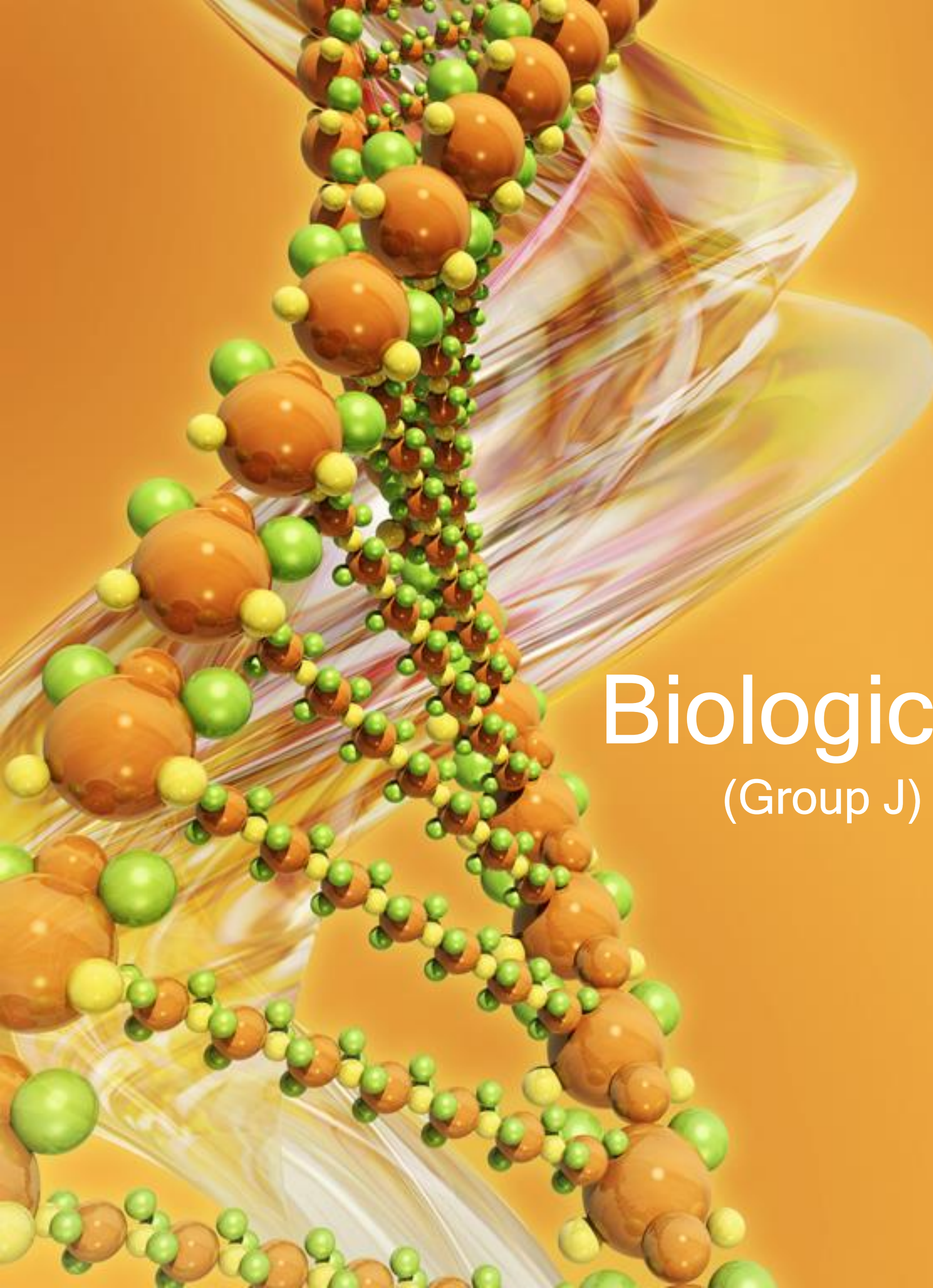
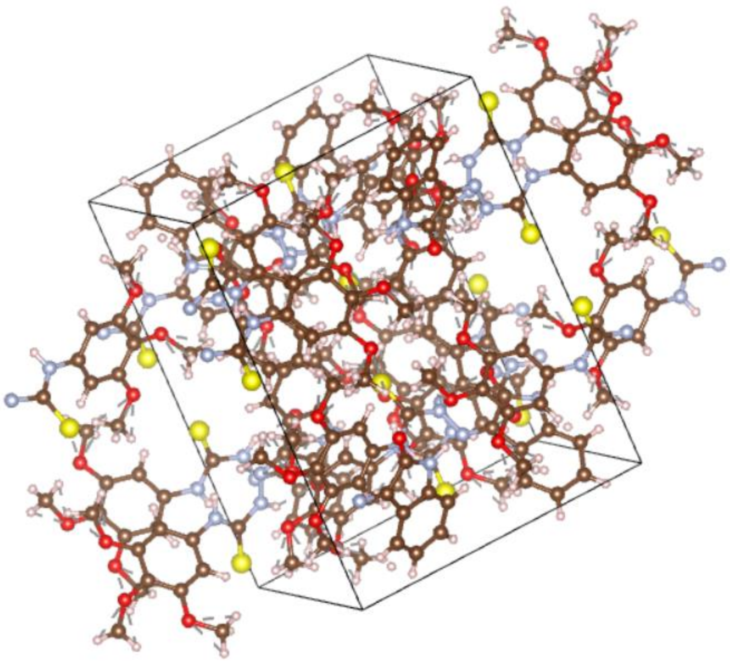


Biological Crystallography

(Group J) : powerpoint by Ali Ghelichkhani

Protein

- Discovered by chance 150 years ago
- First protein crystals : Hemoglobin from worms and fishes by German biologist



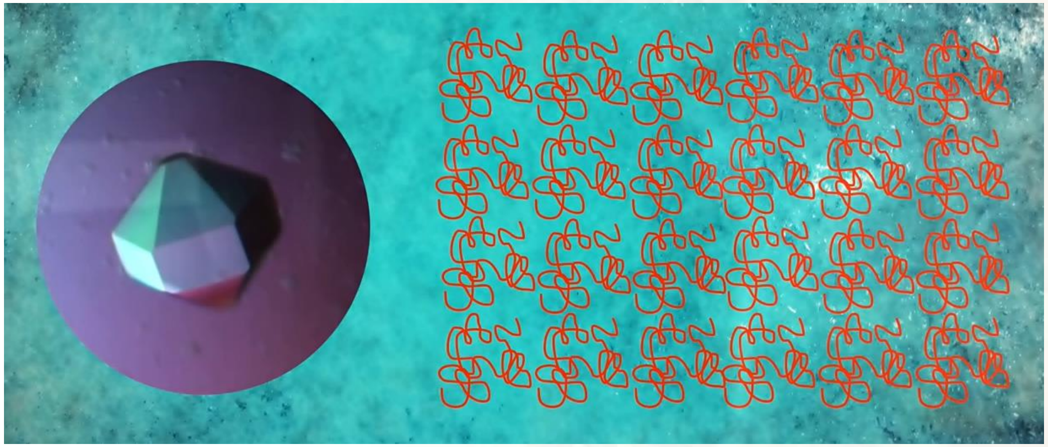
CoD ID : [1501662]

