

Review Questions for Exam 3

P. 1

1.
 - a. CO_2 is produced in the conversion of pyruvate to acetyl CoA and in steps 3 and 4 of the citric acid cycle.
 - b. O_2 is used as the final e^- -acceptor in the electron transport chain.
2.
 - a. Step 9 glycolysis - a dehydration reaction. It is losing H_2O and a $\text{C}=\text{C}$ double bond is formed.
 - b. Step 3 glycolysis - a phosphorylation reaction. A phosphate group is being added to carbon 1 on fructose-6-phosphate.
 - c. pyruvate \rightarrow acetyl CoA is an oxidation and a decarboxylation. A COO^- (carboxylate) group is removed and becomes CO_2 .

$\text{CH}_3\overset{\text{O}}{\parallel}\text{C}\overset{\text{O}}{\parallel}\text{C}\text{O}^-$

\nwarrow this part gets attached to coenzyme A to form acetyl CoA.
 - d. Step 8 of CAC - an oxidation rxn. An ^{alcohol} OH-group on malate is converted to a ketone group on oxaloacetate.
 - e. Step 5 of CAC - Coenzyme A is removed. $\overset{\text{O}}{\parallel}\text{C}$ in succinyl CoA is converted to $\overset{\text{O}}{\parallel}\text{C}\text{O}^-$ (carboxylate) (ketone group)
3. pyruvate gets converted to lactate under anaerobic conditions (low O_2). NAD^+ is formed in this reaction. If there's no/low O_2 , the e^- -transport chain isn't occurring, so there's no other source of NAD^+ . NAD^+ is needed for glycolysis to continue. (Glycolysis doesn't require O_2). Under these conditions (anaerobic), glycolysis would be the only way ATP could be formed.
4. in yeast, the process of fermentation converts pyruvate to ethanol and CO_2 . This reaction is used to make beer, wine, and bread.
5. The molecule shown is 3 glucose units connected. When it is hydrolyzed, will have 3 molecules glucose.

5 continued 3 glucose

Glycolysis	Step	1	3 ATP used	-3 ATP
		3	3 "	-3 ATP
		6	6 NADH produced	
		7	6 ATP produced	
		10	6 ATP produced	
Pyr → acetyl CoA			6 NADH	
CAC	step	3	3 NADH	
(6 cycles)		4	6 NADH	
		5	6 ATP	
		6	6 FADH ₂	
		8	6 NADH	

Total yield: 12 ATP
 30 NADH
 6 FADH₂

Started with 3 6-C sugars - 18C total
 so we'll get 18 molecules CO₂.
 they are formed in pyruvate → acetyl CoA
 step 3, 4 of CAC

(6 CO₂)
 (6)
 (6)

 18 CO₂ total

In e⁻ transport chain, NADH and FADH₂ are oxidized and the energy is used to make ATP

Best estimate

12 ATP	=	12 ATP
30 NADH × 2.5	=	75 ATP
6 FADH ₂ × 1.5	=	9 ATP
		<u>96 ATP total</u>

Maximum

12 ATP	=	12 ATP
30 NADH × 3	=	90 ATP
6 FADH ₂ × 2	=	18 ATP
		<u>120 ATP total</u>

6. 1,3-bisphosphoglycerate

Glycolysis	step 7	1 ATP
	10	1 ATP
pyr → acCoA		1 NADH
CAC	step 3	1 NADH
	4	1 NADH
	5	1 ATP
	6	1 FADH ₂
	8	1 NADH

Total	3 ATP	best estimate		max
	4 NADH	3		3
	1 FADH ₂	$3 \times 2.5 = 7.5$	$4 \times 3 = 12$	12
		$1 \times 1.5 = 1.5$	$1 \times 2 = 2$	2
		<u>14.5 ATP</u>		<u>17 ATP</u>
		best estimate		max

