INTERNATIONAL BIOLOGY OLYMPIAD e.V. IBO

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF SCIENCE AND TECHNOLOGY

Protein Inquiry: Bridging Qualitative and Quantitative Analysis with BYOD Tools

Isabella Marini
President National Association Natural Science Teachers
Liceo Scientifico 'Dini' Pisa

25th July 2025- The IBO Educational Conference- Quezon City

Agenda

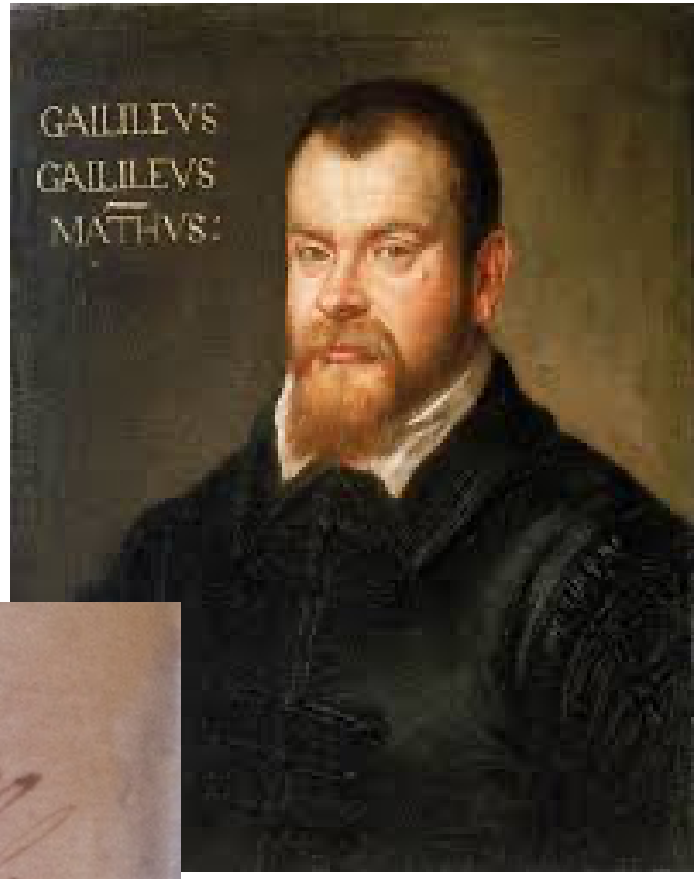
* Ice breaking
* Proteins, Inquiry and BYOD
* My proposal
* Discussion and conclusions

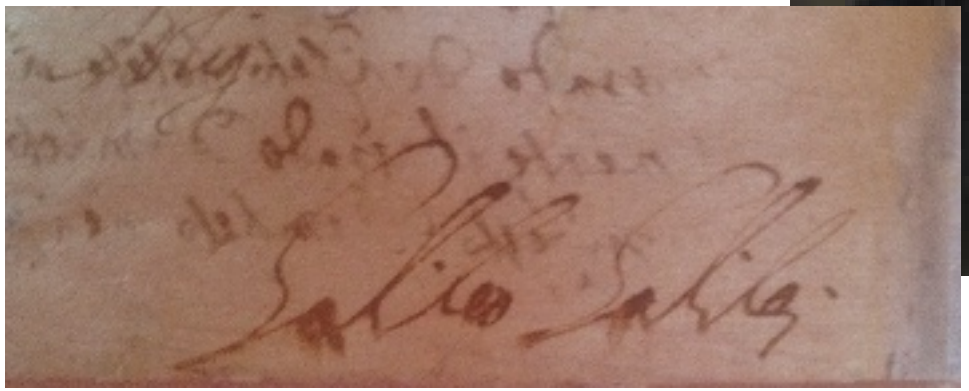
SCIENTIX
The community for science education in Europe

Ice breaking…

INTERNATIONAL BIOLOGY OLYMPIAD e. V. IBO

Sensate esperienze e necessarie dimostrazioni





Galileo's scientific method, which integrates:

- **empirical, observable experiences ("sensible experiments")…**
- **logical reasoning and evidence ("necessary demonstrations")**

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SCUOLA NORMALE SUPERIORE

ASSOCIAZIONE NAZIONALE INSEGNANTI SCIENZE NATURALI -1979-

ANISN PISA

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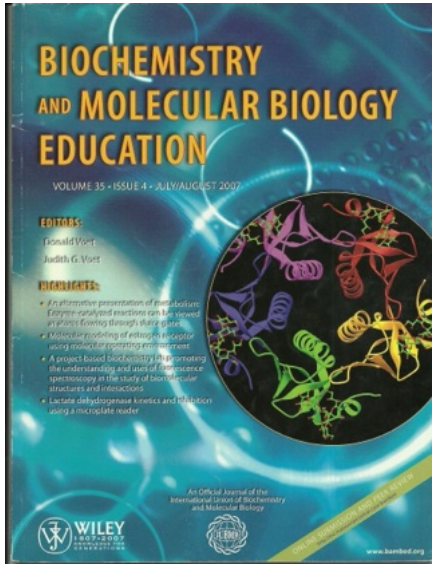
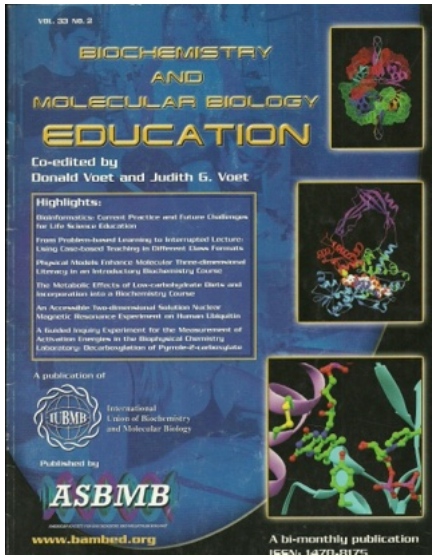

BIOCHEMISTRY AND MOLECULAR BIOLOGY EDUCATION
WILEY


LA RIVISTA DI SCIENZE PER LA CLASSE
linx MAGAZINE
Nelle nostre mani


From School to University
EMBO
5th International Workshop on Secondary School Science Education
11-13 May 2006
MEETING BOOKLET


BIOCHEMISTRY AND MOLECULAR BIOLOGY EDUCATION
Co-edited by Donald Voet and Judith G. Voet
Highlights:
ASBMB
www.bambed.org
A bi-monthly publication


JBC
JOURNAL OF BIOLOGICAL CHEMISTRY
ASBMB JOURNALS


SCIENCE in SCHOOL
Highlighting the best in science teaching and research


EDITRICE LA SCUOLA
NUOVA secondaria
mensile di cultura, orientamenti educativi, problemi didattico-istituzionali per la scuola secondaria superiore
1


NATURALMENTE
bollettino di informazione degli Insegnanti di Scienze Naturali


GUIDA PER L'INSEGNANTE
Franco Favilli | Isabella Marini | Joanne Spataro
IL CLIL DI SCIENZE
CHIMICA • SCIENZE DELLA TERRA • BIOLOGIA • BIOCHIMICA
CLIL
DeA SCUOLA
DeAGOSTINI
Ambiente educativo Digitale

President
National Association of Natural Science Teachers

45 years of activity
24 Regional Sections
14 IBSE-ANISN Centres

Quality science education
Widespread scientific culture

1500 teachers of all school levels

Accredited by the Italian Ministry of Education and Merit for teacher training and the **valorisation of excellence**

INTERNATIONAL BIOLOGY OLYMPIAD e. V. IBO

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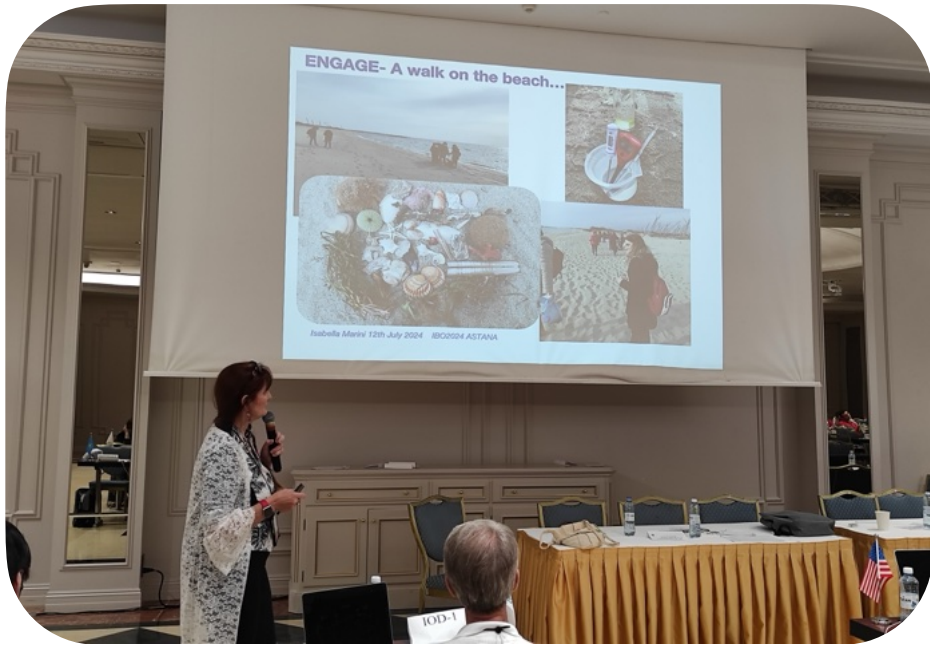
IBO Educational Conference

2024 — Digital Life Sciences

Friday, July 12, 2024 — 05:00 PM to 09:00 PM
Conference hall - Radisson Hotel, Astana



Shells to Machine Learning: Empowering e-Students' skills

Isabella Marini, Chairperson, National Association of Natural Science Teachers, Italy

INTERNATIONAL BIOLOGY OLYMPIAD e.V. IBO

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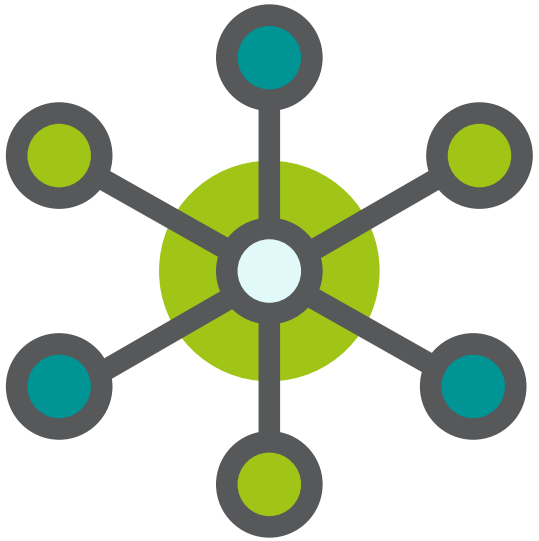


