



Question of the Day

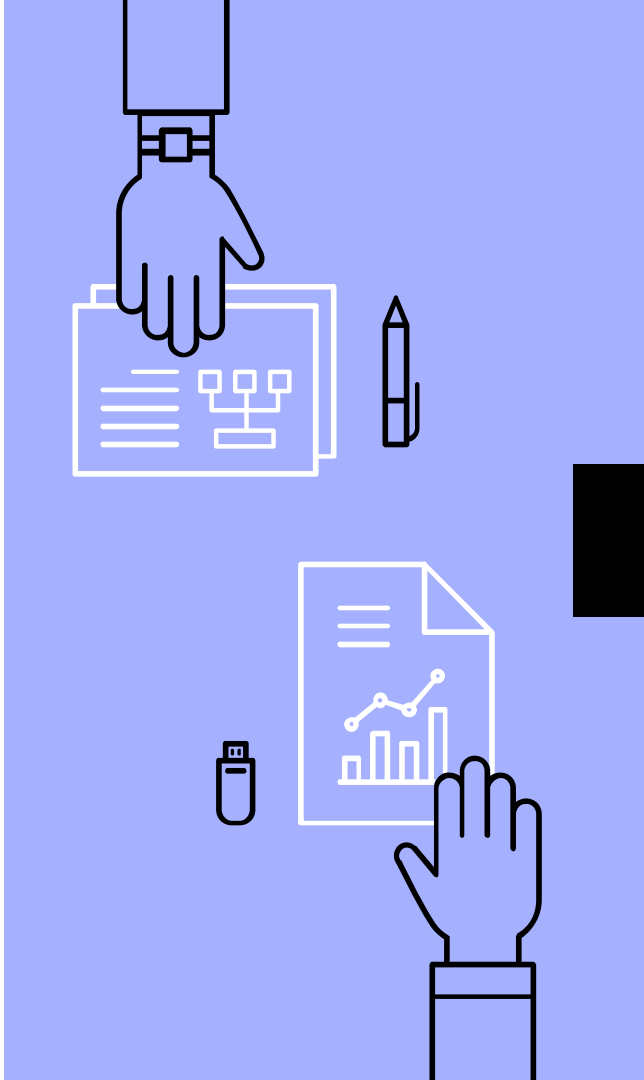
What is the best brand of ice cream?



Recap & Intro

Previously, we learned about various basic bio lab techniques...

Today, we will learn about advanced bio lab techniques that used in analysis of molecules, as well as learn about the various uses of molecular & cellular biology research and why investigations in this field can be important for society!



