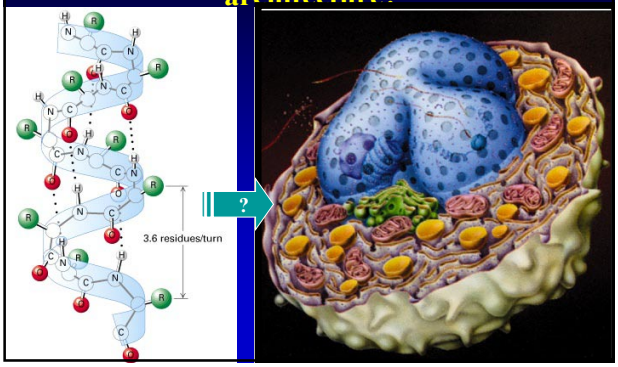
What is membrane traffic about?

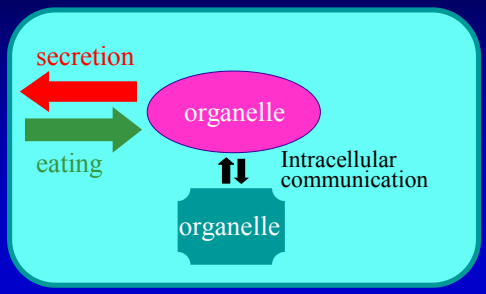
Organelle Biogenesis

How is the linear information of the genome translated into a 3-D cellular architecture?



Traffic must be tune balanced, regulating the organelles' specific identity

Extra-cellular environment



What is membrane traffic about? - summary

- Vectorial movement of proteins and lipids in membranes
- Protein processing and maturation
- Morphology of of intracellular organelles

Hallmarks of membrane traffic Summary

- The membrane traffic flows along highly organized and directional routes.
- The flow of membranes between compartments is mediated by membrane containers (vesicles) carrying cargo from one compartment to another.
- Membrane traffic is balanced. The morphological and functional identity of each organelle is kept despite the massive material exchange (communication) between different organelles.

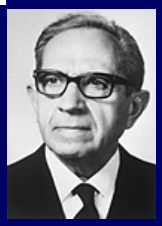
INTRODUCTION

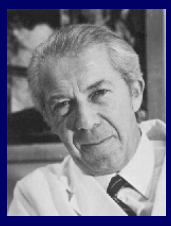
- What is membrane traffic about?
- Membrane organelles and intracellular pathways
- Membrane traffic is important for maintaining organelle's identity
- Membrane traffic is an important field in cell biology

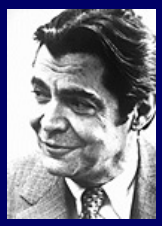
Cellular histology

Camillo Golgi
(1843-1926)
1906 Nobel Laureate
in medicine

Discovery of lysosomes and the secretory pathway





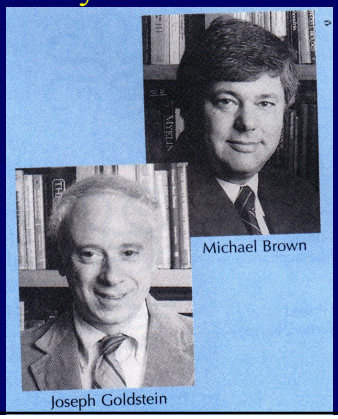


Albert Claude Christian De Duve George Palade

for their discoveries concerning the structural and functional organization of the cell

Cholesterol synthesis and traffic

Metabolism
of cholesterol



Protein biosynthesis and translocation

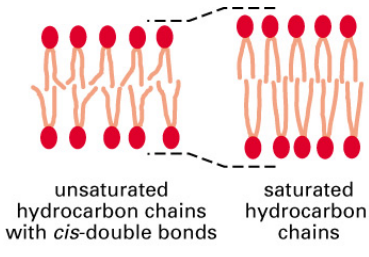
Gunther Blobel
Protein targeting

Rafting over a sea of lipids

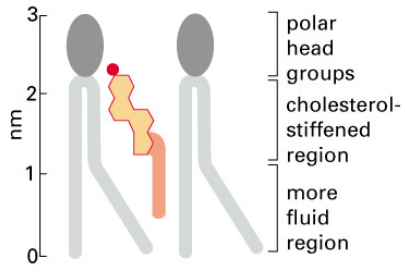
The concept of lateral membrane domains - lipid rafts

The strongest principle that underlies membrane biology (traffic) is the ability of membranes to form and maintain
LATERAL DOMAINS

