

Al-Farabi Kazakh National University  
Higher School of Medicine  
Department of Fundamental Medicine

# **Lipidomics.**

**Lecturer and creator: PhD Pinsky Ilya Vladimirovich**

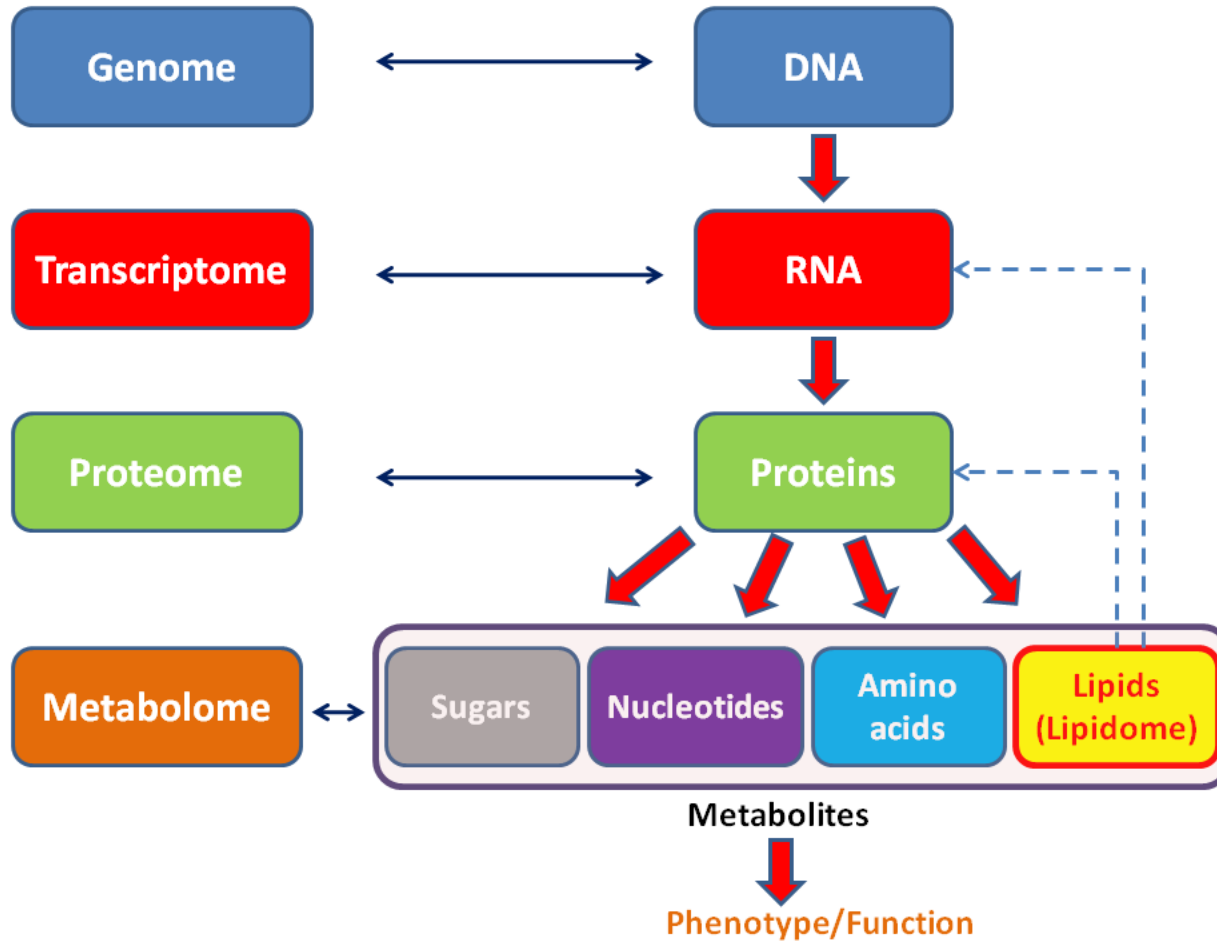
# LEARNING OUTCOMES

## As a result of the lesson you will be able to:

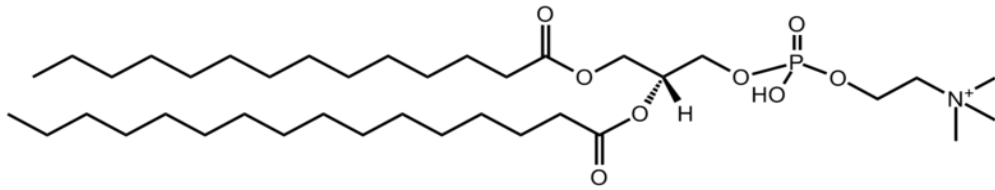
- 1. Give the definition to the terms “lipids”, “lipoproteins”, “lipidome”, “lipidomics”.
- 2. Analyze the different types of lipids by their chemical structure and function, give the specific examples.
- 3. Explain the methods of lipidomic research.
- 4. Explain different disturbances of lipid metabolism and methods of their diagnostics and treatment, give the specific examples.

# Definitions

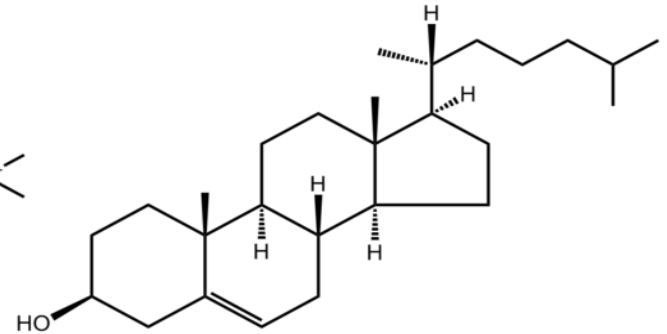
**Lipidomics** is the large-scale study of pathways and networks of cellular **lipids** in biological systems[1][2][3] The word "**lipidome**" is used to describe the complete lipid profile within a cell, tissue, organism, or ecosystem and is a subset of the "**metabolome**" which also includes the three other major classes of biological molecules: **proteins/amino-acids, sugars and nucleic acids**. Lipidomics is a relatively recent research field that has been driven by rapid advances in technologies such as **mass spectrometry (MS), nuclear magnetic resonance (NMR) spectroscopy, fluorescence spectroscopy, dual polarisation interferometry and computational methods**, coupled with the recognition of the role of lipids in many metabolic diseases such as **obesity, atherosclerosis, stroke, hypertension and diabetes**. This rapidly expanding field[4] complements the huge progress made in genomics and proteomics, all of which constitute the family of systems biology.



