Lipid (1)

Lipid

- fats, oil, wax
- phospholibid, cholestrol
- bile salts, steroid horman
- sphigolipids, ei cosanoid.
- fat - soluble vi (A, D, E, K)

→ - low solubility water
- High nonpolar solvent
(like dissolve like)

Lipid → larg hydrocarbon (nature)
↳ yeild larg energy:-
- Represent highly reduced form of carbon.
- upon oxidation in (metabolism)

(In Biological system)

hydrocarbonic
- only non-polar
- ex: triacylglycerols.
← ثلاثي جليسريد

amphipathic
- polar + non-polar
- fatty acid.

Biological important in Lipid

- energy (Lipid > - carbohydrate - protein)
- nervous system, cell memb. → constituent. مكون رئيسي
← الخلايا والدهنية
- Stored lipid → store energy → protect internal organs → subcutaneous thermal
← ضد فقدان حرارة الجسم.
- cholestrol : synthesis → steroid horman → vit (D) → bile acid / salt)
- sypply body → essential fatty acid (لا يصنعها الجسم) → fat soluable v. (A, D, E, K)

Faty Acid

(composed)
- long, straight - hydrophobic carbon - chain
- methyl group ↓ - end - W - carbon
- carboxyl group → ionize (COO⁻) ↓ - at other end - pka = 4,8 - (COO⁻) give (F.A) It's amphipathic nature

under phesyological condition ← (بتتأين في الفسيولوجي).

الكربونة تسمى
2 ← (α - carbon) → carboxyl termenall
3 ← (β ~)
4 ← (γ ~)
end ← W (ω)
↳ يعني → terminal methyl group

normal
- nature (FA) : (14 - 24) C
- Human (16 - 20).
- certain marine orga. (odd) number
- (FA) ≥ 10 : insoluble in water (LCFA)
long chain fatty acid

even x odd

C2 bulding block → (even number)
acetyl group (CH_3-CO) → CH_2 ?
reduce -CO- ← هيدروفوبيك hydrophobic

stearic acid : - saturated - 18:0

Classified

- V-long: C > 20
- long: 20 > C > 12 — oxidized as fuels
- medium: 12 > C > 6 — (in dairy fat) ex: milk, butter. - maternal milk - vegetable oil.
- Short: C < 6
  - ex - acetic acid (2c)
  - propinic (3c)
  - butyric (4c)

chain

- Saturated
  - No duble bond.
  - packing tightly
  - diet → high saturi. ↓ cause
    - (a) cholestrol in artries. انسداد الشرايين
    - (b) heart diseas
- unsaturated
  - mono unsat.
    - sing duble bond
    - olive oil
    - more energy
    - Rutation → flexible molcule
    - each C=C spaced 3 carbon
    - (higher plant)
    - most common: H.cell → palmitic acid (16), stearic acid (18)
    - H.cell → most common: oleic acid 18:1(9)
  - poly unsat.
    - duble bond > one
    - oil → fish, sunflower, corn
    - (1 - 4) duble bond
    - less energy
    - slightly more abundant
    - No Rotation (restrict) Regid.

organs chain

- animal: - saturated monounsat. (16 C FA)
- plant (vegetable): - polyunsaturated (long chain F.A)

duble bond

- cis (F.A)
  1. Cause (kink)
  2. prevent packing tightly
  3. Keep liquid (Room T)
  4. more common
  - H atoms same side of duble bond
- trans (F.A)
  - not nature.
  - manufactured by → hydrogenation
  - It's raise (LDL) → Bad cholestrol level → heart disease.
  - involved more linear way
  - change property: - (M.P) - shelf life - flavor - stability.
  - It's favorable for food industry
  - used: - margarine - baked goods.
  - Natural trans: Small amount in → animal meat → dairy product.
  - H atoms: opposite side of duble bond

* Fat consumption:

increase: obese (risk) → heart disease, cancer

↓ Reduce → fat intake → (Reduce the risk)

Numbering ~> carbon atom (tow system)

Δ) delta (w.δ)

numbering from (carboxyl-carbon) → ①

ex: arachidonic [20 : 4 Δ 5,8,11,14]
- 20 → # carbon
- 4 → # duble bond
- 5,8,11,14 → مواقع الروابط

- كويز مطلوب حفظ:
- Oleic acid (18 : 1Δ9) (w9)
- α-linoleic ~ (18 : 3Δ 9,12,15) (w 3) *
- (requiring in diet) Arachidonic ~ : 20 : 4 5,8,11,14 w 6

(w) omega

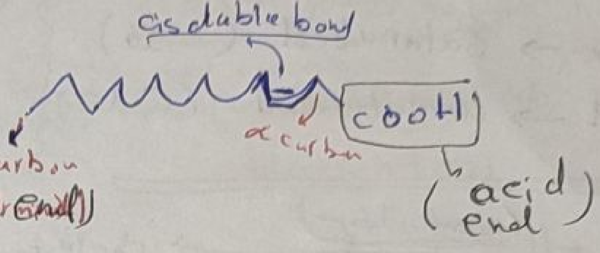
Numbering from methyl/terminal end.

ex:- Arachidonic (w6) ~ the closest number duble bond (من النهاية)

- linolenic ~ w6

contrast ↓

- linolenic ~ w3 FA



Essential fatty acid → can't synthesis naturally
→ get it from our diet.

