Chem 452 - Lecture 1
Introduction to Biochemistry
110907

Even though biology presents to us an amazing diversity of life forms, there is an underlying uniformity that connects these forms at the cellular and molecular levels. Biochemistry embodies this uniformity. In this lecture we will examine the relationship between form and function at the molecular level and will look at how chemical and physical principles can be applied to understand biological molecules.

What is "Biochemistry"

Biochemistry

From Wikipedia, the free encyclopedia

For the journal, see Biochemistry (journal).

"Biological Chemistry" redirects here. For the journal formerly named Biological Chemistry Hoppe-Seyler, see Biological Chemistry (journal).

This article **needs additional citations for verification**. Please help improve this article by adding reliable references. Unsourced material may be challenged and removed. *(June 2011)*

Biochemistry, sometimes called **biological chemistry**, is the study of chemical processes in living organisms, including, but not limited to, living matter. Biochemistry governs all living organisms and living processes. By controlling information flow through biochemical signalling and the flow of chemical energy through metabolism, biochemical processes give rise to the incredible complexity of life. Much of biochemistry deals with the structures and functions of cellular components such as proteins, carbohydrates, lipids, nucleic acids and other biomolecules although increasingly processes rather than individual molecules are the main focus. Over the last 40 years biochemistry has become so successful at explaining living processes that now almost all areas of the life sciences from botany to medicine are engaged in biochemical research. Today the main focus of pure biochemistry is in understanding how biological molecules give rise to the processes that occur within living cells which in turn relates greatly to the study and understanding of whole organisms.

Among the vast number of different biomolecules, many are complex and large molecules (called *biopolymers*), which are composed of similar repeating subunits (called *monomers*). Each class of polymeric biomolecule has a different set of subunit types.[1] For example, a protein is a polymer whose subunits are selected from a set of 20 or more amino acids. Biochemistry studies the chemical properties of important biological molecules, like proteins, and in particular the chemistry of enzyme-catalyzed reactions.

The biochemistry of cell metabolism and the endocrine system has been extensively described. Other areas of biochemistry include the genetic code (DNA, RNA), protein synthesis, cell membrane transport, and signal transduction.

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What is "Biochemistry"

- If biochemistry is the study of the chemical process in living systems, what are some examples of **living systems?**

Biology is Varied and Complex

What is "Biochemistry"

- How can we possibly study all of these livings systems?

What is "Biochemistry"

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BACTERIA	EUKARYA	ARCHAEA
Escherichia	*Saccharomyces*	*Methanococcus*
Salmonella	*Zea*	*Archaeoglobus*
Bacillus		*Halobacterium*
	Homo	

What is "Biochemistry"

- How can we possibly study all of these livings systems?

What is "Biochemistry"

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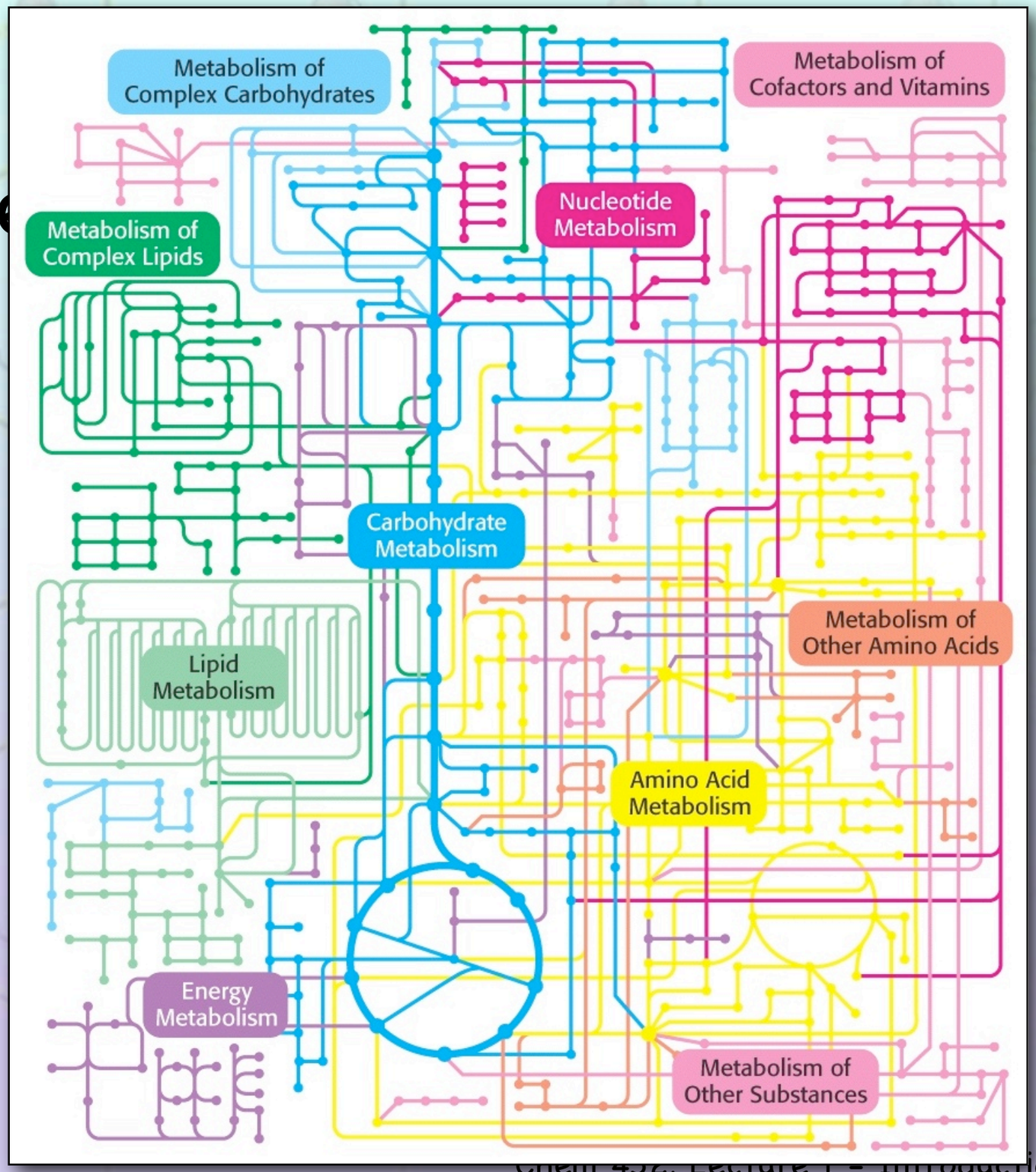

