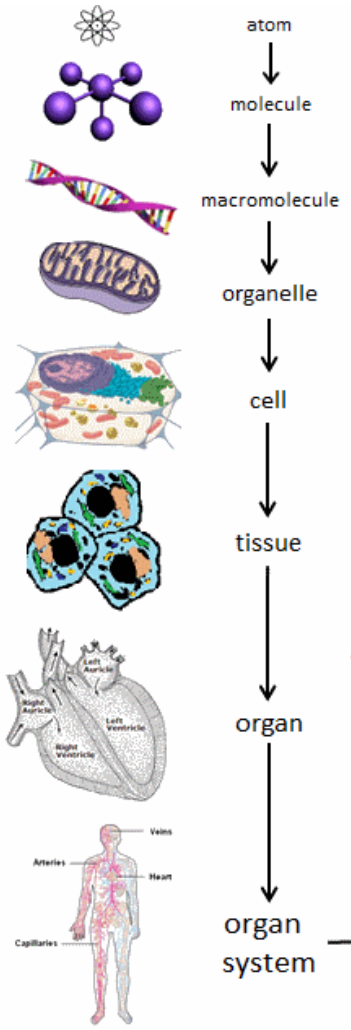
STRUCTURAL PROTEIN

Dr. Zhiyi Wei
SUSTC

Biological structures



Structure is central topic of life

Biological structures are maintained and regulated by structural proteins

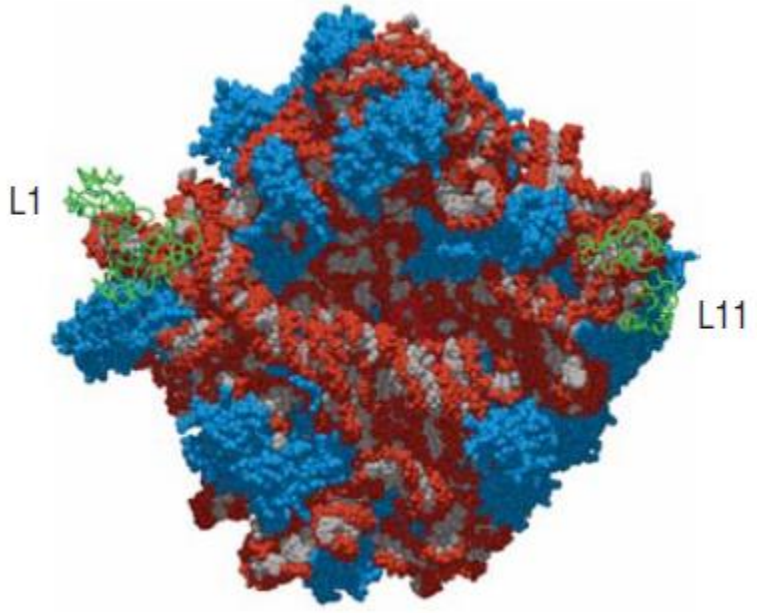
- Organs, tissues and cells are shaped and supported by structural proteins
  - Connective tissue (collagen)
  - Skin (keratin)
- Biological structures are dynamic, which is controlled by structural proteins
  - Muscle (myosin)
  - Lung (elastin)
  - Cellular structures (cytoskeleton)
- Some biological structures are temporary formed
  - Blood clot (fibrinogen)
    - Unregulated clotting is lethal

Shape

Force

Flexibility

Biological structures at molecular level also involve structural proteins



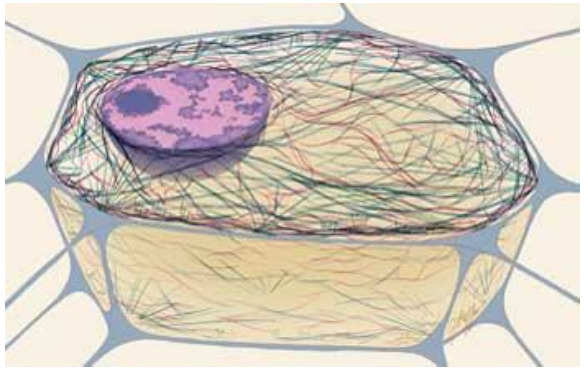
Structure of the 50S (large) subunit of the bacterial ribosome

