भारतीय सांकेतिक विज्ञान संस्थ हैदराबाद
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Introduction of Bio-nanotechnolgy

BT1110

Lecture 7 : Protein Engineering

Himanshu Joshi 14 November 2023

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Course contents

- Introduction to nanotechnology and bionanotechnology,
- Biological self-assembly
- Biologically inspired nanostructures - introduction to biomimetics
- Nucleic acid nanotechnology
- DNA origami
- **Protein engineering**
- Lipid nanotechnology
- Chirality in biological systems
- Interaction of nanomaterials with biological systems
- Virology: viruses and vaccines

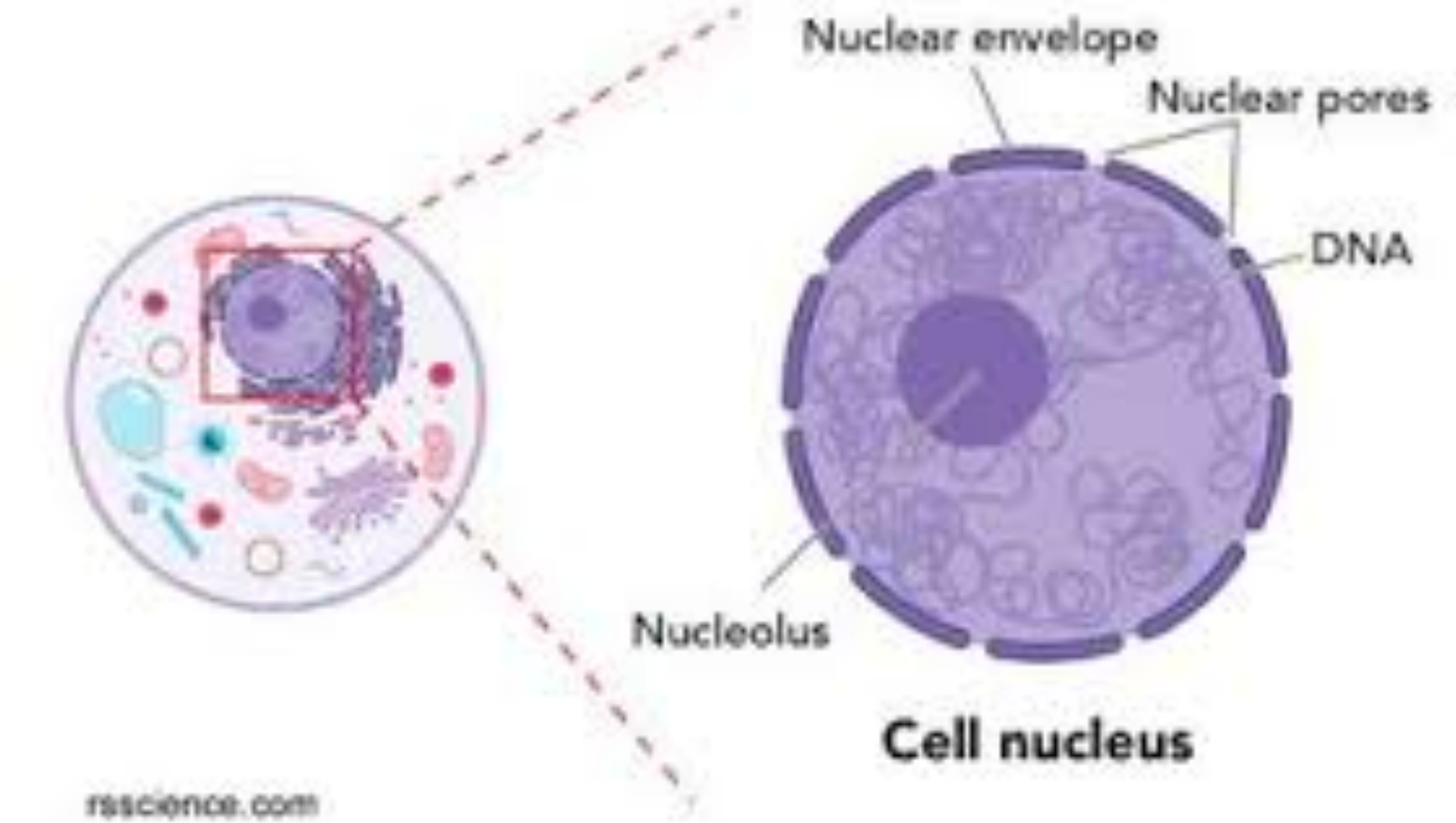
Central dogma of molecular biology

Can also be called the central dogma of life

How the generic information is transferred to full living organism, humans, animals, plants etc.

DNA to RNA to proteins, ultimately these proteins will decide how we look, work, think and live etc.

