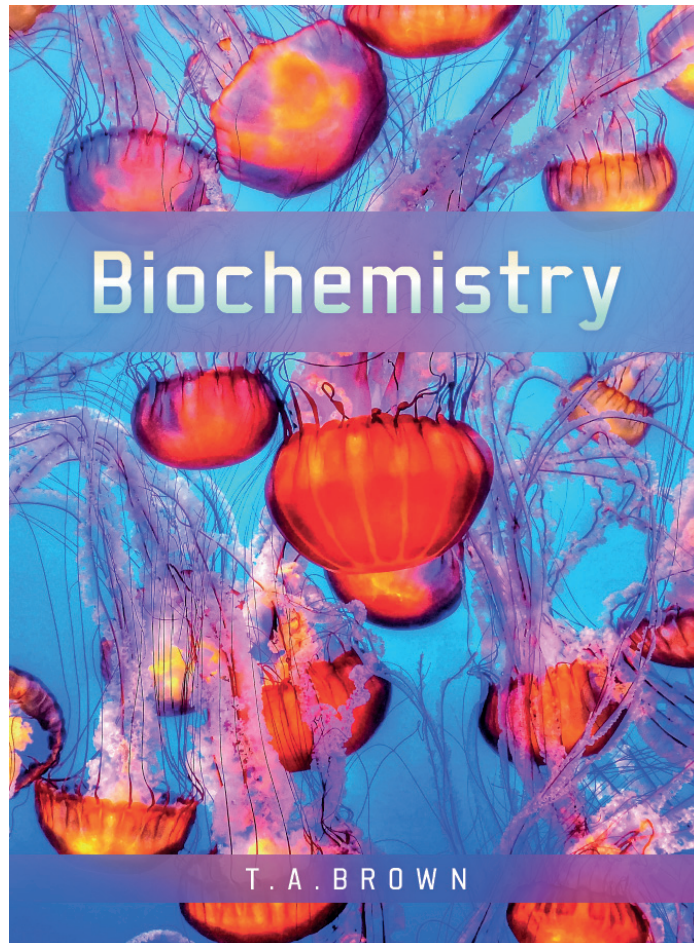


# Answers to end of chapter MCQs



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## Chapter 2

- Approximately how many species of animals, plants and fungi are there believed to be on the planet?  
(A) 8.7 million
- What is the approximate length of a cell of the single-celled organism *Paramecium*?  
(C) 120  $\mu\text{m}$
- Which one of the following statements about the nucleoid is **incorrect**?  
(C) A nucleoid is surrounded by a membrane
- Which of these is an example of a prokaryote that forms chains of cells?  
(A) *Anabaena*
- Which one of the following statements regarding the archaea is **correct**?  
(B) Many of the environments in which they live are hostile to other forms of life
- Which of the following describes the typical cell shapes for prokaryotes?  
(B) Bacillus, coccus and spirillum
- Peptidoglycan, present in bacterial cell walls, is a type of which of these structures/compounds?  
(D) Polysaccharide
- Which one of the following statements is **incorrect** regarding biofilms?  
(C) Only bacteria with flagella are able to form a biofilm
- Which one of the following statements is **correct** regarding human cells?  
(C) There are  $10^{13}$  cells present in an adult human made up of over 400 specialized types
- Pore complexes are a feature of which type of eukaryotic organelle?  
(D) Nuclei
- Within the nucleus, which specific regions do chromosomes occupy?  
(D) Territories
- The inner mitochondrial membrane is infolded to form plate-like structures called what?  
(A) Cristae
- The proteins responsible for ATP synthesis are located in which part of a mitochondrion?  
(C) The inner mitochondrial membrane
- What are the stacks of thylakoid in a chloroplast called?  
(C) Grana
- What are the stacks of membranous plates that make up the Golgi apparatus called?  
(A) Cisternae
- Glycosylation, which occurs in the Golgi apparatus, is best described by which of the following statements?  
(B) Addition of short chains of sugars to some proteins
- The vesicles that fuse with the *cis* face of the Golgi apparatus come from where?  
(C) Rough endoplasmic reticulum
- What is the protein that forms a coat around a virus called?  
(B) Capsid
- Which one of the following is **not** a feature of a prion?  
(D) The structures of the infectious and normal versions of a prion are indistinguishable
- Tiny microfossils of structures resembling bacteria have been discovered in rocks of what age?  
(D) 3.4 billion years
- The experiment carried out by Miller and Urey in 1952 resulted in synthesis of which type of biochemical compound from methane, ammonia, hydrogen and water vapor?  
(A) Amino acids
- When did the first multicellular algae appear in the fossil record?  
(B) 900 million years ago
- What is the mass extinction that resulted in the extinction of the dinosaurs called?  
(B) Cretaceous–Tertiary event
- When did *Homo sapiens* first appear in Africa?  
(C) 195 000 years ago

## Chapter 3

- Titin, the longest known polypeptide, has how many amino acids?  
(D) 33 445
- Which amino acid is given the one-letter abbreviation 'A'?  
(A) Alanine
- Which amino acid has an unusual side-chain that includes the nitrogen of the amino group attached to the  $\alpha$ -carbon?  
(B) Proline
- The D- and L-forms of an amino acid are examples of what?  
(D) All of the above
- What is a molecule that has two ionized groups called?  
(C) Zwitterion
- Which one of the following statements regarding the isoelectric point of an amino acid is **incorrect**?  
(C) It is a pH value greater than the  $pK_a$  of the amino group
- Which two amino acids have positively charged side-chains at pH 7.4?  
(A) Arginine and lysine

