BIOCHEMISTRY EXAM 5 Study Sheet — Chapters 11, 12, 14, 15 — 4-29-24

Chapter 11: Lipids and Membranes

1) Lipid Structural Classes

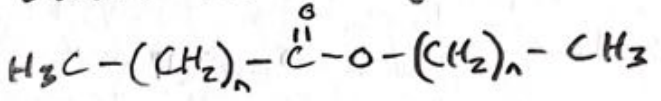
① Fatty Acids
monocarboxylic acids with hydrocarbon chains 12-20 carbons long
α carbon is the #2 carbon

- C14:0 Myristic Acid
- C16:0 Palmitic Acid
- C18:0 Stearic Acid
- C18:1 Δ^9 Oleic Acid
- C18:2 $\Delta^{9,12}$ Linoleic Acid
- C20:4 $\Delta^{5,8,11,14}$ Arachidonic Acid

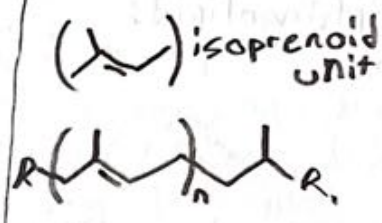
② Triacylglycerols
esters of glycerol with 3 fatty acid tails
no charge = neutral
neutral fats
FAs always even # of carbons
Natural double bond almost always cis

glycerol

③ wax esters
FA esters with long chain alcohols

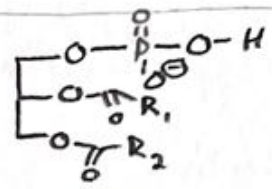


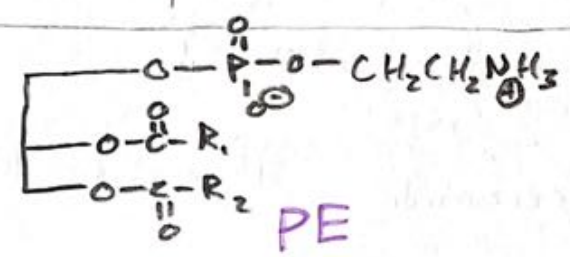
④ Isoprenoids
biomolecules that contain repeating 5 carbon sequences
begin from synthesis of isopentenyl from acetyl CoA



⑤ Phospholipids
structural component of membranes
amphipathic molecules: polar head, nonpolar tail

- PA: Phosphatidic Acid (head group = H)
- PC: Phosphatidyl choline
- PE: Phosphatidyl ethanolamine
- PS: Phosphatidyl serine
- PI: Phosphatidyl inositol (don't need to know structure)


PA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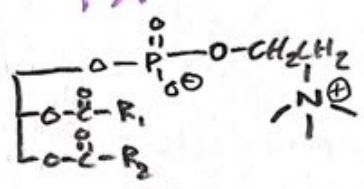
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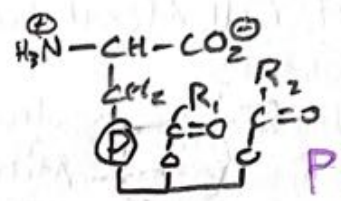
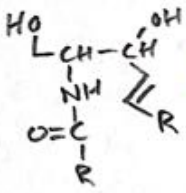
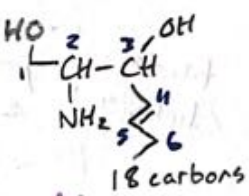

PS

⑥ Sphingolipids
shinglolipid backbone
S_0 = sphingosine backbone
S_0 + FA = Ceramide


Ceramide



sphingosine backbone
C18:1 Δ^4 trans

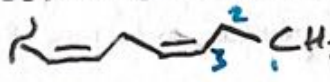
S_0 + FA + Sugar = Cerebroside
S_0 + FA + P_i + Choline = Sphingomyelin
Neutral sugar = globosides
Negatively charged sugars = gangliosides