3 CO₂ made:

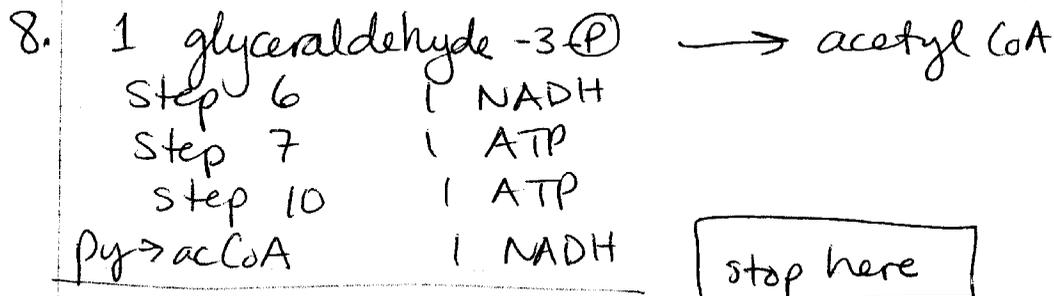
pyr → acetyl CoA	1 CO ₂
CAC step 3	1
" " 4	1
	<u>3 CO₂</u>
	total

7. fructose-6-P starts before step 3 (6 carbons)

Glycolysis	step 3	-1 ATP (used)
	6	2 NADH
	7	2 ATP
	10	2 ATP
Pyr → acCoA		2 NADH
CAC (steps 3, 4, 8)		3 NADH
(2 turns) step 5		2 ATP
step 6		2 FADH ₂

	low	high
5 ATP	5	5
$10 \text{ NADH} \times 2.5 = 25 \text{ ATP}$	25 ATP	$10 \times 3 = 30 \text{ ATP}$
$2 \text{ FADH}_2 \times 1.5 = 3 \text{ ATP}$	3 ATP	$2 \times 2 = 4 \text{ ATP}$
	<u>33 ATP</u>	<u>39 ATP</u>
	best estimate	maximum

Totals	5 ATP
	10 NADH
	2 FADH ₂



So 2 NADH and 2 ATP formed.

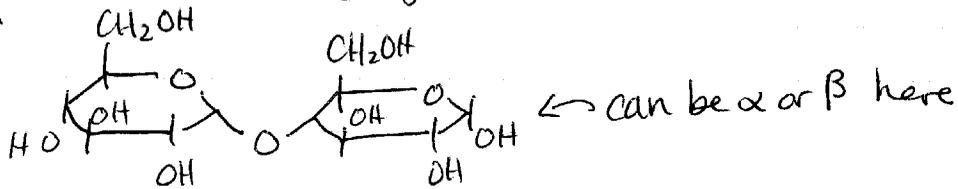
$$\begin{array}{l} \searrow \times 2.5 \\ 5 \text{ ATP} + 2 \\ 2 \times 3 \quad 6 \text{ ATP} + 2 \end{array} = \begin{array}{l} 7 \text{ ATP total (best estimate)} \\ 8 \text{ ATP (max)} \end{array}$$

9. On the inner mitochondrial membrane, NADH and FADH_2 are oxidized back to NAD^+ and FADH_2 by transferring their electrons to enzyme clusters and mobile electron carriers. The electrons are transferred from one thing to another, and at enzyme complexes I, III, and IV, the energy released by the e^- transfers is used to pump H^+ ions from the matrix to the intermembrane space. This creates a proton gradient (different concentration on each side of membrane). The final e^- acceptor is O_2 . The proton gradient is a high energy state and not stable. H^+ ions "want" to get back to the other side to equalize the concentrations on each side of the membrane, but they can only get back to the other side by going through the protein ATP synthase. The energy released as this happens is coupled with the formation of ATP.
10. Similarities: all are polymers of D-glucose. amylose, amylopectin, and glycogen contain α -1,4-glycosidic bonds, while cellulose contains β -1,4-glycosidic bonds (which are indigestible ~~by~~ humans). amylose and cellulose are not branched, while glycogen and amylopectin have branches

connected by α -1,6-glycosidic bonds. Glycogen is more highly branched than amylopectin.
 Source: cellulose, amylose, and amylopectin are found in plants, while glycogen is found in animals.

