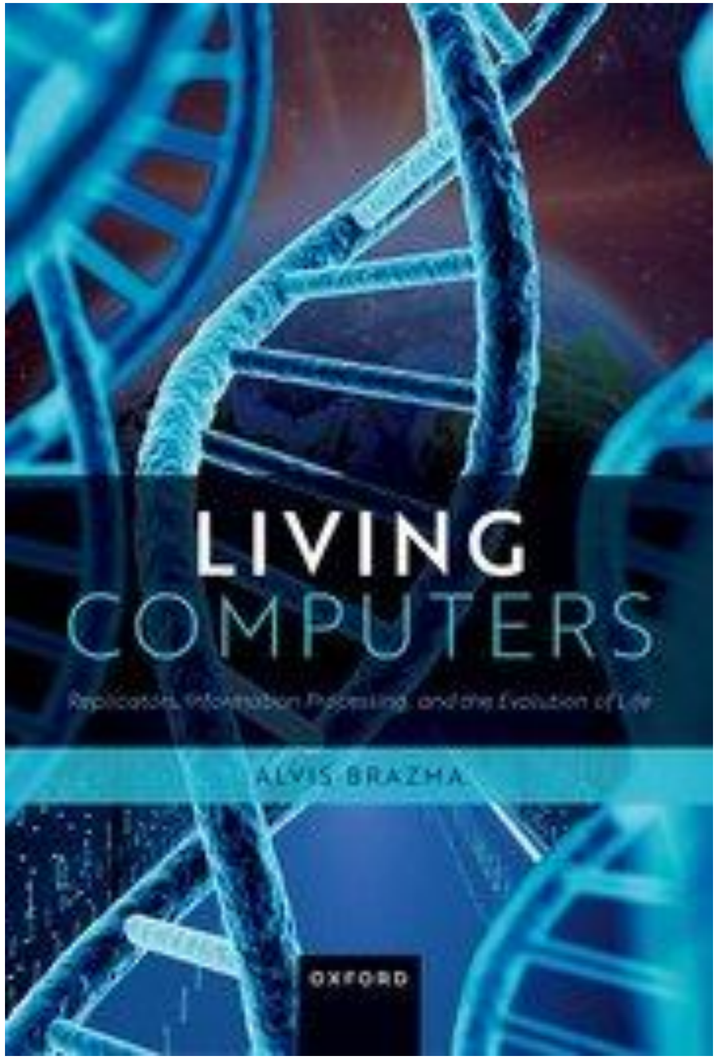
Pirmā tikšanās ar Alvja Brāzmas grāmatu «Living Computers»

Seminar of the Science and Religion Dialogue Group (ZuRD),

September 27, 2023.

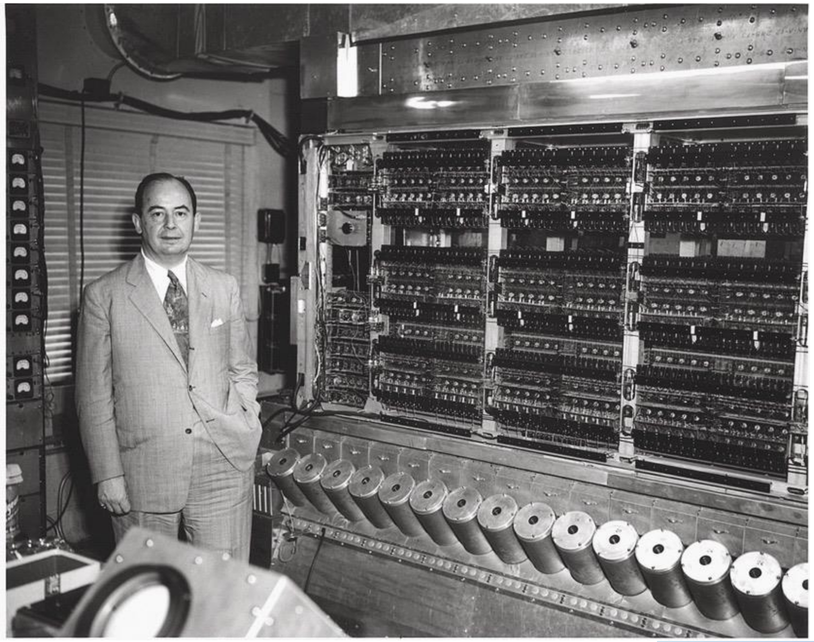
Dainis Zeps

Alvis Brāzma «Living Computers»