Lipid Major Functions

1) **Energy** storage
TAG and FA (Fatty Acids)
2) **Structural** membranes
PL (Phospholipid), SL (sphingolipid)
CHO (cholesterol), waxes (plant)
3) **Bioactive signalling**
steroid, eicosanoids (C20)
Isoprenoids

Class of organic molecules that are not soluble in H_2O

Ω3 FA Double bond starting 3 from tail



2) Roles of Fatty Acids

Degree of unsaturation affects chemical and physical properties
Saturated Fats - typically solids (↑ MP) from animal sources
Unsaturated Fats - called oils (↓ MP) from plant sources or cold fish
The Cis Double Bond acts like a kink, changes conformation


Unsaturated fat — Saturated fat

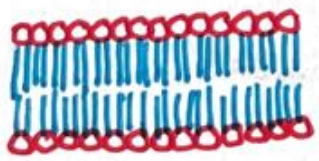
Unsaturated fats have weaker intermolecular forces. Inability to pack together, lowering MP

Trans Fatty Acids
1) Can be found in small amounts

Health Considerations
1) eat unsaturated fats
2) eat less saturated fats
3) Avoid trans fats
2) More stable doc to trans double bond
3) Increased risk of heart disease, trans FA increase LDL concentration and lowers HDL concentration

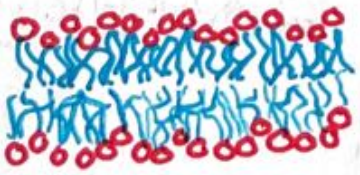
FA Phase Diagram

Ordered Gel Phase (S_0) — Solid Head, Ordered Tail

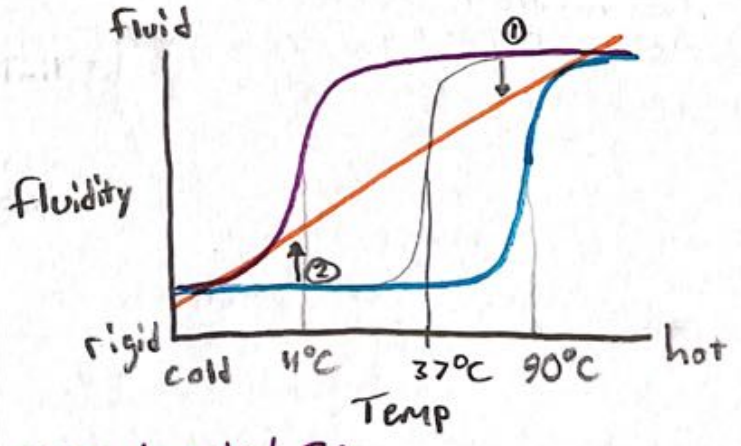


- Tightly packed
- ordered Ⓟ groups
- FA Tails in line

Cool ↑ ↓ Heat



Disordered Liquid Phase (L_d)
Liquid Head, Disordered Tail



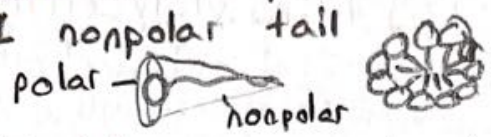
- Unsaturated FA
- normal mixed FA
- saturated FA
- Cholesterol - acts as a buffer
  makes fluid membranes more rigid
  makes rigid membranes more fluid

Eicosanoids

C20, generally
contain a loop structure
Derived from arachidonic acid or EPA
Produced in most mammalian tissues.
Used in muscle contraction, inflammation, pain perception and blood flow regulation

4) Micelles and Bilayer Vesicles

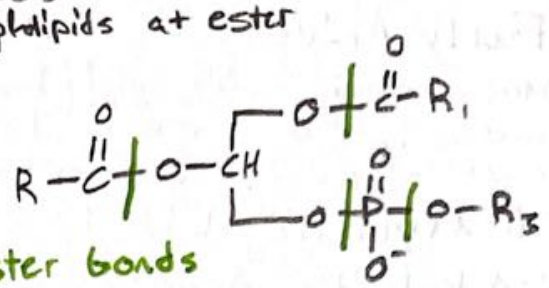
Micelle Detergents often create micelles. No water in the center
Detergents have a polar head and 1 nonpolar tail



