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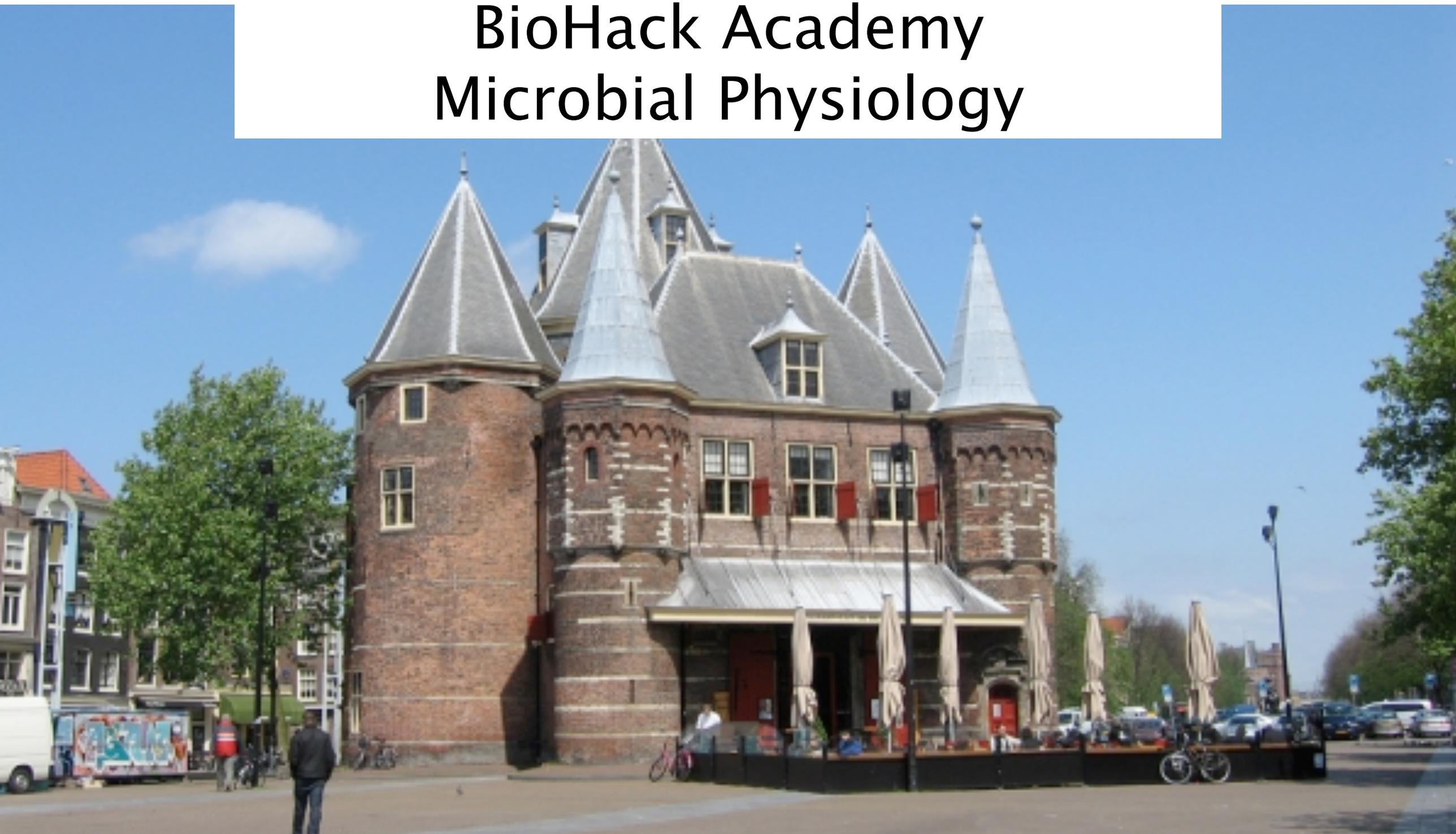
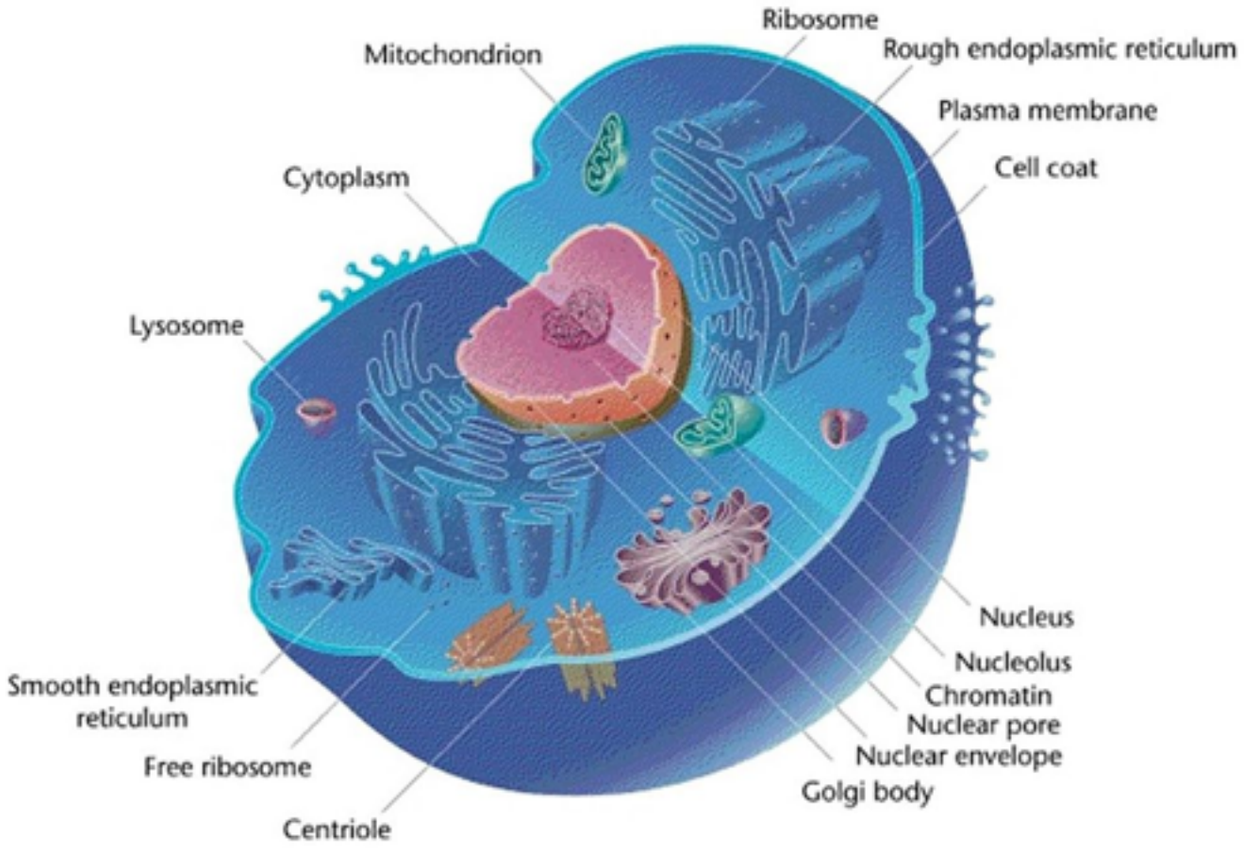
BioHack Academy
Microbial Physiology



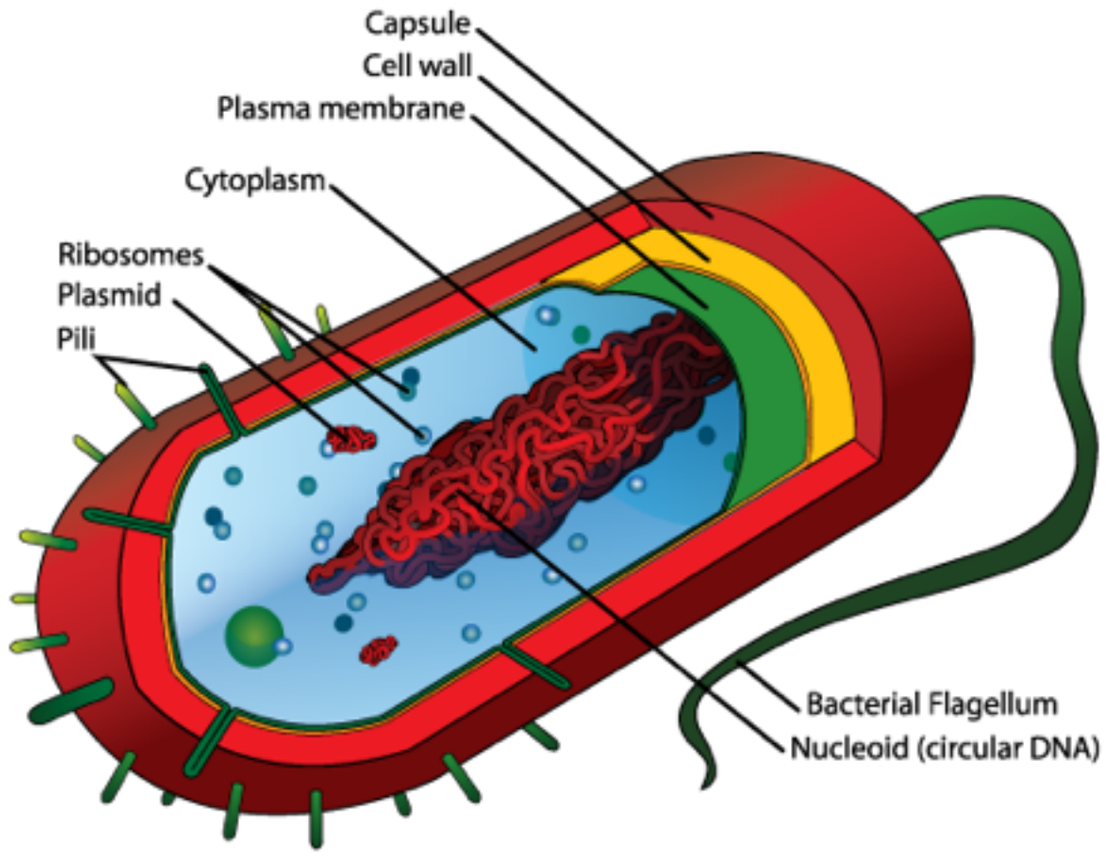
What are these comics made of?

Eukaryotic cell



Marion - CC-BY-SA 3.0

Prokaryotic cell



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The Cell

Life is made out of cells

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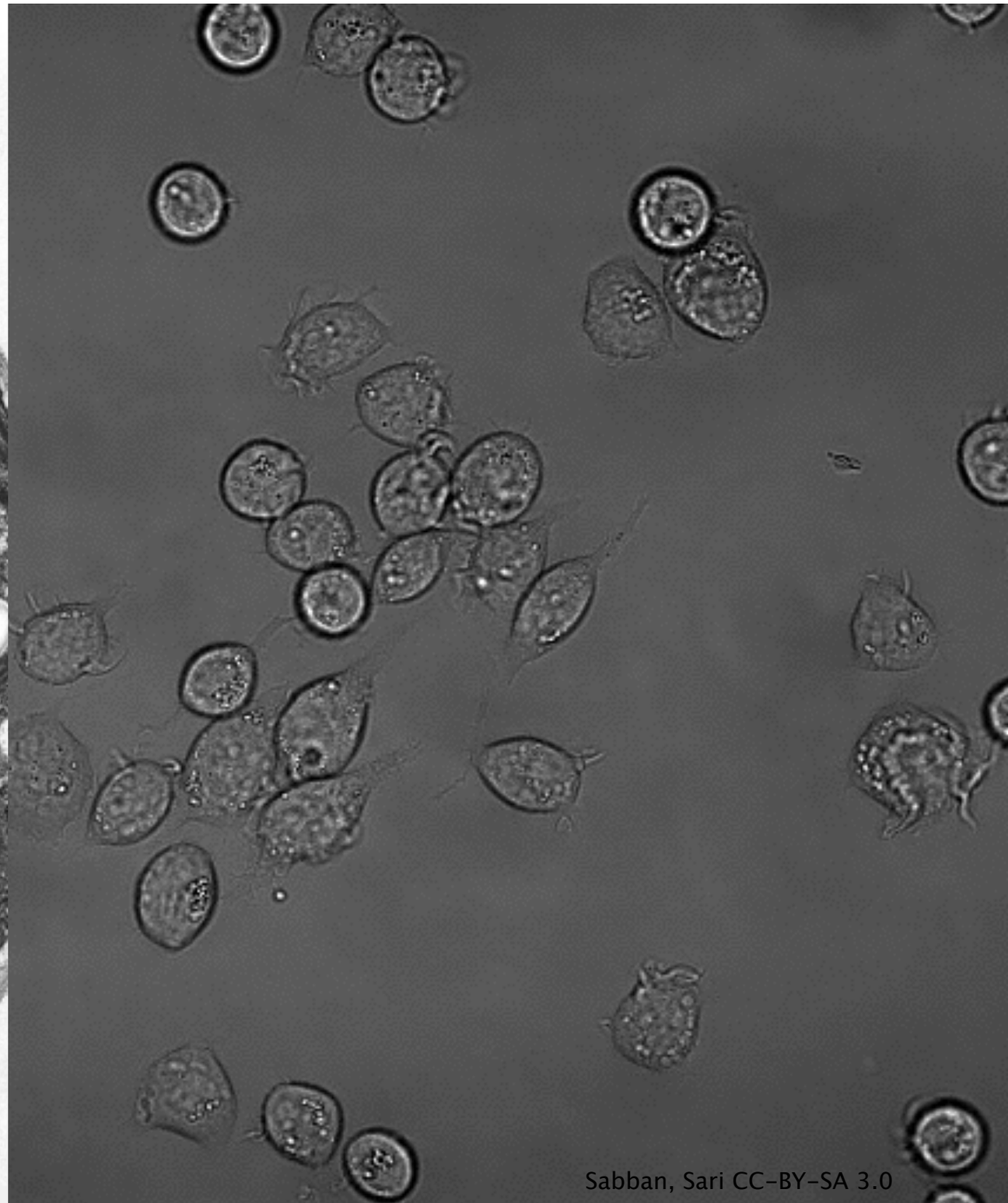
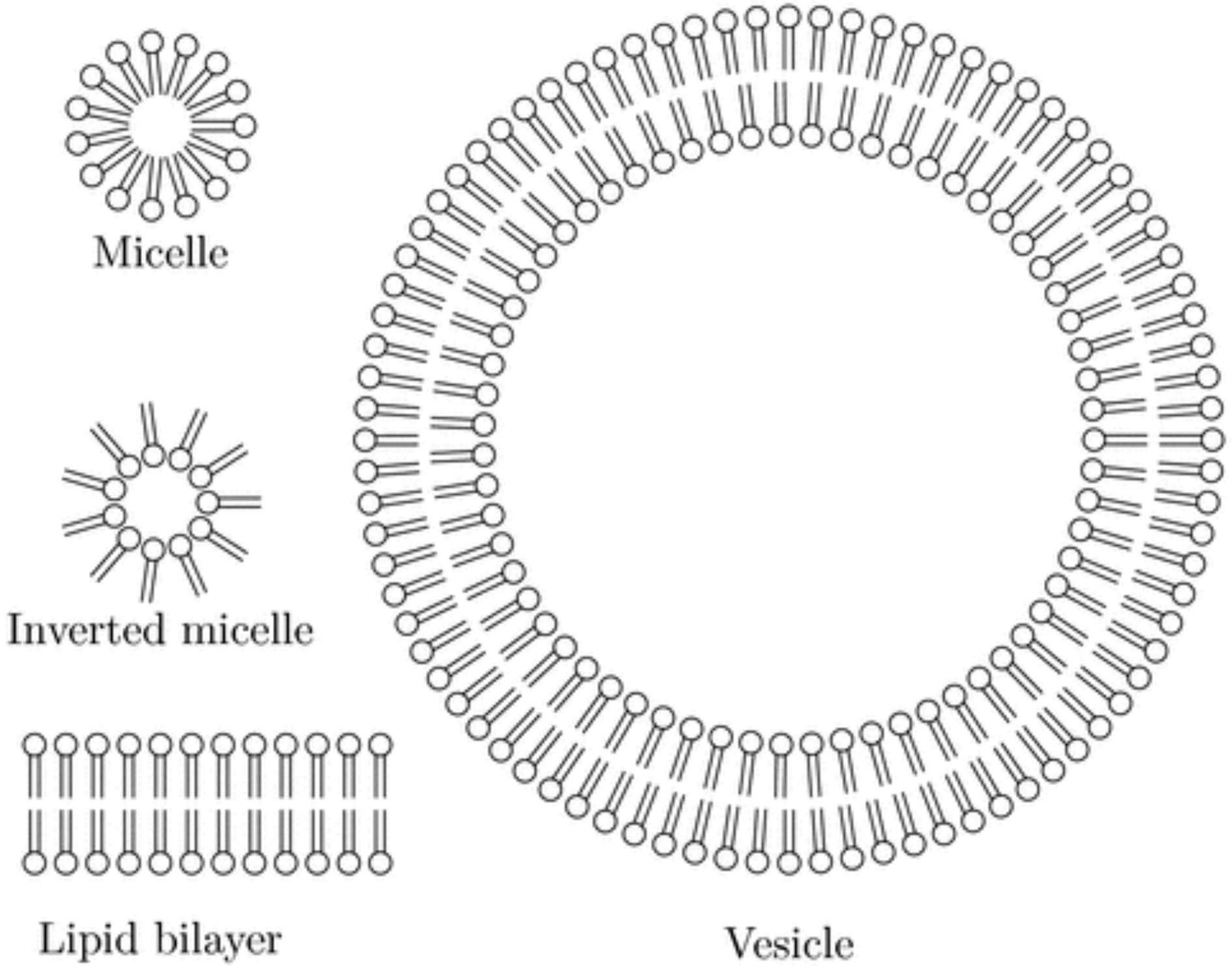


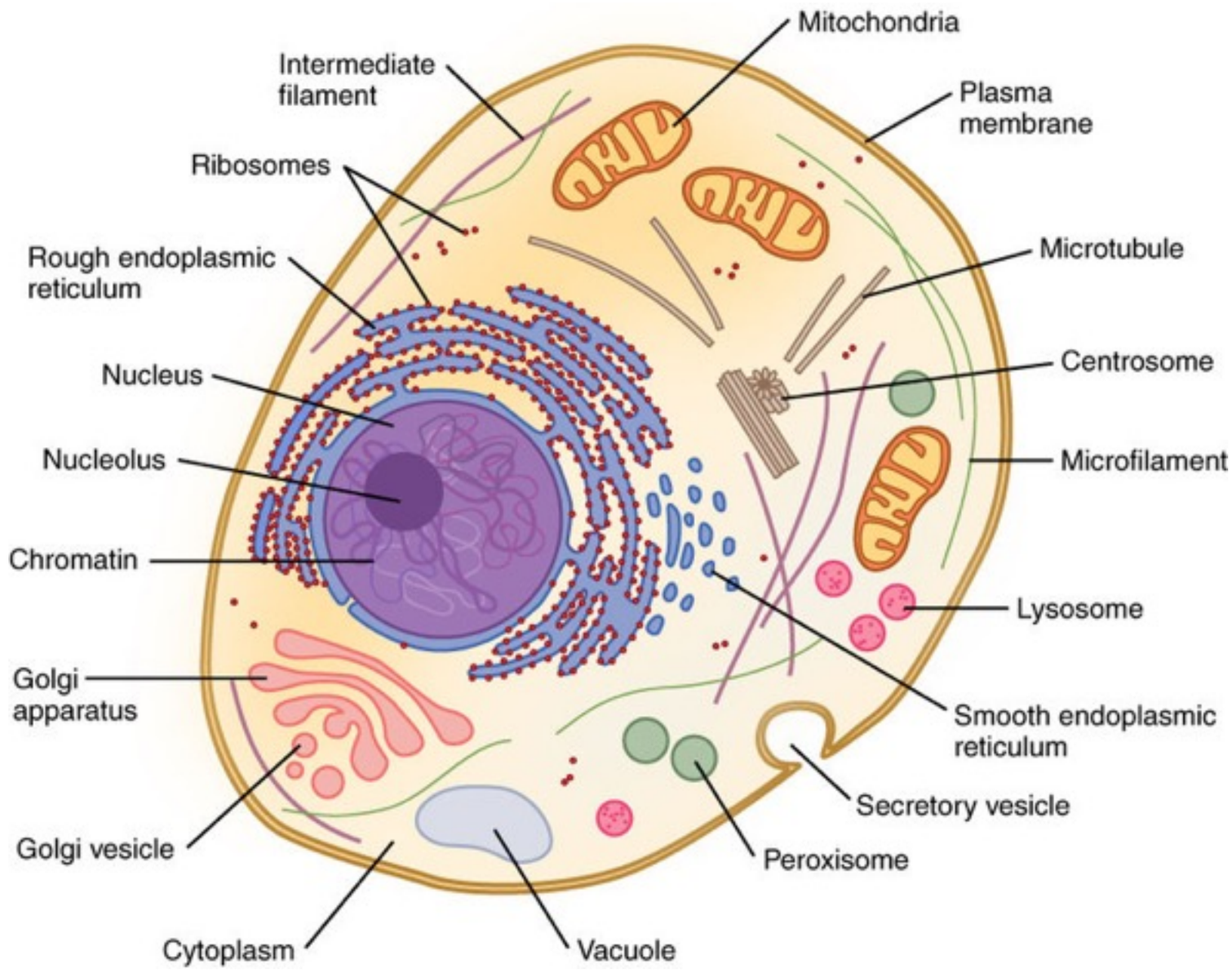
Sabban, Sari CC-BY-SA 3.0

Lipid bilayer cell



What's a cell made of:

- Lipids
- DNA
- RNA
- Proteins
- Metabolites
- Ions



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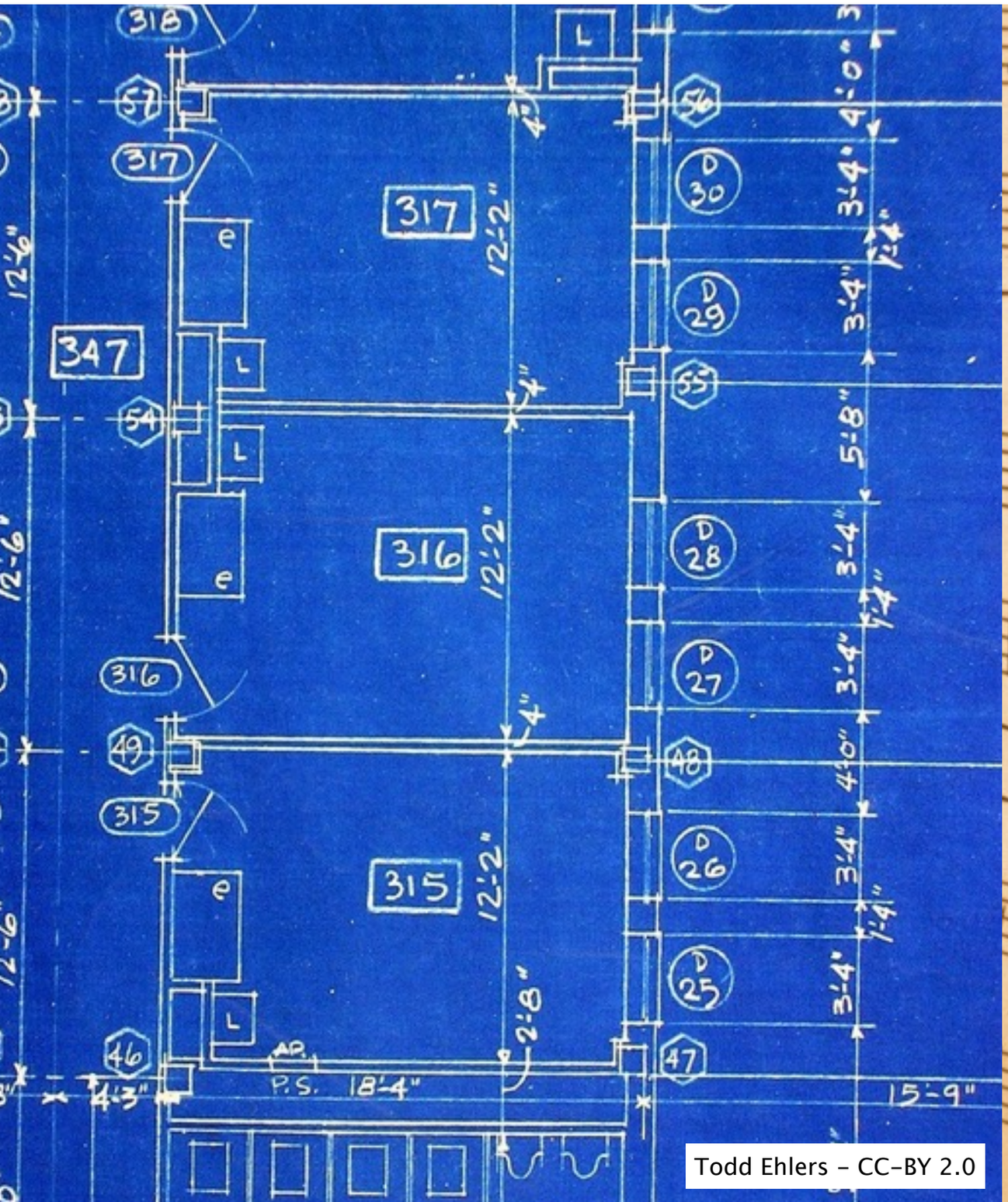
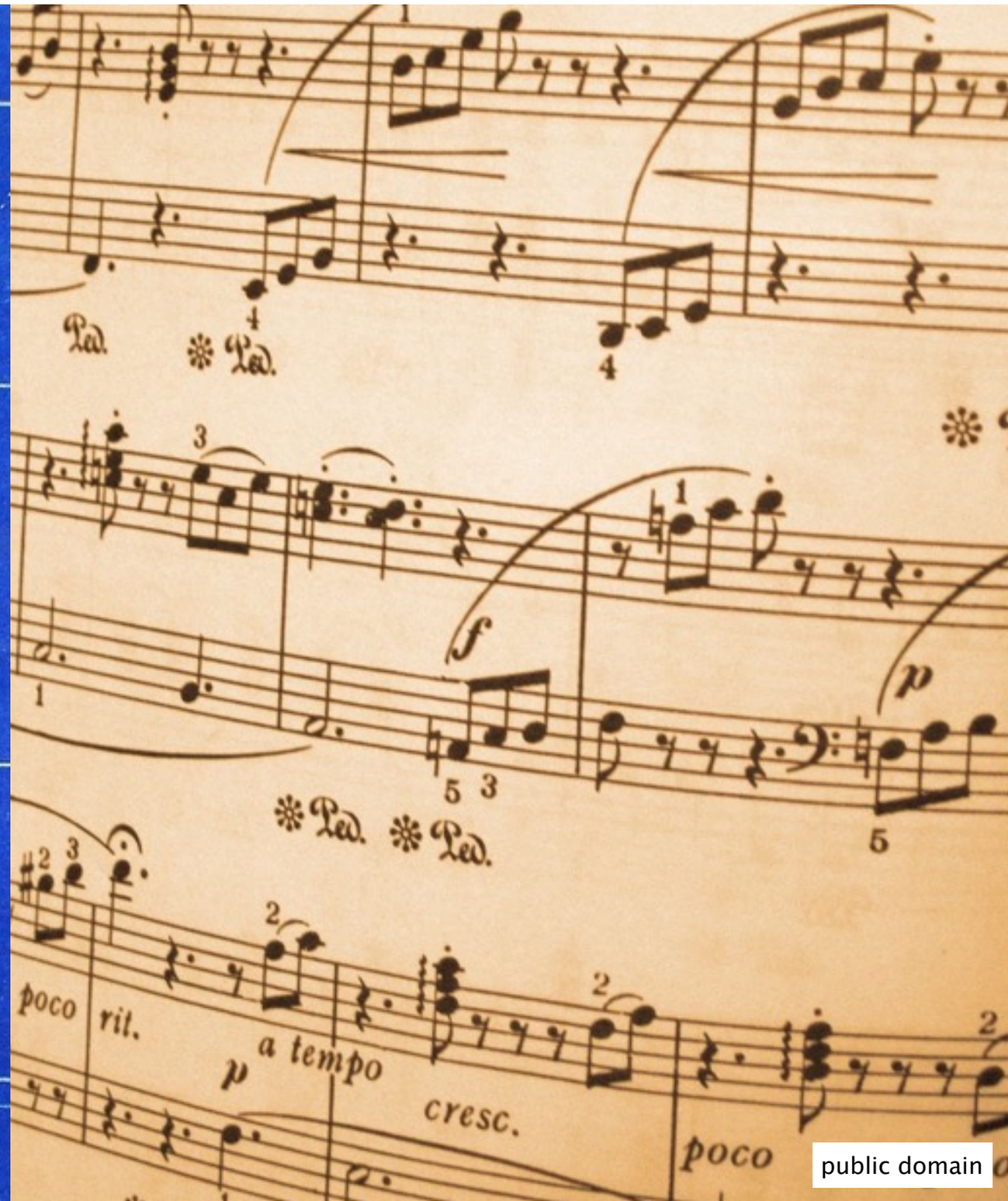
DNA & Chromosomes

Blueprint or music

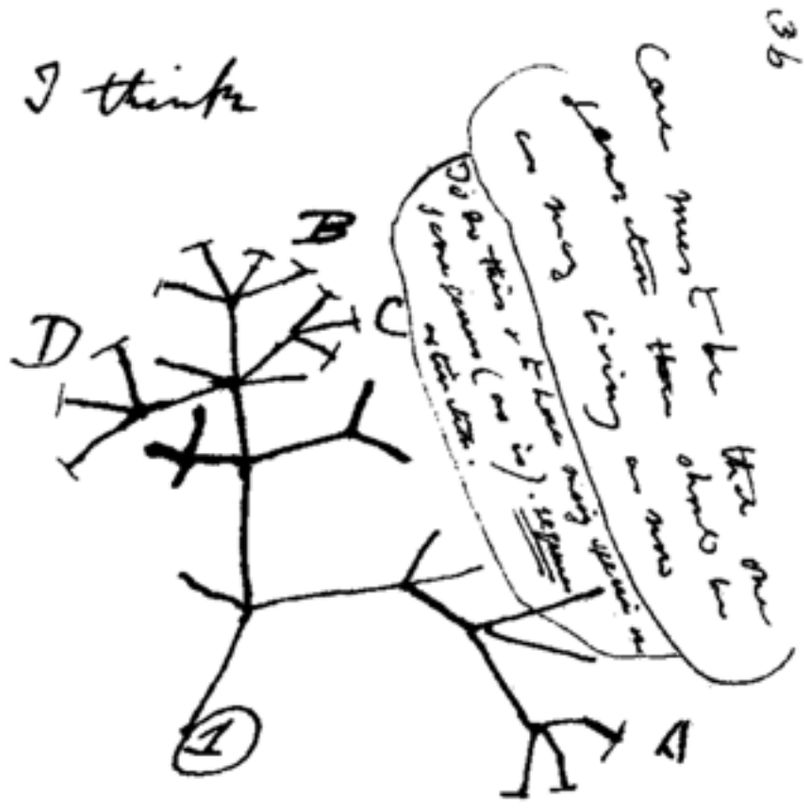


Todd Ehlers – CC-BY 2.0



public domain

Origin of Species



Then between A & B. Causing
loss of relation. C & B. The
first gradation, B & D
rather greater distinction
Then genera would be
formed. — Bearing relation

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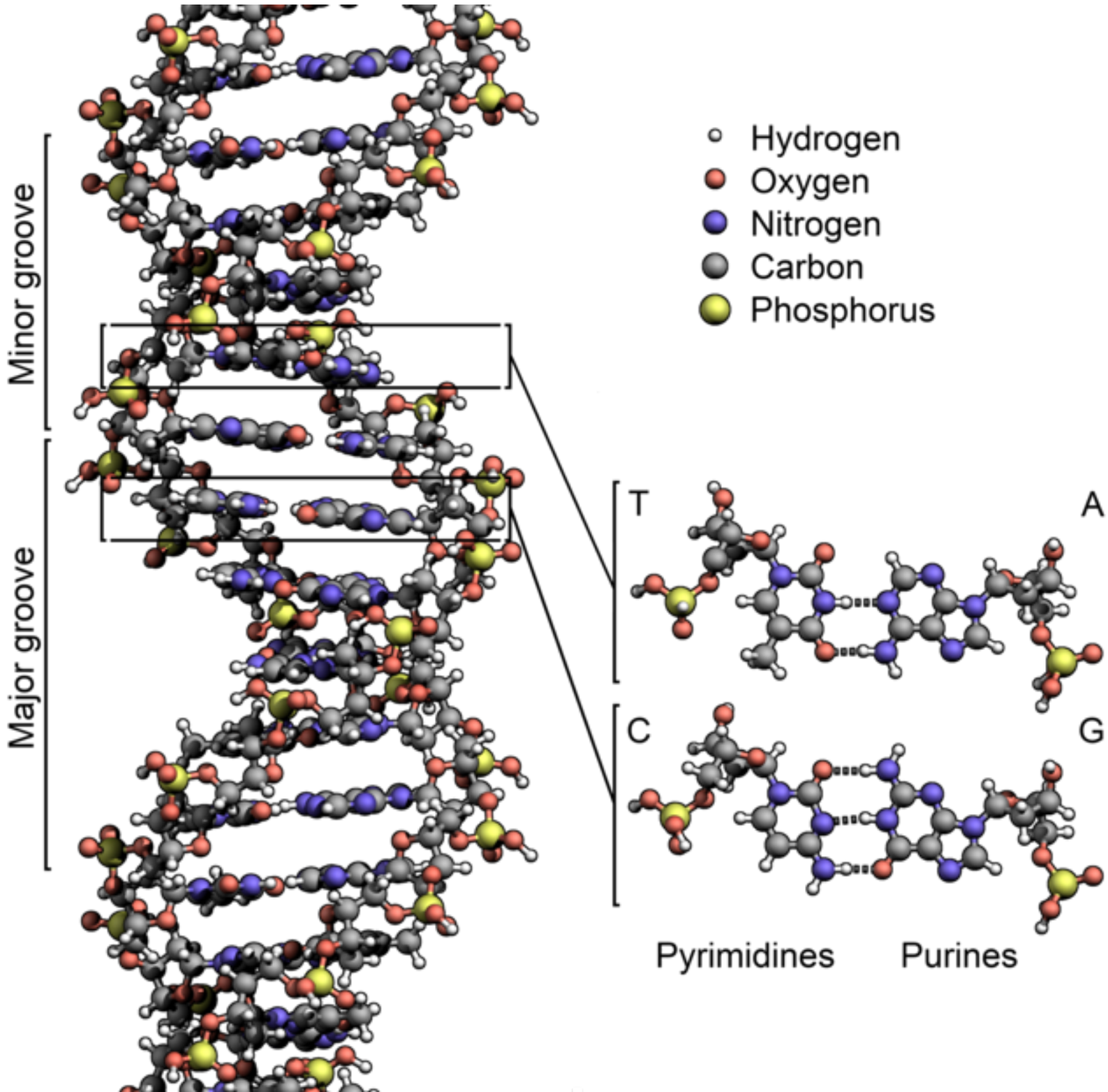
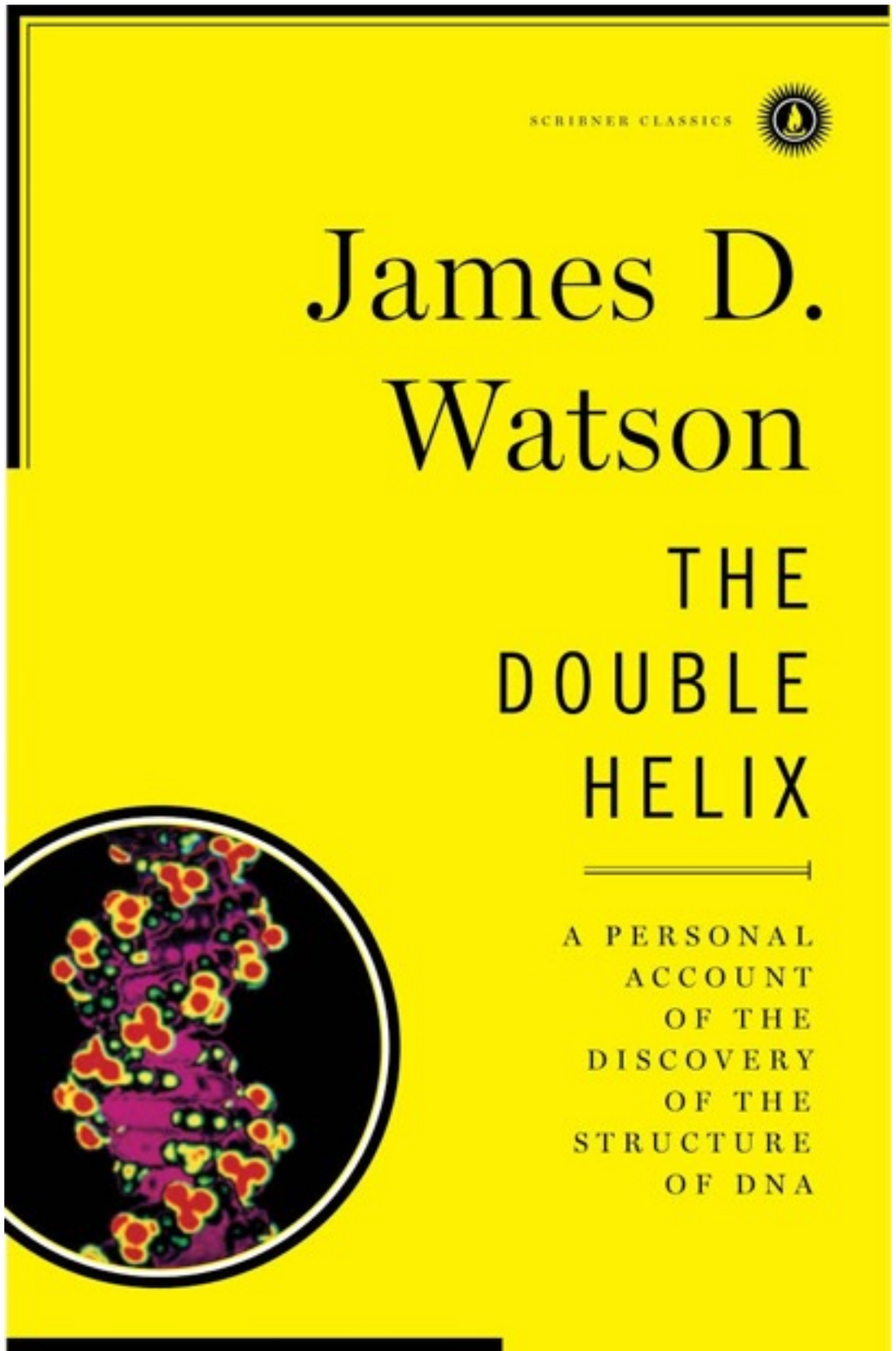
DNA Molecule