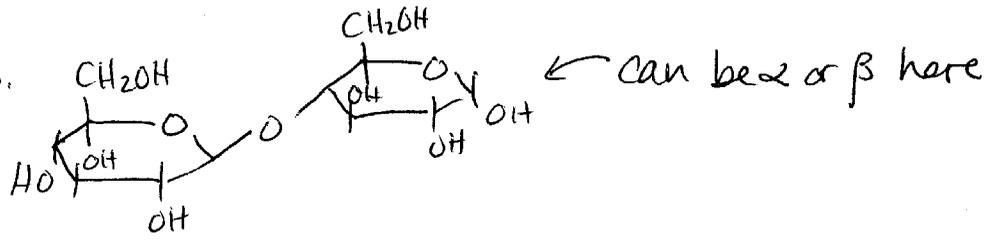
11. a.

α -1,4



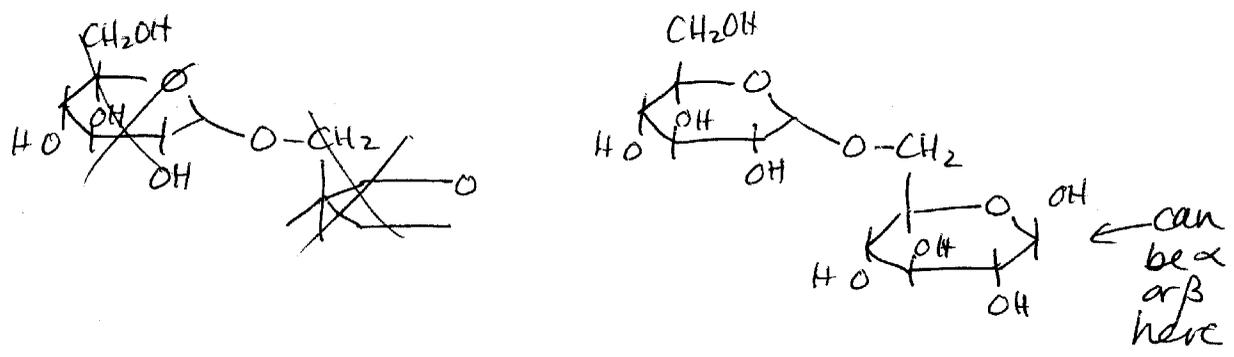
b.

β -1,4



c.

α -1,6



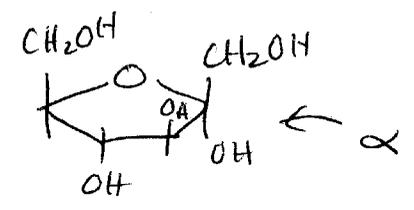
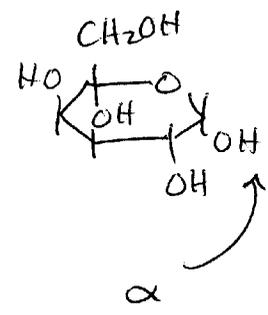
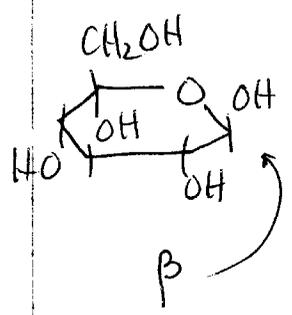
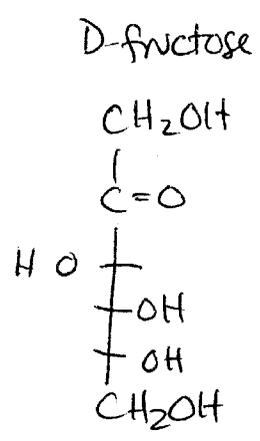
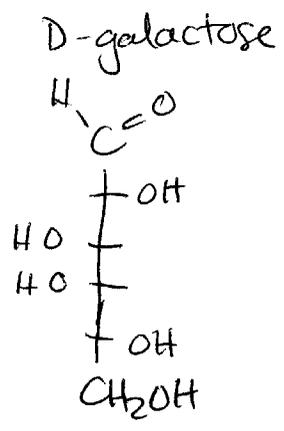
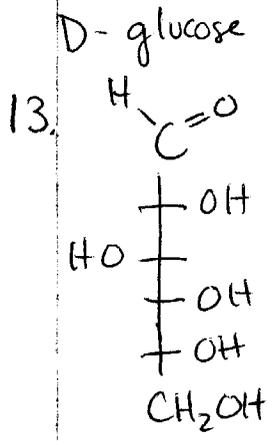
12. (a) These test for the presence of a reducing sugar.

