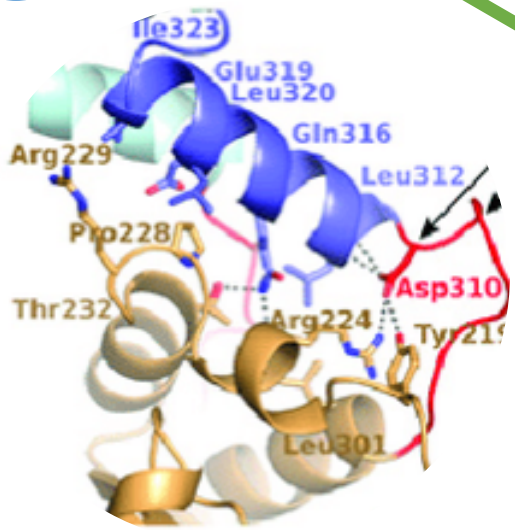

Introduction to Molecular Biophysics

(Biophysics at molecule level)

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What does Biophysics study (at molecule level)?

- It studies and explains the physical behaviour of life at the molecular level.
- It uses the tools and terminology of physical chemistry to describe the dynamic of living organisms
- It answers some question about the dynamic and the kinetics of the biomolecules
- It gives a logic about the dynamics in the living molecules

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Biophysics and proteins

- What does Biophysics (at at molecule level) study?
- Biophysics is the of study structural and functional biomolecules such as protein, DNA and RNA etc.
- Since, Proteins, DNA and RNA are the biomolecules,
- Biophysics can explain the Protein function and structure, using kinetics, thermodynamics and characterization facilities to understand the biological systems.

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Biophysics of the biomolecules

- How do we study the biophysics of biomolecules ?
- There are several biochemical and biophysical techniques to study biomolecules.
- What are the techniques that are used to study the biophysics of proteins?

1. Genetic engineering. (described later)
2. Cloning techniques. (described later)
3. Protein expression and purification methods.
4. Structural and functional assays. Such as: Protein-protein interactions, protein-ligand interactions (for dug design) and DNA or RNA-protein interactions.

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Techniques used to study the biophysics of at molecule level?

1. Expression of Genes in Bacteria, Yeast, and Cultured Mammalian Cells.
2. Protein purification Methods.
3. **Examination of protein purity**
4. Protein Crystallization for structure analysis.
5. Protein NMR
6. **Optical spectroscopic techniques for biomolecules. 1- Absorbance.**
7. **Optical spectroscopic techniques for biomolecules** 2- Fluorescence .
8. Kinetics of proteins.
9. Circular dichroism.
10. **Sedimentation assays**
11. Electron microscopy.
12. Thermodynamics of proteins.
13. Mass spectroscopy .

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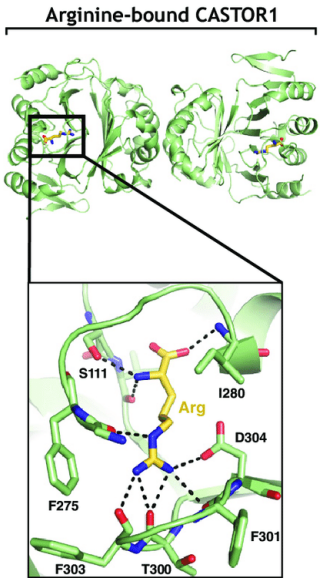
What is Structural biology?

- **Structural biology** is the study of the molecular **structure** and dynamics of **biological** macromolecules, particularly proteins and nucleic acids.
- It shows how alterations in their **structures** affect their function.
- Why it is useful?
- Because is explains how biological molecules are built (3D shape) and therefore, how it does work.
- What is that for?
- It is to understand the diseases formation and to design dugs for treatment.



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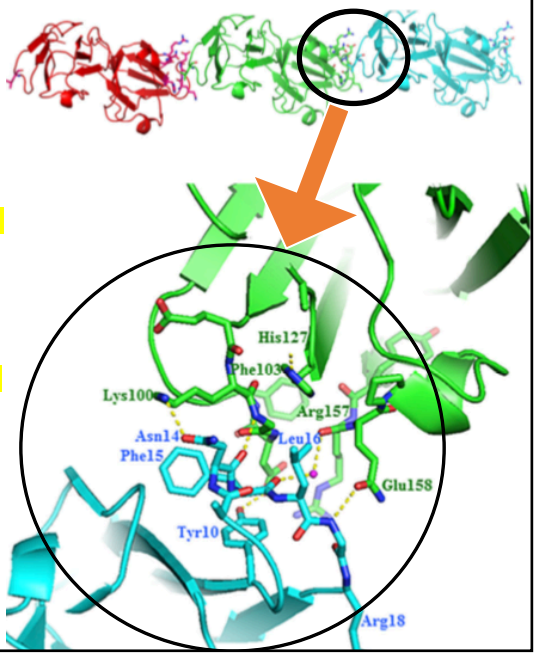
What are Protein-protein interactions ?

