

BBL342: Physical and Chemical Properties of Biomolecules

Semester II, session 2022-23

Know your instructor

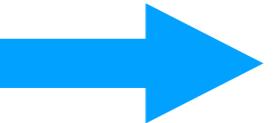


Amit Das

- Joined DBEB as an Assistant Professor in Nov 2022
- PhD, S. N. Bose National Centre for Basic Sciences, Kolkata
- Postdoctoral experiences
 - NCBS TIFR, Bangalore
 - Northeastern University, Boston, MA, USA

BBL342: Physical and Chemical Properties of Biomolecules

Evaluation policy

- 
1. Minor I - 20 marks
 2. Minor II - 20 marks
 3. Major – 40 marks
 4. Quiz 1-2 – 10 marks
 5. Tutorials - 10 marks (collected on weekly basis)

Course topics and organization of the lectures

Minor I + Quiz 1

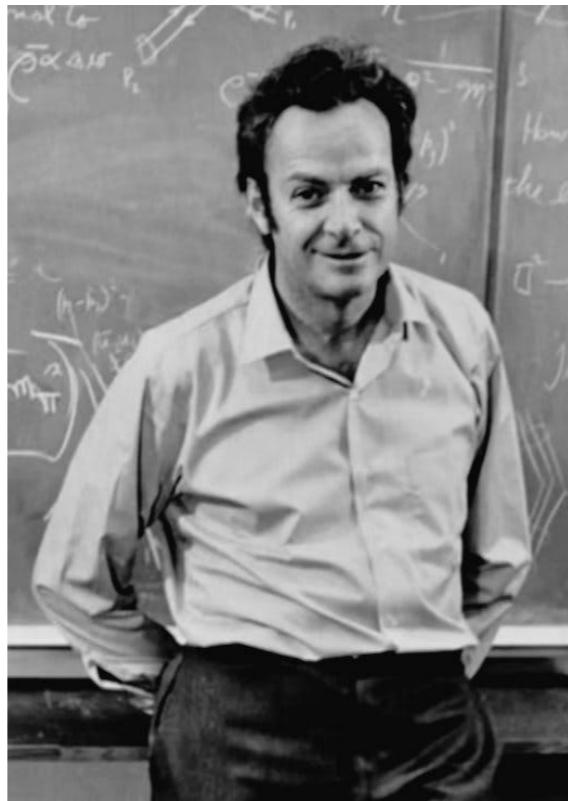
1. Understanding life, cell structure & biomolecules
2. Molecular forces in Biology
3. Rate of reaction and free energy
4. Water
5. Proteins
 - A. Amino acid
 - B. Structural protein
 - C. Membrane protein
6. DNA
7. RNA
8. Carbohydrates
9. Lipids

Minor II + Quiz 2

1. Purification of biomolecules
2. Transport properties
 - A. Diffusion
 - B. Membrane transport
 - C. Directed motility
3. Centrifugation
4. Electrophoresis
5. Introduction to spectroscopy
6. X-ray Diffraction
7. Absorption Spectroscopy
8. Luminescence and Fluorescence
9. Microscopy

Major Exam

1. Mass spectroscopy
2. NMR spectroscopy
3. IR spectroscopy
4. Recap of topics from minor I & II
5. Practice for major exam



“....everything that living things do can be understood in terms of the jigglings and wigglings of atoms”

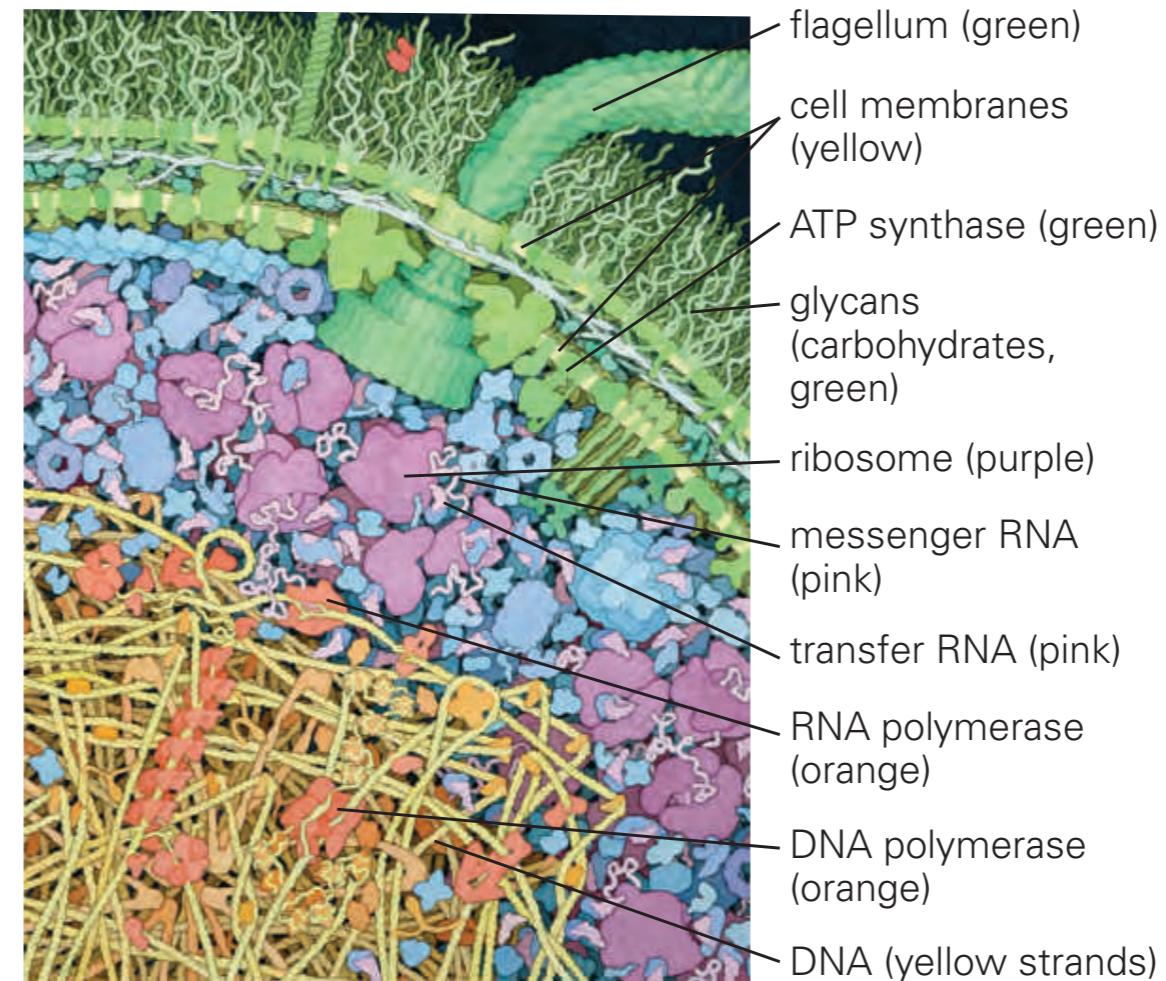
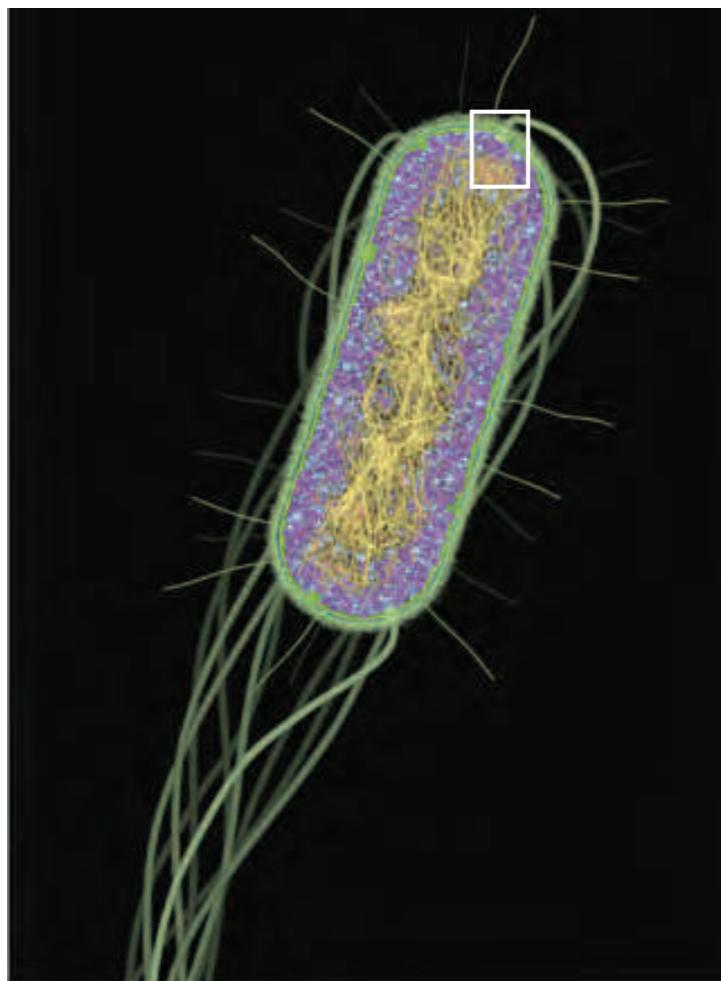
— Richard Feynman

