Bioeconomy, biosystems and biotechnology in every day life

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General Directort of Scientific Center for Sustainable Development

The structure of our biosystem

The blue planet, our home

The ecosystem

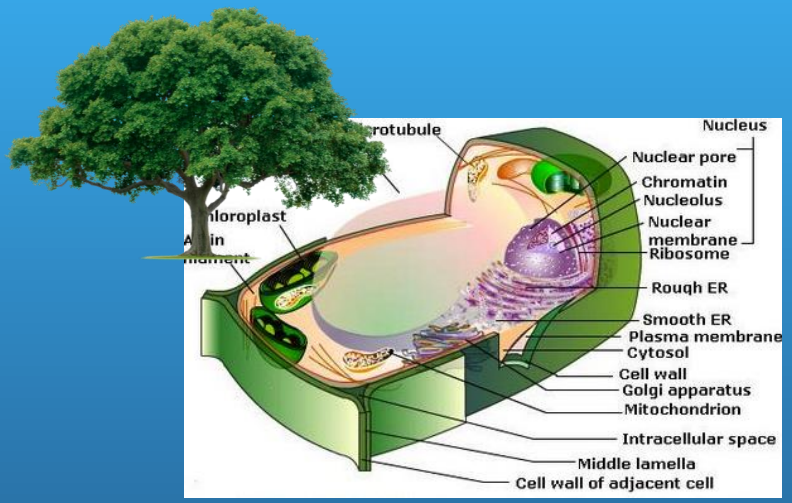
Components of our ecosystem

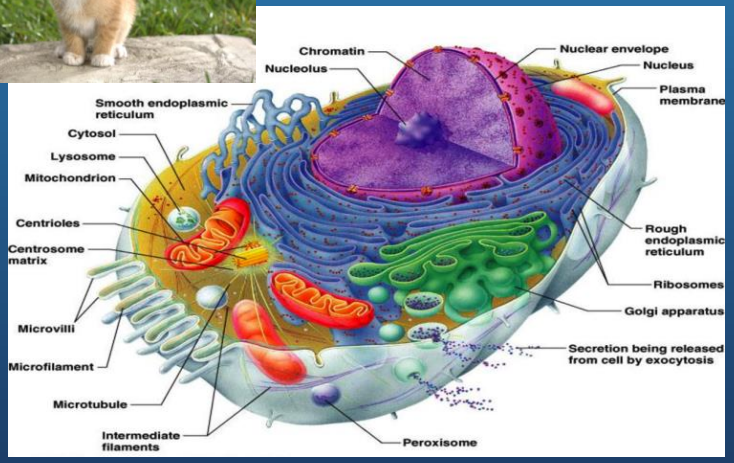


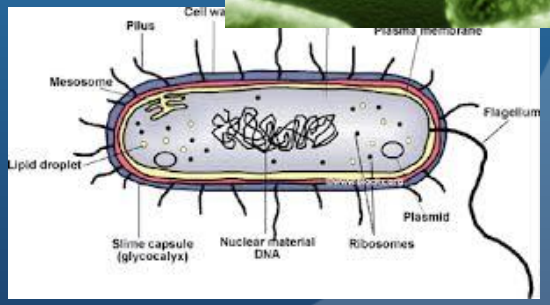



We are seeing a tiny part of what is there

Basic components of the living organisms are the cells

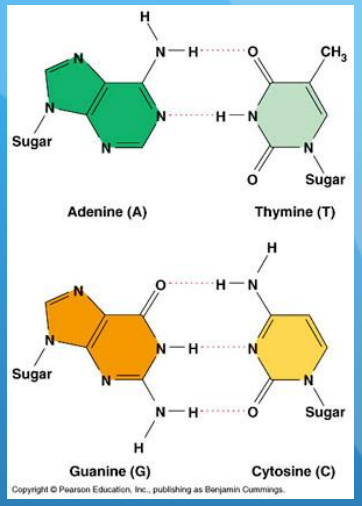






The information stockpile of our biosystem

DNA>RNA

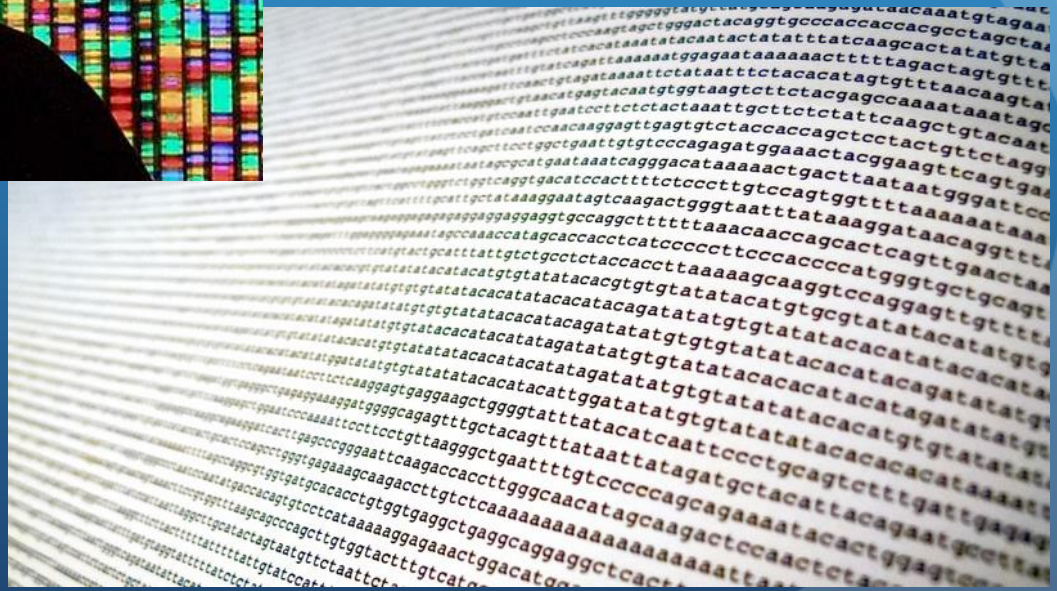


~3 meters in humans only 2% encodes proteins, the functional molecules

The human genome

The book is open, no § ,.?!

To understand the entire information in the book it will take a long time



DNA: an unlimited pool of information: why?

Bacterial DNA (*10^6)

Archeobacterial DNA(*10^6)

Viral DNA(*10^4)

Eucaryotic DNA(*10^{10})

Cell free environmental DNA

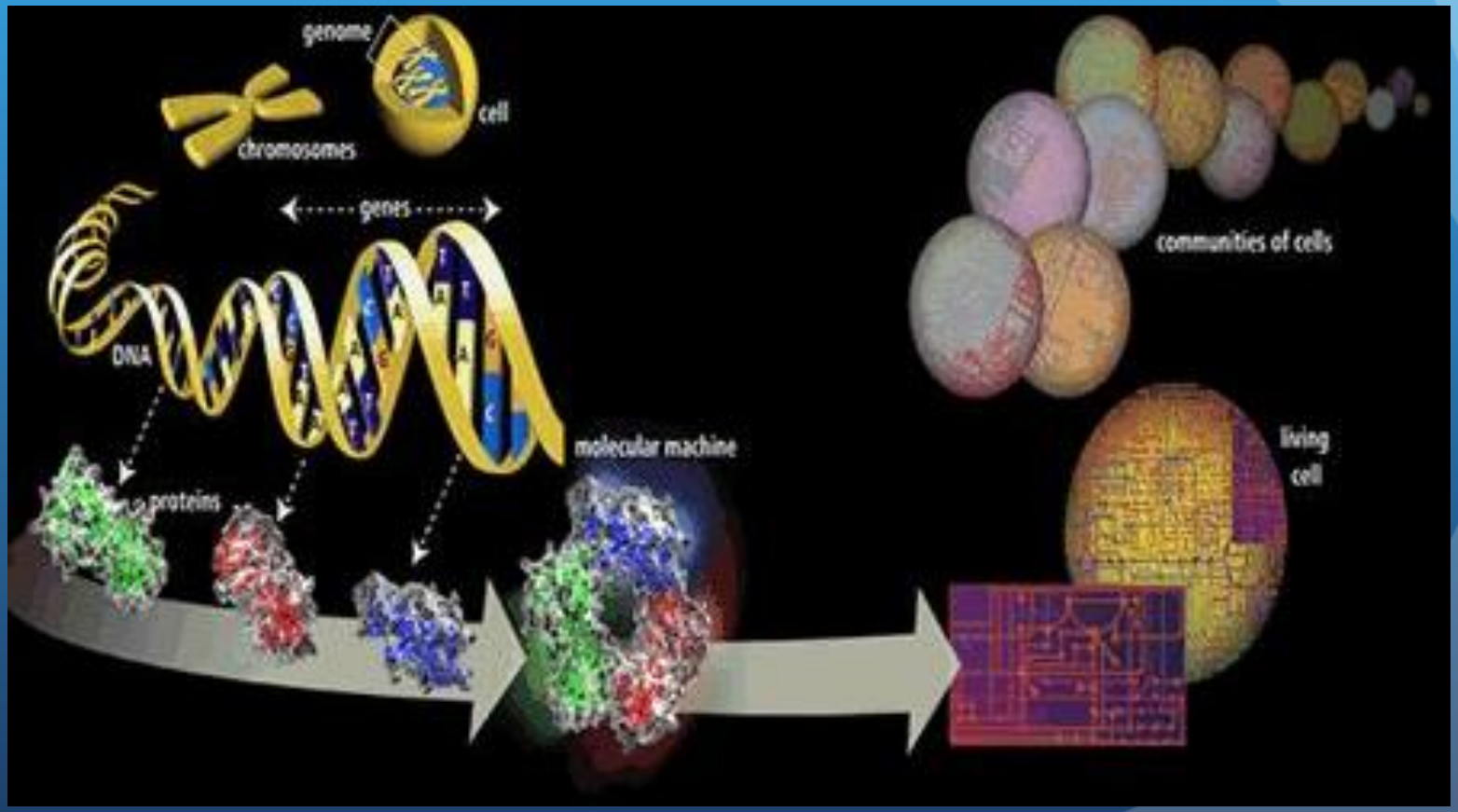
Recombinant DNA-gene technology

Shuffled DNA-directed evolution

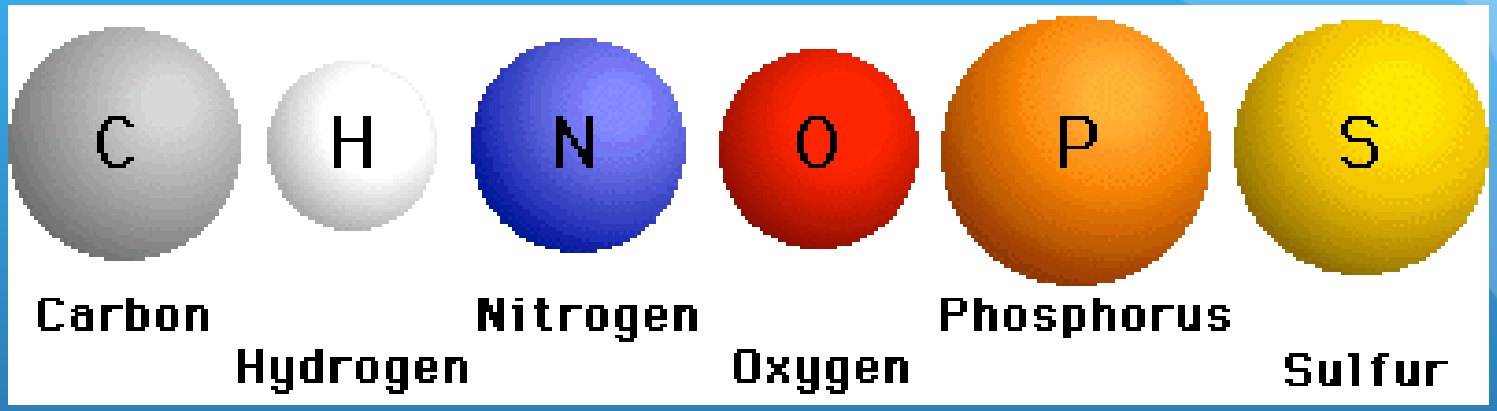
Ancestral DNA (calculated)

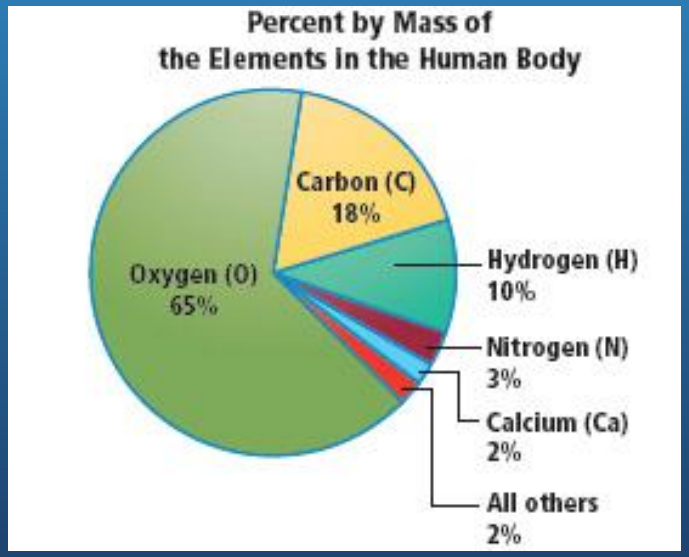
Synthetic DNA (artificial)

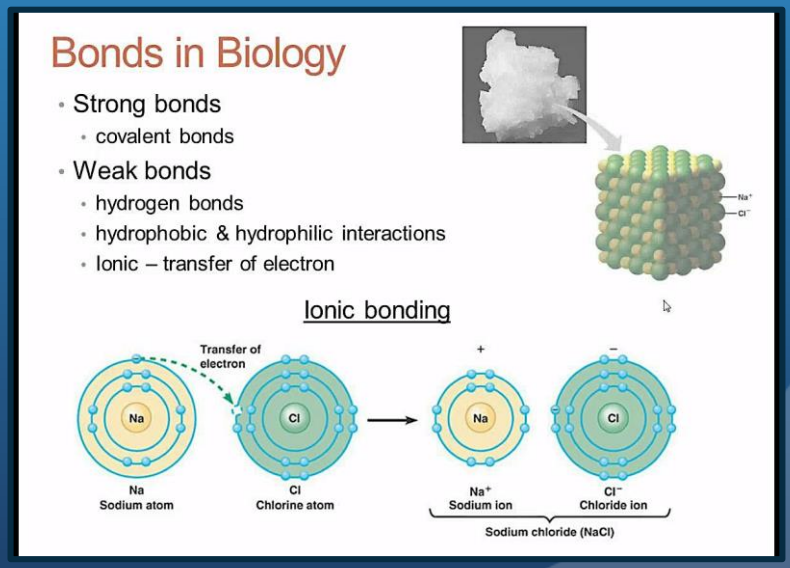
The DNA provides the essential information (genes-regulatory elements etc) to the cell machinery (proteinosynthesis) to build functional molecules: the proteins