Bilayer Vesicles Contains head group and 2 tails, form phospholipid bilayers

5) Phospholipases

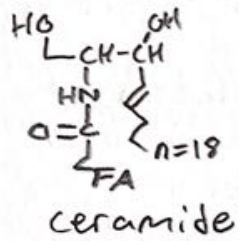
Hydrolyze ester bonds in glycerophospholipid molecules
cur phospholipids at ester bonds.



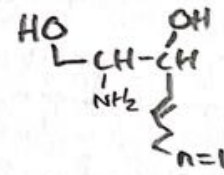
Cuts ester bonds

6) Sphingolipids

Components of plant and animal membranes, containing a long chain amino alcohol



ceramide



sphingosine backbone

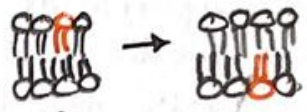
8) Membrane Structure

Phospholipid bilayers
Contains head group & 2 tails
Distinction: Detergents, 1 tail
They create micelles
FFA are rare in biochem due to them being deterg.

Fluidity

Motion 2 types
① Lateral (very fast)

② Transverse (slow)



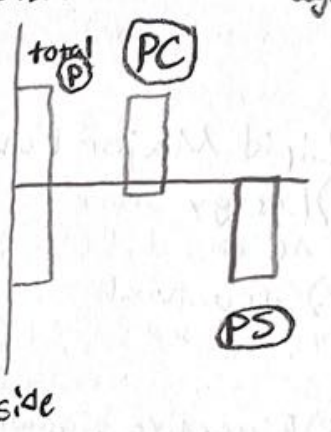
(Flipases)

Functions of Cell Membranes

1) Define Boundary
2) Regulate traffic: semi-selectively permiable
3) Define compartments: Mitochondria, chloroplasts, lysosomes
4) Organize Reactions: surface effect, allows for reaction control on membrane
5) Energy Conservation: works like a battery. ETC, conc and electron gradient
6) Cell-Cell communication: signals, receptors, fusion

Diversity and Direction

allows PS to be on outside and sends signal to remove cells due to aging outside



Lipid Rafts

Microdomains sphingolipids and cholesterol tend to stick together
L_o -head groups liquid tails are ordered

Membrane Permiability

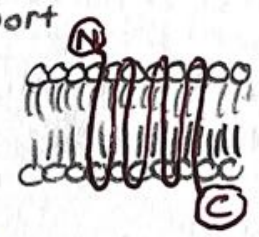
1) Depends on type of molecule
   Low barrier (O_2 & H_2O)
   High barrier (ions & sugar)
2) Various transport mechanisms
   Diffusion (entropy driver, [conc] gradient
   Facillitated transport (protein mediated)
   Passive: No E involved
   Active 1° (ATP, hv, redox, P-, V-, F-type)
   P-type = sodium, potassium, ATP
   V-type = vacules, lysosomes
   F-type = mitochondria (chloroplasts)
   Active 2°: coupled with 1°
   Channels and pores: selective but not saturable
   Voltage or ligand gated (opened up to let everything through)

Nonpolar substances diffuse down thier concentration barrier
H_2O goes through aquaporin to be shielded from the nonpolar middle

9) Membrane Proteins

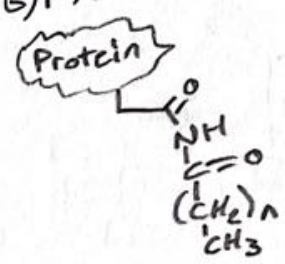
1) Integral - Inside, creates a channel for transport

7 transmembrane loops



2) Periferal
Sits on top of membrane, Hydrophobic bottom

3) Anchored
a) (GPI) Glycerol Phospho inositol
b) FA



c) Isoprenol
Through cystein
C15 or C20
mode of regulation because these linkages are reversable