How do we begin to understand the living things?

Understanding the things they are made of

Living things are made of cells → organelles → biomolecules → Atoms

Architecture of a living cell



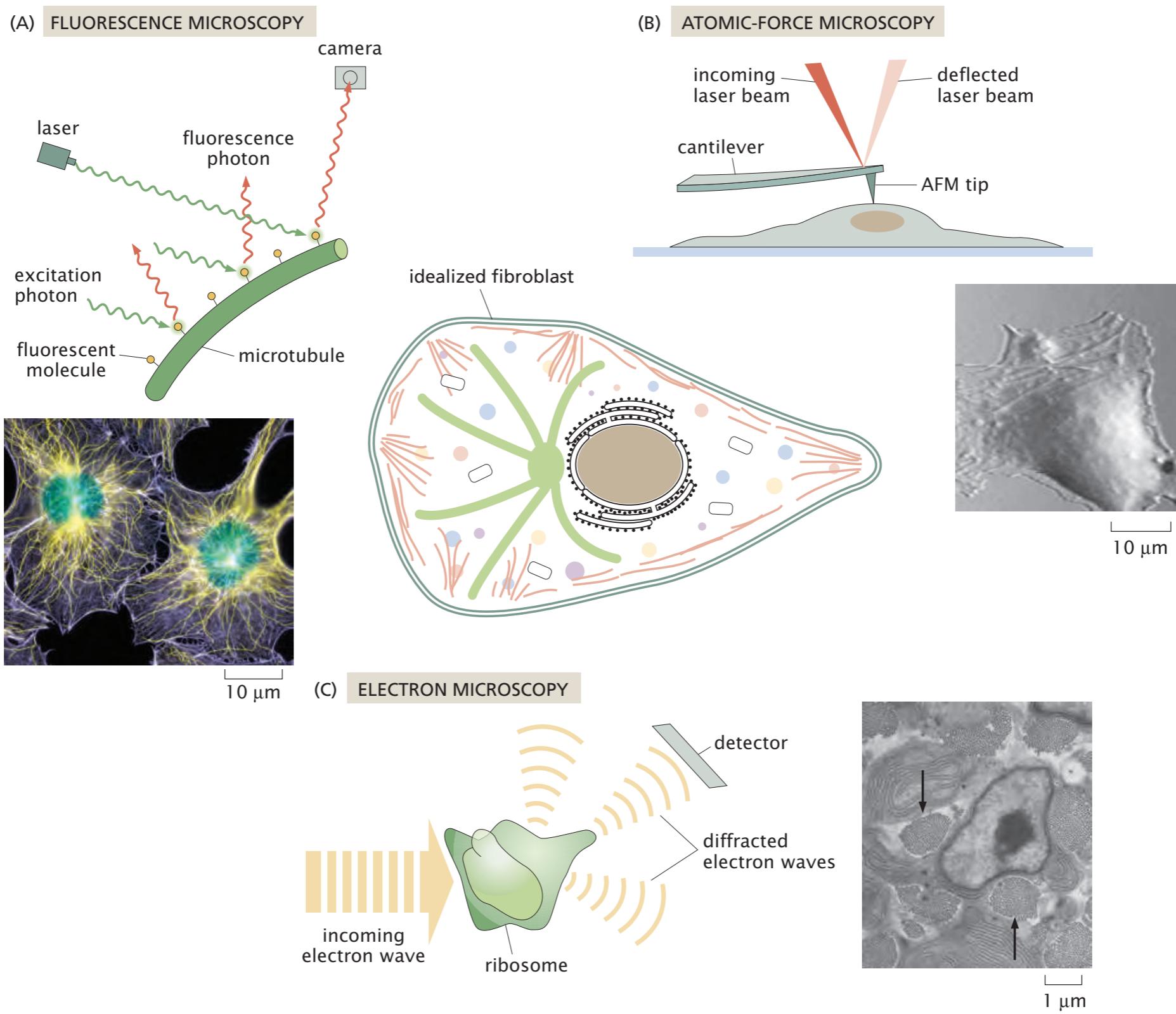
D. Goodshell, *Biochem. Mol. Biol. Educ.* 2009

An artist's impression of an E-Coli cell

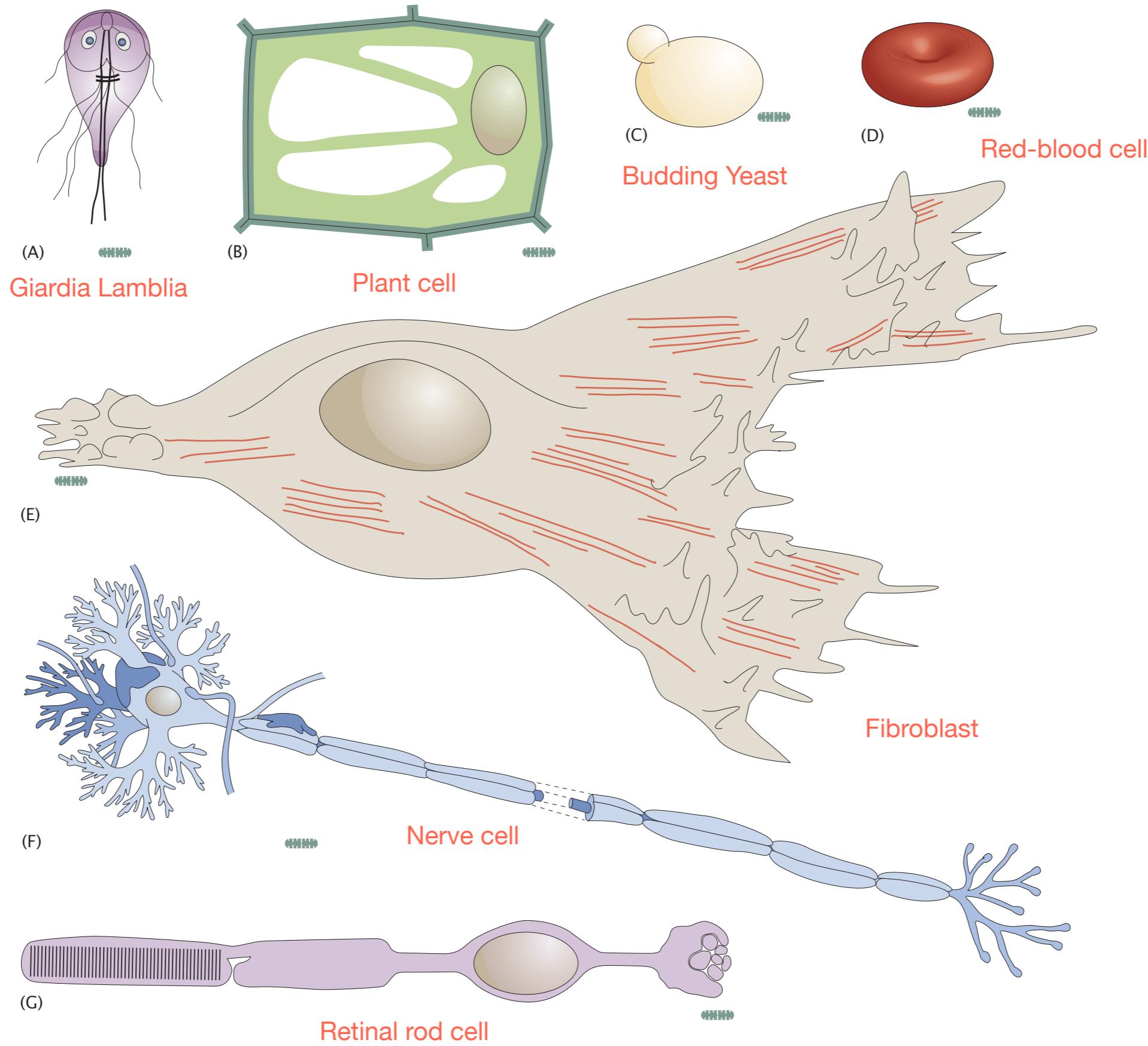
These illustrations are drawn to represent a typical E-Coli cell with right concentrations and shapes of the molecules inside