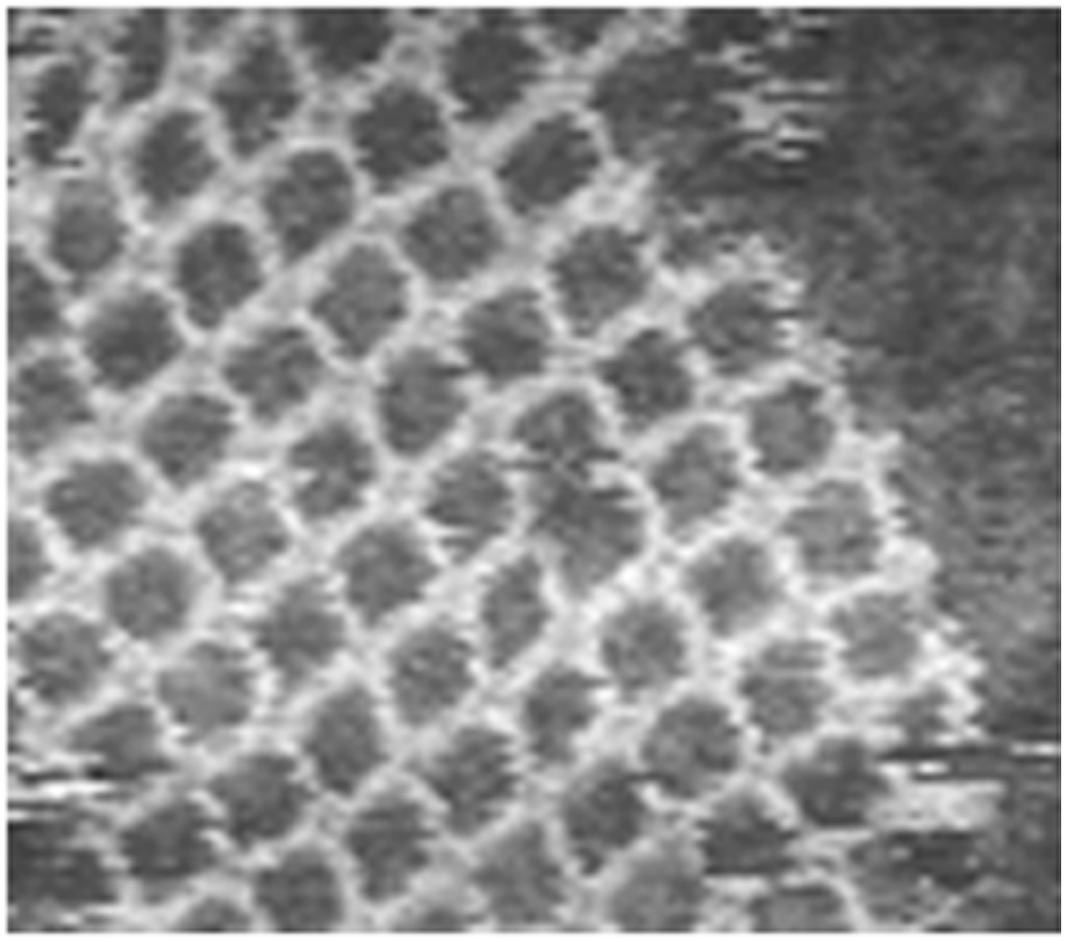
Discovery of the double helix



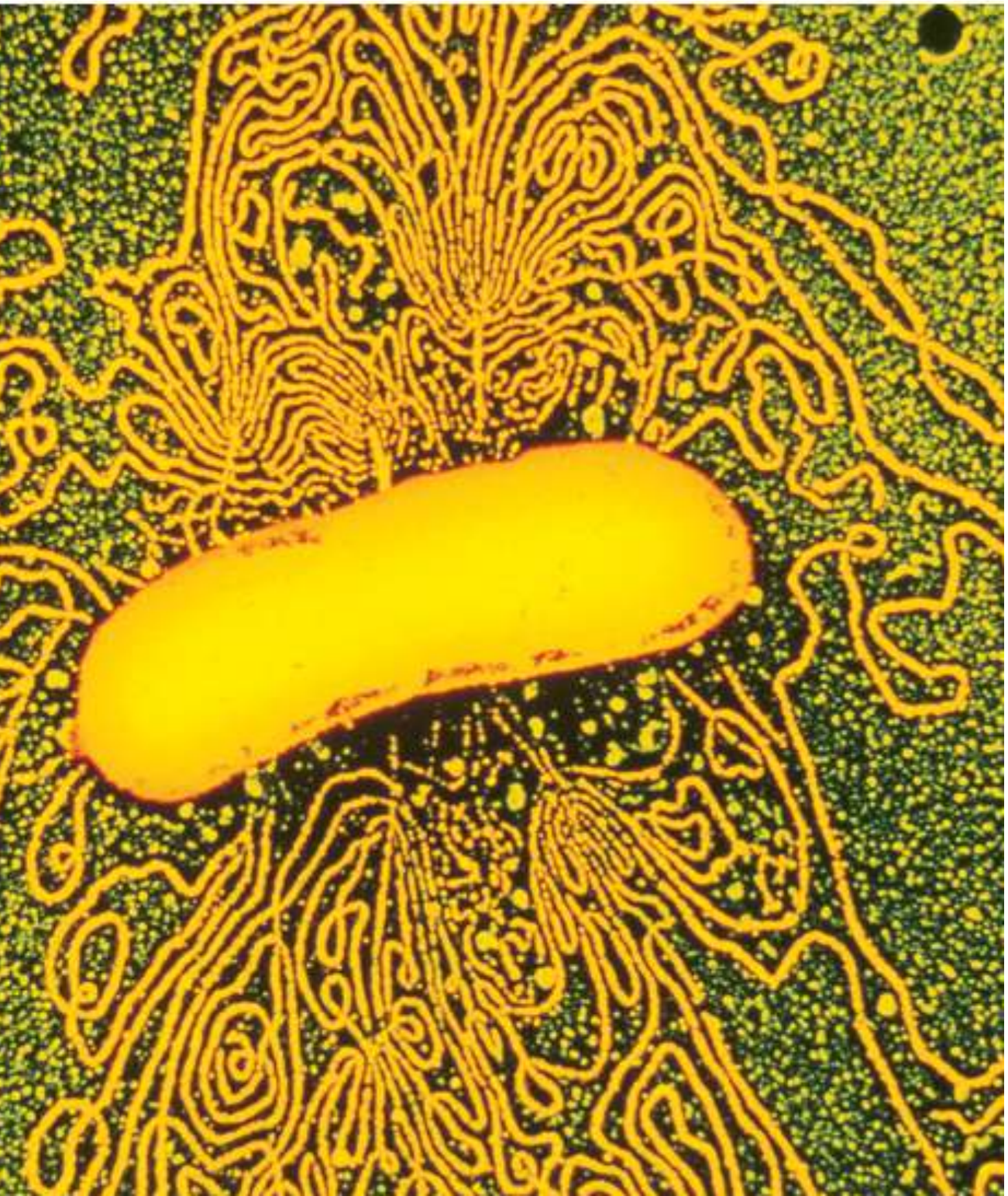
Alternative structures: DNA knitting

A

B



5,000 vs 25,000 genes



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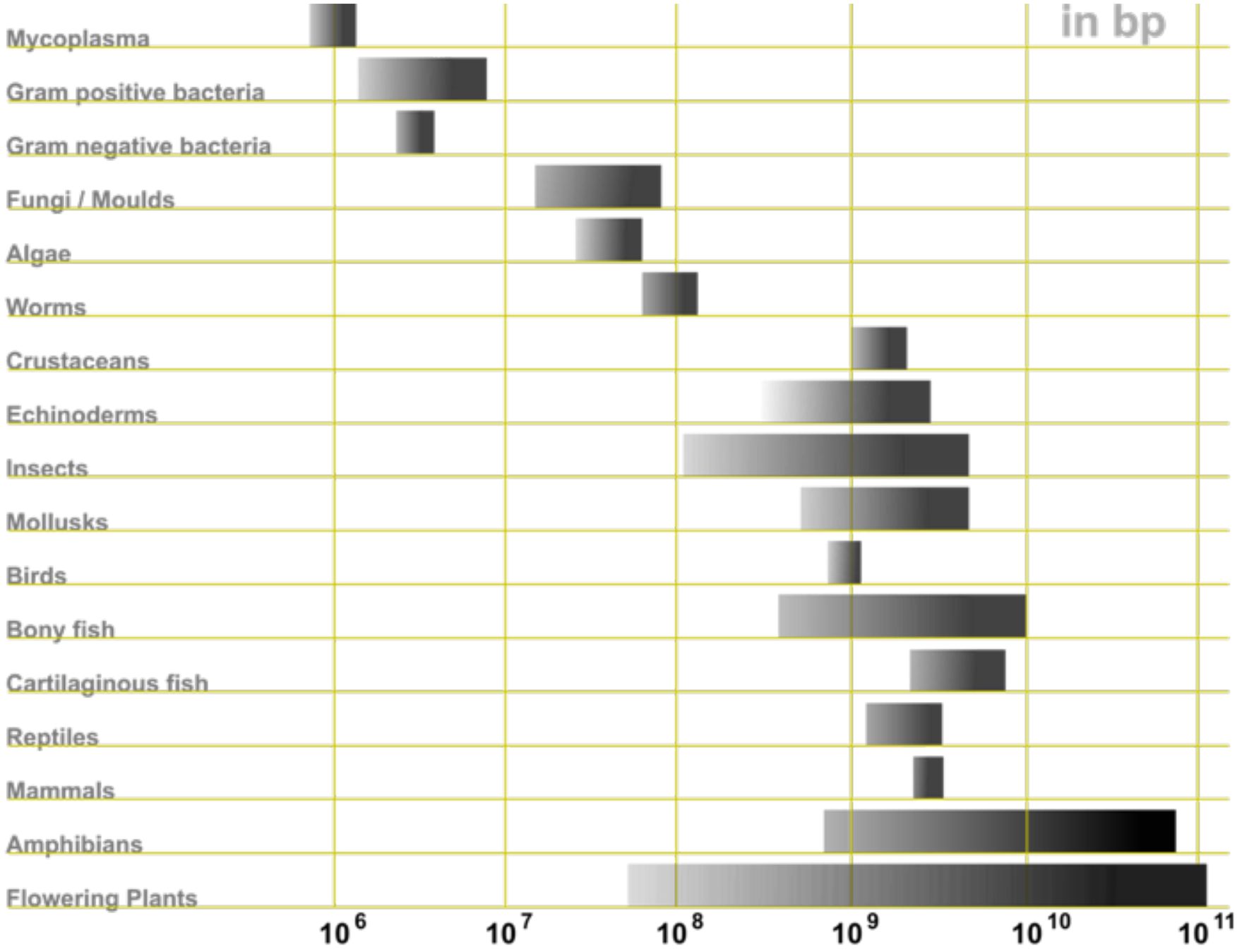
Genome size compared



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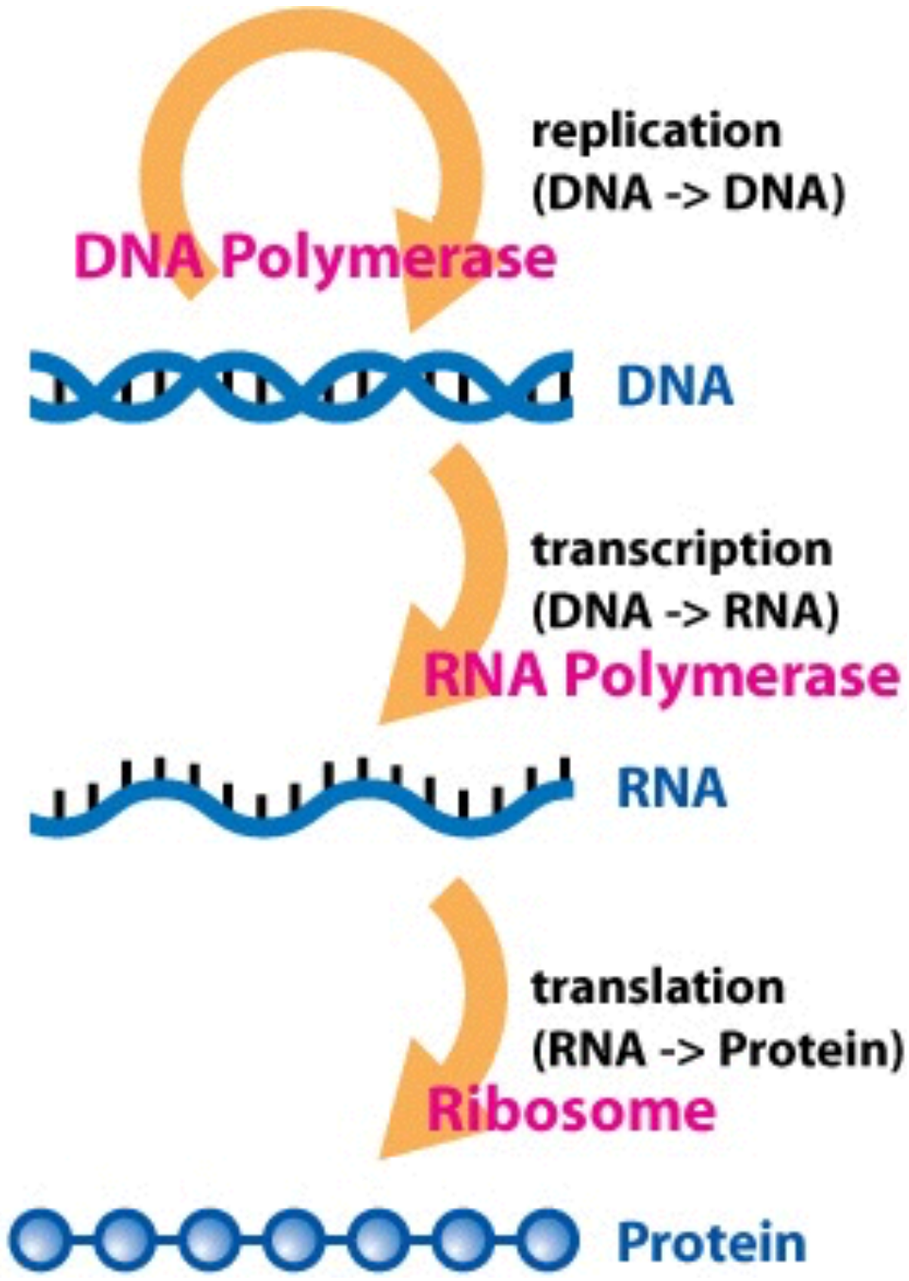
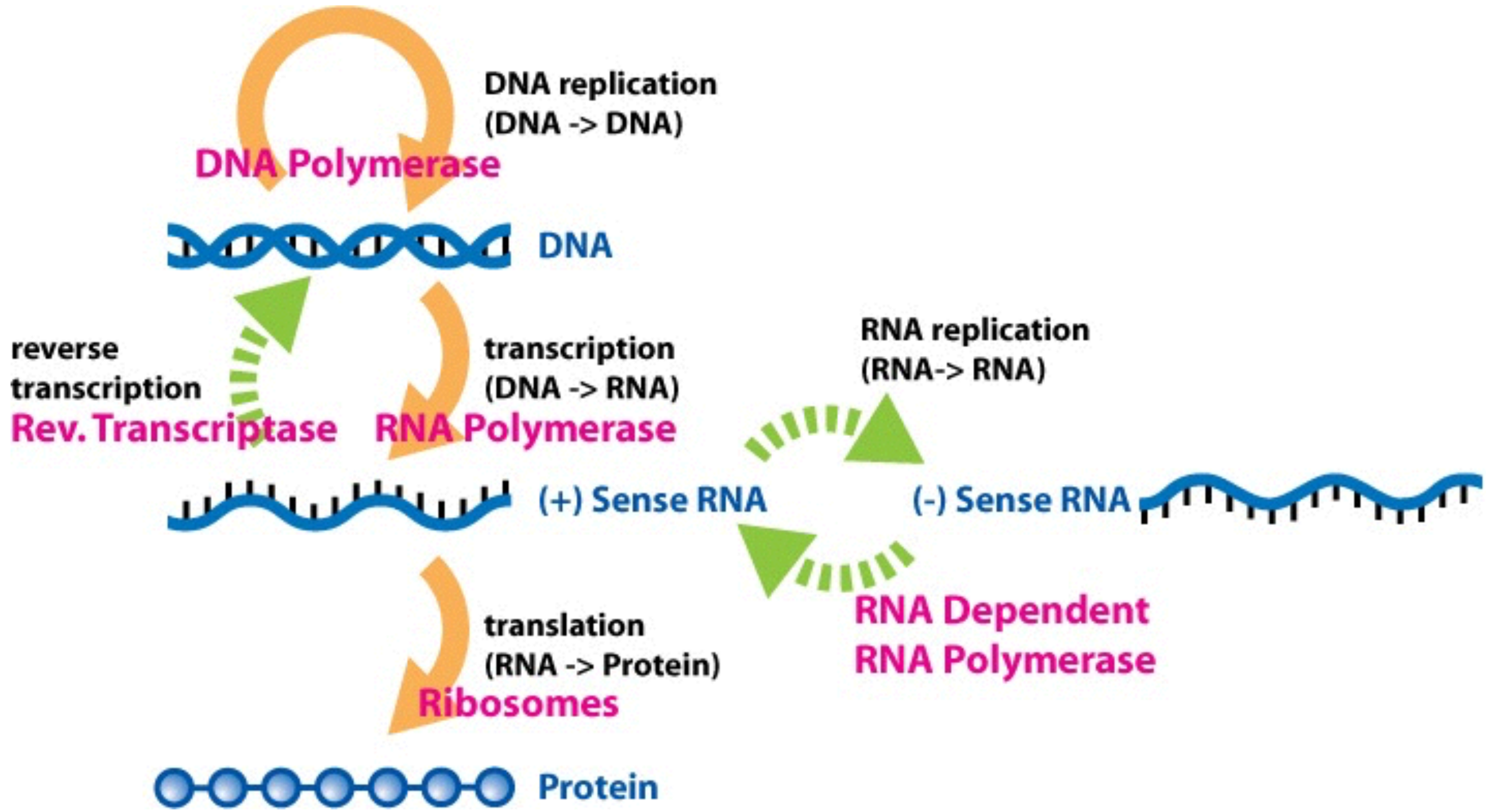
RNA

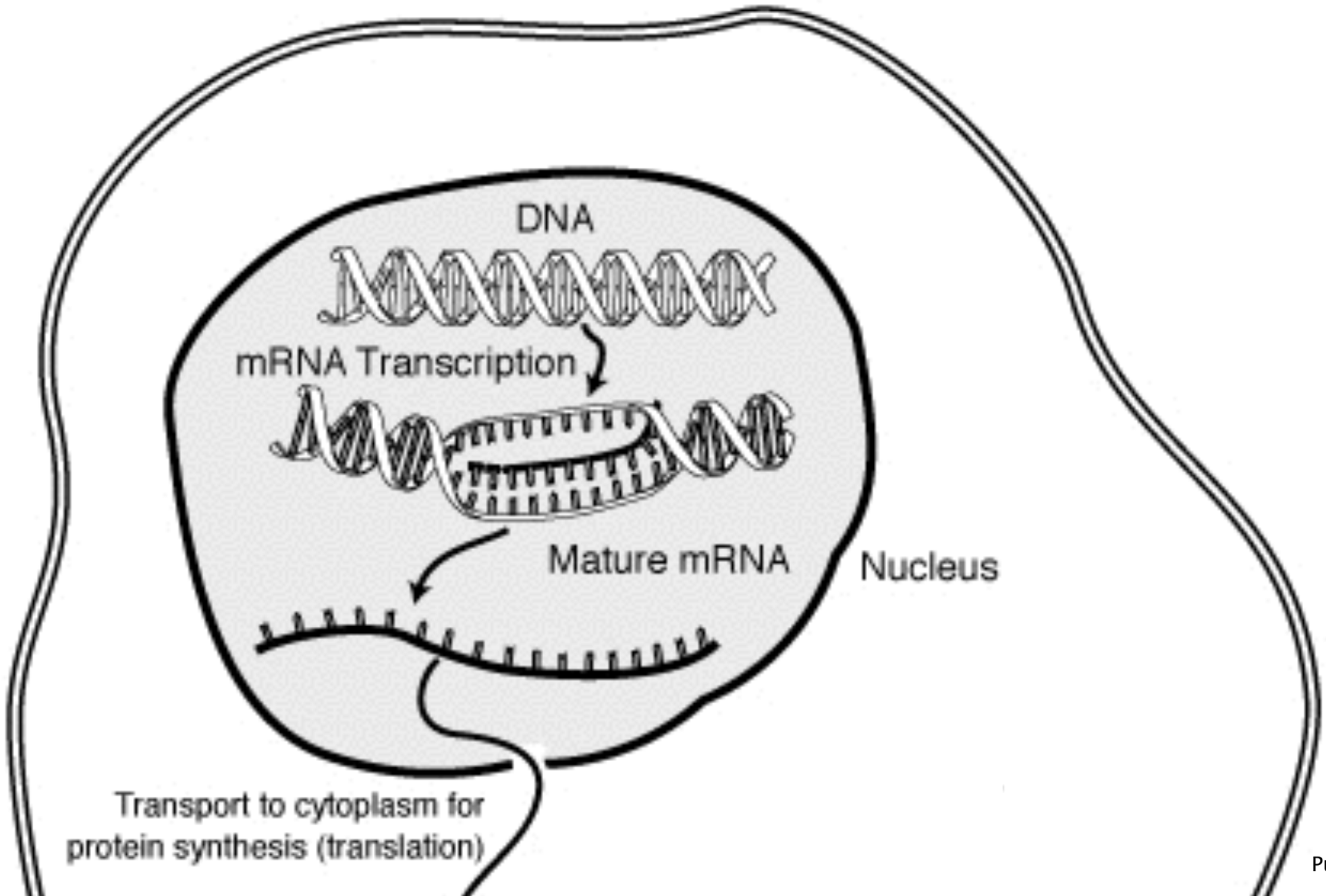
“Central Dogma”



“Central Dogma”



“Central Dogma” in the cell



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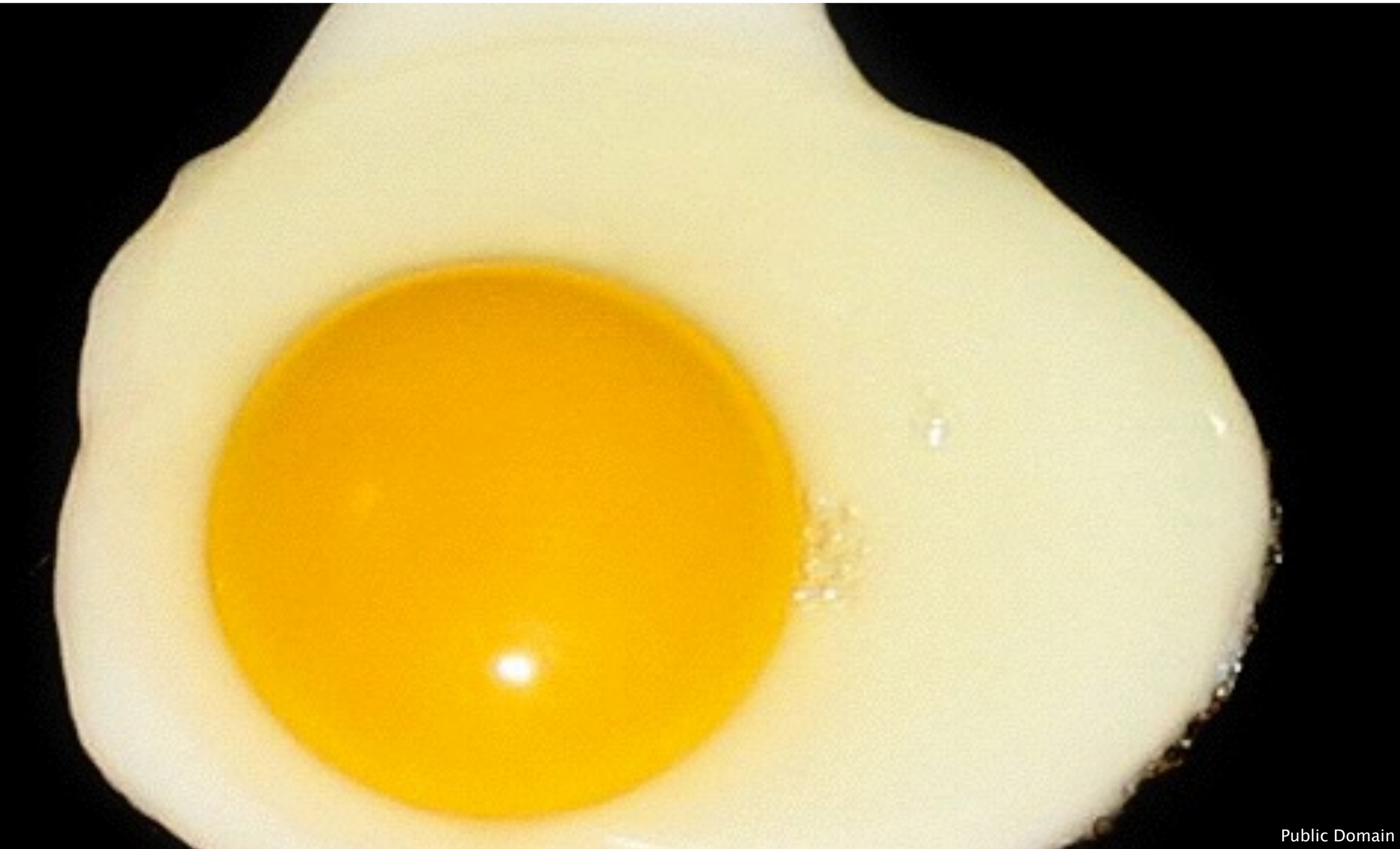
Proteins

