

# **INTRODUCTION TO PROTEIN-PROTEIN INTERACTION**

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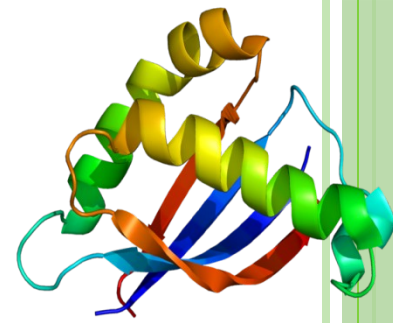
**Guidance By: Dr. Sriparna Saha**

# OUTLINE OF THE PRESENTATION

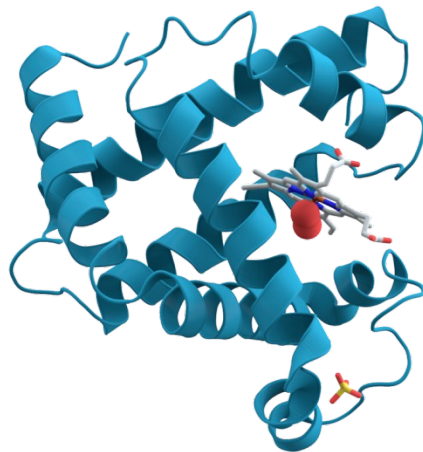


- What is Protein??
- Protein Structure
- RNA/DNA/ Gene/ Protein
- Central Dogma of Biology
- Microarray and Gene Expression Data
- Protein-protein Interaction
- Protein Interaction Network
- Conclusion

# WHAT IS PROTEIN



- Protein are large biomolecules that consisting of one or more long chains of amino acids
- A protein contains at least one long polypeptide( chain of amino acids)
- Primarily the sequence of amino acid differs the protein from each other

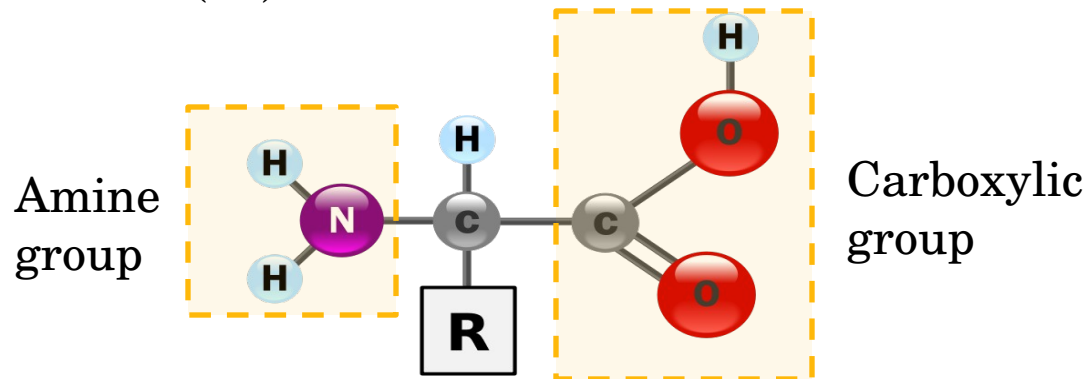


3D structure of  
protein myoglobin

# AMINO-ACIDS AND POLYPEPTIDE



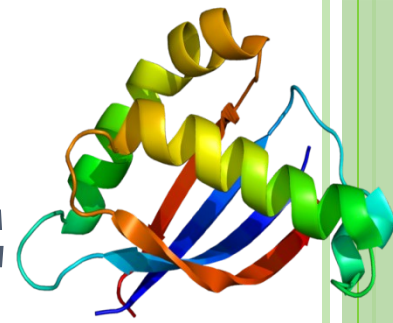
- Amino acid are biologically important organic compound that consists of
  - Amine group(  $\text{-NH}_2$  )
  - Carboxylic Acid group (  $\text{-COOH}$  )
  - and a side chain(  $\text{- R}$  )