Results from diversity of experimental techniques

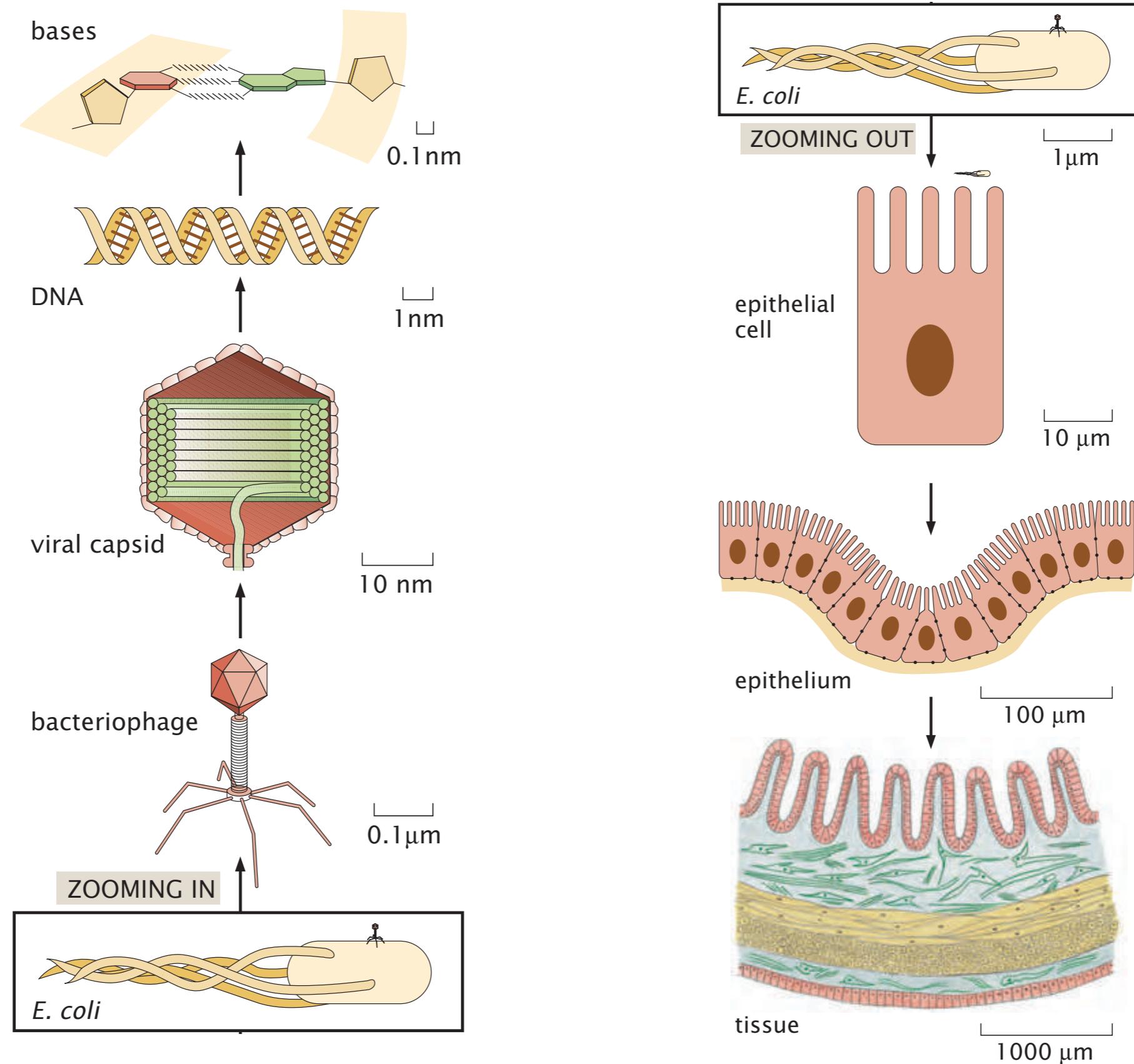
Experimental techniques that have revealed structure of the cell



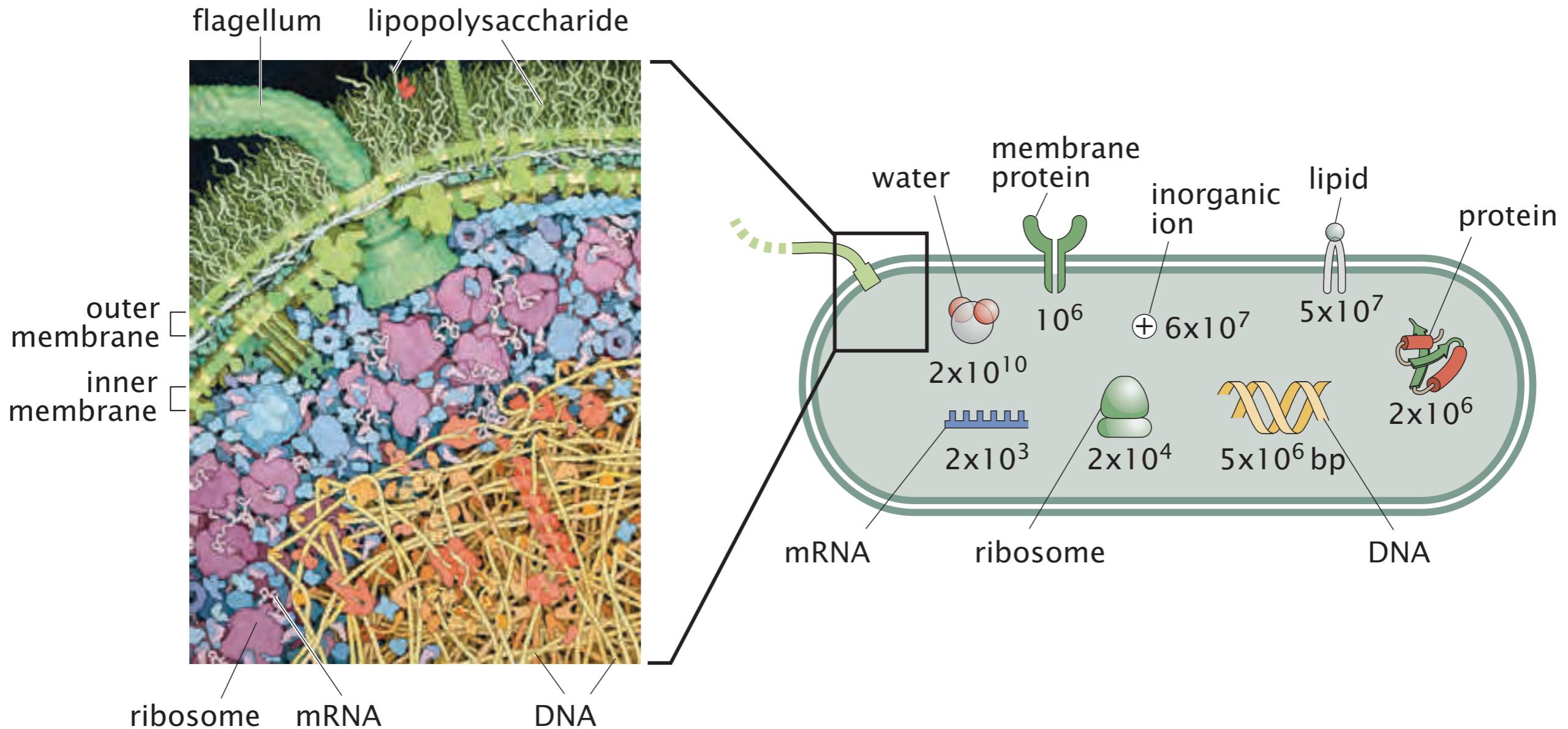
Different types of cells measured with the *E. coli* ruler



How big are the cells and their stuff compared to *E-Coli*



What are the cells made of?