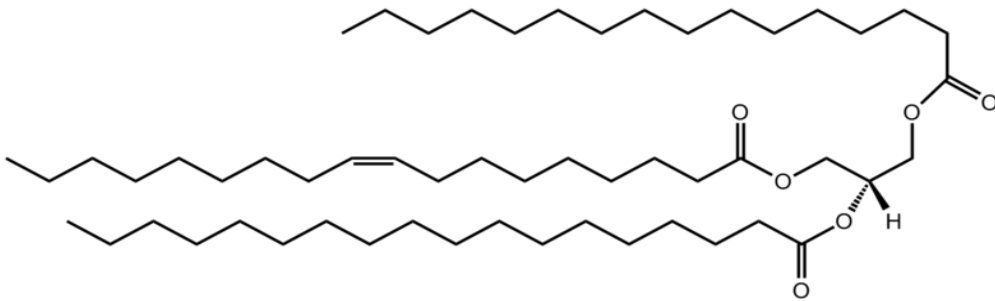
[https://en.wikipedia.org/wiki/Lipidomics#/media/File:Metabolomics\\_schema.png](https://en.wikipedia.org/wiki/Lipidomics#/media/File:Metabolomics_schema.png)



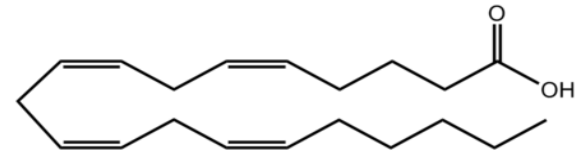
**1-myristoyl-2-palmitoyl-*sn*-glycerophosphocholine**  
(Glycerophospholipids)



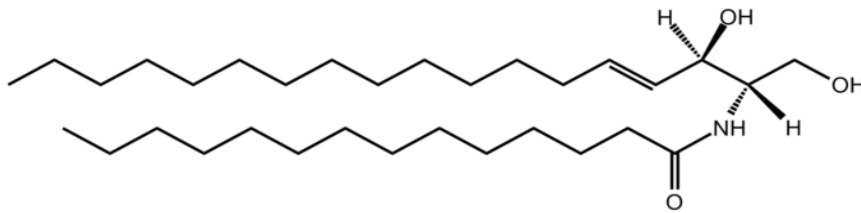
**Cholesterol (Sterol lipids)**



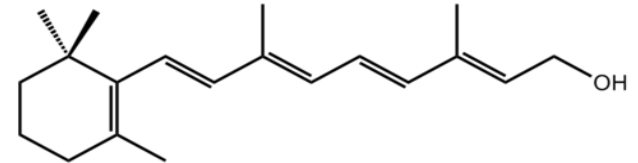
**1-oleoyl-2-stearoyl-3-palmitoyl-*sn*-glycerol**  
(Glycerolipids)



**Arachidonic acid (Fatty acyls)**

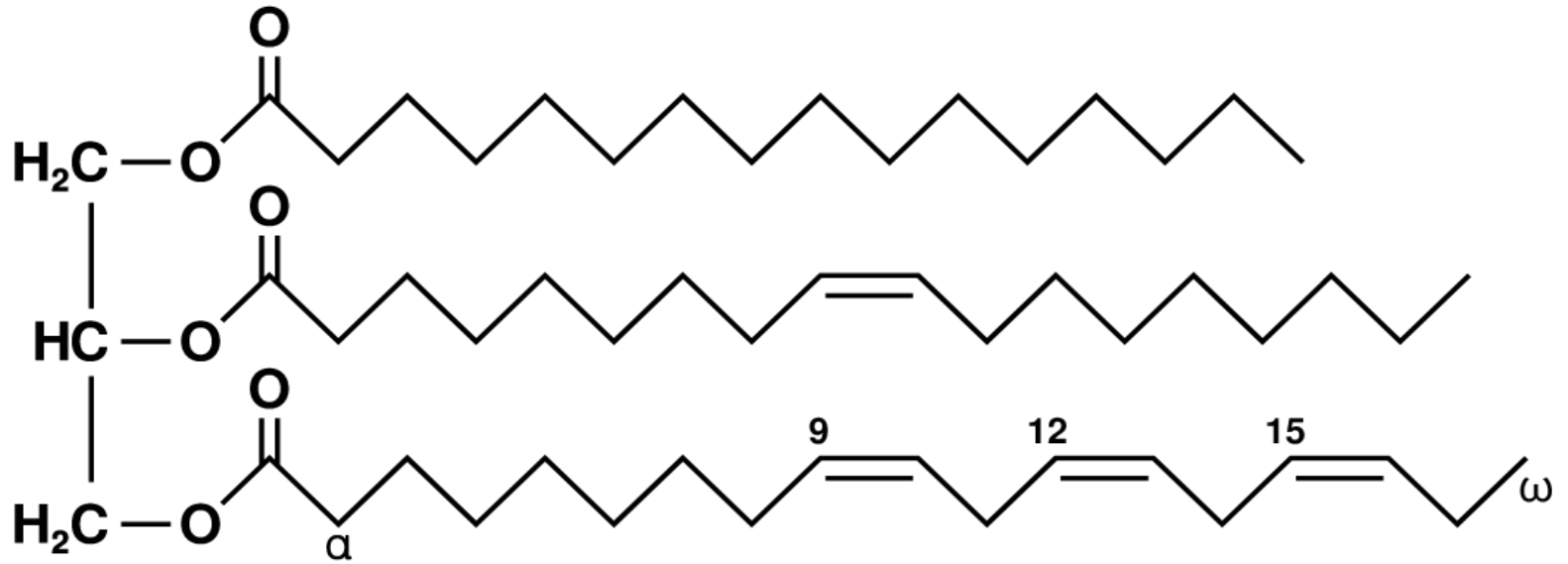


**N-myristoyl-sphing-4-enine**  
(Sphingolipids)



**Retinol (Prenol lipids)**

[https://en.wikipedia.org/wiki/Lipidomics#/media/File:Lipid\\_examples.png](https://en.wikipedia.org/wiki/Lipidomics#/media/File:Lipid_examples.png)



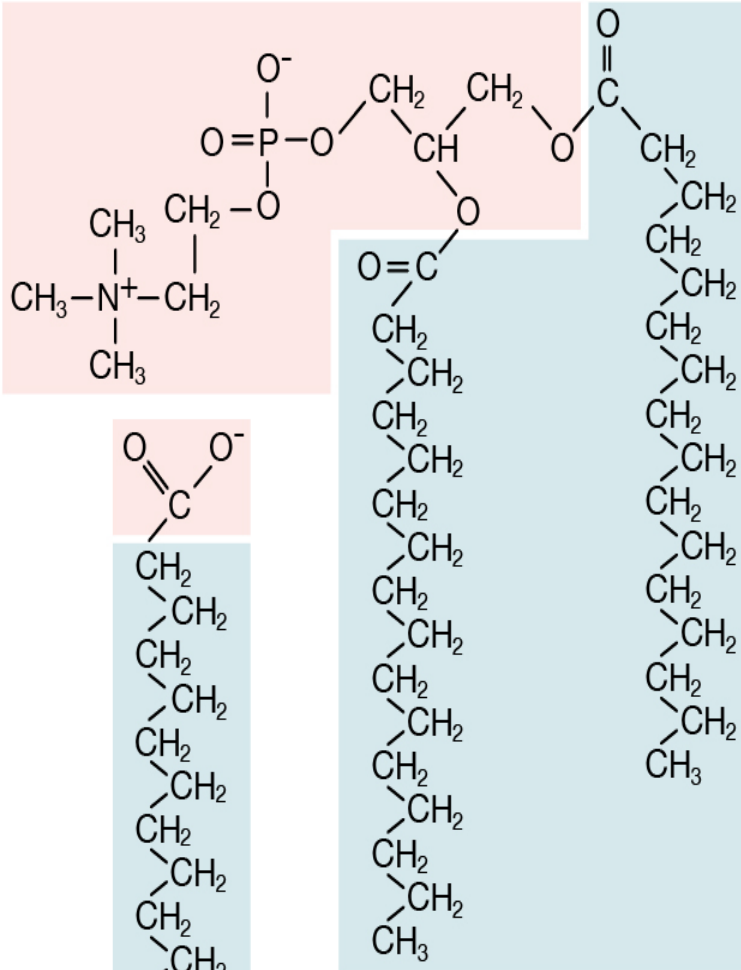
Triglyceride - Wikipedia  
[en.wikipedia.org](https://en.wikipedia.org)