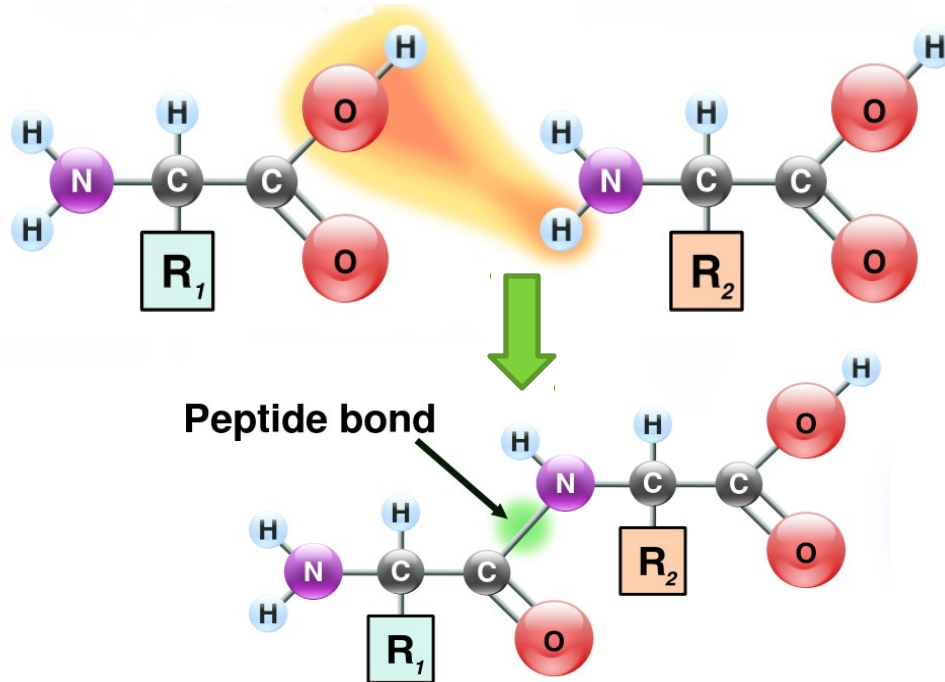
Structure of an  $\alpha$ -amino acid

- Therefore the key elements of amino acid are **carbon (C)** , **hydrogen(H)** , **oxygen(O)** and **nitrogen(N)**

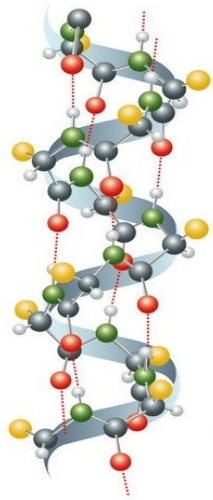
# AMINO-ACIDS AND POLYPEPTIDE



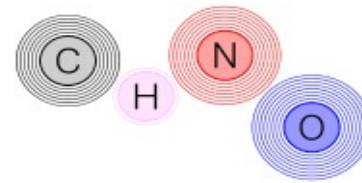
- Though there are about 500 amino acids, only 20 amino acids appear in genetic code
- When two or more amino acids are connected through **peptide bond** it is called polypeptide (amino acid chain)



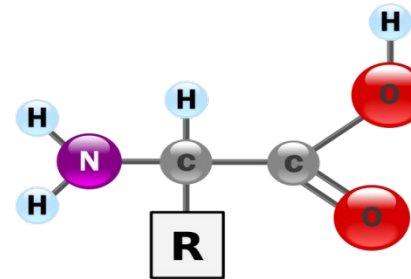
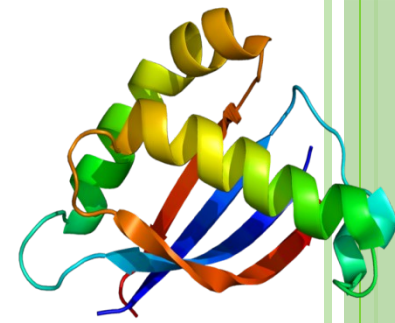
# STRUCTURAL ELEMENTS OF PROTEIN