- From https://global.oup.com/academic/product/living-computers-9780192871947?cc=lv&lang=en&
- About what in the book of professor of Oxford University Alvis Brāzma?
  - Replicators, Information Processing, and the Evolution of Life
    - Explores biology from the perspective of information science and computing, treating evolution as a computational process
    - Proposes an underlying thesis that life and the recording of information have emerged jointly and inseparably
    - Describes the major information processing transitions in the evolution of life, from the polymers of prelife to the computer clouds of today
    - Describes the major information processing transitions in the evolution of life, from the polymers of prelife to the computer clouds of today
    - Argues that the emergence of human language was a transition as remarkable as the dawn of life itself
    - Provides the reader with the information to speculate on our future existence

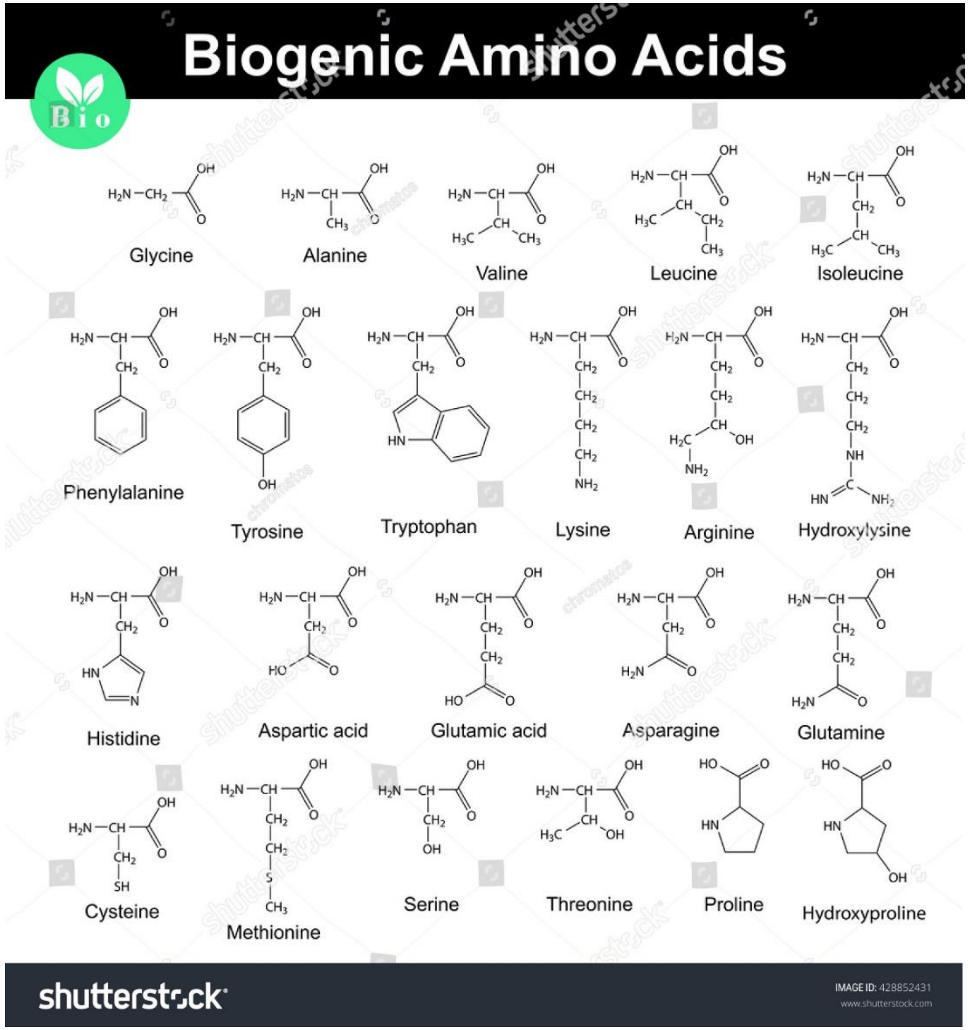
Informatics about biology of life before life



- John von Neumann in front of a computer at the Institute for Advanced Study in Princeton in 1952.

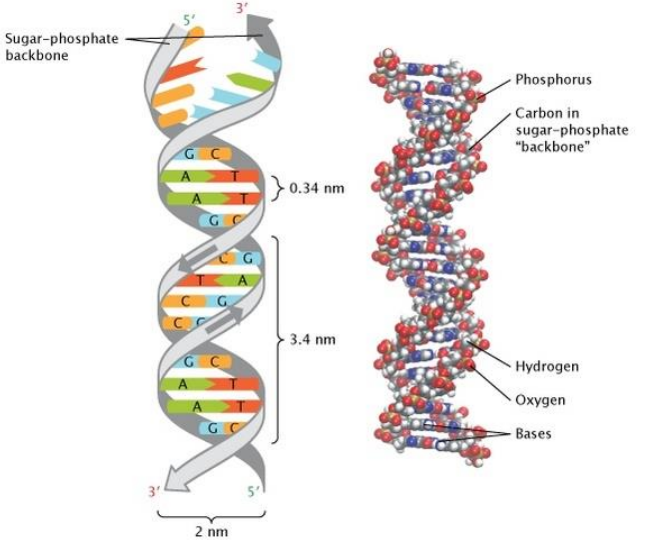
- Mechanical replicator problem and selfreplication
- Turing machine and UTM
- Church lambda calculus, Church-Turing thesis
- Kolmogorov complexity and Second law of TD:
  - Kolmogorov and Chaitin proved mathematically that if the number of objects or digits is large, then only a small proportion of the arrangements have a description shorter than their enumeration, and the larger the number, the smaller the proportion.