## structural formula

## space-filling model

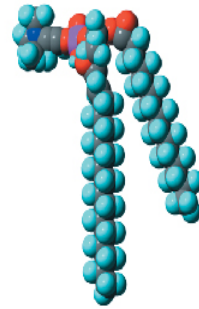
## generic simplified depiction

phospholipid (phosphatidylcholine)



fatty acid (stearic acid)

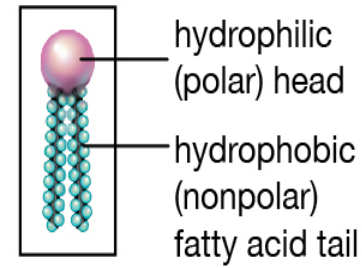
phospholipid molecule



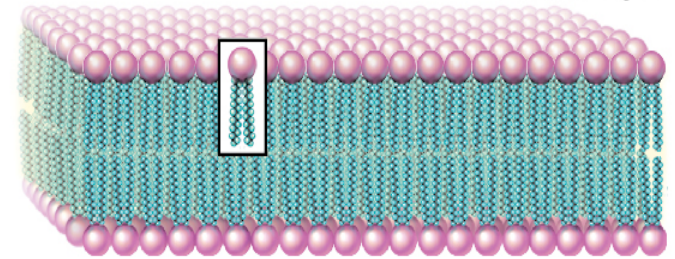
fatty acid molecule



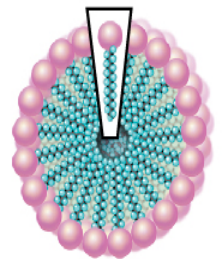
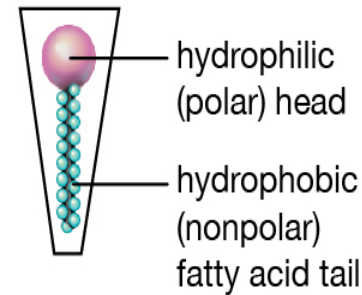
phospholipid molecule



