72. test tube 1 – isotonic; test tube 2 – hypertonic; test tube 3 - hypotonic
73. The red blood cells would shrivel up because water leaves the cells. This process is called crenation.
74. The red blood cells would swell because water moved into the cells. The cells would burst due to hemolysis.
75. Pancreatic amylase is synthesized at the ribosome. The data shows that at time 5 minutes and 10 minutes, the ribosomes show the largest percentage of amylase.
76. ribosomes → ER → Golgi apparatus → secretory vesicles
77. Pancreatic amylase is a protein that is going to be excreted from the cell. There is a high percentage of amylase found in secretory vesicles which are bound for the plasma membrane. This data shows large amounts of pancreatic amylase in the secretory vesicles.
78. It showed that membrane proteins were free to migrate throughout the plasma membrane. The plasma membrane has a fluid consistency.
79. The rate of protein movement would increase as temperature increases. The concepts investigated are diffusion and membrane fluidity.
80. Osmosis was responsible for the potato cells gaining and losing water.
81. Potato cells were placed in a hypotonic solution in test tube 2. Water entered the potato cells, increasing the mass of the cells.
82. Potato cores that lost mass were placed in hypertonic solution and therefore lost water. Potato cores that gained mass were placed in hypotonic solution and therefore gained water.
83. test tubes 4 and 5
84. about 15% sucrose concentration
85. Graph
86. The molarity of the glucose solution is directly proportional to the percent change in mass. As the molarity increases, so does the percent change in mass.
87. The selectively permeable membrane does not allow the sugar molecules to pass through because they are too big. Because the right side has the dilute solution, there are more water molecules on the right side than the left side. Water diffused from an area of higher concentration (right side) to an area of lower concentration (left side) through the process of osmosis. This results in the rise in the solution level on the left side.
88. Graph
89 **a.** Both the surface area and volume increase as the cell gets bigger, but the volume increases at a faster rate.

b. As the cell gets bigger, the surface area to volume ratio decreases.

c. The 3-mm cube has the smallest surface-area-to-volume ratio.
90. The Blob would not have an adequate surface area for exchanging nutrients and wastes and it would not be able to survive for long.
91. Without a properly functioning cell wall, the bacterium is not protected by the outside environment and is susceptible to attacks by other organisms like viruses.

Chapter 4 Diagnostic Questions

1. **b.** sequence of amino acids in the polypeptide chain.
2. **d.** the sequence of nitrogenous bases in the DNA molecule of an organism.
3. **a.** There are more genes than chromosomes.
4. **b.** DNA controls the production of proteins in the cell.
5. **a.** nucleotide.
6. **d.** adenine, cytosine, guanine, and thymine
7. **a.** genes
8. **a.** The gene for albumin has a different sequence of nitrogenous bases than the gene for melanin.
9. **a.** a gamete.
10. **d.** it cannot be passed on from one generation to the next.
11. **c.** change the arrangement of the genetic material.
12. It carries the genetic information of an organism and is passed on from one generation to the next.
13. Genes are found on chromosomes, which are found in the nucleus of a cell.
14. mutagens, radiation, drugs
15. rabbit
16. No, just because there are 10 amino acids different, doesn't mean the amino acids are in the exact same order for both whales and kangaroos.

Chapter 4 Review Questions

1. **b.** are nucleic acids.
2. **a.** adenine and guanine.
3. **c.** C-A-T-G-T-A-C
4. **c.** T-A-G
5. **a.** uracil
6. **b.** replication
7. **a.** ribosome.
8. **b.** The primary structure of Molecule 2 would be different.
9. **a.** adenine pairs with thymine by forming two hydrogen bonds
10. **a.** a gene.
11. **c.** to carry specific amino acids to the ribosome
12. **b.** the nucleolus.
13. **b.** to read the codons on the mRNA
14. **b.** histidine
15. **c.** anticodon
16. **d.** GTC
17. **c.** mRNA nucleotide bases.
18. **b.** 4
19. **a.** insulin
20. **b.** peptide bonds