Functional roles of structural proteins

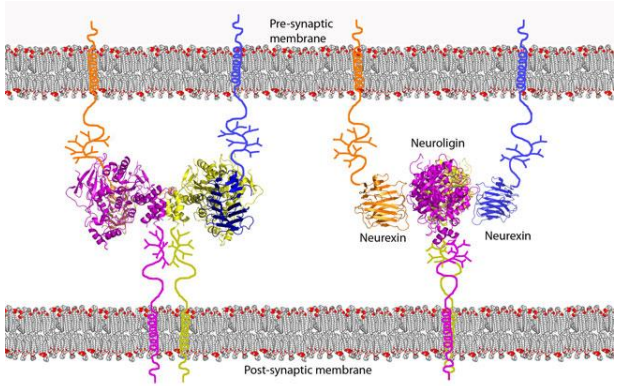
Framework

Connector

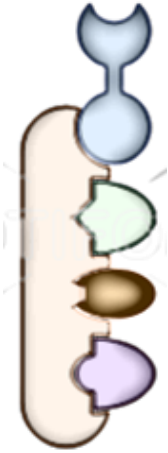
Scaffold



Fibrous proteins
Cytoskeletons



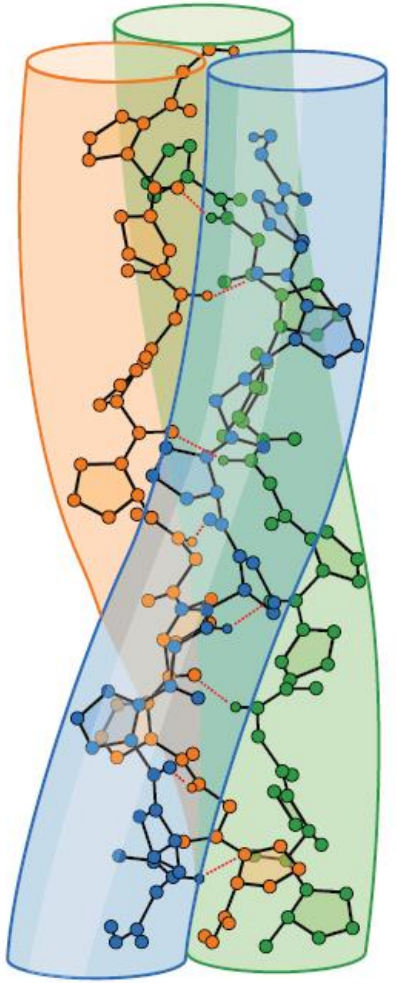
Adhesion molecules



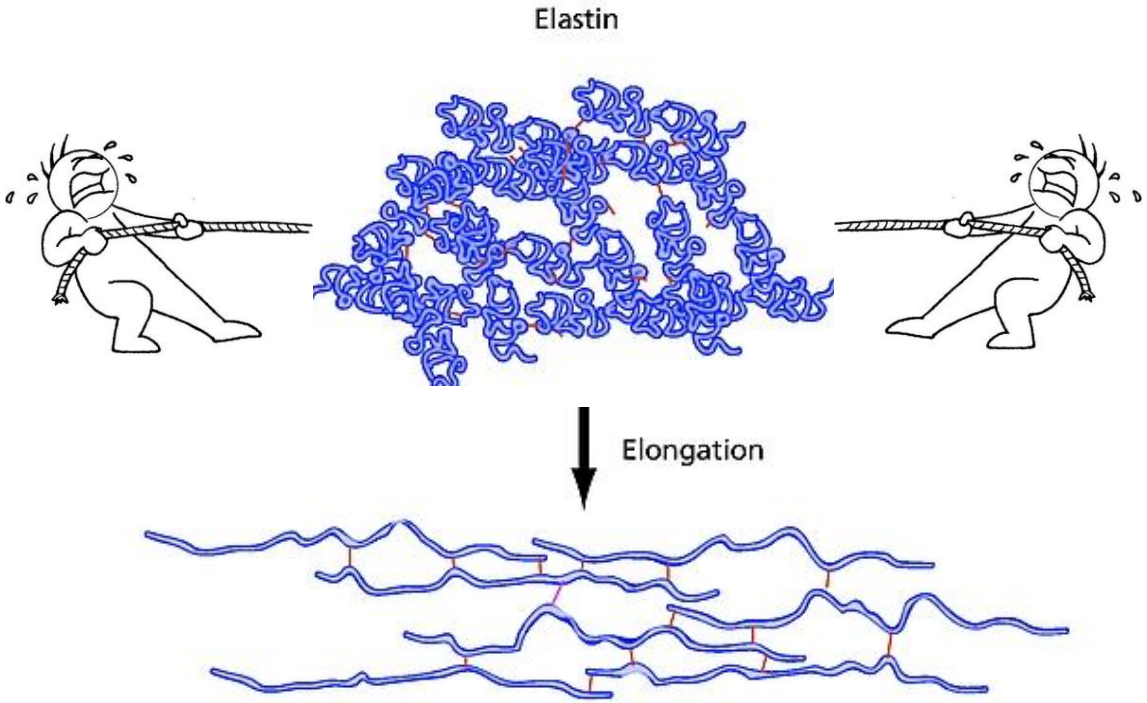
Scaffold proteins

Fibrous proteins form stable assemblies

- Fibrous proteins
  - Have a filamentous, or elongated form
  - Provide mechanical support
- Stabilization forces
  - Weak interactions
    - Need enormous numbers of weak interactions
    - To place the complementary surfaces on simple repeating secondary structure elements
      - Coiled-coils
      - Sheets
  - Cross-linking