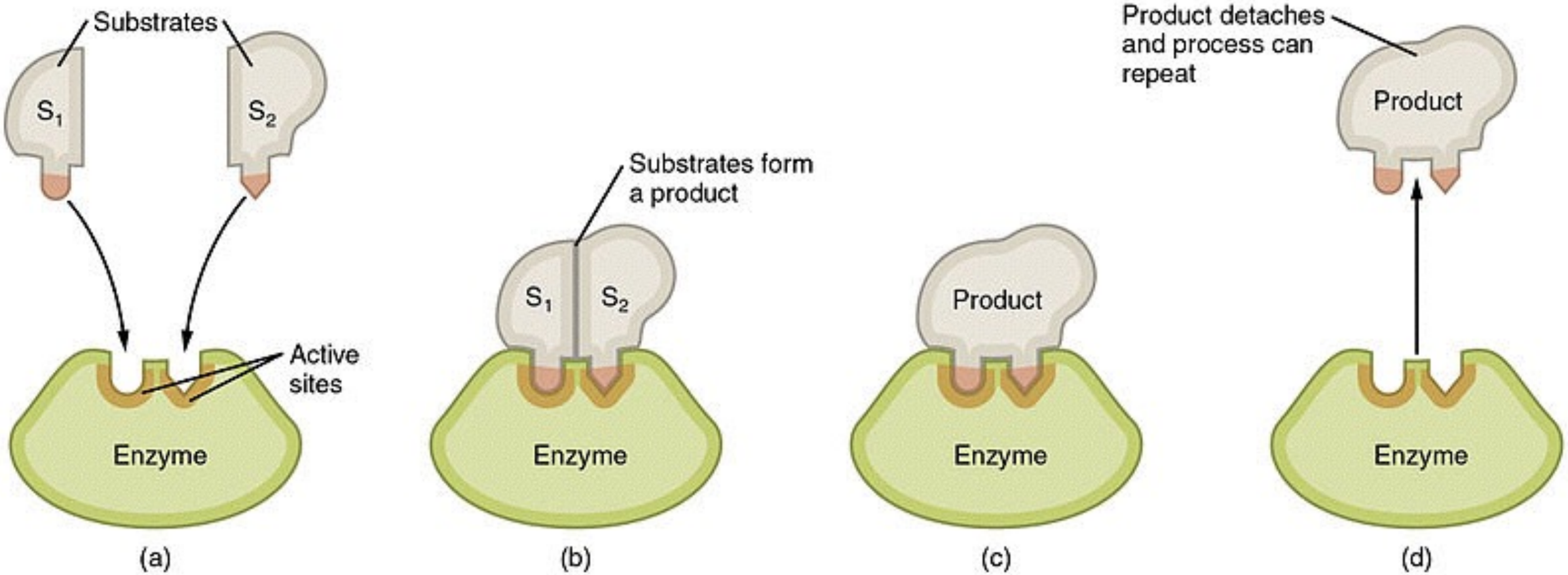
Proteins


whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
whey
Public Domain

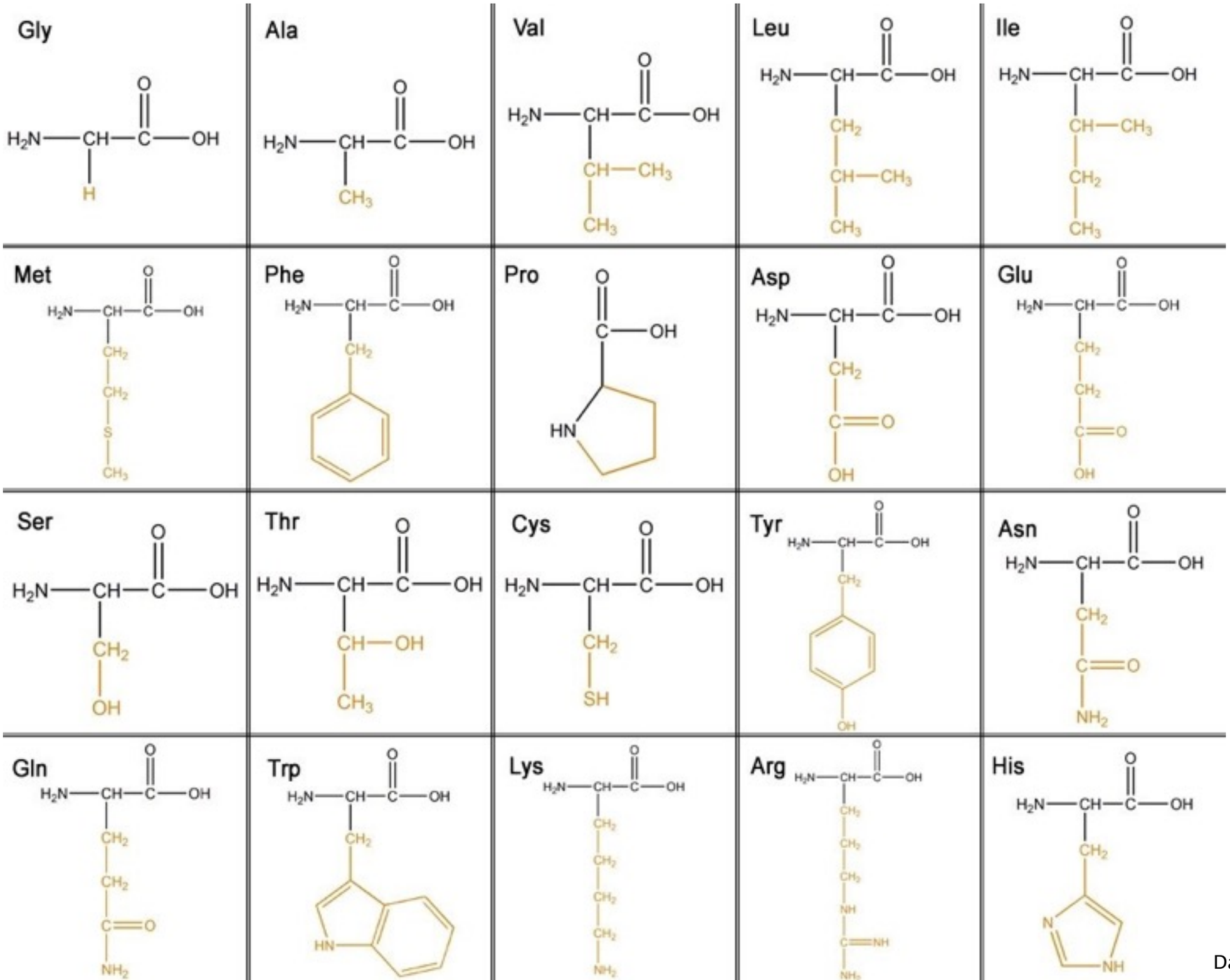
Egg white



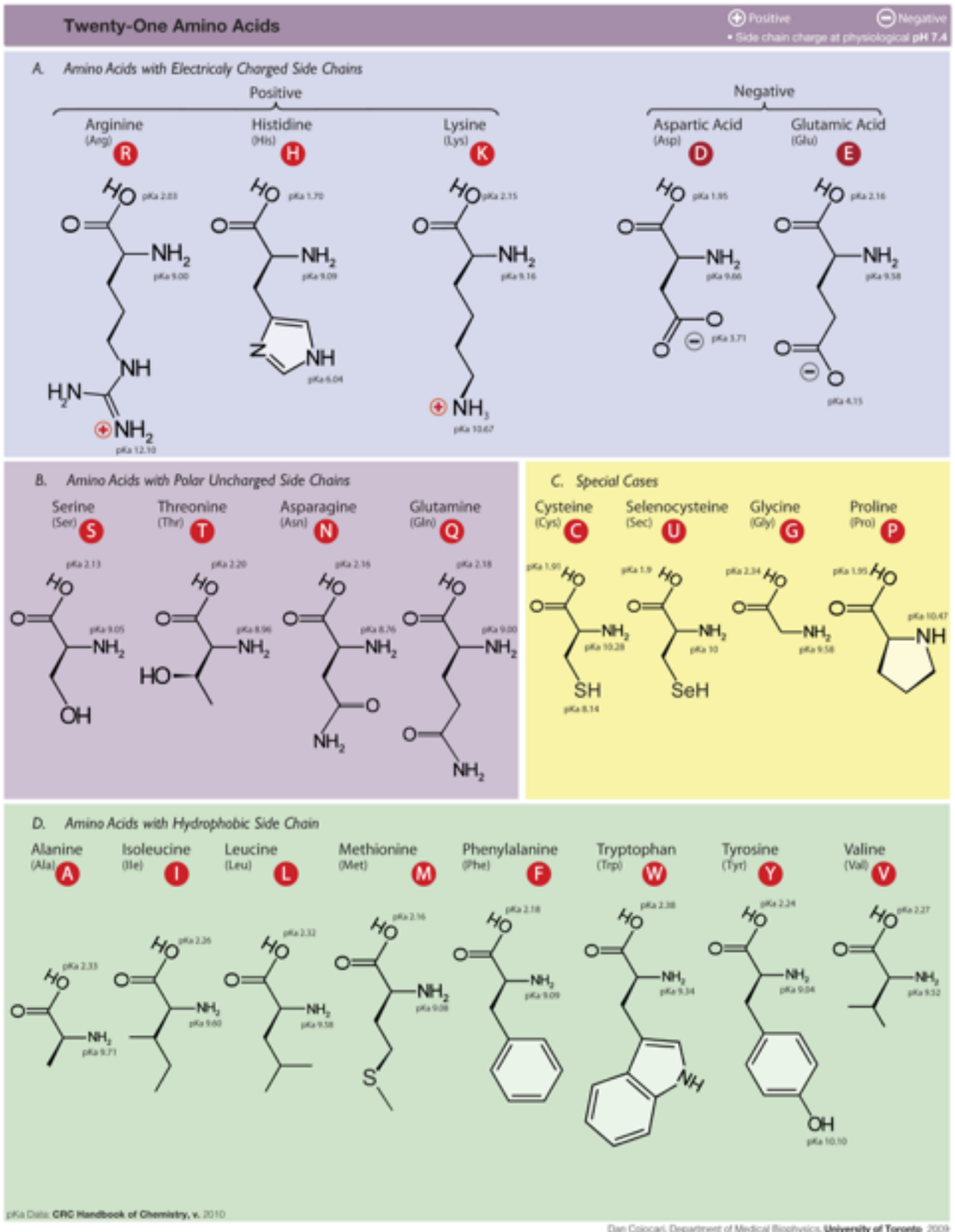
Some proteins are enzymes



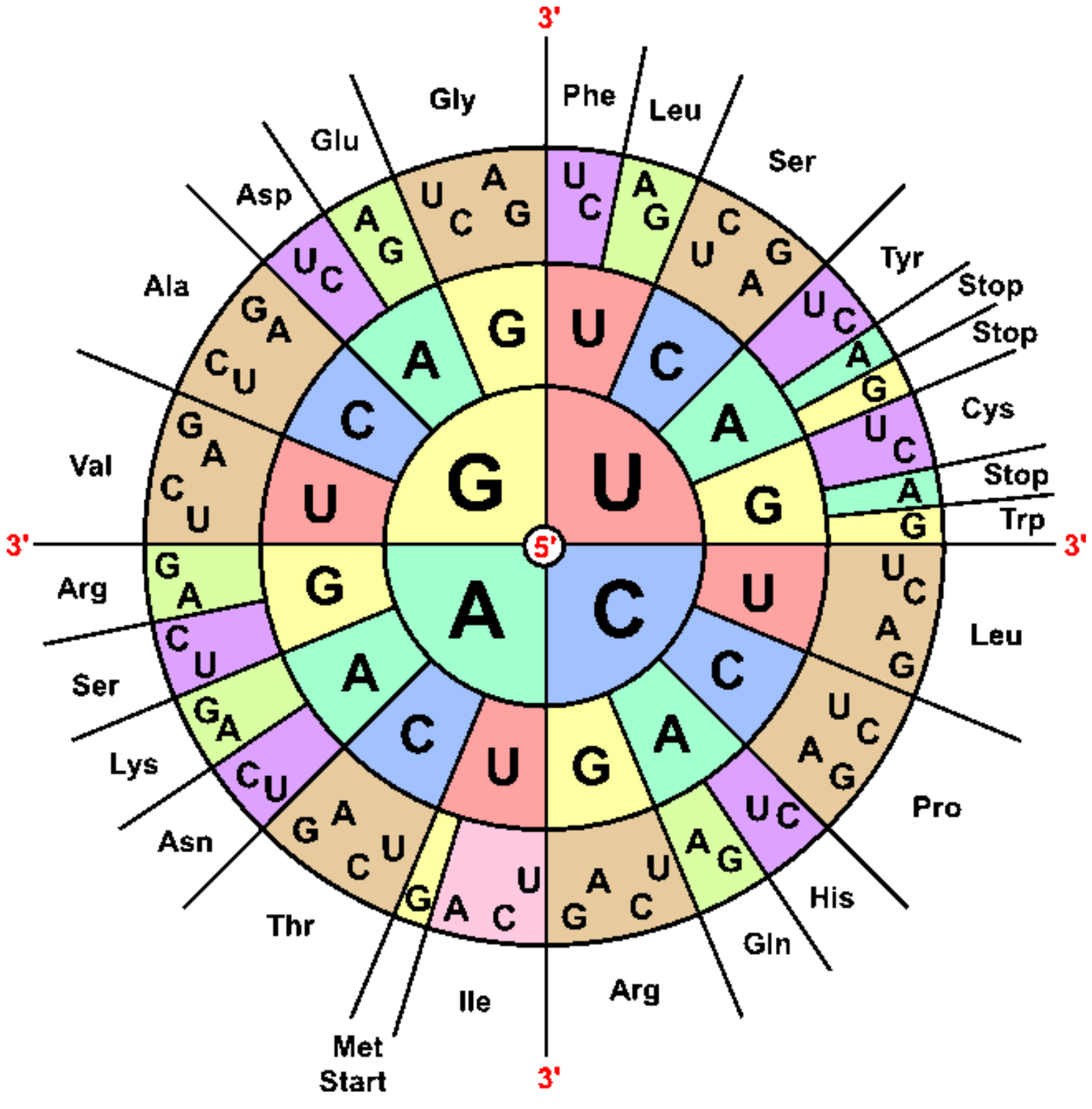
Amino acids, the building blocks



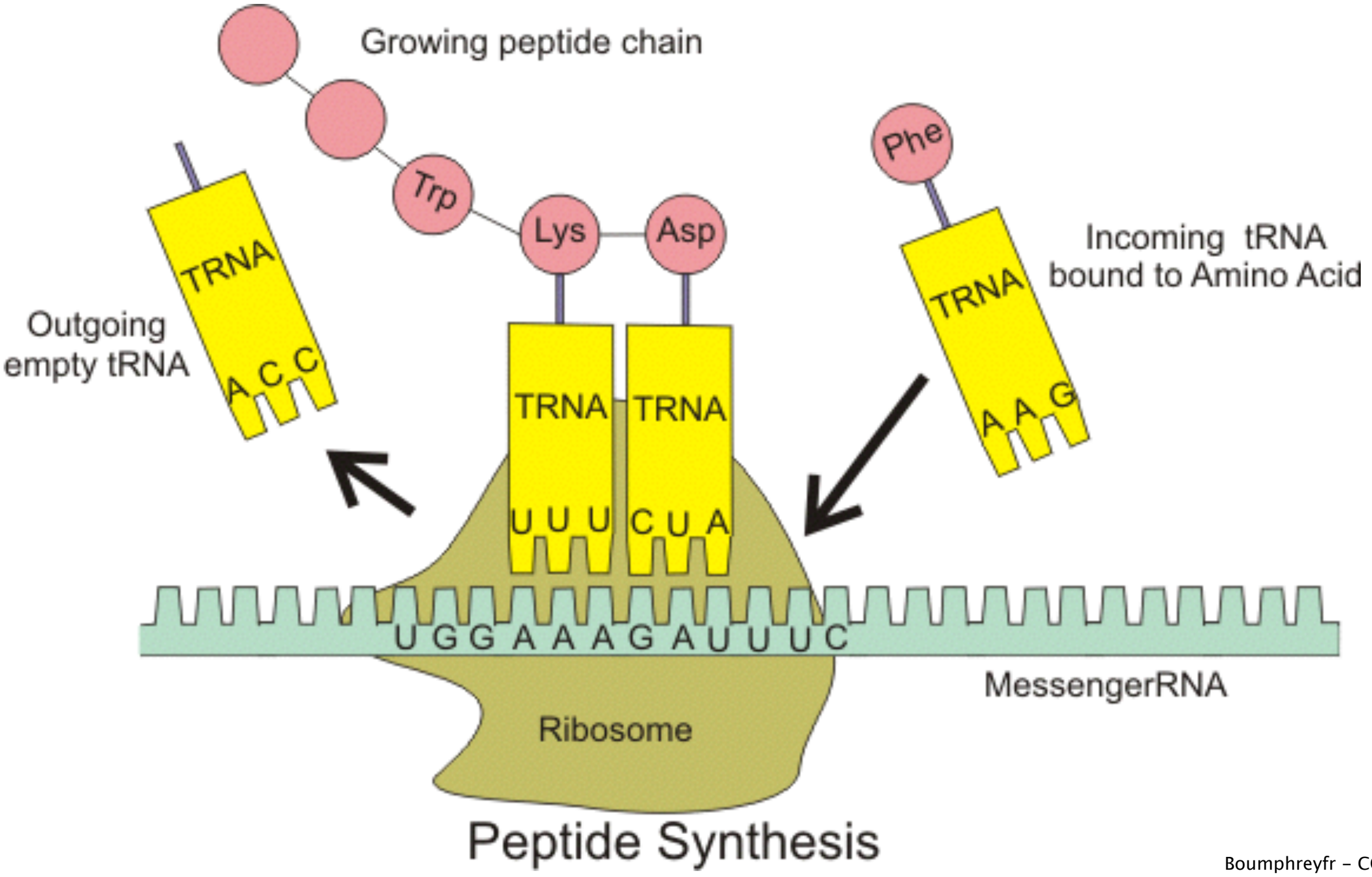
Amino acid groups



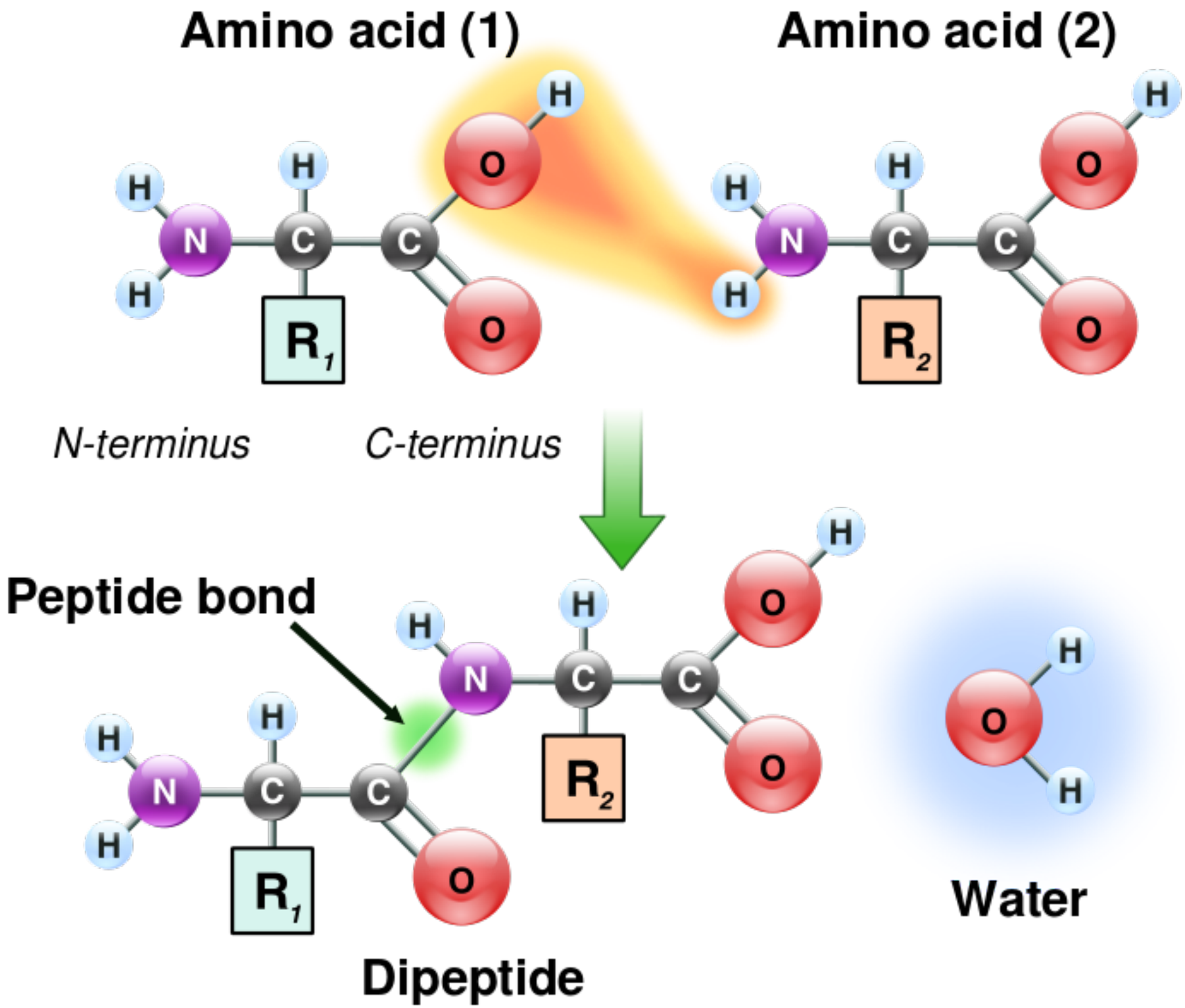
Amino acid rosetta stone



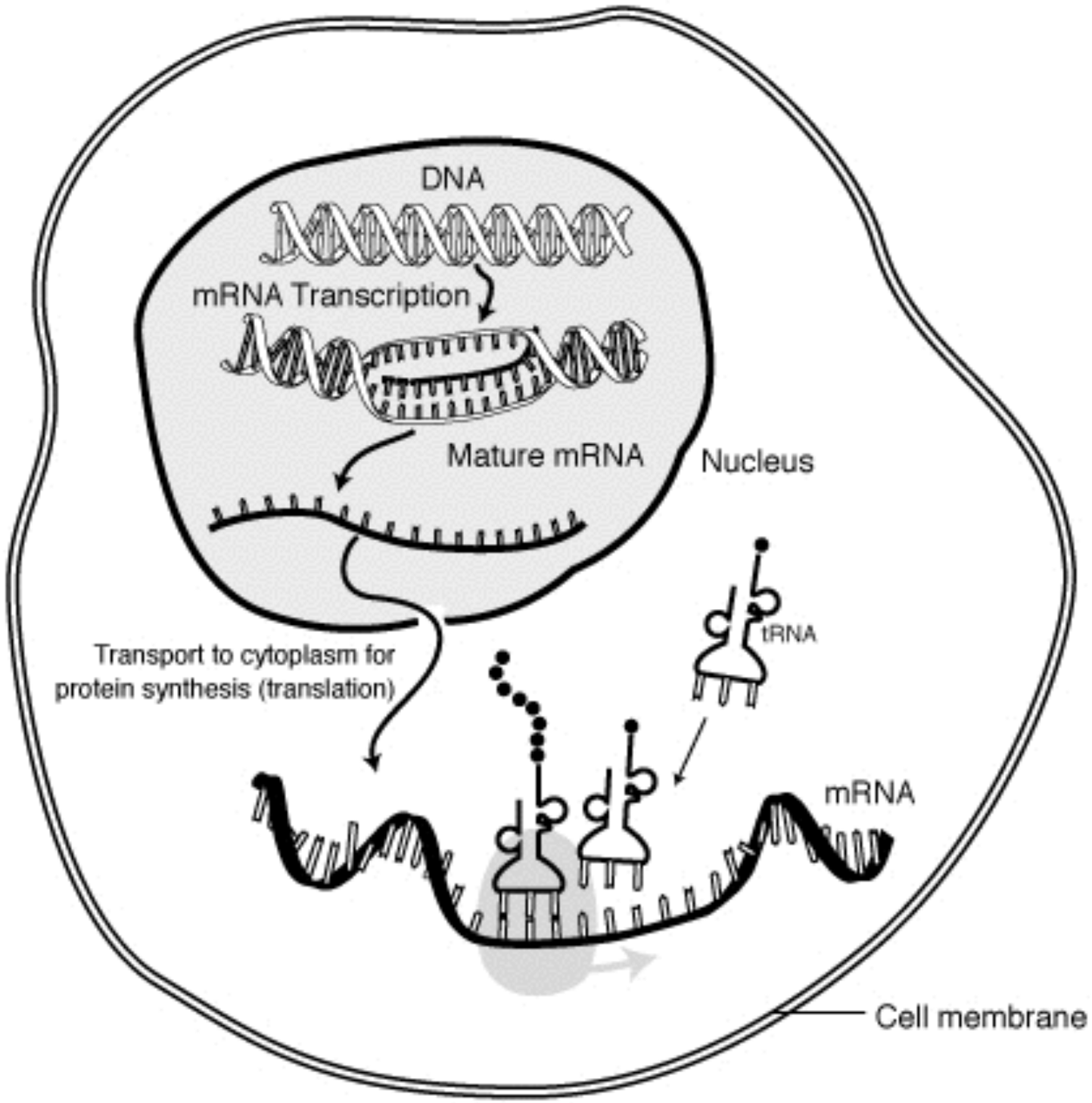