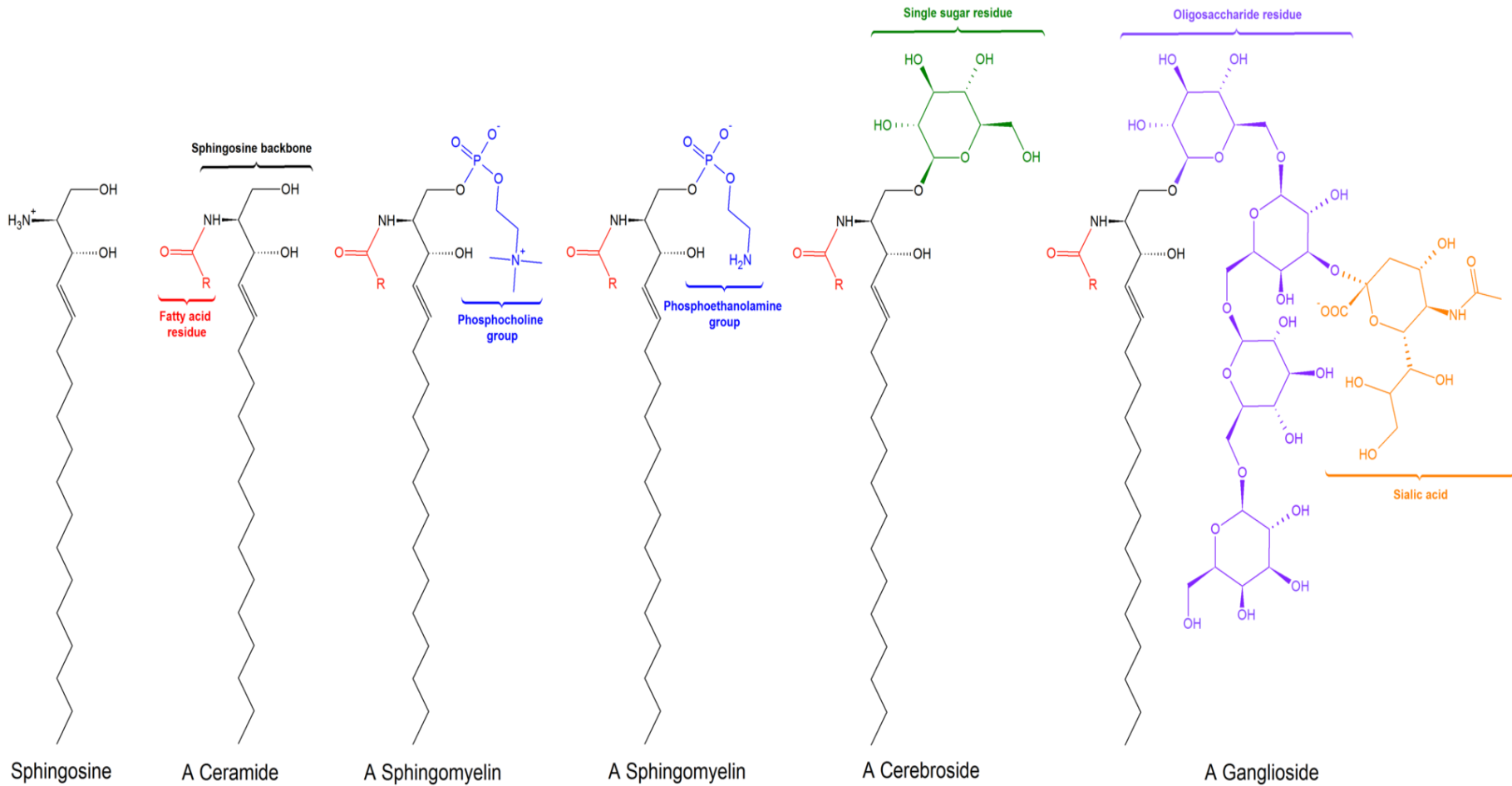
lipid bilayer



fatty acid molecule

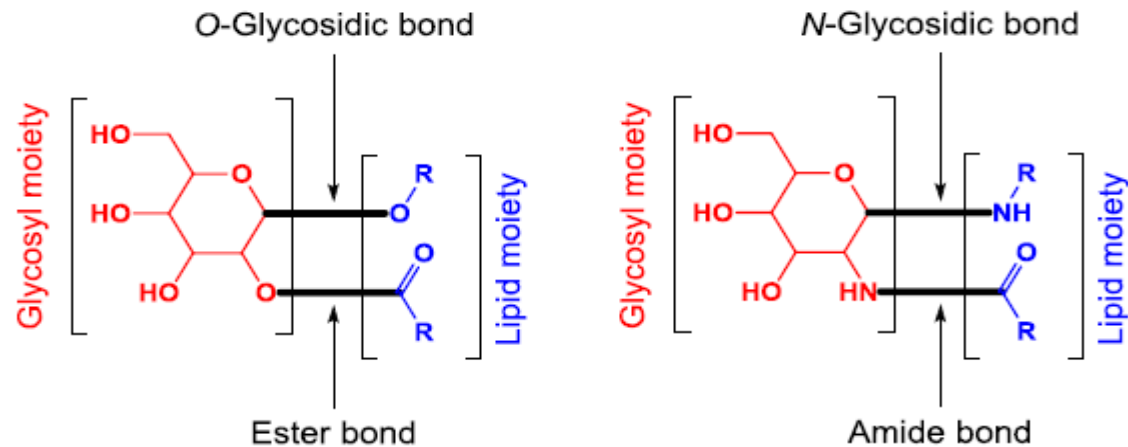
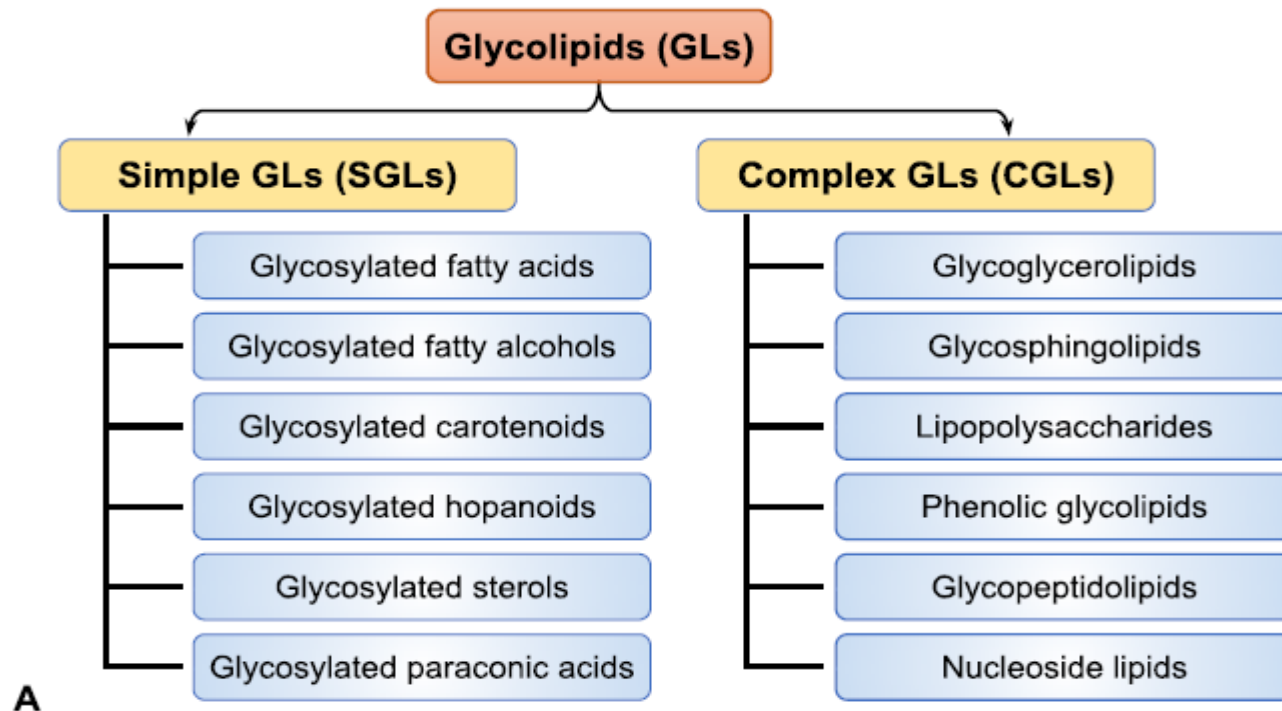


micelle

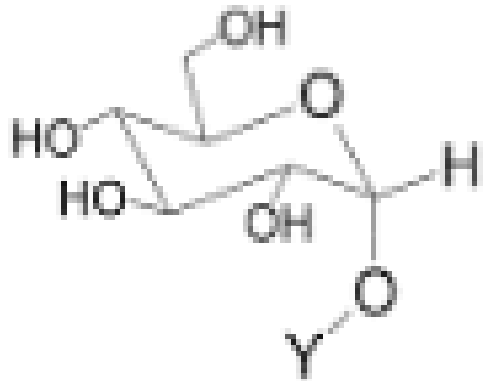


[https://en.wikipedia.org/wiki/Sphingolipid#/media/File:Sphingolipids\\_general\\_structures.png](https://en.wikipedia.org/wiki/Sphingolipid#/media/File:Sphingolipids_general_structures.png)



