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Le membrane e i lipidi

Biochimica et Biophysica Acta (BBA) - Biomembranes
Volume 1838, Issue 6, Pages 1449-1692 (June 2014)

Membrane Structure and Function: Relevance in the Cell's Physiology, Pathology and Therapy

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Reciprocal influences between cell cytoskeleton and membrane channels, receptors and transporters

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Review

The Fluid—Mosaic Model of Membrane Structure: Still relevant to understanding the structure, function and dynamics of biological membranes after more than 40 years ☆

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Reciprocal influences between cell cytoskeleton and membrane channels, receptors and transporters

Preface

Reciprocal influences between cell cytoskeleton and membrane channels, receptors and transporters

Jean-Claude Hervé

Lipid Rafts As a Membrane-Organizing Principle
Daniel Lingwood and Kai Simons
Science **327**, 46 (2010);
DOI: 10.1126/science.1174621

Bagatolli L. and Mouritsen O. *Is the fluid mosaic (and the accompanying raft hypotesis) a suitable model to describe fundamental features of biological membranes? What may be missing?*
Frontiers in Plant Science, novembre 2013, doi 10.3389/fpls.2013.00457

Sonnino S. and Prinetti A. *Membrane Domains and the "Lipid Raft" Concept.*
Current Medicinal Chemistry 2013, 20: 4-21

Cellular membranes are not autonomous cellular structures, because they are linked in several ways throughout the cellular interior through cytoplasmic systems, including cytoskeletal networks, signal transduction systems, transport systems, and other structural, enzymatic and communication networks. In tissues membranes are also linked outside the cell to extracellular matrix, other cells and to interstitial protein structures.

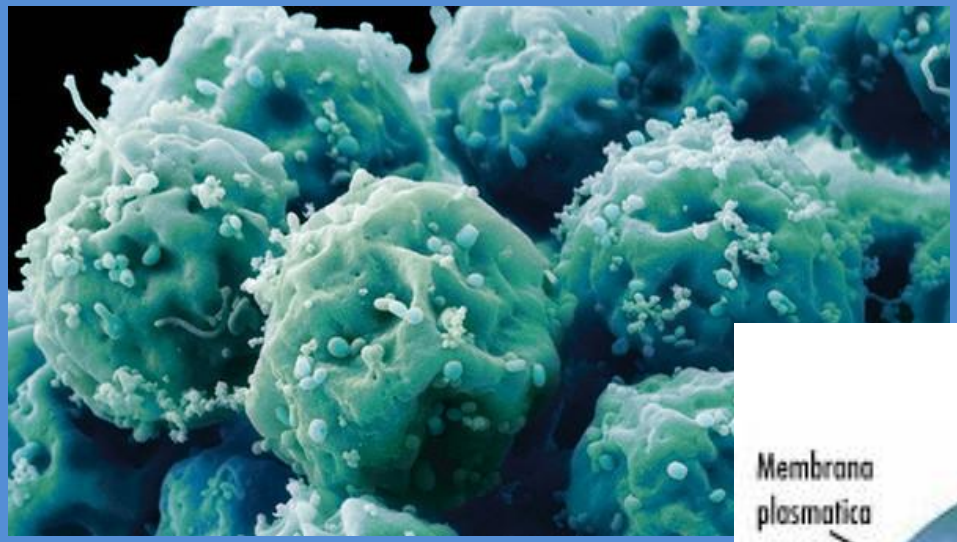
Thus cellular membranes are fully integrated structures within tissues, and plasma membranes must at the same time be sensitive and reactive to environmental changes and signals.

This is probably why membranes have evolved to become such complex, dynamic structures. They have to quickly and selectively respond to a number of quite different signals from inside and outside cells. How they do this by subtle changes in membrane structure, dynamics and organization will continue to intrigue investigators for some time.

Le membrane cellulari

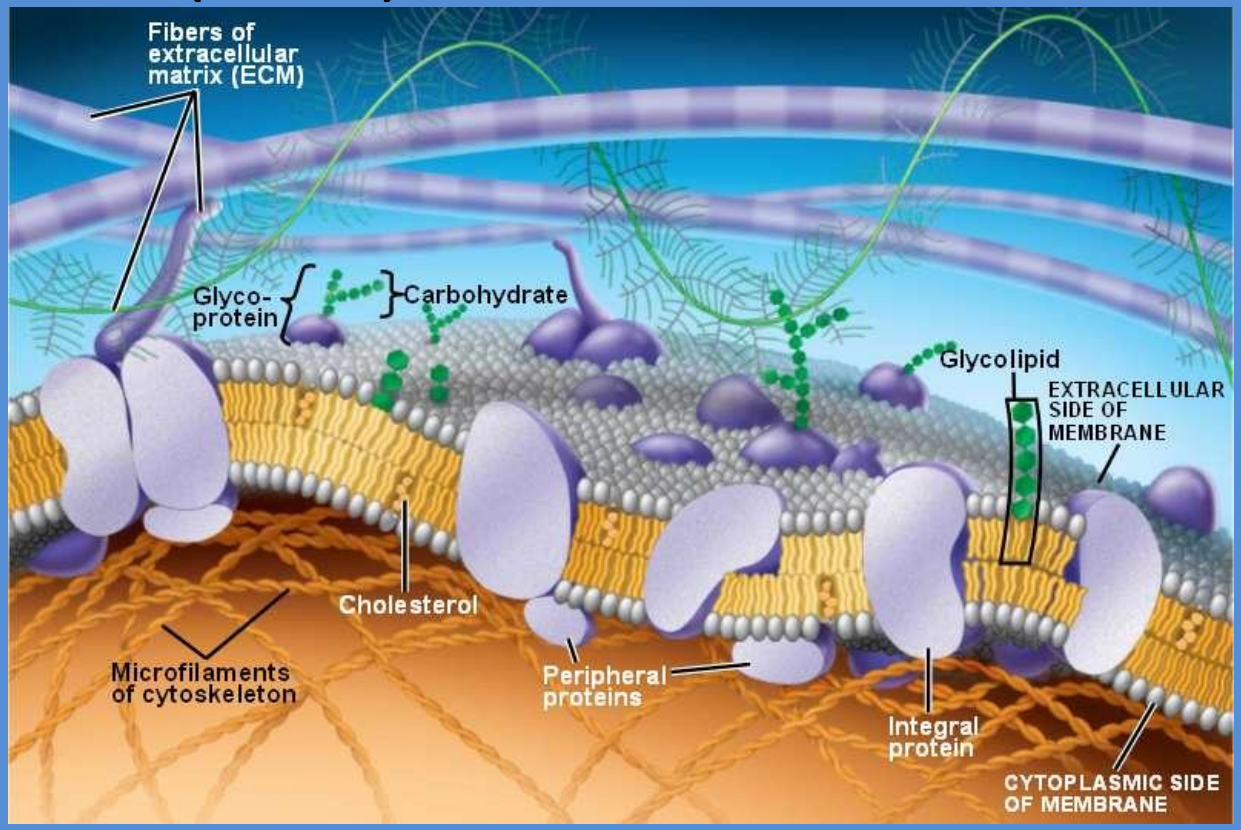
ed in particolare

LA MEMBRANA PLASMATICA




Struttura della cellula
Membrana plasmatica
Apparato di Golgi
Nucleolo
Nucleo
Vacuolo
Lisosoma
Mitocondrio