Phospholipipase - takes the FA off of the proteins

Chemical Principles

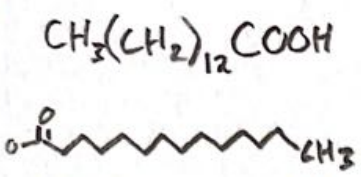
$$Q = \frac{[outside]}{[inside]} < 1$$

$\ln Q < 0$ then $\Delta G = -$ meaning,

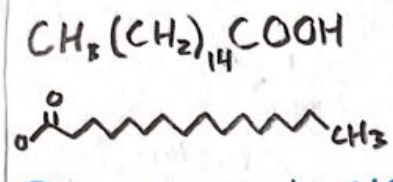
→ Spontaneous diffusion

$$V_0 = \frac{V_m [S]_{outside}}{K_t + [S]_{outside}}$$

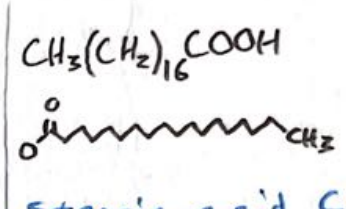
Structures to Memorize



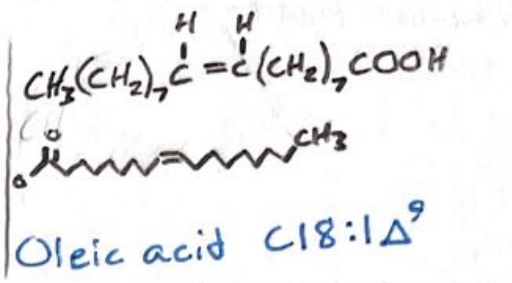
Myristic acid C14:0



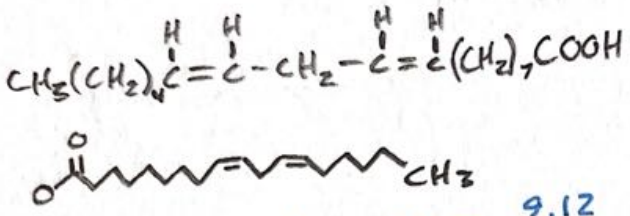
Palmitic acid C16:0



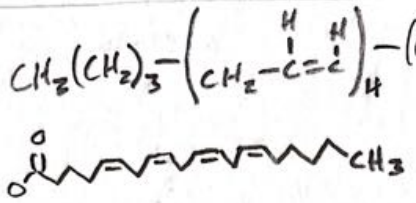
Stearic acid C18:0



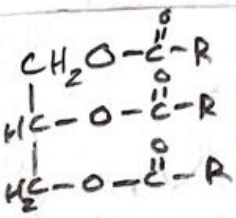
Oleic acid C18:1Δ^9



Linoleic acid C18:2$\Delta^{9,12}$

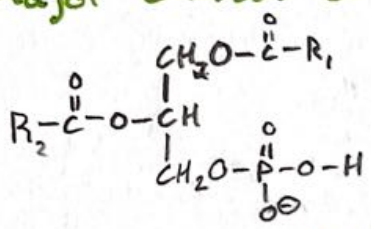


Arachidonic acid C20:4$\Delta^{5,8,11,14}$

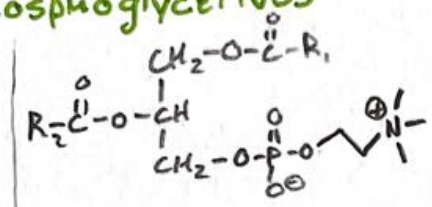


Triacylglycerol (TAG)