↓ In human icloude:-

linoleic acid (w 6)
- precurso → arachidonic ~ 20:4Δ
- Polyunsaturated
- presont in phospholibid of c(mem)
- Substrate to synthesis: prostaglandin
  - important media in
    - pain
    - influmation responses.
      - produce → pain, sleep.
      - Blood coagulation
      - Reproduction

non-stareidal anti-influmation
- aspirin
- inhibiting prostuglandin synthesis

α-Linoleic ~ (w 3)
- precursor of (w 3) → growth, development

* dificiency of linolenic
  - decrease vision
  - altered learning behaviour

Melting point

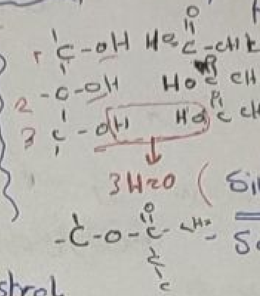
Saturated
- higher (m.p)
- linear → pocked rogather
close interaction between intera molcale.
- more solid at Room tempreture

unsaturated
- lower (m.p)
- duble bond
→ result: bend / kink
- intermolcular interaction
- weaker: (low m.P)

* increase chain length increas T_m (M.P)
* (oleate): - rigid, kink (cis duble bond)

- oleate —ionized→ oleic acid) unsaturated
17:1Δ9
- palmitic " → saturated (C 16)
15:0
- oleic acid → unsaturated (C 18)

(Triglycerides) esterification
- consist → glycrol (OH); → three fatty acid
- TCG: - main component in ① animal fat, ② vegetable oil
- most found: adipose tissue
- 90/95% make the diety fat
- Glycerine (glycerol):
- colorless, viscous, sweet test
- M Furmela: CH_2CHCH_2 (OH OH OH)
- Soluble in water (polar) with three hydroxyl group.



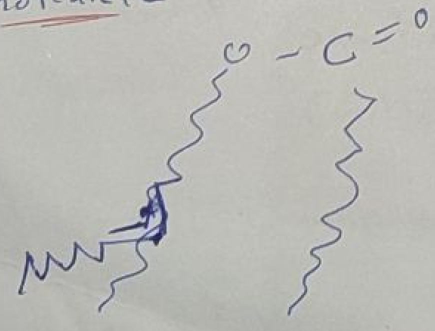
(3) fatty acid group
→ (simple) same
→ (mixed) - different -
natural fat → mixture of them

lipid (ع):- (مركبات عضوية)
→ Tricyglycerd (try gleseril)
 - Acid + Alchol → H_2O + Ester
→ phospho libid (Amphipathic)
 → phospho glycride
 → sphingo libid
→ waxes (ester)
→ cholestrol
→ Eicosanoid.

* oxidative Reaction: it yeld large amount of energy (metabolism) ← TCG
ox: 1g → 38 kg / 9 cal
: Protein + carbohy: 17 kg

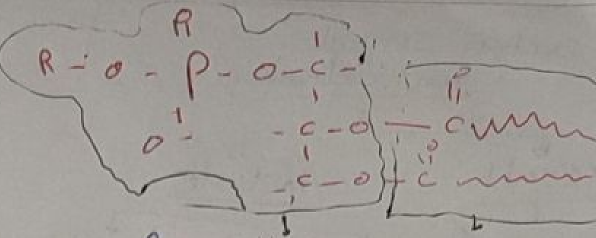
TCG → animal → primarily: adipose tissue
(derived) (sources)
→ dietry lipid (90%-95%)
→ synthesized in the liver (kidney, ...)

(phospholipid):
- Amphipathic: ⊖ ⊕ ...
- found mainly: cell membrane
- tow classes.
الاثنين بالمحتوى
- Both: play role: generation of lipid-sinalling molcule



(Waxes)
- Is Esters → fatty alcohols (FA + alcohol); → fatty acid } → long chain
- Saturated → usually (solid)
- may → unsaturated; → include sterols: cholestrol.
- water insoluble → weakly polar → ester group
- waxes → animal skin: water-repellant; → leave certain plant; → bird feathers
- wax coating: cause: shiny surface of polished Apple.
- Ex: oleoyl alcohol esterify stearic acid

- phosphoglyceride:



- glycerol → backbone.
- hydroxyl group → C-1, C-2 → estrify → carboxyl group → tow FA chain
  → C-3 → ~ → phosporic acid.

- the simplest one / intermediate in byosynthesis others (alcohol moieties) → phosphatidate (further addition) → phosphatidic acid (parent) → parent compound for phosphoglyceride.

phosphatidyl serine, phosphatidyl choline, phosphatidyl inositol → amino acid + phosphatidate

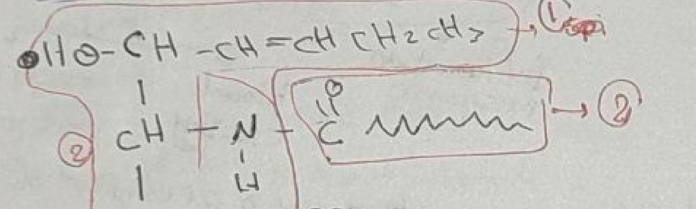
---

3 types: sphingolipids → backbone: sphingosine.