La membrana plasmatica: modello di Singer e Nicolson (1972) “a mosaico fluido”

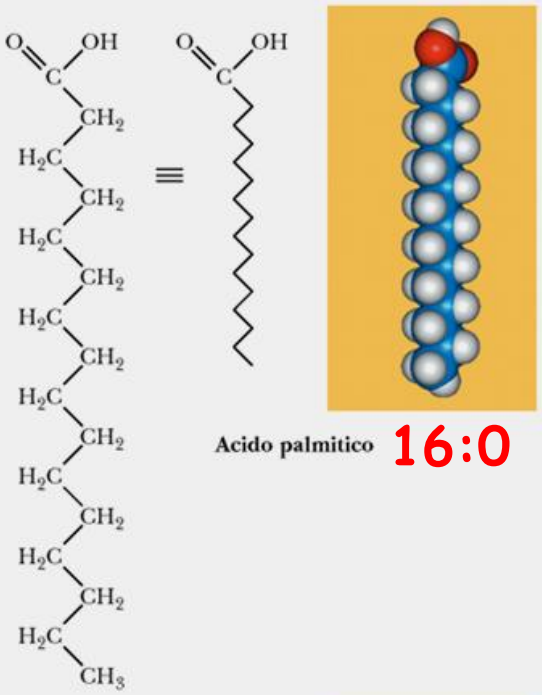


I lipidi sono una componente fondamentale della membrana non solo come supporto

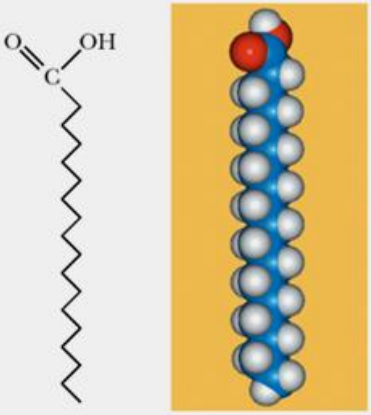
- Il “lipidoma” cellulare e’ composto teoricamente da :
- 9600 specie di glicerofosfolipidi
- Piu’ di 100.000 specie di sfingolipidi
- Migliaia di varianti di mono-, di-, tri-gliceridi
- Numerose strutture basate sugli acidi grassi e steroli.

Tuttavia vedremo come nonostante tutta questa apparente confusione la membrana cellulare diventa un sistema ovviamente estremamente funzionale e ordinato. Come sempre nelle cellule (o nella vita) tutto ha un ruolo preciso.

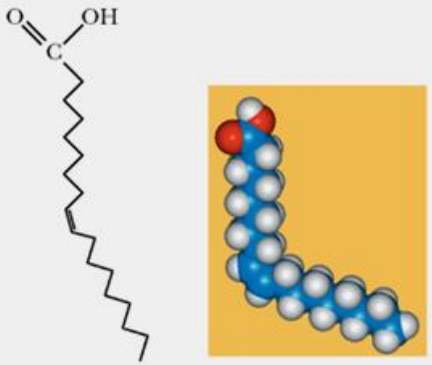
Tratto da: M.K. Campbell, S.O. Farrell - "Biochimica", ed. EdiSES