21. **d** The sequence of amino acids may be different during protein synthesis.
22. **c.** helicase breaks the hydrogen bonds between the complementary DNA strands
23. **d.** 3 → 5 → 1 → 2 → 4
24. **b.** leucine
25. **d.** 75 nucleotides
26. **a.** a plasmid.
27. **a.** they reproduce quickly.
28. **c.** restriction enzyme and DNA ligase
29. **d.** to introduce foreign DNA into the bacterial DNA
30. **b.** Humans can use it to produce Hepatitis B vaccine.
31. **d.** recombinant DNA technology.
32. **d.** splicing pieces of DNA from one organism into the DNA of another organism
33. **d.** to cut out specific base-pair sequences out of a DNA molecule
34. **a** to produce large amounts of human hormones
35. **b.** is used to produce large amounts of a targeted sequence of DNA.
36. **b.** Silk fibres will be produced in the goat's milk
37. **d.** a transgenic organism.
38. **c.** genetic engineering.
39. **b.** help treat cancer.
40. **b.** Cold temperatures can influence the expression of genes.
41. **a.** I and II only
42. **c.** The genetically engineered bacteria may out-compete the native species of bacteria that already exist in the environment.
43. base sequence on DNA → amino acid sequence → tertiary structure of a protein → protein function → expression of a trait
44. **a.** I
    b. II, III and IV
    c. I
    d. I, II, III and IV
    e. I
    f. I
    g. II
    h. III
    i. IV
    j. I, II, III and IV
45.

	DNA	RNA
Subunit	Nucleotide (sugar, phosphate, base)	Nucleotide (sugar, phosphate, base)
Sugar	Deoxyribose	Ribose
Nitrogenous bases	Thymine, Adenine, Cytosine and Guanine	Uracil, Adenine, Cytosine and Guanine
Number of Strands	Double-stranded	Single-stranded

Base Pairings	Adenine with Thymine Cytosine with Guanine	Adenine with Uracil Cytosine with Guanine
Process that Produces this Nucleic Acid	Replication	Transcription

46. semi-conservative replication
47. helicase, DNA polymerase and DNA ligase
48. In Step X, the enzyme helicase unwinds the double-stranded DNA by breaking the hydrogen bonds between the nitrogenous bases. In Step Y, complementary base pairing occurs. DNA nucleotides present in the nucleus are joined to the DNA molecule by DNA polymerase.
49. in the nucleus
50. **a.** adenine
    b. thymine
    c. deoxyribose sugar
    d. phosphate group
51. ATP and RNA
52. it is ribose instead of deoxyribose
53. double hydrogen bonds; covalent bonds
54. Combination of 2, 3, and 4 or 1, 3, and 4.
55. They might be different because each amino acid is coded by more than one codon.
56. **a.** gene mutation
57. A change in a single amino acid can cause a change in the primary structure of a protein. This therefore will change the tertiary structure of the protein and its function. The function of the protein is dependent on its shape.
58. The red blood cell's shape has now changed due to the change in amino acid sequence. This therefore affects its function to effectively carry oxygen around the body.
59. Sickle cell disease still persists in the human population because it provides those people with resistance against malaria. There is a benefit to having the disease.
60. Percentages would be higher because people who have sickle cell anemia are resistant to malaria.
61. deletion mutation
62. the gene would code for a different amino acid
63. **a.** gel electrophoresis and DNA fingerprinting
    b. If the bands on the gel matched up between the two samples, then the meat came from the same animal.
64. **a.** Comparative genomics is used to identify similarities between human DNA and DNA of other organisms. It allows scientists to insert a suspected human gene associated with a disease into another organism to confirm that this gene is the cause of the disease.
    b. Functional genomics help scientists understand the function of various genes and their expression. This information can be used for treatment of a disease.

c. Proteomics is used to study the structure, function and interaction of cellular proteins in different cell types. This is essential to the discovery of better drugs.

d. Bioinformatics is the use of computer technologies to find significant patterns to help study proteomics, structural genomics, functional genomics and comparative genomics.