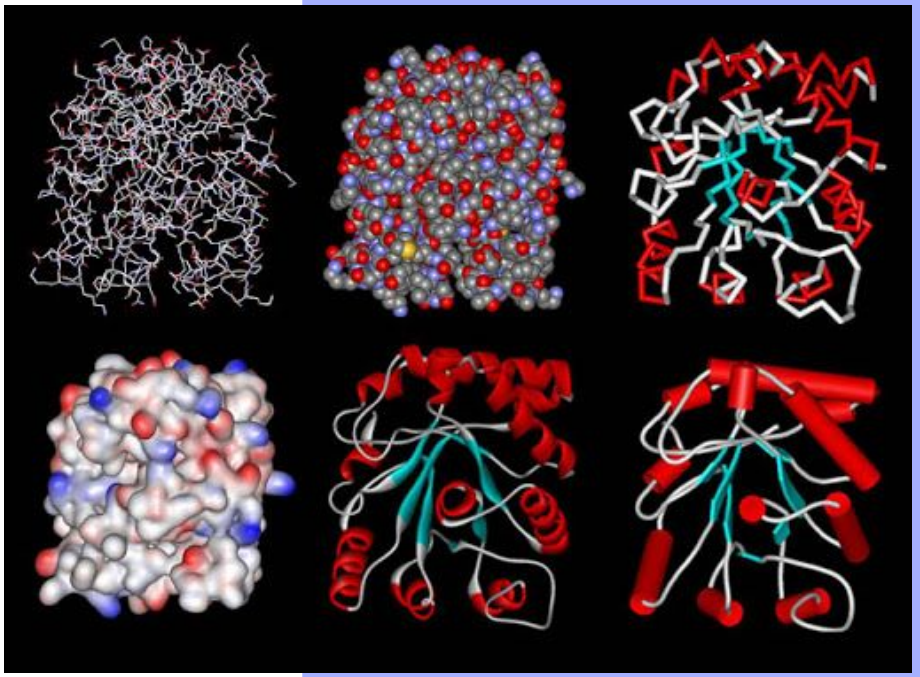
Quick summary of proteins

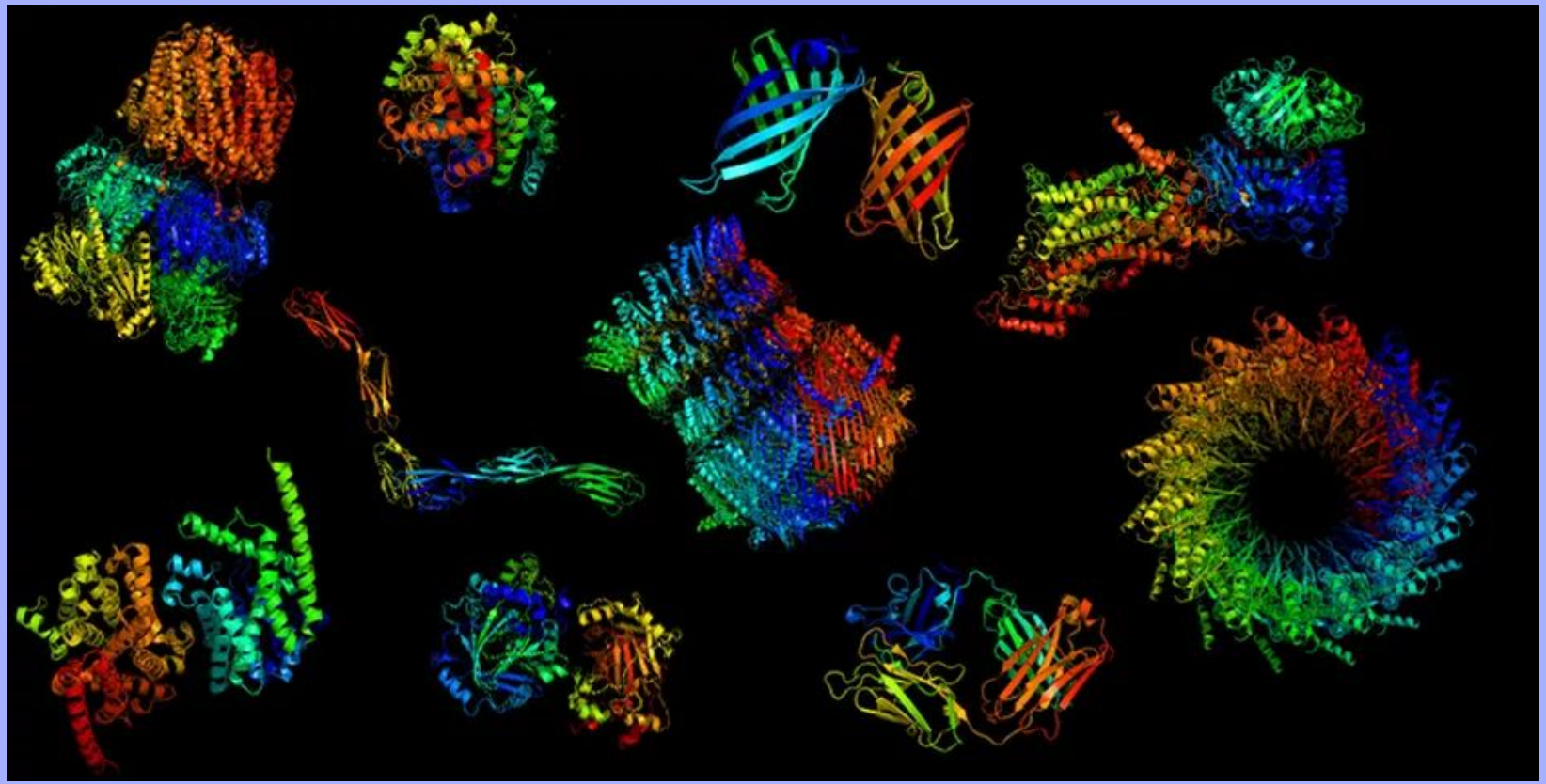
The very foundation of molecular and cellular biology research will most likely focus on a specific set of proteins.