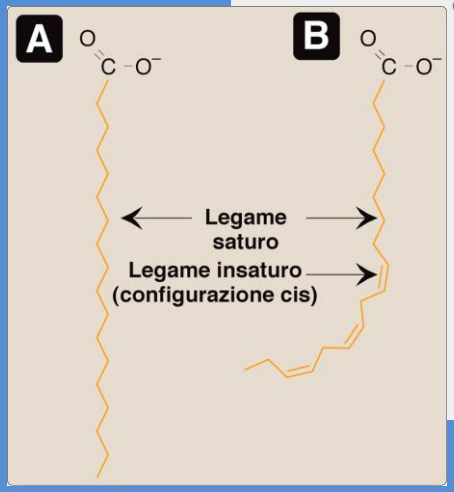
Acido palmitico 16:0

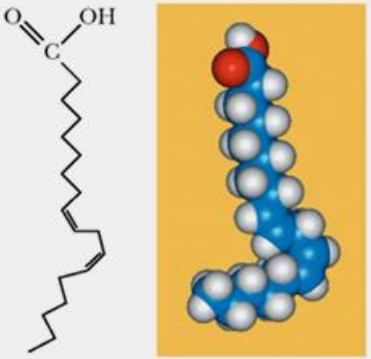


Acido stearico 18:0

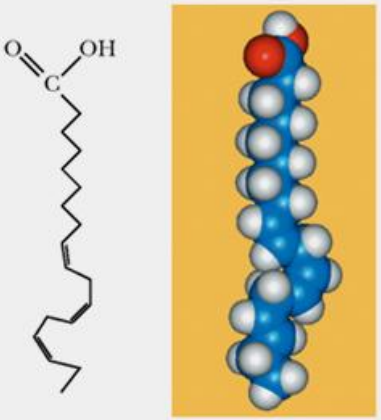


Acido oleico 18:1 9

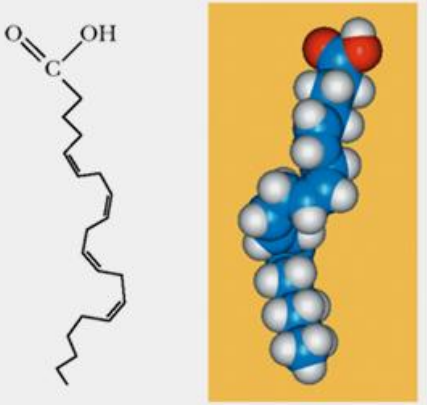




Acido linoleico 18:2 9,12

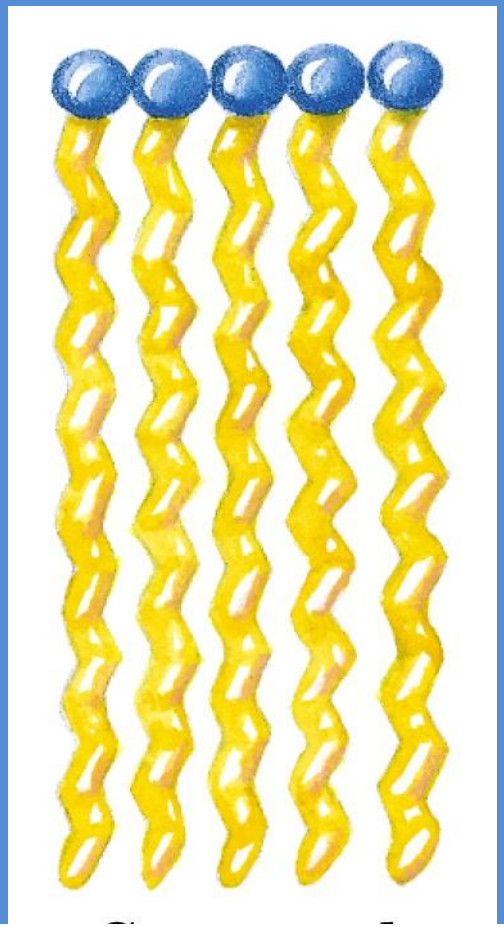


Acido α-linolenico 18:3 9,12,15

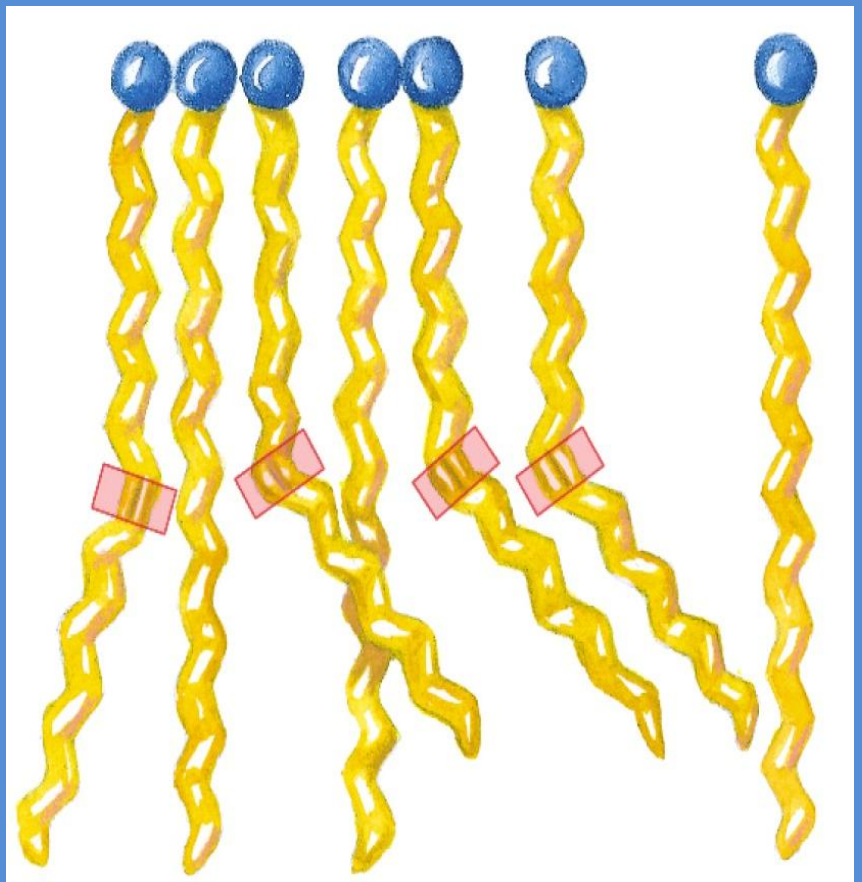


Acido arachidonico 20:4 5,8,11,14

IMPACCHETTAMENTO DEGLI ACIDI GRASSI CON DIVERSO GRADO DI INSATURAZIONE



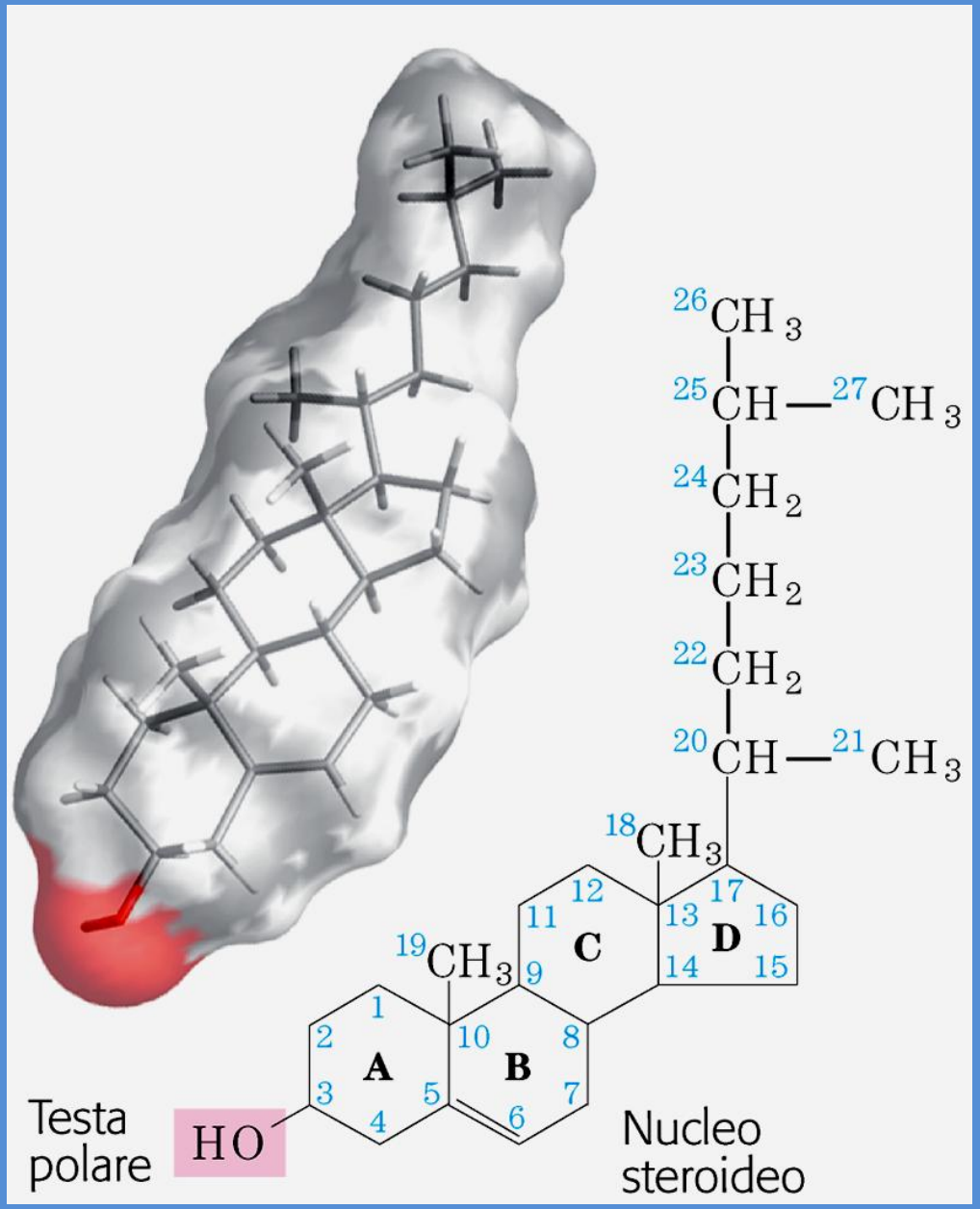
Acidi grassi saturi



Miscela di acidi grassi saturi ed insaturi

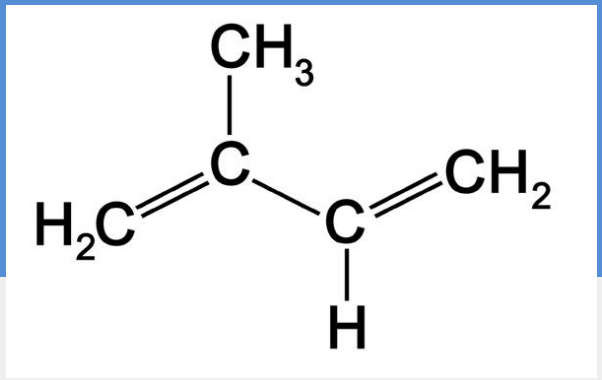
