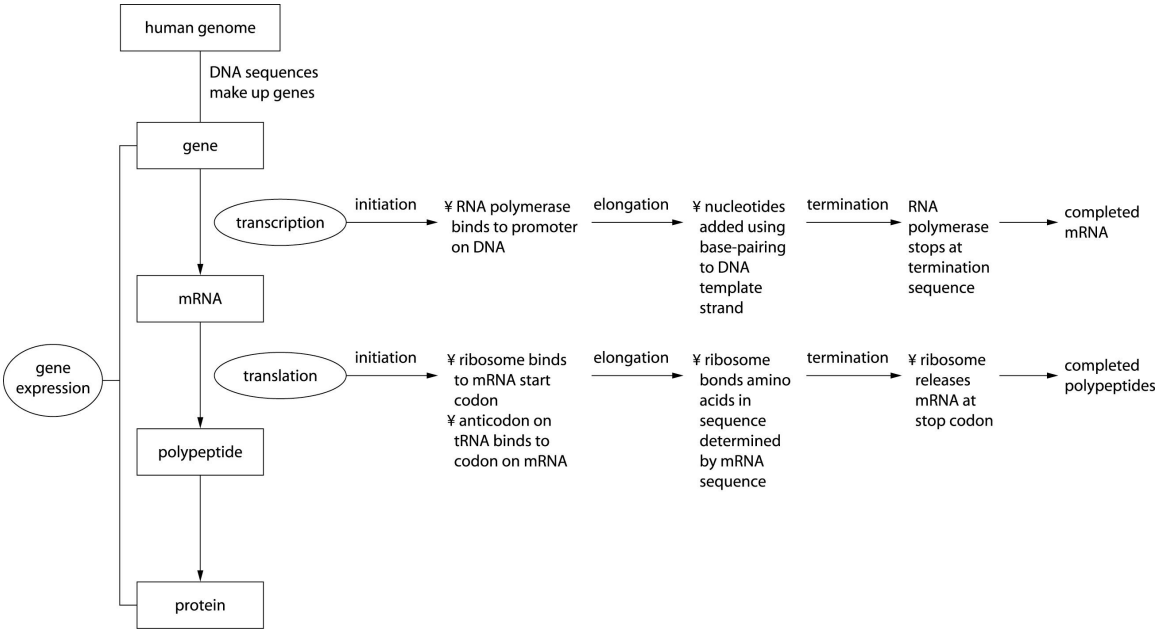
CHAPTER 20 SUMMARY

Make a Summary

(Page 700)

1. Sample answer:



2. Students' answers will likely be more detailed, contain appropriate vocabulary, and reflect any revisions to previous misconceptions.

CHAPTER 20 REVIEW

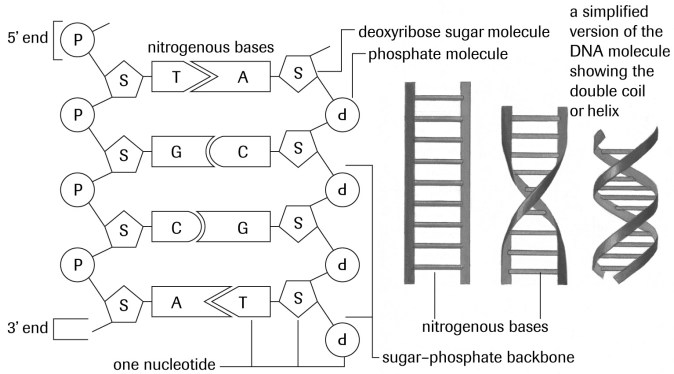
(Pages 702–704)

Part 1

1. D
2. C
3. 7, 6, 1, 4
4. D
5. C
6. 9, 7, 8, 5
7. 3, 6, 1, 4

Part 2

8.



9. The incidence of error during replication is minimized because of the use of a parent strand as a template in building a new daughter DNA strand (a complement to the original parent DNA). Also, since DNA comprises complementary nucleotides, the new strand that is built contains the same coding information as the parent strand. Another mechanism that DNA uses to minimize errors during replication is that of exonuclease activity of DNA polymerase III and DNA polymerase I. Once the new complementary strand is synthesized, these two enzymes can remove any incorrectly paired nucleotide and insert the appropriate nucleotide in its place.

10.