replication transcription translation

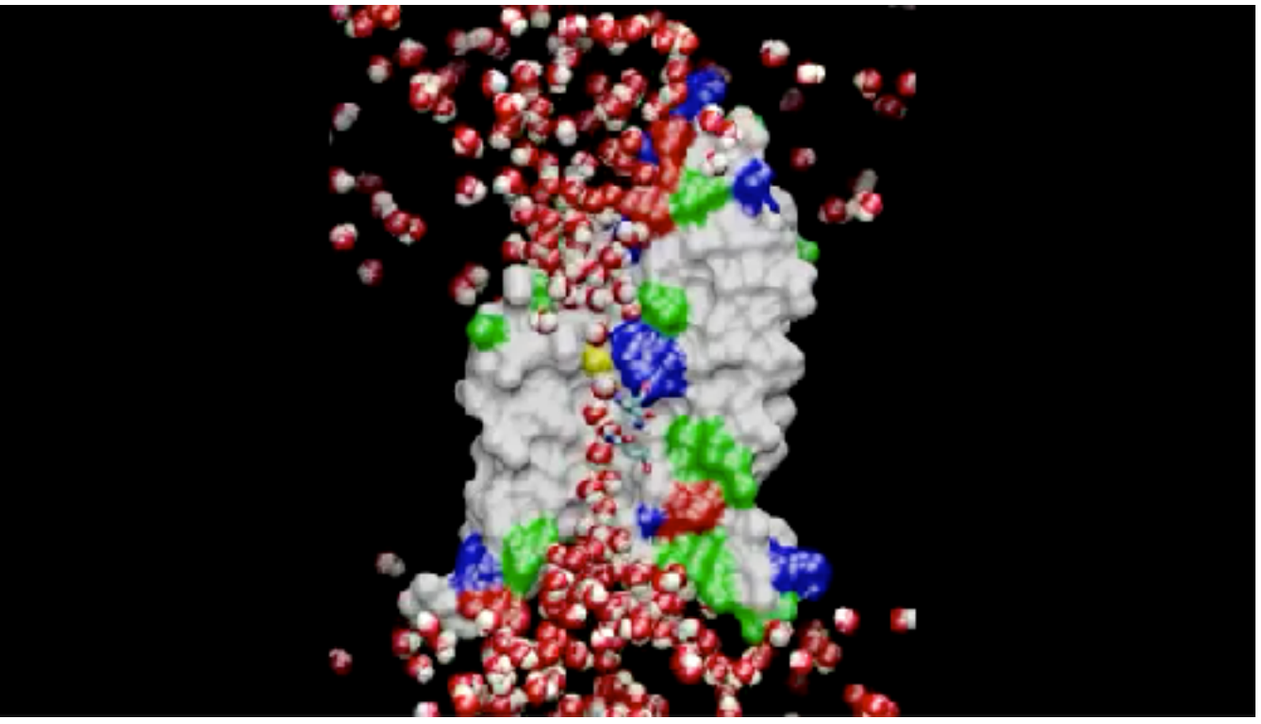


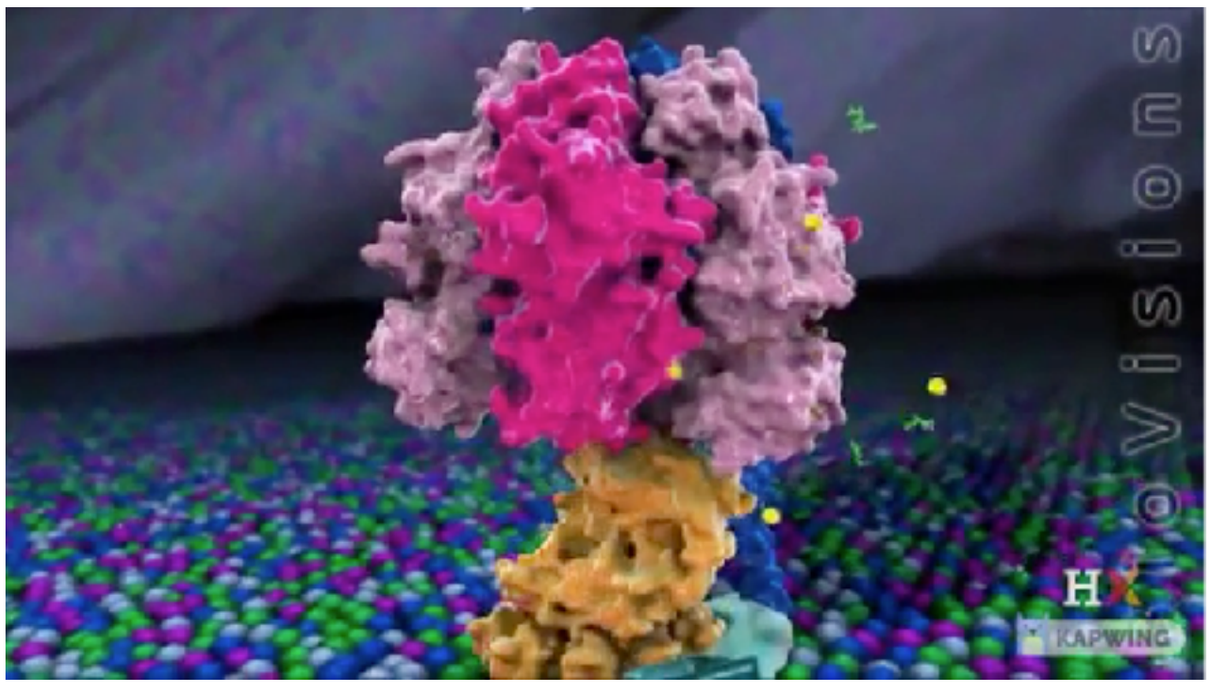
37.2 trillion cells
Each cell contain ~ 2 m of DNA folded in ~ 10 μM

Protein Engineering

Proteins for the candidates for new material synthesis and device fabrications.

Most of the important biological processes happening in you body are these protein molecules doing