“A protein is a naturally occurring, extremely complex substance that consists of amino acid residues joined by peptide bonds. Proteins are present in all living organisms and include many essential biological compounds such as enzymes, hormones, and antibodies.”

“Examples of proteins include enzymes, antibodies and some hormones which help to speed up chemical reactions, defend against diseases and regulate the activity of cells.”

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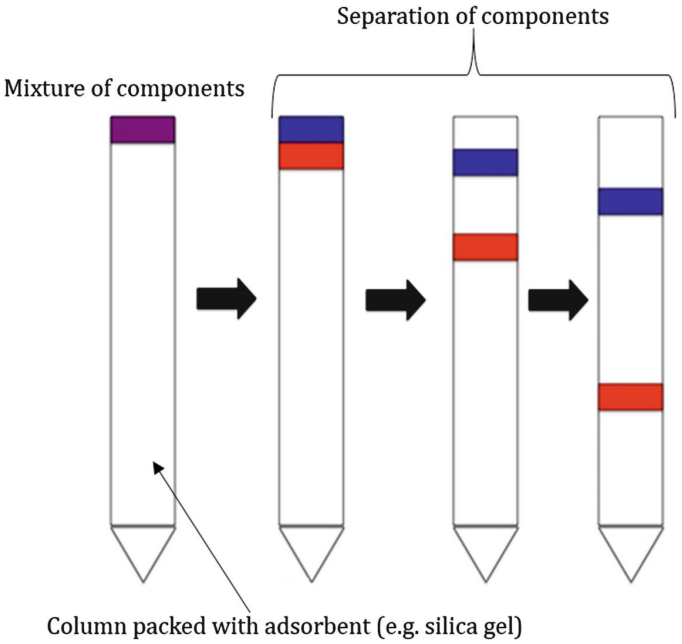




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What is chromatography?

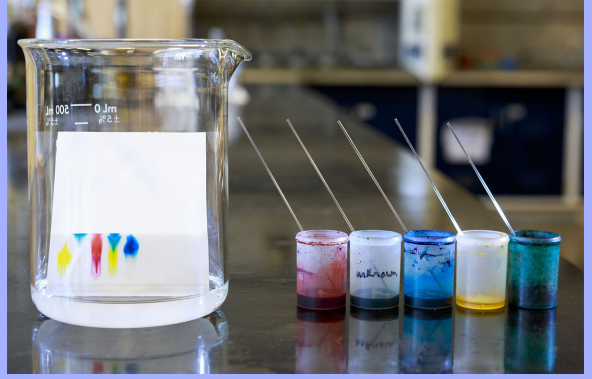
"Chromatography is a laboratory technique for the separation of a mixture."

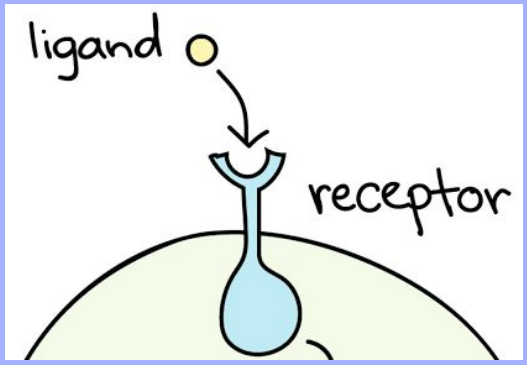


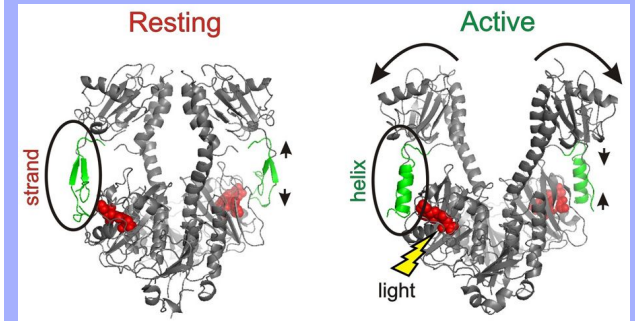


Overview Terms

- **pH:** hydrogen ion concentration (how acidic/basic it is)
- **Affinity:** degree to which substance combines with another
- **Chromatography:** process for separating components of a mixture
- **Ligand:** molecule that bonds to another molecule, which helps transmit a signal in the process
- **Conformational changes:** alteration in the shape of a protein
- **Protein "folding":** process in which a protein gains a functional shape