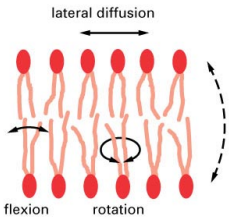
Saturated fatty acids (less cis double bonds) make the membrane thicker and more order



Cholesterol intercalates between phospholipids



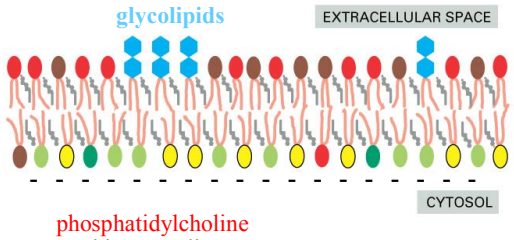
Most lipids and many proteins are Laterally mobile on the surface of biomembranes



Flippases do not occur in most membranes

MCB chapter 10

Phospholipids and glycolipids are distributed asymmetrically across the lipid bilayer



phosphatidylcholine
sphingomyelin
phosphatidylserine
phosphatidylethanolamine

Figure 11-17 Essential Cell Biology, 2/e. (© 2004 Garland Science)

In old and dead cells

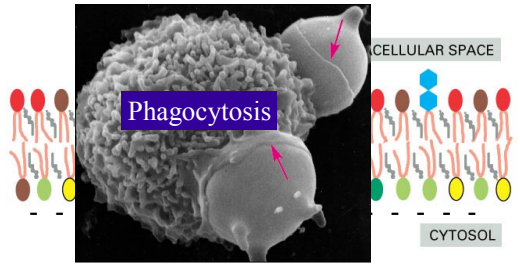
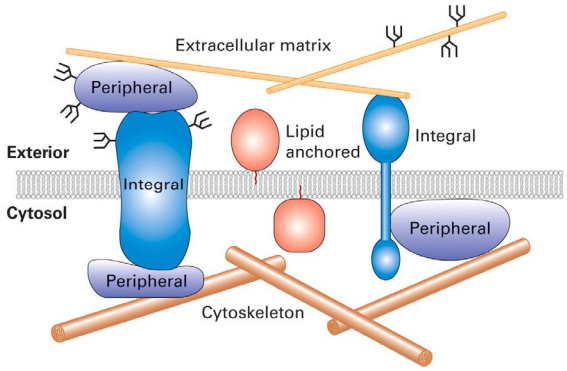
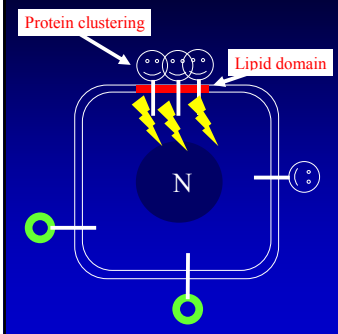


Figure 11-17 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Proteins are distributed asymmetrically across the lipid bilayer



Lateral membrane domains



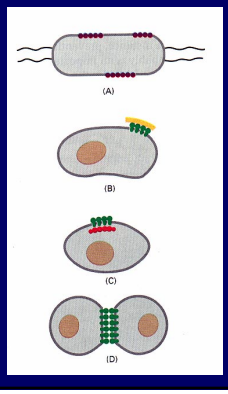
Structure:

- High concentration of certain proteins and lipids
- Little exchange with the surrounding membrane
- Retention

Functions:

Working platform for enzymes.
Increasing the efficiency of biological work.

Mechanisms for membrane protein clustering in lateral domains

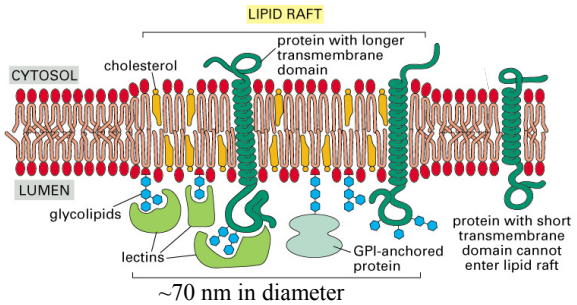


protein-protein

protein-exoskeleton

protein-cytoskeleton

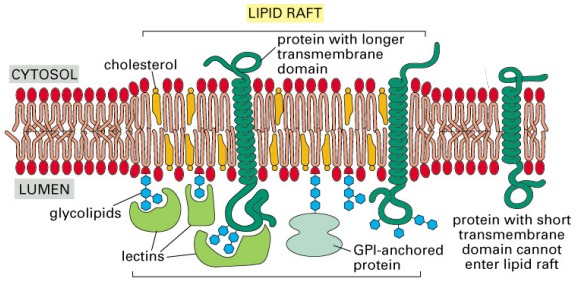
Cell-cell adhesion



~70 nm in diameter

The membrane in rafts is though to be:

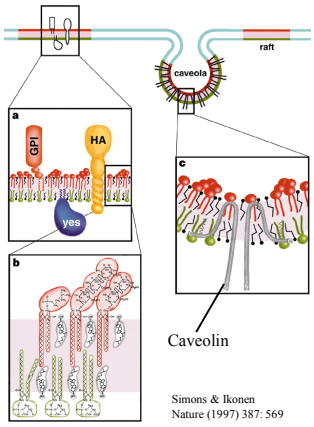
- More ordered
- Less fluid
- Thicker



Concentration of

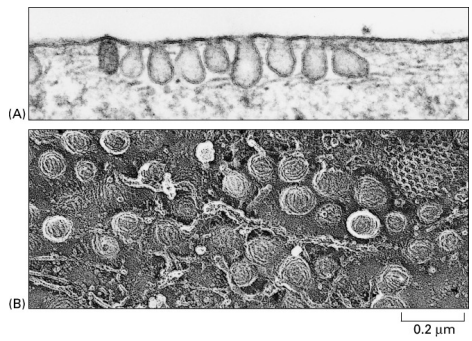
- Lipids with longer and straighter (saturated) fatty acid chains (mainly Glycolipids)
- Cholesterol (glue)
- Membrane proteins with longer trans-membrane domains
- GPI-linked proteins
- Signaling proteins

Lipid rafts serve as signaling platforms

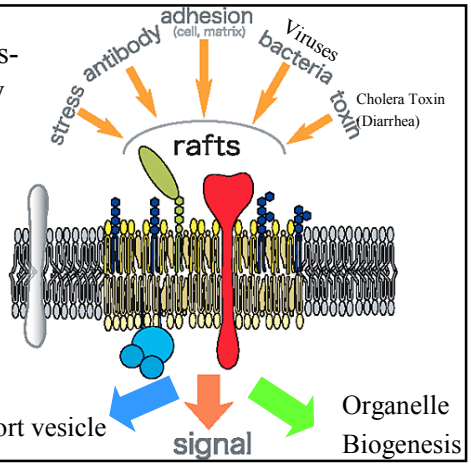


Simons & Ikonen
Nature (1997) 387: 569

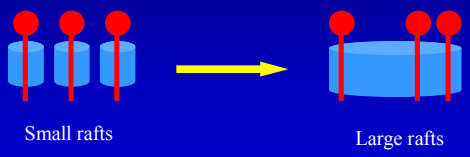
Caveolae

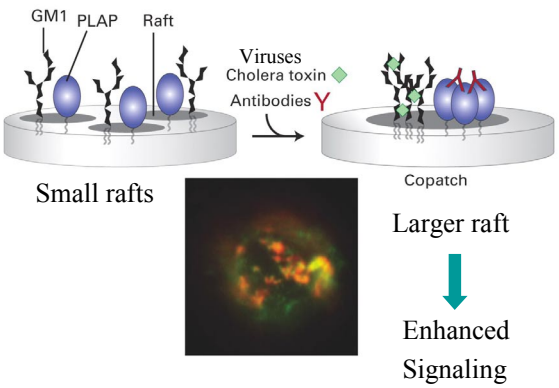


Lipid Rafts-
Summary

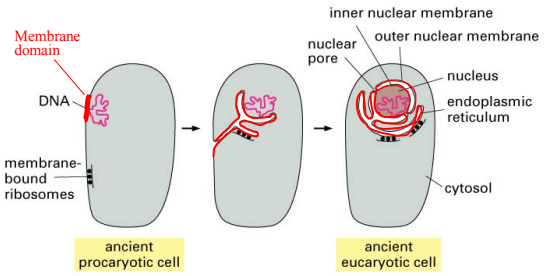


Rafts can be induced to form larger raft platforms





Membrane domains and the evolution of organelles



Summary

- Rafts are small (50 - 100 nm) membrane domains enriched with cholesterol and sphingolipids
- Rafts are dynamic - can be induced to become larger
- Rafts are involved in transmitting signals from the external environment into cell's interior, and in vesicle/organelle biogenesis

?

- How many membrane domains are there?
- What is their biochemical and biophysical nature?
- How membranes regulate their assembly (dynamics)?
- What is their cellular function?