The chemical basis of life







The physical basis of life

The Laws of Thermodynamics

0. Two bodies in thermal equilibrium are at same T
1. Energy can never be created or destroyed.

$$\Delta E = q + w$$

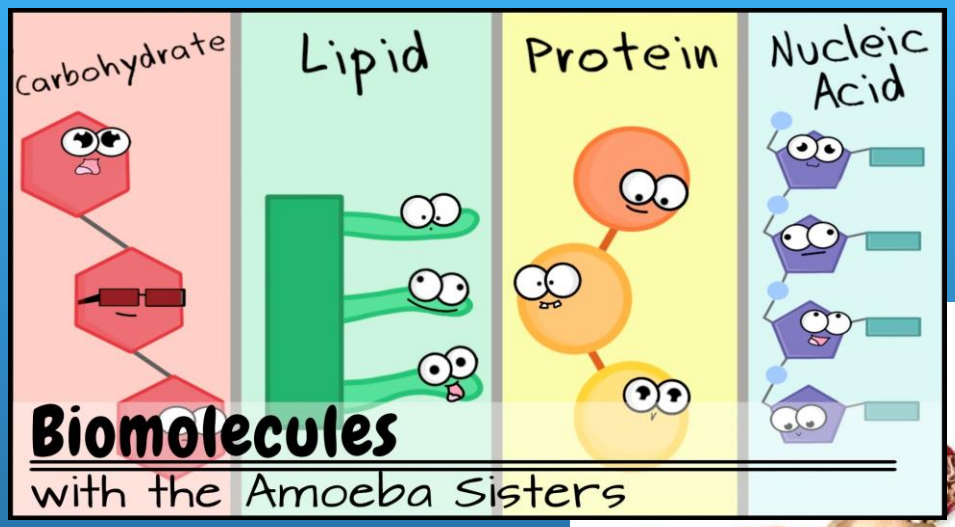
2. The total entropy of the UNIVERSE (= system plus surroundings) MUST INCREASE in every spontaneous process.

$$\Delta S_{TOTAL} = \Delta S_{system} + \Delta S_{surroundings} > 0$$

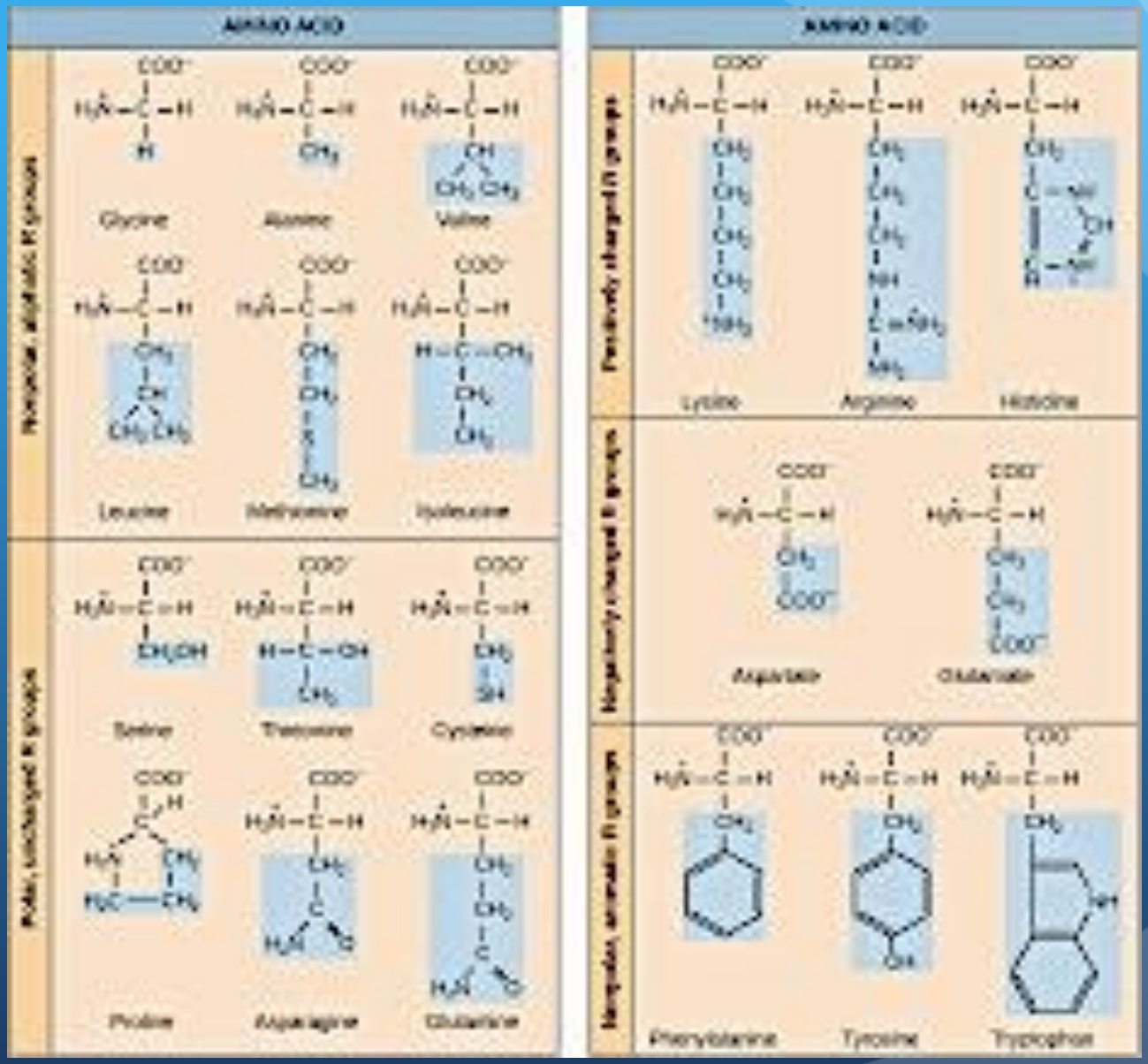
3. The entropy (S) of a pure, perfectly crystalline compound at T = 0 K is ZERO. (no disorder)

$$S_{T=0} = 0 \text{ (perfect xll)}$$

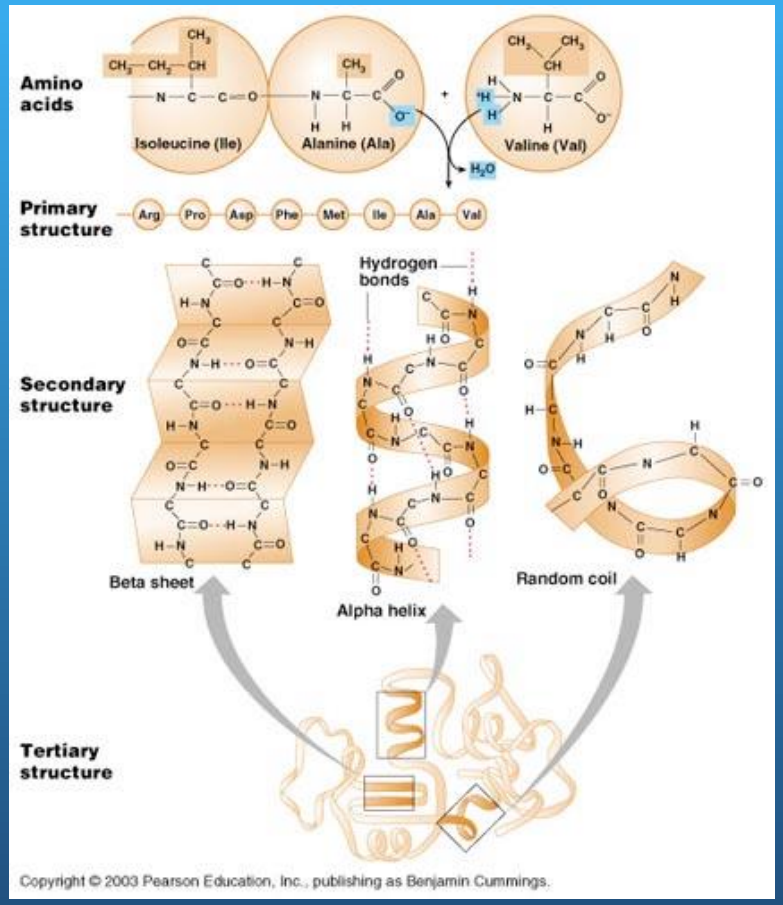
The major biomolecules



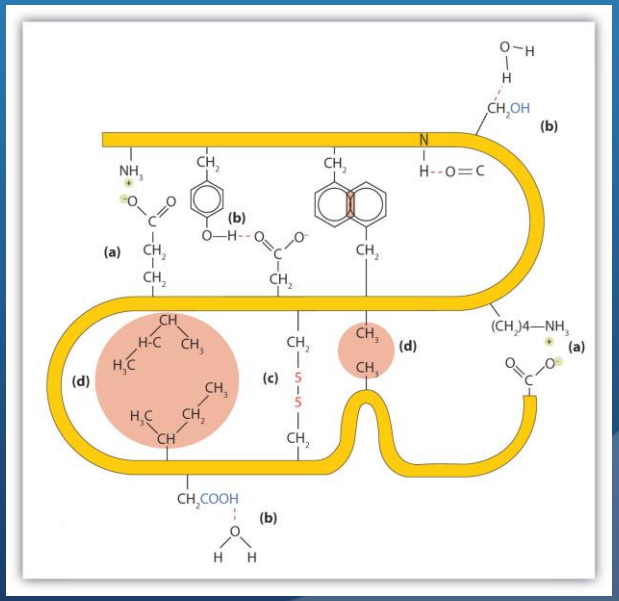
Proteins=linear chains of amino acids



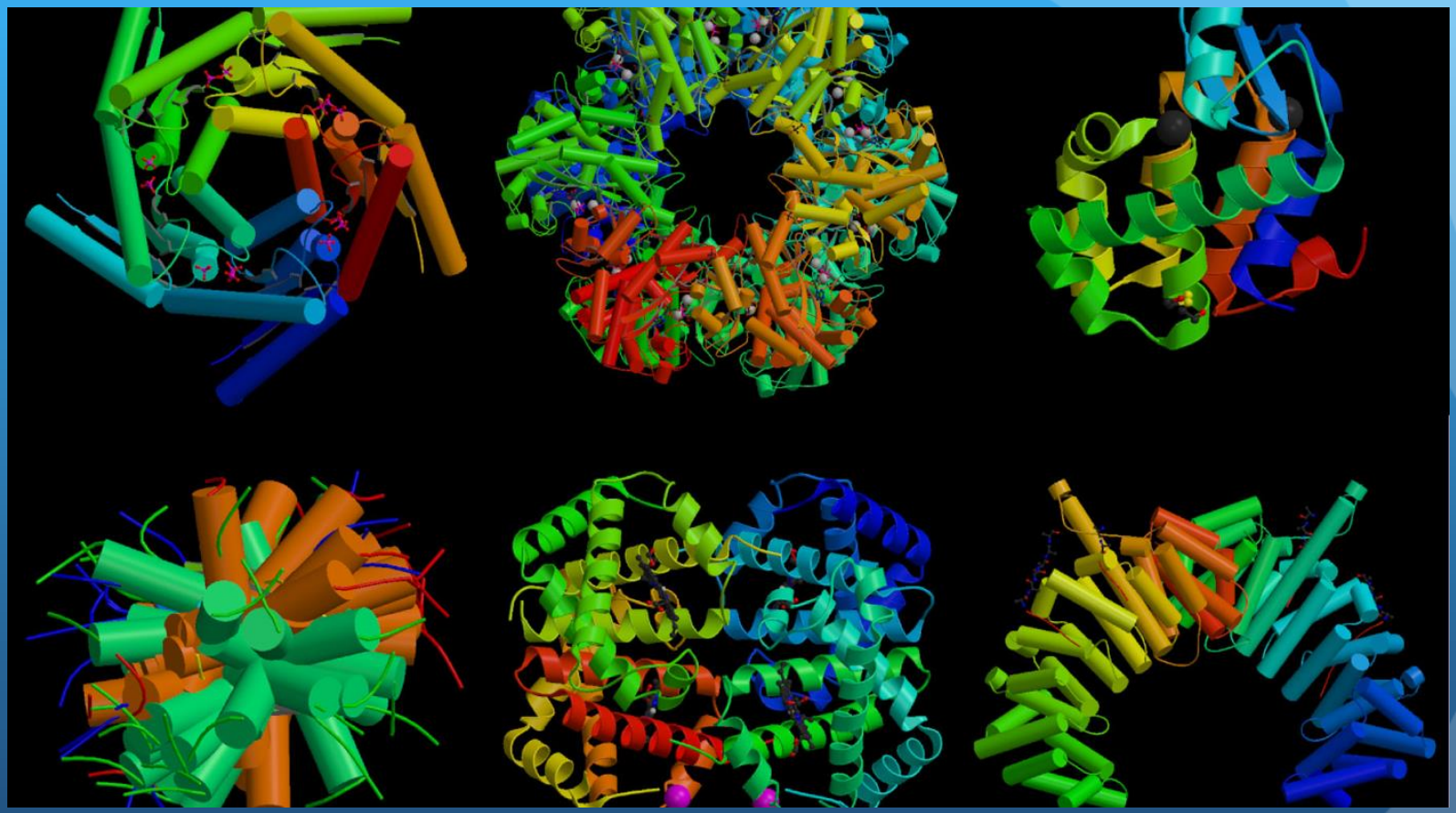
The structure of proteins



Amazing numbers: random synthesis of proteins of 300 aa length, using the 20 amino acids can create 20^{300} (~50000)