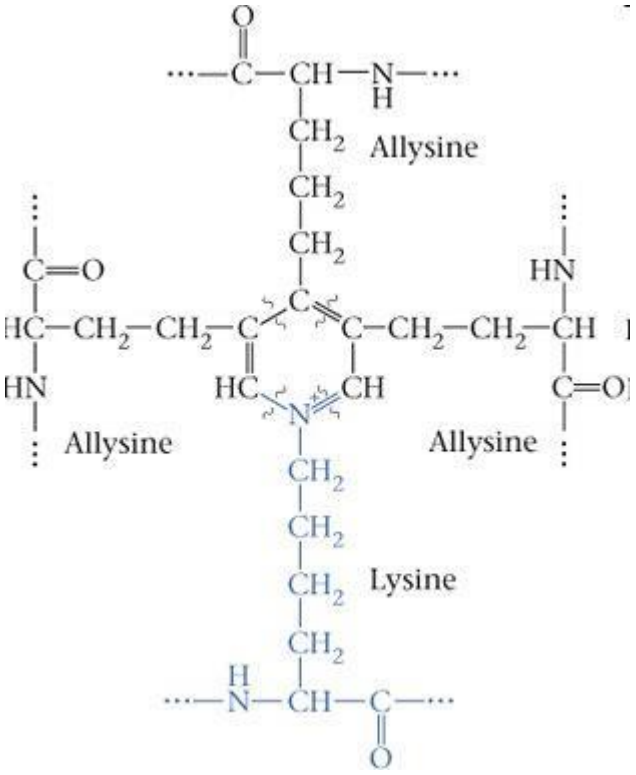


Elastin



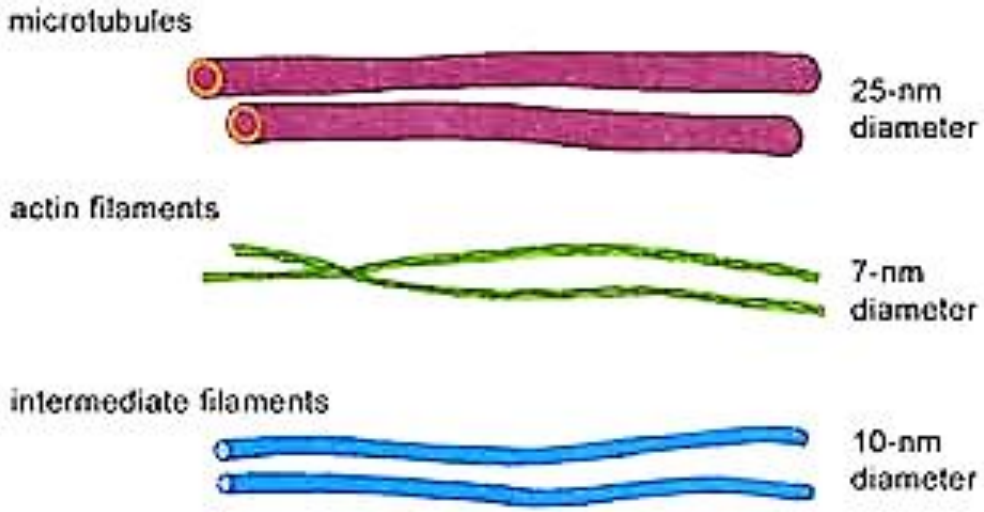
Elastin

- Composed of soluble tropoelastin (~65 kDa)
  - Glycine/Valine
  - Modified Alanine/Proline
- Tropoelastin is highly crosslinked to form rubberlike, elastic fibers
  - Insoluble
  - Be able to recoil spontaneously as soon as force is relaxed
- Desmosine
  - The most common interchain crosslink
  - Lysine converted to allysine by lysyl oxidase
  - Crosslink is spontaneously formed

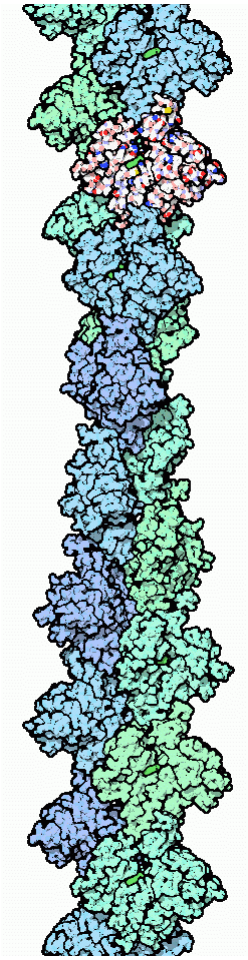


Cytoskeleton

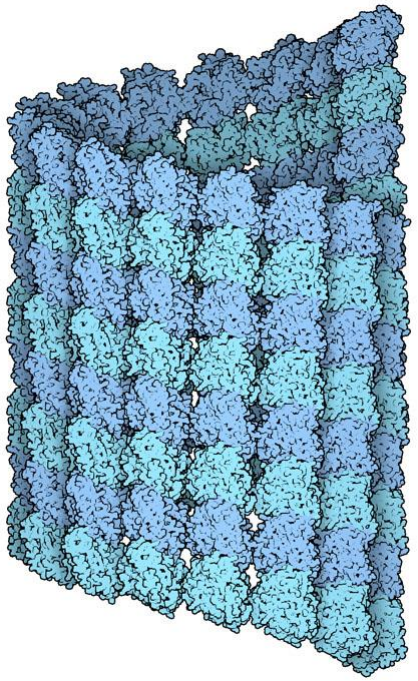
- Actin filament (F-actin)
  - G-actin
- Microtubule
  - Tublin
- Intermediate filaments
  - Belong to fibrous proteins