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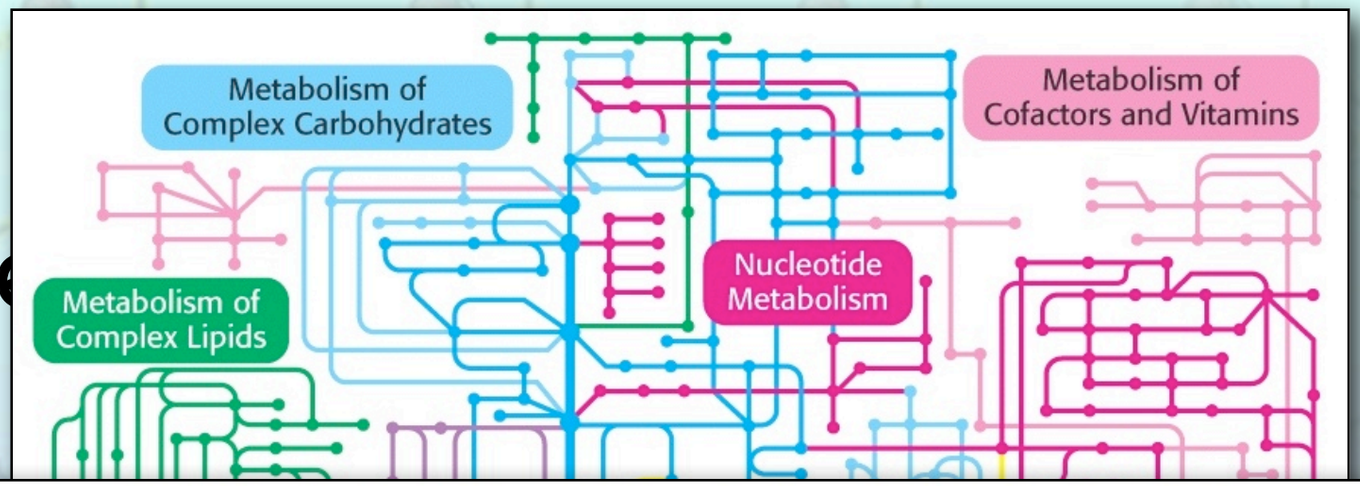

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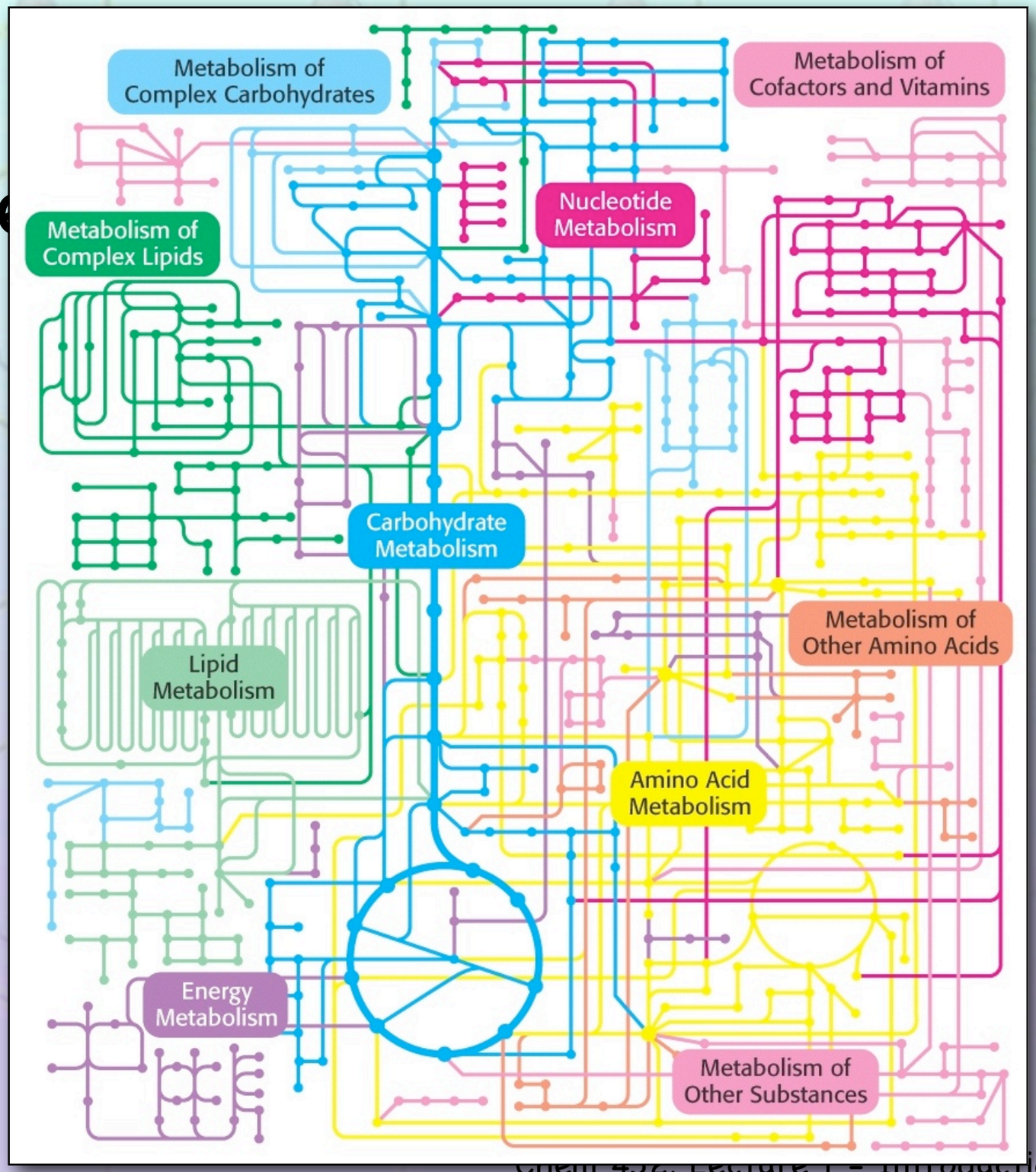
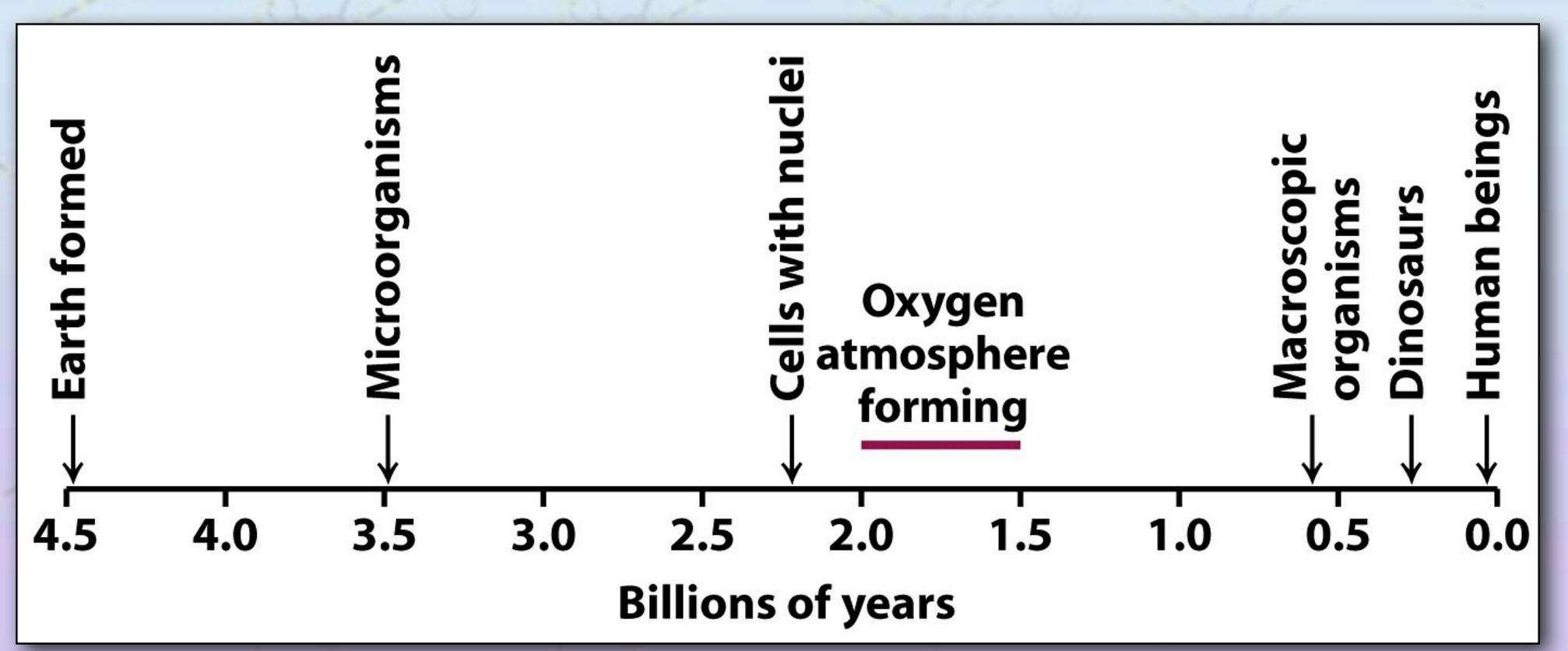