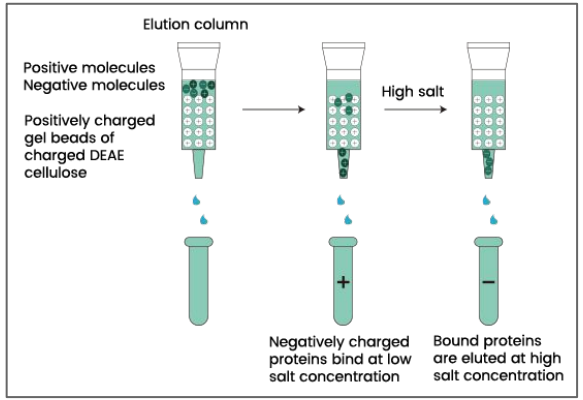






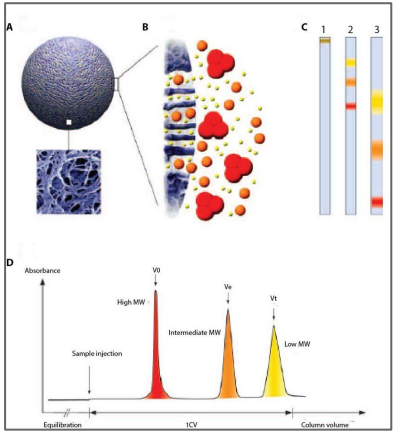
Ion-exchange chromatography

- Separates based on sign and magnitude of net electric charge
- pH and [free salt ion] affect protein affinity



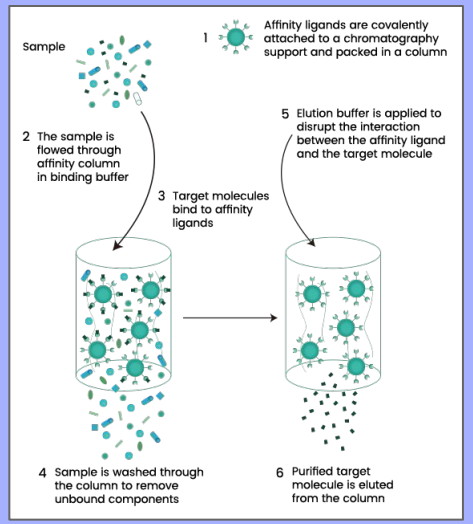
Size-exclusion chromatography

- Aka gel filtration chromatography
- Separates based on size
- Large proteins emerge from the column before small protein do



Affinity chromatography

- Separates based on binding affinity (high concentration of salt or ligand)



Electrophoresis

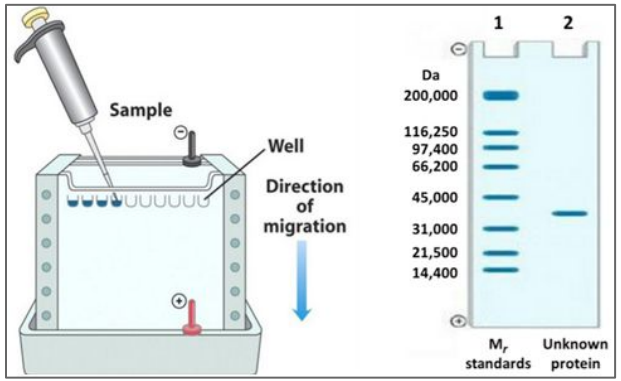
- Often used to monitor a protein purification
- Direction of migration in gel is downwards (- to +)
- Can be used to determine the size of a protein with unknown molecular mass