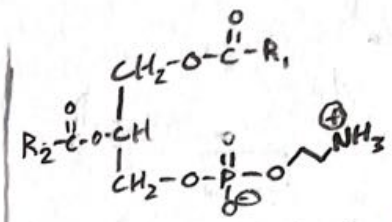
Major Classes of Phosphoglycerides



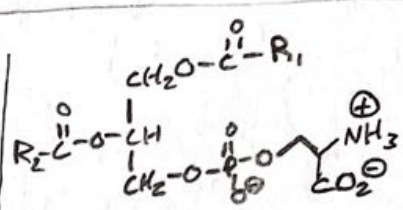
Phosphatidic acid PA



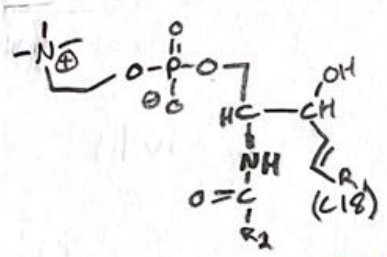
Phosphatidyl choline PC



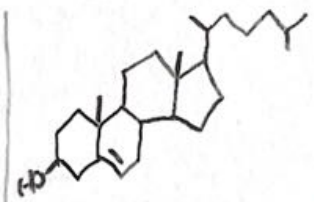
Phosphatidyl ethanolamine PE



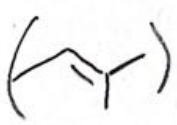
Phosphatidyl serine PS



Sphingomyelin SM



Cholesterol CHO



Isoprenoid unit

Sex hormones

Testosterone ♂
Estrogen ♀
Progesterone ♀ : Blocks ovulation
Provera = sim to progesterone
Agonost = does same as original
RU486 = starts ovulation "The pill" morning

Chapter 12: Lipid Metabolism

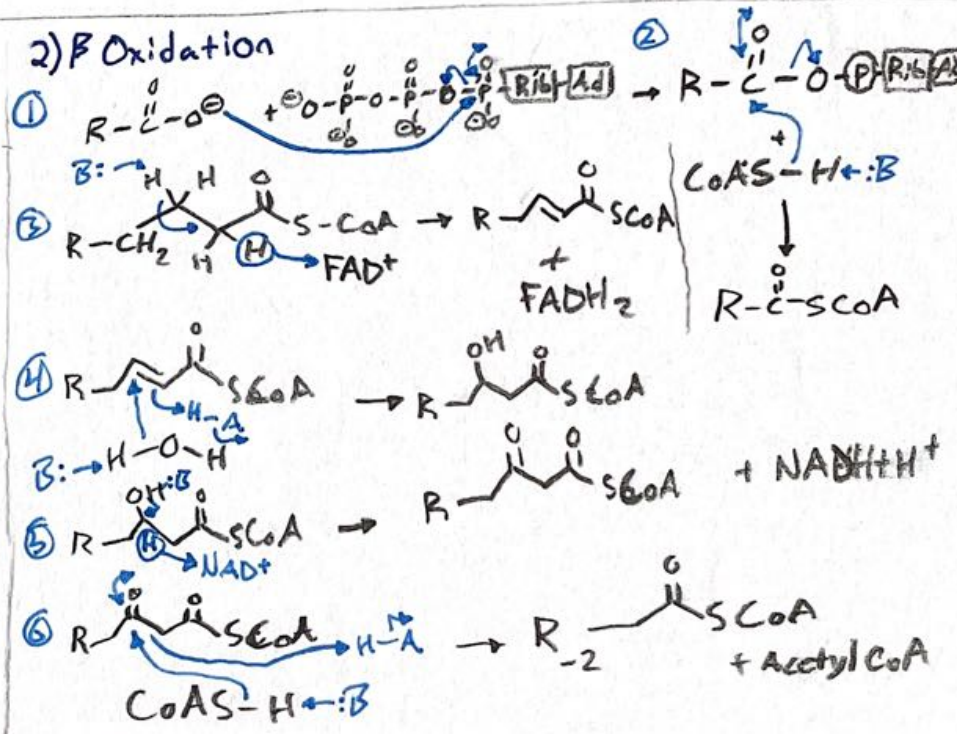
1) Lipoprotein Pathway

8 steps for the digestion of FAT (TAG)