8. What is the name given to the type of chemical bond that forms between the slightly electropositive hydrogen atom in a polar group and an electronegative atom?  
(C) Hydrogen bond
9. Which one of the following statements is a feature of hydrophobic amino acids?  
(C) They have nonpolar side-chains
10. Which one of the following compounds is an example of a modified amino acid that is found in collagen?  
(A) 4-hydroxyproline
11. Which one of the following statements regarding a peptide bond is **incorrect**?  
(A) A peptide bond is able to rotate
12. Because of steric effects, what proportion of the possible combinations of *psi* and *phi* bond angles never occur?  
(C) 77%
13. An  $\alpha$ -helix is stabilized by what type of interactions?  
(C) Hydrogen bonds between peptide groups four positions along the polypeptide
14. A  $\beta$ -sheet is stabilized by what type of interactions?  
(C) Hydrogen bonds between two parts of a polypeptide so that those segments are held together side by side
15. A collagen polypeptide forms what type of secondary structure?  
(D) Left-handed helix
16. Which one of the following statements regarding silk fibroin is **incorrect**?  
(D) The fibroin polypeptide forms a triple helix which gives it tensile strength
17. The structure in which two  $\alpha$ -helices lie side by side in antiparallel directions in such a way that their side-chains intermesh is called what?  
(A)  $\alpha\alpha$  motif
18. Which of these proteins has a quaternary structure?  
(C) Hemoglobin
19. The tobacco mosaic virus capsid is made up of how many subunits?  
(C) 2130
20. The unfolding of a protein is called what?  
(A) Denaturation
21. What does the molten globule model for protein folding state?  
(D) All of the above statements are part of the molten globule model
22. Hsp70 proteins are examples of what?  
(B) Molecular chaperones
23. The GroEL/GroES complex is a type of what?  
(A) Chaperonin
24. Which one of the following is an example of a storage protein?  
(B) Ferritin

## Chapter 4

1. A hydroxyl group is attached to which carbon of the deoxyribose sugar in DNA?  
(C) 3'
2. Which two purines are found in DNA molecules?  
(B) Adenine and guanine
3. What is the link between the nitrogenous base and the sugar component of a nucleotide called?  
(B)  $\beta$ -N-glycosidic bond
4. What is the nitrogenous base that is found in DNA but **not** RNA called?  
(C) Thymine
5. In a polynucleotide, the link between adjacent nucleotides forms between which pair of carbons?  
(D) 3' and 5'
6. Which one of the following techniques was **not** used in work that led to discovery of the double helix structure of DNA?  
(B) Nuclear magnetic resonance spectroscopy
7. Which one of these does the pairing between the two strands of the DNA helix involve?  
(C) Hydrogen bonds
8. Which one of these statements is **correct** with regard to base stacking?  
(D) It results from attractions between the aromatic rings of the nucleotide bases
9. What causes the C2'-endo or C3'-endo conformations of a nucleotide to arise?  
(D) Sugar pucker
10. Which type of DNA forms a left-handed helix with 12 bp per turn and a diameter of only 1.84 nm?  
(C) Z-DNA
11. When referring to 1 000 000 base pairs of DNA, which abbreviation is used?  
(B) Mb
12. Which one of the following statements is **incorrect** with regard to tRNA?  
(B) G-T base pairs can occur in a tRNA
13. The four nucleotide sequence 5'-UUUCG-3' forms a relatively stable structure called what?  
(C) Tetraloop
14. Which of the following is not a common type of chemical modification seen in tRNA molecules?  
(D) Phosphorylation
15. How long is a 47 Mb DNA molecule?  
(D) 1.6 cm

16. What type of enzyme was used in the experiments which showed that proteins are associated with DNA in chromatin?  
(A) Endonuclease
17. What is the name of the proteins that make up the 'beads' of the beads-on-a-string structure for chromatin?  
(A) Histones
18. What are the vertebrate proteins called H1a–H1e, H1°, H1t and H5?  
(B) Linker histones
19. Which one of the following statements is **correct**?  
(A) During interphase much of the DNA is in the form of the 30 nm chromatin fiber
20. In the bacterial nucleoid, the DNA is folded into a compact structure by what process?  
(D) Supercoiling
10. Terpenes are based on a small hydrocarbon compound called what?  
(B) Isoprene
11. What is the composition of the core sterol structure?  
(C) Four hydrocarbon rings, three of which have six carbons each and one of which has five carbons
12. Which one of the following compounds is **not** a type of steroid hormone?  
(B) Eicosanoids
13. What is the disease that results from vitamin D deficiency called?  
(B) Rickets
14. Which of these types of eukaryotic membrane has the highest protein content?  
(B) Inner mitochondrial membrane
15. The model for membrane structure proposed by Singer and Nicholson in 1972 is called what?  
(A) Fluid mosaic model

## Chapter 5

1. Which one of these statements describes the typical lipid?  
(C) Hydrophobic and lipophilic
2. Which one of the following statements is **incorrect** with regard to fatty acids?  
(D) All of the above statements are correct
3. Which one of the following statements is **incorrect** with regard to unsaturated fatty acids?  
(C) They form linear molecules that are able to pack together closely
4. Which one of these compounds is an example of an omega-6 fatty acid?  
(B) Linoleic acid
5. What is the difference between a simple and complex triacylglycerol?  
(A) In a simple triacylglycerol the three fatty acids are identical, in a complex one they are different
6. What is a compound formed by heating a triacylglycerol with an alkali such as sodium hydroxide called?  
(B) Soap
7. What is the difference between glycerophospholipids and other triacylglycerols?  
(D) In a glycerophospholipid, one of the fatty acids is replaced by a hydrophilic group attached to the glycerol component by a phosphodiester bond
8. Which of these compounds is **not** an example of a glycerophospholipid?  
(A) Phosphosphingosine
9. What is a ganglioside?  
(A) A sphingolipid carrying a complex sugar head group
16. Which one of the following statements is **correct** with regard to an integral membrane protein?  
(D) All of the above statements are correct
17. A barrel-like structure, with the walls of the barrel made up of  $\beta$ -sheet, is a typical feature of what?  
(C) Transmembrane protein
18. What is the erythrocyte transporter protein an example of?  
(D) Uniporter
19. What is the mammalian  $\text{Na}^+/\text{K}^+$  ATPase protein an example of?  
(B) P-type pump
20. What is the mammalian  $\text{Na}^+/\text{glucose}$  transporter protein an example of?  
(C) Symporter
21. What is the  $\text{Na}^+/\text{Ca}^{2+}$  exchange protein an example of?  
(A) Antiporter
22. What is the commonest cystic fibrosis mutation called?  
(A)  $\Delta\text{F508}$
23. In the MAP kinase system, what are individual proteins in the cascade activated by?  
(D) Phosphorylation
24. Which one of the following statement is **incorrect** with regard to calmodulin?  
(C) Is an integral membrane protein

