Bioeconomy, biosystems and biotechnology in every day life

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The structure of our biosystem

The blue planet, our home

The ecosystem

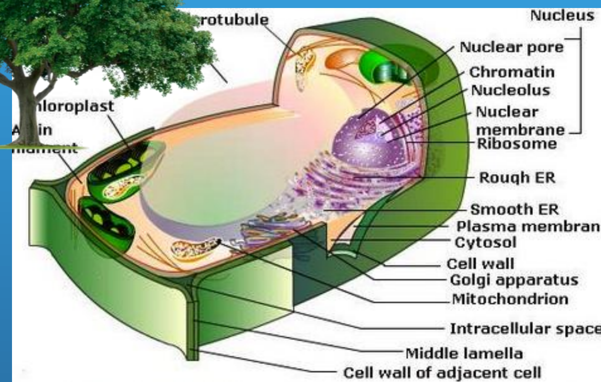
Components of our ecosystem

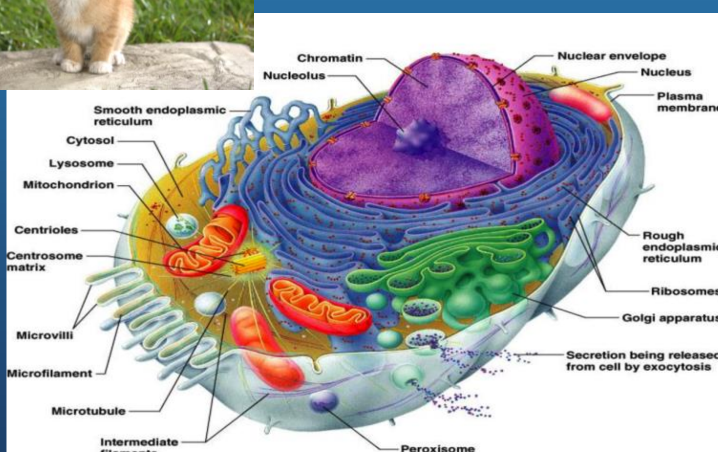


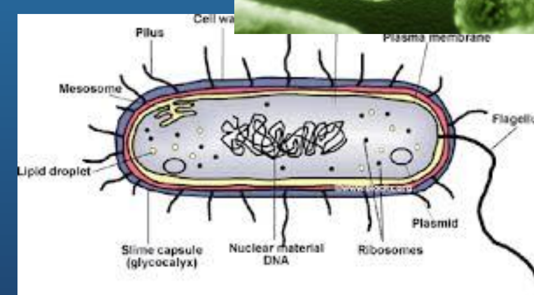



We are seeing a tiny part of what is there

Basic components of the living organisms are the cells

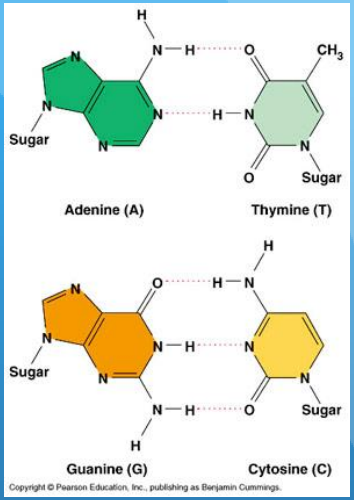






The information stockpile of our biosystem

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

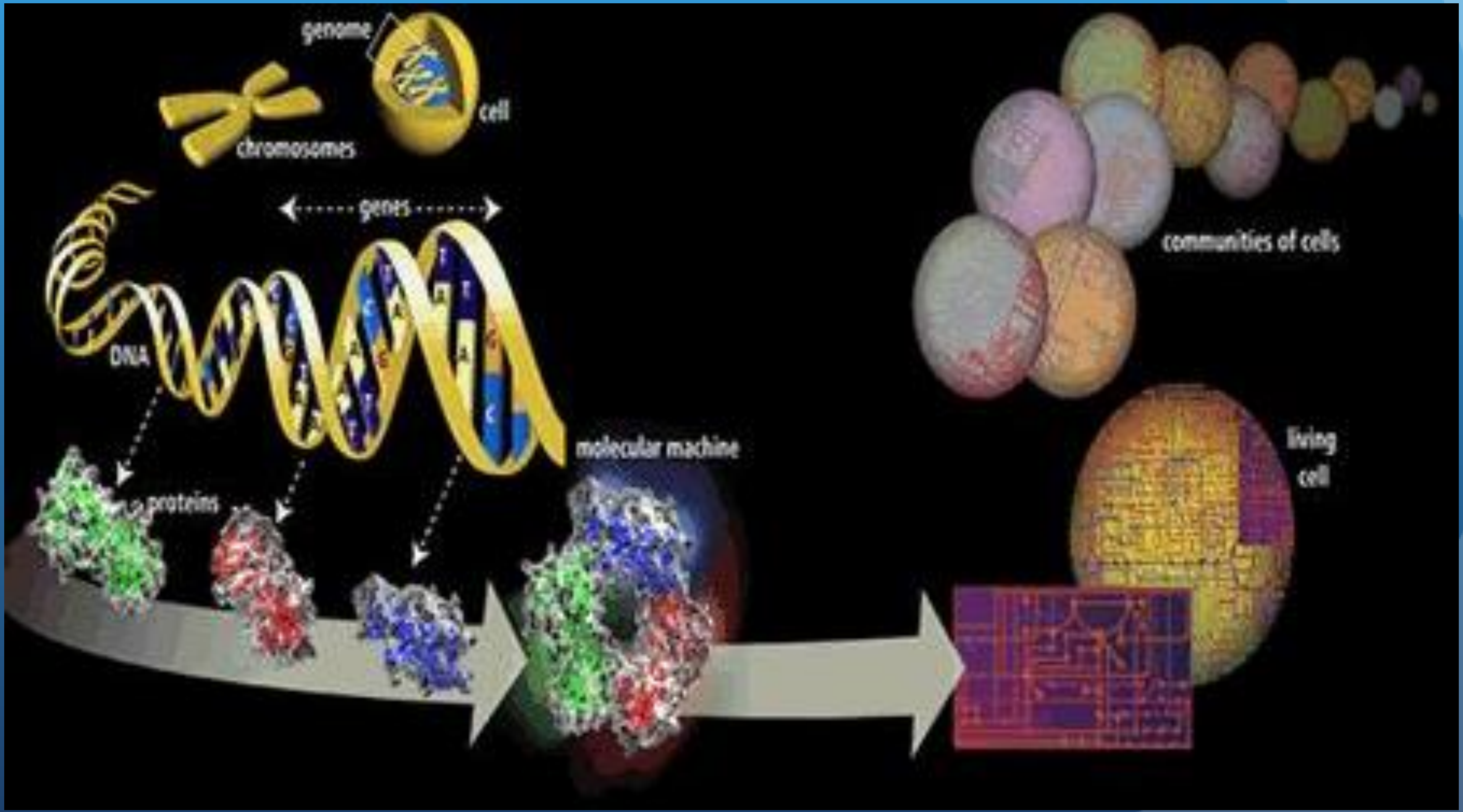
Recombinant DNA-gene technology

Shuffled DNA-directed evolution

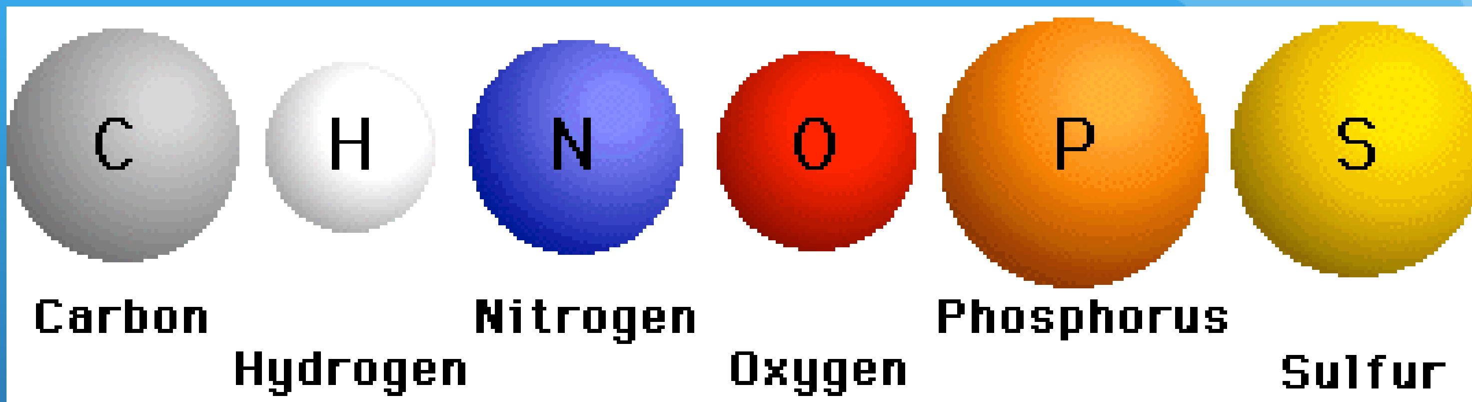
Ancestral DNA (calculated)

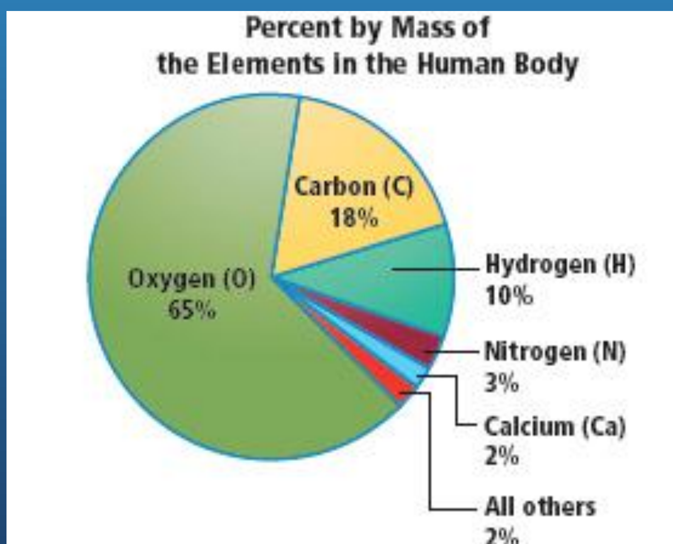
Synthetic DNA (artificial)

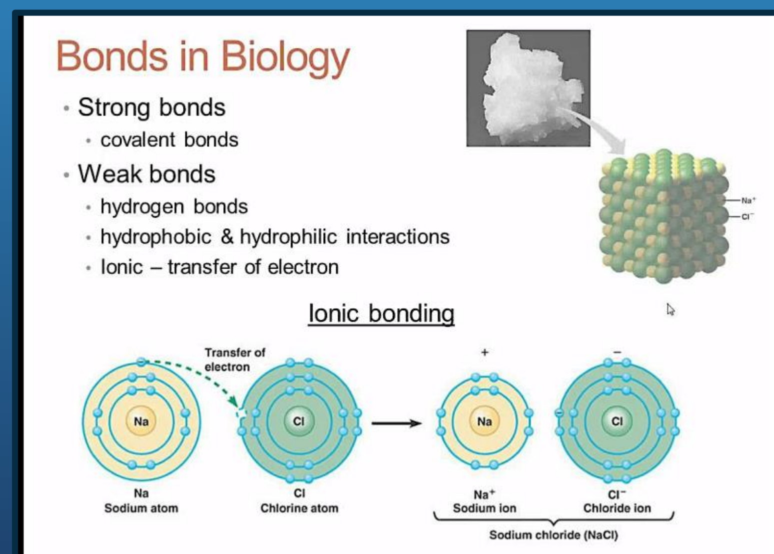
The DNA provides the essential information (genes-regulatory elements etc) to the cell machinery (proteinosynthesis) to build functional molecules: the proteins



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.

$$\Delta E = q + w$$

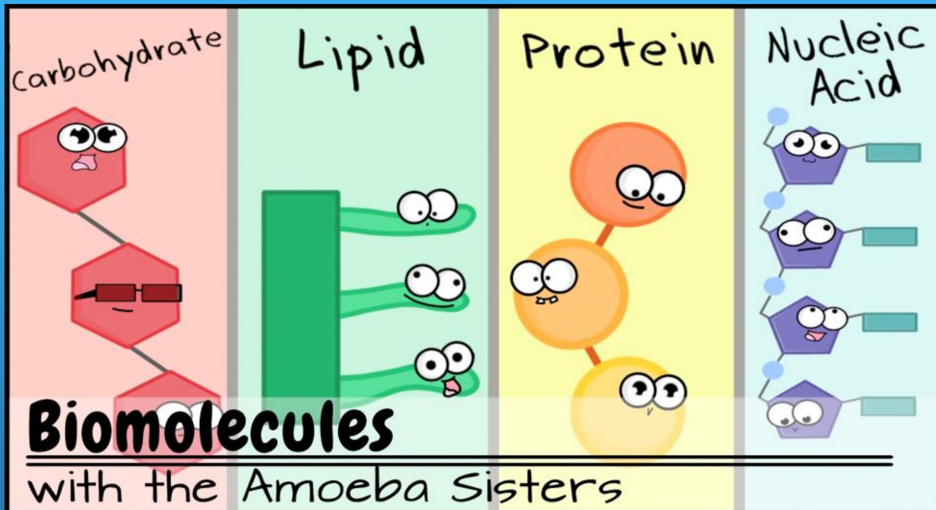
2. The total entropy of the UNIVERSE (= system plus surroundings) MUST INCREASE in every spontaneous process.

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

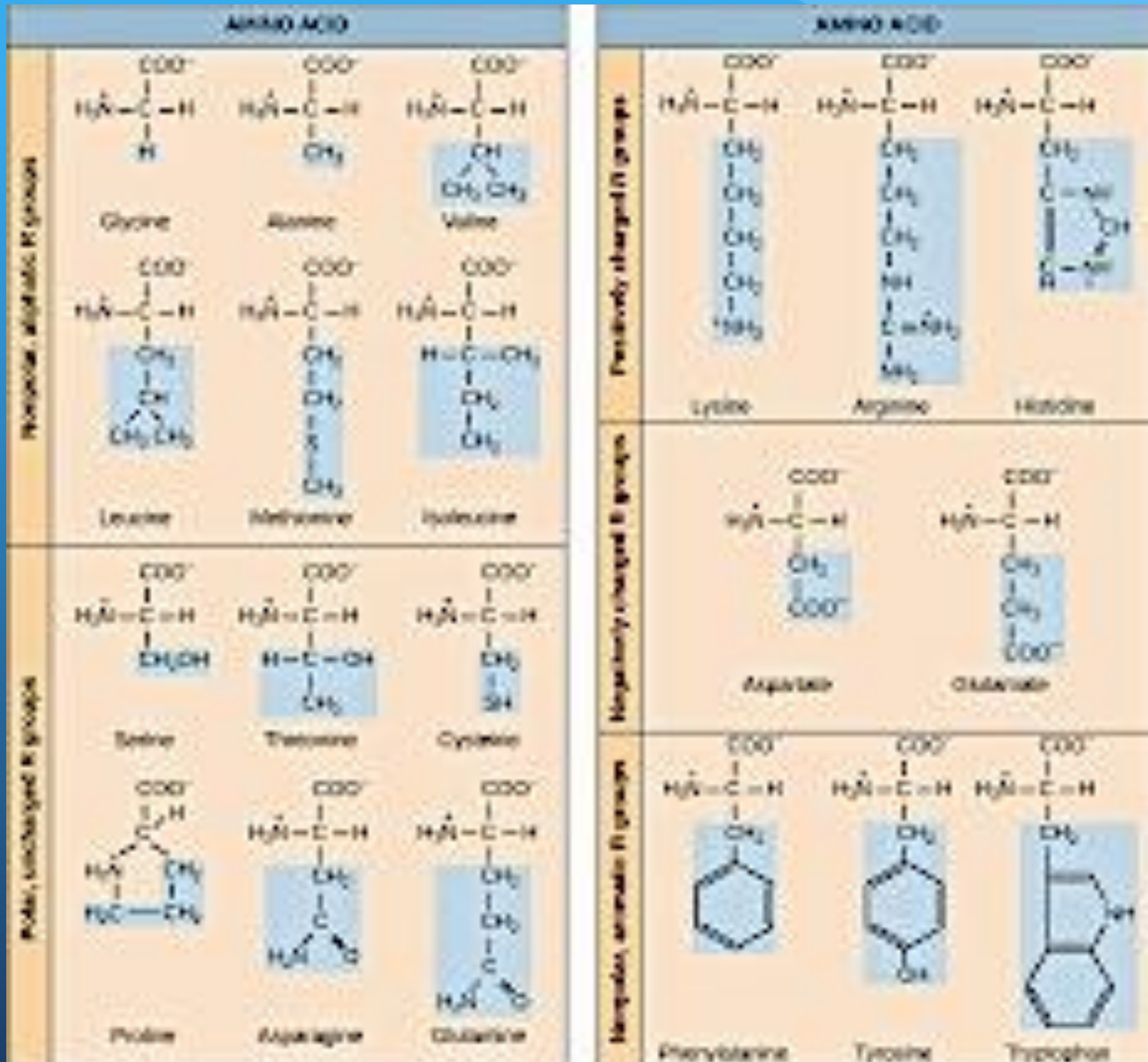
3. The entropy (S) of a pure, perfectly crystalline compound at T = 0 K is ZERO. (no disorder)