Cells are made of different types of macromolecules

What are these macromolecules?

Macromolecules in the cells are all biomolecules



biomolecule

/bɪə(ʊ)'mɒlɪkjʊ:l/

noun

noun: **biomolecule**; plural noun: **biomolecules**; noun: **bio-molecule**; plural noun: **bio-molecules**

a molecule that is produced by a living organism.

Use over time for: biomolecule



Four major classes of biomolecules

Nucleic acids

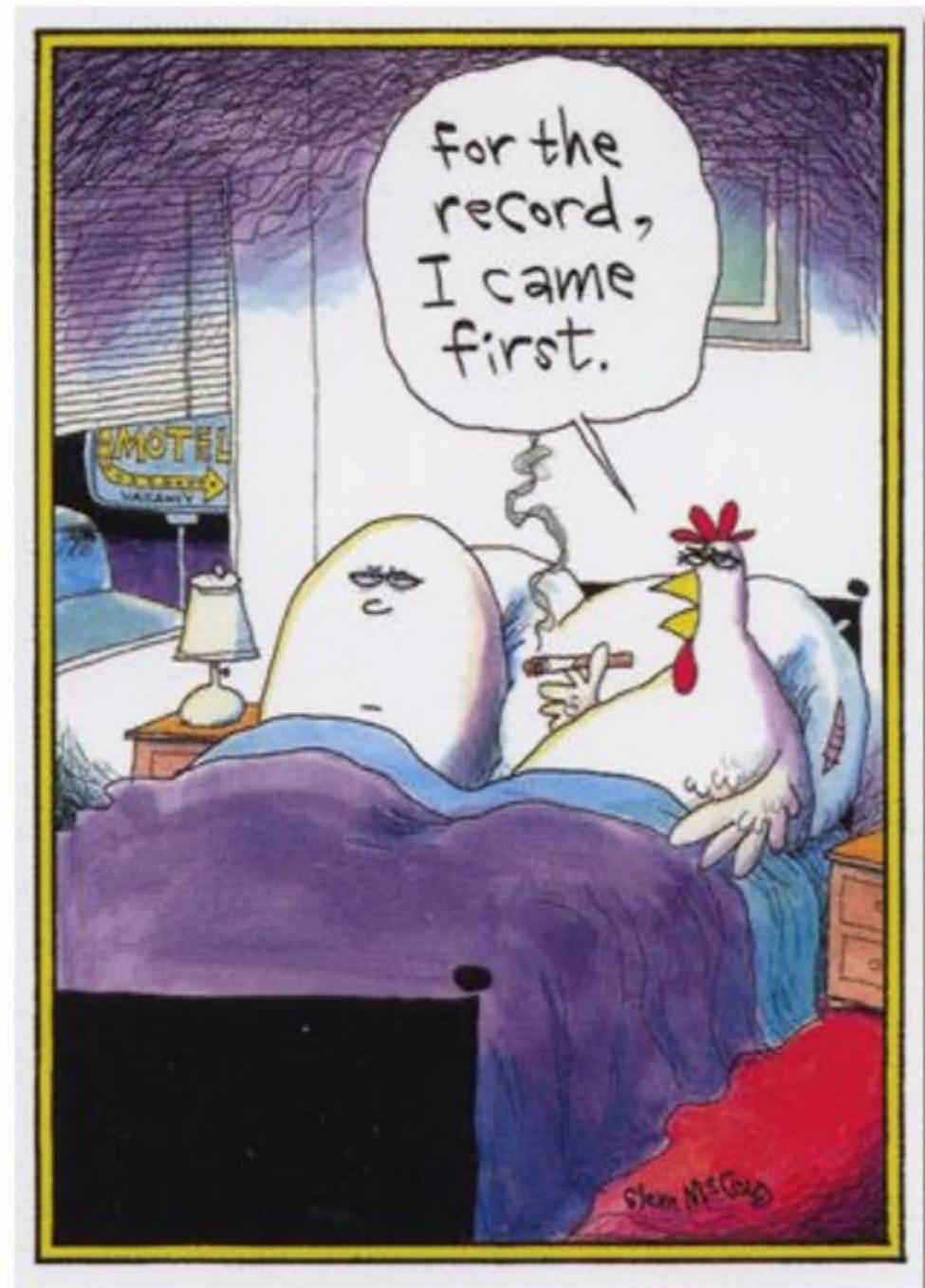
Glycans

Proteins

Lipids

Are biomolecules synthesized only through ‘bio’ means?

Which came first: life or biomolecules?



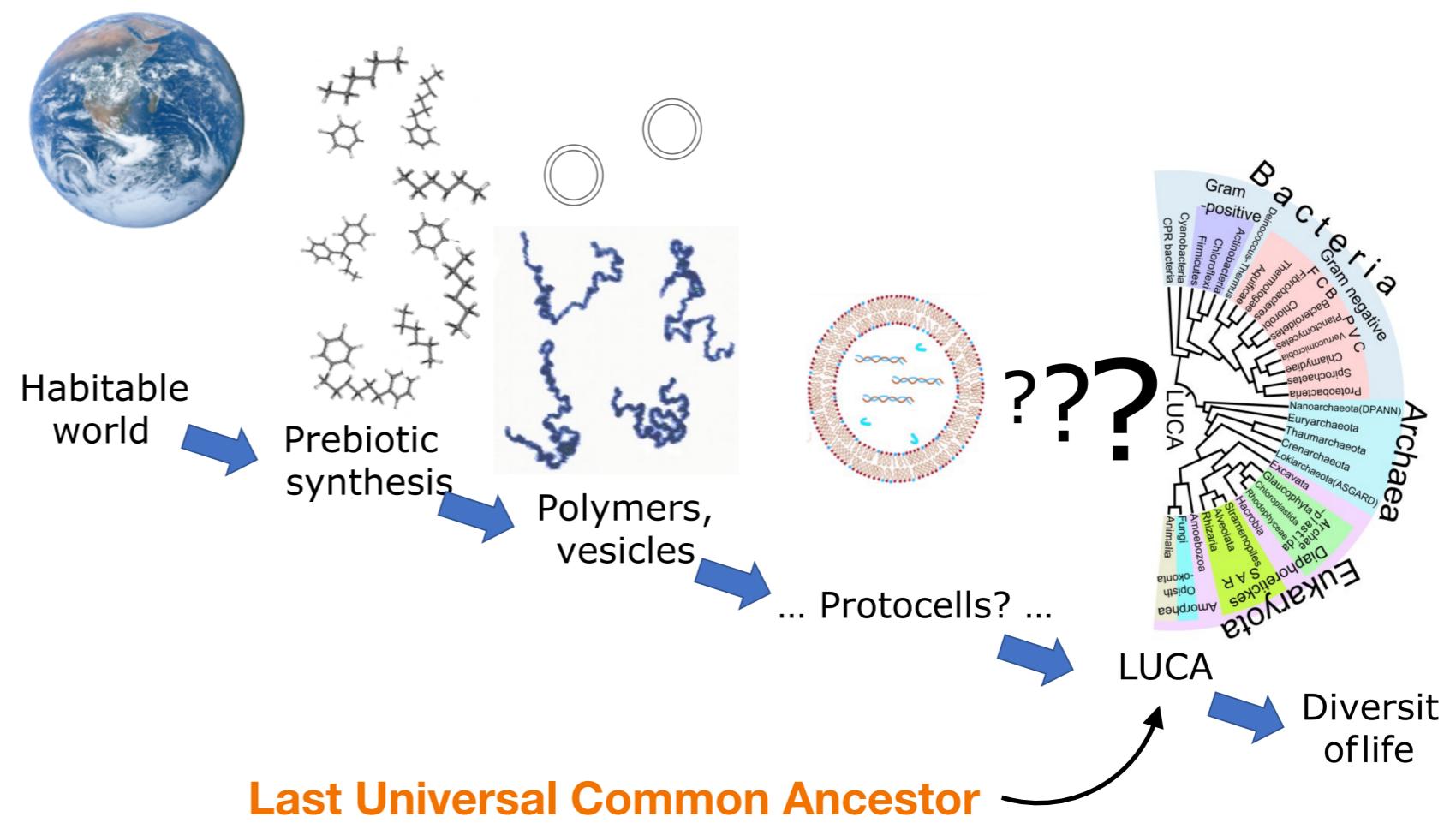
Which came first: life or biomolecules?



