

Optimising Neuronal membranes

Lipids are classified as

1. Simple lipids – oils and fats

2. Complex lipids

a) Phospholipids

b) Glycosphingolipids

**containing a fatty acid,
sphingosine and a CHO**

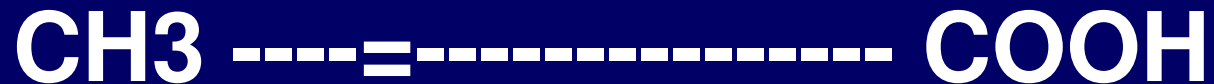
c) Lipoproteins

Simple lipids are

a) Saturated (no double bonds)



b) Unsaturated (mono or poly double bonds)



(Methyl (w) end Carboxyl end)

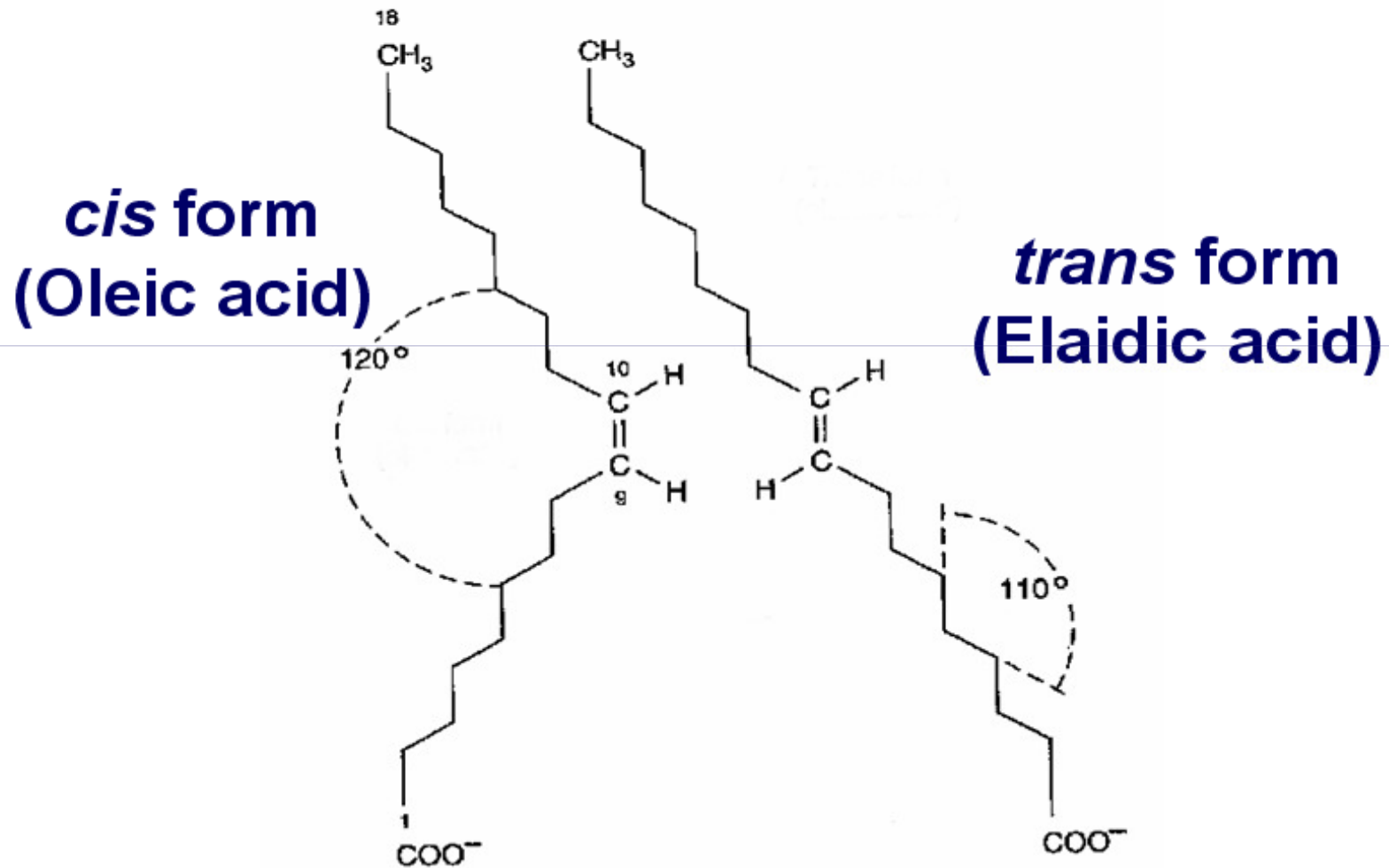
Saturated fatty acids



Name	Number	
Formic	1	Bee stings
Acetic	2	Rumen fermentation
Propionic	3	Rumen fermentation
Butyric	4 (-8°C)	Rumen fermentation
Valeric	5	Rumen fermentation
Caproic	6 (-3°C)	Coconut

Caprylic	8 (17 °)	Coconut
Nonanoic	9	Licorice root
Capric	10 (32 °)	Coconut
Undecanoic	11	Castor bean oil
Lauric	12 (44 °)	Breast milk, Coconut
Myristic	14 (54 °)	Nutmegs, Coconut
Palmitic	16 (63 °)	Animal and plant fats
Stearic	18 (70 °)	Animal and plant fats
Arachidic	20 (75 °)	Peanuts
Behenic	22 (80 °)	Seeds
Lignoceric	24 (84 °)	Cerebrosides, Peanuts

Unsaturated fatty acids can be in either *cis* or *trans* forms



Monoenoic acid (one double bond)

Number	Series	Common Name	Systematic Name	Source
16:1:9	w7	Palmitoleic	Cis-9-hexadecenoic	All fats
18:1:9	w9	Oleic	Cis-9-Octadecenoic	Olive
18:1:9	w9	Elaidic	Trans-9-Octadecenoic	Hydrogenated fats
22:1:13	w9	Erucic	Cis-13-Docosenoic	Rapeseed
24:1:15	w9	Nervoic	Cis-15-Tetracosenoic	Cerebrosides Honesty seed

Dienoic acids (two double bonds)

18:2:9,12	w6	Linoleic	all-cis-9,12-Octadenoic	Corn, peanut, soybean
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Trienoic acids (three double bonds)

18:3:6,9,12	w6	γ -Linolenic	all-cis-6,9,12-Octadecatrienoic	EPO, BSO, Borage
18:3:9,12,15	w3	α -Linolenic	all-cis-8,12,15-Octadecatrienoic	Flax, walnut, pumpkin

Tetraenoic acids (four double bonds)

20:4:5,8,11,14	w6	Arachidonic	all-cis-5,8,11,14-Eicotetraenoic	Peanut
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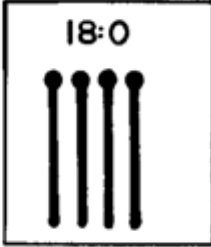

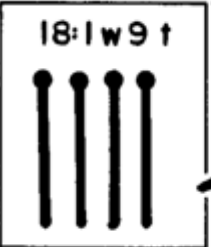
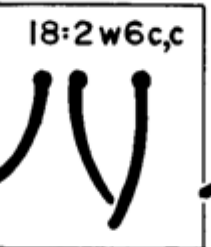
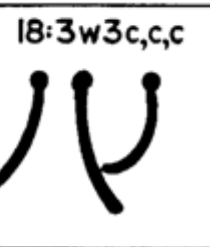
Pentaenoic acids (five double bonds)