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

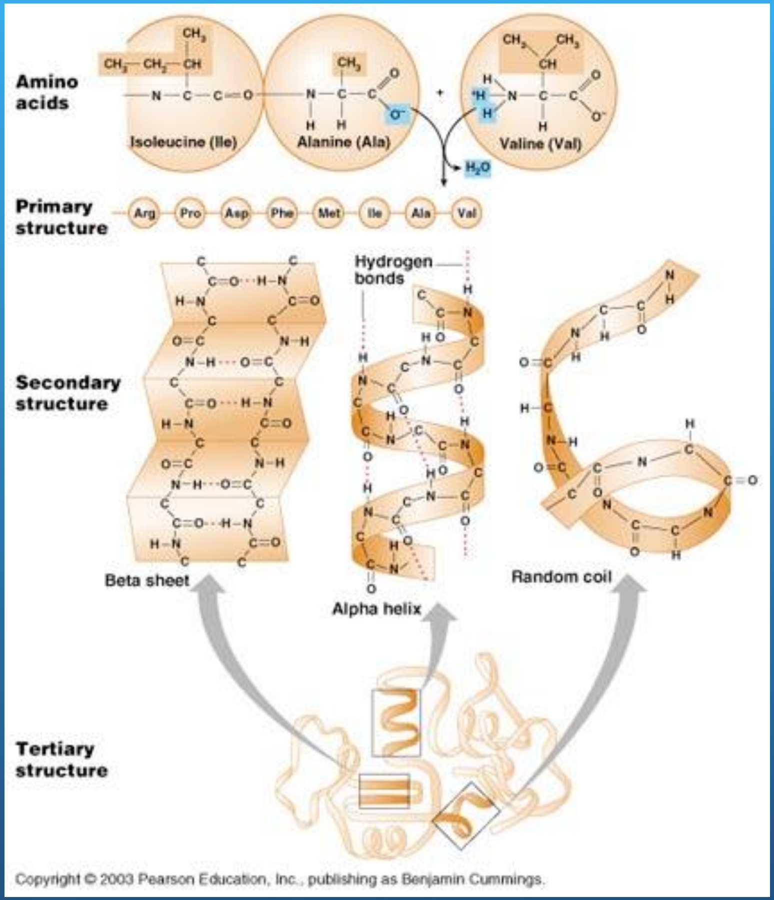
The major biomolecules



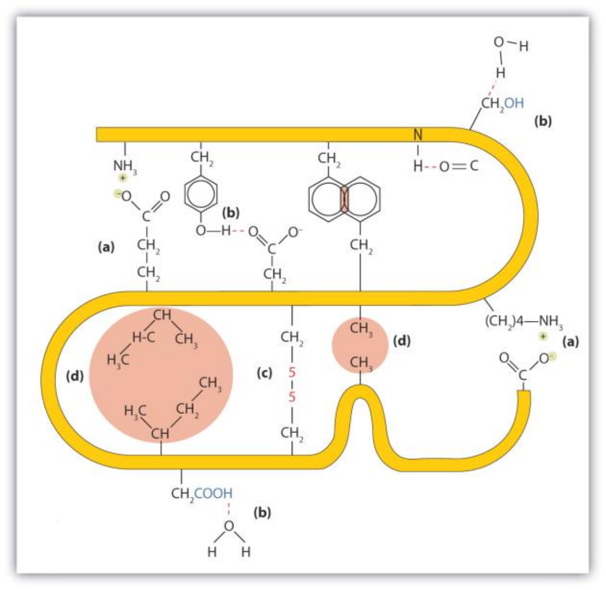
Proteins=linear chains of amino acids



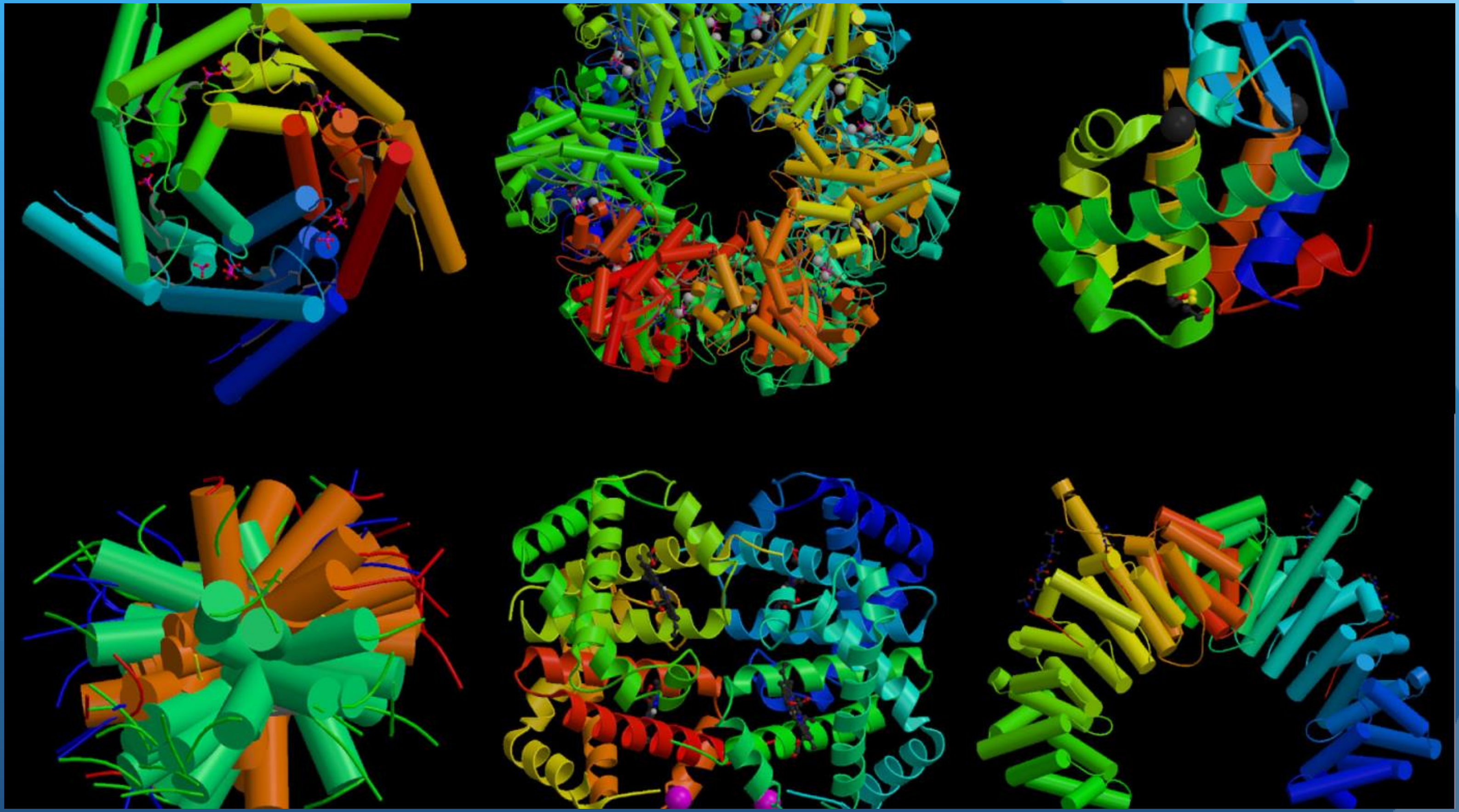
The structure of proteins



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

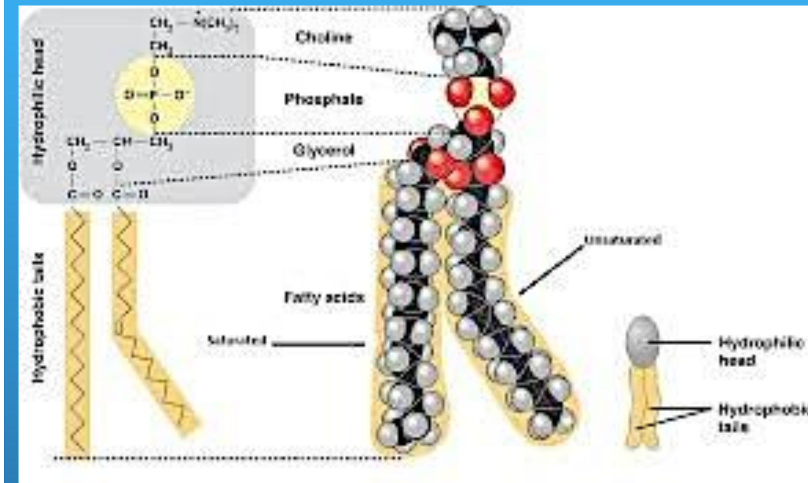


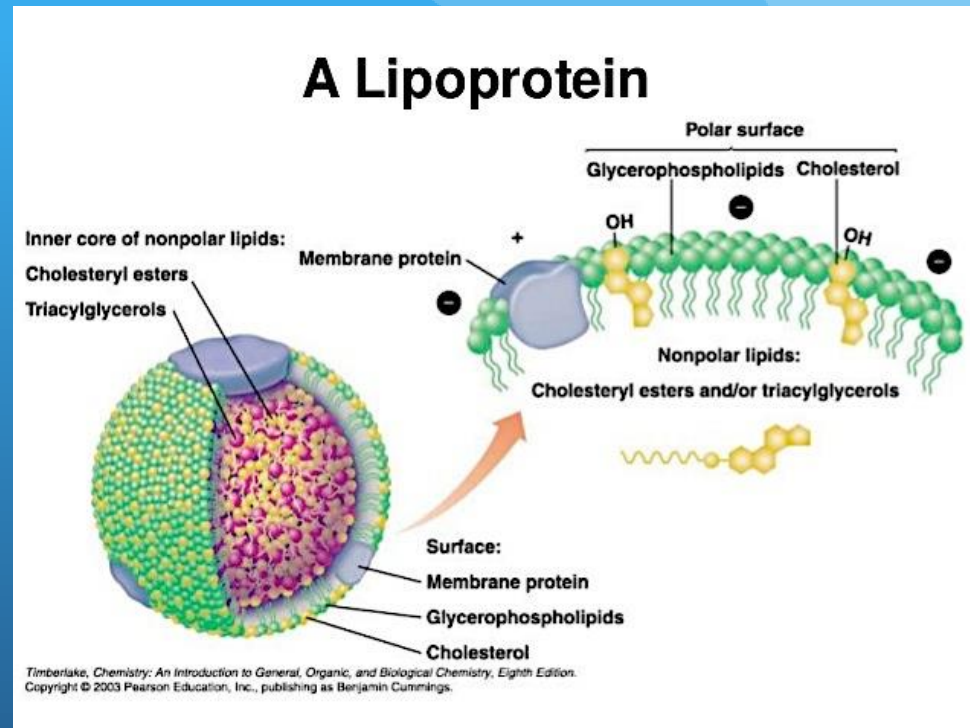
The structure of proteins

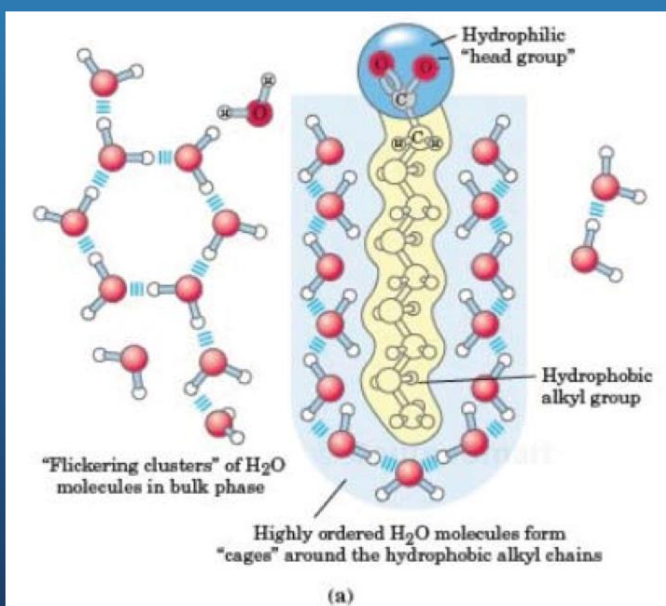


The existing proteins is a tiny fraction of the existing possibilities

The structure of lipids

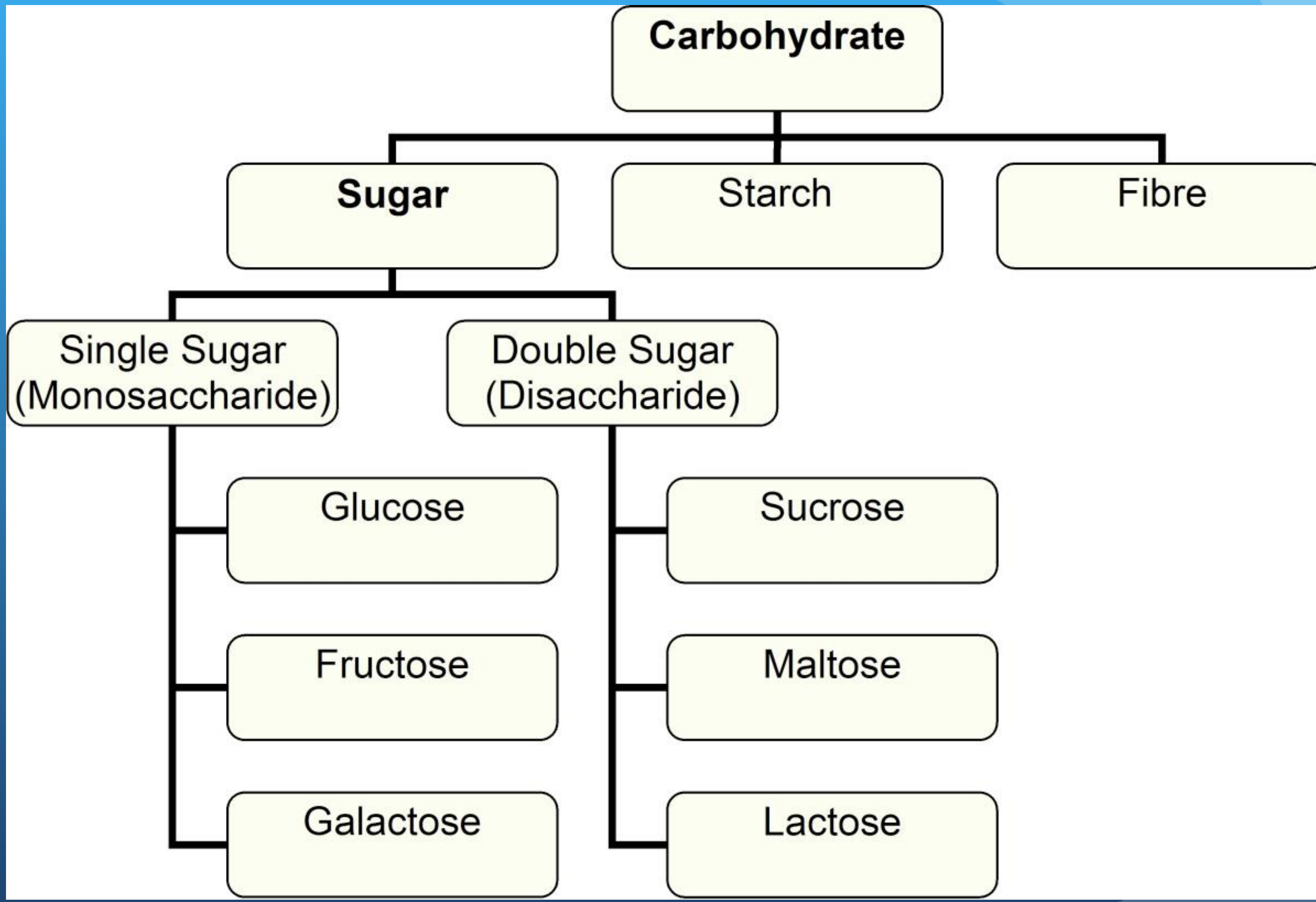




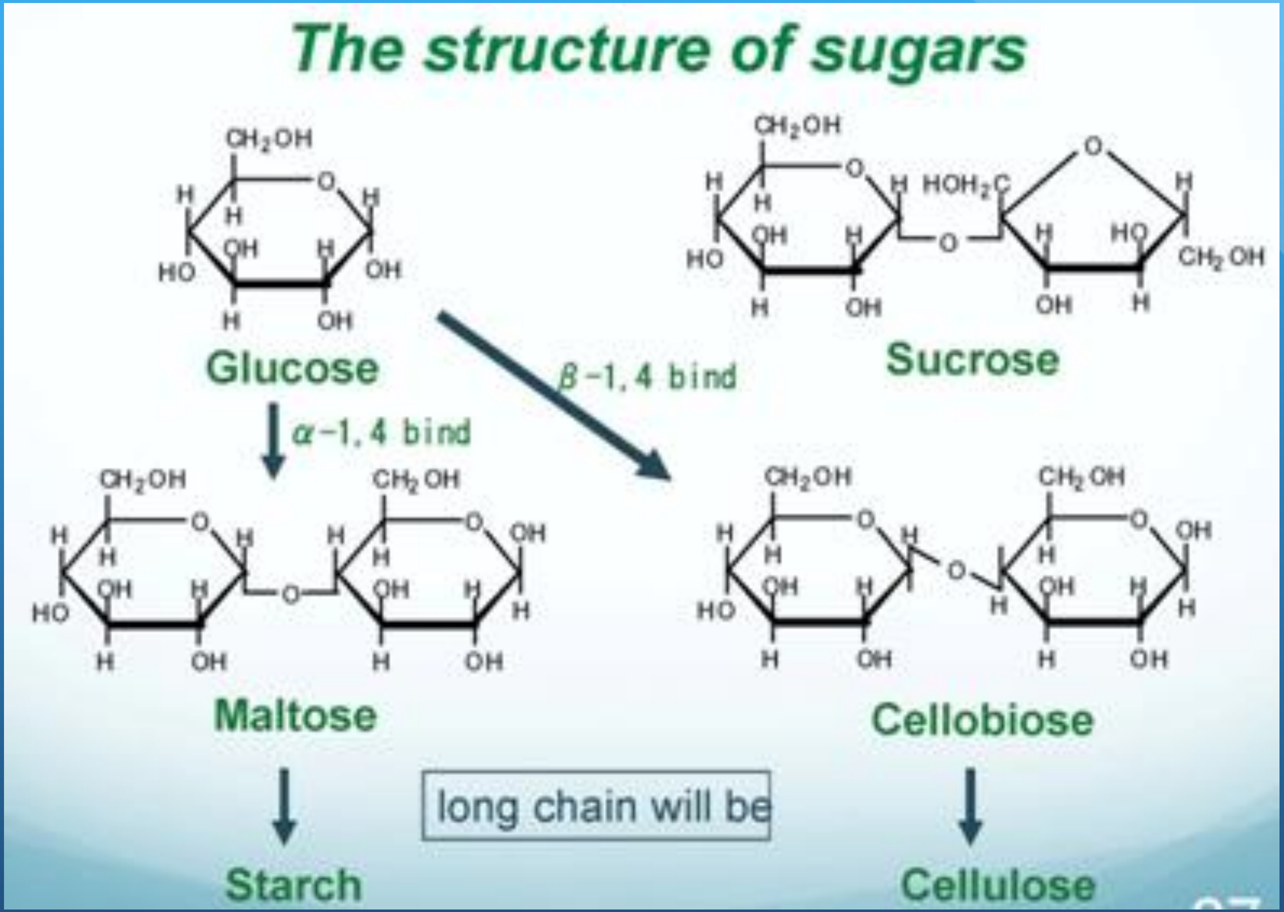


An amazing feature of lipids is their hydrophobicity, the driving force for self assembly

