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Lipids: Structure, Properties, and Cell Roles

Exam — Cell Membrane

Pre-med/IB-style questions on lipid types (fatty acids, triglycerides, phospholipids, steroids), amphipathic behavior, membrane fluidity/permeability, lipid asymmetry and signaling, and classic conceptual traps (cis vs trans, cholesterol effects, detergents).

40 items — Printable Exam

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1 Which molecule is amphipathic and most likely to self-assemble into a bilayer in water?



- A Glucose
- B Triacylglycerol (triglyceride)
- C Phosphatidylcholine
- D Cholesteryl ester
- E Glycine

2 Compared with phospholipids, triacylglycerols are better suited for long-term energy storage mainly because they:



- A Have charged phosphate heads that make them water-soluble
- B Are highly reduced and stored without much associated water
- C Form bilayers that trap energy inside cells
- D Contain peptide bonds that store chemical energy
- E Are catalysts that speed up ATP synthesis

3 Two fatty acids are both 18 carbons long. Which change would MOST increase melting point and decrease membrane fluidity at a fixed temperature?



- A Add one cis double bond (18:0 → 18:1 cis)
- B Convert a cis double bond to a trans double bond
- C Remove a double bond (18:1 cis → 18:0)
- D Shorten the chain from 18 carbons to 12 carbons
- E Add a phosphate group to the fatty acid tail





4 A trans-unsaturated fatty acid behaves more like a saturated fatty acid than a cis-unsaturated fatty acid because trans double bonds:



- A Create large kinks that prevent packing
- B Make the chain straighter, allowing tighter packing
- C Make the fatty acid positively charged
- D Turn the fatty acid into a carbohydrate
- E Prevent the fatty acid from being part of membranes

5 Which statement BEST describes cholesterol's effect on a mammalian plasma membrane?



- A It always increases membrane fluidity at all temperatures
- B It always decreases membrane fluidity at all temperatures
- C It buffers fluidity: decreases fluidity at high temperature but prevents solidification at low temperature
- D It replaces phospholipids to form the bilayer backbone
- E It makes the membrane freely permeable to ions

6 At the same temperature and saturation level, which membrane would generally be MORE fluid?



- A Membrane with shorter fatty acid tails
- B Membrane with longer fatty acid tails
- C Membrane with more hydrogen bonding between water molecules





- D Membrane made only of triglycerides
- E Membrane with more peptide bonds in the bilayer

7 A cell is cooled rapidly. Which lipid change would BEST help maintain membrane function in the cold (homeoviscous adaptation)?



- A Increase saturated fatty acid content
- B Increase trans-unsaturated fatty acid content
- C Increase cis-unsaturated fatty acid content
- D Replace phospholipids with triglycerides
- E Increase peptide bond formation in membrane proteins

8 What is the BEST explanation for why phospholipids spontaneously form bilayers in water?



- A Phospholipids form covalent bonds with water to stabilize the membrane
- B Water molecules gain entropy when hydrophobic tails are sequestered away from water (hydrophobic effect)
- C Phospholipids are charged and attract each other strongly
- D Bilayers form because fatty acid tails hydrogen-bond to each other
- E Bilayers form only when ATP is consumed

9 Why do many detergents form micelles rather than stable bilayers in water?





- A Detergents usually have two tails, which favor bilayers
- B Detergents often have a single hydrophobic tail, creating a cone shape that favors micelles
- C Detergents are always fully hydrophobic, so they cannot self-assemble
- D Micelles require peptide bonds to form
- E Bilayers cannot form in water under any conditions

10 Which substance would diffuse **FASTEST** across a pure phospholipid bilayer (no transport proteins)?



- A O₂
- B Glucose
- C Na⁺
- D Cl⁻
- E Amino acid (charged form)

11 Ions cross lipid bilayers very poorly mainly because:



- A Ions are too large to fit between lipid tails
- B Ions would have to shed their hydration shell to enter the hydrophobic core, which is energetically costly
- C Ions do not interact with water
- D The membrane core is positively charged and repels all ions
- E Ions immediately form peptide bonds with phospholipids





12 A membrane shifts from a more “gel-like” state to a more “fluid” state as temperature rises. Which outcome is most likely as fluidity increases?