Tratto da: A.L. Lehninger "Introduzione alla Biochimica", ed. Zanichelli

STRUTTURA DEL COLESTEROLO

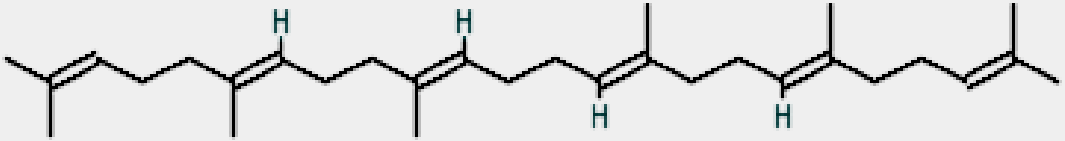


Tratto da: D.L. Nelson, M.M. Cox "I principi di Biochimica di Lehninger", IV ed., Zanichelli

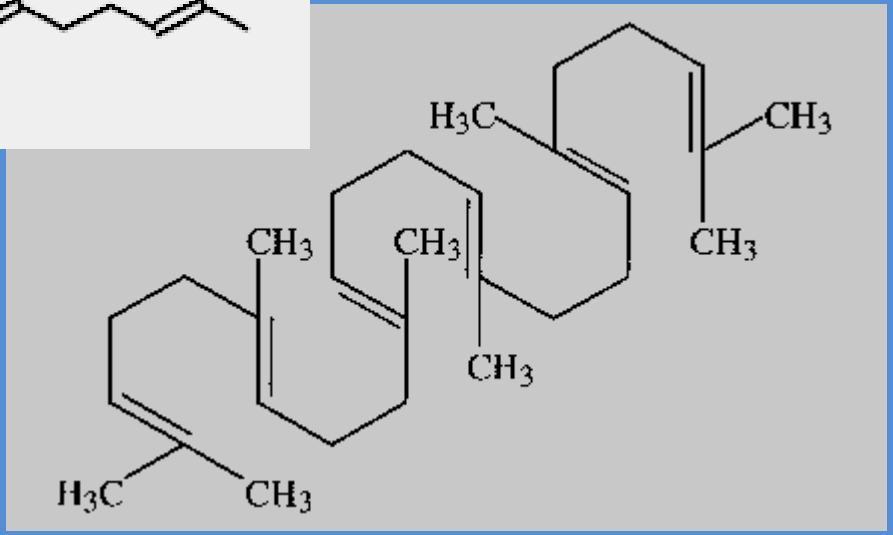
I Prenoli ovvero i composti (quasi sempre precursori del colesterolo) formati dalla unione di unita' isoprenoidi



isoprene



squalene

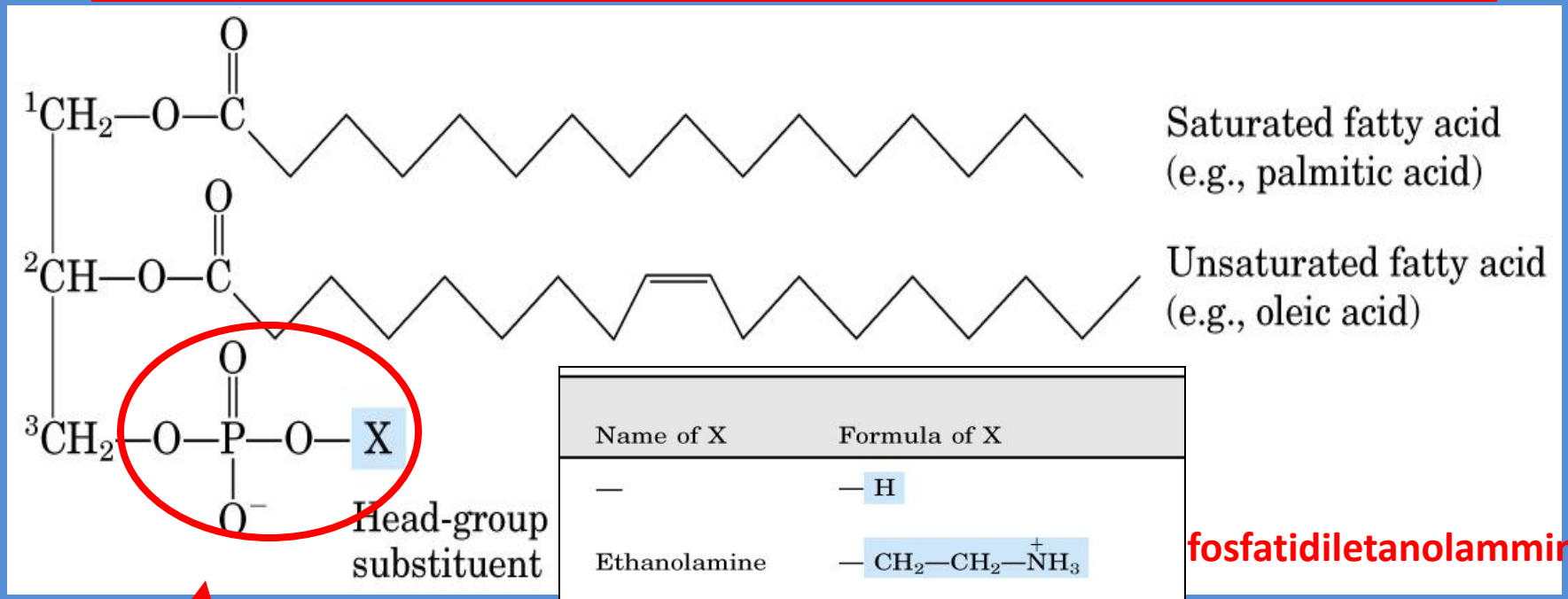


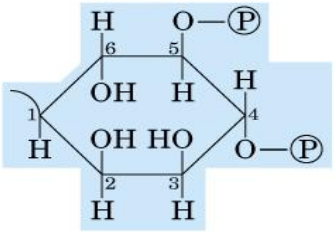
- Le membrane cellulari sono composti principalmente di glicerofosfolipidi, sfingolipidi e colesterolo