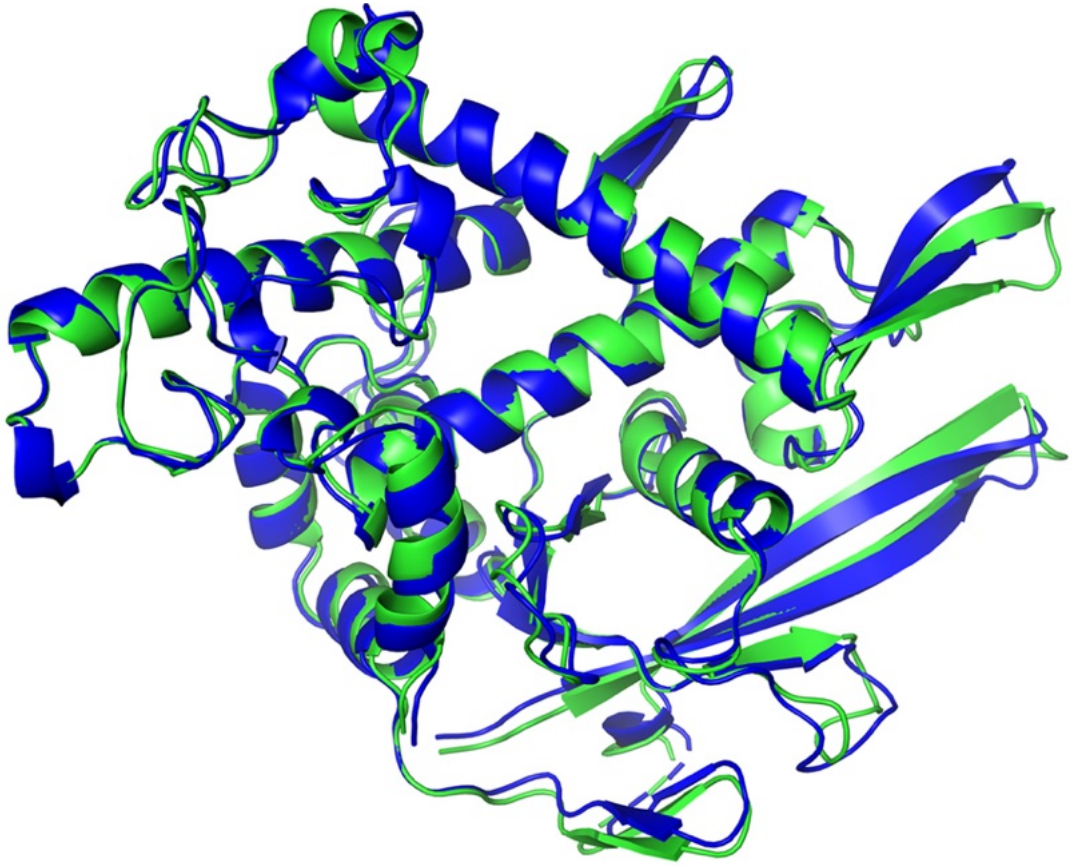
The IBO Educational Conference

1. Using Technology in Biology Classrooms, Despite Limited Resources

2. Strengthening Research Techniques Teaching and Training for Public School Students

3. Difficult Biology Concepts Made Easy

Proteins



Mentimeter

www.menti.com

CODE
1964 5591

Inquiry Based Learning

Proteins, Inquiry and BYOD

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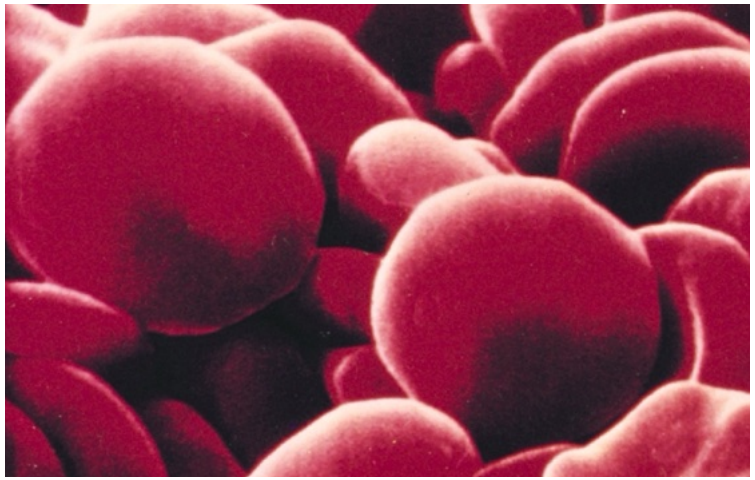
Proteins are versatile, ubiquitous, and in many ways astonishing molecules: they enable the fundamental chemical reactions of life, transduce and transmit signals within organisms, shape cells and tissues; they recognize and defeat invaders, form the molecular motors that allow us to capture energy, move, and perceive environmental signals...



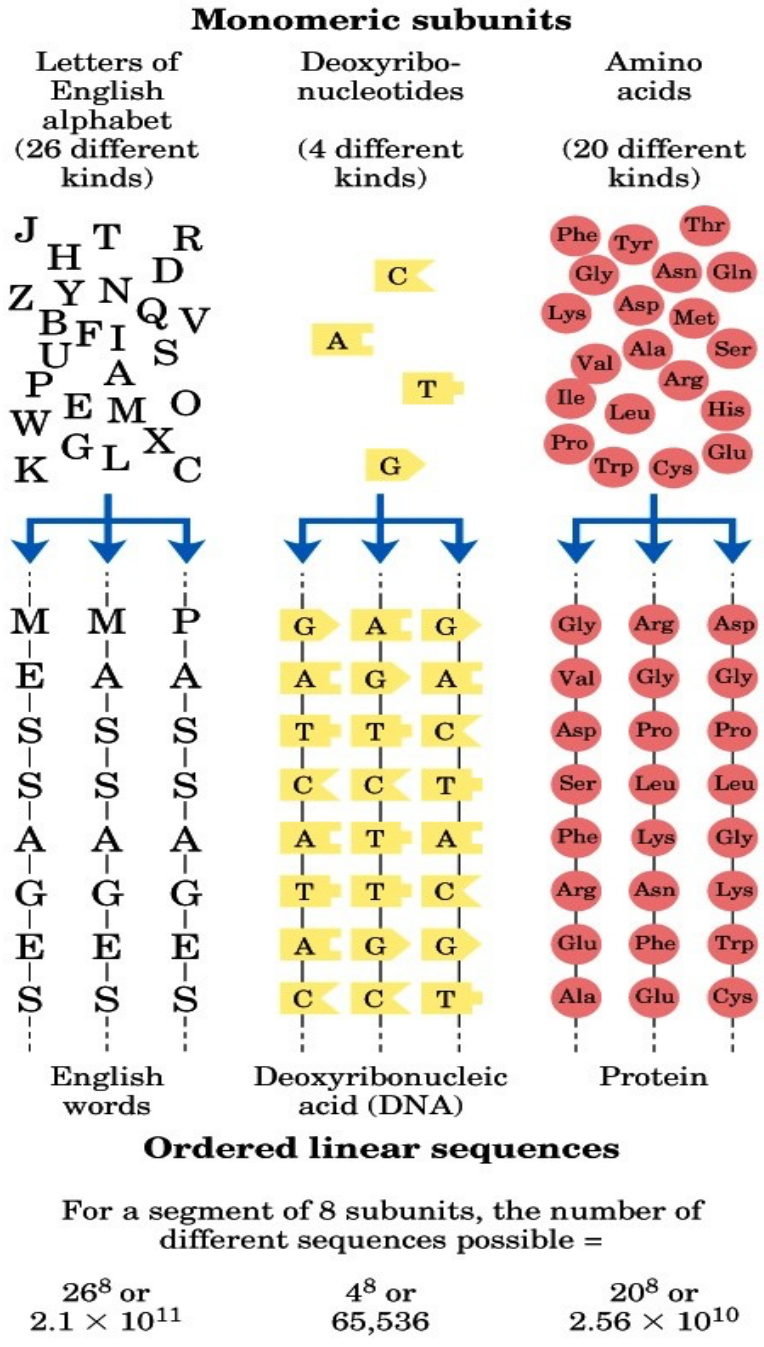
The name protein that I propose for the organic oxide of fibrin and albumin, I wanted to derive from the Greek word ***πρωτειος,*** *because it appears to be the primitive or principal substance of animal nutrition.*

(Berzelius,Letter to Mulder 10th July 1838)

πρωτειος meaning “of the first rank”

nomina numina...

The most abundant molecules in living organisms, second only to water.
Complex structure…

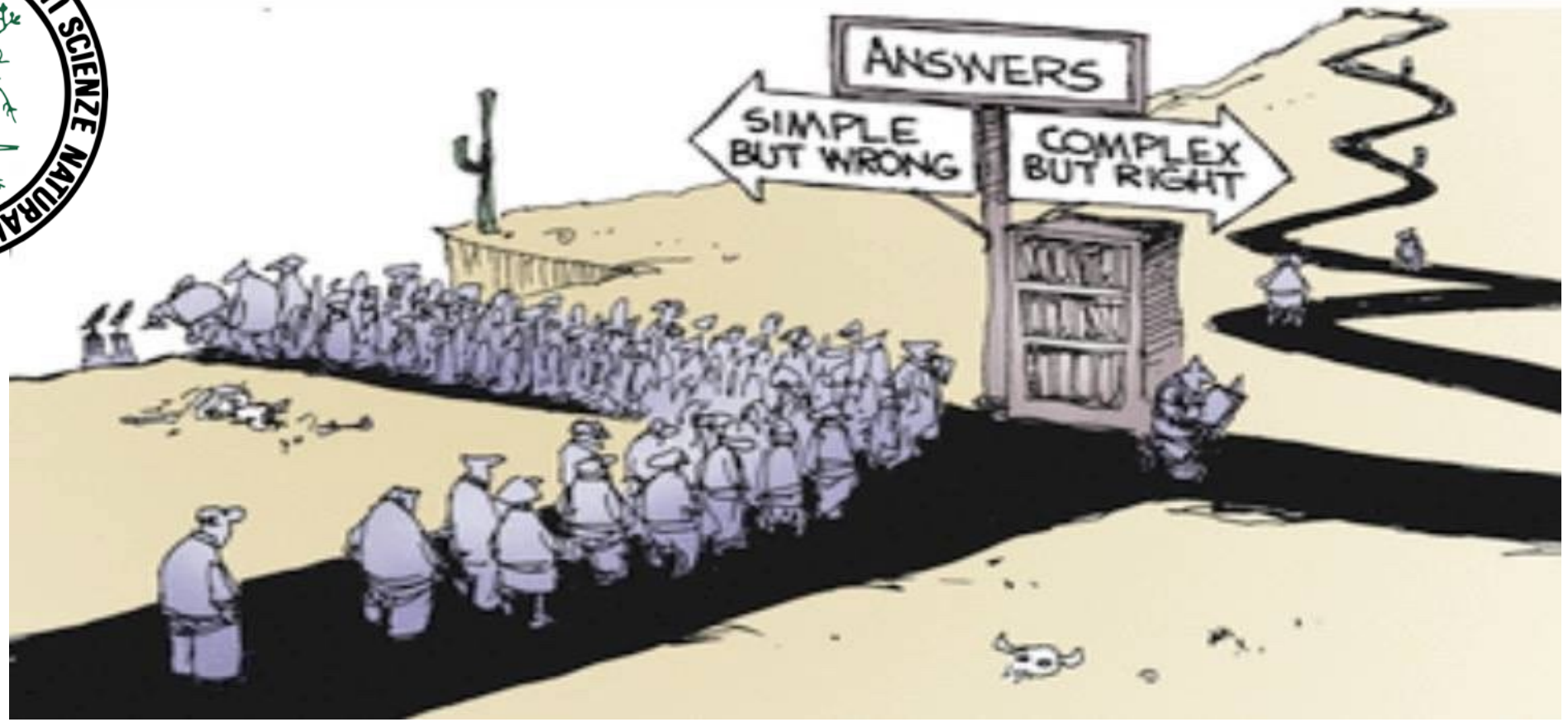


We are able of producing about 100,000 different proteins, but the number of possible proteins with 300 amino acids (the "average" size of a protein) far exceeds the number of atoms in the universe (20^{300}).