1) Fat molecules are emulsified with bile salts to form mixed micelles
2) Lipases release 2 FFAs and mono acyl glycerol (MAG) form the micelle
3) FAs and MAGs are taken up by the intestine
4) FAs are re-esterified into TAG and packaged as Chylomicrons
5) Chylomicrons are released into the blood (and lymph) and travel to cells needing energy
6) At the site of delivery lipases release the FFAs and glycerol from the Chylomicrons
7) FAs are taken up by the cells needing energy (use or storage)
8) FAs are broken down by the process of β oxidation to release energy or to be re-esterified into TAG for storage (adipocytes)

When lipoprotein lipase has removed 90% of the TAGs in chylomicrons, they become remnants and are removed from the blood by the liver.
These remnants are repackaged in the liver to become the lipoprotein particles (VLDL, ILDL, LDL)

2) β Oxidation



ATP Calculation

each cycle produces 1 acetyl CoA, 1 $FADH_2$, 1 NADH + H^+

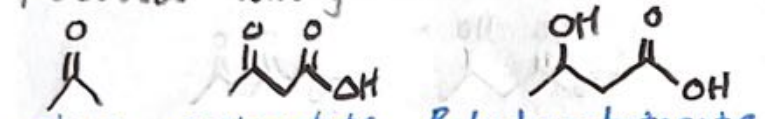
Calculation of ATP produced from C16:0 FA

→ 8 acetyl CoA pieces

Step	for each turn	C16:0 FA	Total
Box	1 NADH 1 $FADH_2$	7 NADH 7 $FADH_2$	108 − 2 = 106
TCA	3 NADH 1 $FADH_2$ 1 ATP	24 NADH 8 $FADH_2$ 1 ATP	2 for activation
ETC	2.5 1.5	77.5 22.5	

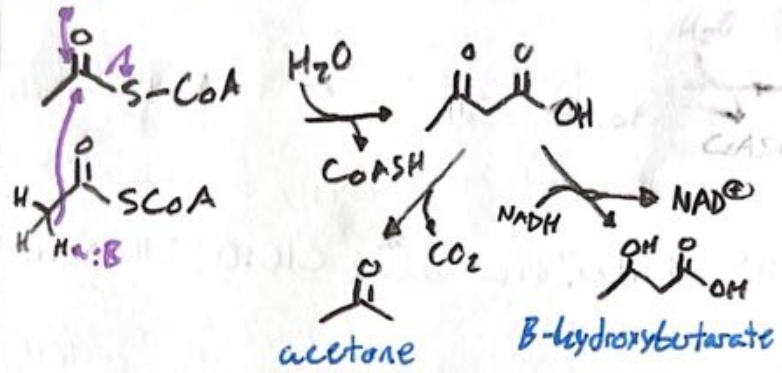
3) Ketone Bodies

Ketosis, can be caused by periods of low sugar uptake such as starvation, restricted diet, or uncontrolled diabetes They are glucose substitutes used in brain function. Result from partial oxidation of FA when more acetyl CoA is produced than can be processed through TCA cycle

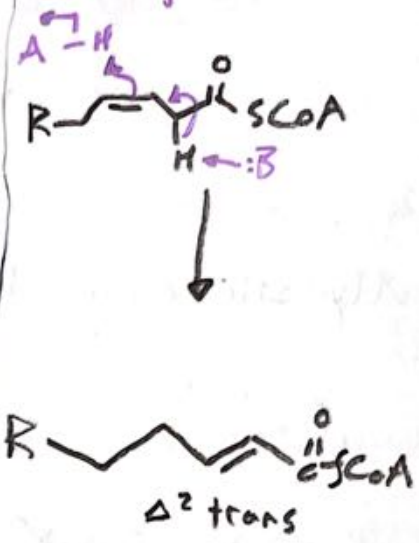


acetone acetoacetate B-hydroxybutarate

Ketone Body Synthesis



Handling of UnSat FATS



5) Lipogenesis