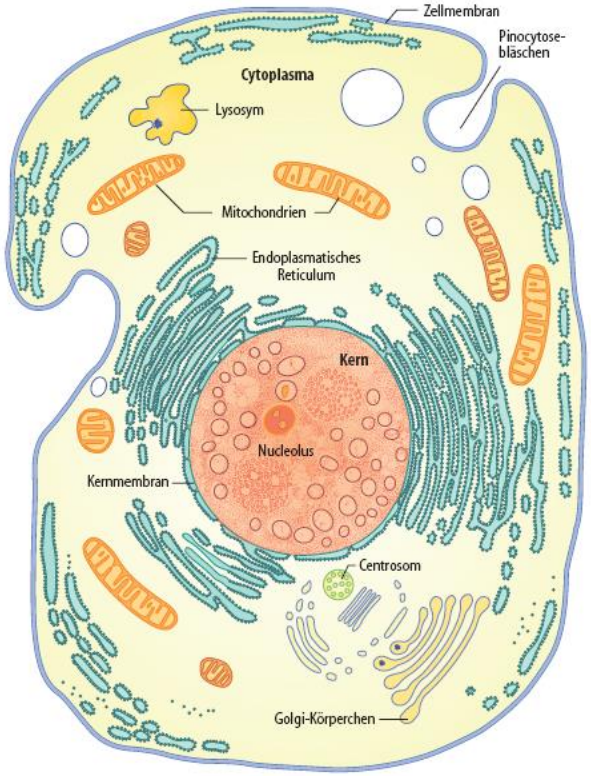
Membranes and Signal transduction

Importance of cell membranes:

a) Border (outer – inner)
b) Barrier (protection)
c) Substance- and Information exchange
d) Recognition
e) Formation of tissues

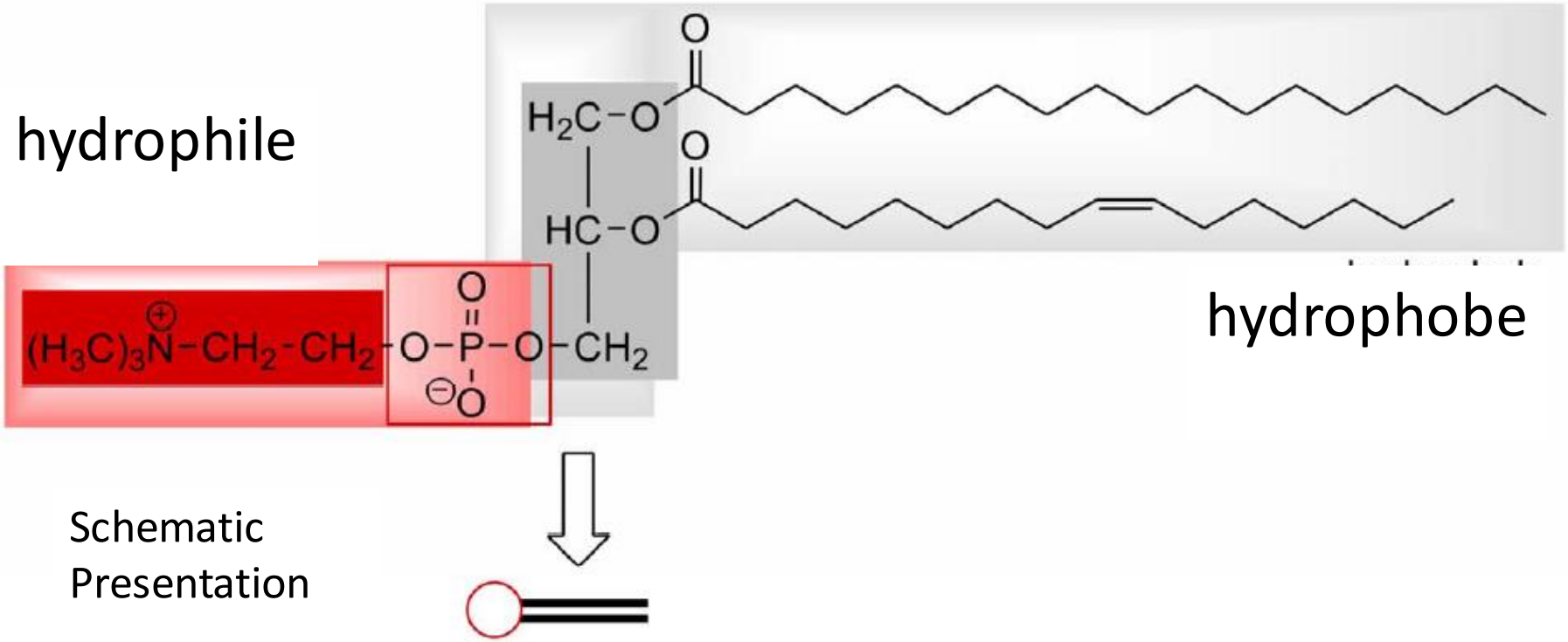


Composition of Membranes:

a) Lipids (Phospholipids)	79%
b) Proteins	18%
c) Carbohydrates (Lipid- and Protein-bound)	~ 3%

Phosphatidylcholine

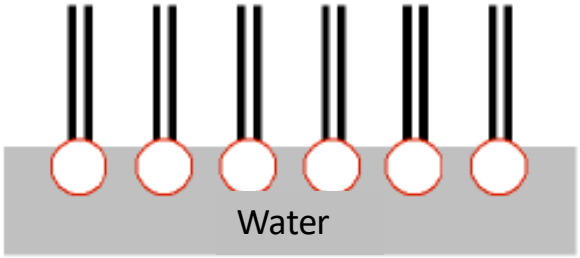
hydrophile



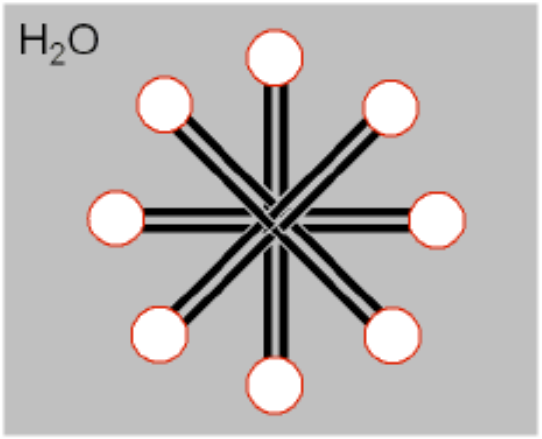
hydrophobe

Schematic
Presentation

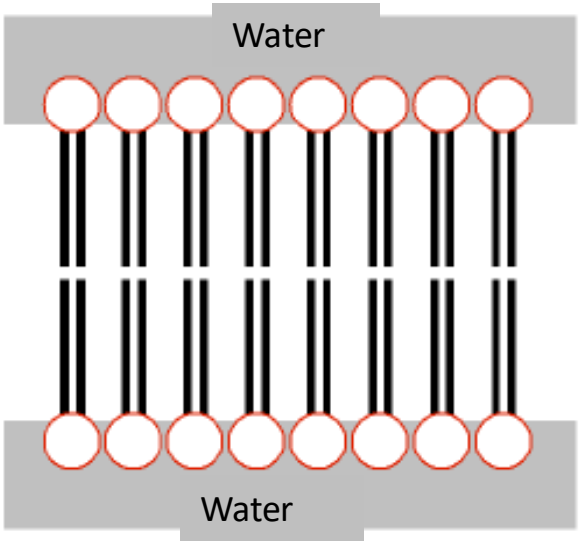
Monomolecular layer
(Air or lipophilic phase)