Enzyme	Function
DNA ligase	The enzyme that joins DNA fragments together by catalyzing the formation of a bond between the 3′ hydroxyl group and a 5′ phosphate group on the sugar-phosphate backbones
DNA gyrase	The bacterial enzyme that relieves the tension produced by the unwinding of DNA during replication
DNA helicase	The enzyme that unwinds double-helical DNA by disrupting hydrogen bonds
DNA polymerase I	An enzyme that removes RNA primers and replaces them with the appropriate deoxyribonucleotides during DNA replication
DNA polymerase III	The enzyme responsible for synthesizing complementary strands of DNA during DNA replication

11. TTAACGTAT
12. Both strands of a DNA molecule act as a template during replication. If both new complementary strands were synthesized in the same direction (toward the replication fork), one strand would be built in the 5′ to 3′ direction (the leading strand), whereas the other complementary strand would have to be built in the 3′ to 5′ direction (because of the antiparallel nature of DNA strands). However, DNA polymerase III, the enzyme responsible for the synthesis of new complementary strands, can only be built in the 5′ to 3′ direction. To deal with this problem, a mechanism has evolved in which one strand, the lagging strand, is built in small segments away from the replication fork. Initially, small segments of RNA, known as RNA primers, are laid by primase along the lagging strand template. DNA polymerase III uses these segments to start synthesizing small sections of DNA away from the replication fork. These small sections of DNA sequence are called Okazaki fragments. DNA polymerase I will then excise the RNA primers and replace them with the appropriate nucleotides. DNA ligase joins the gaps in the Okazaki fragments by creating a phosphodiester bond. The result is discontinuous replication of the 3′ to 5′ parental strand.
13. The following proportions would be found in the complementary strand: 15 % thymine, 30 % adenine, 20 % cytosine, and 35 % guanine. The proportions in the whole molecule would be as follows:
adenine = (15 % + 30 %)/2 = 22.5 %

thymine = (30 % + 15 %)/2 = 22.5 %
cytosine = (35 % + 20 %)/2 = 27.5 %
guanine = (20 % + 35 %)/2 = 27.5 %

14. Messenger RNA (mRNA) represents the product of transcription of a gene. Ribosomes found in the cytoplasm synthesize proteins using mRNA as the template. Since DNA is transcribed into mRNA, the DNA itself does not have to exit the nucleus and be subjected to degradation. Transfer RNA (tRNA) delivers amino acids to the ribosome. The amino acids are used to build protein during the process of translation. Ribosomal RNA (rRNA) binds with ribosomal proteins to form ribosomes.
15.

Transcription	Translation
Initiated by the enzyme RNA polymerase, RNA polymerase binds to the promoter region of DNA, causing DNA to unwind.	Initiated when ribosome binds to 5′ cap (eukaryotes) of messenger RNA sequence.
RNA polymerase synthesizes messenger RNA strand in the 5′ to 3′ direction. RNA polymerase adds one complementary ribonucleotide at a time.	Ribosomes build polypeptide chains with the aid of transfer RNA. The ribosome moves along mRNA, reading the code in triplets known as codons. When the ribosome encounters the start codon, appropriate tRNA will bring in methionine amino acid residue. Transfer RNA and messenger RNA must be complementary for amino acid to be placed on polypeptide chains. For every triplet of ribonucleotides read, the corresponding amino acid is added to the growing polypeptide chain.
Terminated when RNA polymerase encounters a termination sequence on the DNA strand.	Terminated when the ribosome encounters a stop codon. Enzymes known as release factors cause ribosome to fall off the mRNA strand.
Posttranscriptional modifications are made, including capping and tailing and excising introns if mRNA is eukaryotic.	Polypeptide chain is folded into protein.
Transcription takes place in the nucleus.	Translation takes place in the cytoplasm.

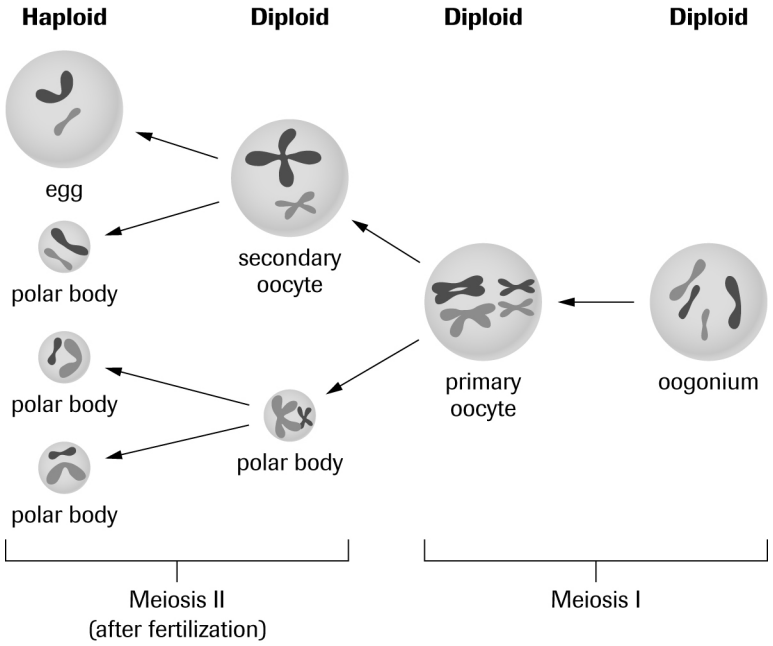
16. RNA polymerase transcribes in the 5′ to 3′ direction; therefore, the 3′ to 5′ strand will be the template strand.
3′–TTCATGTCGTA–5′: template strand
5′–AAGUACAGCAU–3′: mRNA strand
lys–tyr–ser: polypeptide chain
17. Every codon must consist of a triplet of base pairs because there are 20 amino acids. If doublets of base pairs were used to code for amino acids, only 16 possibilities would exist (42 = 16), which would not be enough to code for all the amino acids. The triplet combination allows for 64 combinations (43 = 64), which are more than enough to code for all amino acids, as well as the start and stop signals.
18. The structure of mRNA is similar to DNA as follows. Both are polymers of repeating units; both contain the nitrogenous bases adenine, guanine, and cytosine; and both contain phosphate in their backbone. Messenger RNA does differ from DNA. Messenger RNA is single-stranded, whereas DNA is double-stranded; mRNA contains uracil, whereas DNA contains thymine as a complement to adenine; and mRNA contains a ribose sugar, whereas DNA contains a deoxyribose sugar in its backbone.
19. Blunt ends are fragment ends of a DNA molecule that are fully base paired at the end, whereas sticky ends possess short, single-stranded overhangs. Blunt ends result when fragments are cut by certain restriction enzymes that always cleave at a specific location and specific site, such as *Sma*I (shown below), and when only the phosphodiester bonds of the DNA backbone are broken. Sticky ends result when fragments are cut by certain restriction enzymes that always cleave at a specific location and specific site, such as *Eco*RI (shown

