Chapter 10 Lipids

Multiple Choice Questions

1. **Structural lipids in membranes**
   Pages: 343-345 Difficulty: 2 Ans: A
   Which of the following statements concerning fatty acids is correct?

   A) One is the precursor of prostaglandins.
   B) Phosphatidic acid is a common one.
   C) They all contain one or more double bonds.
   D) They are a constituent of sterols.
   E) They are strongly hydrophilic.

2. **Storage Lipids**
   Pages: 346-358 Difficulty: 2 Ans: E
   Which of the following molecules or substances contain, or are derived from, fatty acids?

   A) Beeswax
   B) Prostaglandins
   C) Sphingolipids
   D) Triacylglycerols
   E) All of the above contain or are derived from fatty acids.

3. **Storage Lipids**
   Pages: 346-358 Difficulty: 2 Ans: B
   Which of the following statements is true of lipids?

   A) Many contain fatty acids in ester or amide linkage.
   B) Most are simply polymers of isoprene.
   C) Testosterone is an important sphingolipid found in myelin.
   D) They are more soluble in water than in chloroform.
   E) They play only passive roles as energy-storage molecules.

4. **Structural lipids in membranes**
   Pages: 350-351 Difficulty: 2 Ans: D
   Which of the following contains an ether-linked alkyl group?

   A) Cerebrosides
   B) Gangliosides
   C) Phosphatidyl serine
   D) Platelet-activating factor
   E) Sphingomyelin

5. **Structural lipids in membranes**
Pages: 351-353 Difficulty: 2 Ans: A
Sphingosine is *not* a component of:

A) cardiolipin.
B) ceramide.
C) cerebrosides.
D) gangliosides.
E) sphingomyelin.

6. **Structural lipids in membranes**
Page: 352 Difficulty: 2 Ans: D
Which of the following statements about membrane lipids is true?

A) Glycerophospholipids are found only in the membranes of plant cells.
B) Glycerophospholipids contain fatty acids linked to glycerol through amide bonds.
C) Lecithin (phosphatidylcholine), which is used as an emulsifier in margarine and chocolate, is a sphingolipid.
D) Some sphingolipids include oligosaccharides in their structure.
E) Triacylglycerols are the principal components of erythrocyte membranes.

7. **Structural lipids in membranes**
Page: 352 Difficulty: 2 Ans: A
Which of the following is true of sphingolipids?

A) Cerebrosides and gangliosides are sphingolipids.
B) Phosphatidylcholine is a typical sphingolipid.
C) They always contain glycerol and fatty acids.
D) They contain two esterified fatty acids.
E) They may be charged, but are never amphipathic.

8. **Structural lipids in membranes**
Pages: 352-353 Difficulty: 2 Ans: B
A compound containing *N*-acetylneuraminic acid (sialic acid) is:

A) cardiolipin.
B) ganglioside GM2.
C) phosphatidylcholine.
D) platelet-activating factor.
E) sphingomyelin.

9. **Lipids as signals, cofactors, and pigments**
Pages: 352-363 Difficulty: 2 Ans: B
Fatty acids are a component of:

A) carotenes.
B) cerebrosides.
C) sterols.
D) vitamin D.
E) vitamin K.

10. Structural lipids in membranes
Pages: 354-355 Difficulty: 2 Ans: A
Which of the following statements about sterols is true?

A) All sterols share a fused-ring structure with four rings.
B) Sterols are found in the membranes of all living cells.
C) Sterols are soluble in water, but less so in organic solvents such as chloroform.
D) Stigmasterol is the principal sterol in fungi.
E) The principal sterol of animal cells is ergosterol.

11. Structural lipids in membranes
Pages: 354-355 Difficulty: 2 Ans: B
Which of the following is *not* true of sterols?

A) Cholesterol is a sterol that is commonly found in mammals.
B) They are commonly found in bacterial membranes.
C) They are more common in plasma membranes than in intracellular membranes (mitochondria, lysosomes, etc.).
D) They are precursors of steroid hormones.
E) They have a structure that includes four fused rings.

12. Structural lipids in membranes
Page: 355 Difficulty: 2 Ans: A
Which of the following best describes the cholesterol molecule?

A) Amphipathic
B) Nonpolar, charged
C) Nonpolar, uncharged
D) Polar, charged
E) Polar, uncharged

13. Structural lipids in membranes
Page: 356 Difficulty: 2 Ans: A
Tay-Sachs disease is the result of a genetic defect in the metabolism of:

A) gangliosides.
B) phosphatidyl ethanolamine.
C) sterols.
D) triacylglycerols.
E) vitamin D.

14. Storage Lipids
Pages: 357-361 Difficulty: 2 Ans: C
An example of a glycerophospholipid that is involved in cell signaling is:

A) arachidonic acid.
B) ceramide.
C) phosphatidylinositol.
D) testosterone.
E) vitamin A (retinol).