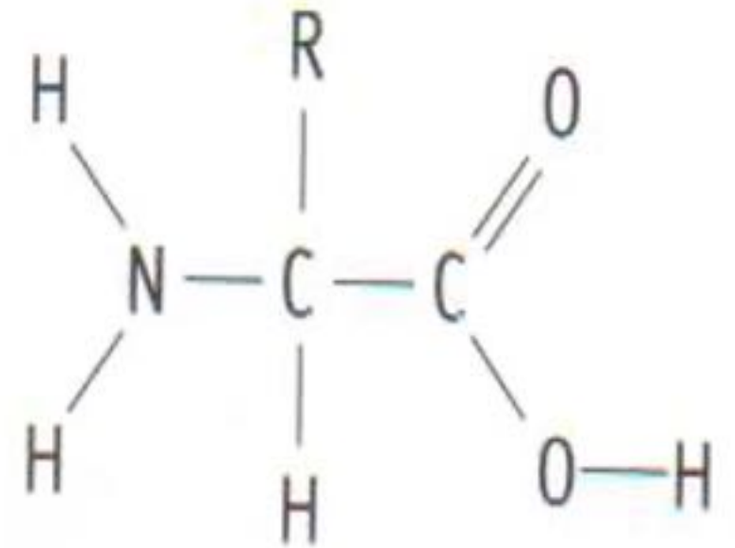


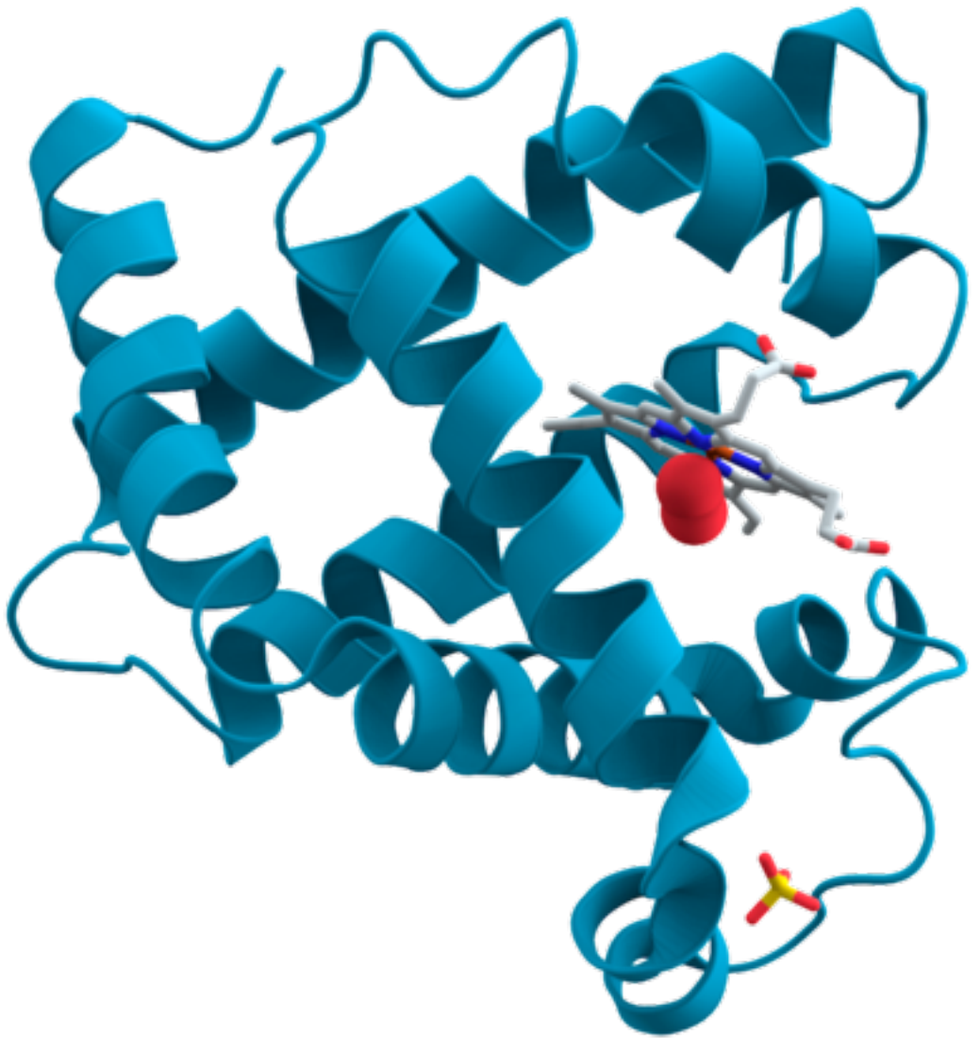


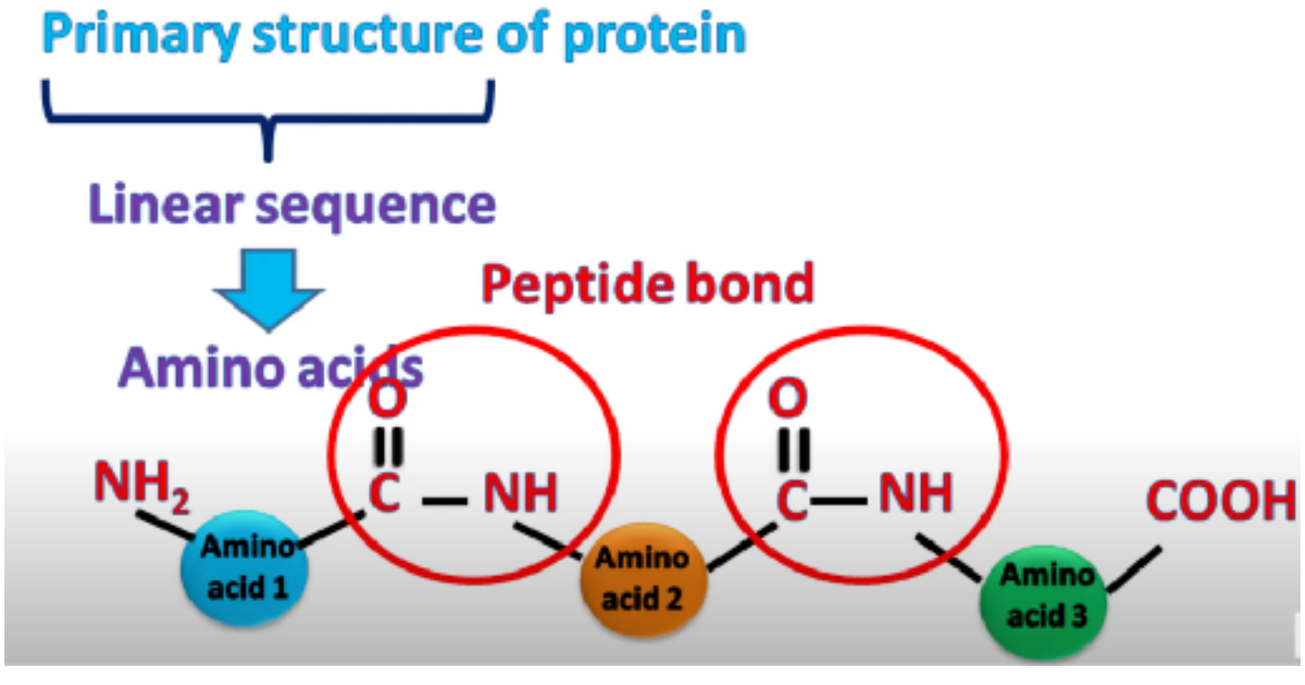
Reference:
https://youtu.be/wJyUtbnoO5Y

What are proteins

One or more long chains of amino acid residues.