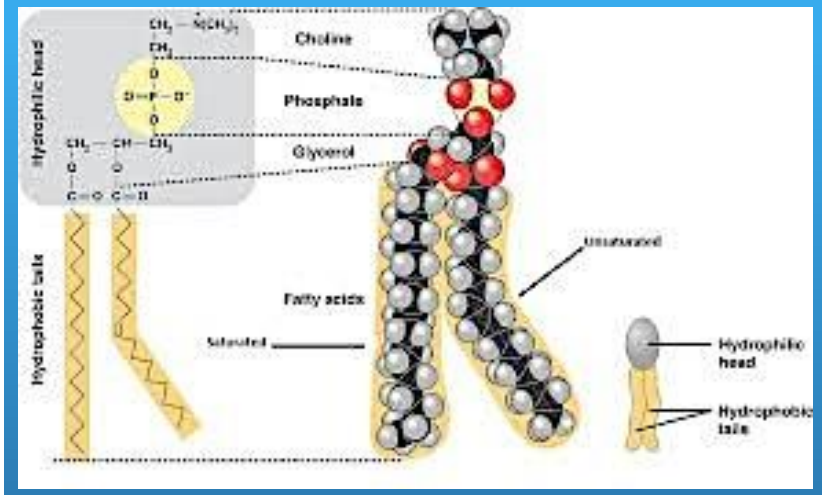


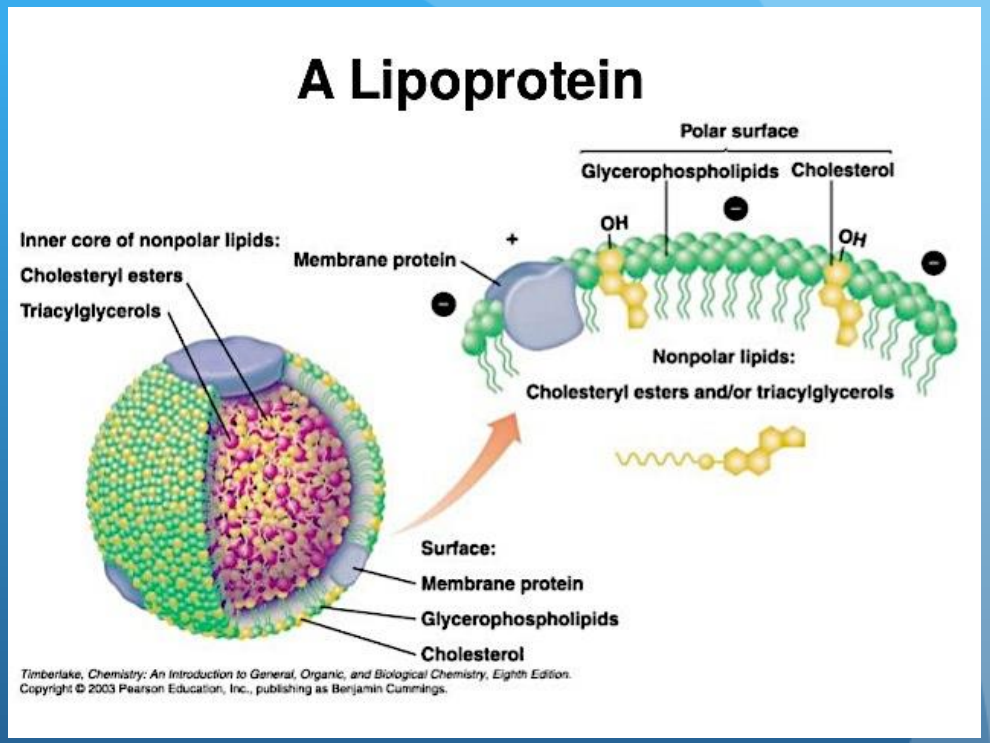
The structure of proteins

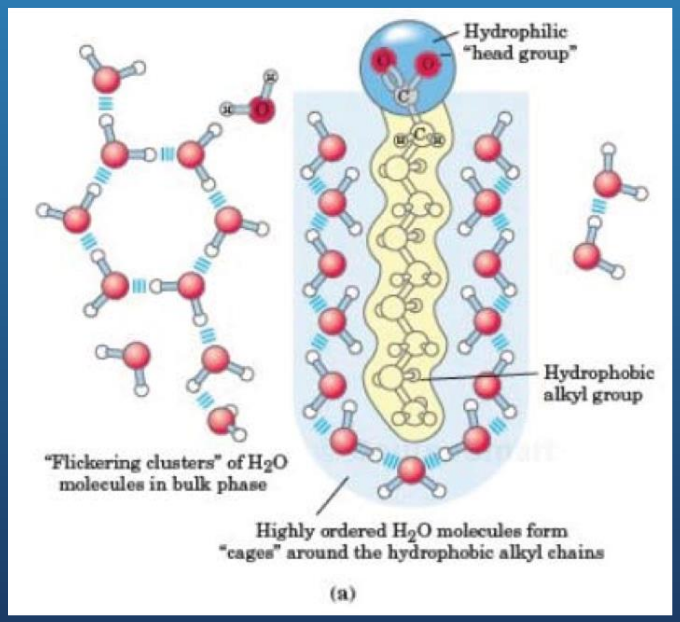


The existing proteins is a tiny fraction of the existing possibilities

The structure of lipids

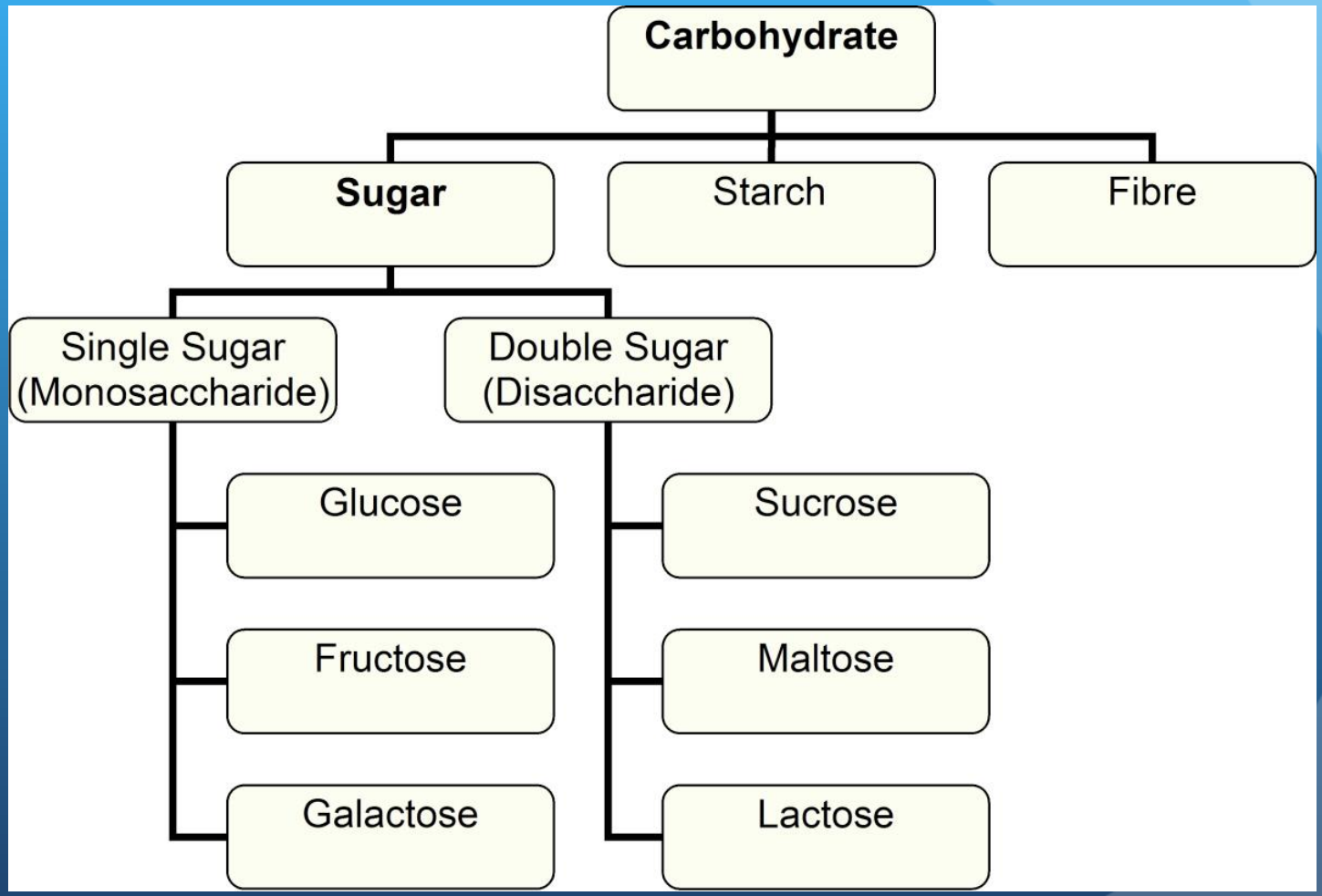




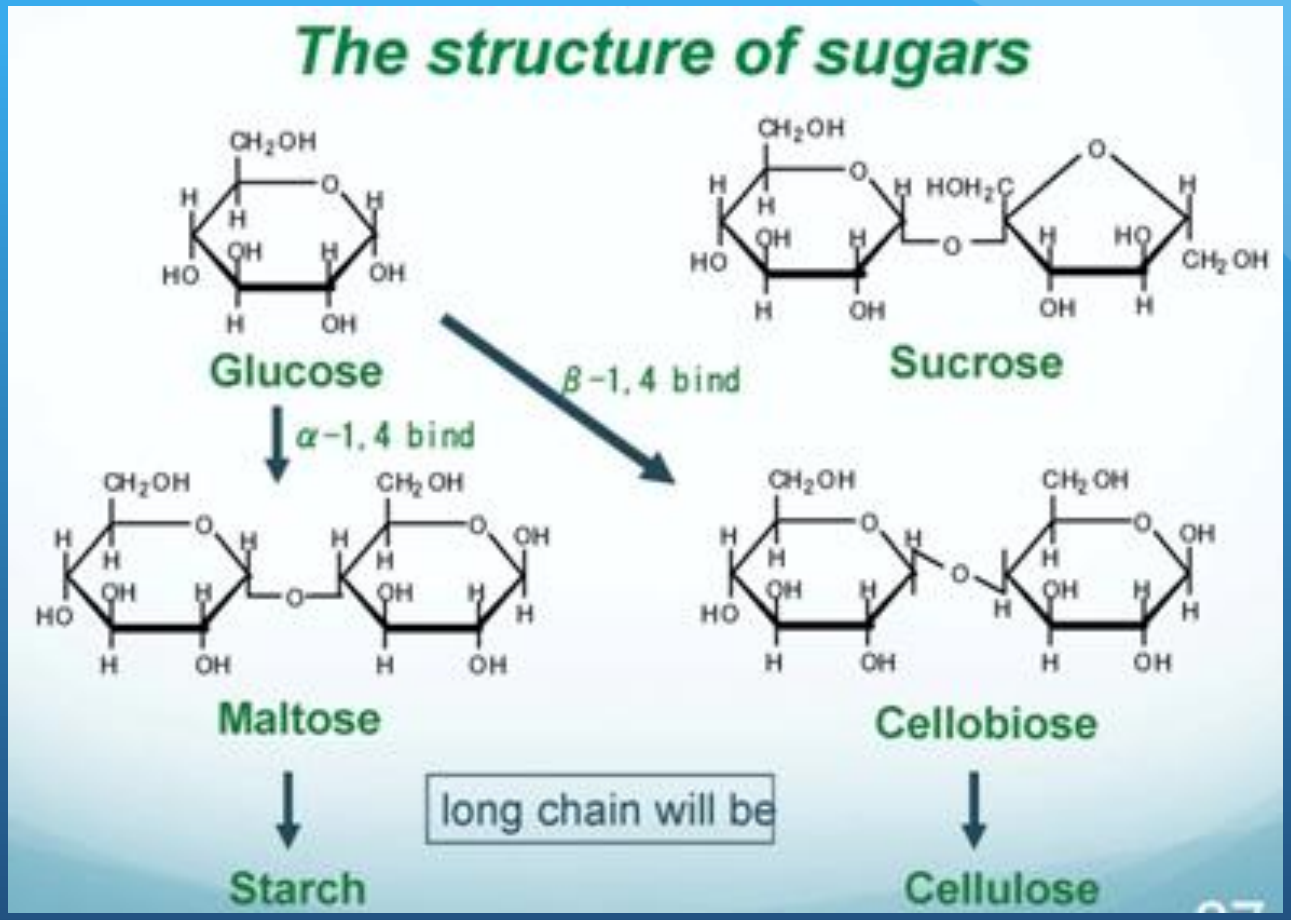


An amazing feature of lipids is their hydrophobicity, the driving force for self assembly