Amino acids building blocks and alphabet of the life /double helix



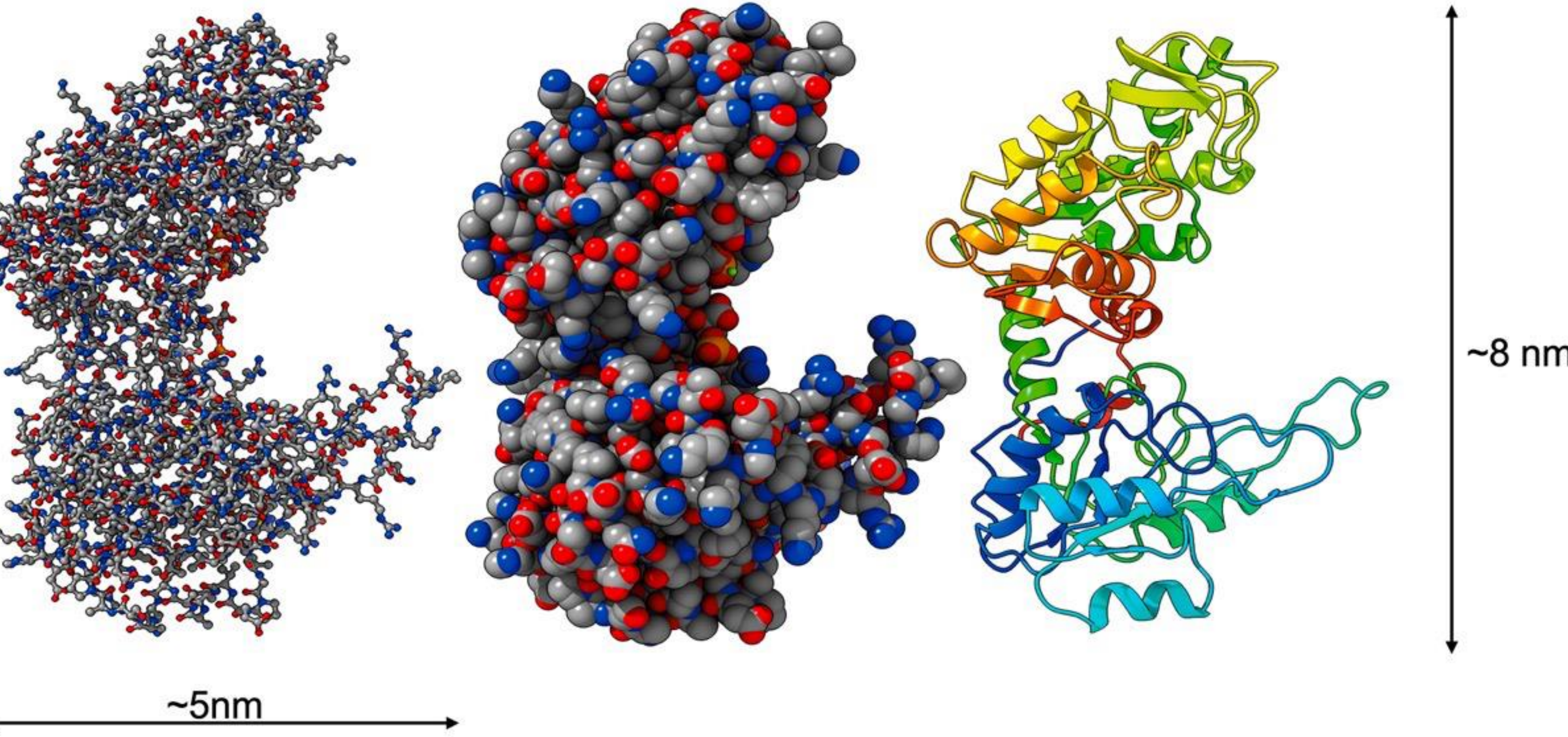
- Nature of life has 20 amino acids which are designated with Latin letters