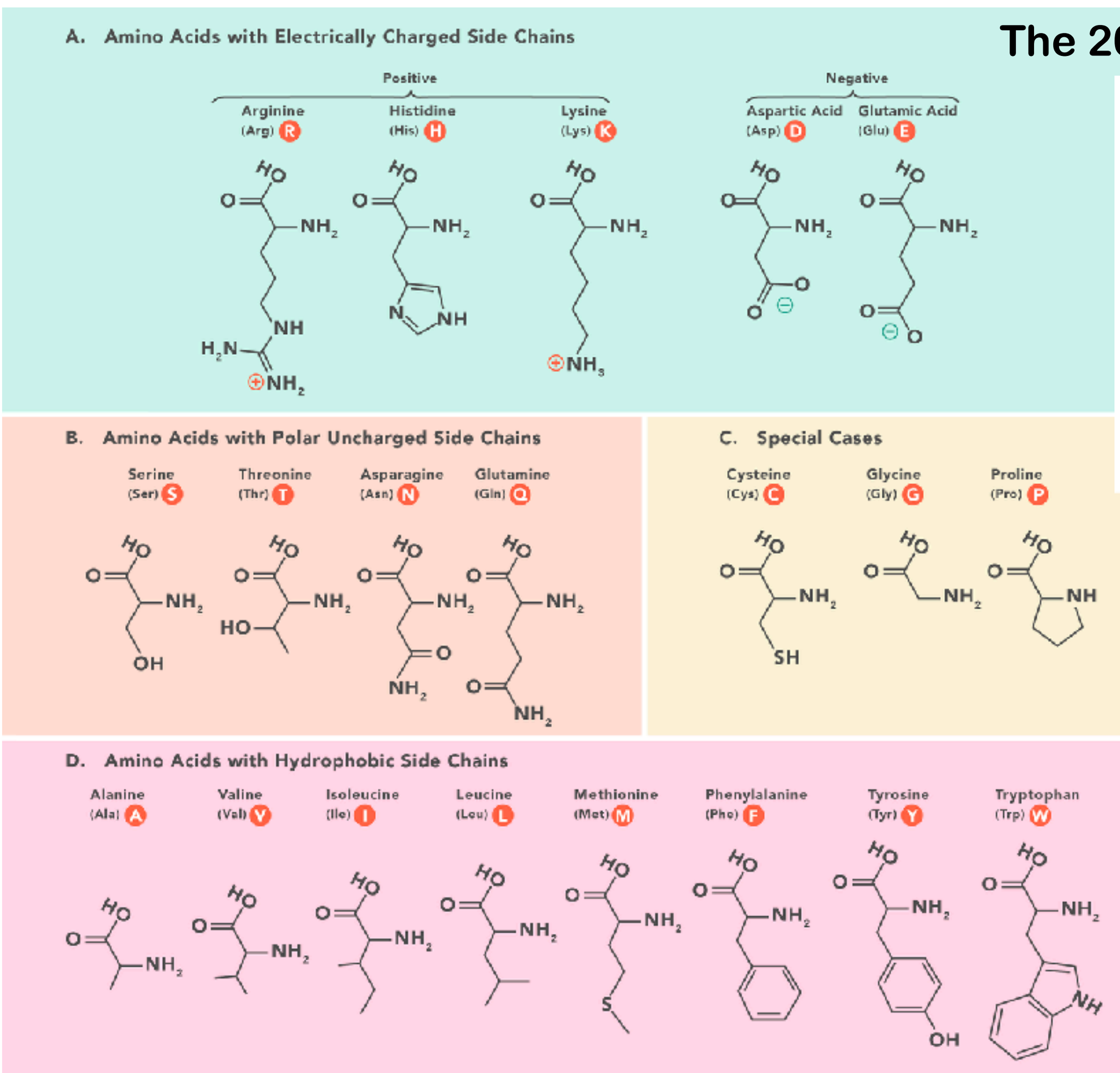






The 20 Amino acids

G	Glycine	Gly
A	Alanine	Ala
L	Leucine	Leu
M	Methionine	Met
F	Phenylalanine	Phe
W	Tryptophan	Trp
K	Lysine	Lys
Q	Glutamine	Gln
E	Glutamic Acid	Glu
S	Serine	Ser
P	Proline	Pro
V	Valine	Val
I	Isoleucine	Ile
C	Cysteine	Cys
Y	Tyrosine	Tyr
H	Histidine	His
R	Arginine	Arg
N	Asparagine	Asn
D	Aspartic Acid	Asp
T	Threonine	Thr



Fun facts about

- Roughly 500 amino acids have been identified in nature, but just 20 amino acids make up the proteins found in the human body

- Of the twenty amino acids common to all life forms (not counting selenocysteine), humans cannot synthesize nine:

  histidine, isoleucine, leucine,
  lysine, methionine, phenylalanine,
  threonine, tryptophan valine.