The structure of carbohydrates



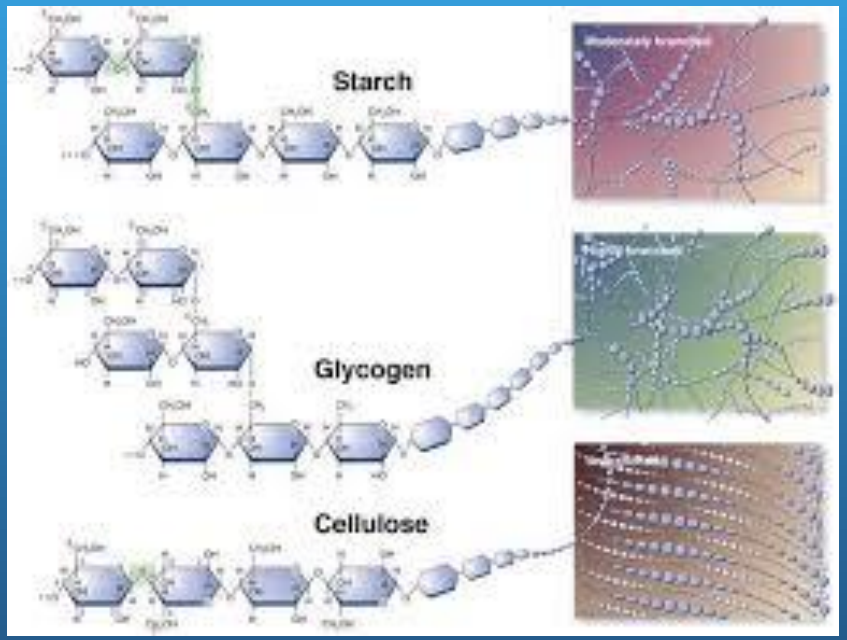
The structure of carbohydrates

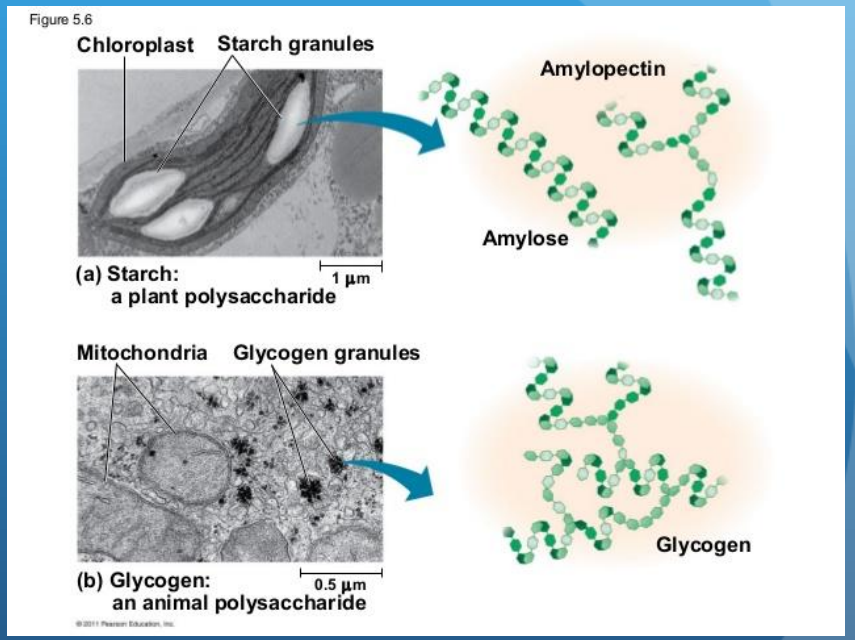


A single bond defines the structure of polysaccharides

The structure of carbohydrates

The polysaccharides are linear and branched

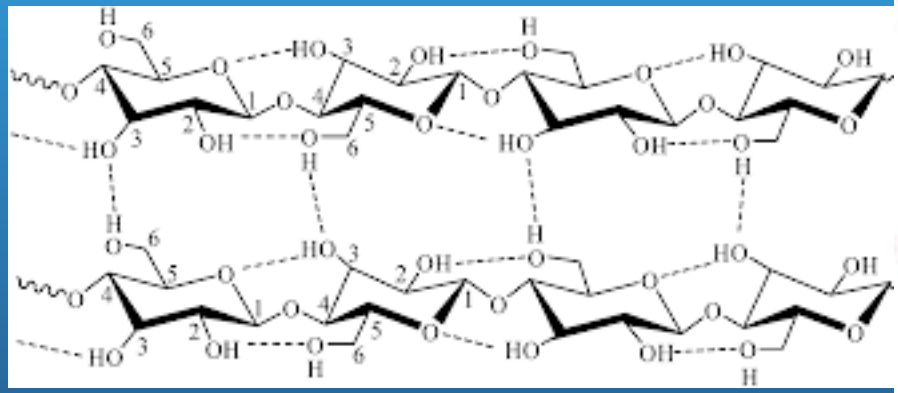


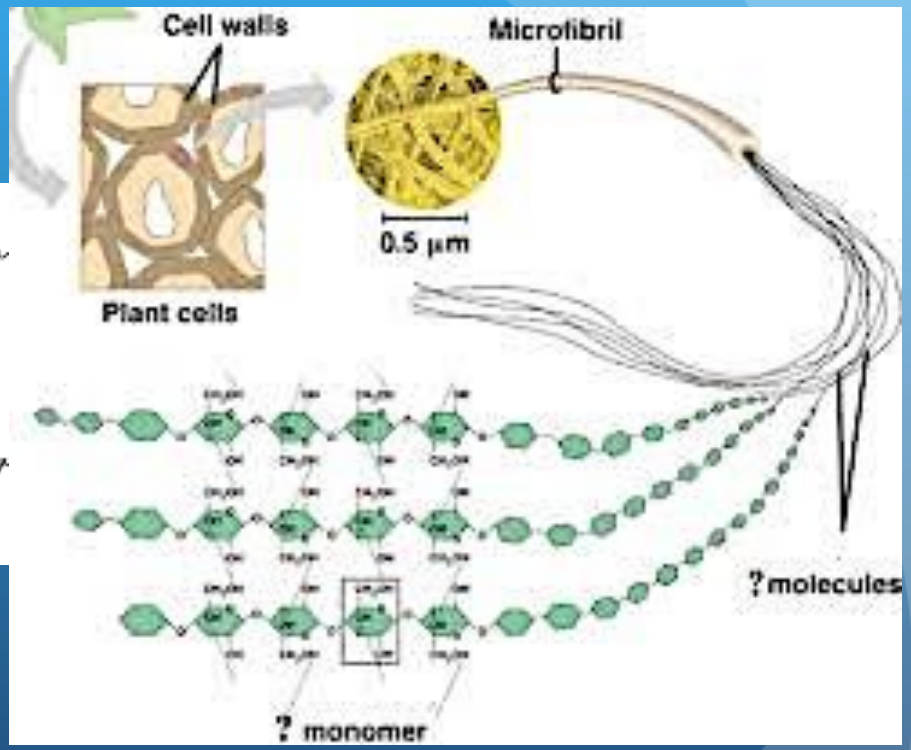


α-1,4 construct helical polysaccharides=storage

The structure of cellulose

The structural polysaccharides are linear

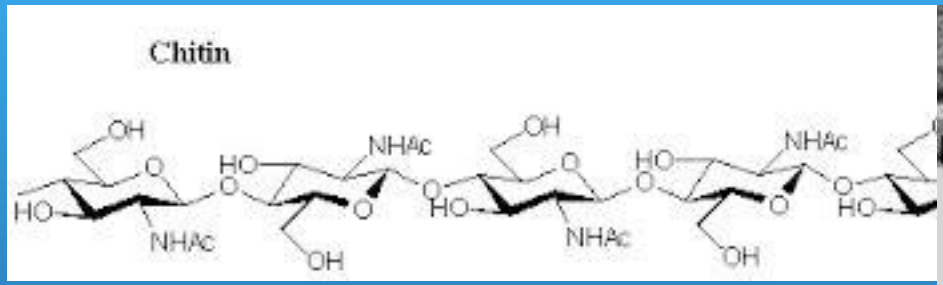


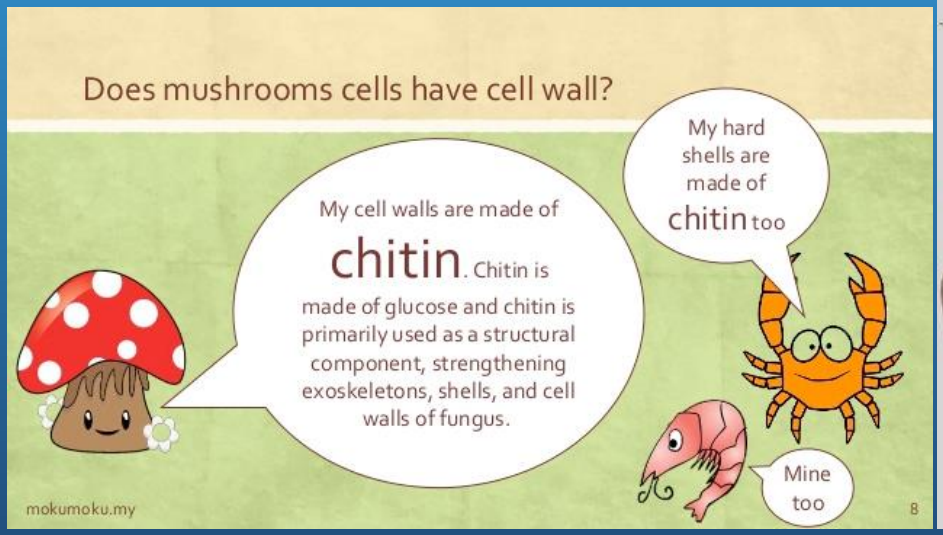


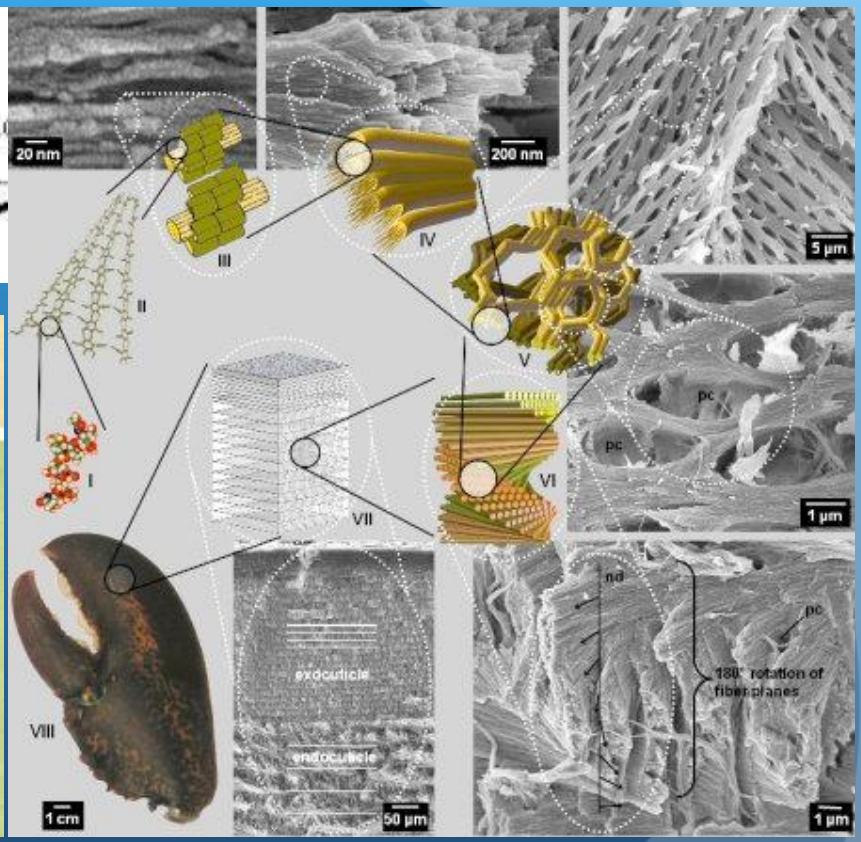
β-1,4 construct linear polysaccharides=structure

The structure of chitin

The structural polysaccharides are linear

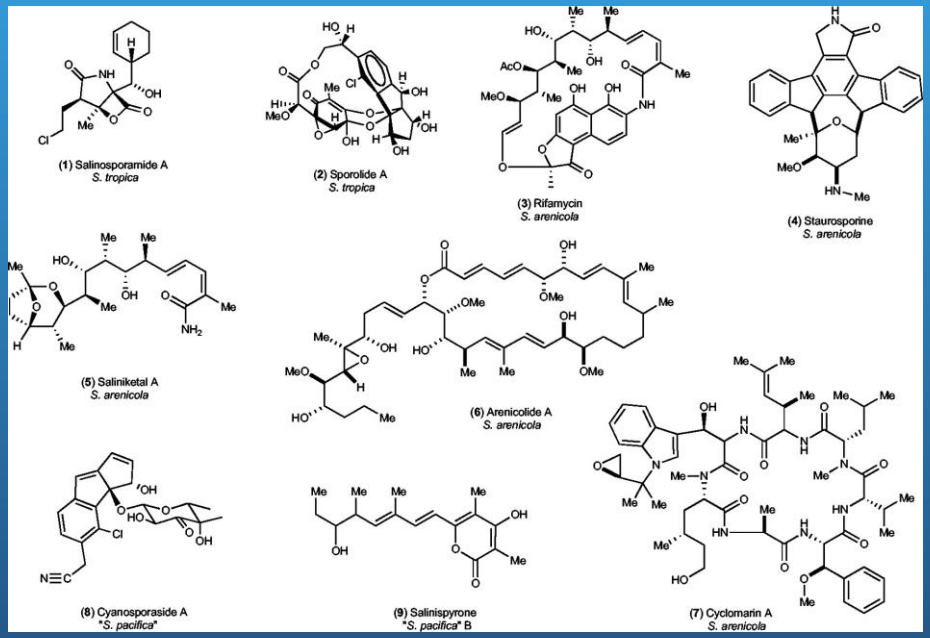


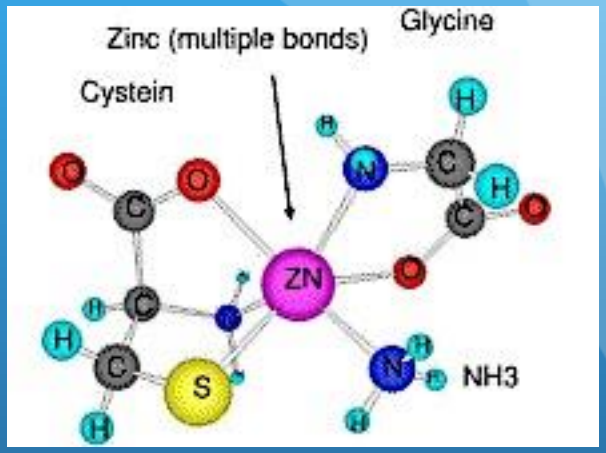


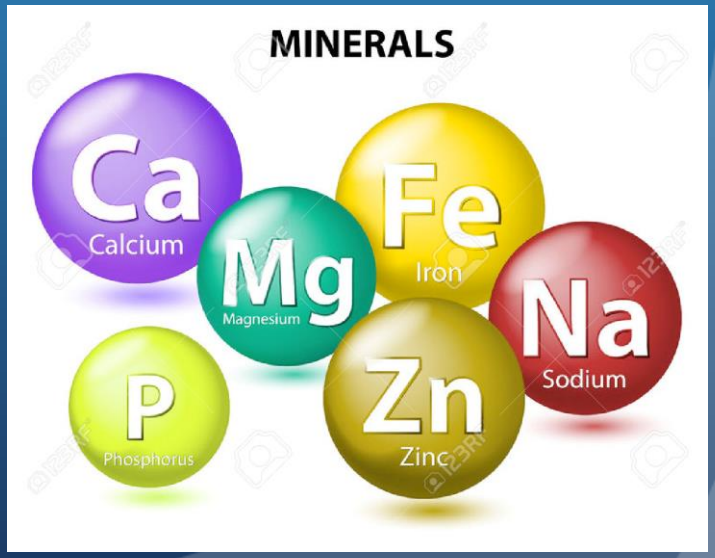


β-1,4 construct linear polysaccharides=structure

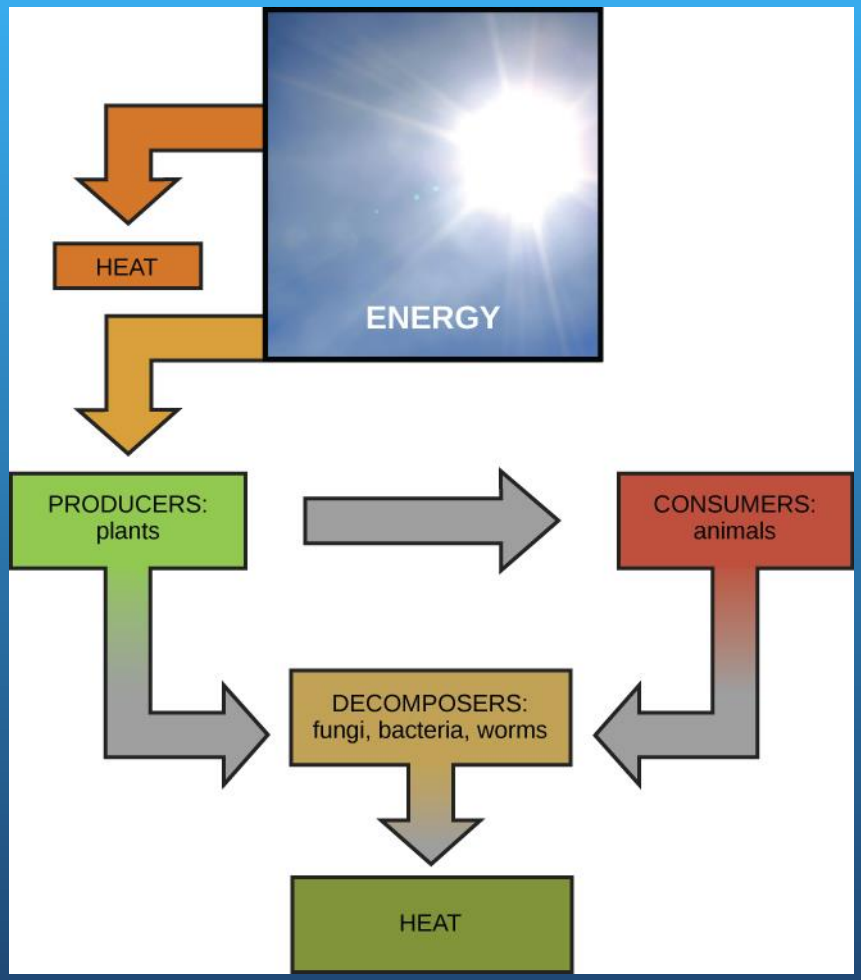
The rest: small metabolites and trace elements