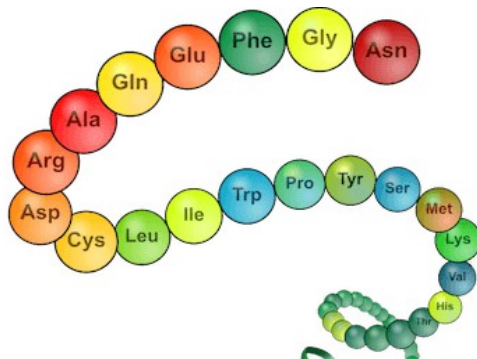
3d structure of protein



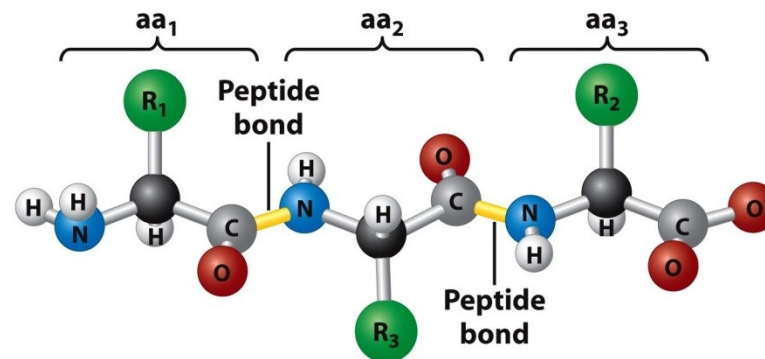
Key elements of protein



Molecular structure of amino acid

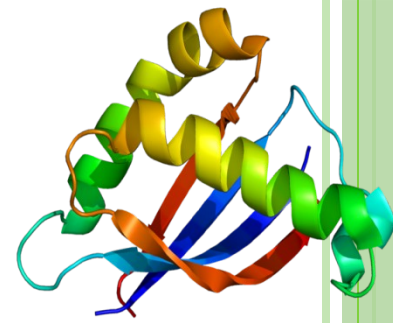


chain of Amino acid

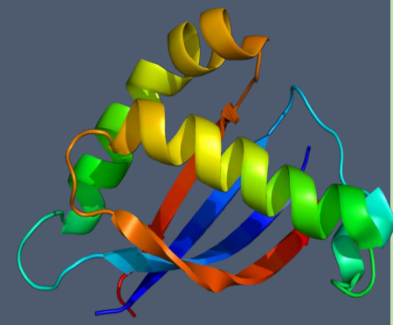


Molecular structure of peptide

# PROTEIN STRUCTURE



- Protein structure is the three-dimensional arrangement of atoms in a protein molecule
- To perform several biological functions, protein folds into one or more specific spatial conformations
- Several non-covalent interactions are responsible for this confirmations
- Levels of protein structure
  - **Primary structure:** *linear sequence* of amino acids in the polypeptide chain
  - **Secondary structure :** *helical structure* due to hydrogen bond between the main-chain peptide groups. **E.g**  $\alpha$ -helix and  $\beta$ -sheets
  - **Tertiary structure:** folded into a compact *globular structure* due to hydrophobic interactions