- These amino acids, called essential amino acids, must be obtained from our diet

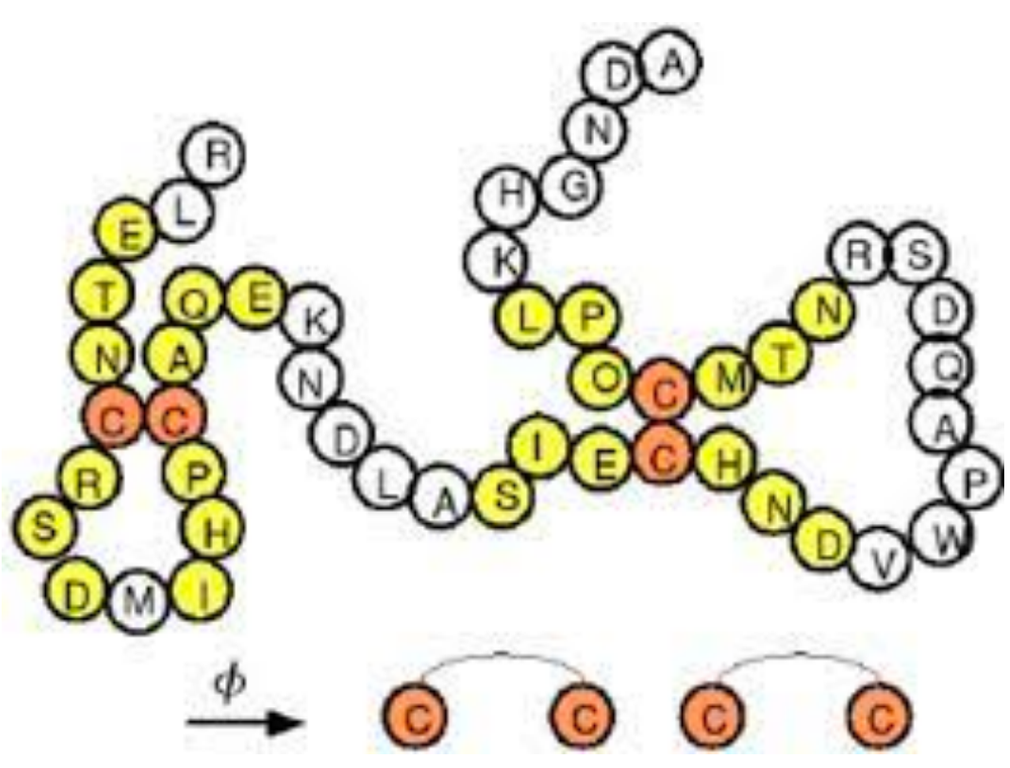
Peptide vs Protein

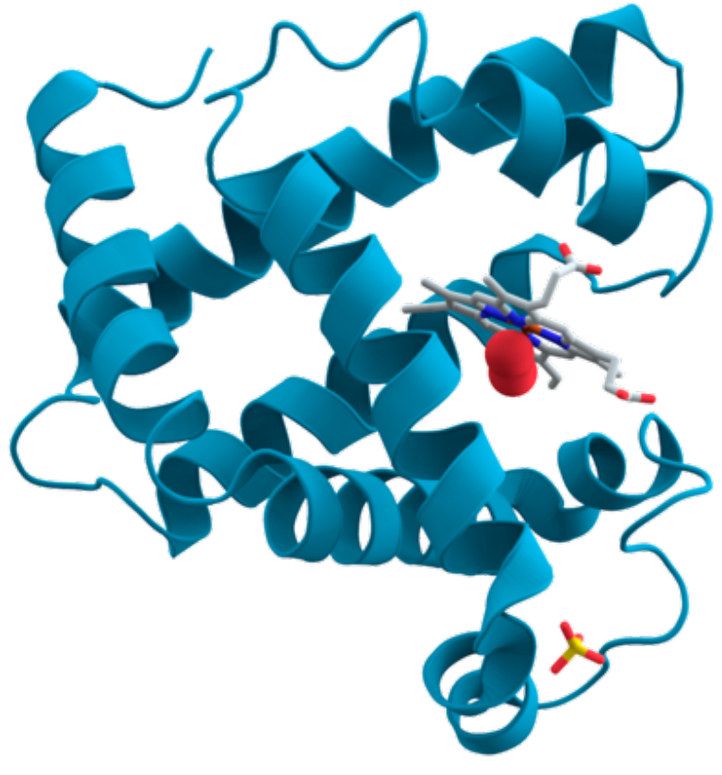
Small chains of containing less than 20–30 residues, are rarely considered to be proteins and are commonly called peptides.

Protein folding

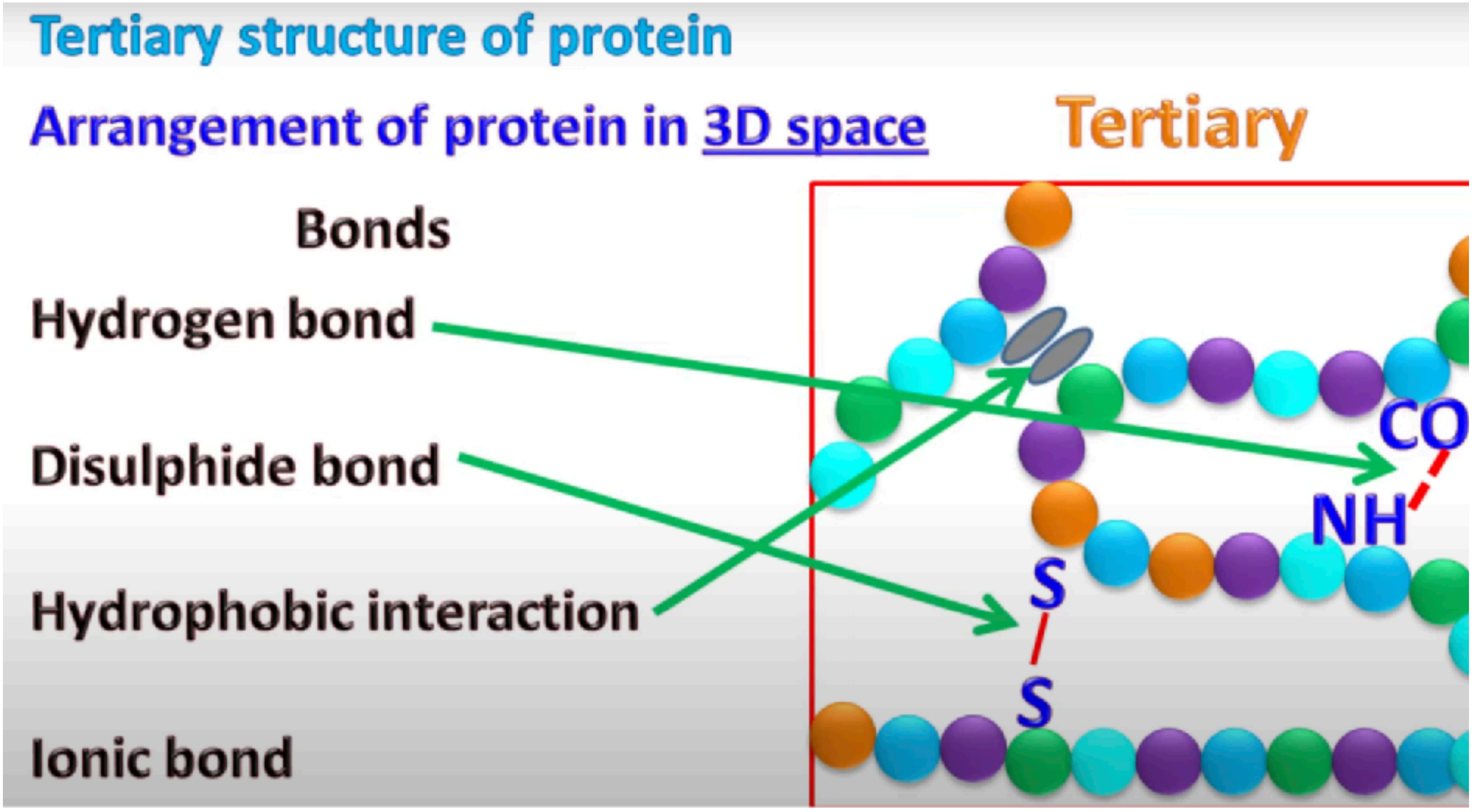
Protein folding is the physical process by which a protein chain is translated into its native three-dimensional structure.