Inquiry is….

a series of processes ***implemented by students in an intentional way*** *such as:*
know how to diagnose problems, critically commenting on experiments and identify alternative solutions, know how to plan an investigation, formulate conjectures, search for information, elaborate models, discuss with peers with coherent arguments"
Linn et al., 2004

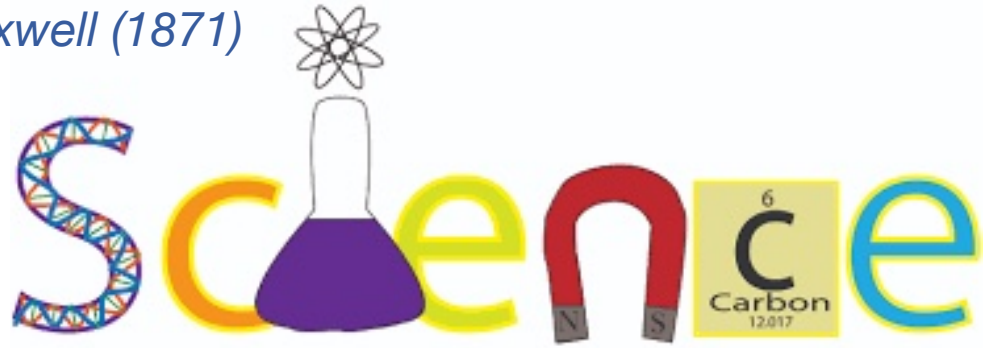
*If your goal is to engage students in **critical thinking**… you need to present **interesting challenges** to solve, rather than **simply explaining** how other smart people have already solved those challenges...*



Lab in Science Education…

The simpler the materials of an illustrative experiment, and the more familiar they are to the student, the more thoroughly is he likely to acquire the idea which it is meant to illustrate. **The educational value of such experiments is often inversely proportional to the complexity of the apparatus.** The student who uses home-made apparatus, which is always going wrong, often learns more than one who has the use of carefully adjusted instruments, to which he is apt to trust, and which he dares not take to pieces.

Introductory Lecture in Experimental Physics James Clerk Maxwell (1871)

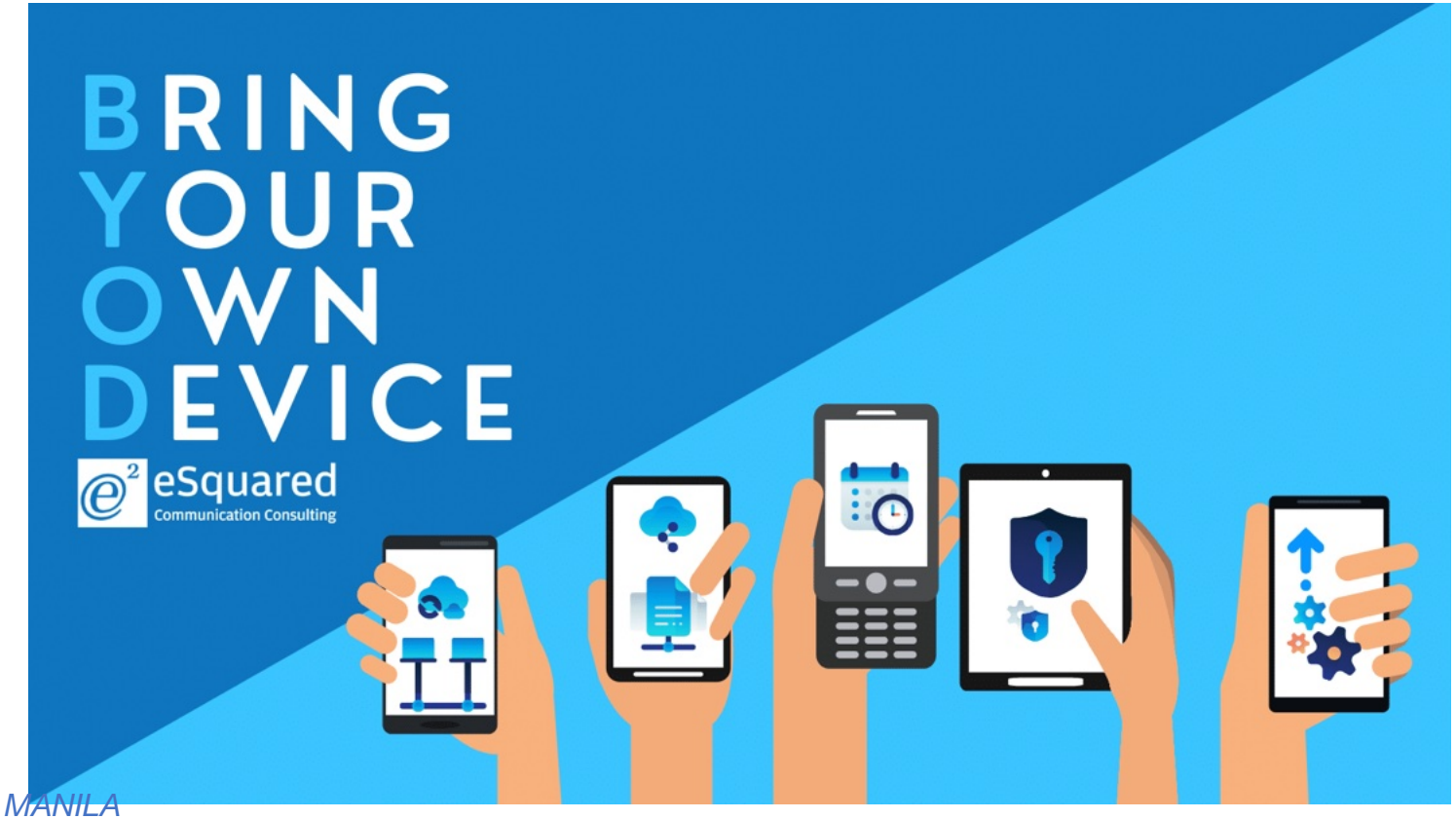


Materials

Gornall chemicals…

In the Philippines:

- high diffusion of smartphones
- high diffusion of smartphones in high school students (mainly for social media, gaming, and communication)
- low experience with BYOD in public schools



My proposal on proteins…

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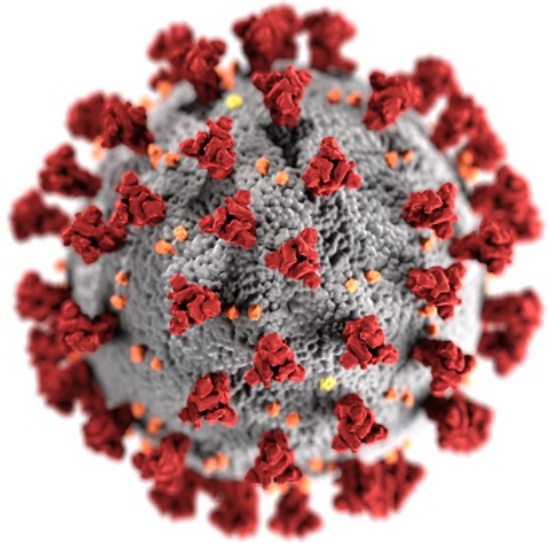
COVID19 pandemic…
educational emergency…