FOSFOLIPIDI

- I fosfolipidi sono i costituenti delle membrane biologiche, dove svolgono ruoli sia strutturali che funzionali
- Alcuni di essi, come ad es. il fosfatidilinositolo, vengono scissi in risposta ad un ligando extracellulare, portando il messaggio di tale molecola all'interno della cellula

STRUTTURA DEI GLICEROFOSFOLIPIDI



Name of X	Formula of X
—	— H
Ethanolamine	— CH_2—CH_2—$\overset{+}{N}H_3$
Choline	— CH_2—CH_2—$\overset{+}{N}(CH_3)_3$
Serine	— CH_2—$CH(\overset{+}{N}H_3)$—COO^-
myo-Inositol 4,5-bisphosphate	

fosfatidiletanolammina

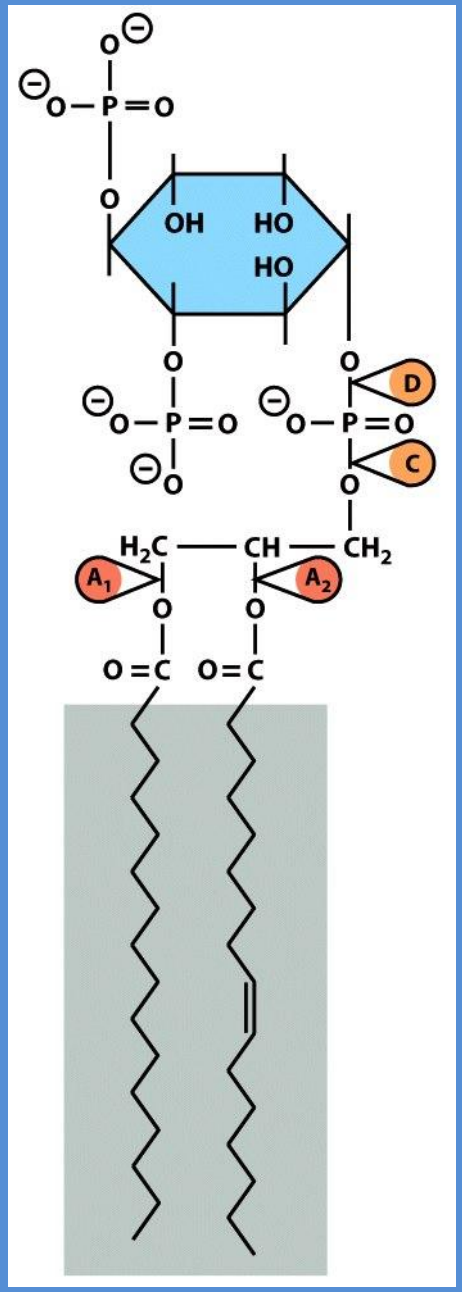
fosfatidilcolina

fosfatidilserina

fosfatidilinositolo

Testa polare

Tratto da: A.L. Lehninger "Introduzione alla Biochimica", ed. Zanichelli

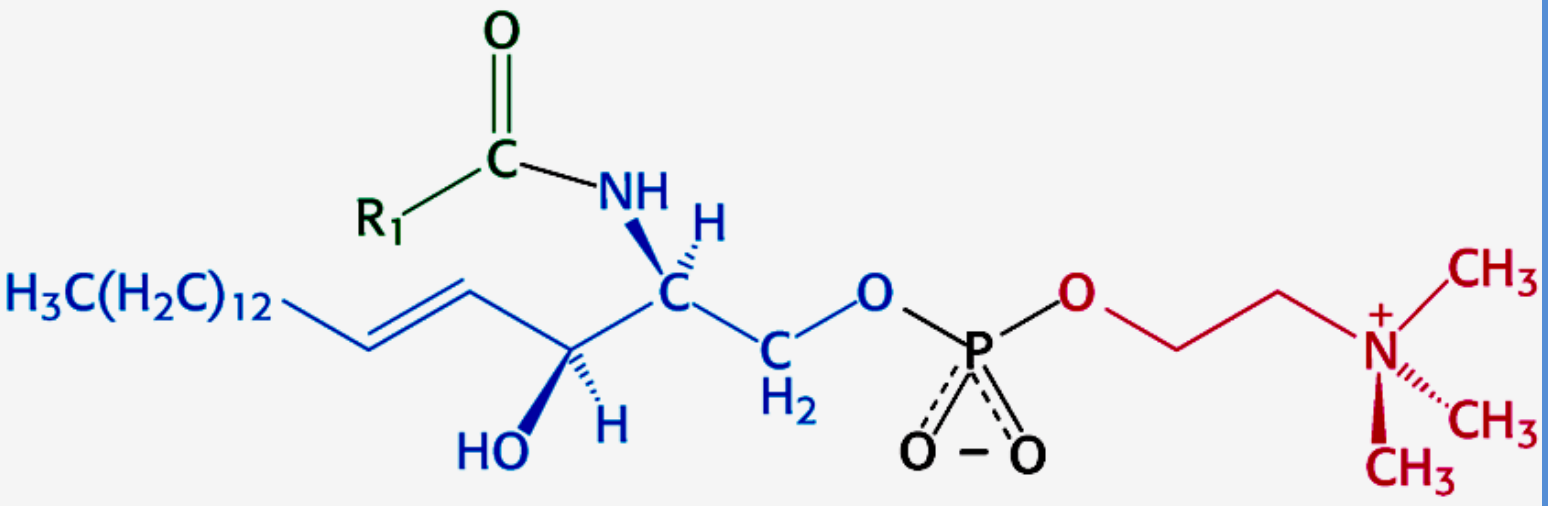


Fosfatidil inositolo e i siti di attacco delle fosfolipasi

Figure 10-17c *Molecular Biology of the Cell* (© Garland Science 2008)

sintesi della sfingosina : palmitoil CoA + serina

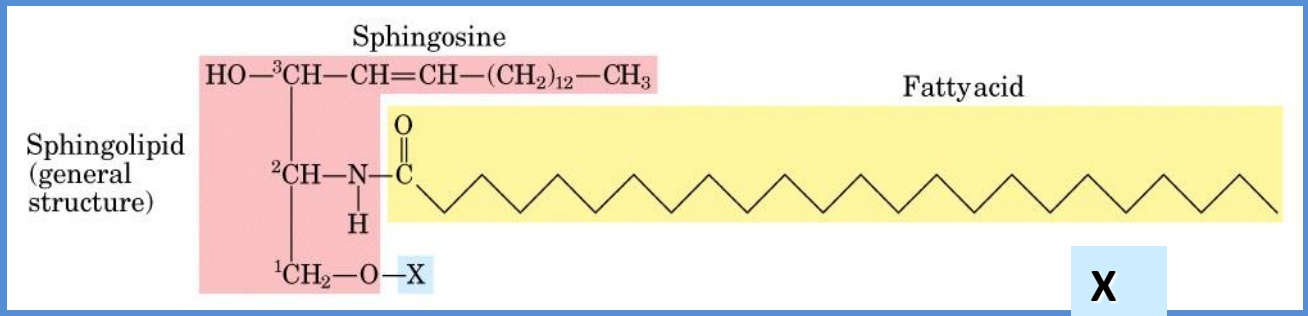
Sfingosina



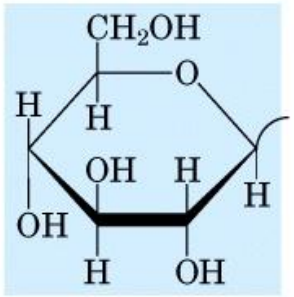
Sfingomielina

STRUTTURA DEI GLICOLIPIDI

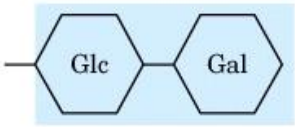
I glicolipidi sono derivati della sfingosina