- A** Lateral diffusion of membrane proteins and lipids increases
- B** Peptide bonds in membrane proteins break
- C** All ion gradients across the membrane disappear instantly
- D** Phospholipids stop being amphipathic
- E** The bilayer becomes covalently cross-linked

13 Which membrane lipid movement is typically the SLOWEST without enzymes?



- A** Rotation of a phospholipid around its axis
- B** Flexing of fatty acid tails
- C** Lateral diffusion within one leaflet
- D** Flip-flop (movement from one leaflet to the other)
- E** Vibration of bonds in the lipid tails

14 A flippase enzyme in the plasma membrane most directly helps maintain lipid asymmetry by:



- A** Moving lipids from the outer leaflet to the inner leaflet in a selective way
- B** Moving lipids randomly in both directions equally
- C** Breaking phospholipids into fatty acids and glycerol
- D** Adding double bonds to fatty acids
- E** Making peptide bonds between membrane proteins





15 Which enzyme would most directly **RANDOMIZE** phospholipids between the two leaflets (reducing asymmetry), especially during cell stress?



- A** Flippase
- B** Scramblase
- C** ATP synthase
- D** DNA polymerase
- E** Peptidyl transferase

16 Phosphatidylserine (PS) is normally enriched in the inner leaflet of the plasma membrane. Its exposure on the outer leaflet is a key signal for:



- A** DNA replication
- B** Protein translation
- C** Apoptosis recognition by phagocytes
- D** Glycogen synthesis
- E** Microtubule polymerization

17 Glycolipids involved in cell recognition are most commonly located on which side of the plasma membrane?



- A** Cytosolic (inner) leaflet only
- B** Extracellular (outer) leaflet only
- C** Evenly distributed between inner and outer leaflets
- D** Only inside the nucleus





- E Only on mitochondrial inner membranes

18 Lipid rafts are best described as membrane microdomains that are:



- A Regions lacking cholesterol and rich in polyunsaturated fats
- B Cholesterol- and sphingolipid-rich regions that are more ordered and often involved in signaling
- C Areas where phospholipids are covalently cross-linked
- D Nuclear pores made of lipids
- E Permanent holes in membranes for ion diffusion

19 A protein is attached to the OUTER surface of the plasma membrane via a GPI anchor. Which statement is most accurate?



- A The protein is anchored to the cytosolic leaflet by a fatty acid tail
- B The protein is anchored to the extracellular leaflet by a glycolipid-based anchor
- C The protein must span the membrane as an ion channel
- D The protein is anchored by a peptide bond to phospholipid heads
- E The protein is stored inside the nucleus until needed

20 Steroid hormones (e.g., cortisol) can often enter cells without a membrane transporter because they are:



- A Large, highly charged polymers





- B** Hydrophobic molecules that can diffuse through the lipid bilayer
- C** Ions that pass through lipid tails easily
- D** Proteins that use ribosomes as carriers
- E** Carbohydrates that cross via simple diffusion

21 Eicosanoids (like prostaglandins) are best described as:



- A** Long-term energy storage molecules made of three fatty acids
- B** Local signaling molecules derived from fatty acids
- C** Primary structural components of DNA
- D** Enzymes that break peptide bonds
- E** Transporters that move ions across membranes

22 Why do fats provide more energy per gram than carbohydrates when oxidized?



- A** Fats contain more oxygen atoms per carbon
- B** Fats are more reduced (more C–H bonds), yielding more electrons for ATP production
- C** Fats contain peptide bonds that release ATP directly
- D** Fats are stored with large amounts of water, increasing mass
- E** Carbohydrates cannot be oxidized in cells





23 A key reason triglyceride stores are compact compared with glycogen stores is that triglycerides:



- A** Must bind water molecules to remain stable
- B** Are hydrophobic and stored without much water, unlike glycogen
- C** Are made of amino acids and fold tightly
- D** Are positively charged and repel water
- E** Form rigid crystals that occupy less space than liquids

24 Because most lipids are poorly soluble in water, the body transports many lipids in blood primarily as:



- A** Free fatty acids dissolved directly in plasma at high concentration
- B** Lipoprotein particles with a hydrophobic core and hydrophilic surface
- C** DNA–lipid complexes formed in the nucleus
- D** Peptide-bond polymers called liposomes
- E** Pure triglyceride droplets floating freely in plasma

25 Which feature makes a lipoprotein particle soluble in blood plasma?



- A** A surface made mainly of phospholipid heads and apolipoproteins facing water
- B** A surface made mainly of triglyceride tails facing water
- C** A surface made mainly of DNA and RNA
- D** A surface made mainly of cholesterol esters facing water
- E** A surface made mainly of peptide bonds without side chains





26 Which statement correctly contrasts a phospholipid with a triglyceride?



- A** Phospholipids have 3 fatty acid tails; triglycerides have 2
- B** Phospholipids are mainly structural membrane molecules; triglycerides are mainly energy-storage molecules
- C** Triglycerides are amphipathic and form bilayers; phospholipids are fully hydrophobic
- D** Triglycerides contain nitrogenous bases; phospholipids contain ribose
- E** Phospholipids are polymers made by peptide bonds