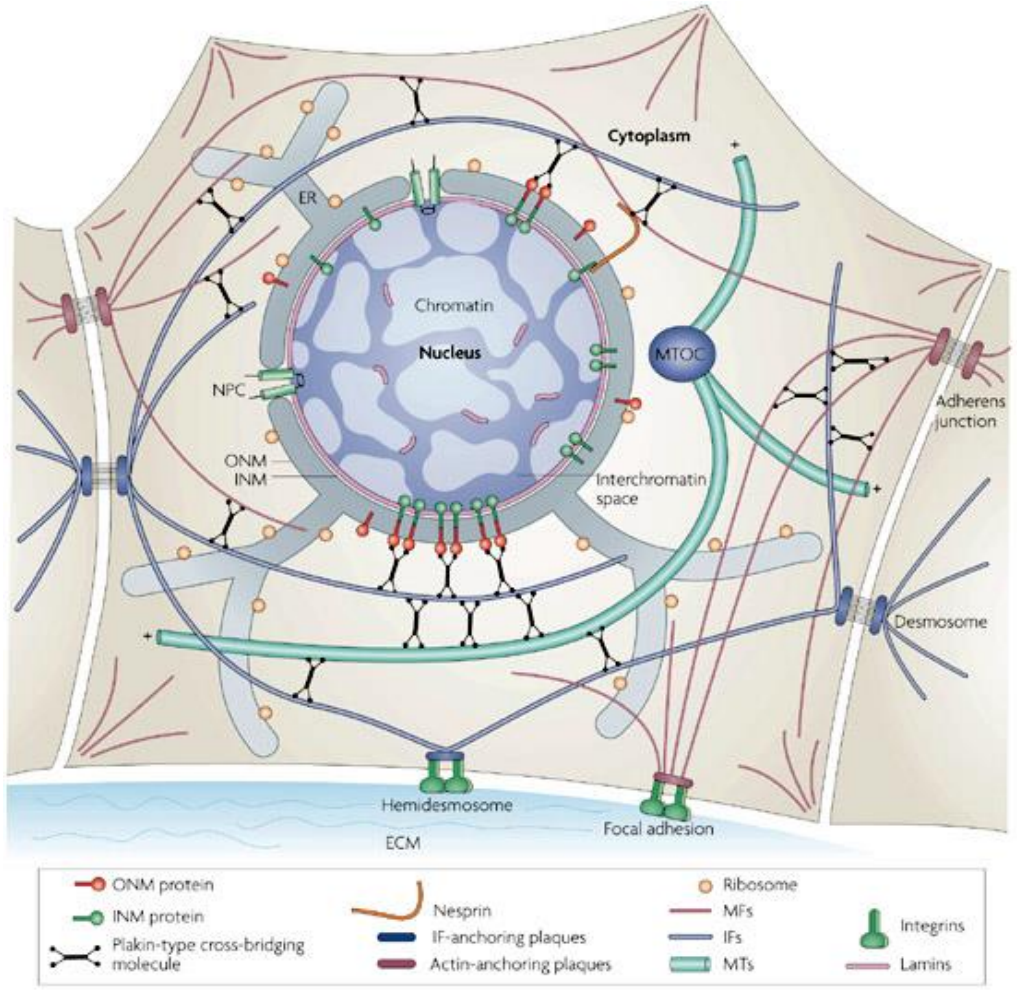
F-actin



Microtubule



Cytoskeleton

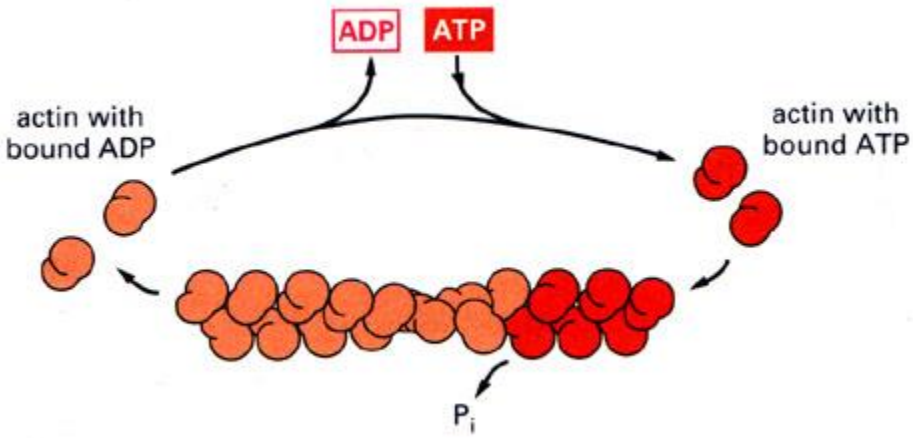


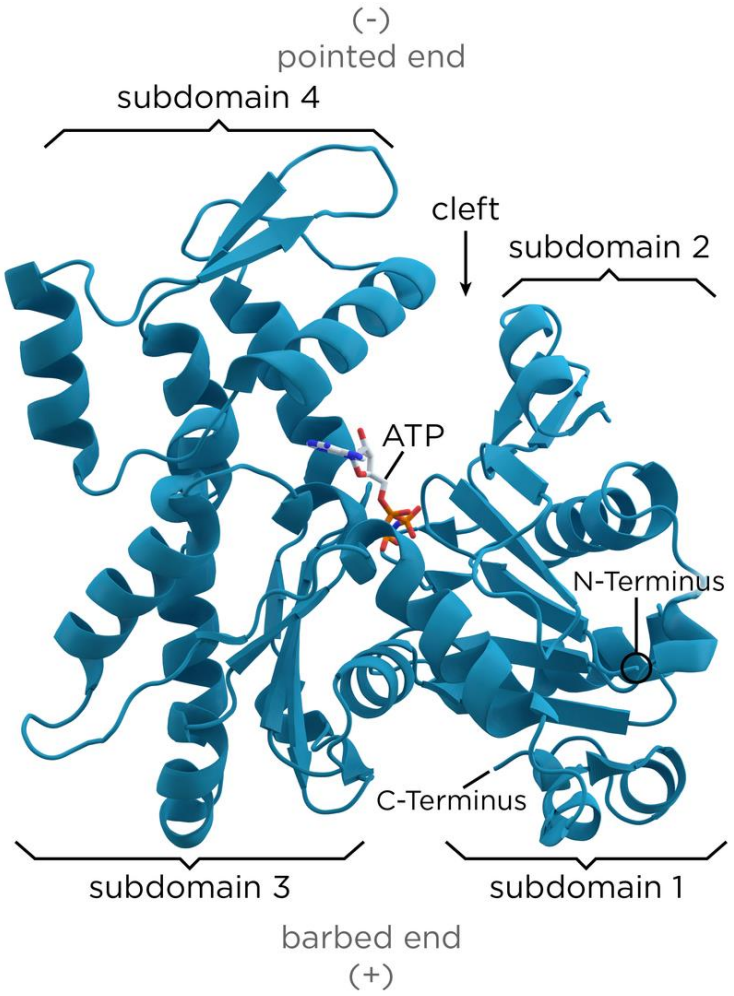
Nature Reviews Molecular Cell Biology, 2007