(+) test: red precipitate

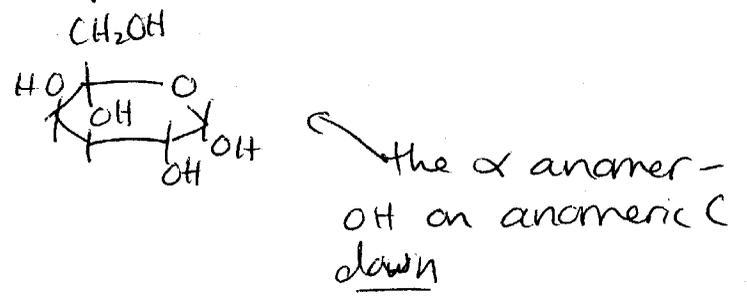
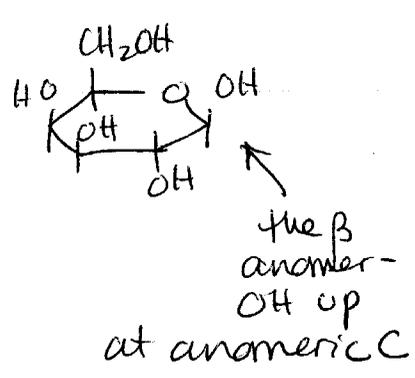
(+) test means the sugar present can be oxidized, so it has a "free" anomeric carbon.

(b) I_2 test - (+) test is blue/black color in solution. This means starch is present.

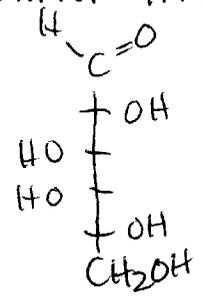
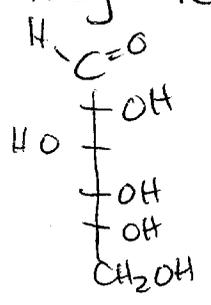
(c) Br_2 is orange. If you add it to something and the orange color fades to colorless, it's a positive test. This tests for the presence of double or triple bonds. If the tested solution turns orange immediately, it means that the orange Br_2 had nothing to react with, so no double or triple bonds were present.



14. (a) anomers - same sugar, cyclic structure, but α and β forms. Two different orientations at the hemiacetal group.

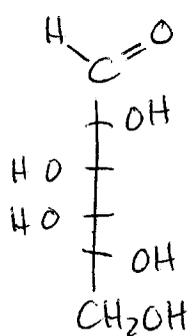


(b) diastereomers - have the same formula, same connections, but different arrangement in space. they are not mirror images of each other.

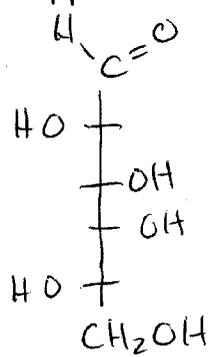


glucose and galactose are diastereomers. (they are not enantiomers) same general backbone but different orientations of OH at the chiral carbons, (at least one that's different.)

14c. enantiomers - stereoisomers - nonsuperimposable mirror images. opposite orientation at each chiral C.



D-galactose

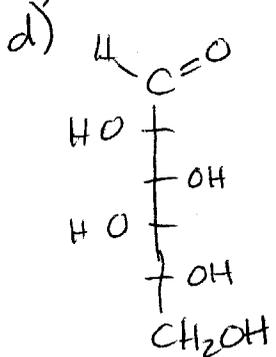


L-galactose

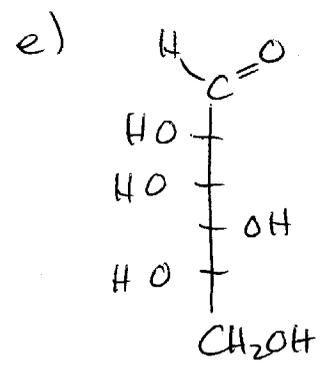
15. a) 4 chiral carbons (C-2, 3, 4, and 5)