## Chapter 6

1. What is glyceraldehyde?  
(D) All of the above
2. Which one of these compounds does **not** have a chiral carbon?  
(A) Dihydroxyacetone

3. Which one of these sugars is an aldopentose?  
(D) Ribose
  4. Which one of these sugars is **not** an aldohexose?  
(D) Ribulose
  5. Which of these statements best describes enantiomers?  
(D) Isomers whose structures are mirror images of one another
  6. Which of these statements best describes anomers?  
(C) Cyclic monosaccharides that differ only in the arrangement of groups around the anomeric carbon
  7. What are erythrose and threose examples of?  
(B) Diastereomers
  8. What are D-glucose and D-galactose examples of?  
(D) Epimers
  9. What is conversion between the  $\alpha$  and  $\beta$  anomers of glucose called?  
(D) Mutarotation
  10. Which one of the following statements is **incorrect** with regard to lactase persistence?  
(C) It is also called lactose intolerance
  11. What is the link between the two monosaccharide units in a disaccharide called?  
(C) O-glycosidic bond
  12. What is the **correct** chemical name for maltose?  
(A)  $\alpha$ -D-glucopyranosyl-(1 $\rightarrow$ 4)-D-glucopyranose
  13. Sucrose is a disaccharide made up of which two compounds?  
(B) Glucose and fructose
  14. In proteins, O-linked glycans are attached to which two amino acids?  
(D) Serine and threonine
  15. Which one of the following is **not** a modified monosaccharide found in glycans?  
(B) Cellobiose
  16. What is the branched form of starch called?  
(A) Amylopectin
  17. The branch points in starch are made up of what type of linkage?  
(B)  $\alpha$ 1 $\rightarrow$ 6
  18. What does the reducing end of a starch molecule terminate with?  
(C) The anomeric carbon
  19. Chitin is a homopolysaccharide of which sugar?  
(A) N-acetylglucosamine
  20. Which of the following is an example of a heteropolysaccharide?  
(C) Hyaluronic acid
- ## Chapter 7
1. What was the first enzyme to be shown to be a protein?  
(D) Urease
  2. The active site of ribonuclease A contains two copies of which amino acid?  
(B) Histidine
  3. Which one of the following statements is **correct** with regard to tryptophan synthase?  
(A) An intermediate in the biochemical reaction is channeled between two subunits of the enzyme
  4. What is an RNA enzyme called?  
(B) Ribozyme
  5. Which is the metal ion cofactor in cytochrome oxidase?  
(A)  $\text{Cu}^{2+}$
  6. Riboflavin (vitamin B<sub>2</sub>) is the precursor of which organic cofactors?  
(B) FAD and FMN
  7. What is the term used to describe the combination of an enzyme with its cofactor?  
(B) Holoenzyme
  8. Which one of the following statements is **correct** with regard to redox reactions?  
(C) Oxidation is loss of electrons, reduction is gain
  9. What are enzymes with identical functions from different organisms called?  
(B) Homologous enzymes
  10. What is the term used to describe an enzymatic reaction that releases energy?  
(C) Exergonic
  11. What term is used to denote the energy difference between the substrates of an enzymatic reaction and the transition state?  
(B)  $\Delta G^\ddagger$
  12. Which one of the following statements is **incorrect**?  
(A) An enzyme changes the  $\Delta G$  values for substrates and products
  13. Which thermodynamic term is a measure of the degree of disorder of a system?  
(C) Entropy
  14. The lock and key and induced fit models refer to which aspect of enzyme behavior?  
(D) Specificity of substrate binding
  15. Which one of the following statements is **incorrect** regarding thermostable enzymes?  
(D) All of the above statements are incorrect
  16. What is the term used to denote the substrate concentration at which the rate of an enzymatic reaction is half of the maximum value?  
(B)  $K_m$

17. In the Lineweaver–Burk plot, what does the intercept with the  $x$  axis give?  
(C)  $1/K_m$
18. Diisopropyl fluorophosphate (DIFP) is an example of what type of enzyme inhibitor?  
(C) Irreversible
19. What is the name of the enzyme, inhibited by DIFP, that is involved in transmission of nerve impulses?  
(A) Acetylcholinesterase
20. In which type of inhibition does  $V_{max}$  stay the same, but  $K_m$  is increased?  
(A) Competitive reversible
21. In which type of inhibition is  $V_{max}$  reduced, but  $K_m$  stays the same?  
(C) Non-competitive reversible
22. An allosteric site is the part of an enzyme that does what?  
(A) Binds an inhibitor or other effector molecule
23. What is the name given to the first step in a metabolic pathway that produces an intermediate that is unique to that pathway?  
(B) Commitment step
24. The concerted and sequential models refer to which aspect of enzyme behavior?  
(A) Cooperative substrate binding
8. What is the production of ATP by phosphoglycerate kinase called?  
(D) Substrate-level phosphorylation
9. In exercising muscle cells, what is excess pyruvate converted into?  
(C) Lactate
10. Which one of the following statements is **correct** with regard to the Cori cycle?  
(B) Lactate from muscles is transported to the liver where it is converted to glucose
11. What is *Saccharomyces cerevisiae* an example of?  
(A) Facultative anaerobe
12. What are the two enzymes involved in alcoholic fermentation?  
(C) Pyruvate decarboxylase and alcohol dehydrogenase
13. To be used in glycolysis, fructose is first converted to which of the following?  
(B) Fructose 1-phosphate
14. Which of the following is UDP–glucose involved in?  
(B) Galactose–glucose interconversion pathway
15. The main control point in glycolysis is the step that results in synthesis of what?  
(A) Fructose 1,6-bisphosphate
16. Which one of the following is **not** an inhibitor of phosphofructokinase?  
(A) ADP
17. Which compound regulates phosphofructokinase activity in response to substrate availability?  
(B) Fructose 2,6-bisphosphate
18. The glucagon receptor protein is an example of what?  
(D) All of the above
19. Hexokinase is inhibited by which one of these compounds?  
(D) Glucose 6-phosphate
20. Regulation of pyruvate kinase involves which one of the following?  
(B) Activation by fructose 1,6-bisphosphate and inhibition by ATP