- **Discovery of DNA Structure and Function: Watson and Crick**



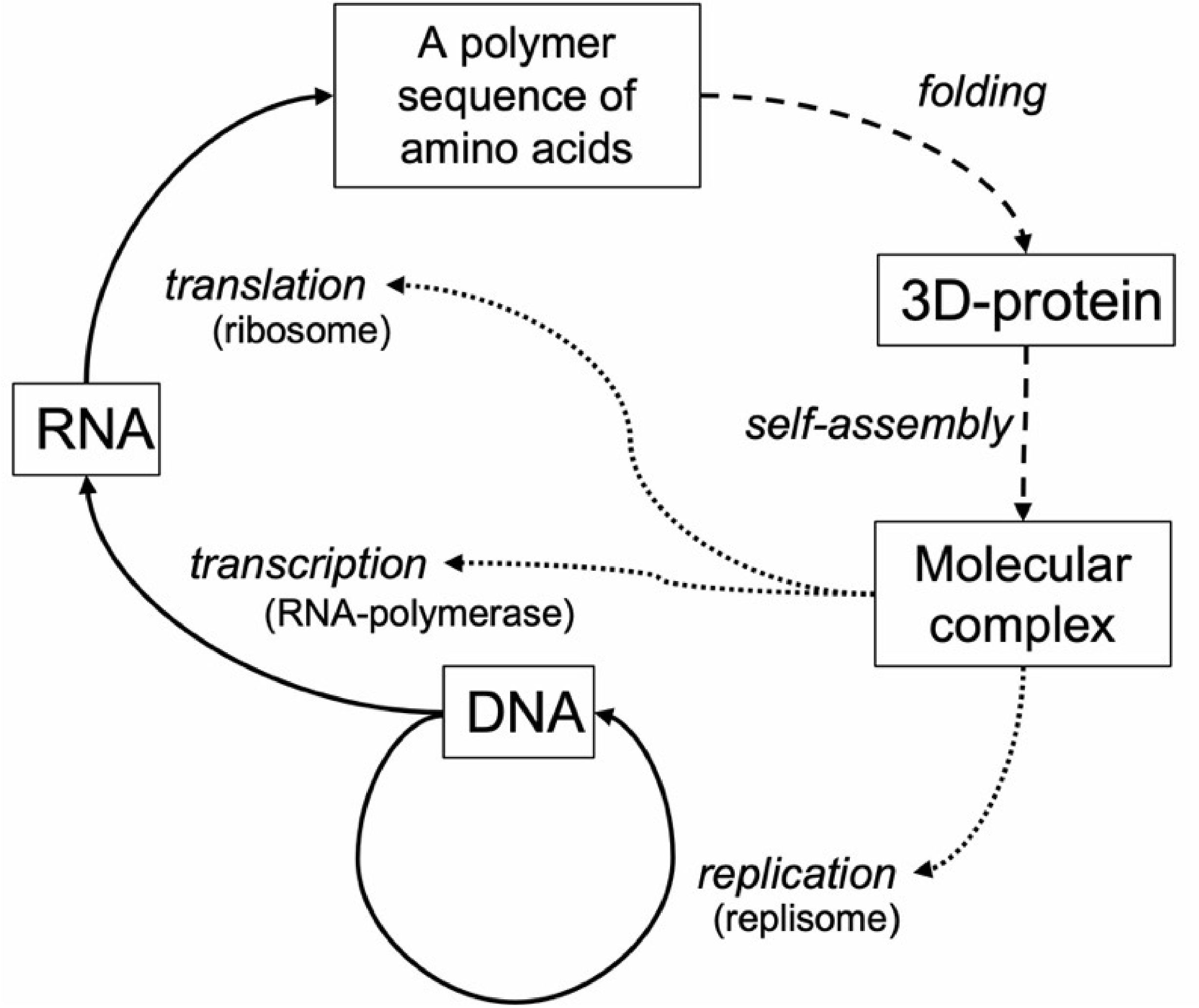
Book of Gennady Dlyasin

- The ABC of Hermes Trismegistus, or the Molecular Secret Writing of Thinking. G. Dlyasin.
- We have discussed this book in our seminars.
- The author himself has talked about his scientific affairs in this direction and some similar to this.
- About the alphabet of life and how amino acids work to arrange the living matter of life.