Lattice type	P
Space group name	P 21/n
Space group number	14
Setting number	2

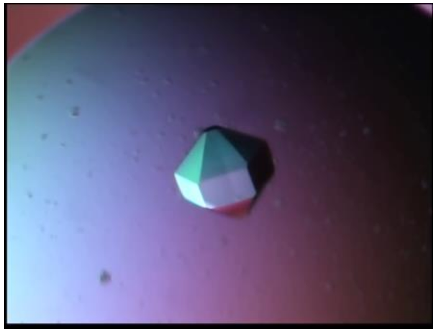
isatin-β-thiosemicarbazones

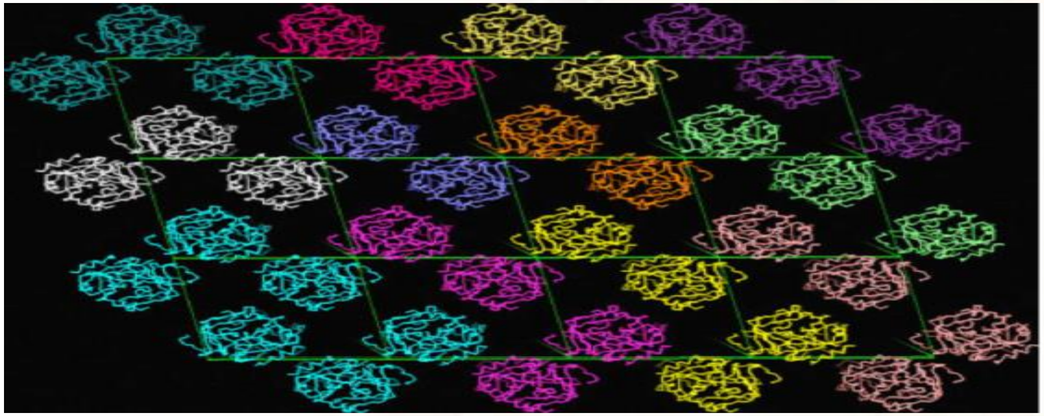
Protein Crystals

Locked with molecules with Ordered grid-like structure

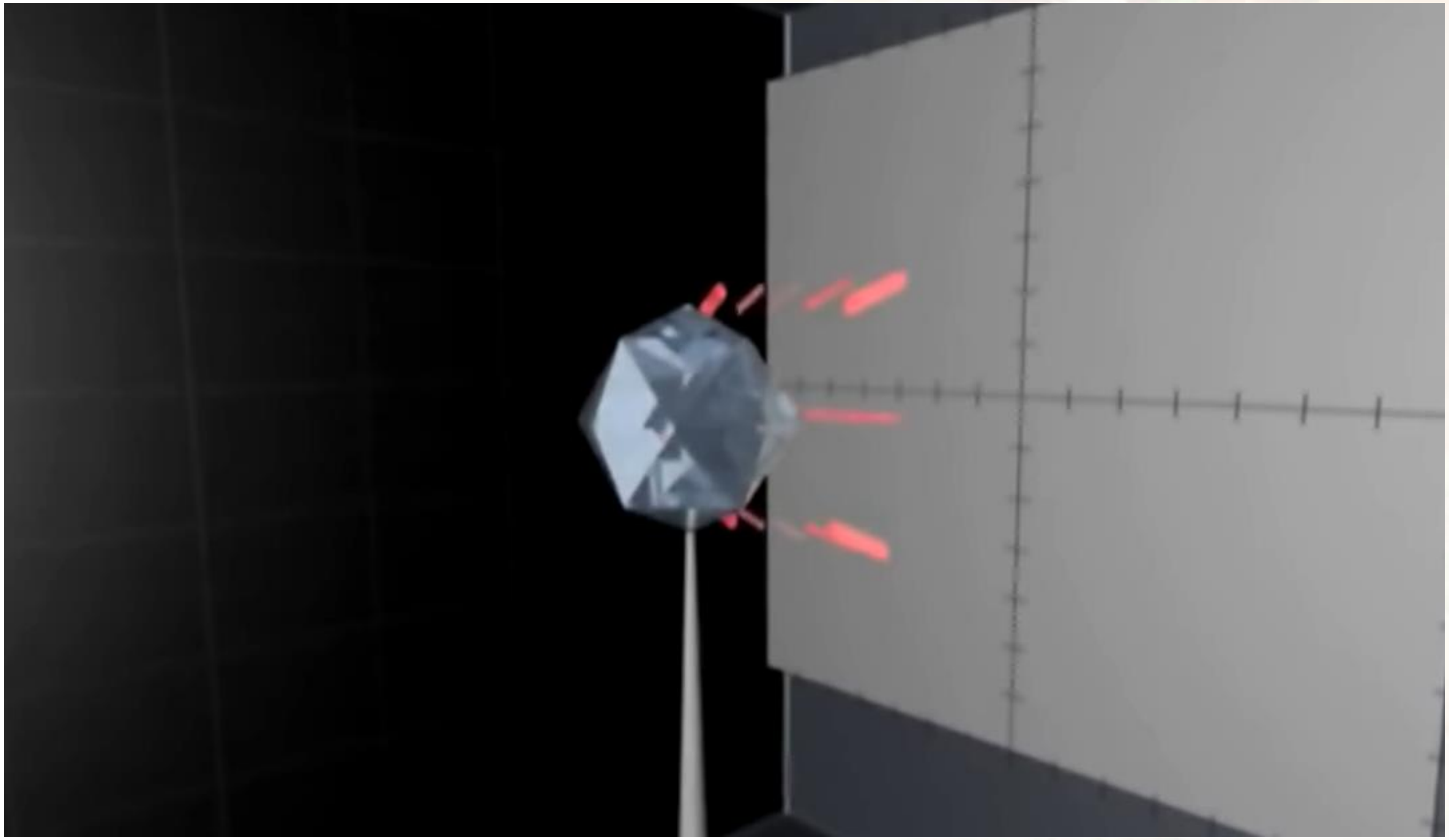


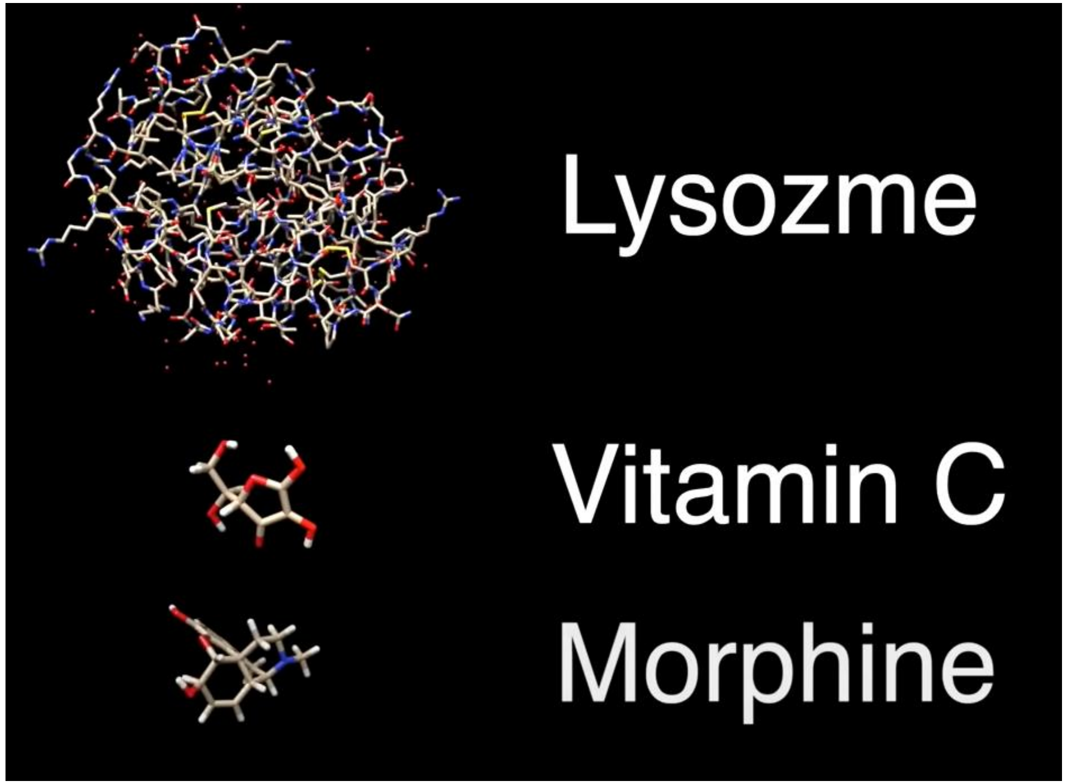
Simple Motif

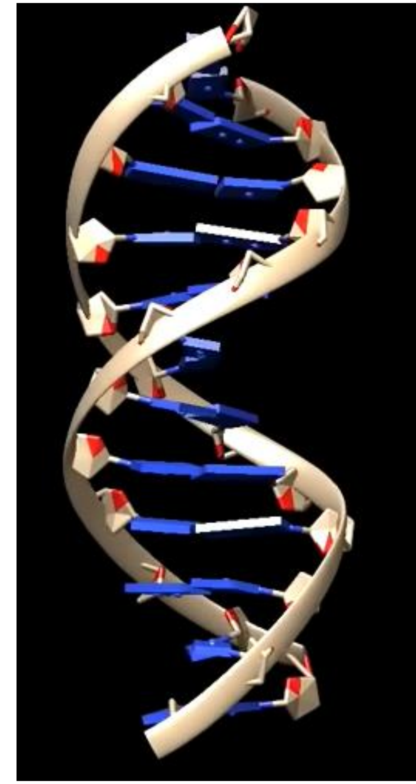




X-Ray Crystallography



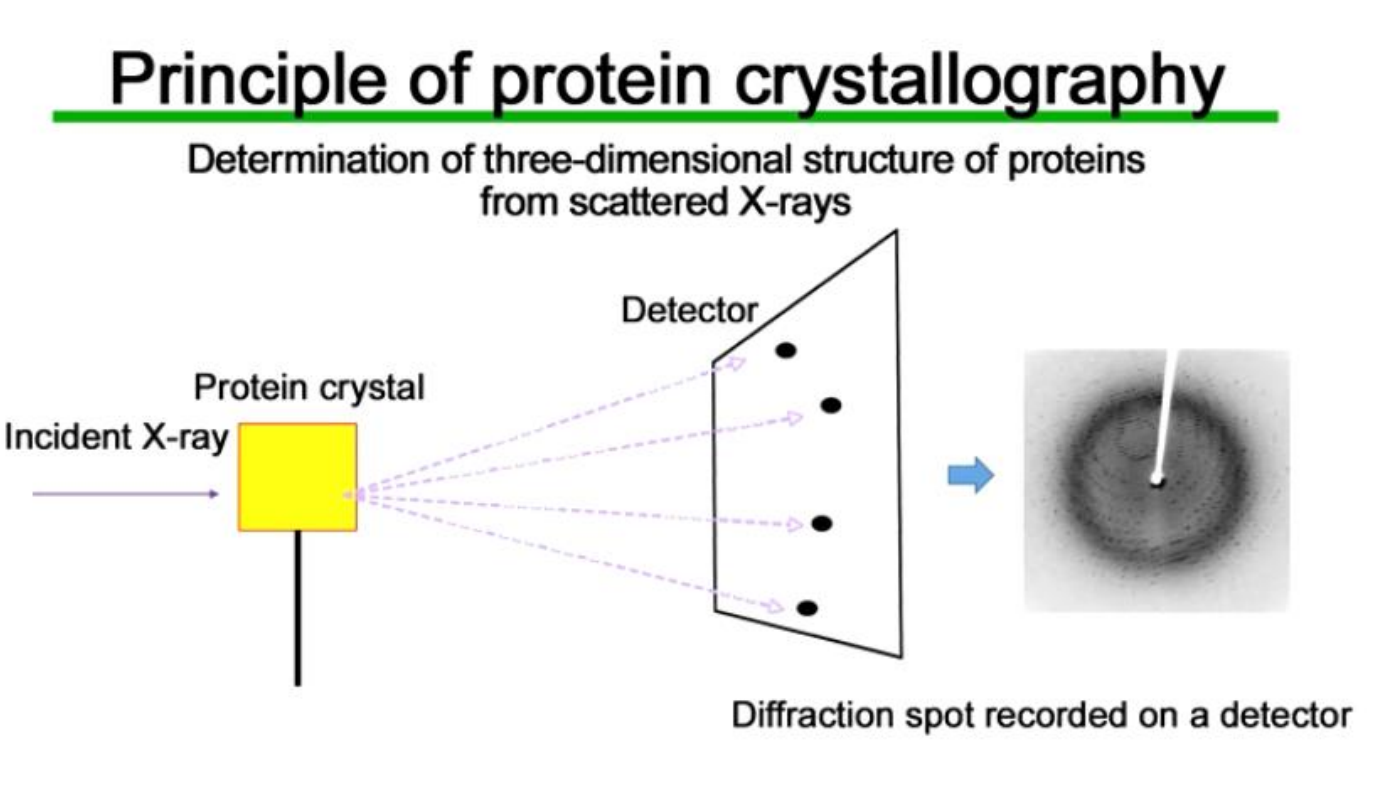




Proteins
Vitamins
Drugs

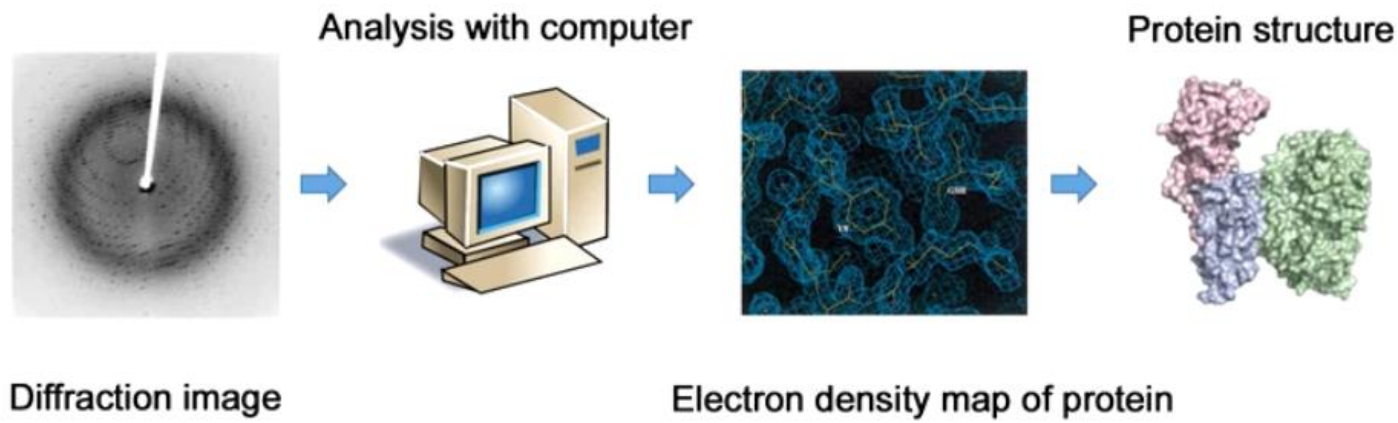
DNA

X-Ray and Protein



Principle of protein crystallography

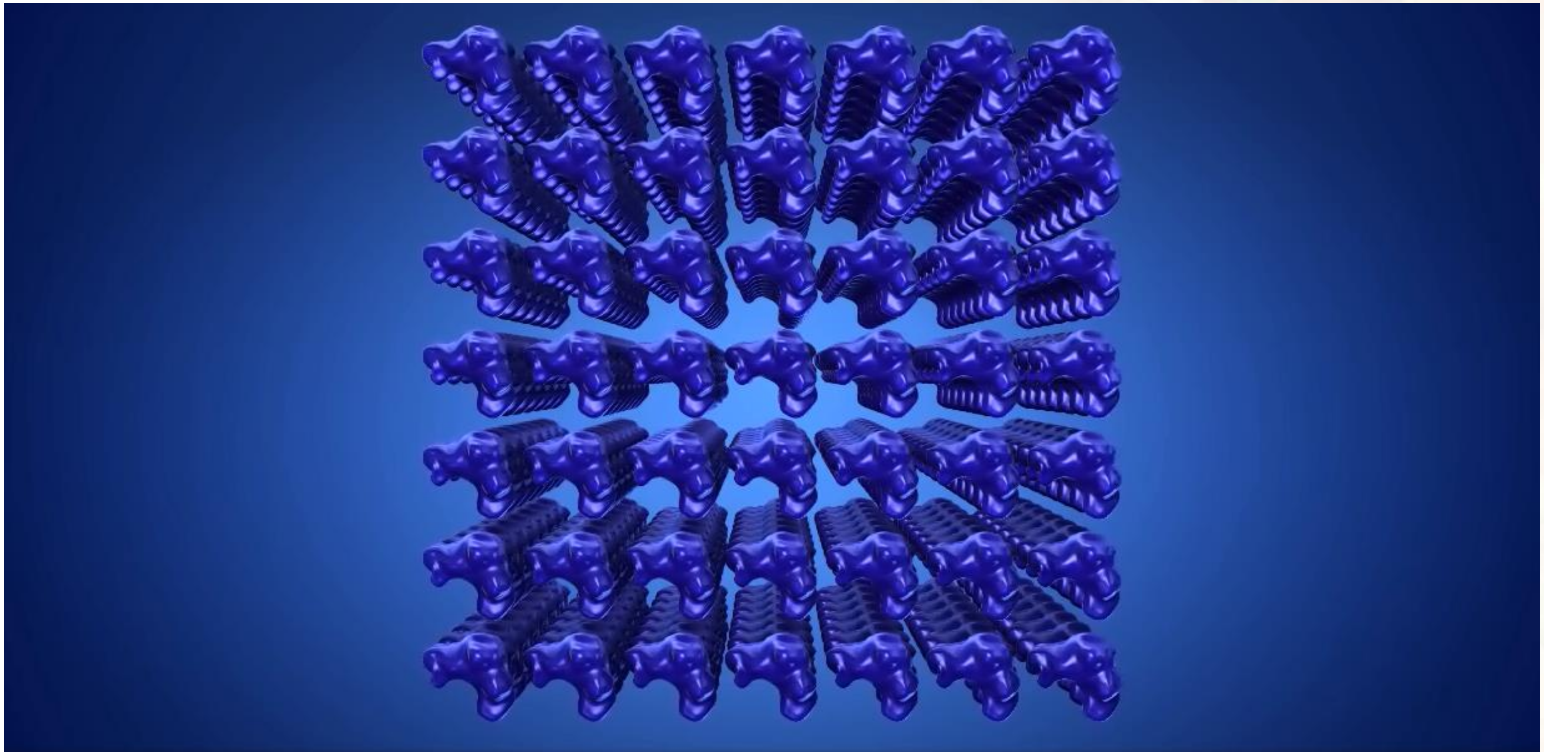
Determination of three-dimensional structure of proteins
from scattered X-rays



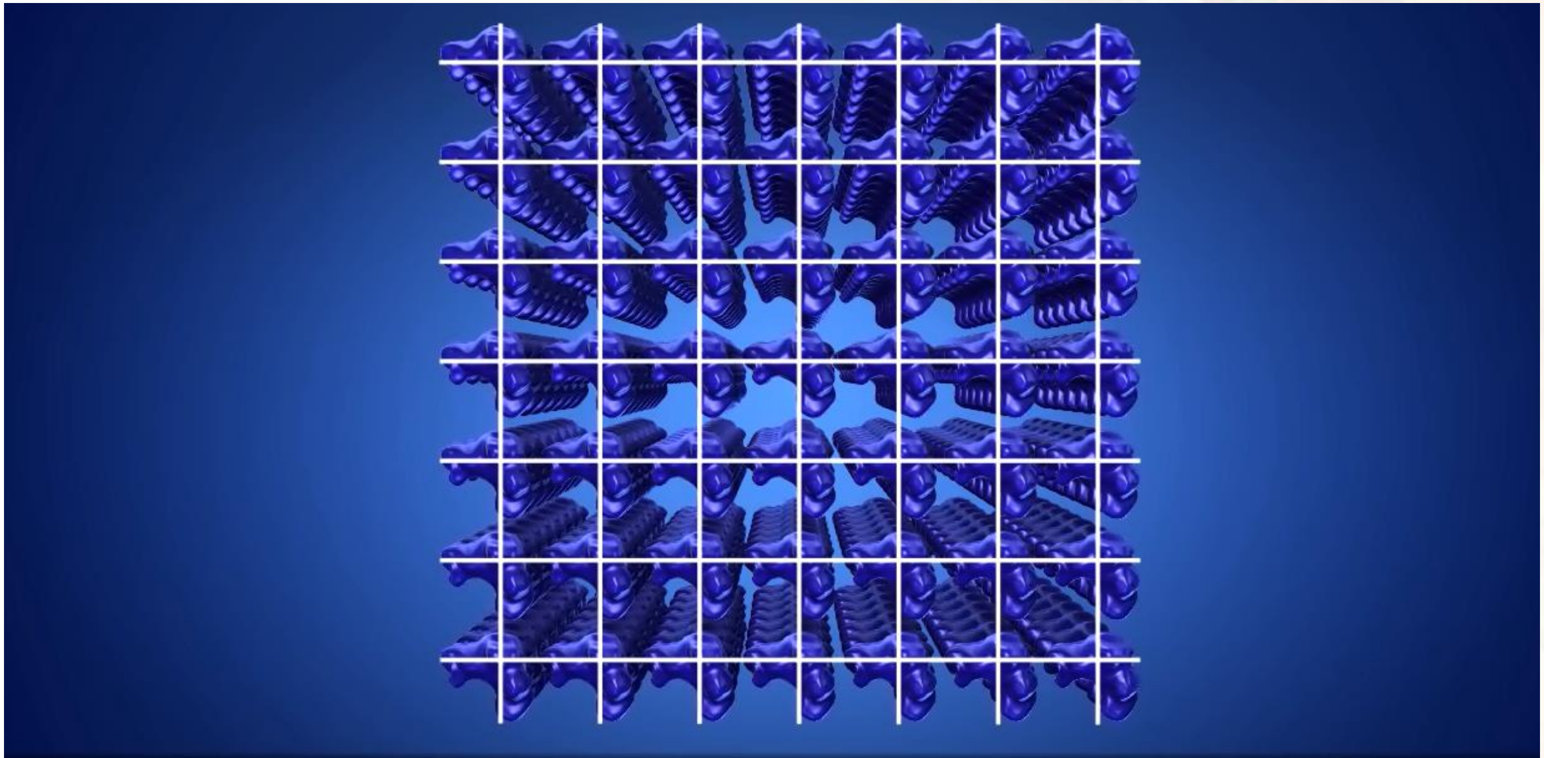
Procedure of protein crystallography

- ① Sample preparation
  - Overexpression
  - Purification
  - Crystallization
- ② Diffraction experiment
  - Diffraction data collection
- ③ Structural analysis
  - Calculation of electron density
  - Model building