20:5:5,8,11,14,17	w3	Timnodonic (EPA)	all--cis-5,8,11,14,17-Eicosapentaenoic	Fish oil, Canola, Eggs
22:5:7,10,13,16,19	w3	Clupanodonic (DPA)	all-cis-7,10,13,16,19, Docosapenaenoic	Fish oil

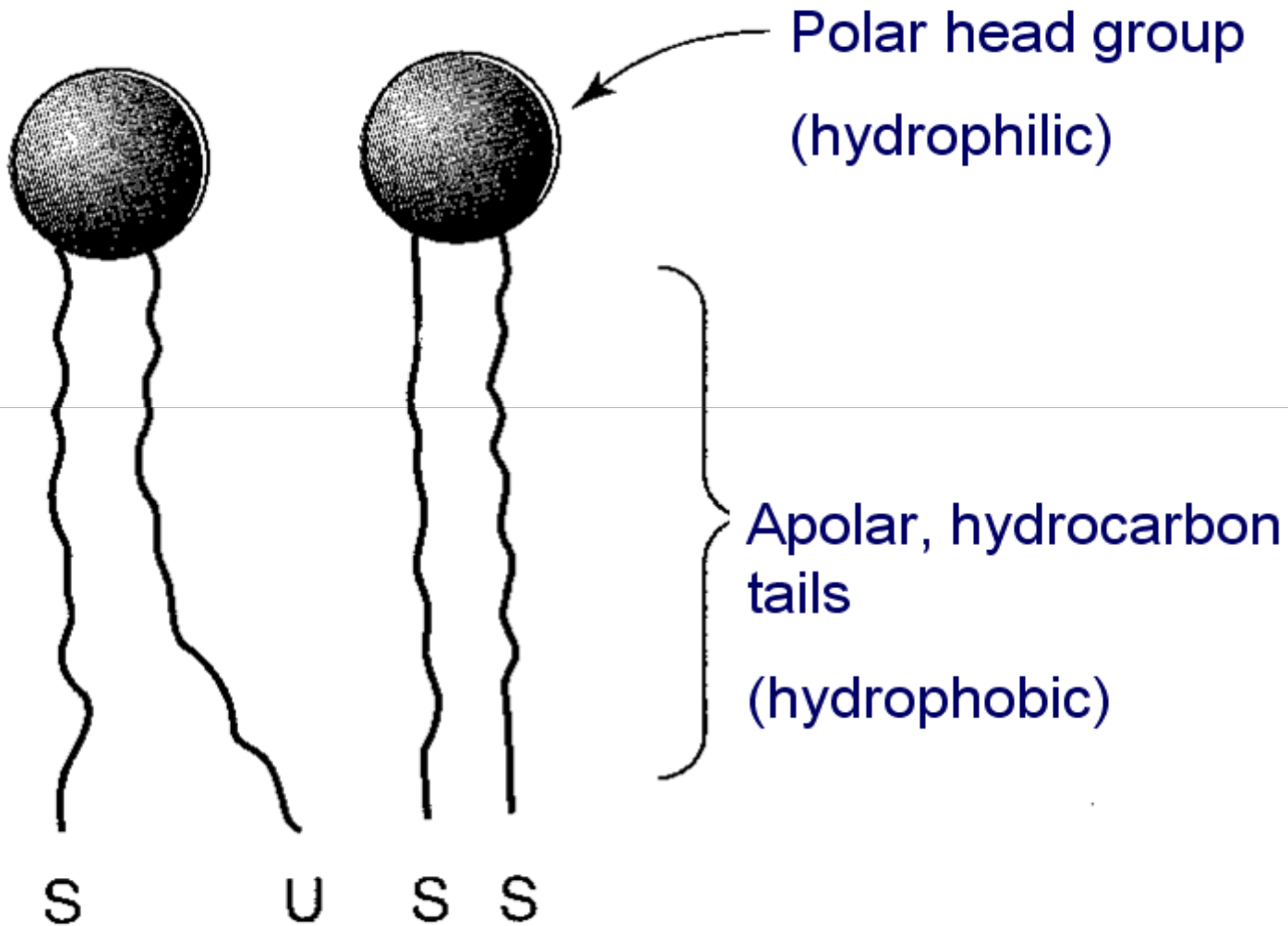
Hexaenoic acids (six double bonds)

22:6:4,7,10,13,16,19	w3	Cervonic (DHA)	all-cis-4,7,10,13,16,19-Docosahexaenoic	Fish oil, Algae, Eggs
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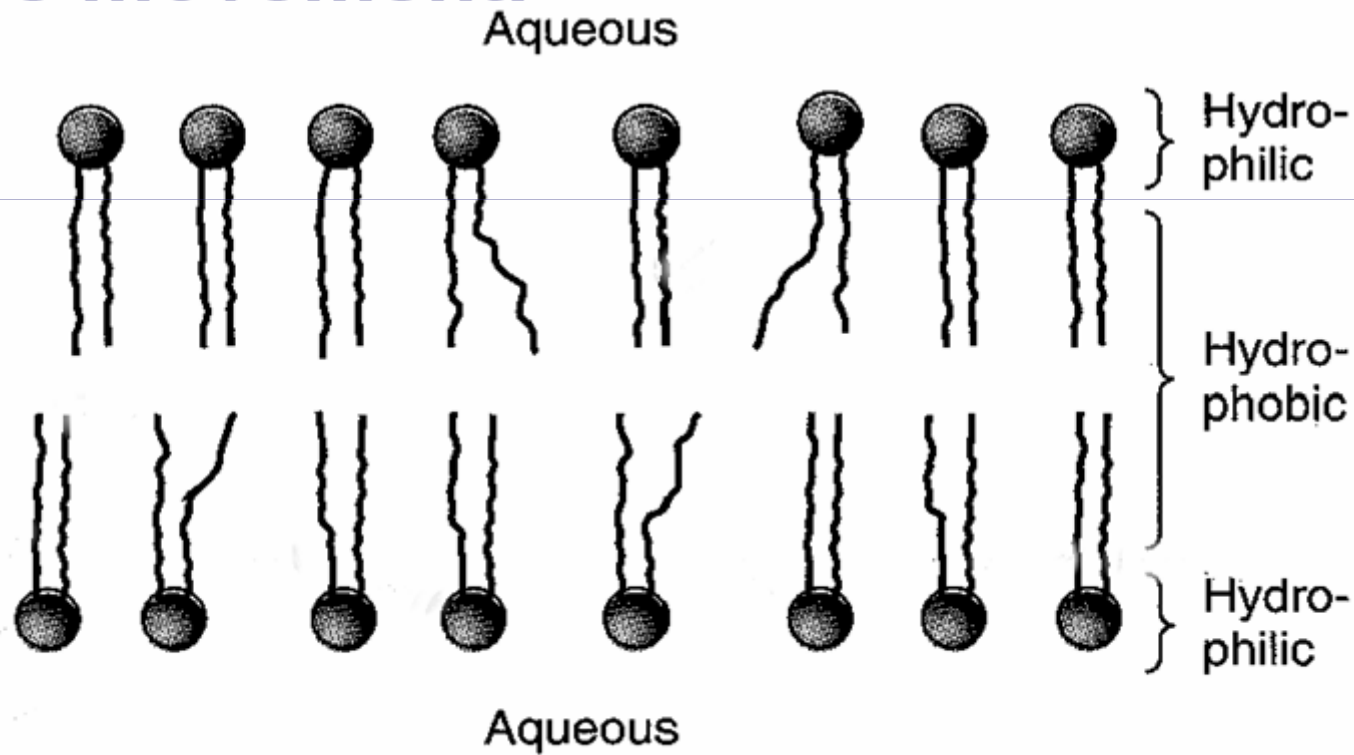
Fatty Acid Properties