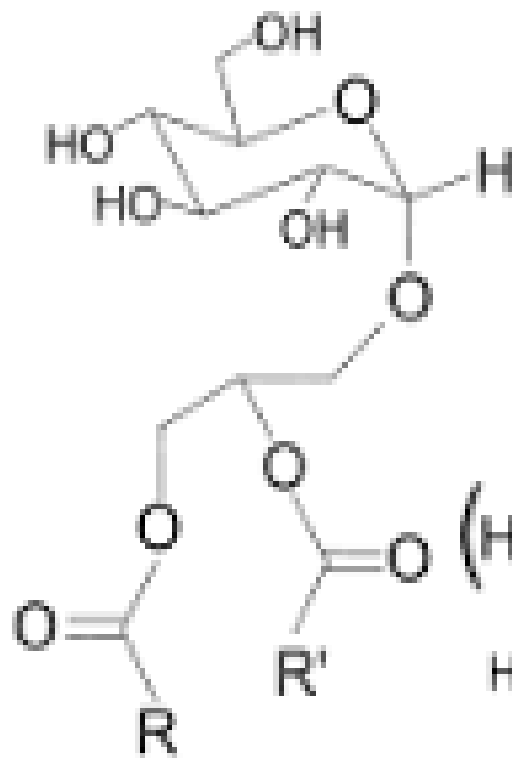


### Glycolipids

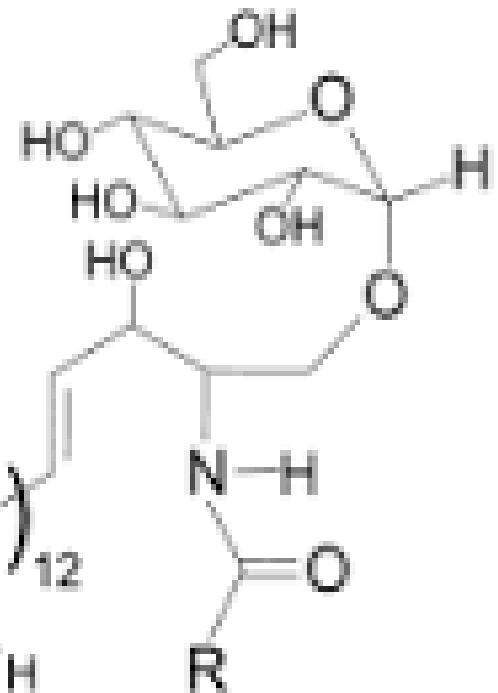


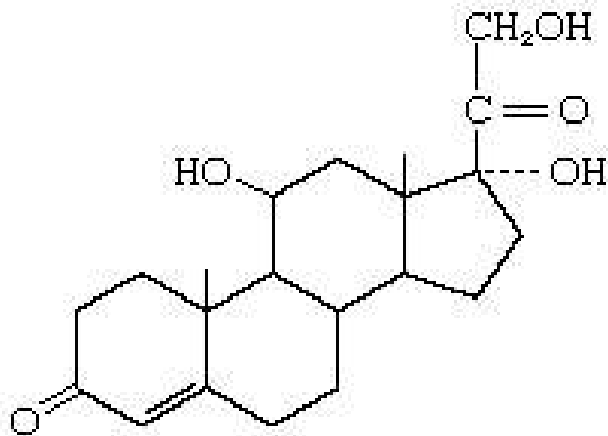
Y = Lipid

### Glycero-Glycolipids

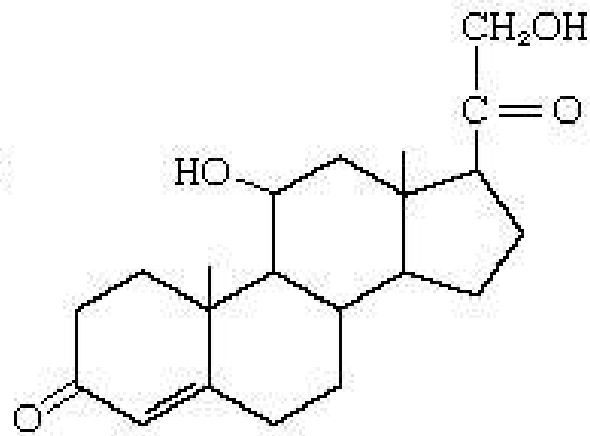


### Sphingo-Glycolipids

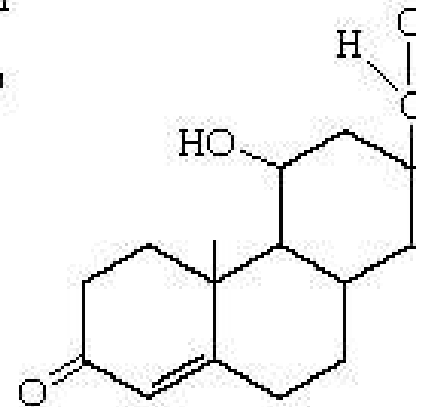