Biology is Varied and Complex

- At the molecular level, living systems look remarkably similar.
  - This similarity is a reflection of how life evolved on earth



Biology is Varied and Complex

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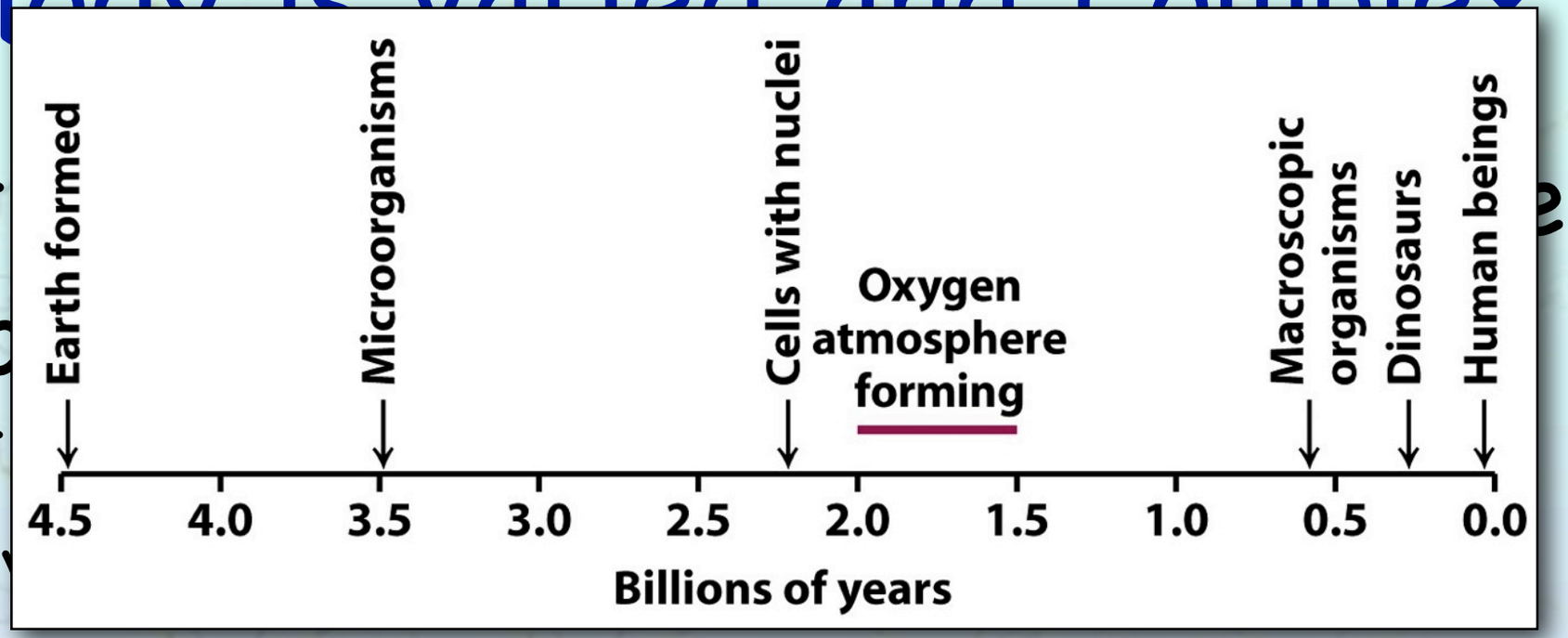

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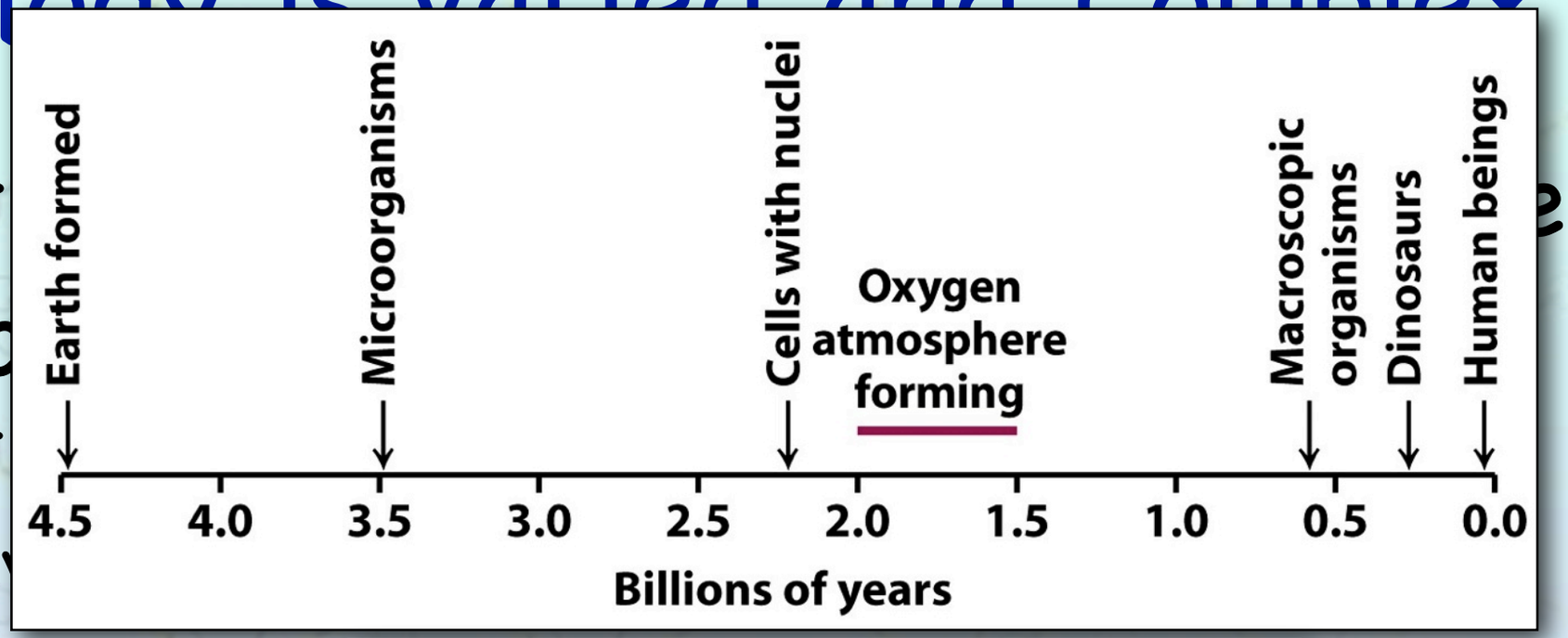