## Chapter 8

1. How much energy is produced by the complete oxidation of 1 mole of glucose?  
(D) 2870 kJ
2. What are the activated carrier molecules synthesized during glycolysis?  
(A) ATP and NADH
3. One NADH molecule can generate how many ATPs when entered into the electron transport chain?  
(C) 3
4. Glycolysis results in a net gain of how many ATP molecules?  
(D) 8
5. Which enzyme catalyzes the first step in the glycolysis pathway?  
(C) Hexokinase
6. Which compound is split to give one molecule of glyceraldehyde 3-phosphate and one of dihydroxyacetone phosphate?  
(A) Fructose 1,6-bisphosphate
7. Which compound is converted into pyruvate by the enzyme pyruvate kinase?  
(D) Phosphoenolpyruvate

## Chapter 9

1. What does each molecule of pyruvate yield during the TCA cycle?  
(B) One molecule of ATP, three of NADH and one of  $FADH_2$
2. The enzymes of the TCA cycle are located in which part(s) of the mitochondrion?  
(C) Inner mitochondrial membrane and mitochondrial matrix

3. How does pyruvate pass through the outer mitochondrial membrane?  
(C) Through a porin
4. How does pyruvate pass through the inner mitochondrial membrane?  
(B) It is transported by the mitochondrial pyruvate carrier protein
5. The pyruvate dehydrogenase complex converts pyruvate into which compound?  
(A) Acetyl CoA
6. ATP is generated by which enzyme(s) during the TCA cycle?  
(C) Succinyl CoA synthetase
7. Which enzyme regenerates the oxaloacetate used up in the first step of the TCA cycle?  
(C) Malate dehydrogenase
8. Which of the intermediates in the TCA cycle can be used as a substrate for production of glutamate, other amino acids and purines?  
(B)  $\alpha$ -Ketoglutarate
9. Which group of compounds are stimulators of pyruvate dehydrogenase kinase?  
(A) Acetyl CoA, ATP and NADH
10. Which compound is an inhibitor of pyruvate dehydrogenase kinase?  
(D) Pyruvate
11. What is the symbol used to denote the standard free energy charge?  
(D)  $\Delta G^{\circ}$
12. What is the standard free energy charge for oxidation of NADH?  
(C)  $-220.2 \text{ kJ mol}^{-1}$
13. At which complex does NADH enter the electron transport chain?  
(A) Complex I
14. At which complex does  $\text{FADH}_2$  enter the electron transport chain?  
(B) Complex II
15. Which of these complexes contains one or more FeS proteins?  
(D) All of the above
16. How many protons are pumped for every NADH molecule that is oxidized by the electron transport chain?  
(C) 10
17. Proton pumping involves movement of protons from where to where?  
(D) From the mitochondrial matrix to the intermembrane space
18. Between 10 and 14 copies of which subunit of the  $\text{F}_0\text{F}_1$  ATPase form a barrel that spans the inner mitochondrial membrane?  
(C) Subunit c
19. The rate of ATP synthesis is controlled by availability of which compound?  
(A) ADP
20. Which one of the following statements is **incorrect** with regard to a typical uncoupler of the electron transport chain?  
(D) Stimulates over-production of ATP
21. Which one of the following compounds is an uncoupler of the electron transport chain?  
(C) 2,4-Dinitrophenol
22. Which one of the following statements is **correct** with regard to thermogenin?  
(B) It is a proton transport protein that reverses the effects of proton pumping
23. During the malate–aspartate shuttle, which enzyme converts oxaloacetate to malate in the cytoplasm?  
(B) Malate dehydrogenase
24. The glycerol 3-phosphate shuttle takes place in which type of tissue?  
(A) Brown adipose tissue

## Chapter 10

1. Which of the following terms is a synonym for 'primary producer'?  
(C) Autotroph
2. Where is the chloroplast electron transport chain located?  
(C) Thylakoid membrane
3. Which of the following types of bacteria are able to photosynthesize?  
(D) All of the above
4. Which are the main light-harvesting pigments of plants and green algae?  
(A) Chlorophyll a and chlorophyll b
5. Which one of the following compounds is **not** an accessory pigment?  
(B) Ferredoxin
6. What is the process by which an energy quantum is passed from one chlorophyll molecule to another called?  
(D) Resonance energy transfer
7. What is the photosystem I reaction center called?  
(D) P700
8. What is the photosystem II reaction center called?  
(B) P680

9. The xanthophyll cycle is involved in which process?  
(C) Photoprotection
10. What is the intermediate compound between photosystems II and I in the photosynthetic electron transport chain called?  
(C) Plastoquinone
11. Which one of the following statements regarding cyclic photophosphorylation is **incorrect**?  
(B) Oxygen is generated
12. Rubisco combines one molecule of CO<sub>2</sub> with which five-carbon sugar?  
(B) Ribulose 1,5-bisphosphate
13. The active site of Rubisco contains a lysine that has been modified by what process?  
(A) Carbamoylation
14. What is the enzyme that controls Rubisco activity called?  
(B) Rubisco activase
15. What is the enzyme that uses ATP to make ribulose 1,5-bisphosphate called?  
(C) Ribulose 5-phosphate kinase
16. What is the compound that activates Calvin cycle enzymes by cleaving the inhibitory disulfide bonds in those enzymes' molecules?  
(D) Reduced thioredoxin
17. Sucrose is synthesized in what part of a plant cell?  
(C) Cytoplasm
18. What is the activated intermediate used in synthesis of starch?  
(A) ADP-glucose
19. Stored starch synthesis takes place in what part of a plant cell?  
(A) Amyloplasts
20. Which one of the following statements regarding C4 plants is **incorrect**?  
(D) Carbon fixation and the Calvin cycle occur at different times of the day
5. Which of the following are the two hormones that maintain blood glucose levels within the normal range of 75–110 mg dl<sup>-1</sup>?  
(C) Insulin and glucagon
6. Which of the following statements is **incorrect** regarding glycogen phosphorylase?  
(C) Glycogen phosphorylase is activated by protein kinase A
7. Which of the following statements is **incorrect** regarding the β-adrenergic receptor protein?  
(A) It is the receptor protein for insulin
8. What is the role of AMP in allosteric control of glycogen metabolism?  
(B) AMP stimulates glycogen phosphorylase *b*
9. What is the role of glucose 6-phosphate in allosteric control of glycogen metabolism?  
(D) Glucose 6-phosphate stimulates glycogen synthase *b*
10. Which enzymes catalyze the synthesis of phosphoenolpyruvate from pyruvate and a phosphate group during gluconeogenesis?  
(C) Pyruvate carboxylase and phosphoenolpyruvate carboxykinase
11. Which mitochondrial transport protein is utilized during the synthesis of phosphoenolpyruvate from pyruvate and a phosphate group during gluconeogenesis?  
(A) The malate-α-ketoglutarate carrier protein
12. Which of the following compounds is converted to pyruvate prior to entry into gluconeogenesis?  
(A) Lactate
13. Which of the following compounds is converted to oxaloacetate prior to entry into gluconeogenesis?  
(B) Amino acids
14. Which of the following statements is **correct** regarding the regulation of gluconeogenesis?  
(D) ATP inhibits phosphofructokinase
15. Which of the following statements is **incorrect** regarding the regulation of gluconeogenesis?  
(D) ATP inhibits fructose 1,6-bisphosphatase
16. Which of the following is an alternative name for the pentose phosphate pathway?  
(B) Phosphogluconate pathway
17. Which of the following is **not** a role of the pentose phosphate pathway?  
(B) A source of glucose for glycolysis
18. Which of these enzymes is **not** involved in the oxidative phase of the pentose phosphate pathway?  
(A) Phosphopentose epimerase
19. Which compound is the starting point for the non-oxidative phase of the pentose phosphate pathway?  
(D) Ribulose 5-phosphate