Ribosome



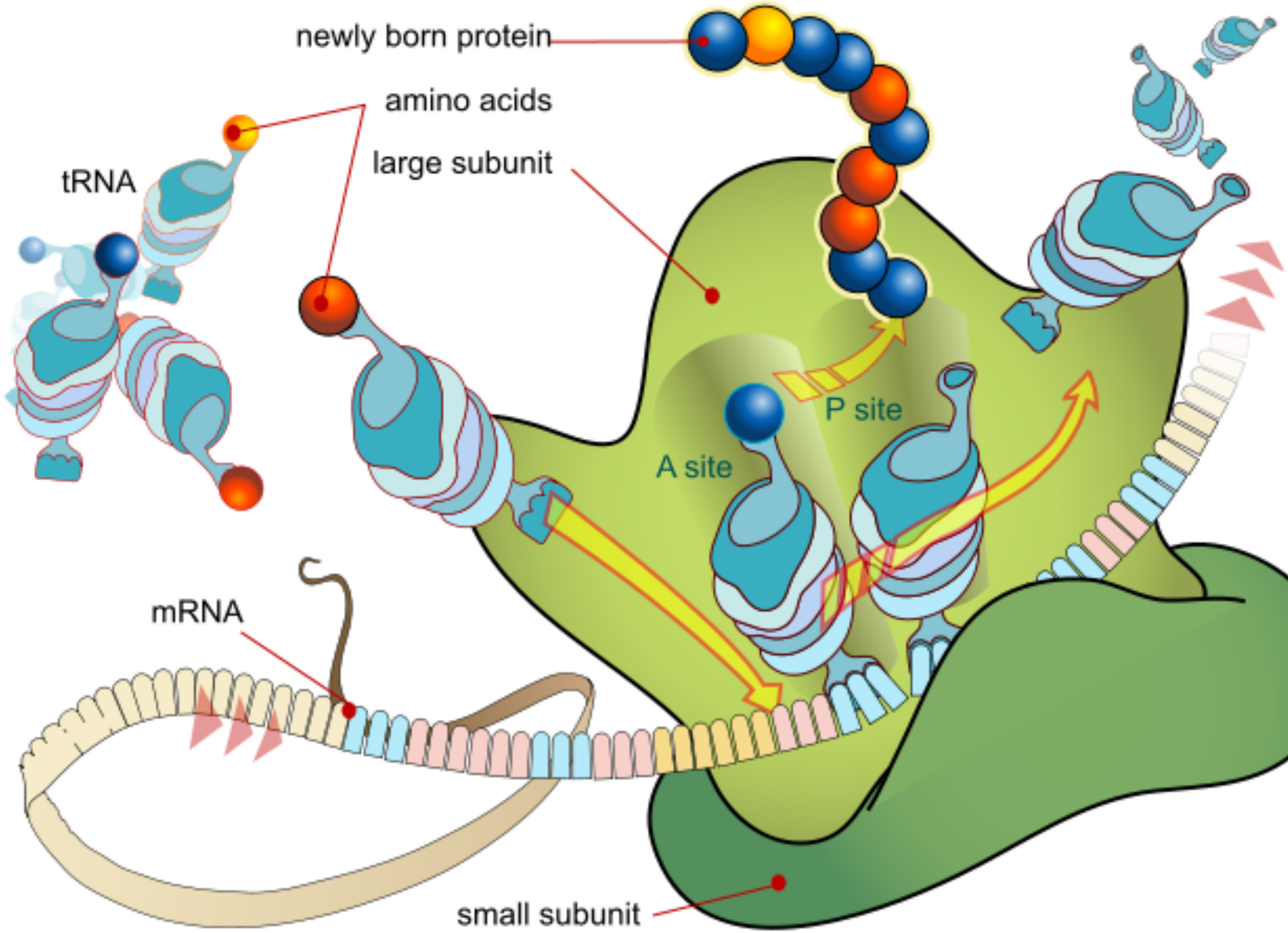
Peptide bond formation



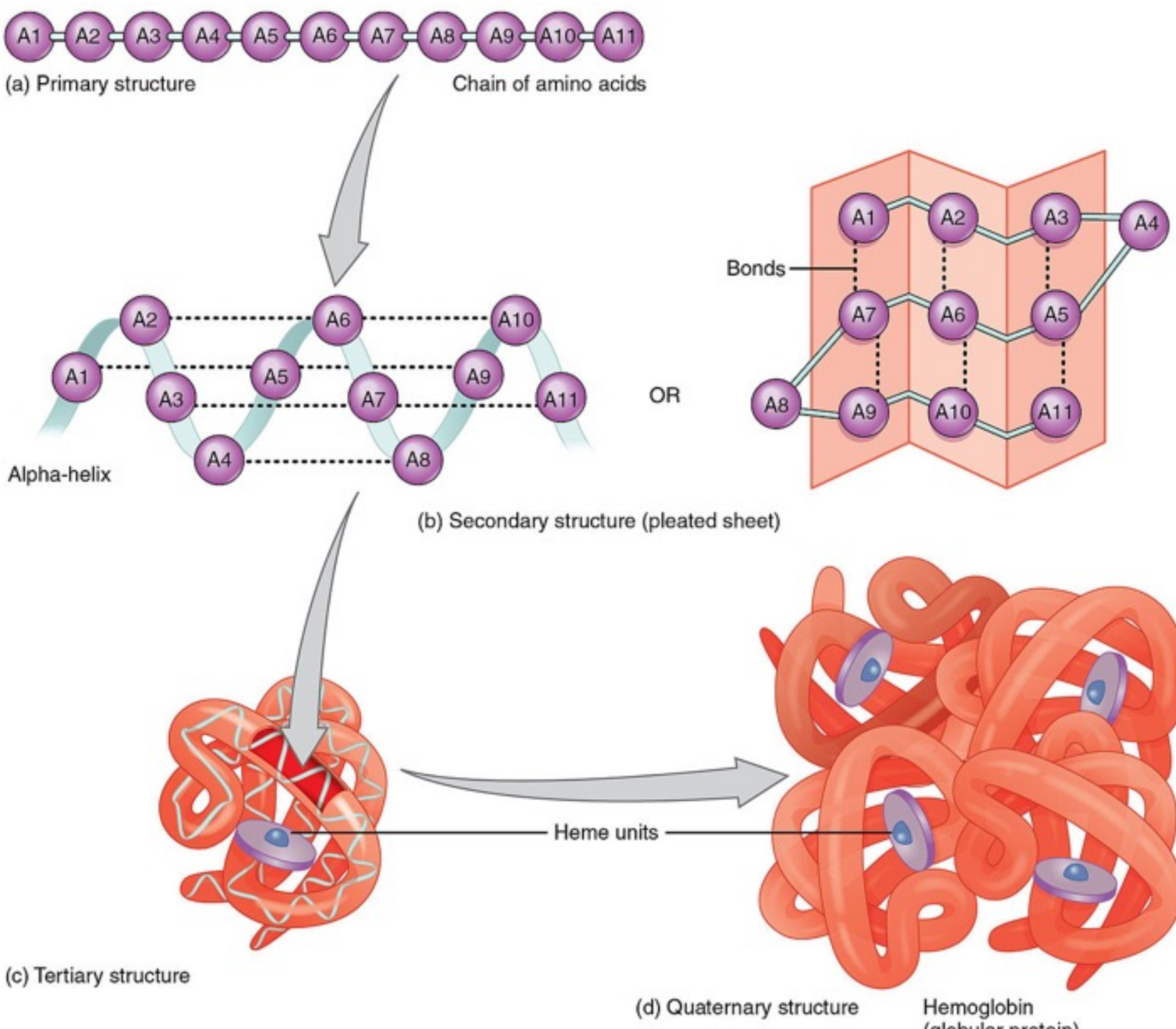
“Central Dogma” in the cell



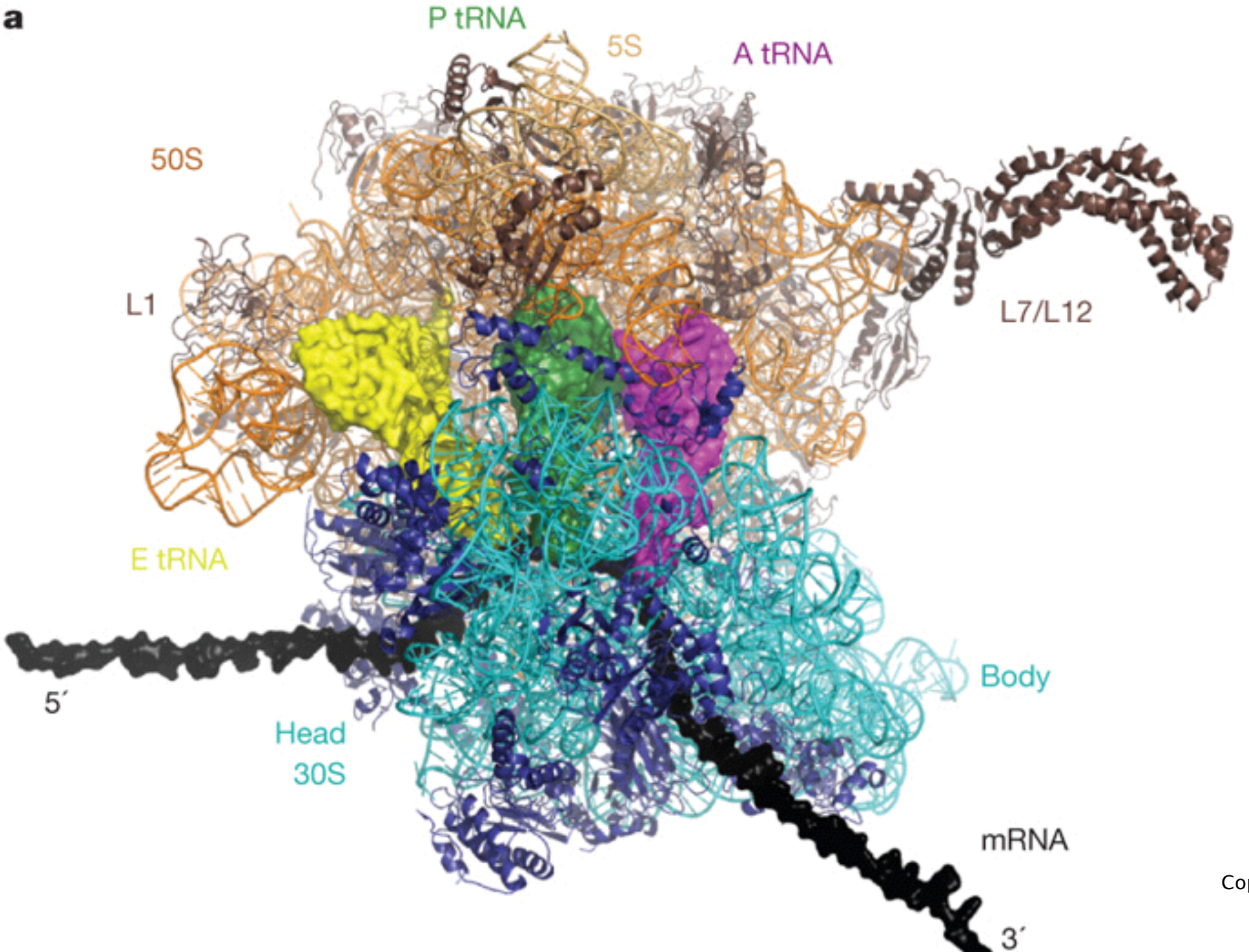
Process in more or less 3D



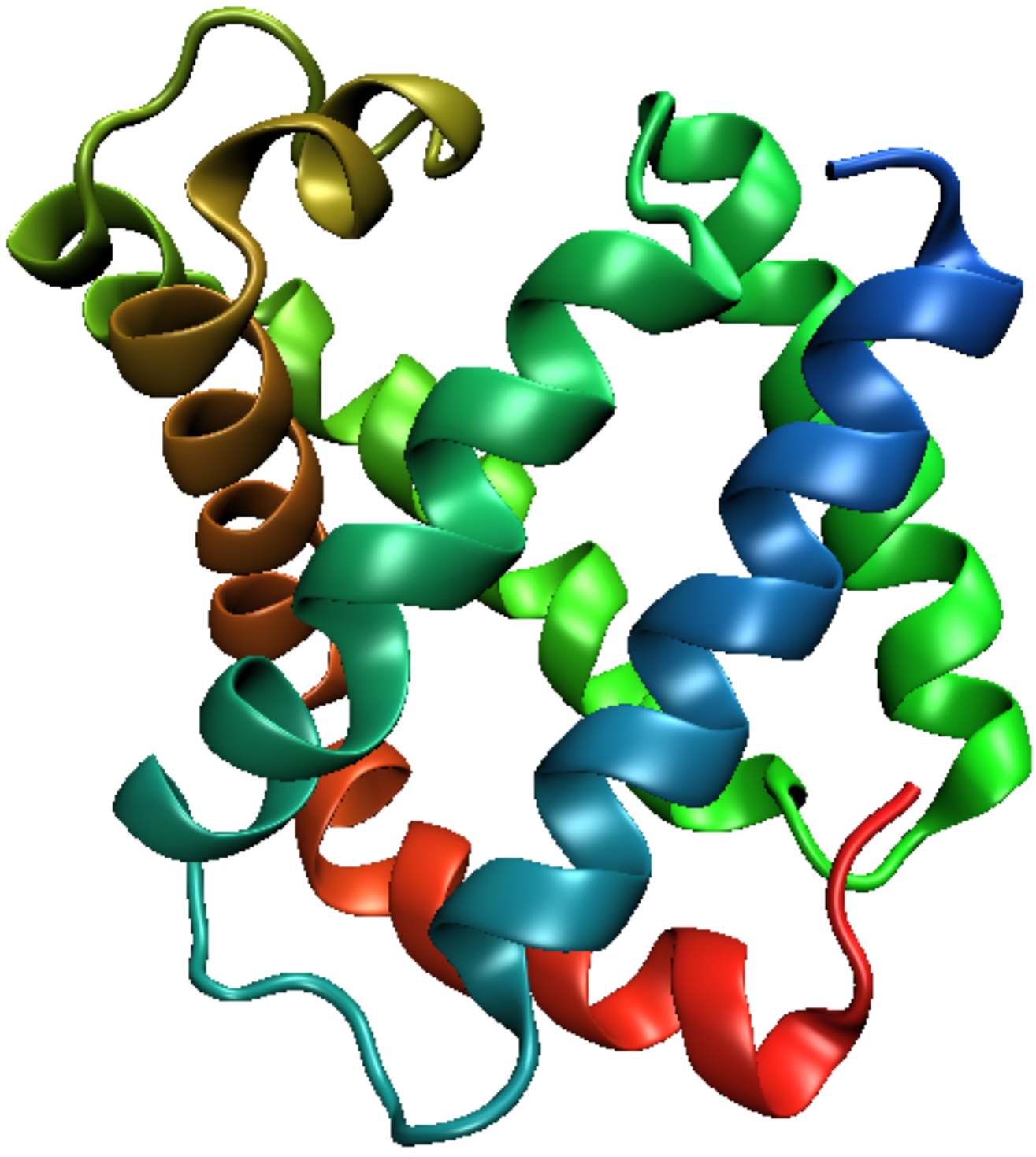
Protein folding



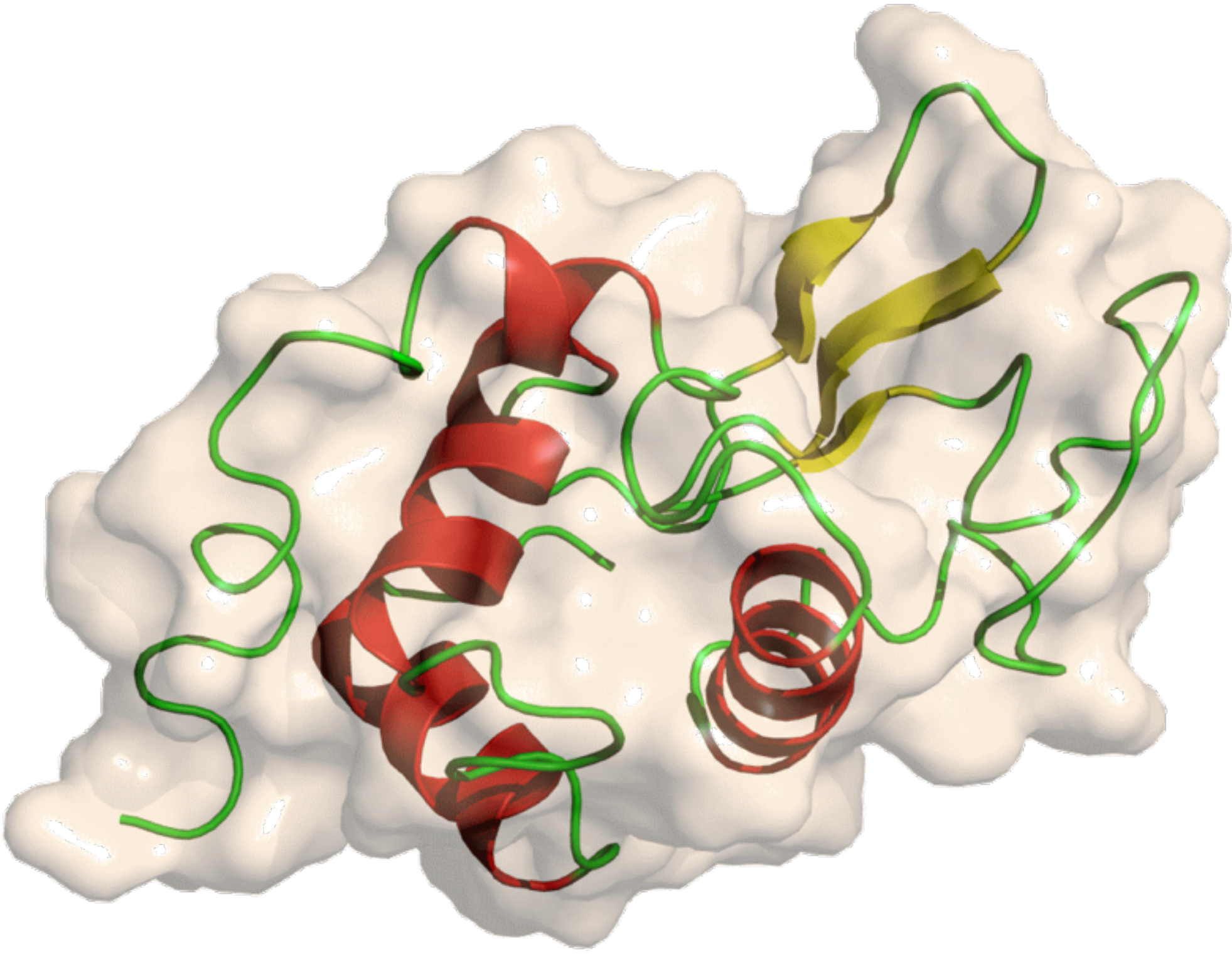
Snapshot of the process in 3D



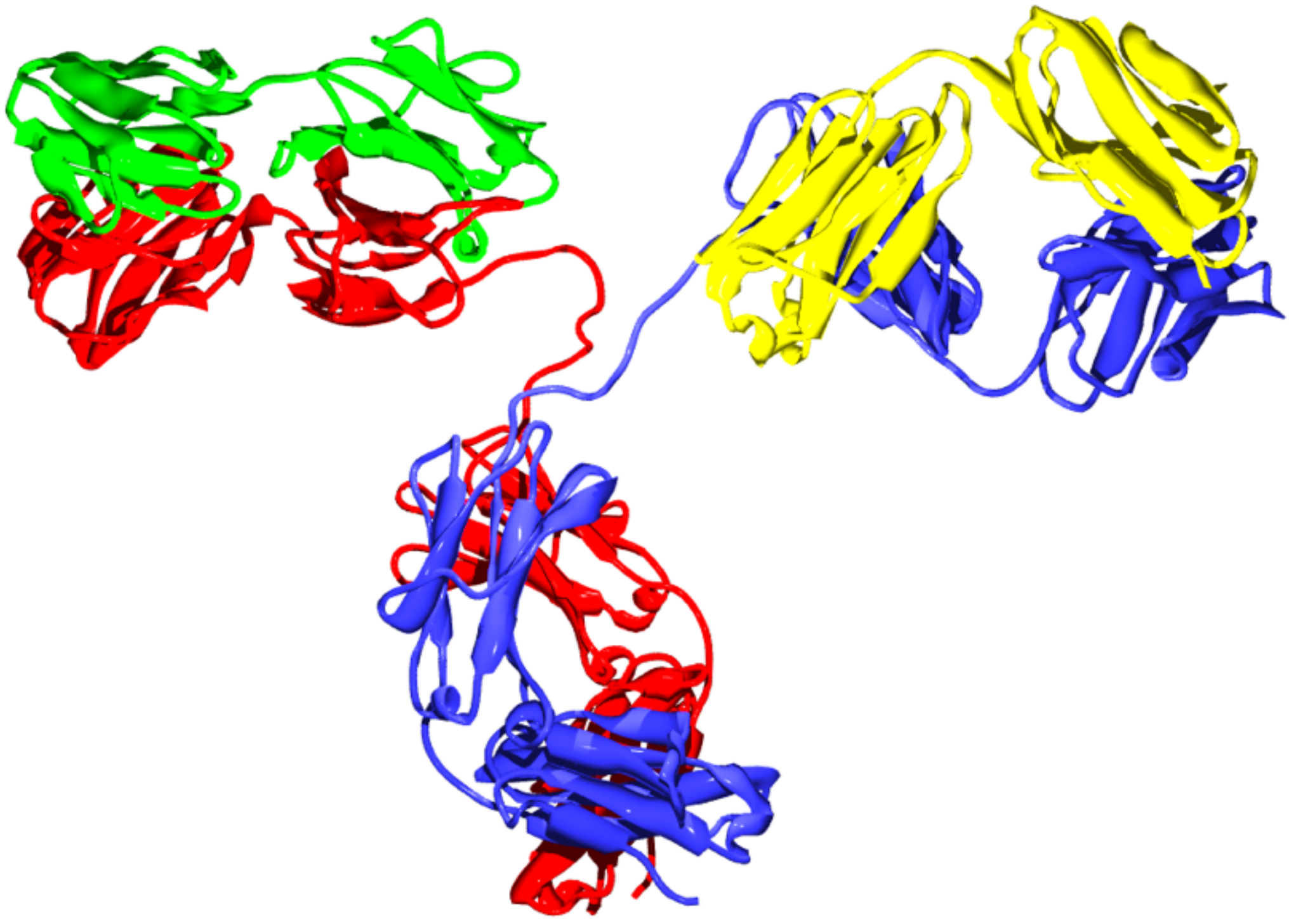
Myoglobin



Lysozyme

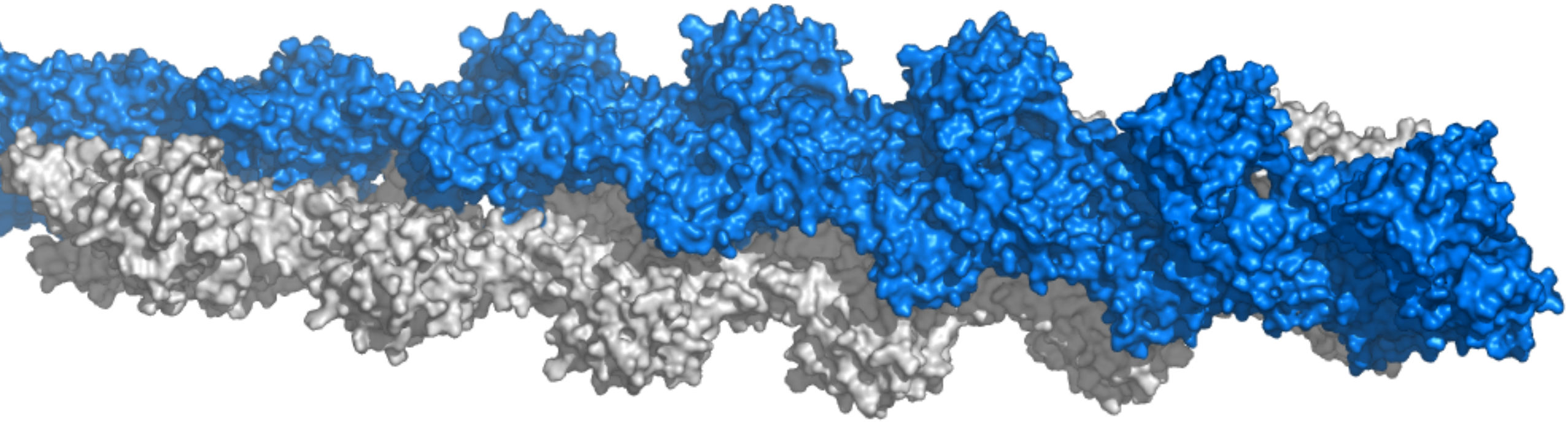