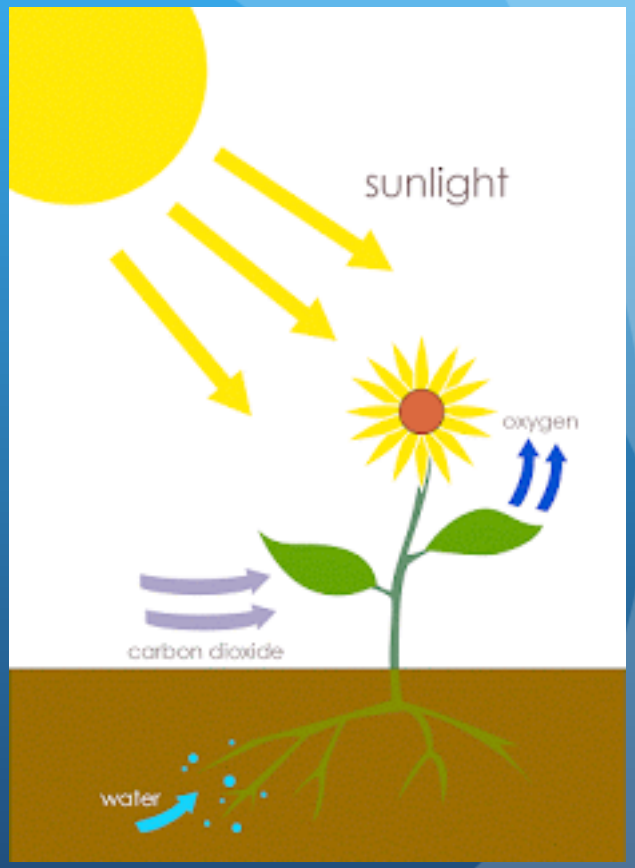




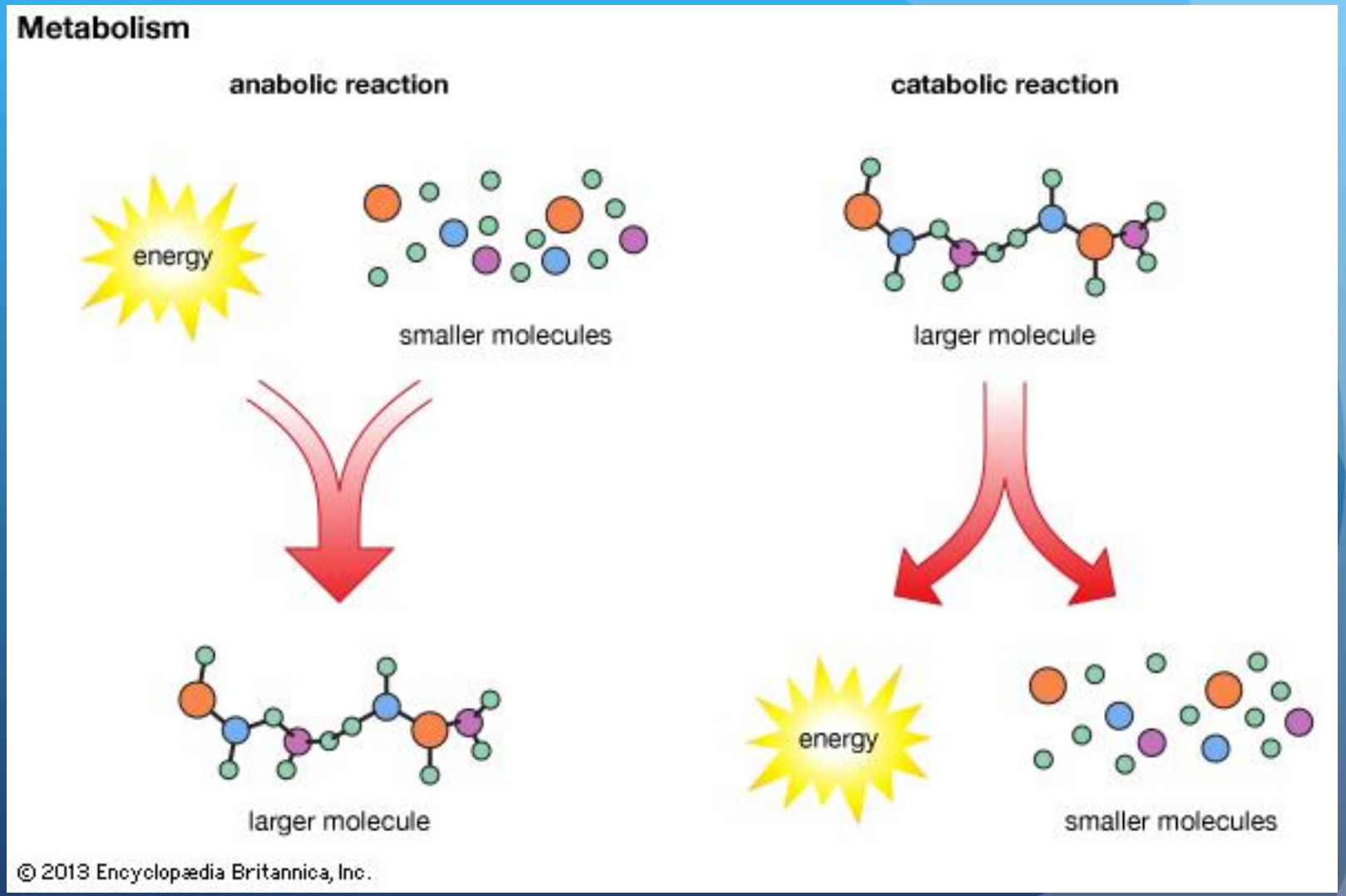


Energy in biosystems

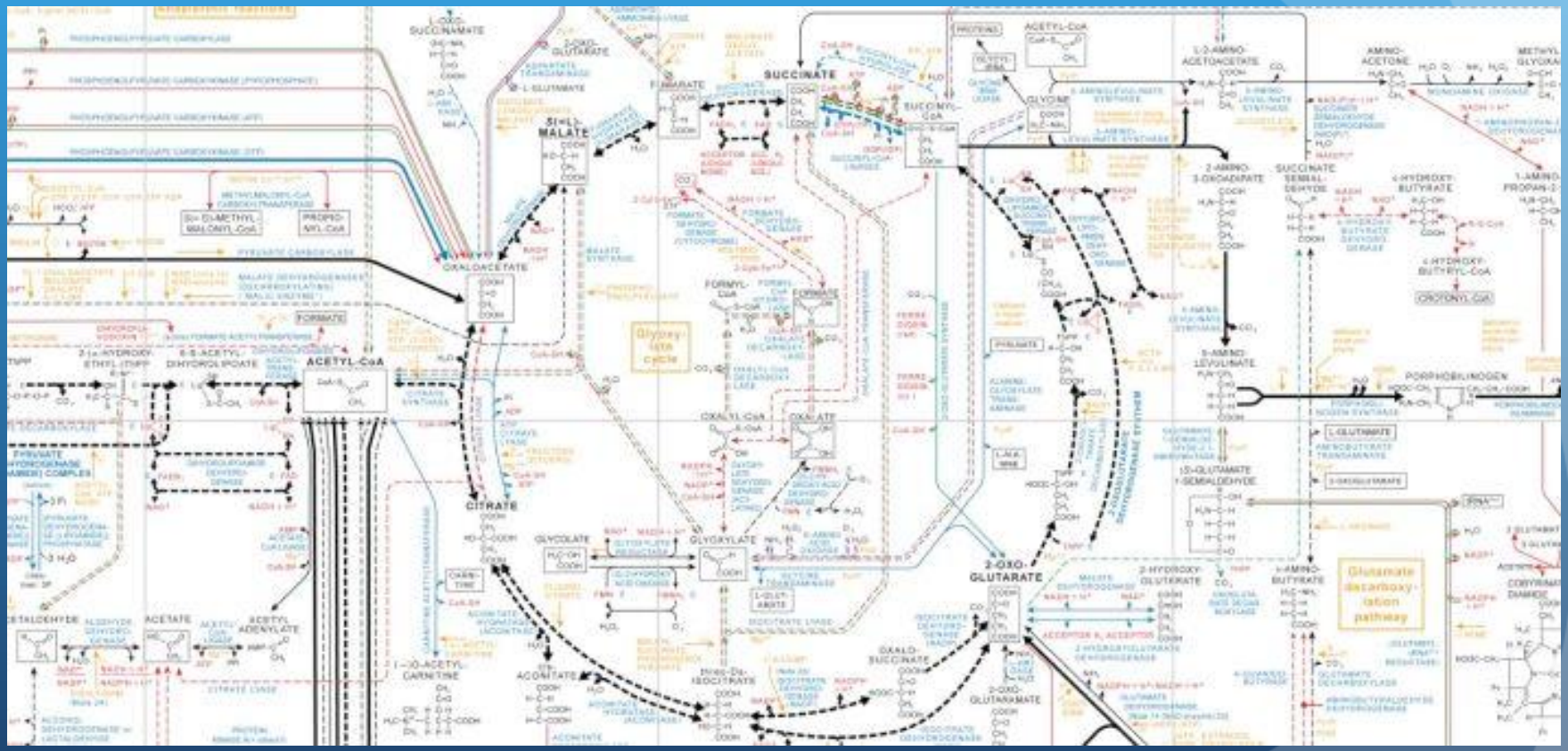




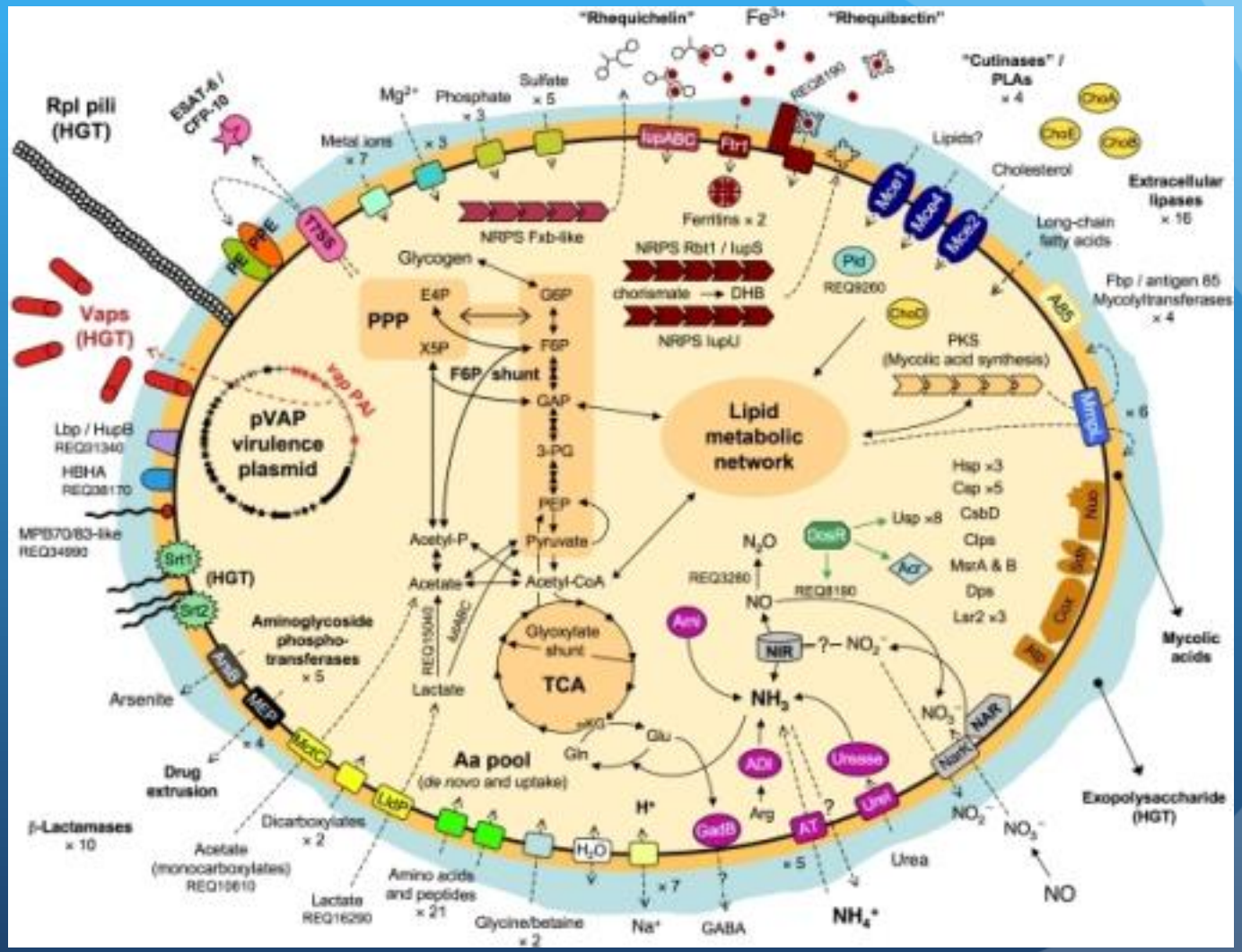
The cellular metabolism



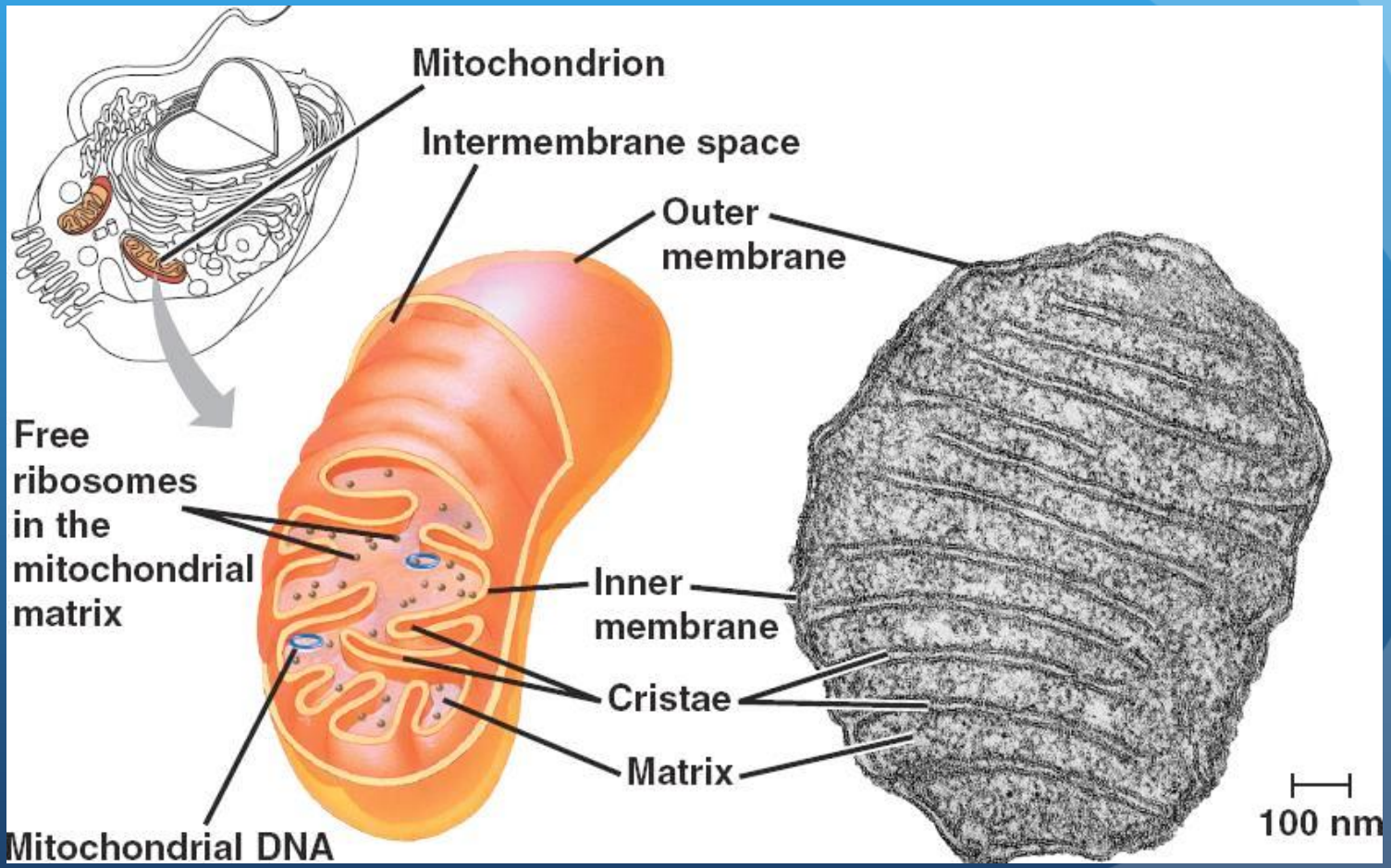
The cellular metabolism is a very complicated network of simple organic chemistry reactions, the metabolic pathways