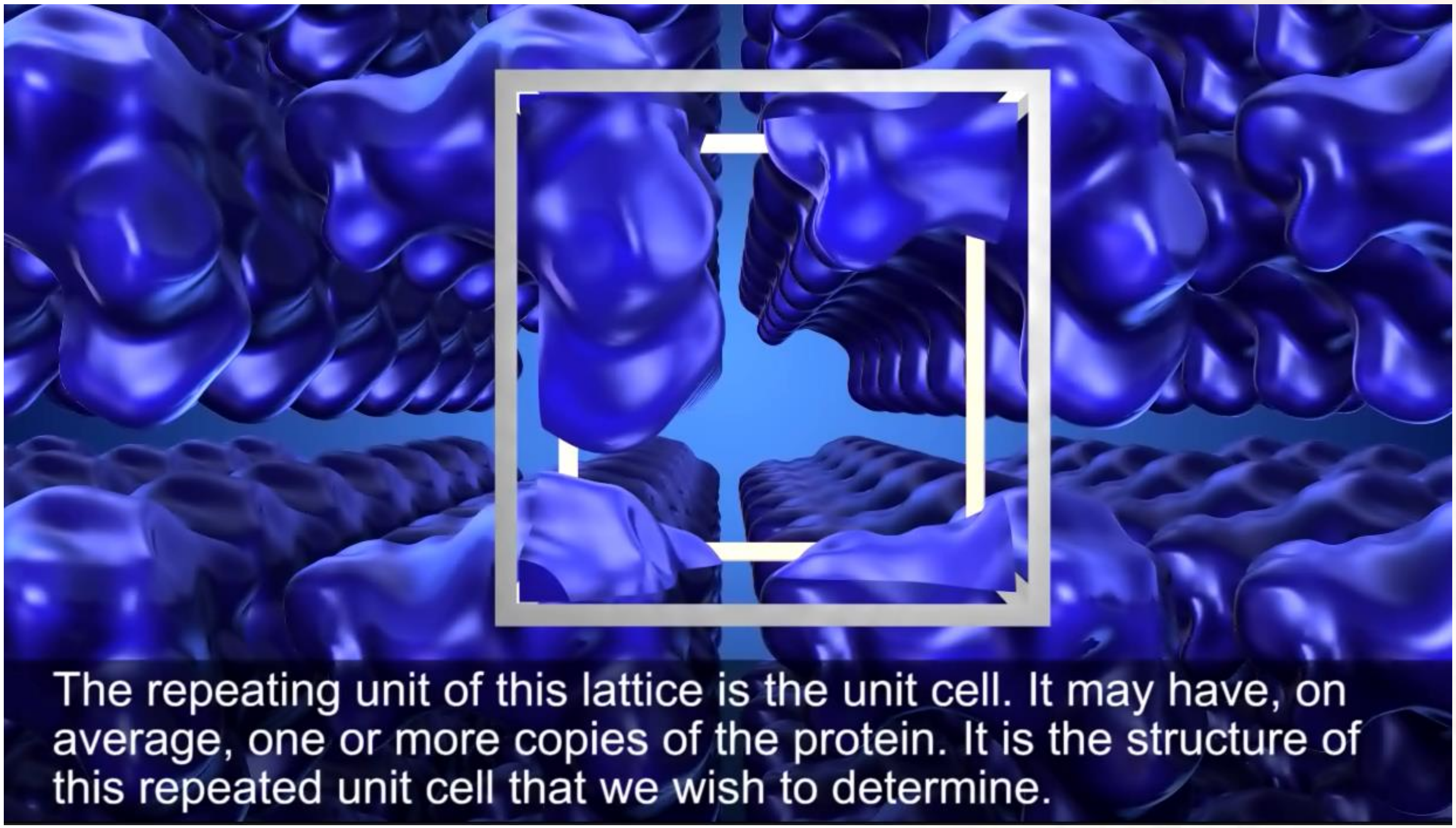
Protein Crystals Diffractions

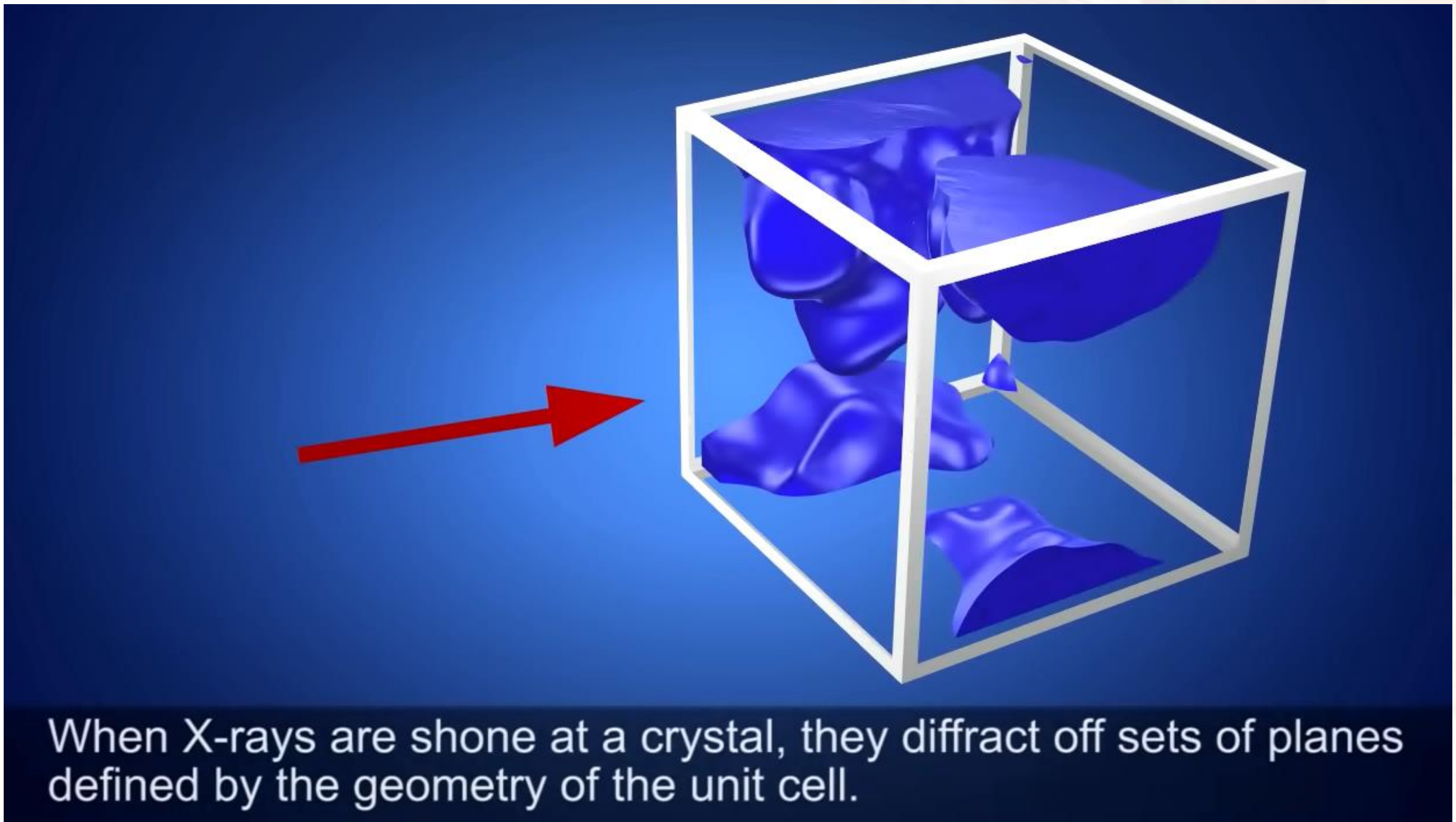


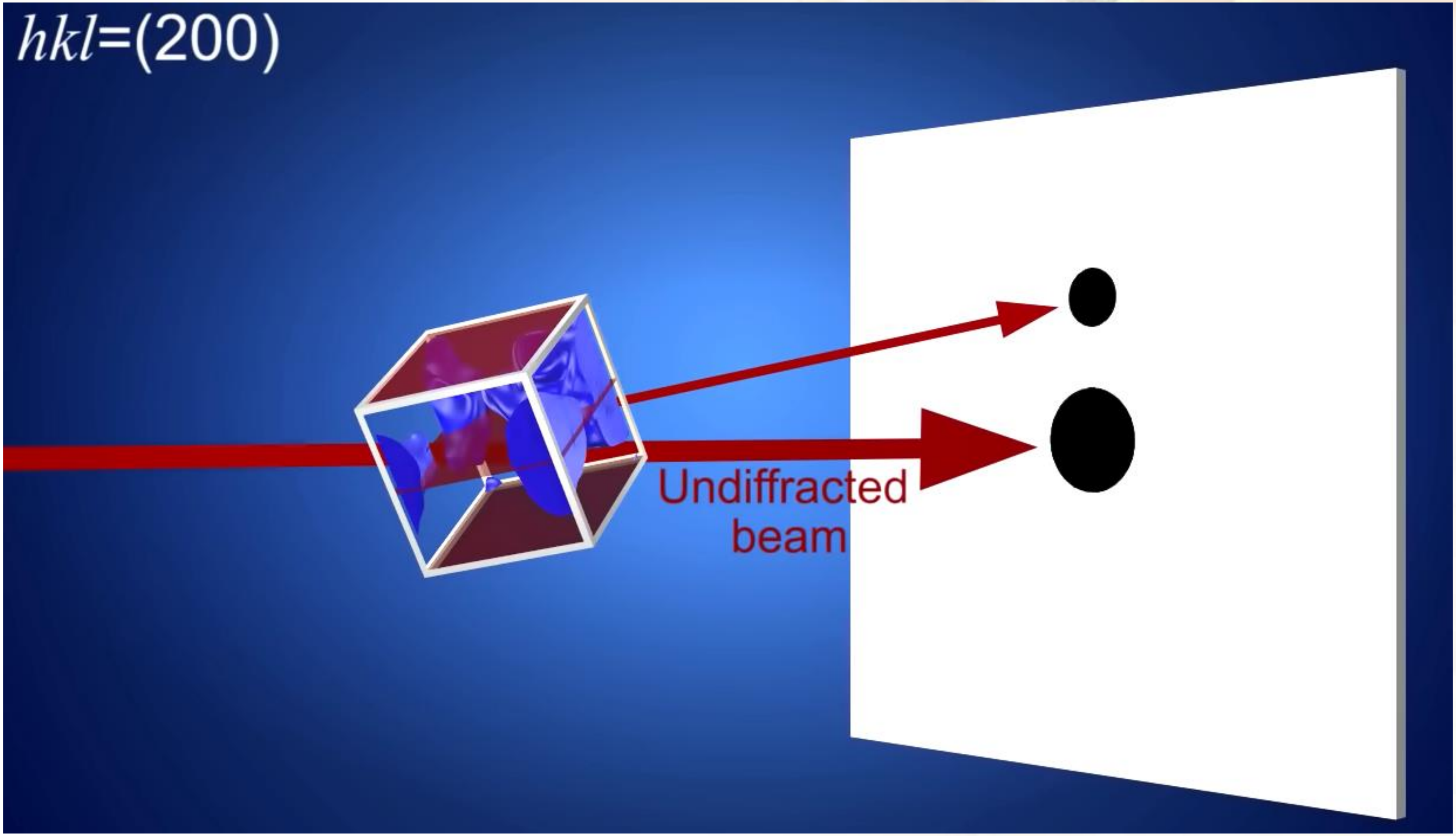
A protein crystal is a solid comprising an ordered array of proteins with solvent between them.