The structure of carbohydrates



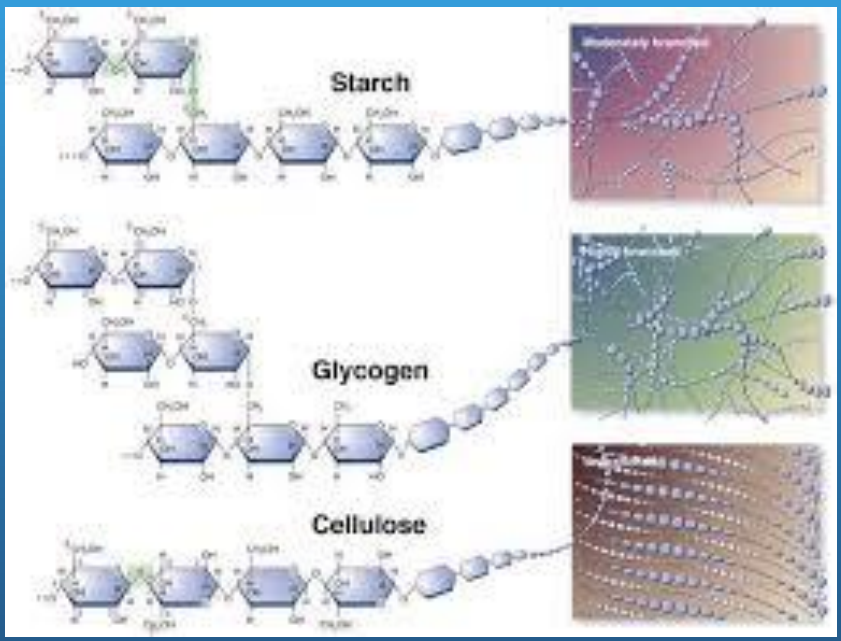
The structure of carbohydrates

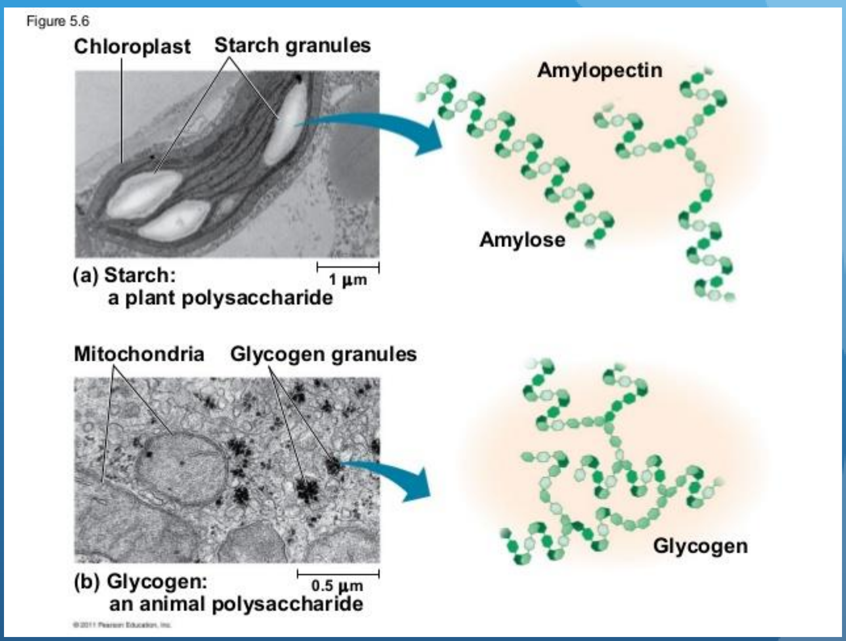


A single bond defines the structure of polysaccharides

The structure of carbohydrates

The polysaccharides are linear and branched

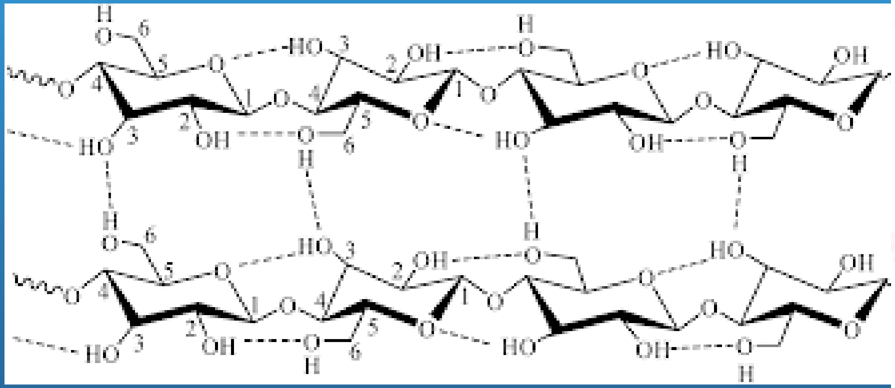


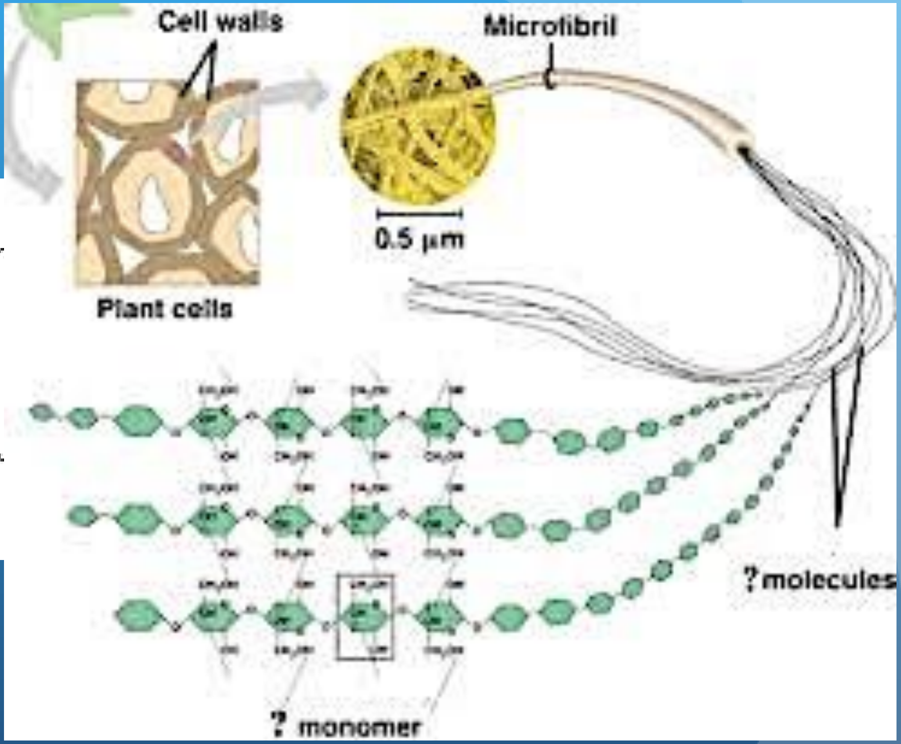


α-1,4 construct helical polysaccharides=storage

The structure of cellulose

The structural polysaccharides are linear

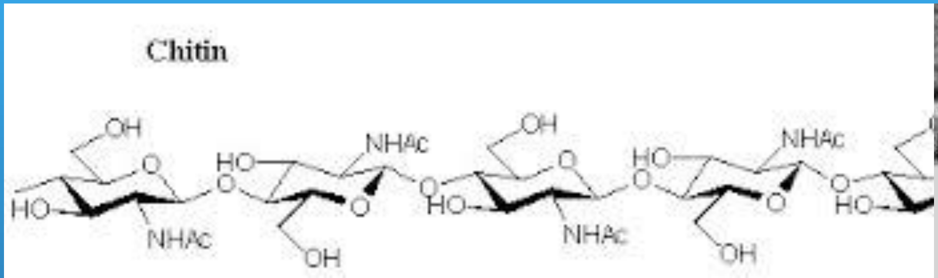


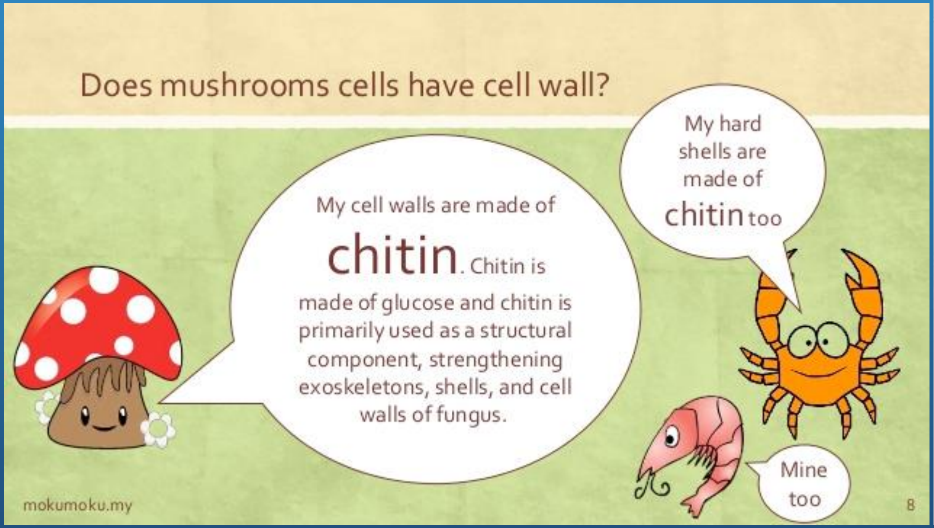


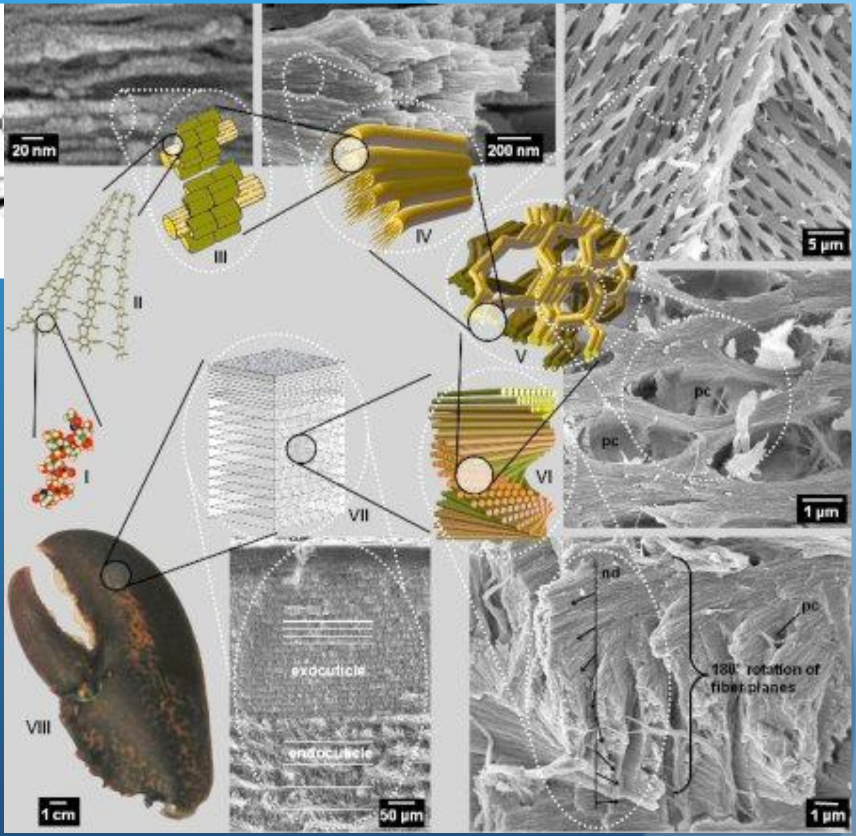
β-1,4 construct linear polysaccharides=structure

The structure of chitin

The structural polysaccharides are linear

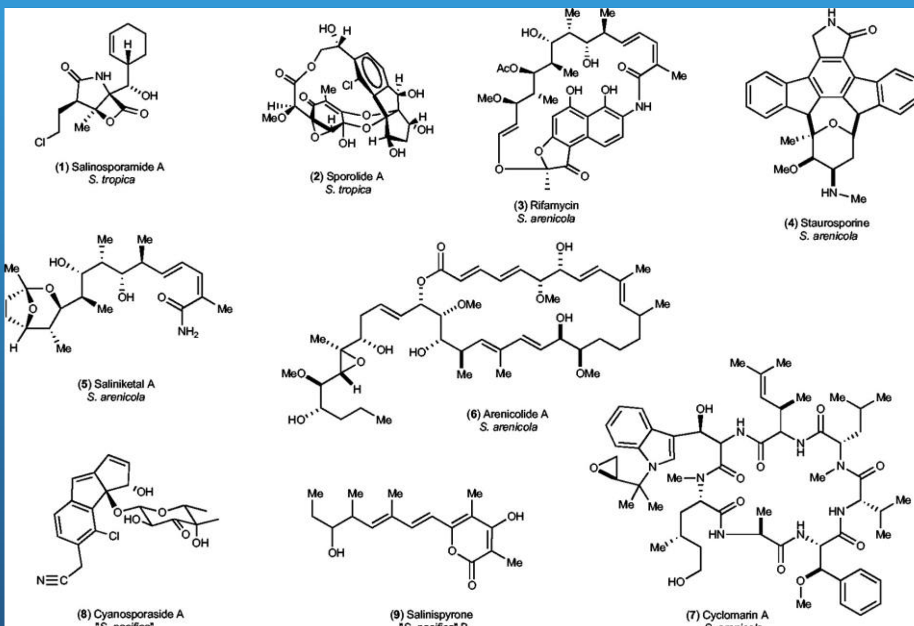


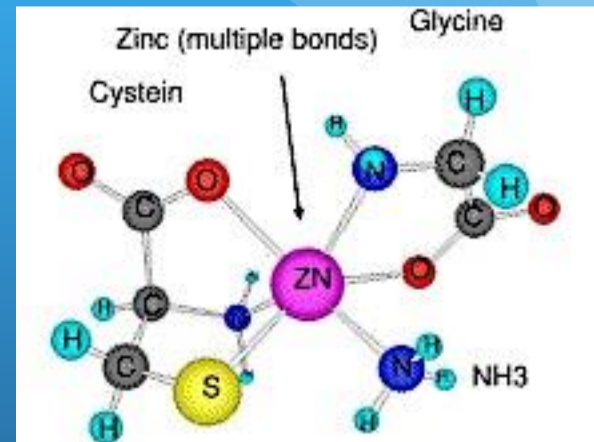


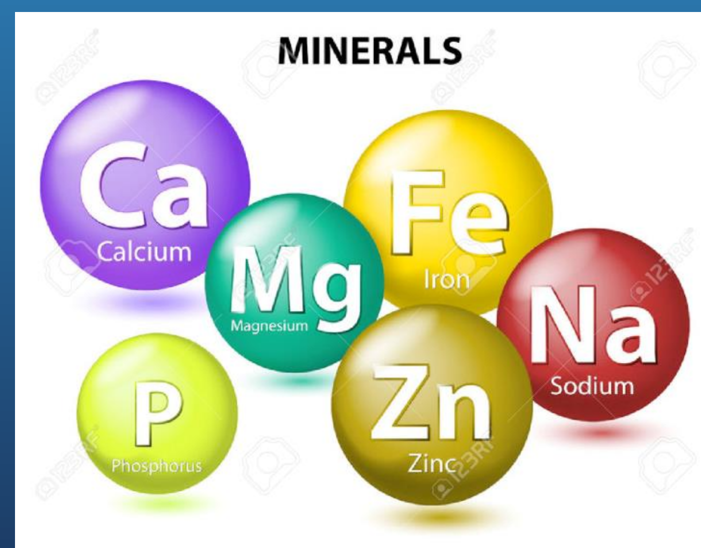


β-1,4 construct linear polysaccharides=structure

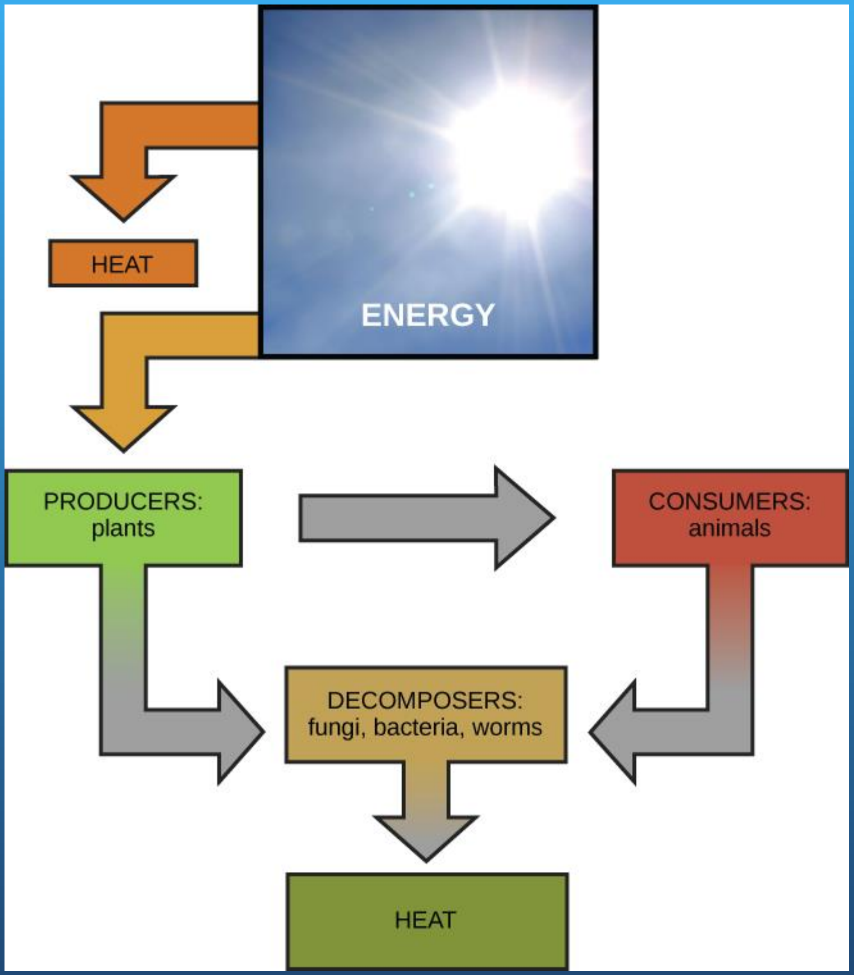
The rest: small metabolites and trace elements