Most widely accepted theory

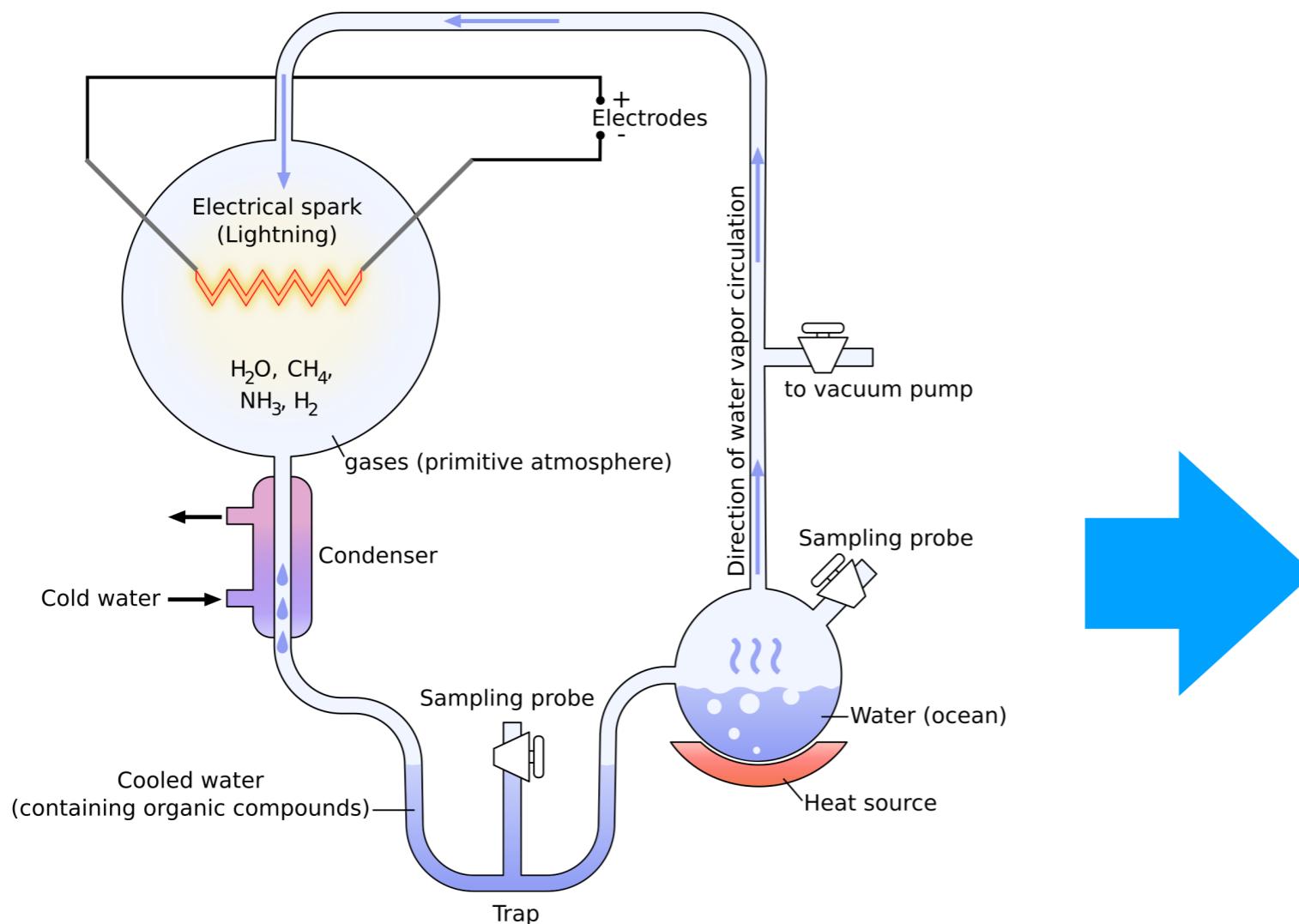
abiogenesis

from *a-* 'not' + Greek *bios* 'life' + *genesis* 'origin'