National Recovery and Resilience Plan

A problem…a challenge…an opportunity

Mater artium necessitas
Necessity is the mother of invention

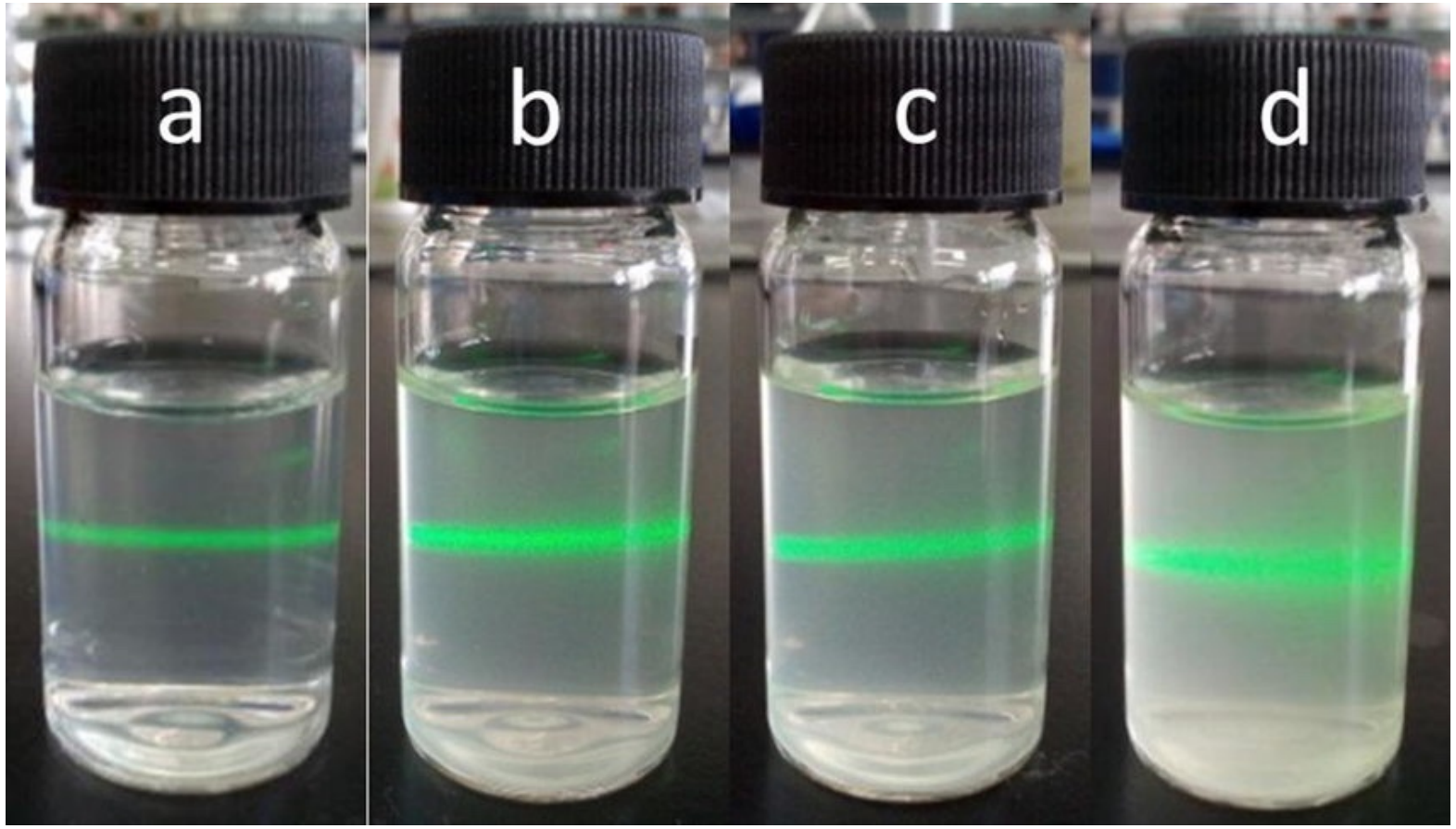
Inquiry Based Learning

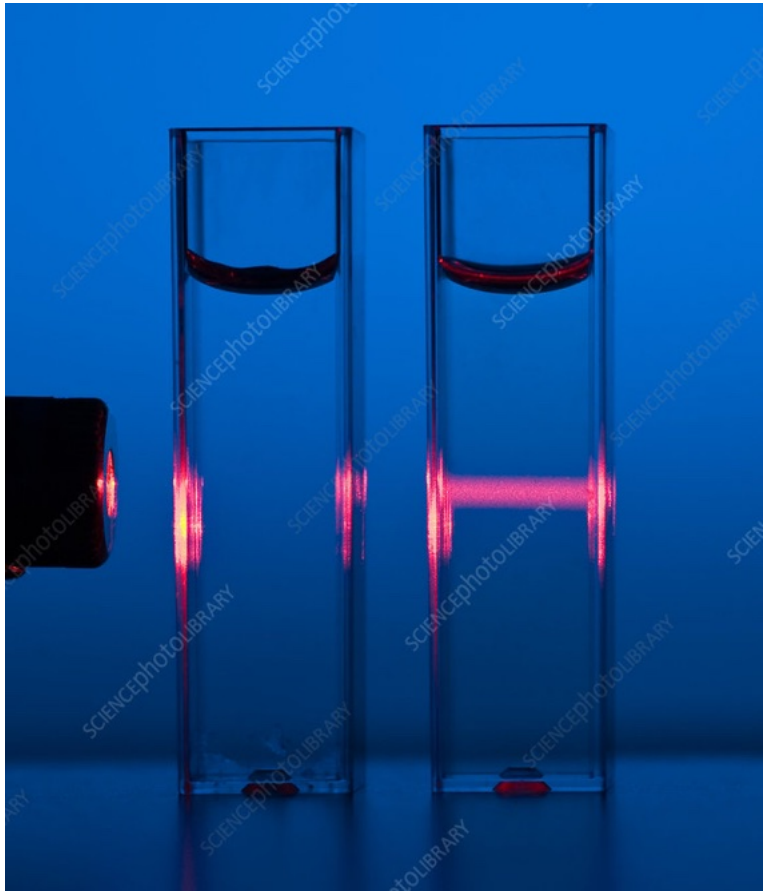
LICEO SCIENTIFICO "ULISSE DINI" - Pisa

desmos

Tyndall effect

The wavelength of light acts as a probe for protein dimension. By observing how light of a specific wavelength is scattered by proteins, we can infer information about their size…

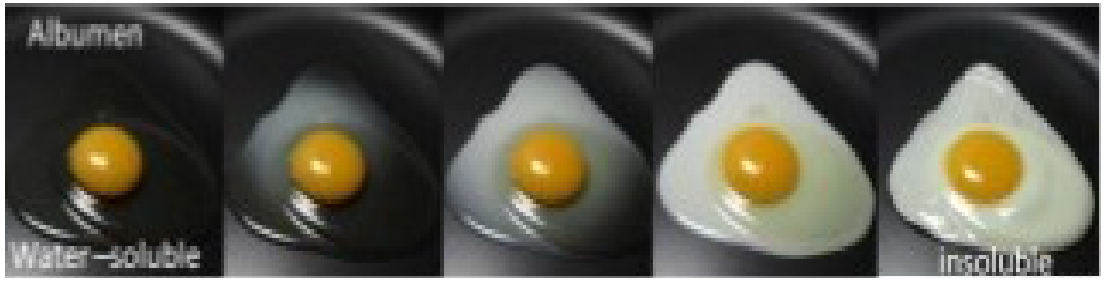




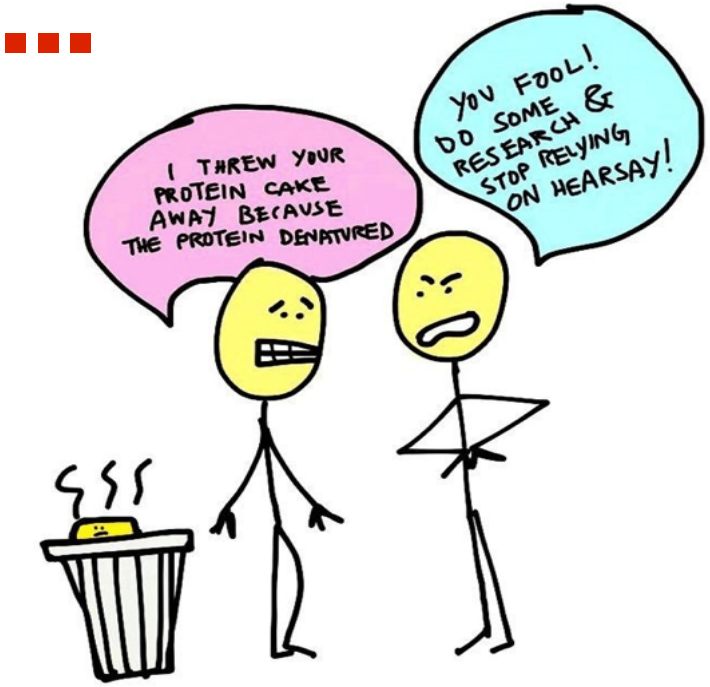
Materials: laser pointer, salt solution, egg white dispersion

https://amrita.olabs.edu.in/?sub=73&brch=2&sim=28&cnt=4

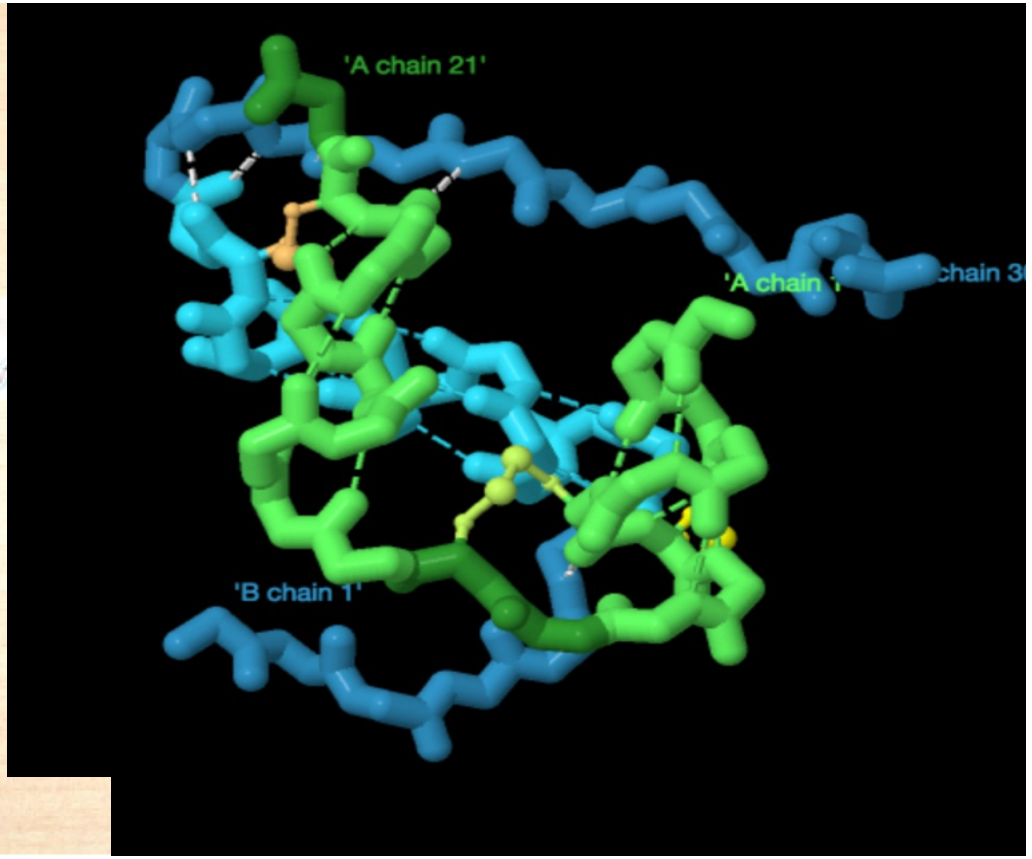
Denaturation



➔Heat
➔Acids (HNO3, HCl, lemon juice, vinegar)
➔Bases (NaOH, NaHCO3)
➔Organics (alcol o acetone)
➔Heavy metals (AgNO3, CuSO4)
➔Mechanical stretching
➔Ionic substances (NaCl)



Structure is everything for proteins….



MODELS

https://pdb101.rcsb.org/learn/paper-models/insulin

https://cdn.rcsb.org/pdb101/learn/resources/insulin/insulin-activity.pdf

Qualitative biuret assay

Food

Cotton ball and silkworm cocoon ball

Gornall Reagent

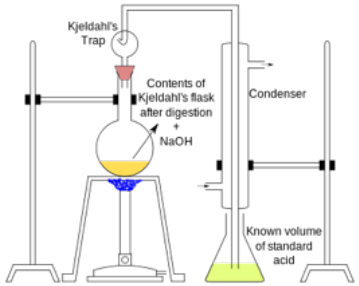
Dissolve in one liter of aqueous solution:

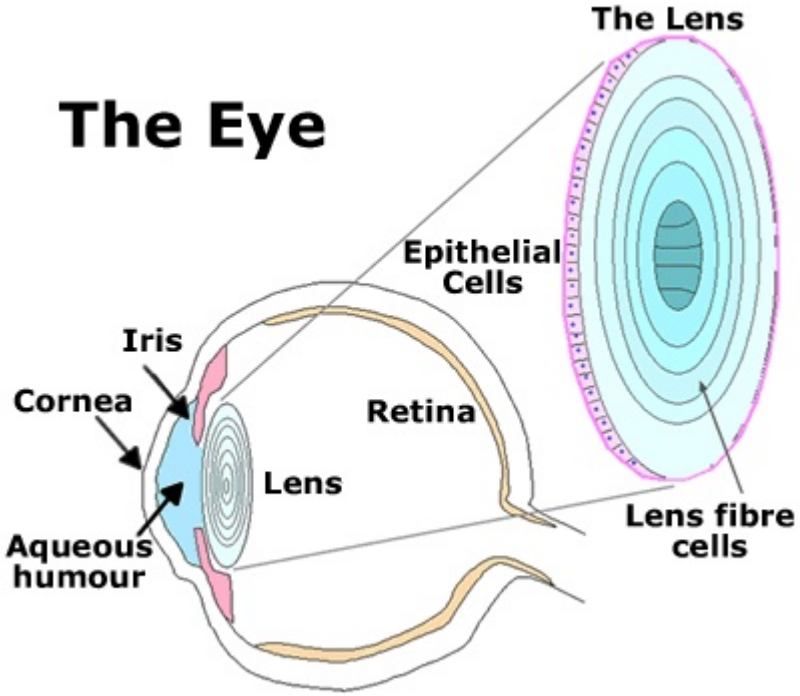
- 1.5 g of $CuSO_4 \cdot 5H_2O$ (copper(II) sulfate pentahydrate)
- 6 g of sodium potassium tartrate tetrahydrate
- 300 mL of 10% (w/v) NaOH (sodium hydroxide)

engage

How much protein is in egg white?