Antibody

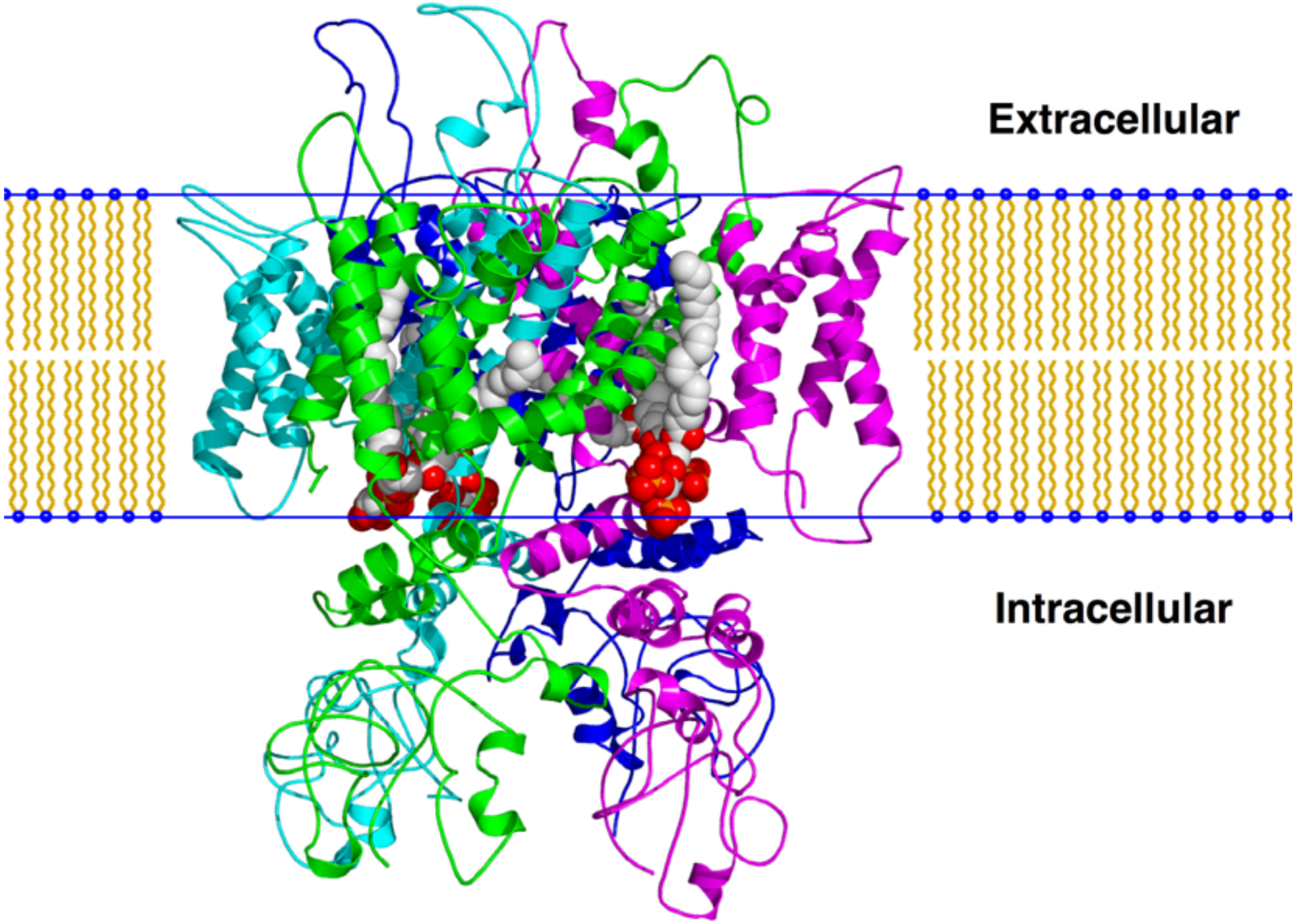


PDB 1IGT, PMID 9048542

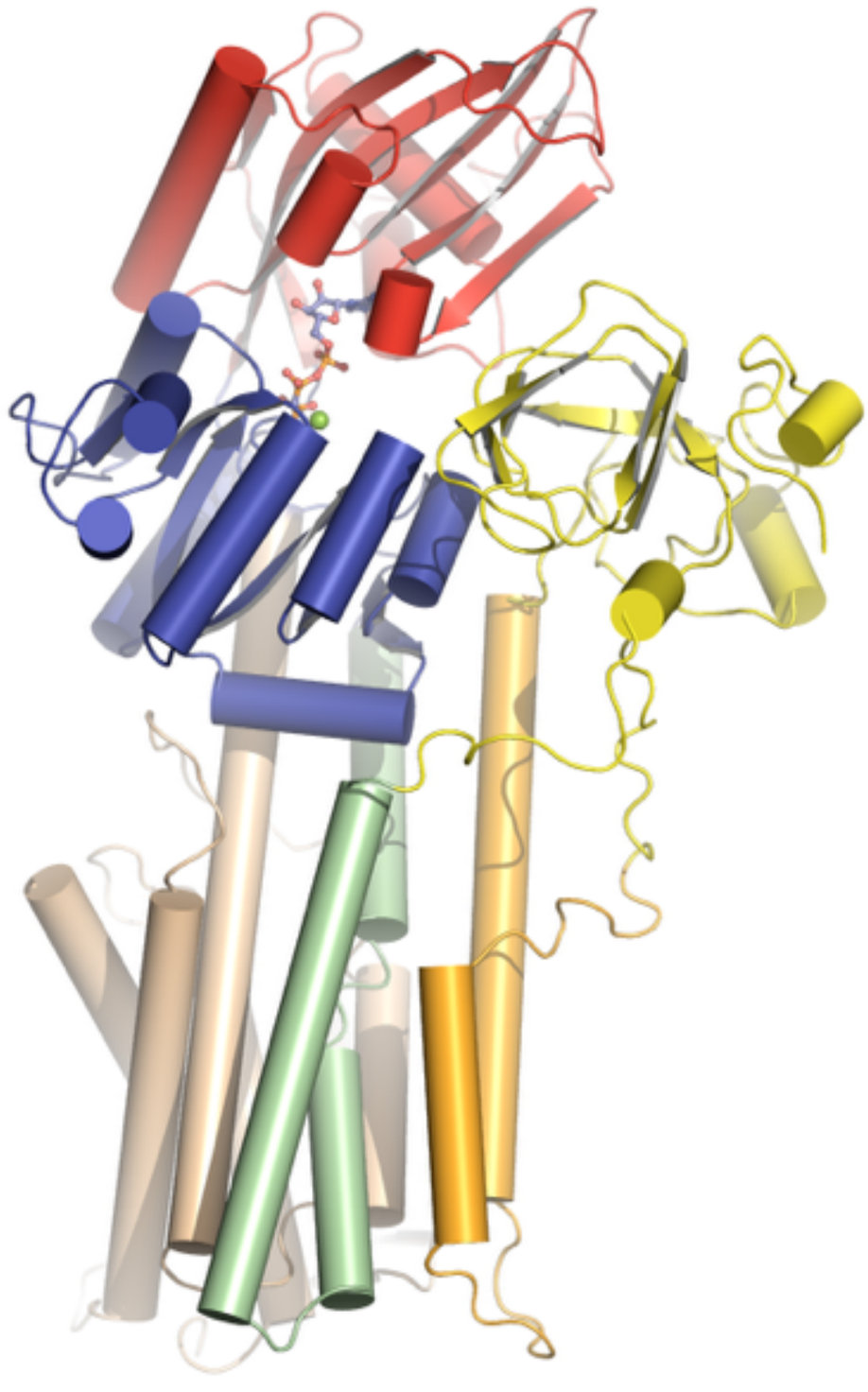
Structural proteins: Actin



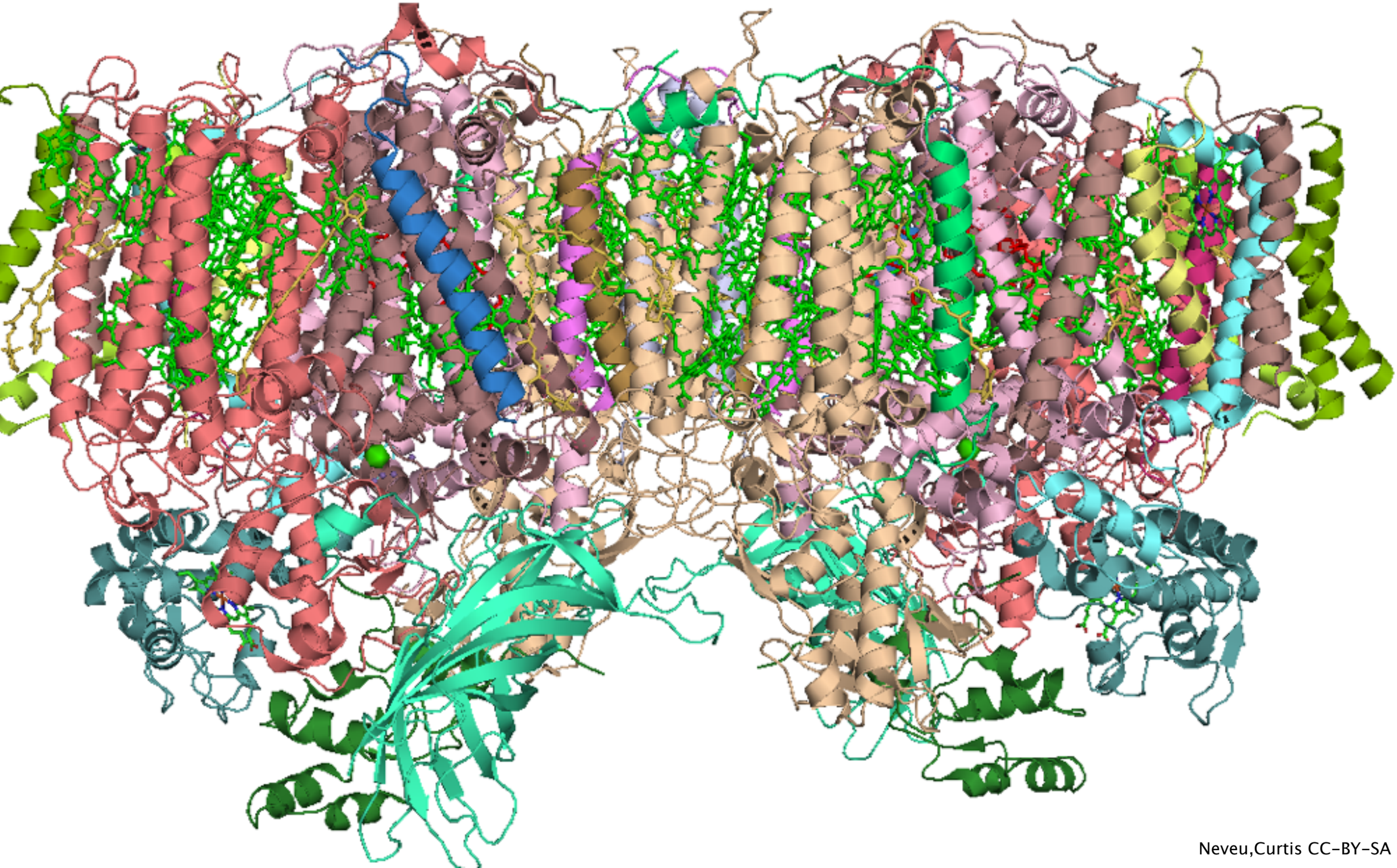
Receptor proteins



ATPase

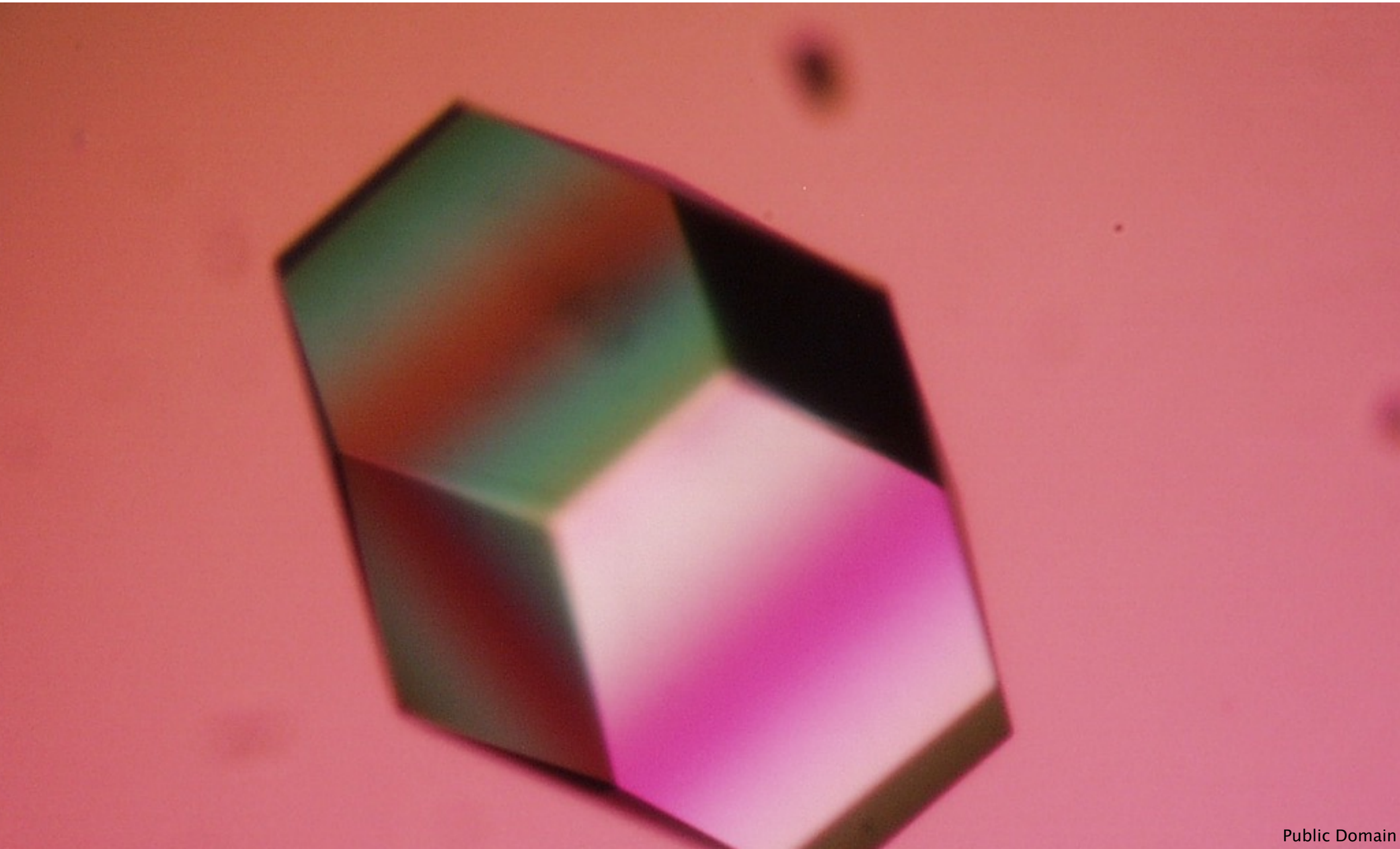


Photosystem II

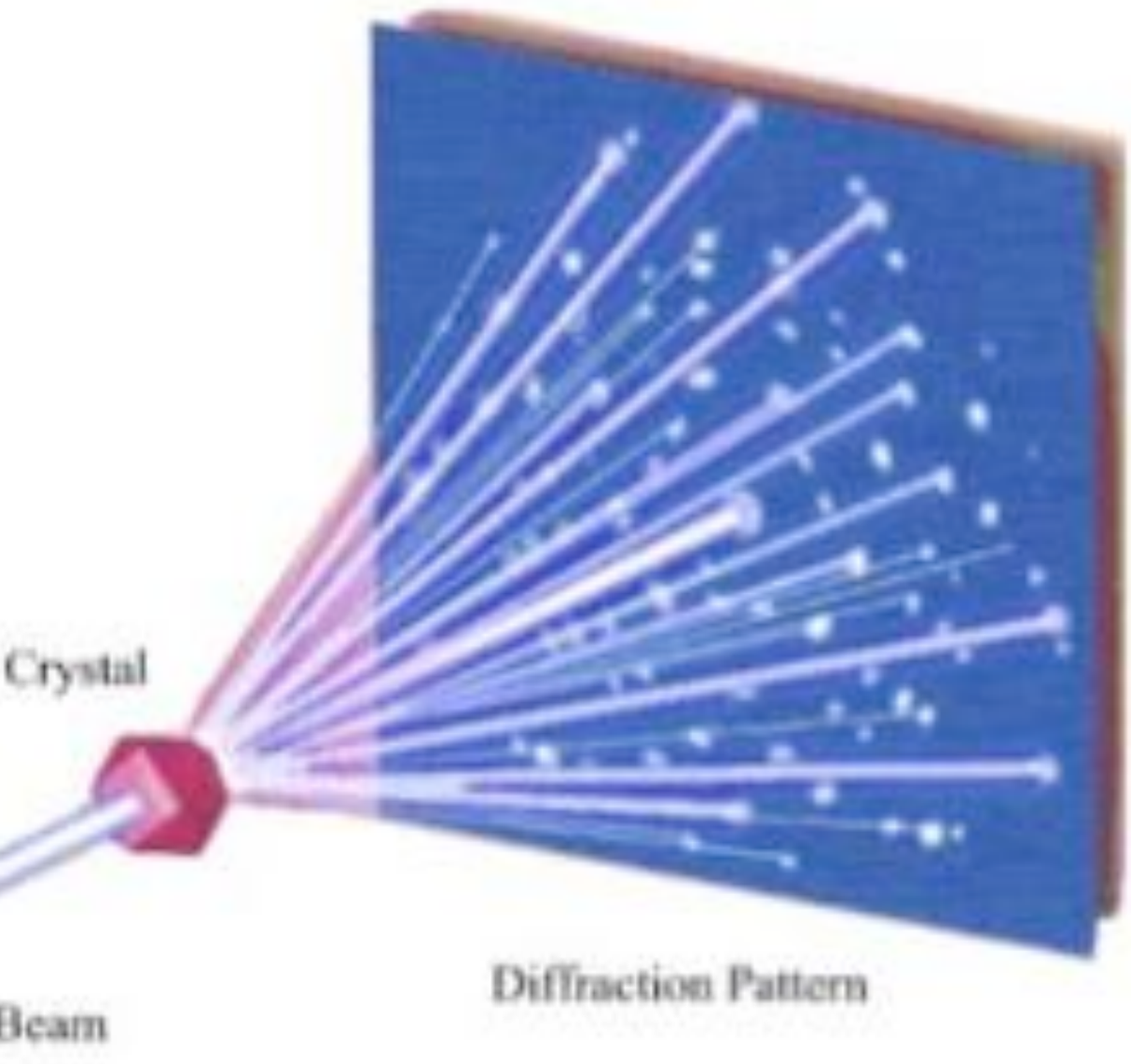


Synchrotron EMBL Grenoble

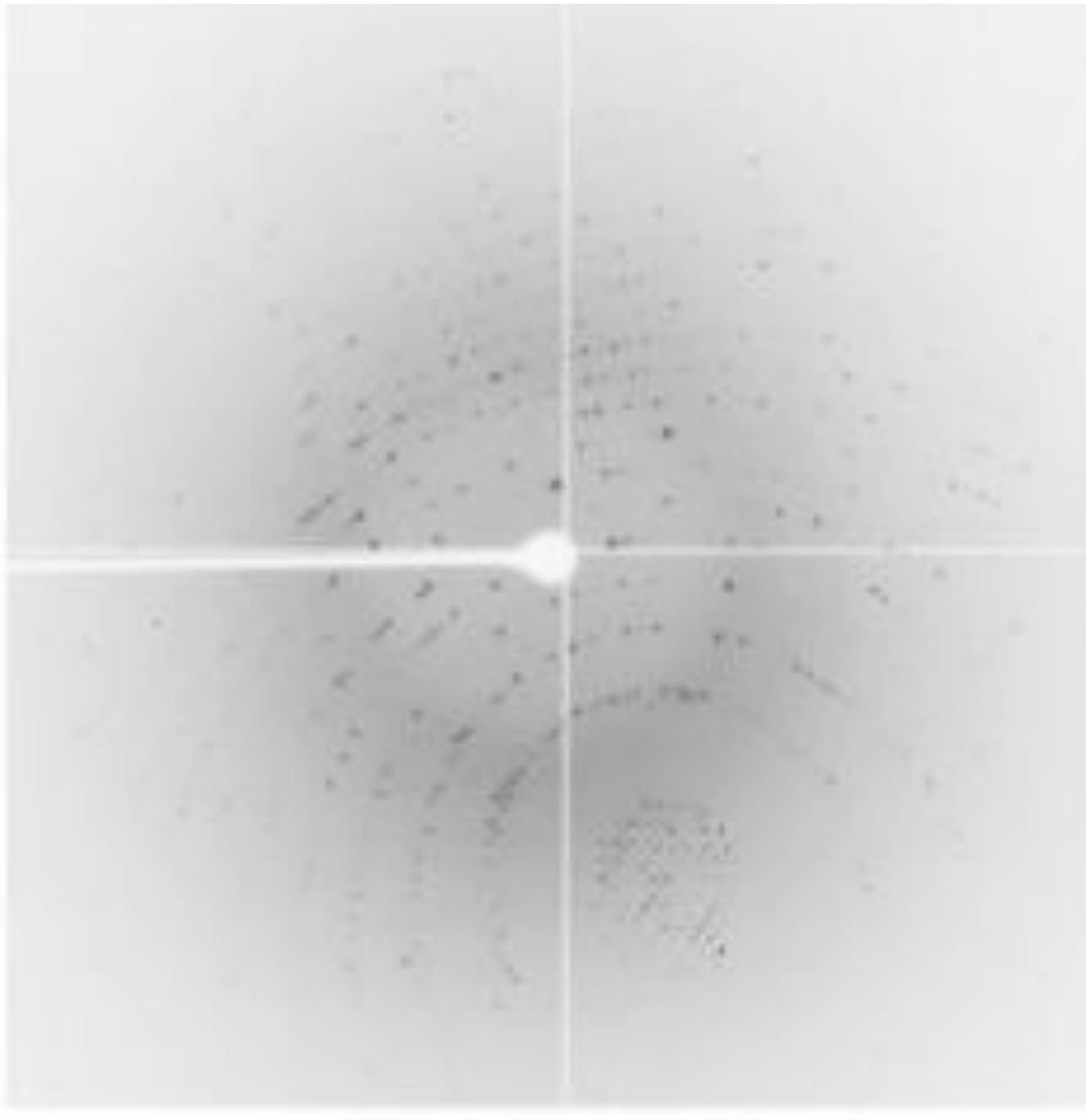
Lysozyme crystal



Protein crystal diffration



Diffraction Process



Diffraction Pattern from NSLS