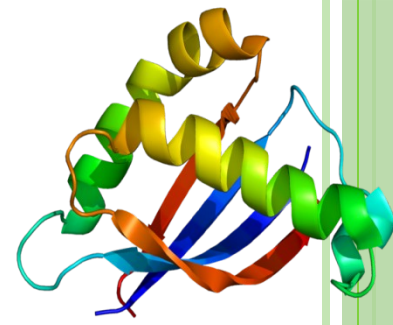


# THE CENTRAL DOGMA

Relation between DNA, RNA and  
proteins

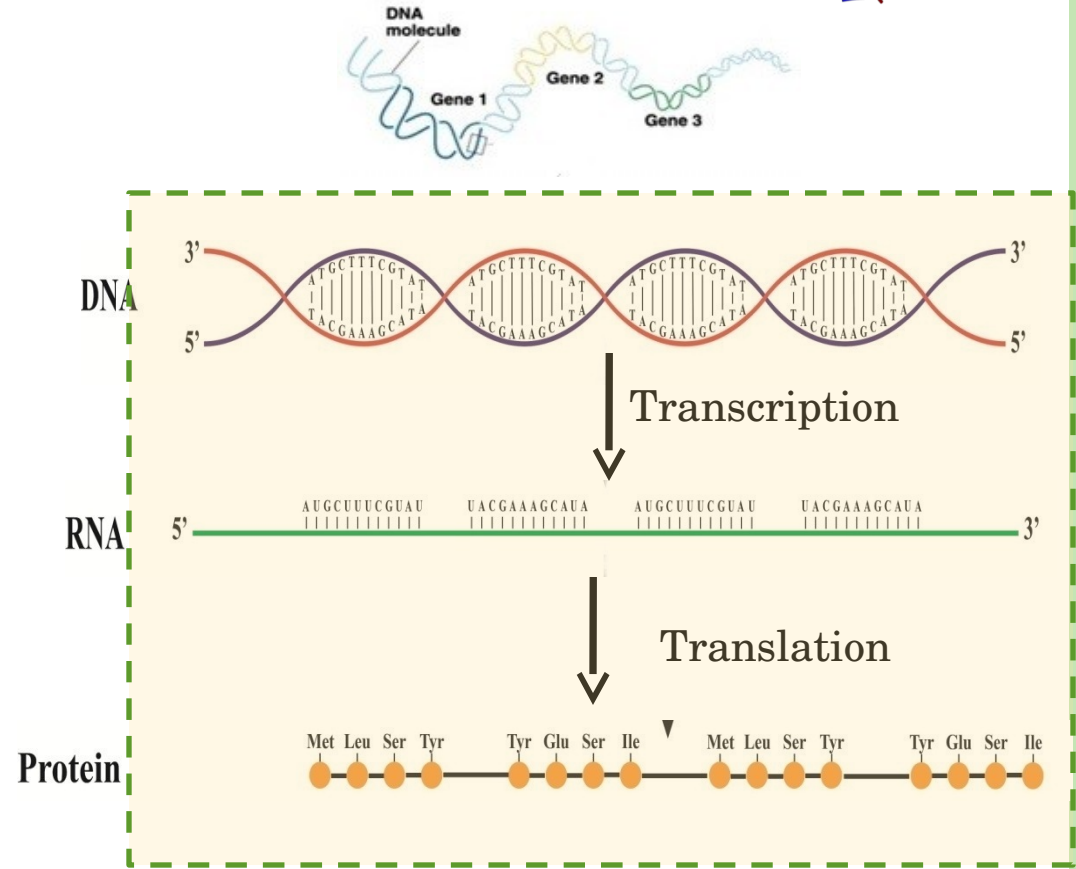
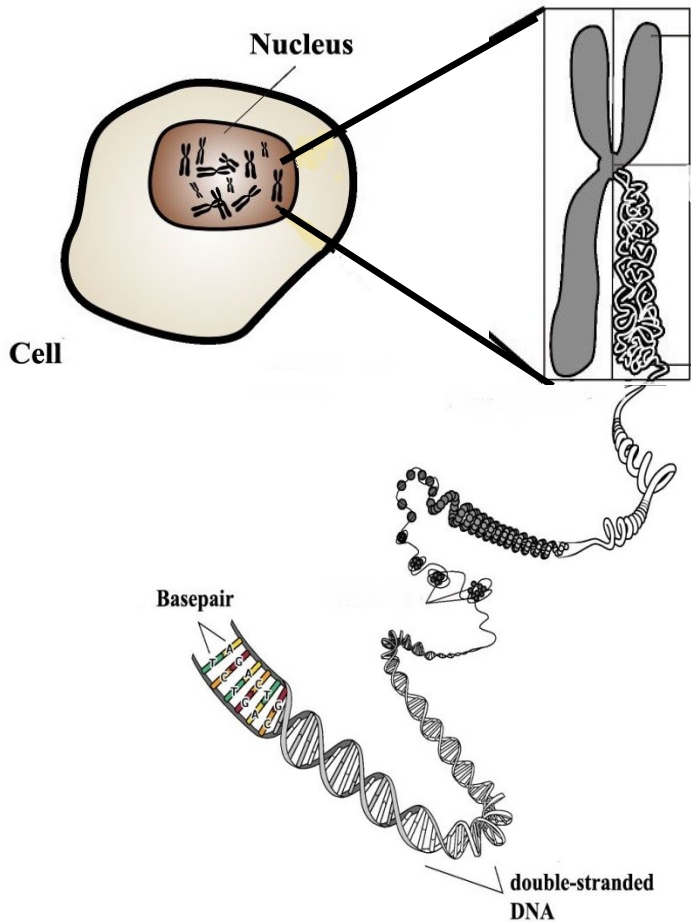
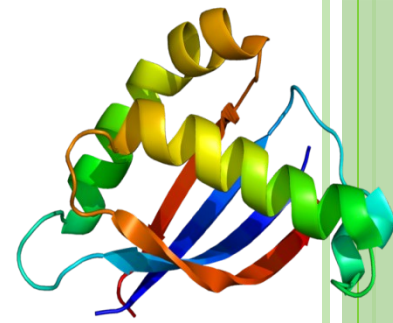