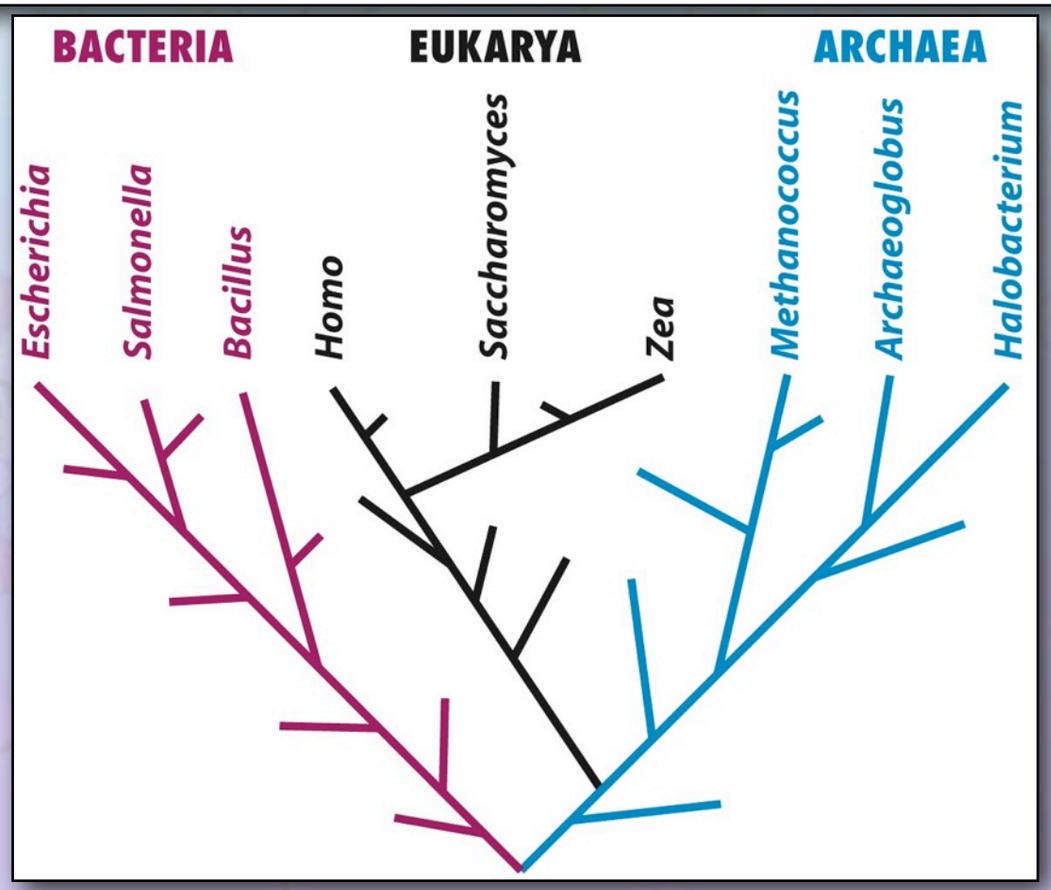

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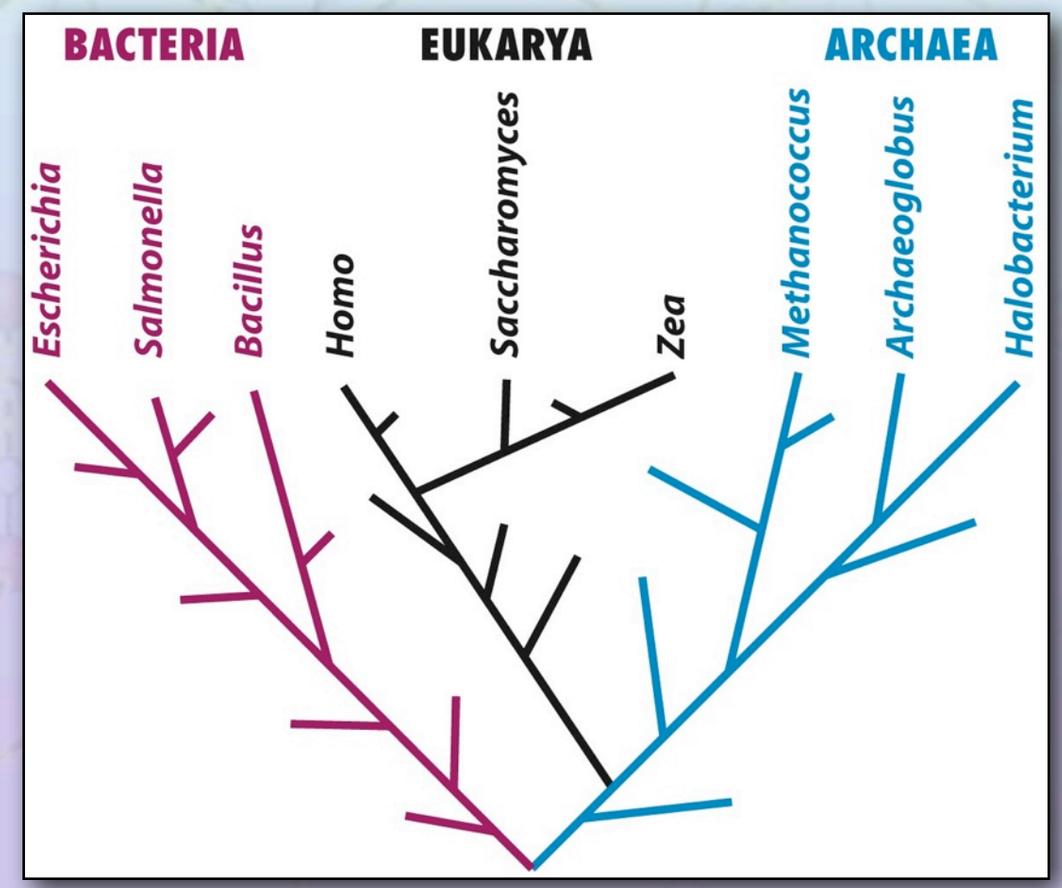
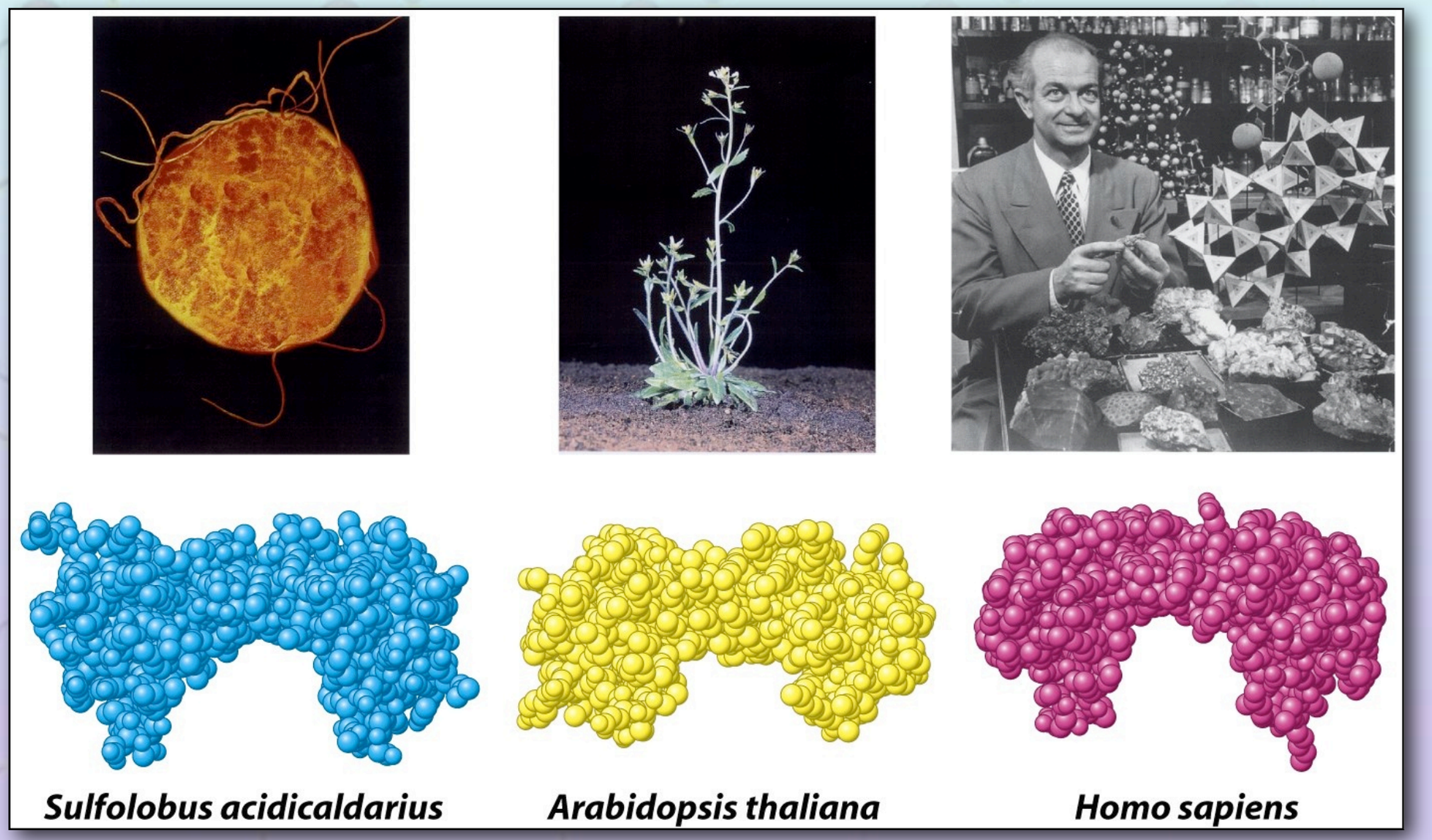