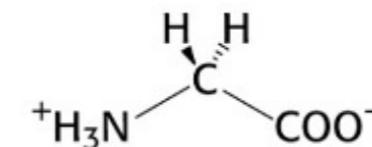
Prebiotic synthesis of biomolecules

Biomolecules first arose on the planet by chemical evolution

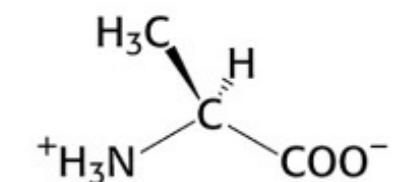


Miller-Urey experiment 1953

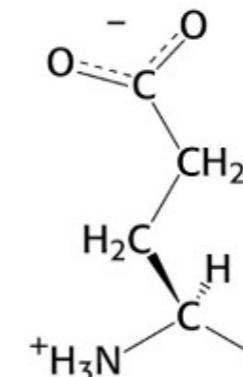
Essential amino acids



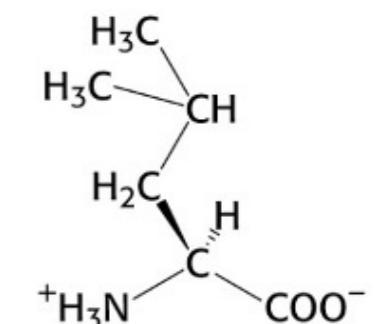
Glycine



Alanine



Glutamic acid



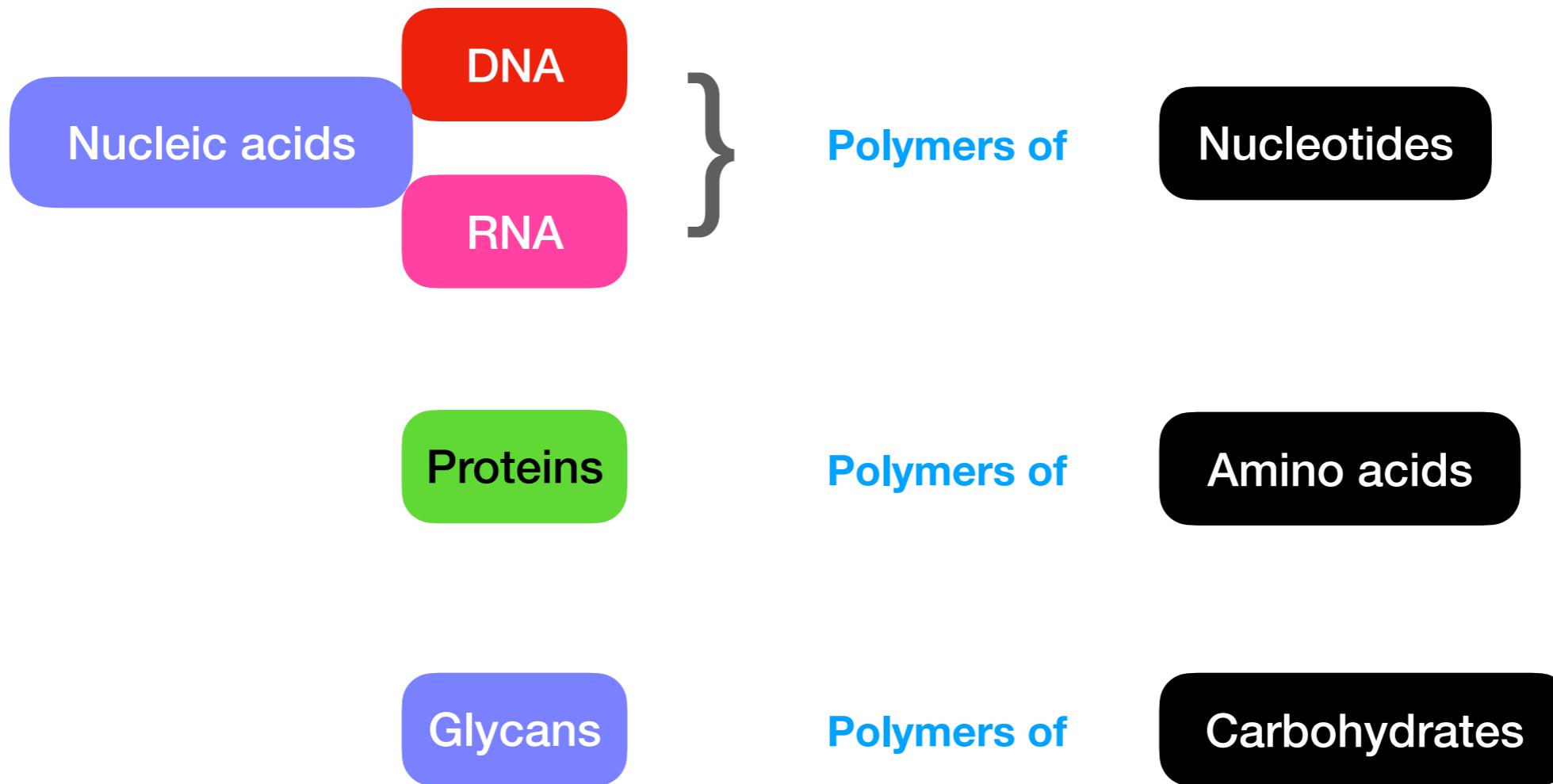
Leucine

& other organic compounds

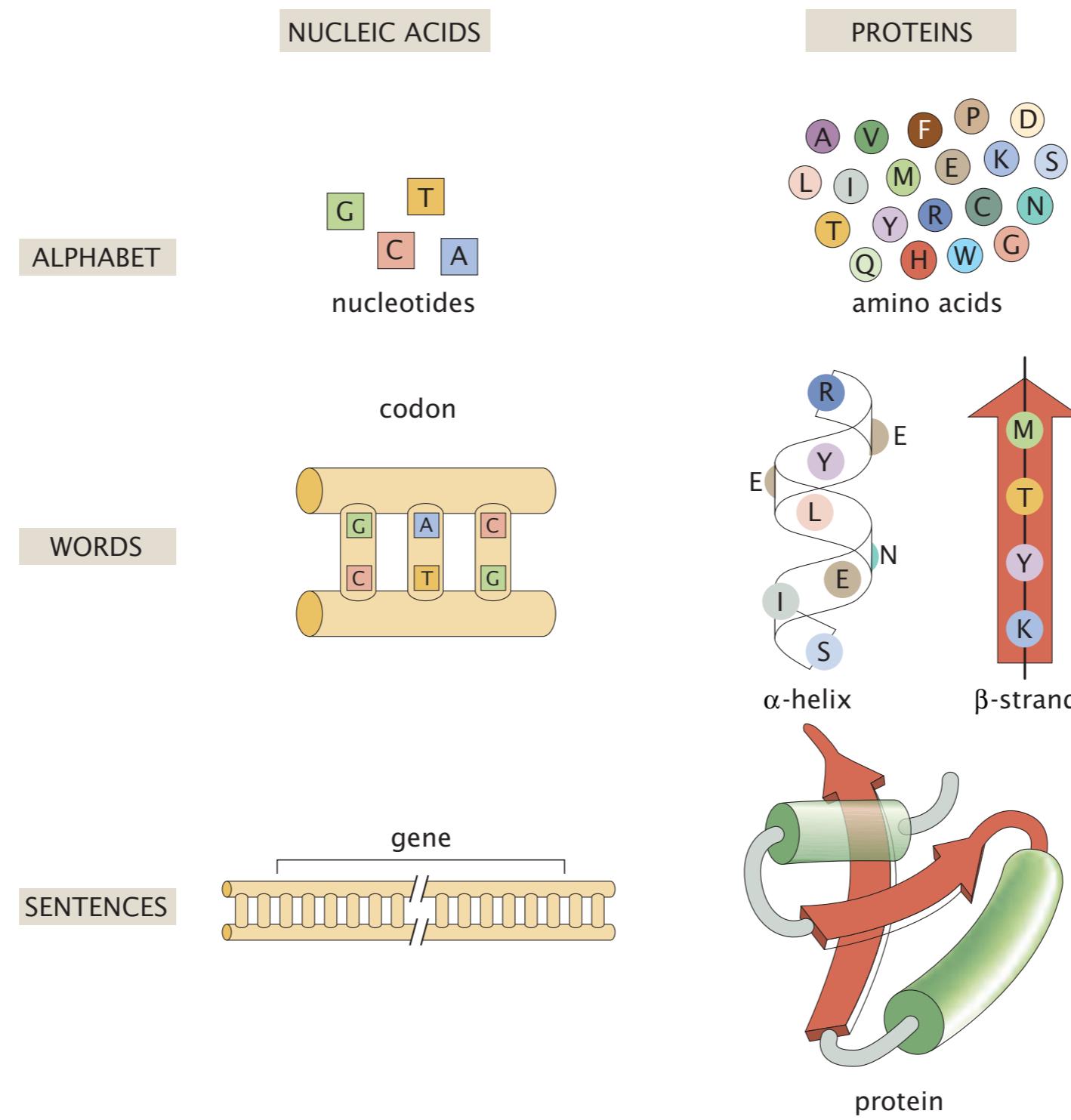
Ref: Cairns-Smith, A.G. (1966). "The origin of life and the nature of the primitive gene". *Journal of Theoretical Biology*. **10** (1): 53–88

<https://www.nasa.gov/ames/spacescience-and-astrobiology/center-for-the-emergence-of-life>

Majority of macromolecules in the cell are polymers!



Crick's “two great polymer languages”



What kind of polymers are these?