# CENTRAL DOGMA

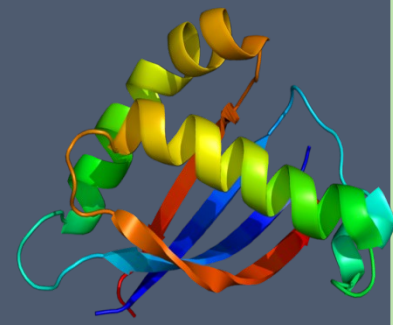


- Explains *the flow of genetic information from **DNA** to **RNA**, to make a functional product **Protein***
- ***Stages of Central Dogma***
  - ***Replication***: Fundamental step of central dogma, make a new DNA from existing DNA by DNA polymerase
  - ***Transcription***: Make new mRNA from DNA by RNA polymerase
  - ***Translation***: Make new protein from mRNA by ribosome

# CENTRAL DOGMA

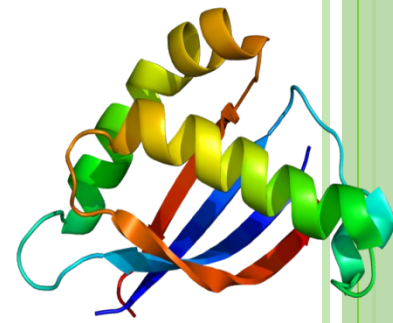


Central Dogma of Molecular Biology



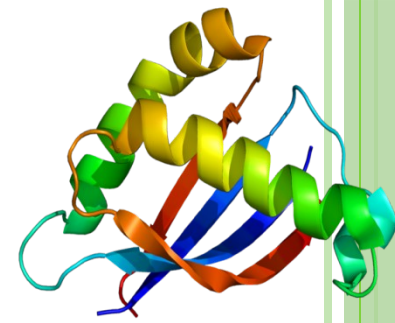
# GENE EXPRESSION VALUES

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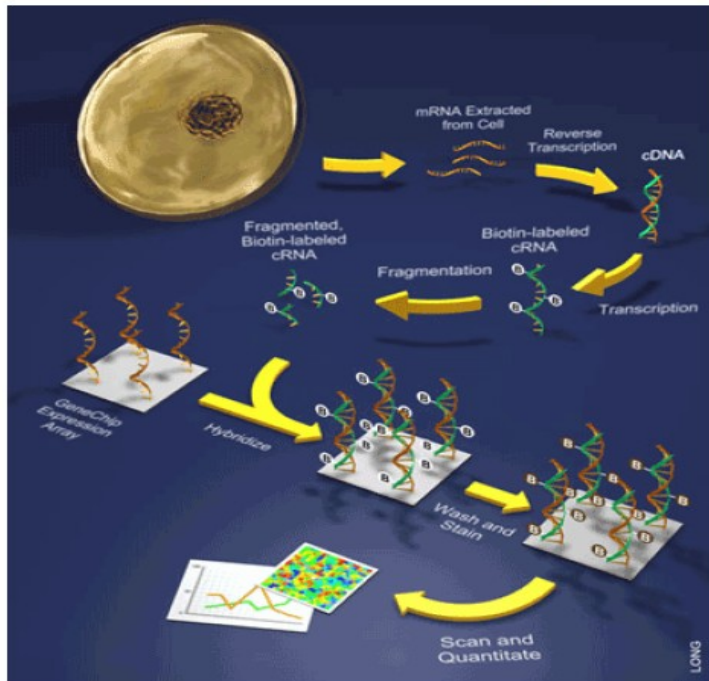


- In the field of molecular biology, **gene expression profiling** is the measurement of the activity of thousands of genes at once
- Gene expression values of large genes are measured by microarray
- Gene expression can be quantified **by measuring either mRNA or protein**
- Gene Expression Measurement Method
  - Single Channel Arrays:
    - Give estimations of the absolute levels of gene expression
    - compare two set of condition for each gene
    - requires two separate single-dye hybridizations
  - Two Channel Arrays:
    - Two hybridized cDNA samples (e.g. diseased tissue versus healthy tissue) and labelled with two different **fluorescent dyes (Cy5 and Cy3)**