~5nm
~8 nm

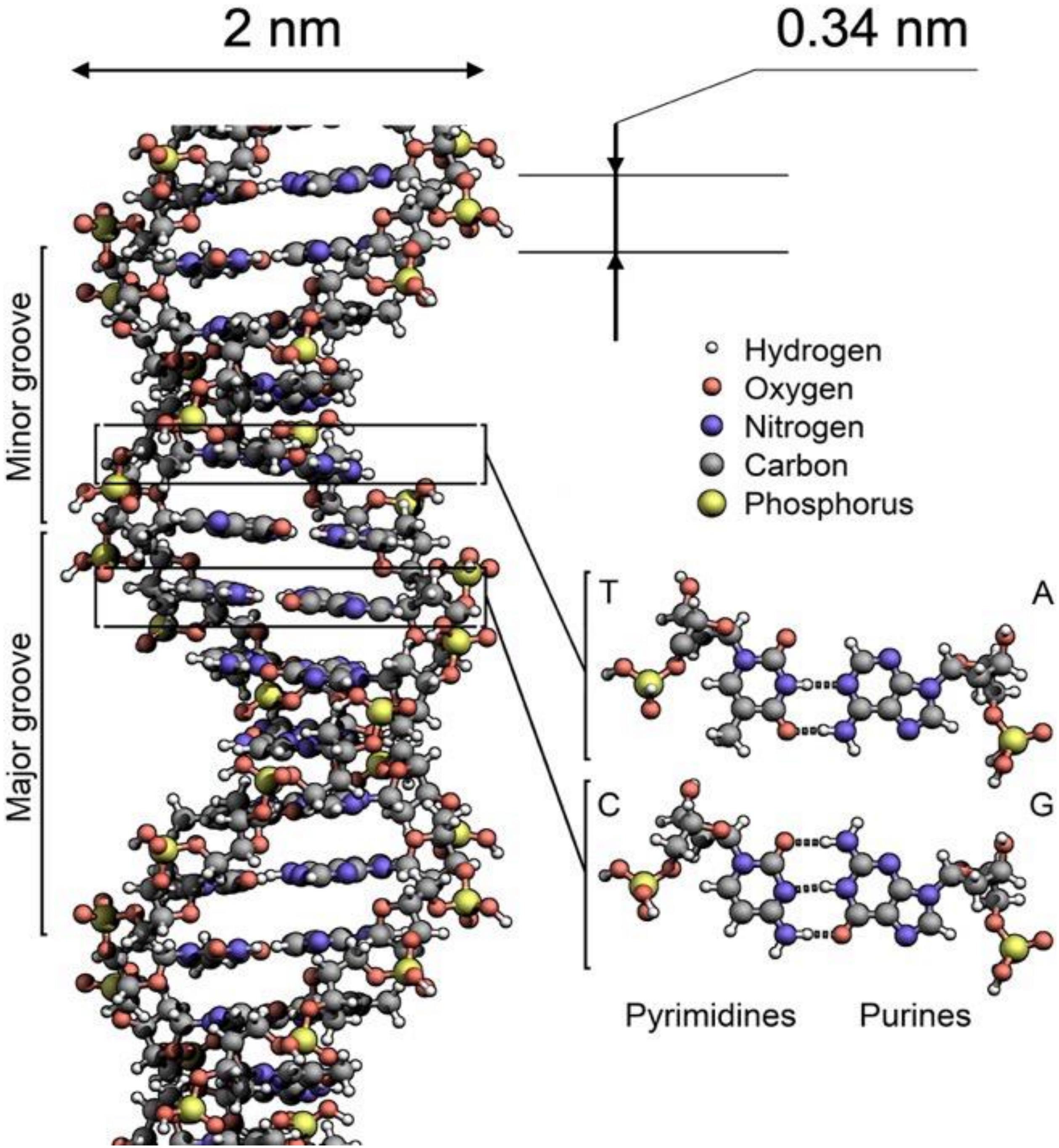
Pages 57 Three different models of the structure of the protein called *phosphoglycerate kinase*—PGK enzyme

- 3D molecular complex:
- The monomers that make up a protein—*amino acids*—are small molecules made of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sometimes sulphur (S) atoms. Among the 20 different amino acids, the smallest one—glycine—consist of just 10 atoms ($C_2H_5NO_2$), while the largest one—tryptophan—of 27-atoms ($C_{11}H_{12}N_2O_2$). Thus, there is a hierarchy in nature: five different chemical elements are combined to make 20 different amino acids, which then are linked in various orders to make billions of different proteins. There is convention to denote different amino acids by different Lattin letters. For instance, glycine is denoted by G, while tryptophan by W. To give a few more examples, M stands for methionine, S for serine, and L stands for leucine. The amino acid sequence of the PGK protein shown in Figure 3.1, can be spelled out as:
- MSLSSKLSVQDLDLKDKRVFIRVDFNVPLDGKKITSNQRIVAALPTIKYVLEHHPRYVVLASHLGRPNG
ERNEKYSLAPVAKELQSLLGKDVTFLNDCVGPEVEAAVKASAPGSVILLENLRYHIEEEGSRKVDGQKV
KASKEDVQKFRHELSSLADVYINDAFGTAHRAHSSMVGFDLPQRAAGFLLEKELKYFGKALENPTRPF
LAILGGAKVADKIQLIDNLLDKVDSIIIGGGMAFTFKKVLENTEIGDSIFDKAGAEIVPKLMEKAKAKGV
EVVLPVDFIIADAFSADANTKTVTDKEGIPAGWQGLDNGPESRKLFAATVAKAKTIVWNGPPGVFEF
EKFAAGTKALLDEVVKSSAAGNTVIIGGGDTATVAKKYGVTDKISHVSTGGGASLELLEGKELPGVAFL
SEKK



3 – 1 correspondence

- How 3D protein folds into 1D sequence of amino acids?
- How 1D code unfolds into living 3D molecular complex of protein?