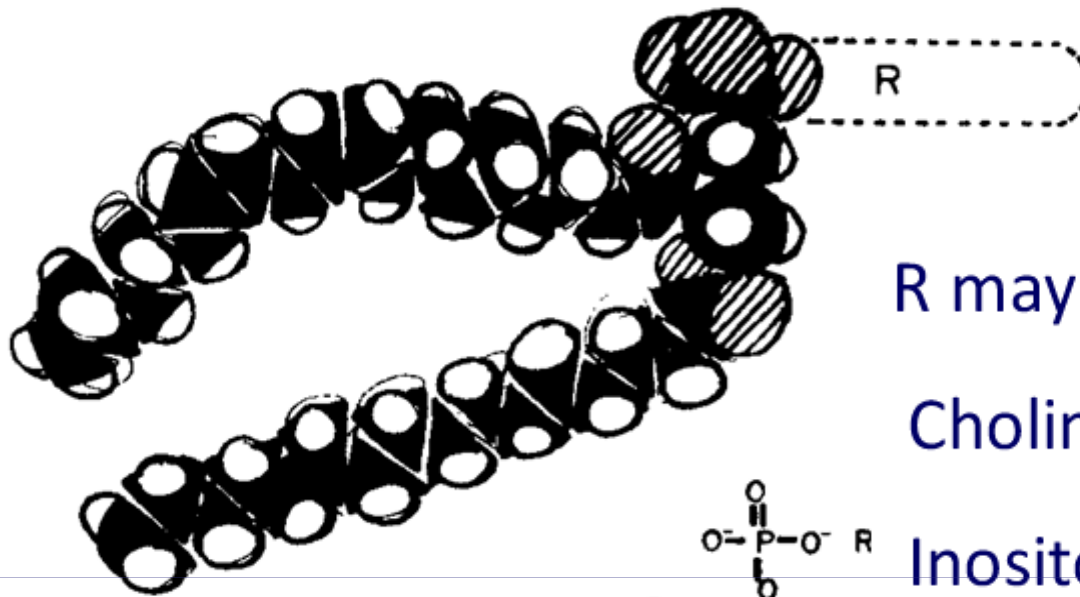
	18:0	18:1 w 9 c	18:1 w 9 t	18:2 w 6 c,c	18:3 w 3 c,c,c
Stacking	acid end fatty end 				
Saturation	Saturated	Unsaturated 1 double bond cis-configuration	Unsaturated 1 double bond trans-	Unsaturated 2 double bonds cis, cis-	Unsaturated 3 double bonds cis, cis, cis-
Melting Point	70°C sfa sticky	13°C cis-single slightly anti-sticky	44°C trans-single slightly sticky	-5°C cis, cis-double anti-sticky	-12°C cis, cis, cis-triple very anti-sticky
Repelling Charges	no charge	1 neg. charge	1 neg. charge	2 neg. charges	3 neg. charges

A Phospholipid



The unsaturated fatty acid tails are kinked and lead to more spacing between the polar heads and hence more movement.