- **Protein–protein interactions** (PPIs) are physical contacts between two or more **protein** molecules.
- It is as a result of biochemical events driven by **interactions** that include electrostatic forces, hydrogen bonding and the hydrophobic effect.



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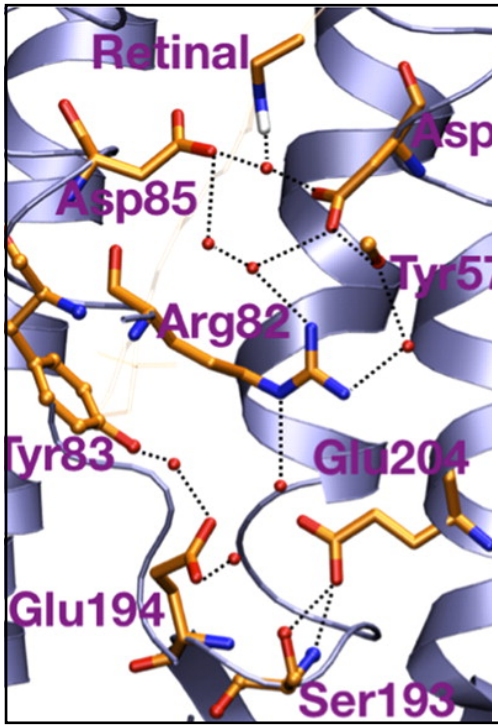

What are several types of bonds and forces that hold a protein and affect its interaction with other?

- **There are several types of bonds and forces that hold a protein in its tertiary structure.**

1. **Hydrophobic interactions** greatly contribute to the folding and shaping of a protein.
2. **Hydrogen bonding: between OH and H.**
3. **The ionic bonding** can occur between the positively and negatively charged "R" groups.
4. **The disulphide bridge**. Between S-S of 2 cysteine molecules.
5. **Van der Waals forces** stabilize protein structure.

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Examples:

- Muscles contraction (striated muscles) are regulated by **Protein–protein interactions** which result in a mechanical movement of the body. The same with (cardiac and smooth muscles) but for different functions.
- The activity of the cell is regulated by extracellular signals. Signal propagation inside and/or along the interior of cells depends on PPIs between the various signalling molecules.
- Membrane proteins are carried by PPIs.
- In cell metabolism, many biosynthetic processes enzymes interact with each other to produce small compounds or other macromolecules.

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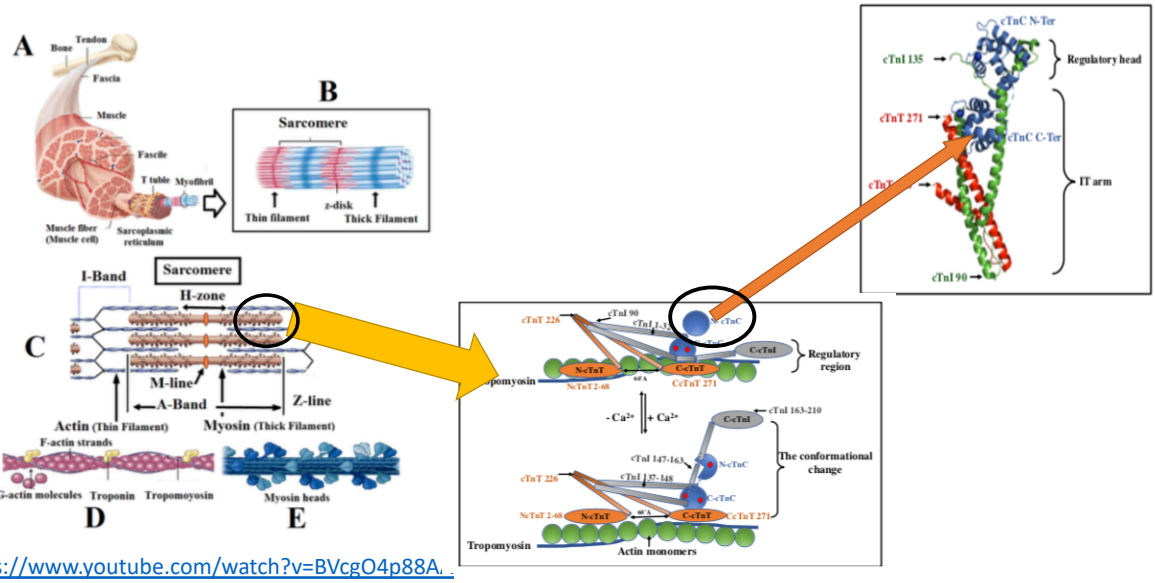
Muscles contraction PPIs