DNA structure

- Two nucleotide strands are wound around each other in a double helix. Nucleotide A forms hydrogen bonds with T, and C with G. A and G are somewhat smaller and are called *purines*, while T and C are larger and called *pyrimidines*.
- The dotted lines between purines and pyrimidines represent the hydrogen bonds. One full helical turn is about 10 “steps”, each “step” taking about 0.34 nm, thus a full turn is about 3.4 nm.

Crick's central dogma

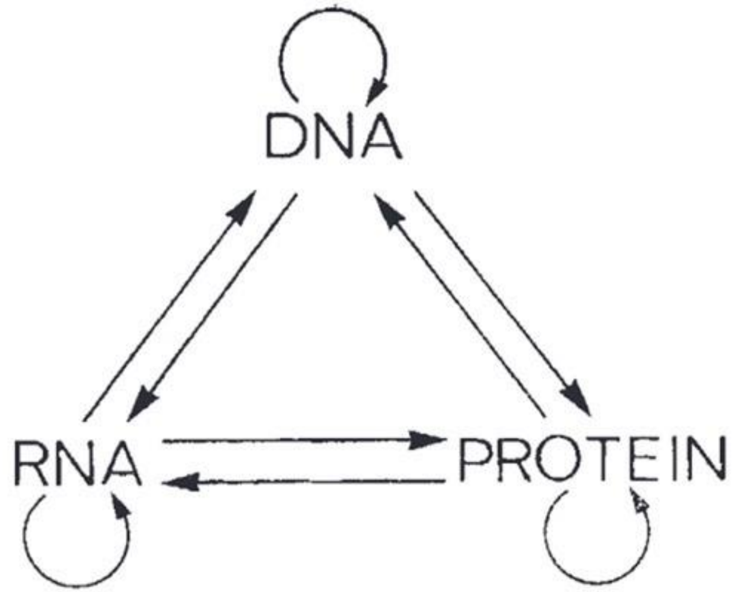


Fig. 1. The arrows show all the possible simple transfers between the three families of polymers. They represent the directional flow of detailed sequence information.