R maybe

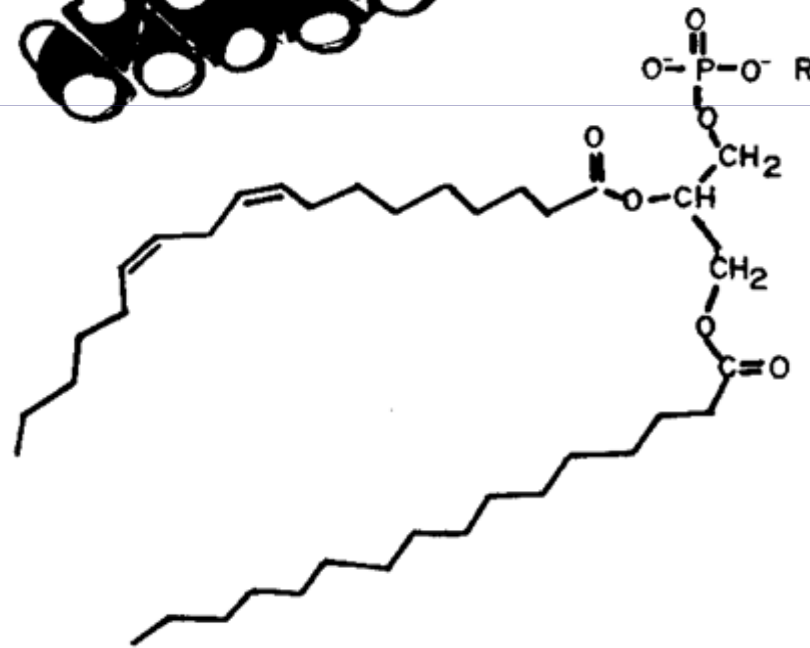
Choline

Inositol

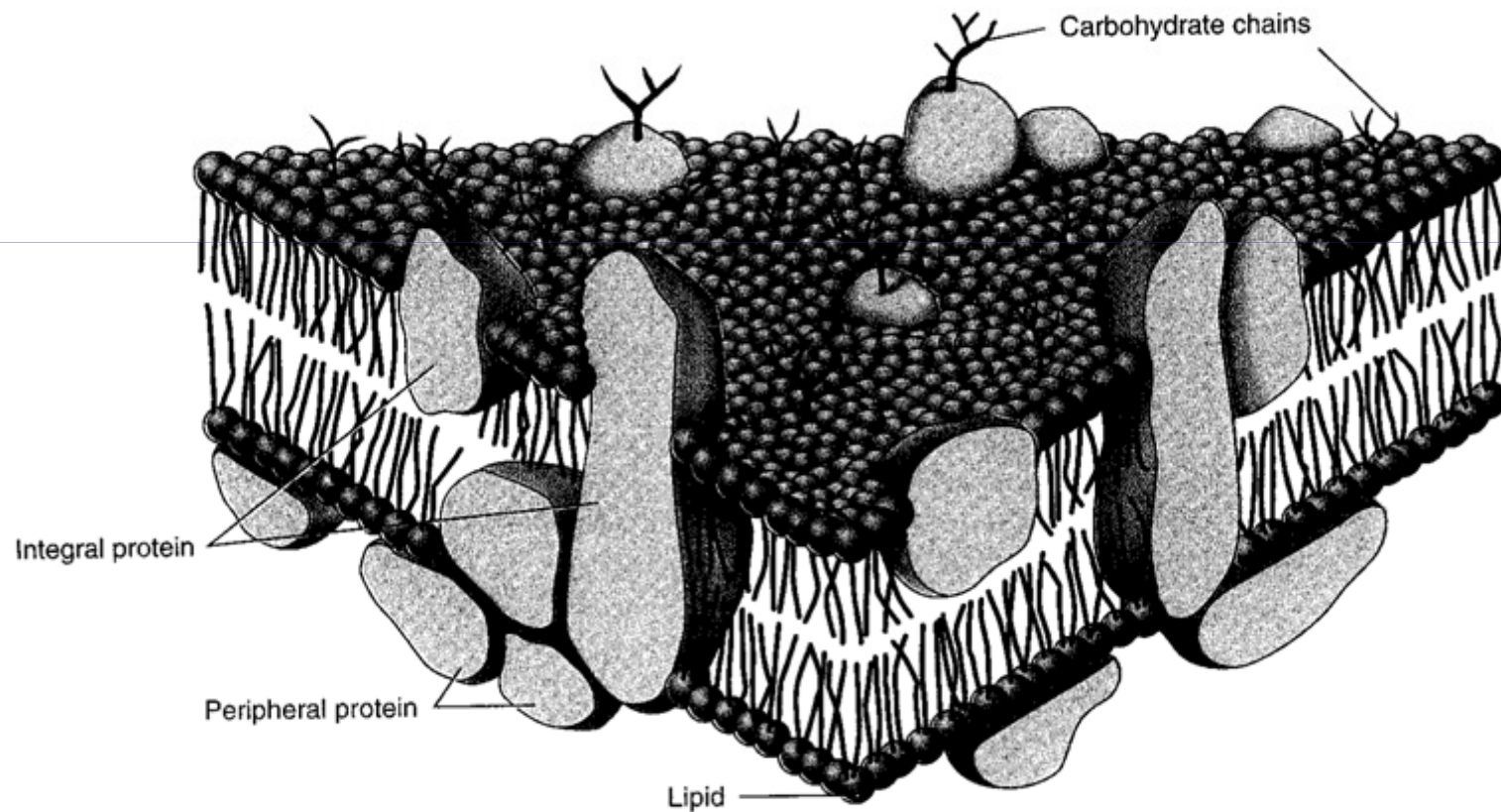
Ethanolamine

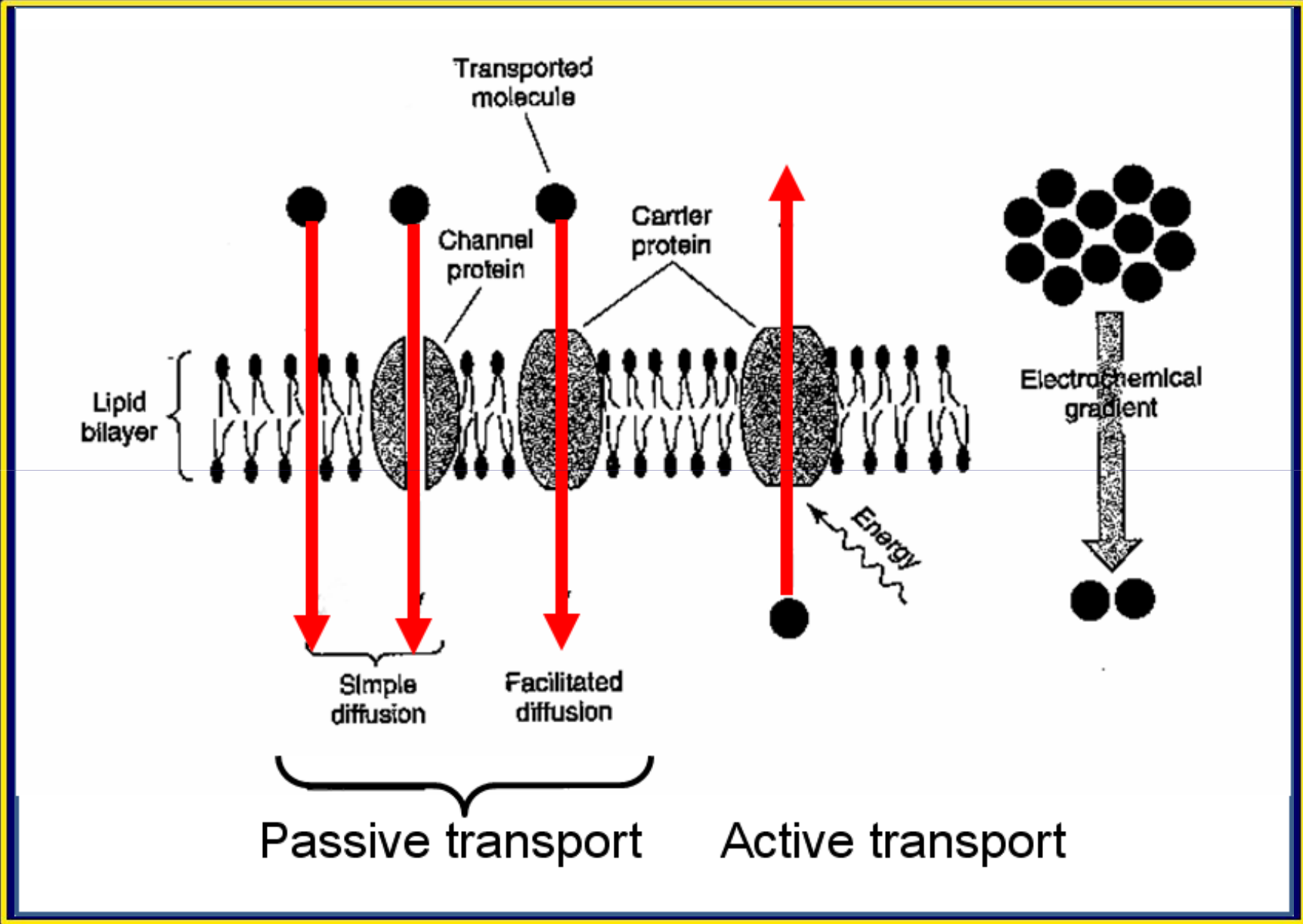
Serine

Threonine



Cell Membranes



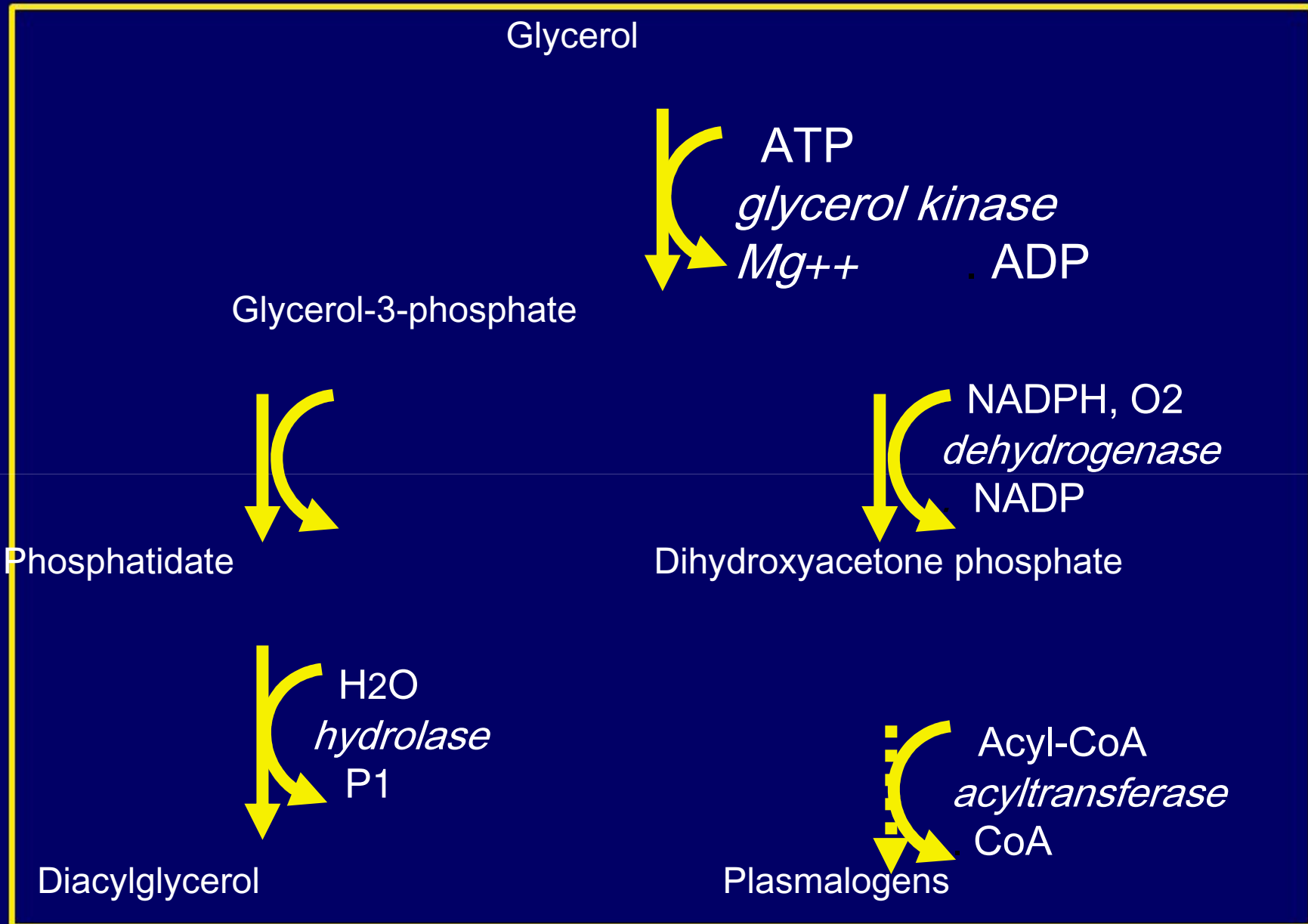


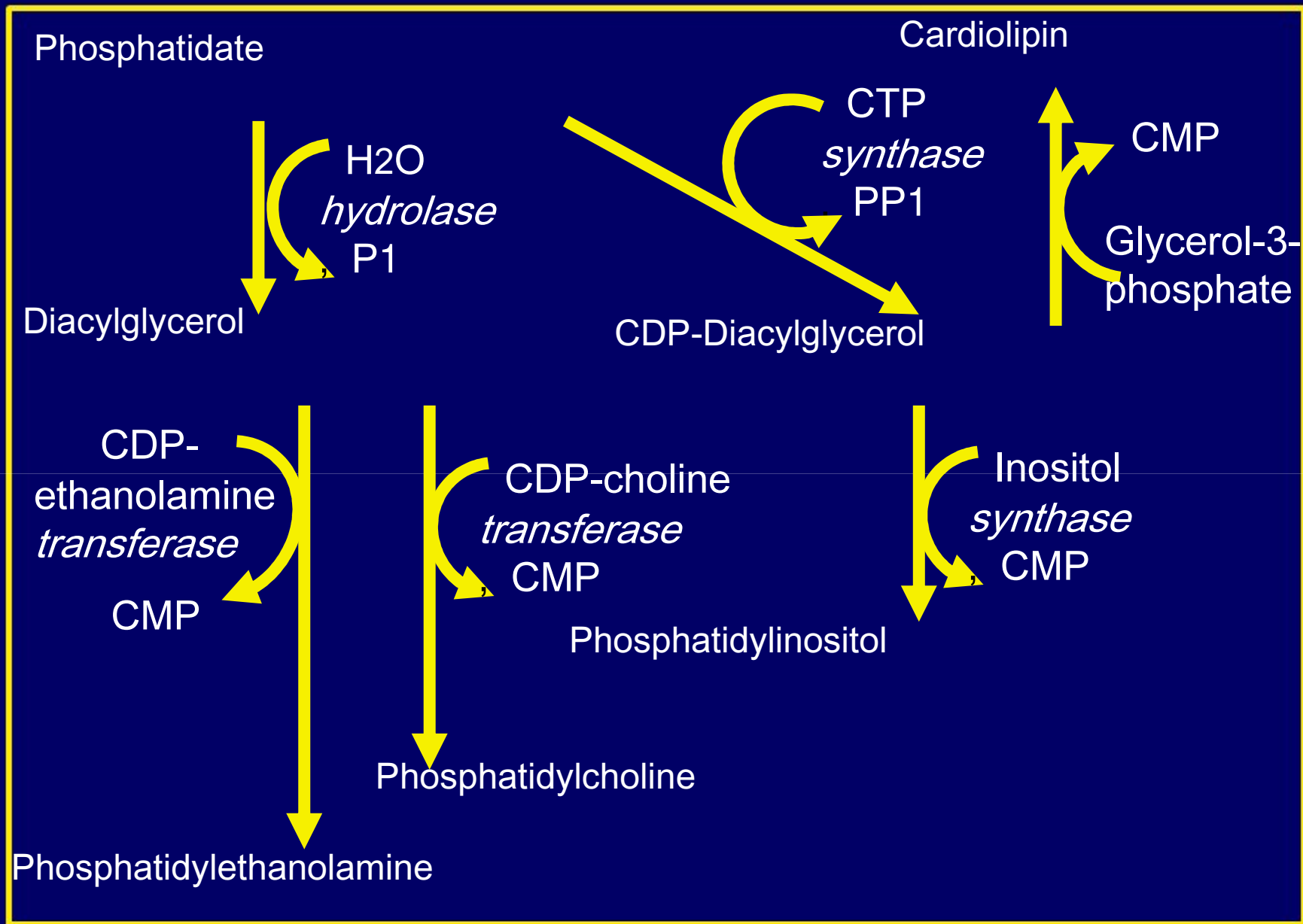
Neuronal cell membranes

Glial cells – the C1 position is taken by a saturated fatty acid and C2 by an unsaturated fatty acid

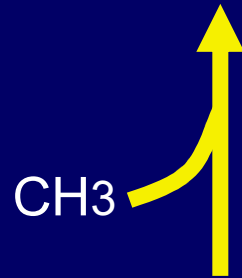
Neurones – in many neurones the C1 position is taken by Arachidonic acid and C2 by DHA.

Retina – both C1 and C2 positions are taken by DHA.