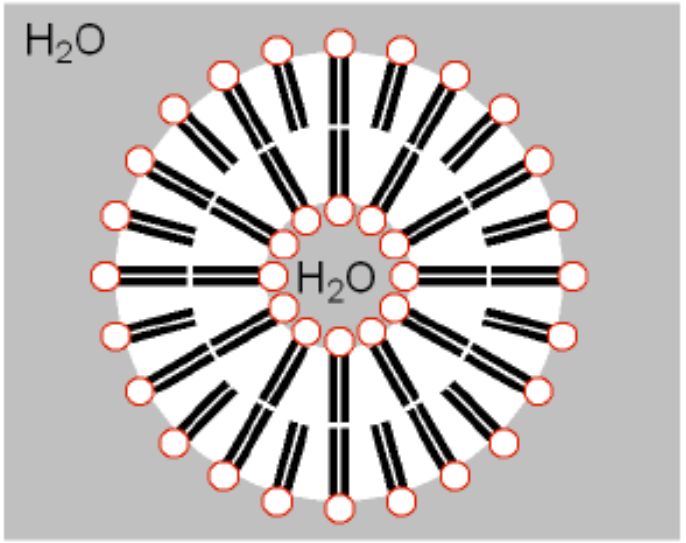
b) Micelle

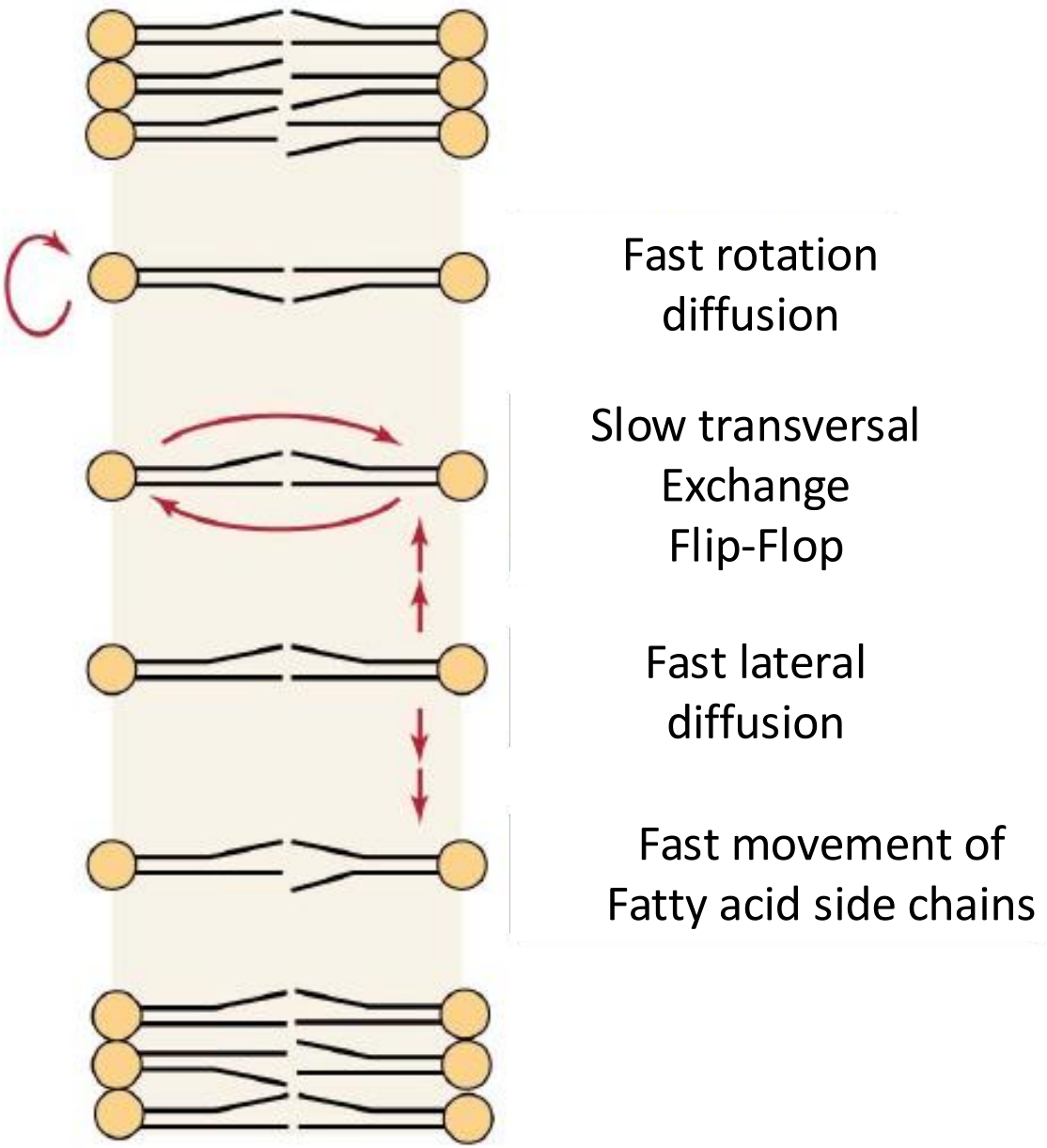


Double-molecular layer



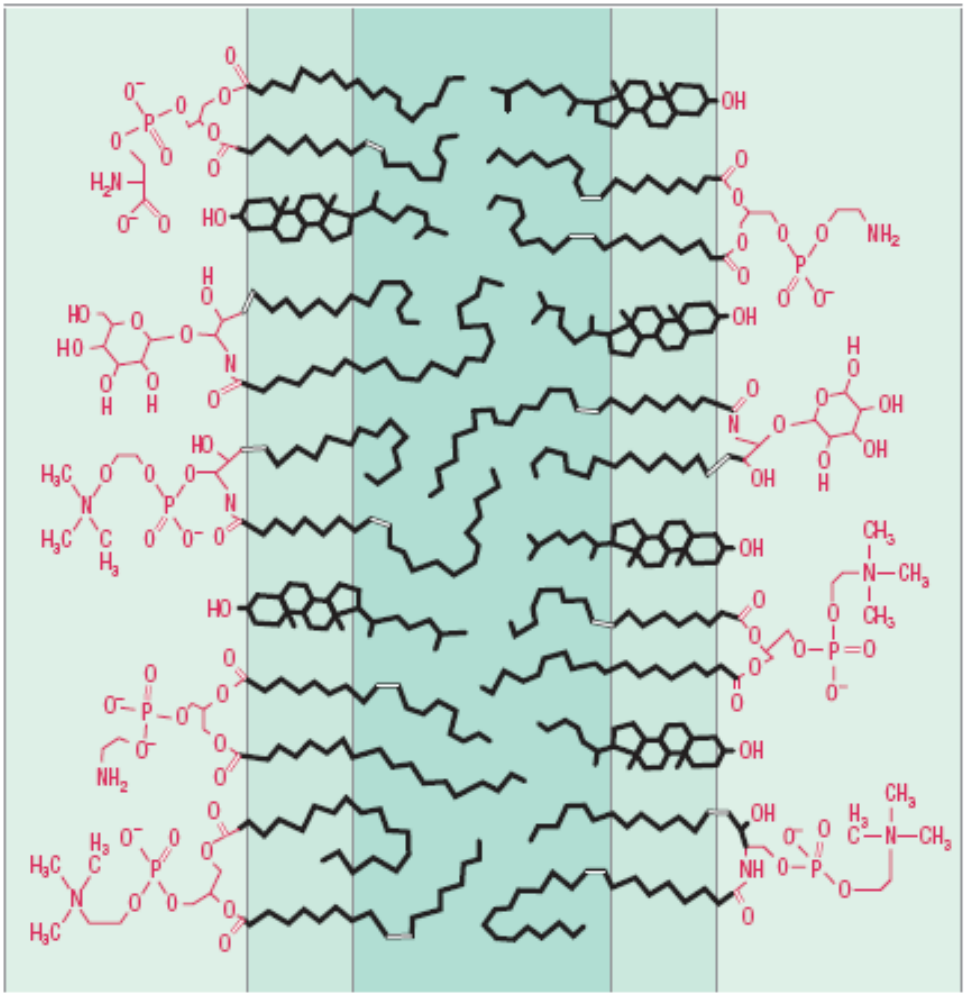
Liposome, Vesicle
(classical cell membrane)





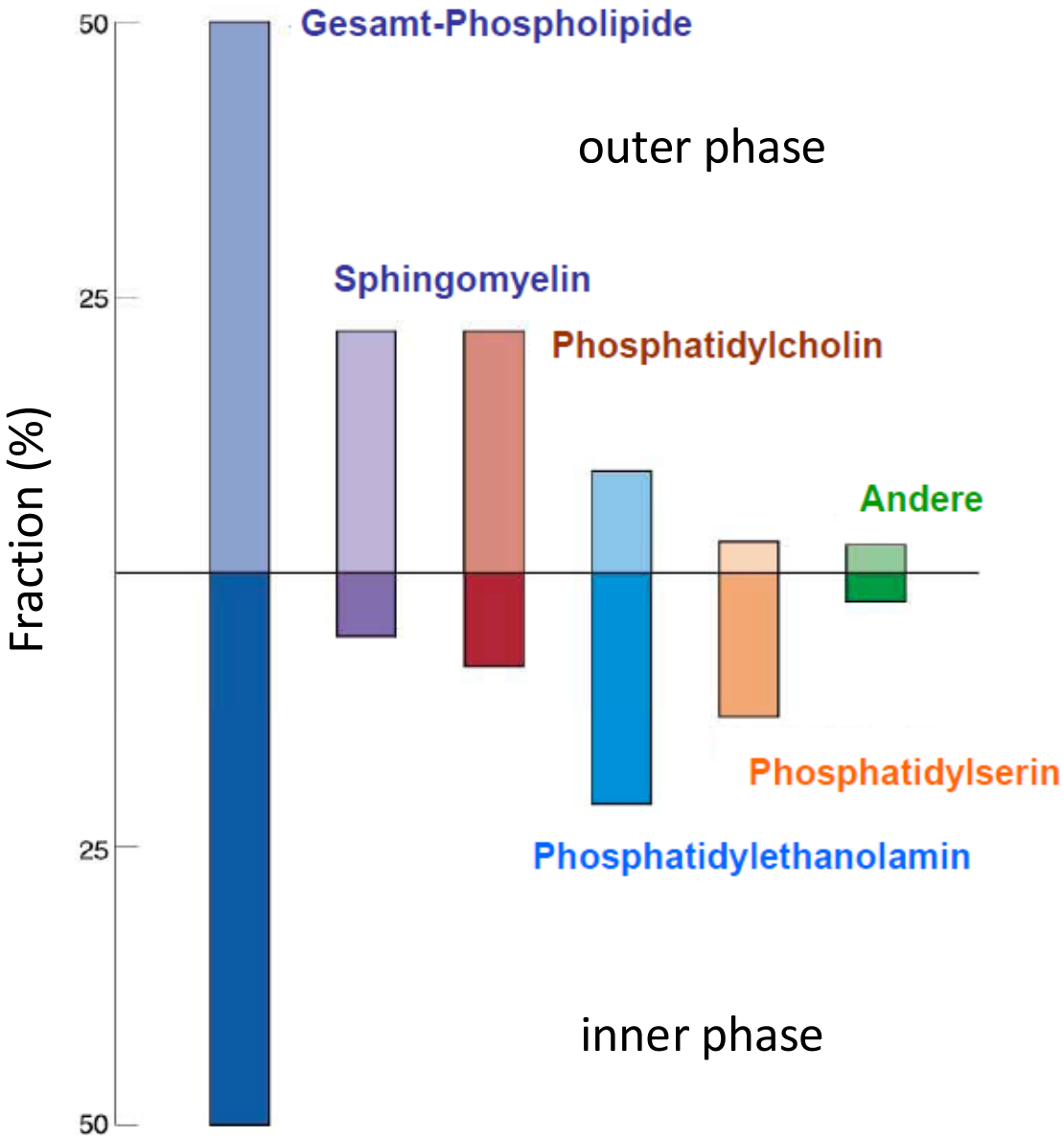
Mobility of membrane components

The double membrane is not homogenous



Intracellular Water/Protein | polar groups | fluid Phase | polar Groups | extracellular Water/Protein