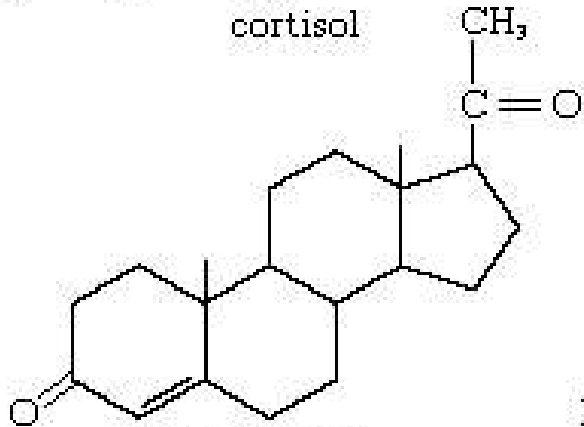
cortisol



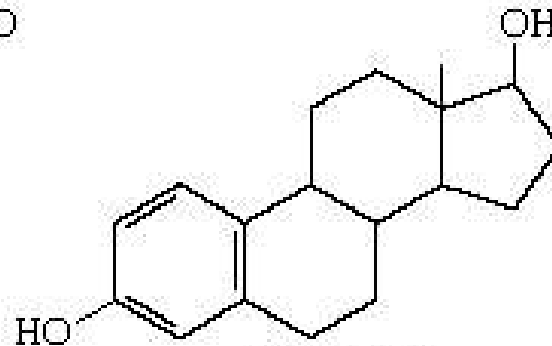
corticosterone



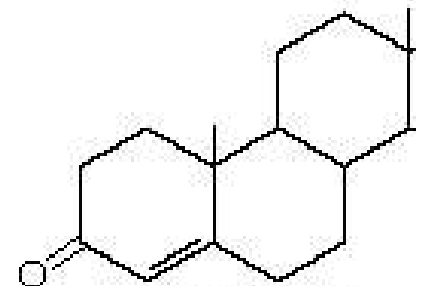
aldosterone



progesterone



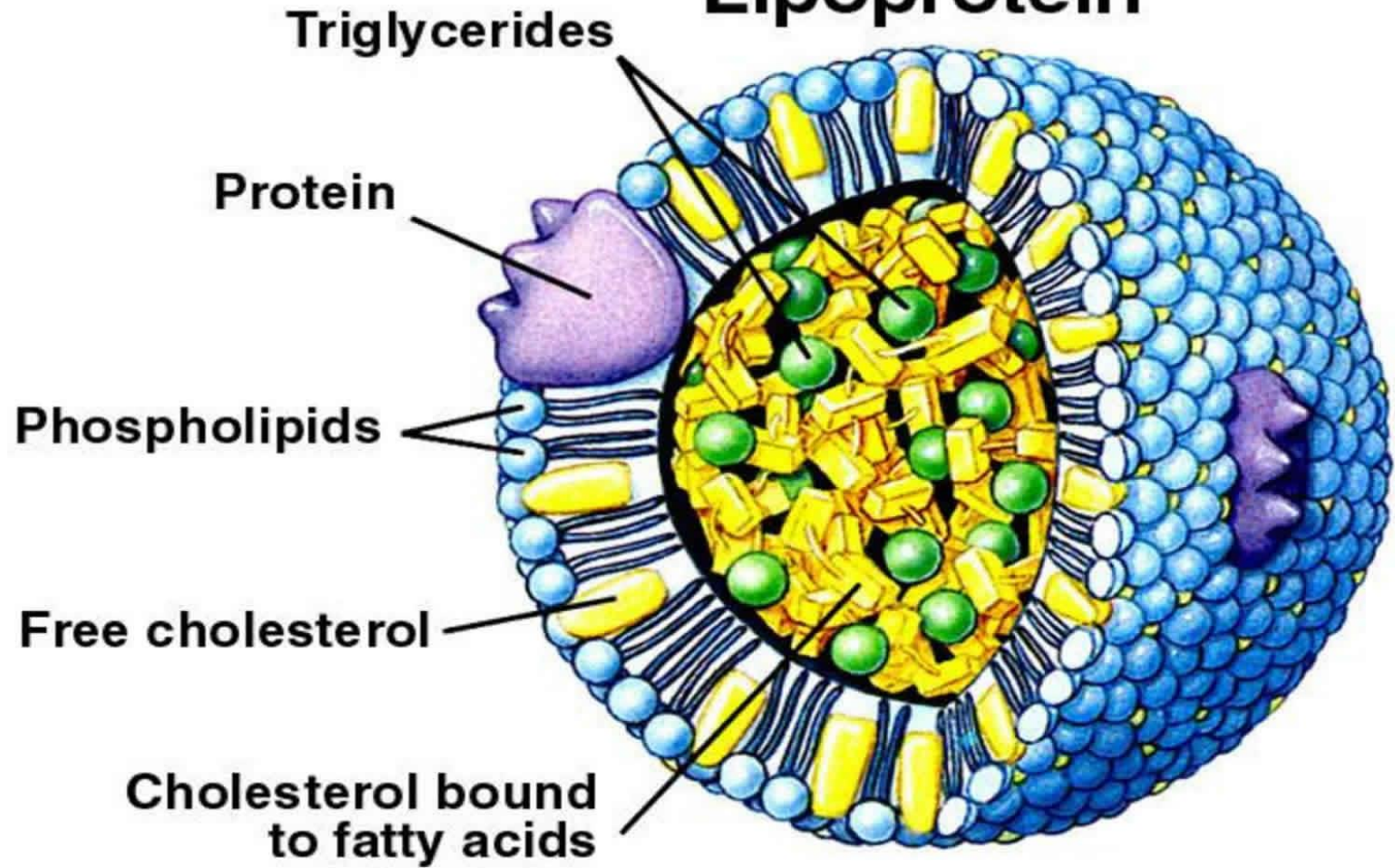
$\beta$ -estradiol

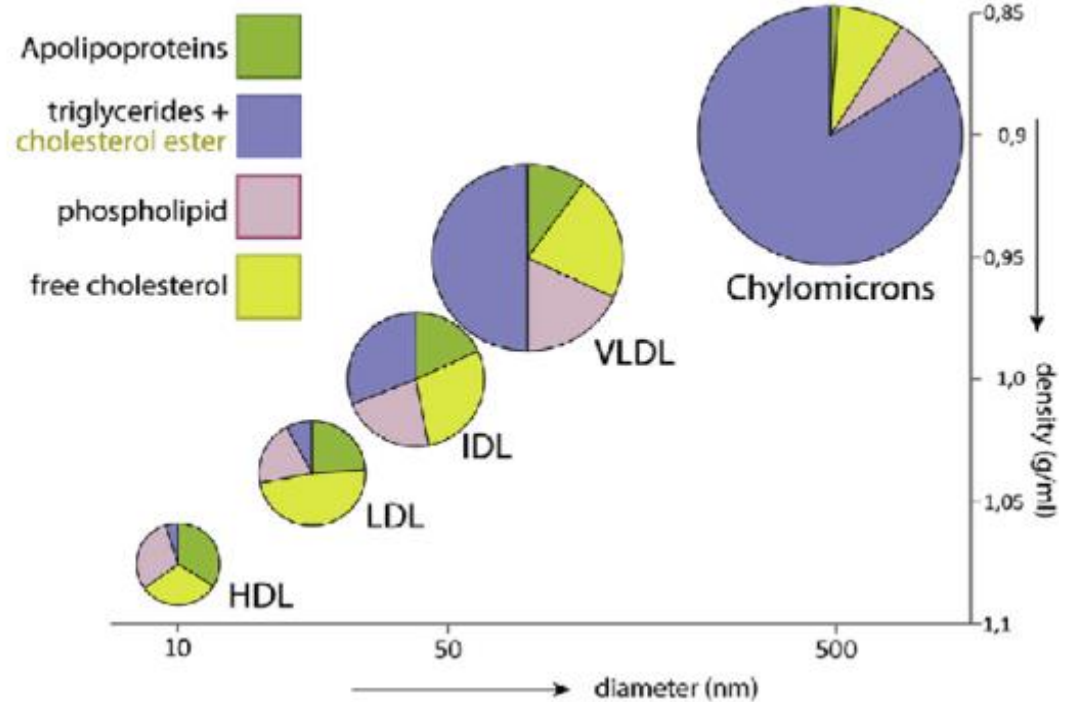
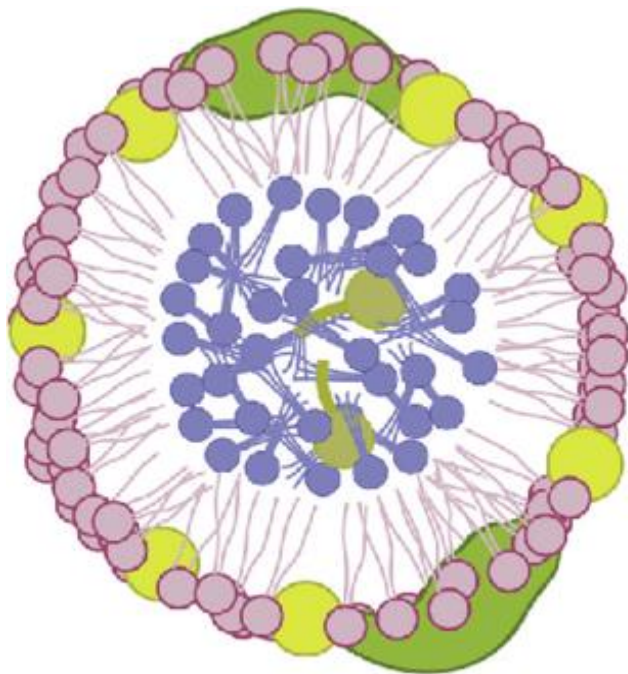