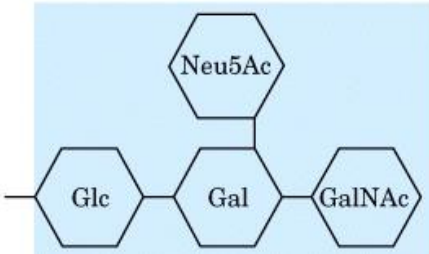
cerebrosidi un monosaccaride: glucosio o galattosio



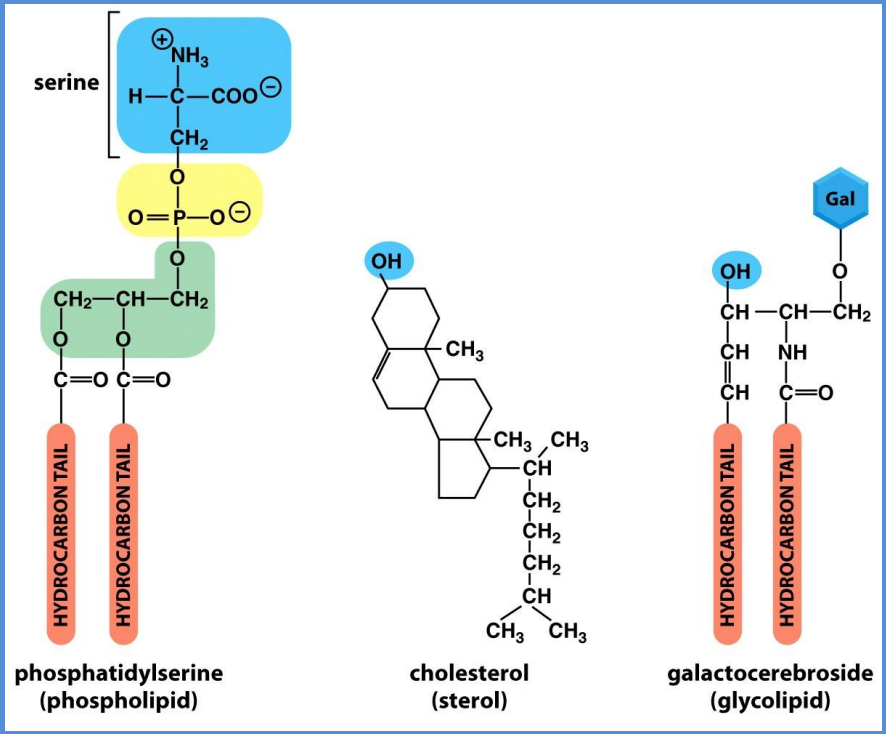
globosidi 2,3,4 monosaccaridi: glucosio o galattosio (neutri)



gangliosidi complesse catene oligosaccaridiche (cariche negativamente)



Tratto da: A.L. Lehninger "Introduzione alla Biochimica", ed. Zanichelli

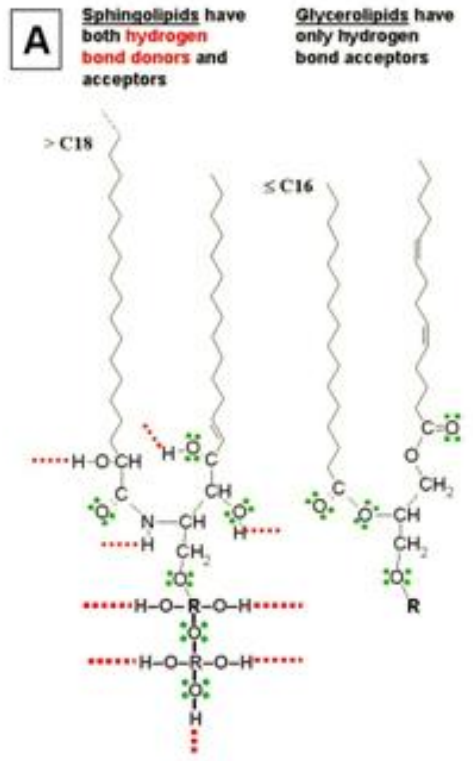


- Gli sfingolipidi presentano **catene idrocarburiche** normalmente **SATURE**

- I glicerofosfolipidi presentano di solito ALMENO una catena **INSATURA**

Figure 11-7 *Essential Cell Biology* (© Garland Science 2010)

Gli sfingolipidi hanno **teste polari** che presentano maggiori possibilità di formare legami H



Glycosynapses: microdomains controlling carbohydrate-dependent cell adhesion and signaling

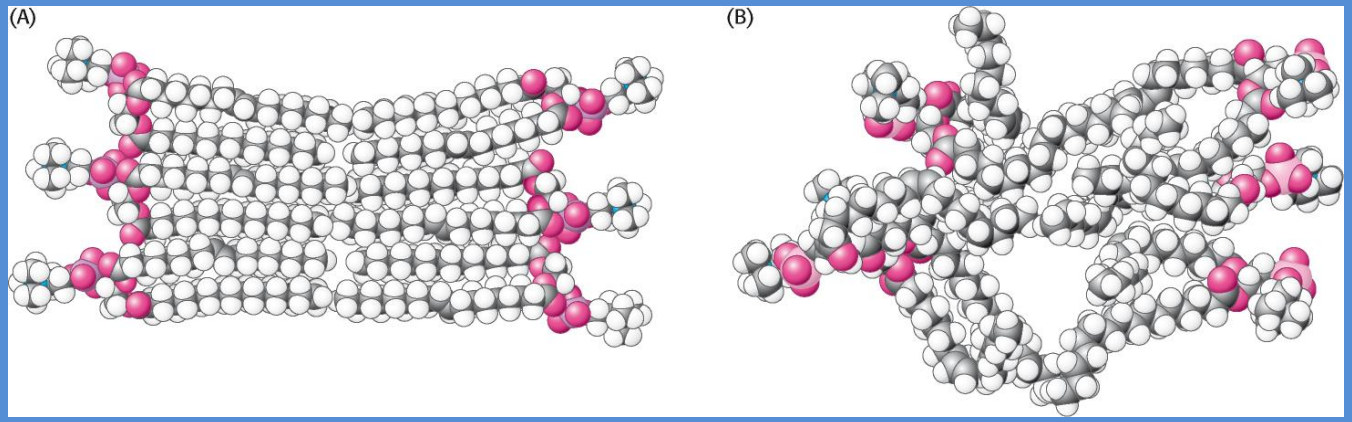
Anais da Academia Brasileira de Ciências (2004) 76(3): 553-572