(2) major component →
- sphingosine: - 18 carbon - amino alcohol - unsaturated.
- Fatty acid: amide linkage (between → -COOH, → NH_2)

تربط المجموعة الثانية تبع السفنجوسين

General structure



connected with ceramide:
- (H) → ceremide
- phosphocholine → ① sphingomyelin → myelin sheath
- glucose → natural glycolipid (glucosylcerebroside)

myelin sheath →
- di, tri, tetra saccharide → Lactosylceramide (globoside)
- complex oligosaccharide → ganglioside (GM2)

② cerebroside (neutral glycolipid)
- cell membrane
- mono saccharide → glucose (GlcCer) → glucosylceramide; galactos (GalCer) → galactosylceramide

③ Ganglioside: complex glycosphingolipid
- oligo sacch connect ceramide
- in head: sialic acid - (presence) → (net negative charge) (at neutral pH)
- outer layer: plasma membrane
- importance → antigens → receptor cell

antigens: (site → biological recognition at celular level)

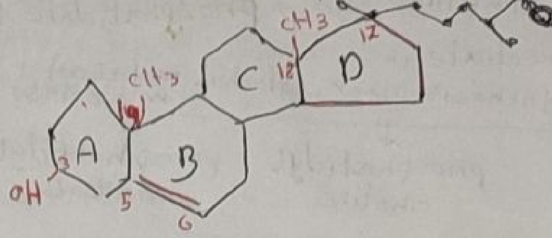
Carbohydrate + sphingosine → cerebroside, globoside, ganglioside

~~carbon~~ several genitic disease

- result
  - absence of enzym
    - breakdown the glycolipids
- include
  - Tay-Sachs disease
  - Krabbe disease

Cholestrol structure

- Four fused hydro carbon ring (Steroid nucleus)
- eight-carbon branched hydrocarbon attach → 17: Ring
- Ring A: C3 → hydroxyle gp
- Ring B: C5 - C6 → dubleban



(Cholestrol)

- waxy, whitish yellow fat
- other body make
  - cell membrane
  - steroid hormons → تستيرون / استروجين
  - vit D
  - bile acids → digist / absorb fat
- Sources
  - 80% → liver intestine
  - 20% → food
- animal cell make, plant x
- cant oxidize the carbon in complex ring structure → No Caloric value
- High concentration → Blood
  - (LDL) low density libo protein → formation of: artherosclerotic plaques → fatty desposit on arterial wall → heart attack / strock

USMB

diet High concentration saturated fat → increase circulatory levels of LDL cholestrol

Eicosanoids

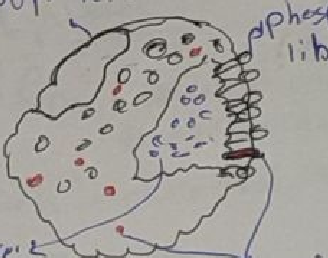
eicosa = 20 number.

- from polyunsaturated fatty acid
- 20 carbon atoms
- include
  - prostaglandins (PG)
  - leukotrienes (LT)
    - → Inflamation Response
  - thromboxanes (TX)
    - in blood platelets → blood clotting / constriction blood vessel
- most common precursor of eicosanoids
  - → Arachidonic acid.
    - polysaturated fatty acid
    - 20C, 4 duble bond
    - cant synthsys by body
    - diet contain it / أو
    - precursor from them → which is linoleic acid → المادة الأولية الي بتتصنع.

precursor: المادة الأولية

Lipoprotein

Apoprotein — phospho libid



I Plasma lipoprotein

- Func:- transport lipid (tri, choles.) from [liver / small intestint] → out perphral tissue → back the liver again

- lipoprotein
  - differ: ratio → protein / lipid.
  - particular contain → apoprotein / lipid.

(Libo particles):

- Chylomicrons
  - lowest density
  - largest size
  - Lipid > protein
- very low density (VLDL)
- (LDL) low density
  - denser (الأكثف)
  - higher protein
- High density libo (HDL)
  - densest
  - Smallest size.

Size and Density of lipoprotein

- Triacylglycerol (TAG) → chylomicrons / VLDL
  (تقصد الدهون)
- cholestrol + phospholipid → LDL / HDL

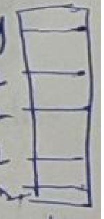
Separtion (plasma (lipo protein)

- electrophoresis → charge, molecular weight
  1. α lipoprotein (HDL)
  2. β-lipo (LDL)
  3. pre β lipo (VLDL)
  4. chylomicrons (immobolized fraction)
- Ultracentrifugation → density
  1. CM
  2. VLDL
  3. LDL
  4. HDL

في تكوينها: protein / lipid

so → differ → size / electrophoretic mobility

density: higher protein conetent → highe desity (بتنزل تحت أكتر)



→ very large
→ very negative

(* Albumin + FFA) → (تعتبر الأولى) -free fatty acid- albumin complex (not true lipoprotein)

(Revesion)

- (Am) ① fatty acid: long straight chain + methyl end (inert) + carboxyl end
- (Hyd) ② Triglysrd:- glycrol (3OH) + fatty acid = ester
- (Hyd) ③ waxes - fatty alcoho - fatty acid
- (Am) ④ phospho lipid. ⊖ ⊕
  - Int m: phosphotidate
    - phosphoglyceride: P — FA, FA / another amino acid)
    - Sphingolibid: sphengosine (NH2, 18C, duble bond) + fatty acid
      - Int M: ceremide (amide linkage)
      (بربط على الأمين)
- (Am) ⑤ cholestrol: 4 cyclos, 8 carbon chain

(b) lipo structure → lipid (sperical) / protein (apoprotein)

1. enzym
2. (outer / inner) Apoprotein:- span the region core / outer envelope
   - have part: exposed at surface.
3. lipid
   - A outer part: polar monophospholipid
     - free cholestrol → + charged group point out → water
   - B core: -esterified cholestrol
     - Triacylglycerol
     - form the center droplet (phobic)

محبون للاستر بينقل الكوليسترول.
مسؤول عن المحتوى للكوليسترول.

(Apoprotein function) :-

- part of structure (Lipoprotein) (apo B)
- enzym cofactor (apo c-II)
- Lipoprotein Lipase
- inhibitors enzym (Apo-A-II) } Cholesterol
- lipoprotein lipase (Apo c-III)
- ligands (B-10) (apoE) } interaction with lipoprotein receptor in tissue

chylomicrons → in intestinal mucosal cell.