27 Vegetable oils are typically liquid at room temperature mainly because they contain:



- A** Many long saturated fatty acids that pack tightly
- B** Many cis-unsaturated fatty acids that pack less tightly
- C** Mostly peptide bonds that prevent crystallization
- D** Large amounts of cholesterol, which always solidifies membranes
- E** Only single-tailed detergents

28 Partial hydrogenation of vegetable oil tends to make it more solid at room temperature mainly because it:



- A** Adds cis double bonds and increases kinks
- B** Removes some double bonds and can create trans double bonds, increasing packing
- C** Adds phosphate heads, making it water-soluble
- D** Breaks triglycerides into amino acids





- E Turns fatty acids into carbohydrates

29 Waxes (wax esters) are especially useful for organisms mainly because they:



- A Are highly polar and dissolve easily in water
- B Are hydrophobic and form water-resistant protective coatings
- C Are the main component of ribosomes
- D Form ion channels in membranes
- E Are made of nucleotides and store genetic information

30 Which statement BEST distinguishes sphingolipids from many common phospholipids?



- A Sphingolipids have a sphingosine backbone instead of a glycerol backbone
- B Sphingolipids are made of amino acids linked by peptide bonds
- C Sphingolipids are always water-soluble and do not enter membranes
- D Sphingolipids contain ribose sugars as their backbone
- E Sphingolipids cannot contain fatty acid chains

31 Myelin membranes are particularly lipid-rich. Which composition pattern best supports their insulating role?



- A High triglycerides only, no cholesterol
- B High cholesterol and sphingolipids, creating a tightly packed, less permeable membrane





- C High glucose and amino acids forming a gel layer
- D High RNA content for rapid signaling
- E High free ions to accelerate conduction directly through the membrane

32 Cardiolipin is a distinctive phospholipid found in high amounts in which membrane, supporting energy-related protein complexes?



- A Plasma membrane outer leaflet
- B Inner mitochondrial membrane
- C Nuclear envelope outer membrane only
- D Golgi lumen
- E Ribosome surface

33 Archaea often survive extreme environments partly because their membrane lipids commonly contain:



- A Ester-linked fatty acids on glycerol (like typical bacteria)
- B Ether-linked isoprenoid chains, which are more chemically stable
- C Peptide bonds linking hydrocarbons
- D Cellulose microfibrils embedded in the membrane
- E Phosphodiester bonds like DNA





34 Which enzyme class most directly hydrolyzes triglycerides into glycerol and fatty acids?



- A Proteases
- B Lipases
- C Kinases
- D Polymerases
- E Ligases

35 A signal causes phospholipase C to cleave a membrane phospholipid called PIP₂. Which products are formed (concept level)?



- A ATP and ADP
- B DNA and RNA
- C DAG (diacylglycerol) and IP₃ (inositol trisphosphate)
- D Glycogen and glucose
- E Cholesterol and bile salts

36 Why does DAG (diacylglycerol) usually remain in the membrane after being produced from PIP₂?



- A DAG is highly charged and attracted to water
- B DAG is hydrophobic (two fatty acid tails) and partitions into the lipid bilayer
- C DAG forms covalent bonds to DNA, trapping it in the nucleus
- D DAG is a protein and cannot leave the membrane
- E DAG is pumped into the membrane by ATP synthase





37 A major function of cholesterol in cells is NOT only as a membrane component, but also as a precursor for:



- A** Steroid hormones
- B** Amino acids
- C** DNA nucleotides
- D** Cellulose
- E** Peptide bonds

38 Which statement correctly distinguishes cholesterol from a cholesteryl ester?



- A** Cholesteryl esters are more amphipathic than cholesterol
- B** Cholesteryl esters have a fatty acid attached, making them more hydrophobic and suited for storage/transport in cores
- C** Cholesteryl esters form the polar head group of phospholipids
- D** Cholesterol cannot be found in membranes, only cholesteryl esters can
- E** Cholesteryl esters are carbohydrates linked to cholesterol

39 Which explanation best accounts for why cis double bonds increase membrane fluidity?



- A** They create kinks that reduce tight packing of lipid tails
- B** They add positive charges to fatty acids
- C** They increase hydrogen bonding between tails
- D** They convert fatty acids into proteins





- E They form covalent crosslinks between phospholipids

40 A researcher punctures an artificial phospholipid bilayer (liposome) with a fine needle. Why can such bilayers often “self-seal” after small disruptions?



- A Because phospholipids form covalent bonds instantly to repair holes
- B Because exposed hydrophobic tails are energetically unfavorable in water, driving lipids to rearrange and close the gap
- C Because ATP-driven pumps pull lipids into place
- D Because DNA repair enzymes fix membrane breaks
- E Because peptide bonds in the membrane tighten like a zipper







#	Ans	Answer Text
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2	B	Are highly reduced and stored without much associated water
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