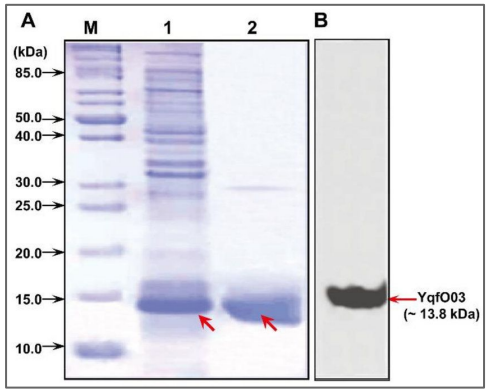
SDS-PAGE electrophoresis

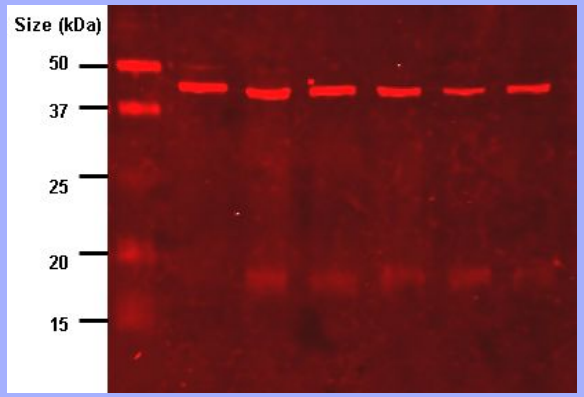
- Most popular technique is **SDS-PAGE electrophoresis**
- Separates based on size (mass to charge ratio is equal for all)
- Smaller proteins found further down on the gel