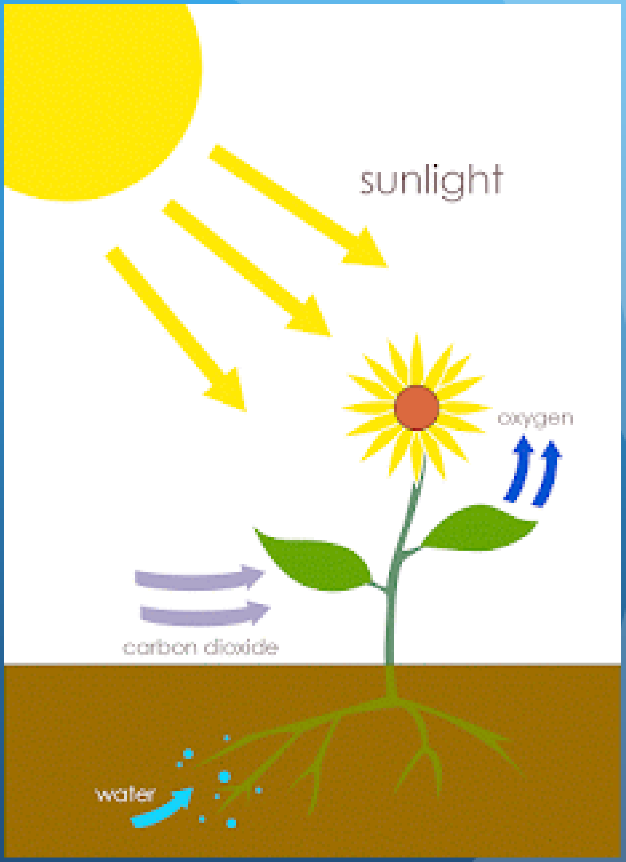




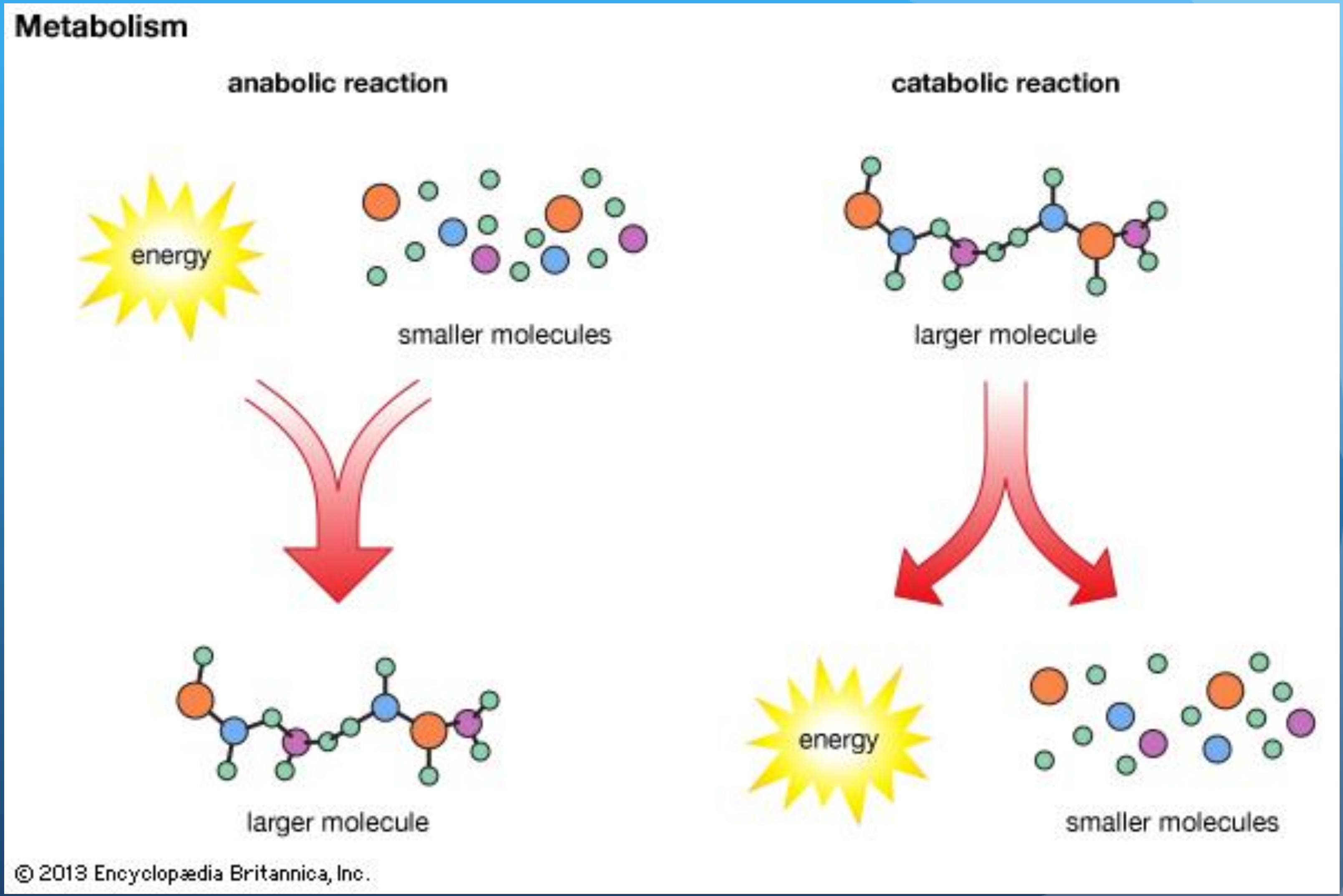


Energy in biosystems

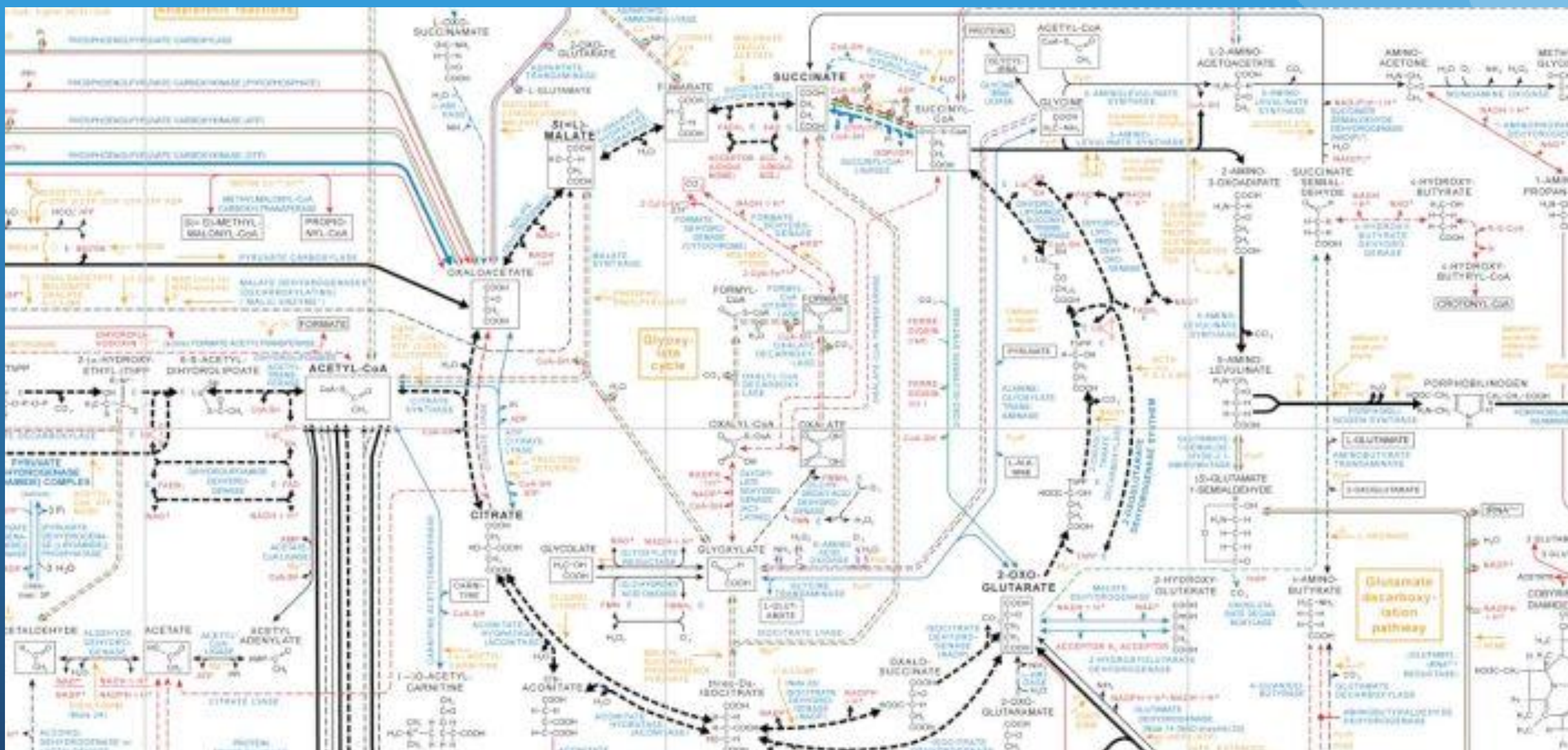




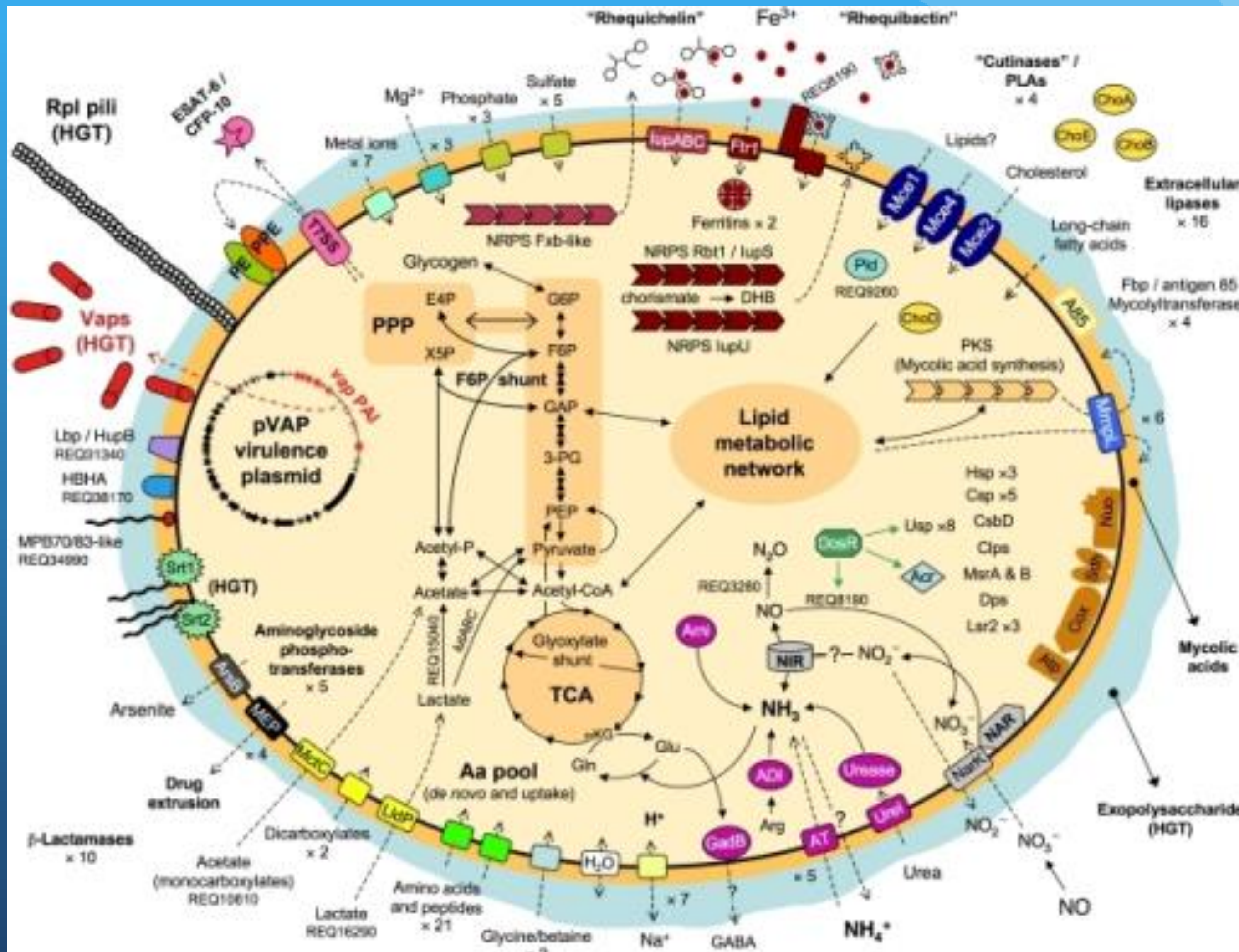
The cellular metabolism



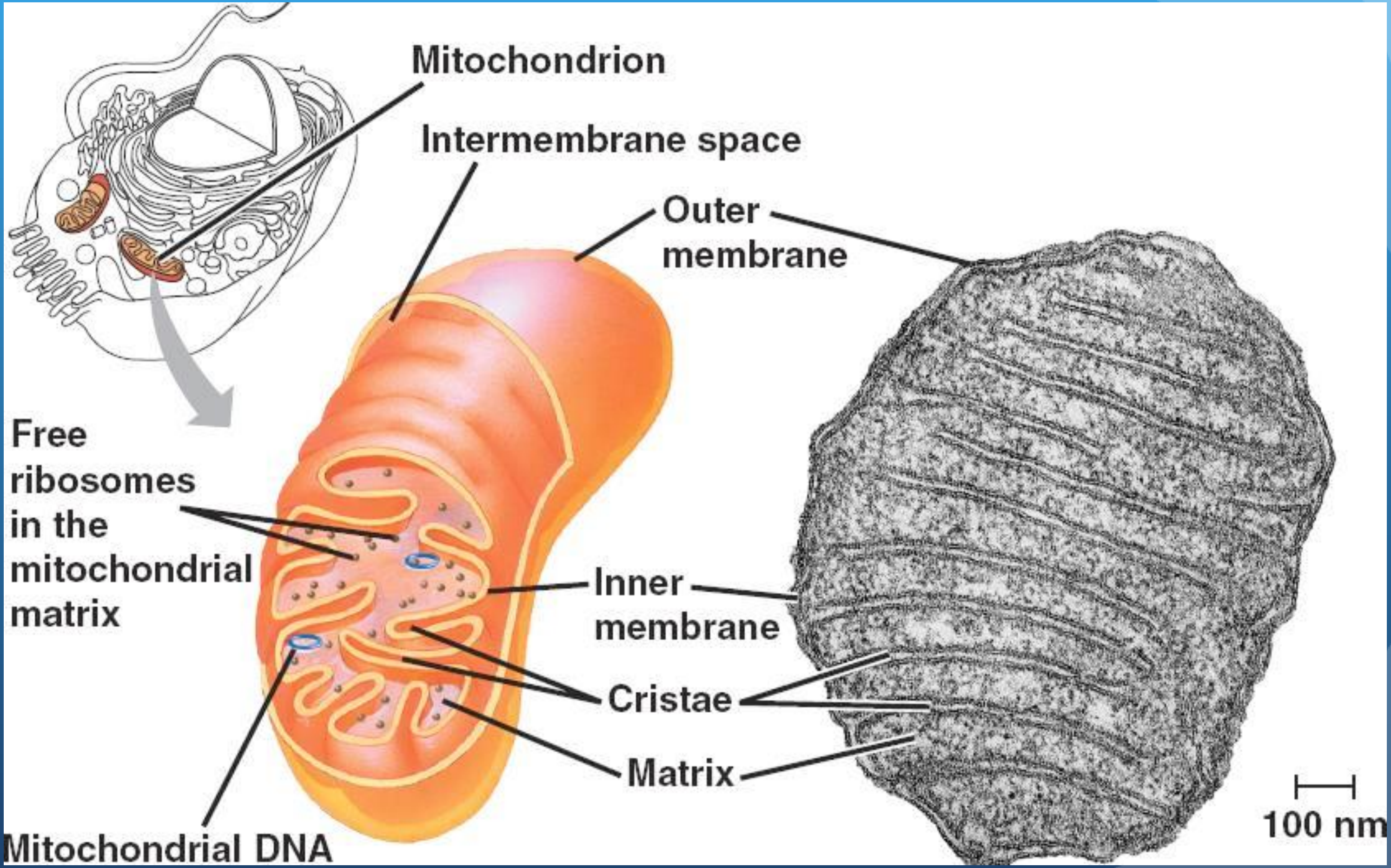
The cellular metabolism is a very complicated network of simple organic chemistry reactions, the metabolic pathways



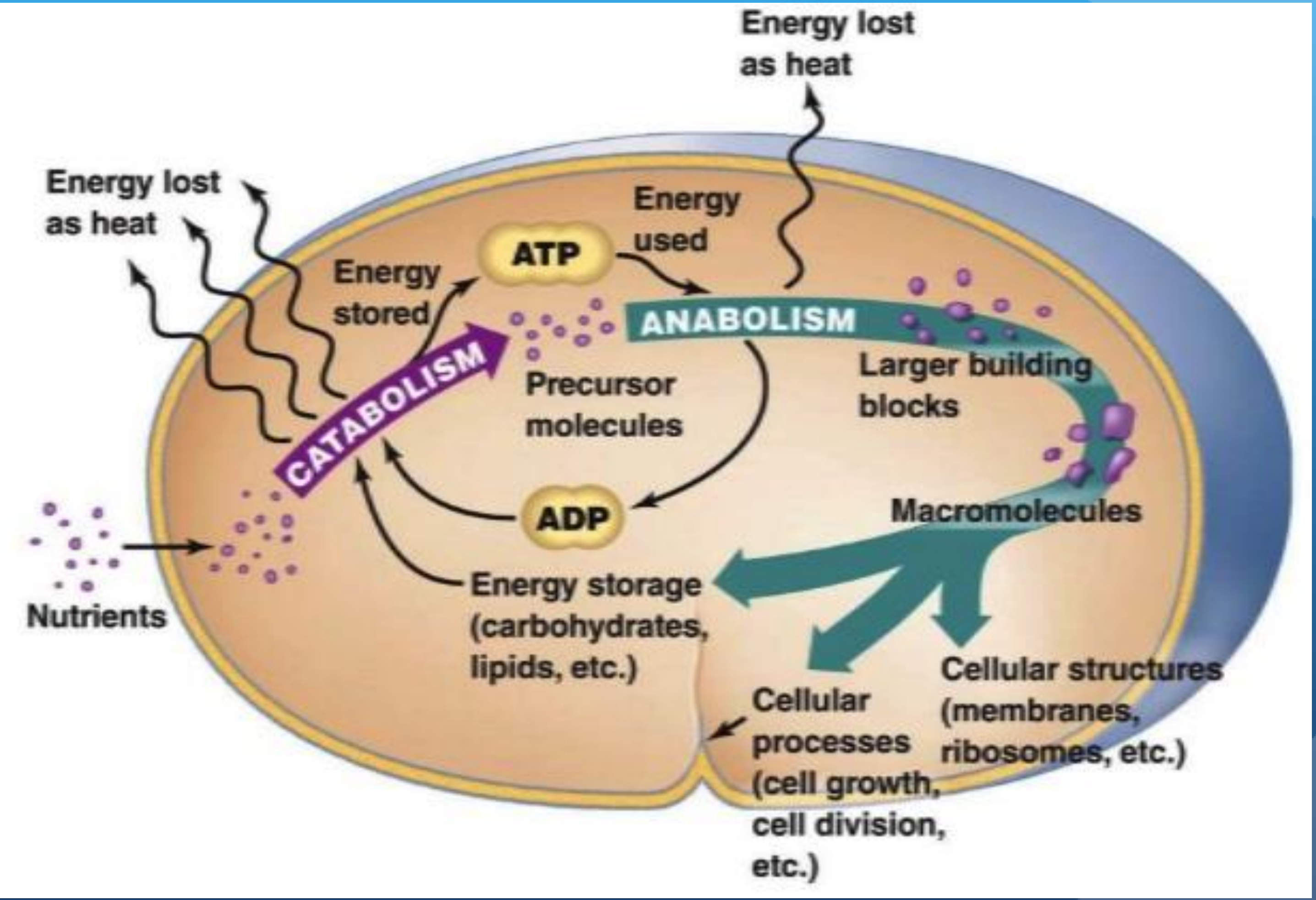
The cellular metabolism is controlled in various ways



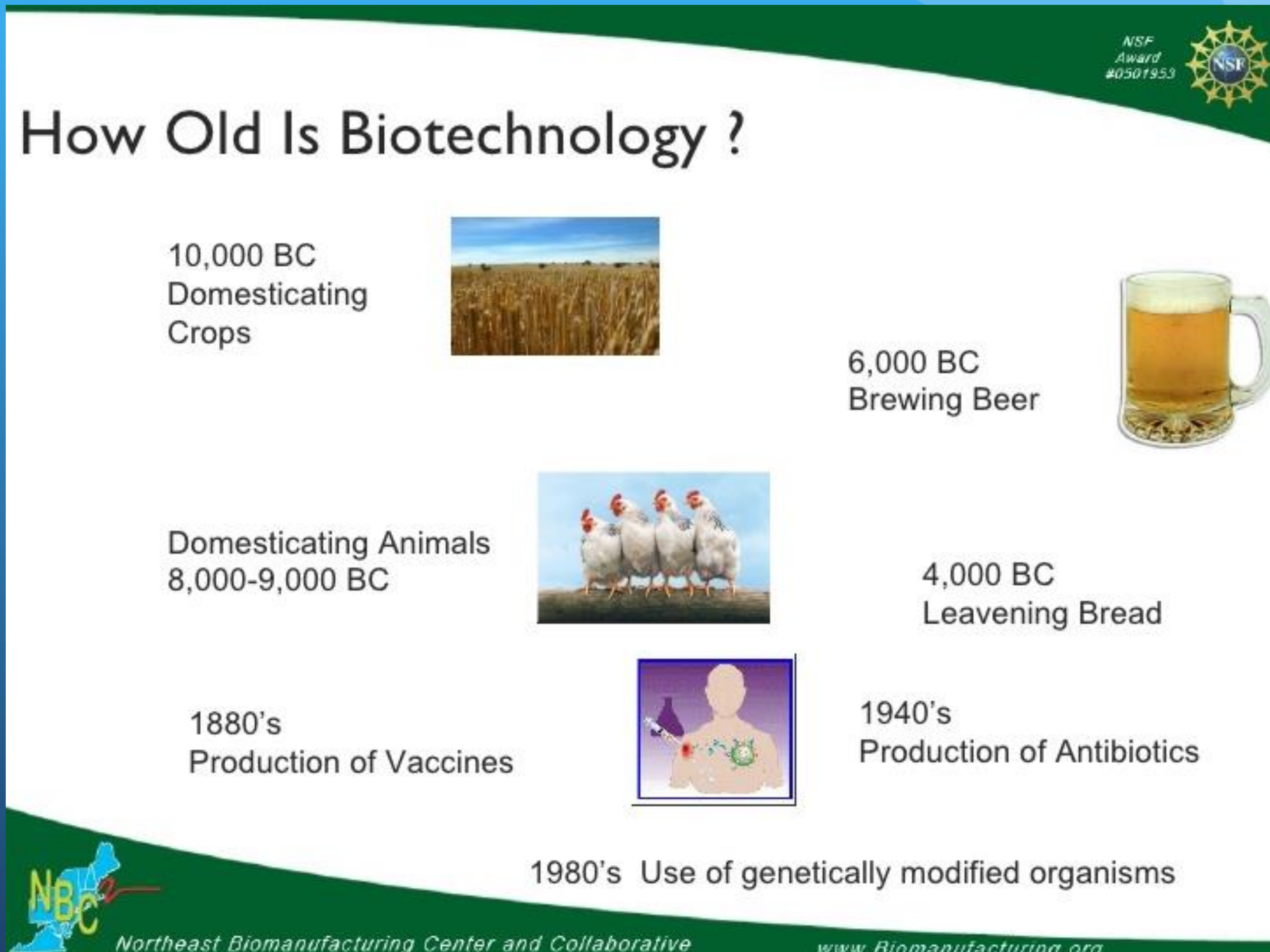
The energy is capture either in high energy bonds (ATP) or in reduced molecules (NADPH, NADPH, $FADH_2$)



