymes	repair genetic damage caused by UV rays

36. What is a *thymine dimer*? How might it occur? How is it repaired?

Covalent linking of thymine bases that are adjacent, which causes interference w/ replication. Occurs due to sunlight. Repaired by DNA repair enzymes

37. Make a sketch of a chromosome and label the *telomeres*.

38. Explain telomere erosion and the role of *telomerase*.

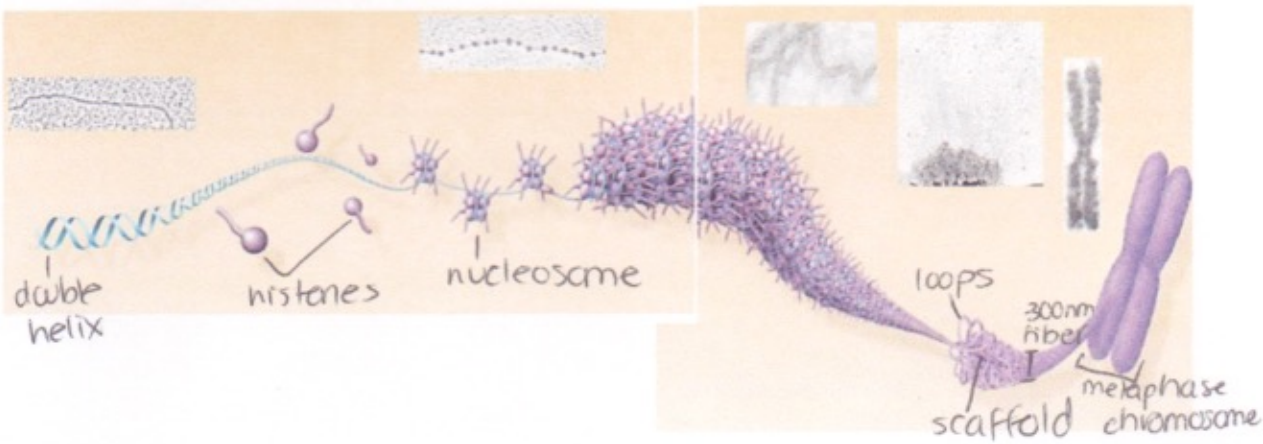
With each round of replication, the DNA strand gets shorter, as does the telomere section, which protects the DNA from becoming shorter. Telomerase catalyzes the lengthening of telomeres in eukaryotic germ cells, restoring original length & compensating for shortening.

39. Why are cancer cells immortal, but most body cells have a limited life span?

Apparently cancer cells can stabilize telamere length, allowing them to persist and not self-destruct. If body cells that are not cancerous ~~shorten~~ divide too much and the DNA continues shortening, they will not survive.

Concept 16.3 A chromosome consists of a DNA molecule packed together with proteins

40. On the diagrams below, identify the following: ~~*30-nm fiber*~~, ~~*metaphase chromosome*~~, ~~*double helix*~~, ~~*histone proteins*~~, ~~*nucleosomes*~~, ~~*protein scaffold*~~, ~~and *looped domains (300-nm fiber)*~~.



41. Distinguish between *heterochromatin* and *euchromatin*.

Testing Your Knowledge: Self-Quiz Answers
Now you should be ready to test your knowledge. Place your answers here:

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