Its the 3d structure where the protein becomes biologically functional.





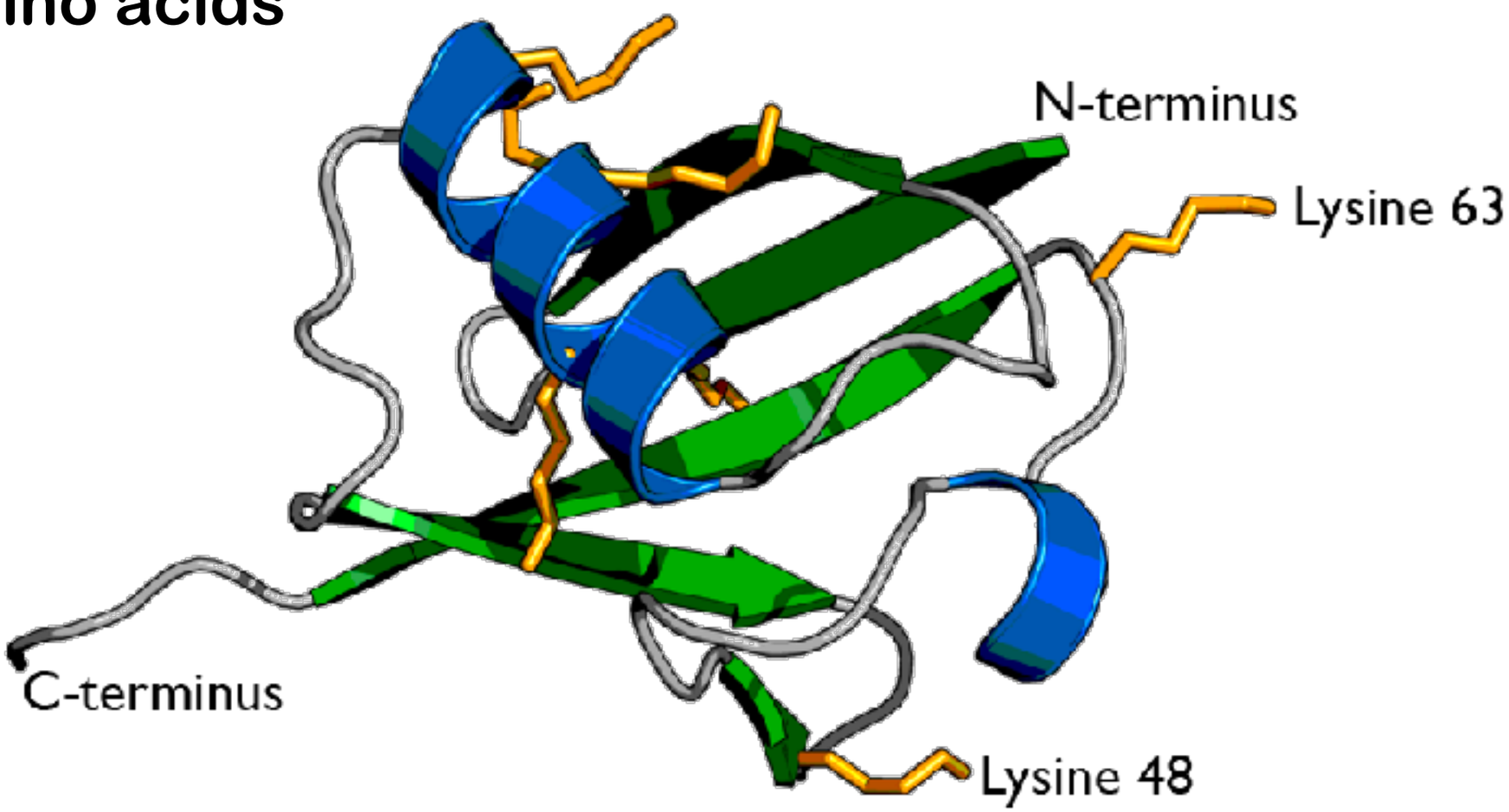
Non-covalent interactions making the 3d struture of protein