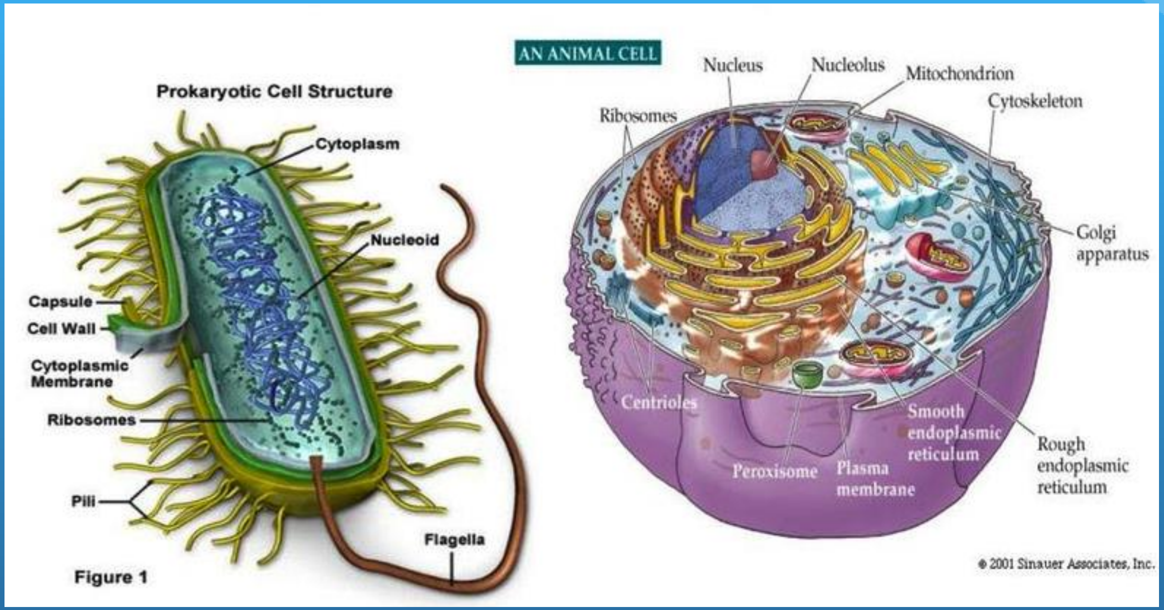
The cell factory mostly recycle the biomolecules very efficiently

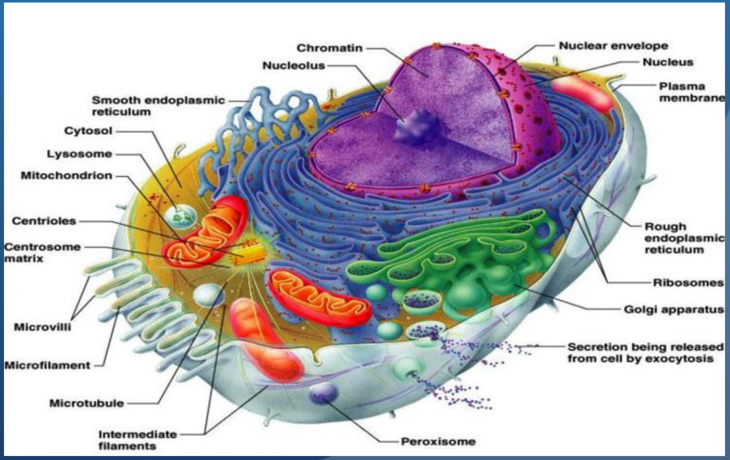


Biotechnology: so young and so old



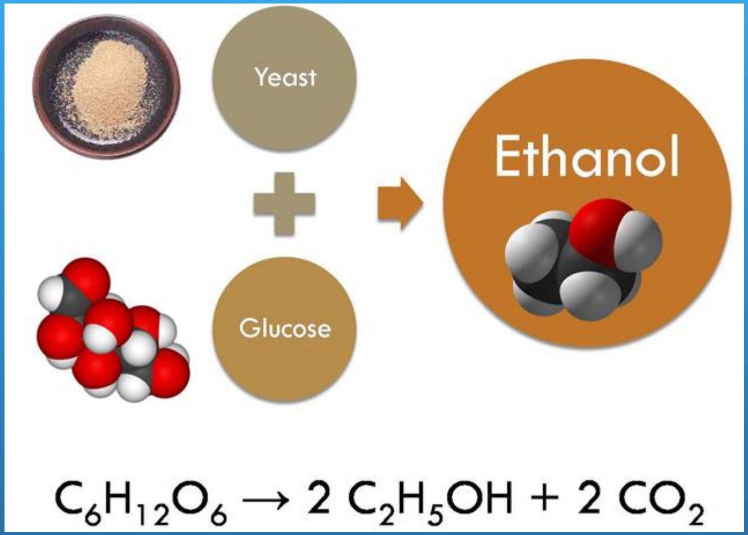
The cell factory the major tool of modern biotechnology

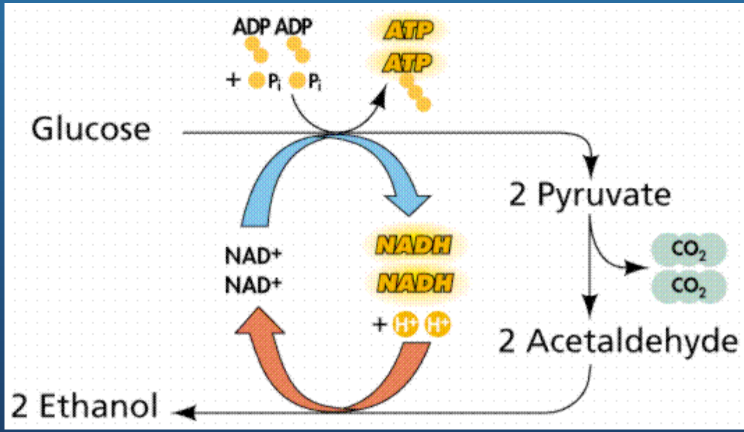




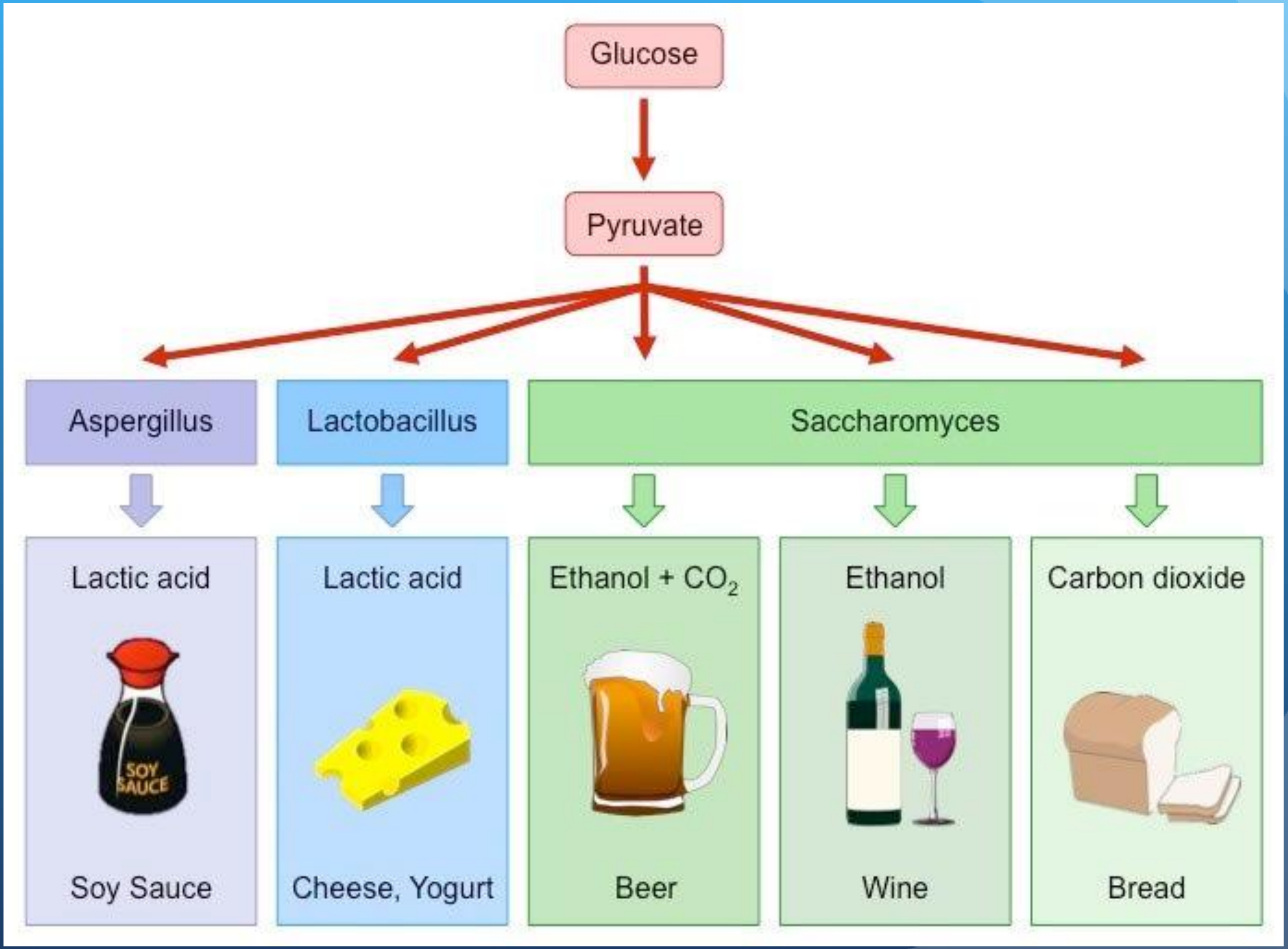
Biotechnology started empirically

The most important biotechnological application

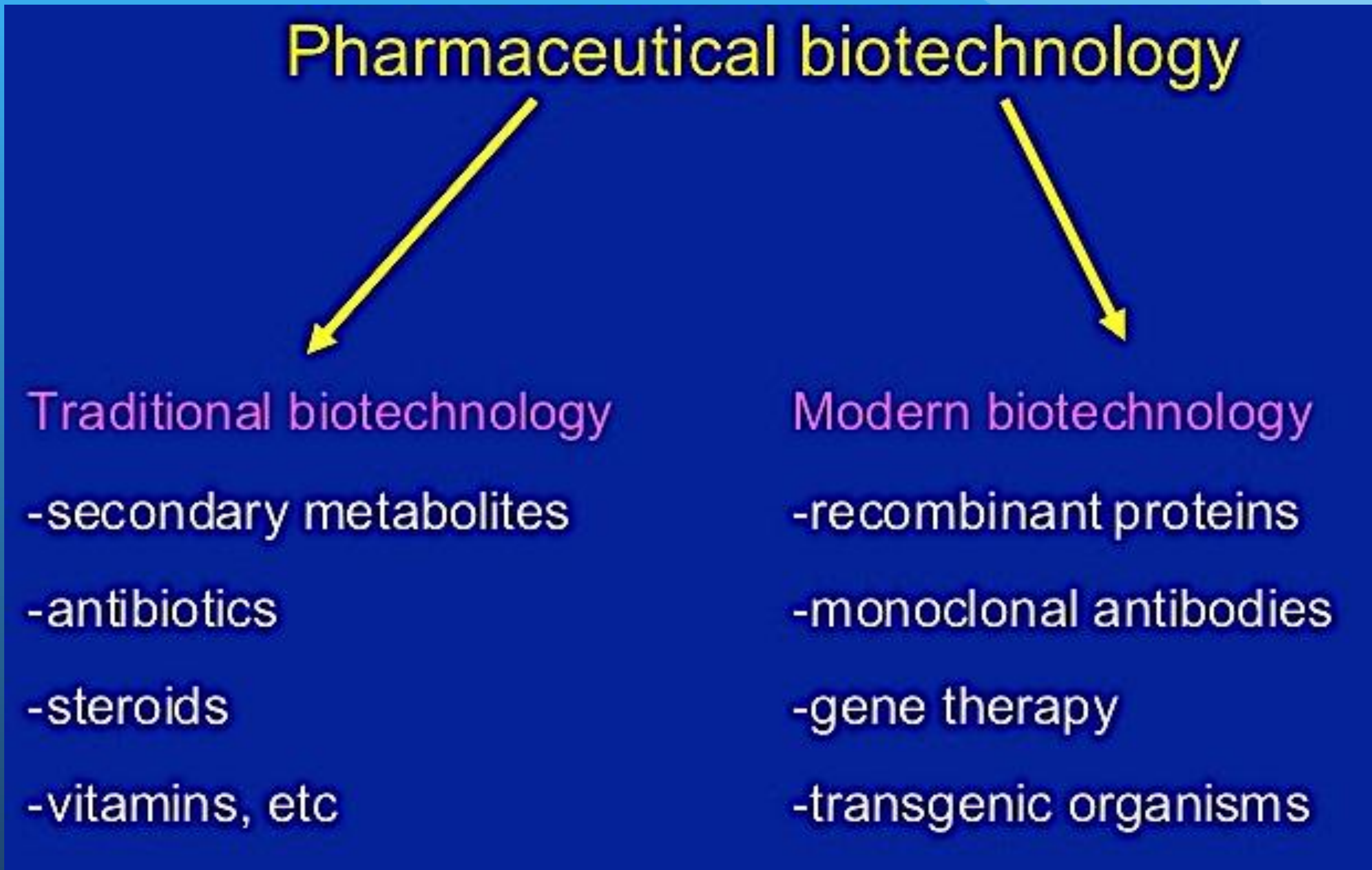




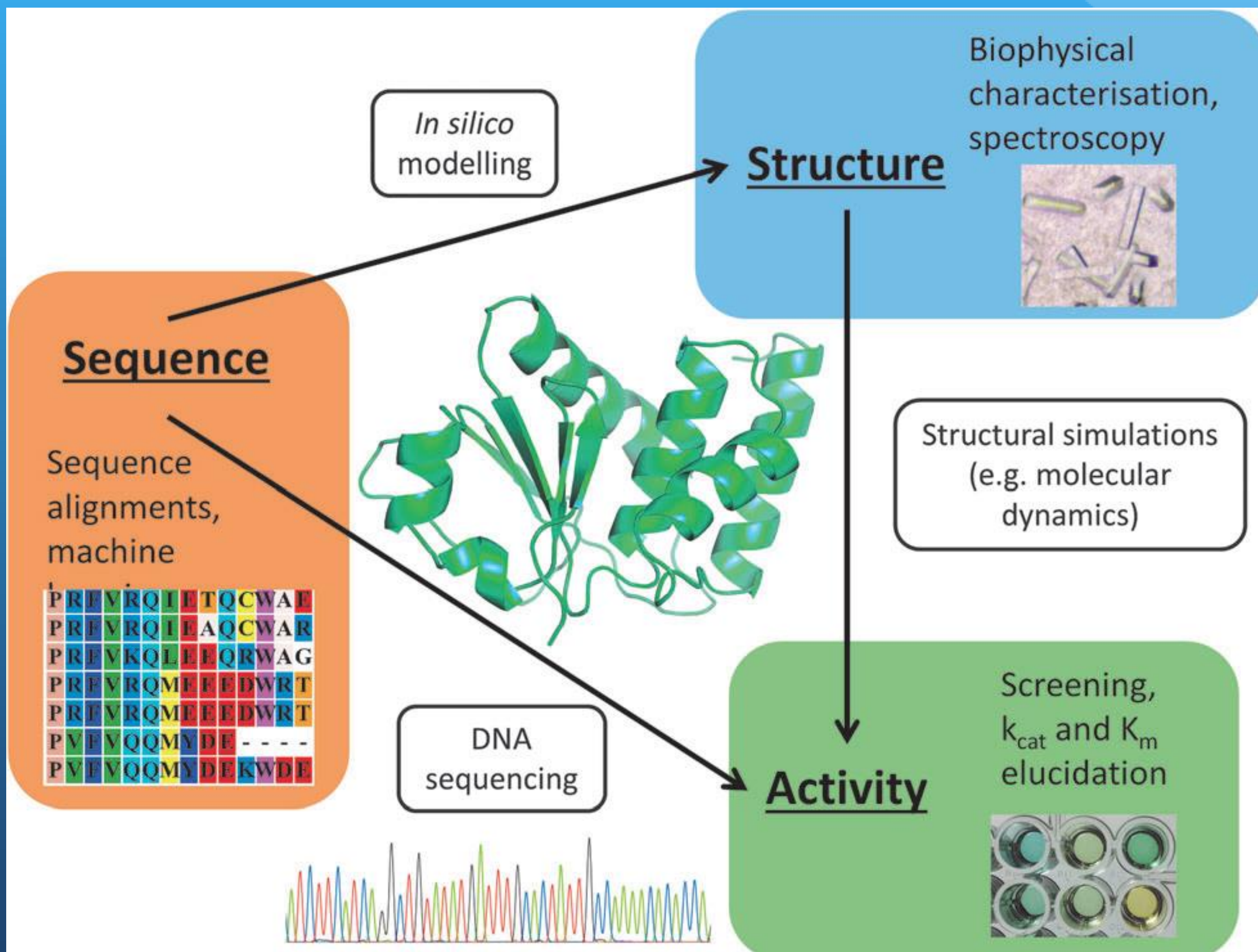
The most usual biotechnological applications