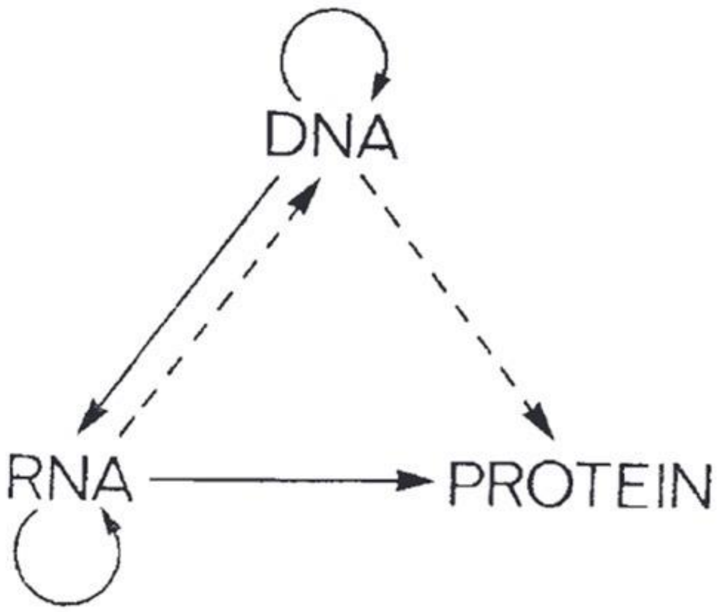
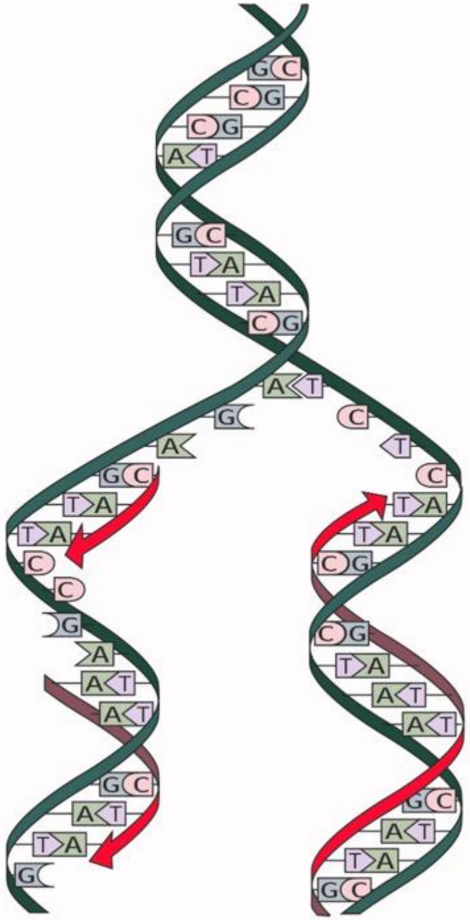
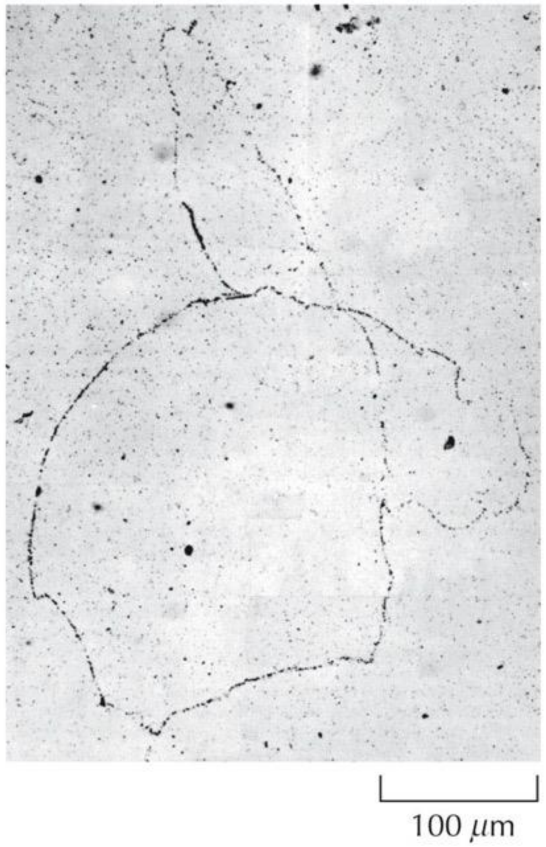
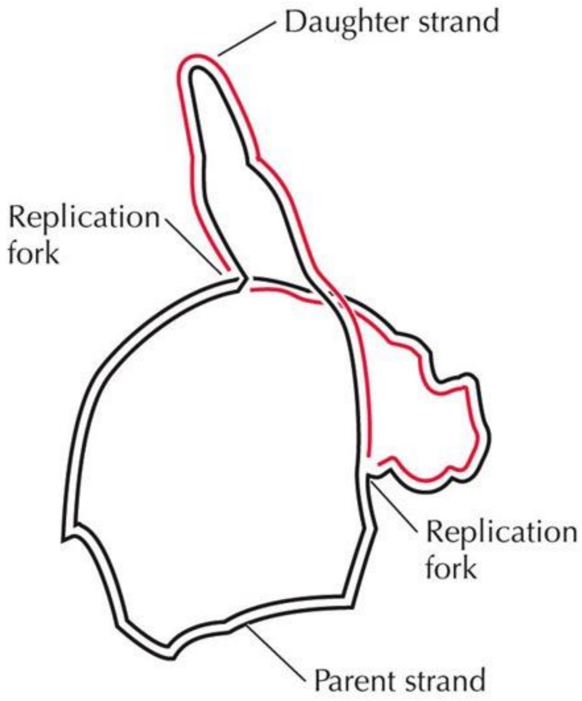


Fig. 2. The arrows show the situation as it seemed in 1958. Solid arrows represent probable transfers, dotted arrows possible transfers. The absent arrows (compare Fig. 1) represent the impossible transfers postulated by the central dogma. They are the three possible arrows starting from protein.