## Chapter 11

1. What is the structure of glycogen?  
(C) (α1→4) chains and (α1→6) branch points
2. The predominant substrate for glycogen synthesis is what?  
(B) UDP-glucose
3. What is the role of glycogenin?  
(B) It makes the primer for glycogen synthesis
4. What is the enzyme that removes glucose units from the non-reducing ends of the glycogen molecule called?  
(A) Glycogen phosphorylase



20. Which philosopher banned broad beans, possibly because of the pentose phosphate pathway?  
(B) Pythagoras

## Chapter 12

- In what form are acetyl units shuttled across the inner mitochondrial membrane prior to fatty acid synthesis?  
(A) Citrate
- What is the name of the prosthetic group contained in the acyl carrier protein?  
(C) Phosphopantetheine
- Which of these reactions is **not** involved in the cycle of events that build up a saturated fatty acid?  
(A) Phosphorylation
- What is the name of the enzyme that cleaves the completed fatty acid from its carrier protein?  
(B) Thioesterase
- Which compound replaces malonyl ACP during synthesis of a fatty acid with an odd number of carbons?  
(A) Propionyl ACP
- Which complex of enzymes introduces double bonds into fatty acids?  
(D) NADH-cytochrome  $b_5$  reductase, cytochrome  $b_5$  and desaturase
- Which of the following statements concerning regulation of fatty acid synthesis is **incorrect**?  
(C) AMP stimulates fatty acid synthesis
- Which hormones inhibit fatty acid synthesis?  
(C) Glucagon and epinephrine
- The cells that store fat in adipose tissue are called what?  
(A) Adipocytes
- Which of the following statements is **incorrect** with regard to triacylglycerol breakdown?  
(B) The process is called  $\beta$ -oxidation
- Glycerol released by triacylglycerol degradation is converted into which intermediate in glycolysis?  
(B) Dihydroxyacetone phosphate
- Which group of hormones increase the rate of triacylglycerol breakdown?  
(D) Glucagon, epinephrine, norepinephrine and adrenocorticotrophic hormone
- How is energy provided for attachment of a fatty acid to coenzyme A, prior to fatty acid breakdown?  
(B) Hydrolysis of ATP to AMP
- What is the name of the compound to which fatty acids are attached in order to pass through the inner mitochondrial membrane?  
(D) Carnitine
- Which of these reactions is **not** involved in the cycle of events that break down a saturated fatty acid?  
(D) Reduction
- How many ATPs are obtained by complete breakdown of palmitic acid?  
(D) 129
- Which of the following statements is **incorrect** concerning fatty acid breakdown in peroxisomes?  
(B) The process does not occur in plants
- Which of the following statements is **incorrect** with regard to breakdown of unsaturated fatty acids?  
(D) Degradation of an unsaturated fatty acid always yields propionyl CoA
- Which enzyme links together acetyl CoA units at the start of the cholesterol synthesis pathway?  
(A) Thiolase
- What is the name of the linear molecule that cyclizes to form the sterol family?  
(B) Squalene
- Which is the commitment step in cholesterol synthesis?  
(D) Conversion of HMG CoA to mevalonate
- How does cholesterol regulate the activity of HMG CoA reductase?  
(B) By stimulating its breakdown
- Which of the following is **not** a derivative of cholesterol?  
(D) Heme
- Which of these compounds is **not** a steroid hormone?  
(D) Insulin

## Chapter 13

- What is the name given to species able to fix nitrogen?  
(B) Diazotrophs
- Which one of the following groups of organisms do **not** include nitrogen fixers?  
(A) Mycobacteria
- Which of the following statements is **incorrect** with regard to nitrogen fixation?  
(D) Within a nodule the bacteria die, releasing nitrogen-fixing enzymes
- Which of these statements describes the nitrogenase enzyme?  
(A) Four subunits, two of type  $\alpha$  and two  $\beta$ , with a single MoFe center
- The nitrogenase complex is protected from oxygen by what?  
(A) Leghemoglobin
- What is the prosthetic group of nitrite reductase called?  
(D) Siroheme