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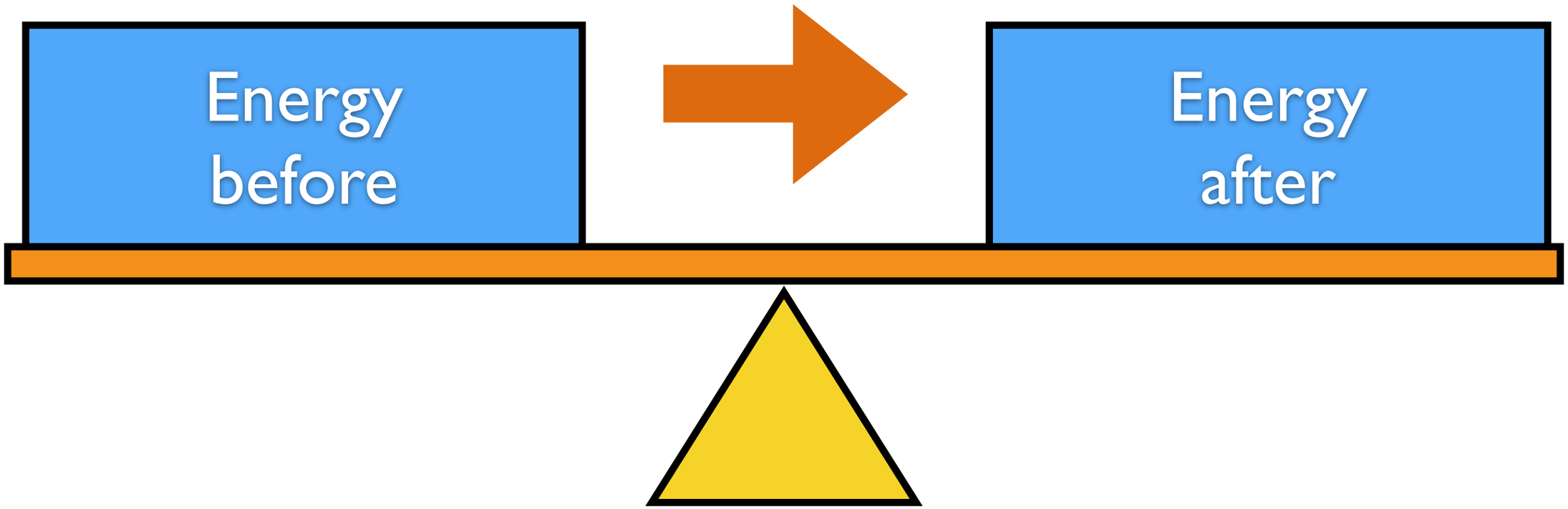
Energy

Energy from the environment

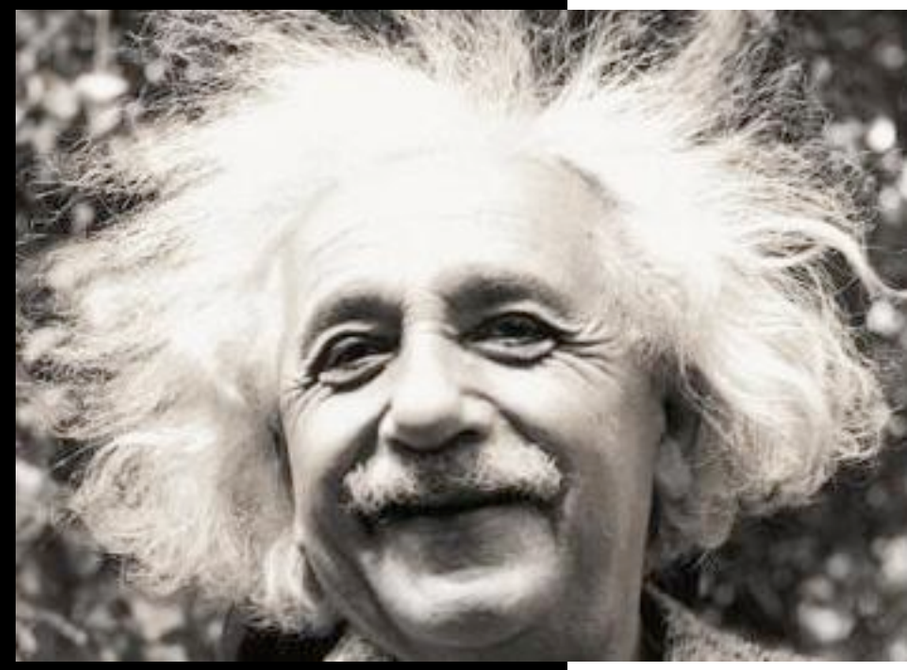
Brocken Inaglory CC-BY-SA 3.0

First law of thermodynamics

Energy
transformation



E = mc^2

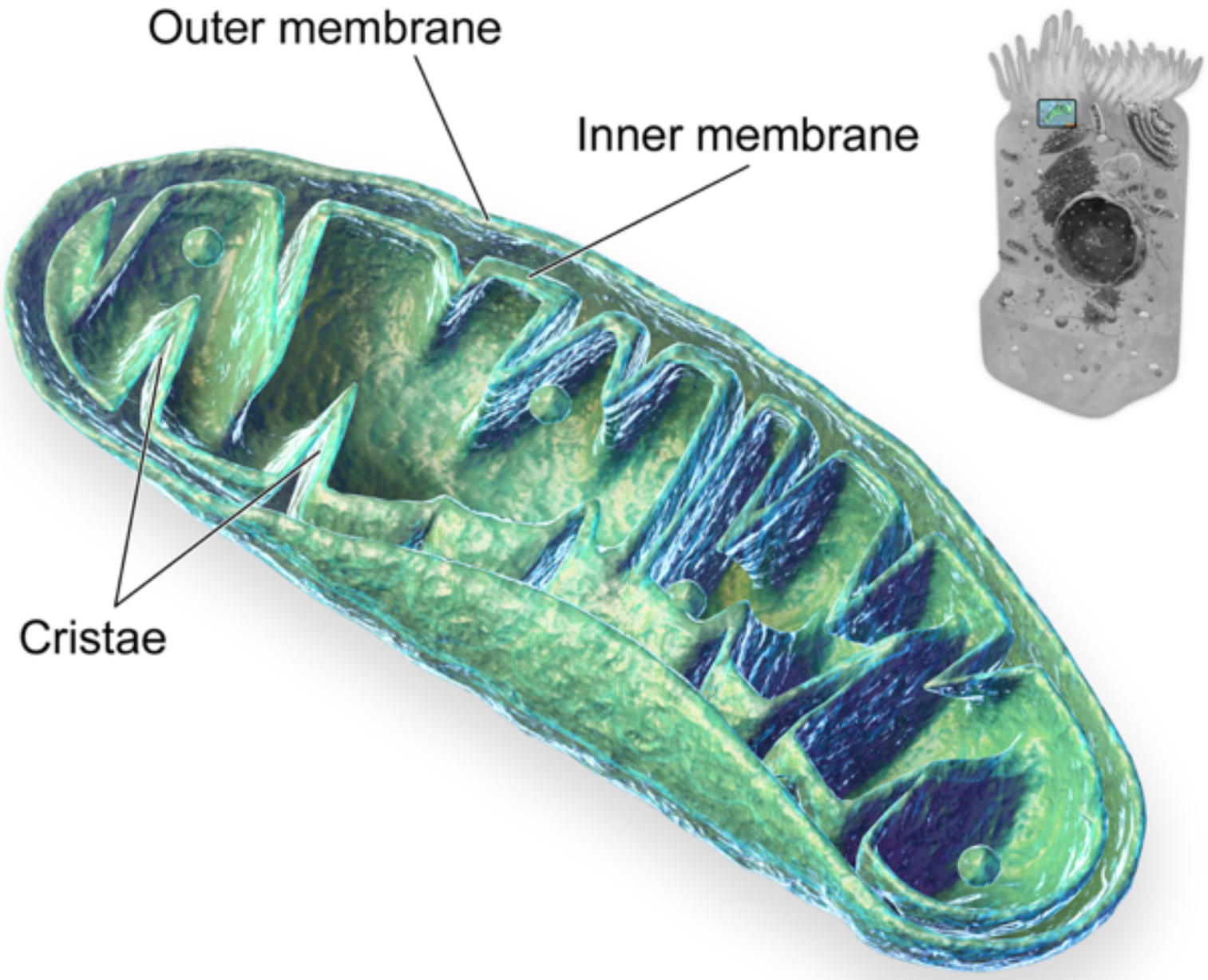


Second law of thermodynamics

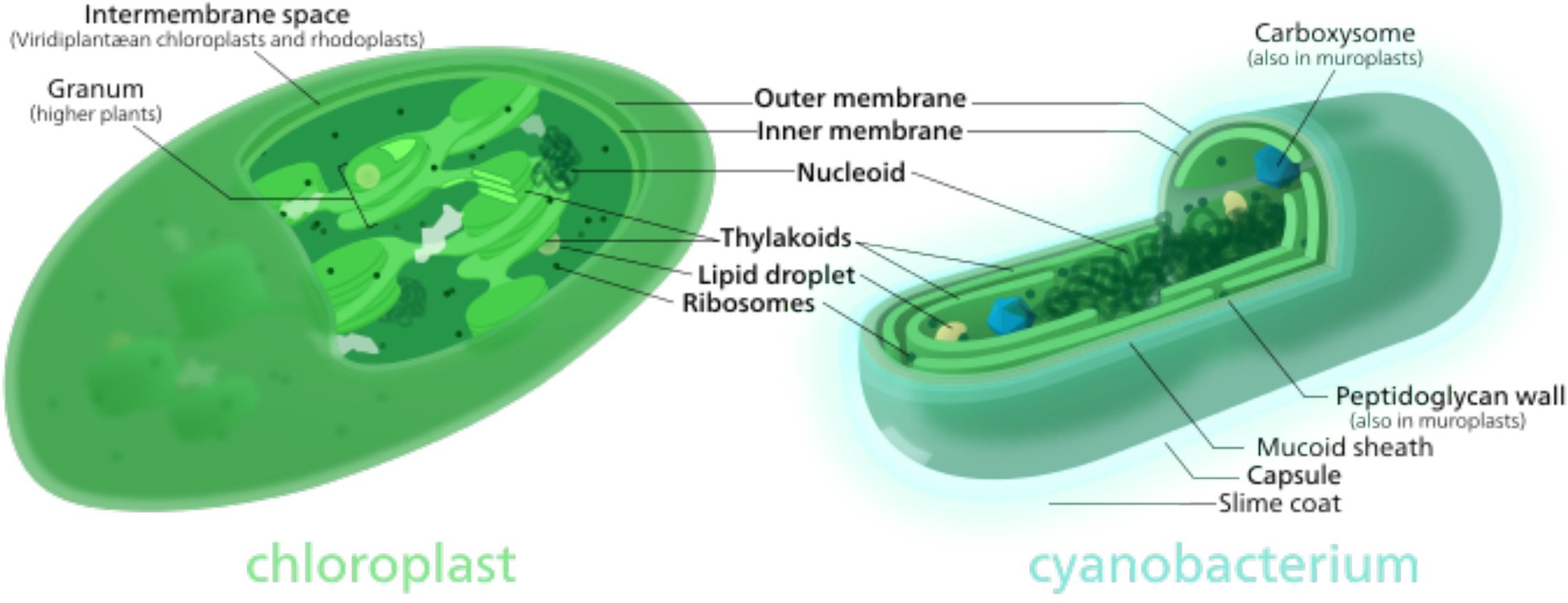
Nothing will happen spontaneously unless it increases the **entropy** of the universe