Actin

- G-actin is a ATPase
- Actin switches between ATP and ADP bound states

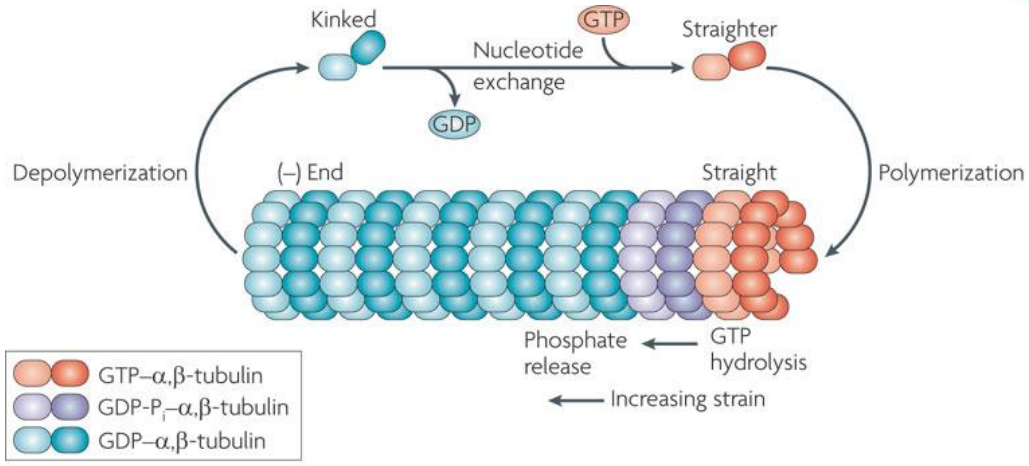
Catalytic protein with structural role

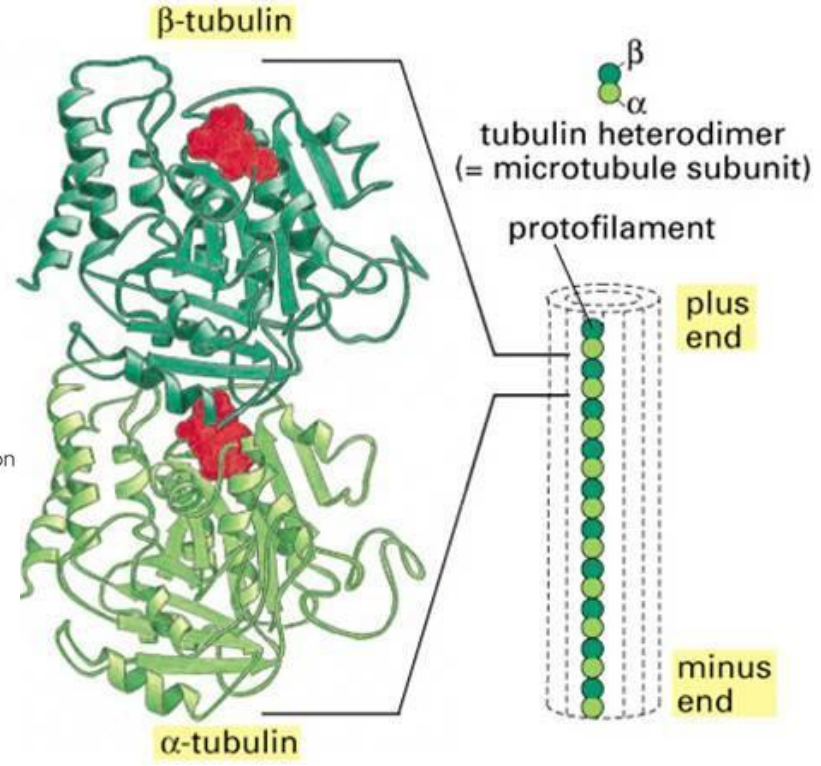




Tubulin

- α, β-tubulin
- Tubulins are GTPases
- Tubulins switch between GTP and GDP bound states