5.

DNA	GCA	ATG	TCA	GTT
mRNA	CGU	UAC	AGU	CAA
tRNA	GCA	AUG	UCA	GUU
Amino acid	arginine	tyrosine	serine	glutamine

66. The base pairs of DNA (A/T and G/C) and RNA (A/U and G/C) need to be highly specific so that replication, transcription and translation are accurate when they are carried out. The copying of the genetic code and the making of the correct proteins depend on the specificity of the base pairings. If specificity of the base pairing is compromised, then potential mutations could occur more often.

67. the amino acid sequence would now be "cysteine"-tyrosine-serine-glutamine

68. The shape of the protein could now change because the amino acid sequence (primary structure) is now different.

69. 64 combinations

70. The farmer gets to choose the cow that has the desirable traits and reproduce more copies of that cow in a shorter amount of time.

71. a. The cows in a cloned herd would be identical to each other because they have the same genetic makeup. The cows from a non-cloned herd will have some genetic variation.

b. The cloned herd will have the desirable traits that the farmer wants because it is identical to the best cow in the herd; help improve the overall quality of the herd.

c. If a disease is introduced and all the cows are genetically identical, they may all be susceptible to the disease and can die.

d. a cow that is healthy and resistant to disease; a dairy cow that can produce litres of high quality milk; a cow that is well-adapted for extreme climates; a cow that is fertile

e. There will be genetic variation in the offspring because the normal cow might only contribute certain genes each time an offspring is produced.

f. These cows would more likely develop diseases.

72.

Species W	DNA sequence	CAG	TGT	CCT	GTA
	mRNA sequence	GUC	ACA	GGA	CAU
	amino acids sequence	**valine**	**threonine**	**glycine**	**histidine**
Species X	DNA sequence	CAG	TGC	CCG	GCA
	mRNA sequence	GUC	ACG	GGC	CGU
	amino acids sequence	**valine**	**threonine**	**glycine**	**arginine**
Species Y	DNA sequence	CAT	TGC	CCG	GTG
	mRNA sequence	GUA	ACG	GGC	CAC
	amino acids sequence	**valine**	**threonine**	**glycine**	**histidine**
Species Z	DNA sequence	CAA	TGC	CGT	GTA
	mRNA sequence	GUU	ACG	GCA	CAU
	amino acids sequence	**valine**	**threonine**	**alanine**	**histidine**

73. The sequences of amino acids are the same, with the exception of one amino acid.

74. Species W and Species Y

75. Take segments of DNA from each of the four flowers and run them on gel electrophoresis. Compare the patterns on the gel.

76. It would produce no change because it would still code for valine. The amino acid sequence has not changed.]

77. a. 4, 639, 221 bases

b. 3866 bases/second

78. HGP was important to determine the location of all the genes in the human genome. This allowed scientists to identify the location of defective genes that caused diseases. The defective genes could be replaced with normal genes to cure diseases.

79. The benefit of knowing the location and sequence of bases in a gene is being able to identify defective genes and using gene therapy to replace these defective genes.

80. Scientists must be careful because a normal gene could be removed by accident and this would cause the person to not produce a protein that might be need for normal functioning.

81. Some ethical issues could include: Should humans get to play god by deciding who gets to live or not? How do we determine which diseases are more important and others? Who decides how much this is going cost?

82. You could change this by counting all the characters in the entire novel to determine the exact number of characters in the entire book.

83. The assumption is that that all books the size of your novel will contain the exact same number of characters and therefore bases. Some books that are the same size have more or less characters.

84. Restriction enzymes are used to produce the DNA fragments placed in the well.

85. An electric current is used to separate DNA fragments on the basis of size.

86. Species C is most closely related because it has four matching bands on the gel.

87. If plants are closely related, then they should have similar genetic makeup and DNA segments. The physical characteristics of plants may vary and can be influenced by environmental factors. Therefore these characteristics will not be accurate at indicating the degree of the relationship between different species.