below) and when both the hydrogen bonds between nucleotides and the phosphodiester bonds of the DNA backbone are broken.

Blunt Ends: *Sma*I		Sticky Ends: *Eco*RI	
5′–GGG	CCC–3′	5′–G	AATTC–3′
3′–CCC	GGG–5′	3′–CTTAA	G–5′

20. The restriction enzyme site for *Alu*I, which cuts between the G and C, is highlighted in the fragment below:
    CGTCATCGATCATGCAGCTC
21. The presence of an antibiotic-resistance gene marker in a plasmid may be used to determine whether a transformation has been successful by transforming the plasmid into a bacterial colony and then plating the bacteria on a medium containing the antibiotic for which the resistance gene exists in the plasmid, as well as on positive and negative control plates. If the transformed bacteria grow on the plate containing the antibiotic, although controls reveal expected results, this provides strong evidence that the transformation was effective.
22. By working with proteins, scientists can see how cells use proteins for various functions. They can study the effect that the lack of a certain protein or the structure of a protein that is altered has on the body. Once they identify the shape, structure, and function that are affected by the protein, they can begin to analyze the DNA sequence from which the protein was translated to determine the mutation that has occurred in the DNA.
23. Students' answers will vary depending on opinion. If the genetically engineered microbe mutates, the mutation may have a deleterious effect on crop yield or supply. The mutation may not allow for control of the microbe by a farmer. The introduction of a new species into an environment is always accompanied by some risk. It may result in skewing of the balance established by nature among species. Yet the introduction of the microbe will allow for a higher crop yield. The microbe's presence will reduce insurance costs for the farmer since the chance of frost no longer poses the same danger as it did before the microbe was present. The microbes will reduce the cost of tomatoes to the consumer since supply will have increased in the market.
24. Valine
25. It will result in repeating valine amino acids in the sequence. This would cause the protein to have a different function than intended.
26. PCR could be used to identify short fragments of the DNA. DNA sequencing could be used to identify the gene itself.
27. Genetic engineering and recombinant DNA technologies have allowed scientists to change the genetic makeup of a variety of different organisms.
28. People are concerned that these genes may mutate to produce undesirable results or spread through cross-pollination into other organisms, where the gene may pose an environmental problem. The benefits of this technology include creating medications and drugs to fight disease, developing new crops that will produce greater yield, and many others.

29 mtDNA. Mitochondrial DNA is passed along maternal lines and allows for lineage to be shown.

30. 

The mother passes on the mtDNA to her children. Mitochondria are found in the human egg and pass on to the zygote during fertilization. Sperm do not contain mitochondria in the head portion; therefore, no mitochondria are passed on to the zygote.

31. PCR and gene sequencing would be used to identify these genes since we are looking for genetic markers found in these individuals.
32. Advantages: cultural and traditional ties and the possibility of determining treaty rights if lineage can be proven
Disadvantages: stereotyping for employment and other social programs and discrimination

UNIT 30 C PERFORMANCE TASK: INVESTIGATING HUMAN TRAITS

Materials

- survey or questionnaire
- other materials according to the design

Procedure

Students' procedures should include the following information:

- the tools (e.g., survey) used to gather the data
- how the data were collected
- a description of the sample

Evidence

Answers for questions (a) and (b) will vary according to the data collected.

Analysis

(c) Answers will vary according to the data sample collected by students.
(d) Myopia and colour vision are sex-linked.
(e) The tables below may be used for comparison. Other information is also available on the Nelson Web site. Students' research may identify other information.