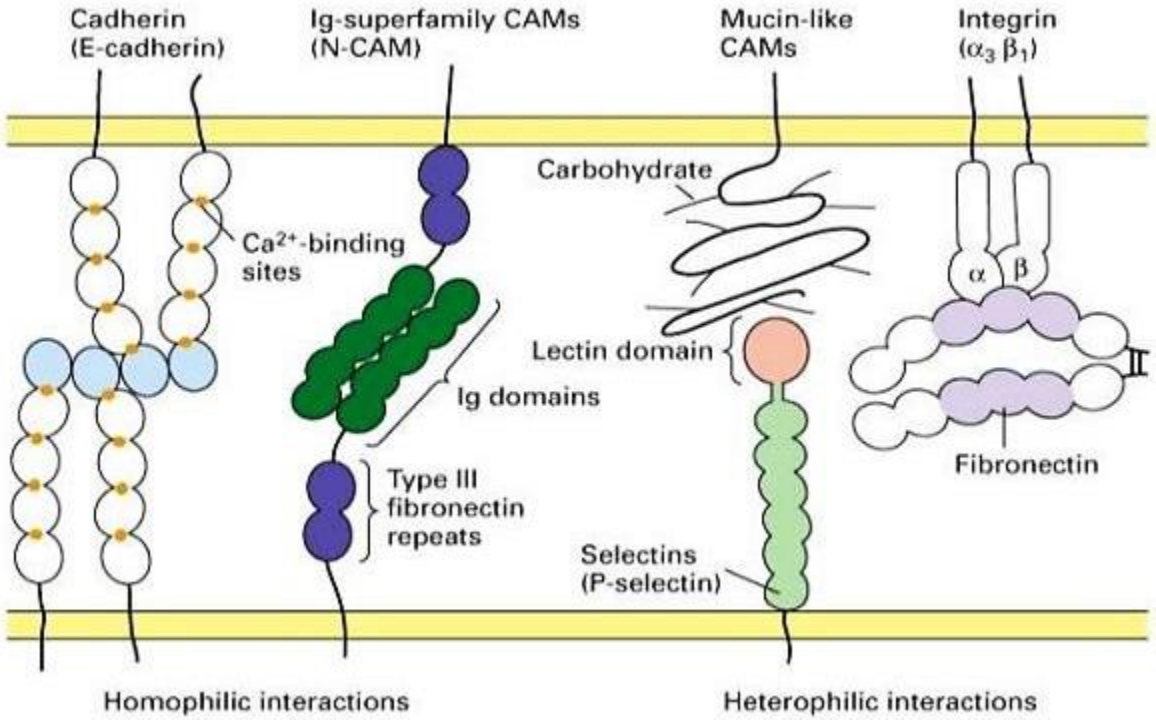




Adhesion molecules

Development

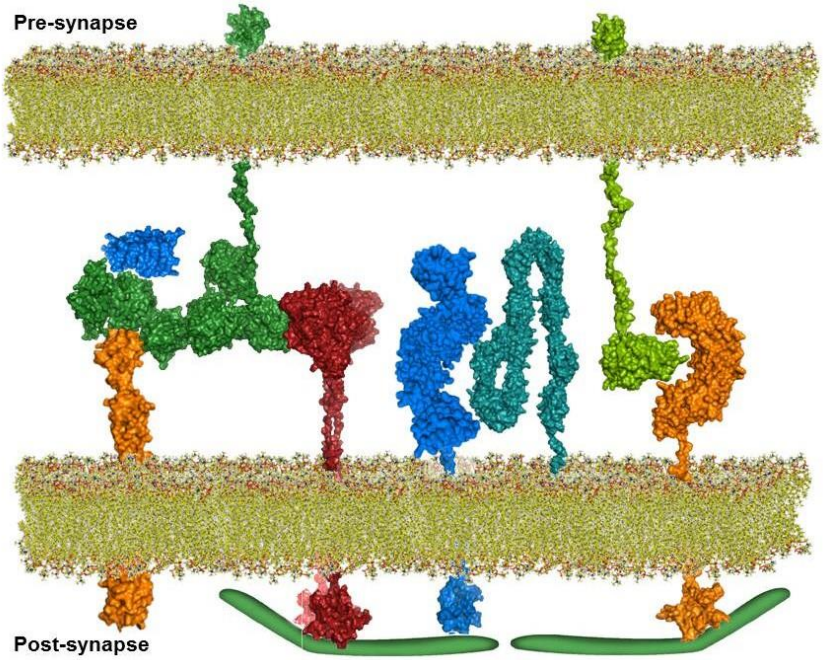
Immunity

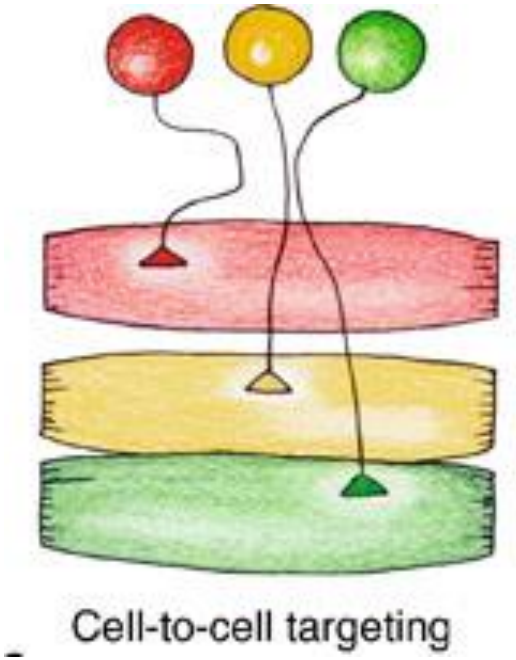


Cancer

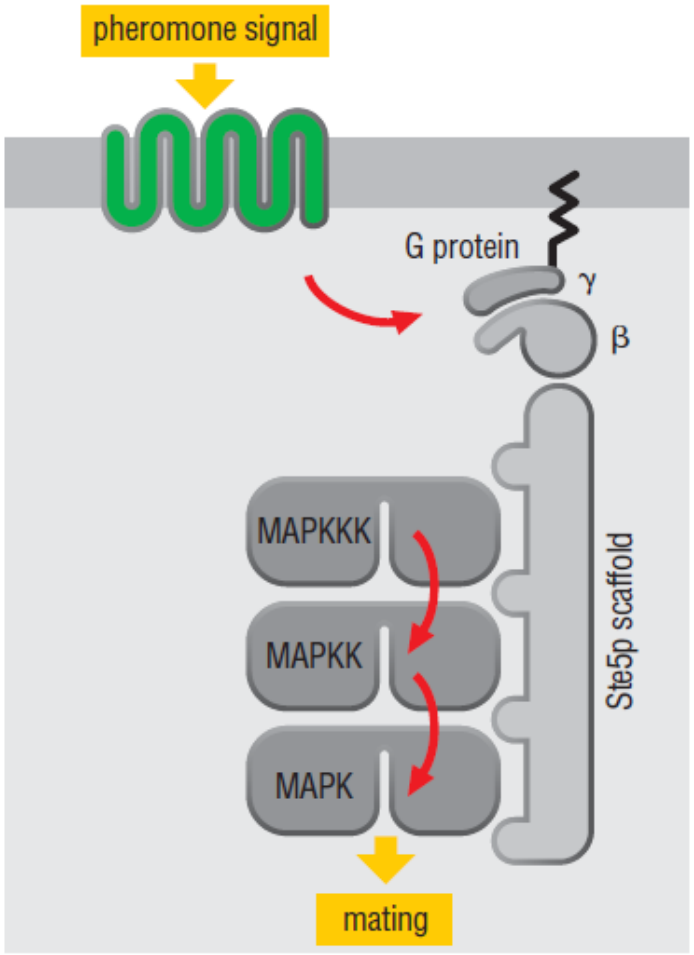
Nerve

Adhesion molecules for synaptic connection



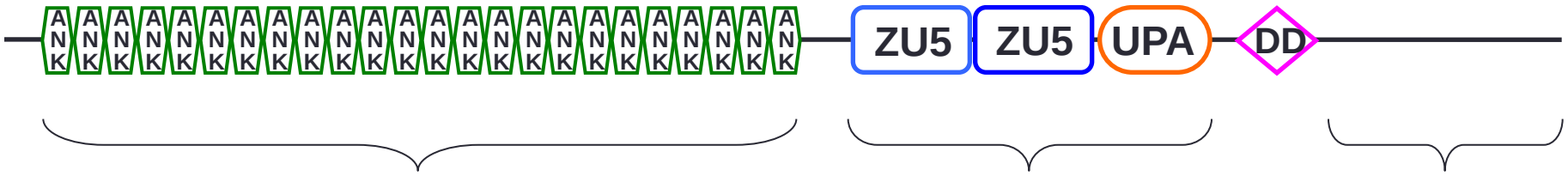


Scaffold proteins



- Signal transduction
  - Sequential reactions
- Usually do not have enzymatic activities but can increase efficiency
- Specific recruitment
  - Increase local concentration
  - Diffusion is slow
- Forming a signaling complex