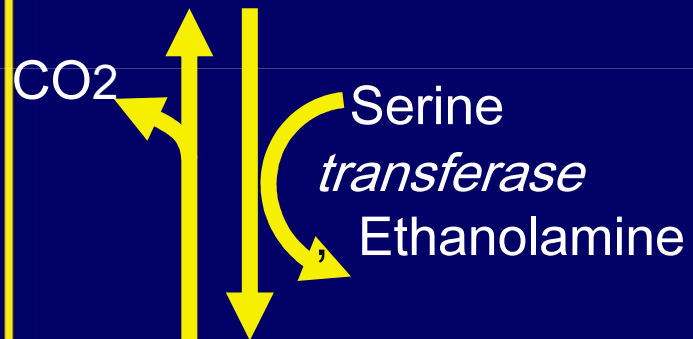




Phosphatidylcholine



Phosphatidylethanolamine



Phosphatidylserine

Phosphatidylinositol



Phosphatidylinositol -4-phosphate



Phosphatidylinositol-4,5-bisphosphate

Key nutrients for synthesising the phospholipids

Acetyl CoA (Vit B5)

NAD, NADPH (Vit B3)

Mg, Zn, SAM (Mg, B6, Folates, B12)

Choline

Ethanolamine

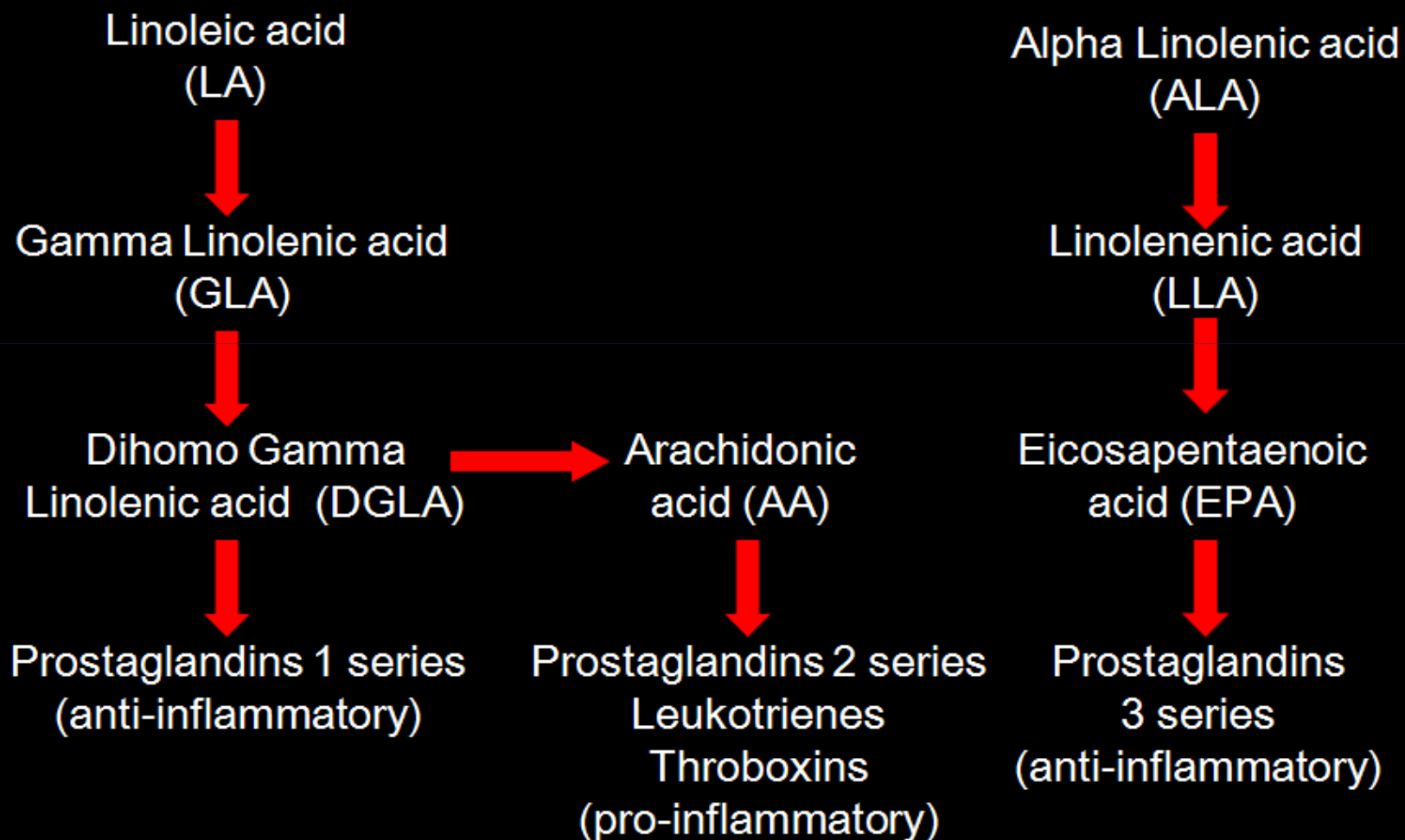
Serine

Inositol

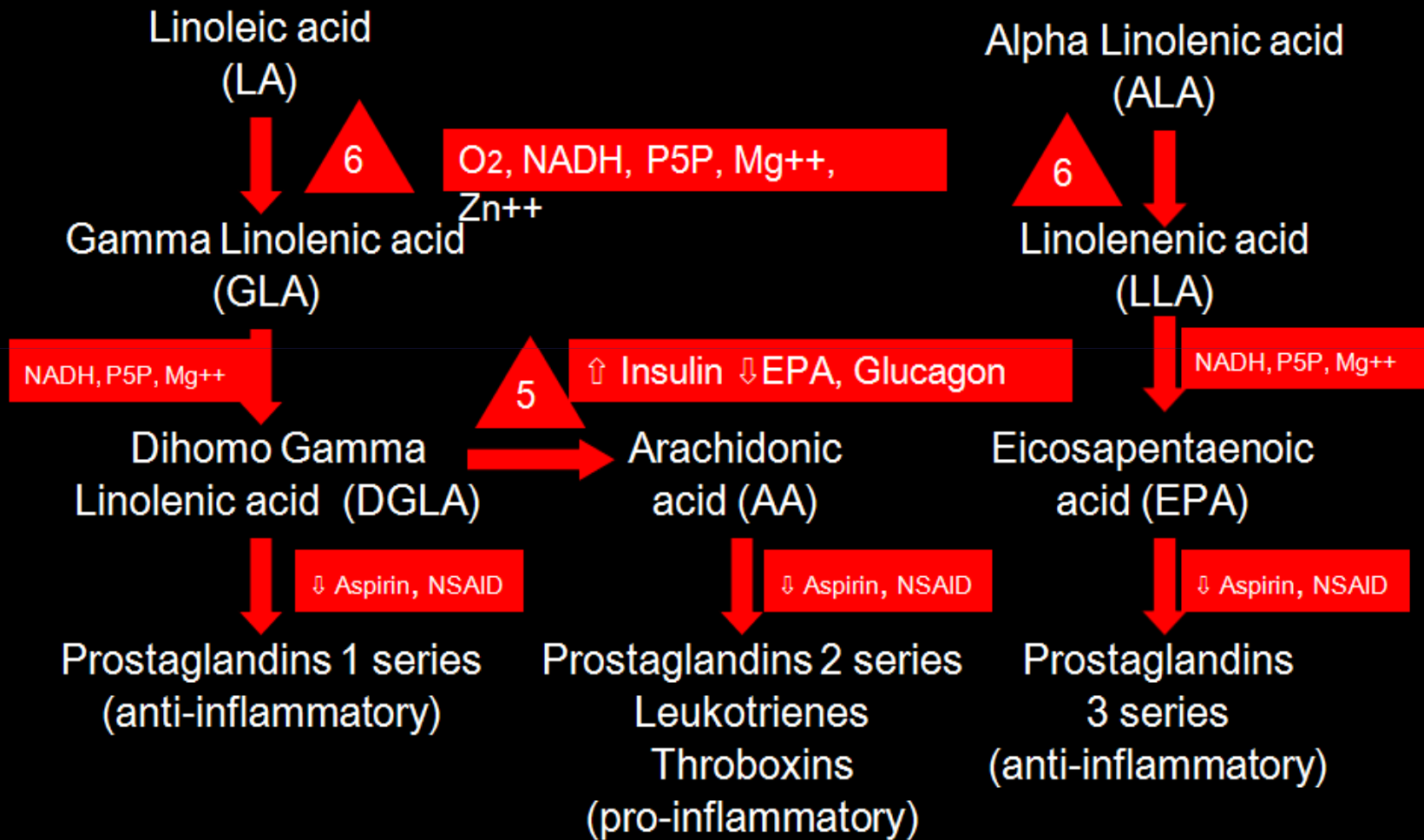
Saturated fatty acids C16-18 (palmitic – stearic)