testosterone

steroid | Definition, Structure & Types  
britannica.com

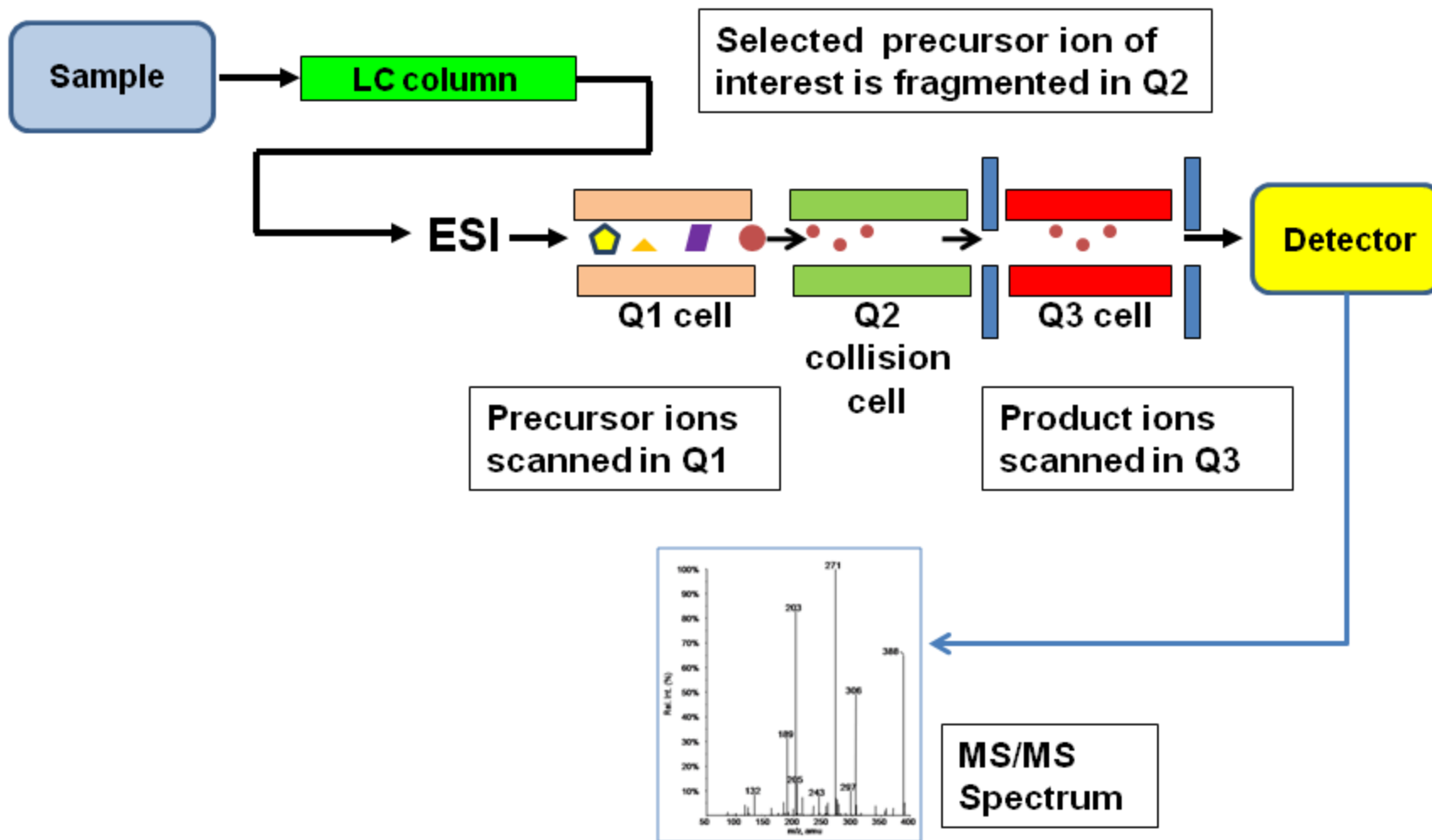
# Lipoprotein

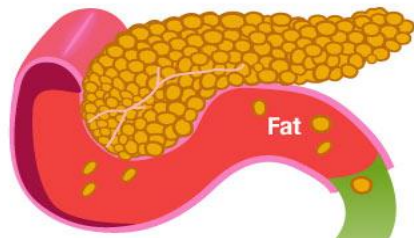




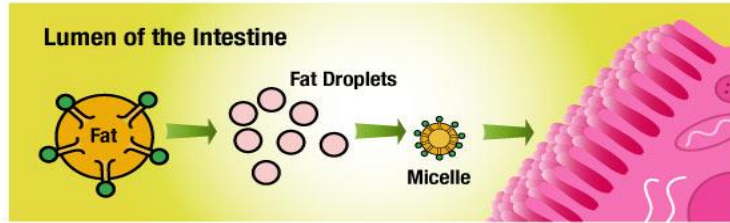
Composition and main physical-chemical properties of main lipoproteins  
[researchgate.net](https://www.researchgate.net)