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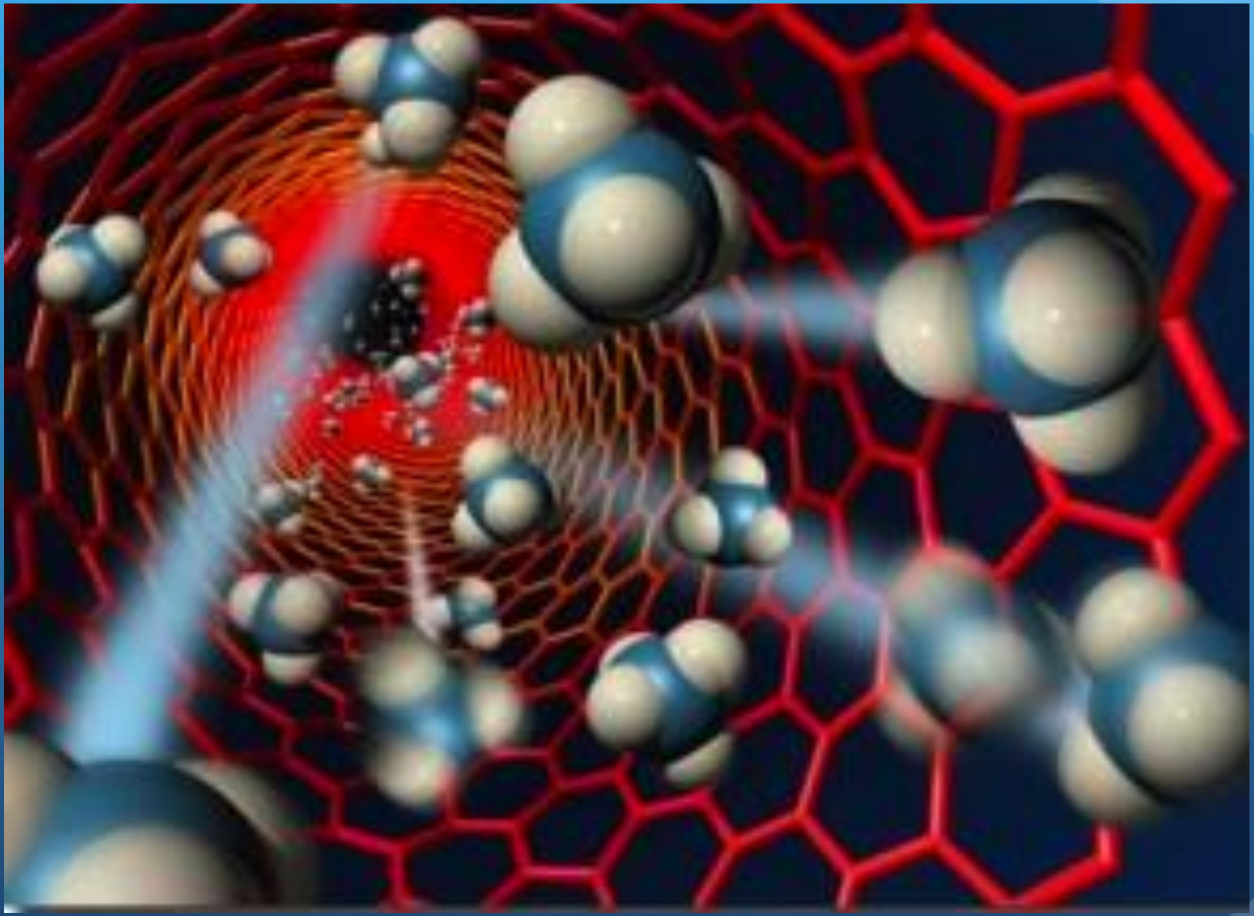
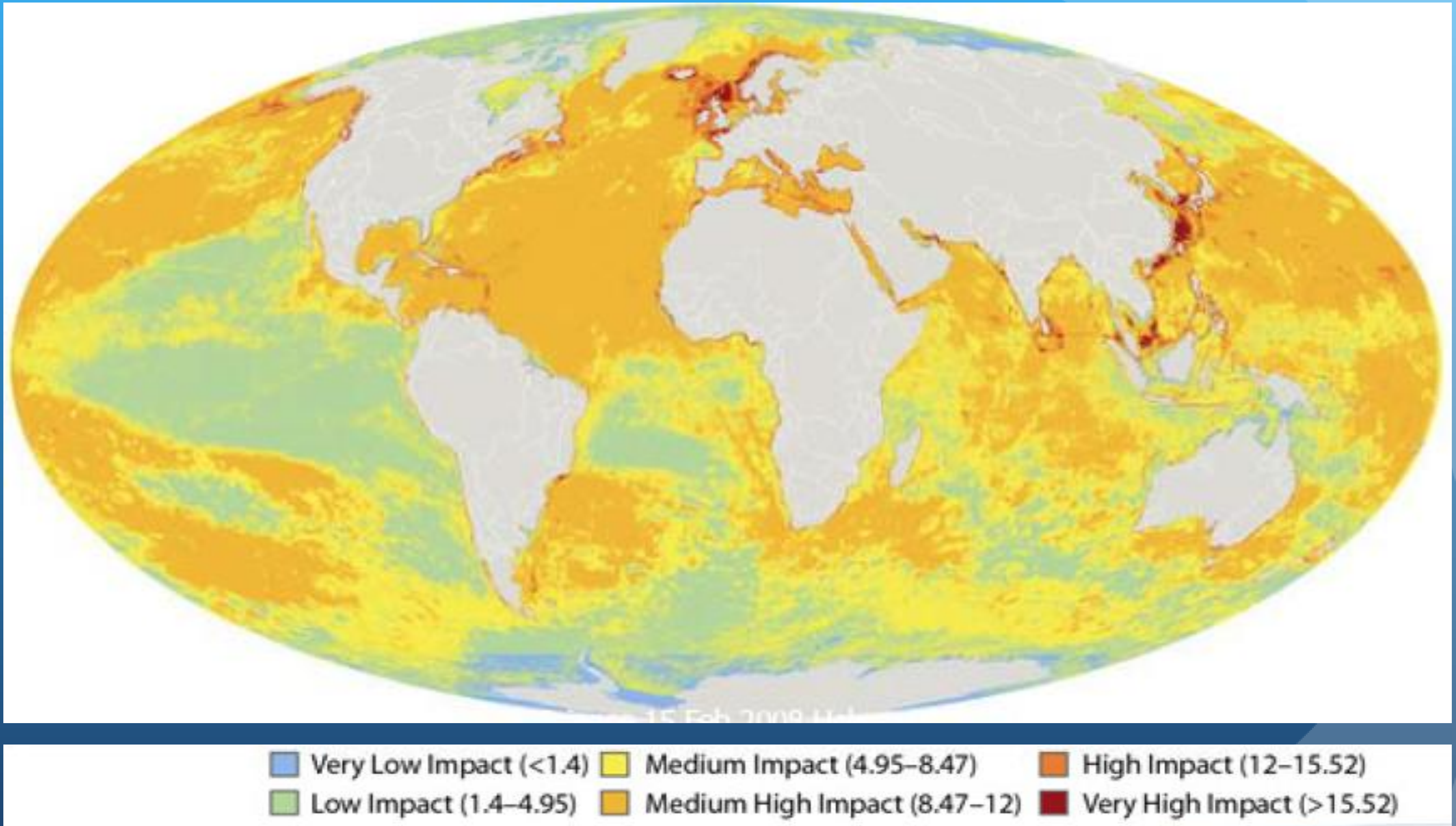
[#]Centre de Recherches sur les Macromolécules Végétales, Centre National de la Recherche Scientifique, Grenoble Cedex 9, France BP 53, 38041

Biotechnology and Nanotechnology

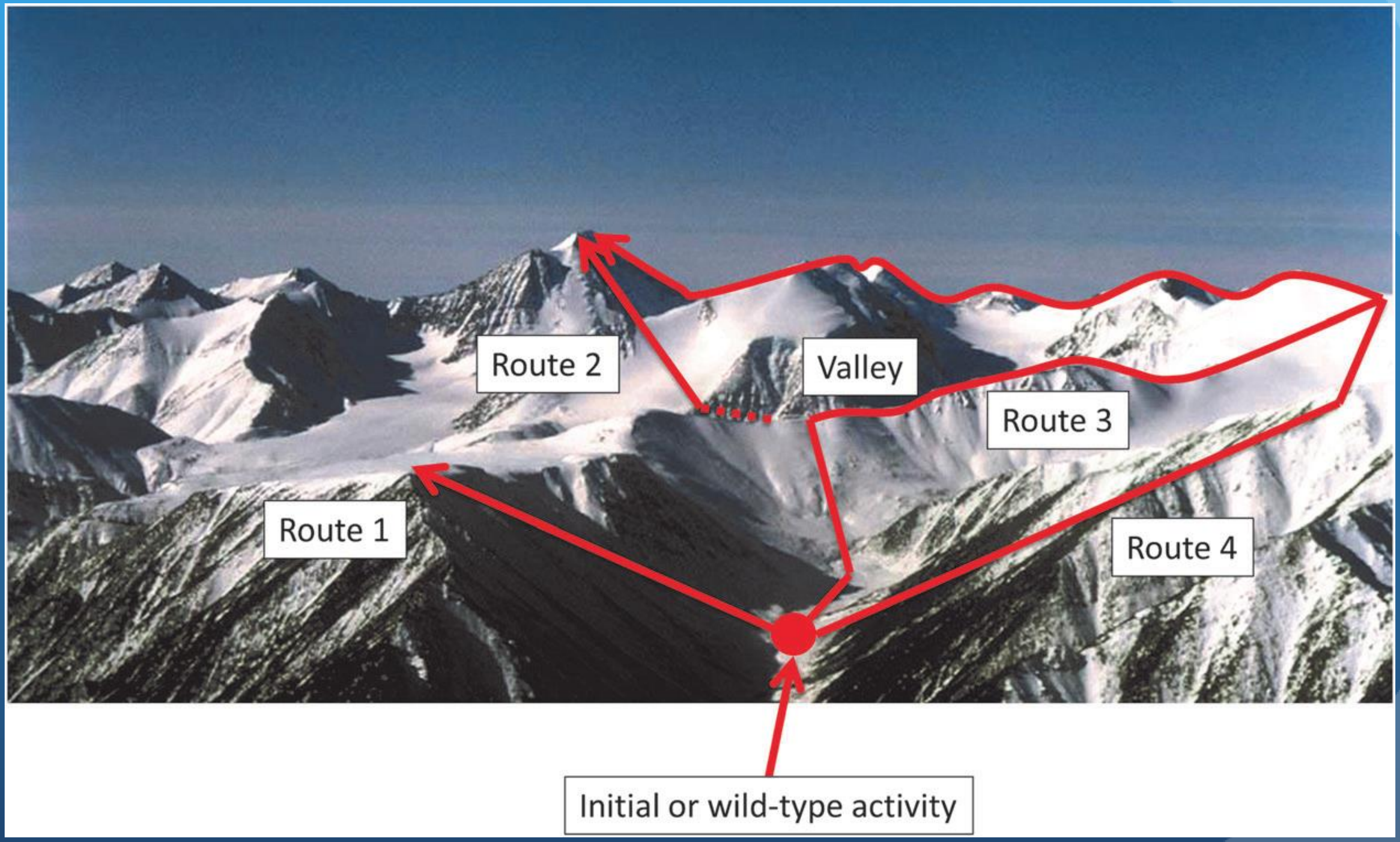


Marine environment is "the bioresource" for the future

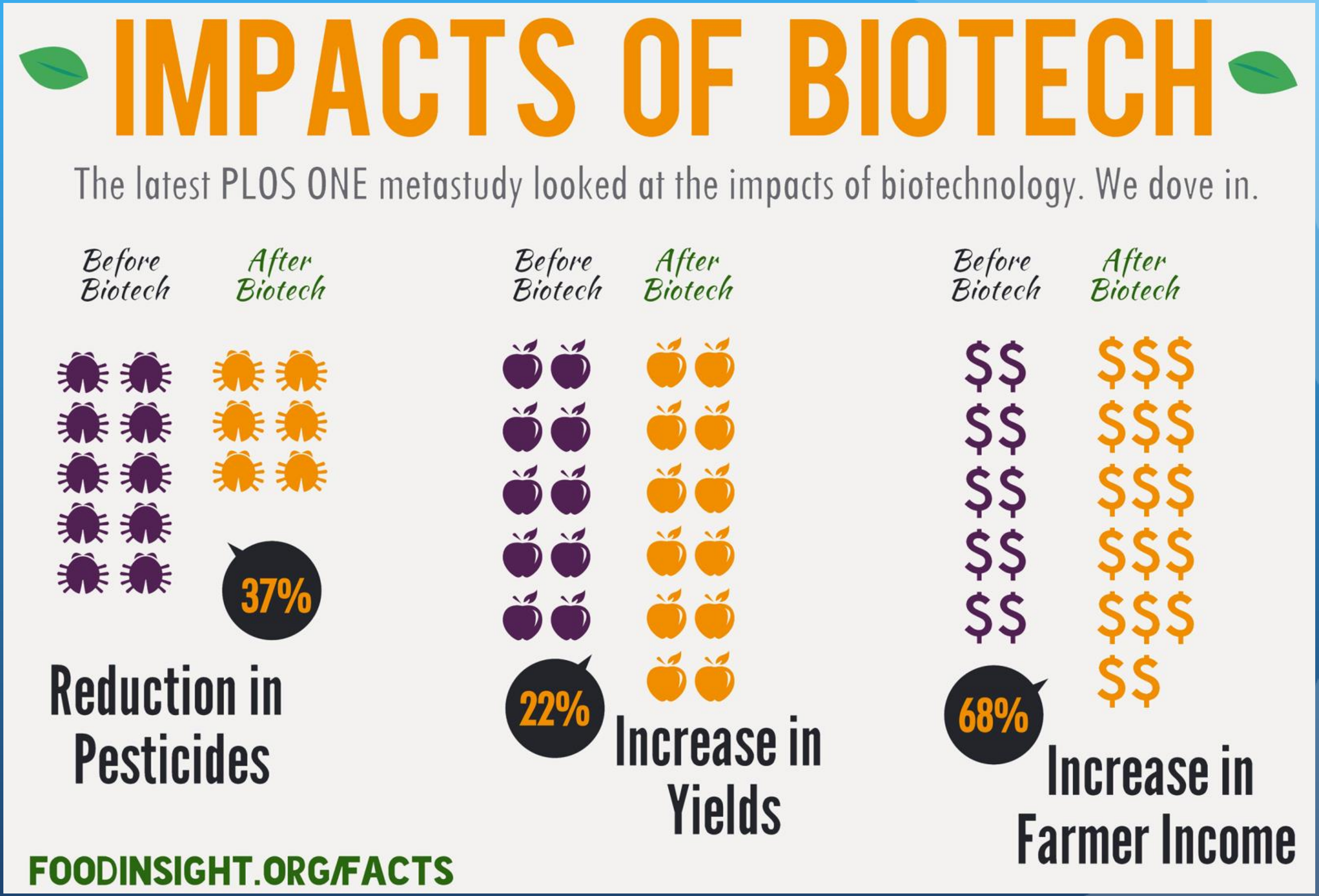


Research presented by Halpern et al in Science in Feb 2008

Synthetic biology: a "sport" similar to climbing



Biotech and Bioeconomy



Synthetic Biology and Bioeconomy

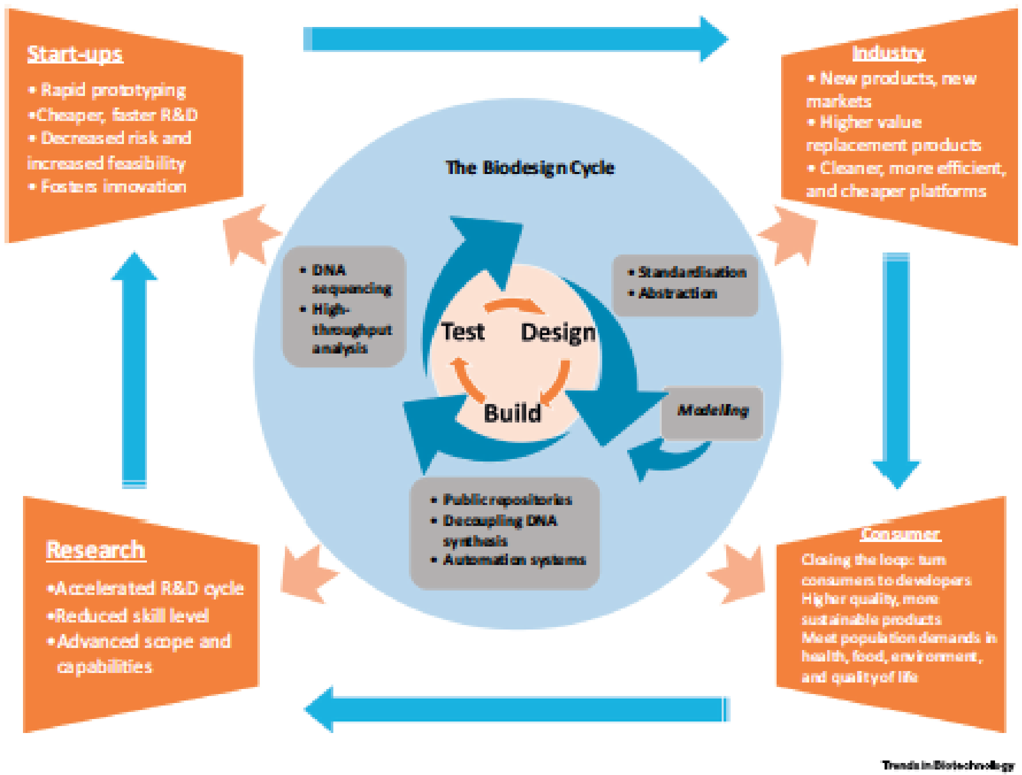


Figure 1. The Synthetic Biology Biodesign Cycle and Impacts on Stakeholder Groups in the Product Supply Chain.

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.

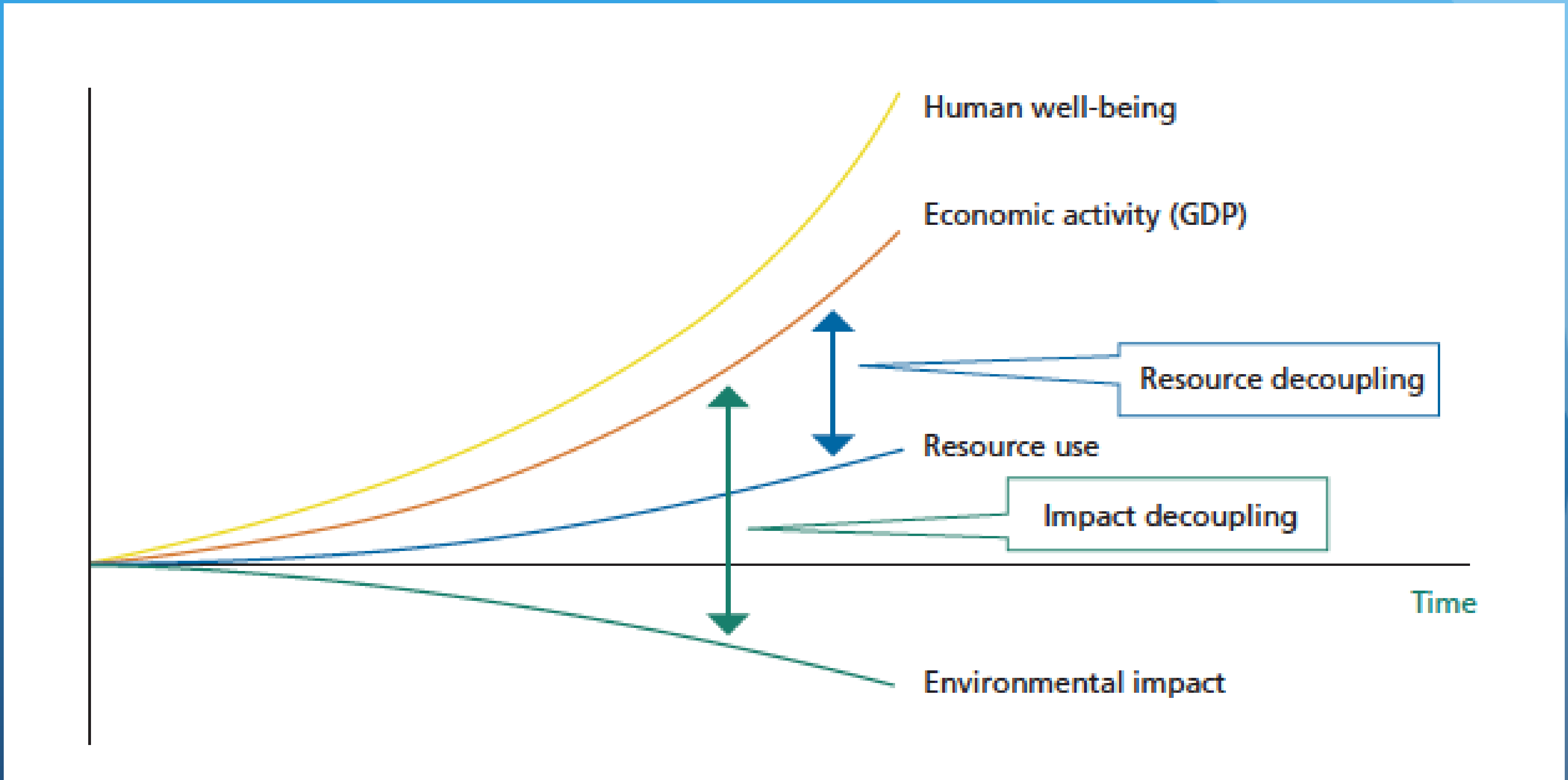
The take home message

We have to think simple to solve complicated problems.