b) an aldohexose

c) D

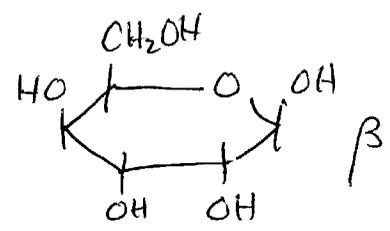


a diastereomer
D

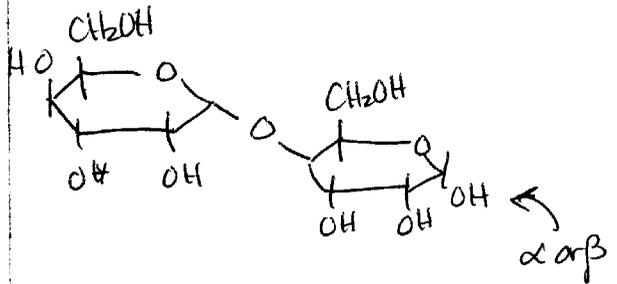


the enantiomer
L

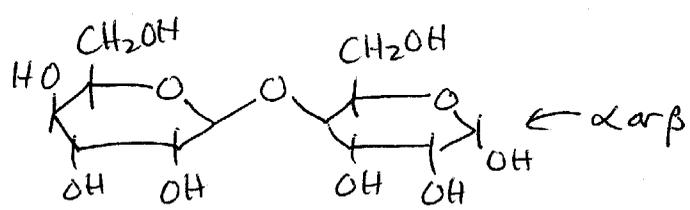
f) ring form



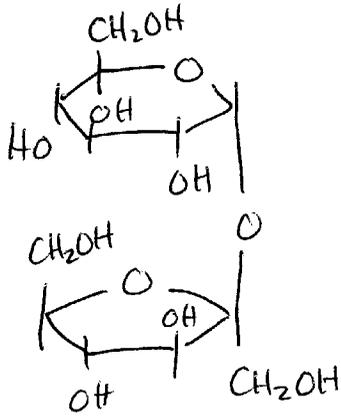
g. α -1,4



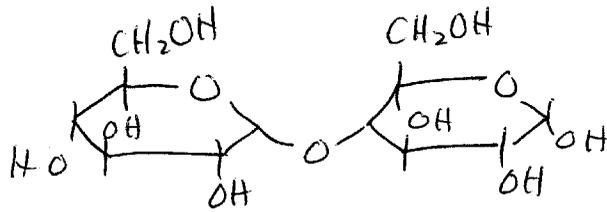
h. β -1,4



16. Sucrose



maltose

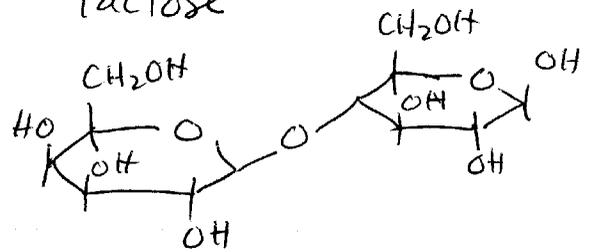


α -1,4-glycosidic bond
hydrolysis gives 2 glucose

α, β -1,2 glycosidic bond
not a reducing sugar,
no free anomeric C so
it can't open up, can't
be oxidized.

when hydrolyzed, we get
glucose + fructose

lactose



β -1,4-glycosidic bond
hydrolysis gives glucose
+ galactose.

17. product of complete hydrolysis of starch: glucose

Need either acid

or an enzyme that hydrolyzes the α -1,4 glycosidic
bonds.