7. Which of the following is **not** a non-essential amino acid?  
(C) Histidine
8. Which of the following is an essential amino acid?  
(D) Threonine
9. What is the initial product formed by reaction of ammonia with  $\alpha$ -ketoglutarate?  
(A) Glutamate
10. Which three amino acids are derived from 3-phosphoglycerate?  
(D) Serine, glycine and cysteine
11. Which amino acid is obtained by transamination of pyruvate?  
(A) Alanine
12. Which of the following statements is **incorrect** regarding synthesis of phenylalanine, tryptophan and tyrosine in bacteria?  
(C) Tyrosine is obtained by oxidation of phenylalanine
13. What are the different versions of DAHP synthase, which respond to allosteric control by different amino acids, called?  
(C) Isozymes
14. Which of the following statements is **incorrect** regarding the salvage pathway for nucleotide synthesis?  
(D) GTP cannot be made by this pathway
15. In *de novo* nucleotide synthesis, which compound combines with aspartate to form cytosine and uracil?  
(A) Carbamoyl phosphate
16. Which of these enzymes is **not** involved in tetrapyrrole synthesis?  
(D) Argininosuccinase
17. Adenines and guanines that are excess to requirements are converted to which compound?  
(B) Uric acid
18. Excess tetrapyrroles are converted into which compound?  
(C) Bile pigments
19. What cofactor is possessed by the transaminase enzymes involved in amino acid degradation?  
(B) Pyridoxal phosphate
20. Which of the following is a glucogenic amino acid?  
(C) Methionine
21. Which of the following is a ketogenic amino acid?  
(D) Leucine
22. What name is given to species, including many aquatic invertebrates, which excrete excess ammonia into the water in which they live?  
(A) Ammonotelic
23. Which of the following is **not** an intermediate in the urea cycle?  
(C) Oxaloacetate

24. The link between the urea and TCA cycles is provided by what?  
(A) The aspartate–argininosuccinate shunt

## Chapter 14

1. The *E. coli* origin of replication spans approximately how far?  
(D) 245 bp
2. What are the proteins that form a barrel structure at the *E. coli* origin of replication called?  
(A) DnaA
3. The prepriming complex in *E. coli* is initially made up of which proteins?  
(B) DnaB and DnaC
4. What is the function of a helicase?  
(C) To break base pairs
5. Human DNA has approximately how many origins of replication?  
(C) 20 000
6. Which of the following statements is **incorrect** with regard to rolling circle replication?  
(A) It is the process used to replicate the human mitochondrial genome
7. What is the function of a DNA topoisomerase?  
(A) To unwind the double helix
8. Which enzyme is responsible for most of the template-dependent polynucleotide synthesis during DNA replication in *E. coli*?  
(C) DNA polymerase III
9. The proofreading function of a DNA polymerase uses which activity?  
(A) 3'→5' exonuclease
10. Which of the following statements is **incorrect** with regard to eukaryotic DNA polymerases?  
(D) DNA polymerase  $\beta$  replicates the lagging strand
11. The enzyme that synthesizes the primers for DNA replication in *E. coli* is called what?  
(C) Primase
12. How long are the Okazaki fragments in *E. coli*?  
(D) 1000–2000 nucleotides
13. How long are the Okazaki fragments in humans?  
(A) Less than 200 nucleotides
14. The enzyme that removes the Okazaki fragments in *E. coli* is called what?  
(A) DNA polymerase I
15. Which of the following statements is **incorrect** with regard to termination of replication in *E. coli*?  
(C) A Tus protein contains an RNA subunit

16. Which of the following is **not** a feature of telomerase enzymes?  
(B) It contains an RNA subunit of 550 nucleotides
17. What type of DNA modification enables the daughter strand to be recognized during mismatch repair?  
(B) Methylation
18. MutS and MutH are involved in which repair process in *E. coli*?  
(B) Mismatch repair
19. Deamination of adenine results in what?  
(D) Hypoxanthine
20. In base excision repair, the enzyme that cleaves the  $\beta$ -*N*-glycosidic bond between a damaged base and the sugar component of the nucleotide is called a what?  
(B) DNA glycosylase
21. Which of the following is **not** a type of photoproduct?  
(A) DNA photolyase
22. UvrA and UvrB are involved in which type of repair process in *E. coli*?  
(C) Nucleotide excision repair
23. What are the proteins that protect single-stranded regions prior to repair in humans called?  
(D) PARP1 proteins
24. The repair process for single-stranded breaks which involves recombination is called what?  
(A) Post-replicative repair
7. What is the name of the sequence located around nucleotide +1 in the promoter for a eukaryotic protein-coding gene?  
(D) Initiator sequence
8. What is the name of the protein that recognizes and binds to the TATA box of the promoter for a eukaryotic protein-coding gene?  
(A) TBP
9. How is RNA polymerase II activated?  
(C) Addition of phosphate groups to the C-terminal domain of the largest subunit
10. How large is the transcription bubble in *E. coli*?  
(B) 12–14 bp
11. How rapidly does RNA polymerase II synthesize RNA?  
(B) Up to 2000 nucleotides per minute
12. Which of the following statements is **correct** regarding the cap structure?  
(C) The initial reaction is between the 5' triphosphate of the terminal nucleotide and the triphosphate of the incoming GTP
13. An intrinsic terminator in *E. coli* typically contains which features?  
(D) All of the above
14. What is Rho in a Rho-dependent terminator?  
(A) A helicase protein
15. Which of the following statements is **incorrect** regarding polyadenylation of a eukaryotic mRNA?  
(A) The poly(A) tail is a series of up to 250 adenine nucleotides that are placed at the 5' end of the RNA

## Chapter 15

1. Which of the following is **not** a type of noncoding RNA?  
(D) mRNA
2. Which of the following is the consensus sequence for the -35 box of an *E. coli* promoter?  
(A) 5'-TTGACA-3'
3. Which of the following is the consensus sequence for the -10 box of an *E. coli* promoter?  
(C) 5'-TATAAT-3'
4. How is the structure of the *E. coli* RNA polymerase described?  
(A)  $\alpha_2\beta\beta'\sigma$
5. Which of the following statements is **incorrect** with regard to transcription initiation in *E. coli*?  
(B) The RNA polymerase covers a region of some 20 base pairs
6. Which types of genes are transcribed by RNA polymerase II?  
(A) Protein-coding genes, most snRNA genes, miRNA genes
16. What is the sedimentation coefficient of the *E. coli* pre-rRNA?  
(D) 30S
17. During tRNA processing in *E. coli*, which enzyme makes the cut that forms the 5' end of the mature tRNA?  
(D) Ribonuclease P
18. In a discontinuous gene, the segments that do **not** contribute to the amino acid sequence of the protein are called what?  
(D) Introns
19. What is the consensus sequence of the 5' splice site of a GU-AG intron?  
(B) 5'-AG↓GUAAGU-3'
20. What are the biochemical reactions occurring during splicing of a GU-AG intron called?  
(C) Transesterifications
21. What is the structure within which the splicing reactions for a GU-AG intron occur called?  
(A) Spliceosome