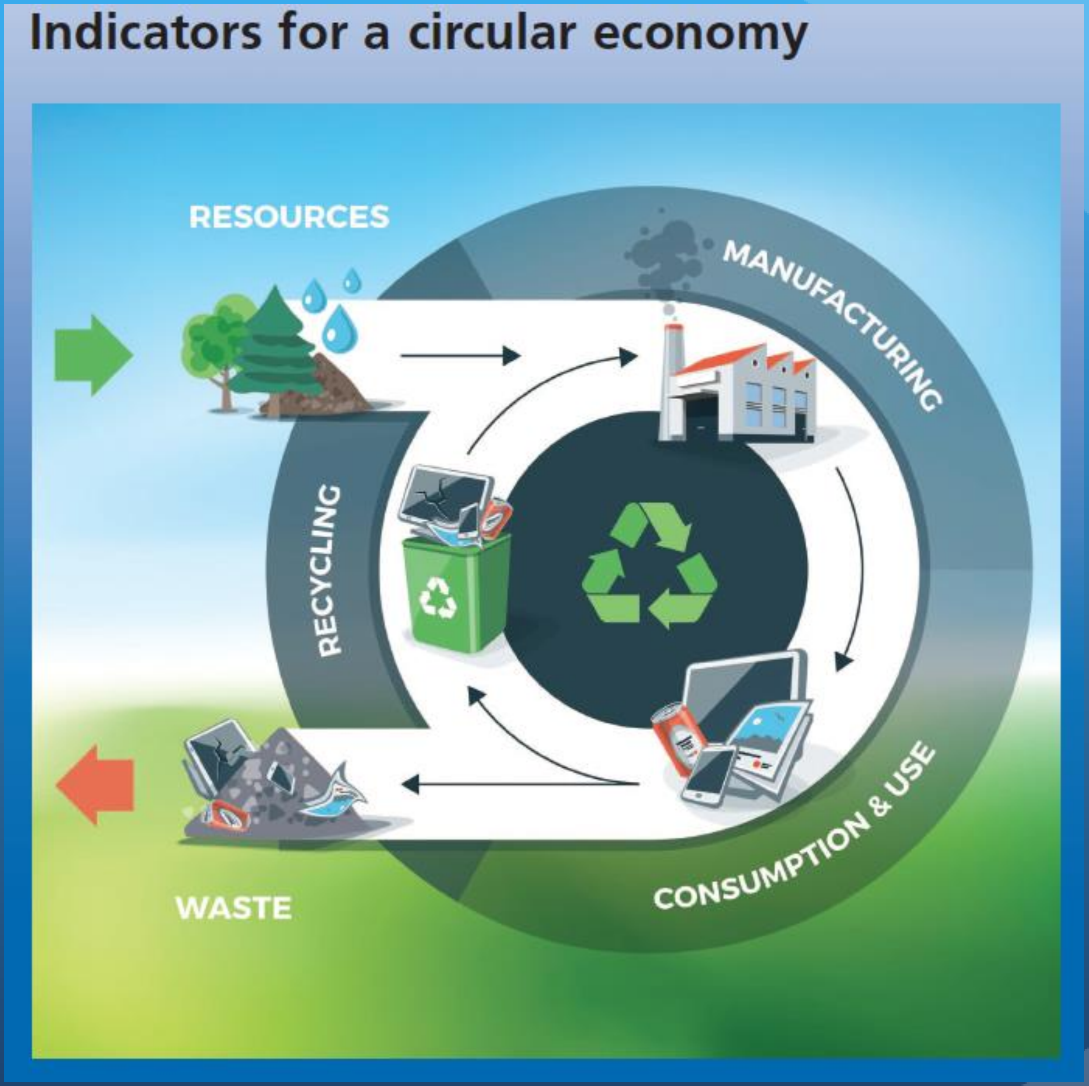
Nature has the time to play its own “Lego” and find wise and sustainable solutions.

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



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Perspectives for Greece
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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


zoover

1st International Conference on Bioeconomy Education

End of April 2018

Tolo, 150 Km from Athens

Thank you

Bioeconomy in every day life

Prof. Dr. C. E. Vorgias
National and Kapodistrian University of Athens, Greece and
General Director of Sustainability Science Center

Bioeconomy in every day life

Bioeconomy: What is it?

Whether for food, clothing or consumer goods, in the kitchen or in the garage, many everyday products contain components made from renewable raw materials or are produced using biobased procedures. The bioeconomy has thus made its way into everyone's lives, even though we're not usually aware of it.

According to experts, bioeconomy is **"… the knowledge-based production and use of renewable resources to make products, processes and services available for various economic sectors**."

Bioeconomy: What is it?

For this reason, the bioeconomy makes an important contribution by linking **economic growth** with **environmental sustainability**.
In view of depleting fossil-based resources, **climate change** and a growing world population, sustainable resource-efficient strategies are in demand to guarantee the well-being of modern societies.

Which is why the bioeconomy is of central importance in all economic sectors.

Modern tools used in the bioeconomy

The development of the bioeconomy is dependent on the use of modern technologies. In particular, great potential results through the **intelligent** combination of **bio** and engineering sciences.

There have been pioneering advances in recent years in the life sciences that have given the concept of the bioeconomy a major boost. These include insights into **biodiversity**, the molecular basis and the metabolism of organisms.

Together with innovations from chemistry, systems engineering, mechanical engineering and information technology, processes and applications have been developed that can be utilised industrially in many different ways.

Modern tools used in the bioeconomy

Due to the interplay between all these implements, existing production processes have been optimised and many innovative solutions have been established.

Today, companies can access biological mini-factories in the form of bacteria, fungi or cells as well as biobased processes with biogas or aquaculture farms and biorefineries to manufacture industrial products.

Resources of the bioeconomy

A key aspect of the bioeconomy is its **renewable** raw material base.

Biological resources – by that we mean living organisms such as plants, animals or microorganisms – grow, thrive and produce a wide variety of organic substances through their metabolism. This biomass can be used in many ways: as food or feed, as well as a material and energy supplier for the industry.

An important goal of the **bioeconomy** is to reduce the consumption of **fossil fuels** in the industry, such as coal, oil and natural gas. By doing this, harmful carbon dioxide emissions can be reduced

Resources of the bioeconomy

Microorganisms Waste material and the environmental impact of industrial processes increased.

The use of **renewable resources** is therefore a way to improve the **sustainability** of the economy.

The guiding principle of the bioeconomy is that of a **circular economy**. Ideally, there are closed systems where natural raw and waste materials are not only processed and converted, but are also utilised several times and converted even further.

This principle is implemented in **modern biorefineries**. Using different technologies, waste materials such as straw, grass or wood waste can be converted into a wide range of intermediate and end products – while fully utilising all biomass building blocks.

Bioeconomy in everyday life

Diversity: Dresses made from milk or coffee, car tyres from dandelion, sneaker soles from rice husks or armchairs that are tanned with extracts from olive leaves – sometimes you have to look twice to see the qualities of **biobased products**, and very often you don't even see which **biobased technology** is hidden inside.

Bioeconomy in everyday life

Economic impact: The 'organic' label is well-known in the food industry, bioplastics play an increasing role in the chemical industry and bioenergy is a hot topic in agriculture.

However, products made from **natural resources** or **biobased** procedures are available in many other areas too.

The **impact** of the **bioeconomy** is also evident in the cosmetics, textile or building industries.


Car tyre

Raw material

Because natural rubber is elastic even at low temperatures, car manufacturers use rubber to produce car tyres. Traditionally, latex from the **subtropical rubber** tree is used as the raw material. However, the tree plantations are increasingly threatened by a fungus, which causes the global market price to fluctuate. The **Russian dandelion** is an environmentally alternative. It thrives in Central Europe – even on soil unsuitable for farming.

Procedure

With the help of modern plant breeding techniques, researchers at the Fraunhofer Society in Germany have turned a wild plant into an useful plant, which is robust and high yielding.

Together with German tyre manufacturer Continental, a pilot plant for the production of **dandelion-based** rubber has been set up in Germany.

Here the **sap** from the **dandelion roots** is extracted. The first **winter tyres** have already been launched. Road tests are currently being carried out.

Engine cover

Raw material

Car engine components have to withstand extreme heat of over 200 °C. German car manufacturer Daimler employs **a percentage** of raw castor oil for the production of its Mercedes A-Class engine covers. The oil is extracted from the seeds of the castor oil plant ***Ricinus communis***, which belongs to the euphorbiaceae family. The plant is cultivated in barren soil in the tropics and its fruit is inedible.

Procedure

The Dutch chemical company DSM derives a building block called **sebacic acid** for synthesis from the **castor oil**. When it is combined with other conventional **petroleum-derived components**, an extremely high-performance biopolymer is produced. This technical polymer called **polyamide is 70% biobased**. Daimler then processes the granulated plastic to make engine covers. It is heat-stable and vibration proof.

Wall plugs

Raw material

Wall plugs are made from highly robust and resistant plastics such as nylon. German construction company Fischer relies on a polymer that is partly based on castor oil as a raw material. The oil is extracted from the seeds of the castor oil plant ***Ricinus communis***, which belongs to the spurge plant genus. The plant grows especially well in India, Brazil and China.
Its fruit is inedible.

Procedure

US chemical company Dupont extracts a chemical synthetic building block from castor oil called sebacic acid. The synthetic polymer polyamide is produced together with other petroleum-derived building blocks.
This polymer is 58% **biobased**. Waldachtal-based Fischer then processes the plastic granules into plugs. The biobased wall plugs may be slightly more expensive, however, they are as robust as traditional nylon plugs.

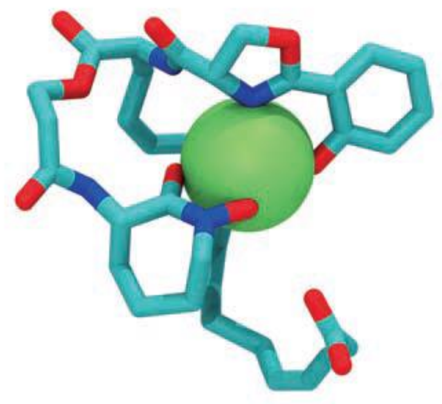
Fibreboard

Raw material

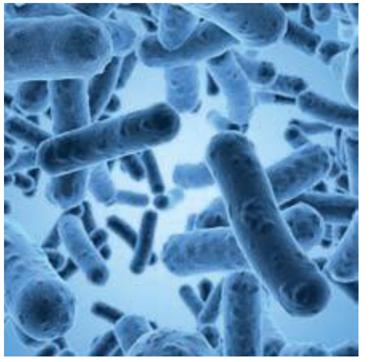
Agricultural by-products such as rice husks, corn stalks, coconut shells and coffee residues are often treated as waste, but they are a rich source of fibres. Taiwanese company Etouch Innovation combined the rice husks with a sort of biobased resin. Then this mixture can be processed into a fibre composite building material that has similar properties as conventional oilbased plastics. The material is **biodegradable** and their production does not compete with food production.

Procedure

The fibres derived from the agricultural byproducts are mixed with natural resins to create a bio-composite material. As the product of Taiwanese company Etouch Innovation comes in pellets it can be used with current plastic molding methods. The **biobased material** can also be combined with plastics made by petrochemistry. Such **biohybrid materials** are lightweight, sturdy, fire-resistant and have excellent insulation characteristics, making them an attractive green building material.



Rust remover



Raw material

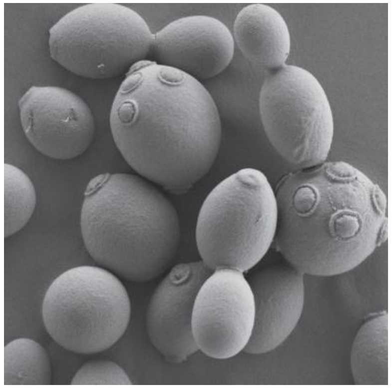
In nature, there is a mechanism to eliminate rust. Rust is nothing but atoms of iron, which have reacted with oxygen. And then there are some microorganisms such as bacteria that eat iron. In order to get to this important element, the bacteria produce **siderophores**. These protein molecules can trap iron atoms and incorporate them into their structure. Which is why **siderophores** are used as **biodegradable rust removers**.

Procedure

In order to use **siderophores** as biological dust removers, the German company ASA Spezialenzyme has developed a procedure that uses the bacteria of the species ***Streptomyces olivaceus***. The microbes are cultivated in closed bioreactors and release the iron-binding molecules in the fermentation medium. They are filtered out and manufactured into a usable product.

Instead of using concentrated inorganic acids, rust can be removed from iron parts in an environmentally friendly way.

Bioethanol



Raw material

Biofuels such as bioethanol are derived from renewable raw materials. Until now, sugars from arable crops have been used. To avoid competition with food production, residual materials such as straw have come to the attention of several biofuel manufacturers. This is because straw or wood is largely composed of lignocellulose fibres, which has a high potential for energy conversion.

Procedure

The Swiss chemical company Clariant has established a **biorefinery** demonstration plant, in which wheat straw bioethanol is produced. With the help of enzymes, the lignocellulose is decomposed and recovered from the plant fibre into its individual components. The resulting sugar molecules serve as food for yeast and the fungi ferment them into alcohol. This can then be added to premium petrol for petrol engines.

Bike

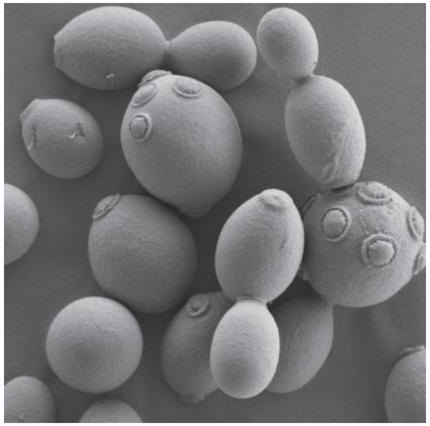
Raw material

Unlike materials such as aluminium, iron or carbon, wood is a renewable resource, for which you only need sunlight and CO_2 for photosynthesis. Meanwhile, engineered wood has caught up in terms of strength and processability. The German company **Lignotube Technologies uses** real wood veneer as the basis for lightweight tubes for bicycles.

Procedure

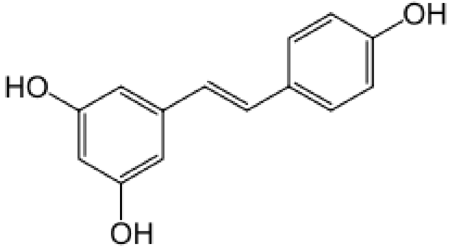
Inventors at Lignotube Technologies have developed a resource-saving procedure for lightweight hollow tubes called **Lignotubes**, which are made from a multilayer composite material of wood veneers. The thin-walled tubes are lightweight and robust and their production uses a minimal amount of real wood. The individual layers of veneer are crosswise glued. The first product is a designer bicycle built using a Lignotubes frame.

Chewing gum



Raw material

Many luxury foods contain healthy ingredients. Among them is the secondary plant compound **resveratrol**. This exists naturally in the skin of **red grapes** and the plant **Japanese knotweed.** The natural substance belongs to the chemical class of polyphenols. As antioxidants, they are considered to protect against cancer and cardiovascular diseases.



Procedure

The concentration and quality of the resveratrol from plant extracts varies greatly. Therefore, companies like the Swiss company Evolva rely on biotechnological procedures: they use yeast as microbial cell factories. When fed with sugar, the fungi produce resveratrol in large amounts by fermentation. The purified product is a white, odourless and tasteless powder. Danish company Fertin Pharma uses it as an ingredient in one of its chewing gum products.

Toothpaste

Raw material

Bacteria are one of the pathogens that cause caries by producing acids that damage tooth enamel. Now, there is a probiotic toothpaste that sends targeted lactic acid bacteria to fight the pathogens. The microbes are the natural enemies of caries. After cleaning, they accumulate in the mouth around the pathogens and clump together with them. These aggregates can then be easily removed.

Procedure

Whilst looking for effective weapons against caries, the German company Organobalance made a find in their own culture collection. Thousands of food organisms with interesting features are stored here. Before they can be used as an additive for toothpaste. German chemical company BASF cultivates the bacteria in huge bioreactors, which conform to the standards of the food industry. The toothpaste is already available to buy in Croatia from Neva Cosmetics.

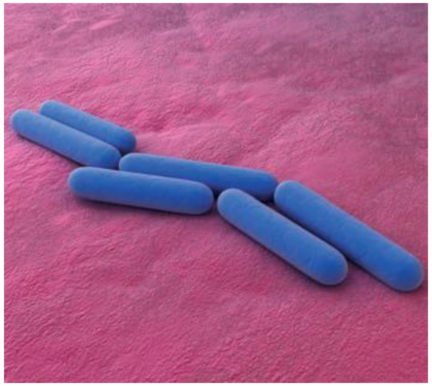
Toilet brush

Raw material

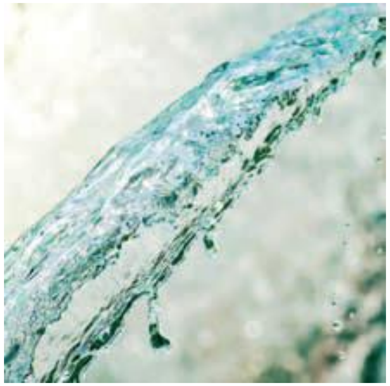
Plastics are for the most part, petroleum based. But there are now procedures that use the renewable raw material wood as a raw material source. A large proportion is made up from lignin. Lignin is a waste product during paper production and is usually burnt afterwards. But the German company Tecnaro uses it as a key component for biobased plastics, which can be used to produce a wide range of household products.

Procedure

Tecnaro produces a bio-composite material from a mix of biopolymers derived from renewable raw materials. The result is a granular material, which like plastic, can be processed in injection moulding machines, extruders or presses in many different ways. Furthermore, the products are completely biodegradable and compostable. They can, for example, be used for the production of toilet brushes.



Toilet paper

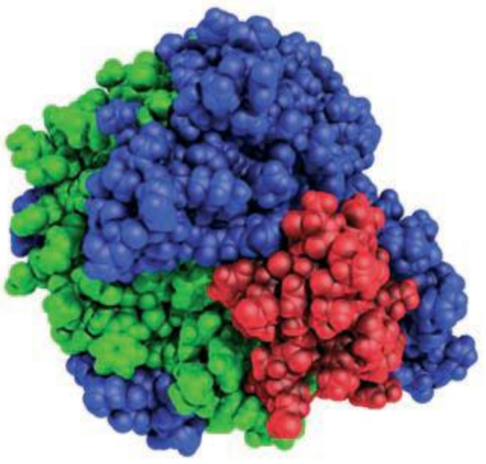


Raw material

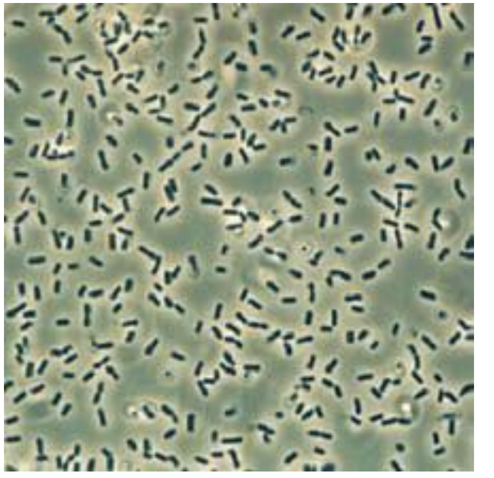
The cleaning power of natural bacteria that live on the skin can be used in domestic toilets: they can break down the most diverse organic matter. The Italian company Sofi del has launched a bioactive toilet paper that uses this technology. When it comes into contact with water, the spores germinate, multiply and clean the sewage pipes from its deposits.