Asymetric Distribution of Lipids in the Membrane

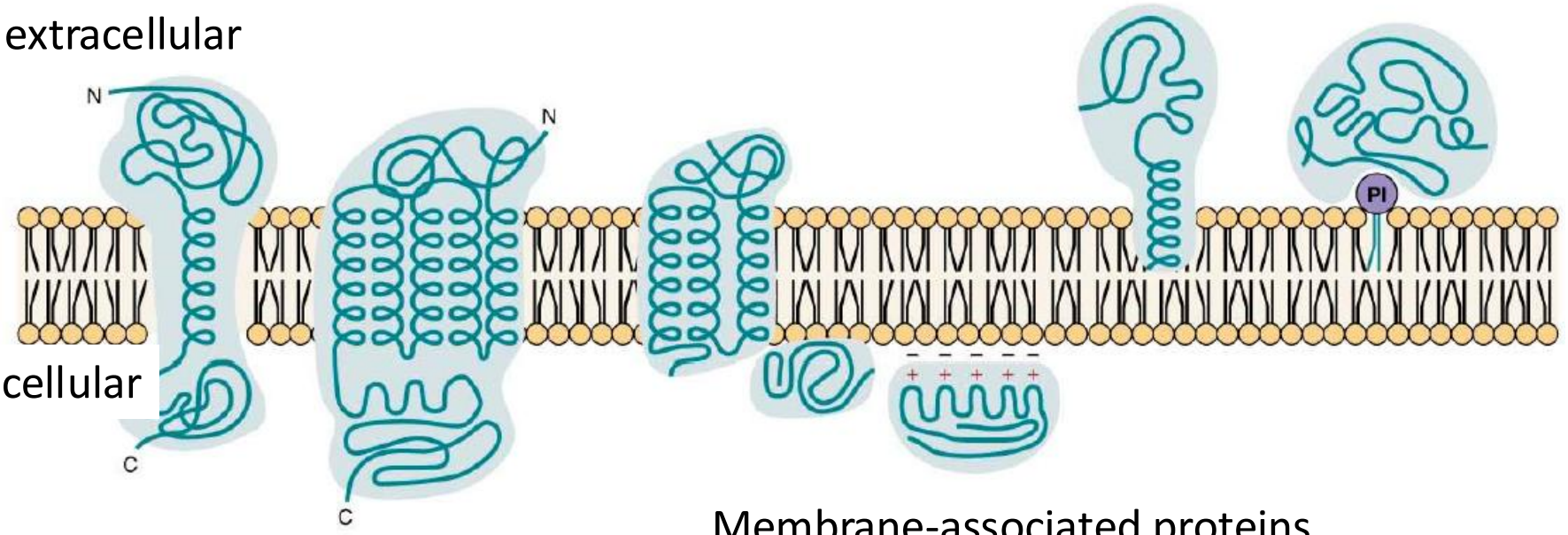


Proteins of the Membrane

integral membrane proteins

Peripheral membrane proteins

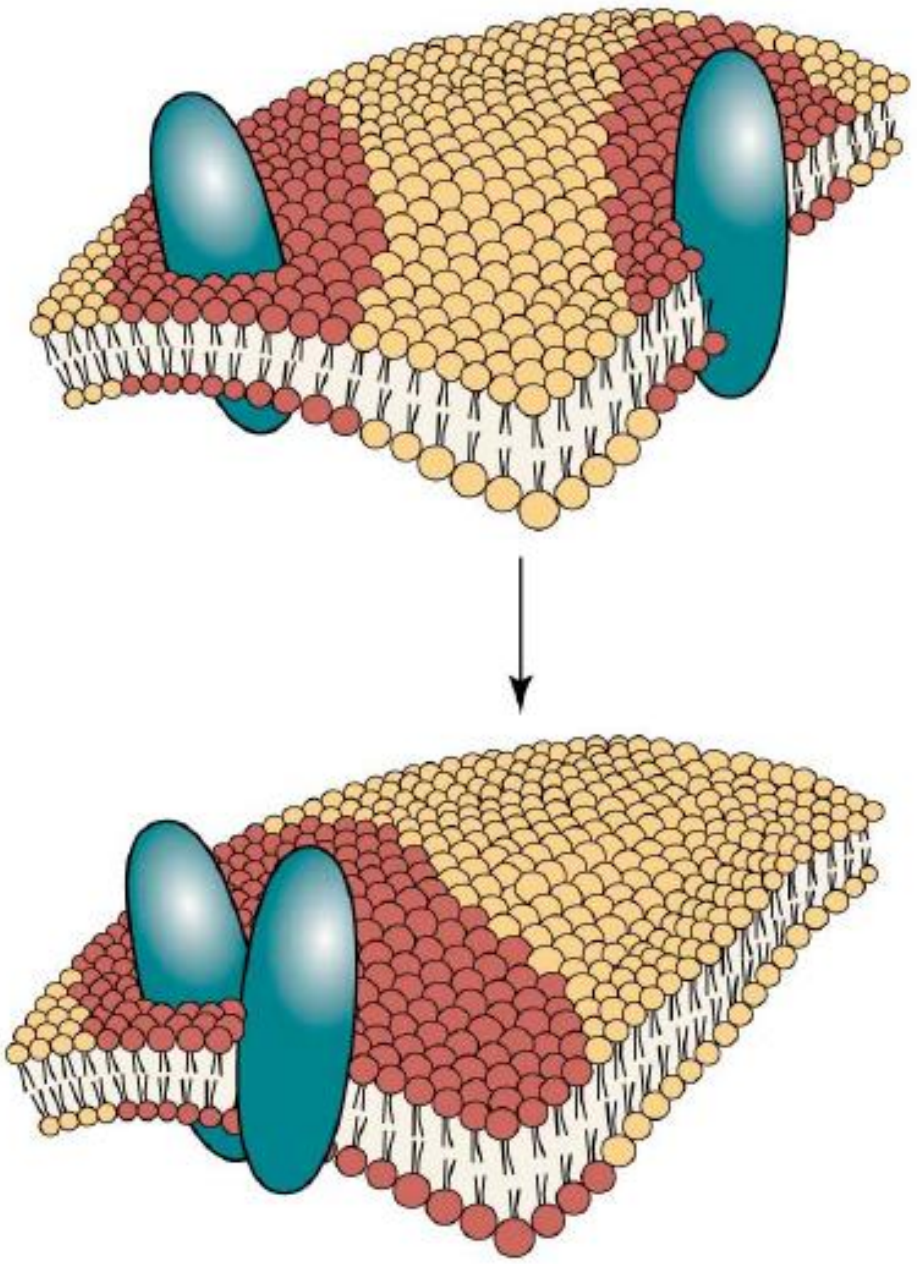
extracellular



intracellular

Membrane-associated proteins

Lipid Rafts



Summary

Membranes:

- thickness in human cells: 70-100 Å
- Lipid-Double layer with Proteins
- Asymetric Double layer
- Fluid Mosaic (Lipid Rafts)

Properties of Membranes

Non-permeable for:
water, ions, charged molecules
polar substances
peptides and proteins
Macromolecules

permeable for:
small, lipophilic molecules
small, non-polar substances

Transport:
- diffusion
- active transport primary
  secondary
- special case: gap junctions

Membrane Proteins

Adhesion proteins
Cadherins, CAM, Integrins

Carrier
Antiporter, Symporter

Pore proteins
Aquaporins

Receptors
G protein-coupled receptors (GPCR)
Receptor Tyrosine Kinases (RTK)
Receptor Serine/Threonine kinasen
Receptor guanylyl cyclases
Tyrosine kinase-coupled receptors

Ion channel
- Physiology - Lectures!

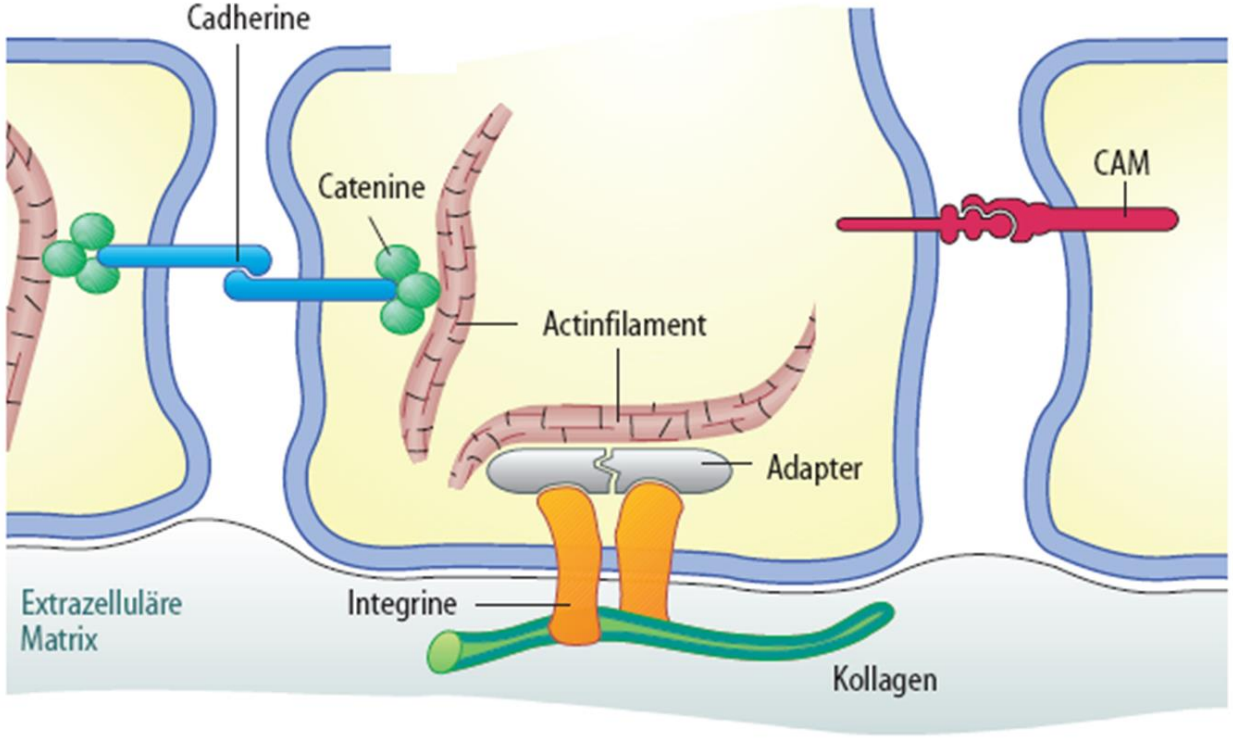
Adhesion proteins

Cell adhesion molecules:

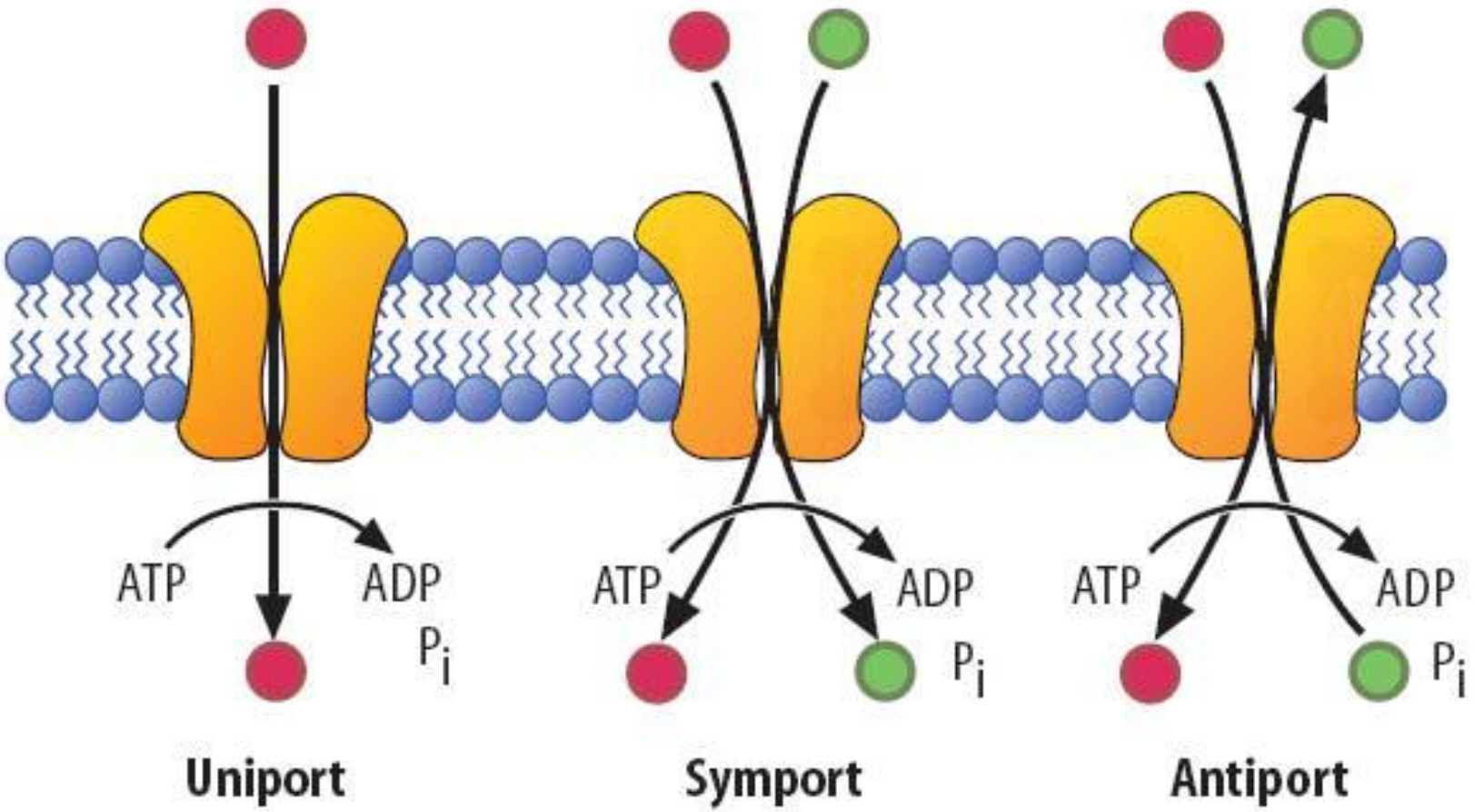
- homologous binding: (E-Cadherin, N-Cadherin)
- heterologous binding: (CAMs – cell adhesion´molecules; N-CAM, I-CAM)

Matrix Protein Receptors:

- Integrins (Transmembrane Proteins; Heterodimers)
- Dystroglykan

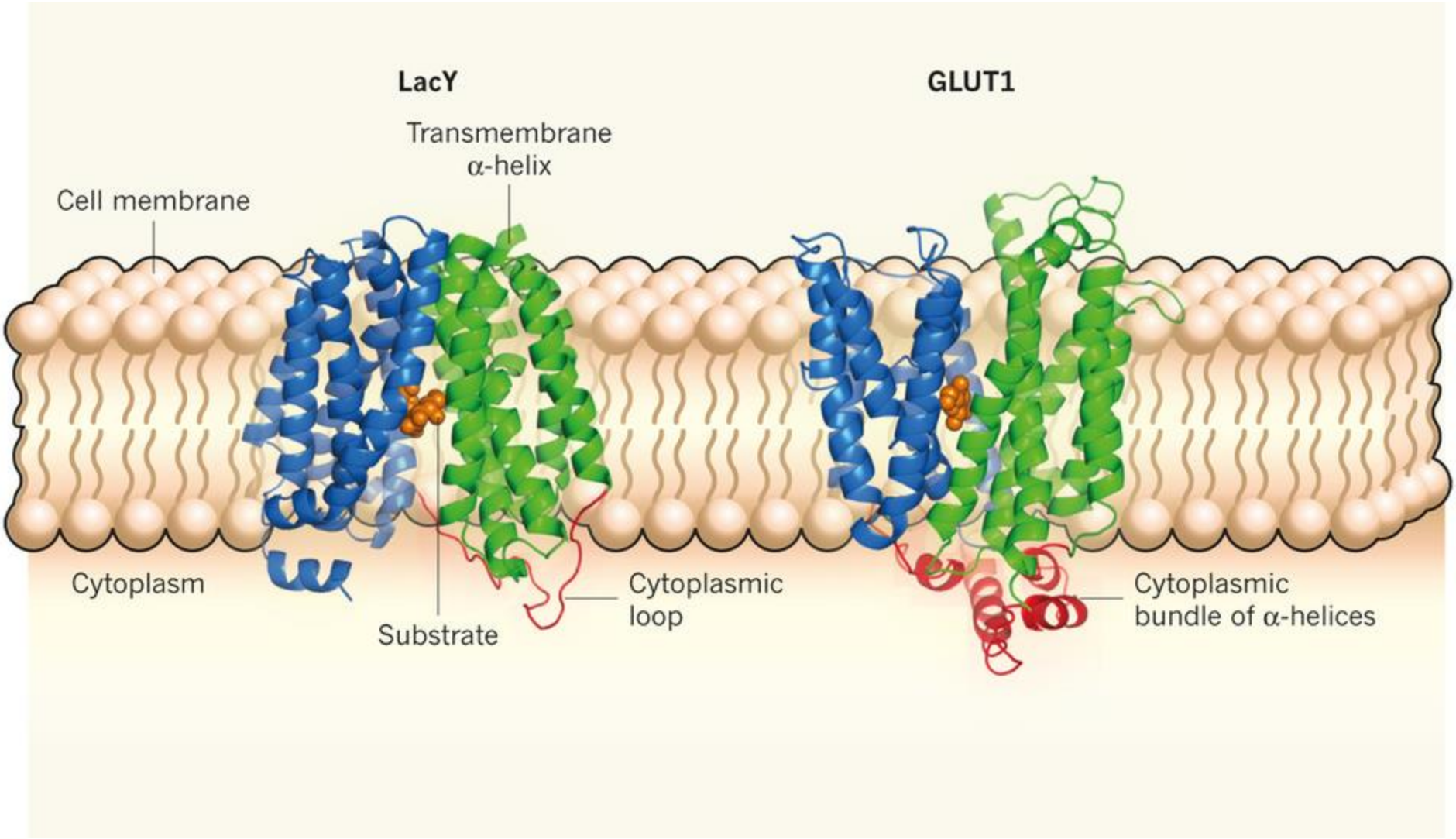


Transport proteins - Carrier



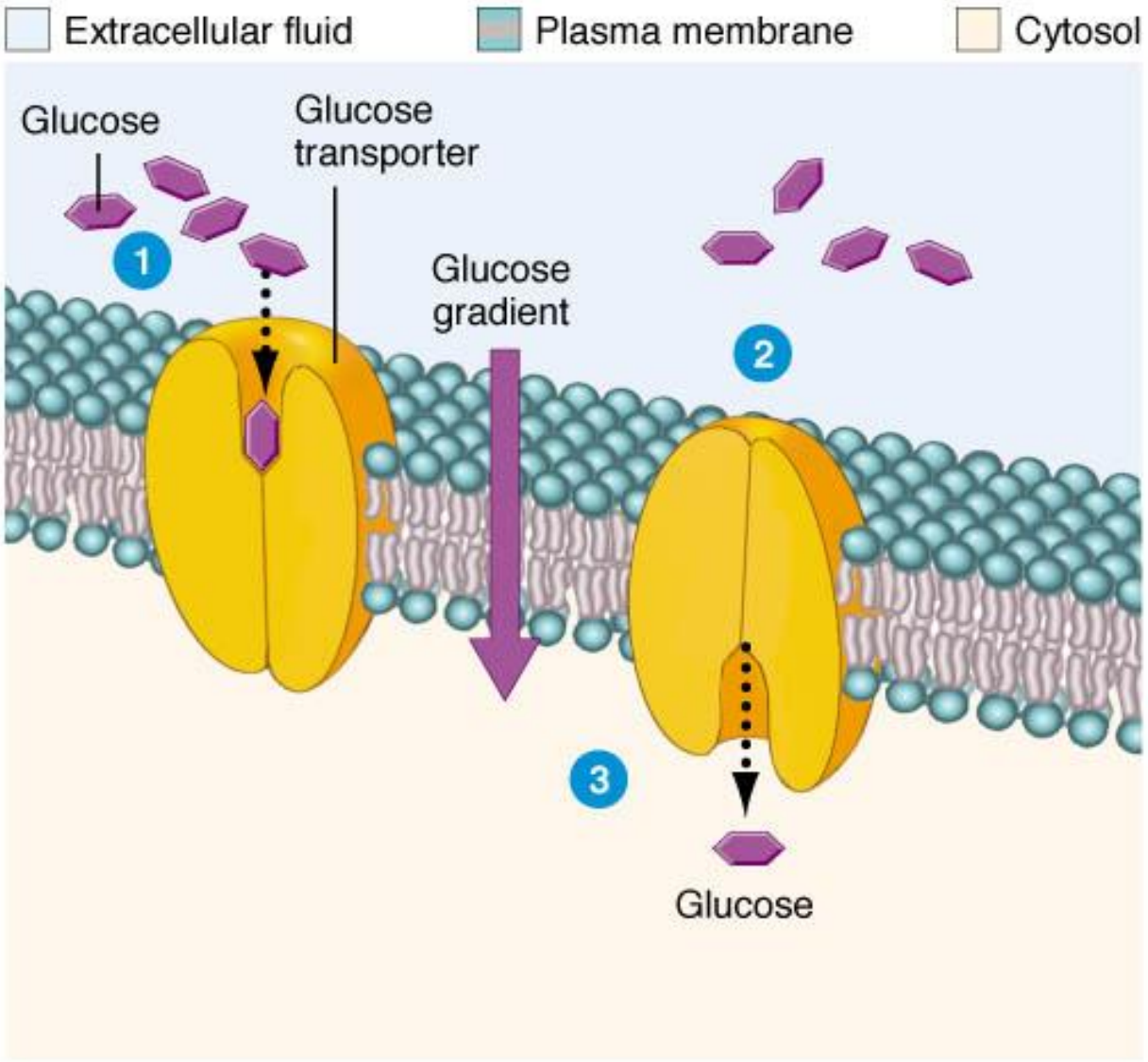
Transport proteins – Carrier

Sugar Transporter

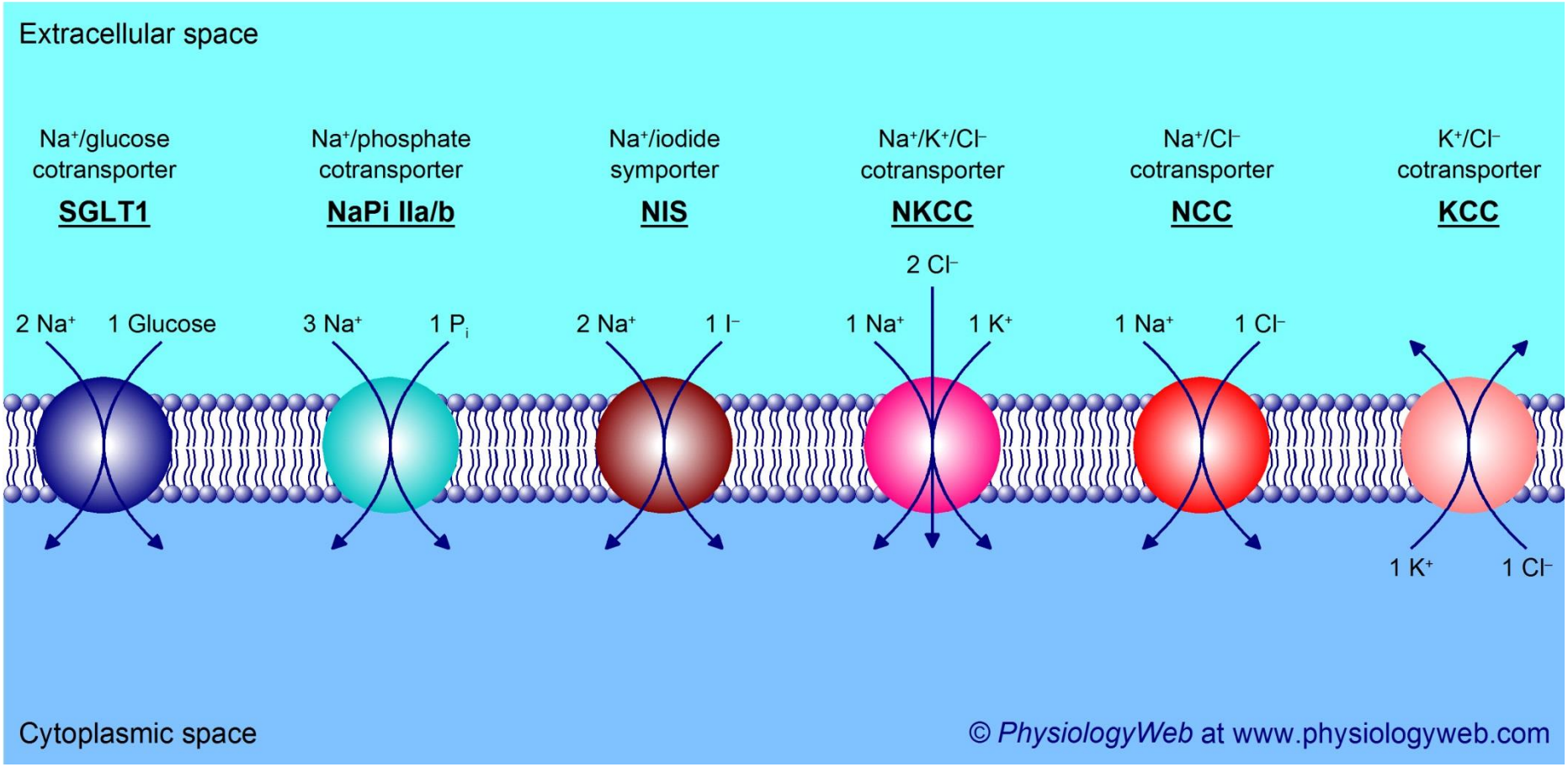


Transport proteins – Carrier

Sugar Transporter

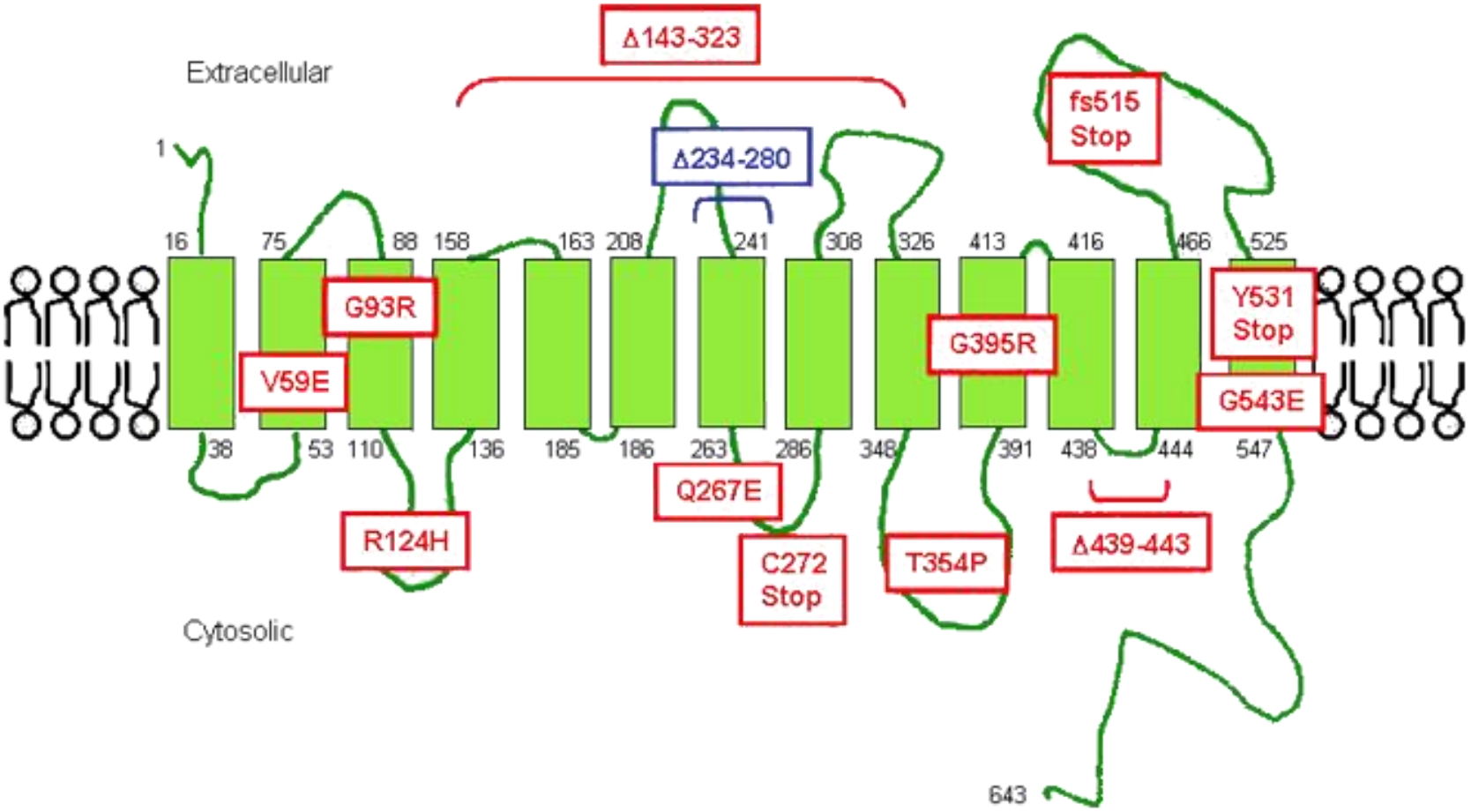


Transport proteins - Symporter



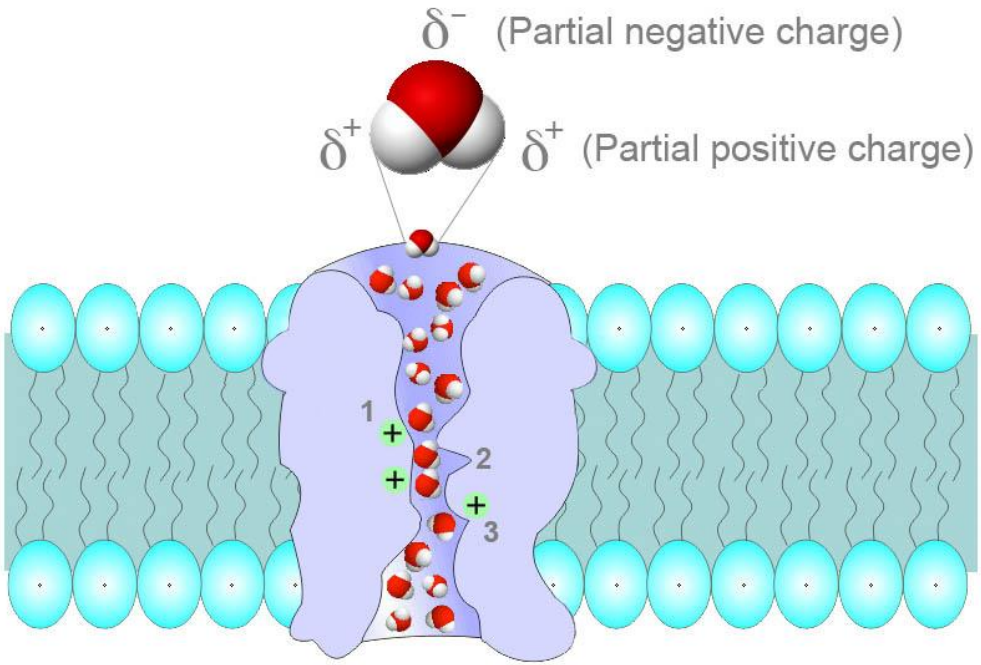
Transport proteins – Carrier

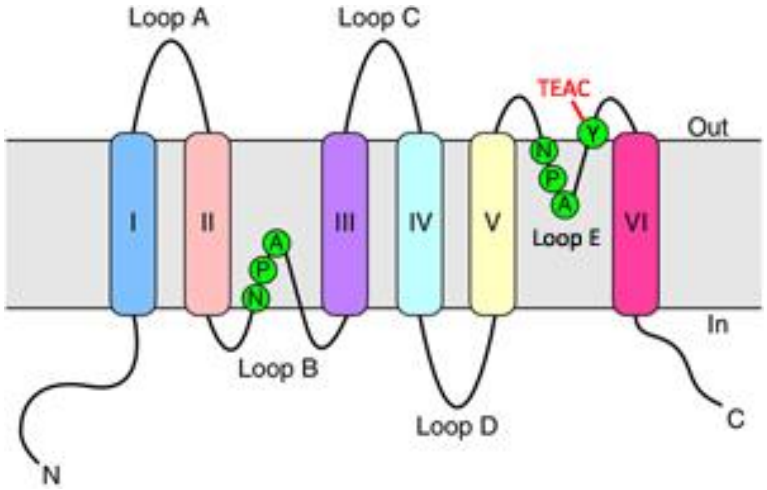
Na-I-Symporter

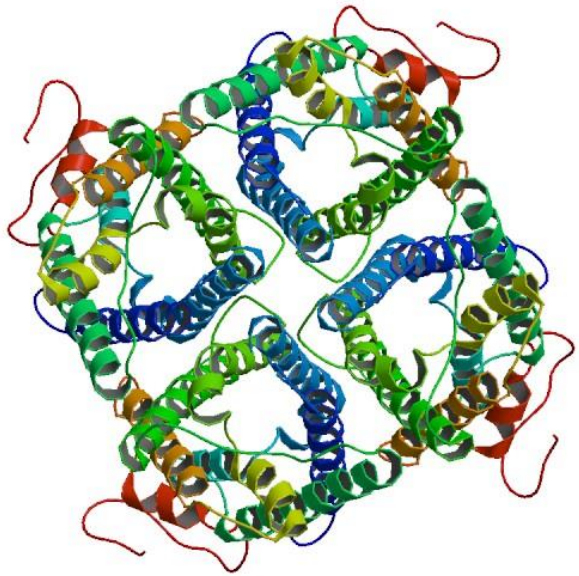


Pore proteins