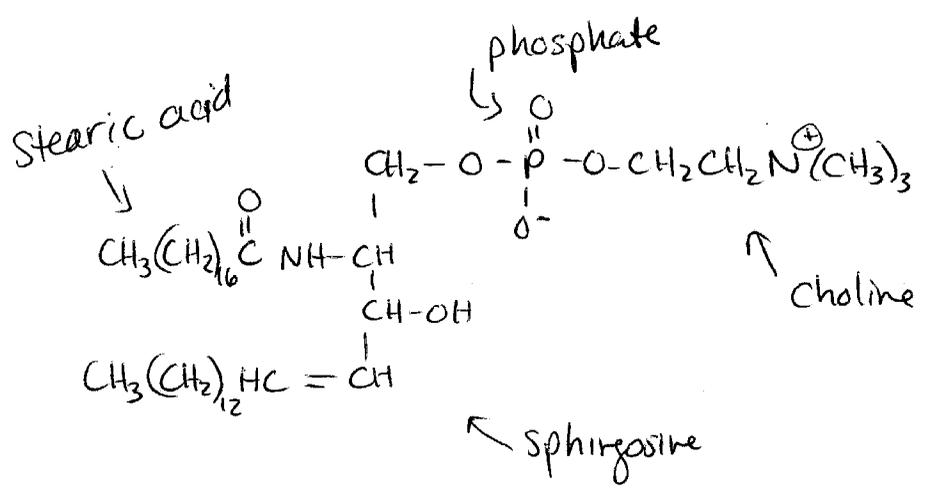
18. a wax - an ester with a long hydrocarbon chain
on each side - both with an even # C's



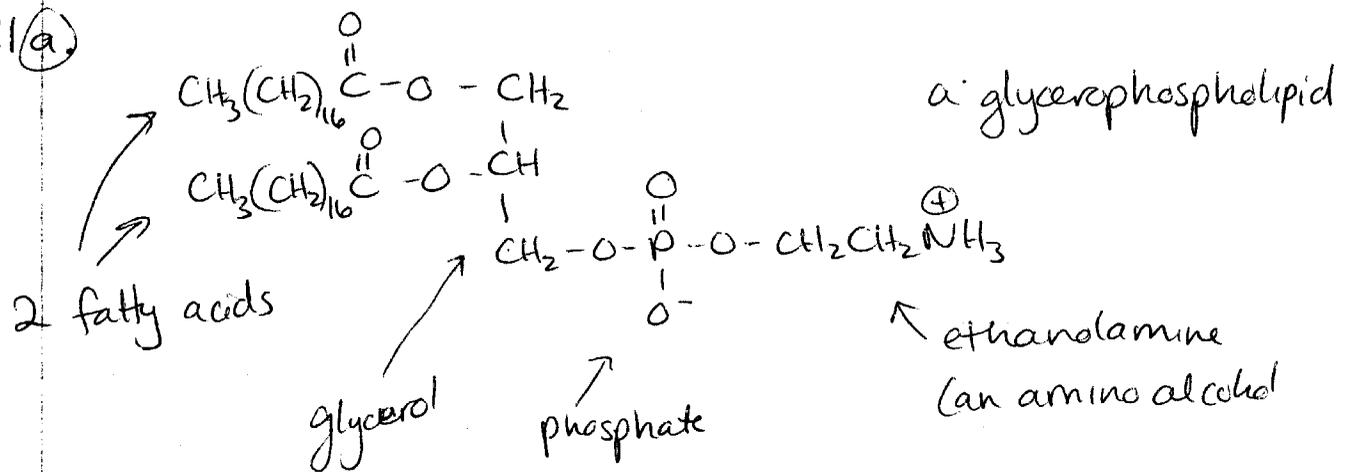
(many possible
correct answers)

19. This is a glycosphingolipid. It contains a monosaccharide,
sphingosine, and a fatty acid.

20.