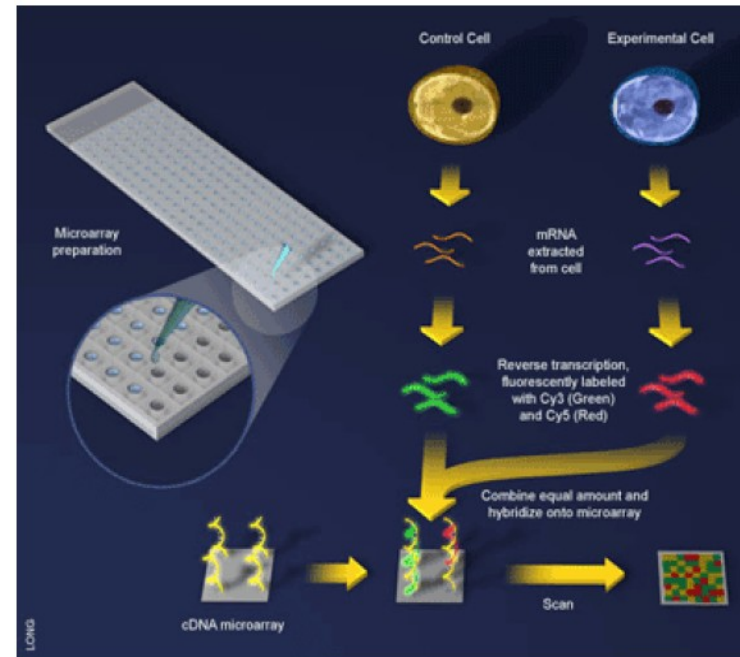
# GENE EXPRESSION VALUE



## Single channel arrays



## Dual channel arrays



# GENE EXPRESSION DATASET

( <http://www.ncbi.nlm.nih.gov/sites/GDSbrowser?acc=GDS1388> )