Biology is Varied and Complex

- Biochemistry unifies biology
  - Macromolecules and metabolites



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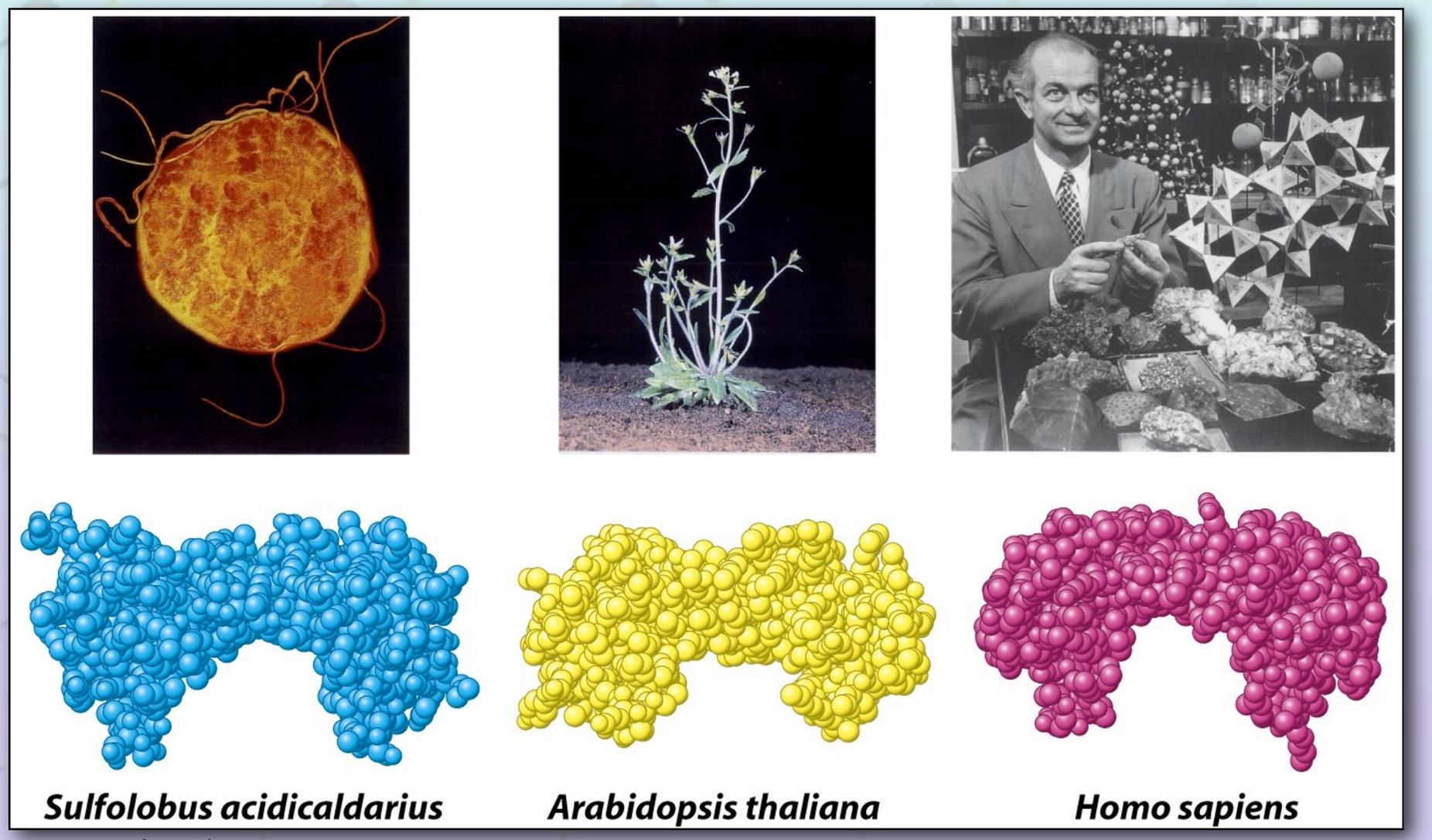