Unsaturated fatty acids C18-24

Eicosanoids



Eicosanoids



Eicosanoids



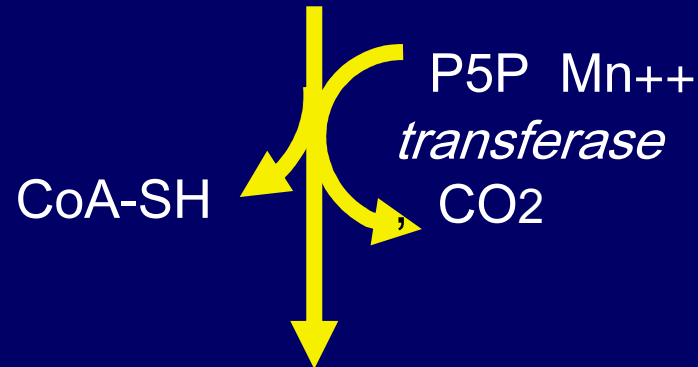
Gangliosides_s

SPHINGLOMYELINS

CoA + Palmitic Acid

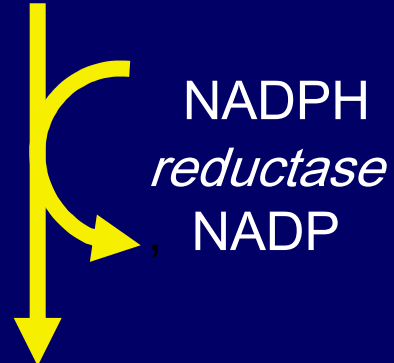


Palmitoyl CoA + Serine

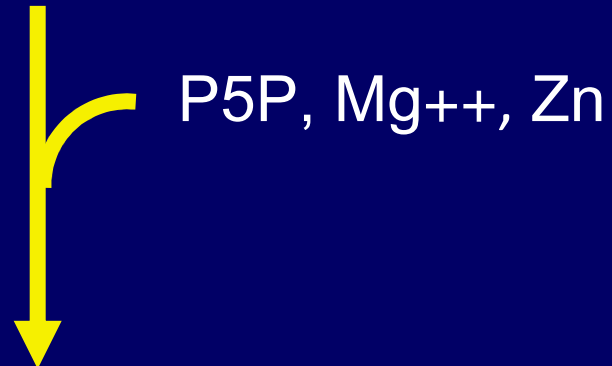


3-Ketosphinganine

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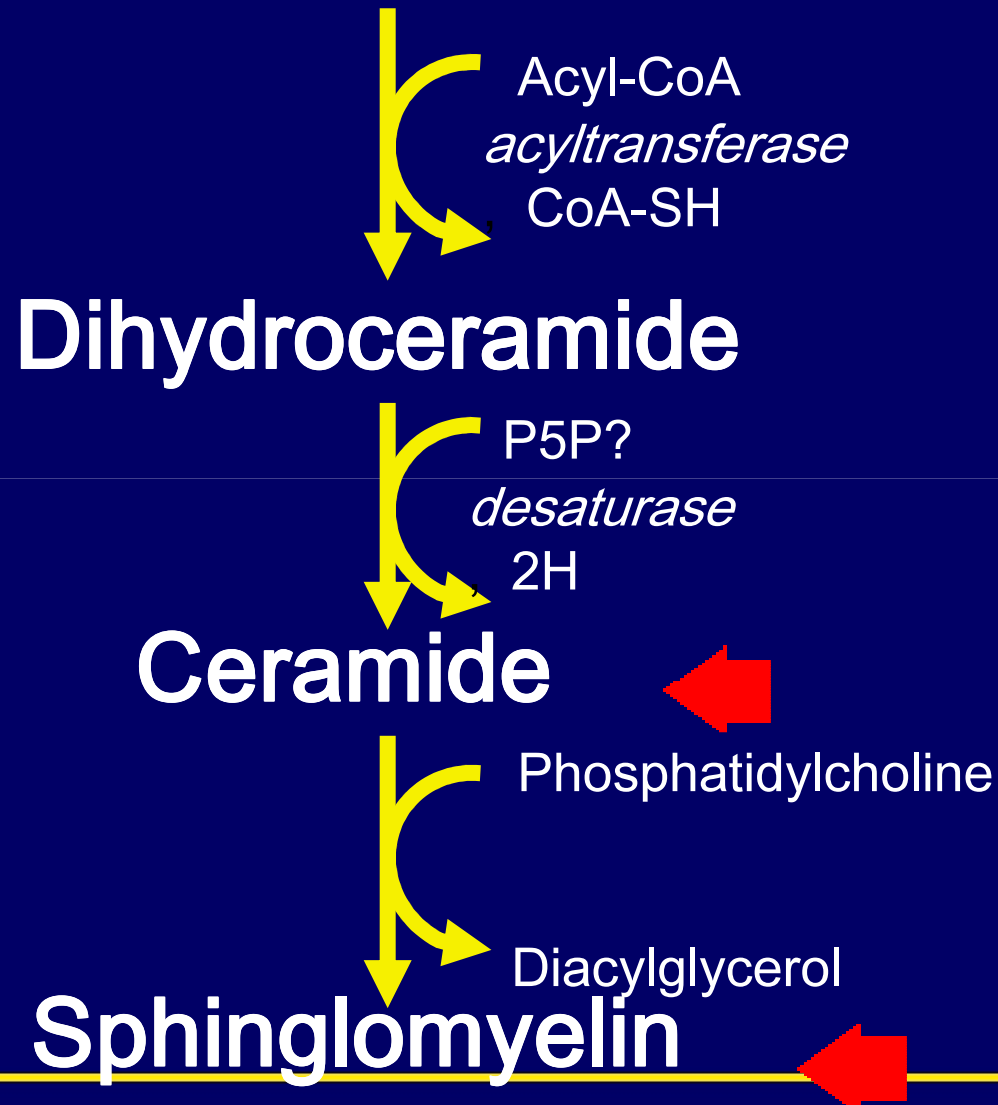