Another scaffold case: Ankyrin



Membrane binding domain (MBD)

Spectrin binding domain (MBD)

Regulatory domain

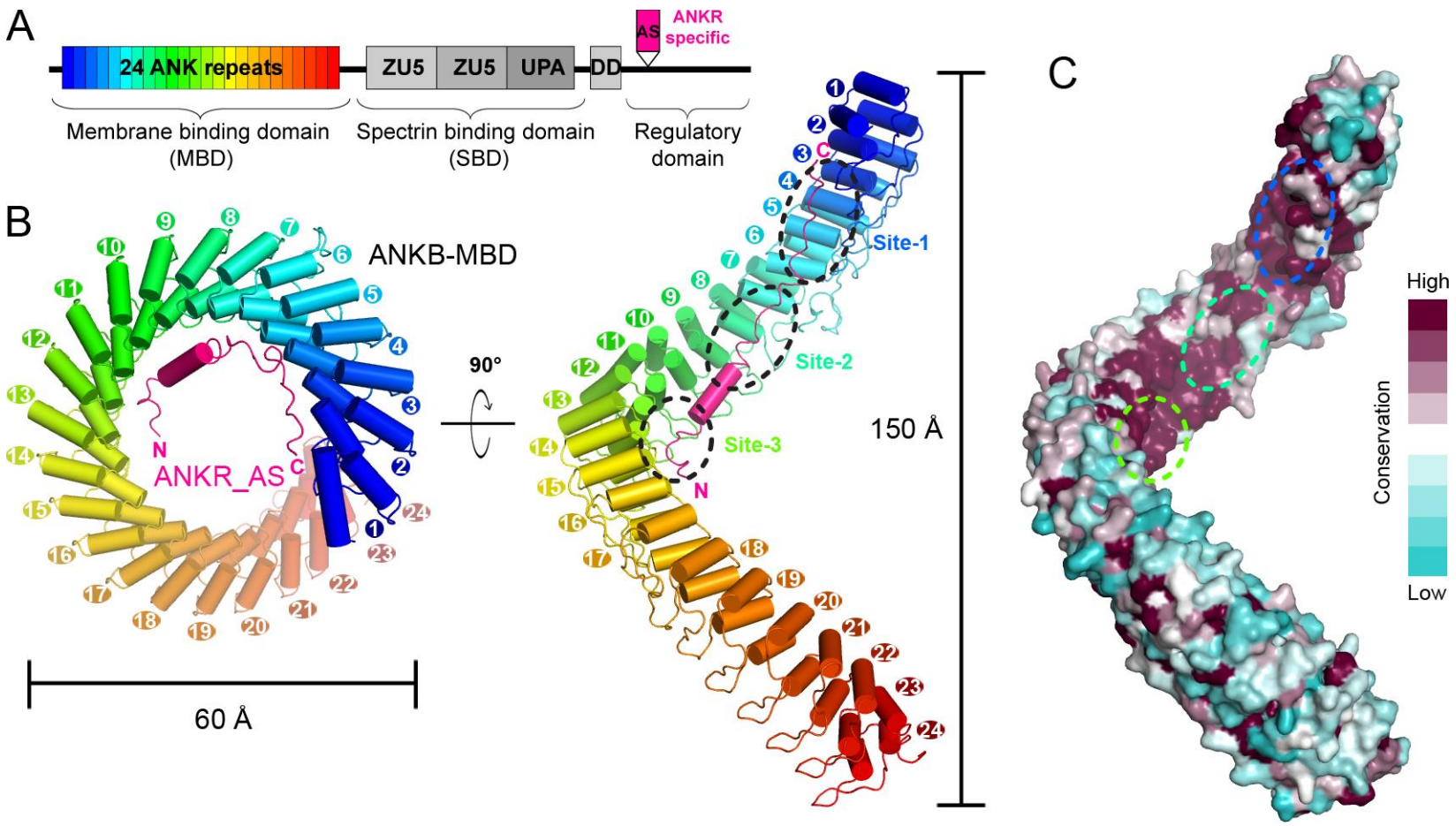
Ion channels:
Anion exchanger
Na/Ca exchanger
Sodium channels
Calcium channels
KCNQ2/3
Na/K-ATPase
Rh antigen
IP3 receptor
Ryanodine receptor
CNG-beta1

Cell adhesion molecules:
L1-CAMs
CD44 ?
E-cadherin
Dystroglycan

Cellular transport:
Tubulin
Clathrin

Spectrin
Dynactin-4

Ank-MBD (R/B)
EB1/3 (G)
HSP40 (B)
Obscurin/titin
PP2A (B)


A
24 ANK repeats
ZU5
ZU5
UPA
DD
AS
ANKR specific
Membrane binding domain (MBD)
Spectrin binding domain (SBD)
Regulatory domain
B
ANKB-MBD
N
ANKR_AS
C
60 Å
90°
Site-1
Site-2
Site-3
150 Å
C
High
Conservation
Low