↳ Func:- Carry dietary lipid
intestine → peripheral tissue

↳ Fate → synthesize → in cell
- secreted by exocytosis (into lymph)
- pass blood → become chylomicrons

Lipoprotein lipases → exsist in:- -capillary wall (adipose tissue)
-muscle → es. cardiac muscle.

↳ extracellular Enzym

↳ digest → tracylgcerol of CM → Fatty A. + Golycerol

↳ deliver mainly → dipose tissue
↳ heart, muscle (80%)
↳ liver (20%)

Result :- CM → be
↳ smaller
↳ decrease tracylglesrol content
↳ become richer → chdestr
↳ protein

VLDL → Produce: liver

↳ Func:- Carry lipid
- liver → perphyral tissue.

↳ FA → syntesis liver
- obtain: blood
synthesis from glucose.

(Forming of LDL:)

↳ as VLDL pass circulation → release Fatty acid glycerol → degraded TAG by lipoprotein Lipase.

VLDL → intermediate density lipoprote → Remove more TAC → for mLDL LDL

→ healthy :- major source of fatty acid

VLDL → excess tracylglycrol → dietry glucose.

LDL (Bad FA)

*Nascent: immature

- func:- provide cholestrol to perpheral tissue.
- Rich → cholestrol and cholestrol ester.
- 60%. back → liver.
- 40% extrahepatic → adrenocortical, → gonal } cell → synthisis steroid hormon.
- elevated level } → atherosclerotic plaques

HDL (good cholestrol)

- Created by number mechanism:
- Nascent synthesis by → liver, → intestine } small molcule contain: cholestrol, - phospholipid, - apoprotein } دول مكلم Li.P..
- maturation:- nasant partical accumulate → phospholipid, cholestrol → عشان بدو يحولهم esters (from cell of blood vessele.) → core full of cholestrol ester ← HDL take globular shape → mature HDL

accept free cholestrol from perpheral tissue :. ← soit → tend lower blood cholestrol levels in vescular tissue

↓

taken cholestrol

- converted to chelstrol ester → part of transfure → VLDL; returned by liver → IDL, LDL
- Remainder cholestrol → trasface as part of HDL → Liver → Synthisis VLDL; - convert - bile salt; - directly bile.

Reverse cholestrol trusport

(HDL) { remove cholestrol from louded cell → Liver
- esterfication cholestrol → prevent frome leaving HDL بالعربي: يمنع
- High level HDL → vasculo protective

Desired value

LDL cholestrol : less 100 mg/dL (obtimal مثالي)
high 130 - 159 mg/dL (bord line high) ارتفاع حدي

HDL ~ : greater 40 - 60 ومكانه لازم يكون desired

Total cholestrol : less 200
- Bordl. high 200 - 239

Triglyceride : 10 - 150 مطلوب اقل

VLDL 2 - 38

---

hypercholestrolemia (ارتفاع نسبة)

cholestrol synthesized (in liver)
↓
essentially three Fates (مصير)
↓
it can be

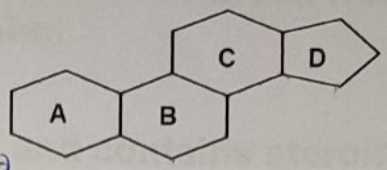
- esterified with fatty acid
  - by enzy (ACAT) { acyl - CoA - Cholest. acid transferase }
  - to make cholestrol ester → stored it lipid droplet.
- Exported to the perphiral tissue
  - through backaging into lipoprotein particles
- converted into bile acid → trasported to → bile duct.
  - and - secreated into small intestine to aid in fat transport

Bile Acide
- as muth as 50% → cholestrol in liver → converted → bile acid (daily basis).
- is amphipathic molcule. → stored in gall bladder
- secreated into intestine through bile duct.
- Reabsorbed and returned to liver
  - greater 95% , rest is excreted as waste.
  - الباقي ≈ 5%

* cholestrol → very large molcule → OH (hydrophobic) وحدة تقريبا

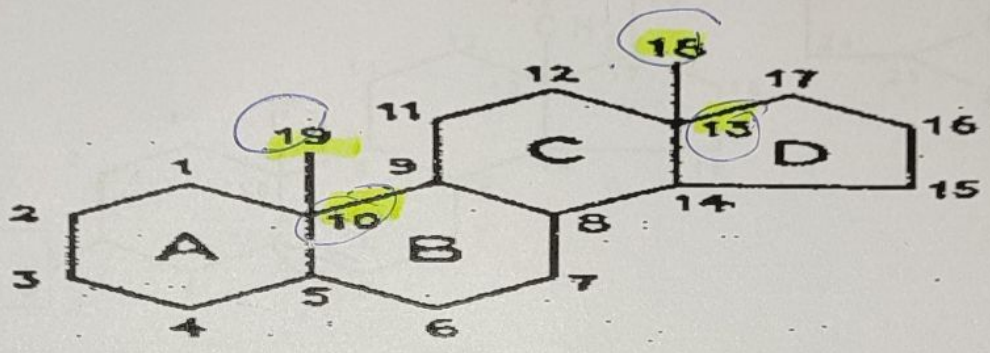
Steroids

- Steroids are group of plant and animal lipids that have a similar tetracyclic nucleus.



Steroid nucleus:

- So this tetracyclic nucleus is composed of 17 carbon atoms besides two methyl groups (C_{18}, C_{19}).
- There is a methyl group at C_{10} (it makes C 19).
- And there is another methyl group at C_{13} (it makes C18).



Steroids include:

1. Sterols.
2. Bile acids and salts.
3. Steroid hormones.
4. Vitamin D.

STEROLS:

- This group of steroids has a hydroxyl group (OH) at C_3 i.e. it is an alcohol, and an aliphatic side chain at C_{17}.