Archaea

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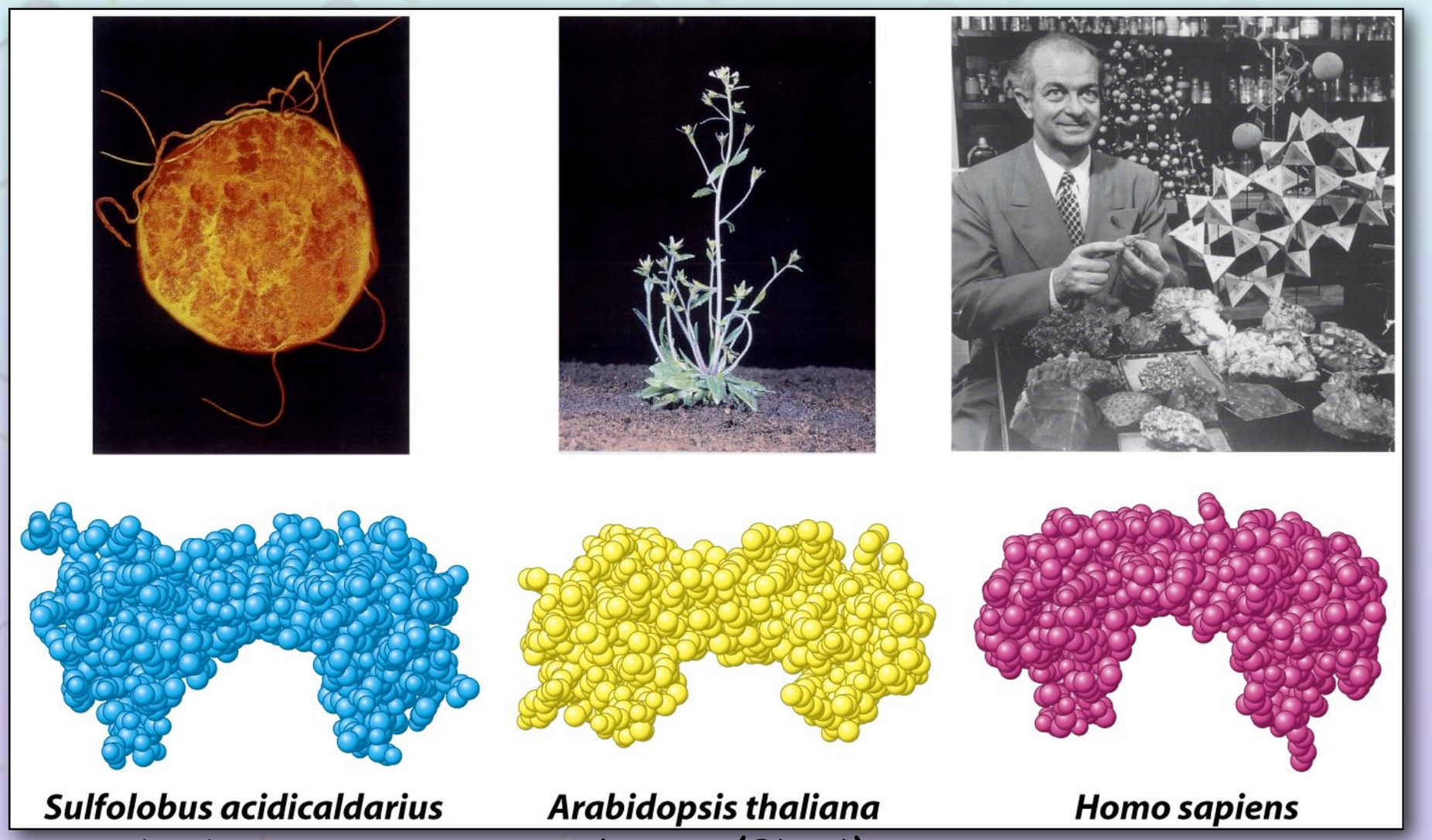

Archaea Eukarya (Plant)

Biology is Varied and Complex

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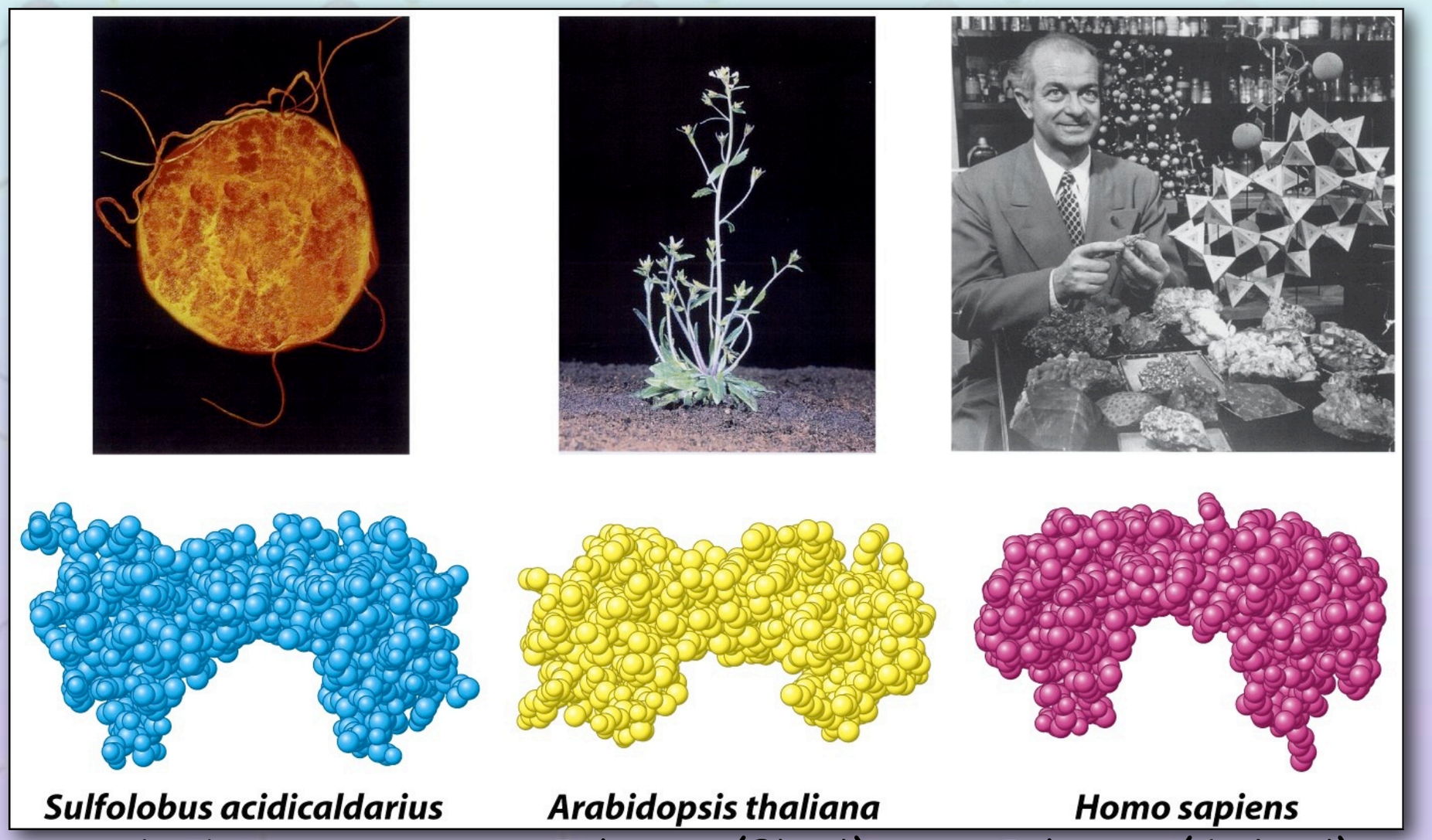
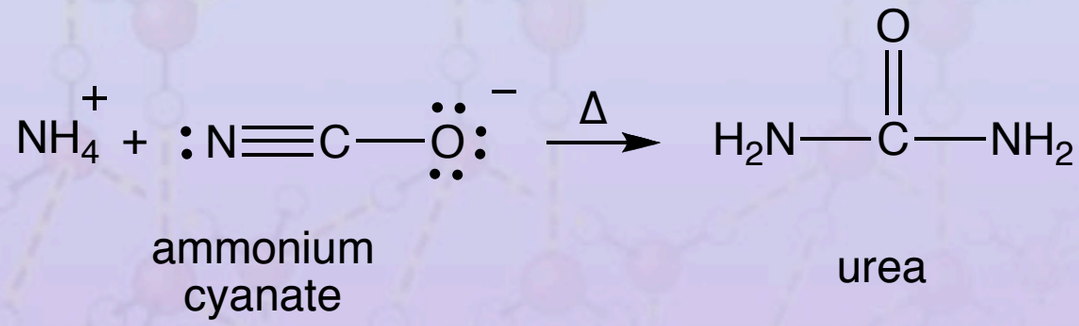