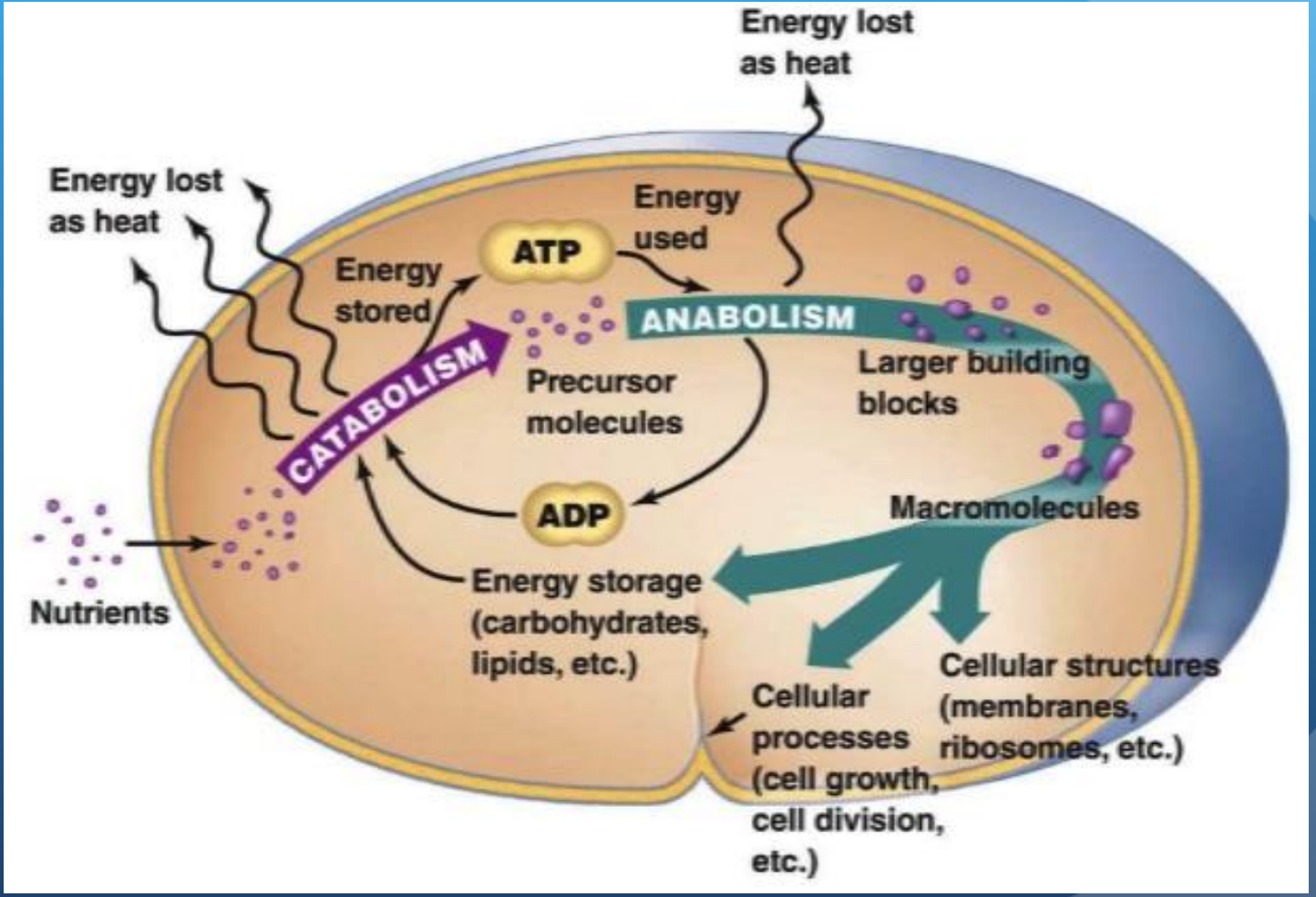
The cellular metabolism is controlled in various ways



The energy is capture either in high energy bonds (ATP) or in reduced molecules (NADPH, NADPH, $FADH_2$)



The cell factory mostly recycle the biomolecules very efficiently



Biotechnology: so young and so old

NSF Award #0501953

How Old Is Biotechnology ?

10,000 BC
Domesticating Crops

6,000 BC
Brewing Beer

Domesticating Animals
8,000-9,000 BC

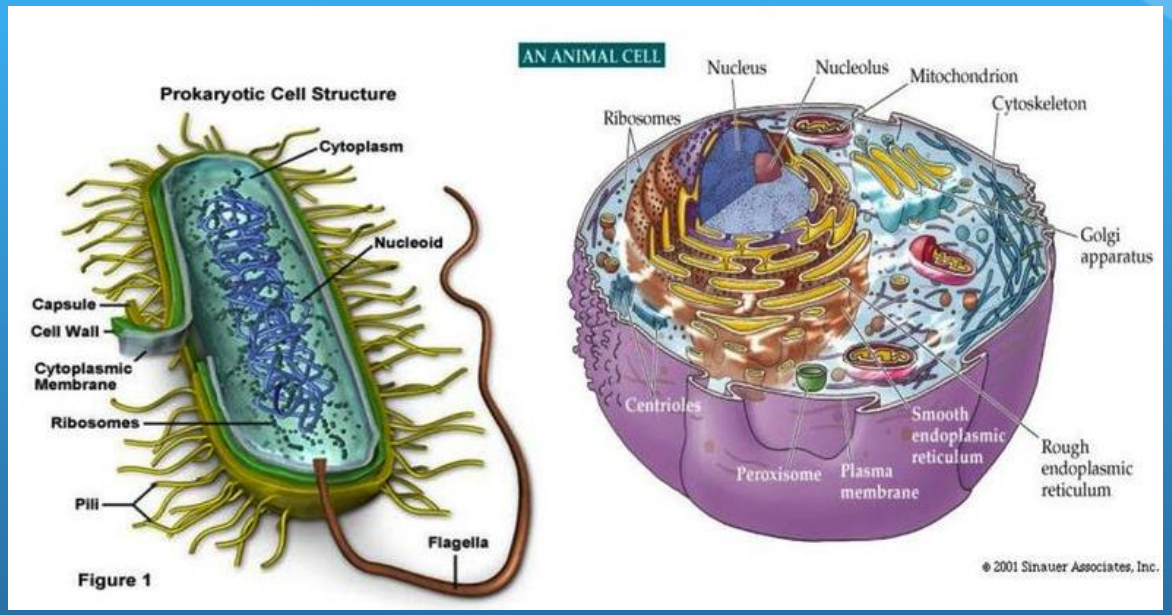
4,000 BC
Leavening Bread

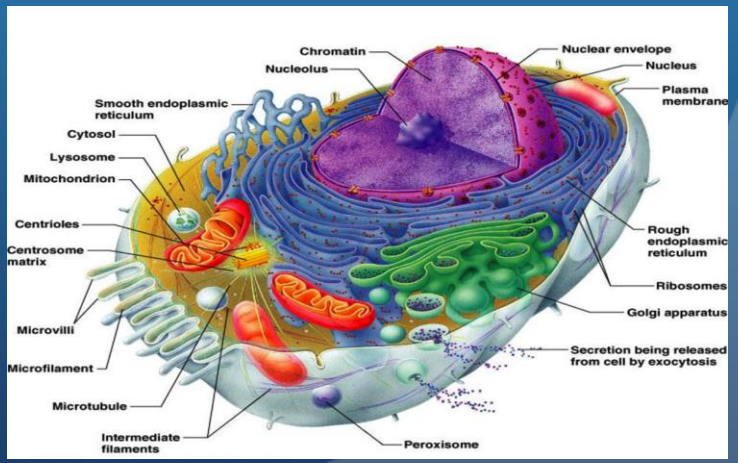
1880's
Production of Vaccines

1940's
Production of Antibiotics

1980's Use of genetically modified organisms

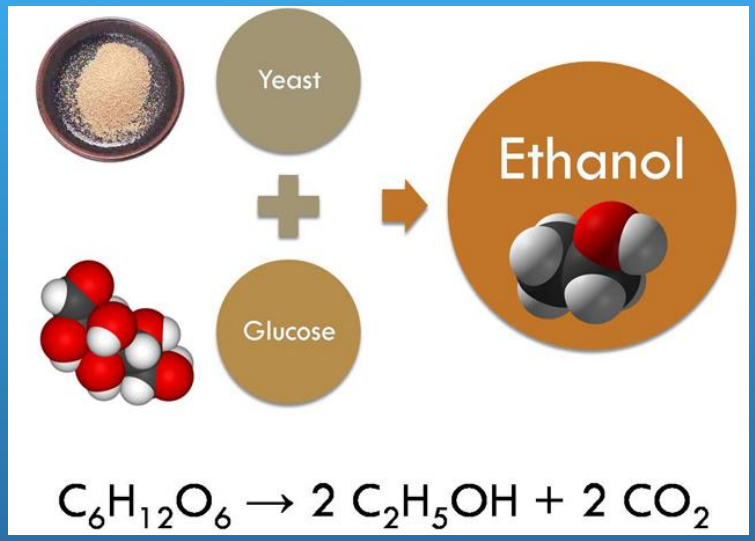
The cell factory the major tool of modern biotechnology