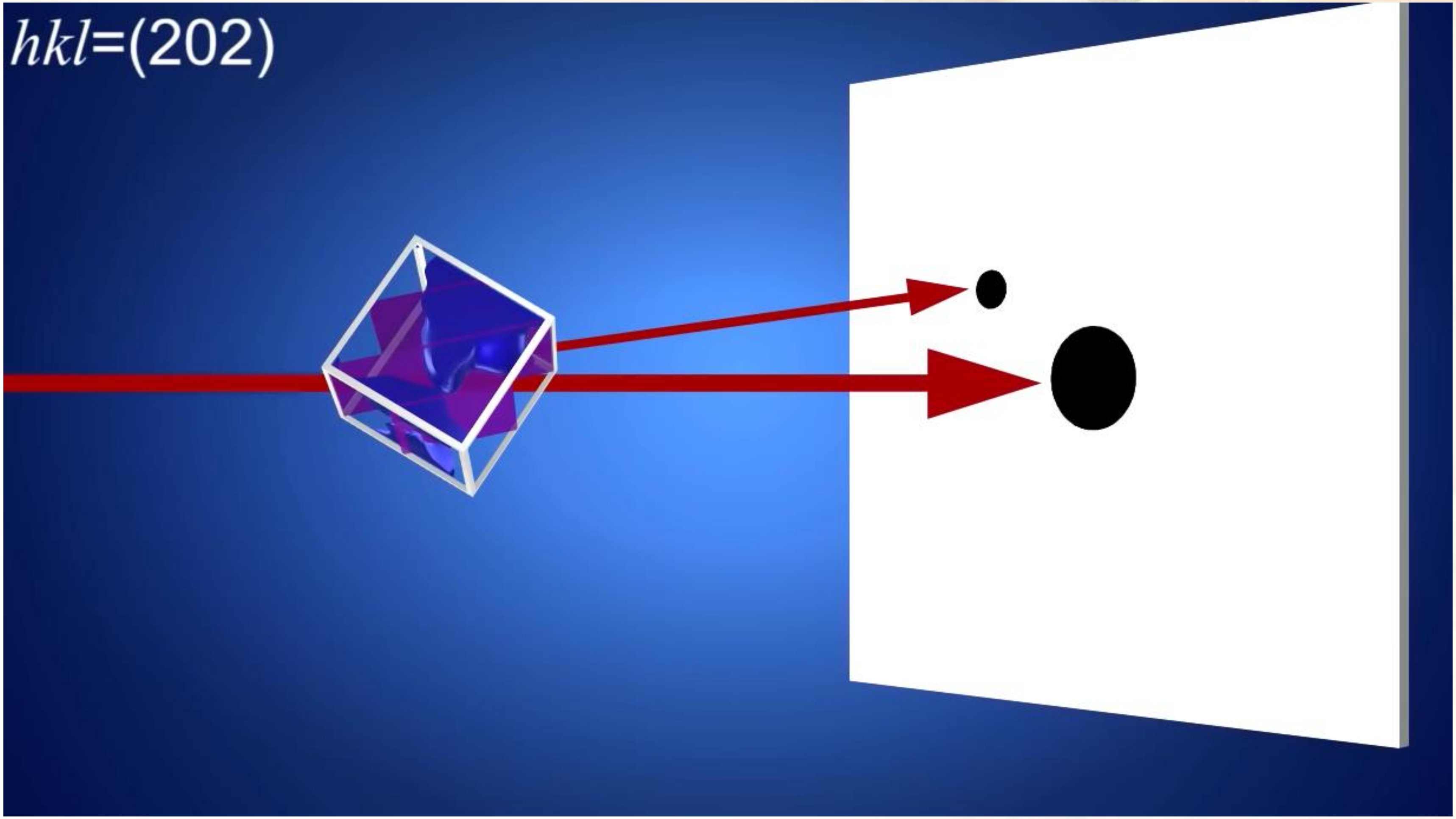


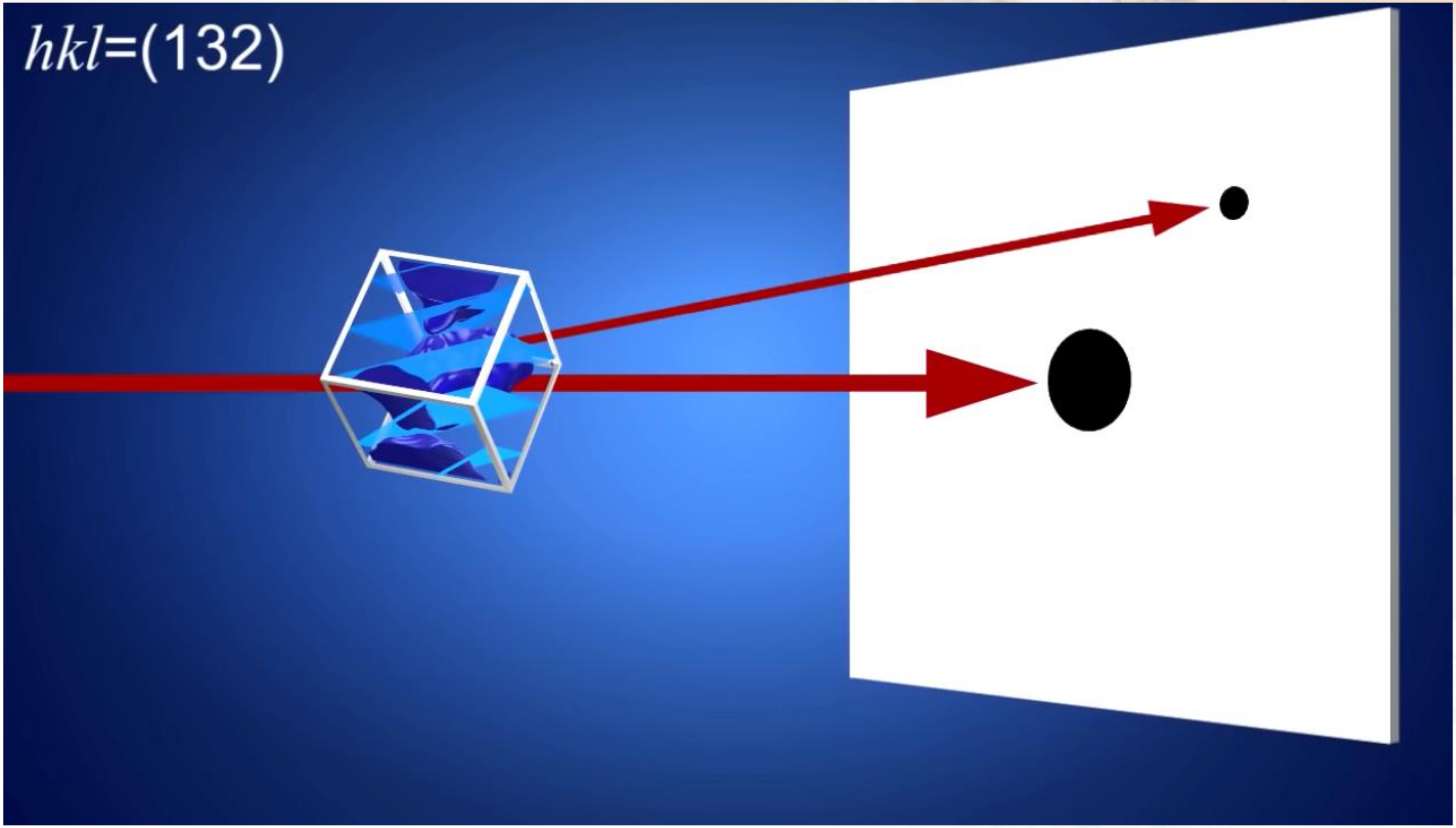
The arrangement of the proteins within the crystal can be described by a lattice, showing the repeating structure.

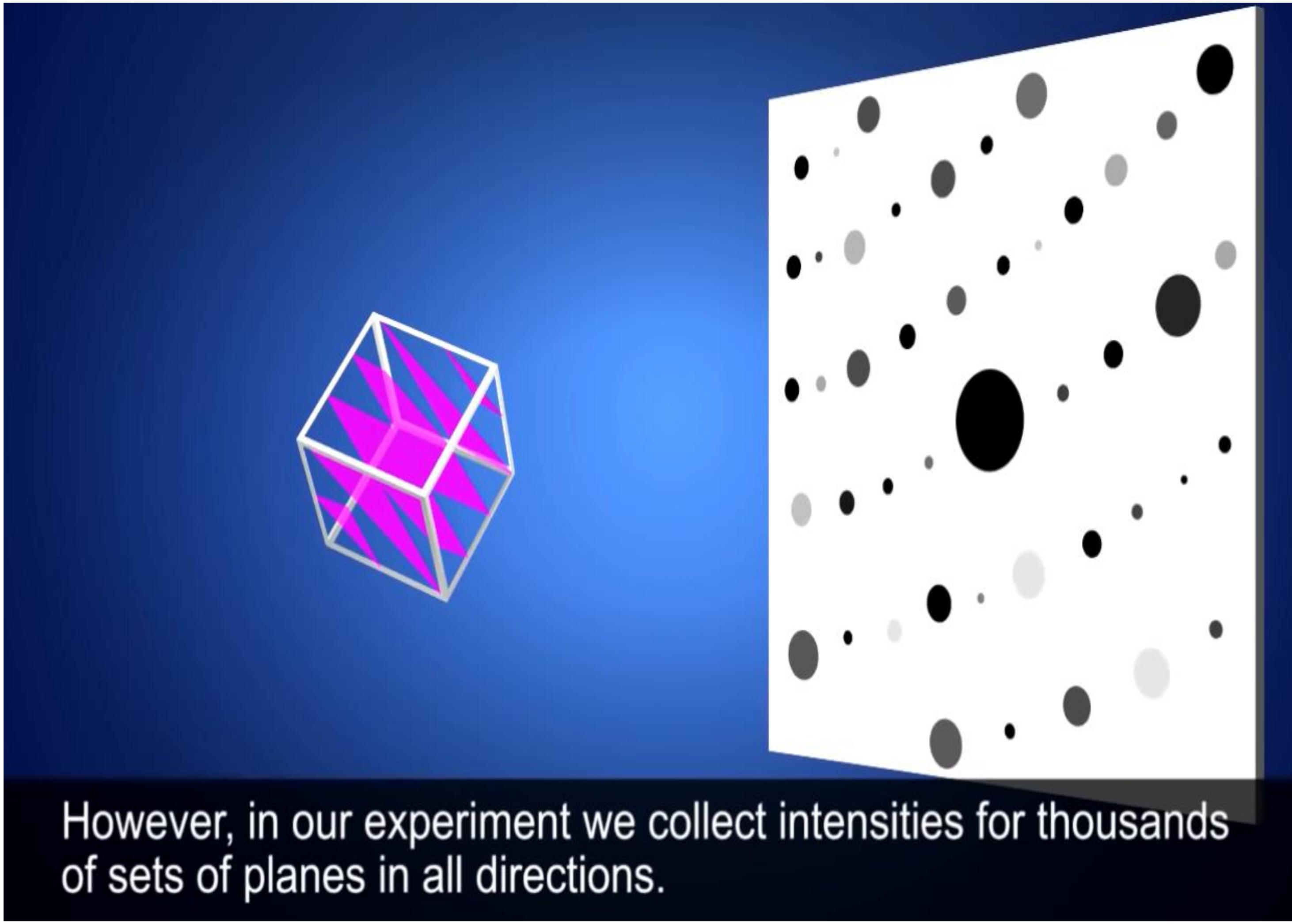

The repeating unit of this lattice is the unit cell. It may have, on average, one or more copies of the protein. It is the structure of this repeated unit cell that we wish to determine.


When X-rays are shone at a crystal, they diffract off sets of planes
defined by the geometry of the unit cell.

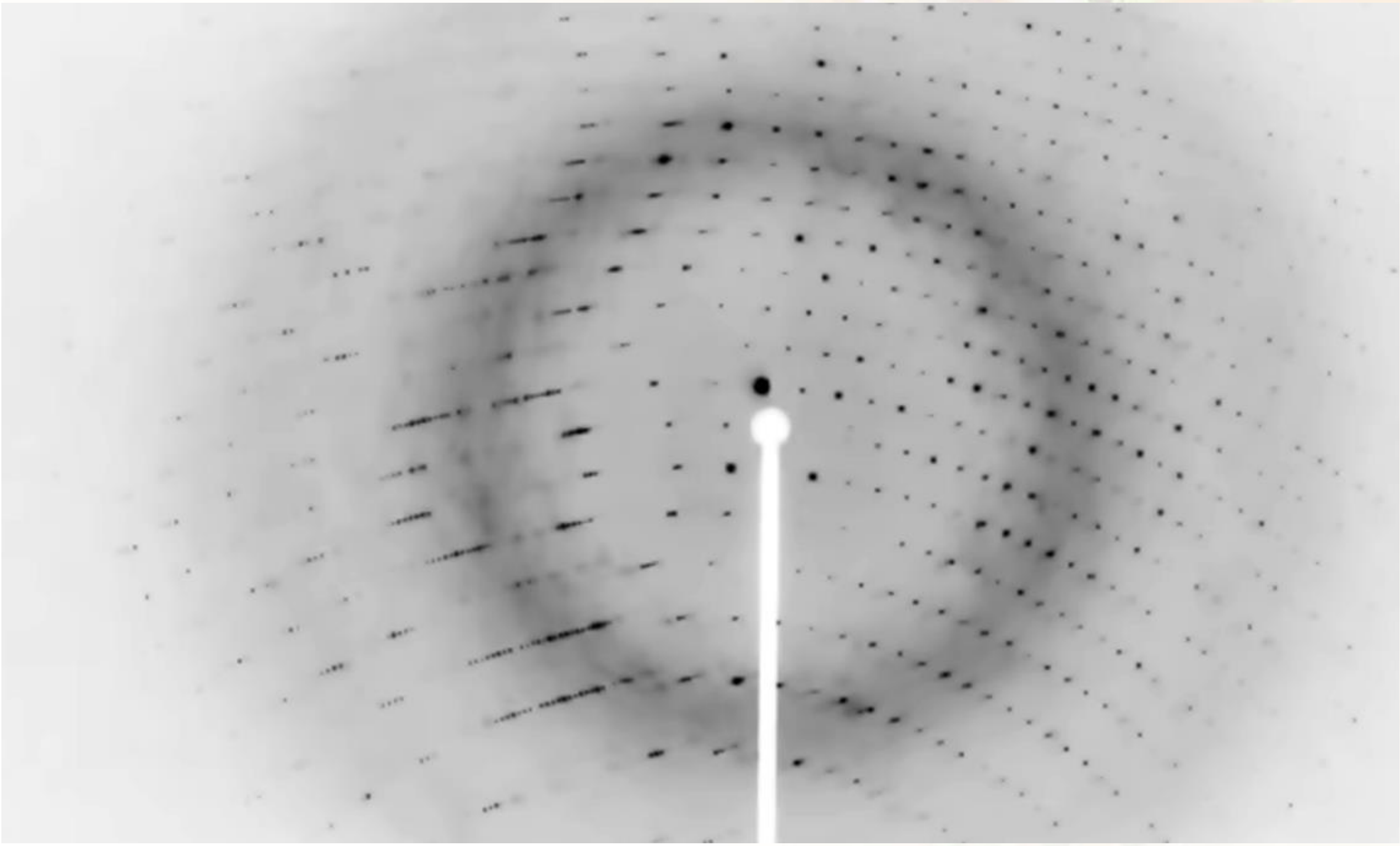

hkl=(200)
Undiffracted
beam


hkl=(202)

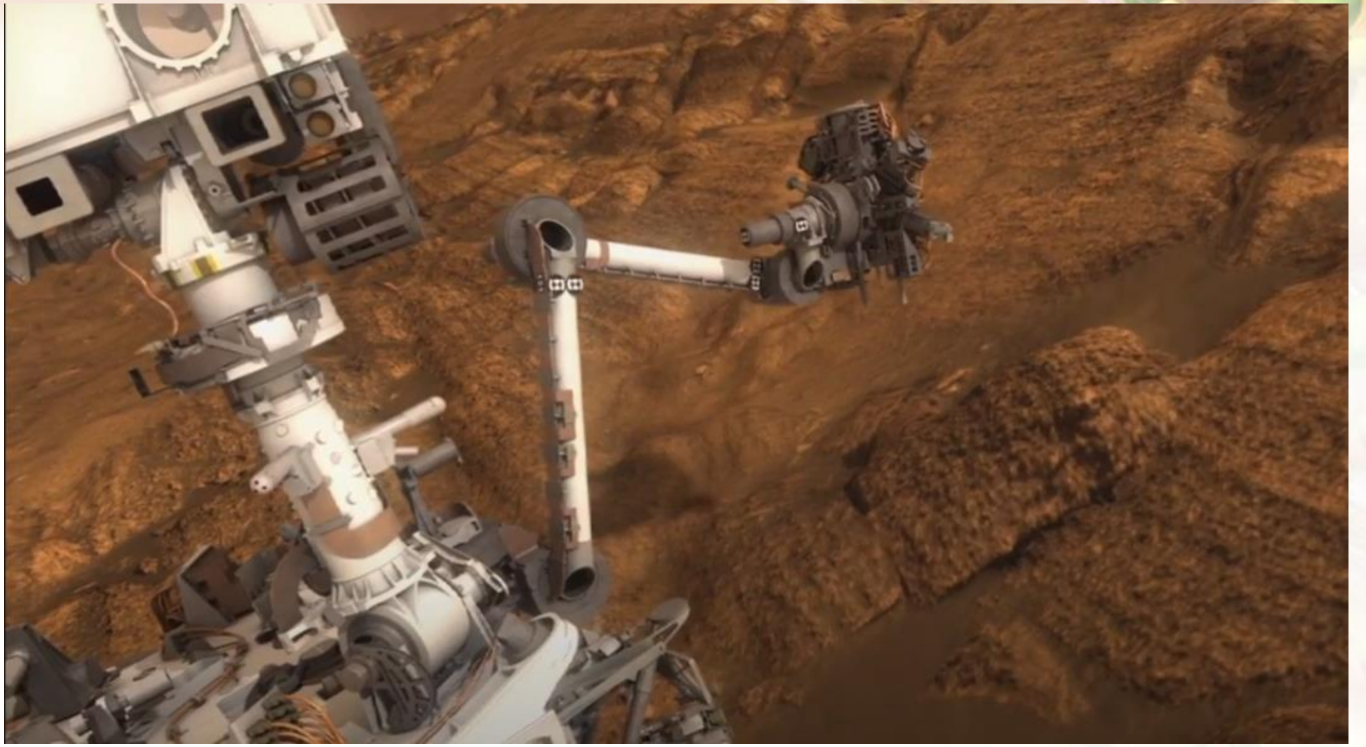

hkl=(132)



There is a good chance in these planes for:
(200) 10000 electrons
(132) 5000 electrons



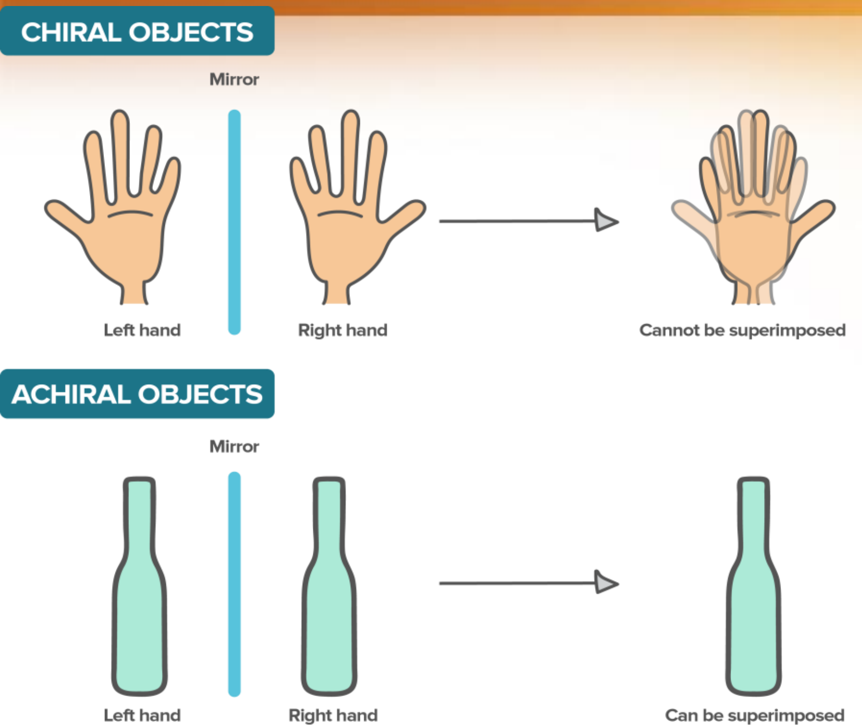
Astrobiology



What about Iran ? Well ISA is all we got for now.