SENITIROH HAKOMORI

I

Aggregati di glicosfingolipidi (GSL) come base dei microdomini a GSL e loro funzione. Panel A: Basi fisicochimiche degli aggregati di GSL. Gli sfingolipidi ei GSK hanno gruppi idrossilici e aminoacilici che fungono sia da donatori che accettori di legami di idrogeno. Viceversa, i glicerolipidi non hanno gruppi idrossilico e possono fungere solo da accettori di legami di idrogeno. Perciò, l'interazione intorno/laterale è molto superiore fra gli sfingolipidi e GSLs. [Schema modificato da Pascher (1976)]. I GSLs e la sfingomielina (SM) formano una fase detta "liquid-ordered, (lo) ", mentre i glicerolipidi formano una fase "disordered gel phase". Questa differenza di fase riflette il punto di fusione: GSL > 70°; SM 39-41°, glicerofosfolipidi < 0°

Sappiamo che i lipidi tendono spontaneamente in un ambiente acquoso a formare un doppio strato (bilayer) in modo da esporre le teste polari all'acqua e le code idrofobiche sequestrate all'interno del bilayer. Ricordiamo che non sono strutture impaccatissime e regolari ma strutture irregolari con un non perfetto allineamento (mismatch) delle code idrocarburiche



Berg, biochimica zanichelli

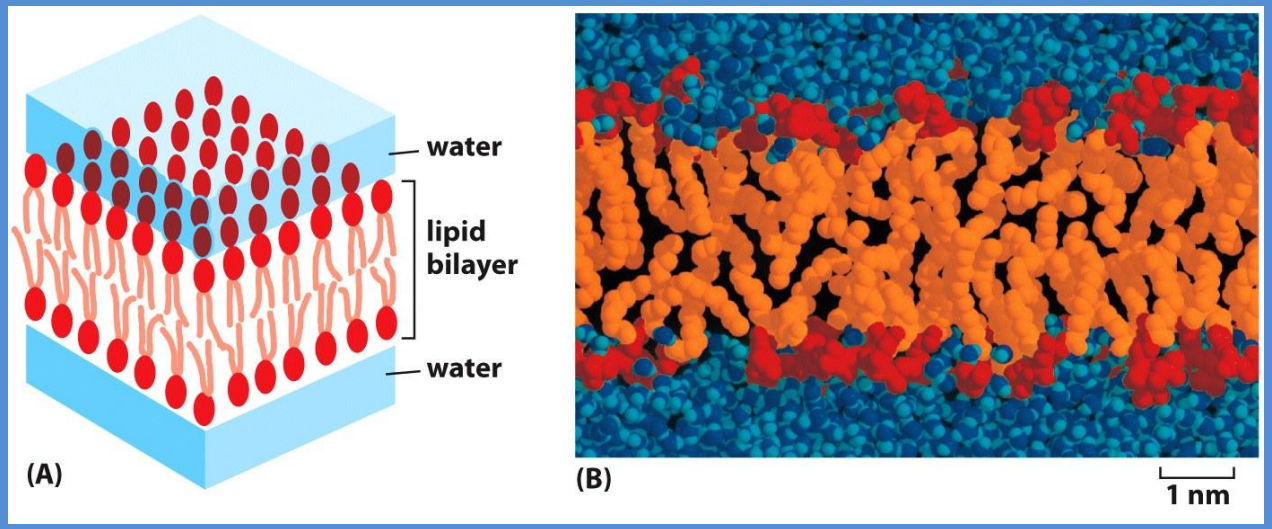


Figure 11-11 *Essential Cell Biology* (© Garland Science 2010)