The "melamine scandal"





Where are the longest-lived proteins in our body found?

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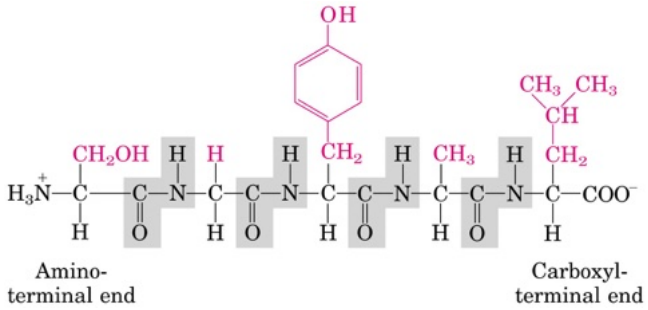
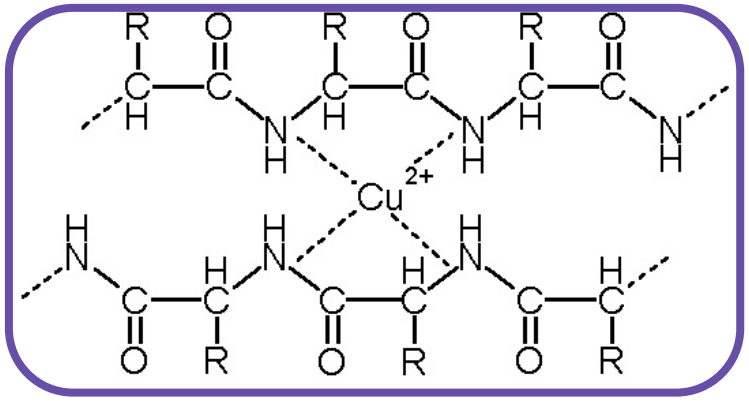
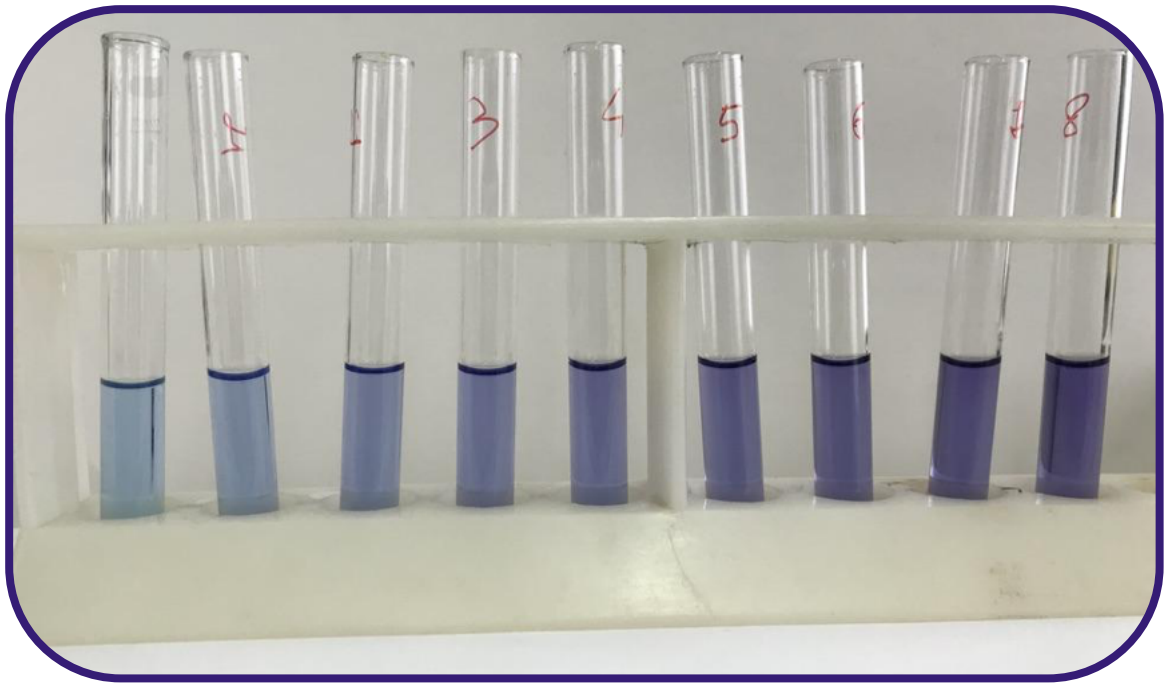
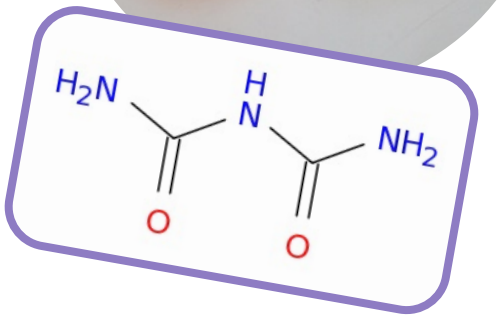
Biuret assay