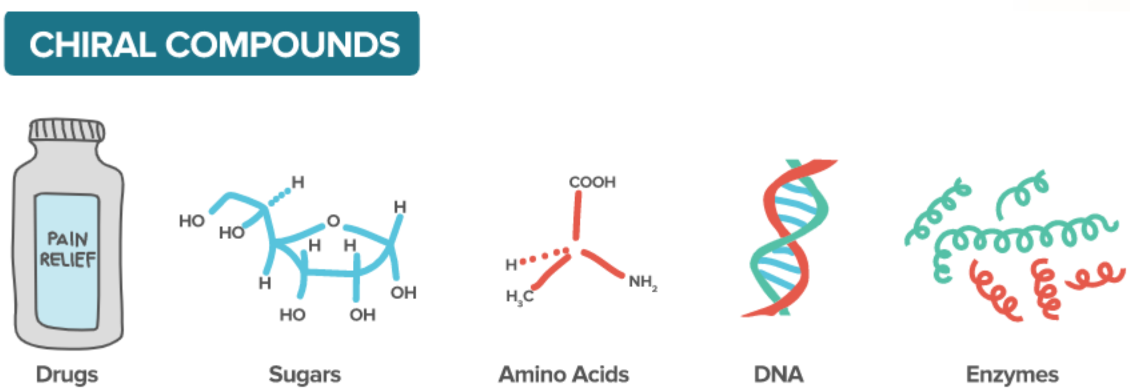

D-AMINO ACID
L-AMINO ACID
LIFE

Chirality



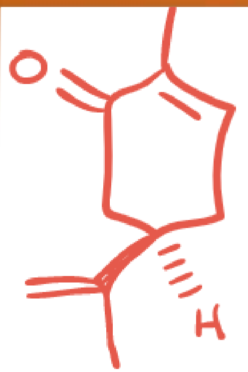
Chirality is derived from the Greek word χειρ (kheir) that stands for "hand". An object is said to be chiral if the object and its mirror image are non-superimposable, just like our right and left hand.

Molecular chirality was discovered by Louis Pasteur back in 1848, when he successfully separated the two isomers of sodium ammonium tartarate.

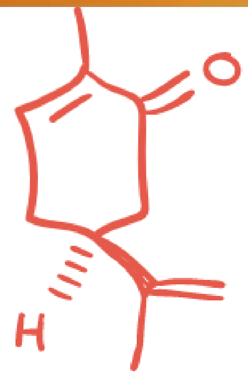


Most biological compounds are chiral

Like what ?



R-CARVONE
SPEARMINT OIL



S-CARVONE
CARAWAY OIL

Human olfactory sensory organs are chiral, so the following pair of enantiomers smell very differently to us. R-isomer of carvone smells like spearmint leaves, while S-isomer of carvone smells like caraway seeds.

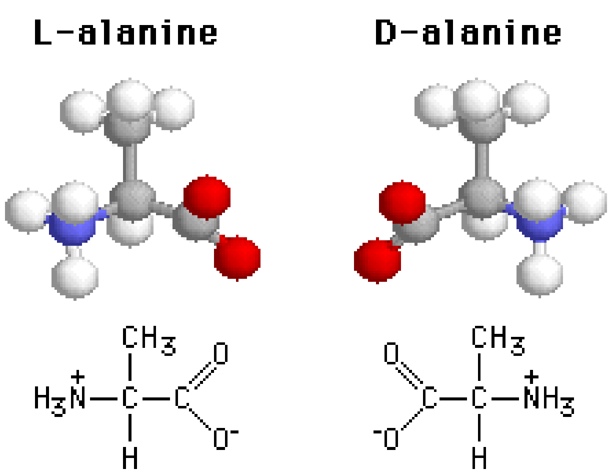
In the case of the well-known painkiller, ibuprofen, the (S)-enantiomer has the desired pharmacological activity while the (R)-enantiomer is totally inactive.

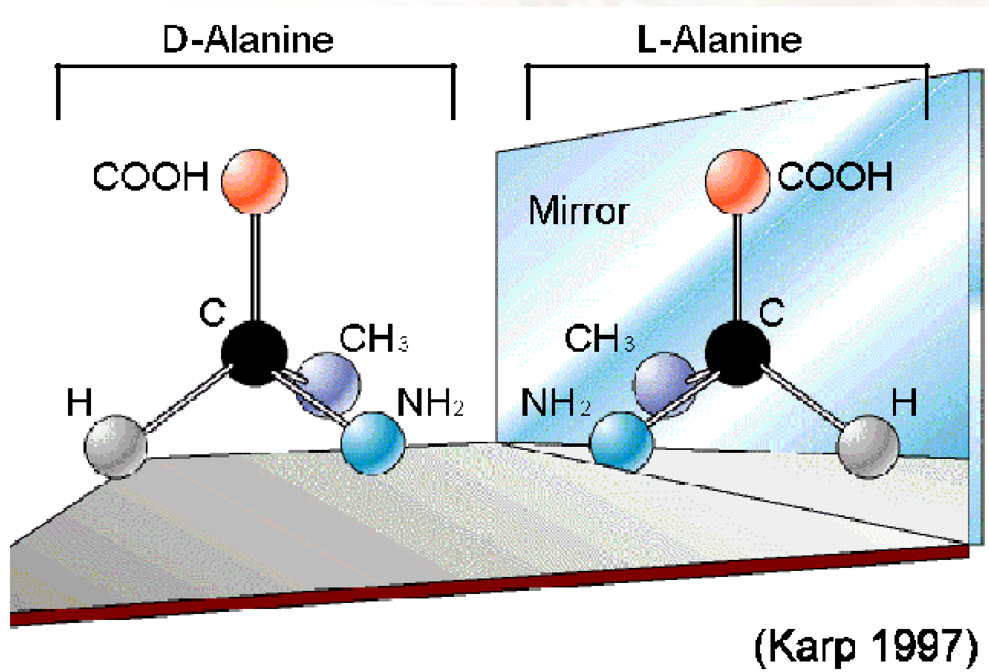
S-IBUPROFEN

R-IBUPROFEN

L- and D- Amino Acids

Every amino acid (except glycine) can occur in two isomeric forms, because of the possibility of forming two different enantiomers (stereoisomers) around the central carbon atom. By convention, these are called L- and D- forms, analogous to left-handed and right-handed configurations





Only L-amino acids are manufactured in cells and incorporated into proteins. Some D-amino acids are found in the cell walls of bacteria, but not in bacterial proteins.

Glycine, the simplest amino acid, has no enantiomers because it has two hydrogen atoms attached to the central carbon atom. Only when all four attachments are different can enantiomers occur.

a Little Bit Organic Chemistry

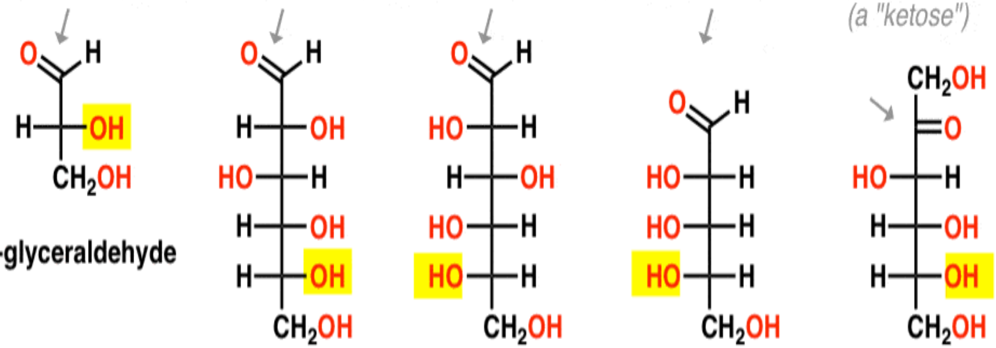
D- and L- Sugars

For a sugar drawn in the Fischer projection with the most oxidized carbon at the top:

- If the OH on the bottom chiral center points to the **right**, the sugar is **D**
- If the OH on the bottom chiral center points to the **left**, the sugar is **L**

most oxidized carbon (aldehyde) at top: these are "aldoses"

ketone (a "ketose")



D-glyceraldehyde

D-Glucose

L-Glucose

L-Ribose

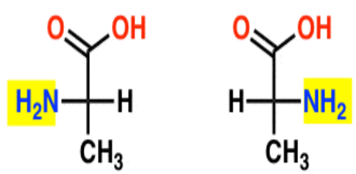
D-Fructose

enantiomers

L- and D- is a means of describing the **absolute configuration** of a molecule that pre-dates *R* and *S* but is still used for some biological molecules (sugars, amino acids). It's a quick way of denoting enantiomers: e.g. L-glucose and D-glucose are enantiomers.

L- and D- have no relation to the optical rotation of a molecule.

The D- L- system can also be applied to other chiral molecules, e.g. amino acids:



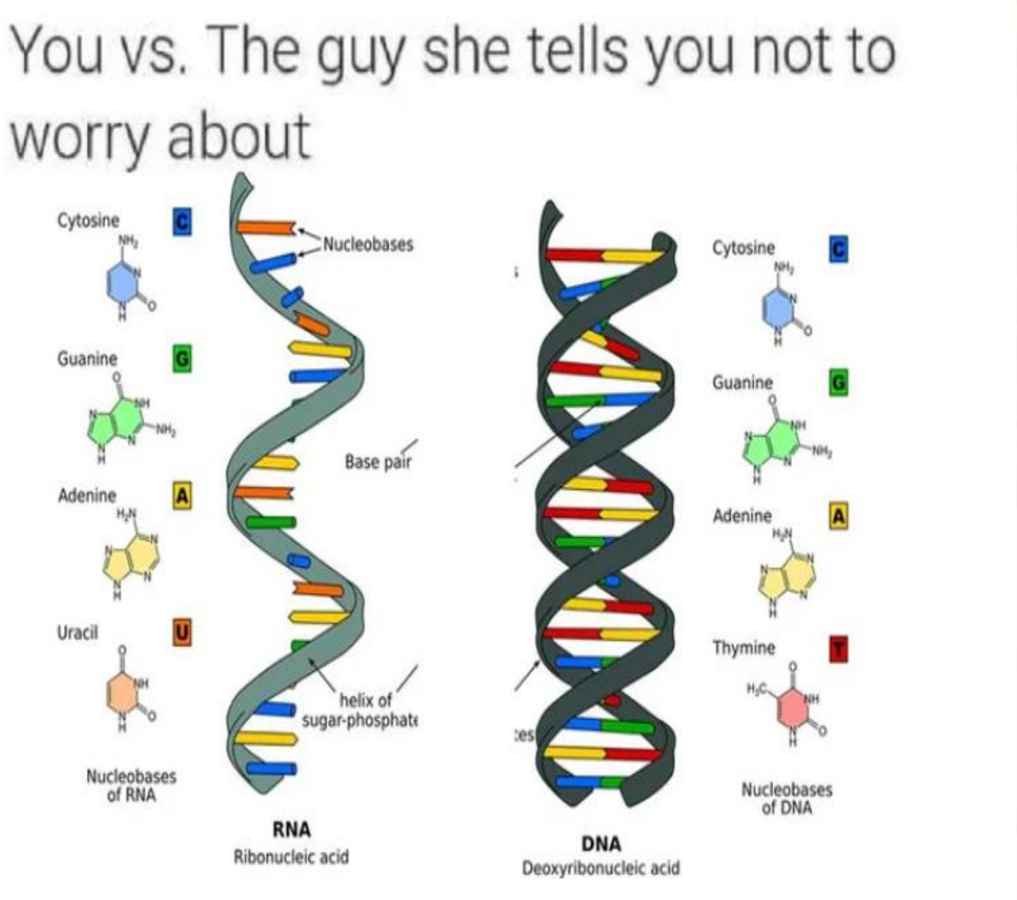
L-alanine

D-alanine

enantiomers

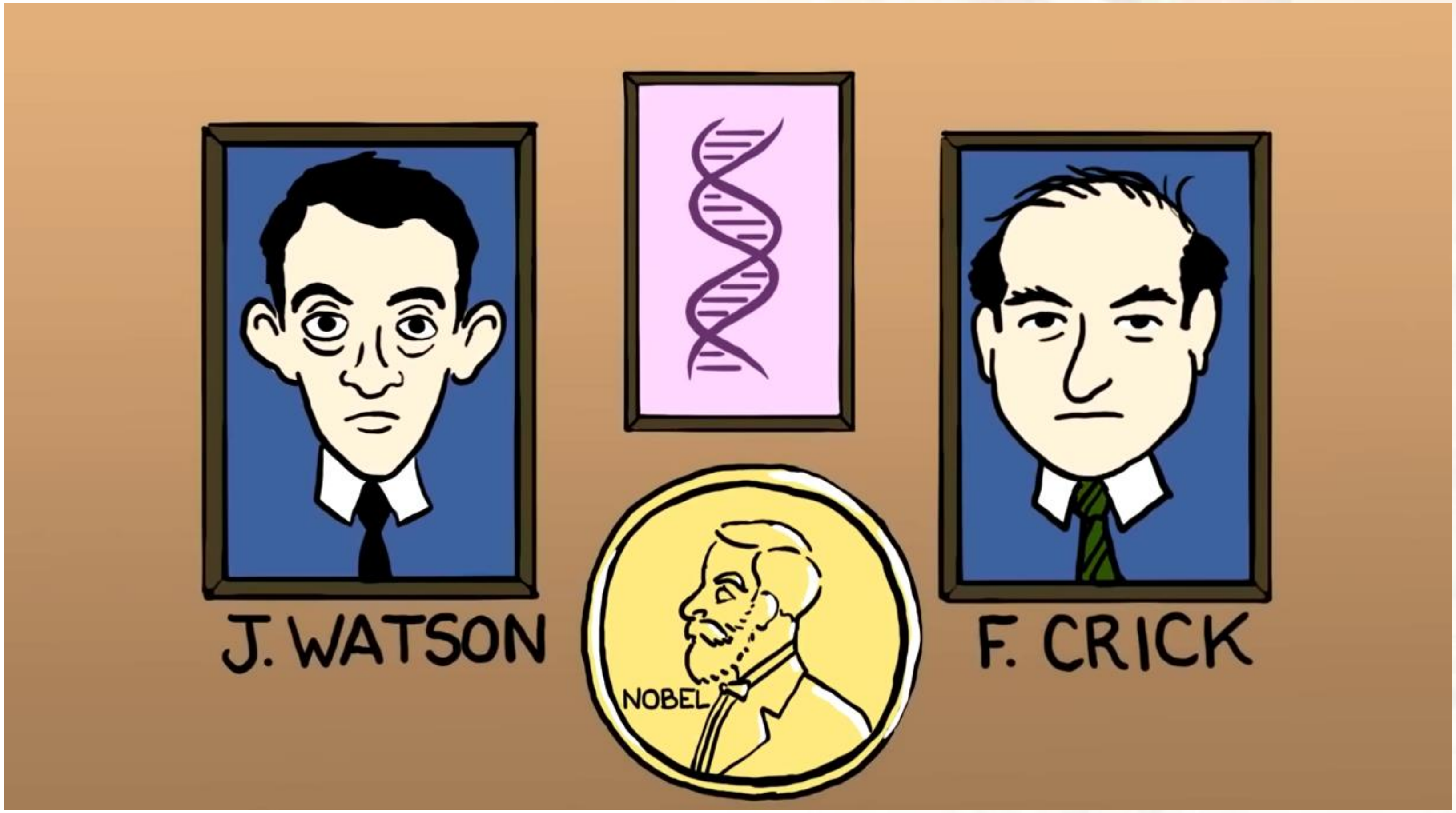
It turns out that most naturally occurring sugars are D-, and most naturally occurring amino acids are L- . There is a tremendous amount of information compressed in that statement, and there is no competing system (R/S, +/–) which could replace the L- and D- with a single character.

DNA

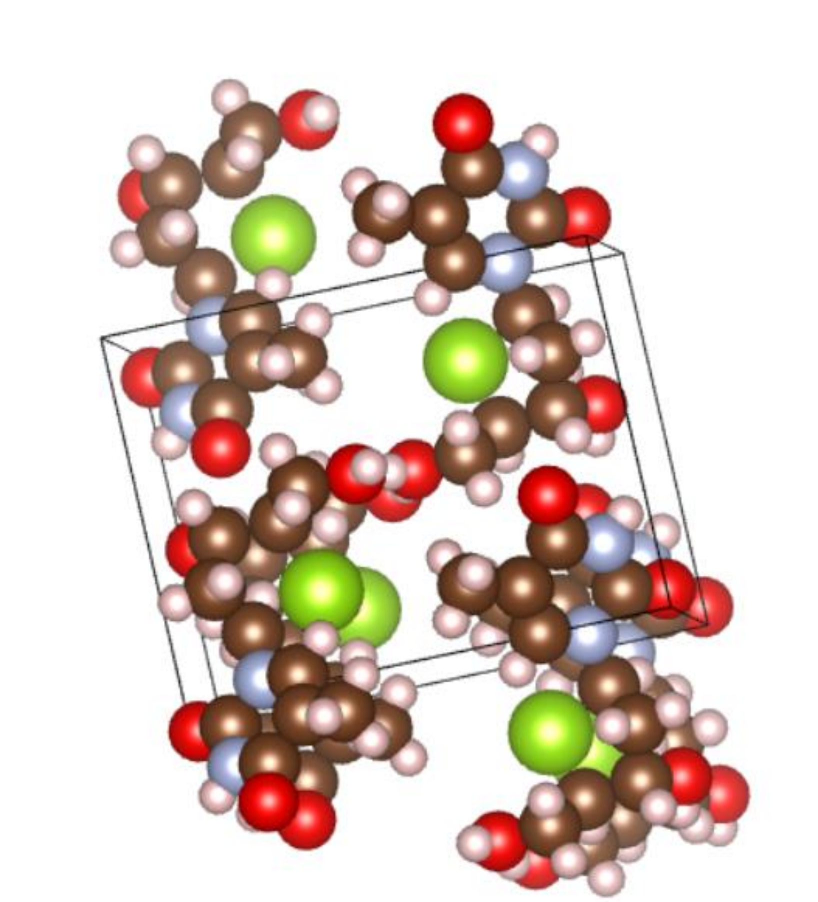

You vs. The guy she tells you not to worry about
Cytosine
Guanine
Adenine
Uracil
Nucleobases of RNA
Nucleobases
Base pair
helix of sugar-phosphate
RNA
Ribonucleic acid
DNA
Deoxyribonucleic acid
Cytosine
Guanine
Adenine
Thymine
Nucleobases of DNA

In memory of Rosalind Franklin

Nobel is ours.



DNA Structure



CoD ID : [1502953]

Lattice type	P
Space group name	P 21/n
Space group number	14
Setting number	2

a new DNA building block, 4'-selenothymidine

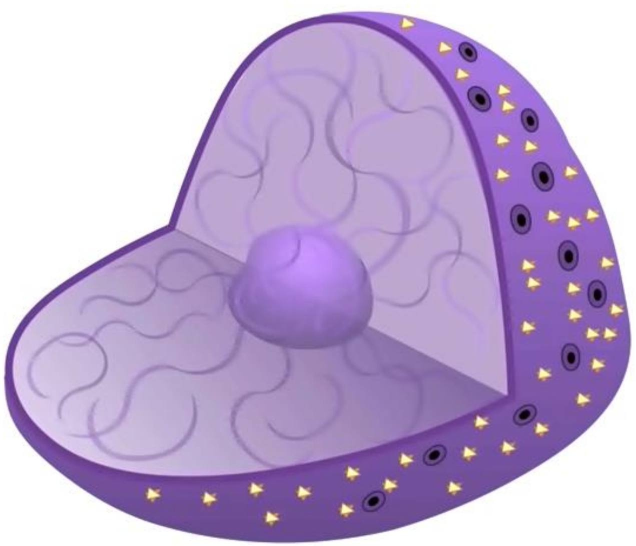
DNA Stands for :

deoxyribonucleic acid

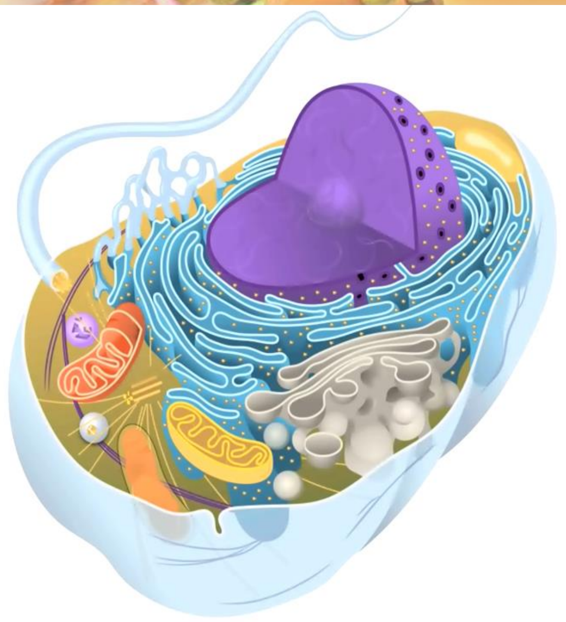
contains the information that determines inherited characteristics