88. In ex vivo gene therapy, bone marrow stem cells are removed from the body and an RNA retrovirus is used to insert a normal gene into the bone marrow stem cells. The viral recombinant DNA carries the normal gene into the genome and the genetically engineered cells are returned to the human body. In vivo gene therapy is used to treat cystic fibrosis patients. The gene needed to cure cystic fibrosis is delivered to the lower respiratory tract using an adenovirus vector found in an aerosol spray.

89. Answer will depend on what topic the student picks. For example, using restriction enzymes, the insulin gene from a human chromosome is inserted into a vector, a circular piece of bacterial DNA from *E. coli*. The bacteria that received the gene now can produce the protein insulin. Insulin is then collected for use by people with diabetes.

90. Research

91. Research

Chapter 5 Diagnostic Questions

1. **b.** proteins

2. **b.** the ribosomes

3. **c.** the lysosomes

4. **b.** plasmid

5. **b.** It speeds up chemical reactions.

6. **d.** an increase in temperature causes the reactants to move more quickly, therefore increasing the number of collisions between the reactants

7. **a.** substrate; **b.** enzyme; **c.** enzyme-substrate complex; **d.** products

8. structure B and structure D

9. structure C

10. DNA polymerase, RNA polymerase, ligase, restriction enzymes

11. Enzymes are important in the digestion of food. Without enzymes, it would take too long for you to digest your food.

12. **a.** all enzymes are proteins, but not all proteins are enzymes

b. enzymes are molecules, not organisms and cannot be killed; heat causes the enzyme to denature, therefore changing its active site and this causes a loss in function

c. the enzyme has an active site that the substrate binds to

d. enzymes undergo a conformational change once it forms the enzyme-substrate complex, but once it releases its products, it changes back to its original shape

e. enzymes will denature only by a change in pH, high temperature and exposure to a heavy metal; enzyme will not denature due to the depletion of the substrate

f. once an enzyme binds with the substrate, it forms an enzyme-substrate complex which cause the reaction to proceed further

g. enzymes are not used up in the course of a chemical reaction; they will be used again for the next reaction

h. reactant 1 + reactant 2 $\leftrightarrow$ product 1 + product 2; use double headed arrow

Chapter 5 Review Questions

1. **d.** by temporarily combining with the substrates

2. **d.** there has to be a perfect fit between the enzyme's active site and the substrate.

3. **b.** a triglyceride.

4. **a.** The amount of glycerol and fatty acids produced in 10 minutes at different pH levels.

5. **d.** changing the temperature from 37°C to 15°C

6. **c.** an inhibitor.

7. **c.** maltase.

8. **c.** amino acids.

9. **b.** maltose.

10. **b.** step 2

11. **a.** enzymes and hydrolysis.

12. **c.** size of the substrate

13. **c.** The disaccharide would break down slower or not at all.

14. **a.** Cellulose would not fit into the active site of the catalyst.

15. **c.** Each enzyme works best within a particular pH range.

16. **a.** pepsin

17. **b.** It would decrease.

18. **c.** The shape of amylase was altered with the increasing pH level.

19. **c.** 7

20. **d.** Trypsin is less active at a pH of 10 than at a pH of 7.

21. **c.** 7.5

22. **a.** pepsin

23. **d.** to measure the amount of oxygen produced per unit time and therefore catalase activity

24. **b.** The liver cells had a greater amount of catalase than the potato cells.

25. **b.** Catalase denatured when it was exposed to high temperatures.

26. **a.** amino acid

27. **b.** I and III only

28. **a.** threonine

29. **b.** Isoleucine inhibits enzyme #1 from reacting with threonine and therefore prevents the production of α-ketobutyrate.

30. **d** the rate of production of α-keto-β-methylvalerate would decrease

31. Graph

32. The substrate, sucrose, binds to the active site of the enzyme. This forms an enzyme-substrate complex. Water is needed during this hydrolysis reaction to break the bond between glucose and fructose. The products are released from the enzyme.

33. glucose and fructose

34. With the increase in temperature, this will cause denaturation of the enzymes in bacteria and this will cause the bacteria to die.