DNA and RNA are linear *heteropolymers*

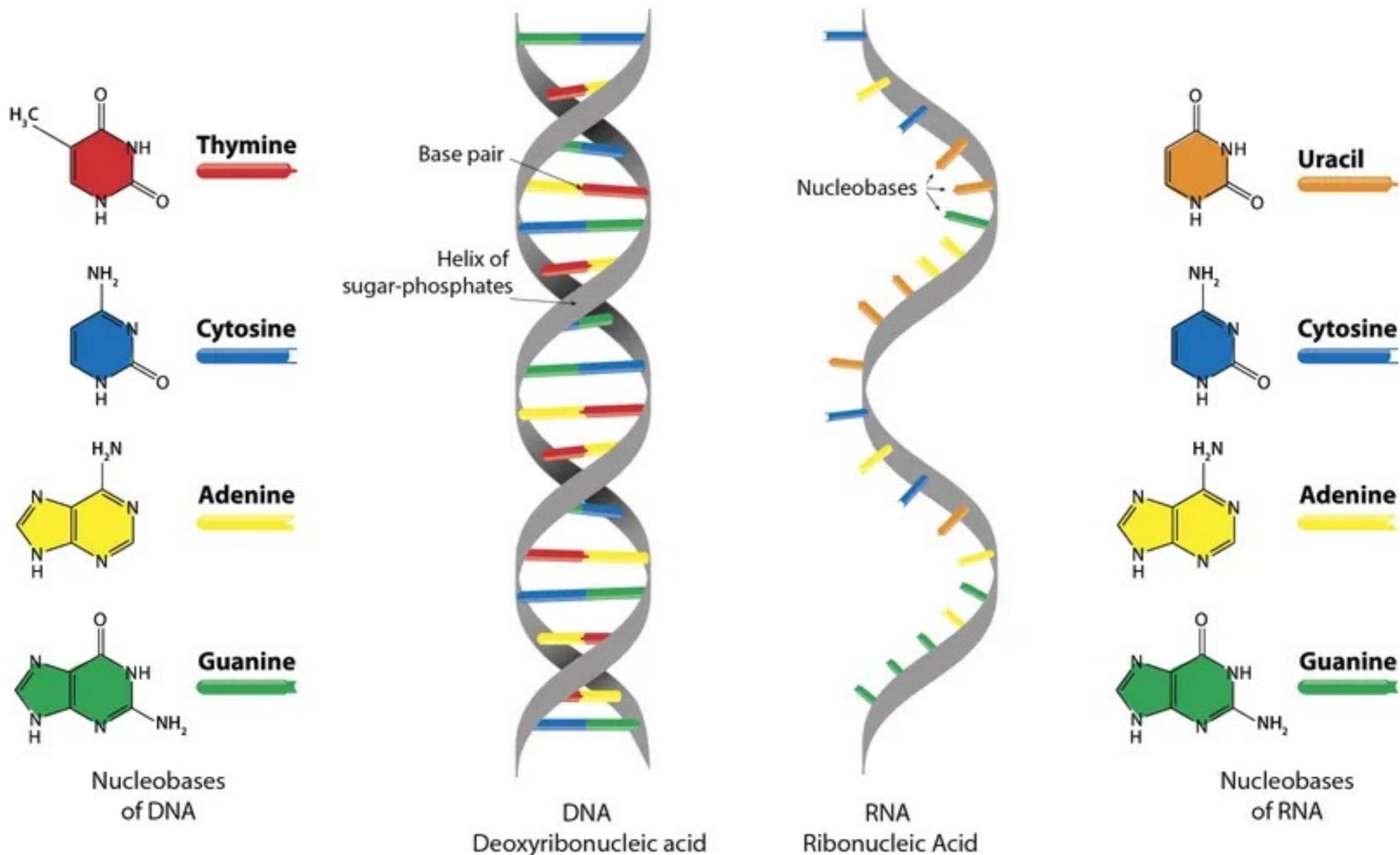
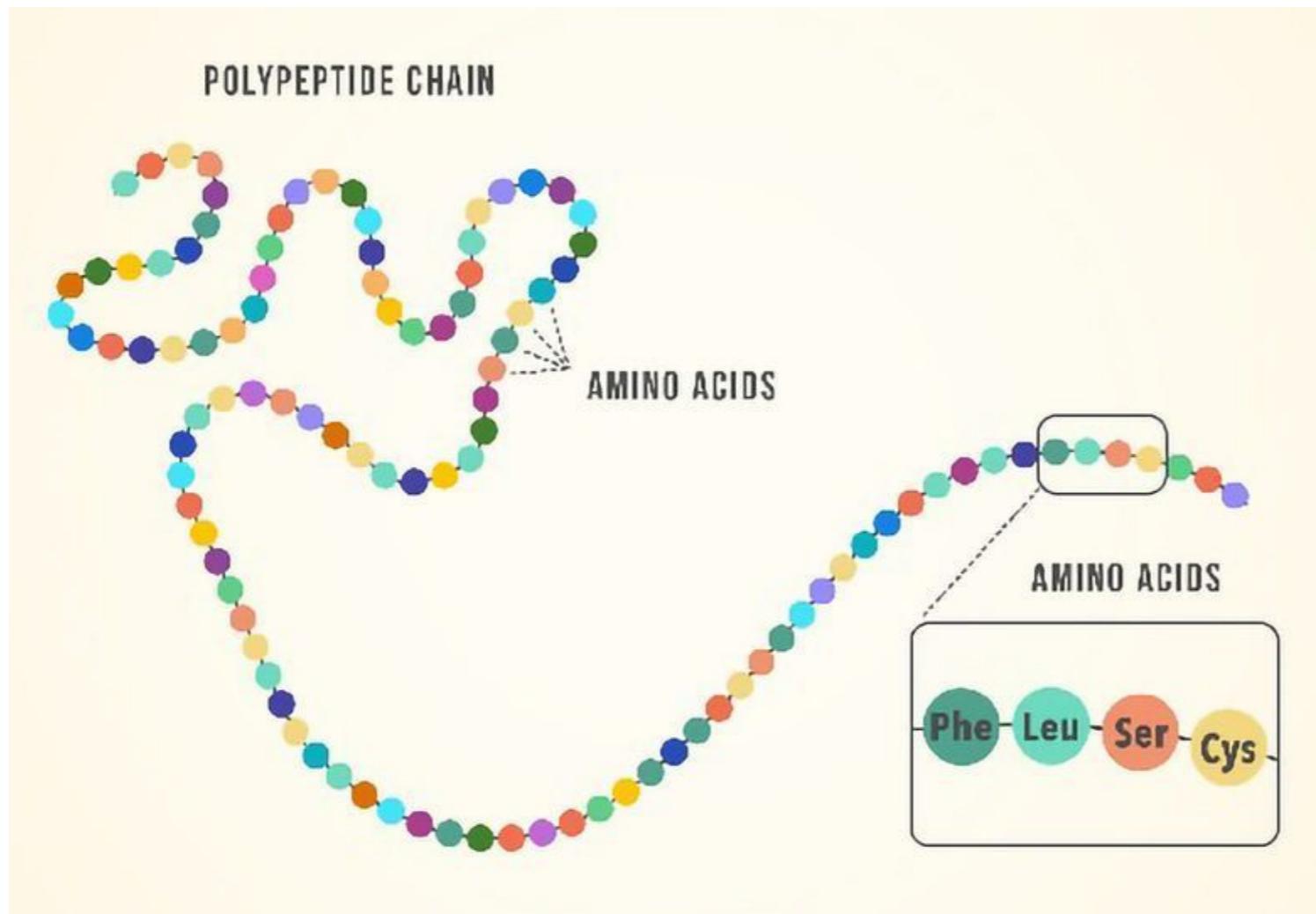


Image source: Google

What about proteins?