15. **Lipids as signals, cofactors, and pigments**
Pages: 360-363 Difficulty: 1 Ans: B
Which of the following is *not* a fat-soluble vitamin?

A) A
B) C
C) D
D) E
E) K

16. **Lipids as signals, cofactors, and pigments**
Pages: 360-363 Difficulty: 2 Ans: C
Which vitamin is derived from cholesterol?

A) A
B) B_{12}
C) D
D) E
E) K

17. **Lipids as signals, cofactors, and pigments**
Page: 361 Difficulty: 2 Ans: E
Identify the molecule(s) derived from sterols.

A) Arachidonic acid
B) Gangliosides
C) Phosphatidylglycerol
D) Prostaglandins
E) Vitamin D

Short Answer Questions

18. **Storage lipids**
Pages: 344-345 Difficulty: 1
Circle the fatty acid in each pair that has the higher melting temperature.

(a) $18{:}1^{\Delta 9}$ $18{:}2^{\Delta 9,12}$
(b) 18:0 $18{:}1^{\Delta 9}$
(c) 18:0 16:0

Ans: (a) $18{:}1^{\Delta 9}$ (b) 18:0 (c) 18:0

19. **Storage lipids**
Pages: 344-345 Difficulty: 2
Describe the dependence of the melting point of a fatty acid upon (a) chain length and (b) unsaturation; (c) explain these dependencies in molecular terms.

Ans: All other things being equal, (a) the longer the acyl chain, the higher the melting temperature; and (b) the more unsaturation, the lower the melting temperature. (c) The melting temperature is a measure of the thermal energy needed to break the intermolecular interactions that stabilize the "solid" form of a lipid, which depends upon how well the individual lipid molecules fit into the nearly crystalline array of lipids. When a shorter acyl chain lies between two longer chains in a nearly crystalline array of lipid molecules, there is a cavity at the end of the short acyl group that allows freer motion to the neighboring acyl chains. A cis double bond introduces a "kink" into the acyl chain, so that it does not pack as easily with its straighter neighbors.

20. **Storage lipids**
Page: 345 Difficulty: 1
What is the effect of a double bond on fatty acid structure?

Ans: Most double bonds in fatty acids are in the cis configuration. This results in a rigid bend in the hydrocarbon chain. (See Fig. 10-1, p. 345.)

21. **Storage lipids**
Pages: 345-346 Difficulty: 2
In cells, fatty acids are stored as triacylglycerols for energy reserves. (a) What is the molecule to which fatty acids are esterified to form triacylglycerols? (b) Define the logic behind cells storing fatty acids in esterified form.

Ans: (a) Three fatty acids are esterified to glycerol. (b) Triacylglycerols are uncharged and insoluble in water. They form lipid droplets within adipocytes, which do not contribute to the osmolarity of the cytosol in those cells, and do not require any water of hydration.

22. **Storage lipids**
Pages: 345-349 Difficulty: 2
What is the most significant chemical difference between triacylglycerols and glycerophospholipids that leads to their different functions?

Ans: Triacylglycerols are nonpolar hydrophobic molecules that can be stored in specialized nonaqueous cellular compartments. Glycerophospholipids are amphipathic molecules that can serve as structural components of membranes, which have hydrophilic and hydrophobic regions.

23. **Storage lipids**
Page: 346 Difficulty: 2
Describe three functions of triacylglycerols in mammals and one function in higher plants.

Ans: Triacylglycerols provide mammals with (1) stored fuel, (2) insulation, and (3) a source of metabolic water. In some animals, such as camels and desert rats, the oxidation of stored lipids provides water; in hibernating animals, oxidation of stored lipids generates heat to maintain body temperature (see Chapter 4). In plants, oxidation of the triacylglycerols stored in seeds provides the energy and precursors for biosynthetic processes during germination, before photosynthetic mechanisms become functional.

24. **Structural lipids in membranes**
Page: 348 Difficulty: 2
What are the chemical components of a biological wax, and what is their general structure?

Ans: A wax consists of a long-chain fatty acid in ester linkage with a long-chain fatty alcohol. (See Fig. 10-5, p. 348.)

25. Structural lipids in membranes
Page: 350 Difficulty: 2
Draw the structure of phosphatidylserine in the ionic form it would have at pH 7.

Ans: For this structure, see Fig. 10-8, p. 350. At neutral pH, there is a charge on the phosphate group, and serine is in the zwitterionic form; it has a protonated amino group and an ionized carboxyl group.

26. Structural lipids in membranes
Page: 350 Difficulty: 3
Give the structure of phosphatidylethanolamine containing one palmitate and one oleate. Show the ionic form expected at pH 7. How many ester bonds are there in this compound?

Ans: See Fig. 10-8, p. 350 for the phospholipid structure and Table 10-1, p. 344 for the structures of the fatty acids. There are two carboxylate esters and two phosphate esters (one phosphodiester) in the molecule.