Types of sterols:

A. Animal sterols:

- Cholesterol and its derivative 7-dehydrocholesterol.

B. Plant sterols:

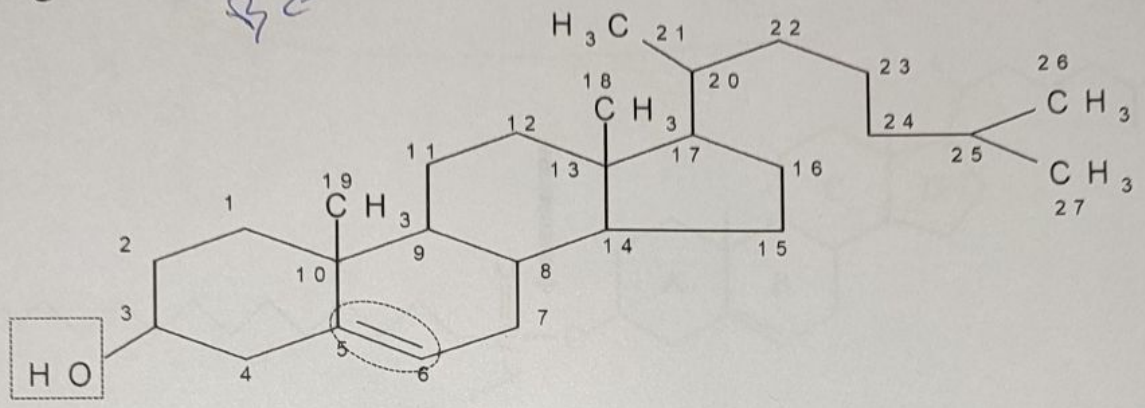
- Ergosterol.

Cholesterol

- **Naming:** The word cholesterol is derived from Greek words; chole= bile, steros= solid, ol= alcohol.

Chemistry of cholesterol:

- It is a solid alcohol of 27 carbon atom and contains steroid ring.
- it has a double bond between C_5 and C_6.
- One hydroxyl group at C3 which is characteristic to all sterols.
- The OH group is beta oriented, projecting above the plane of ring.



Properties of cholesterol:

- It has amphipathic properties which allow it to play structural role in *membrane* and in the outer layer of *lipoprotein*.

Cholesterol Sources

1. It is formed in the body from acetyl CoA. Most of the cholesterol is synthesized by the liver.
2. It is present in diet: egg yolk, meat, liver and brain. (It occurs in animal fats but not in plant fats).

Biomedical importance:

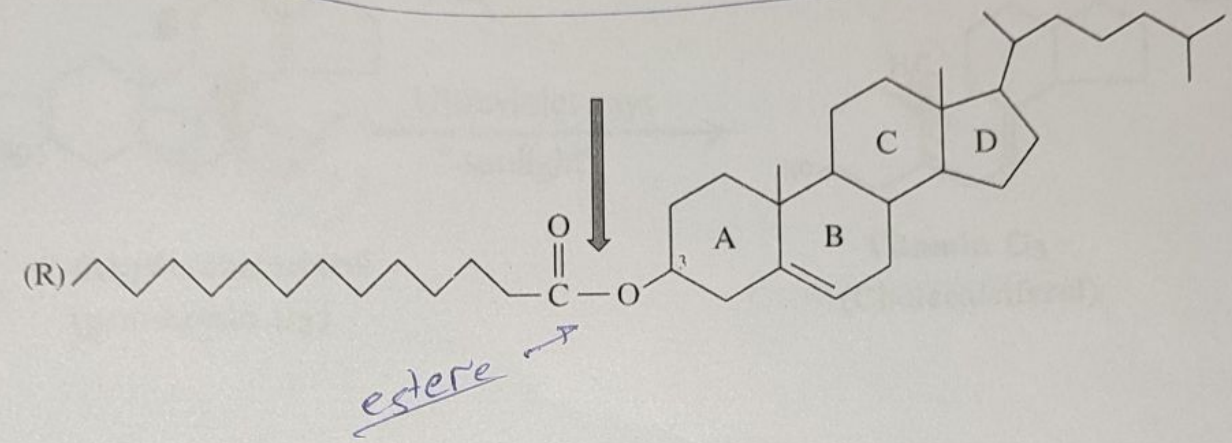
1- It is the main sterol in human body (Nervous tissue, brain, suprarenal gland, and in bile, ,,).

2- It is present in blood (normal level 150-200 mg / dl).

3- It is often found as cholesterol ester (in combination with fatty acids). The fatty acid is attached to the hydroxyl group e.g. Cholesteryl oleate or linoleate.

Cholesterol esters (CE)

- Cholesterol is converted to cholesteryl esters for cell storage or transport in blood
- Fatty acid is esterified to C-3 OH of cholesterol
- Cholesterol esters are very water insoluble (hydrophobic) and must be complexed with phospholipids or amphipathic proteins for transport



Biomedical importance:

4- It is a major constituent (main part) of the plasma membrane. The fused ring system makes cholesterol less flexible than most other lipids.

5- It is the precursor of:

- Sex hormones
- Cortical hormones → secretion of Adrenal gland (brain separation)
- Vitamin D
- Bile acids.