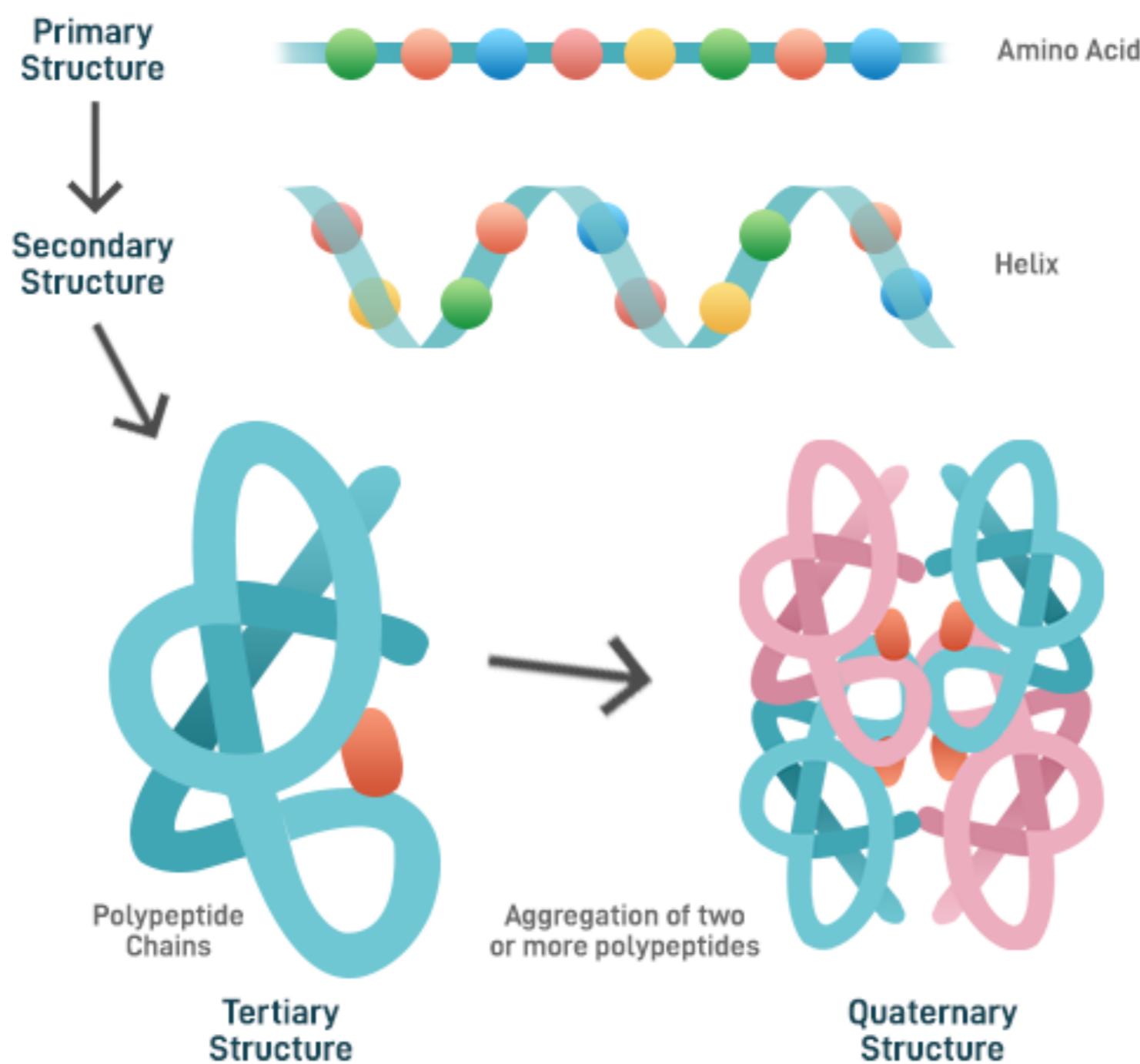


Also heteropolymers

But do the proteins exist like this in the cell?

Not really!

Structural hierarchy of a protein



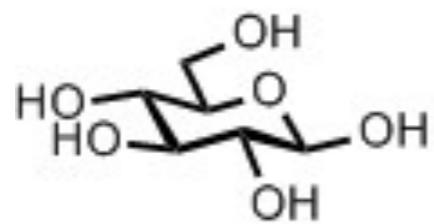
A common feature of DNA, RNA and proteins in terms of organization of the monomeric entities

They are all linear polymers

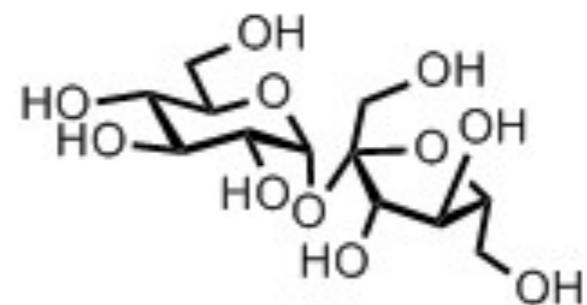
Are there non-linear polymers in biological systems?

Glycans are branched polymers

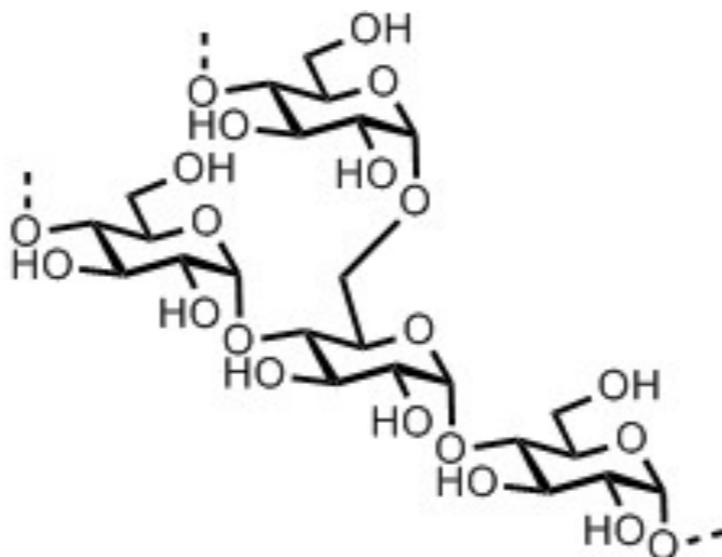
Glycans



Glucose



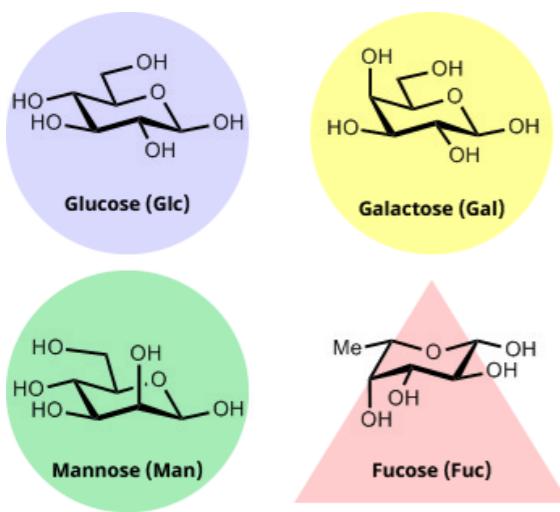
Sucrose



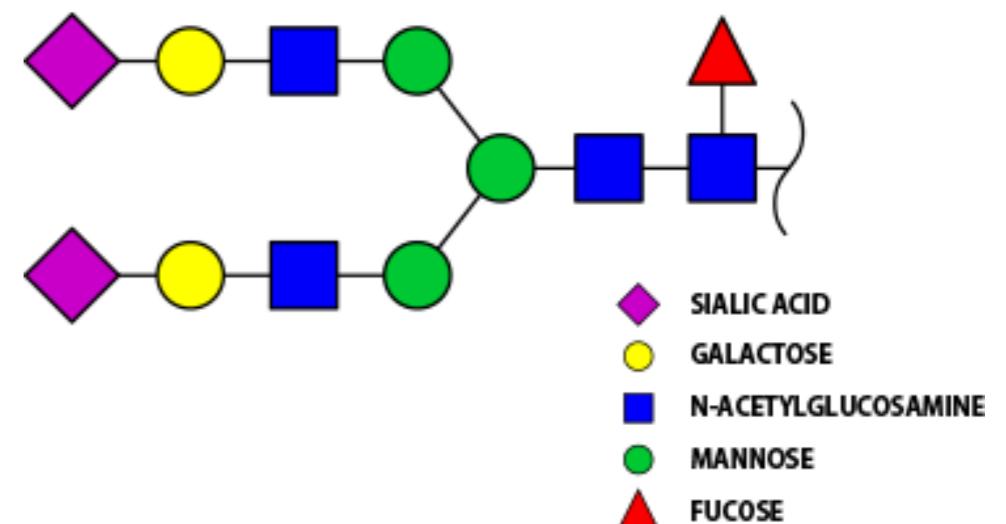
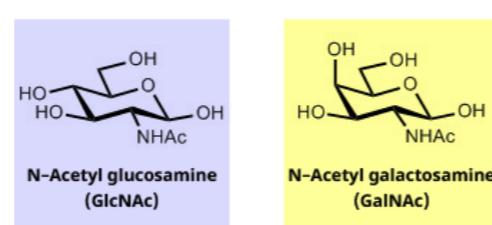
Starch

The Glycan world is vast!

Glycan structures are conventionally represented using a schematic system in which each type of monosaccharide is represented with a different color



monosaccharides



oligo-saccharides

Science is fun!



Courtesy: YouTube

Next class:

Structure and function of cells, and

Importance of energy and entropy in living systems