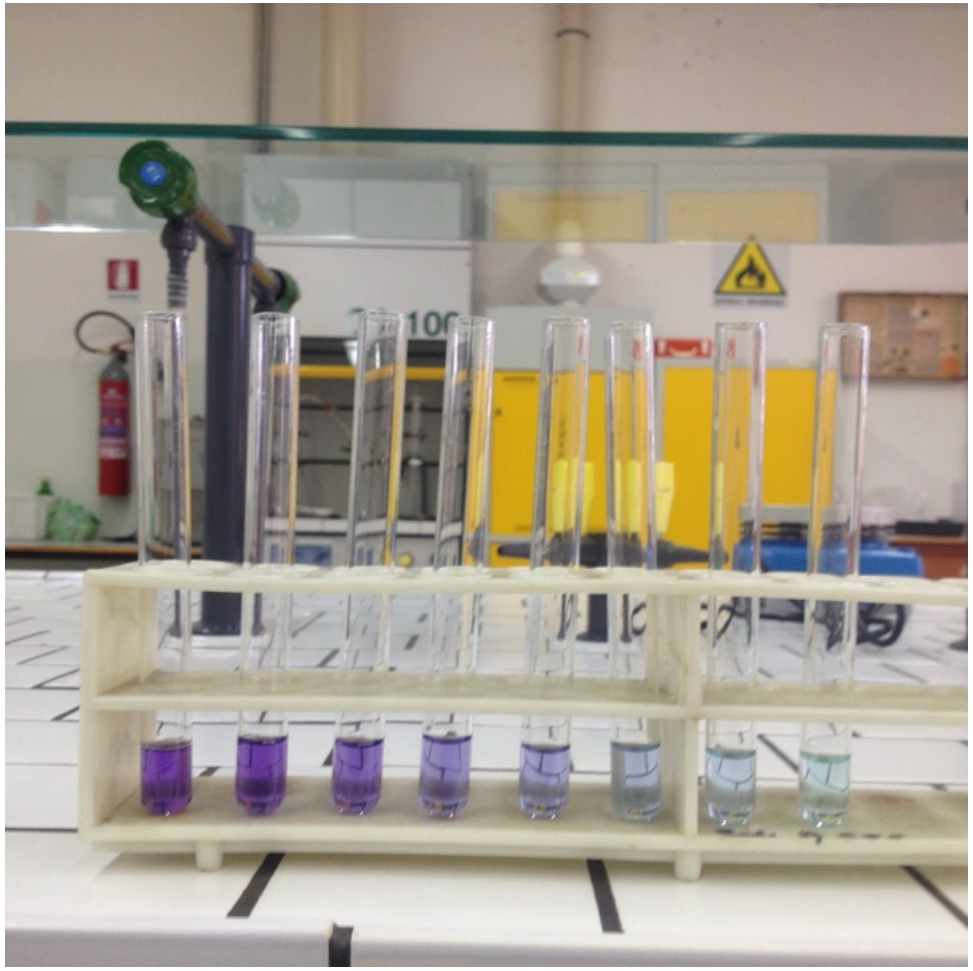


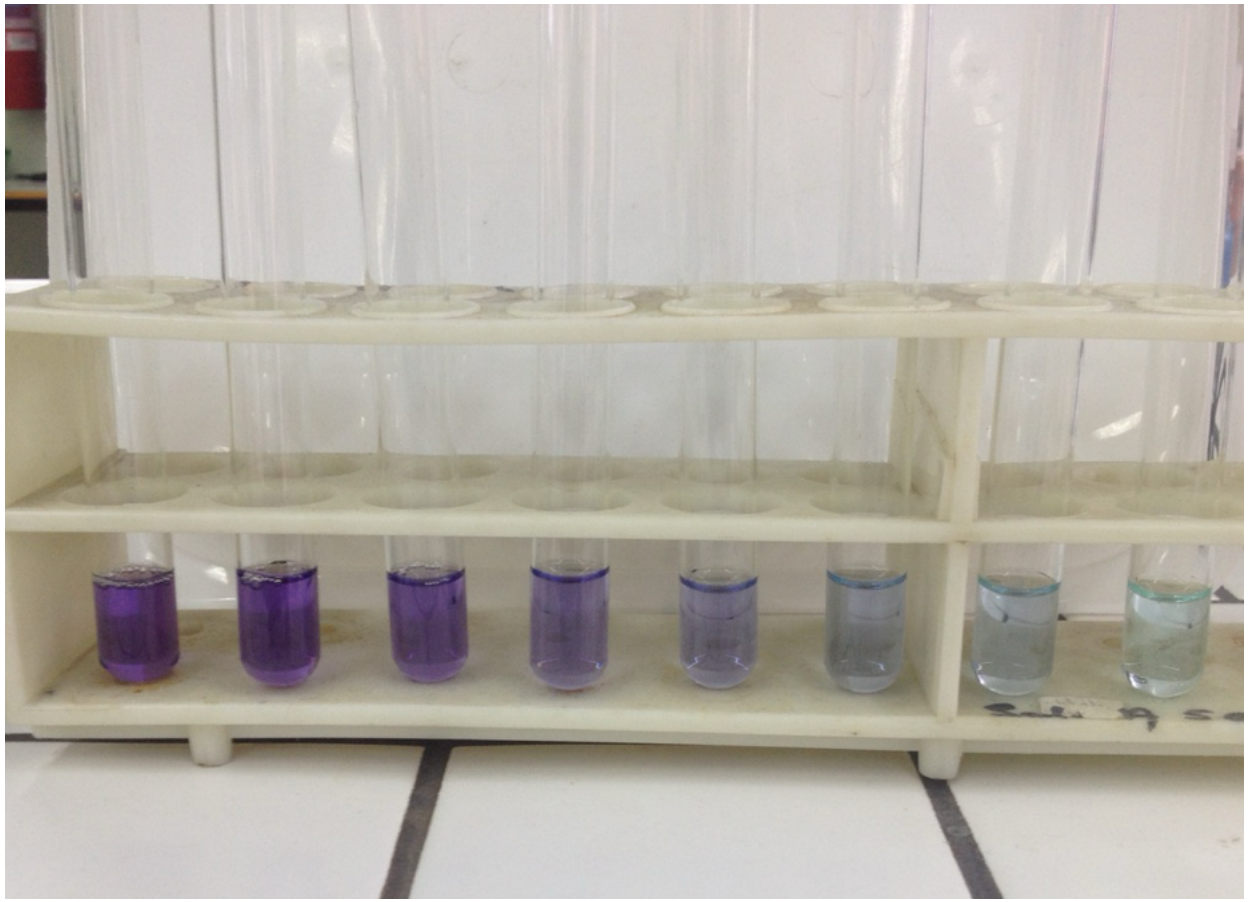




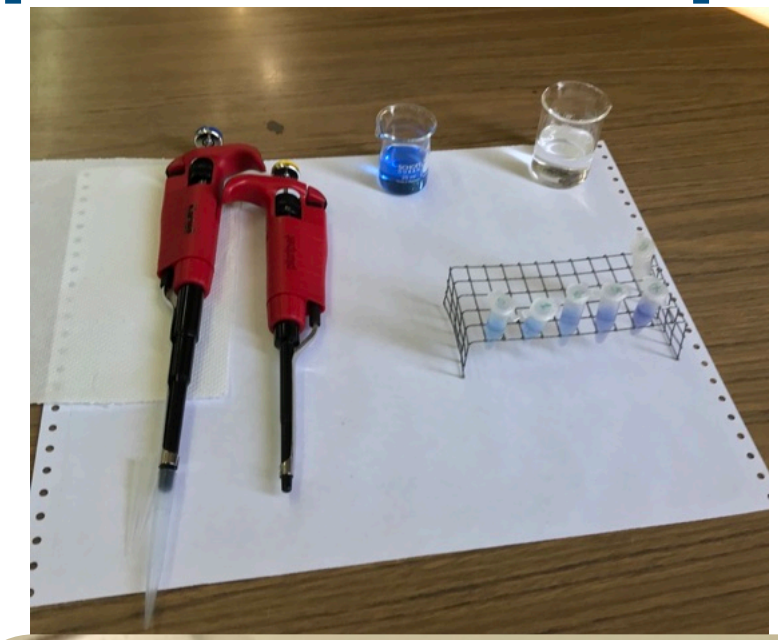
MATERIALS

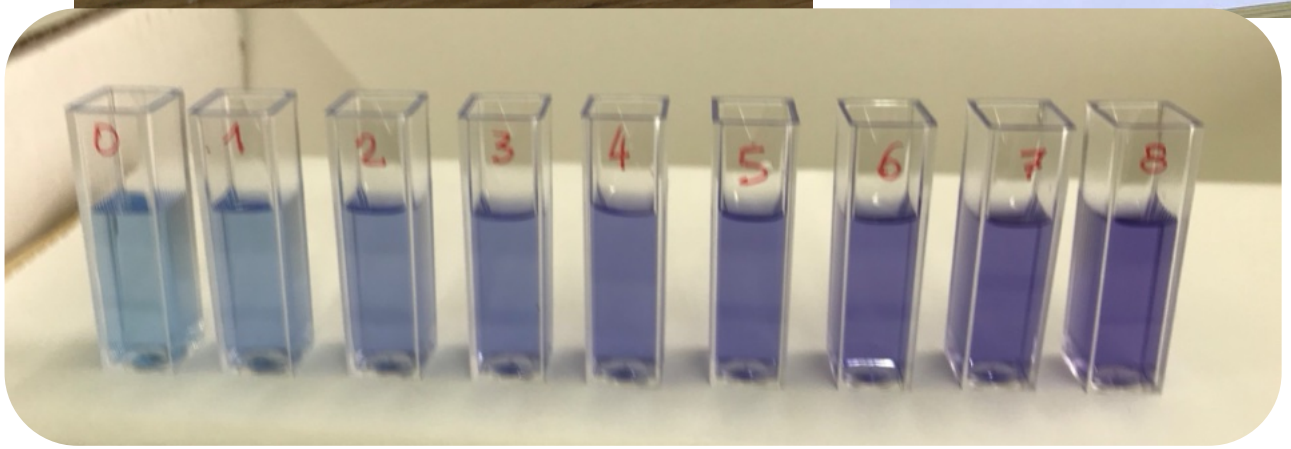
- Micropipettes
- BSA 10 mg/mL
- Gornall's Reagent
- 3 mL plastic cuvettes
- Test tubes
- Test tube rack
- Eppendorf (tube) rack
- Eppendorf (or glass) tubes
- Distilled water



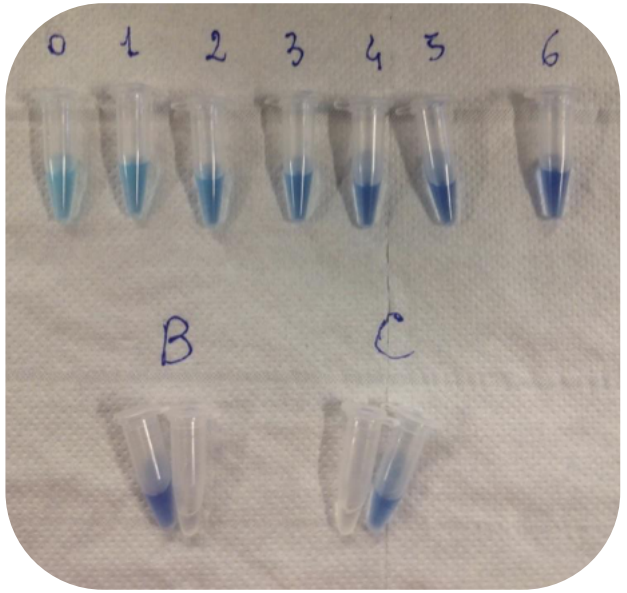


From qualitative to quantitative



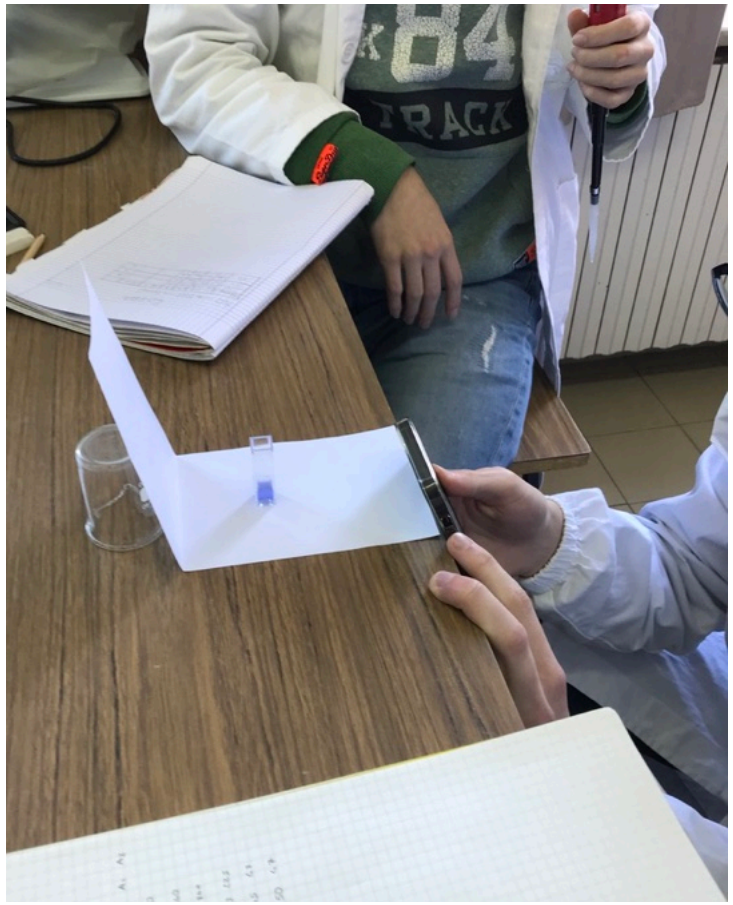


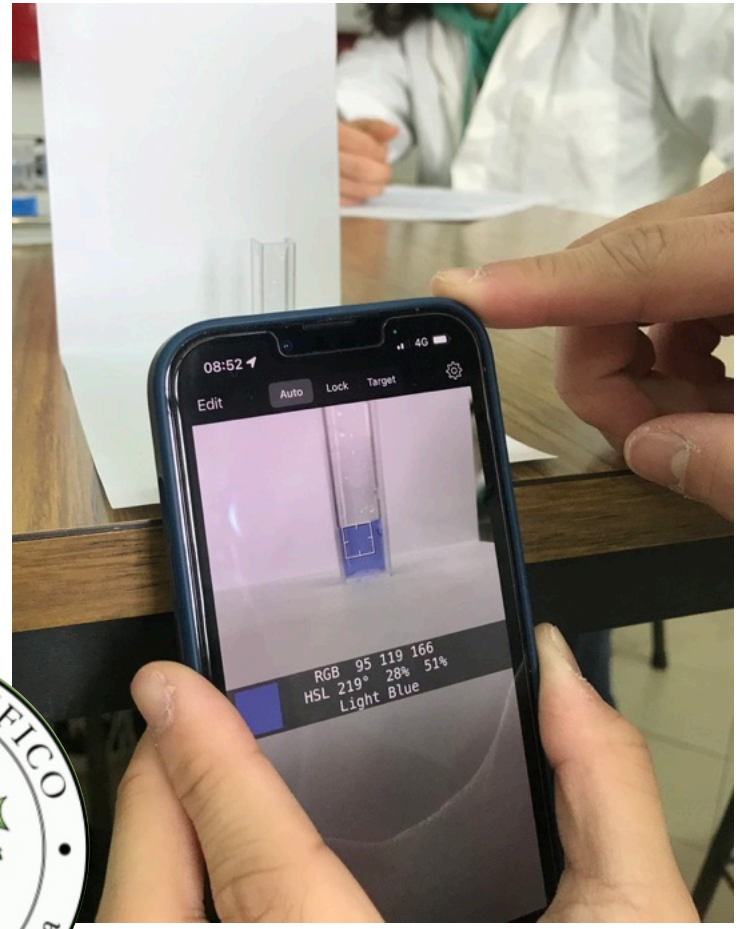
To the naked eye…




G
BSA

BYOD...