Entropy is a measure of disorder

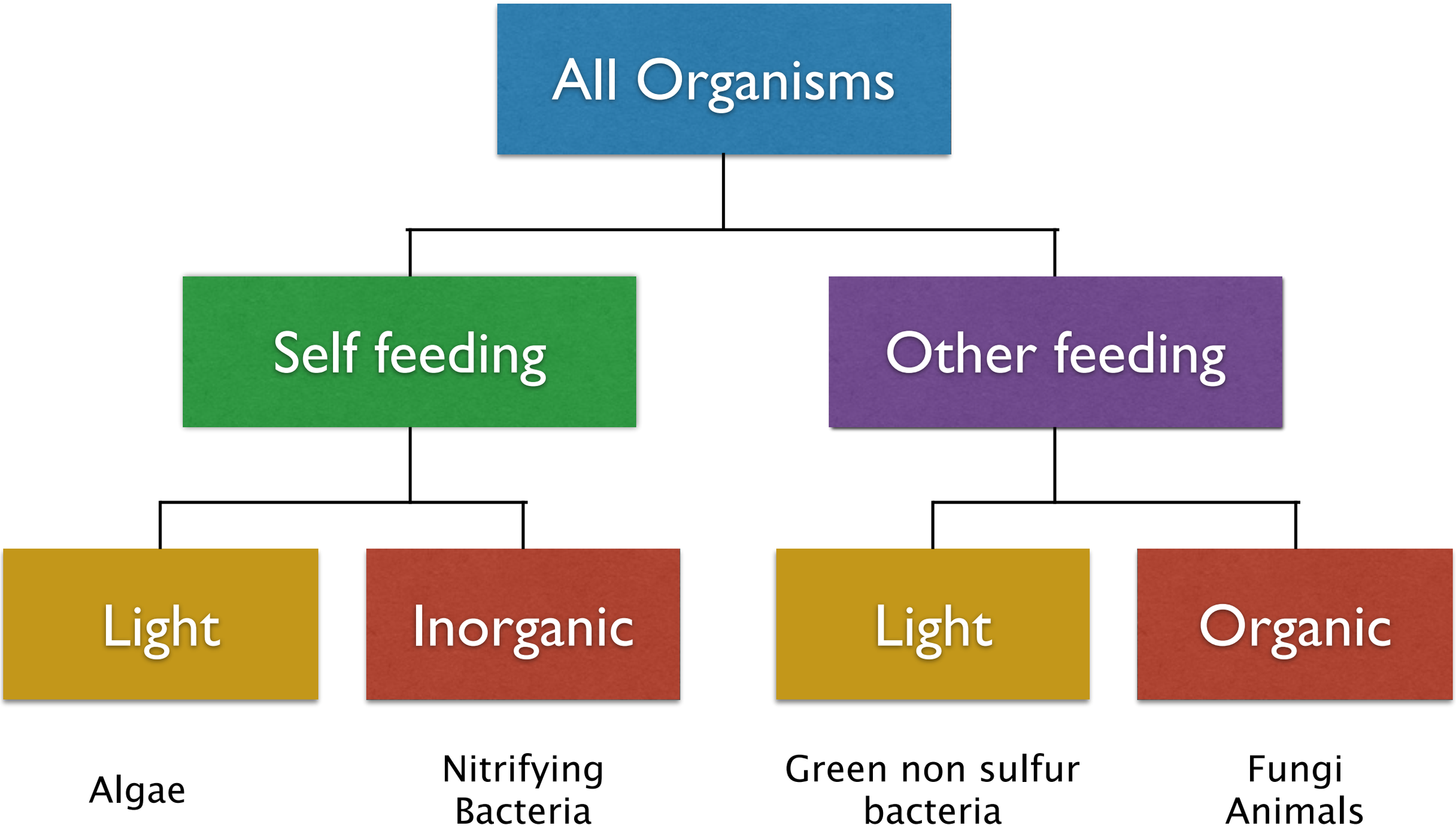
Mitochondria



Chloroplasts

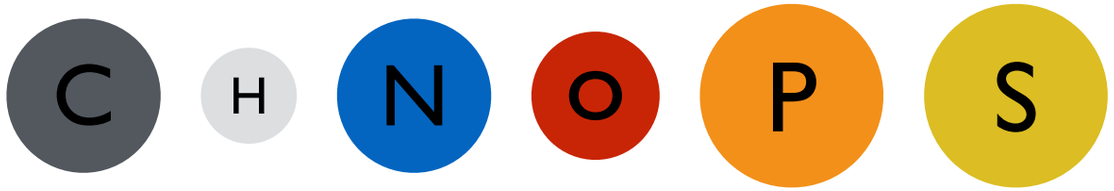


Diversity in Metabolism

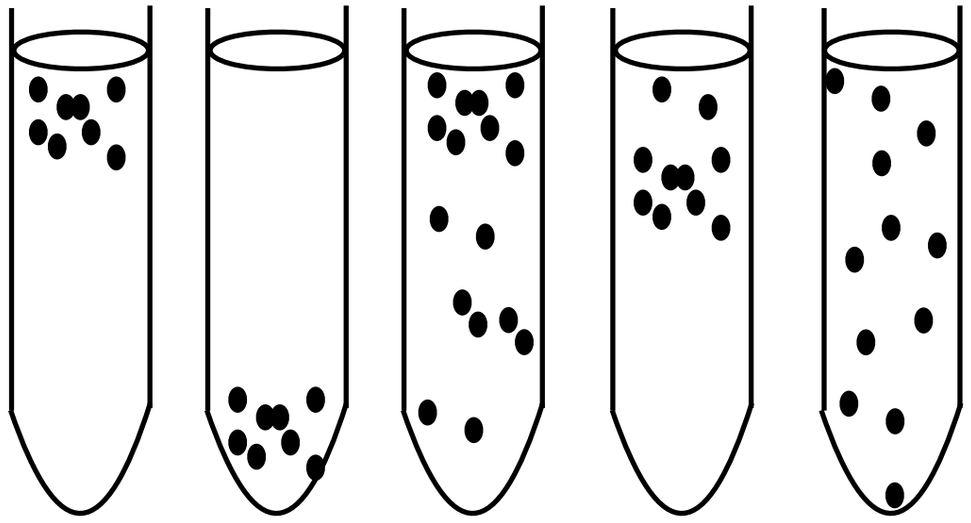


Diversity in growth conditions

Nutrients



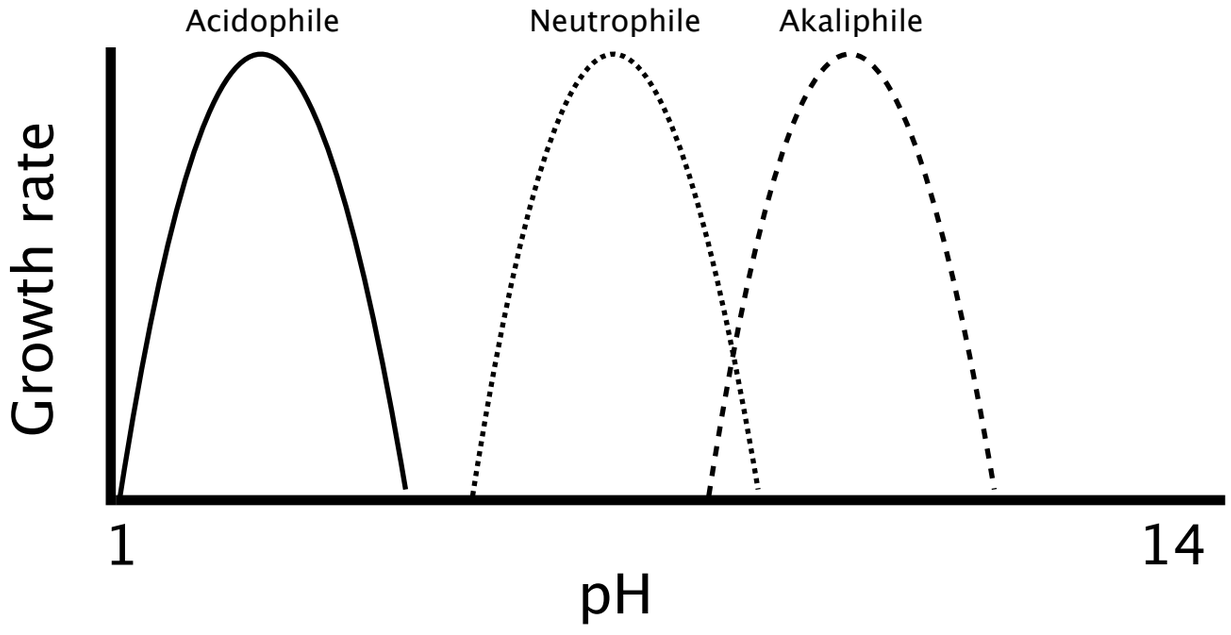
Atmosphere



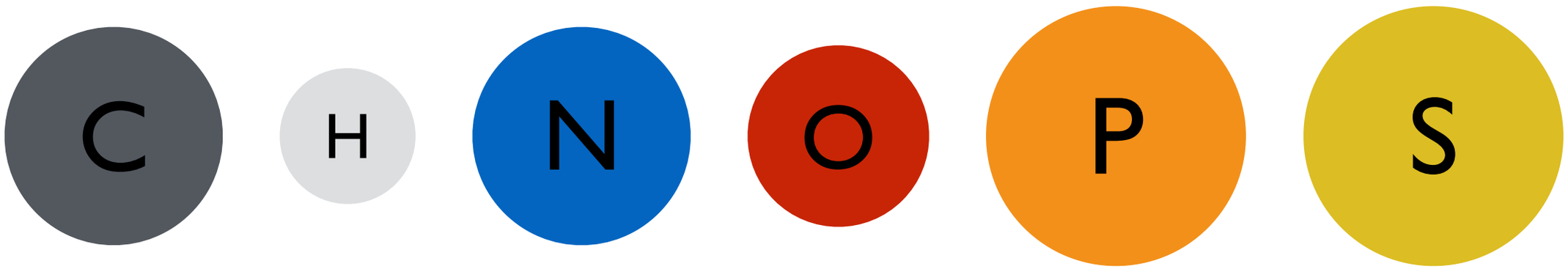
Temperature

Pixabay - CC0

pH



Elements of Life



Carbon

Hydrogen

Nitrogen

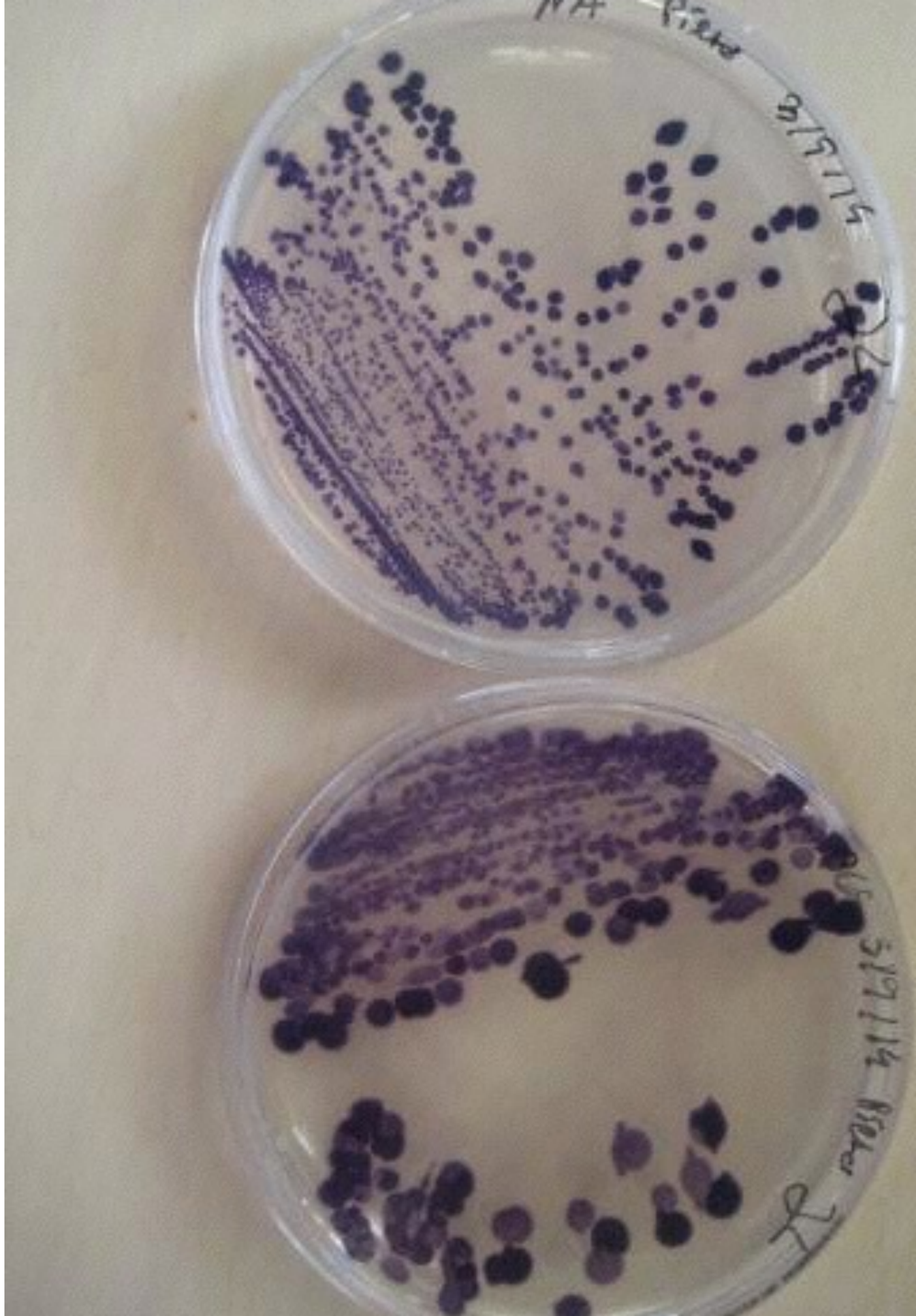
Oxygen

Phosphorus

Sulfur

Non selective

- Plate count agar
- Nutrient agar



Slightly selective

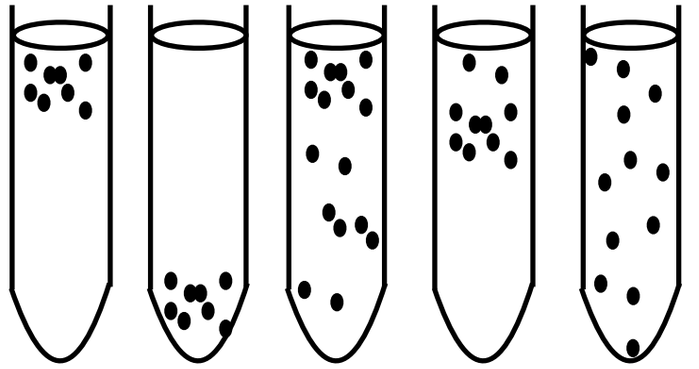
- Malt agar
- MRS agar

- Kombucha medium

Selective

- Spirulina medium

Diversity in Atmosphere

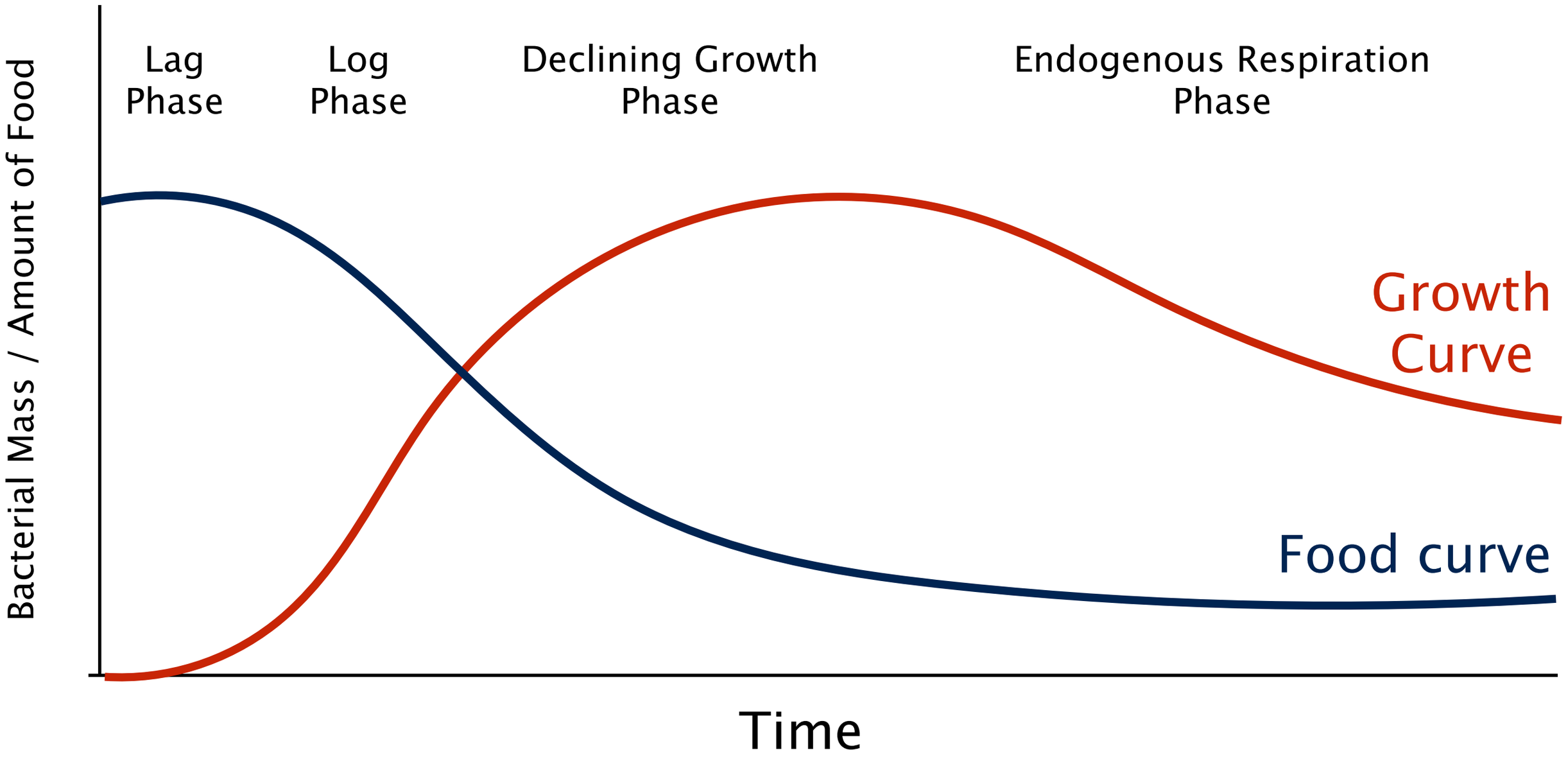


Term	Property	Example
Strict aerobe	Requires oxygen	Pseudomonas aeruginosa
Stric anaerobe	Does not tolerate oxygen	Bacteroides fragilis
Facultative anaerobe	Aerobe, but can also grow anaerobically	Escherichia coli
Aerotolerant	Anaerobe, but can tolerate oxygen	Clostridium perfringens
Micro-aerophilic	Prefers reduced level of oxygen	Helicobacter spp.
Capnophilic	Prefers increase level of oxygen	Neisseria spp.

Diversity in Temperature

Term	Property	Example
Psychrophilic	Temp < 10 C	Flavobacterium spp
Thermophilic	Temp > 60 C	B. stearothermophilus
Mesophilic	20 - 40 C	Most pathogens

Bacterial growth curve



Conclusions

- Life is made out of cells
- Cells are envelopes made out of lipids
- Cells create specialised structures to conduct chemical reactions
  - Structures are made out of standardised blocks
    - DNA out of nucleotides (A, T, C or G)
    - Proteins out of amino acids (20 types)
  - The combination (sequence) of building blocks results in a specific 3D shape
  - Shape = function
  - Shapes interact by docking