Aquaporins

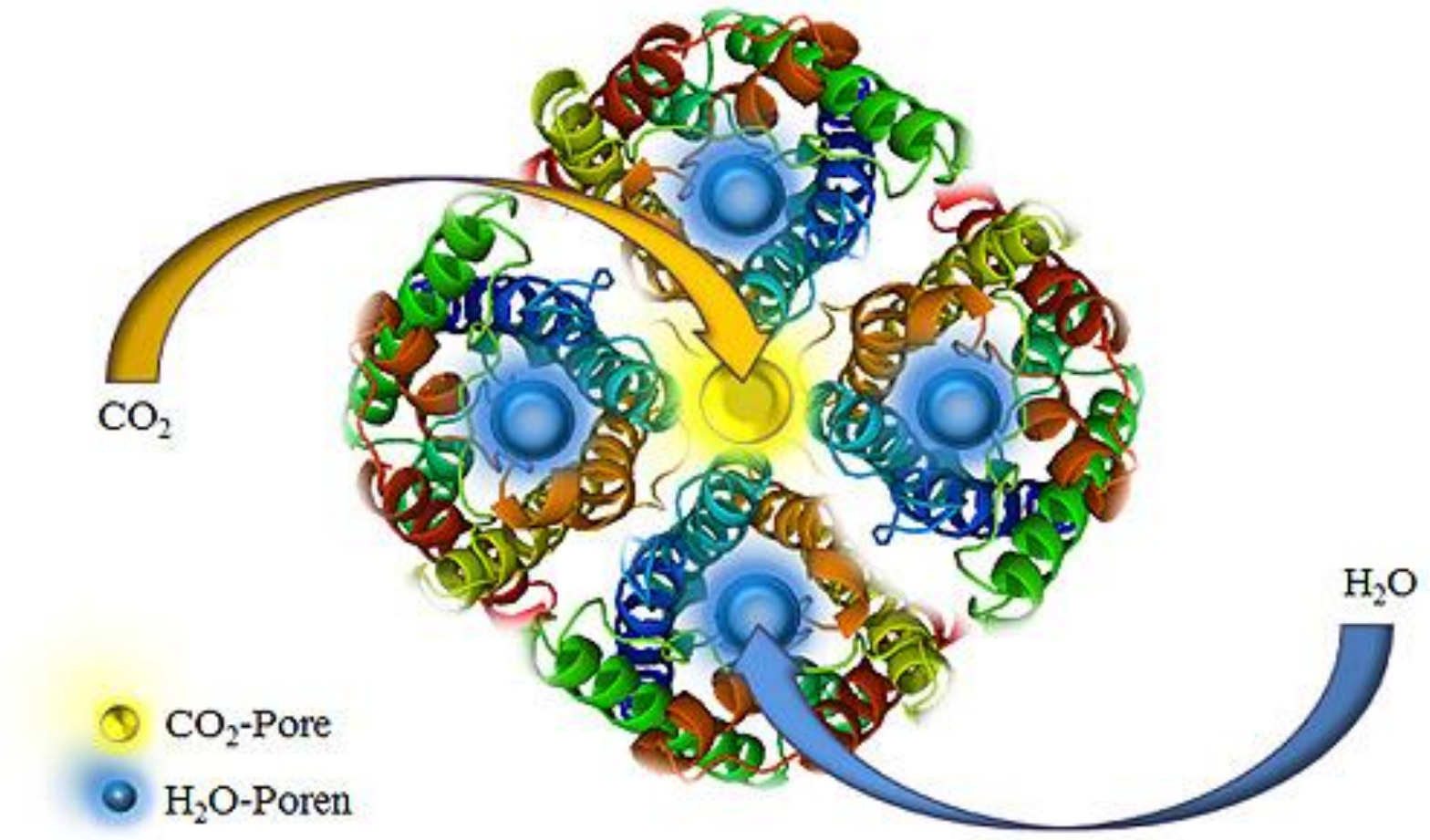






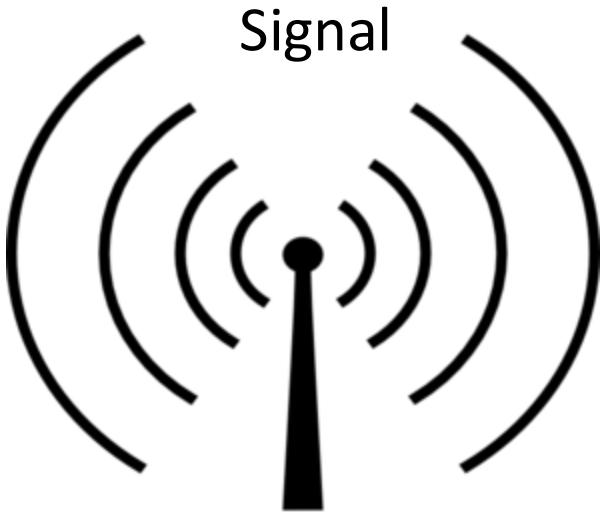
Pore proteins

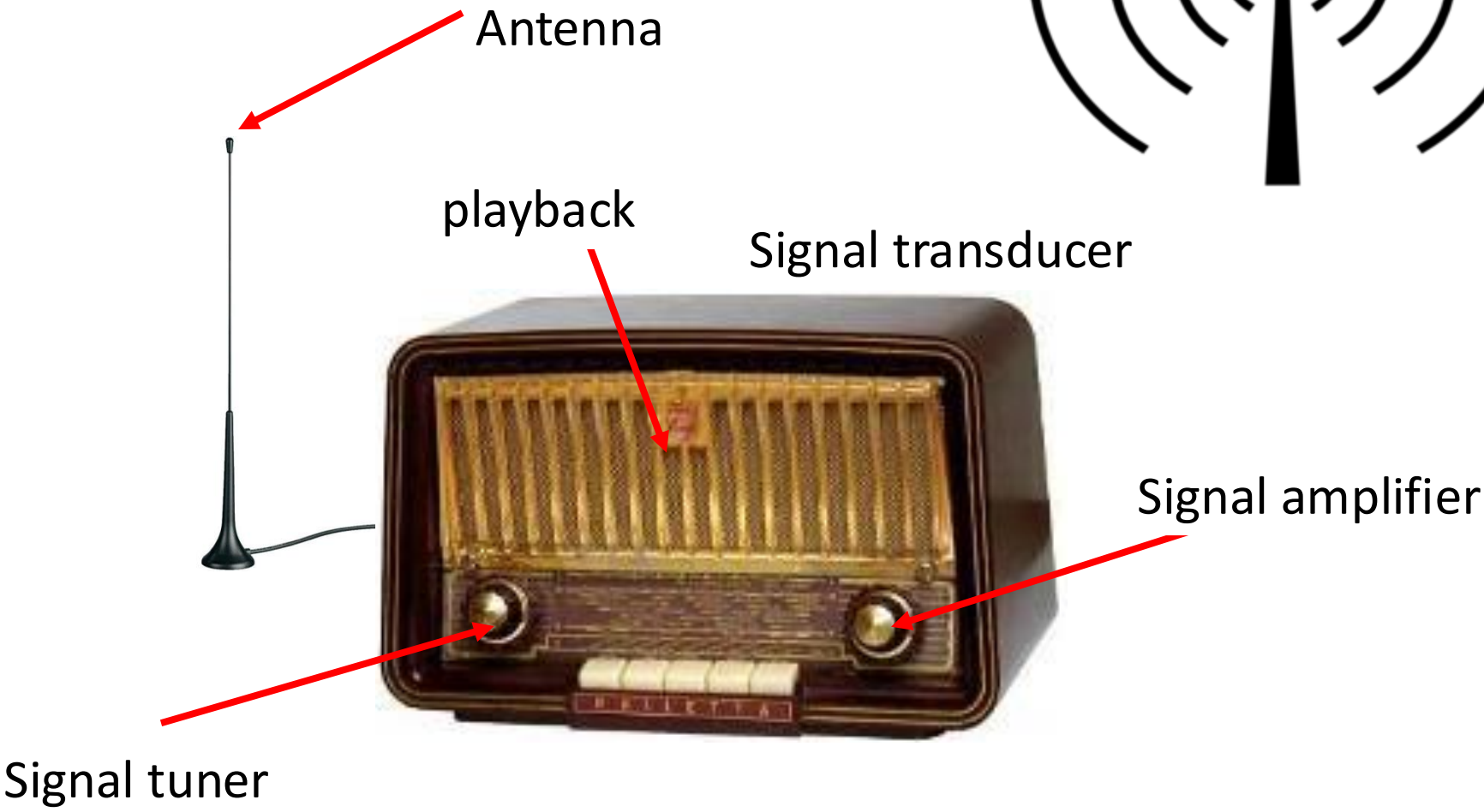
Aquaporins



Signal transduction

Signal transduktion





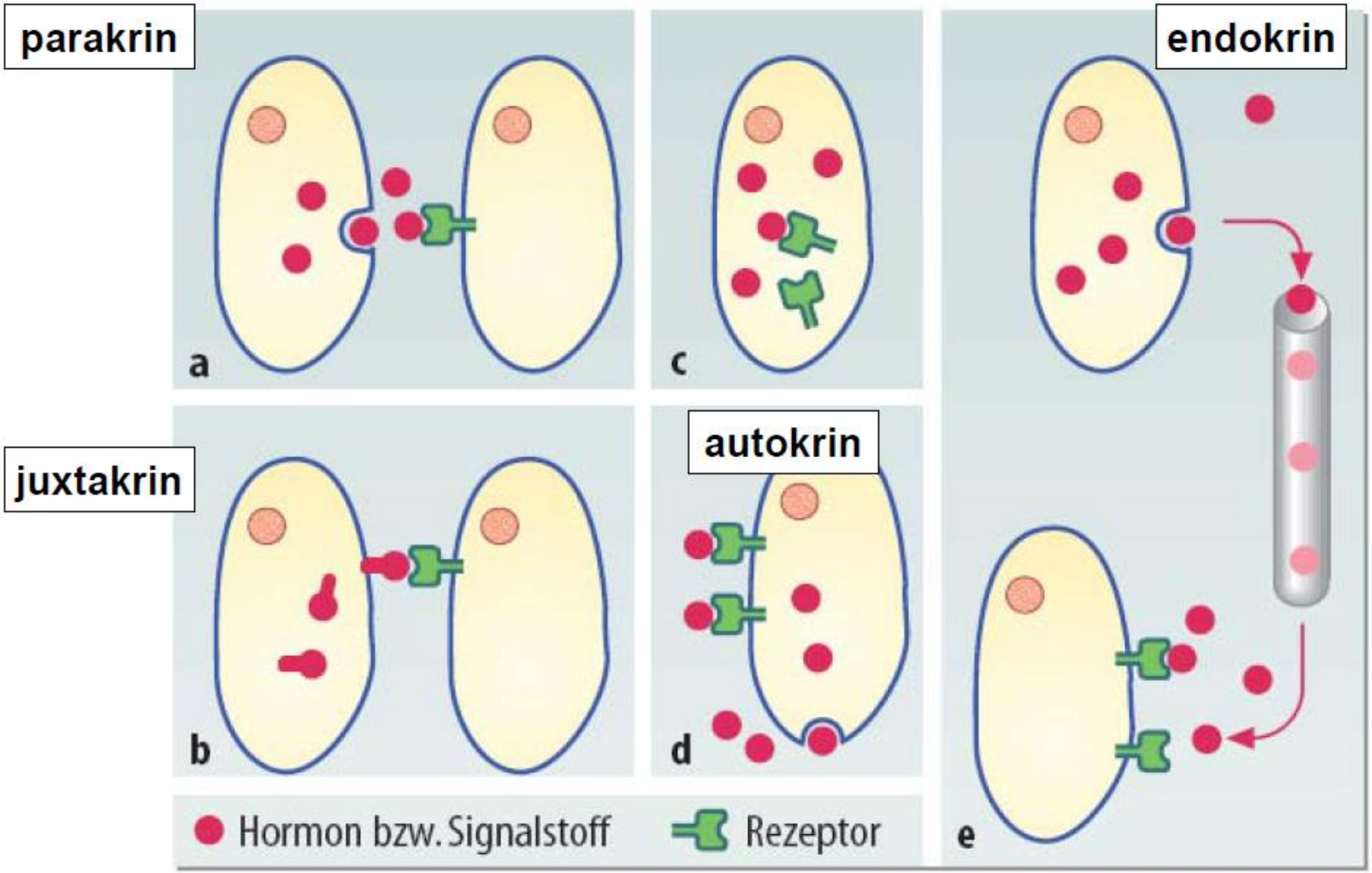
Signal transduction

Signal	→	**Hormone**
Antenna	→	**Receptor**
Tuner	→	**Co-Receptors**
		Adaptor
Amplifier	→	**Enzymes**
Playback	→	**Effectors**

Signals

- heat
- Light
- mechanical and acoustic signals
- odors
- taste substances
- Pheromones
- extracellular Matrix
- cell surface – glycoproteins
- Antigens