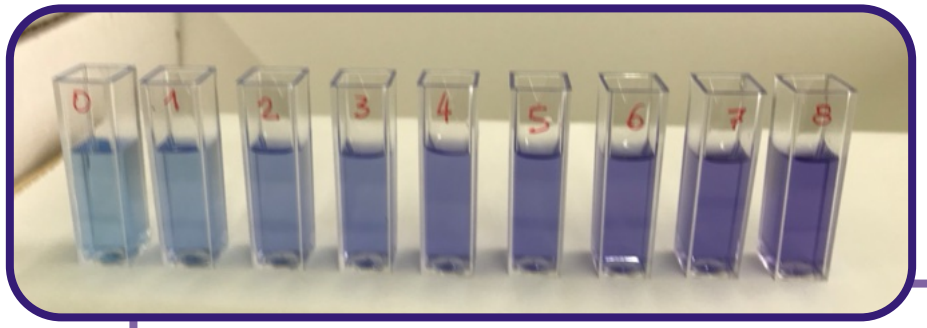

08:52
Edit
Auto
Lock
Target
RGB 95 119 166
HSL 219° 28% 51%
Light Blue

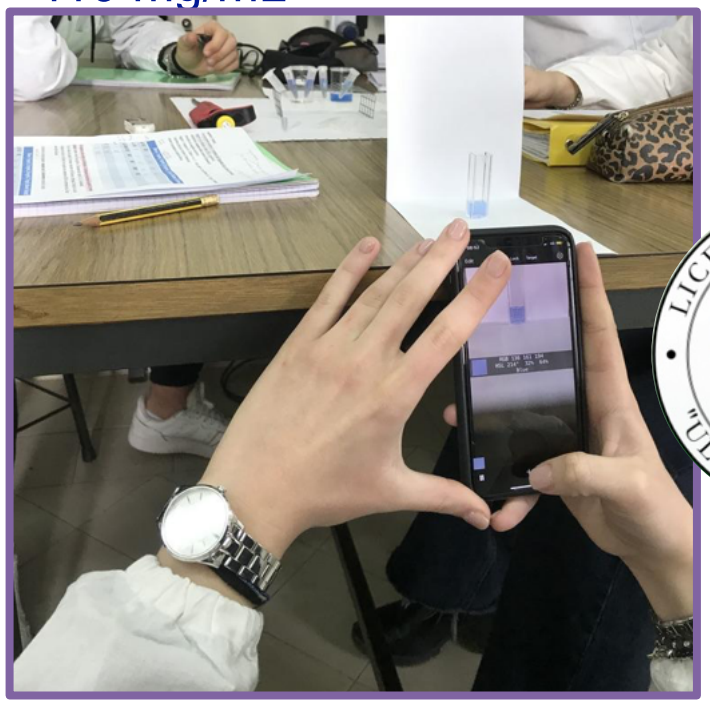
HSL calibration

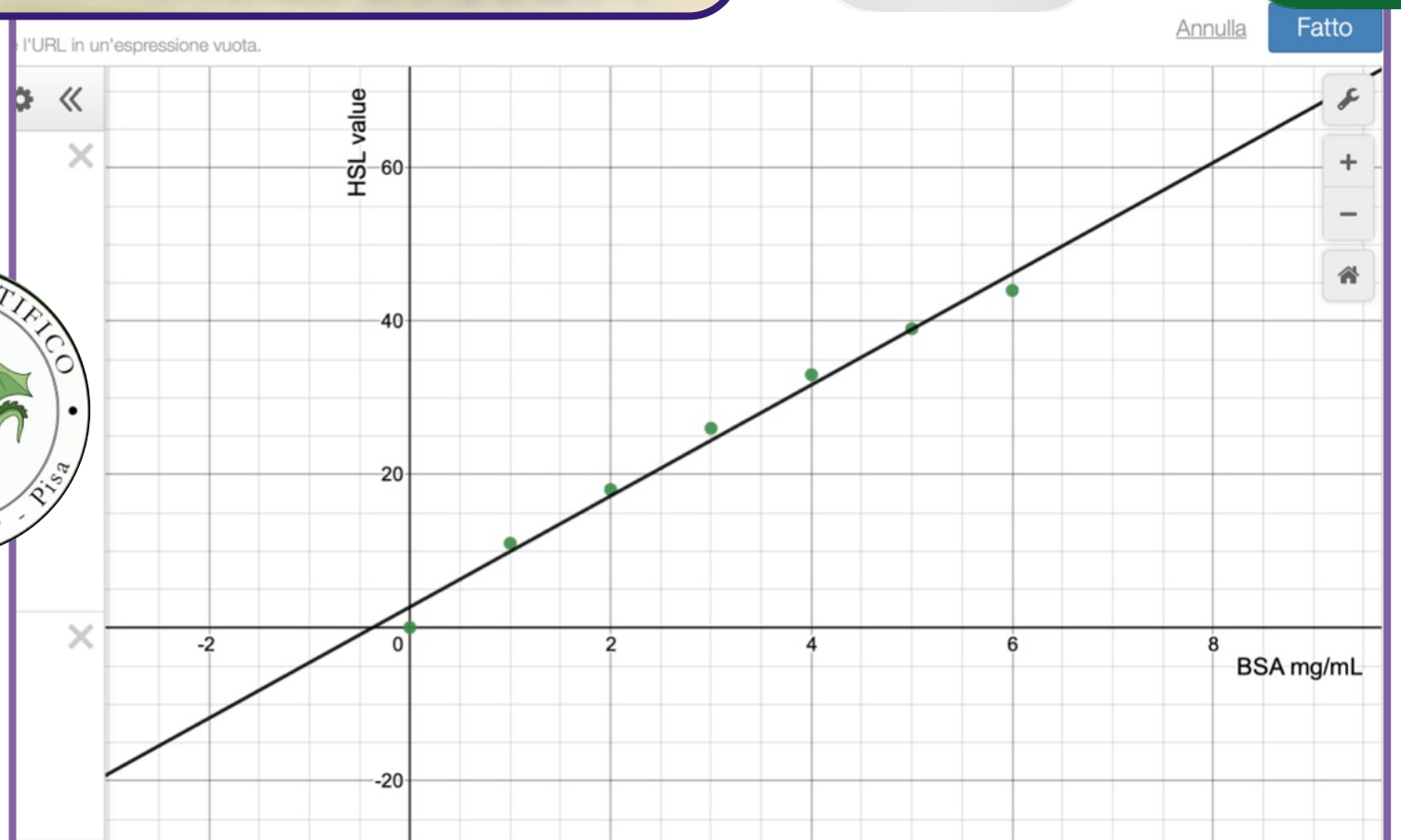
BYOD…

- BSA as standard
- Homemade optical bench
- Smartphone app Color Assist
- H-value data
- Calibration curve

- First estimated protein concentration of egg white: 110 mg/mL



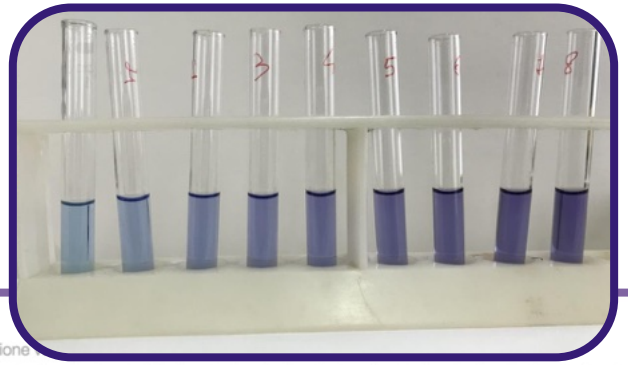




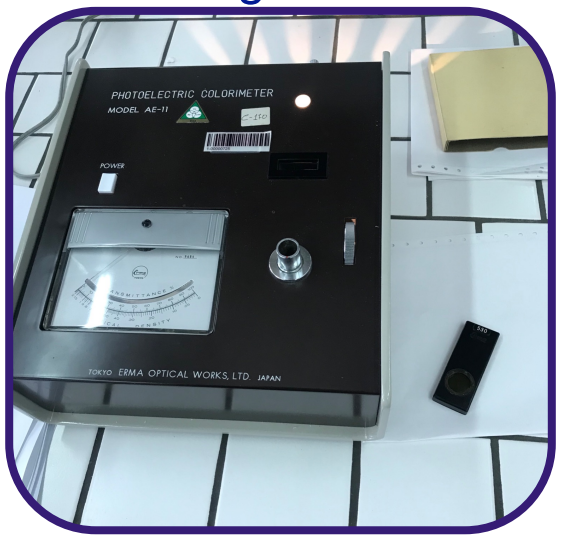
Colorimeter calibration

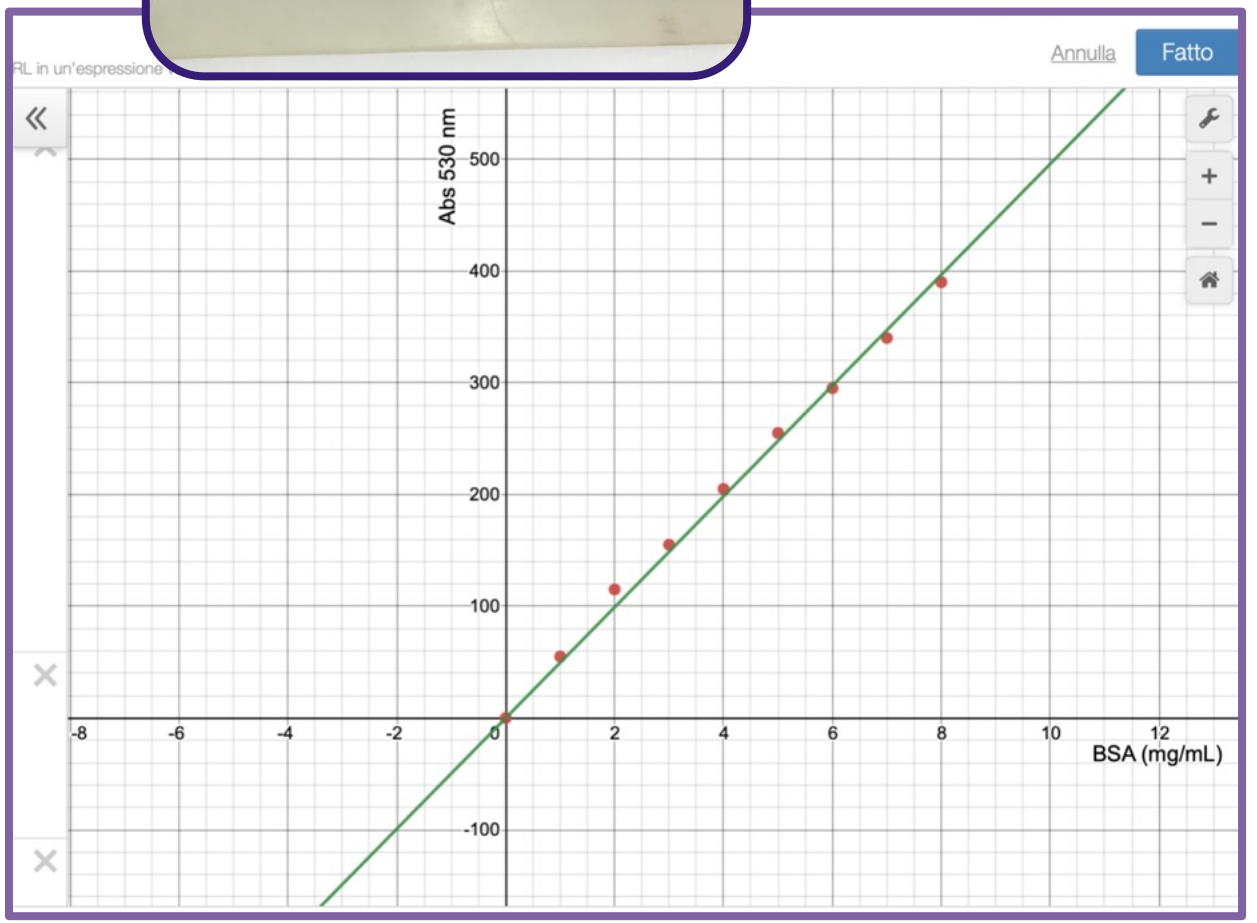
- BSA as standard
- Lambert-Beer Law
- Abs at 530 nm
- Calibration curve