Procedure

Sofi del's bioactive toilet paper is coated with the spores from the bacterial species *Bacillus subtilis*. The bacteria are sprayed onto the inner sides of adjacent layers of paper and only release their special cleaning effect in the sewage pipes when the toilet paper comes into contact with water. Because the pulp structures are loosened from the paper, the bioactive toilet paper protects the sewage system at the same time. Applied long term, less maintenance in septic tanks is necessary.



Detergents



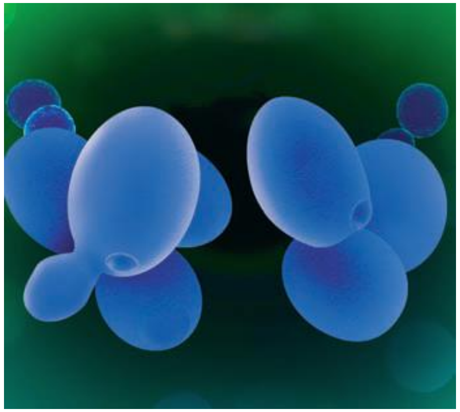
Raw material

Manufacturers of cleaning products such as detergents have been using the power of enzymes for many years. The biocatalysts accelerate biological processes and are active even at low temperatures. There are several classes of enzymes. Some remove dirt particles, while others work by preventing the fabrics from pilling. The use of enzymes means that less detergent and energy is required.

Procedure

Industrial enzymes for cleaning products and detergents have the biggest market share. A variety of biotech companies have developed special procedures to enable the production of vast quantities of these bioactive ingredients in steel bioreactors.

To do this, microbes such as yeast or bacteria are converted into industrial production organisms which are then used by companies such as German company Henkel or Italian Allegro Natura.



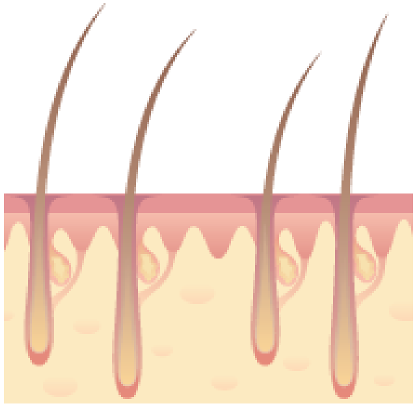
Face cream

Raw material

It's been known for decades that yeast extracts aid in wound healing. Researchers observed that, as a response to stress factors such as ultraviolet light, ozone or heat, yeast cells start to produce a set of protective molecules. Some of these natural agents have interesting skin firming properties, making them interesting candidates as components in face and body creams.

Procedure

Greek cosmetics firm Korres uses yeast cells as mini-factories. The microorganisms are cultivated using fermentation biotechnology. They are fed with a special diet of amino acids. When the yeast cells are irradiated with UV light or treated with ozone, they start to produce short biomolecules, known as hexapeptides. These agents can be isolated and used as bioactive ingredients in anti-aging creams or lotions.



Conditioner

Raw material

Growing and regenerating hair depends on the activity of stem cells, which reside close to the hair follicles in the skin. Hair follicles can be viewed as mini-organs, embedded in a microenvironment. When they are not working properly, loss of hair density can be a consequence. Researchers at the French cosmetics company L'Oréal have discovered a bioactive molecule that impacts the regenerative potential of the stem cells.

Procedure

The researchers have identified a molecule called **stemoxydine**. When applied to the scalp, it apparantly mimics hypoxia in the hair follicle microenvironment. According to L'Oréal, this stimulates stem cell activity and revitalises the hair. The compound has clinically proven its capacity to increase hair density (number of visible hairs) in three months time.

Trainers

Raw material

The waste which accumulates during food is usually thrown away. This is also true for rice husks. German sportswear manufacturer Puma uses this waste material for its eco-friendly trainers “Re-suede”. The rice husks replace a portion of the rubber content used for the outsoles. Therefore less petroleum-based rubber is used. This reduces energy consumption and increases the environmental balance.

Procedure

The remake of Puma’s classic trainer “Suede” was designed as an eco-product based mainly on recycling. Compared to conventional products, it reduces CO2 emissions by 80%. But it’s not just the outsole that’s made from waste materials. The synthetic Ultrasuede upper material is also comprised of recycled polyester fibres. And what’s more – the shoe comes in sustainable packaging – Puma’s “Clever Little Bag”.

Tennis racket

Raw material

Tennis players choose rackets that enable them to maximise their performance and lower the risk of muscular injury. Together with French Lineo sporting goods retailer Decathlon has developed a racket made from a plant-based material: flax fibres. Flax plants are also the source for linen used in the textile industry. The flax fibres in the tennis rackets are an important structural component of a hybrid material.

Procedure

The flax and a resin are combined to create a biobased composite material. The flax fibres are incorporated into the frame as drape-formed plies of flax/epoxy and carbon/epoxy prepregs. Thanks to the vibration-damping properties of flax fibre, a flax content of 8% to 25% gives effective results that reduce the risk of tennis elbow.

T-Shirt

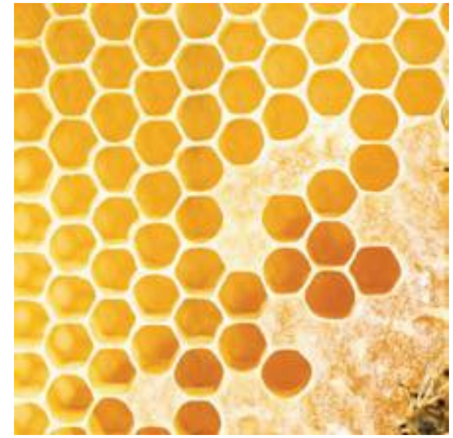
Raw material

At best, aft er brewing a cup of coffee the average consumer will dispose of the coffee grounds in the compost bin. However, there's more to coffee grounds than meets the eye. They absorb unpleasant odours, dry quickly and protect from UV light. Which makes it an ideal resource in the development of sustainable textiles for professional and recreational athletes. Taiwanese company Singtex has been using coffee grounds from Starbucks for their clothing range "S.Café" since 2006.

Procedure

From espresso to functional clothing: the Taiwanese company Singtex is a pioneer in using coffee grounds for the production of sustainable textile fibres. The biggest challenge in the production of its "S.Café" clothing range was the neutralisation of the coffee aroma. First, the coffee grounds are crushed into microscopic pieces and then mixed with polyester fibres. Hugo Boss, Nike and Vaude use these fibres to make sport and leisurewear.

Clothing

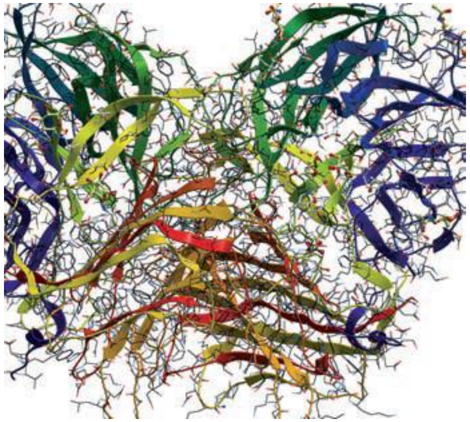


Raw material

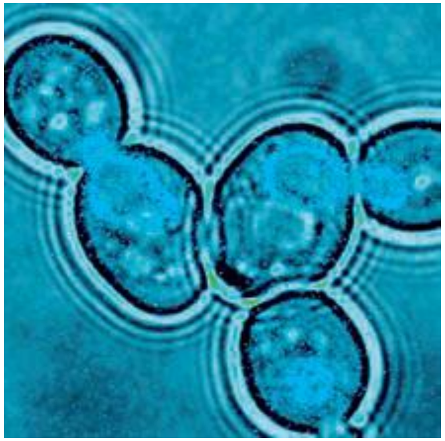
Milk is a popular food product, but not all milk proteins are actually used. Every year, millions of tonnes of milk are accrued, which cannot be used for consumption. And this is where the technology of German company Qmilch and Swiss textile fi rm Calida comes in. They use the milk protein Casein for the production of textile fi bres and clothing such as dresses or underwear. These are silky to the touch, naturally antibacterial and can be easily dyed.

Procedure

It has long been known that casein can be spun into fibres. However, not only a lot of water, but also a lot of chemicals are required for this: now beeswax and zinc have been added. The production of the organic fibre is carried out to meet the Global Organic Textile (GOT) standard: compared to the conventional wet spinning process, significantly fewer resources are consumed.



School uniform



Raw material

Kids can be rough on their clothes, especially when they wear the same school uniform day in and day out. British retailer Marks & Spencer in a collaboration with Danish biotech specialist Novozymes have developed schoolwear that is produced with a special enzyme technology that keeps the kids' uniforms looking like new longer. At the same time, the production process is more sustainable.

Procedure

The enzymes are produced by industrial microorganisms. As the enzymes are added during the textile bleaching and dying process, the whole industrial process saves water and reduces energy. The enzymes work as biocatalysators and help the fibres strengthen from the inside out, helping to eliminate fibre ends that can stick out from the surface. This keeps the surface smooth, reduces pilling and ensures consistent bright colours.

Side table

Raw material

Stones made of the mineral granite are known for properties such as durability and extreme hardness. Artists and architects have dreamed of being able to mould this material just like ceramic. On the basis of pure granite which is mined in quarries and crushed in a mineral mill, Denk Keramik – a manufacturer of ceramic products – has developed a innovative material called Granicium.

Procedure

The granite is crushed and ground into grain fractions of different size. Water and a mix of microorganisms is then added. The yeast and lactic acid bacteria serve as binding agents. The moist material can be formed like a ceramic clay. As the material is very sensitive, it must be shaped with a lot of technical skill. After firing, it is crystalline grey in colour and hard as granite.

Carpet

Raw material

Carpets have to be durable, easy to clean and as soft as possible. This is achieved using special synthetic fibres. Nowadays, they are partly **biobased**. The chemical company Dupont, for example, uses corn starch as a plant-based raw material. The starch is converted into sugar by enzymes and subsequently serves as a source of food for special microbes that turn it into bio-based polymer building blocks for high-tech fibres.

Procedure

The production of biobased high-tech fibres for carpets is carried out using the bacterial species Escherichia coli. These were purposefully reprogrammed into biological mini-factories that produce the basic platform chemical 1,3-propanediol (Bio-PDO). This synthetic building block is linked to the petrochemical-derived monomer TPA and turned into a plastic. Using this plastic, the US firms Dupont and Mohawk produce a carpet that is 37% bio-based.

Armchair

Procedure

Tones of olive leaves fall every year at harvest time in the Mediterranean, and until now, most of it was burned as green waste. Two German companies Wet-green and N-Zyme Biotec have developed a process that extracts the tannins from the olive leaves in an aqueous solution. This cuts out toxic acids and salts during the procedure. The tanning agent has IMO approval, which permits the production of premium leather according to the IVN Natural Leather Standard.

Raw material

Tanning agents based on heavy metal salts such as chromium (III) sulphate are usually used in the industrial production of leather. Olive leaves are a natural and environmentally friendly alternative. They contain secondary compounds which the plants use as a pest defense. This forms the basis for a biodegradable tanning agent. It not only protects the environment but also makes the leather extremely skin friendly.

Plastic bags Sector

Raw material

Packaging materials can be made from bioplastics, which are both biodegradable and compostable. Italian companies Novamont and Ibiplast use vegetable oil derived from thistles as raw material for the production of such polymers. Cellulose, maize starch and their combinations are also included during the manufacturing of this sustainable polymer.

Procedure

The starch blend material is traded by Novamont under the name Mater-Bi. This bioplastic is suitable for processing by all common conversion technologies. It is biodegradable and compostable and therefore can be used to make cling film and plastic bags that can be utilised in organic waste management. The bioplastic is in accordance with the main European and international standards.

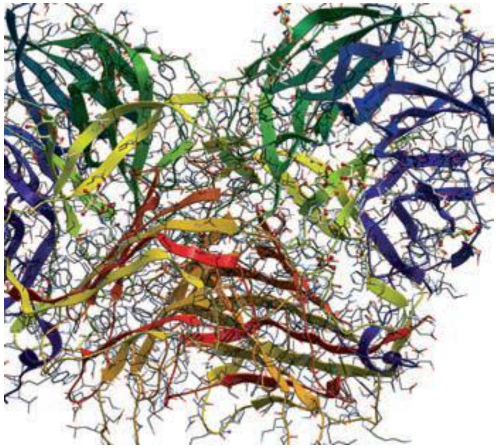
Dishes

Raw material

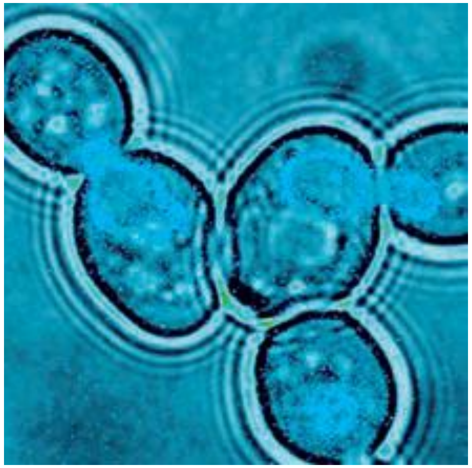
Fast-growing plants such as bamboo are easily cultivated and are therefore increasingly used by tableware manufacturers as a renewable resource. Companies like German Magu or Dutch company Capventure, offer, for example, bamboo tableware, consisting of up to 60% shredded bamboo fibres. The plants come from plantations which are regularly cut and replanted.

Procedure

So that colorful cups, plates and bowls can be made from renewable raw materials, the bamboo fibres are first ground and mixed with dyes and other raw materials, such as corn. For durability, a synthetic resin is often added to the bamboo, which makes the products food safe, odor and taste neutral, durable, dishwasher safe and can be cleaned hygienically. Some companies use natural resin as a binding agent.



Baked goods



Raw material

The baking industry relies on enzymes as indispensible additives in bread and rolls. The biocatalysts accelerate the natural processes and can therefore affect the volume as well as the uniform density of the dough. The variety of enzymes used in baking is large. Some intensify the colour of baked goods, while others ensure a crusty bread crust or a longer shelf life.

Procedure

Many baking enzymes such as amylase or lipase are naturally present in wheat. In order to make them available for the industry in large quantities, the biomolecules are specifically produced by certain production organisms. These organisms are usually bacteria or fungi which were once discovered in nature. Companies such as Danish Novozymes have optimised this further so that the mini-factories can produce the desired enzymes in the largest quantities possible.

Coffee cup

Raw material

Transform old coffee into new products: that is the idea behind the products of German company Kafform. They manufacture coffee cups and saucers that consist of used coffee grounds. Up to 40% of the product is made from recycled coffee grounds. Each cup is made of 60 grms of coffee grounds, which is equivalent to eight espressi.

Procedure

The recycled material called Kaffeeform consist not only of coffee grounds, but also of plant fibres, cellulose and a resin made of biopolymers. For the manufacturing process, the company uses an injection moulding procedure. The resulting products are stable, washable and can thus be easily reused.

Coffee capsules

Raw material

Coffee capsules have become extremely popular among coffee drinkers that love to brew high quality coffee in single serve systems at home. However, the pods produce large amounts of plastics and aluminium waste on a daily basis. Coffee producers such as Swiss Ethical Coffee Company and Italian Lavazza have developed capsules that are based on vegetable- based on corn starch and plant fibres.

Procedure

The capsules are manufactured on the basis of plant fibres, vegetable oil derived from thistles and maize starch, resulting in a bioplastic. There are no metallic properties or substrates in the capsules. The product is biodegradable and compostable. The capsule complies with the European EN13432 standard, currently the strictest available in terms of biodegradability for industrial compost. The biobased capsules are compatible with a range of espresso machines.

Ice cream

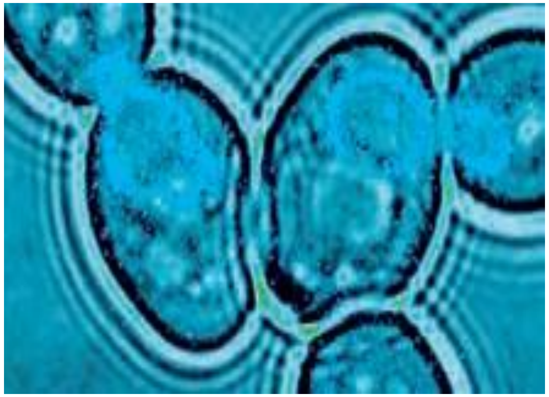
Raw material

Lupines are green multi-talents. As nitrogen fixers they are great fertilizers for German soil. In addition, their seeds are rich in protein, which is why they have come to the attention of food manufacturers as an alternative source of protein. Lupine seeds are usually very bitter tasting due to the high content of alkaloids, which is why blue sweet lupines came into play. In contrast to other types of lupine, they have a low content of bitter-tasting alkaloids.

Procedure

The Fraunhofer spin-off Prolupin tinkered for a long time before the first product – an ice cream – was introduced to retail groups such as German REWE. First, the lupine seeds are peeled and processed into paper-thin flakes. The flakes are then de-oiled and unwanted aromas are extracted. Only then do the experts isolate the proteins. The dairy-free product contains neither lactose nor gluten and is suitable for allergy sufferers. In Austria, it is available under the trademark Vegavita.

Washing-up liquid



Raw material

The active chemical components in washing-up liquids and household cleaners are called **surfactants** and **tensides**. Conventionally, they are produced on the basis of oil chemistry. Belgian company Ecover which is known for its ecologically sound cleaning products uses several natural resources as a basis for their tensides. Among others, these are plant-based ingredients such as **rapeseed oil**.

Procedure

The company has developed a biobased manufacturing process, in which the yeast ***Candida bombicula*** plays a key role as mini-factory. The fungus was once isolated from bumblebees. In combination with glucose, it produces the desired biosurfactant product from the sustainable raw materials.

Plastic bottles

Raw material

Biobased plastics are based on renewable raw materials that can be used for different plastic products. Most drinking bottles are made out of the plastic PET (polyethylene terephthalate). This polymer is produced using two different chemical building blocks, one of which is monoethylene glycol (MEG). MEG can now partially be made from ethanol that comes from sugar cane.

Procedure

Microbes such as yeast feed on cane sugar, fermenting it into the alcohol MEG. When mixed with other chemical building blocks, the plastic BIO-PeT is produced, which is 30% **biobased**. Several consumer goods manufacturers, including US-company Coca-Cola, have joined forces to increase the amount of BIO-PET in their plastic bottles. Although the bottles are not biodegradable, they can be channeled into the recycling system.

Beer (gluten-free)

Raw material

For many gluten-intolerant people, beer is off the list of consumable products. The main raw material in beer production – malted barley – contains the gluten protein. Gluten can trigger inflammation of the intestinal mucus in people with gluten
intolerance. To prevent this, German beer brewer Lammsbräu adds special enzymes called transglutaminases to the beer after the brewing process.

Procedure

The production of beer is an old biobased process. Today, brewing takes place in huge fermenters made of steel. The starch in malted barley is converted into sugar by enzymes. This solution is fermented with hops and yeast. For the production of its gluten-free beer, Lammsbräu adds enzymes called transglutaminases after the brewing process. The enzymes, products of German N-Zyme Biotec, change the structure of the gluten so that the mix of proteins can be removed more easily.

Bioeconomy in every day life is not a dream is a fact.

Thank you