6- High level of cholesterol in blood will lead to its precipitation in the wall of blood vessels "atherosclerosis". Also high levels of blood cholesterol may lead to stones in gall bladder (gall stone).

accumulation

high blood cholestrol → artries → Weakness

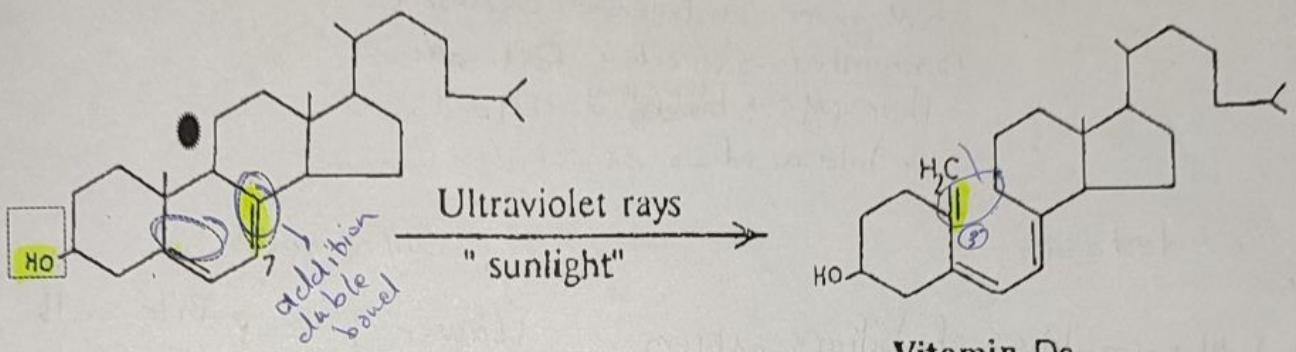
7-dehydrocholesterol (pro-vitamin D3)

- 7-dehydrocholesterol is stored under the skin, and by the effect of ultraviolet rays(in sunlight) it is transformed to cholecalciferol (vit. D_3 .)

(pro-VD3 + UV sunlight → cholecalciferol)
V.D 3

Insufficient sunlight can lead to a deficiency of vitamin D_3, interfering with Ca^{2+} transport and bone development. Rickets can result.

insufficient sunlight → pro V_3 → V_3 → Ca^{+} → rickets.



7-dehydrocholesterol
(provitamin D_3)

Vitamin D_3
(Cholecalciferol)

Clinical correlation

- Low density lipoproteins (LDL) transports cholesterol from liver through blood to the tissues (Bad cholesterol)

(liver → blood → tissue)

- High density lipoprotein (HDL) transports cholesterol from blood to the liver where it is metabolised (Good cholesterol)

blood → liver.

- ↑LDL, ↑ Cholesterol — High risk of heart attack
- ↑HDL, ↓ Cholesterol — Low risk of heart attack

lipid (4) → Bile acids
↳ sex hormons

Bile Acid ~ hydroxylate steroid (OH كحولية)
مجموعة كاربوكسيلية ← COOH
COOH → acid, negative
↳ (liver)

≈600 mg → bile salt synthesiz daily to replace losing in feces 5%.

amphipathic
- stored: gall bladder

Peroxisomal enzym: assist hepatic biosynthesis → bile acid

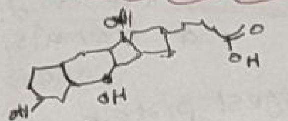
- Found in the bile of → mammals
  ↳ verbrate
- conjugated → taurin / glycine } AA.
. residue to give anion called bile salt (with cation)
- liver → synthesize → via: cytochrome P450-mediate oxidation of cholesterol in multistep process.

from cholesterol primary bile salt (tow only)
- cholic
- chenodeoxycholic

(Classifaction)
(1) Primary / secondary
(2) AA: conjugatey / non-con
salt: sodium / potasim

(salt of bile acid)
polar derivatives of cholestrol + acid

(Structure)



- lary family of molcule
- steroid structure (nucleuse ring)
- side chain terminate → (COOH) carboxylic acid
- different number of hydroxyl group
  (duble bond)

conjugation ~ * mainly four bile acid secreted from liver.
- prior secretion ↳ live conjugated them with tow A.A.
- glycine = $NH_2CH_2COO^-$
- Taurine = $NH_2CH_2CH_2SO_3^-$
= 8 total possible conjugate bile acid.

In duodenum always in (deprotonate) form (A^-).
↓
match water soluble
↓
able to emulsify Fats

from cholestrol ↳ **synthesis of bile acid**
1) hydroxylation reaction
2) epimerization of 3β-hydroxyl gr
3) saturation of duble b.
4) side chain cleavage / oxidation
[illegible]

(Enterohepatic circulation)
- bile acid secreted into lumen of intestine
- Bacterial partial dehydroxylation → Form (secondary bile acid)
- all these bile acide → taken back 95% into blood stream → return liver → be secreated → process (enterohepatic circulation)
5% excreated → faeces

Function of bile acid / salts → powerful detergent or emulsifying agent

in intestine ↓ to aid digestion and absorbtion ↓ of

- fatty acid
- monoglycerol
- water-soluble vitam
- + other fat products

- contain (micelles) → aid lipase to digest protein
- Form micelles can solubilize lipid as
  - → Amphipathic molecule
  - → Conjugated bile salt.
  - → Sit at lipid / water interface.

<2> prevent percipitation of cholestrol in bile.

<3> Remove cholestrol from body
- → major pathway
- → 5% lost → faeces.

(4) Signaling molecule.

It has influence in metabolism
- → lipid.
- → glucose.

<5> inhibitory effect upon apoptosis (انتحار الخلايا)

+ being study → Alzhemer's effect.

↓ Beneficial.

بتبطء موت الخلايا ← خصوصاً الخلايا العصبية فتعالج بعض الأمراض مثل الزهايمر.

Slide (4)

Clinical Significance of bile salt

Hyperlipidemia

as → Bile acid made from endogenous cholestrol
↳ destruption of entero hepatic circulation of bile acid → lower cholestrol

- Bile acid sequestrants (حابسة) - bind bile acid in gut
  - prevent reabsorption.
  - ∴ No more endogenous cholesrol is shunted → produce Bile
  - therapy ~ lowering cholos. level
  - ∴ bile acid → excreted in faeces.

colon Cancer

- At high concentration bile salt is toxic.
- percentage relevant to colon cancer.