22. Which of the following statements is **incorrect** with regard to splicing of a Group I intron?  
 (B) Cleavage of the 5' splice site is induced by a nucleotide within the intron
23. Which two types of chemical modification are most common in rRNAs?  
 (C) Conversion of uracil to pseudouracil and 2'-O-methylation
24. How are most of the human snoRNAs synthesized?  
 (D) By cutting up spliced introns

## Chapter 16

- What does the term 'degenerate' mean with regard to the genetic code?  
 (C) Some amino acids are specified by more than one codon
- Which of these combinations are the termination codons in the standard genetic code?  
 (A) UAA, UAG, UGA
- Which of the following is **not** a nonstandard codon meaning in human mitochondria?  
 (C) CCA codes for stop
- A class I aminoacyl-tRNA synthetase links the amino acid to which carbon on the terminal nucleotide of the tRNA?  
 (A) 2'
- In *Bacillus megaterium*, tRNA<sup>Gln</sup> molecules are initially aminoacylated with what?  
 (C) Glutamic acid
- Due to wobble, the anticodon UAI, where I is inosine, can base pair with which codons?  
 (D) AUA, AUC and AUU
- Which of the following describes the composition of the large subunit of the *E. coli* ribosome?  
 (C) 2 rRNAs and 34 proteins
- What is the function of the E site in a bacterial ribosome?  
 (C) It is the site through which the tRNA departs after its amino acid has been attached to the polypeptide
- What is the consensus sequence for the *E. coli* ribosome binding site?  
 (B) AGGAGGU
- What is the *E. coli* initiation factor which mediates association of the large and small subunits of the ribosome called?  
 (C) IF-3
- Which of the following statements is **incorrect** regarding initiation of translation in eukaryotes?  
 (D) Recognition of the initiation codon is mediated by eIF-2
- Which of the following is the role of elongation factor EF-1A during polypeptide synthesis in *E. coli*?  
 (C) Directs the next aminoacyl-tRNA to the A site in the ribosome
- What is the role of the *E. coli* ribosome recycling factor?  
 (A) Disassociation of the ribosome into subunits after completion of translation
- Processing of melittin involves proteolytic cleavage yielding peptides containing how many amino acids?  
 (A) 2
- What are endopeptidases that process prohormones called?  
 (C) Prohormone convertases
- What process is responsible for synthesis of the Gag-Pol rather than Gag polyprotein of HIV-1?  
 (A) The ribosome makes a frameshift at the end of the Gag sequence
- Which of the following is **not** obtained by processing of proopiomelanocortin?  
 (D) Thyroid-stimulating hormone
- The epidermal growth factor receptor is an example of a what?  
 (B) Receptor tyrosine kinase
- Ubiquitin attaches to which amino acids in histone proteins?  
 (A) C-terminal lysines
- Which of the following statements is **incorrect** with regard to the nuclear localization signal present on proteins that are transported to the nucleus?  
 (C) Cleaved off as the protein crosses the nuclear membrane
- Where are translocator outer membrane complexes located?  
 (A) Mitochondrial outer membranes
- What is the name of the structure, made up of a short noncoding RNA molecule and six proteins, that aids transfer of proteins to the endoplasmic reticulum?  
 (A) Signal recognition particle
- What is the role of the KDEL sequence?  
 (C) Directs a protein to the membrane of the endoplasmic reticulum
- What is the tag that directs a protein to a lysosome?  
 (B) Mannose 6-phosphate

## Chapter 17

- The  $\sigma$  subunit of the *E. coli* RNA polymerase contains which type of DNA-binding structure?  
 (B) Helix-turn-helix
- What is the standard  $\sigma$  subunit of the *E. coli* RNA polymerase called?  
 (B)  $\sigma^{70}$

3. What is the  $\sigma$  subunit of the *E. coli* RNA polymerase that is used during heat shock called?  
(A)  $\sigma^{32}$
4. Which bacteria uses alternative  $\sigma$  subunits during its sporulation pathway?  
(B) *Bacillus* species
5. What is the role of the lactose permease of *E. coli*?  
(D) Transports lactose into the cell
6. Which statement describes the situation when lactose is present?  
(C) Repressor binds to inducer and allows transcription of the lactose operon
7. What is the repressor binding site called?  
(B) Operator
8. What is the role of the IIA<sup>Glc</sup> protein of *E. coli*?  
(B) Mediates the effect of glucose on transcription of the lactose operon
9. Which statement describes the situation when glucose and lactose are present?  
(C) Neither CAP nor repressor bound, lactose operon is not transcribed
10. What is a basal promoter element, sometimes found upstream of a eukaryotic protein-coding gene?  
(C) A site that determines the rate of transcription of the gene when not subject to up- or down-regulation
11. Which of the following is **not** a type of activation domain?  
(B) Basic domain
12. Which of the following statements is **incorrect** regarding the mediator protein?  
(D) Is made up of 25 subunits in humans
13. Which of the following is **not** a steroid hormone?  
(D) Adrenocorticotrophic hormone
14. With regard to attenuation control of the *E. coli* tryptophan operon, which statement describes the situation when tryptophan is present?  
(C) Ribosome does not stall, terminator structure forms, transcription terminates
15. Global regulation of eukaryotic translation is mediated by phosphorylation of which initiation factor?  
(A) eIF-2
16. Which of the following statements is **correct** regarding transcript-specific control of ferritin synthesis in mammals?  
(C) In the presence of iron, IRP-1 detaches from the mRNA
17. Which of the following is **not** a component of the bacterial degradosome?  
(C) RNase P
18. What is the eukaryotic equivalent of the degradosome called?  
(D) Exosome
19. What is the endoribonuclease that cleaves mRNA in the RNA-induced silencing complex called?  
(B) Argonaute
20. What is the endoribonuclease that cleaves miRNAs from their precursor molecules called?  
(D) Dicer
21. Human cells make approximately how many miRNAs?  
(A) 1000
22. What is the median half-life for a eukaryotic protein in mouse fibroblasts?  
(D) 46 hours
23. Which of the following statements is **incorrect** with regard to ubiquitination?  
(B) The bond involves the N-terminal amino acid of ubiquitin, which in most species is a glycine
24. How many lysines are there in a ubiquitin molecule?  
(C) 7