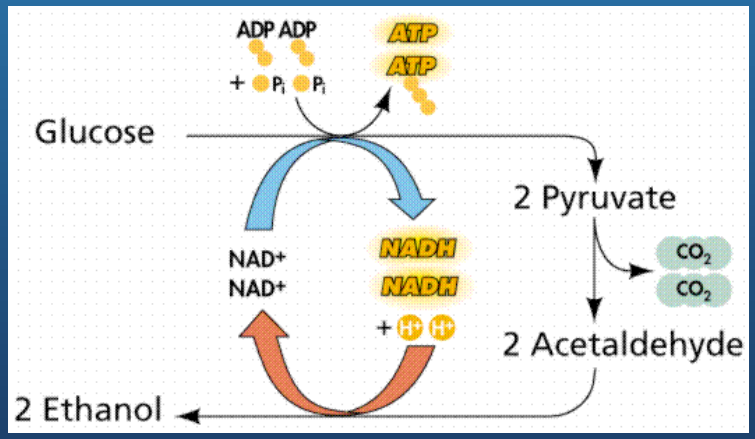




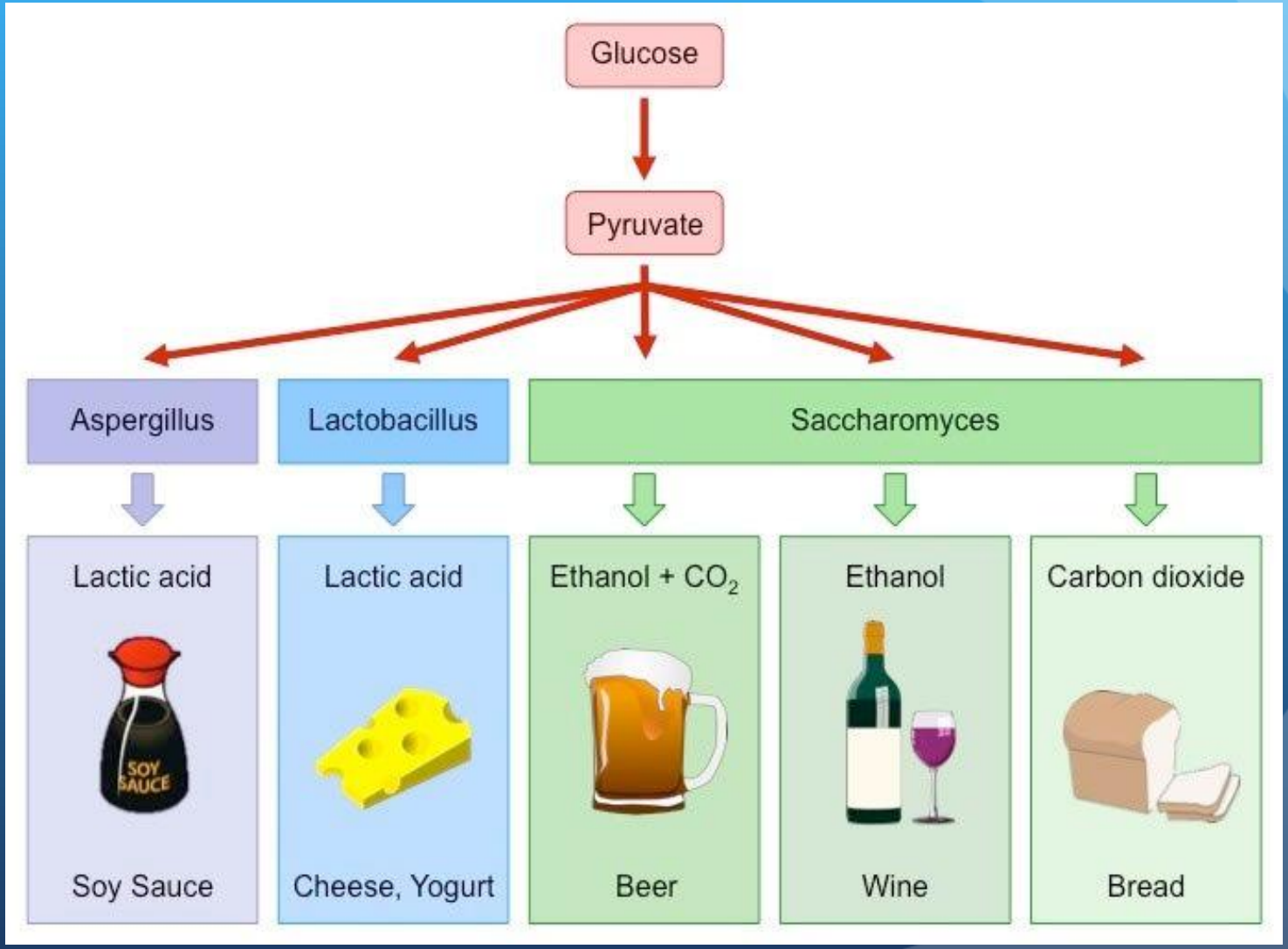
Biotechnology started empirically

The most important biotechnological application

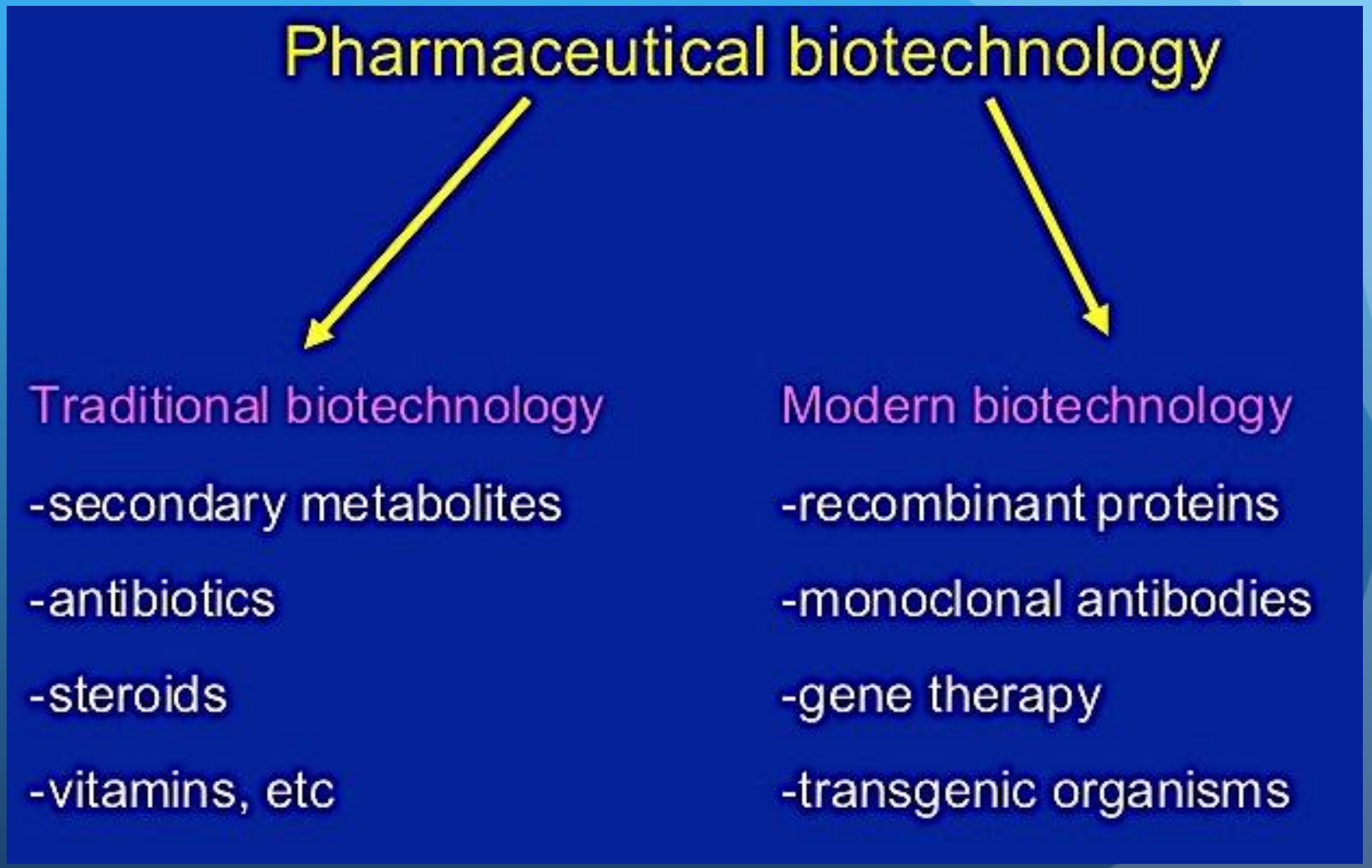




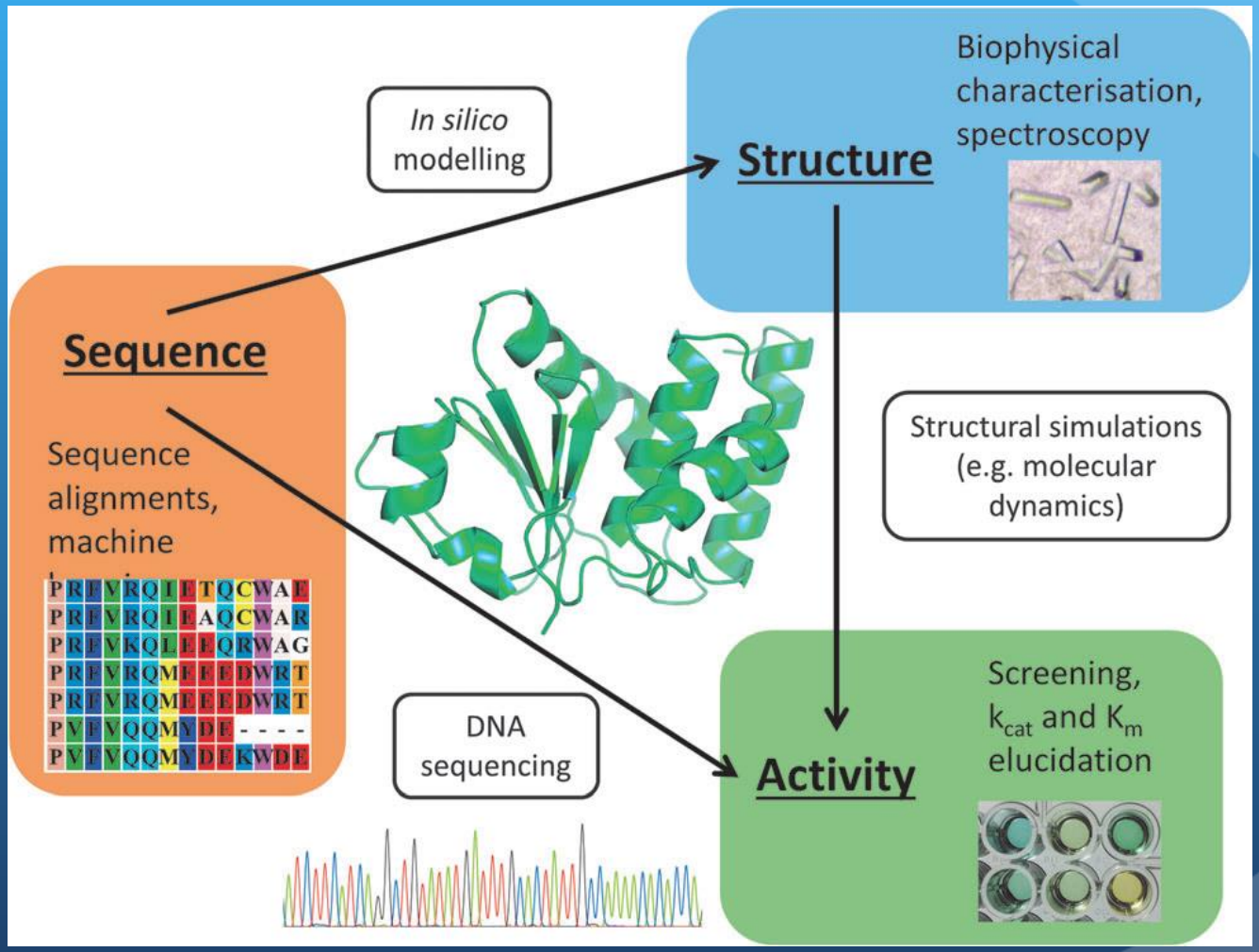
The most usual biotechnological applications



Traditional *vs* Modern Biotechnology



Synthetic biology-directed evolution
New biocatalysts



Synthetic biology-directed evolution New biocatalysts of universal interest

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY

Article

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Toward Efficient Enzymes for the Generation of Universal Blood through Structure-Guided Directed Evolution

David H. Kwan,[†,‡] Iren Constantinescu,[§,∥] Rafi Chapanian,[§,∥] Melanie A. Higgins,[⊥] Miriam P Kötzler,[†,‡] Eric Samain,[#] Alisdair B. Boraston,[⊥] Jayachandran N. Kizhakkedathu,[‡,§,∥] and Stephen G. Withers*[,†,‡]

[†]Centre for High-Throughput Biology, [‡]Department of Chemistry, [§]Centre for Blood Research, [∥]Department of Pathology and Laboratory Medicine, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z3

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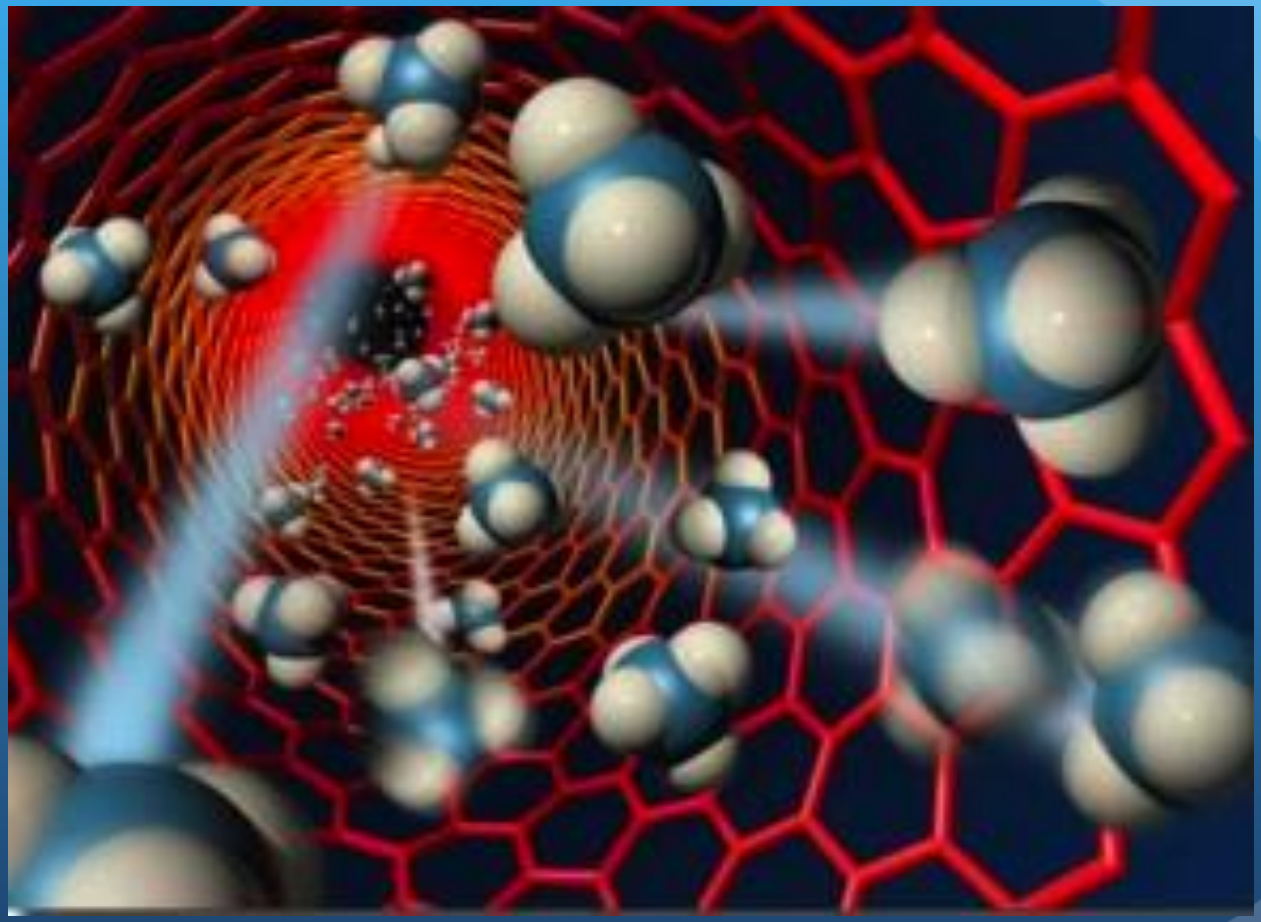
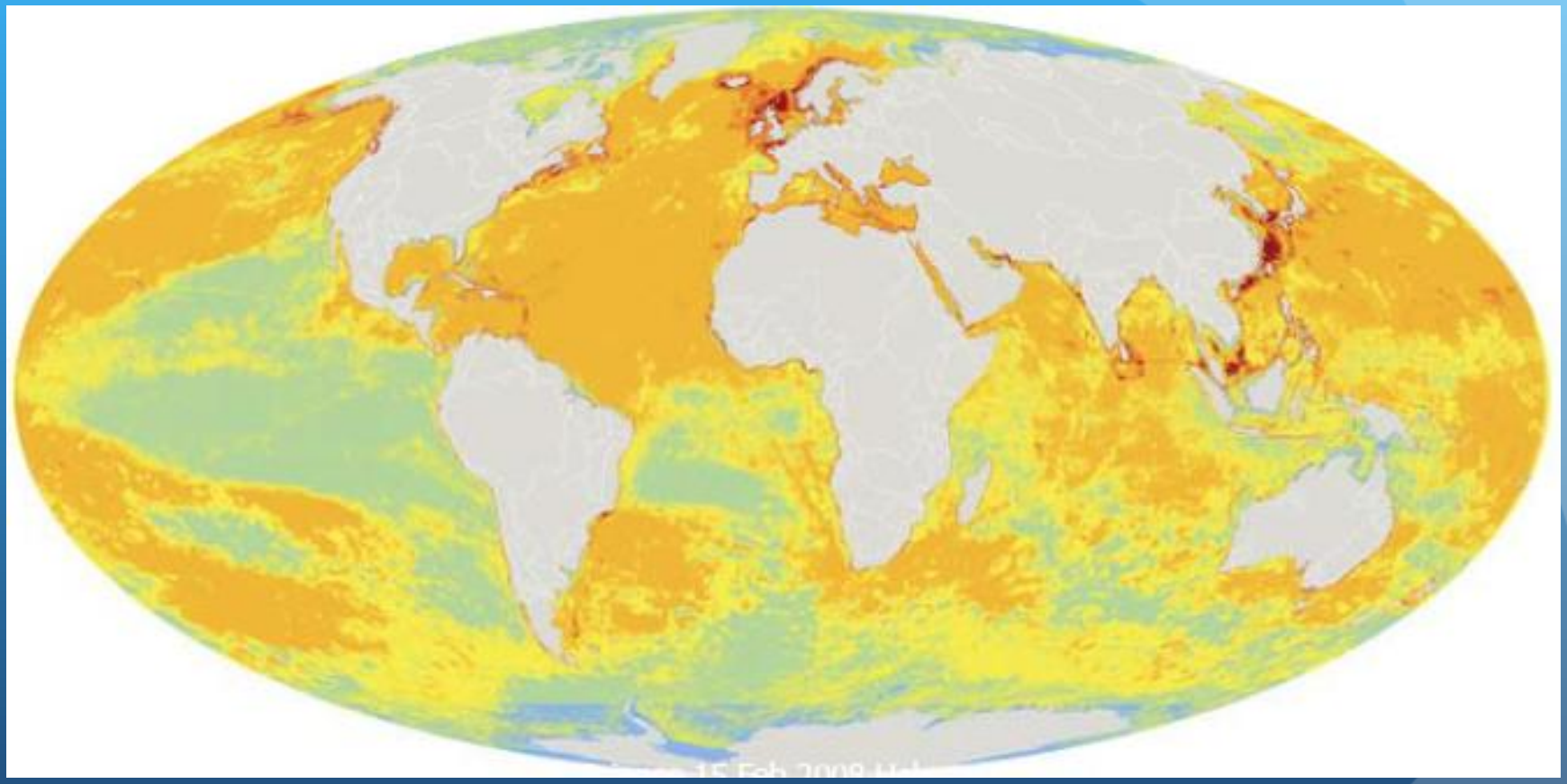
[#]Centre de Recherches sur les Macromolécules Végétales, Centre National de la Recherche Scientifique, Grenoble Cedex 9, France BP 53, 38041