Reference
https://youtu.be/PPJ7C3hcnPw

Example of a small Protein

<u>Ubiquitin</u>
76 amino acids



- regulating the survival and death of cancer cells
- its relationship to stress
- its role at mitochondria and its disease implications

Amnio acid to functional proteins

Structure of Proteins

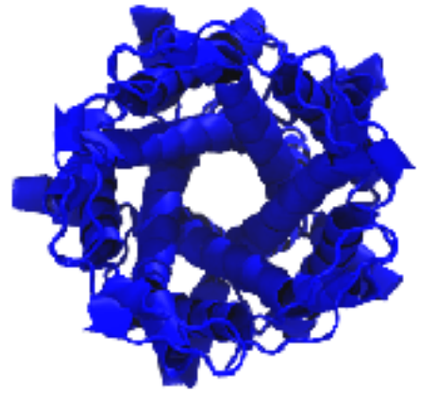
Primary

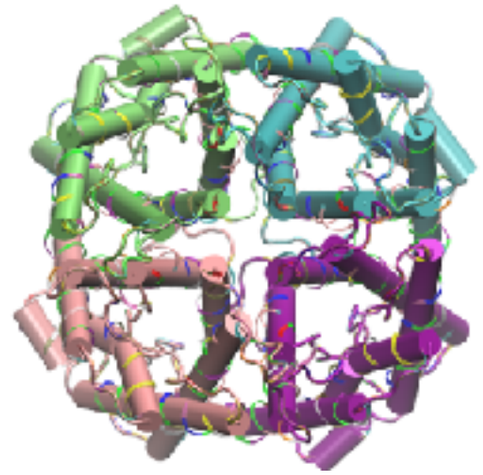
α Helix

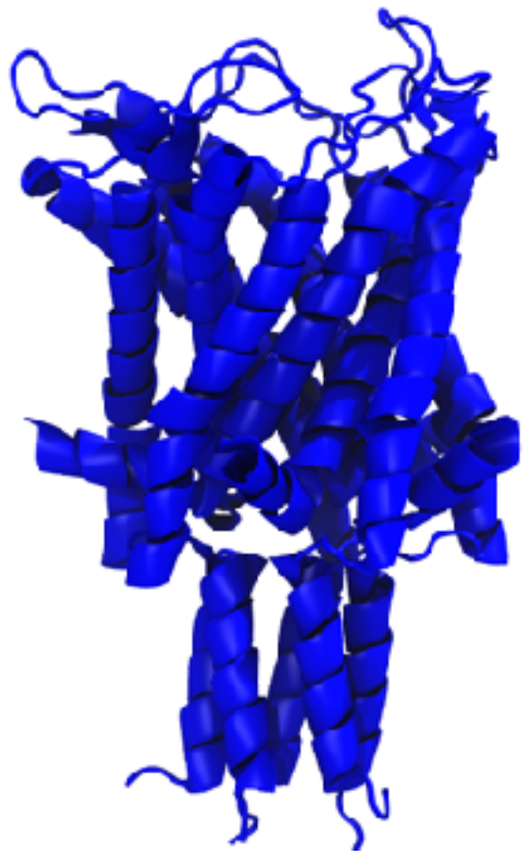
β sheet

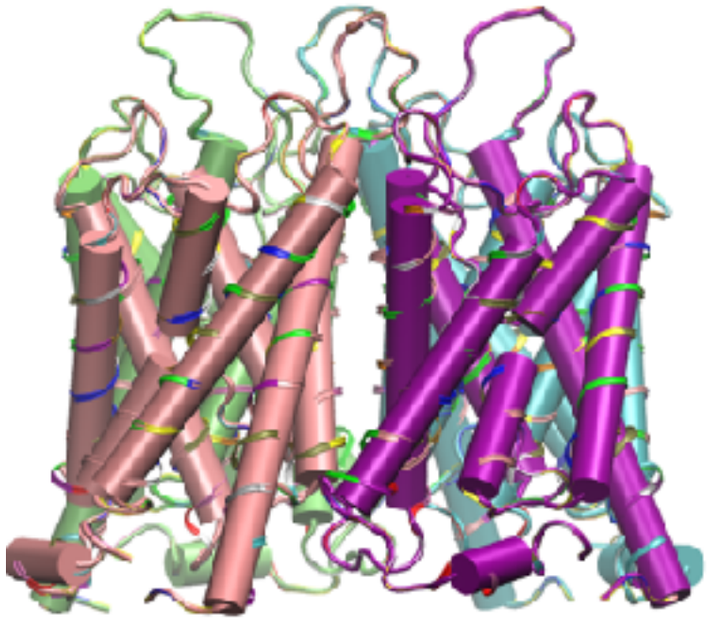
Tertiary

Quaternary