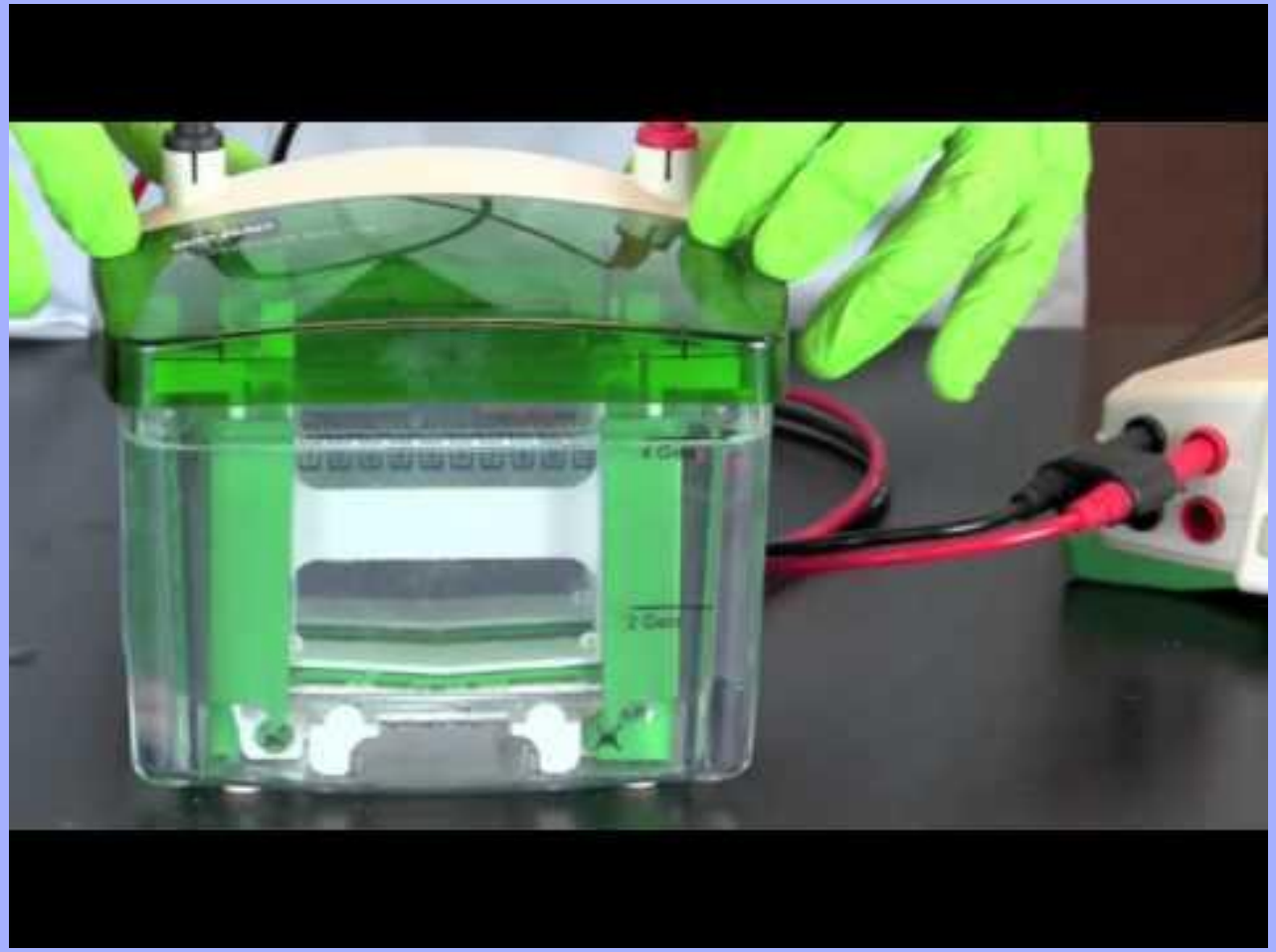
Immunological techniques

- Aka western blot
- “Stain” proteins separated on SDS-PAGE gel, and then transfers to visualize





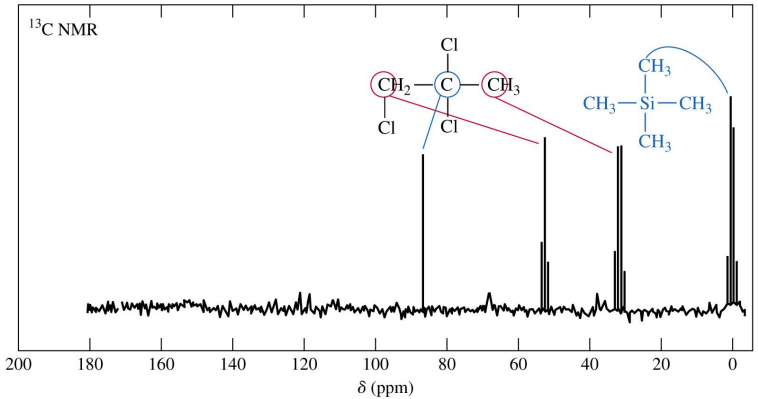


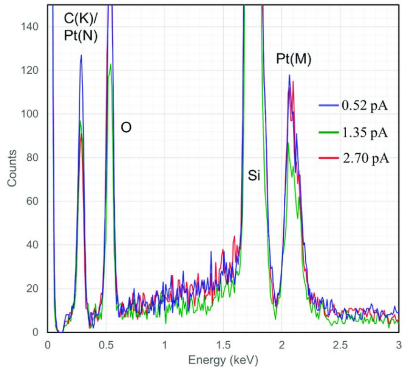


SDS-PAGE electrophoresis of Fish Muscle (i.e. running a gel)

NMR spectroscopy & X-ray spectroscopy

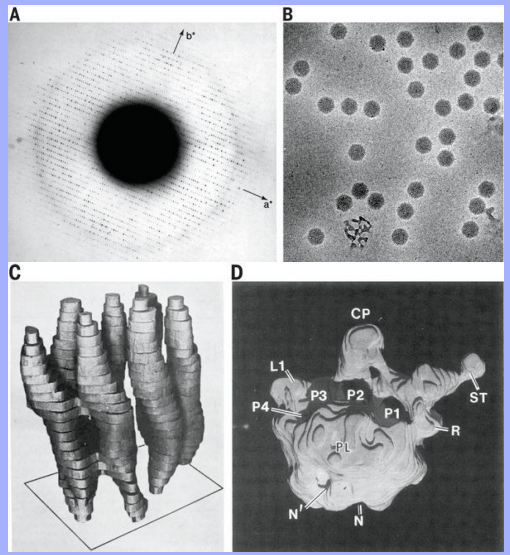
- NMR is carried out on molecules in solution
- Used to determine the (dynamic) structure of proteins, such as...
  - Conformational changes
  - Protein folding
  - Interactions with other molecules





Single particle cryo-electron microscopy

- Used to determine 3D structure of large molecular complexes (such as proteins)