- Hormones
- Cytokines
- Chemokines

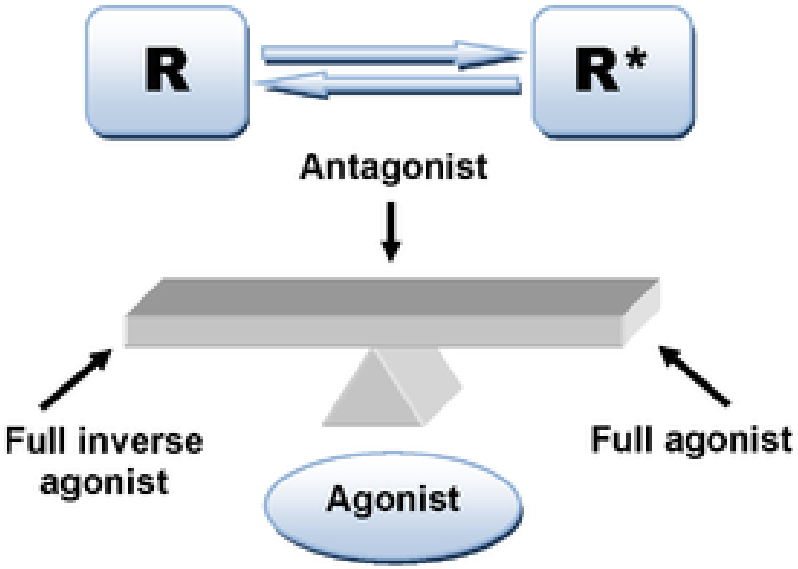
Signals

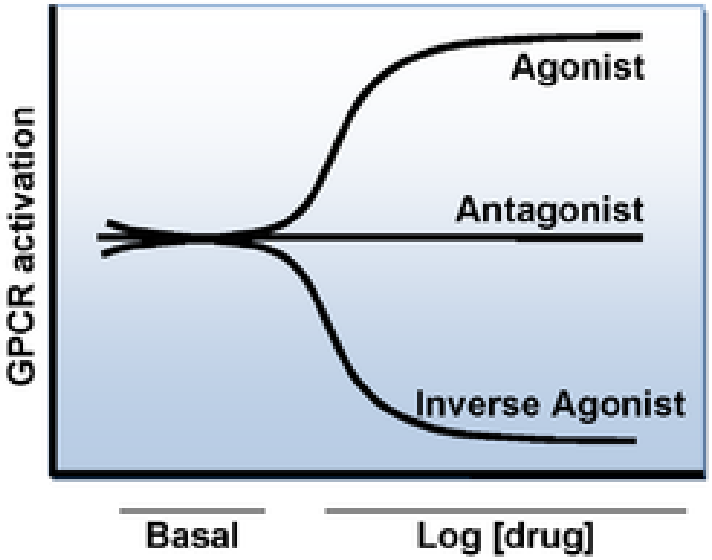

parakrin
endokrin
juxtakrin
autokrin
a
b
c
d
e
Hormon bzw. Signalstoff
Rezeptor

Rezeptor definition (biochemical)

Biomolecule or Biomolecule complex,

- Signal molecule binds
- Structural changes
- Activation of one or more signal transduction cascades





Receptor types

- metabotropic vs ionotropic

- nuclear receptors (Steroid hormones; thyroid hormones)

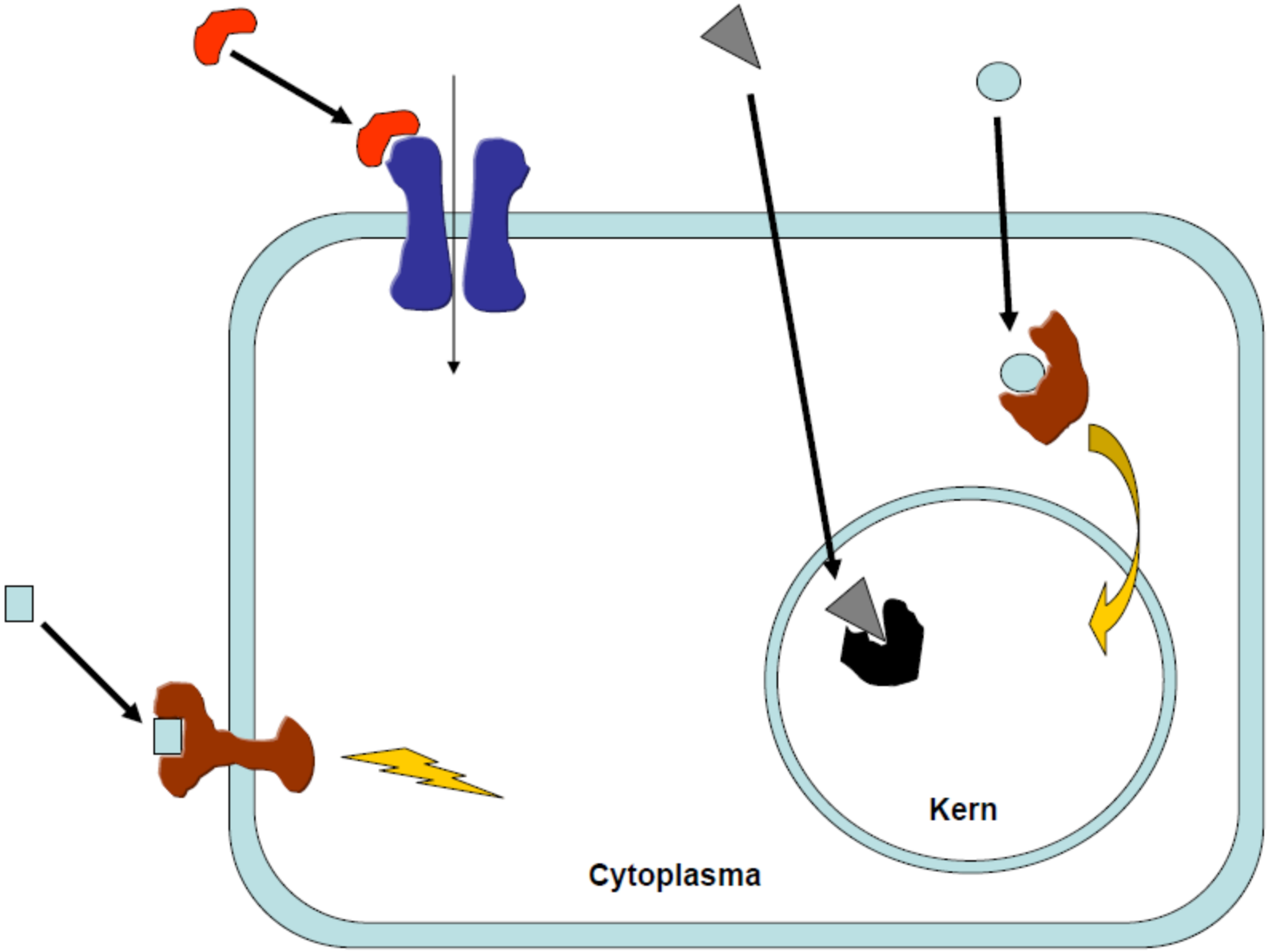
- Membrane receptors (Peptides / Proteo-Hormones)