Cholestasis

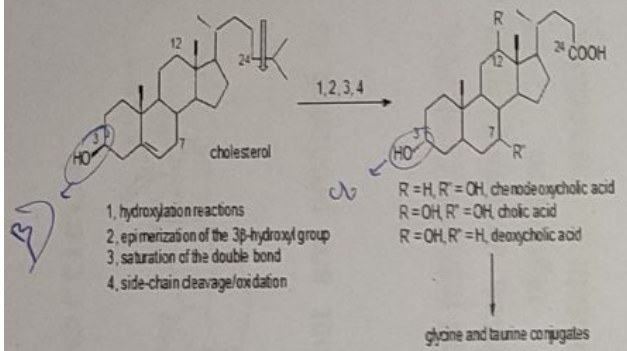
- Functional abnormalities of biliary system
result: increase bile acid in blood.
- Related: the itching

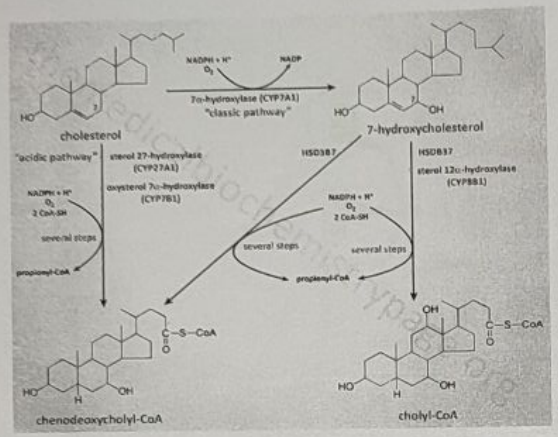
Gall stones

[lower] → Bile salt
↳ phospholipid

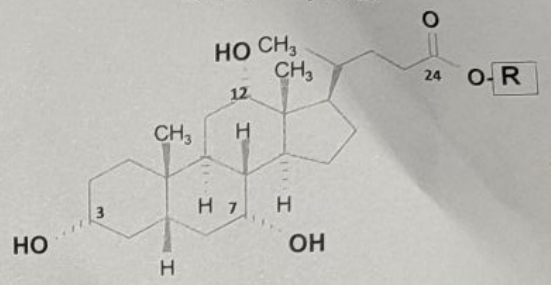
- reduce cholestrol solubality
↓ lead to
mycro crystal formation
- oral therapy with chenodeoxy cholic
· dissolve cholstrl ← use gallstone

Biosynthesis of bile acids





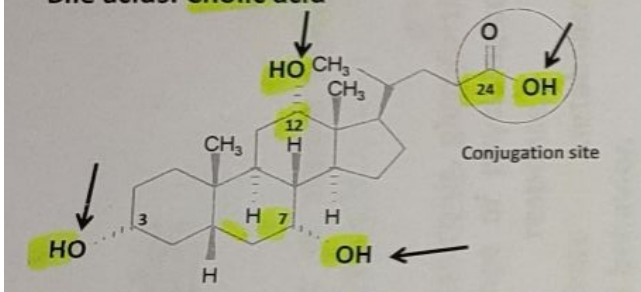
Bile acids/salts



R= H in non-conjugated bile acids.
R= Na+/K+ in non-conjugated bile salts.
R= glycine/taurine in conjugated bile acids.
R= Na+/K+ salts of glycine/taurine in conjugated bile salts.

Bile acids: Cholic acid

non-conjugated bile acid

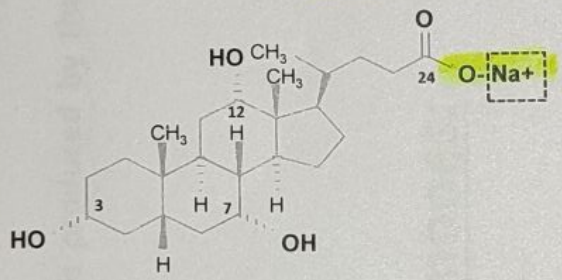


Polar groups are:
- OH groups
- COOH group

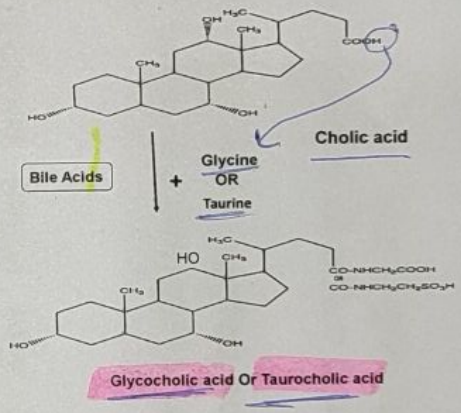
Cholic acid is the most common bile acid. It contains 3 OH groups at 3, 7, 12.