DNA

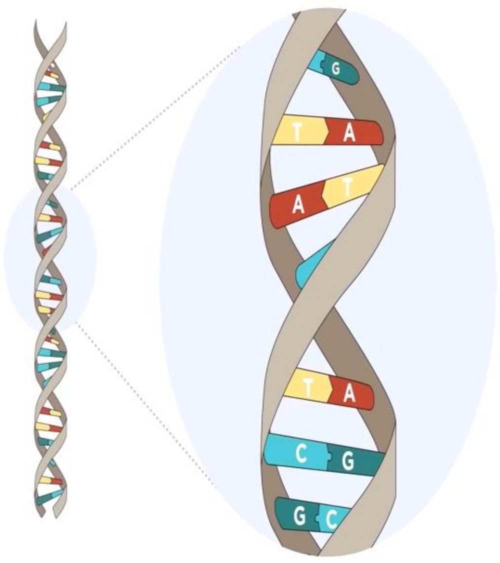
Cells need codes

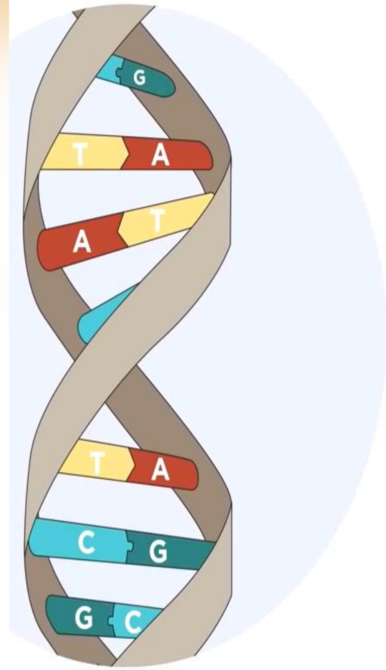


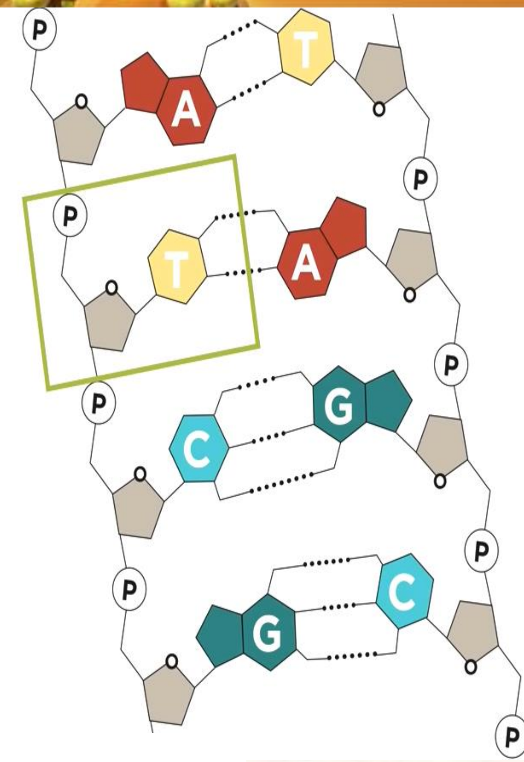
nucleus

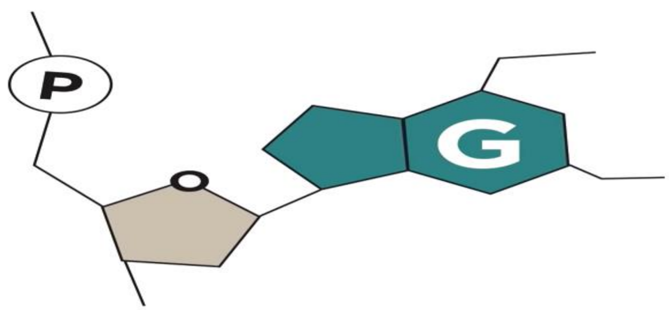


Codes need to be compiled

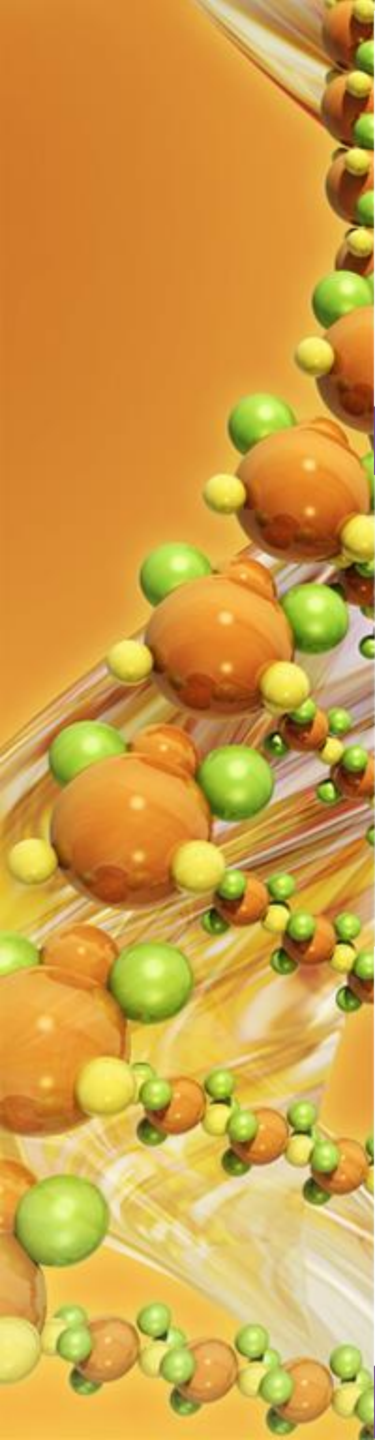


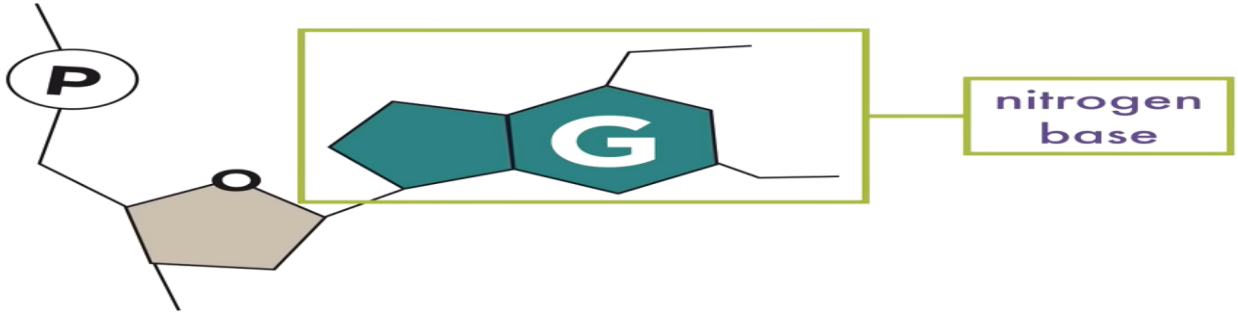




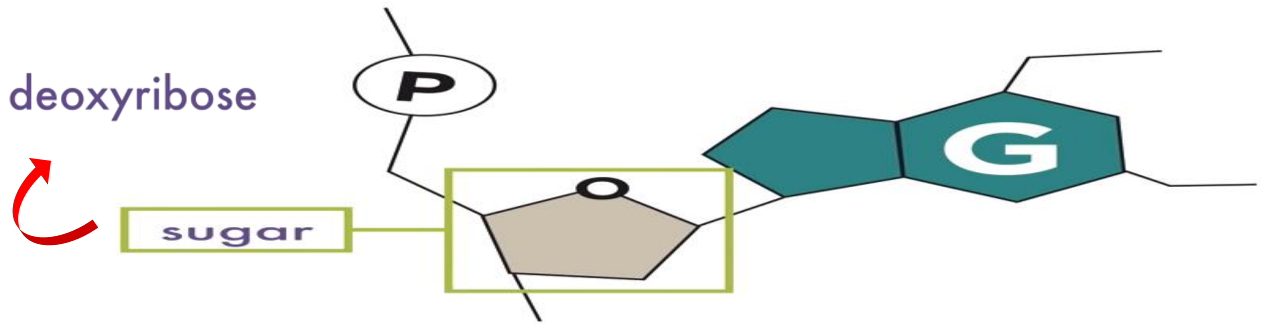


nucleotide

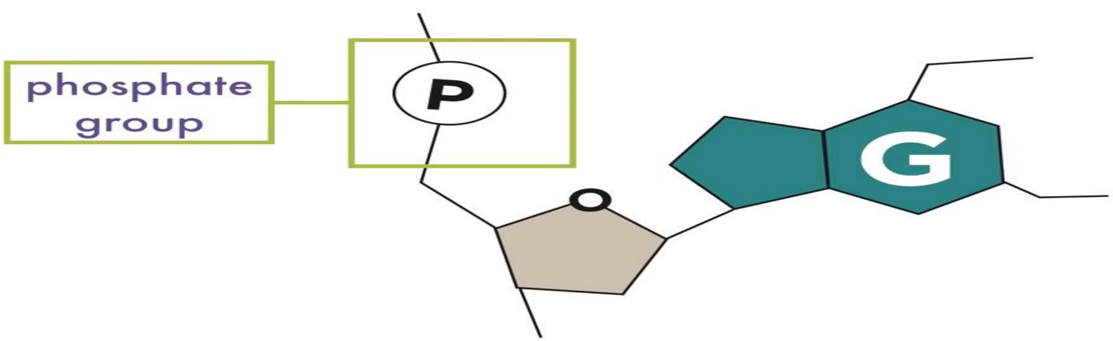




nucleotide

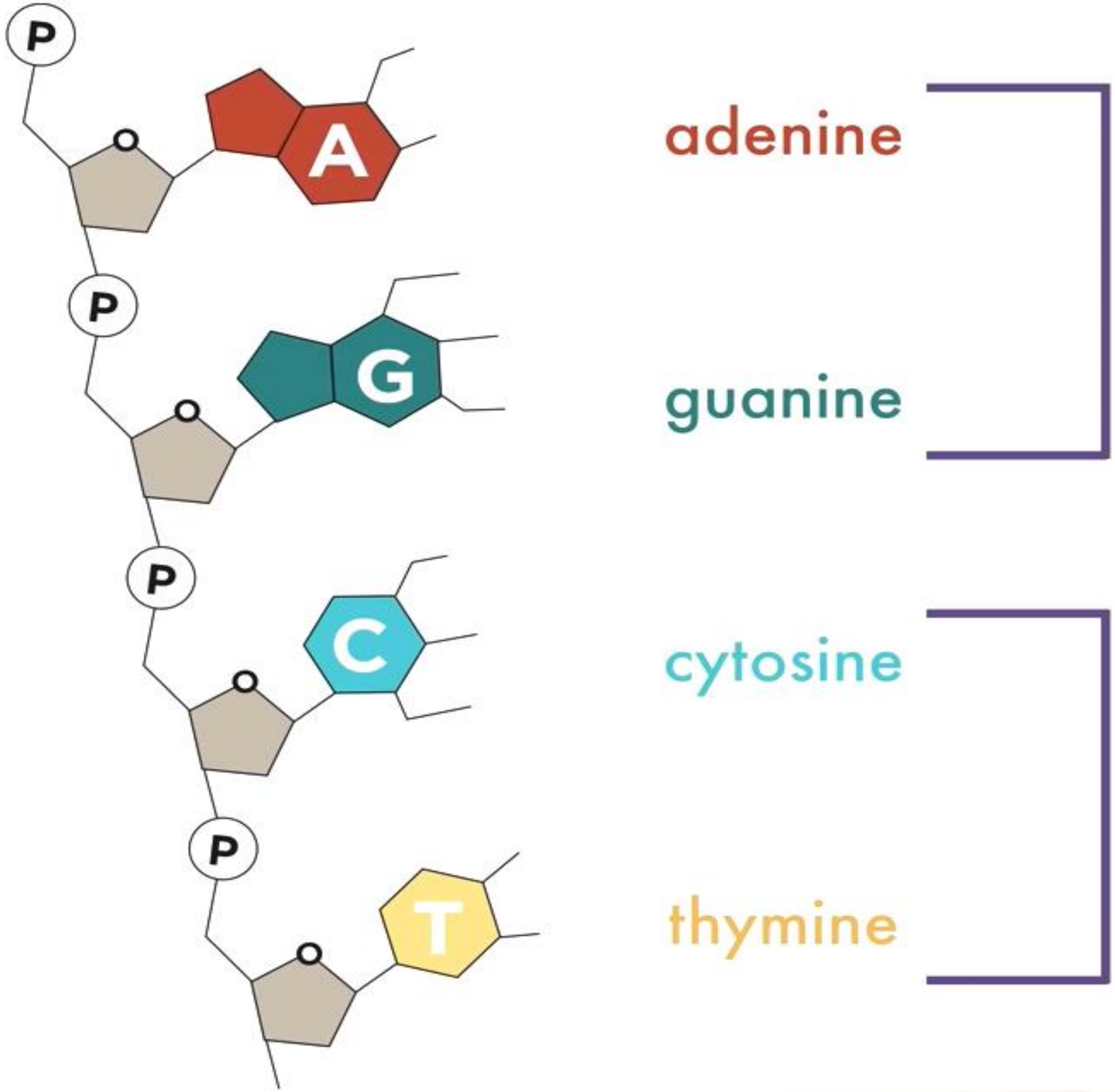


nucleotide



nucleotide

Building Blocks



purines

Two Rings

pyrimidines

One Ring

Restricted Photo

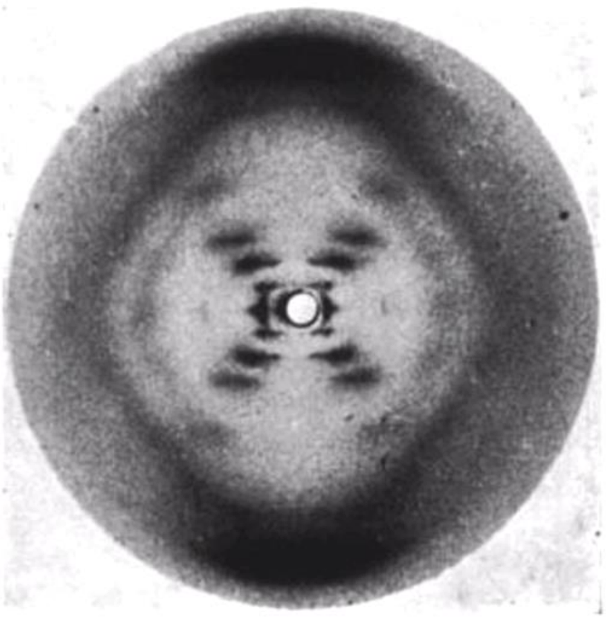


Photo 51

DNA molecule
is a helix

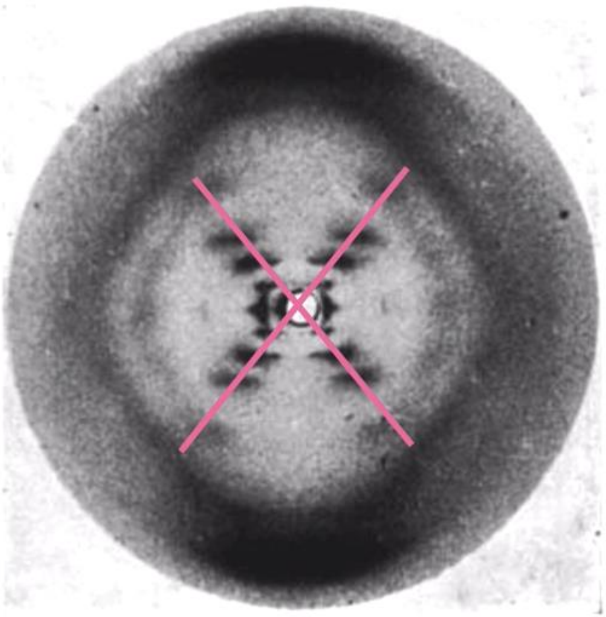
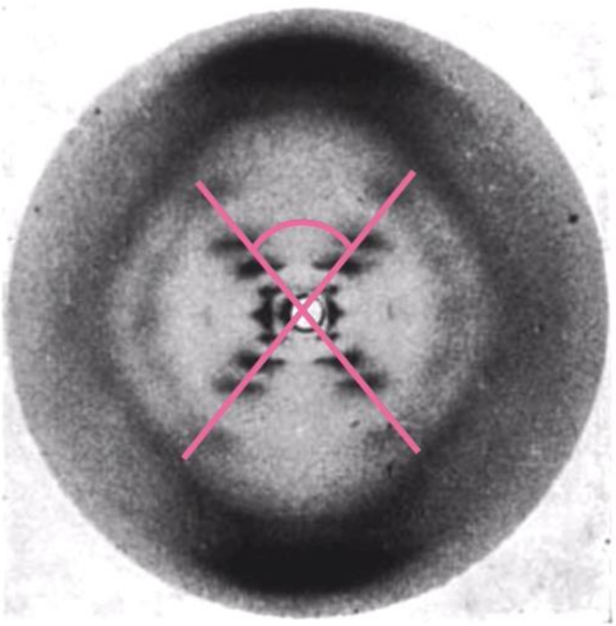


Photo 51

DNA molecule
is a helix



angle of cross
indicates
steepness of
the angle of
the helix

Photo 51

a twist of the helix occurs every 3.4 nm

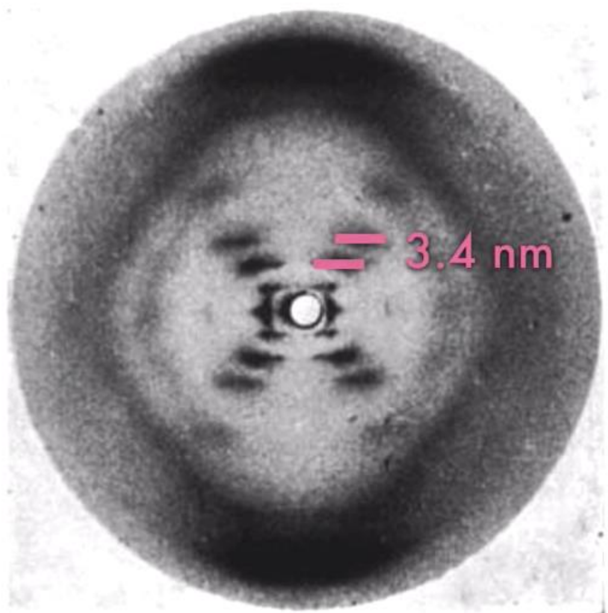
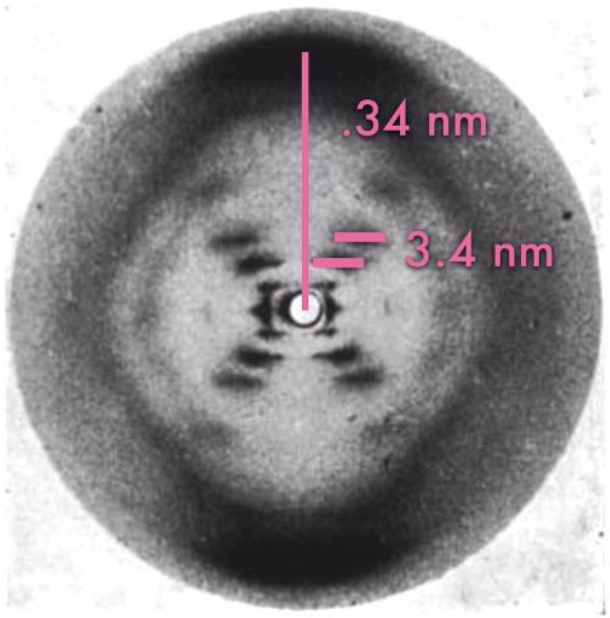


Photo 51

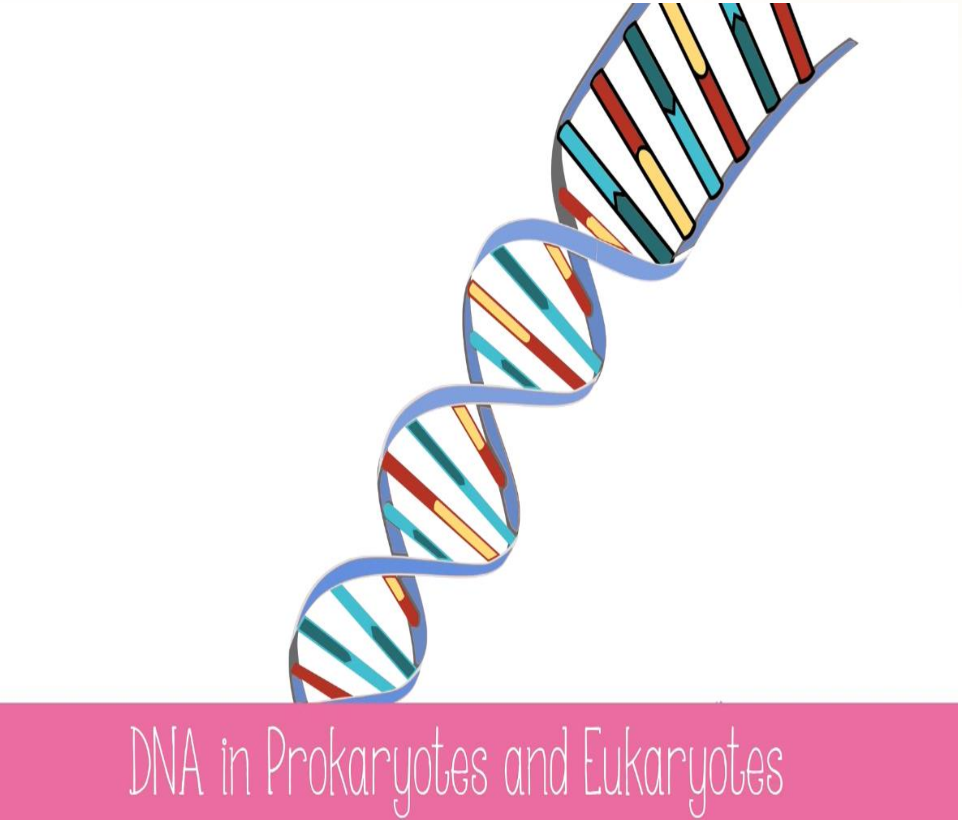
a twist of the helix occurs every 3.4 nm