Biotechnology and Nanotechnology

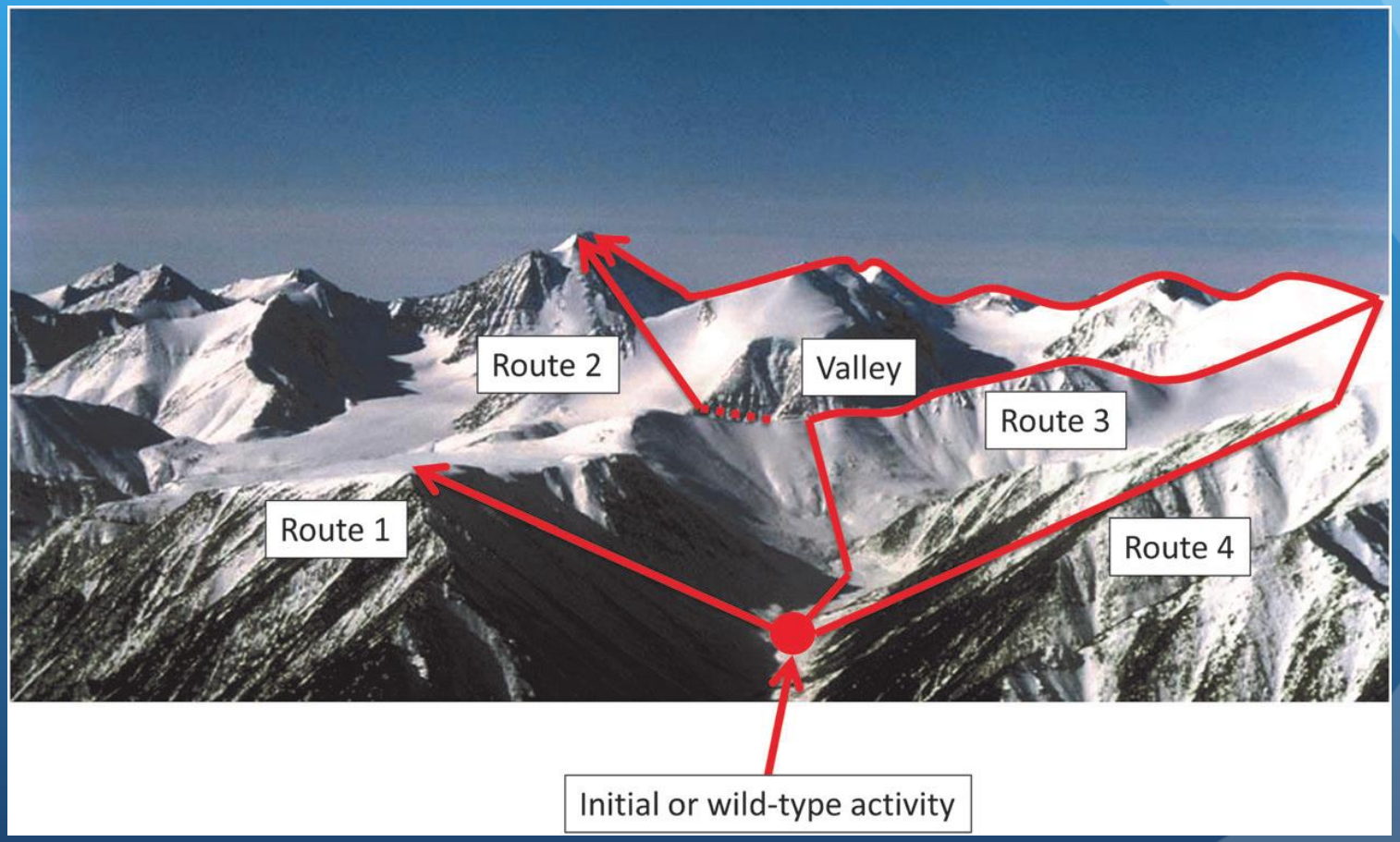


Marine environment is “the bioresource” for the future

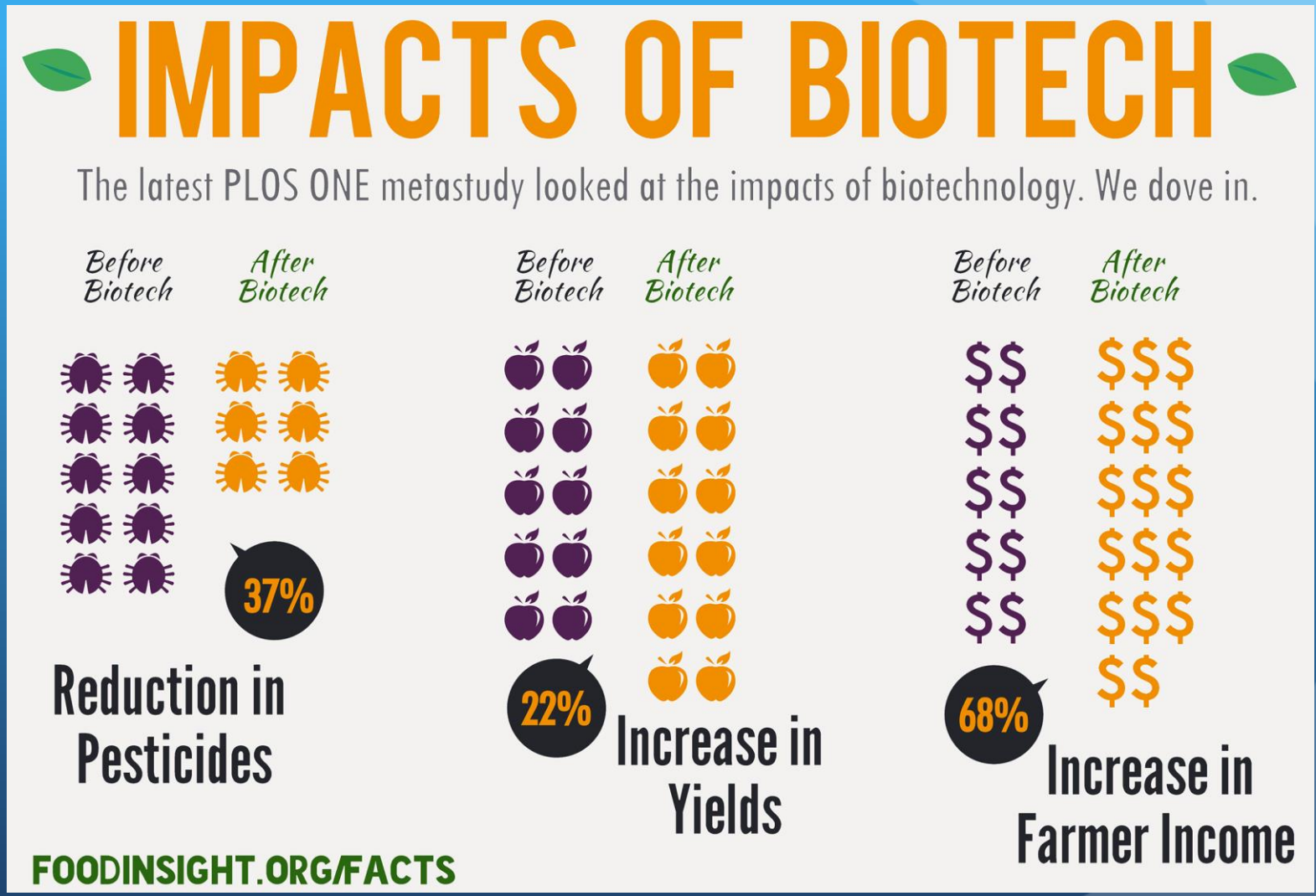


Research presented by Halpern et al in Science in Feb 2008

Synthetic biology: a “sport” similar to climbing



Biotech and Bioeconomy



Synthetic Biology and Bioeconomy

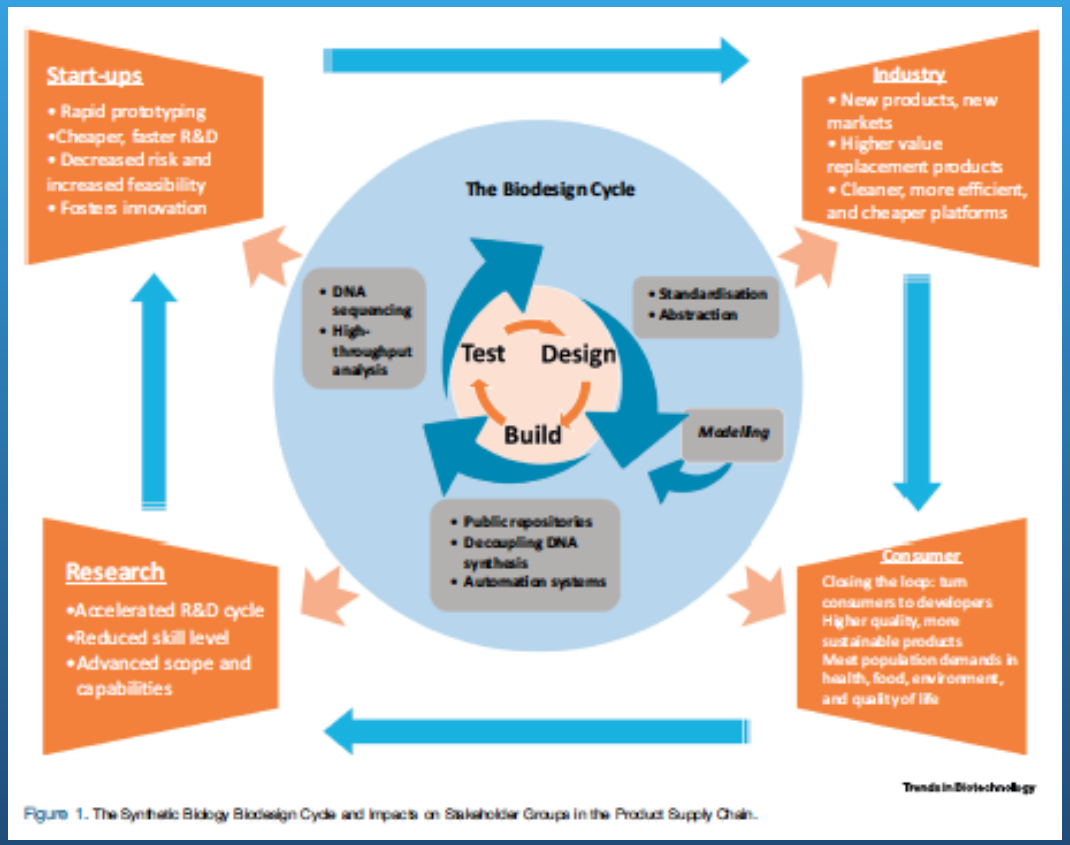


Figure 1. The Synthetic Biology Biodesign Cycle and Impacts on Stakeholder Groups in the Product Supply Chain.

Science & Society

Synthetic Biology in the Driving Seat of the Bioeconomy

Yensi Flores Bueso[1,2,3,4,*] and Mark Tangney[1,2,3,*]

Synthetic biology is revolutionising the biotech industry and is increasingly applied in previously unthought-of markets. Here, we discuss the importance of this industry to the bioeconomy and two of its key factors: the synthetic biology approach to research and development (R&D), and the unique nature of the carefully designed, stakeholder-inclusive, community-directed evolution of the field.

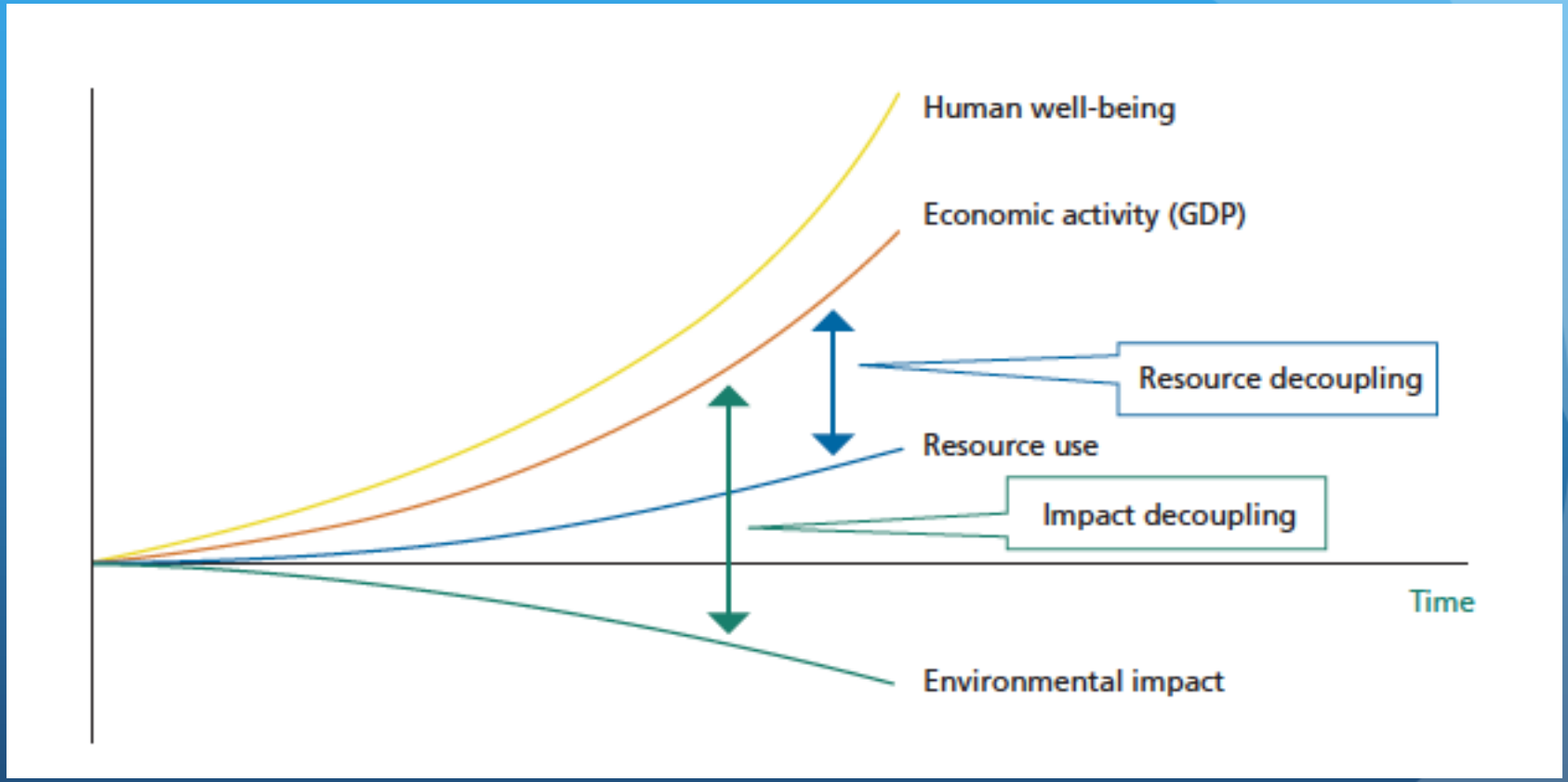
The take home message

We have to think simple to solve complicated problems.

Nature has the time to play its own “Lego” and find wise and sustainable solutions.

We do not have the time to do so, therfore we have to learn from nature and copy.

The take home message



The take home message

Bioeconomics M.Sc

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Διιδρυματικό / Διατμηματικό Πρόγραμμα

The Bioeconomy in Europe - Hype or Reality ?
Perspectives for Greece

Το ΠΜΣ στη «ΒΙΟ-ΟΙΚΟΝΟΜΙΑ»
διοργανώνει εκδήλωση παρουσίασης και έναρξης του Προγράμματος

Κεντρικός Ομιλητής

Dr. Christian Patermann

τέως Διευθυντής του Προγράμματος για την "Έρευνα στη Βιοτεχνολογία, Γεωργία και Διατροφή"
της Γενικής Γραμματείας Έρευνας της Ευρωπαϊκής Επιτροπής και
νυν Σύμβουλος της Γερμανικής Κυβέρνησης σε θέματα Βιο-Οικονομίας

Πέμπτη, 1η Ιουνίου 2017 και ώρα 18:00
Αίθουσα Συνεδρίων Πανεπιστημίου Πειραιώς

ΤΜΗΜΑ
ΟΙΚΟΝΟΜΙΚΗΣ ΕΠΙΣΤΗΜΗΣ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

ΤΜΗΜΑ ΒΙΟΛΟΓΙΑΣ
ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ


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Thank you