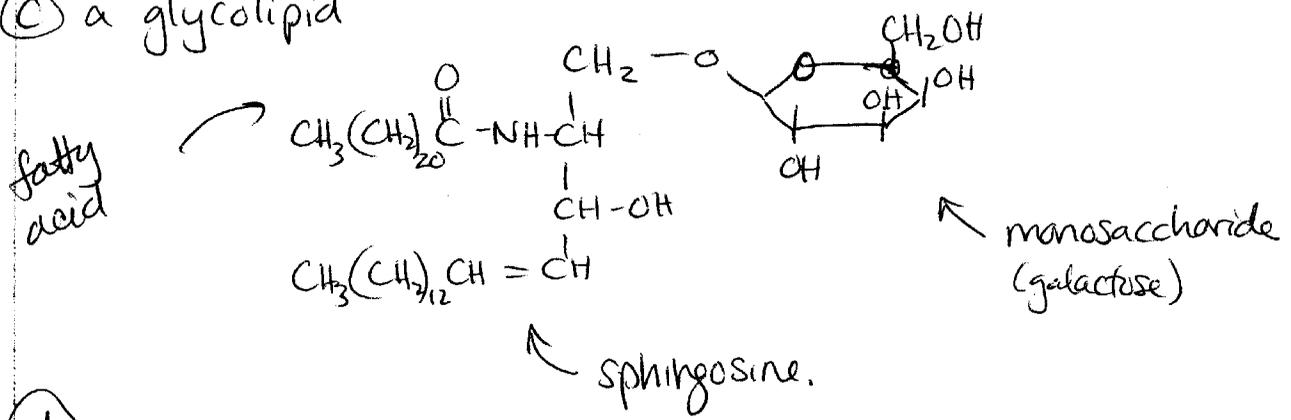


21(a)

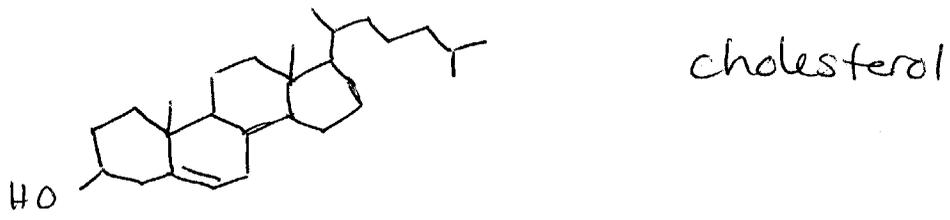


(b) this is just like #20! See above.
 a sphingomyelin contains sphingosine, a fatty acid, phosphate, and an amino alcohol.

(c) a glycolipid



(d)

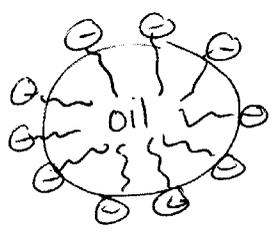


22. When you hydrogenate a triglyceride, you are adding H_2 to the double bonds in the fatty acids.

This will make the texture more solid and will increase the melting point.

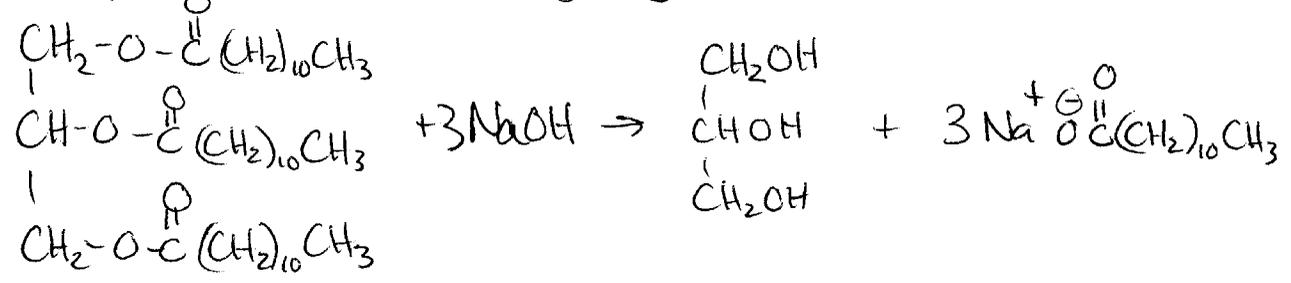
Saturated fatty acids and fats have a more regular structure (compared to unsaturated fats with their cis double bonds and kinks in the hydrocarbon chains). Saturated fats stack on each other easily, so they form solids more easily.

23. a. Soap molecules have a \ominus charged "head" group and a long, nonpolar tail. Soap molecules can surround oil/grease droplets and form a micelle around them.



The nonpolar tails are embedded in the grease droplet, and the charged head groups are on the outside, facing the water. The micelles are soluble in water and can be washed away easily.