## Detection of a fatty acid by LC-MS/MS

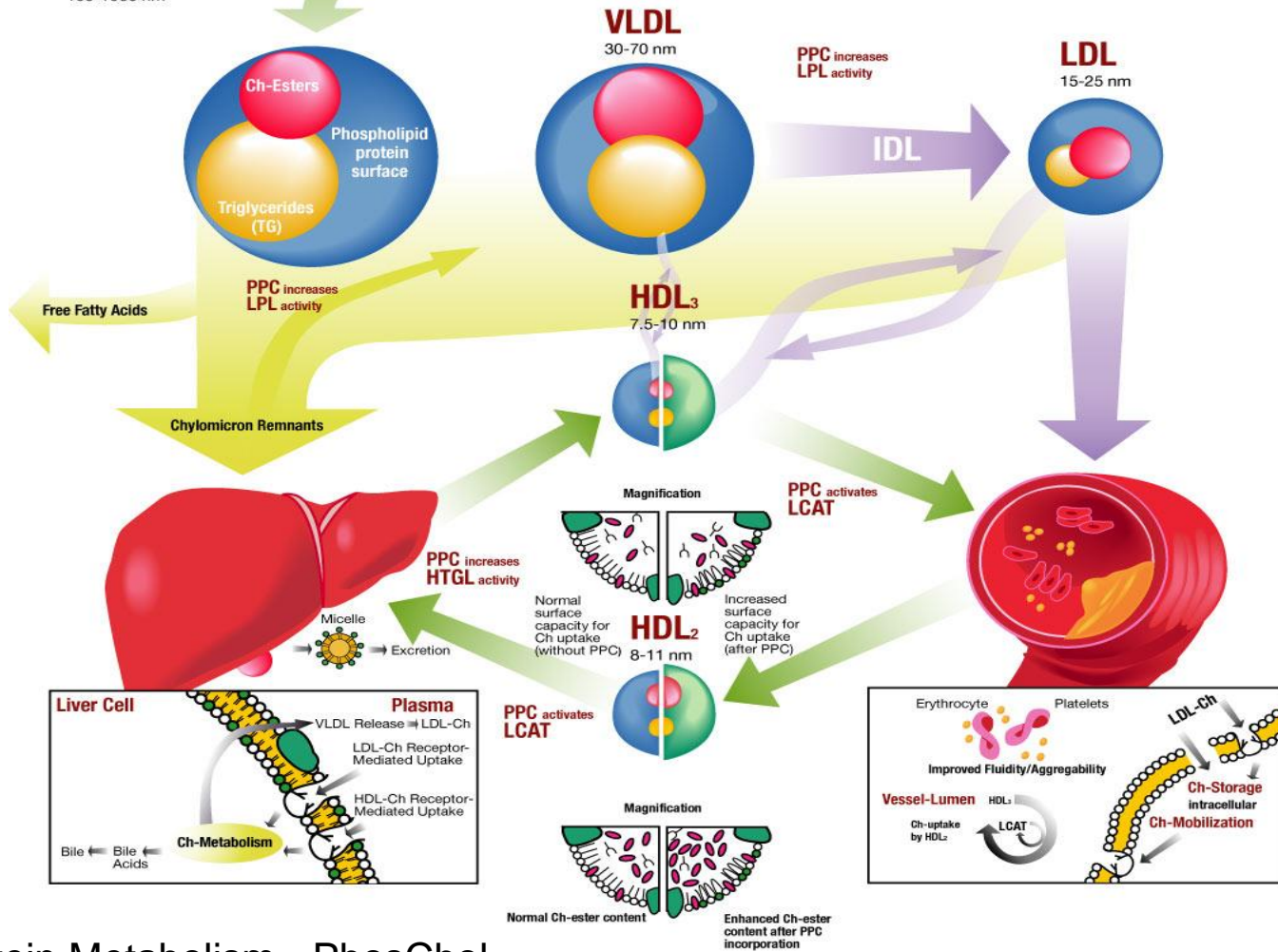


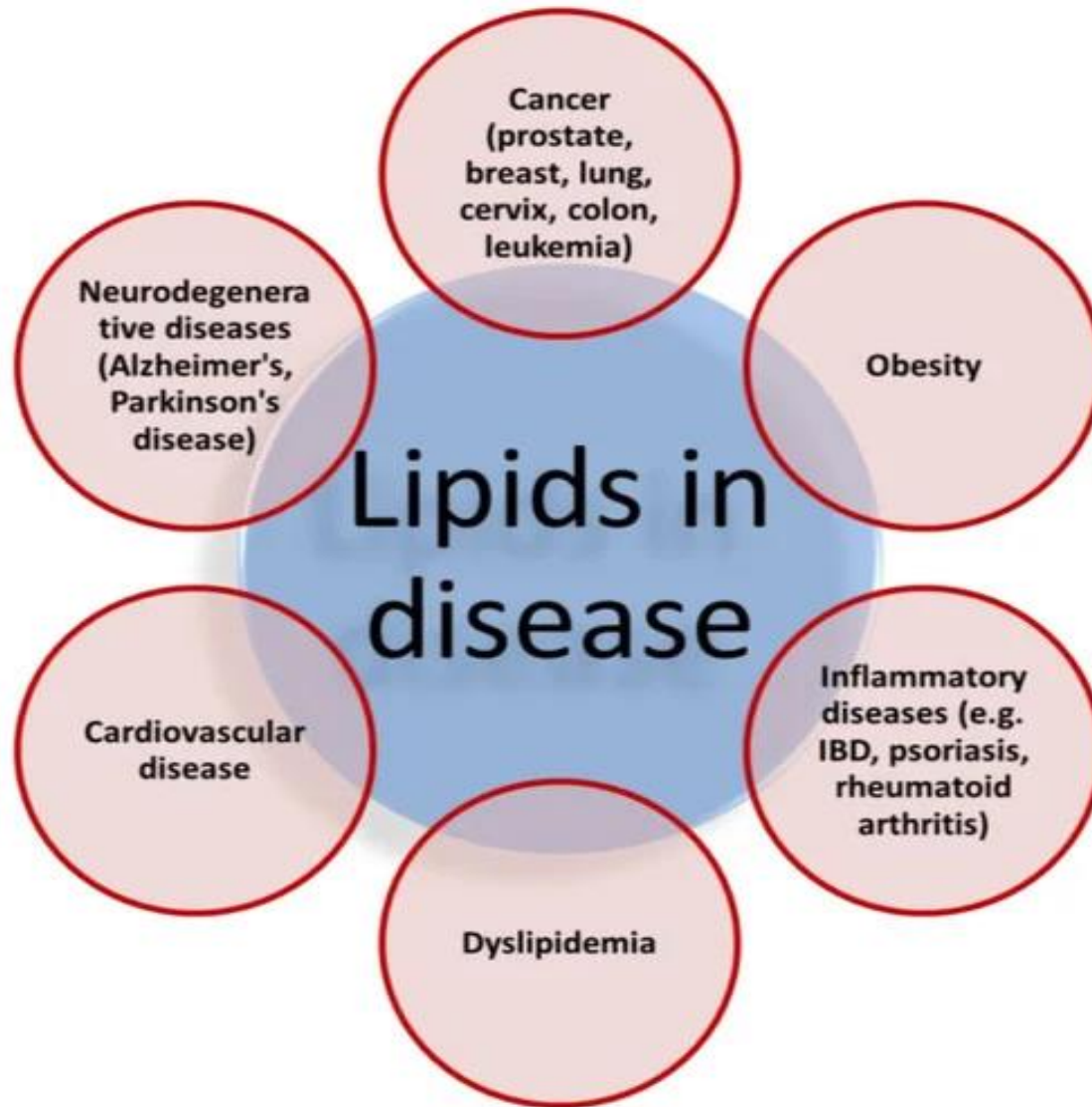


**Chylomicron**  
100-1000 nm



PPC Improves Emulsification of Exogenous Lipids





Special Issue : Emerging Role of Lipids in Metabolism and Disease  
mdpi.com



Disorder	Age at onset	Clinical presentation	Tissues Manifesting defect	Bloodwork	EMG	Biopsy	Extra
CDSP	Infantile	Acute hypoketotic hypoglycemia, cardiomyopathy, muscle weakness, hypotonia	Muscle, heart, kidney	carnitine ↓ ammonia ↑ glucose ↓	Myopathic	Lipid storage	
CPT-I	Infantile	L-CPT-I: lethargy, coma, seizures, hepatomegaly M-CPT-I: myopathy, cardiomyopathy	Liver (L-CPT-I), muscle (M-CPT-I)	carnitine ↓ acylcarnitines ↑			Dicarboxylic aciduria
CPT-II	Neonatal  Infantile  Adult	Hypoketotic hypoglycemia, encephalopathy, arrhythmias, cardiomyopathy, congenital anomalies Similar, but less severe Exercise-induced pain, stiffness, myoglobinuria	All tissues	Infantile: acylcarnitines ↑ in plasma, low total Adult: normal acylcarnitine, CK ↑ (normal between attacks)	Normal between attacks	Seldom lipid accumulation	LAER-test normal
CACT	Neonatal	Hypoketotic hypoglycemia, hepatomegaly, cardiac symptoms, muscle weakness	Muscle, heart, liver	Low plasma free carnitine with increased acylcarnitines		Lipid storage in liver, kidney, muscle, heart	Dicarboxylic aciduria
VLCAD	Childhood  Adult	Hypoketotic hypoglycemia, hepatocellular disease, hypertrophic cardiomyopathy, hypotonia Exercise-induced pain, myoglobinuria, +/- hypoglycemia	Muscle, heart, liver	Acyl-carnitine accumulation, CK ↑		Lipid storage in multiple tissues	Dicarboxylic aciduria
LCAD		Hypotonia, muscle weakness, hypoketotic hypoglycemia				Lipid storage in type I fibres	Decreased total carnitine in muscle
MCAD		Lethargy, vomiting, coma, hypoglycemia, sudden death		carnitine ↓ midchain acylcarnitines ↑			Decreased total carnitine in muscle, dicarboxylic aciduria, urinary glycine conjugates
SCAD	Infantile  Adult	Nonketotic hypoglycemia, failure to thrive, hypotonia, seizures Chronic myopathy	Muscle, liver	C4-carnitine ↑		Lipid storage	Decreased total carnitine in muscle, increased excretion of urinary ethylmalonic and methylsuccinic acids

# References

1. Wenk MR (July 2005). "The emerging field of lipidomics". *Nat Rev Drug Discov.* 4 (7): 594–610. doi:10.1038/nrd1776. PMID 16052242. S2CID 83931214.
2. Watson AD (October 2006). "Thematic review series: systems biology approaches to metabolic and cardiovascular disorders. Lipidomics: a global approach to lipid analysis in biological systems". *J. Lipid Res.* 47 (10): 2101–11. doi:10.1194/jlr.R600022-JLR200. PMID 16902246.
3. "Lipidomics". *The Lipid Chronicles*. 2011-12-15. Retrieved 2012-01-08.
4. Han X (2007). "Neurolipidomics: challenges and developments". *Front. Biosci.* 12: 2601–15. doi:10.2741/2258. PMC 2141543. PMID 17127266.