https://www.youtube.com/watch?v=BVcgO4p88A

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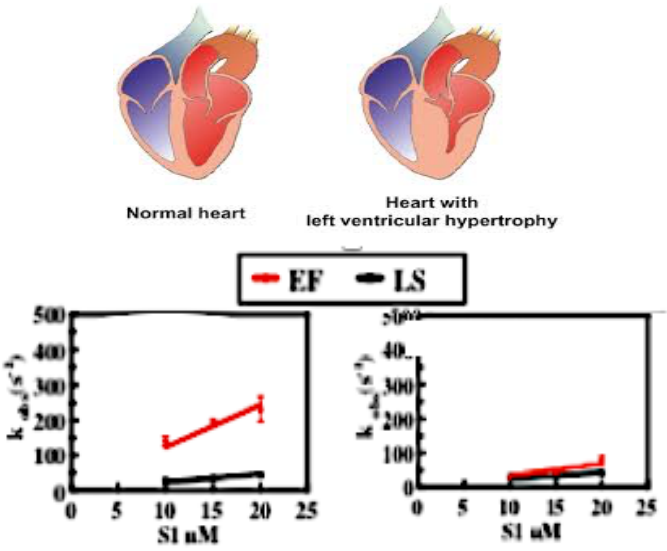
Example of function measured by biophysics

e.g: We measure the difference on the contractility/ time between a healthy heart (WT) and a diseased heart (mutation).



WT **Mutation**

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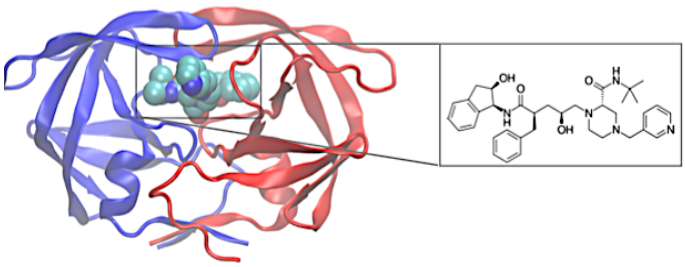
What are protein-ligand interactions?

- Protein-ligand interactions facilitate understanding drug design.
- There are many compounds act as ligands that could be used as a drug.
- **Ligand** binding **interactions** changes the **protein** state and **protein** function.
- The ligand is chosen by a computational process called 'Molecular Docking'.
- As below:



An example HIV-1 Protein-ligand interactions: protease structure in complex with the small molecule indinavir.

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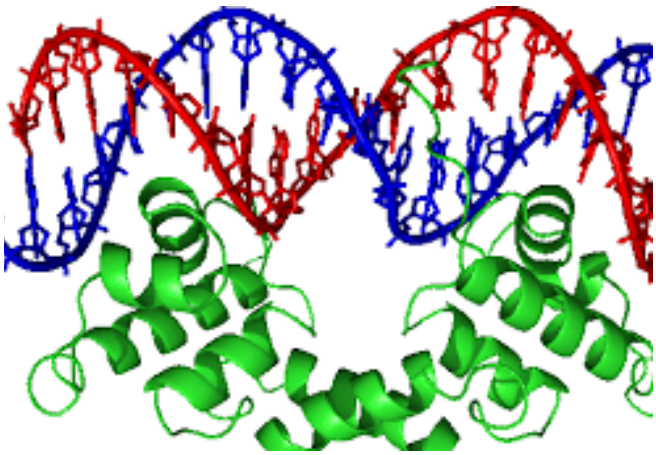
DNA or RNA-protein interactions

- **DNA-protein interactions** include those between **DNA** and transcription factors or other regulatory **proteins**.
- **RNA-protein interactions** include those between **RNA** and the ribosome, and other **RNA**-binding **proteins.**



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What the next steps?

1. Expression and purification of gene as a protein.
2. Tissue purified proteins preparations.

- why we are going to learn these topics?

- In order to do functional and structural assays at molecular level.
- How can be biophysics be involved in these topics?
- All the interactions of the biomolecules are based on the biophysics science.
- All the instatements are based on the biophysics science.

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