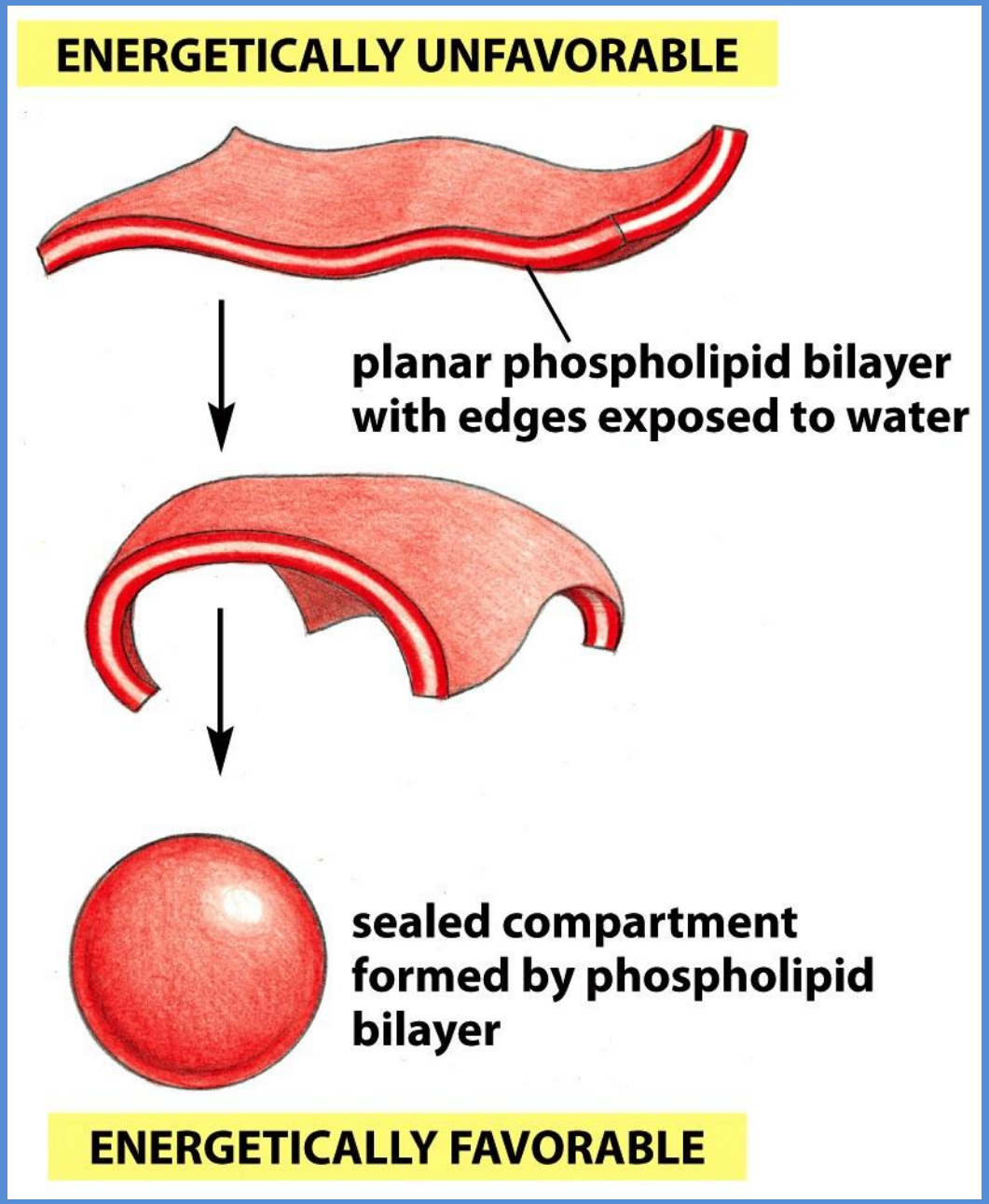
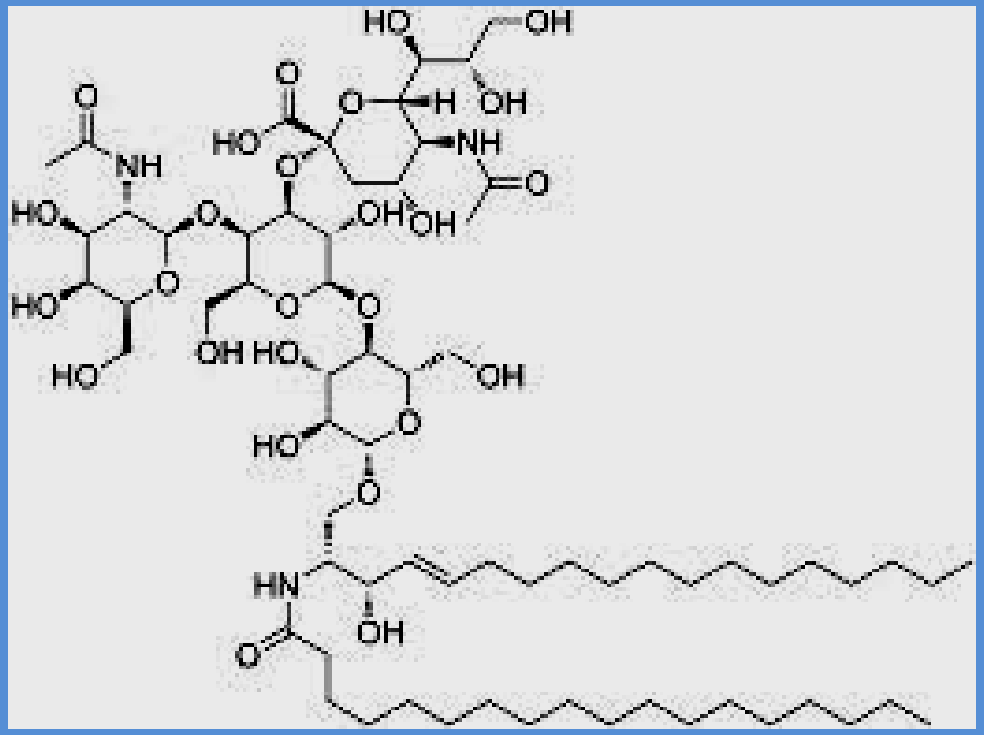
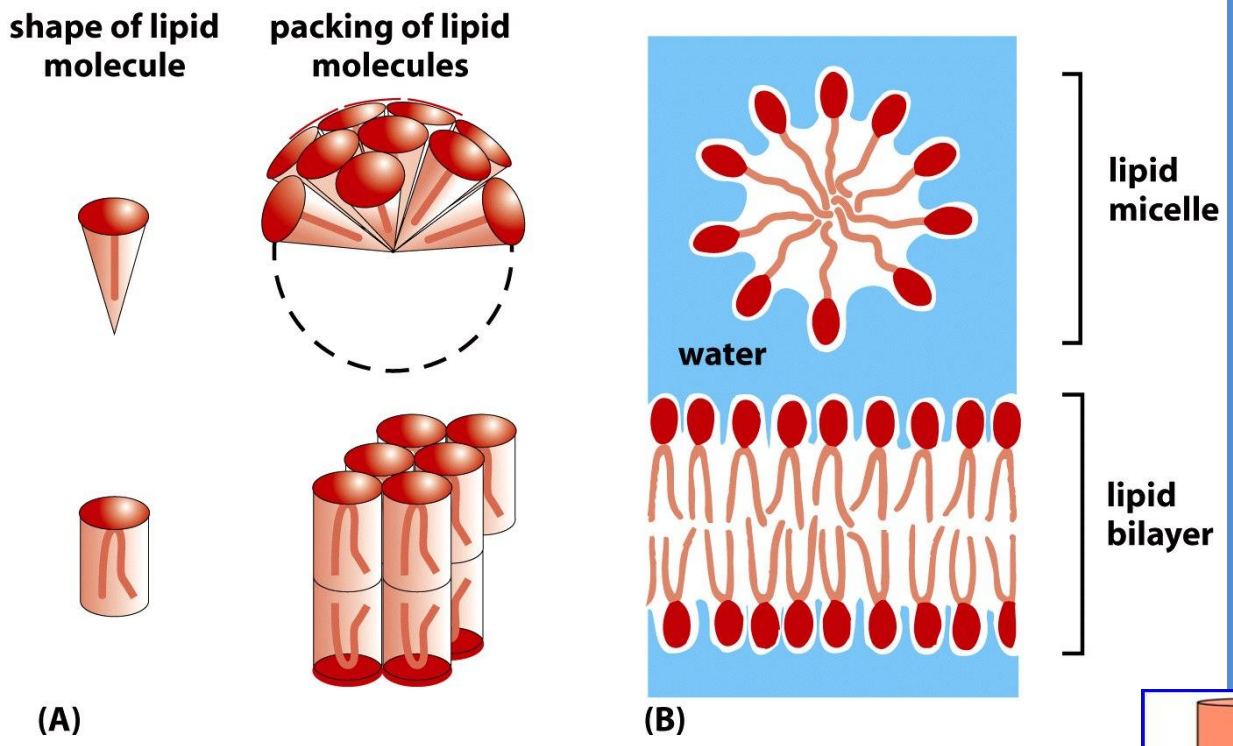


Figure 11-12 *Essential Cell Biology* (© Garland Science 2010)

Di regola ammettiamo che i lipidi anfipatici (FOSFOLIPIDI) tendano a formare spontaneamente il bilayer, ma questo non e' vero per gli glicosfingolipidi piu' complessi come i **gangliosidi** in cui la testa polare ha un tale ingombro da non permettere la formazione di vescicole ma solo di micelle.





La geometria stessa del lipide puo' rendere ragione della sua capacita' di formare diversi tipi di aggregati