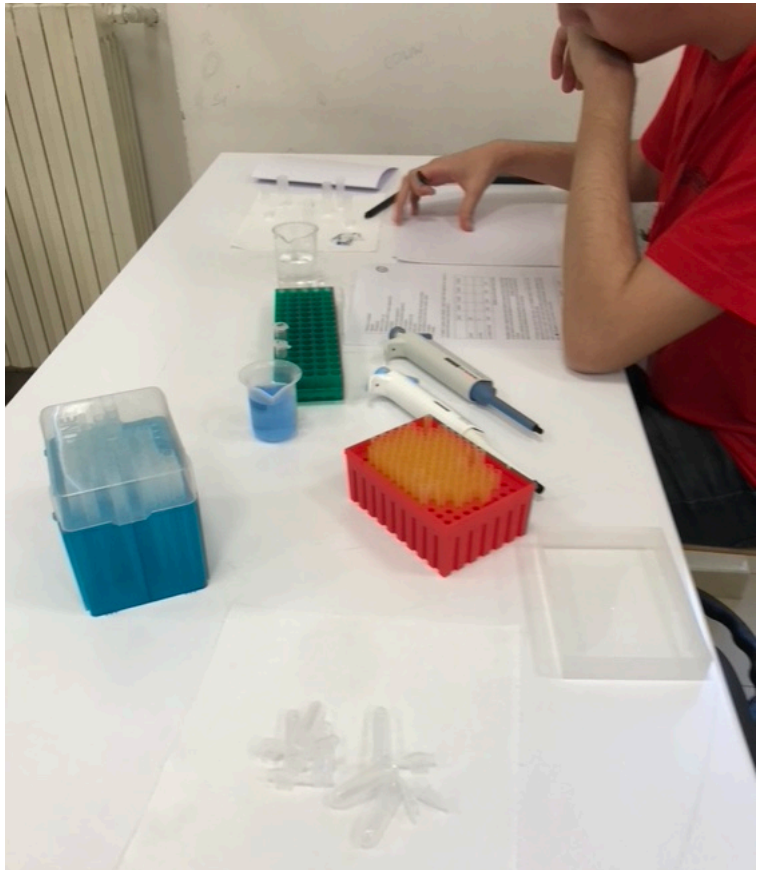
$$A_\lambda = \varepsilon_\lambda c\, d$$

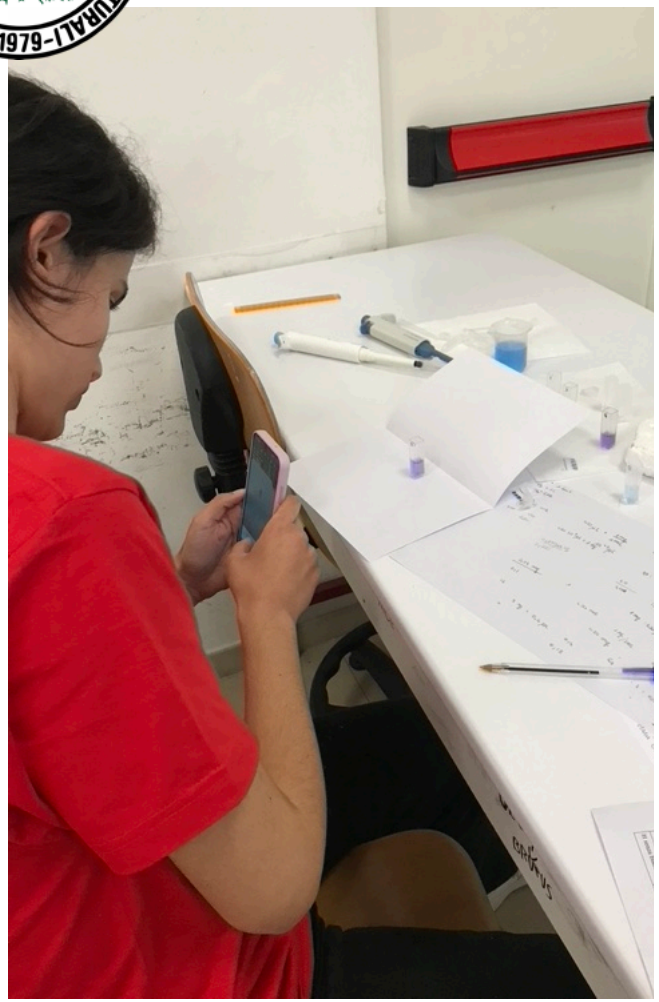


- Estimated protein concentration of egg white: 110 mg/mL

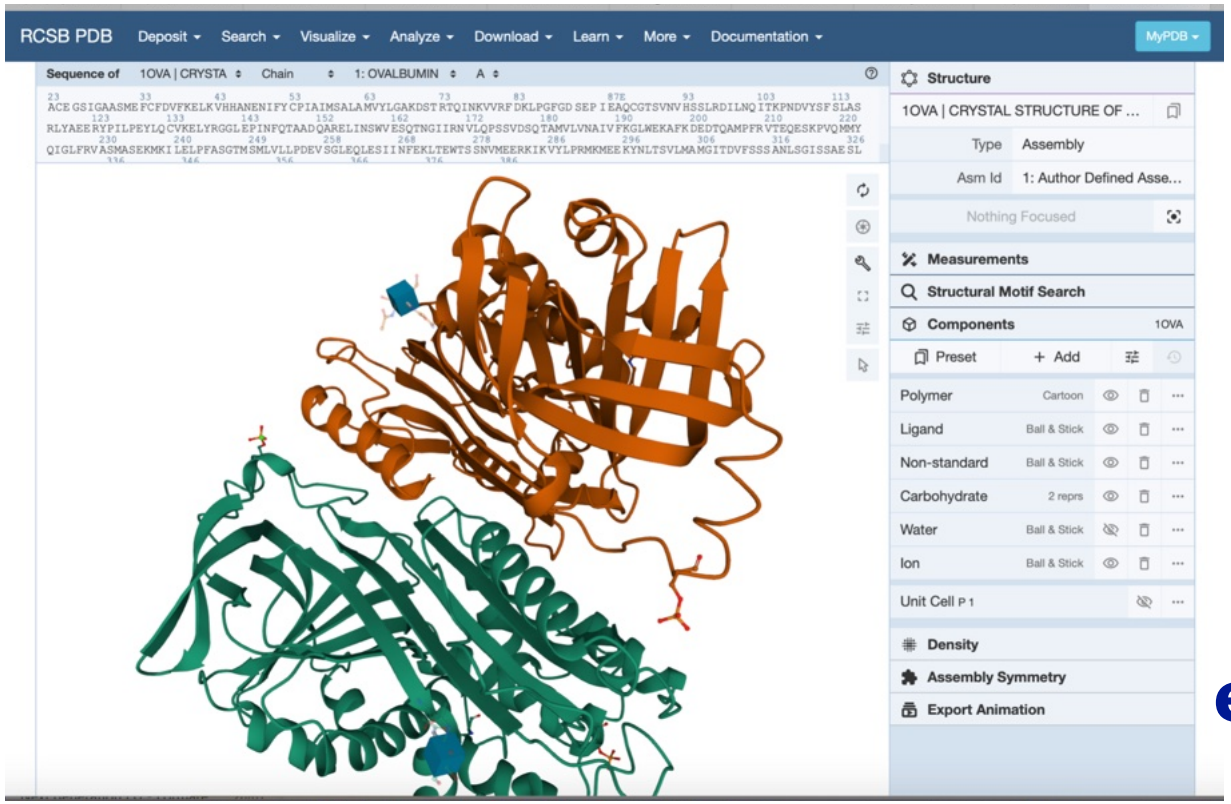








Bioinformatics



egg albumin

https://www.rcsb.org/3d-view/5OTB/1 https://www.uniprot.org/uniprotkb/P19121/entry#structure

BLAST

Basic Local Alignment Search Tool

The versatile biuret…

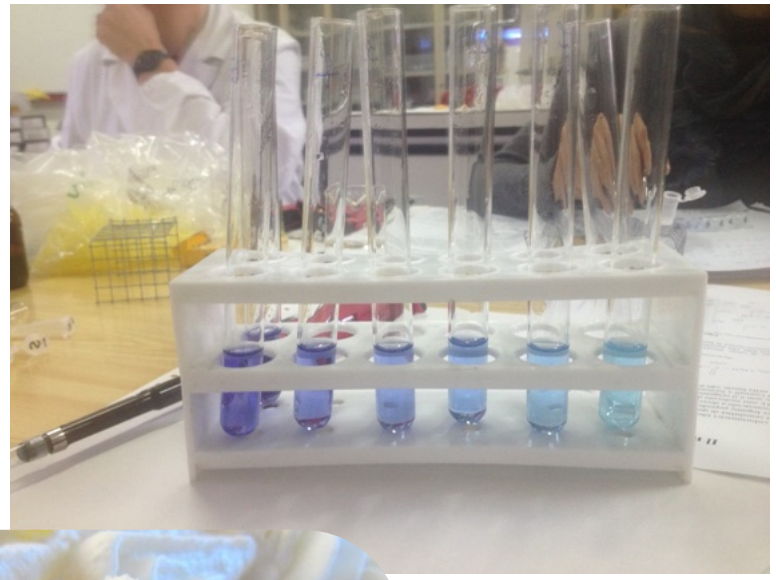
DNA isolation (protein decrease…)

Nutrition (protein and food…)

Biochemistry History

The extraordinary world of proteins…

Denaturation, hydrolysis, proteases…



Protein and art…

An Old Woman Cooking Eggs, Diego Velasquez, 1618

Brera Madonna, Piero della Francesca, 1472

The student should not learn thoughts but how to think; the teacher should not carry, but lead him if he/she wants him to be able to walk by himself in the future. [Kant, 1765]

THANKS FOR YOUR ATTENTION!

presidenteanisn@gmail.com
isabella.marini@liceodini.it