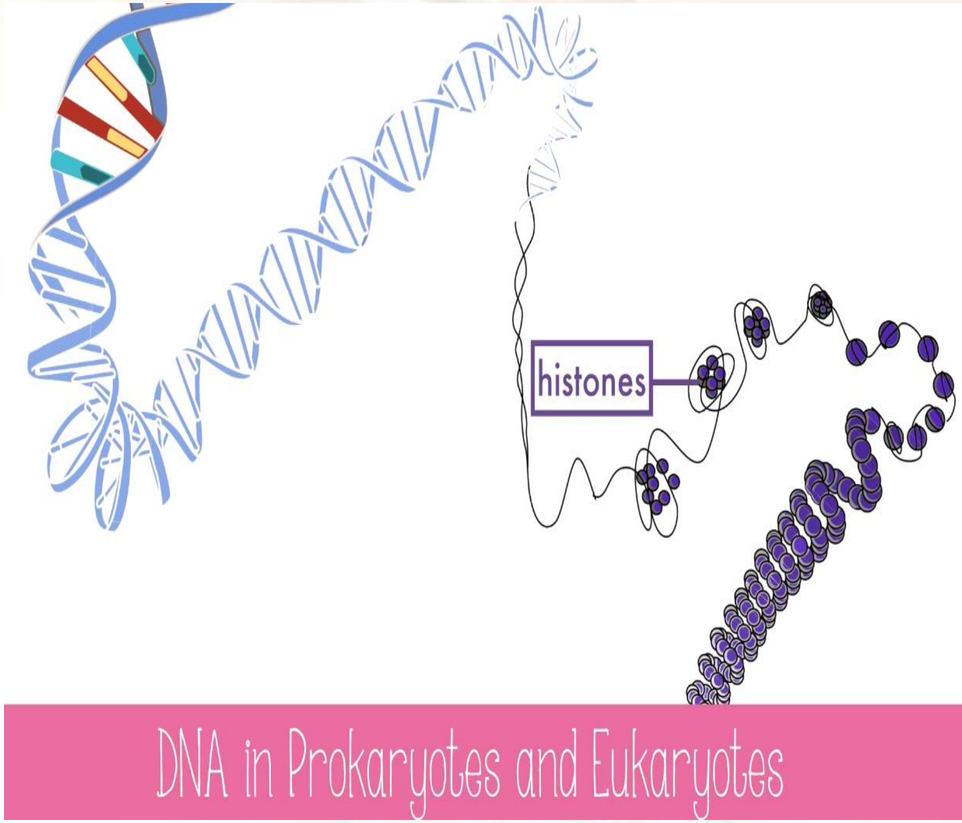


nitrogen bases are 0.34 nm apart from each other

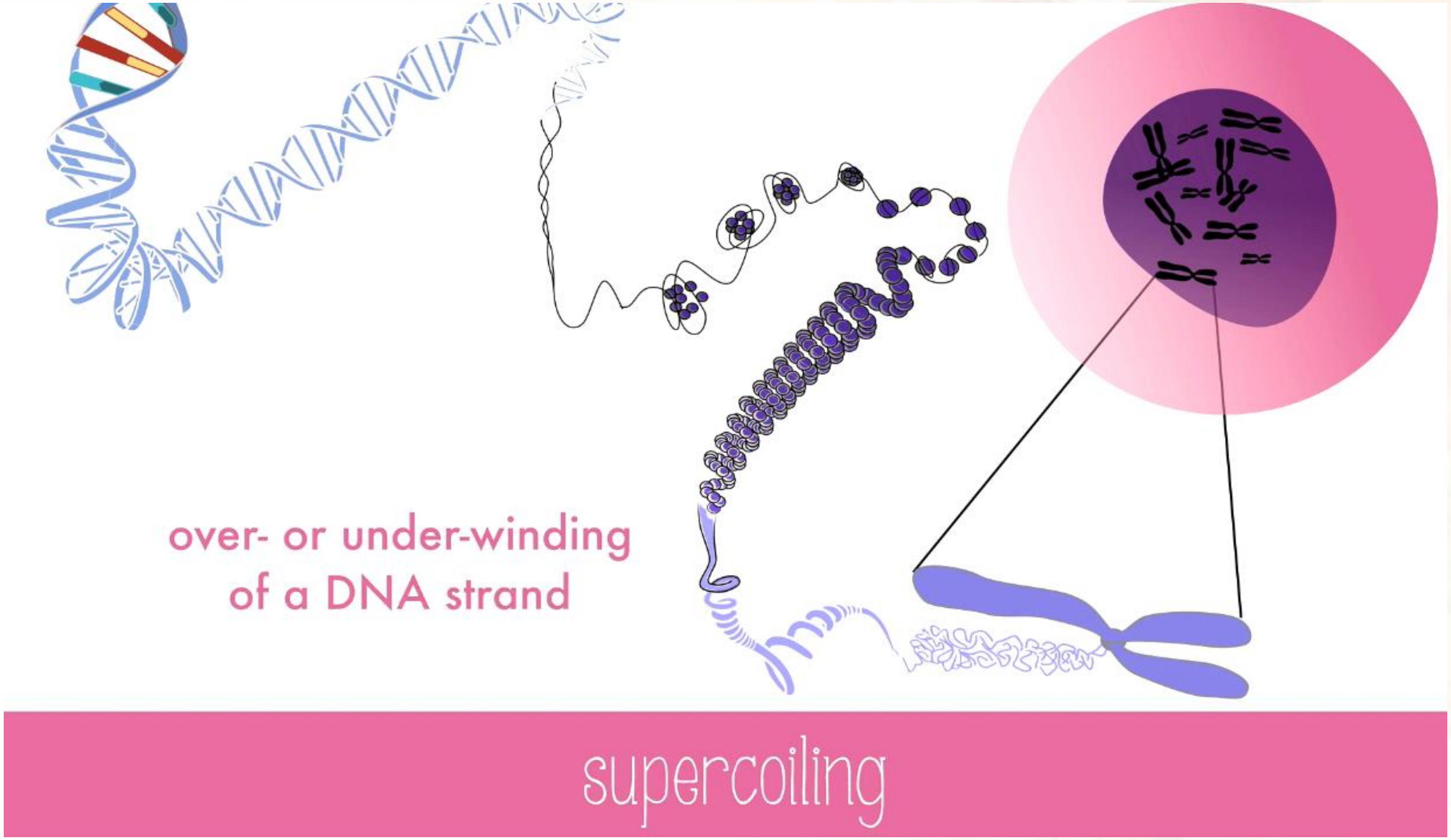
Photo 51

So what's the difference ?

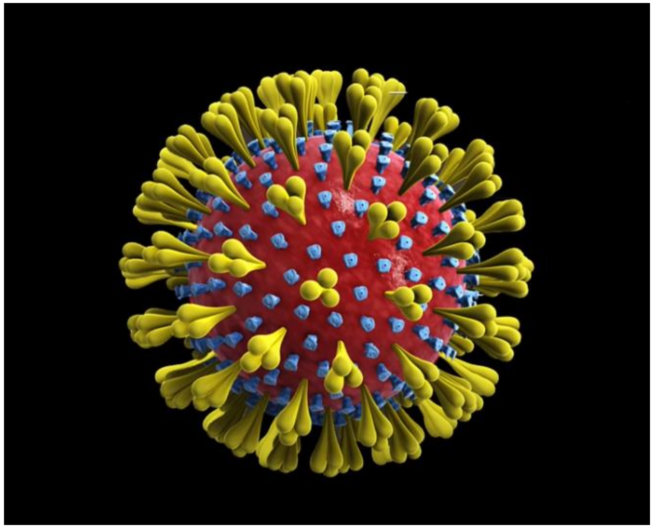




Let's Coil!

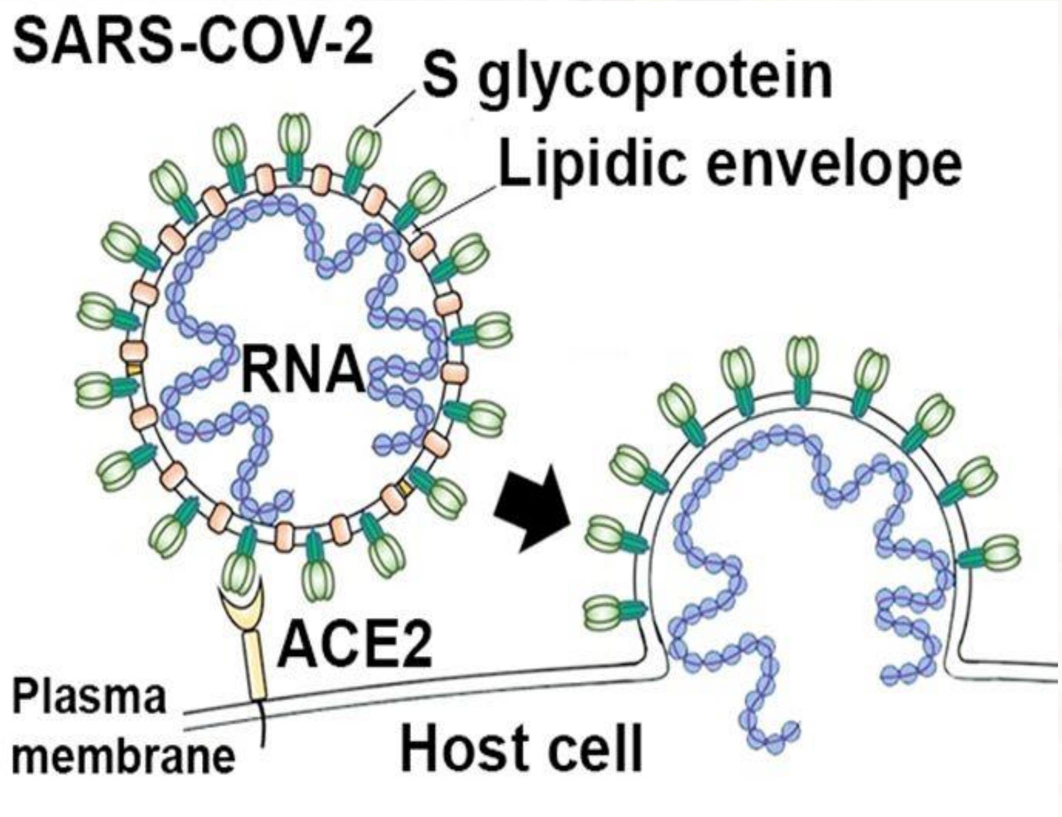


What role can crystallography play in the fight against covid-19



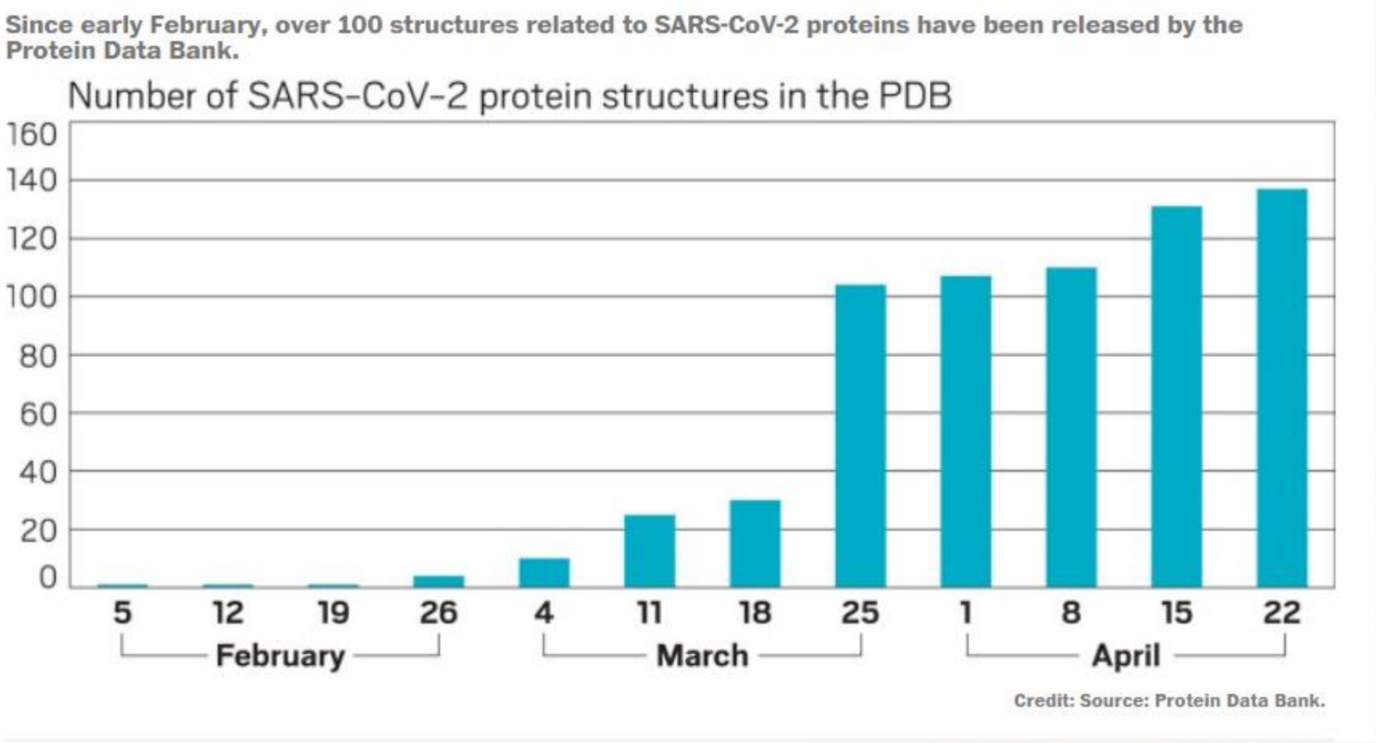
Virustructure

[3D-View(Click)]



Catch covid if you can

a surge in structures



Be hopeful

> I think things are moving at a very, very fast pace.
>
> – *Ian A. Wilson, professor of structural biology, Scripps Research in California*

"We all want it to move as quickly as we can," Wilson says. "And I think things are moving at a very, very fast pace." But developing any kind of drug or vaccine from these efforts and getting it through all the necessary steps required for regulatory approval will take time

"Clearly, the whole world is looking for new entities at the moment," says Ian A. Wilson at Scripps Research in California, who is using X-ray crystallography to look for antibodies that bind to SARS-CoV-2's spike protein. Wilson's focus since the 1980s has been using structural biology to develop universal vaccines for influenza and HIV.

Please protect yourself

We hope to meet you all at the university one day again.