- Ligand-regulated Ion channels (Neurotransmitters; Ligands)

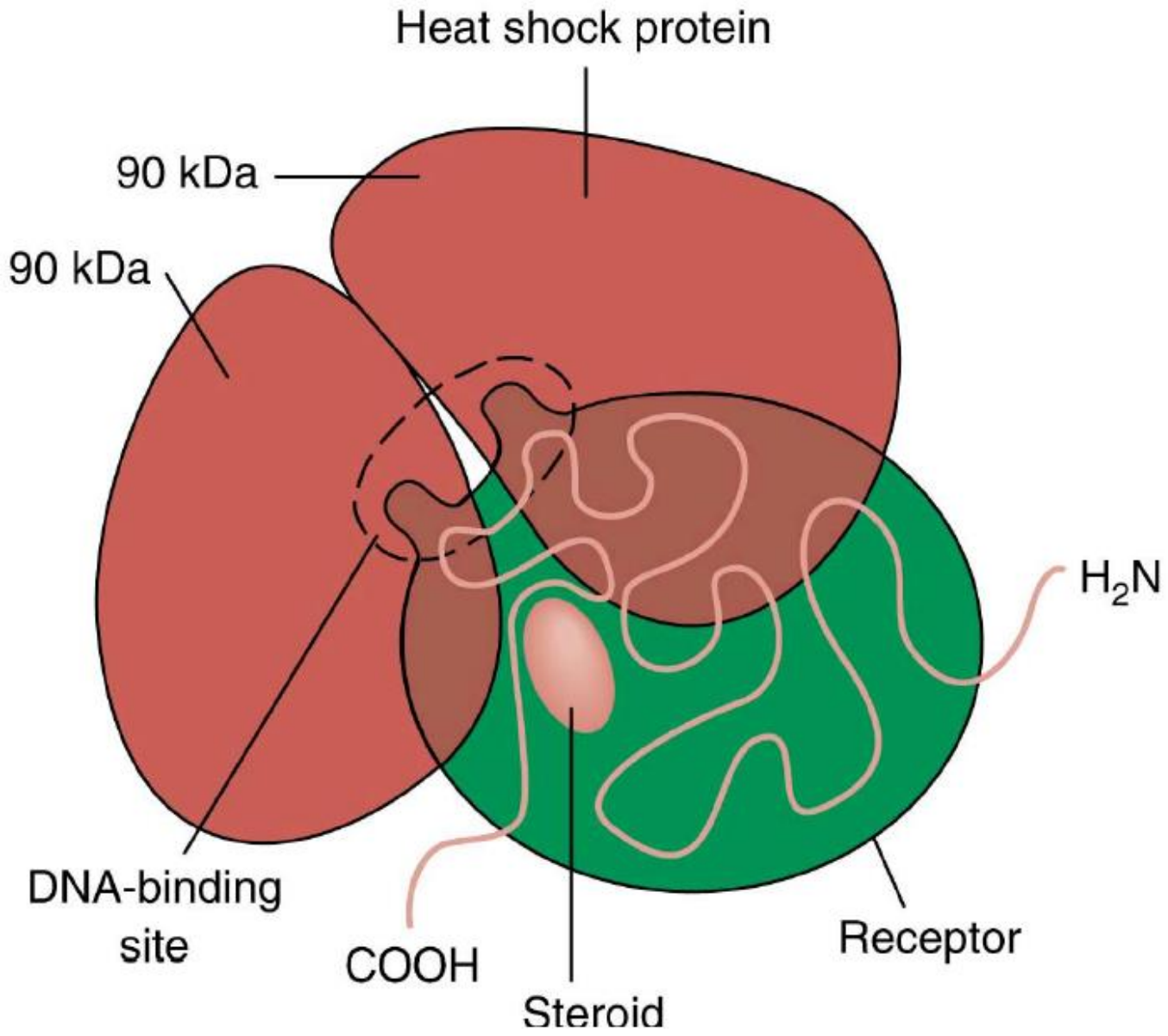
Receptor types

1. Nuclear receptors
2. G protein-coupled receptors
3. Receptor Tyrosine kinases (RTK)
4. Receptors with associated kinases