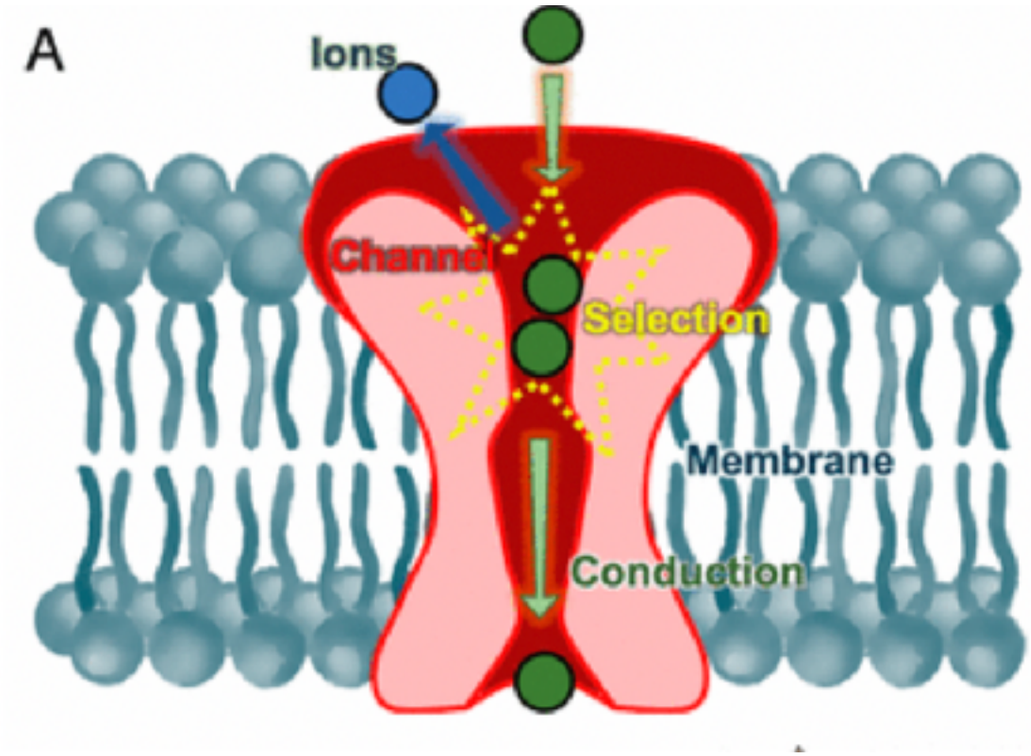


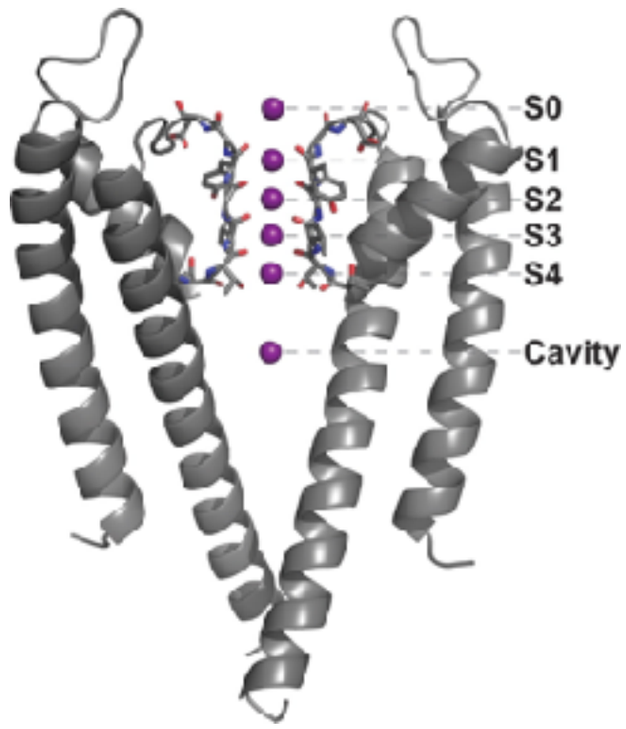






Protein channels in membrane and biomimetics



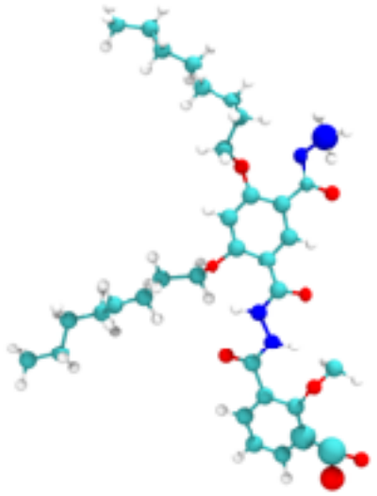


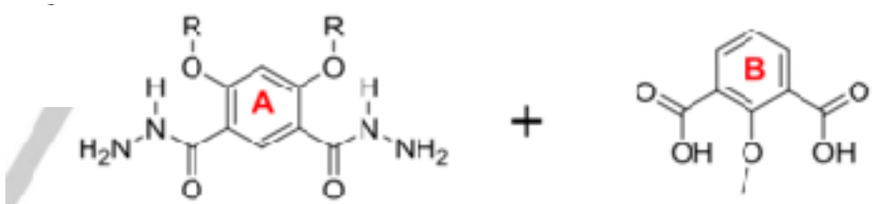
Chem. Rev. 2019, 119, 13, 7737–7832

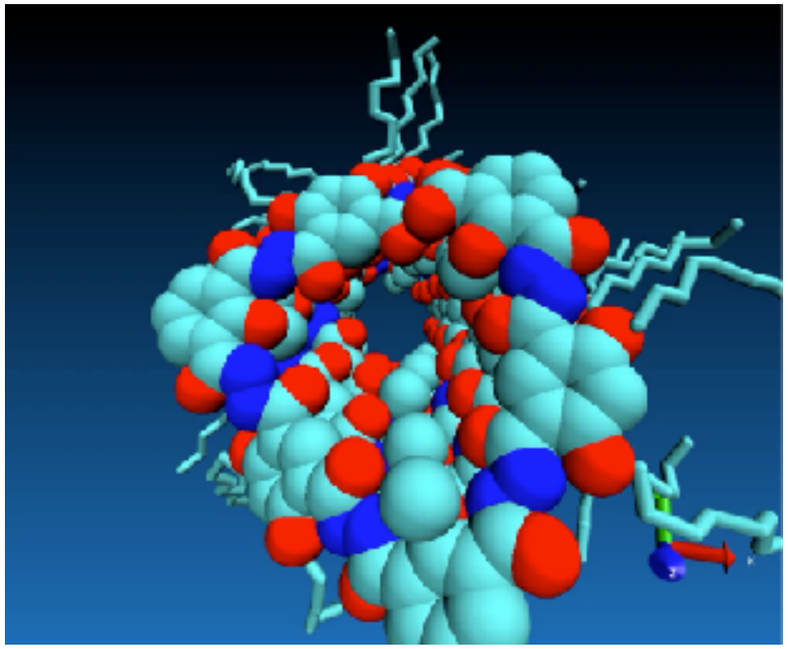
Protein channels regulates some key functions at cellular level like

- Propagation of nerve impulses
- Enabling vital functions like heartbeat
- Brain activity
- Muscle contraction etc

Polymeric organic nanotubes







Polymerization