Archaea Eukarya (Plant) Eukarya (Animal)

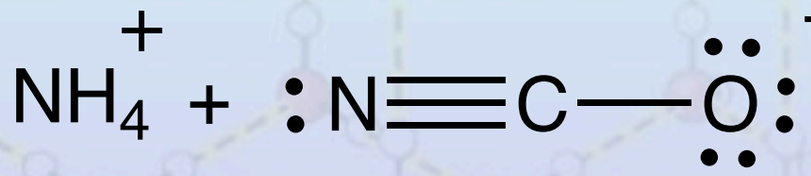
A brief history of Biochemistry

- Fredrich Wöhler (1800-1882)
  - Demonstrated in 1828 that urea, a compound that had only been associated with living cells, could be synthesized from an inorganic compound outside of the cell.



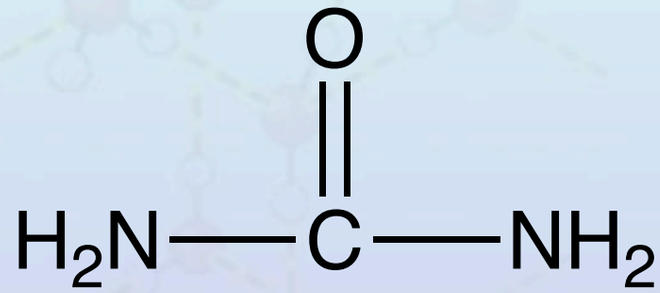
A brief history of Biochemistry

- Predict and compare the physical properties of



ammonium cyanate

and



urea

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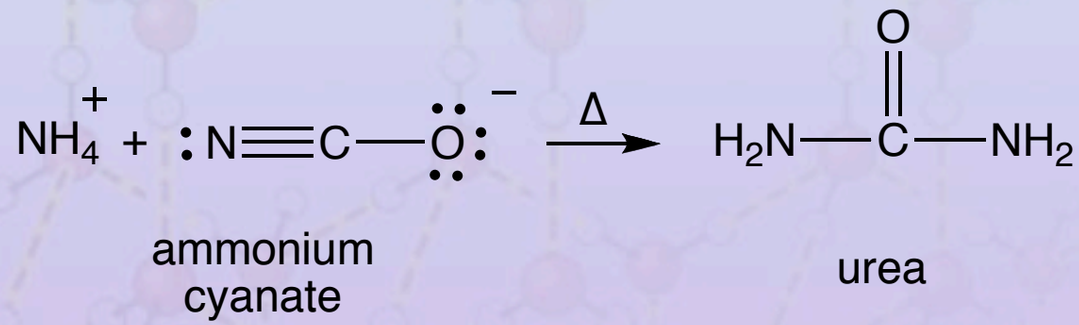
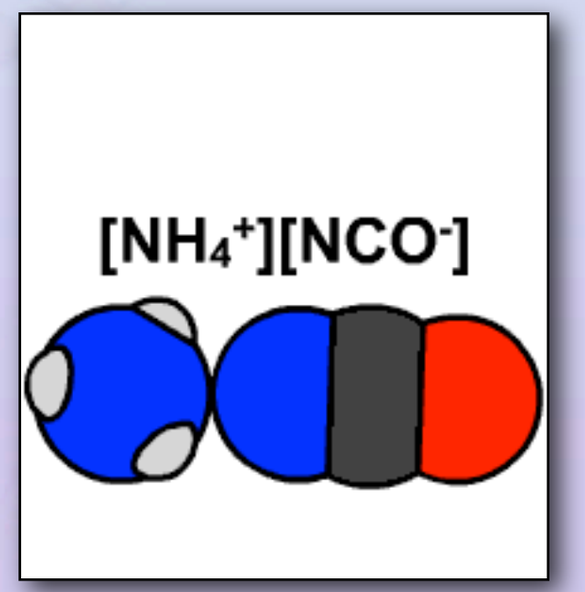
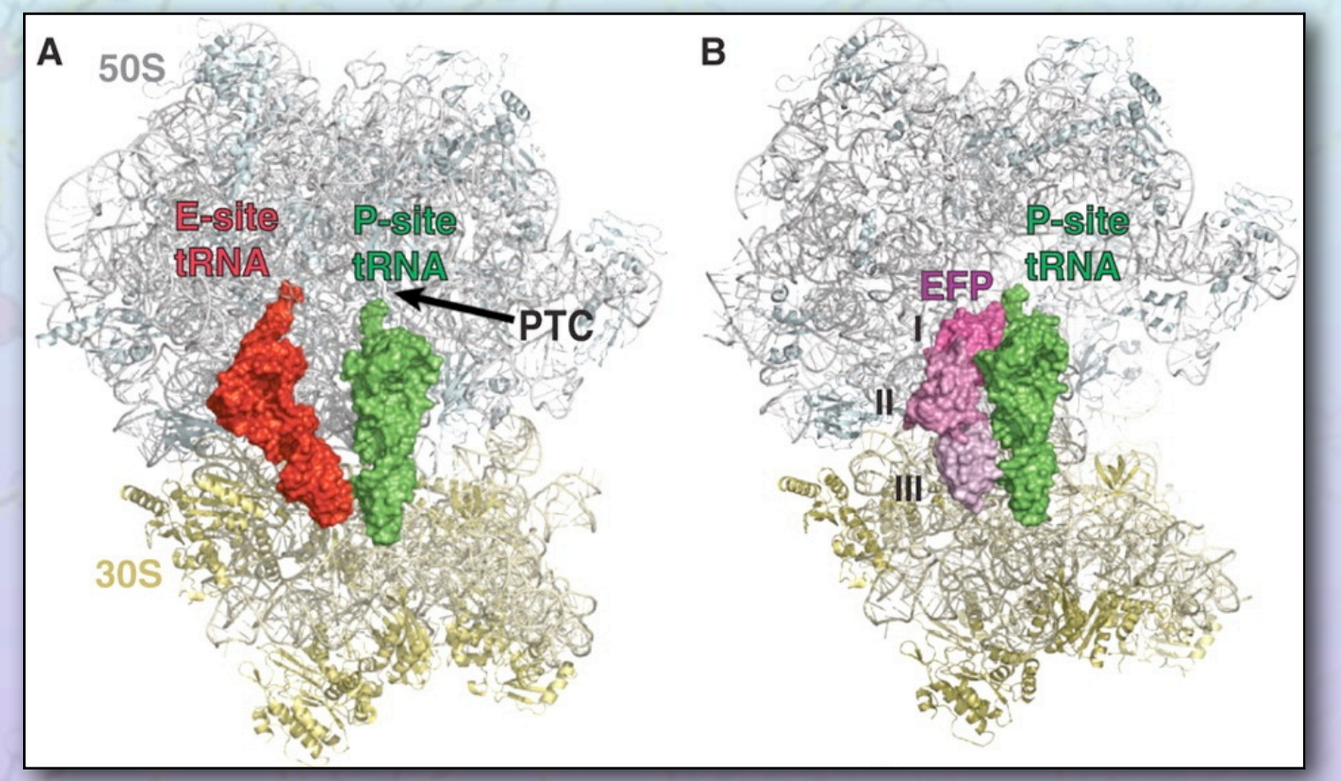