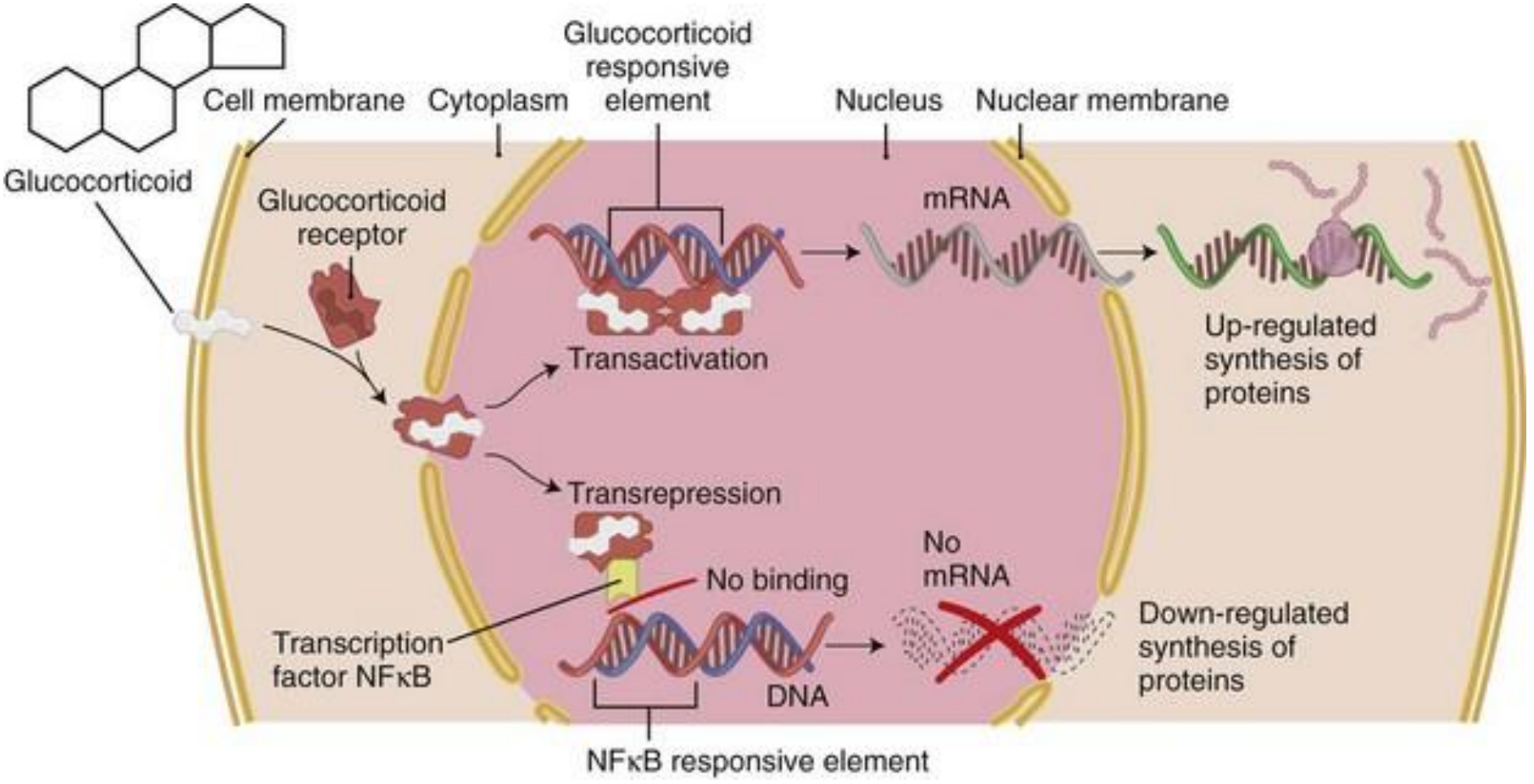
Receptor types



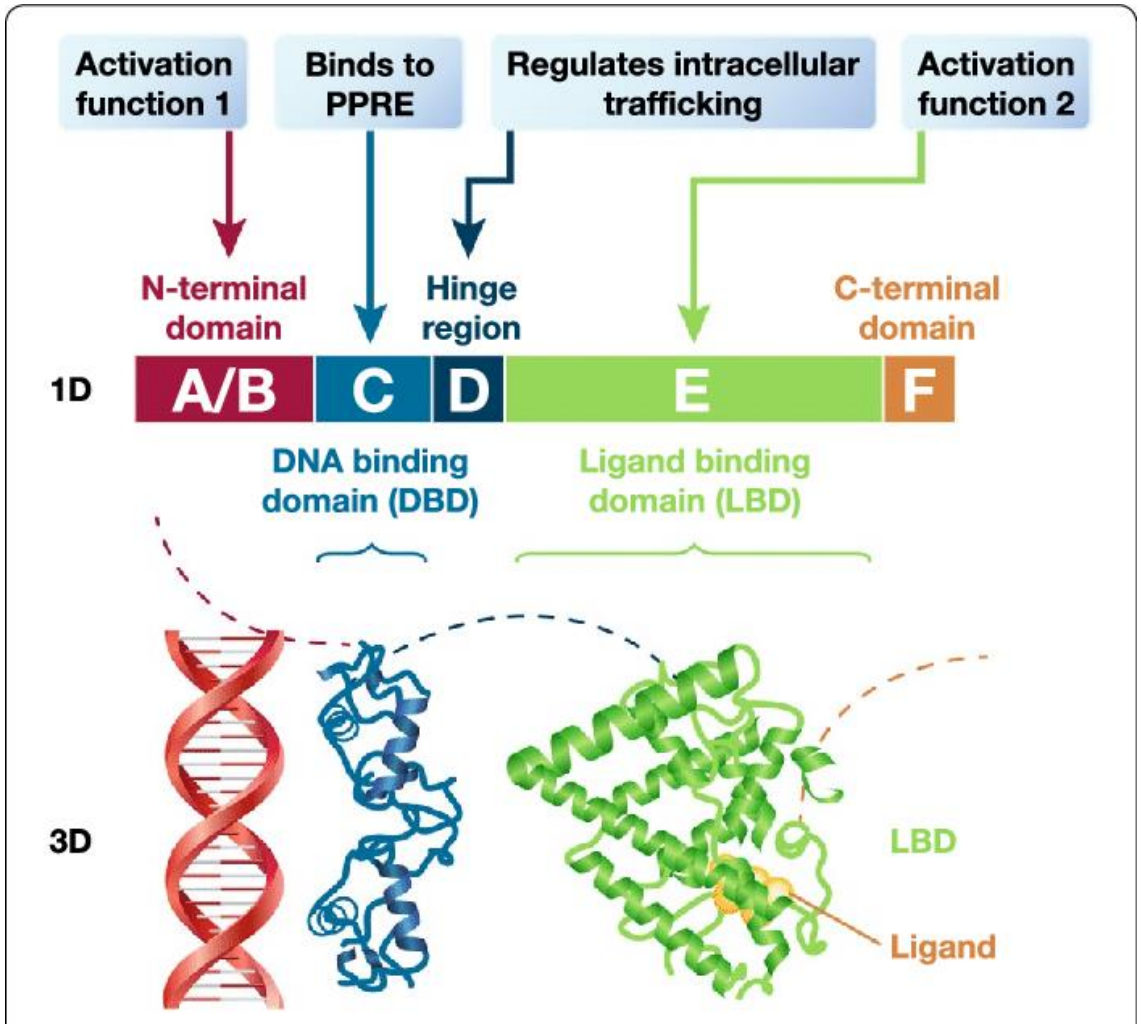
Steroid Receptor - Structure



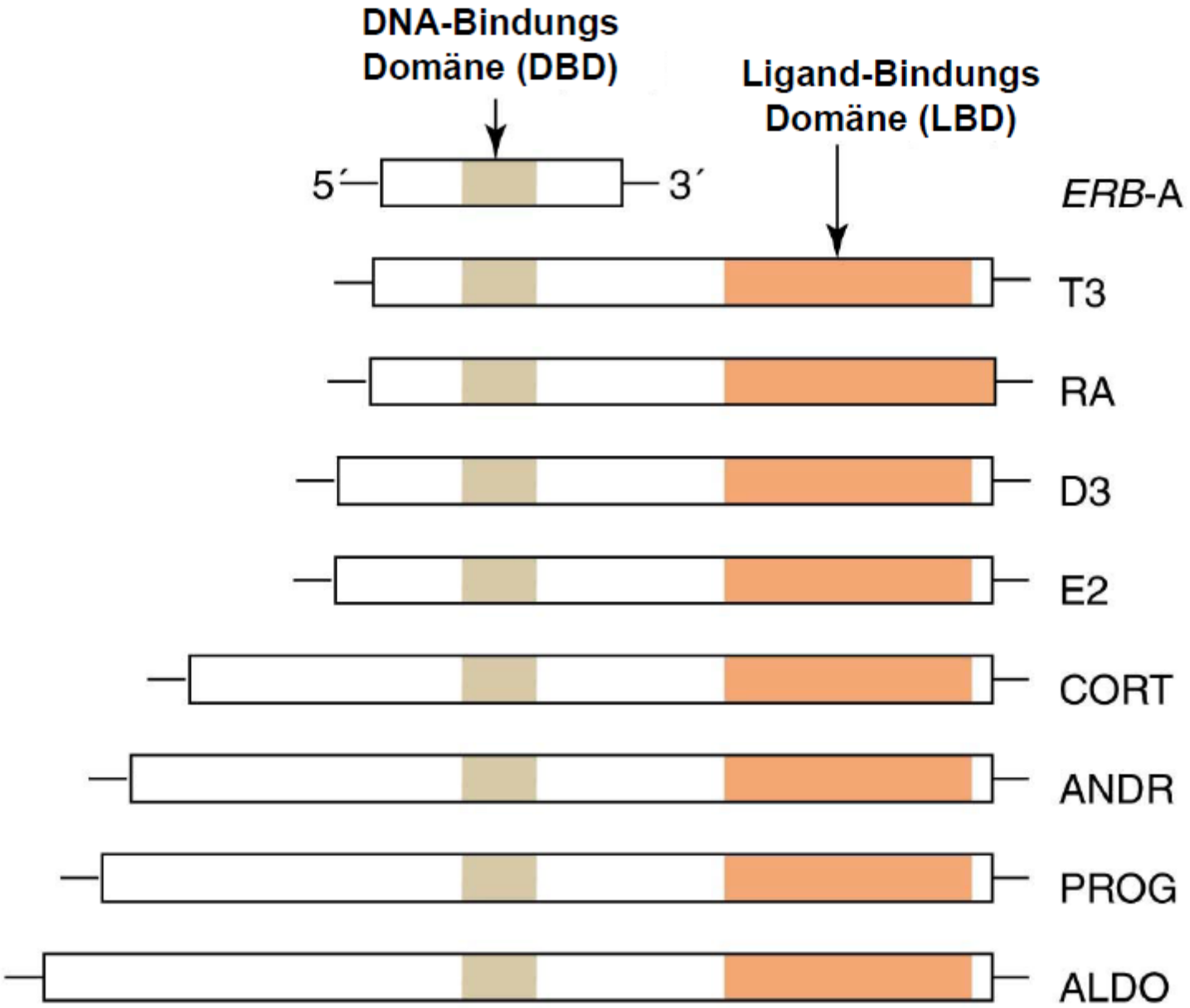
Steroid Receptor – Activation prozess



Steroid Receptors - Structure



Nuclear Receptors - Structure



Nuclear Receptors - Dimerization

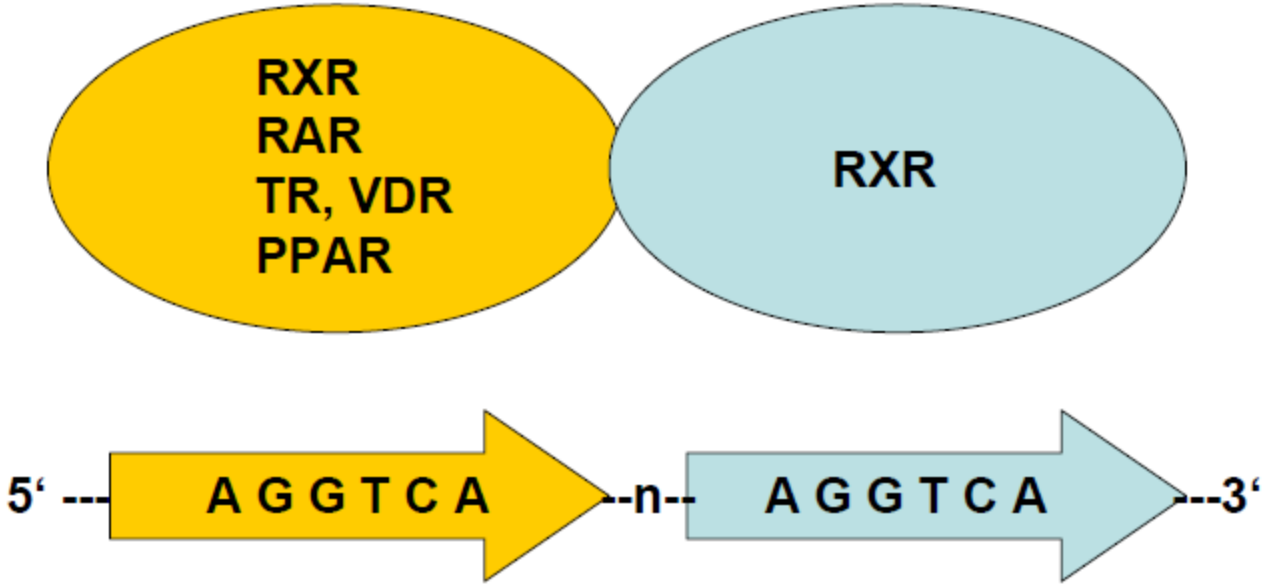
- **Steroid receptors: Homodimers (in Cytoplasm)**

e.g.: Glucocorticoids, Progesterone

- **non-steroidal Receptors: Homodimers or Heterodimers (most are in the nucleus)**

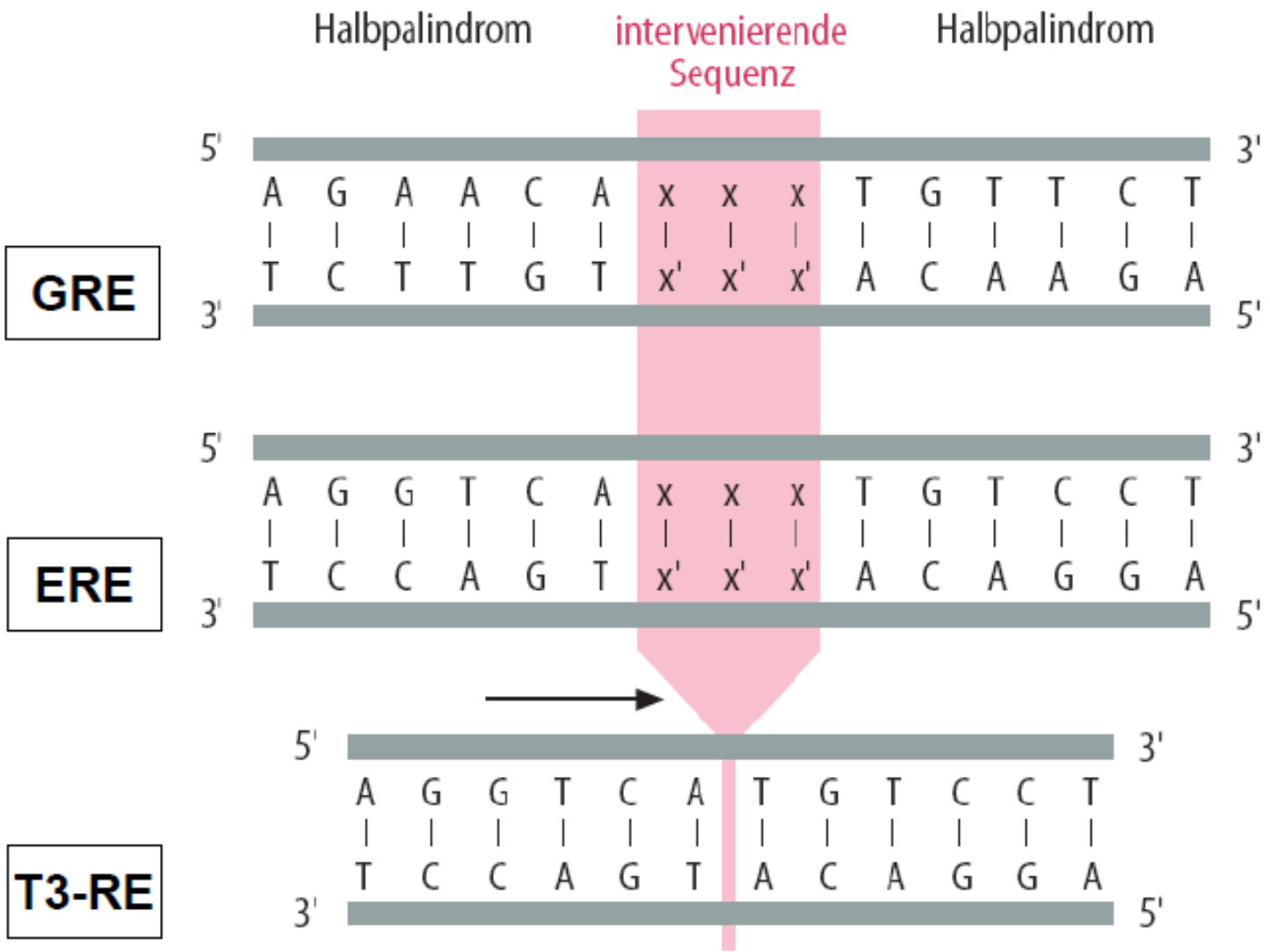
e.g.: Retinoic acid (RAR, RXR)
bile acid (LXR)
Vitamin D (VDR)
thyroid hormone (TR)

Nuclear Receptors – DNA Binding



RXR	9-cis-Retinsäure
RAR	all-trans-Retinsäure
TR, VDR	T3, Vitamin D
PPAR	Peroxisomen Proliferatoren (z.B. Clofibrat)

Nuclear Receptors – DNA Binding



Nuclear Receptors – DNA Binding