DNA replication fork





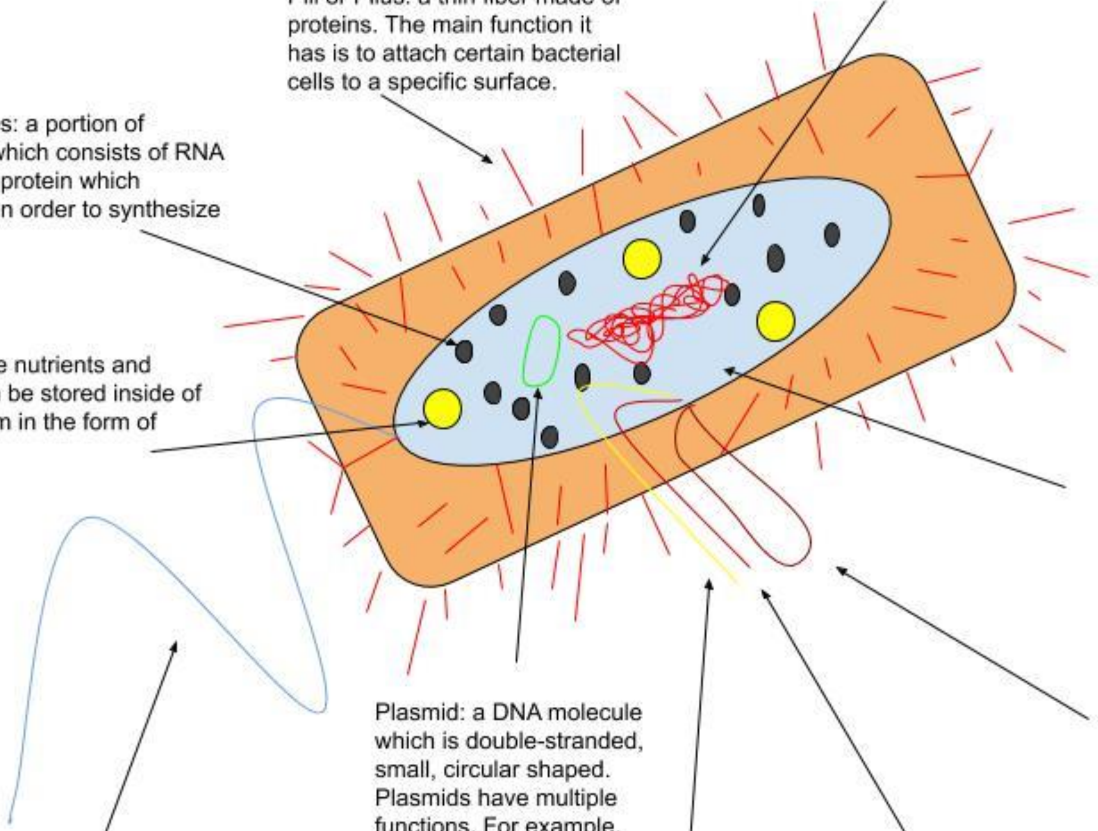


Chromosome: they carry around genetic information and they are made of DNA as well as protein in combination as chromatin.

Pili or Pilus: a thin fiber made of proteins. The main function it has is to attach certain bacterial cells to a specific surface.

Ribosomes: a portion of particles which consists of RNA and other protein which functions in order to synthesize proteins.

Granules: the nutrients and reserves can be stored inside of the cytoplasm in the form of proteins.



Cytoplasm: the material within a cell.

Capsule: acts as an additional barrier that protects the cell when it comes to contact with another organism, helps keep moisture and it helps the cell stick to nutrients as well as surfaces.

Plasmid: a DNA molecule which is double-stranded, small, circular shaped. Plasmids have multiple functions. For example, often plasmids carry certain genes that help the organism survive.

Prokaryotic Flagellum: primary function is to allow cell movement.

Cell Wall: helps maintain the shape of the cell, helps protect the cells interior and it helps prevent the cell from bursting when the cell consumes water.

Plasma Membrane: a lipid bilayer which surrounds the cytoplasm of the cell. The plasma membrane separates the cytoplasm from the environment out outside and also it acts as a barrier and controls what goes in and out of the cell.

Human language

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  - It is certainly unlikely that anything like human language existed more than a few hundred thousand years ago. Language adds to behavioural complexity enormously, which arguably is achieved via accumulating information outside DNA.
  - Since the emergence of human language some hundred thousand years ago, and writing, about ten thousand years ago, information has started growing outside the DNA of genomes. It seems likely that information outside genomes is now growing faster than inside them. This new type of information too is contributing to life's complexity.
  - However, when it comes to the questions of how the human faculty of language emerged, what fundamental elements distinguish human language from other animal communication, and what is the genetic basis of human language, opinions still differ wildly.
  - It is one of the key theses of this book that **the transition from having no language to having language was as important a transition as the one from *pre-life* to the first self-replicating systems**. It opened a new phase in the evolution of life.
  - In their seminal monograph *Major Transitions*, John Maynard Smith and Eors Szathmary describe a small number of evolutionary events that they argue have most contributed the evolution of life on Earth to its present forms. These are
    - the origin of life,
    - the origin of chromosomes,
    - the origin of eukaryotes,
    - the origin of sex,
    - the origin of multicellular organisms,
    - the origin of social groups, and
    - the origin of language[4].
  - All these major events can be viewed as changes in how life processes information. In my opinion two of them stand out. First, the emergence of life itself, which led to information being recorded in polymer molecules and from some point mostly DNA. Second, the emergence of (human) language, which led to information breaking out of DNA into new physical media.

Paldies par uzmanību!

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