## Chapter 18

1. Antibodies are synthesized by which cells?  
(A) B lymphocytes
2. Which type of immunoglobulin exists as a pentamer in human blood?  
(D) Immunoglobulin M
3. What is the feature on the surface of an antigen that is recognized by an antibody called?  
(B) Epitope
4. The position in the precipitin reaction where the relative amounts of antigen and antibody that are optimal for complex formation is called what?  
(A) Zone of equivalence
5. What is the process that results in movement of immunoglobulin molecules in a gel towards the negative electrode called?  
(C) Electroendosmosis
6. Which of the following statement is **incorrect** with regard to ELISA?  
(A) It is less quantitative than immunoelectrophoresis
7. Which of the following methods is **not** used in protein profiling?  
(C) Gas chromatography
8. In which type of chromatography are small porous beads used as the matrix?  
(B) Gel filtration
9. In which type of chromatography are polystyrene beads that carry either positive or negative charges used as the matrix?  
(D) Ion exchange

10. In which type of chromatography are silica or other particles whose surfaces are covered with nonpolar chemical groups such as hydrocarbons used as the matrix?  
(A) Reverse phase
11. Which of the following statements is **incorrect** regarding the use of isotope-coded affinity tags (ICATs)?  
(D) A  $^{12}\text{C}$ -labeled ICAT will give a peptide a higher  $m/z$  ratio than a  $^{13}\text{C}$  label
12. Which of the following **cannot** be determined by circular dichroism?  
(D) The sequence of amino acids in an  $\alpha$ -helix
13. Which of these ions **cannot** be used to generate an NMR spectrum?  
(B)  $^{12}\text{C}$
14. Which of these is **not** a type of NMR?  
(C) NOSEY
15. Which of the following is **not** achievable by X-ray crystallographic study of a protein?  
(D) Following protein folding in real time
16. What degree of resolution can be achieved in the most successful X-ray crystallography studies?  
(A) 0.1 nm
17. What is the rate of movement of substrates through individual pathways called?  
(A) Metabolic flux
18. In gas chromatography, what is the stationary phase?  
(C) Liquid
19. Chemical ionization gives what type of molecular ion?  
(A)  $[\text{M}+\text{H}]^+$
20. Which of the following is **not** a feature of a quadrupole mass spectrometer?  
(D) The mass analyzer is a single magnet
21. What is the type of gentle ionization procedure used with unstable lipids, in conjunction with HPLC, called?  
(A) Electrospray ionization
22. The antigenic glycan that distinguishes the A, B and O blood groups has what features?  
(B) A, *N*-acetylgalactosamine; B, *D*-galactose; O, absent
23. To which sugars does concanavalin A bind?  
(C) Terminal  $\alpha$ -glucose and  $\alpha$ -mannose units in *O*-linked, though not *N*-linked, glycans
24. Treatment with which of the following specifically removes *O*-linked glycans?  
(B) Borohydride ions
2. What is the activity of RNase V1?  
(C) Cuts only double-stranded RNA polynucleotides
3. Which restriction endonuclease leaves a 3' overhang?  
(D) *Pst*I
4. Which restriction endonuclease leaves a blunt end?  
(B) *Pvu*II
5. Which restriction endonuclease has a degenerate recognition sequence?  
(A) *Hin*II
6. How is the frequency of blunt end ligation by DNA ligase increased?  
(C) By increasing the DNA concentration
7. Complementary DNA is synthesized by which DNA polymerase?  
(D) Reverse transcriptase
8. In a PCR, what delimits the region of the target DNA that will be amplified?  
(D) The annealing positions of the primers
9. Which of the following statements is incorrect with regard to a reporter probe used in real-time PCR?  
(C) When the oligonucleotide is free in solution, it emits fluorescence
10. What are the chain terminating nucleotides used in DNA sequencing?  
(A) 2',3'-dideoxynucleotides
11. How many nucleotides can be read in a single chain termination sequencing experiment?  
(B) Up to 1000
12. Which of the following enzymes is **not** used in pyrosequencing?  
(B) DNA ligase
13. Which of the following is **not** used in a next generation sequencing method?  
(D) Capillary gel electrophoresis
14. The gene for which enzyme, present in the pUC8 plasmid, specifies resistance to ampicillin?  
(B)  $\beta$ -lactamase
15. When pUC8 is used, how are bacteria that contain recombinant plasmids recognized?  
(D) Ampicillin resistant, unable to metabolize lactose
16. What is the process by which a yeast vector integrates into chromosomal DNA called?  
(B) Homologous recombination
17. The Ti plasmid is used to clone genes into which type of organism?  
(B) Plants
18. What is a vector used for recombinant protein production called?  
(C) Expression vector

## Chapter 19

1. What is the activity of S1 endonuclease?  
(C) Cuts only single-stranded DNA polynucleotides

- 19.** Why is a high level of transcription undesirable when a recombinant protein is being made in *E. coli*?  
(C) The high level of transcription could interfere with plasmid replication
- 20.** What is the inducer of the lactose operon, used in recombinant protein production?  
(D) Isopropyl- $\beta$ -D-thiogalactoside
- 21.** What are the semi-solid aggregates of partially folded recombinant protein that accumulate in *E. coli* cells called?  
(A) Inclusion bodies
- 22.** Why are cDNAs used when animal genes cloned in *E. coli* are being used for recombinant protein production?  
(D) They lack introns
- 23.** When *Pichia pastoris* is used for recombinant protein production, which chemical is used to induce the alcohol oxidase promoter?  
(A) Methanol
- 24.** The promoter from which gene has been used to drive factor VIII synthesis in the mammary tissue of pigs?  
(D) Whey acidic protein