(b) Saponification: base hydrolysis of a fat or oil



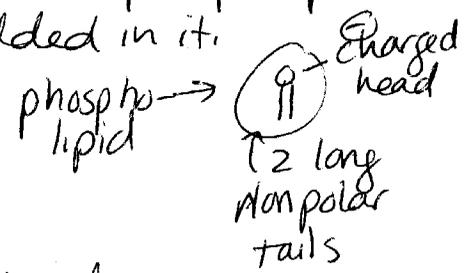
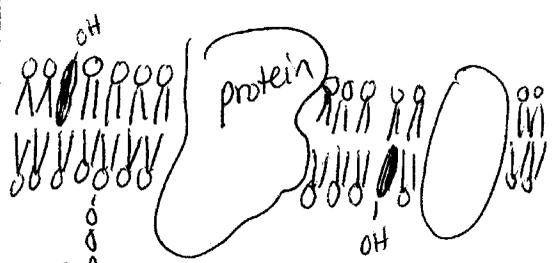
fat

Strong base

→ glycerol

carboxylate salts (soap)

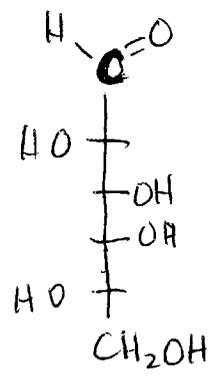
24. The cell membrane is a lipid bilayer of phospholipids with cholesterol and proteins embedded in it.



charged head groups on outside, facing water.
Nonpolar tails on inside, away from water.

a glycolipid

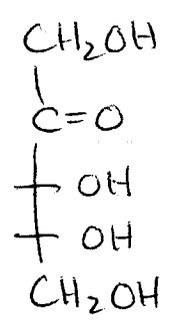
25.



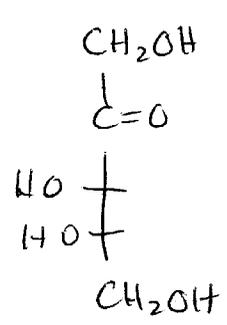
Soluble in water - has lots of OH groups that can H-bond to water.
Very polar.

L-galactose

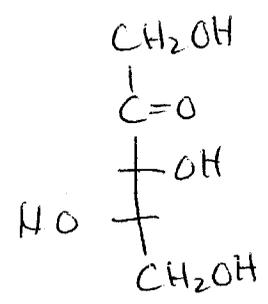
26.



D



the ~~the~~ L enantiomer

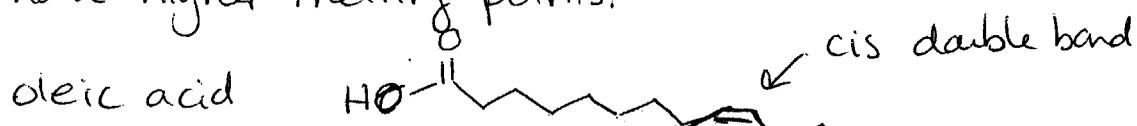


L a diastereomer

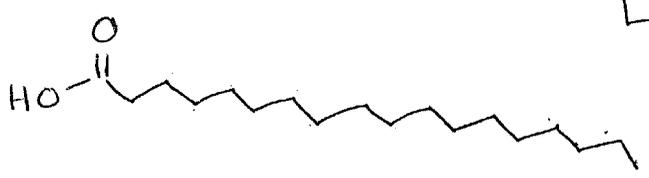
27. Fats and oils - both are triacylglycerols. Fats are solid at room temp. and tend to come from animal sources. Oils are liquid at room temp. and tend to come from plant sources.

27 continued Fats contain a high proportion of saturated fatty acids, while oils contain a high proportion of unsaturated fatty acids. Unsaturated fatty acids contain cis double bonds, which form permanent bends in the carbon chains. These don't line up very effectively with each other, so they don't easily form a solid and they will have low melting points. Saturated fatty acids are regular, and they can line up and stack pretty easily to form a solid. They would have higher melting points.

28.



Stearic acid



Stearic acid has the higher melting point - it's saturated. See explanation for # 27.

- 29.
- nonpolar molecules can easily pass through the membrane by themselves, with no assistance.
 - Some polar molecules can pass through channels in the membrane - the channels are inside/through certain integral membrane proteins.
 - Some things are facilitated by proteins - they bind to the protein on one side, then go through and ~~unbind~~ unbind from the protein on the other side.
 - Some things are actively transported to the other side, (by a protein) using energy in the process.

30. See answer to # 9.

31. Steps 3, 4, 6, and 8 are redox rxns - NAD⁺ or FAD are reduced in these rxns, so substrates must be oxidized.