27. Structural lipids in membranes
Page: 350 Difficulty: 2
Draw the structure of phosphatidylcholine. Circle the part of the molecule that is polar and draw an arrow to the part that is nonpolar.

Ans: For this structure, see Fig. 10-8, p. 350. At neutral pH, there is a negative charge on the phosphate group, and the quaternary amino group of choline carries a fixed positive charge; this entire phosphorylcholine moiety is polar. The acyl chains attached to glycerol are the nonpolar part of the molecule.

28. Structural lipids in membranes
Page: 350 Difficulty: 2
Show the basic structure of all glycerophospholipids.

Ans: All glycerophospholipids have two fatty acids in ester linkage with C-1 and C-2 of glycerol; often the fatty acid at C-1 is saturated, and that at C-2 is unsaturated. C-3 of glycerol is joined to an alcohol-containing head group through a phosphodiester linkage, which is negatively charged at neutral pH. (See Fig. 10-8, p. 350.)

29. Structural lipids in membranes
Page: 351 Difficulty: 3
What chemical features distinguish a plasmalogen from a common glycerophospholipid?

Ans: (1) The long-chain acyl group attached to C-1 of glycerol is ether-linked in a plasmalogen, but is an ester-linked fatty acyl group in typical glycerophospholipids. (2) There is a double bond between C-1 and C-2 of this fatty acyl chain in plasmalogens, but not in other phospholipids. (See Fig. 10-9, p. 351.)

30. Structural lipids in membranes
Page: 353 Difficulty: 2
Show the structure of sphingosine and indicate the relationship between sphingosine and ceramide.

Ans: The structure of sphingosine is shown in Fig. 10-12, p. 353, which also shows that the attachment of a fatty acyl group to sphingosine in amide linkage converts it to ceramide.

31. Structural lipids in membranes
Page: 353 Difficulty: 3
What chemical features distinguish a cerebroside from a ganglioside?

Ans: A cerebroside has a single sugar residue joined to ceramide; a ganglioside has an oligosaccharide joined to ceramide. (See Fig. 10-12, p. 353.)

32. Lipids as signals, cofactors, and pigments
Pages: 353-361 Difficulty: 2
Match the compounds on the left with the important roles they play listed on the right. (Answers are used only once.)

(a)	prostaglandins	___ blood clotting
(b)	sphingolipids	___ necessary for sight
(c)	thromboxanes	___ mediates pain and inflammation
(d)	vitamin A	___ important component of myelin membranes

Ans: c; d; a; b

33. Structural lipids in membranes
Page: 356 Difficulty: 2
Explain the cause of hereditary diseases of sphingolipid metabolism, such as Tay-Sachs and Niemann-Pick diseases.

Ans: These diseases are the result of mutations in the genes that code for enzymes of sphingolipid breakdown. The mutant enzyme is defective and unable to catalyze its reaction in the metabolic pathway; this results in the accumulation of the metabolic intermediate that is the substrate for the enzyme. (See Box 10-2, p. 356.)

34. Lipids as signals, cofactors, and pigments
Pages: 360-363 Difficulty: 2
Match each of these vitamins with its biological role: Vitamins A, D, E, K.

____ blood clotting
____ vision
____ Ca^{2+} and phosphate metabolism
____ prevention of oxidative damage

Ans: K; A; D; E

35. Lipids as signals, cofactors, and pigments
Pages: 361-362 Difficulty: 2
Show the structure of isoprene; explain what is meant by isoprenoid compounds and give an example.

Ans: The structure is shown on page 361. Isoprenoid compounds contain chains that consist of multiple isoprene units. (See Fig. 10-22, p. 362, for examples.)

36. Lipids as signals, cofactors, and pigments
Pages: 361-362 Difficulty: 2
What do all these compounds have in common: vitamin A, vitamin K, ubiquinone, and dolichol?

Ans: They are all lipids with potent biological activities derived from isoprenoid precursors.

37. Working with Lipids
Pages: 363-364 Difficulty: 2
Explain why extraction of lipids from tissues requires organic solvents.

Ans: Lipids are either strongly hydrophobic or amphipathic. Because the solvent in tissues is water, lipids are mainly present in aggregates. This aggregation does not occur in organic solvents; as a result, the lipids are more soluble and thus extractable from the tissues.

38. Working with Lipids
Pages: 364-365 Difficulty: 3
If beeswax, cholesterol, and phosphatidylglycerol were dissolved in chloroform, then subjected to thin-layer chromatography on silica gel using a mixture of chloroform/methanol/water as the developing solvent, which would move fastest?

Ans: In this chromatography, the least polar compound (beeswax) moves fastest and the most polar (phosphatidylglycerol, which has a negative charge on its head group) moves the slowest. (See Fig. 10-23, p. 364.)