A brief history of Biochemistry

- Roll forward to 2009 (181 years later)
  - We can now view the steps of protein synthesis by ribosomes at the atomic level



Blaha *et al.*, "Formation of the First Peptide Bond: The Structure of EF-P Bound to the 70S Ribosome" *Science* **2009**, *325*, 966-970.

A brief history of Biochemistry

- Nobel Prize in Chemistry, 2009

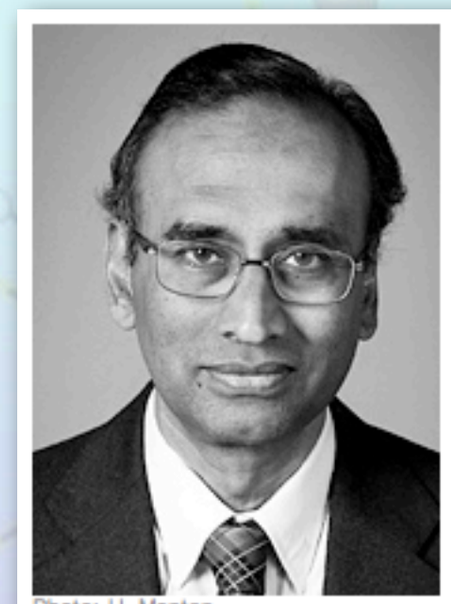


Photo: U. Montan

Venkatraman Ramakrishnan

Photo: U. Montan

Thomas A. Steitz

Photo: U. Montan

Ada E. Yonath

The Nobel Prize in Chemistry 2009 was awarded jointly to Venkatraman Ramakrishnan, Thomas A. Steitz and Ada E. Yonath *"for studies of the structure and function of the ribosome"*.

Nobel Prize Committees News Release

Using Jmol to view structures

- Styer's companion website (6th Ed.) and "Living Figures"

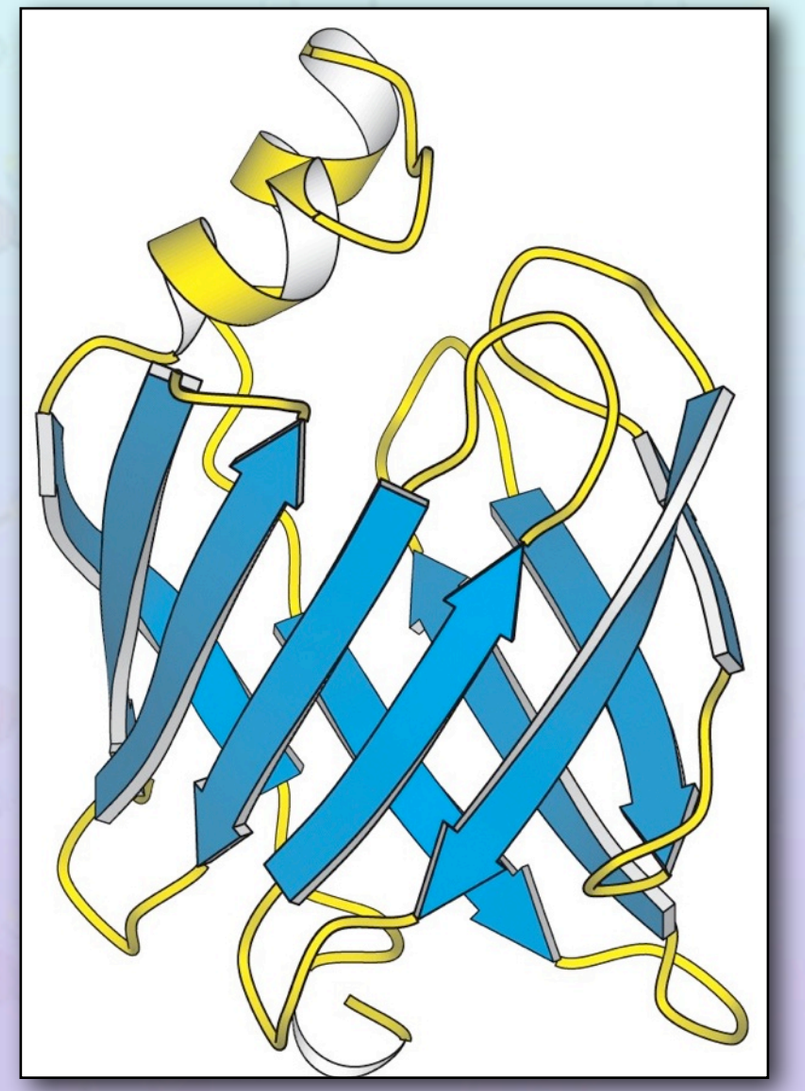


Figure 2.40 A protein rich in β sheets. The structure of a fatty acid b-binding proteins [Drawn from 1FTP.pdb]

Looking ahead to Friday (110909)

- Review DNA structure and function
- Review non-covalent interactions.
- Review the properties of water and the hydrophobic effect
- Review Thermodynamics
- Problem Assignment for Chapter 1