Dihydrosphingosine

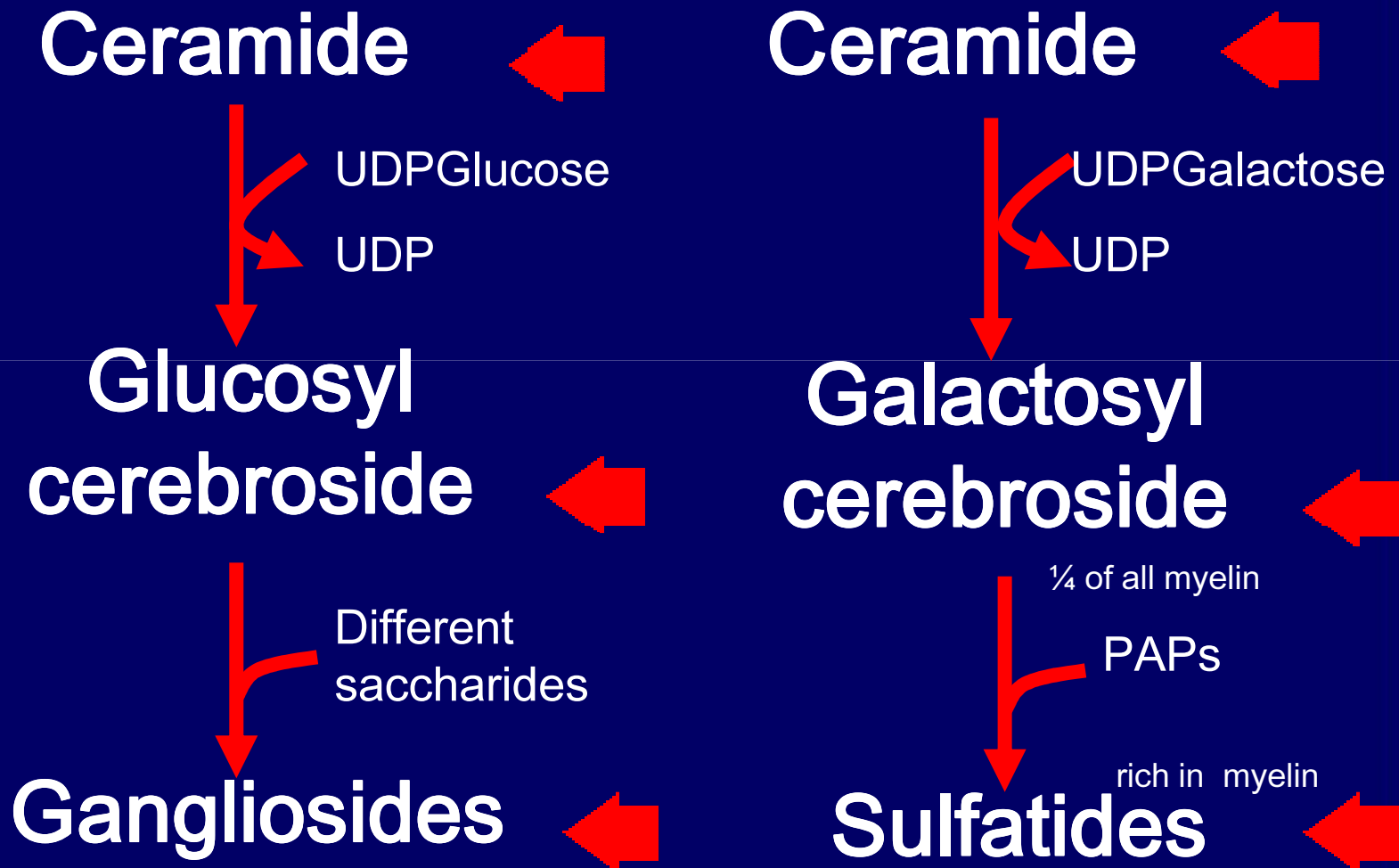


Sphingosine

Sphingosine + Palmitic Acid



GLYCOSPHINGOLIPIDS



Gangliosides

The fatty acid maybe Palmitic, Stearic, Behenic or Lignoceric acids or a monounsaturated fatty acid such as Nervonic acid

Ganglioside GM3

Sphingosine +

Fatty acid +

Glucose +

Galactose+

N.A.Neuraminic

Ganglioside GM2

Sphingosine +

Fatty acid +

Glucose +

Galactose+

N.A.Neuraminic +

N.A.Galactosamine

Ganglioside GM1

Sphingosine +

Fatty acid +

Glucose +

Galactose+

N.A.Neuraminic +

N.A.Galactosamine +

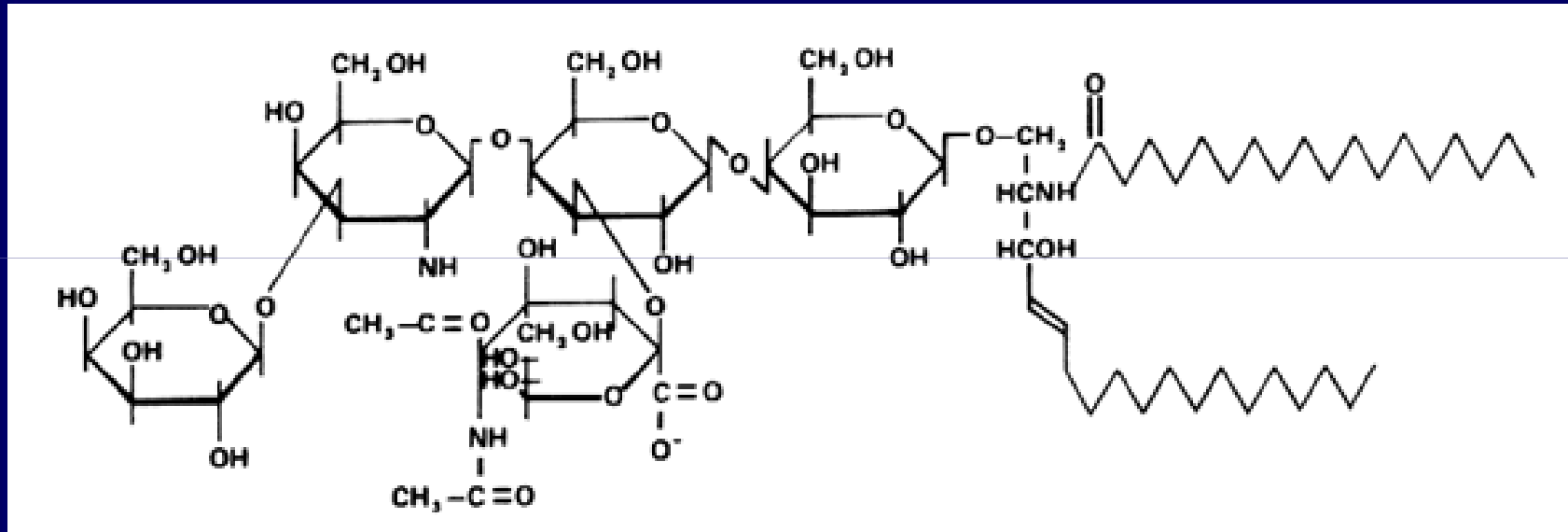
Galactose

Saccharides are attached by UDP and CMP carriers

The level of **gangliosides** in myelin is low but Ganglioside GM1 prevails. Specific binding has been proven for many kinds of gangliosides. When administered parenterally, gangliosides:

1. Circulate in the bloodstream continuously.
2. Do not express toxicity.
3. Pass through blood-brain barrier.
4. Incorporate themselves into neuronal membranes.

Ganglioside GM1



Ganglioside GM1

1. Restores **dopaminergic** neurons after damage to nigro-striatal system, enhances uptake of dopamine and activity of tyrosine hydroxylase.

2. Restores **cholinergic** neurons after damage to the hippocampus, enhances activity of choline acetyl transferase and AChesterase.

3. Restores high-affinity uptake of **choline** in the cortex after injuries of the forebrain.

4. Protects **serotonin and noradrenergic** neurons from neurotoxin-induced degeneration.

5. Diminishes cerebral **oedema** and restores ionic balance after cerebral traumas.

6. Stimulates regeneration of the **optic nerve.**

7. Possibly restores **melatonin** uptake.