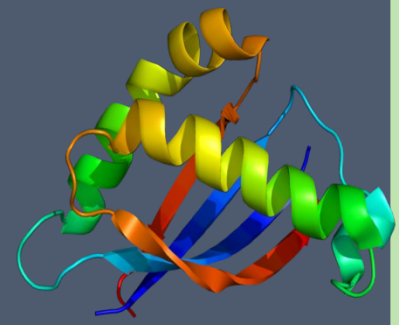


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1001_at TIM1 20.9 18.5 10.8 13.5 20.5 10.7 3.7 12.8 25.4 23.1 11.5 34.2 28 17.7 26.3 17.5
1002_f_at CYP2C19 4.7 18.9 17.6 2.6 5.5 3.3 3.2 1.8 9.8 22.1 26.5 6.4 8.2 6.3 2.5 3.3 10.8 5.5 7.2 3.6 6.1
1003_s_at CXCR5 174.1 231.7 214.1 201.6 314.5 8.4 7.2 204.6 22.3 109.3 100.4 414 75.7 211.8 232.5 189 2
1004_at CXCR5 257 194.3 221.5 185.4 376.4 355.9 176.8 244.2 186.2 743 268.7 423.2 132.6 157 155.1 216 244.6
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807.6
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1011_s at YWHAE 25.9 31.7 43.3 40.9 40.8 26.7 45.1 62 60.4 63.4 38.6 12.5 53.6 72.8 59.6
```

Gene expression level of gene  $i$  in mRNA sample  $j$

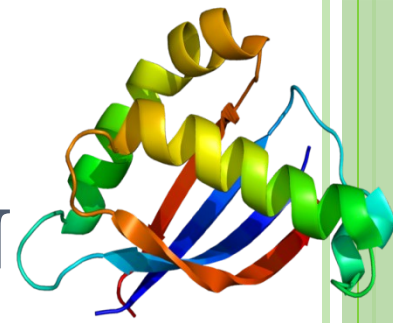
Single Channel Arrays: (normalized)  $\text{Log}_2(\text{Intensity})$

Double Channel Arrays:  $\log_2 \frac{\text{Intensity}(\text{Cy5})}{\text{Intensity}(\text{Cy3})}$

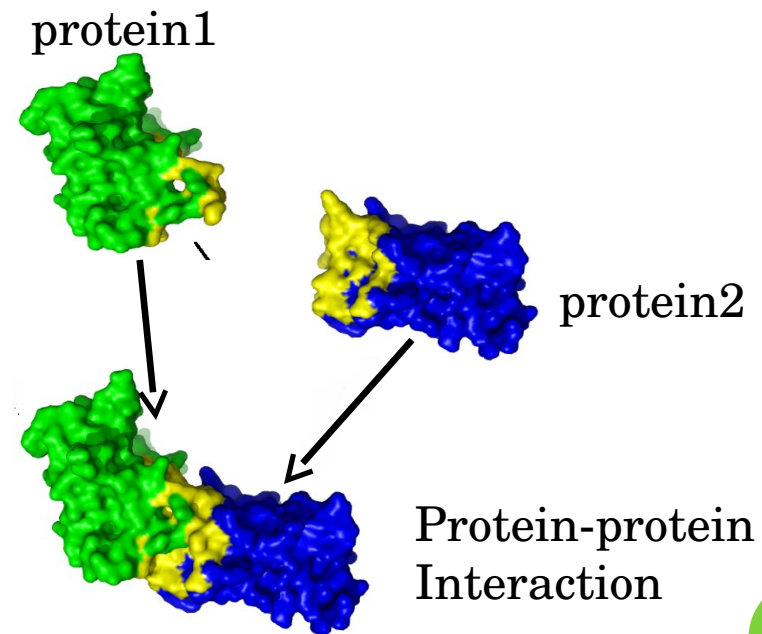


# PROTEIN-PROTEIN INTERACTION

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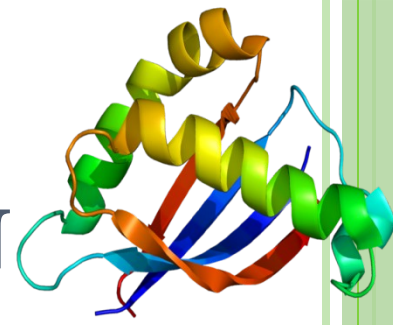


- Lasting and specific physical contacts established between two or more proteins for carried out some specific biological activity
- Represents pair wise protein interactions of the organisms
- Example of PPI
  - Muscle Contraction
  - Cellular Transportation



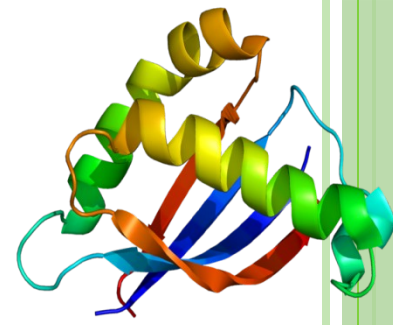


# PROTEIN-PROTEIN INTERACTION



- Interaction between two proteins is carried out by several biochemical events
  - **Electrostatic Forces:-** Force interacting between static electrically charged particles
  - **Hydrogen bonds:-** electrostatic attraction between hydrogen(H) and highly electronegative atom(e.g. O, N)
  - **Van der Waals forces:-** residual attractive or repulsive forces between molecules or atomic groups
  - **Hydrophobic interactions:-** Maximize hydrogen bond

# TYPES OF INTERACTION



## ○ ***Stability***

- Stable:- Always stable and active e.g. Hormones, Hemoglobin
- Transient:- Control the majority of cellular processes, can be strong or weak, fast or slow

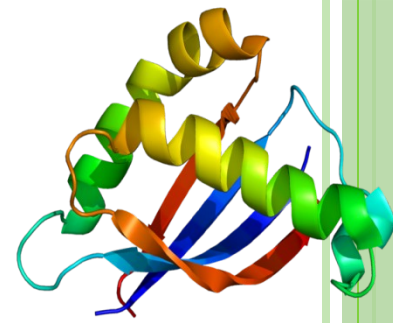
## ○ ***Structural***

- Homo-oligomer :- Same type of subunits e.g. Enzymes
- Hetero-oligomer:- Different types of subunits e.g. G-proteins

## ○ ***Chemical Bonding***

- Covalent Bonding: Share electron pairs
- Non-covalent Bonding: Rather sharing electrons , involves in some electromagnetic forces

# IMPORTANCE OF PPI NETWORK

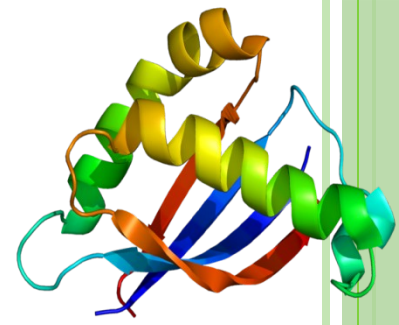


- Useful for isolating groups of interacting proteins that participate in the same biological process
- Helps to understand the mechanism of regulating cell life
- Useful to predict the biological functions of uncharacterized proteins



# REFERENCES

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- <https://en.wikipedia.org/wiki>



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