Bile salts: Sodium cholate

(non-conjugated bile salt)

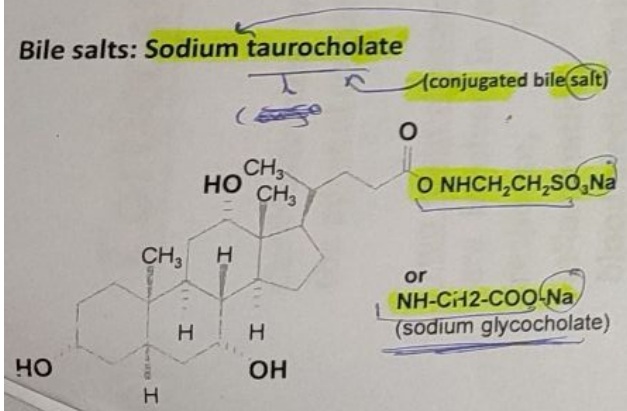


Bile Acid Conjugation



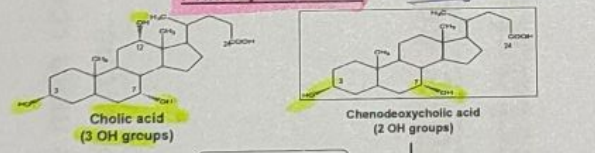
Bile salts: Sodium taurocholate

(conjugated bile salt)



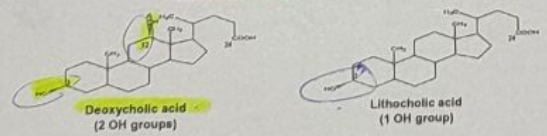
Primary and secondary bile acids

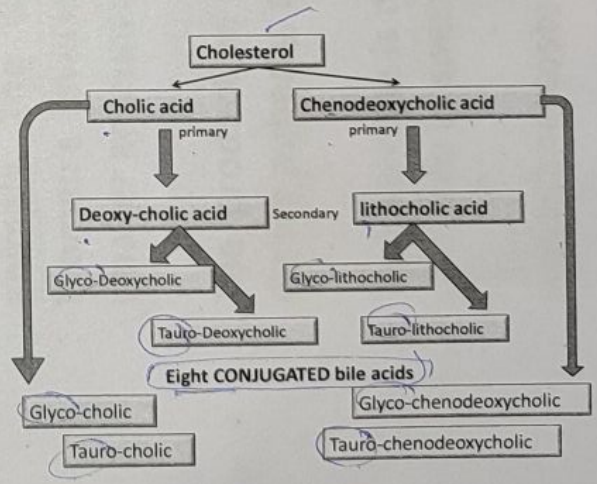
Primary Bile Acids



7-dehydroxylation by gut bacteria

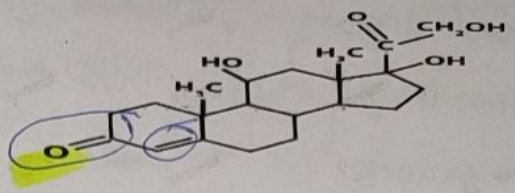
Secondary Bile Acids





Corticosteroids:

Cortisol



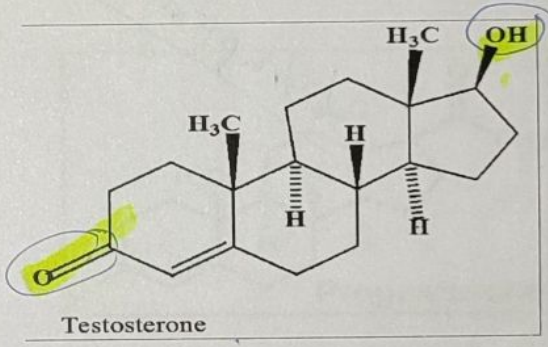
Corticosteroids are a class of steroid hormones that are produced in the adrenal cortex of vertebrates.

Two main classes of corticosteroids, glucocorticoids and mineralocorticoids, are involved in a wide range of physiological processes, including stress response, immune response, and regulation of inflammation, carbohydrate metabolism, protein catabolism, blood electrolyte levels, and behavior.

Some common naturally occurring steroid hormones are cortisol, corticosterone, cortisone and aldosterone.

The main corticosteroids produced by the adrenal cortex are cortisol and aldosterone.

Male sex hormones:
Testosterone



Testosterone

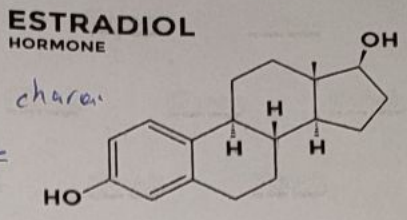
Testosterone is a hormone found in humans, as well as in animals. The testicles primarily make testosterone in men. Women's ovaries also make testosterone, though in much smaller amounts.

The production of testosterone starts to increase significantly during puberty, and begins to dip after age 30 or so.

Testosterone is most often associated with sex drive, and plays a vital role in sperm production.

A man's testosterone levels can also affect his mood.

Female sex hormones:
Estradiol

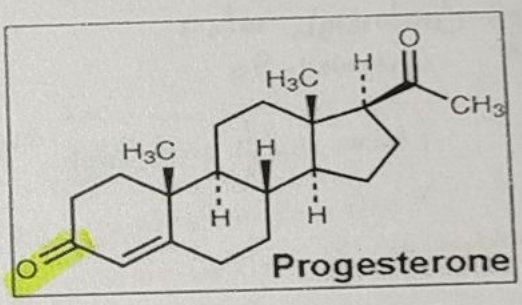


Estradiol , also spelled oestradiol, is an estrogen steroid hormone and the major female sex hormone.

Estradiol is responsible for the development of female secondary sexual characteristics such as the breasts, widening of the hips, and a female-associated pattern of fat distribution

It is important in the development and maintenance of female reproductive tissues such as the mammary glands, uterus, and vagina during puberty, adulthood, and pregnancy.

Female sex hormones:
Progesterone



Progesterone is an endogenous steroid and progestogen sex hormone involved in the menstrual cycle, pregnancy, and embryogenesis of humans and other species.

Progesterone has a variety of important functions in the body.

It is also a crucial metabolic intermediate in the production of other endogenous steroids, including the sex hormones and the corticosteroids, and plays an important role in brain function as a neurosteroid