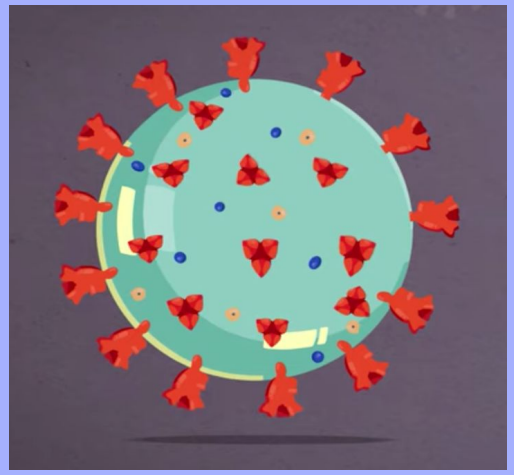


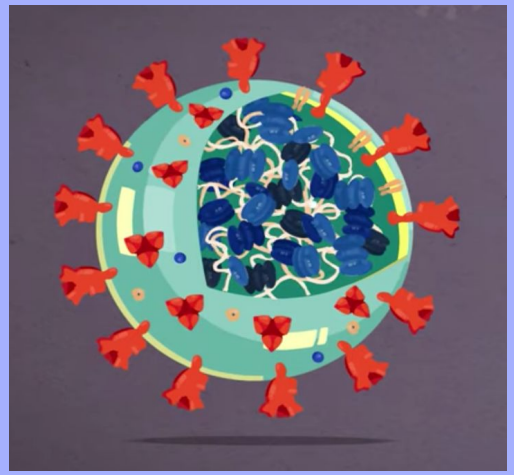
Why is molecular & cellular biology important?
The COVID-19 vaccine!

Principles of molecular and cellular biology are used to investigate many important biological issues, including but not limited to cancer therapies, metabolism/nutrition, and vaccines. This field of research is particular relevant today as we are living through the COVID-19 (coronavirus) pandemic.

“Coronavirus Anatomy Explained: Science, Simplified”

Video link: https://www.youtube.com/watch?v=8hgc2iZfITI






How vaccines work
against COVID-19

University Labs

We are going to explore professors at Cornell university who are doing relevant research in molecular biology that is contributing to the field of science and to society!

Link: https://biology.cornell.edu/research/faculty/?title=&body_value=&field_research_interest_value=Molecular+Biology





Discuss what you're interested in about cells...what is it about them that you would like to know? What kind of research would you like to do with cells?

What lab techniques (pipette, spectrophotometer, compound microscope, gels, x-rays, etc.) would you use to carry out these investigations?

What more knowledge do you need in order to do the kind of research you wish to conduct in the future?

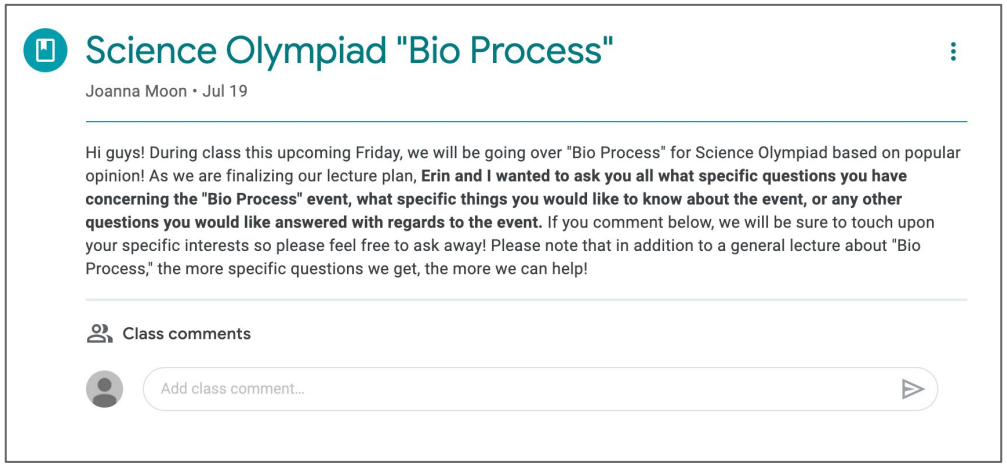




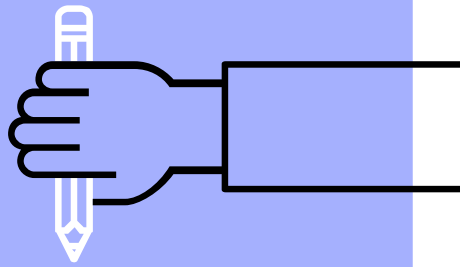
To be continued…

Next class:

- Science Olympiad “Bio Process”







End of Day 5

Any questions?
Please ask away!

